BURNS McDONNELL

Central Landfill Development Plan

Matanuska-Susitna Borough, Alaska

Landfill Development Plan
Project No. 120344

Final Report
8/28/2020

Central Landfill Development Plan

prepared for

Matanuska-Susitna Borough, Alaska
Landfill Development Plan
Palmer, Alaska

Project No. 120344

Final Report
8/28/2020

prepared by

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EXECUTIVE SUMMARY

Burns & McDonnell developed the Central Landfill Development Plan (Plan) for the Matanuska-Susitna Borough (MSB or Borough) to provide an evaluation and update of the current landfill development plan and any recommended changes, incorporating conceptual design of leachate and landfill gas (LFG) management systems, and the feasibility of select leachate treatment and LFG reuse options. The Plan provides a summary of the data, assumptions, and approaches that were used in the conceptual layout and cell sequencing for the Central Landfill (CLF).

ES.1 Landfill Development Plan Update

There are three major development phases in the conceptual cell layout for the Plan. Each phase includes multiple individual landfill cells. Phase 1 includes the developed landfill area (Cells 2A, 2B, 3, and 4) and future Cell 5. Phases 2 and 3 are divided into corridors, which may contain two or three landfill cells each, depending on operational preferences as phasing progresses (e.g., cell life). Phase 2 is located south of Phase 1 and includes seven corridors. Phase 3 is located east of Phases 1 and 2 and includes eight corridors. This corridor orientation throughout the Landfill development takes advantage of piggybacking airspace over existing waste.

The base grades of the Landfill were developed so that bottom grades provided a minimum 10-foot separation from the historic high groundwater table, in accordance with Alaska Administrative Code (AAC) regulations and provide a minimum one-percent slope for leachate collection trenches. Leachate from Phase 1 will drain to a sump located at the southwest corner of Cell 5. Leachate from existing Cells 2B, 3, and 4 will also be rerouted to drain into Cell 5 when constructed. Cell 5 design has been modified from previous plans to maximize the Phase 1 disposal volume.

To maximize disposal volume, the final grading plan for Phases 1 through 3 was developed with a main ridge running generally north-south from the northern boundary of Phase 1 and Phase 3 down to the southern boundary of Phase 2. The elevation of this ridge is 348.5 ft above mean sea level , which is the maximum elevation permitted by the Alaska Department of Environmental Conservation (ADEC) permit, adjusted to North American Vertical Datum (NAVD) 88 datum. Final cover crown grades slope down from either side of these ridges at four percent with side slopes at 3:1. ADEC has requested that a stability analysis be completed with the future closure of each individual cell to confirm that 3:1 final cover slopes are stable.

The sequencing of corridors allows for eliminating the need for rerouting leachate collection as future cells are developed and an optimization of landfill airspace and tie-ins while allowing the Crevasse

Moraine Trail System to remain open for as long as possible. The current trail system should not be impacted for at least the next 40 years.

Based on the base grades and final cover surfaces developed herein, waste disposal projections, and the 2019 top of waste surface provided by MSB:

- Remaining Phase 1 capacity for waste and daily/intermediate cover soil is 2.6 million cubic yards with an estimated life of over 20 years.
- Phase 2 capacity for waste and daily/intermediate cover soil is 23.1 million cubic yards.
- Phase 3 capacity for waste and daily/intermediate cover soil is 24.0 million cubic yards.
- Overall MSW Landfill disposal capacity is approximately 51.5 million cubic yards.
- The estimated remaining life of the Landfill is approximately 130 years.

ES.2 Leachate Management Plan

Phases 1 and 2 are designed with base grades that "stair-step" downward to the south, mirroring the slope of the groundwater table while maintaining a minimum 10-foot separation. Cell 5 and each corridor within Phase 2 will be sloped to direct leachate to the west, with sump discharge into a forcemain which directs leachate to the storage lagoons or future treatment option.

This Plan evaluated three options to treat and dispose of collected leachate. Costs based on a 20-year planning period are provided for each option below:

- Continued hauling to, and disposal at, the Anchorage Water and Wastewater Utility.
  - NPV $7.3 million; $0.095 per gallon
- Evaporation using either LFG or natural gas, with residual disposal in the Landfill.
  - NPV $6.1 million; $0.080 per gallon using LFG
- Membrane filtration with residual disposal in the Landfill.
  - NPV $9.0 million; $0.117 per gallon

Note that the cost of evaporation becomes prohibitive if operation is fueled with natural gas (NPV of $15.6 million, with per gallon cost of $0.204). The construction cost estimate for membrane filtration includes $773,425 of Engineering costs for work completed to-date, representing sunk costs already expended by MSB for this option. Whichever leachate management method MSB selects, leachate recirculation should be incorporated into Landfill operation.

ES.3 Landfill Gas Management Plan

During 2020, gas monitoring results have led to the MSB initiating an active system to control migration at the northern property boundary. Later in 2020, construction will include installation of vertical extraction wells in Cells 1 and 2A, condensate management systems, and an enclosed blower/flare skid to combust the collected landfill gas (LFG). The gas collection and control system (GCCS) is designed for year-round operation. The Plan provides the phased development of the LFG collection field as landfill cells close. Each closure (next projection is Cells 2B and 3 in 2023) would include installation of additional extraction wells that would direct LFG to the collection system and flare. Construction of Cell 5 will trigger Federal air permitting compliance requirements in accordance with 40 CFR 60, Subpart XXX.

Active collection of the projected gas volumes provides an opportunity to beneficially reuse the energy in the LFG. This Plan evaluated four such opportunities. Costs based on a 20-year planning period are provided for each option below along with the projected simple payback:

- LFG to electrical generation with energy sale to Matanuska Electric Association (MEA).
    - NPV $5 million; 9.7 years
- Use of waste heat from electrical generation for leachate evaporation.
    - NPV $2.9 million; 13.3 years
- LFG Pipeline to Mat-Su Regional Medical Center for combined heat and power.
    - NPV $6.4 million; 10.8 years
- LFG Pipeline to Mat-Su Regional Medical Center for direct heating.
    - NPV $1.9 million; 11.9 years

Burns & McDonnell recommends that MSB begin discussion with MEA on developing the electric generation concept.

ES.4 C&D Development Plan

The disposal airspace between the 2019 existing C&D base grade and the proposed C&D final intermediate contours is 2.8 cubic yards. The remaining life of the C&D Landfill as developed in this Plan, and as currently operated, is about 42 years or until 2062. If MSB purchases a compactor to improve disposal density, the remaining life of the C&D Landfill as developed in this Plan could increase by almost 40 percent.

ES.5 Asbestos Site Development Plan

The disposal airspace between the existing grade and the proposed asbestos final contours is about 520,000 cubic yards, excluding final cover. Using the life projection assumptions outlined in the report, the remaining life of the Asbestos Cell as developed is approximately 57 years, or until 2077.

ES.6 Financial Assurance Plan

The Matanuska-Susitna Borough has a long-term plan for its Landfill that includes three phases as described herein. Based on current tonnage levels and an estimated two percent tonnage growth, Phase 1 is expected to reach capacity in FY 2043. Therefore, the focus of the financial assurance liability is Phase 1, with total liability at the end of FY 2019 calculated at $5,073,571 (capacity consumed multiplied by total financial liability). The Borough recognized a financial liability of $5,463,707 at the end of FY 2018. Therefore, the decrease in liability for FY 2019 is $390,136.

ES.7 Soil Balance Plan

The volume balance computations for the entire site development (i.e., Municipal Solid Waste Landfill, C&D Landfill, and the Asbestos Cell) take into account quantities of onsite soil requirements for cell construction, daily and intermediate cover, and final cover. The soil balance model results in a net gravel surplus of over 2.4 million cubic yards. Note that if the waste to soil cover ratio is increased to 5:1 for the MSW Landfill, the gravel surplus increases to 4.1 million cubic yards. This volume could be removed for offsite use and sale for revenue.

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LIST OF ABBREVIATIONS

Abbreviation	**Term/Phrase/Name**
AAC	Alaska Administrative Code
ADC	alternate daily cover
ADEC	Alaska Department of Environmental Conservation
AUF	airspace utilization factor
AWWU	Anchorage Water and Wastewater Utility
BMPs	best management practices
BOD_5	Biochemical oxygen demand
Borough	Matanuska-Susitna Borough
Btu	British thermal units
Burns & McDonnell	Burns & McDonnell Engineering Company, Inc.
C&D	construction and demolition
CHP	combined heat and power
Clark	Clark Technology, LLC
CLF, Landfill	Central Landfill
CNG	Compressed natural gas
CS	condensate sump
GCCS	gas collection and control system
GCL	geosynthetic clay liner
GCO	gas cleanout
gpd	gallons per day
GPS	Global positioning system
GL	gas lateral
HDPE	high density polyethylene
HHW	household hazardous waste
HELP	Hydrologic Evaluation of Landfill Performance
LDP, Plan	Central Landfill Development Plan

Abbreviation	**Term/Phrase/Name**
LEL	lower explosive limit
LFG	landfill gas
LLDPE	linear low-density polyethylene liner
MSB, Mat-Su	Matanuska-Susitna Borough
MSL	mean sea level
MSW	municipal solid waste
NAVD	North American Vertical Datum
NMOC	nonmethane organic compounds
NPV	Net Present Value
NSPS	New Source Performance Standards
O&M	operations and maintenance
pcy	pounds per cubic yard
PFAS	per- and polyfluoroalkyl substances
RD&D	Research, Development & Demonstration
ROI	radius of influence
scf	standard cubic feet
scfm	standard cubic feet per minute
SDR	standard dimension ratio
SVOCs	semi volatile organic compounds
US EPA	United States Environmental Protection Agency
VCRS	Valley Community for Recycling Solutions
VOCs	volatile organic compounds
WASB	Borough Wastewater and Septage Board

1.0 INTRODUCTION

The Central Landfill (CLF or Landfill), owned by the Matanuska-Susitna Borough (MSB or Borough) and operated by the Solid Waste Division under the Public Works Department, is located three miles west of Palmer, Alaska, at 1201 North 49th State Street. The total Landfill facility is approximately 620 acres and is bordered by a residential subdivision to the north; commercial-residential development to the west, northeast, and east; and undeveloped land to the south. CLF has operated since 1980 and receives approximately 150 to 220 tons of waste daily, comprised of municipal solid waste (MSW), construction and demolition debris (C&D), and asbestos. The Landfill currently governed by Alaska Department of Environmental Conservation (ADEC) Solid Waste Permit SW1A007-20, expiring December 4, 2020.

The developed MSW Landfill is comprised of Cells 1, 2A, 2B, 3, and 4 (accounting for 54.56 acres of the site). Current disposal is in Cell 3; Cell 4 was constructed in 2018. Cells 2B, 3 and 4 are lined with leachate collection. Operations at the Landfill also include a C&D waste landfill, an asbestos cell, a household hazardous waste processing facility, a recycling center, a composting classroom, and a maintenance shop for operations. MSB operates a system of five Transfer Stations and eight Transfer Sites that serve the Landfill. The estimated remaining life of the Landfill is approximately 130 years. The southern and eastern portion of the Landfill site also includes the Crevasse Moraine Trail System, a temporary set of recreation trails. Under an agreement between the Borough's Solid Waste and Land Management Divisions, these trails will be operated until the land is required for landfill expansion as authorized by Borough Resolutions 85-035 and 89-183. Trail use is coordinated with the Parks & Recreation Division of the Borough Planning Department. The Solid Waste Division contracts spreading, compaction, and soil cover of MSW, C&D, and asbestos operation to a private contractor, as well as site snow removal and road maintenance. This contract currently extends through June 30, 2023. Site conditions and Landfill facilities are depicted in **Figure 3** to **Figure 5**.

The purpose of this Landfill Development Plan (LDP or Plan) is to provide an evaluation and update of the current landfill development plan and any recommended changes, incorporating conceptual design of leachate and landfill gas (LFG) management systems, and the feasibility of select leachate treatment and LFG reuse options. The Plan provides a summary of the data, assumptions, and approaches that were used in the conceptual layout and cell sequencing for the CLF.

1.1 Previous Landfill Development Plans

Several plans have been prepared over the Landfill's life. Most recently in 2014, CH2M HILL developed the "Matanuska-Susitna Borough Central Landfill Development Plan" (CH2MHill, October 2014), which included future cell sequencing; soil balance; budgetary cost estimates for leachate treatment; and discussion on the potential for onsite co-treatment of septage and leachate, methane capture and reuse, and annual contribution to the closure fund. Changes at the Landfill since this document's release has created the need for a new, updated development plan which incorporates recent changes in site development, technology, and landfill facilities.

1.2 Other Sources

To support the work on this Plan, Burns & McDonnell has relied on data and information provided from the following sources:

- Topography, site features, and imagery provided by MSB:
    - All Points North. Control Survey with Aerial Imagery. August 20, 2019.
- Historic tonnage data for MSW, C&D, asbestos provided by MSB.
- Historic airspace utilization for MSW provided by MSB.
- Historic LFG monitoring data provided by MSB.
- Historic groundwater monitoring data and elevations provided by MSB.
- Historic sound readings (June 2016 and July 2018) conducted by Code Compliance and provided by MSB.
- MSB MSW/C&D Waste Characterization Study. 2018/2019.
- Construction as-recorded plans and cost information:
    - CH2M Hill. Cell 1 Closure Plan. 1990/1991.
    - CH2M Hill. Cell 2B Construction. June 8, 2005.
    - MACTEC. Cell 3 Construction Phase II, December 15, 2010.
    - HDR, Inc. Cell 2A Closure. January 26, 2015.
    - HDR, Inc. Cell 4 Construction. November 2019.
- MSB Resolution Serial No. 85-035. “Classifying and reserving land as future landfill sites”. March 19, 1985.
- MSB Resolution Serial No. 89-182. “Classifying as reserve-use lands the Borough Central Sanitary Landfill”. August 1, 1989.
- MSB Resolution Serial No. 89-183. “Approving a temporary permit for that portion of the Crevasse Moraine Trail System which traverses the Central Landfill Site to be reissued annually as needed and until such a time that the expansion of the Landfill site prohibits the recreational use”. August 1, 1989.
- Kinney Engineering, LLC. Draft Traffic Impact Analysis 09-051. September 1, 2009.

- ADEC. Waiver Request for Elevation of Palmer Central Landfill Cell 2A. February 21, 2014.
- CH2M Hill. Matanuska-Susitna Borough Central Landfill Development Plan. October 2014. (CH2MHill, October 2014).
- MSB. Draft Mat-Su Borough – Gateway Sub-Area Transportation Planning Study. February 2015.
- ADEC. Solid Waste Permit SW1A007-20. December 4, 2015.
- CH2M-Hill. C&D Cell Development Plan. May 31, 2017.
- HDR. Tech Memo 8 Cell 4 Design. February 27, 2018.
- HDL Engineering Consultants. Aggregate/Soils Test Report. July 31, 2018.
- Heartland Water Technology. Budgetary Proposal #190360. March 2019.
- All Points North. Vertical elevation survey datum memo. August 20, 2019.
- MSB. C&D Cell Expansion request. November 4, 2019.
- Clark Technology, Inc. (Clark) 95-percent Leachate Treatment Facility Plans, Specifications, Costs and Engineering Report, 2019/2020. (Clark Technology, 2019).
- ADEC. Matanuska-Susitna Borough Central Landfill, permit revision for new C&D Cell Solid Waste Permit No. SW1A007-20a. January 30, 2020.
- Clark Technology, Inc. (Clark) 100-percent Leachate Treatment Costs, 2020. (Clark Technology, 2020).

2.0 LANDFILL DEVELOPMENT PLAN UPDATES

2.1 Assumptions and Methodology

The following future development criteria were used for the MSW Landfill:

Property Boundaries: The Central Landfill Property boundary was obtained from Borough legislation 85-035, 89-182, and 89-183. Per direction from the MSB, future landfill disposal development is limited to the area east of the existing Matanuska Electric Association (MEA) 100-foot power line easement as shown on **Figure 5**, located on the west side of the Animal Shelter and C&D Landfill, and east of the Recycling Center. Development west of this easement would be limited to a possible entrance relocation with new scalehouse, customer convenience area, administrative office, and/or other support facilities (**Figure 6**).

Depth to Groundwater: Base grades of lateral expansions must maintain a minimum ten-foot vertical separation from historic high groundwater table, in accordance with Title 18 Alaska Administrative Code (AAC) Chapter 60.217. The historic high-water table estimate was determined by contouring using the highest historic elevation at each applicable well for the data record. This contour map is provided in **Figure 7**. Note that these water table elevations should be evaluated at the time of each cell construction, and with each Landfill permit reissuance, to verify compliance with this regulation. This may require additional groundwater well or piezometer installation.

Landfill Sequencing: Landfill sequencing is configured to maximize solid waste capacity of individual cells, utilize space within the landfill property to optimize landfill footprint, and preserve the Crevasse-Moraine trail system for as long as possible. This Plan divides the MSW Landfill development into the following three Phases as shown on **Figure 8**:

- Phase 1 – Existing Cells 1, 2A, 2B, 3, and 4 and future Cell 5. The intent of building out Phase 1 is to streamline leachate collection from the lined cells (Cell 2B, 3, 4, and 5), maximize Cell 5 capacity during construction, and to square up the area to align with future expansion to the south and east.
- Phase 2 – This area represents the seven waste disposal corridors south of Phase 1.
- Phase 3 – This area represents the eight waste disposal corridors east of Phases 1 and 2.

Once MSW disposal moves to Phases 2 and 3, each corridor can be divided into cells. Cell size will be determined based on waste tonnage, airspace utilization factor (AUF), and the desired cell life at the time of construction. Cell construction (and numbering) would start at the leachate sump, or low end, and progress up slope if more cells are required. For example, as shown on **Figure 8**, Phase 2, Corridor 1 would be divided into Cell 6 to the west, and Cell 7 to the east.

Buffer Zones: Buffer zones are measured from the cell boundary to the facility boundary. The buffer on the east, west, and south sides will be the minimum of 100 feet from the property boundary and 300 feet from the north property boundary due to residential proximity. Besides providing distance between disposed waste and adjacent property, the buffer zones also provide a location for perimeter access roads, stormwater control, and leachate, LFG, and electric utilities.

Landfill Slopes: Interior landfill slopes will have a slope no greater than 3 to 1 (horizontal to vertical). Development between Phases 1 and 2, and between Phases 1/2 and 3, will not have a separation berm. Phase edges will meet at the base grades as shown in **Figure 9** (and Cell 5 base grades in **Figure 10**). Removal of this berm maximizes airspace and maximizes the economic value of gravel recovery during cell excavation. Exterior landfill slopes are defined in the permit to have a slope no greater than 4 to 1 (horizontal to vertical); however, analysis completed in the previous CH2MHill plan confirmed liner and waste mass stability for increasing the outer intermediate slopes to 3:1 (horizontal to vertical) under static and seismic conditions. As requested by MSB and as completed in the previous CH2MHill plan, the maximum height was not increased and exterior 3:1 slopes of the Landfill were maintained in this Plan. ADEC has requested that a stability analysis be completed with the future closure of each individual cell to confirm that 3:1 final cover slopes are stable. The previous analysis is included in Appendix A for reference.

Access Roads: Access roads were established in the Plan as indicated on the drawings. **Figure 9** shows an access road around the entire MSW Landfill build out. In addition, each cell and corridor will be surrounded by an access road to allow traffic entrance at multiple locations. The maximum design grade is five percent on the main perimeter road, with the exception of the southeast corner of Phase 2, which is a 6.7 percent grade. Access roads within cells should not exceed 10 percent. Access roads are also provided from the perimeter to the crown of the final cover, graded at 6.7 percent, as shown on **Figure 11**. Road width of 30 feet is recommended to be maintained.

Maximum Height Limit: The current permitted vertical elevation of the Landfill cells is 340 ft above mean seal level (MSL), which was defined by utilizing locally established datum (ADEC Solid Waste Permit SW1A007-20a). The Landfill final cover was graded to an adjusted maximum elevation of 348.5 ft above MSL utilizing the current site datum North American Vertical Datum (NAVD) 88 and is shown on **Figure 11**. The actual vertical elevation is the same, it is just redefined using the most recent datum as described in the August 20, 2019 memorandum from All Points North (provided in Appendix B).

Phasing/Sequencing: Phasing for the site was developed on a per cell basis for Cells 3 through 5 (**Figure 12** and **Figure 13**) and on a per corridor basis for Phase 2 (**Figure 14** through **Figure 17**) and as one buildout for Phase 3 (**Figure 18**). Volumes for each of the sequencing completed are included on the drawings and are indicative of the waste and daily/intermediate cover for each cell. Cross sections of the base grades, final cover, and phasing are also provided on **Figure 19** and **Figure 20**.

Bottom Liner Cross Section: For this Plan, the bottom liner cross section in ascending order is: prepared subgrade, six-inch sand cushion layer, geosynthetic clay liner (GCL), textured 60-mil high density polyethylene (HPDE) geomembrane liner, geotextile cushion fabric, and 18-inches of granular drainage material (gravel). The GCL provides a more economical option to a two-foot compacted clay layer and has better impermeability performance. The granular drainage layer was reduced from the previously constructed 24-inches to 18-inches to allow for liner cost savings as well as additional airspace while still protecting the liner and meeting regulations. **Figure 21** provides a detail of this liner profile.

Final Cover Cross Section: In ascending order, the final cover cross section will include a six inch grading layer, a textured 40-mil linear low density polyethylene (LLDPE) geomembrane liner, 18-inches of granular drainage material (sand), and six-inches of topsoil. **Figure 21** provides a detail of this cover profile. The 40-mil LLDPE geomembrane is recommended to replace the GCL used in the Cell 2A closure, and was detailed in the previous development plan.

Leachate Collection System: Leachate will drain via gravity to a low spot within each landfill corridor where it will then be collected in a sump and pumped through a side slope riser to a force main at the Landfill perimeter, and then to the leachate storage lagoons. Leachate collection pipes will slope a minimum of one percent to the sumps. The leachate piping plan for the entire Phase 1 through Phase 3 MSW Landfill buildout is shown on **Figure 22** with select leachate collection details provided on **Figure 23** and **Figure 24**. See Section 4.2 for more detail on the proposed leachate system.

Landfill Gas Collection and Control System (GCCS): During 2020 it is anticipated that the first phase of an active GCCS will be installed in closed Cells 1 and 2A (see Burns & McDonnell Issued for Bid plans dated June 1, 2020 and June 17, 2020 Addendum). This Plan builds off of this 2020 design to provide a site build out for Phases 1 through 3 (**Figure 25**) as well as system details (**Figure 25** through **Figure 29**). See Section 5.0 for more detail on the proposed gas system.

Stormwater Control: The goal for stormwater control is to prevent ponding, prevent run-on and runoff from the waste footprint, minimize stormwater contact with waste, and minimize erosion. Intermediate slope diversion berms are recommended to minimize stormwater flow into the adjacent open cell. Final cover slopes include diversion berms and downslope channels to convey stormwater to the landfill perimeter. From there, stormwater is conveyed via ditches at the perimeter of the Landfill based on the design topography, with a minimum ditch slope of 0.5 percent. Ditches with design velocities greater than five feet per second are recommended to be reinforced with riprap, erosion control blanket, or turf reinforcement mat to minimize erosion. Stormwater ponds will be located at low topographic points around the Landfill perimeter. A conceptual stormwater plan design for the final MSW Landfill build out through Phase 3 is provided in **Figure 30** with typical details provided in **Figure 31**.

Desired Soil Balance: Excavation of future cells will be conducted to maximize the value of the underlying geology as a gravel resource for construction projects at the Landfill and within the region, for fill required in future Landfill projects, and for daily, intermediate, and final cover soils during landfill operation and closure. This includes MSW, C&D, and asbestos landfill development. For each cell and corridor in Phases 1 and 2, and for Phase 3 in its entirety, volume estimates are provided for excavation cut and fill, subgrade cushion layer, daily and intermediate cover requirements, final cover soil requirements, gravel for sale, and excess soil. Section 9.0 of the Plan provides more detail on the site soil balance.

Crevasse Moraine Trail System: In accordance Borough legislation Resolution Serial No. 89-183, established in 1989, the Landfill development shall not impact this trail system until removal is necessary for expansion. The trail locations are shown in green on **Figure 3** while the Phase 1 through 3 Landfill development is illustrated on **Figure 8**. Current develop extends to the Section line which would be through Phase 2, Corridor 2 with trail maintenance to the south and east. Based on the projections in this Plan (Section 2.6), construction of Phase 2, Corridor 3 would not be necessary until after 2060. Therefore, the current trail system can be maintained for approximately the next 40 years. Trails within Phase 3 of Landfill development can likely remain in place for approximately 100 years.

2.2 Conceptual Cell Layout

There are three major development phases in the conceptual cell layout. Each phase includes multiple individual landfill cells. Phase 1 includes the developed landfill area (Cells 2A, 2B, 3, and 4) and future Cell 5. Phases 2 and 3 are divided into corridors, which may contain two or three landfill cells each, depending on operational preferences as phasing progresses (e.g., cell life). Phase 2 is located south of Phase 1 and includes seven corridors. Phase 3 is located east of Phases 1 and 2 and includes eight corridors. The general arrangement of Phases 1, 2, and 3 is provided in **Figure 5**. This corridor orientation throughout the Landfill development takes advantage of piggybacking airspace over existing waste.

2.3 Base Grades

The base grades of the Landfill were developed so that bottom grades provided a minimum 10-foot separation from the historic high groundwater table, in accordance with AAC regulations, and provide a minimum one-percent slope for leachate collection trenches. Base grade slopes are a minimum four percent toward the collection trenches. Historic high groundwater elevations were contoured and are presented in **Figure 7**. Groundwater generally slopes from north to south, with approximate elevations ranging from 240 ft north of Cell 2A to 120 ft at the southern edge of Phase 2 based on data from groundwater monitoring wells across several sampling events. Internal side slopes are 3H:1V down to the landfill bottom. The corridor bases in Phases 2 and 3 “stair-step” down to follow the decreasing groundwater elevation. This improves the constructability of the corridors while minimizing the distance between the landfill base and groundwater. As each cell and corridor is designed, MSB should revisit the historic high-water table to see if adjustments to base grade elevation are necessary to maintain minimum 10-foot separation, or if base grades could be lowered to increase capacity. The total build-out for the base grade in Phases 1, 2, and 3 is depicted in **Figure 9**; cross sections are provided in **Figure 19** and **Figure 20**.

2.4 Leachate Collection

Base grades are developed to include adequate slope for leachate collection systems to drain to the sumps. Leachate from Phase 1 will drain to a sump located at the southwest corner of Cell 5. Two leachate collection pipes run east to west within trenches, meeting a header collection trench that drains southwesterly toward the sump. Leachate from Cell 2B, 3, and 4 will also drain into this header collection trench as a modification when Cell 5 is constructed.

As shown in **Figure 22**, leachate from Phase 2 collects in a 2.5-foot-deep sump at the west end of each of seven corridors where it is pumped to the leachate storage lagoons at the leachate treatment area on the west side of the site via side slope risers and a leachate transmission force main. Note that Corridors 6 and 7 will share the same sump. Two leachate collection pipes run the length of each corridor (except for one collection pipe in Phase 2, Corridor 7) and are spaced approximately 175 feet apart. The sequencing of cells and corridors is planned such that leachate drainage is optimized. Leachate collection on the west side of Phase 2 while each corridor “stair-steps” down to the south, is the most efficient development by minimizing the distance between the base grade and groundwater, maximizing the disposal capacity, and minimizing piping distances and added infrastructure for leachate conveyance. Leachate collection system details are included in **Figure 23** and **Figure 24**.

In the Phase 3 landfill area, Corridors 1 through 4 include a minimum four-percent slope toward leachate collection pipes and two-percent slope toward the sumps. Corridors 5 through 8 include a minimum four-percent slope toward leachate collection pipes and one-percent slope toward the sumps. Each corridor has two leachate collection trenches that lead to a header trench that directs leachate to the sump. Leachate is pumped via sideslope riser and force main to either the existing leachate storage lagoons or a potential future leachate management area planned east of Phase 3, Corridor 5 (**Figure 22**). Leachate collection on the south and east side of Phase 3, while each corridor "stair-steps" or slopes down to the south, is the most efficient development by minimizing the distance between the base grade and groundwater, maximizing the disposal capacity, and minimizing piping distances and added infrastructure for leachate. A decision to develop a leachate treatment option to the east of Phase 3 should be made before Phase 3 is developed.

The ability to access the entire length of leachate collection piping with cleaning equipment is critical. It is common that leachate rock will form in piping due to chemical precipitation, changes in oxidation state, changes in LFG pressure, and pipe welding or fitting ridges. Leachate rock clogs piping, pumps, and decreases the efficiency for leachate removal from the landfill. This inefficiency can lead to leachate head increases greater than 12-inches, in violation of Title 18 ACC Chapter 60.330(b)(2). As a result, as illustrated on **Figure 22**, cleanouts are provide at both ends of leachate collection pipes within the Landfill and should be extended to maintain access as filling progresses within cells; cleanouts should also be provided every 500 to 1,000 feet along the leachate force main around the Landfill perimeter.

Leachate piping along the base of all future cells will be perforated, 6-inch diameter, standard dimension ratio (SDR) 11 high density polyethylene (HDPE) pipe. Piping up the internal side slopes to perimeter cleanouts will be solid, 6-inch diameter, SDR 11 HDPE pipe. The leachate forcemain to the lagoons or, if used, a leachate recirculation forcemain back out to the cells will be a solid, 4-inch diameter, SDR 11 HDPE pipe.

2.5 Final Grading Plan

Final cover, in ascending order, includes a six-inch layer of leveling course, 40 mil LLDPE textured geomembrane liner, 18-inch granular drainage material, and six inches of topsoil. This profile is shown on **Figure 21**. The final grading plan for Phases 1 through 3, as proposed on **Figure 11**, was developed with a main ridge running generally north-south from the northern boundary of Phase 1 and Phase 3 down to the southern boundary of Phase 2, with a maximum elevation of 348.5 ft above mean sea level (NAVD 88). This is the maximum elevation permitted by the ADEC permit, adjusted for the NAVD 88 datum. Two sub-ridges tee off of the main ridge, one in Phase 2, and one in Phase 3, to maximize disposal volume. Final cover crown grades slope down from either side of these ridges at four percent.

2.6 Projections and Sequencing

The Phase 2 corridors are oriented west to east. Development will occur across a corridor west to east (with leachate collection sumps located on the western most cell of the corridor) and then north to south to the subsequent corridor. The size of each cell within a corridor will be determined at the time of construction depending on the tonnage, AUF, and cell life desired, as well as available construction budget.

Phase 3 Corridors 1 through 4 are oriented north-south. Development will occur south to north across a corridor and then west to east to the subsequent corridor. Corridors 5 through 8 are oriented east to west. Development will occur east to west across a corridor and then south to north to the subsequent corridor. Again, the size of each cell within a corridor will be determined at the time of construction depending on the tonnage, AUF, and cell life desired, as well as available construction budget.

The sequencing of corridors allows for eliminating the need for rerouting leachate collection as future cells are developed and an optimization of landfill airspace and tie-ins while allowing the Crevasse Moraine Trail System to remain open for as long as possible. Refer to **Figure 12** through **Figure 18** for landfill cell and corridor sequencing. Note that Phase 2, Corridor 2 matches up with construction north of the fence line along the section line easement.

A model provided in Appendix C calculates a projection of cell and corridor usage through Phase 3. A conservative estimate, using an average annual waste tonnage growth rate of 2.0 percent and an average AUF of 1,328 pounds per cubic yard (pcy), is summarized in Table 2-1 through Phase 1. The average AUF was obtained from the MSB provided historic AUF for Cell 3. Note that the MSB should revisit this site life model annually to account for any input changes. A realistic planning window for landfill capital planning is 10 to 20 years. For reference, however, Phase 2 site life is projected for about 100 years into the future and Phase 3 life is projected about 130 years into the future under these assumptions.

Based on the base grades and final cover surfaces developed herein, and the 2019 top of waste surface provided by MSB:

- Remaining Phase 1 capacity for waste and daily/intermediate cover soil is 2.6 million cubic yards.

- Phase 2 capacity for waste and daily/intermediate cover soil is 23.1 million cubic yards.
- Phase 3 capacity for waste and daily/intermediate cover soil is 24.0 million cubic yards.
- Overall MSW Landfill disposal capacity is approximately 51.5 million cubic yards.

Table 2-1: Phase 1 Life Estimate

Cell	Construct	Begin Disposal	End Disposal	Close
3	2008	2009	2022	2023
4	2018	2022	2032	2033
5	2030	2032	2043	2044

Note: Life estimates based on an average AUF of 1,328 pcy with a 2.0 percent growth rate.

2.7 Landfill Cell Access Roads

Figure 9 shows the location of a perimeter access road around the entire MSW Landfill development through Phase 3. Besides at topographic changes west of Phase 2, Corridor 2, in the southwest corner of Phase 2, and in the northwest corner of Phase 3, the road is relatively flat. Although not provided in this Plan, each cell should have a perimeter access road included as part of design at construction. Access roads to the final cover crown are illustrated in **Figure 11** with a total of four around the entire MSW Landfill development.

2.8 Stormwater

The purpose of stormwater controls is to prevent run-on and runoff into the MSW Landfill footprint, minimize stormwater contact with waste, and to minimize erosion. Stormwater runoff from future cells is directed to the perimeter ditches. In general, stormwater flows to the low points at the perimeter of the Landfill and to ponds at points of low topography. Specific stormwater ponds, ditches, and other stormwater controls may need to be developed during final design as cells are developed. This design should, at a minimum, control the 25-Year, 24-Hour storm event. Additional stormwater discharge locations may need to be identified, if during detailed design, the stormwater volume exceeds the ditch capacity. General ditch and stormwater pond locations are shown on **Figure 30**. Stormwater control details are provided in **Figure 31**.

During cell operation, to minimize waste contact and leachate generation, intermediate grades should be well compacted and slope away from the working face, with the working face kept as small as practical for customer traffic. Intermediate slopes in place for longer than one year should be seeded to minimize runoff velocities and erosion. As shown on the sequence drawings, temporary diversion berms are recommended on intermediate slopes that lead to open cells to minimize stormwater run-on and leachate generation. During construction, new slopes and ditching should be protected with erosion control matting, seeding, riprap, and/or other best management practices (BMPs) (e.g., silt fence, biorolls, straw bales) to slow runoff velocities and minimize erosion.

Proposed final cover slopes are steep at 3:1. To manage stormwater after closure, diversion berms are proposed to slow runoff velocity down these slopes. Downslope channels are also proposed at select locations where runoff is focused by the diversion berms, access roads, or final cover topography. Downslope channels should have riprap or other engineered controls to dissipate velocity and discharge into the perimeter ditch. Stormwater control details are provided in **Figure 31**.

2.9 Entrance Road Evaluation

The existing main entrance to the Landfill facility is on the north side of the site at N 49th State Street and Chanlyut Circle, controlled by three-way stop signs. The entrance area contains a scalehouse, administrative office, household hazardous waste (HHW) facility, customer convenience drop off, and the landfill operator's and maintenance facilities. West of this intersection are the entrance to the Landfill's unattended scale for commercial account customers, the MSB Animal Shelter, and Valley Community for Recycling Solutions (VCRS). Traffic to these latter facilities impacts traffic flow into the Landfill's main entrance at the intersection. Occasionally, customers are going to both the Landfill and VCRS, complicating traffic flow.

2.9.1 Near-Term Entrance Improvements

Queuing distance for both inbound, and outbound traffic at the existing north scalehouse entrance area is limiting. During busy periods, traffic backups occur inbound along N 49th State Street, and outbound in the paved area north and east of Cell 1. A Traffic Impact Analysis completed by Kinney Engineering, LLC evaluated these impacts in 2009 and then projected impacts with the current traffic configuration in 2019. This document is provided in Appendix D for reference. According to this analysis, the 2019 projected queuing storage and probability of exceeding queue storage were:

- Three customers inbound to the scalehouse before traffic backs up on to southbound 49th State Street at a 67-percent probability of occurrence; and
- Ten customers outbound of the scalehouse before traffic backs up into Landfill operations at a 92-percent probability of occurrence.

Recent observations by MSB staff confirm these projections.

The Kinney Engineering Analysis recommended four alternatives to improve traffic flow and queuing. Based on our review of this analysis, Alternative 2 is recommended as the best option. In that scenario, East Chanlyut Circle would arc north to meet East Lee Ann Drive. This would be a controlled intersection with stop signs eastbound and westbound. As part of this upgrade, 49th State Street could be widened to incorporate more storage and southbound righthand turn lanes. This traffic reroute is depicted on **Figure 5** in conjunction with the potential addition of the College Connector. This option:

- Extends the inbound queue length.
- Provides traffic separation and control for customers heading west to the commercial scale, the animal shelter, or VCRS.
- Provides traffic separation and control for customers that may be going to both the scalehouse and VCRS while avoiding an internal road where such traffic could impact Landfill operations or become disoriented on site.
- Does not directly address any outbound queuing issues.

On site traffic flow or scalehouse transaction modifications may be needed to improve outbound queuing. Since the 2009 study, MSB has reconfigured the outbound queue to obtain more storage.

2.9.2 Long-Term Entrance Improvements

Ultimately, as the Landfill expands to the south, an alternate entrance should be considered. The Conceptual Site Entrance Plan (**Figure 6**) proposes to bring traffic in from the west side of the site to provide better queuing and scalehouse access for haulers and Landfill staff. Traffic will approach the Landfill from College Connector Road. Positioning the long term site entrance and Landfill facilities location on the west side of the Phase 2 area opens up space for access to a waste to energy/septage facility, future compost area, appliance and tire recycling drop off area, customer convenience area, Landfill diversion sorting area, and Landfill management office. Two options are presented for the relocated scalehouse in **Figure 6**. During this transition, the HHW program could move to the current equipment maintenance shop, when the Landfill operations and equipment maintenance moves to this new area (which could be constructed prior to the remainder of the facilities depicted in **Figure 6**). This location is also situated for better customer access to Phase 2 as those corridors are developed. Development of this area could align with operation of Cells 4 and 5, projected during the next 20 years. Note, however, that MSB would need to secure the right-of-way from the University to develop the College Connector .

2.10 Noise Assessment

Noise control is managed on-site through ordinance and operation to prevent a nuisance to adjacent land uses. This is accomplished by limiting hours of equipment operation as outlined in the ADEC operating permit for the Landfill, and by requiring acceptable noise reducing muffler systems on heavy landfill operating and construction equipment, as needed.

The Solid Waste Division is diligent on complying with local Ordinance requirements. Complaints to the Borough result in a Code Compliance investigation. The investigating officer moves into position adjacent to the area the complaint references unannounced and a series of readings are taken. The Central Landfill has been surveilled for noise complaints twice over the last seven years, once in June 2016 and again in July 2018. Each time noise never exceeded the limit of 60 dB(A) established for land of residential use from 7 AM to 10 PM as outlined in Borough Ordinance 8.52.015 Table 1: Maximum Permissible Sound Level Limits.

2.11 Yard Waste and Organics Composting

The Borough completed four separate waste composition studies during December 2018 and February, May, and August 2019 on MSW and C&D disposed at the Landfill. This work indicated that over the course of a year about 20 percent of the waste disposed in the MSW and C&D Landfills is comprised of food waste, compostable paper, grass, leaves, brush, and trees. Based on observed participation in other programs, Burns & McDonnell estimates that about half of this material could be diverted from Landfill disposal through promotion of a source separated organics program. Currently, Landfill staff are composting yard waste (i.e., brush, grass, and leaves) north of Cell 2A. Brush is chipped and used for erosion control. Wood chips would be suitable for erosion control on the Landfill’s intermediate slopes. MSB reports that there is considerable demand from the public for the resulting compost.

Organic wastes, such as yard wastes and food wastes, generally compose the largest single type of municipal solid waste materials disposed by weight in the Landfill. Diversion of these materials from disposal offers both measurable benefits and challenges. The benefits include increased landfill airspace savings, production of a compost by-product for beneficial reuse, and the potential for an additional revenue stream from the sale of the compost. The challenges may include implementing a separate collection program, additional processing costs for the organic materials, and creating a demand for the either the give-away or sale of the compost by-product.

Comparatively, organics degradation is slower in the anaerobic conditions of a landfill (environment lacking free oxygen) than with degradation in aerobic conditions (environment containing free oxygen) such as composting. The landfilled waste will begin producing landfill gas (LFG) shortly after placement and will increase to moderate production levels within approximately 2 years. Displacement of the organics from the landfill into a composting program may potentially have an impact on the overall LFG generation. However, organics collection programs typically capture only a limited fraction of the total organics landfilled. Therefore, the impacts on LFG generation are very site specific. Section 5.4 and Appendix I of the Plan present modeled results that estimate the reduction in LFG generation if MSB would implement an organics diversion program. If the program begins in 2022, LFG generation would be 10 percent less than without composting in 2030.

A number of U.S. local governmental solid waste management programs have added or are currently considering offering curbside and/or drop-off food waste collection to their suite of services. The challenges with adding food waste typically includes increased contamination and additional operational requirements (e.g. achieve pathogen destruction). Local governmental programs currently offering food waste collection have found the need to increase resources to educate customers on types of contamination and the various benefits of food waste diversion to operate effective programs.

The west entrance development shown in **Figure 6** provides a 2.5-acre area for dedicated composting of yard waste and source separated organics. This area would be a suitable size for an MSB program and is positioned on a topographic ridge to minimize grading pursuant to MSB staff. This location could be used at any time in future development and accessed from the road south of the C&D Landfill.

3.0 CONSTRUCTION & CLOSURE PLAN FOR CELLS 2B-5 (PHASE 1)

3.1 Assumptions and Methodology

The same assumptions applied to the Plan, as outlined in Section 2.0, also apply to construction and closure for Cells 2B through 5. The construction and closure for Cells 2B through 5 is planned in such a way to maximize landfill capacity, minimize stormwater runoff, eliminate rework of system components as development progresses, and maximize potential aggregate sales from excavations.

3.2 Conceptual Construction and Closure Grading Plans

General arrangement of the Landfill cells is depicted in **Figure 5**. Waste is currently being placed in Cell 3, with Cell 4, constructed in 2018, the next area to receive waste. The sequencing of Cell 3, with final intermediate grades indicated, is shown in **Figure 12**. Grades will tie into the grading of the closed Cell 2A and Cell 2B with intermediate cover. Current closure at the high point in Cell 2A is 348.5 feet (NAVD88). Based on the site life projections presented in Section 2.6, these Cell 3 intermediate grades are anticipated to be reached in 2022. Closure construction could then commence in 2023, including expansion of the GCCS, initially to be installed in Cells 1 and 2A in 2020.

Note that previously MSB has considered extending the Crevasse Moraine trails on the final cover as the Landfill undergoes phased closure. Based on the development recommended in this Plan, that is not recommended since, as outlined in Section 5.0, the LFG collection piping will be above the cover surface, interfering with end-use activity on the cover. Burns & McDonnell also recommends that public trail users not be able to access portions of the Landfill with active operation, including the GCCS. However, the current trail system is estimated to remain in place for approximately 40 years based on expansion projections.

Disposal transition from Cell 3 to Cell 4 is estimated to take place during 2022. During this period, two working faces will be required, one high in Cell 3 for bulky waste that could damage the Cell 4 liner, and one on the Cell 4 base for softer residential waste to protect the Cell 4 liner. This initial “fluff” lift is typically 10 to 15-feet thick. This filling logic applies as waste disposal transitions to all new cells. Cell 4 intermediate grades are proposed in Plan A of **Figure 13**. Cell 4 is projected to reach capacity in 2032 with final cover construction and GCCS expansion likely in 2033 based on the life projections described in Section 2.6. Note that Burns & McDonnell recommends that waste not be placed over the Cell 4 sump area to allow a more efficient tie-in to Cell 5. This is described in more detail in Sections 3.3 and 3.4.

Base grades of Cell 5 are depicted in **Figure 10**. Working with the natural topography and boundaries of existing cells, the base grades of Cell 5 were developed to maximize excavation volumes and minimize fill volumes during construction, therefore optimizing disposal volume and potential for MSB to sell aggregate on the market. The base grades were also developed such that Cell 5 will square off the site development's geometry to the east and south. Subsequent development will proceed to Phase 2 corridors. Final cover grades are depicted in **Figure 11** and the Cell 5 final intermediate grades are presented in Plan B on **Figure 13**. Waste disposal in Cell 5 is estimated to occur between 2032 and 2043 (Section 2.6).

3.3 Cell 4 Stormwater Controls

Two stormwater flaps are currently positioned on the liner, one east to west across the Cell 4 midpoint and another immediately upstream of the sump, both minimizing the amount of stormwater reaching the sump and requiring treatment as leachate. As stormwater accumulates, MSB staff are pumping out the stormwater retained behind these flaps. Waste filling will begin south of the midpoint flap at the tipping pad; at that time, the sump flap would need to be removed to allow leachate flow to the sump. The midpoint flap would be removed when waste placement transitions north of the flap after a few waste lifts.

In order to tie-in Cell 4 to the proposed Cell 5 in this plan, Burns & McDonnell recommends the Cell 4 fill plan shown in Plan A of **Figure 13**. The southern toe of waste would align with the east-west southern boundary of the cell and waste would not be placed over the sump. Instead, as Cell 4 waste lifts are placed, the area above the sump will be filled with approximately 49,500 cubic yards of soil (similar to daily/intermediate cover) up to the perimeter berm elevation of approximately 235 feet (NAV88). This fill will have a one-percent slope outward to promote runoff from the Cell 4 south intermediate slope. A filter geotextile is recommended below this fill to minimize fines infiltration into the gravel drainage media used for leachate collection.

The soil fill option would require little maintenance but would generate some leachate and would need to be excavated as part of Cell 5 construction. The soil could be reused as daily or intermediate cover. MSB should coordinate the soil placement to protect the Cell 4 sump before Cell 4 operation begins and during subsequent lifts as Cell 4 is accepting waste (anticipated in 2022, see Section 2.6).

The final intermediate crown of Cell 4 (**Figure 13**, Plan A) creates a natural ditch on the surface of the final cover that slopes toward the southwest. This could potentially create significant stormwater runoff down the southern intermediate slope to the Cell 4 sump area. A temporary diversion berm and letdown structure is recommended to divert runoff from this Cell 4 crown area, down the southern intermediate slope, to the Landfill perimeter west of the Cell 4 sump.

3.4 Tie-In Details

The low point of the Cell 4 sump area will become a “hinge” point in Cell 5 for the purpose of tying the cells together. The temporary fill placed during Cell 4 operation, if used, will be excavated, and can be reused for daily or intermediate cover. The proposed Cell 5 base grade will tip down at a 12-percent slope from the Cell 4 “hinge” to the Cell 5 base as shown in **Figure 10**. The existing Cell 4 SSR vault, piping and leachate force main surface piping will be removed. It is possible that a portion of the Cell 4 infrastructure and controls could be reused for the Cell 5 SSR. The leachate collection lines in the Cell 4 sump will tie into new leachate collection piping in Cell 5. Note that this new leachate piping will also carry leachate from Cells 2B and 3. Leachate collected from Cell 5 and from the previously developed cells will be routed to the Cell 5 sump located at the southwest corner of Cell 5 from where it will be pumped via the SSR to the perimeter force main. The leachate collection system for Cell 5 is also illustrated in **Figure 10**.

Leachate collection for Phases 1 and 2 is planned to be on the west side of the site, with cell development occurring from west to east, therefore eliminating the need for temporary leachate storage tanks or rework of system components as development progresses.

3.5 Conceptual Schedule

Based on the site life projection model presented in Section 2.6, Table 3-1 provides a conservative estimate of Phase 1 development. Again, note that this model should be adjusted annually based on the latest information on annual MSW tonnage, percent growth, AUF, and surveyed remaining capacity. For capital planning, projections within a 10 to 20-year timeframe should be used.

Table 3-1: Phase 1 Life Estimate

Cell	Construct	Begin Disposal	End Disposal	Close
3	2008	2009	2022	2023
4	2018	2022	2032	2033
5	2030	2032	2043	2044

Note: Life estimates based on an average AUF of 1,328 pcy with a 2.0 percent growth rate.

3.6 Cost Estimates

Closure cost estimates for the future construction and remaining open area of Phase 1 (Cells 2B through 5) were calculated as part of the financial assurance update as further described in Section 8.0. The total area of closure is 40.32 acres and total closure cost estimates in 2020 dollars is $9.0 million ($223,241 per acre). This includes the expansion of the Phase 1 active LFG system (installation of 39 additional wells and associated LFG piping as indicated on **Figure 25**. The incremental closure areas as depicted on **Figure 12** and **Figure 13** provide the following partial closure areas and years as defined in Section 2.6:

- Cell 2B-3 – 13.21 acres in 2023
- Cell 4 – 4.12 acres in 2033
- Cell 5 – 7.21 acres (for financial assurance calculations, if Cell 5 is the last cell, then this area would increase to 22.99 acres) in 2044

Construction cost estimates for Cell 5 (9.5 acres) were also estimated at $6.5M (2020 dollars). However, this estimate includes the cost for excavation of the cell (520,000 CY at $2.8M), which could be at least partially completed with a gravel mining contract to offset costs. Cell 5 construction is currently anticipated for year 2030 (Section 2.6); however, these estimates should be revisited regularly to confirm timing. Cost estimates are included in Appendix L.

4.0 LEACHATE MANAGEMENT PLAN

4.1 Assumptions and Methodology

An analysis of the potential leachate generation, leachate recirculation, and maximum daily head on the liner system that may be expected during various stages of landfill development was conducted using the Hydrologic Evaluation of Landfill Performance (HELP) Model Version 3.07, which was developed by the United States Army Corps of Engineers. The HELP model is a hydrologic model of water movement across, into, though, and out of landfills. The model uses climatologic, soil, and design data in a daily sequential analysis that accounts for the effects of surface storage, runoff, infiltration, evapotranspiration, percolation, soil moisture storage, and lateral drainage. Discussion on the HELP model analysis and associated assumptions and methodology is included in Appendix E.

Based on MSW Landfill development described in Sections 2.0 and 3.0 herein, and the projected leachate generation, this section outlines the leachate collection plan and then evaluates on-site leachate treatment options.

4.2 Leachate Collection Plan

The leachate collection lines in Cell 4 will tie into new leachate collection piping in Cell 5. Leachate drainage from the previously developed cells will be routed to a sump located at the southwest corner of Cell 5. The leachate collection system for Cell 5 is included in **Figure 10**.

Phase 1, Cell 5 and the corridors in Phases 2 and 3 each contain two leachate collection trenches that run the length of the respective cells with the exception of Phase 2, Corridor 7, which contains one leachate collection trench. The purpose of the leachate collection trenches is to receive leachate from the drainage layer and transfer it to the leachate collection sump. Access to the leachate collection pipes for maintenance and cleaning is provided by cleanout risers, which will extend up the sideslopes.

Construction of a leachate collection trench generally begins with the placement of a protective geotextile cushion (10-ounce thickness minimum) above the HDPE geomembrane liner. A three-inch bridge layer of coarse aggregate is placed in the trench, and the pipe is then aligned. Two feet of additional coarse aggregate overlies the pipe after installation. Note that the coarse aggregate over the rest of the cell is 18-inches thick.

As shown in **Figure 22**, leachate from the leachate collection trenches will be transferred via sideslope risers to a perimeter force main and direct leachate to the leachate storage lagoons or other leachate management systems.

Leachate piping along the base of all future cells will be perforated, 6-inch diameter, SDR 11 HDPE pipe. Piping up the internal side slopes to perimeter cleanouts will be solid, 6-inch diameter, SDR 11 HDPE pipe. The leachate forcemain to the lagoons or, if used, a leachate recirculation forcemain back out to the cells will be a solid, 4-inch diameter, SDR 11 HDPE pipe.

4.2.1 Leachate Collection Locations

A 2.5-foot deep sump will be located at the low point of Cell 5 and within each Phase 2 corridor, located in the southwest corner. The leachate management area for Phases 1 and 2 is located to the southwest of Cell 3. In Phase 3, sumps will be located on the south end of Corridors 1 through 4 and at the east end of Corridors 5 through 8. A future leachate treatment area for Phase 3 leachate may be considered by the MSB (prior to Phase 3 construction) on the east side of Phase 3 as shown on **Figure 9**. Based on the HELP modeling annual projection of leachate generation from Cells 2B, 3, 4, and 5 all being pumped from the Cell 5 sump (see Table 4-2) of approximately 4.4 million gallons, a minimum pumping capacity of 25 gallons per minute is recommended for the Cell 5 pump. This pumping rate will allow for variations of higher flow during precipitation and snow melt events. Specific pump flow and head parameters should be determined with each cell design.

4.2.2 Construction and Operational Considerations

Behind labor costs, leachate management is typically the next highest cost for landfill operation. Therefore, it makes sense to consider all methods to reduce leachate generation, including:

- Placing a rain flap, as MSB has done during Cell 4 construction, to divert a portion of the precipitation entering the cell to stormwater during the first few lifts of disposal.
- Designing stormwater control structures around the cell perimeter to prevent run-on into the cell manage runoff from the cell. This includes diversion berms on internal intermediate slopes as shown on the sequence drawings to limit drainage into the operating cell.
- Minimizing the size of the working face to match the customer traffic, maintaining the current size as outlined in the current operations plan.
- Providing suitable daily cover to minimize stormwater contact with waste.
- Using compacted, relatively impermeable intermediate cover that sheds stormwater to the cell perimeter.
- Placing final cover on cells that have reached final intermediate grade with minimal future settlement anticipated.

4.3 On-Site Leachate Treatment Evaluation

The leachate generated at the Landfill is currently collected in lagoons and hauled to the Anchorage Water and Wastewater Utility (AWWU) treatment plant. This treatment plant is the only available facility located near enough to the Landfill to feasibly receive the generated leachate.

MSB is concerned that future developments affecting AWWU will lead to significant price increases or permit restrictions for their hauled leachate in future years, which may lead to on-site leachate treatment becoming economically viable. Analysis of the leachate and the different options for handling it on-site are discussed in the following sections.

4.3.1 Leachate Volume

The volume of leachate generated at the Landfill varies based on season, rainfall, and landfill cell utilization. The variability of the leachate volume generated has led to leachate being stored on-site before hauling to AWWU.

Table 4-1 shows the annual quantities of leachate hauled to AWWU. In 2019, about 3 million gallons of leachate were generated from Cells 2B, 3 and a small portion of Cell 4. Current disposal is in Cell 3 with Cell 4 constructed but not yet open. Most of the precipitation hitting the Cell 4 footprint is contained by two rain flaps and diverted as stormwater.

Table 4-1: Leachate Outhaul Quantities

Year	Total Gallons
2014	1,405,129
2015	1,230,474
2016	1,462,836
2017	1,407,389
2018	2,051,541
2019	3,151,360

As part of Cell 4 construction in 2018, MSB completed the construction of two leachate storage lagoons to replace a lower capacity underground leachate storage tank. The ponds provide a total capacity of 500,000 gallons (750,000 gallons with available freeboard) with equalization for hauling operations or a future leachate treatment system. Based on the current leachate generation of 7,500 to 8,000 gallons per day (as provided by MSB), the lagoons provide about two months of holding capacity.

A basis of 20,000 gallons of leachate treated per day (gpd) was used to evaluate leachate management options. A rate of 20,000 gpd is higher than the current and projected leachate generation as additional cells are opened in the near future. However, it reflects a treatment rate where leachate stored in the lagoons as it is generated and a treatment option then operates at 20,000 gpd for a limited time period (e.g., 10 hours per day, 5 days per week). This basis provides treatment and equipment cost efficiency and flexibility as leachate generation changes. This basis also aligns with forecasting analyses conducted in a recent engineering report (Clark Technology, 2019) and the previous sequencing plan (CH2M HILL, 2014).

Table 4-2 presents the approximate average annual leachate generation rates for various Landfill development scenarios for Phase 1. The model's results are conservative, as they do not take into account the variations in leachate generation from the relatively flat areas of the landfill to the sideslopes.

Table 4-2: HELP Model Average Annual Leachate Generation

Year	Active Filling		Intermediate Cover		Final Cover/Closed		Average Annual Leachate Generation (Mgal)
	Cells	Approx. Area (ac)	Cells	Approx. Area (ac)	Cells	Approx. Area (ac)	
2020	3	5.00	2B, Part of 3	17.24	-	0	3.2
2025	4	8.59	Part of 3	9.03	2B, Part of 3	13.21	3.5
2040	5	9.47	Part 4	14.38	2B, 3, Part 4	17.336	4.4

Note: For baseline leachate generation with no recirculation: active filling 272,000 gallons/acre, intermediate filling 123,000 gallons/acre, and closed 0.15 gallons/acre.

During the active filling and intermediate cover conditions of Landfill development, up to 94 and 100 percent of leachate generated, respectively, can be recirculated through the Landfill while maintaining less than twelve inches of head on the liner system. Leachate recirculation has the potential to reduce the volume of leachate collected during the active filling and intermediate cover conditions of Landfill development. More discussion on leachate recirculation can be found in Section 4.3.3.4.1 of this Plan. In addition, the amount of precipitation that will potentially enter a cell to generate leachate is greatly reduced when final elevations are reached and when individual cells receive final cover.

4.3.2 Leachate Quality

The constituents found within landfill leachate can vary significantly at a landfill and this variation leads to challenges in treating the leachate. For the Landfill, the leachate quality has historically been tested and reported as part of the disposal agreement with AWWU. These sampling events have been compiled as historical data and combined with more detailed sampling data from September 2019's engineering report (Clark Technology, 2019). Table 4-3 summarizes the results from the Clark Technology sampling event in September 2018, as well as the averaged data reported to AWWU between 2016 and the end of 2018.

Table 4-3: Leachate Quality Summary

Parameter	Abbrev.	Unit	Value
Total Dissolved Solids	TDS	mg/L	15,000
Total Suspended Solids*	TSS	mg/L	268
Total Kjeldahl Nitrogen	TKN	mg/L	1,100
Biochemical Oxygen Demand*	BOD_5	mg/L	7,890
Chemical Oxygen Demand	COD	mg/L	17,000
Phosphorus, Total		mg/L	1.2
Phosphorus, as PO4	PO4	mg/L	3.8
Ammonia, as N		mg/L	1,100
Ammonia, as NH3	NH3	mg/L	1,300
Cyanide**	CN	mg/L	0.006
Total Aromatic Hydrocarbons**	TAH	mg/L	1.86
Total Oil & Grease**	O&G	mg/L	33.5
pH**			7.0
Metals			
Antimony	An	mg/L	0.01
Arsenic*	As	mg/L	0.08
Barium	Ba	mg/L	0.42
Beryllium*	Be	mg/L	0.00098
Cadmium*	Cd	mg/L	0.00089
Calcium	Ca	mg/L	1,000
Chromium*	Cr	mg/L	0.18
Cobalt	COD	mg/L	0.14
Copper*	Cu	mg/L	0.016
Iron	Fe	mg/L	260
Lead*	Pb	mg/L	0.0081
Magnesium	Mg	mg/L	290
Manganese	Mn	mg/L	20
Mercury*	Hg	mg/L	0.00018
Molybdenum	Mb	mg/L	0.0066
Nickel*	Ni	mg/L	0.74
Potassium	K	mg/L	450
Selenium	Se	mg/L	0.019
Silver*	Ag	mg/L	0.0027

Parameter	Abbrev.	Unit	Value
Sodium	Na	mg/L	1,500
Vanadium	V	mg/L	0.09
Zinc*	Zn	mg/L	3.8
Per-and Polyfluoroalkyl Substances (PFAS)			
Perfluorobutanoic acid	PFBA	ng/L	770
Perfluoropentanoic acid	PFPeA	ng/L	680
Perfluorobutane sulfonic acid	PFBS	ng/L	51
Perfluorohexanoic acid	PFHxA	ng/L	1,200
Perfluoroheptanoic acid	PFHpA	ng/L	350
Perfluorohexane sulfonic acid	PFHxS	ng/L	220
Perfluorooctanoic acid	PFOA	ng/L	540
Perfluorononanoic acid	PFNA	ng/L	18
Perfluorooctane sulfonic acid	PFOS	ng/L	16
6:2 Fluorotelomer sulfonic acid	6:2 FTS	ng/L	160
Volatile Organic Compounds (VOCs)			
Benzene		ug/L	15
Ethylbenzene		ug/L	12
Chloroethane		ug/L	ND
1,2-Dichloroethane		ug/L	12
cis-1,2-Dichloroethane		ug/L	ND
trans-1,2-Dichloroethane		ug/L	ND
Methylene Chloride		ug/L	30
Vinyl chloride		ug/L	ND
m-Xylene & p-Xylene		ug/L	26
o-Xylene		ug/L	14
Toluene		ug/L	1,300
Semi Volatile Organic Compounds (SVOCs)			
Bis(2-ethylhexyl)phthalate		ug/L	ND
2-Methylphenol		ug/L	15
Phenol		ug/L	1,100
3-Methylphenol & 4-Methylphenol		ug/L	7,900

Note: ND is an acronym for non-detectable
*Includes averaged data from AWWU reporting and Clark sampling data.
**Only includes averaged data from AWWU reporting.

Table 4-4 summarizes the historic leachate sampling data provided to AWWU twice each year, as well as the corresponding industrial discharge permit limits for each parameter at AWWU. This data set includes sampling events from 2016 to the end of 2018 when storage occurred in the underground tanks. Leachate zinc concentrations occasionally exceeded the AWWU permit limit. Now that leachate storage occurs in the lagoons, concentrations should be reviewed to see if there is a change.

Table 4-4: Historical Leachate Sampling Summary

Parameter	Unit	Limit	Historical		
			Min	Average	Max
Arsenic	mg/L	3.7	0.0137	0.02628	0.0438
Beryllium	mg/L	14.5	0.001	0.001	0.001
Cadmium	mg/L	0.69	0.0002	0.0009	0.00125
Chromium	mg/L	2.77	0.0852	0.17404	0.306
Copper	mg/L	3.38	0.009	0.01778	0.0246
Lead	mg/L	0.69	0.00486	0.005266	0.006
Mercury	mg/L	0.2	0.000167	0.000209	0.00025
Nickel	mg/L	3.88	0.426	0.7304	1.18
Silver	mg/L	2.5	0.0025	0.0025	0.0025
Zinc	mg/L	5.62	1.74	3.548	6.12
Cyanide	mg/L	1.7	0.0044	0.00608	0.0099
Total Suspended Solids	mg/L	No limit	90	311.6	700
Biochemical Oxygen Demand	mg/L	No limit	2,520	6,868	14,400
Biochemical Oxygen Demand, Soluble	mg/L	No limit	2,520	6,632	14,300
Total Aromatic Hydrocarbons	mg/L	5	0.366	1.8615	3.8
Oil and Grease; Total	mg/L	250	22.2	33.46	71.5
pH		5.0-12.5	6.67	6.974	7.2

4.3.3 Leachate Treatment Options

There are several ways to feasibly manage the future demands for the leachate generated from the Landfill. These vary from supplementary treatment options to primary systems designed to treat the entire leachate stream. This Plan considers the following three primary options:

- Option 1: Status Quo of Hauling to AWWU
- Option 2: Evaporation
- Option 3: Membrane Filtration

Additionally, leachate recirculation is a management method that could be used with any of these three primary options and could possibly be a stand-alone option as well. Certain treatment methods, such as reverse osmosis and ultrafiltration can become more efficient with leachate pretreatment to remove nitrogen, biochemical oxygen demand (BOD_5), metals, and VOCs. These will be evaluated in this Plan as well.

4.3.3.1 Option 1: Status Quo of Hauling to AWWU

The first leachate management option considered is for MSB to continue to haul the leachate to AWWU without constructing a new treatment system on-site. MSB currently hauls approximately three million gallons of leachate each year. This volume has historically been stored within tanks and hauled, as needed, to AWWU throughout the year. MSB currently pays $0.082 per gallon for combined hauling to, and disposal at, AWWU. Further cost analysis will be provided in later sections. As indicated in Table 4-2, annual leachate generation is projected to increase up to 4.4 million gallons through Cell 5 development. AWWU regularly attends Borough Wastewater and Septage Board meetings (WASB) and has alluded to either cutting off or increasing costs to the Borough or adding permit conditions to reduce contaminant loading as an incentive to build their own treatment plant. This helps facilitate the longevity of their existing permit which otherwise, could be discontinued by United States Environmental Protection Agency (US EPA) if they do not see efforts at constituent reductions.

The recently constructed leachate storage lagoons have increased MSB's storage capacity of leachate. This additional storage can help to reduce the required hauling frequency but is unlikely to significantly change the rate of disposal for this option. As leachate generation grows, MSB would need to add more trucks to the round trip to AWWU. A maximum of three truckloads can be hauled to AWWU each day according to MSB, which equals 18,000 gallons per day. Assuming hauling occurs five days per week, a maximum of 4.6 million gallons per year can be transported from MSB to AWWU. Based on HELP modeling projections, this maximum is applicable for Phase 1 operation through Cell 5 (i.e., at least the next 20 years). If leachate volumes exceed the daily or annual maximums allowed by AWWU, then addition storage at MSB will need to be constructed. Resources at the Landfill could be reallocated to other projects and needs if the AWWU option remains viable. Additional leachate storage will likely be required when Phase 2 is operational in about 20 years.

This option has the benefit of no capital expenses; the only expenses are related to the actual volume of leachate generated rather than a system designed for a greater capacity than is observed, no construction required, and no additional operation and maintenance. The drawbacks of this option are related to MSB being subject to uncertain price increases for hauling the leachate to AWWU in the future. A decision to implement an alternate treatment method may need to be made quickly.

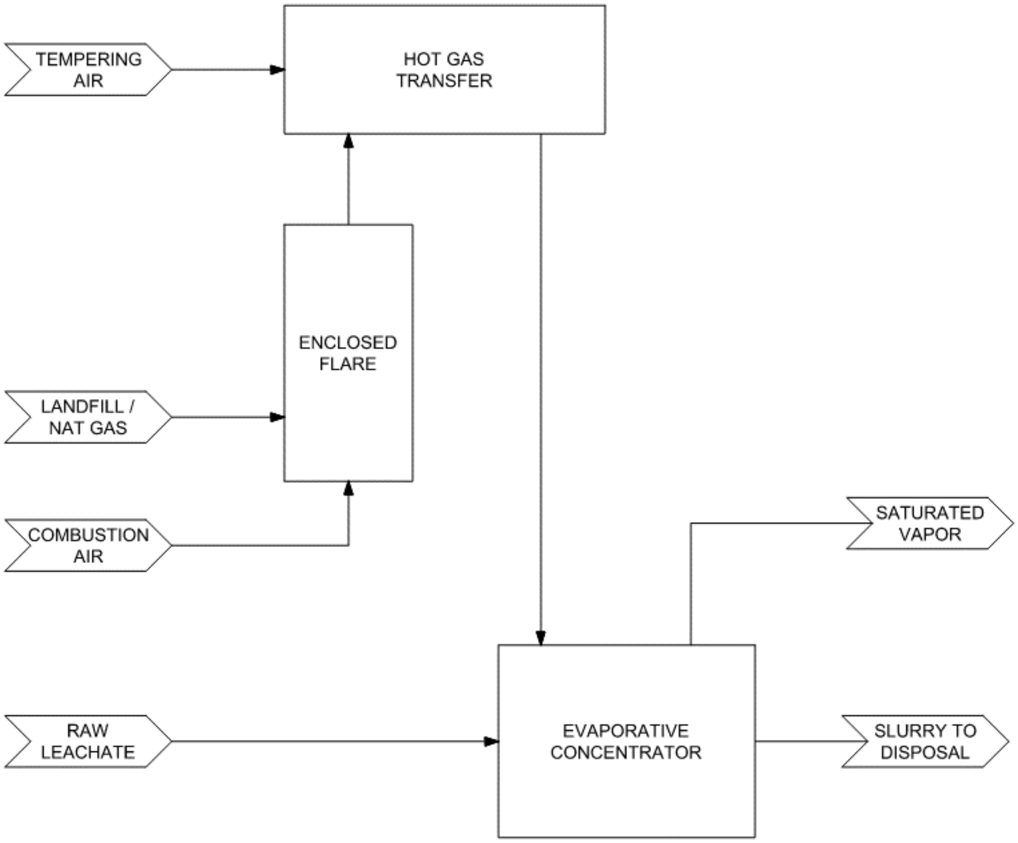
4.3.3.2 Option 2: Evaporation

The leachate produced by MSB can be evaporated on site through a direct contact evaporation process. Direct contact evaporators systems are designed to operate with flexible water chemistries and feed gas. There are a couple vendors that provide leachate evaporation technology. One is Heartland Water

Technology, who has provided information for their direct contact evaporator offering which fits the needs of MSB. Their technology is being used currently at the Kenai Peninsula Borough Central Peninsula Landfill in Soldotna, Alaska. Encon Evaporators is another vendor providing leachate evaporation technology.

A process flow diagram of the evaporator system is illustrated in Figure 4-1.

Figure 4-1: Overall Process Flow Diagram for Direct-Contact Evaporator



Some key aspects of this system include the required fuel source and the product streams. The fuel source of LFG or natural gas is required to produce combustion heat used for evaporating the leachate. The vapor product stream will leave the system as a gas and will not require disposal measures, while the concentrated slurry is removed from the system and can be applied (i.e., recirculated) to the waste mass within the Landfill. Since this material is a slurry, disposal in the Landfill is considered leachate recirculation and will require a Research, Development & Demonstration (RD&D) permit from ADEC. Air emissions will be present from the evaporation of the compounds within the leachate. Further investigation into the volatilization of specific compounds should be evaluated according to ADEC regulations to determine if an air permit is required.

Technology vendors report that leachate is concentrated through the evaporation process resulting in an expected volume reduction of 95 percent based on the water chemistry of the leachate. At 95 percent reduction, and the anticipated range of leachate generation from Phase 1 of 3.2 to 4.4 million gallons, the range of evaporated volume would approximately be 3.0 to 4.2 million gallons per year. This results in approximately 160,000 to 220,000 gallons per year of concentrated slurry to recirculate to the Landfill. The evaporation system may operate at a lower percent reduction to allow for easier transport or recirculation of the concentrated slurry. If the percent reduction is reduced in practice, a greater volume of slurry would be returned to the Landfill.

The evaporation system has significant operational flexibility. If operating, the evaporator can likely utilize all the LFG collected on-site. A conservative 200 standard cubic feet per minute (scfm) of 50 percent methane LFG available was used as a basis for the evaluation as the flow from the GCCS after closure of Cells 2B and 3 in 2023. A flow of 200 scfm can treat approximately 10,000 gallons/day. Additional LFG will become available in the future as phases of the Landfill close (see Appendix I for projected LFG generation). Note that for the evaporator unit, fuel demands exceeding the supply of LFG can be supplemented with utility natural gas; this may not be necessary based on the projected leachate generation and LFG collection rates for the next 20 years. The system is also capable of handling a wide range of flows between the current leachate production rate of 7,500 to 8,000 gpd and the design rate of 20,000 gpd. This allows for continuous or intermittent operation that best suits the schedule of MSB's seasonal operations and leachate storage capabilities.

Material compatibility should be considered by the supplier of the evaporator system. Evaporator components may be susceptible to thermal fatigue, combustion byproduct deposition, and corrosion. Materials in contact with the leachate will need to be resistant to corrosion due to salts in the leachate. Selection of robust materials of construction and cleaning the system according to manufacturer recommendations should minimize risk of corrosion.

The benefits of this system are the ability to use the LFG produced on-site at MSB, the high-volume reduction leading to minimal material being returned to the Landfill, and the flexible operating conditions. The fact that the Borough is investing in an active GCCS in 2020 makes this option more attractive. The drawbacks of this system include the increased operation and maintenance (O&M) demands for MSB staff, the significant capital expense, and the financial reliance on LFG availability. Additionally, if MSB pursues another end use for LFG, the purchase of natural gas in the evaporator would significantly increase operating costs.

4.3.3.3 Option 3: Membrane Filtration

During the past three years, MSB has considered using a proprietary leachate treatment process from Clark, called Leachbuster®, and a 100-percent level design has been completed.

This system involves multi-stage membrane filtration and produces and extremely clean effluent stream. The system can treat the leachate to US EPA Groundwater Discharge Standards and US EPA Primary Drinking Water Standards referenced in ADEC Rules 18 AAC 80 and 18 AAC 70, respectively. These standards have been chosen as the basis for the treatment level by MSB. The filtration system offered by Clark is modular which allows for a wide range of operating flows and future expandability. The proposed system also has the capability of operating continuously or as a batch process, providing additional flexibility for operation based on leachate volume available. This system may require further pretreatment of the leachate if the water chemistry changes significantly in the future, due to the high selectivity of this filtration system. Changes in water chemistry could be related to seasonal variability, cell development, implementation of leachate recirculation, or increases in certain waste components at the Landfill. Regular leachate quality and flow monitoring are recommended to assess the need for future adjustments.

This option has been further evaluated and designed by Clark Technologies than any other option evaluated in this Plan. Approximately $770,000 of research, permitting, and design services have been completed to date; this level of design would reduce time and effort of implementing the full constructed system. Another benefit of this system is the ability to reuse the treated water for purposes like irrigation, equipment washdown, and dust control.

This system has a slightly greater amount of concentrate that must be returned to the Landfill. The pilot study completed by Clark indicates 92 percent permeate recovery. In practice, ultrafiltration and reverse osmosis units experience a range of 70 to 90 percent permeate recovery due to leachate flow and quality variability. With the projected Phase 1 leachate generation of 3.2 to 4.4 million gallons per year, the potential permeate rate for the next 20 years could range from 2.2 to 4 million gallons per year. The permeate would be stored for future use or discharged via a forcemain to near the south end of the C&D Landfill expansion area (see **Figure 5**). Conversely, the potential concentrate range could be 320,000 to 1,300,000 gallons per year. Membrane filtration has a significant capital cost, as well as more O&M requirements than the other options. These O&M requirements include membrane cleaning (including chemicals) and replacement, high pressure pump maintenance, higher electrical usage, and clean water forcemain outfall maintenance.

4.3.3.4 Supplementary Options

4.3.3.4.1 Leachate Recirculation

Recirculation of leachate returns the collected raw leachate, or the residuals from the evaporation or membrane options, back to the waste within the Landfill. Incoming waste has a typical moisture content of 20 to 25 percent while the field capacity is 45 to 55 percent. During recirculation, this liquid accumulates in the waste pore space as dictated by available surface tension. A moisture content increase to 30 to 35 percent is desired. Leachate generation will increase as moisture content increases and surface tension decreases.

The HELP modeling completed on this Plan (Appendix E) indicates that 94 percent of leachate generated in an active cell can be recirculated, while 100 percent of leachate from a cell at intermediate grades can be recirculated. As a rule of thumb, 25 to 50 gallons of leachate can be recirculated for each ton of waste disposed. In 2019, 57,311 tons of MSW were disposed indicating that between 1.4 and 2.9 million gallons of leachate could have been recirculated. This is 45 to 90 percent of the 2019 leachate generated volume and all of the concentrate volume from the evaporation or membrane technology.

Recirculation can be completed by several methods including:

- “Rabbit holing” by excavating holes in the active or intermediate areas and discharging a tanker or pumping a known volume into the hole, and then covering the hole with Waste and cover soil. The location is documented with global positioning system (GPS) survey. This option has advantages low capital costs and good moisture distribution in the waste. A drawback is that it can be labor intensive depending on the daily volume.
- Pumping systems that deliver leachate from the lagoon area to the disposal cells. The current 2020 GCCS project includes a vault (see **Figure 23**) by the lagoons that has a stub out for future leachate recirculation to future cells. At each cell, whether in active, intermediate, or final development, a pump at the lagoons can direct leachate to a buried lateral or bed in the cell, or to a spray system at the active working face. Laterals and beds are spaced every 100 feet horizontal and staggered vertically every 20 feet. This option has higher capital costs, but operation can be automated. Water distribution in the waste can be limited if lateral or beds are used, while distribution can be maximized with working face application. To minimize health impacts, working face application is limited to non-customer hours, during non-freezing weather, and with wind restrictions to minimize drift.

Recirculation can provide several benefits including waste degradation, reduced leachate concentrations, reduced leachate volume from waste storage, leachate treatment from the biology within the waste, increase LFG generation rate to support a reuse project, accelerated waste settlement allowing the recapture of airspace, deferment of permitting and construction costs, and leachate management savings. Leachate application to the working face can improve compaction and litter control. The positive impact of recirculation on LFG generation rate provided in Appendix I of this Plan. Long term, since leachate quality will be improved, settlement will be maximized, and LFG generation has been accelerated, financial assurance liabilities during post-closure should be reduced.

Challenges of leachate recirculation include potential odors, inefficient LFG collection due to higher waste moisture content, higher leachate concentrations for certain parameters (e.g., ammonia), slope stability, and leachate seeps. These challenges can be overcome through engineering and operational controls.

Recirculation should be incorporated into whichever primary leachate treatment option MSB implements in the future, even if hauling to AWWU is continued. The design of the LFG management system should consider the increased gas production if recirculation is considered further. Design elements of the GCCS that address leachate recirculation and proactive LFG collection are shown on **Figure 24** and **Figure 27**. This includes horizontal collectors on the liner and within the waste. Overall leachate recirculation would have positive effects on leachate treatment and management at MSB but would require additional capital expenses and operational requirements.

The initial capital expense to implement a pumped recirculation system would be about $250,000 for pump systems, flow meters, electric and controls, and the initial forcemain and manifold. MSB would then spend about $50,000 to $100,000 annually to expand the system of laterals or beds as cells are developed. Recirculation could begin in Cell 3 with the installation of laterals or beds within the final lift. This construction should occur in the 2021/2022 timeframe since Cell 3 is projected for closure in 2023. Infrastructure would include a forcemain into the cell, with distribution to four recirculation laterals or two recirculation beds at a cost of $250,000. Recirculation into Cell 3 could continue even after closure occurs. The airspace gained (15 to 30 percent) and the resulting revenue should compensate these expenses. Once valves are manually adjusted, operation would be automated where the pump would be started, and system shutdown would occur at a specified volume for each lateral or working face application. Note that working face application would occur after hours to maintain customer safety.

4.3.3.4.2 Pretreatment

Leachate flow and quality is quite variable depending on waste disposed, phase of landfill development, time of year, and precipitation. Pretreatment of the leachate upstream of a major treatment process option like membrane filtration may be recommended, or even required based on the water chemistry of the leachate to improve treatment efficiency. High concentrations of organics, phosphorus, nitrogen, solids, metals, alkalinity, or excessively high or low pH can all affect the treatment performance of the evaluated technologies.

The evaporation and membrane filtration options both include forms of chemical addition to clean and improve the performance of their treatment systems. Additional forms of chemical or biological pretreatment or filtration may be required as designs progress further. For example, air addition to the current lagoons could reduce BOD_5, VOCs, and metals concentrations. It is important that these designs and operation are based on comprehensive testing (before design and during operation) to understand the variability on leachate quality and flow. The guidance of the selected technology manufacturers is followed based on the leachate quality analysis.

4.3.3.5 Combination of Options

It is possible to combine some of the leachate treatment methods evaluated. This includes implementation of either leachate recirculation or pretreatment with each of the three primary options. For example, leachate recirculation can lead to an overall reduction in the contaminant levels within the leachate and the amount of leachate that must be hauled or treated. Pretreatment could be applied to either evaporation or membrane filtration to improve performance and/or reduce operations and maintenance for the systems.

Membrane filtration and evaporation can also be applied in series to further reduce the amount of concentrated byproduct returned to the Landfill. This system would apply filtration in the same manner as Option 2 but would include an additional evaporator system for the concentrate stream. This would further reduce liquid volume of the stream while retaining most of the residual contaminants that would return to the Landfill. This system would have a significantly increased capital and O&M costs without significant benefit to MSB. The treated stream in Option 1 and Option 2 can already be disposed of or reused, while the return of the concentrated byproduct stream should not impact the Landfill at the volumes being considered.

4.3.4 Byproduct Handling

Each of the on-site treatment options have a waste stream that is proposed to return (i.e., recirculated) to the Landfill as a concentrate. Any byproducts returned to the Landfill should be tested and confirmed as non-toxic according to the US EPA developed Toxicity Characteristic Leaching Procedure. If the byproducts cannot be deemed non-toxic, then additional measures like chemical addition or further treatment may be required, or off-site disposal may be required. These additional measures would further impact the financial aspects of on-site treatment and should be evaluated in further phases of design. Testing by Clark during their development of Option 3 has indicated that these byproducts are non-hazardous. This is consistent with byproduct testing for these technologies at other MSW landfills.

4.3.5 Cost Analysis for Leachate Treatment

A 20-year life cycle cost analysis was conducted for each of the primary treatment options to directly compare their costs over the course of their operating lifetimes. Time value of money was used to present the final cost at the end of 20-years in 2020 dollars. Additional details on construction costs are provided in Appendix F. This timeframe is consistent with the Phase 1 development of the Landfill, with operation through Cell 5 projected until 2043.

General assumptions for the life cycle cost analysis are as follows:

- Time value of money based on 2020 dollars
- Net Present Value (NPV) is equated using: $NPV = Cost * \left(\frac{1}{(1+interest\ rate)^{current\ year-intial\ year}}\right)$
- 20-year life cycle for each option
- Debt Service cost of 1.5 percent (i.e. 1.5% annual interest being paid on equal loan payments over life-cycle)
- Inflation rate of 2.14 percent
- Discount rate of 0.67 percent
- No salvage value of any construction costs
- O&M costs based on the range of 3.2 to 4.4 million gallons of leachate treated per year through Phase 1 Landfill development, with a daily design capacity of 20,000 gallons of leachate treated per day for operational flexibility. The total volume of leachate over the 20-year period is 76.6 million gallons.
- Labor estimate is included in General Maintenance and is based on an annual Salary & Benefit of $160,000

- Electrical price = $0.1682 per kilowatt hour (kWh), based on Palmer industrial rate according to (SOURCE - https://www.electricitylocal.com/states/alaska/palmer/)
- Natural gas price = $10.66/1,000 cubic feet, based historical natural gas data from MSB

4.3.5.1 Option 1: Status Quo of Hauling to AWWU

A summary of the 20-year life cycle cost for Option 1 is provided in Table 4-5.

Table 4-5: Option 1 – Status Quo Life Cycle Cost Summary

Year	Construction Cost	Debt Service	OM&R	Additional Energy	Total	Total Present Value	Summation Present Value
2020	$ 0	$ 0	$ 262,400	$ 0	$ 262,400	$ 262,000	$ 262,000
2021		$ 0	$ 268,020	$ 0	$ 268,020	$ 266,000	$ 528,000
2022		$ 0	$ 299,420	$ 0	$ 299,420	$ 295,000	$ 823,000
2023		$ 0	$ 305,820	$ 0	$ 305,820	$ 300,000	$ 1,123,000
2024		$ 0	$ 312,370	$ 0	$ 312,370	$ 304,000	$ 1,427,000
2025		$ 0	$ 319,050	$ 0	$ 319,050	$ 309,000	$ 1,736,000
2026		$ 0	$ 325,880	$ 0	$ 325,880	$ 313,000	$ 2,049,000
2027		$ 0	$ 332,850	$ 0	$ 332,850	$ 318,000	$ 2,367,000
2028		$ 0	$ 339,980	$ 0	$ 339,980	$ 322,000	$ 2,689,000
2029		$ 0	$ 347,250	$ 0	$ 347,250	$ 327,000	$ 3,016,000
2030		$ 0	$ 354,680	$ 0	$ 354,680	$ 332,000	$ 3,348,000
2031		$ 0	$ 362,270	$ 0	$ 362,270	$ 337,000	$ 3,685,000
2032		$ 0	$ 465,180	$ 0	$ 465,180	$ 429,000	$ 4,114,000
2033		$ 0	$ 475,130	$ 0	$ 475,130	$ 436,000	$ 4,550,000
2034		$ 0	$ 485,300	$ 0	$ 485,300	$ 442,000	$ 4,992,000
2035		$ 0	$ 495,680	$ 0	$ 495,680	$ 448,000	$ 5,440,000
2036		$ 0	$ 506,290	$ 0	$ 506,290	$ 455,000	$ 5,895,000
2037		$ 0	$ 517,130	$ 0	$ 517,130	$ 462,000	$ 6,357,000
2038		$ 0	$ 528,190	$ 0	$ 528,190	$ 468,000	$ 6,825,000
2039		$ 0	$ 539,500	$ 0	$ 539,500	$ 475,000	$ 7,300,000
Totals	**$ 0**	**$ 0**	**$ 7,842,390**	**$ 0**	**$ 7,842,390**	**$ 7,300,000**	

Note: OM&R is Operation, Maintenance and Replacement

The life-cycle cost analysis for Option 1 assumed:

- The annual design volume of 3.2 million gallons steps to 3.5 million gallons in 2022 when Cell 4 opens and 4.4 million gallons in 2032 when Cell 5 opens;
- Leachate is hauled to AWWU at a rate of $0.082 per gallon (2020 dollars);

- Price of hauling and disposal at AWWU increases with inflation; and,
- Continued acceptance of leachate by AWWU.

The total NPV for treating 76.6 million gallons of leachate is $7,300,000. The resulting NPV cost per gallon of leachate hauled and disposed at AWWU is $0.095 per gallon.

4.3.5.2 Option 2: Evaporation

A summary of the 20-year life cycle cost for Option 2 is provided in Table 4-6.

Table 4-6: Option 2 Life Cycle Cost Summary

Year	Construction Cost	Debt Service	OM&R	Additional Energy	Total	Total Present Value	Summation Present Value
2020	$ 3,426,314	$ 200,000	$ 102,630	$ 100	$ 302,730	$ 303,000	$ 303,000
2021		$ 200,000	$ 104,826	$ 100	$ 304,926	$ 303,000	$ 606,000
2022		$ 200,000	$ 107,070	$ 100	$ 307,170	$ 303,000	$ 909,000
2023		$ 200,000	$ 109,361	$ 110	$ 309,471	$ 303,000	$ 1,212,000
2024		$ 200,000	$ 111,701	$ 110	$ 311,811	$ 304,000	$ 1,516,000
2025		$ 200,000	$ 114,092	$ 110	$ 314,202	$ 304,000	$ 1,820,000
2026		$ 200,000	$ 116,533	$ 110	$ 316,643	$ 304,000	$ 2,124,000
2027		$ 200,000	$ 119,027	$ 120	$ 319,147	$ 305,000	$ 2,429,000
2028		$ 200,000	$ 121,574	$ 120	$ 321,694	$ 305,000	$ 2,734,000
2029		$ 200,000	$ 124,176	$ 120	$ 324,296	$ 305,000	$ 3,039,000
2030		$ 200,000	$ 126,833	$ 120	$ 326,953	$ 306,000	$ 3,345,000
2031		$ 200,000	$ 129,547	$ 130	$ 329,677	$ 306,000	$ 3,651,000
2032		$ 200,000	$ 132,320	$ 130	$ 332,450	$ 307,000	$ 3,958,000
2033		$ 200,000	$ 135,151	$ 130	$ 335,281	$ 307,000	$ 4,265,000
2034		$ 200,000	$ 138,044	$ 130	$ 338,174	$ 308,000	$ 4,573,000
2035		$ 200,000	$ 140,998	$ 140	$ 341,138	$ 309,000	$ 4,882,000
2036		$ 200,000	$ 144,015	$ 140	$ 344,155	$ 309,000	$ 5,191,000
2037		$ 200,000	$ 147,097	$ 140	$ 347,237	$ 310,000	$ 5,501,000
2038		$ 200,000	$ 150,245	$ 150	$ 350,395	$ 311,000	$ 5,812,000
2039		$ 200,000	$ 153,460	$ 150	$ 353,610	$ 311,000	$ 6,123,000
Totals	**$ 3,426,314**	**$ 4,000,000**	**$ 2,528,700**	**$ 2,460**	**$ 6,531,160**	**$ 6,123,000**	

Note: OM&R is Operation, Maintenance and Replacement

The life-cycle cost analysis for Option 2 assumed:

- LFG produced by MSB has no associated cost when used for the evaporation system since the evaporation system is and add on to the flare skid that is being installed in 2020;

- Adequate LFG is available based on projections through Cell 3 closure and no supplemental natural gas is required;
- An annual design volume of 3.2 million gallons steps to 3.5 million gallons in 2022 when Cell 4 opens and 4.4 million gallons in 2032 when Cell 5 opens; and,
- The same capital costs for civil improvements, leachate piping, building, fees, and contingencies as estimate provided by 100% Design Engineering Report (Clark Technology, 2020).

Periods of reduced treatment rate can better utilize the LFG as a fuel source. The lagoons can serve to store leachate for metering into the evaporator, as necessary. With Cells 2B and 3 closure in 2023, at least 200 scfm should be collected by the GCCS and available. The evaporator can treat at least 12,500 gpd using 200 scfm. Note that the direct contact evaporator unit can operate all year including winter conditions at the Landfill.

The total NPV for treating 76.6 million gallons of leachate is $6,123,000. The resulting NPV cost per gallon of leachate treated by evaporation is $0.080 per gallon.

If LFG produced on site is not available to fuel the leachate evaporation process, then natural gas must be purchased to fuel the evaporator. This scenario could be present, for example, from using LFG to generate electricity elsewhere at the Landfill. The NPV for treating 76.6 million gallons of leachate by only purchasing natural gas is $15,637,000. The corresponding NPV cost per gallon of leachate treated by evaporation is $0.204 per gallon.

Capital costs associated with connecting the evaporator unit to utility natural gas are not included as part of the rate or cost estimate in this case. This capital cost would further increase the life cycle cost of the evaporation system in the case of using natural gas as the only fuel, or as a supplementary fuel.

4.3.5.3 Option 3: Membrane Filtration

A summary of the 20-year life cycle cost for Option 3 is provided in Table 4-7.

Table 4-7: Option 3 Life Cycle Cost Summary

Year	Construction Cost	Debt Service	OM&R	Additional Energy	Total	Total Present Value	Summation Present Value
2020	$ 4,775,363	$ 278,000	$ 142,880	$ 20,630	$ 441,510	$ 442,000	$ 442,000
2021		$ 278,000	$ 145,940	$ 21,070	$ 445,010	$ 442,000	$ 884,000
2022		$ 278,000	$ 149,060	$ 21,520	$ 448,580	$ 443,000	$ 1,327,000
2023		$ 278,000	$ 152,250	$ 21,990	$ 452,240	$ 443,000	$ 1,770,000
2024		$ 278,000	$ 155,510	$ 22,460	$ 455,970	$ 444,000	$ 2,214,000
2025		$ 278,000	$ 158,840	$ 22,940	$ 459,780	$ 445,000	$ 2,659,000
2026		$ 278,000	$ 162,230	$ 23,430	$ 463,660	$ 445,000	$ 3,104,000
2027		$ 278,000	$ 165,710	$ 23,930	$ 467,640	$ 446,000	$ 3,550,000
2028		$ 278,000	$ 169,250	$ 24,440	$ 471,690	$ 447,000	$ 3,997,000
2029		$ 278,000	$ 172,870	$ 24,960	$ 475,830	$ 448,000	$ 4,445,000
2030		$ 278,000	$ 176,570	$ 25,500	$ 480,070	$ 449,000	$ 4,894,000
2031		$ 278,000	$ 180,350	$ 26,040	$ 484,390	$ 450,000	$ 5,344,000
2032		$ 278,000	$ 184,210	$ 26,600	$ 488,810	$ 451,000	$ 5,795,000
2033		$ 278,000	$ 188,150	$ 27,170	$ 493,320	$ 452,000	$ 6,247,000
2034		$ 278,000	$ 192,180	$ 27,750	$ 497,930	$ 453,000	$ 6,700,000
2035		$ 278,000	$ 196,290	$ 28,350	$ 502,640	$ 455,000	$ 7,155,000
2036		$ 278,000	$ 200,490	$ 28,950	$ 507,440	$ 456,000	$ 7,611,000
2037		$ 278,000	$ 204,780	$ 29,570	$ 512,350	$ 457,000	$ 8,068,000
2038		$ 278,000	$ 209,170	$ 30,200	$ 517,370	$ 459,000	$ 8,527,000
2039		$ 278,000	$ 213,640	$ 30,850	$ 522,490	$ 460,000	$ 8,987,000
Totals	**$ 4,775,363**	**$ 5,560,000**	**$ 3,520,370**	**$ 508,350**	**$ 9,588,720**	**$ 8,987,000**	

Notes: OM&R is Operation, Maintenance and Replacement. The construction cost estimate includes $773,425 of Engineering costs for work completed to-date, representing sunk costs already expended by MSB for this option.

The life-cycle cost analysis for Option 3 assumed:

- An annual design volume of 3.2 million gallons steps to 3.5 million gallons in 2022 when Cell 4 opens and 4.4 million gallons in 2032 when Cell 5 opens.
- Estimates provided by 100% Design Engineering Report (Clark Technology, 2020) still apply.

The total NPV for treating 76.6 million gallons of leachate is $8,987,000 ($8,143,000 if sunk engineering costs are excluded). The resulting NPV cost per gallon of leachate treated by membrane filtration is $0.117 per gallon ($0.106 per gallon if sunk engineering costs are excluded).

4.3.6 Conclusions & Recommendations

MSB must plan for future increases in the amount of leachate generated, while also considering that the cost of their current method of disposal may increase in the future. These considerations favor having an alternate on-site leachate treatment option, something that MSB has been considering since 2006, ready to implement when economic conditions dictate. The leachate can be effectively treated on-site by membrane filtration or by an evaporation system. Additionally, leachate recirculation is a viable option presently, as a bridge while implementing an on-site strategy, or as an option for concentrate disposal for the on-site options.

Table 4-8 summarizes the benefits, challenges, permitability, constructability, operations, and costs of the three leachate management options evaluated.

Table 4-8: Leachate Treatment Option Benefits, Challenges and Cost Summary

Item	Option 1: Status Quo of Hauling to AWWU	Option 2: Evaporator	Option 3: Membrane Filtration
Benefits	No Capital Expense	Reuse of LFG Volume Reduction Flexible Operation	Clean Water Source Volume Reduction ADEC Approval Process Underway Engineering Complete Flexible Operation
Challenges	Uncertain AWWU pricing Future Permit Conditions Limited Loads per Day	Significant Capital and Moderate Operation Expense Slurry Requiring Landfill Disposal Lost Opportunity for LFG Electricity Project	Significant Capital and Operating Expenses Concentrate Requiring Landfill Disposal
Permitability	AWWU Industrial Discharge Permitting	ADEC Approval with Potential Air Permit	ADEC Approval
Constructability	N/A	Adjacent to LFG Blower/Flare Skid Minimal Below Grade Requirements	Adjacent to Leachate Lagoons Moderate Below Grade Requirements
Operations	Minimal Requirements	Moderate Requirements	Moderate Requirements
Cost*	NPV: $7,300,000 $0.095/gal	NPV: $6,123,000 $0.080/gal	NPV: $8,987,000 $0.117/gal

Note: *Cost shown for evaporator based on LFG energy source; using natural gas, NPV increases to $15.6 million and rate to$0.204 per gallon. Costs shown for membrane filtration include engineering costs completed to date for Option 3. Excluding these costs results in an NPV of $8,143,000 total and $0.106 per gallon.

If an alternate leachate treatment method to AWWU is desired by MSB, both the evaporation and filtration systems are viable options. Evaporation provides operational flexibility (i.e., operate in batch or continuously), benefits from the presence of LFG as a fuel source, has lesser O&M requirements, and slightly lower cost over a 20-year life cycle. However, a key factor making the evaporation system favorable is the development and implementation of an GCCS in 2020 and the associated sunk capital costs for MSB. Selecting the leachate evaporation technology would also mean that the design cost for the 100-percent design of Clark Technology's leachate filtration system would be a sunk cost. If LFG proceeds with another reuse (e.g., electric generation), membrane filtration would have a cost advantage for the on-site alternative. MSB needs to weigh these technical and cost factors when selecting an onsite treatment option.

Further investigation into the effects of leachate recirculation is also recommended. Testing or piloting a recirculation system would provide further insight as to how this practice could affect other treatment options and Landfill operations in general for MSB. Recirculation provides many benefits the most significant of which is the recapture of permitting and constructed airspace.

5.0 LANDFILL GAS MANAGEMENT PLAN

Landfill gas (LFG) generated within the Landfill will be controlled on-site. LFG generation occurs under anaerobic conditions in which methanogenic microorganisms create LFG when breaking down the waste. This process results in LFG composing typically of 50-percent methane and 50-percent carbon dioxide, with trace amounts of nonmethane organic compounds (NMOCs), oxygen, nitrogen, hydrogen sulfide, and siloxanes. The composition of LFG is generally considered to have half the heating value of natural gas, or an average heating value of 506 British thermal units (Btu) per standard cubic feet (scf). LFG movement within the landfill is driven by pressure and waste permeability. With the exception of Cells 1 and 2A at the Landfill, which are unlined, the liner system for future cells should restrict lateral and downward LFG migration into the adjacent geology.

A gas collection system can be installed to control the release of LFG from the Landfill. Collection systems can be passive, with vent wells within the waste or perforated piping beneath the final cover that allows captured LFG to vent at the landfill surface. If more proactive control is required, an active LFG collection system is installed, where a vacuum from a blower is imparted on wells and/or other collectors via a network of header and lateral piping. The collected LFG is combusted in a flare or through a beneficial reuse (e.g. electricity generation). The LFG collectors, piping network, and combustion devices are collectively termed a gas collection and control system (GCCS).

The objectives of this LFG Management Plan are to:

- Describe the existing LFG monitoring program and migration control system.
- Summarize the MSB response to LFG migration in early 2020.
- Present modeling projections of future LFG generation, including the impact of leachate recirculation and organics diversion.
- Describe the design of the active GCCS as a long-term solution to control LFG migration.
- Complete an evaluation of LFG beneficial reuse options.
- Discuss air permitting regulatory compliance.
- Recommend an implementation plan for LFG activities.
- Provide planning level cost estimates for future LFG systems.

5.1 Existing LFG Monitoring and Control

Currently, LFG control consists of a passive venting system beneath the Cell 2A final cover system. Cell 2A final cover was constructed in 2015 and includes a GCL impermeable layer. The venting system consists of a trench grid containing four-inch perforated HDPE pipe installed beneath this GCL to capture collected LFG. The grid system emits LFG at the crown of Cell 2A through a series of seven vertical vents that protrude through the final cover system. The effectiveness of this system in the unlined cell is limited since the surface piping does not influence LFG in deeper portions of the Landfill, which is evidenced by LFG odors at the western toe of Cell 2A and methane detections in the monitoring probes.

The landfill also has an existing network of six perimeter LFG monitoring probes as shown on **Figure 4** (CLFP-1 to CLFP-6). These probes and on-site structures are monitored for methane as specified in the Landfill's ADEC permit documents. The probes are screened in the subsurface strata above the groundwater table. Probes CLFP-1 and CLFP-2 are west and north of the C&D landfill. Probes CLFP-3 to CLFP-6 are along the northern property boundary. There are also two Gas Wells within the Cell 1 waste, CLFG-1 and CLFG-2.

MSB Personnel will continue to conduct monthly gas monitoring at Gas Wells CLFG-1 and CLFG-2; and Gas Monitoring Probes CLFP-1 through CLFP-6; the crawlspaces of the CLF scalehouse building and Animal Control facility; and ambient air at 200-foot intervals along the northern facility perimeter between the Animal Control building and the entrance gate to the Crevasse Moraine trailhead. The crawlspaces are considered confined spaces and will not be entered by the field sampler. Ambient air methane gas monitoring will continue to be performed quarterly at each of the groundwater monitoring wells currently in the sampling program (Monitoring Wells CLF-9, CLF-11, CLF-15R, CLF-16, CLF-17, CLF-19, CLF-20, CLF-21, CLF-22, CLF-24) by the MSB Environmental Consultant, currently Shannon and Wilson, Inc.

An RKI Eagle will be used to measure the concentrations of methane (percentage of the lower explosive limit and/or percent by volume), carbon dioxide (percent by volume), and oxygen (percent by volume). At the time of sampling, barometric pressure will be recorded from the Davis Weather Link weather station. The weather station is located on Cell 2A. Weather station information is available to the field sampler via cell phone application. The RKI Eagle will be calibrated prior to each monitoring event according to the manufacturer's specifications as detailed in the equipment manual, Appendix G. Field measurements will be recorded on the field form for gas monitoring provided in Appendix G.

For Gas Wells and Gas Monitoring Probes, the RKI Eagle will be connected to the probe and the probe valve will be opened. Measurements will be taken continuously until gas readings stabilize within 0.5% by volume. The stabilized measurement will be recorded, the valve shut, and the monitoring device disconnected. The Animal Control and scalehouse crawlspaces will be measured by lowering the monitoring device probe into the crawlspace; the sampler will not enter the confined space. Measurements will be collected from all three sides of the crawlspace opening, with the fourth side being the foundation wall. Measurements will be taken continuously until gas readings stabilize within 0.5% by volume. Ambient air measurements will be collected at predetermined intervals along the northern property. To minimize the impacts of air dilution, the sampler will collect ambient air measurements from the ground surface and/or insert the monitoring device probe into available holes or cracks in the ground surface at the predetermined intervals.

Monthly monitoring events will typically be performed during the first week of the respective month. MSB will submit results of the monitoring event to ADEC within 14 days of the event. MSB personnel will transfer field data to a spreadsheet and submit to ADEC. The spreadsheet will contain all historical sampling data. Field data and historical data sampling will be stored electronically in the MSB records retention system.

5.2 Summary of 2020 Landfill Gas Migration

On January 23, 2020, routine monthly LFG monitoring was performed at the Landfill. During the sampling event, methane levels were detected at 22 percent by volume (or 440-percent of the lower explosive limit [LEL]) at gas monitoring probe CLFP-3. The results were submitted to ADEC on January 24, 2020. ADEC responded with a letter dated January 30, 2020 in which ADEC found the Landfill to be in violation of 18 AAC 60.350 which defines a methane gas exceedance from a municipal solid waste landfill as 100 percent of the LEL at the facility boundary and 25 percent LEL within facility structures, which are equivalent to methane concentrations of 5 percent and 1.25 percent by volume, respectively.

In response, MSB began daily monitoring of the probes and passive vents on January 31, 2020. Gas monitoring probes CLFP-3, CLFP-4, CLFP-5, and CLFP-6 are located outside the limits of waste along the northern extent of the Facility and serve as perimeter methane monitoring compliance points. On January 30, 2020, MSB began contacting all property owners within 1,000 feet of CLFP-3 by telephone. On January 31, 2020, a notification letter was sent via certified mail to all property owners within a half-mile radius of probe CLFP-3 to inform them of the exceedance and to offer methane testing through a third-party contractor at the owners' structures. As a result, 102 property owners were contacted, and 42 properties were tested.

Methane has been detected at one residence, within about 300 feet of CLFP-3. The initial reading on February 3, 2020 from this residence was 16 percent LEL. MSB furnished the resident a dedicated, continuous methane monitoring device set to emit an audible warning tone at 25 percent LEL. Methane has not been detected at the residence since February 20, 2020.

In an effort to mitigate the migration of LFG from the Landfill, MSB completed the following actions:

- On February 4, 2020, MSB inspected the Cell 2A vents to verify operation and they were found to be blocked with snow and ice at the ground surface. Once this was cleared, the vents began emitting LFG as designed. These vents are connected to the horizontal passive LFG collection grid immediately beneath the final cap and influence the upper waste mass. It is suspected that the combination of weather conditions and frost depth led to freezing of condensate within the LFG at this point.
- On February 4, 2020, a portable blower was attached to Vent 1 in Cell 2A to impart a vacuum on the waste mass. The other vent pipes were capped to prevent oxygen intrusion from ambient air. The blower is rated at 80 scfm and was moved to other vents at times to create a more centralized extraction from Cell 2A. Blower operation was suspended if oxygen readings exceeded 10 percent.
- On February 6, 2020, a portable blower was connected to CLFP-3 to impart a vacuum on the probe to intercept LFG migrating toward the north property boundary at this location. This blower is rated also at 80 scfm.
- Methane readings in CLFP-3 began going below 100 percent LEL on about May 1, 2020 and have remained below 100 percent LEL since May 5, 2020. Monitoring reverted to weekly on May 11.

5.3 Landfill Gas Control Plan

In response to the 2020 LFG migration and ADEC's requirements for the implementation of a long-term solution, MSB has completed the design of an initial GCCS that will be installed later this year. The GCCS will be installed within closed Cells 1 and 2A, consisting of 13 gas recovery wells. Both Cells 1 and 2A are unlined. **Figure 25** provides a plan view of this portion of the GCCS. The wells are generally positioned along the northern edge of these cells, serving to intercept LFG within the waste profile before migrating toward the north property boundary. The wells are connected with a series of piping, below grade within Cell 1 and on the surface within Cell 2A. Vacuum will be imparted on the wells and piping network from a new blower/flare skid that will be located near the leachate storage lagoons. LFG will be combusted via an enclosed flare, which was selected since the flame is enclosed at the bottom of flare stack, limiting visibility from adjacent properties.

The GCCS also includes condensate management. LFG is saturated with moisture and has elevated temperature when extracted from a landfill, typically 80 to 120 degrees Fahrenheit. As the LFG travels through the piping outside the landfill and cools to ambient conditions, condensate will form. Condensate generated will be collected in two condensate sumps (CS). CS-01 is located at the northern extent of Cell 2A and CS-02 is adjacent to the flare skid.

5.3.1 Condensate Estimates

CS-01 will consist of a condensate storage tank that will be manually pumped as needed. CS-02 will consist of a large-diameter pipe with an electric pump. When actuated, the pump will transmit the condensate from CS-02 to the leachate vault just east of the leachate lagoons via a condensate force main and then into the lagoons. Details on the GCCS are provided in **Figure 26** through **Figure 29**.

Condensate estimates were calculated based on the modeled LFG generation rates for the base case scenario (no leachate recirculation and no organics diversion). It was assumed 75 percent of the LFG generated is collected by the GCCS, per industry standard. As mentioned above, when the LFG migrates from the waste mass into the GCCS piping network, the temperature of the gas will decrease, causing condensate to form. Using *the Landfill Gas System Engineering Design, a Practical Approach* (CES-LANDTEC 2002) guidance, the temperature of the gas can be used to determine its pressure. The ratio of the initial and final pressures of the gas determines the rate at which condensate will form. Using an average temperature difference of 30 degrees Fahrenheit, a peak daily condensate rate of 0.27 gallons per day per cubic feet per minute (gpd/cfm) was calculated. Using an average annual temperature drop of 20 degrees Fahrenheit, an annual average condensate rate of 0.2 gpd/cfm was calculated. Future condensate generation estimates are provided in Table 5-1.

Table 5-1: Future Condensate Generation

Year	Base Case LFG		Base Case Condensate Generation (gallons per day)	Base Case Condensate Generation (gallons per year)
	Generation (cfm)	Collection (cfm)		
2020	328	246	66	18,126
2030	403	302	81	22,269
2040	478	359	95	26,439
2050	555	417	111	30,711

See Appendix H for condensate calculations and assumptions.

5.3.2 GCCS Design Assumptions and Methodology

The radius of influence (ROI) of gas extraction wells determines the appropriate number and placement of wells for an effective GCCS design. The ROI is based on several factors including waste and interim cover permeability and transmissivity, moisture, and applied vacuum. Typically, well spacing is approximately one well per acre, which results in an ROI of approximately 115 feet. A ROI of 115 feet was used for the gas extraction wells around the perimeter of the Landfill. The existing final cover of the Landfill Cell 2A includes an impermeable GCL, providing a barrier between the waste and atmosphere, minimizing air intrusion. Future closure will replace the GCL with a 40-mil LLDPE geomembrane to further minimize air intrusion into the waste through the GCCS vacuum. A larger ROI of 150 feet was used for the interior gas extraction wells, as a greater vacuum can typically be imparted on interior wells. Well locations and lateral/header piping for the entire Landfill development GCCS, Phases 1 through 3, are provided in **Figure 25**.

LFG extraction wells are typically 2 to 3 feet in diameter and are typically drilled with a bucket auger. Well depth from final cover will be determined at the time of GCCS expansion design for:

- Cell 1 and 2A, since these cells are unlined, as either 10-feet above the historic high groundwater table or at the base of waste when encountered during drilling, which ever has the highest elevation. Note that the bottom of waste in these cells is unknown.
- Cells 2B and beyond, since these cells are lined, approximately 10-feet above the top surface of the leachate collection granular drainage layer.

Besides wells, horizontal collectors are also proposed, particularly if MSB develops a LFG reuse project or if MSB needs to minimize odor or LFG emissions in the future. One option proposed is a gas lateral (GL) collector along the ridge lines of the Landfill base liner. This is illustrated in **Figure 10** as an example for Cell 5. Once there is over 20 feet of waste overlying these collectors, LFG collection can begin. The GL would be connected to the GCCS with a temporary lateral to the existing system. GLs can also be placed within waste lifts, placed about every 100-feet horizontally, every 40-feet vertically, and more than 50-feet from the intermediate sideslope. **Figure 24** and **Figure 27** provide sections and details for horizontal collection systems.

As LFG is extracted, moisture present in the LFG will condense as the temperature drops between the waste mass and atmospheric conditions. The condensate will collect in the piping outside of the waste mass. To facilitate effective LFG collection and mitigate the potential for future condensate blockages in the system, a minimum design slope of three percent will be specified in the design for the lateral and header LFG collection piping that is within the landfill limits.

Condensate traps will be installed at the low points within the GCCS to remove condensate from the piping system. As shown in **Figure 25**, there will be approximately four permanent condensate traps around the Landfill (Phases 1-3) after final closure. The condensate traps will drain via gravity through traps that empty directly into leachate collection cleanouts within the cell. A detail of this condensate trap is provided on **Figure 28**. This option will eliminate the need for additional condensate sumps and a force main around the landfill perimeter and the associated freeze risks, for pump purchase and maintenance, and for electric connections. Temporary condensate traps will be needed in situations where the perimeter GCCS header is sloping down to permanent traps. For example, looking at **Figure 25**, condensate generated from collectors in Phase 2, Corridor 3 would drain in final GCCS buildout to CT-02 in Phase 2, Corridor 7. Temporary traps, similar to that shown on **Figure 28**, would need to be installed in Corridors 4, 5, and 6. They could be abandoned once CT-02 is installed. Similarly, temporary traps would be needed in Phase 3, Corridors 2 and 3, before CT-03 is installed with Corridor 4 construction.

The wellfield collection piping layout has been determined based on the final cover system topography, with a minimum slope of three percent for each pipe segment. A header line will be located around the perimeter of the Landfill with several jumper lines across the crest for contingency and to reduce system head losses. The header line will be located over the Landfill footprint in all three Phases of development; the only underground portion is at the connection point by the flare. Header and lateral piping will also be on the final cover surface, rather than buried. The use of surface piping will allow for adjustments as filling progresses and as waste settles.

The wellfield layout was designed using a combination of branch and loop configurations to connect the extraction wells to the blower/flare skid. The header is looped around the perimeter of the landfill and connected at several locations across the landfill to allow the LFG to flow in multiple directions and follow the path of least resistance. This redundancy is important to allow the LFG to bypass portions of the system that are taken out of service for maintenance. Isolation valves are provided on the collection piping (**Figure 25**) to allow shut down of select portions of wellfield for maintenance or repair while allowing the system to continue operation.

A minimum slope of three percent was used for all piping to prevent condensate from clogging the pipes and to account for potential waste settlement over time. The headers are oriented to slope toward the least number of low points using the existing final cover side slope elevations.

5.3.3 GCCS Features

A LFG blower/flare skid will be installed as part of the initial GCCS construction in 2020, just north of the existing leachate lagoons. LandGEM was used to model future LFG generation at the site and to size the initial blower/flare skid. The initial skid is sized to accommodate between 60 scfm and 600 scfm of LFG, allowing the skid to be used for the next 30 years, based on the LFG modeling in Appendix I.

Remote wells are necessary at certain locations throughout the GCCS in order for all segments of collection piping to maintain a minimum three percent slope. The slotted well screen for the remote wells or GLs will be located downslope of the wellhead and associated connection to the lateral/header line. The remote well will extend above the subgrade and connect to a lateral line running upstream to the wellhead and connection point, as shown on **Figure 26**. Condensate formed in the pipe between the well screen and the wellhead will flow back into the well screen.

As indicated on **Figure 25** and **Figure 28**, gas cleanouts (GCO) have been included to assist with maintaining portions of the header and periodically remove debris or blow out accumulated condensate where future waste settlement occurs. The GCOs are located at each high point along the LFG collection header and where the collection piping crosses the crest of the final cover of the Landfill.

The header and lateral wellfield piping will be located on the surface of the Landfill for ease of access for future maintenance and repair. Above-ground piping will be insulated arctic pipe, without heat trace, to protect from freezing. Details are provided in **Figure 26** through **Figure 29**.

5.3.4 Preliminary GCCS Cost Estimates and Sequencing

The contractor bid for the initial Cell 1 and Cell 2A GCCS construction is approximately $1.91M (2020 USD). Subsequent Phase 1 GCCS expansion costs after the initial installation are included in Appendix L, and total Phase 1 GCCS costs are anticipated to be approximately $5.88M (2020 USD). LFG extraction wells and collection piping will be added to the system as the Landfill cells reach final grade. Additionally, interim piping, horizontal gas collection laterals (GLs), and condensate traps may be needed to support a LFG beneficial use project and/or to adequately capture LFG for the purposes of complying with ADEC requirements. Burns & McDonnell recommends that MSB budget about $50,000 to $100,000 annually for interim LFG system expansions.

With the current phasing plan, approximately 39 wells will be added to Phase 1, 94 wells will be installed in Phase 2, and 115 wells will be installed in Phase 3.

5.4 Modeling of Future LFG Generation

As part of this scope, the LFG generation was modeled using the US EPA Landfill Gas Emissions Model (LandGEM). The LandGEM model utilized current waste receipts and future waste disposal projections. This model is utilized solely as a basis for future potential LFG generation rates for purposes of this feasibility study. The LandGEM model uses three main input values for developing LFG generation projections:

- Waste receipts;
- Lo – potential methane generation capacity; and,
- k – methane generation rate, which is dependent upon waste moisture.

The most important contributing factors to LFG generation aside from total waste disposed, are waste moisture and composition. Other factors include climatological conditions, waste temperature, and soil use, among others. LFG generation will continue to increase as the Landfill continues to expand and incoming tonnage increases. Future LFG generation rates were modeled for four different scenarios:

1. The base case assumes the operations at the landfill will continue as they are today with a consistent annual one percent increase of accepted MSW;
2. The leachate recirculation case adds additional moisture from recirculated leachate to the base case, which increases the Landfill's methane generation rate;
3. The organics diversion case reduced the amount of annual accepted waste by 10 percent and diverting high-moisture waste streams out of the Landfill to decrease the methane generation rate; and,
4. The last case applies both leachate recirculation and organics diversion to the base case, resulting in an overall increase to the Landfill's methane generation rate.

Table 5-2 provides the projected LFG generation rates for each scenario assuming the change in operations is implemented 2022. The rate of LFG collected is a percentage of the overall LFG generation rate and depends on the number of collectors and timing of installation as the MSW Landfill develops. Typical collection efficiencies range from 60 to 85 percent of total generation, with the industry average being about 75 percent, per the US EPA's AP-42 Section 2.4. Appendix I provides for additional information on the future LFG generation.

Table 5-2: Future LFG Generation

Year	Projected LFG Generation (scfm)			
	1. Base Case	2. Leachate Recirculation	3. Organics Diversion	4. Leachate Recirculation and Organics Diversion
2020	328	328	328	328
2025	365	417	348	387
2030	403	506	363	443
2040	478	651	400	543
2050	555	769	444	633

scfm – standard cubic feet per minute

5.5 LFG Beneficial Use Feasibility

Landfill Gas (LFG) is a reliable and renewable energy feedstock that can be utilized beneficially to offset the use of fossil fuels for thermal processes, electricity generation, transportation fuels, and other uses (commonly referred to as LFG to Energy). As MSB is taking the initiative to collect LFG, a portion of the up-front LFG to Energy development costs will be offset through avoidance of installation of a GCCS. For the purposes of this financial feasibility evaluation, Burns & McDonnell has assumed that the installation and operation of the GCCS will occur independently of the beneficial use project (e.g. for compliance with Alaska Department of Environmental Conservation (ADEC) solid waste and air regulations).

As part of this plan, the following options were evaluated:

- LFG for electricity generation at the Landfill;
- LFG for electricity generation at the Landfill with waste heat recovery for leachate evaporation;
- LFG for leachate evaporation at the Landfill;
- An LFG Pipeline to the Mat-Su Regional Medical Center (Medical Center), utilizing the LFG for:
  - Combined Heat and Power (CHP);
  - Direct Use within a New Boiler; and

It should be noted that although the above options were the primary scope of this feasibility study, four other LFG reuse options were initially considered, specifically:

- CHP at the Landfill. There are several buildings that are located at or near the Landfill. Burns & McDonnell reviewed utility bills for each building and the associated relative costs of the CHP equipment (heat exchangers, unit heaters, and glycol supply and return piping). Based on the cursory review, waste heat recovery from a reciprocating engine and associated utilization buildings near the landfill is cost prohibitive due to low thermal requirements for each building.

- Direct use of the LFG in boilers for Landfill building heating. The capital costs associated with this option are relatively low compared to the full analyses conducted; however, the benefit of utilizing LFG collected by the GCCS is not fully realized due to heating demand being substantially lower than the LFG that can be produced by the Landfill. Operation and maintenance for this system would include additional staff time for GCCS monitoring and balancing, utility costs, maintenance of the blower/flare skid and boiler, and unplanned contingencies. Experience with similar systems at other landfills indicates a return on investment of approximately 15 years. This option could be considered if no other reuse options are implemented.
- CHP at Mat-Su College (College). The College is located approximately two miles southwest of the Landfill (closer than the Medical Center by approximately one mile – see **Figure 3**); however, Burns & McDonnell and Borough representatives were unable to make contact with the College. Based on discussions with MSB, the College would have a substantially lower heat demand than the Medical Center, making it difficult to financially justify this option.
- Process LFG to compressed natural gas (CNG) for use as transportation fuel. There are substantial renewable fuel credits available in the United States if the LFG is used for transportation purposes. Two potential CNG options were considered:
  - Upgrading LFG to pipeline quality gas (removing carbon dioxide and other impurities) for injection to the grid. This option was determined to be not feasible as capital and operational costs associated with the project for treatment equipment, gas compressors, and pipeline are substantial relative to the revenue generation potential. For further analysis of this option, the Landfill would need to generate about four times the amount of LFG that is believed to be currently collectable, or roughly 1,000 scfm.
  - Upgrading LFG for use at a dedicated CNG fueling station. This option requires similar equipment to that required for generating pipeline quality gas. The capital costs associated with the treatment and fueling systems for CNG would be less than LFG conversion to pipeline quality gas, but there are additional costs associated with converting and maintaining a fleet of CNG-capable vehicles. Furthermore, the LFG to CNG fuel station would likely be the only CNG station in the region, resulting in potential demand shortages and lack of back-up options should the LFG to CNG station be offline for maintenance or other reasons.

The options evaluated in this feasibility study are further detailed in the following sections.

5.5.1 LFG for Electricity Generation at the Landfill

Based on the LFG generation and associated collection discussed prior in this Section, Burns & McDonnell selected a 1.14-Megawatt (MW) Innio Jenbacher J416 engine for the 20-year analysis, although other LFG fueled electric generators exist. Jenbacher generators have been used successfully around the country in similar LFG reuse projects.

The initial LFG collection quantity in 2021 corresponds to the engine being able to operate at an average of 75 percent of the maximum capacity. Based on LFG collection projections, the engine will be operated at full capacity in year 16 of the analysis, and the average capacity is approximately 90 percent over the 20-year evaluation period. The engine was assumed to be operational for 92 percent of a given year, which is typical for LFG to electricity facilities, as the engine will require preventative and corrective maintenance. The generation equipment would be located adjacent to the blower/flare skid and electricity would connect to Matanuska Electric Association, Inc. (MEA) powerlines at the Landfill property.

Budgetary quotes for the engine, container, switchgear, and operations & maintenance (O&M) were provided by California-based Western Energy Systems. Western Energy Systems currently operates the Joint Elmendorf-Richardson base LFG to electricity project located in Anchorage, Alaska. The selected J416 engine, as identified above, is from the same engine family that is currently in use at the Joint Elmendorf-Richardson base.

The analysis assumes that MSB self develops the project and receives payments from MEA for the electricity generated at the MEA’s Small Facility Power Purchase Rate of $0.07985/kWh. The project simple payback is 9.7 years and has a 20-year net present value of approximately $5.0M (~$250,000 annual benefit). Supporting information is provided in Appendix J.

5.5.2 LFG for Leachate Evaporation at Landfill with Electrical Generation

Burns & McDonnell built upon the preceding feasibility analysis of generating electricity and evaluated the addition of an engine exhaust heat recovery system to evaporate leachate at the Landfill. For the analysis, Burns & McDonnell consulted with Heartland Water Technology regarding their system for recovering engine waste heat and evaporating leachate. Heartland Water Technology’s system can evaporate roughly 5,200 gallons per day when the engine is operated at full load at an operating cost of $0.01-$0.015/gallon. A capital system cost was provided by Heartland Water Technology (roughly $300k less than the evaporator specified for use in Section 4.0) and balance of plant capital costs were assumed to be similar to the costs provided in Appendix F (removed the contingency and engineering costs to avoid double counting).

The analysis includes electricity revenues as specified in the preceding section and an additional avoided cost for not having to haul the leachate that is evaporated by the waste heat evaporation system. The project simple payback is 13.3 years and has a 20-year net present value of approximately $2.87M (~$140,000 annual benefit). Supporting information is provided in Appendix J.

While Heartland Water Technology's system can only evaporate roughly 5,200 gallons per day at full capacity, the total leachate generation at the Landfill is projected to exceed this amount in the future. Therefore, it is anticipated that some leachate will still need to be hauled to AWWU or managed by some other method.

5.5.3 LFG for Leachate Evaporation at Landfill

Additional options for evaporating leachate at the Landfill using LFG is discussed in detail in Section 4.3.3.2 of this Plan. Burns & McDonnell reviewed the financial performance of the leachate evaporation option discussed in Section 4 and compared it with the status quo of hauling leachate to the local POTW. The project simple payback is approximately ***14 years and has a 20-year net present value of approximately $900,000 (~$45,000 annual benefit).*** Supporting information is provided in Appendix F and Appendix J.

5.5.4 LFG Beneficial Use at Medical Center

The Mat-Su Regional Medical Center is located approximately three miles southwest of the Landfill at the intersection of Trunk Road and Parks Highway (see **Figure 3**). Two options were evaluated for the development of a LFG beneficial use project at the Medical Center. The options are (1) electric generation with combined heat and power (CHP) and (2) direct use of the LFG in a new specialized boiler intended to run on LFG.

These scenarios assume that a dedicated, low pressure, LFG pipeline would be required to be constructed from the Landfill to the Medical Center. For this evaluation, the costs associated with the use or acquisition of the land were not included, as it was assumed that the pipeline would be constructed in right of way, on property owned by the Medical Center, and on property owned by the Borough.

The Medical Center currently utilizes two natural gas fired boilers to produce steam for sanitary and building space heat. Medical Center staff provided natural gas utility bills for the last year of operation. The facility used approximately 70,000 MMbtu of natural gas in the last 12 months.

5.5.4.1 Combined Heat and Power at Medical Center

A CHP system includes electric generation and recovery of waste heat that can be used for facility or process heating needs. The generator assumed for this analysis is an Innio Jenbacher J416 Generator (same as the prior analyses). The CHP system maximizes the potential of the LFG by utilizing the heat from the generator and the exhaust. The heat is cycled through a series of heat exchangers which can then cycle through a network of piping that delivers heat to the Medical Center's hot water system for use in building heat. The generator and heat recovery system would be housed in a small building near the Medical Center.

Based on review of the natural gas monthly usage, Burns & McDonnell estimated that approximately 45 percent of the Medical Center's annual natural gas usage could be replaced by hot water supplied by the LFG CHP system. Burns & McDonnell assumed that the hot water would be provided to the Medical Center at a 20 percent discount to current natural gas utility rates, which equates to an overall present value cost savings of $1.1M (~$55,000 annual benefit) to the Medical Center over the 20-year project period.

The analysis assumes that MSB self develops the project and receives payments from MEA for the electricity generated at the MEA's Small Facility Power Purchase Rate of $0.07985/kWh. The analysis also assumes hot water payments of $6.821/MMBtu equivalent delivered to the Medical Center's hot water space heating system. The project simple payback is 10.8 years and has a 20-year net present value of approximately $6.41M (~$320,000 annual benefit) to MSB. Supporting information is provided in Appendix J.

5.5.4.2 Direct Use Heat at Medical Center

Direct use of the LFG in a new specialized boiler (manufactured to combust LFG) was also evaluated. The capital costs associated with this option are less than a CHP option; however, the revenues are also less since there are not electricity sales to MEA. As noted above, the annual average thermal demand is about 70,000 MMBtu and the Landfill was estimated to be able to provide an average of 57,310 MMBtu/year.

Costs associated with maintaining the boiler are included in this evaluation and include preventative and corrective maintenance, consumables and miscellaneous parts, and utility costs. Burns & McDonnell assumed that the landfill gas would be provided to the Medical Center at a 10 percent discount to current natural gas utility rates, which equates to an overall present value cost savings of $930,000 (~$47,000 annual benefit) to the Medical Center over the 20-year project period.

The analysis assumes that MSB self develops and maintains the project and receives payments for LFG used at 10 percent discount to the current rate for natural gas on an equivalent $/MMBtu basis. The project simple payback is 11.9 years and has a 20-year net present value of approximately $1.86M (~$90,000 annual benefit) to MSB. Supporting information is provided in Appendix J.

5.5.5 LFG Beneficial Use Recommendations

Table 5-3 provides a summary of financial performance of each beneficial use option. Table 5-4 compares the benefits, challenges, permitability, constructability, and operations of each option.

Table 5-3: LFG Beneficial Use Financial Summary

Project	Capital Cost	Simple Payback (Years)	Net Present Value to MSB	Average Annual Present Value to MSB
Option 1: LFG to Electricity at Landfill	$3,280,000	9.7	$5,000,000	$250,000
Option 2: LFG to Electricity and Leachate Evaporation at Landfill	$7,220,000	13.3	$2,870,000	$140,000
Option 3: LFG CHP at Medical Center	$6,330,000	10.8	$6,410,000	$320,000
Option 4: Direct Use in Boiler at Medical Center	$4,190,000	11.9	$1,860,000	$90,000

As provided above, LFG to Electricity at the Landfill has the shortest payback period and an attractive net present value over the 20-year evaluation period. Based on the projected financial performance, and through consultation with MSB and MEA representatives, Burns & McDonnell recommends consideration of the Landfill Gas to Electricity Project at the Landfill. Subsequent project development steps should include:

- Discussions with MEA to develop a framework for a project partnership moving forward. Project development options include:
    - MSB develops, owns and operates the plant and sells electricity to MEA
    - MEA develops, owns and operates the plant and purchases LFG from MSB (Recommended if MEA is interested, given their institutional experience in operating reciprocating engine power generation facilities).
- Calibrate LFG collection projections with actual collection information after the initial GCCS is in operation later this year or early in 2021.

- Collect samples of LFG to review potential conditioning / pre-treatment requirements prior to firing in an engine.
- Prepare 30-percent engineering design documents; then refine the financial analysis based on the 30 percent design and associated costs and revenues.
- Finalize design; then construct and operate the project if mutual objectives are achieved by MEA and MSB.

As presented in Appendix J, capital costs include 17.5 percent grouped contingency and profit assumption and 2.5 percent escalation. Debt service and utility price escalation were assumed to be 2.14 percent based on inputs derived in Section 4.0 and discussions with MSB staff.

Table 5-4: LFG End Use Option Benefits and Challenges

Item	Option 1: LFG to Electricity at Landfill	Option 2: LFG to Electricity & Leachate Evaporation at Landfill	Option 3: LFG CHP at Medical Center	Option 4: Direct Use in Boiler at Medical Center
Benefits	No pipeline cost Decreases LFG emissions On-site	No pipeline cost Decreases LFG emissions Significant leachate volume reduction On-site	Decreases landfill emissions Medical Center revenue	Decreases landfill emissions Medical Center revenue
Challenges	Depends on MEA purchase rates	Depends on MEA purchase rates Significant capital cost for evaporator If LFG used for electricity, less leachate can be evaporated Another form of leachate disposal likely required in the future	Coordination with Medical Center Coordination with MEA Pipeline routing – 3 miles	Coordination with Medical Center Pipeline routing – 3 miles
Permitability	ADEC approval with potential air permit	ADEC approval with potential air permit	ADEC approval and air permit Pipeline right-of-way	ADEC approval Pipeline right-of-way

Item	**Option 1: LFG to Electricity at Landfill**	**Option 2: LFG to Electricity & Leachate Evaporation at Landfill**	**Option 3: LFG CHP at Medical Center**	**Option 4: Direct Use in Boiler at Medical Center**
Constructability	Adjacent to LFG Blower/Flare skid Minimal below grade requirements	Adjacent to LFG Blower/Flare skid Minimal below grade requirements	Three-mile pipeline Significant below grade requirements	Three-mile pipeline Significant below grade requirements
Operations	Moderate requirements	Moderate requirements	Minimal requirements	Minimal requirements

Burns & McDonnell recommends that these options be investigated further by MSB after the GCCS is installed later in 2020 and LFG flow projections are verified. Additional analyses should be completed to adjust the LFG generation model if necessary, further refine each options' cost, identify potential contract terms for power and heat purchase, and determine location and routing requirements for a pipeline or power connection, among other possible factors. As part of this refined evaluation, MSB should combine the evaluation to include leachate management and develop a joint Proforma. Combinations could include:

- Leachate evaporation and recirculation.
- Electricity generation, leachate membrane filtration, and recirculation.
- Electricity generation with leachate evaporation, and recirculation.

Burns & McDonnell's estimates, analyses, and recommendations contained in this section are based on professional experience, qualifications, and judgement. Burns & McDonnell has no control over actual landfill gas production or collection rates; weather; cost and availability of labor, material and equipment; labor productivity; energy or commodity pricing; demand or usage; population demographics; market conditions; changes in technology; or other economic or political factors affecting such estimates, analyses, and recommendations. Therefore, Burns & McDonnell makes no guarantee or warranty (actual, expressed, or implied) that actual results will not vary, perhaps significantly, from the estimates, analyses, and recommendations contained herein.

5.6 Air Permitting Requirements

US EPA introduced two new rules which will serve to replace the existing New Source Performance Standards (NSPS) for Municipal Solid Waste (MSW) Landfills (40 CFR 60, Subpart WWW). MSW

Landfills that have a Design Capacity greater than 2,500,000 metric tons and 2,500,000 cubic meters that have commenced construction, modification, or reconstruction after July 17, 2014 are subject to 40 CFR 60, Subpart XXX. MSW Landfills that have commenced construction, modification, or reconstruction on or before July 17, 2014 will be subject to 40 CFR 60, Subpart Cf (Emission Guidelines) when the final federal plan is promulgated (tentatively set for August 2021). ADEC regulations, the NSPS, and the Emission Guidelines require a facility to obtain an ADEC Air Operating Permit once the Design Capacity threshold is exceeded. The current (2020) permitted Design Capacity is below the NSPS threshold, and the Landfill does not require an air permit. Based on review of existing facility information, the Design Capacity will be exceeded when Cell 5 construction commences and MSB will need to apply for a permit within 12 months of commencing construction on Cell 5.

Upon commencing construction of Cell 5, the Landfill will be subject to 40 CFR 60, Subpart XXX or a more recently promulgated regulation at that time. Air compliance related activities include:

- Providing a Design Capacity report within 90 days of commencing construction of Cell 5. Design Capacity is defined by DENR and EPA as “the maximum amount of solid waste a landfill can accept, as indicated in terms of volume or mass in the most recent permit issued by the State, local, or Tribal agency responsible for regulating the landfill, plus any in-place waste not accounted for in the most recent permit”. Thus, the pre-Subtitle D landfill waste located adjacent to the current would also likely need to be included within the Design Capacity report. The Design Capacity report is brief in nature and contains one figure and volume calculations developed to substantiate the developed Design Capacity.
- Conduct a Tier 1 non-methane organic compound (NMOC) emissions evaluation within 90 days of commencing construction of Cell 5. If the Tier 1 NMOC emissions exceed 34 Megagrams per year (Mg/yr), MSB will then conduct Tier 2 NMOC emissions sampling and report within 180 days of the Tier 1 NMOC emissions report submittal.
    - Most active MSW landfills that are subject to Title V permitting requirements exceed the 34 Mg NMOC Tier 1 calculation threshold. The Tier 1 calculation methodology utilizes a default NMOC concentration of 4,000 parts per million (ppm), which is typically significantly higher than measured (Tier 2) concentrations.
    - Tier 2 emissions evaluations are prepared and submitted every 5 years for facilities that exceed the 34 Mg Tier 1 calculation threshold and consist of on-site landfill gas sampling and subsequent laboratory analysis. Sampling typically takes 2-4 days (dependent on weather conditions and the surface area required to be sampled).

- Preparation and submittal of an initial Title V Operating Permit application within 12 months of commencing construction on Cell 5.
- Preparation of semi-annual and annual Title V compliance reports.
- Preparation of annual emission fee reports.
- At some point in time in the future, the Landfill will be subject to the GCCS requirements contained in 40 CFR 60, Subpart XXX. For conservative fiscal planning purposes, we recommend that these costs be included in the budget beginning 30 Months after the initial Tier 2, as provided below.

Burns & McDonnell has prepared an example of a 5-year annual air compliance schedule outline to illustrate annual submittal requirements:

Table 5-5: Example Air Compliance Schedule

Year	Reports	Annual Budgetary Cost in 2020 $USD
2031	• Design Capacity Report • Tier 1 NMOC Report • Title V Application Report • Annual / Semi-Annual Reports • Emissions Fee Report	$35,000
2032	• Tier 2 NMOC Sampling/Reporting • Annual / Semi-Annual Reports • Emissions Fee Report	$40,000
2033-2034	• Annual / Semi-Annual Reports • Emissions Fee Report	$15,000
2035	• Title V Permit Renewal (Due 4.5 years after original permit is issued) • Annual / Semi-Annual Reports • Emissions Fee Report • GCCS Compliance Monitoring	$75,000
2036-2039	• Annual / Semi-Annual Reports • Emissions Fee Report • GCCS Compliance Monitoring	$65,000
2040	• Title V Permit Renewal (Due 4.5 years after original permit is issued) • Annual / Semi-Annual Reports • Emissions Fee Report • GCCS Compliance Monitoring	$75,000
2041-2044	• Annual / Semi-Annual Reports • Emissions Fee Report • GCCS Compliance Monitoring	$65,000

5.7 Future Phase 1 GCCS Implementation Schedule

The GCCS will be installed over time as the Landfill expands. Table 5-6 depicts the anticipated schedule for implementing the GCCS within Phase 1. Note that the Landfill's ADEC solid waste permit requires renewal every five years; the Title V permit will require renewal every five years as well. Interim LFG collection through GLs may be installed by MSB each cell is filled, beginning with Cell 4 in 2022.

Table 5-6: Future Phase 1 GCCS Installation Schedule

Activity	Anticipated Implementation Year
Cell 1 and Cell 2A GCCS Installation	2020
Cell 4 Waste Disposal Begins	2022
Cell 2B and Cell 3 Closure and GCCS Installation	2023
Cell 5 Construction	2030
NSPS Air Permit Application (within 12 months of commencing Cell 5 construction)	2031
Cell 4 Capacity Reached / Cell 5 Waste Disposal Begins	2032
Cell 4 Closure and GCCS Installation	2033
Next Cell Construction (Phase 2, Corridor 1)	2041
Cell 5 Capacity Reached / Next Cell Waste Disposal Begins	2043
Cell 5 Closure and GCCS Installation	2044

Note: Life estimates based on an average AUF of 1,328 pcy with a 2.0 percent growth rate.

6.0 C&D SITE DEVELOPMENT PLAN

6.1 Assumptions and Methodology

The following future development criteria was for the C&D area site development:

Maximum Height Limit: Similar to the MSW Landfill, the maximum height for the C&D area in the Plan is 348.5 feet NAVD 88.

Stormwater Control: The goal for stormwater control is to prevent run-on, run-off, and erosion.

Bottom Liner Cross Section: There is no established bottom liner for C&D waste. Base grades developed by CH2M Hill in the C&D Cell Development Plan (C&D Plan) dated May 31, 2017 (Appendix K) were primarily used for the development for this Plan. Slight modifications were made in the northeast corner of the expansion area to match existing grades, as well as to connect the existing C&D disposal area and the C&D expansion area to have one continuous C&D area.

Depth to Groundwater: Base grades must maintain a minimum ten-foot separation from historic high groundwater table, in accordance with Title 18 AAC Chapter 60.217. As identified in the C&D Plan, groundwater elevation meets the minimum separation requirement.

Final Cover Cross Section: In ascending order, the final cover cross section will include 18 inches of general soil and six inches of topsoil. Title 18 AAC Chapter 60 does not prescribe a final cover profile for C&D landfills. Unlike the MSW Landfill, a liner and LFG vents are not required.

Landfill Slopes: Similar to the MSW Landfill development, the C&D site was graded with an exterior slope of to 3 to 1 (horizontal to vertical). Interior slopes do not require a defined maximum slope, and the slopes developed in the C&D Plan were utilized (as provided on **Figure 32**). The C&D Plan outlines that the western limit of the C&D Landfill will extend to within 50-feet of the MEA powerline guy wires.

Access Roads: Access roads were established in the Plan as indicated on the drawings. The current perimeter road will be maintained for the life of the C&D Landfill. Entrance to the cell will vary depending on elevation and may access from any point on the perimeter road. These roads will maintain a width of 30 feet. One final cover access road will be provided (**Figure 33**). Road widths shall be maintained at 30 feet with a maximum grade of 6.8 percent.

6.2 Expansion Area Grading

Cell 1 of the C&D Landfill is at final grade and should undergo final closure within the next year. The southern extent of the closure limits is shown on **Figure 33**. Disposal in the southernmost portion of Cell 2 has begun in 2020, while gravel extraction continues. The C&D Landfill will be filled in generally 10-foot lifts until the final grades shown in **Figure 33** are obtained. Once Cell 2 attains final intermediate grade, final cover shall be constructed as depicted in **Figure 34**. The disposal airspace between the 2019 existing grade and the proposed final intermediate contours is 2,775,989 cubic yards.

6.3 Projected Tonnages/Remaining Life

The life projection model for the C&D Landfill is provided in Appendix C. Using the assumptions of:

- 5-Year Average Annual tonnage: 12,372.6 tons
- Annual growth rate: 2 percent
- Estimated Airspace Utilization Factor: 1,000 pcy

MSB reports that a Caterpillar D6 dozer is used for C&D waste spreading and compaction and the AUF could be as low as 600 pcy. Burns & McDonnell recommends that MSB use a waste compactor for the C&D Landfill to improve the AUF and extend the life of this asset. With an AUF of 600 pcy, the remaining life of the C&D Landfill as developed in this Plan is 42 years or until 2062. With an AUF of 1,000 pcy, the remaining life of the C&D Landfill as developed in this Plan is 58 years, or until 2078.

6.4 Anticipated Construction Costs

With the exception of final cover, there are no significant construction costs for the C&D Landfill. In 2020 dollars, the planning level final cover cost for Cell 1 closure (5.8 acres) is $550,000. Cell 2 closure costs (20.7 acres) in 2020 dollars is estimated to be $1,950,000. Cost estimates are provided in Appendix L.

7.0 ASBESTOS SITE DEVELOPMENT PLAN

7.1 Assumptions and Methodology

The following future development criteria was for the asbestos area site development:

Maximum Height Limit: The maximum height for the asbestos area in the Plan is 326 ft above MSL NAVD 88. This height is limited by the geometry and size of the asbestos cell.

Stormwater Control: The goal for stormwater control for this cell is to prevent run-on, run-off, and erosion.

Bottom Liner Cross Section: There is no established bottom liner for asbestos waste. For the development, existing site grades were assumed for base grades as the depth of the asbestos in place is unknown. The existing grades are shown in **Figure 35**.

Final Cover Cross Section: In ascending order, the final cover cross section will include 18 inches of general soil and six inches of topsoil. Title 18 AAC Chapter 60.450(I) requires that an asbestos cell shall have a two-foot cover of non-asbestos soil. Unlike the MSW Landfill, a liner and LFG vents are not required.

Landfill Slopes: Similar to the MSW Landfill development, the asbestos site was graded with an exterior slope of to 3 to 1 (horizontal to vertical) until height of 320 ft. From 320 ft to 326 ft it was graded with a crown slope of five percent. Asbestos final cover contours are illustrated in **Figure 36**. Cross sections are provided in **Figure 37**.

Access Roads: Access roads were established in the Plan as indicated on the drawings. The current perimeter road will be maintained for the life of the asbestos cell. The access road will maintain a width of 30 feet and 6.7 percent grade with a maximum grade not to exceed eight percent (**Figure 36**).

7.2 Expansion Area Grading

The current horizontal footprint of the Asbestos Cell will be expanded during development beyond the current footprint as shown on **Figure 35**. The cell will be filled in generally 10-foot lifts until the final grades shown in **Figure 36** are obtained. The disposal airspace between the existing grade and the proposed final contours is 544,032 cubic yards, including final cover. The airspace lost for final cover is 23,215 cubic yards. Consequently, the disposal airspace between the existing grade and the proposed top of waste is 520,817.

7.3 Projected Tonnages/Remaining Life

The life projection model for the Asbestos Cell is provided in Appendix C. Using the assumptions of:

- 5-year annual tonnage (2015-2019): 182 tons
- Annual growth rate: 2 percent
- Estimated Airspace Utilization Factor: 75.7 pcy (calculated from 2017 through 2019 average airspace utilization as provided by MSB).

The remaining life of the Asbestos Cell as developed is 57 years, or until 2077.

7.4 Anticipated Construction Costs

With the exception of final cover, there are no significant construction costs for the Asbestos Cell. In 2020 dollars, the planning level final cover cost is $690,000. Cost estimates are provided in Appendix L.

8.0 FINANCIAL ASSURANCE PLAN

8.1 Assumptions and Methodology

The Matanuska-Susitna Borough has a long-term plan for its Landfill that includes three phases as described previously in this Plan. The current Phase 1 consists of five landfill cells (Cells 1-5, with Cell 2 being divided into Cell 2A and 2B). Based on current tonnage levels and an estimated two percent tonnage growth, Phase 1 is expected to reach capacity in FY 2043 (Section 2.6). Therefore, the focus of the financial assurance liability is Phase 1 and the Borough will incorporate other phases of the Landfill once Phase 1 nears capacity.

8.2 Financial Assurance Model

Cell 1 and Cell 2A have each received final cover and therefore the Borough no longer has financial liability for closure for those two cells. The Borough is currently operating in Cell 3 and constructed Cell 4 during 2018.

In 2020 dollars, the total estimated cost for closure of Cells 2B through 5 is approximately $9.0 million and the 30-year post-closure care cost is approximately $8.4 million for Phase 1, for a total closure and post-closure financial liability of approximately $17.4 million. The estimated capacity of Cells 2B through 5 is 3.7 million cubic yards and an estimated 1.08 million cubic yards have been consumed through 2019. Therefore, 29.2 percent of the capacity has been consumed through 2019.

8.3 Recommendations for Annual Contributions

Total liability at the end of FY 2019 was calculated at $5,073,571 (capacity consumed multiplied by total financial liability). The Borough recognized a financial liability of $5,463,707 at the end of FY 2018. Therefore, the decrease in liability for FY 2019 is $390,136. Financial assurance calculations are provided in Appendix L.

9.0 SOIL BALANCE PLAN

9.1 Assumptions and Methodology

The following assumptions were included in the soil balance plan:

- Fifty percent of the asbestos airspace is used for daily/intermediate cover (1:1 waste to soil ratio)
- Twenty percent of the C&D airspace is used for daily/intermediate cover (4:1 waste to soil ratio)
- Twenty percent of the MSW airspace is used for daily/intermediate cover (4:1 waste to soil ratio)
- Forty percent of the overall material to be excavated on the site is suitable for gravel use/sales
- C&D and Asbestos final cover profile is consistent with above and contains the following soil layers:
  - 1.5-feet of general soil
  - 0.5-feet of topsoil
- MSW final cover profile is consistent with above and contains the following soil layers:
  - 1.5-feet of drainage sand
  - 0.5-feet of cushion soil
  - 0.5-feet of topsoil
- MSW base grade profile is consistent with above and contains the following soil layers:
  - 0.5-feet of cushion soil
  - 1.5-feet of granular drainage material (gravel)

9.2 Soil Balance Model

The volume balance computations for the entire site development is provided in Table 9-1 totaling the quantities of onsite soils for cell construction, daily and intermediate cover, and final cover. The soil balance model results in a net gravel surplus of over 2.4 million cubic yards. Note that if a waste to soil cover ratio of 5:1 is used, the gravel surplus increases to 4.1 million cubic yards. This volume could be removed for offsite use and sale for revenue. A detailed soil balance model for Landfill development is included in Appendix M.

Table 9-1: Soil Balance Summary

	MSW Area	C&D	Asbestos	Total
Total Cut (CY)	18,161,100	569,400	0	18,730,500
Topsoil Available (CY)	379,600	0	0	379,600
Topsoil Needed (CY)	(225,600)	(21,400)	(5,900)	(252,900)
Topsoil Excess (CY)				**126,700**
Gravel Available (CY)	7,112,600	227,800	0	7,340,400
Gravel Needed (CY)	(592,300)	(0)	(0)	(592,300)
Sand/Fines Available (CY)	10,668,900	341,600	0	11,010,500
Total Base Fill (CY)	(3,361,100)	(14,700)	(0)	(3,375,800)
Base Cushion Material (CY)	(197,450)	(0)	(0)	(197,450)
Daily/Intermediate Cover (CY)[1]	(9,965,200)	(555,200)	(260,400)	(10,780,800)
Final Cover Cushion (CY)	(197,450)	(0)	(0)	(197,450)
Final Cover Soil (CY)	(676,700)	(64,200)	(17,600)	(758,500)
Gravel Available for Sale (CY)				**2,448,600**

[1] – Daily cover ratio is likely better with the use of alternative daily cover, which would result in a greater soil surplus and potentially more gravel available for sale. For example, a 5:1 waste to soil ratio results in a gravel surplus quantity of 4.1 million cubic yards.

APPENDIX A – SLOPE STABILITY EVALUATION

Matanuska-Susitna Landfill:

Stability Evaluation

PREPARED FOR: Wright, Shannon/SAC

COPY TO: Harris, Dean/SAC

PREPARED BY: Mayer, Andrew/SAC

DATE: July 28, 2014

PROJECT NUMBER: 496410

This memorandum was prepared to summarize a stability analysis performed on three cross sections of the Matanuska-Susitna Borough Central Landfill. Material properties, geotechnical design criteria, and analyses are summarized below.

Material Properties

Material properties are based on properties used for previous studies. The landfill is comprised of waste overlying an impermeable barrier of a geosynthetic clay liner, granular drain material and an HDPE geomembrane, which overlies native soil.

TABLE 1
Material Properties for Analysis
Mat-Su Landfill

Material/Interface	Peak Friction Angle/ Cohesion Intercept	Residual Friction Angle/ Cohesion Intercept	Unit Weight (pcf)
GCL/HDPE	26˚, 500 psf	10˚, 500 psf	120
HDPE/ Granular Drain Material	28˚, 0 psf	28˚, 0 psf	120
Native Soil	35˚, 0 psf	35˚, 0 psf	130
Waste	20˚, 600 psf	20˚, 600 psf	75

Design Criteria

Shear strength and other stability considerations for geotechnical evaluation are based on previous studies (CH2M HILL, 2010). Mohr-Coulomb effective stress failure criterion was used for all analyses.

Three failure scenarios were considered for analysis of each landfill cross section. The slope stability software SLIDE was used to evaluate a circular slope failure, a block failure near or through the lining material, and failure through the lining. Static and seismic loading were evaluated for each failure mechanism. A minimum factor of safety of 1.5 and 1.0 are required for static and seismic conditions, respectively.

Stark (1994) recommended the use of residual shear strength along the side slopes to account for "down-drag" shearing or the displacements exerted on the lining system due to the settlement of landfill waste. The critical component of the lining system along the side slopes is the GCL at residual internal shear strength. Lining along the base will not be subject to downdrag and therefore the critical component to be considered is the interface strength of the HDPE geomembrane with the granular drain material.

Water level is conservatively assumed to be 6 feet above the lowest point of the landfill lining. This is not anticipated to occur in landfill operations but is intended to be a worst case scenario.

A horizontal pseudo static coefficient of 0.13, approximately half of the site peak ground acceleration, 0.25g, of the 50 year recurrence earthquake, is used for seismic analyses.

Results

SLIDE output results can be found in Attachment 1 of this memo and are summarized in tabular format below.

TABLE 2
SLIDE ANALYSIS RESULTS
Mat-Su Landfill – Cross Section A

Slip Surface	Case	Analysis Method	Required Factor of Safety	Computed Factor of Safety
Circular	Static	Spencer	1.5	2.0
	Seismic	Spencer	1.0	1.4
Block	Static	Spencer	1.5	2.1
	Seismic	Spencer	1.0	1.5
Lining System	Static	Spencer	1.5	2.1
	Seismic	Spencer	1.0	1.4

Note: Seismic analysis performed using horizontal pseudo-static coefficient of 0.13.

TABLE 3
SLIDE ANALYSIS RESULTS
Mat-Su Landfill – Cross Section B

Slip Surface	Case	Analysis Method	Required Factor of Safety	Computed Factor of Safety
Circular	Static	Spencer	1.5	2.0
	Seismic	Spencer	1.0	1.3
Block	Static	Spencer	1.5	2.2
	Seismic	Spencer	1.0	1.5
Lining System	Static	Spencer	1.5	2.2
	Seismic	Spencer	1.0	1.4

Note: Seismic analysis performed using horizontal pseudo-static coefficient of 0.13.

TABLE 4
SLIDE ANALYSIS RESULTS
Mat-Su Landfill – Cross Section D

Slip Surface	Case	Analysis Method	Required Factor of Safety	Computed Factor of Safety
Circular	Static	Spencer	1.5	2.1
	Seismic	Spencer	1.0	1.4
Block	Static	Spencer	1.5	2.1
	Seismic	Spencer	1.0	1.4
Lining System	Static	Spencer	1.5	2.1
	Seismic	Spencer	1.0	1.5

Note: Seismic analysis performed using horizontal pseudo-static coefficient of 0.13.

Conclusions

Acceptable factors of safety were calculated for cross sections A, B, and D for each of the considered potential failure modes. The computed factors of safety are similar in all each of the three cases and are well above required limits.

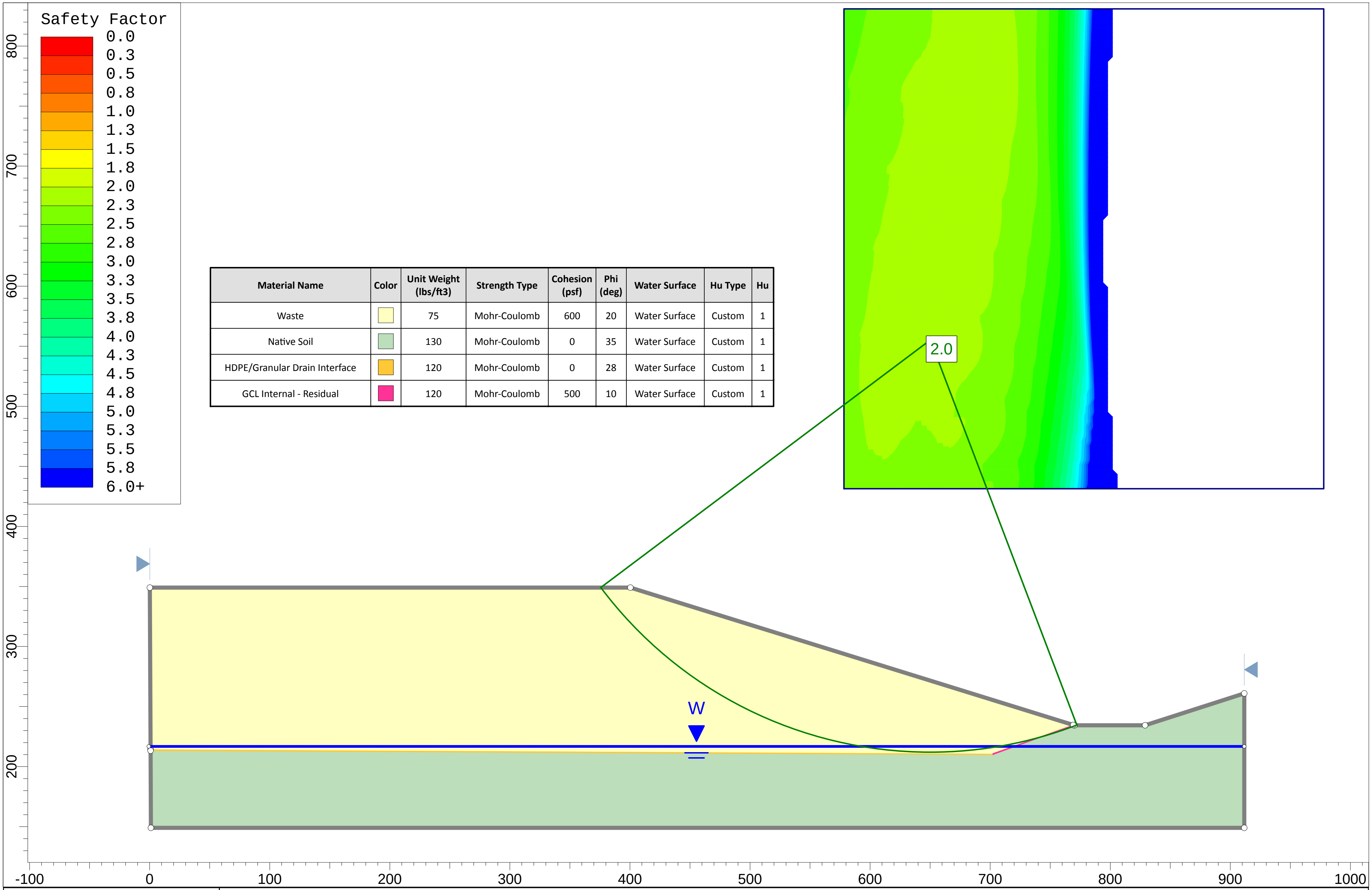
References

CH2M HILL (2010). Slope Stability Evaluation, Leachate Collection System Improvements Design Project, Prepared for Mat-Su Borough, Alaska. October 2010.

Rocscience, Inc. (2014). SLIDE Computer Software. Version 6.029, Build date: April 25, 2014.

Attachment 1

SLIDE OUTPUT



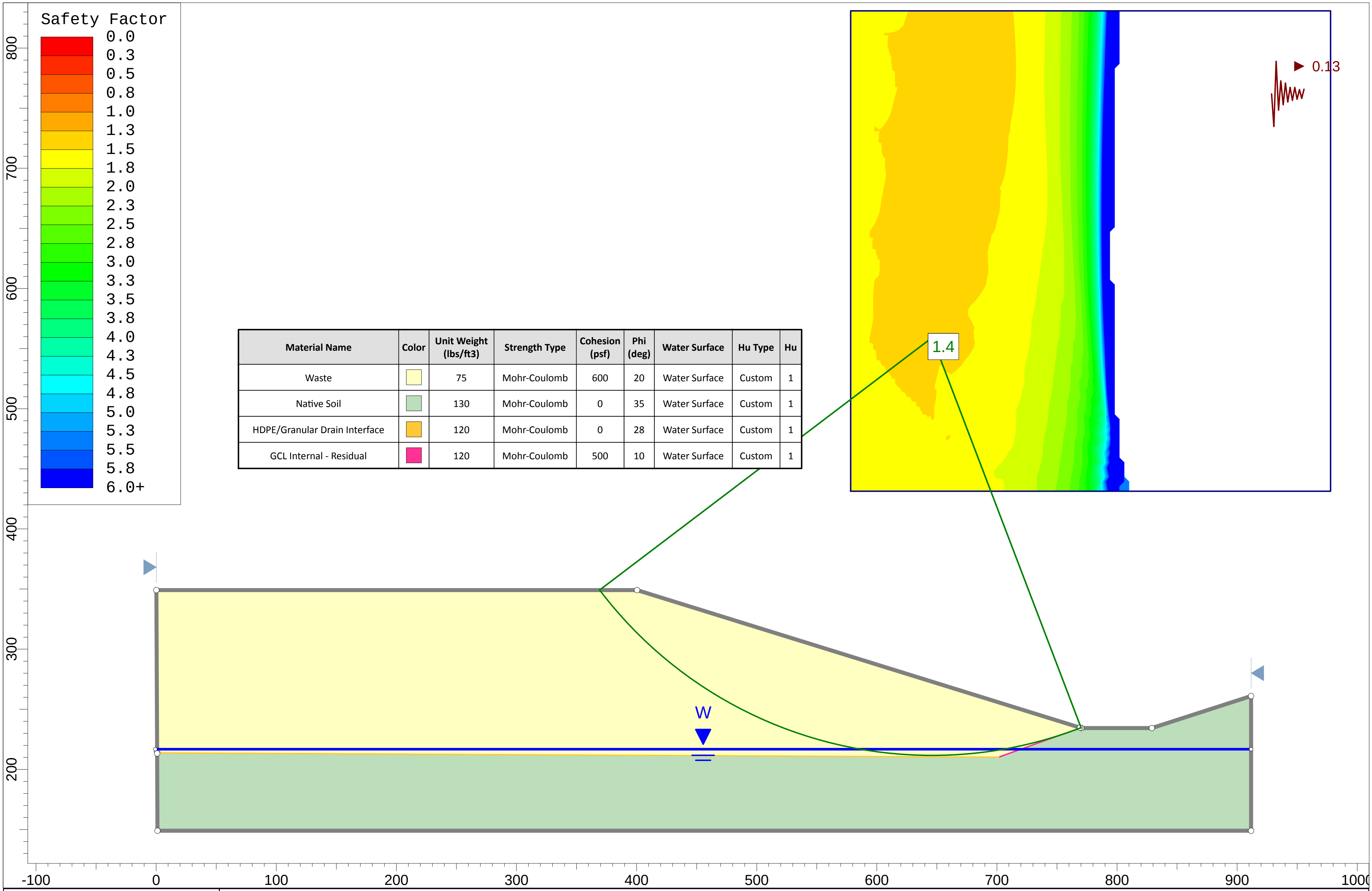
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project	Matanuska-Susitna Borough Central Landfill
Case	**Section A Circular Failure - Static**
Description	

Date 7/28/2014 2:15:44 PM *Scale:* 1:1300 *File Name* Section A.slim



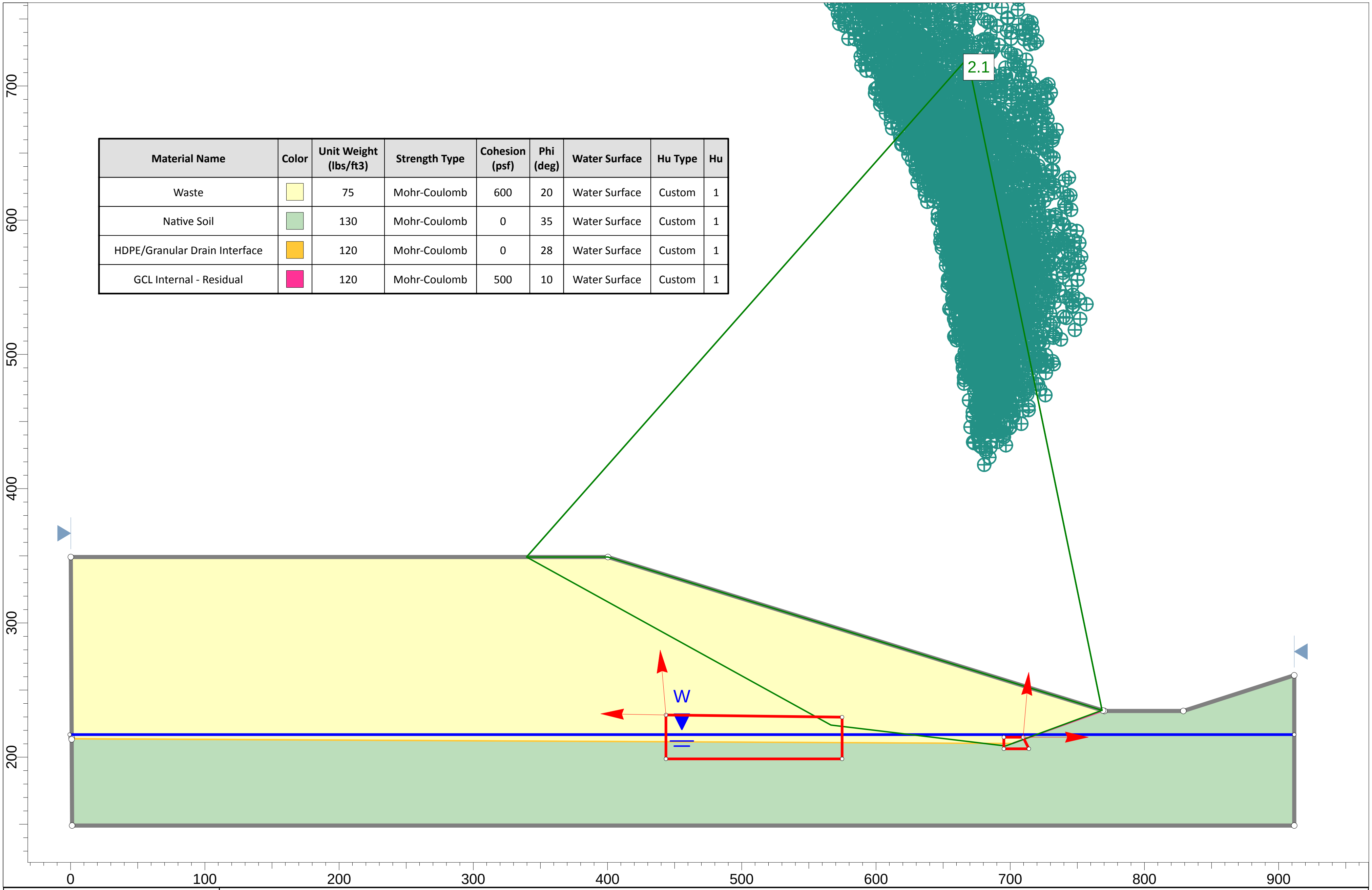
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project	Matanuska-Susitna Borough Central Landfill
Case	**Section A Circular Failure - Seismic**
Description	

Date 7/28/2014 2:11:14 PM *Scale:* 1:1300 *File Name* Section A.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

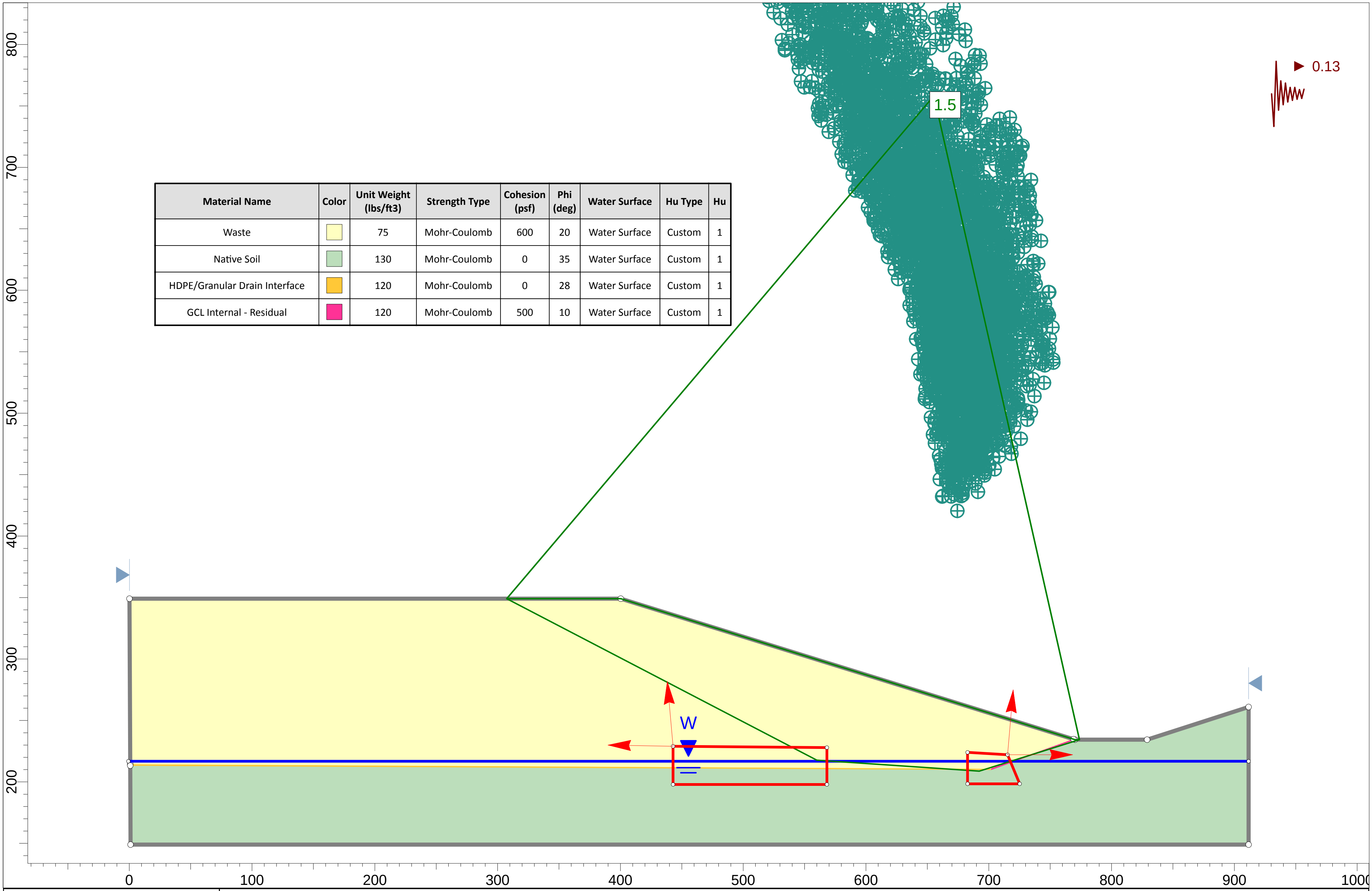
SLIDEINTERPRET 6.029

Project Matanuska-Susitna Borough Central Landfill

Case **Section A Block Failure - Static**

Description

Date 7/25/2014 1:56:03 PM *Scale:* 1:1163 *File Name* Section A.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

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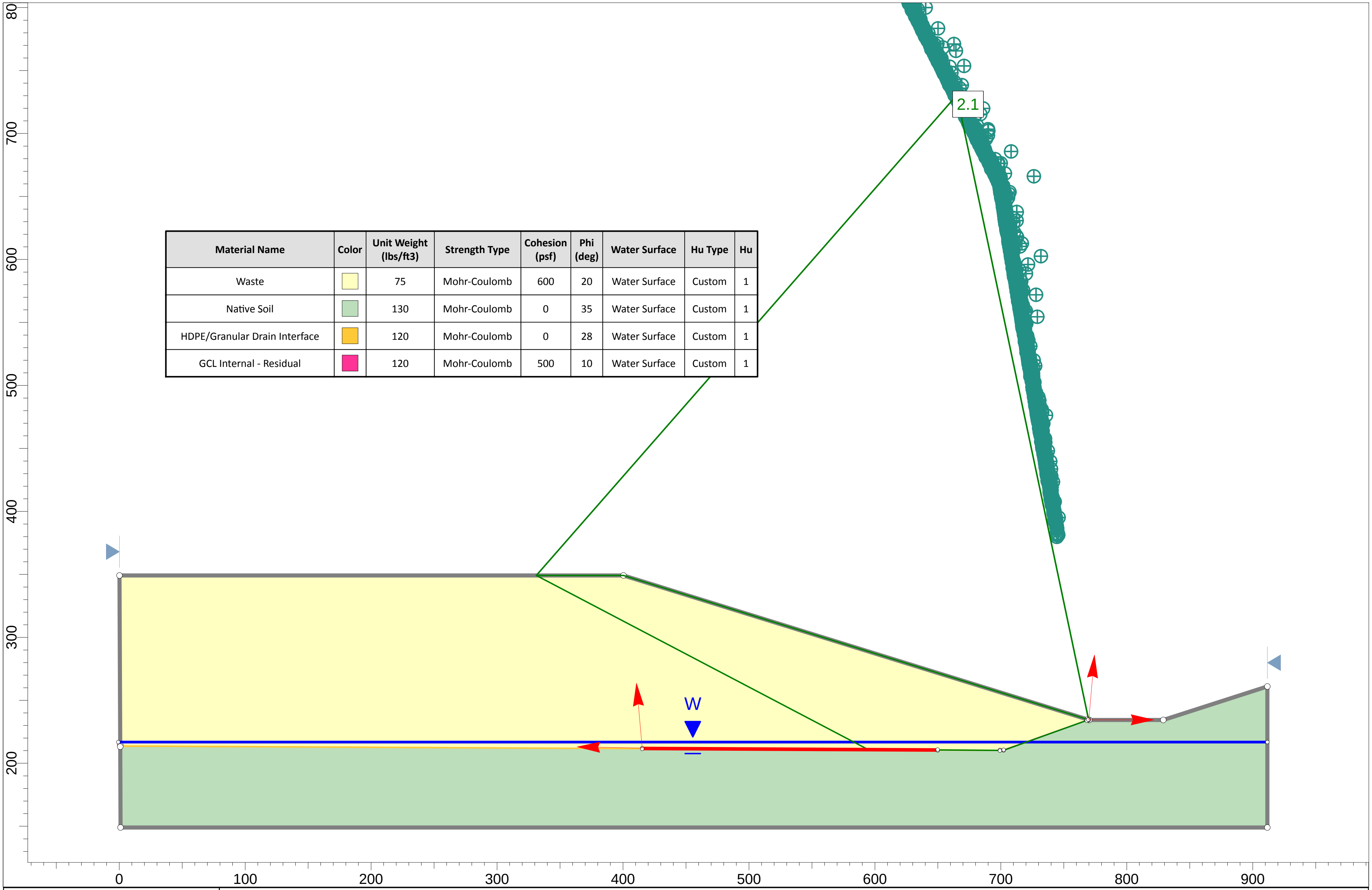
SLIDEINTERPRET 6.029

Project Matanuska-Susitna Borough Central Landfill

Case **Section A Block Failure - Seismic**

Description

Date 7/25/2014 3:17:29 PM *Scale:* 1:1272 *File Name* Section A.slim



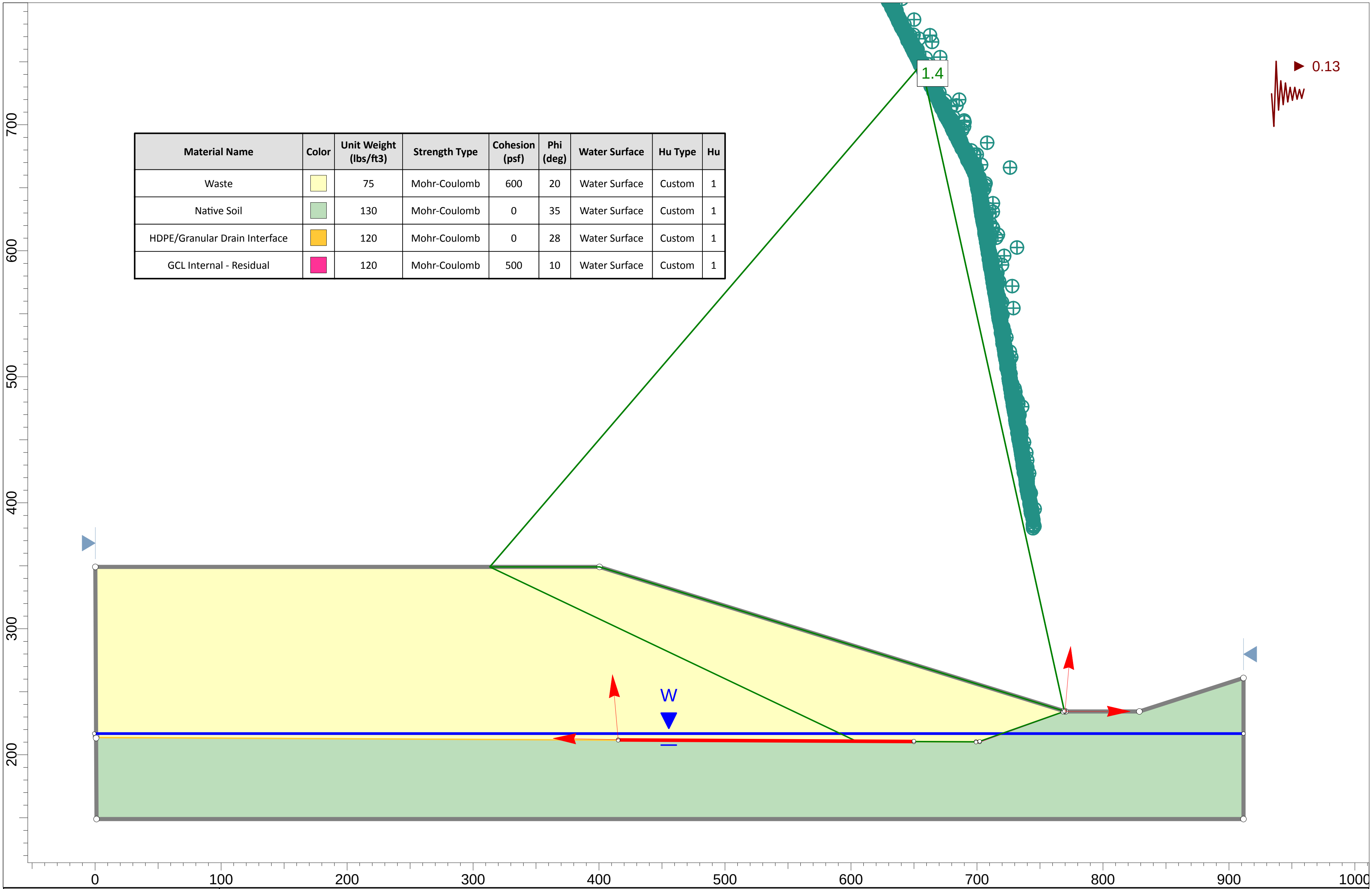
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project	Matanuska-Susitna Borough Central Landfill
Case	**Section A Lining Failure - Static**
Description	

Date 7/25/2014 2:17:58 PM *Scale:* 1:1239 *File Name* Section A.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟥	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

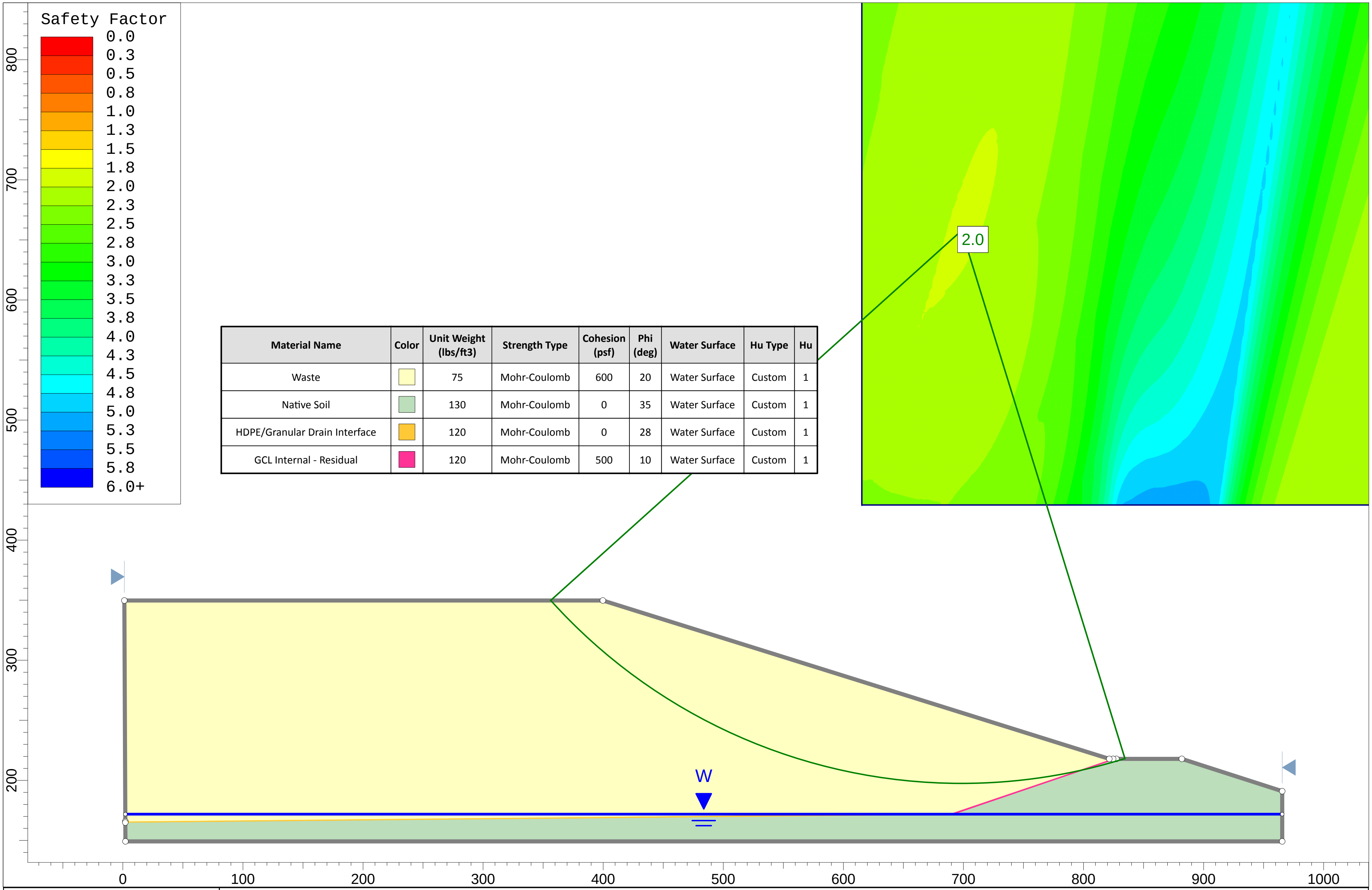
SLIDEINTERPRET 6.029

Project Matanuska-Susitna Borough Central Landfill

Case **Section A Lining Failure - Seismic**

Description

Date 7/25/2014 2:19:26 PM *Scale:* 1:1239 *File Name* Section A.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

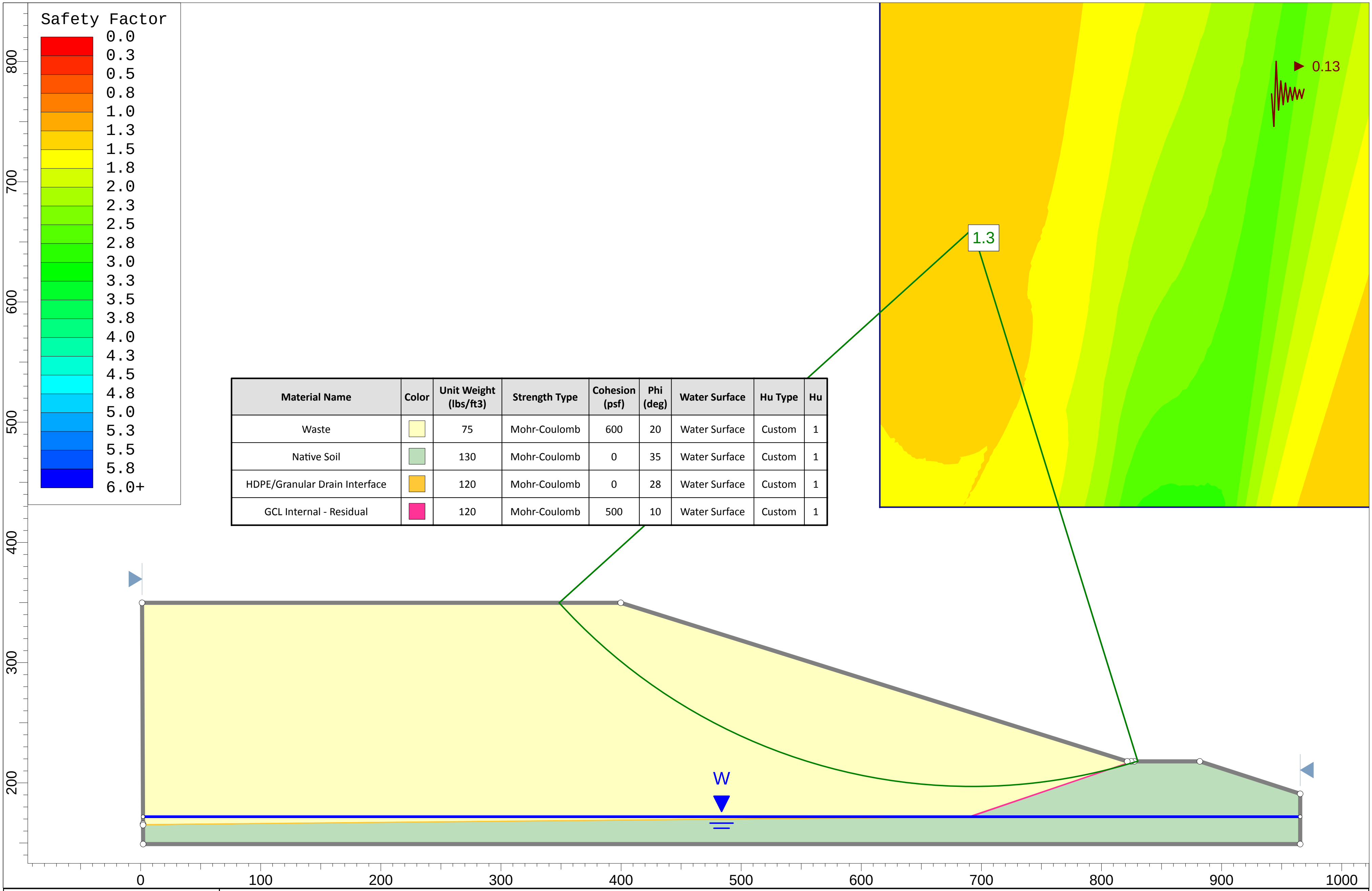
SLIDEINTERPRET 6.029

Project Matanuska-Susitna Borough Central Landfill

Case **Section B Circular Failure - Static**

Description

Date 7/28/2014 2:03:00 PM *Scale:* 1:1300 *File Name* Section B circular.slim



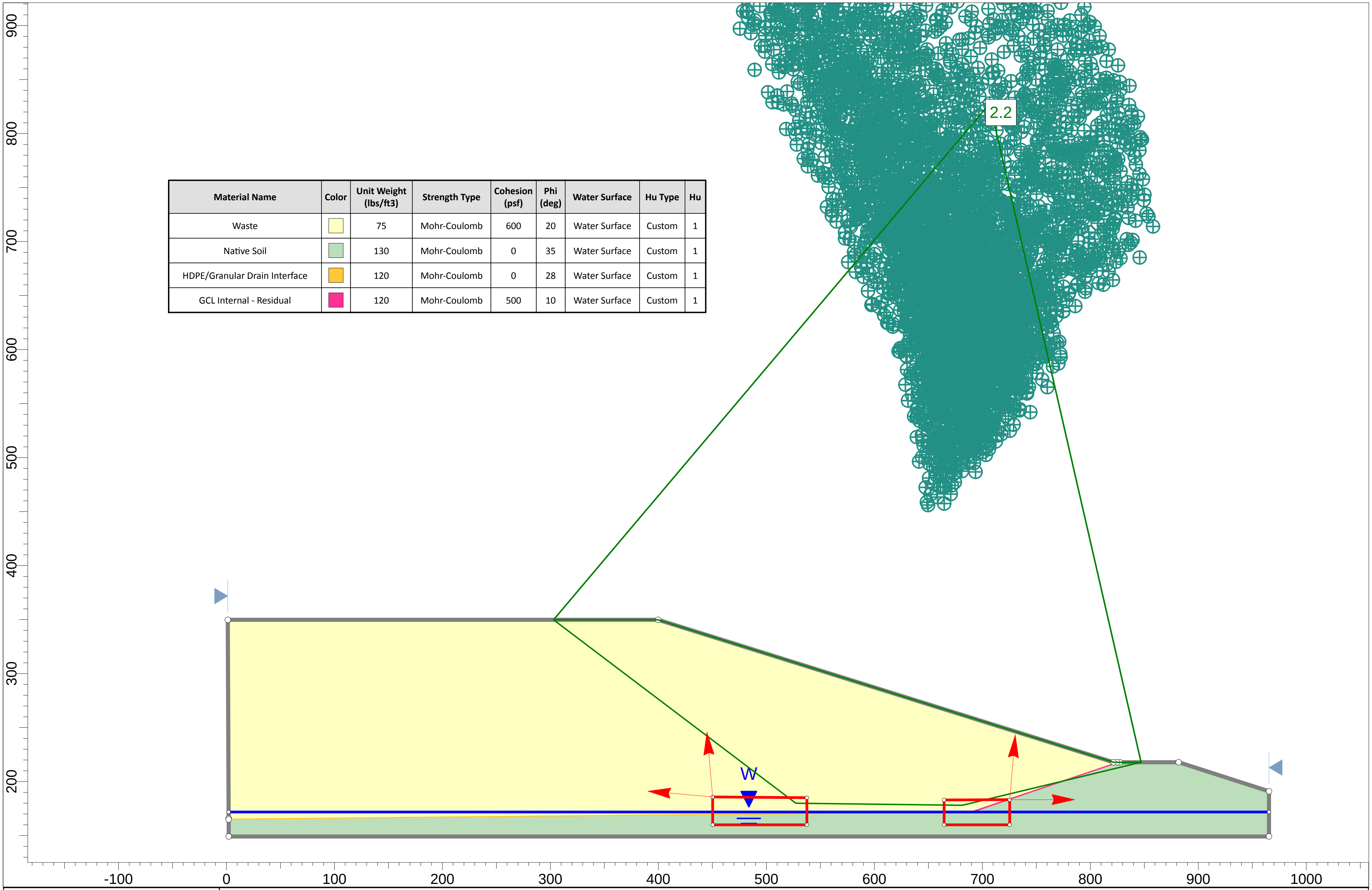
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project	Matanuska-Susitna Borough Central Landfill
Case	**Section B Circular Failure - Seismic**
Description	

Date 7/28/2014 2:01:02 PM *Scale:* 1:1300 *File Name* Section B circular.slim



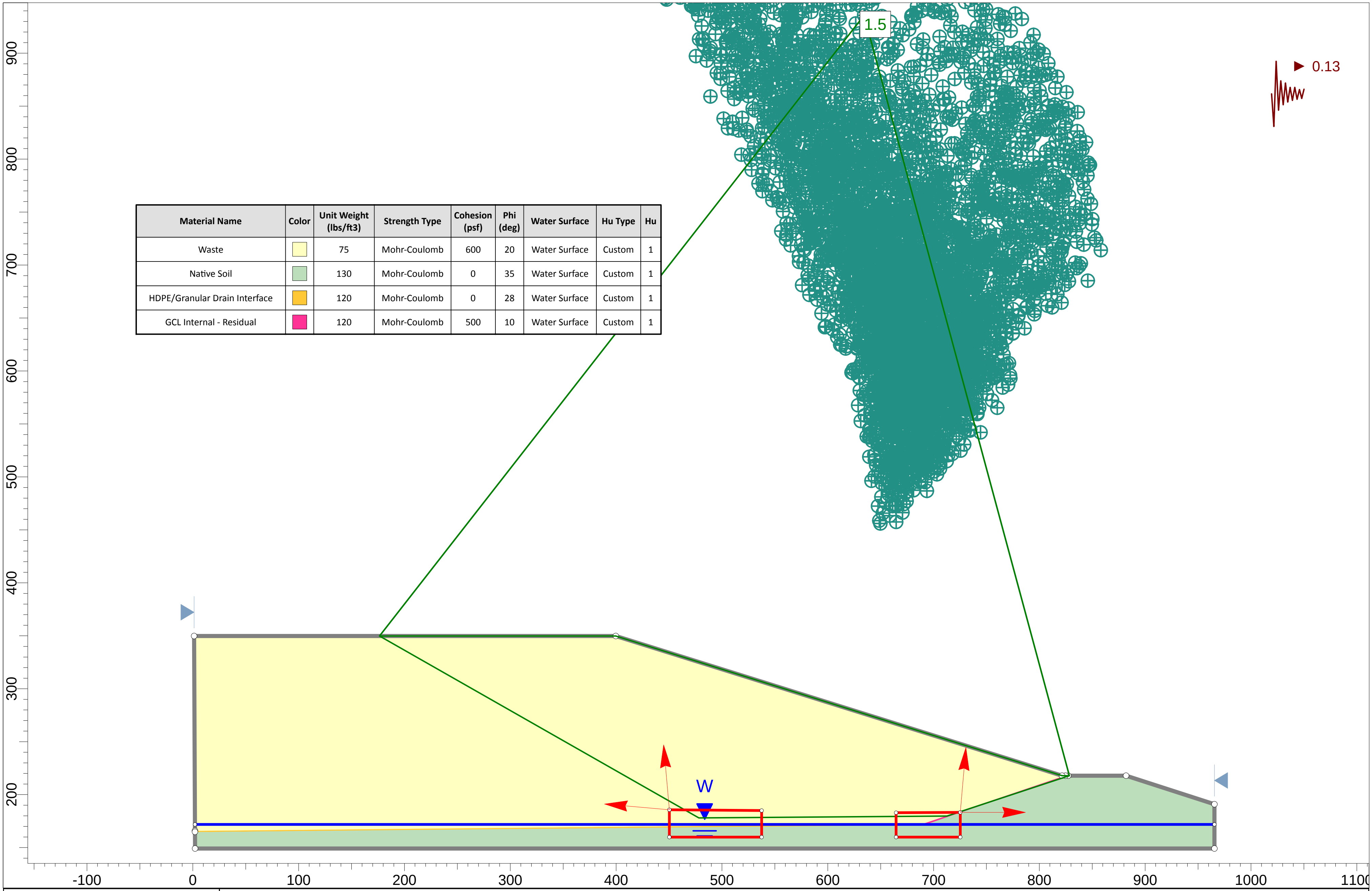
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟥	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project	Matanuska-Susitna Borough Central Landfill
Case	**Section B Block Failure - Static**
Description	

Date 7/24/2014 8:22:01 AM *Scale:* 1:1446 *File Name* Section B block seismic.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟥	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

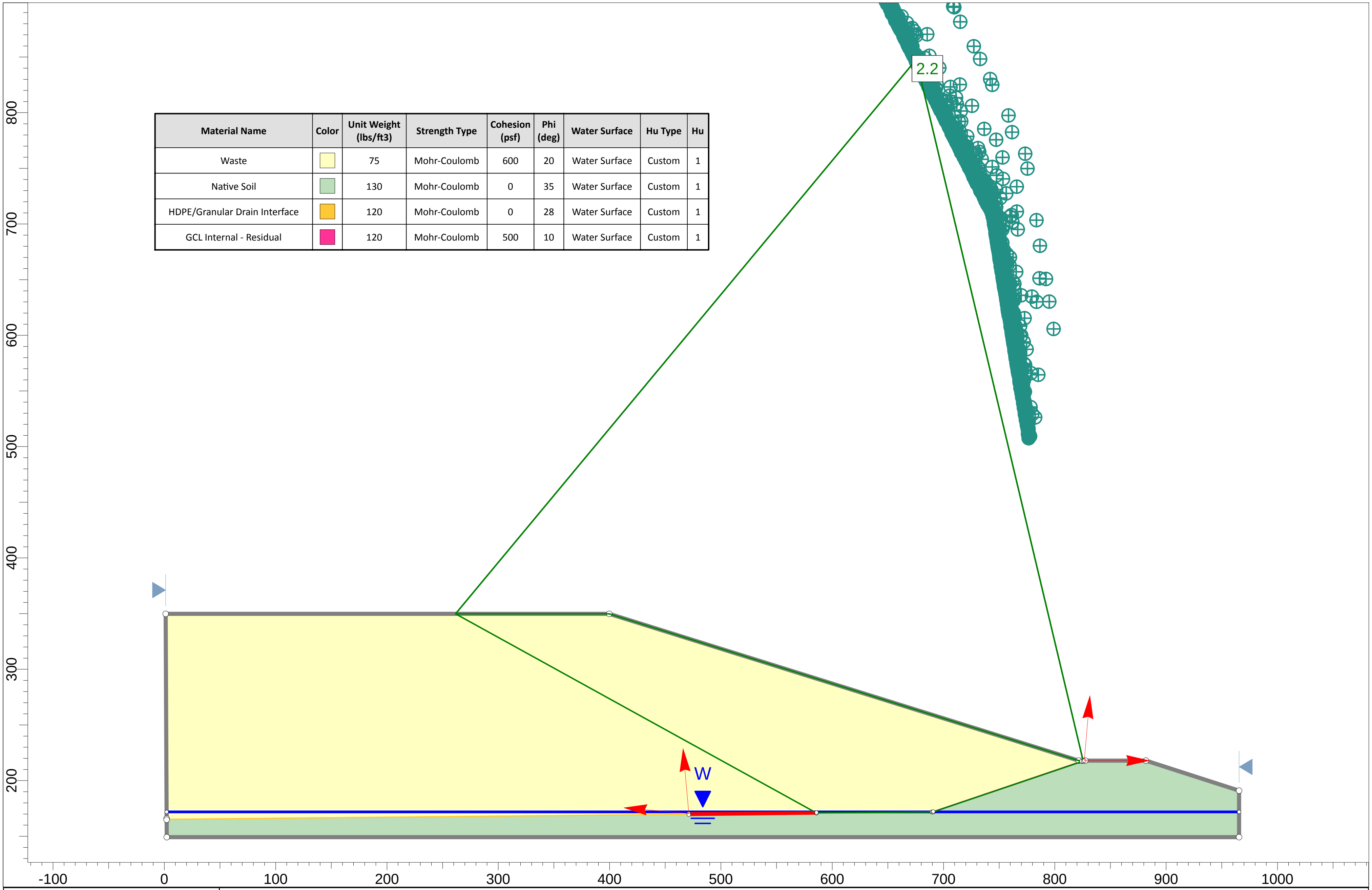
SLIDEINTERPRET 6.029

Project Matanuska-Susitna Borough Central Landfill

Case **Section B Block Failure - Seismic**

Description

Date 7/24/2014 8:16:47 AM *Scale:* 1:1476 *File Name* Section B block seismic.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

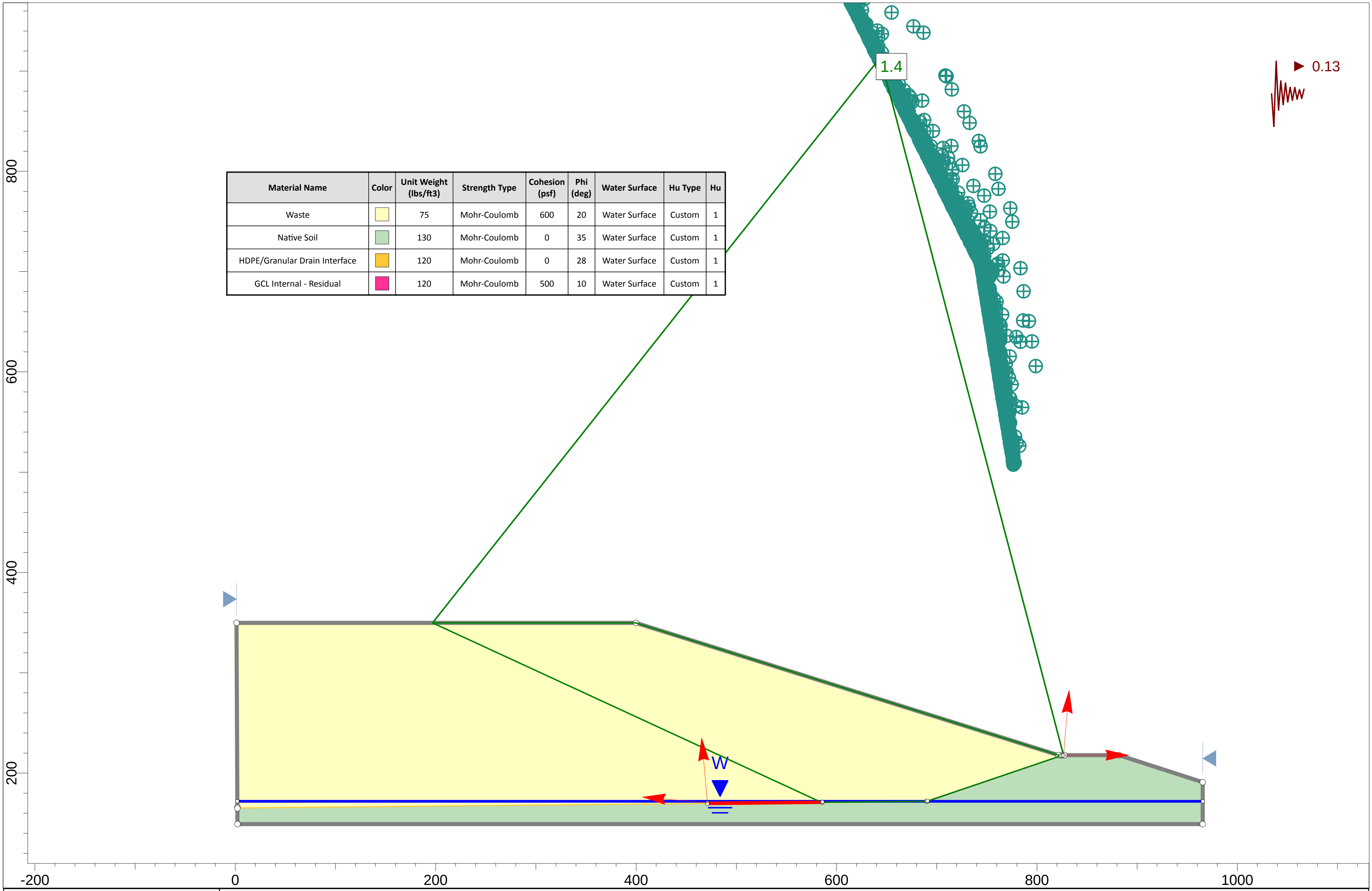
SLIDEINTERPRET 6.029

Project Matanuska-Susitna Borough Central Landfill

Case **Section B Lining Failure - Static**

Description

Date 7/24/2014 7:49:39 AM *Scale:* 1:1402 *File Name* Section B.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

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SLIDEINTERPRET 6.029

Project Matanuska-Susitna Borough Central Landfill

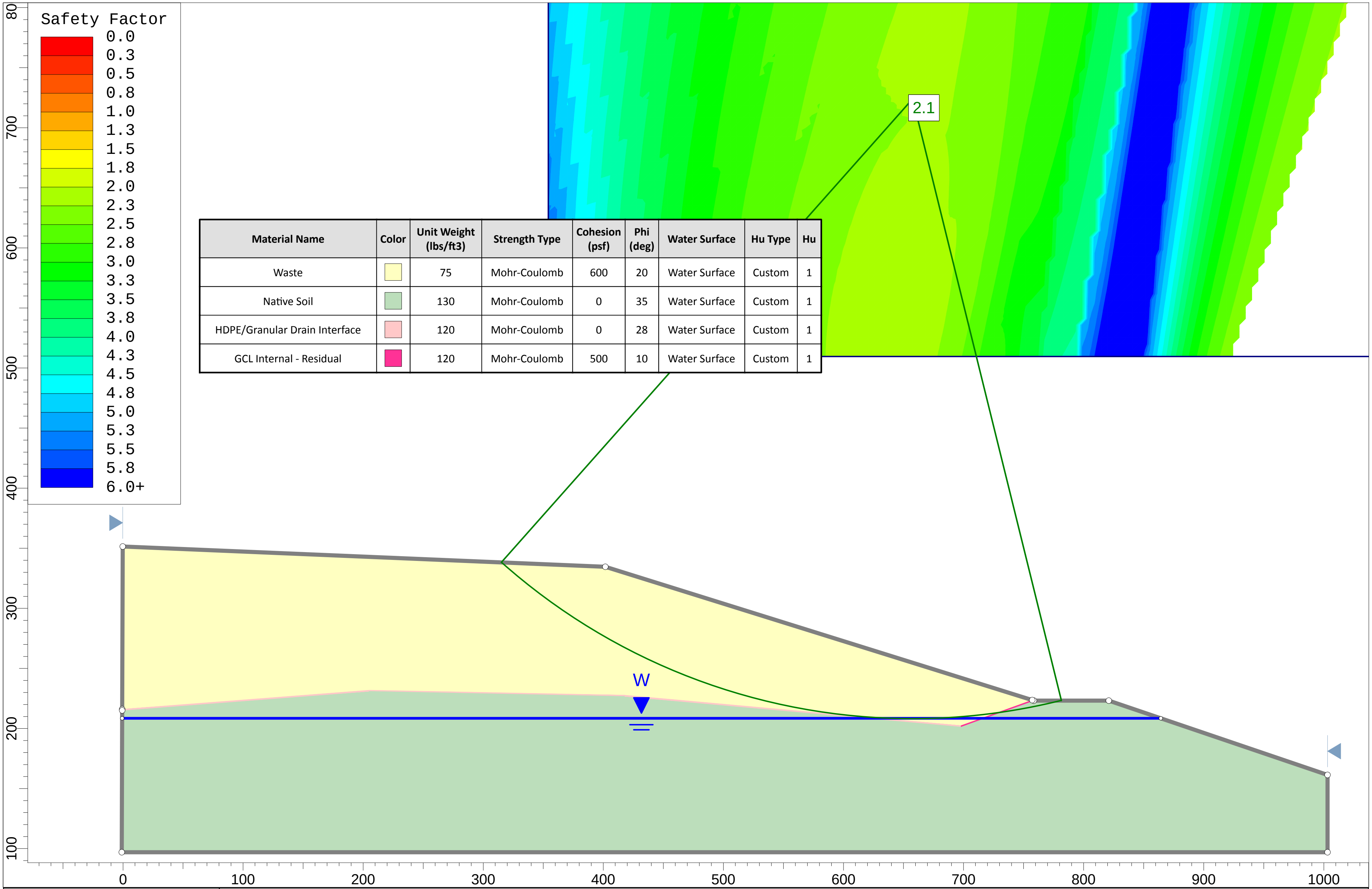
Case **Section B Lining Failure - Seismic**

Description

Date 7/24/2014 7:44:23 AM

Scale: 1:1558

File Name Section B.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟥	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

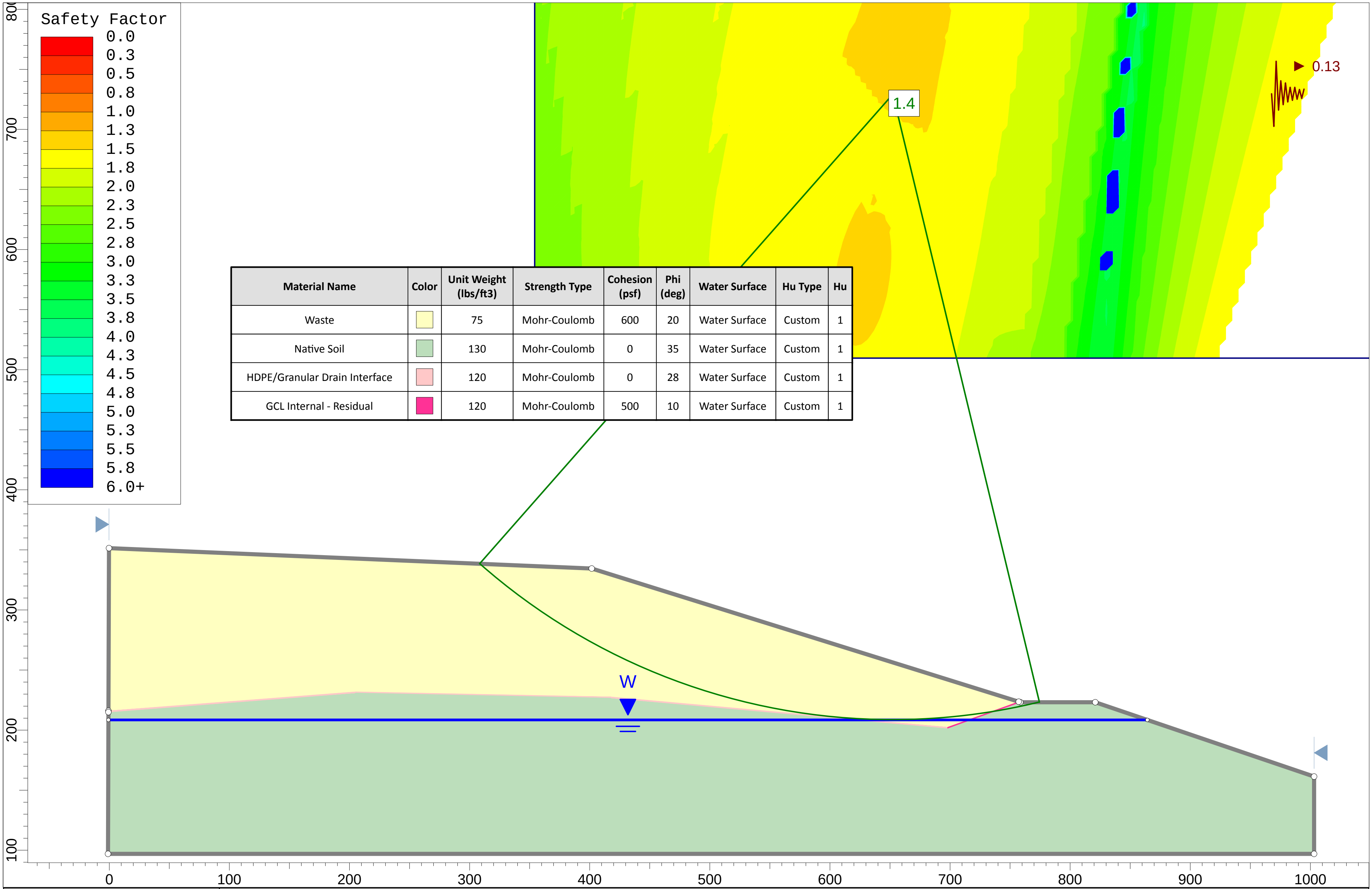
SLIDEINTERPRET 6.029

Project Matanuska-Sisitna Borough Central Landfill

Case **Section D Circular Failure - Static**

Description

Date 7/28/2014 12:51:48 PM *Scale:* 1:1300 *File Name* Section D.slim



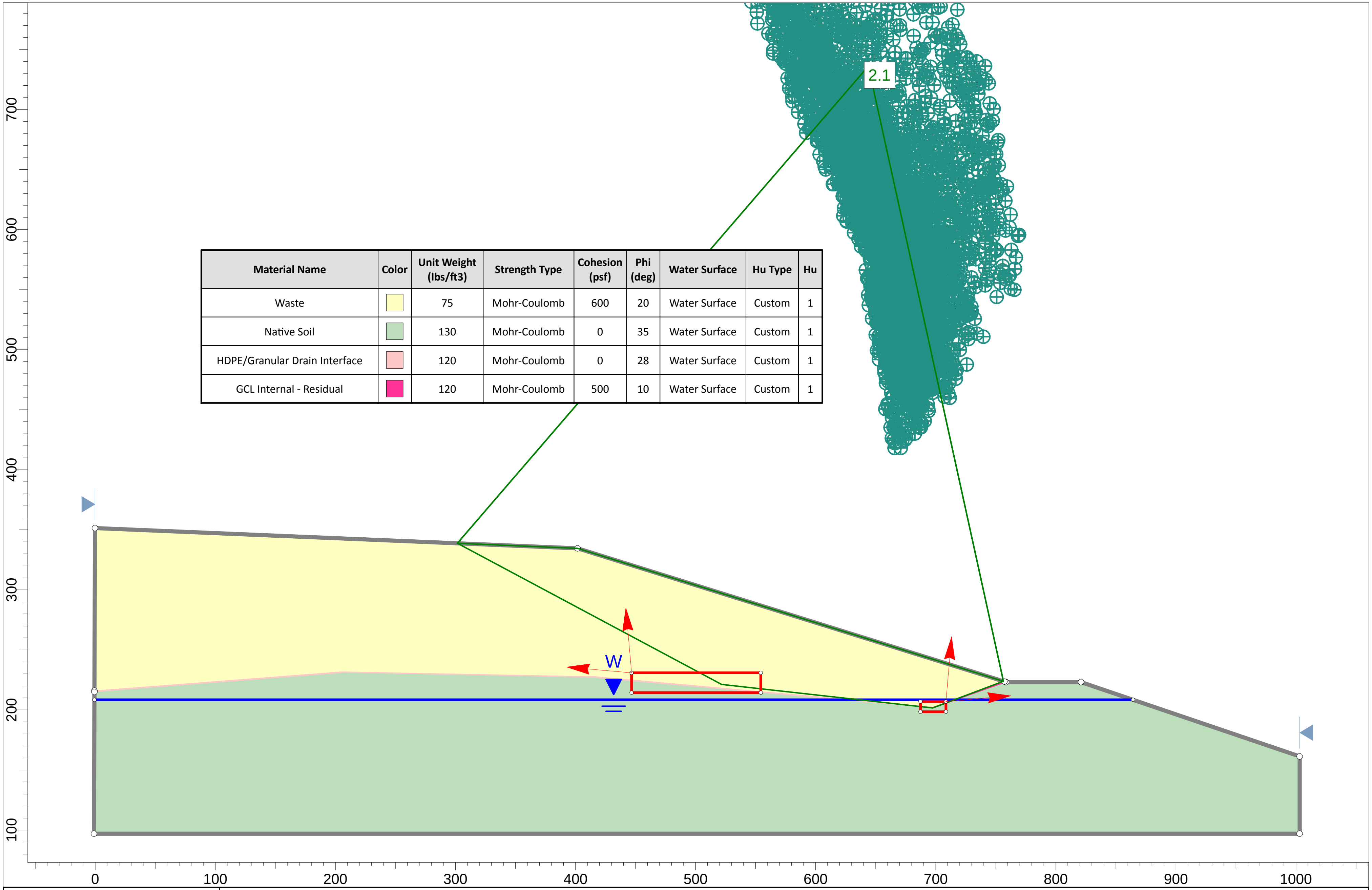
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟥	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project	Matanuska-Sisitna Borough Central Landfill
Case	**Section D Circular Failure - Seismic**
Description	

Date 7/28/2014 12:49:40 PM *Scale:* 1:1300 *File Name* Section D.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟥	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

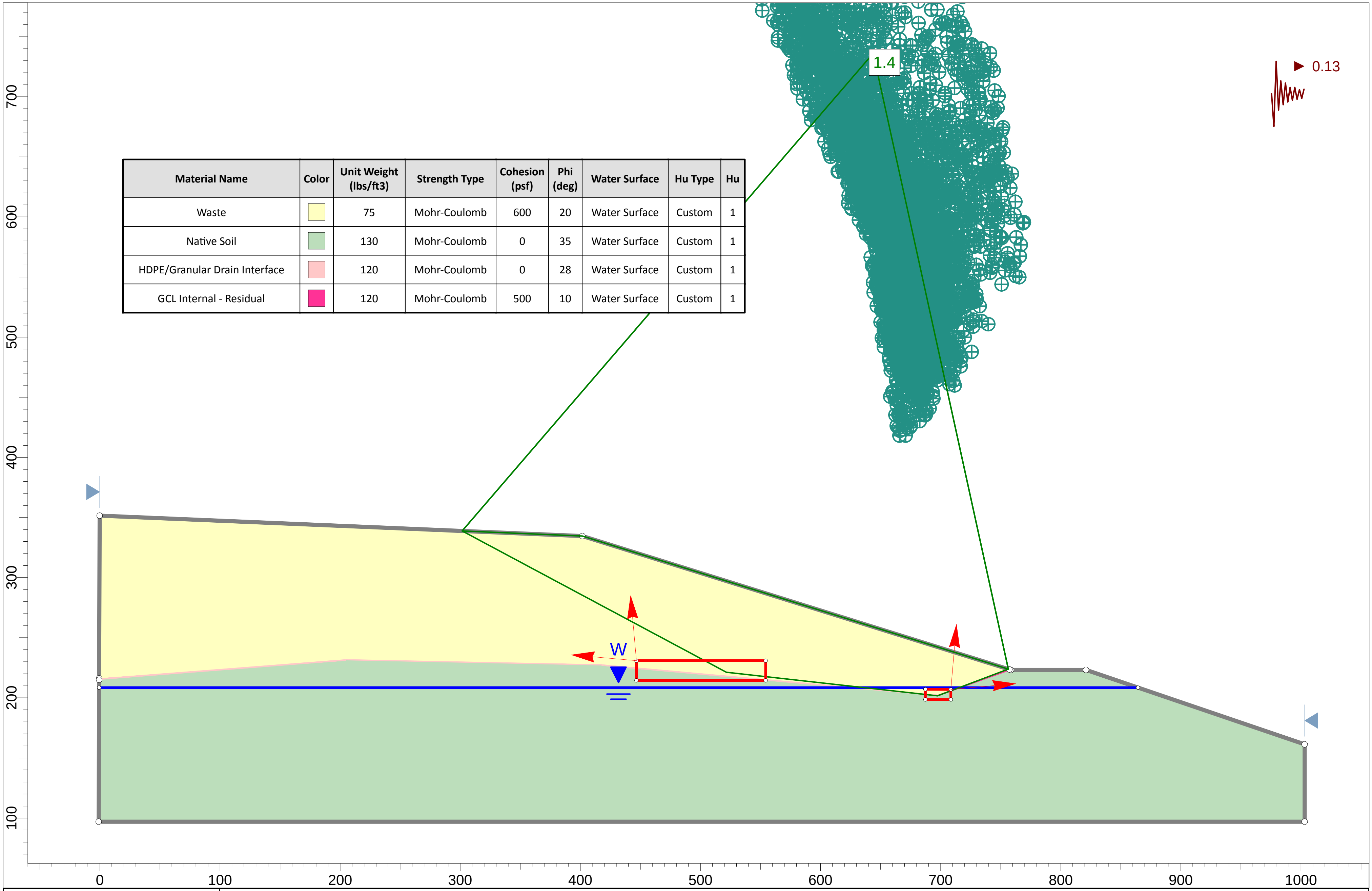
SLIDEINTERPRET 6.029

Project Matanuska-Sisitna Borough Central Landfill

Case **Section D Block Failure - Static**

Description

Date 7/28/2014 12:57:44 PM *Scale:* 1:1300 *File Name* Section D.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟥	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

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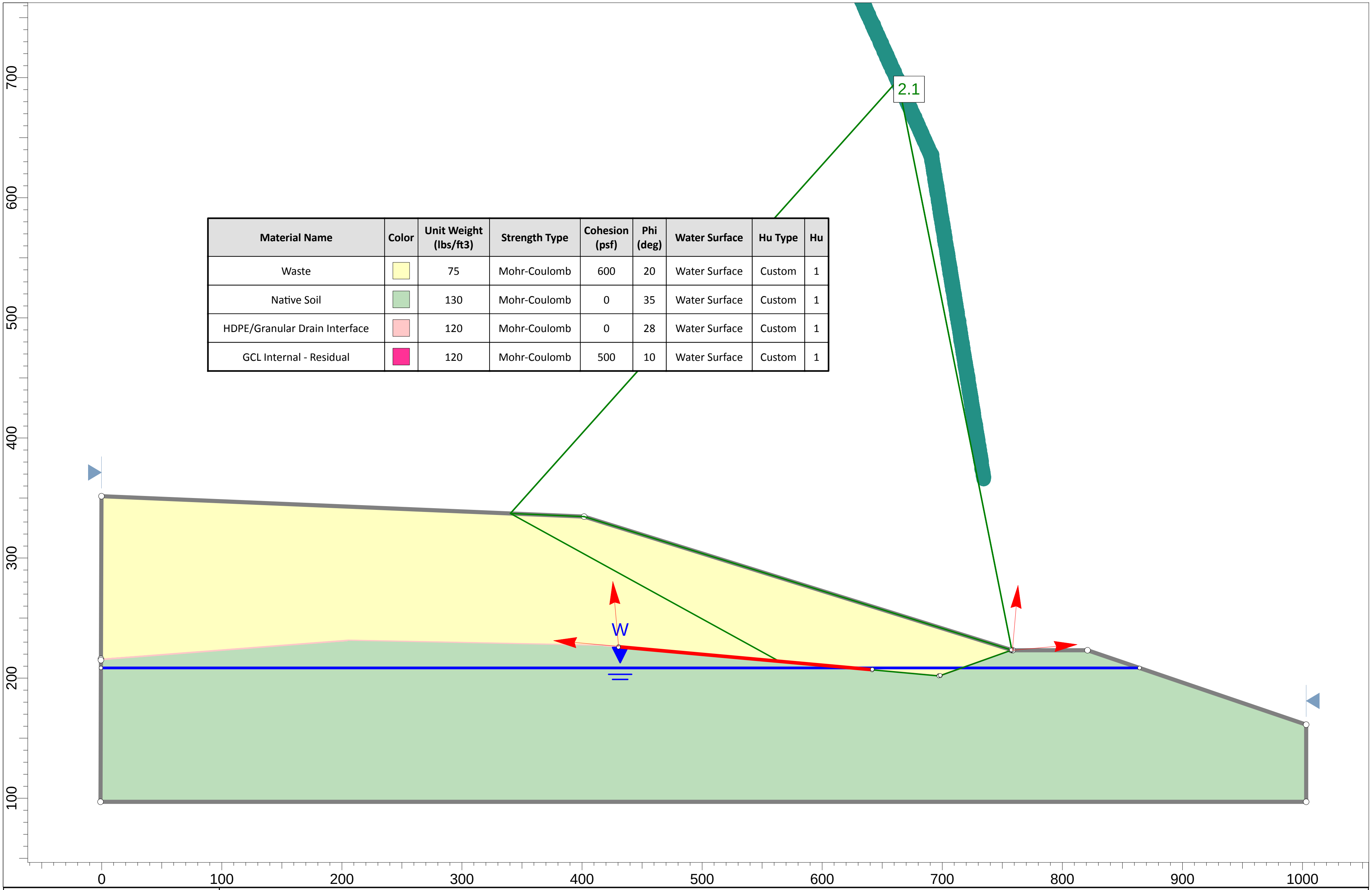
SLIDEINTERPRET 6.029

Project Matanuska-Sisitna Borough Central Landfill

Case **Section D Block Failure - Seismic**

Description

Date 7/28/2014 12:59:27 PM *Scale:* 1:1300 *File Name* Section D.slim



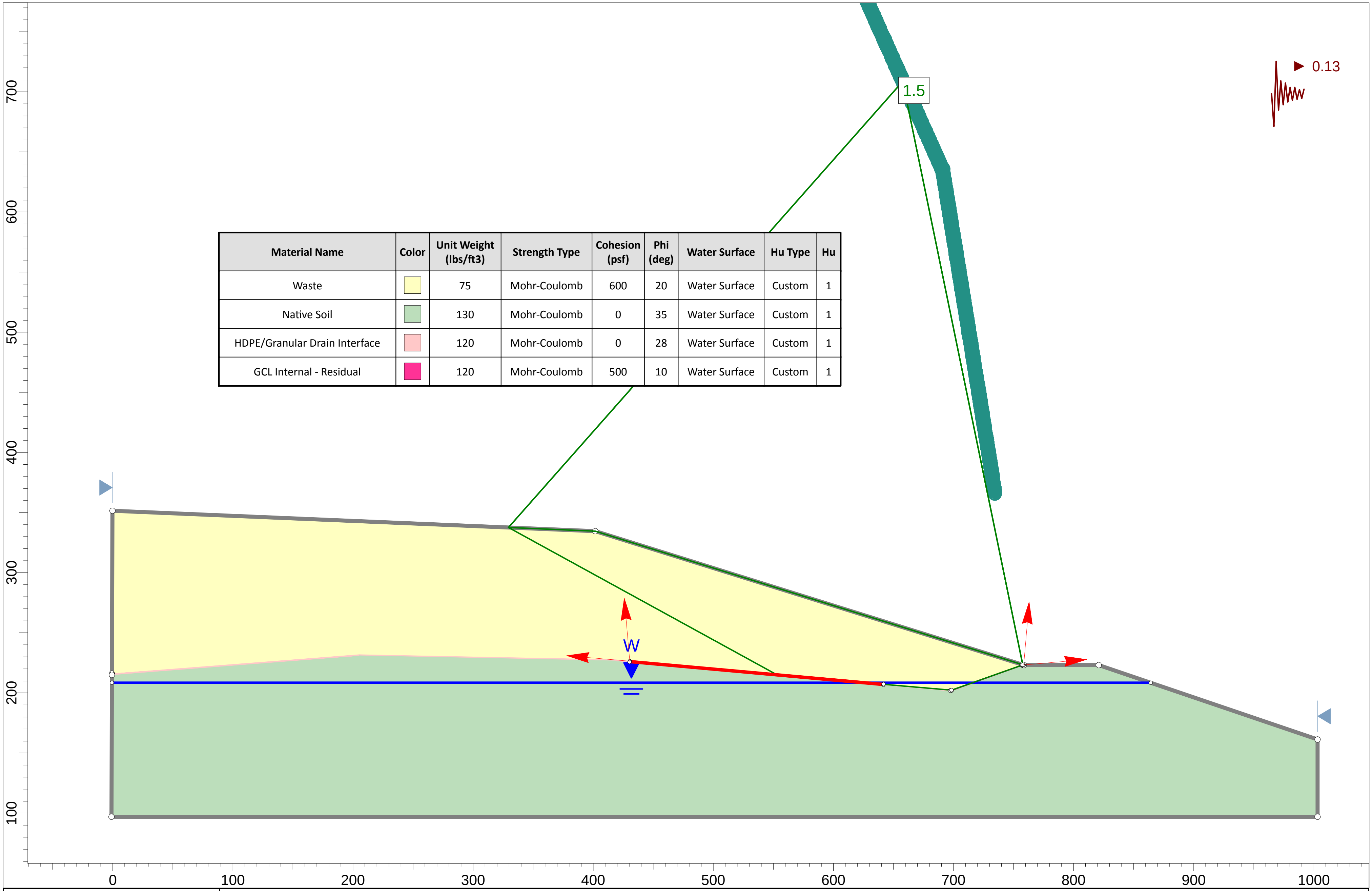
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟥	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟥	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project	Matanuska-Sisitna Borough Central Landfill
Case	**Section D Lining Failure - Static**
Description	

Date 7/28/2014 1:04:05 PM *Scale:* 1:1300 *File Name* Section D.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	▨	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟥	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project Matanuska-Sisitna Borough Central Landfill

Case **Section D Lining Failure - Seismic**

Description

Date 7/28/2014 1:02:56 PM *Scale:* 1:1300 *File Name* Section D.slim

APPENDIX B – ALL POINTS NORTH VERTICAL DATUM MEMORANDUM

ALL POINTS NORTH
LAND SURVEYING &
CIVIL ENGINEERING
P: 907-746-4185 | **F:** 907-746-4186

To:	**Macey "Butch" Shapiro** **Solid Waste Division Manager** **Matanuska Susitna Borough** **907-861-7606**	Date: Job:	**8/20/2019** **19-59 MSB Landfill**
Subject:	**Mat-Su Borough Central Landfill Elevation Memo**		

Memorandum

Mr. Shapiro,

It has come to our attention that various datums have been used for defining elevations at the MSB Central Landfill conversion values between various datums can be seen below.

The vertical datum of all All Points North surveys is NAVD 88 orthometric heights (computed using GEOID12B).

NAVD88 to NAD_83 ellipsoid heights

The translation value from NAVD 88 orthometric heights to NAD_83 ellipsoid heights were determined for all APN control points. The average geoid separation and therefore translation value for converting from NAVD 88 to ellipsoid heights is +33.11'. The source of this information is the National Geodetic Survey computational software.

NAVD88 to NGVD29

The translation value from NAVD 88, to NGVD 29 was determined by analyzing NGS Data Sheets for nearest benchmark stations, namely TT0610 and TT0650. Note that the Landfill site is situated between these two marks. This value ranges from -5.93' to -6.2' thus a average translation value of -6.1' can be used when converting from NAVD 88 to NGVD 29.

NAVD88 to MLLW (per Aerometric)

The translation value from NAVD 88, to the MLLW datum used at the MSB Central Landfill was also determined. Per the 2013 Aerometric survey (provided to APN by the Landfill) control point HV-301 has a MLLW elevation of 304.67. APN tied into this as control point #2004 with a NAVD 88 elevation of 312.70. Thus, a translation value of -8.03 can be used when converting between NAVD 88 and the 2013 Aerometric MLLW datum.

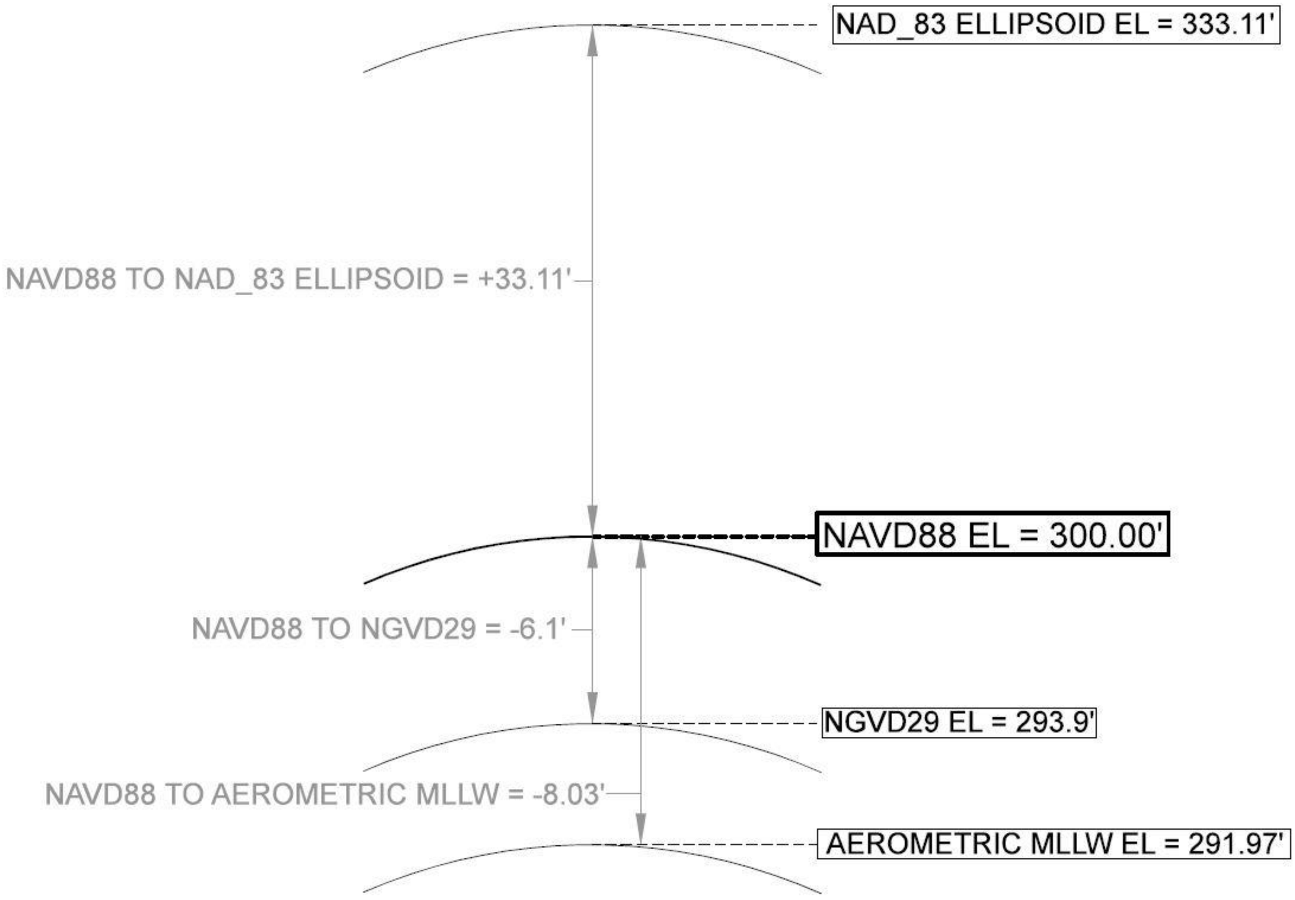
Please find attached depiction of the datums, and other supporting information.

Thank you,

Max Schillinger

Max Schillinger, P.L.S., P.E.
907-746-4185

DATUM TRANSLATION DEPICTION



NAD_83 ELLIPSOID TO NAVD88 ORTHOMETRIC

Point #	Northing	Easting	Description	NAD_83 ELLIPSOID	Geoid Sep.	NAVD88
100	2774382.16	1778122.71	SET PK W/ BLUE FUZZIE	343.39	33.06	310.33
2000	2774385.52	1778127.97	BASE PK''+'' TOPw/PENNANT CLOTH	343.61	33.06	310.56
2004	2774729.15	1778250.38	PM CFB	345.78	33.08	312.70
2006	2774764.41	1780891.76	5RB-FS-AGL-RPC-13##S	338.86	33.31	305.54
2011	2772292.17	1777576.59	5rb-FS-AGL-YPC-12039-SET-cc	356.01	32.93	323.08
2014	2772815.07	1779129.51	5rb-FS-AGL-YPC-12039-SET-cc	298.21	33.09	265.12
2016	2773422.66	1779033.74	hld 2-1/2''AC CP-102	297.17	33.10	264.07
2018	2773616.43	1778911.27	5rb-FS-AGL-YPC-12039-SET-cc	306.92	33.10	273.82
2020	2774188.82	1778767.55	FND SS-DR FS ''DATUM POINT''	337.13	33.11	304.02
2022	2774286.59	1780682.73	FND 2-1/2inAC-FS-AGL SB116	328.04	33.28	294.76
2027	2773146.42	1778163.79	5rb-FS-AGL-YPC-12039-SET-cc	319.79	33.01	286.78
2036	2773142.28	1779867.87	5rb-FS-AGL-YPC-12039-SET	266.47	33.16	233.30
			AVERAGE GEOID SEPERATION =		33.11	

NAVD88 to NGVD29

The NGS Data Sheet

See file dsdata.pdf for more information about the datasheet.

```
PROGRAM = datasheet95, VERSION = 8.12.5.3
1        National Geodetic Survey,   Retrieval Date = AUGUST 21, 2019
 TT0610 ************************************************************************
 TT0610  DESIGNATION -  W 20 RESET 1968
 TT0610  PID         -  TT0610
 TT0610  STATE/COUNTY-  AK/MATANUSKA-SUSITNA BOROUGH
 TT0610  COUNTRY     -  US
 TT0610  USGS QUAD   -  ANCHORAGE C-6
 TT0610
 TT0610                         *CURRENT SURVEY CONTROL
 TT0610  ______________________________________________________________________
 TT0610* NAD 83(1986) POSITION- 61 35 11.     (N) 149 07 39.     (W)    SCALED
 TT0610* NAVD 88 ORTHO HEIGHT -    64.409 (meters)      211.32  (feet) ADJUSTED
 TT0610  ______________________________________________________________________
 TT0610  GEOID HEIGHT    -         10.461 (meters)                     GEOID12B
 TT0610  DYNAMIC HEIGHT  -         64.498 (meters)      211.61  (feet) COMP
 TT0610  MODELED GRAVITY -    981,966.7   (mgal)                       NAVD 88
 TT0610
 TT0610  VERT ORDER      -  FIRST     CLASS I
 TT0610
 TT0610.The horizontal coordinates were scaled from a topographic map and have
 TT0610.an estimated accuracy of +/- 6 seconds.
 TT0610.
 TT0610.The orthometric height was determined by differential leveling and
 TT0610.adjusted by the NATIONAL GEODETIC SURVEY
 TT0610.in June 1991.
 TT0610
 TT0610.Significant digits in the geoid height do not necessarily reflect accuracy.
 TT0610.GEOID12B height accuracy estimate available here.
 TT0610
 TT0610.The dynamic height is computed by dividing the NAVD 88
 TT0610.geopotential number by the normal gravity value computed on the
 TT0610.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 TT0610.degrees latitude (g = 980.6199 gals.).
 TT0610
 TT0610.The modeled gravity was interpolated from observed gravity values.
 TT0610
 TT0610
 TT0610_U.S. NATIONAL GRID SPATIAL ADDRESS: 6VUP870299(NAD 83)
 TT0610
 TT0610                          SUPERSEDED SURVEY CONTROL
 TT0610
 TT0610  NGVD 29 (??/??/92)    62.602  (m)          205.39    (f) ADJ UNCH    1 1
 TT0610
 TT0610.Superseded values are not recommended for survey control.
 TT0610
 TT0610.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 TT0610.See file dsdata.pdf to determine how the superseded data were derived.
 TT0610
 TT0610_MARKER: DB = BENCH MARK DISK
 TT0610_SETTING: 46 = COPPER-CLAD STEEL ROD W/O SLEEVE (10 FT.+)
```

```
TT0610_STAMPING: W 20 RESET 1968
TT0610_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
TT0610
TT0610  HISTORY     - Date     Condition        Report By
TT0610  HISTORY     - 1968     MONUMENTED       CGS
TT0610  HISTORY     - 1975     GOOD             NGS
TT0610
TT0610                          STATION DESCRIPTION
TT0610
TT0610'DESCRIBED BY NATIONAL GEODETIC SURVEY 1975
TT0610'1.1 MI S FROM PALMER.
TT0610'1.1 MILES SOUTH ALONG THE ALASKA RAILROAD FROM THE STATION AT PALMER,
TT0610'0.1 MILE NORTHEAST OF THE CROSSING OF SPRINGER LOOP INNER, 0.25 MILE
TT0610'SOUTHWEST OF THE CROSSING OF A PRIVATE ROAD, 27.6 FEET NORTHWEST OF
TT0610'THE NORTHWEST RAIL, 44 FEET SOUTHEAST OF THE CENTER LINE OF STATE
TT0610'HIGHWAY 1, 61.4 FEET SOUTHWEST OF THE NORTHWEST STEEL LEG OF A STATE
TT0610'TROOPERS 1 MILE SIGN, 8 1/2 FEET SOUTH OF A TELEPHONE POLE, 1.0 FOOT
TT0610'EAST OF A METAL WITNESS POST, ABOUT 1 1/2 FEET LOWER THAN THE HIGHWAY,
TT0610'ABOUT 4 FEET LOWER THAN THE TRACK, AND A DISK ON THE TOP OF A COPPER
TT0610'COATED STEEL ROD DRIVEN TO A DEPTH OF 16 FEET.  THE DISK IS 0.8 FOOT
TT0610'ABOVE THE GROUND AND IS PROTECTED BY A 4-INCH PIPE WHICH PROJECTS 1.4
TT0610'FOOT ABOVE THE GROUND.  SEC 5, 17 N, R 2E.2 E.

*** retrieval complete.
Elapsed Time = 00:00:03
```

NAVD88 to NGVD29

The NGS Data Sheet

See file dsdata.pdf for more information about the datasheet.

```
PROGRAM = datasheet95, VERSION = 8.12.5.3
1        National Geodetic Survey,   Retrieval Date = AUGUST 21, 2019
 TT0650 ***********************************************************************
 TT0650  DESIGNATION -  T 102
 TT0650  PID         -  TT0650
 TT0650  STATE/COUNTY-  AK/MATANUSKA-SUSITNA BOROUGH
 TT0650  COUNTRY     -  US
 TT0650  USGS QUAD   -  ANCHORAGE C-7
 TT0650
 TT0650                         *CURRENT SURVEY CONTROL
 TT0650  ______________________________________________________________________
 TT0650* NAD 83(1986) POSITION- 61 34 04.     (N) 149 19 15.      (W)    SCALED
 TT0650* NAVD 88 ORTHO HEIGHT -     48.584 (meters)       159.40  (feet) ADJUSTED
 TT0650  ______________________________________________________________________
 TT0650  GEOID HEIGHT    -           9.482 (meters)                      GEOID12B
 TT0650  DYNAMIC HEIGHT  -          48.651 (meters)       159.62  (feet) COMP
 TT0650  MODELED GRAVITY -    981,966.9    (mgal)                        NAVD 88
 TT0650
 TT0650  VERT ORDER      -  FIRST     CLASS II
 TT0650
 TT0650.The horizontal coordinates were scaled from a topographic map and have
 TT0650.an estimated accuracy of +/- 6 seconds.
 TT0650.
 TT0650.The orthometric height was determined by differential leveling and
 TT0650.adjusted by the NATIONAL GEODETIC SURVEY
 TT0650.in June 1991.
 TT0650
 TT0650.Significant digits in the geoid height do not necessarily reflect accuracy.
 TT0650.GEOID12B height accuracy estimate available here.
 TT0650
 TT0650.The dynamic height is computed by dividing the NAVD 88
 TT0650.geopotential number by the normal gravity value computed on the
 TT0650.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 TT0650.degrees latitude (g = 980.6199 gals.).
 TT0650
 TT0650.The modeled gravity was interpolated from observed gravity values.
 TT0650
 TT0650
 TT0650_U.S. NATIONAL GRID SPATIAL ADDRESS: 6VUP767282(NAD 83)
 TT0650
 TT0650                          SUPERSEDED SURVEY CONTROL
 TT0650
 TT0650  NGVD 29 (??/??/92)    46.69    (m)          153.2     (f) COMPUTED    1 2
 TT0650
 TT0650.Superseded values are not recommended for survey control.
 TT0650
 TT0650.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 TT0650.See file dsdata.pdf to determine how the superseded data were derived.
 TT0650
 TT0650_MARKER: DB = BENCH MARK DISK
 TT0650_SETTING: 46 = COPPER-CLAD STEEL ROD W/O SLEEVE (10 FT.+)
```

```
TT0650_STAMPING: T 102 1965
TT0650_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
TT0650_SATELLITE: THE SITE LOCATION WAS REPORTED AS NOT SUITABLE FOR
TT0650+SATELLITE: SATELLITE OBSERVATIONS - June 13, 2008
TT0650
TT0650  HISTORY     - Date     Condition        Report By
TT0650  HISTORY     - 1965     MONUMENTED       CGS
TT0650  HISTORY     - 20080613 GOOD             GEOCAC
TT0650
TT0650                          STATION DESCRIPTION
TT0650
TT0650'DESCRIBED BY COAST AND GEODETIC SURVEY 1965
TT0650'4.9 MI E FROM WASILLA.
TT0650'0.9 MILE EAST ALONG THE ALASKA RAILROAD FROM THE STATION AT WASILLA,
TT0650'THENCE 4 MILES EAST ALONG A DIRT ROAD, AT THE JUNCTION OF THE ALASKA
TT0650'RAILROAD, AT THE JUNCTION OF A DIRT ROAD LEADING SOUTH ACROSS TRACKS,
TT0650'AT THE CROSSING OF A POWER LINE, 151 1/2 FEET SOUTH OF THE CENTER LINE
TT0650'OF THE ROAD, 23 FEET WEST OF THE CENTER LINE OF THE ROAD LEADING
TT0650'SOUTH, 58 FEET SOUTHWEST OF AND ACROSS THE ROAD FROM THE FOURTH
TT0650'TELEPHONE POLE WEST OF MILEPOST 155 ON RAILROAD, 66.1 FEET SOUTH OF
TT0650'THE SOUTH RAIL, 1 FOOT NORTH OF POWER LINE POLE F 51, 1 FOOT WEST OF A
TT0650'WITNESS POST, ABOUT LEVEL WITH THE ROAD LEADING SOUTH, AND A 5/8-INCH
TT0650'COPPER COATED ROD THAT IS DRIVEN TO DEPTH OF 48 FEET AND IS ENCASED IN
TT0650'A 5-INCH ORANGEBURG PIPE WHICH PROJECTS 1.0 FOOT.
TT0650
TT0650                          STATION RECOVERY (2008)
TT0650
TT0650'RECOVERY NOTE BY GEOCACHING 2008 (MTT)
TT0650'COORDINATES AT STATION USING HH2 WITH 25 FT OF VARIATION WERE
TT0650'61 34' 03.18, 149 19' 14.76  SOUTHBOUND ROAD FROM THE PREVIOUS
TT0650'DESCRIPTION IS NOW A DRIVEWAY AND RESIDES DIRECTLY SOUTH OF HIGHWAY 3
TT0650'EXIT RAMP, .05 MILES WEST OF A GAS STAION.

*** retrieval complete.
Elapsed Time = 00:00:04
```

NAVD88 TO MLLW

aerometric
Geospatial Solutions
2014 Merrill Field Drive
Anchorage, AK 99501
P: 907-272-4495
F: 907-274-3265
www.aerometric.com
[redacted]

NOTES:

Project Name: Central Landfill 2013

Project: 6130502

This map was compiled to meet horizontal accuracy in accordance with ASPRS Class II Accuracy Standards.

This map was compiled to meet vertical accuracy in accordance with ASPRS Class II Accuracy Standards.

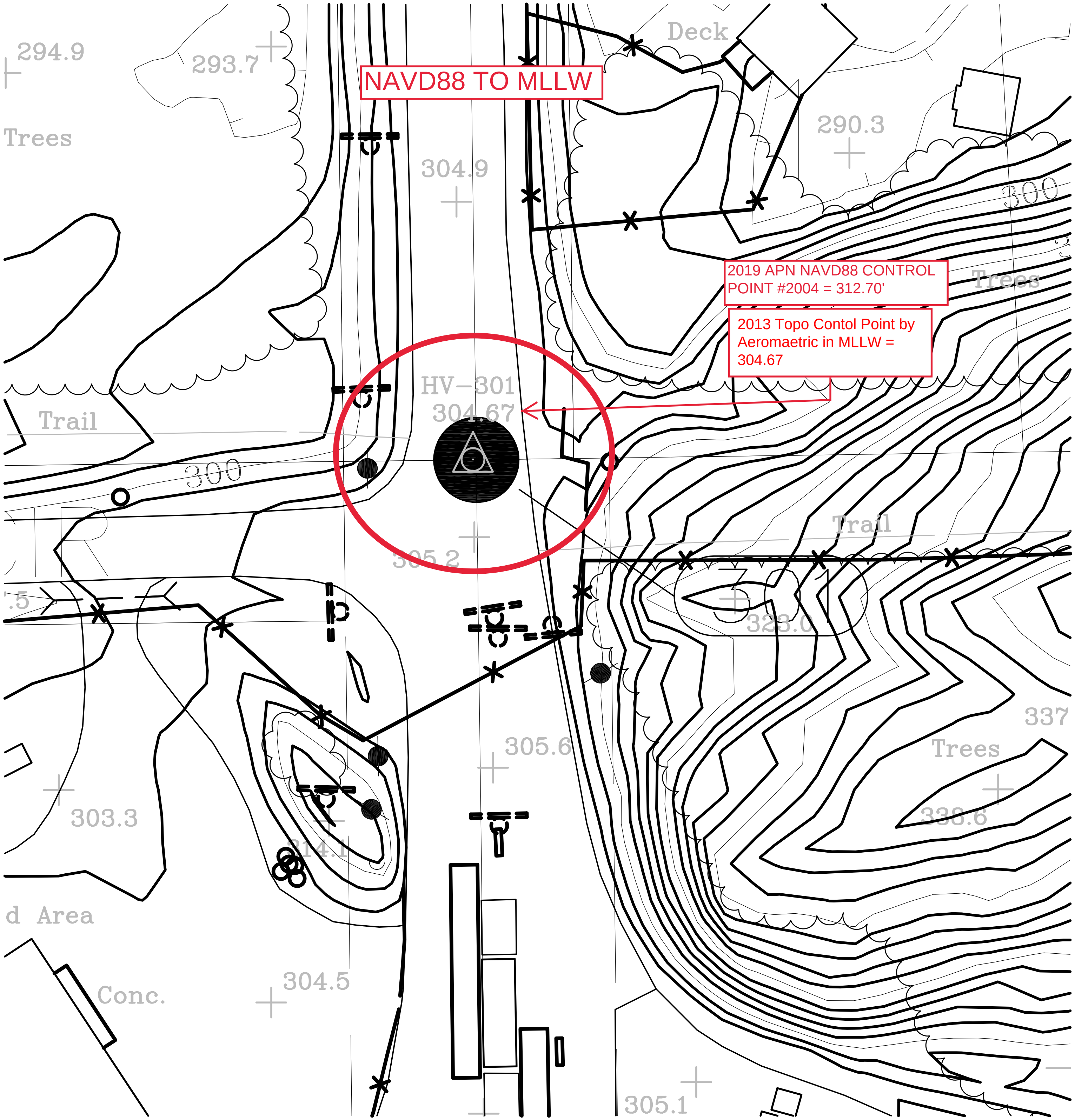
Areas denoting vegetation cover on the ground should be considered less accurate and not used for engineering purposes until field checked in accordance with ASPRS Accuracy Standards.

The map projection is based on NAD83, Alaska State Plane Zone 4, as expressed in U.S. Survey Feet.

Vertical data is referenced to MLLW.

This map is based on photography acquired 05–24–2013 at a nominal scale of 1"=800' and previous photography dated 05–02–2011 at a nominal scale of 1"=800'.

This map produced for output at a scale of 1"=100' with a contour interval of 2 feet.



NAVD88 TO MLLW

2019 APN NAVD88 CONTROL POINT #2004 = 312.70'

2013 Topo Contol Point by Aeromaetric in MLLW = 304.67

APPENDIX C – LIFE OF SITE

Matanuska-Susitna Borough Central Landfill Development Plan
Burns & McDonnell, June 2020
MSW Remaining Life Calculation

Tonnage 2019 = 57,311.21
Average AUF = 1327.8 lb/cy
Growth % = 2.00% (Client Provided)
Remaining Life Cell 3 = 228,466 CY *(Calculated from Fall 2019 Survey Received from USGS Lidar)
Total Capacity Cells 2B-5 = 3,702,204

Year	Projected Tonnage	Airspace Consumed (CY)	Total Airspace Consumed (CY)	Cumulative Capacity Consumed (thru Cell 5)	Airspace Remaining Year End (CY)	
2019	4,385	6,605	1,079,667	29.2%	221,860	*Assume Survey Flown in Nov 2019; tonnage reflects Dec 2019
2020	58,457	88,052	1,167,719	31.5%	133,809	
2021	59,627	89,813	1,257,532	34.0%	43,996	
2022	60,819	91,609	1,349,140	36.4%	935,951	Move into Cell 4; added Cell 4 Volume
2023	62,035	93,441	1,442,582	39.0%	842,510	
2024	63,276	95,310	1,537,891	41.5%	747,200	
2025	64,542	97,216	1,635,107	44.2%	649,984	
2026	65,833	99,160	1,734,268	46.8%	550,824	
2027	67,149	101,144	1,835,411	49.6%	449,680	
2028	68,492	103,166	1,938,578	52.4%	346,514	
2029	69,862	105,230	2,043,808	55.2%	241,284	
2030	71,259	107,334	2,151,142	58.1%	133,950	
2031	72,684	109,481	2,260,623	61.1%	24,469	<-- Construct Cell 5
2032	74,138	111,671	2,372,294	64.1%	1,323,305	Move into Cell 5; added Cell 5 Volume
2033	75,621	113,904	2,486,198	67.2%	1,209,401	
2034	77,133	116,182	2,602,380	70.3%	1,093,219	
2035	78,676	118,506	2,720,886	73.5%	974,713	
2036	80,250	120,876	2,841,762	76.8%	853,837	
2037	81,855	123,293	2,965,055	80.1%	730,543	
2038	83,492	125,759	3,090,814	83.5%	604,784	
2039	85,161	128,275	3,219,089	87.0%	476,510	
2040	86,865	130,840	3,349,929	90.5%	345,670	
2041	88,602	133,457	3,483,386	94.1%	212,213	
2042	90,374	136,126	3,619,512	97.8%	76,087	<-- Construct PH2C1
2043	92,181	138,848	3,702,204	100.0%	1,521,828	Move into PH2C1; added PH2C1 Volume / Cell 5 Life Depleted (FA)
2044	94,025	141,625			1,380,202	
2045	95,906	144,458			1,235,744	
2046	97,824	147,347			1,088,397	
2047	99,780	150,294			938,103	
2048	101,776	153,300			784,803	
2049	103,811	156,366			628,437	
2050	105,888	159,493			468,944	
2051	108,005	162,683			306,261	
2052	110,165	165,937			140,324	<-- Construct PH2C2
2053	112,369	169,255			2,163,469	Move into PH2C2; added PH2C2 Volume
2054	114,616	172,641			1,990,829	
2055	116,908	176,093			1,814,735	
2056	119,247	179,615			1,635,120	
2057	121,632	183,208			1,451,912	
2058	124,064	186,872			1,265,041	
2059	126,545	190,609			1,074,432	
2060	129,076	194,421			880,010	
2061	131,658	198,310			681,700	
2062	134,291	202,276			479,424	
2063	136,977	206,321			273,103	
2064	139,716	210,448			62,655	<-- Construct PH2C3
2065	142,511	214,657			2,738,113	Move into PH2C3; added PH2C3 Volume
2066	145,361	218,950			2,519,163	
2067	148,268	223,329			2,295,834	
2068	151,233	227,796			2,068,038	
2069	154,258	232,352			1,835,687	
2070	157,343	236,999			1,598,688	
2071	160,490	241,739			1,356,950	
2072	163,700	246,573			1,110,377	
2073	166,974	251,505			858,872	
2074	170,313	256,535			602,337	
2075	173,720	261,666			340,671	
2076	177,194	266,899			73,773	<-- Construct PH2C4
2077	180,738	272,237			3,235,509	Move into PH2C4; added PH2C4 Volume
2078	184,353	277,682			2,957,828	
2079	188,040	283,235			2,674,593	
2080	191,801	288,900			2,385,693	
2081	195,637	294,678			2,091,015	
2082	199,549	300,571			1,790,443	
2083	203,540	306,583			1,483,860	
2084	207,611	312,715			1,171,146	
2085	211,763	318,969			852,177	
2086	215,999	325,348			526,829	
2087	220,319	331,855			194,974	<-- Construct PH2C5
2088	224,725	338,492			3,516,679	Move into PH2C5; added PH2C5 Volume
2089	229,220	345,262			3,171,417	

2090	233,804	352,167	2,819,249	
2091	238,480	359,211	2,460,039	
2092	243,250	366,395	2,093,644	
2093	248,115	373,723	1,719,921	
2094	253,077	381,197	1,338,724	
2095	258,138	388,821	949,902	
2096	263,301	396,598	553,305	
2097	268,567	404,530	148,775	<-- Construct PH2C6
2098	273,939	412,620	3,963,966	Move into PH2C6; added PH2C6 Volume
2099	279,417	420,873	3,543,094	
2100	285,006	429,290	3,113,804	
2101	290,706	437,876	2,675,928	
2102	296,520	446,633	2,229,295	
2103	302,450	455,566	1,773,729	
2104	308,499	464,677	1,309,051	
2105	314,669	473,971	835,080	
2106	320,963	483,450	351,630	<-- Construct PH2C7
2107	327,382	493,119	5,007,284	Move into PH2C7; added PH2C7 Volume
2108	333,930	502,982	4,504,302	
2109	340,608	513,041	3,991,261	
2110	347,420	523,302	3,467,958	
2111	354,369	533,768	2,934,190	
2112	361,456	544,444	2,389,747	
2113	368,685	555,332	1,834,414	
2114	376,059	566,439	1,267,975	
2115	383,580	577,768	690,207	
2116	391,252	589,323	100,884	<-- Construct PH3
2117	399,077	601,110	23,565,102	Move into PH3; added PH3Volume
2118	407,058	613,132	22,951,970	
2119	415,199	625,395	22,326,576	
2120	423,503	637,902	21,688,673	
2121	431,973	650,660	21,038,013	
2122	440,613	663,674	20,374,339	
2123	449,425	676,947	19,697,392	
2124	458,414	690,486	19,006,906	
2125	467,582	704,296	18,302,610	
2126	476,934	718,382	17,584,228	
2127	486,472	732,749	16,851,479	
2128	496,202	747,404	16,104,074	
2129	506,126	762,352	15,341,722	
2130	516,248	777,600	14,564,122	
2131	526,573	793,151	13,770,971	
2132	537,105	809,015	12,961,956	
2133	547,847	825,195	12,136,762	
2134	558,804	841,699	11,295,063	
2135	569,980	858,533	10,436,530	
2136	581,379	875,703	9,560,827	
2137	593,007	893,217	8,667,609	
2138	604,867	911,082	7,756,528	
2139	616,965	929,303	6,827,224	
2140	629,304	947,889	5,879,335	
2141	641,890	966,847	4,912,488	
2142	654,728	986,184	3,926,303	
2143	667,822	1,005,908	2,920,396	
2144	681,179	1,026,026	1,894,370	
2145	694,802	1,046,547	847,823	
2146	708,698	1,067,477	(219,654)	Life Depleted

Matanuska-Susitna Borough Central Landfill Development Plan
Burns & McDonnell, June 2020
C&D Remaining Life Calculation, 1000 PCY

C&D Tonnage =	12,372.60	5 yr average (2015-2019)
Average AUF =	1000	lb/cy (assumed value)
Growth % =	2.00%	(Client Provided)
Remaining Life C&D =	2,775,989	CY *(Calculated from Fall 2019 Survey Received from USGS Lidar)

Year	Projected Tonnage	Airspace Consumed (CY)	Airspace Remaining Year End (CY)
2019	1,031	2,062	2,773,927
2020	12,620	25,240	2,748,687
2021	12,872	25,745	2,722,942
2022	13,130	26,260	2,696,682
2023	13,393	26,785	2,669,897
2024	13,660	27,321	2,642,576
2025	13,934	27,867	2,614,709
2026	14,212	28,424	2,586,285
2027	14,496	28,993	2,557,292
2028	14,786	29,573	2,527,719
2029	15,082	30,164	2,497,555
2030	15,384	30,768	2,466,787
2031	15,691	31,383	2,435,404
2032	16,005	32,011	2,403,394
2033	16,325	32,651	2,370,743
2034	16,652	33,304	2,337,439
2035	16,985	33,970	2,303,469
2036	17,325	34,649	2,268,820
2037	17,671	35,342	2,233,478
2038	18,025	36,049	2,197,429
2039	18,385	36,770	2,160,659
2040	18,753	37,505	2,123,153
2041	19,128	38,256	2,084,898
2042	19,510	39,021	2,045,877
2043	19,901	39,801	2,006,076
2044	20,299	40,597	1,965,479
2045	20,705	41,409	1,924,070
2046	21,119	42,237	1,881,832
2047	21,541	43,082	1,838,750
2048	21,972	43,944	1,794,807
2049	22,411	44,823	1,749,984
2050	22,859	45,719	1,704,265
2051	23,317	46,633	1,657,632
2052	23,783	47,566	1,610,066
2053	24,259	48,517	1,561,549
2054	24,744	49,488	1,512,061
2055	25,239	50,477	1,461,584
2056	25,743	51,487	1,410,097
2057	26,258	52,517	1,357,580
2058	26,784	53,567	1,304,013
2059	27,319	54,638	1,249,375

*Assume Survey Flown in Nov 2019; tonnage reflects Dec 2019

2060	27,866	55,731	1,193,643	
2061	28,423	56,846	1,136,798	
2062	28,991	57,983	1,078,815	
2063	29,571	59,142	1,019,673	
2064	30,163	60,325	959,347	
2065	30,766	61,532	897,816	
2066	31,381	62,762	835,053	
2067	32,009	64,018	771,036	
2068	32,649	65,298	705,738	
2069	33,302	66,604	639,134	
2070	33,968	67,936	571,198	
2071	34,647	69,295	501,903	
2072	35,340	70,681	431,223	
2073	36,047	72,094	359,129	
2074	36,768	73,536	285,593	
2075	37,503	75,007	210,586	
2076	38,253	76,507	134,079	
2077	39,019	78,037	56,042	
2078	39,799	79,598	(23,556)	<-- C&D Life Depleted

Matanuska-Susitna Borough Central Landfill Development Plan
Burns & McDonnell, June 2020
C&D Remaining Life Calculation, 600 PCY

C&D Tonnage = 12,372.60 5 yr average (2015-2019)
Average AUF = 600 lb/cy (assumed value)
Growth % = 2.00% (Client Provided)
Remaining Life C&D = 2,775,989 CY *(Calculated from Fall 2019 Survey Received from USGS Lidar)

Year	Projected Tonnage	Airspace Consumed (CY)	Airspace Remaining Year End (CY)	
2019	1,031	3,437	2,772,552	*Assume Survey Flown in Nov 2019; tonnage reflects Dec 2019
2020	12,620	42,067	2,730,485	
2021	12,872	42,908	2,687,577	
2022	13,130	43,766	2,643,811	
2023	13,393	44,642	2,599,169	
2024	13,660	45,535	2,553,635	
2025	13,934	46,445	2,507,189	
2026	14,212	47,374	2,459,815	
2027	14,496	48,322	2,411,494	
2028	14,786	49,288	2,362,206	
2029	15,082	50,274	2,311,932	
2030	15,384	51,279	2,260,653	
2031	15,691	52,305	2,208,348	
2032	16,005	53,351	2,154,997	
2033	16,325	54,418	2,100,579	
2034	16,652	55,506	2,045,073	
2035	16,985	56,616	1,988,456	
2036	17,325	57,749	1,930,708	
2037	17,671	58,904	1,871,804	
2038	18,025	60,082	1,811,722	
2039	18,385	61,283	1,750,439	
2040	18,753	62,509	1,687,929	
2041	19,128	63,759	1,624,170	
2042	19,510	65,034	1,559,136	
2043	19,901	66,335	1,492,801	
2044	20,299	67,662	1,425,139	
2045	20,705	69,015	1,356,124	
2046	21,119	70,395	1,285,728	
2047	21,541	71,803	1,213,925	
2048	21,972	73,239	1,140,685	
2049	22,411	74,704	1,065,981	
2050	22,859	76,198	989,783	
2051	23,317	77,722	912,061	
2052	23,783	79,277	832,784	
2053	24,259	80,862	751,922	
2054	24,744	82,479	669,442	
2055	25,239	84,129	585,313	
2056	25,743	85,812	499,502	
2057	26,258	87,528	411,974	
2058	26,784	89,278	322,696	
2059	27,319	91,064	231,632	
2060	27,866	92,885	138,746	
2061	28,423	94,743	44,003	
2062	28,991	96,638	(52,634)	<-- C&D Life Depleted

Matanuska-Susitna Borough Central Landfill Development Plan
Burns & McDonnell, June 2020
Asbestos Remaining Life Calculation

Asbestos Tonnage =	182	5 yr average (2015-2019)
Average AUF =	75.7	lb/cy
Growth % =	2.00%	(Client Provided)
Remaining Life Asbestos =	520,817	CY *(Calculated from Fall 2019 Survey Received from USGS Lidar)

Year	Projected Tonnage	Airspace Consumed (CY)	Airspace Remaining Year End (CY)
2019	15	401	520,416
2020	186	4,908	515,508
2021	190	5,006	510,501
2022	193	5,106	505,395
2023	197	5,209	500,186
2024	201	5,313	494,874
2025	205	5,419	489,455
2026	209	5,527	483,927
2027	214	5,638	478,290
2028	218	5,751	472,539
2029	222	5,866	466,673
2030	227	5,983	460,690
2031	231	6,103	454,588
2032	236	6,225	448,363
2033	240	6,349	442,014
2034	245	6,476	435,538
2035	250	6,606	428,932
2036	255	6,738	422,194
2037	260	6,873	415,322
2038	265	7,010	408,312
2039	271	7,150	401,162
2040	276	7,293	393,869
2041	282	7,439	386,430
2042	287	7,588	378,842
2043	293	7,740	371,102
2044	299	7,894	363,208
2045	305	8,052	355,155
2046	311	8,213	346,942
2047	317	8,378	338,565
2048	324	8,545	330,019
2049	330	8,716	321,303
2050	337	8,890	312,413
2051	343	9,068	303,345
2052	350	9,250	294,095
2053	357	9,435	284,661
2054	364	9,623	275,038
2055	372	9,816	265,222
2056	379	10,012	255,210
2057	387	10,212	244,998
2058	394	10,416	234,581
2059	402	10,625	223,957

*Assume Survey Flown in Nov 2019; tonnage reflects Dec 2019

2060	410	10,837	213,119	
2061	419	11,054	202,065	
2062	427	11,275	190,790	
2063	436	11,501	179,290	
2064	444	11,731	167,559	
2065	453	11,965	155,594	
2066	462	12,205	143,389	
2067	471	12,449	130,941	
2068	481	12,698	118,243	
2069	490	12,952	105,291	
2070	500	13,211	92,081	
2071	510	13,475	78,606	
2072	520	13,744	64,862	
2073	531	14,019	50,842	
2074	542	14,300	36,543	
2075	552	14,586	21,957	
2076	563	14,877	7,080	
2077	575	15,175	(8,095)	<-- Asbestos Life Depleted

APPENDIX D – LANDFILL TRAFFIC STUDY

Matanuska-Susitna Borough
Transportation Planning

Traffic Impact Analysis, 09-051

Traffic Study for the Central Landfill, Animal Shelter, and Recycle Center

Draft Client Review

September 1, 2009

Prepared by:

Kinney Engineering, LLC

750 West Dimond Boulevard, Suite 203
Anchorage, Alaska 99515
Randy Kinney, P.E., PTOE
907 344-7575

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Tables

Figures

Commonly Used Abbreviations In This Report

ADT, AADT	Average Daily Traffic, Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ADOT/ (&)PF, or DOT/(&)PF	Alaska Department of Transportation and Public Facilities
ATM	Alaska Traffic Manual
AWSC	All-way-stop-control (4 stop signs on all approaches)
CTWLTL	Continuous (or center)-two-way left turn lane
DD, DDHV	Directional Distribution, DD Hourly Volume
DSR	Design Study Report
EB, EBL, EBLT	Eastbound, eastbound left turn
HSIP	Highway Safety Improvement Program (DOT&PF)
Hwy	Highway
ISD	Intersection Sight Distance
ITE	Institute of Transportation Engineers
K	% of AADT or ADT during peak hour
LOS	Level of Service (performance grade)
LRTP	Long Range Transportation Plan
LT, L	Left turn(s)
MOA	Municipality of Anchorage
Mph, MPH	Miles Per Hour
MUTCD	Manual of Uniform Traffic Control Devices
MSB	Matanuska-Susitna Borough
NB, NBL, NBLT	Northbound, northbound left turn
OSHP	Official Streets and Highways Plan
Ped	Pedestrian
Pkwy	Parkway
PSD	Pedestrian Sight Distance
PTR	Permanent Traffic Recorder
RIO	Right-in turns only
RIRO	Right-in, Right-out driveway
Rd, RD	Road
RT, R	Right turn(s)
SB, SBL, SBLT	Southbound, southbound left turn
S, Sec	Second
Sf, SF	Square feet
SSD	Stopping Sight Distance
St, ST	Street
SWS	Solid Waste Services
T, Th, Thru	Through
TWSC	Two-way-stop-control (2 stopped approaches)
v/c	Volume to capacity ratio
VCRS	Valley Community for Recycling Solutions
Veh	Vehicle(s)
Veh/sec, vph	Vehicle(s) per second, vehicles per hour
WB, WBL, WBLT	Westbound, westbound left turn

Executive Summary

This traffic study analyzes the current demand on the Borough Solid Waste Services Landfill, the Animal Control Shelter, and the voluntary recycling program, Valley Community for Recycling Solutions (VCRS). The VCRS is currently located near the intersection of Palmer Wasilla Highway and 49th State Street, but is planned to be relocated to a parcel west of the Animal Shelter and landfill. With all three of these programs soon to be located adjacent to each other on the same site, the combined effect of existing traffic volumes is considered in this report, as well as the impact of future traffic volumes on local intersections external to the site and circulation internal to the site. The study area for this report is depicted in the following exhibit. The study period is 10 years, with a planning horizon year of 2019.

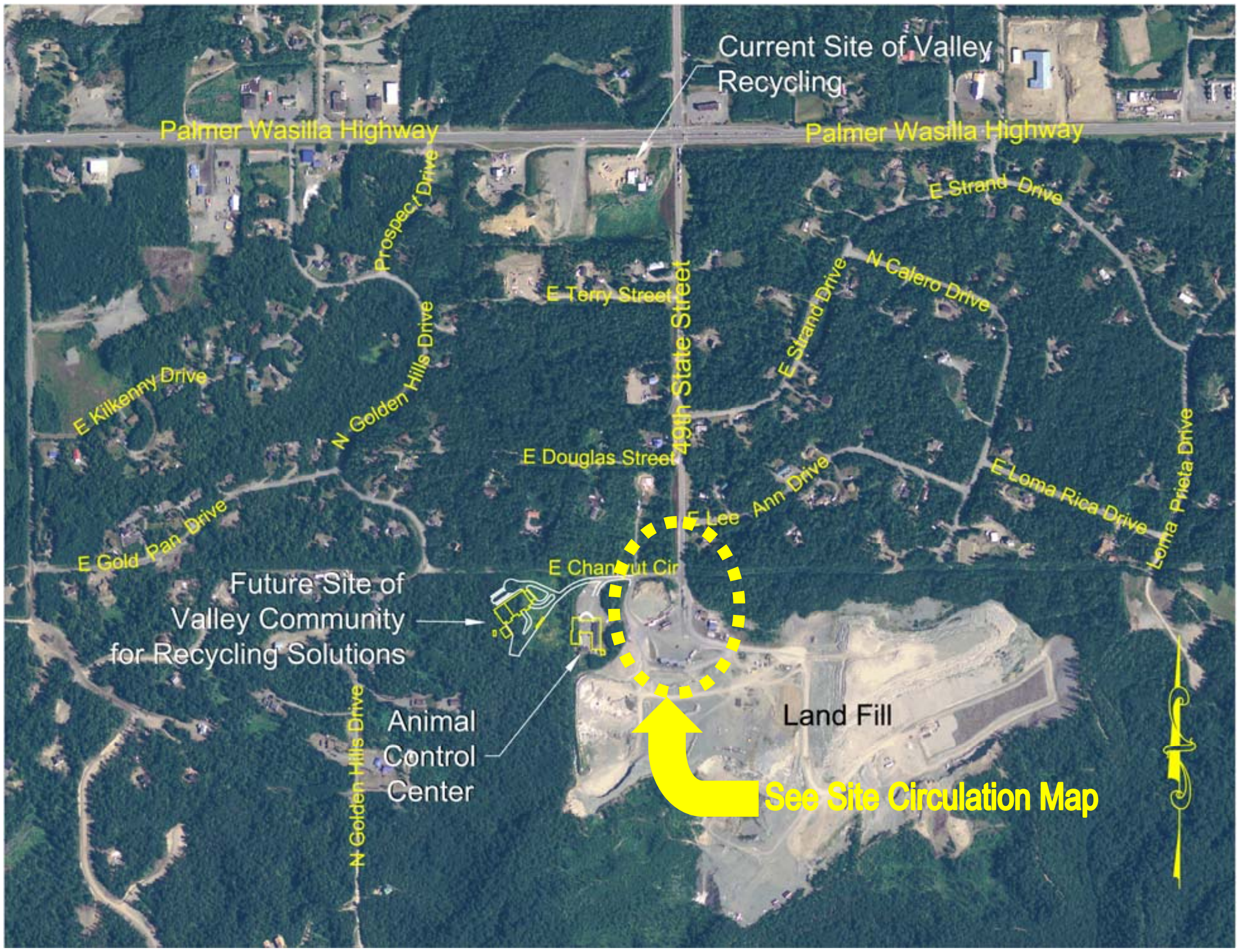


Exhibit A- Study Area

Traffic Volumes

The landfill attracts approximately 70 trips per hour during summer peak hours. Counts on the existing VCRS facility indicates their peak hour (on Saturday) accommodates between 45 and 50 recycling patrons.

A composite map of the existing peak turning movements for key intersections and driveways are presented in Figure 8 on page 16.

Both the background traffic and the facility demand (landfill, animal control, and recycling services) are expected to increase at an annual rate of 3.5%. Design hour traffic volumes are presented in Figure 16, Figure 17, and Figure 18 beginning on page 26.

In addition to these counts, it was determined that approximately 9% of the landfill trips also visit the recycling center on the same trip chain (e.g., home to landfill to VCRS to home). These trips are “captured” by the landfill and in effect reduce the overall impact of the VCRS on roadway volumes. A captured trip to a subsidiary or linked stop doesn’t add traffic, and would be counted only as part of the primary generation. As such, Figure 16, Figure 17, and Figure 18 also accommodate trip capture travel patterns.

Operations

The following exhibit present landfill circulation patterns.

Exhibit B- Landfill Site Circulation

Commercial vehicles (generally refuse haulers) have their own entrance and scale, with a self-service station. After they dump their loads in the east landfill area, they drive by the exit station without weighing their empty truck since their tare weight is known by the SWS staff. Private vehicles (more specifically, non-refuse haulers that include individuals and businesses) enter the landfill at the end of 49th State Street. They have three stages in their visit, the 1) entrance including weigh-in, 2) unloading at the dump stalls, and 3) exit including weighing and paying. Each one of these stages requires a processing time, which for entrance would be the time to move-on the scale, attendant obtaining and recording the weight for billing, the finally the vehicle moving off of the scale. Stage 2 process time at the dump stalls would be sum of the maneuvering time into the stall, unloading, and then departure. Lastly stage 3 processes would be similar to stage 1 process, with the additional task of a payment transaction.

A large enough number of samples were collected at each stage to determine a process mean time that was statistically significant at a 95% confidence level with an allowable 10% error. The following exhibit summarizes available storage for each stage, and the mean processing time for each stage determined from field samples.

Stage	Available Queue Storage (ft)	Storage (number of vehicles)	Average Service (Process) Time
1-entrance	90’ (Chanlyut Circle to inbound scale) 426’ (Lee Ann Drive to inbound scale) 481’ (SBRT taper to inbound scale)	3 (Chanlyut Cir. To Scale)	37.30 sec (move onto scale, weigh-in, move off of scale)
2-unloading refuse	216’ (inbound scale to wait line)	7	4.64 min (average time to unload refuse)
3-exit	290’ (dump area to outbound scale)	10	40.18 sec (move onto scale, weigh-out payment, move off of scale)

Exhibit C- Queues and Process Times

These key queue distances are depicted in the following exhibit.

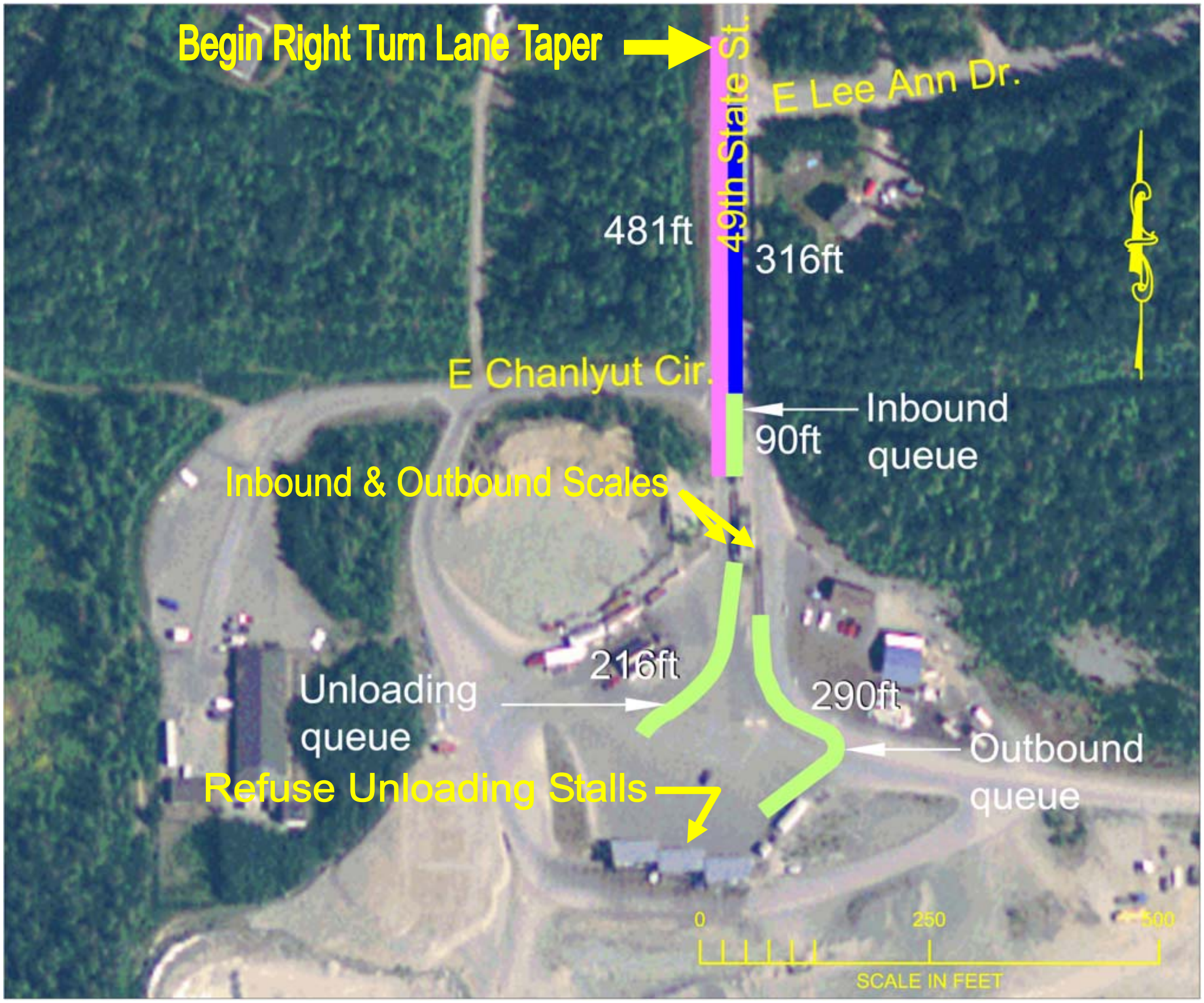


Exhibit D- Queue Storage

With the relocation of the VCRS to the west of the landfill and animal shelter (see Exhibit A on page v), the facility demand increases over time (3.5% per year). The analysis indicates that operations at intersections and roadway segments will be adequate during the study period. The main operational issues will be at the stage 1 entrance and stage 3 exit. Both of these locations will have a demand in the future which results in queues that spill back and exceed storage lengths depicted in Exhibit D above. The following exhibits summarize the queue performance measures in 2009 and 2019 with a relocated VCRS during a peak hour (typically, a summer Saturday afternoon when the landfill and VCRS are open).

Stage	**Arrivals (veh/hr)**	**Service rate (veh/hr)**	**Average Time in Stage**	**Critical Length**	**Available queue storage vehicles (feet)**	**Probability of exceeding queue storage**
1 Inbound Scale	72	96.5, Channel= 1	2.5 minutes in queue and weighing	Scale to Chanlyut	3 vehicles (90 ft.)	23%
				Scale to Lee Ann	14 vehicles (420 ft.)	1%
				Scale to SBRT entrance	16 vehicles (480 ft.)	1%
2 Unloading	72	155.2, Channel= 12	4.7 minutes in queue and unloading	Scale to dump area wait area	7 vehicles (216 ft.)	0%
3 Outbound Scale	72	89.6, Channel= 1	3.4 minutes in queue weighing and payment	Dump area wait area to Scale	10 vehicles (290 ft.)	7%

Exhibit E- 2009 Queues

For most queuing design applications, we would want to contain queues within a designated storage lane about 90 to 95% of the time. Based upon that criterion, we might judge this operation to be deficient since queues at the entrance will spill back beyond Chanlyut about 23% in 2009. There is a stop sign on 49th State Street at the Chanlyut intersection to control intersection entry for southbound vehicles, and it would be expected that the landfill queue on 49th State Street would provide courtesy gaps for those vehicles that are eastbound on Chanlyut and wish to turn onto 49th State Street. However, in the event that a vehicle visits the recycling center, and then has refuse for the landfill (about 9% of all landfill visits), the southbound queue may be not fully cooperate since they might perceive that the vehicle cuts in line in front of them. Furthermore, this system invites abuse since frequent landfill patrons will quickly learn that the time in line will be reduced if a vehicle bound for the landfill by passes the queue by using the southbound right turn lane to turn right into Chanlyut, then circle around to cut into line.

The following table presents 2019 queues, in which external and internal queuing becomes substantially worse.

Stage	Arrivals (veh/hr)	Service rate (veh/hr)	Average Time in Stage	Critical Length	Available queue storage vehicles (feet)	Probability of exceeding queue storage
1 Inbound Scale	101*	96.5, Channel= 1	8* minutes in queue and weighing	Scale to Chanlyut	3 vehicles (90 ft.)	67%*
				Scale to Lee Ann	14 vehicles (420 ft.)	27%*
				Scale to SBRT entrance	16 vehicles (480 ft.)	23%*
2 Unloading	101*	155.2, Channel= 12	4.7* minutes in queue and unloading	Scale to dump area wait area	7 vehicles (216 ft.)	1%*
3 Outbound Scale	101*	89.6, Channel= 1	100* minutes in queue and weighing and payment	Dump area wait area to Scale	10 vehicles (290 ft.)	92%*

*101 vph demand cannot be served. The analysis is performed for 89 vph service rate (constrained by outbound scale service rate).

Exhibit F- 2019 Design Hour Queue Lengths

In addition to the issues with the entrance queue, the exit queue will spill back into the unloading area, unless additional storage is gained through lengthening the exit lead in lanes. Even so, the demand increase of 3.5% per year produces queues that in theory would require waiting times that exceed an hour. It is expected that people will adjust the times that the visit the dump to minimize waits.

Alternatives

Process Point

The limiting factors in this study are the vehicle service times at each stage of the process of using the landfill, in particular the inbound weighing and outbound weighing and paying. The service times place a finite limit on the number of vehicles that can be served in an hour, approximately 89 per hour, is much less than the 2019 peak demand of 101 vph. To address the demand/service imbalance, process point improvement alternatives at the entrance and exit will be required to improve efficiency. These process point alternatives include the following

Demand Management- Reduction of peak hour visits, and consequently queues may be accomplished by demand management instead of site or road improvements. For instance, increasing the number of households serviced by commercial waste vehicles might help reduce the number of private trips required. Establishing higher fees for peak hour usage might encourage people to make their trips to the landfill in off peak hours, reducing the peak hour arrival rate, and in turn may fund additional hours of operation. Otherwise improvements will have to be made to the constraint service points, that is, the inbound and outbound scale processes.

Decrease Service Times- In order to accommodate future demand of over 100 patrons per hour and reduce queues to fit within the physical constraints of the site, the inbound, or entrance average service time must be reduced from 37 seconds to 20 seconds. The exit average service time must be reduced from 40 seconds to 28 seconds. This may only be accomplished through further automation or additional staff to assist processors during peak hours. One option for decreasing service times would be to eliminate the scales and move to a flat rate payment. Under this option, the outbound service time would be eliminated and queues would not back into unloading zone. The inbound service time would include move-up time, the transaction time for paying the flat fee, and finally the move-off time. If this could not be accomplished in 30 seconds, then a second station could be mobilized during peak times.

Increase Scale Service Channels- Adding an additional scale at the outbound scale station would eliminate almost all exiting queues over the available 10 vehicle storage length. Similarly, a second scale at the entrance would reduce the queue spillback to Chanlyut Street (3 vehicles) to about 5% of the time; and practically eliminate queues back to Lee Ann Street or the beginning of the SBRT lane.

Site and Roadway Improvements

In addition to the process point alternatives discussed above, four site and roadway alternatives are proposed and evaluated. These alternatives are conceptually depicted in exhibits following the alternative narrative introductions.

Alternative 1 consists of adding a right turn lane to the eastbound approach of 49th State Street and Chanlyut Circle, and lengthening the right turn lane of the southbound approach to the same intersection, to reduce delay to the eastbound left turn traffic, and reduce the chance of blockage of the southbound right turn lane by the overflow landfill entry queue. This alternative's longer SBRT lane may defer the entrance process point improvements until after 2014.

The eastbound right turn vehicles would encounter a maximum queue of the vehicle being weighed, plus the three vehicles waiting in the 90 feet between the scale and Chanlyut Circle. The arrival rate for the eastbound right turn in 2016 is about 9 vehicles per hour. By the rules of stop sign control, the southbound vehicles would have to yield to the eastbound right turn vehicles upon their arrival. The wait time for the eastbound right turn to enter the queue would be about 45 seconds, given driver adherence to rules of right of way. The queue storage for the eastbound right turn could be satisfied by a lane length of 150'. It is entirely possible that some drivers would elect to take advantage of the eastbound right turn service time without actually going to VCRS.

Alternative 2 requires purchase of additional right of way in order to sweep Chanlyut Circle north to intersect with Lee Ann Drive. This alternative would add a right turn lane to the eastbound approach, and maintain the right turn lane for the southbound approach. The queue storage requirements on both approaches is less than 100 feet, and deceleration is not required for lower speed streets. However, a minimum lane length of 100 feet for both approach right turn lanes is recommend for large vehicles.

This new Chanlyut/Lee Anne intersection would probably be a two way stop controlled intersection. The landfill queue storage would be uninterrupted from the scale to the Chanlyut Circle/ Lee Ann Drive, for about 420 feet. With Alternative 2, and one of the process point alternatives, the queue from the inbound scale would only occasionally spillback to the Chanlyut/Lee Anne intersection. The egress traffic from the stop control approaches would not be impeded by queues into the landfill, and the eastbound right turn traffic coming from VCRS would be joining the back of the landfill queue. Finally, this alternative increases spacing between conflicting movements in and out of the landfill. As an example of this benefit, an outbound vehicle that wishes to visit the VCRS or animal shelter after exiting the landfill turns into the Chanlyut approach 400 feet downstream from the landfill scale and queues formed while awaiting gaps to turn would not impact the landfill exit.

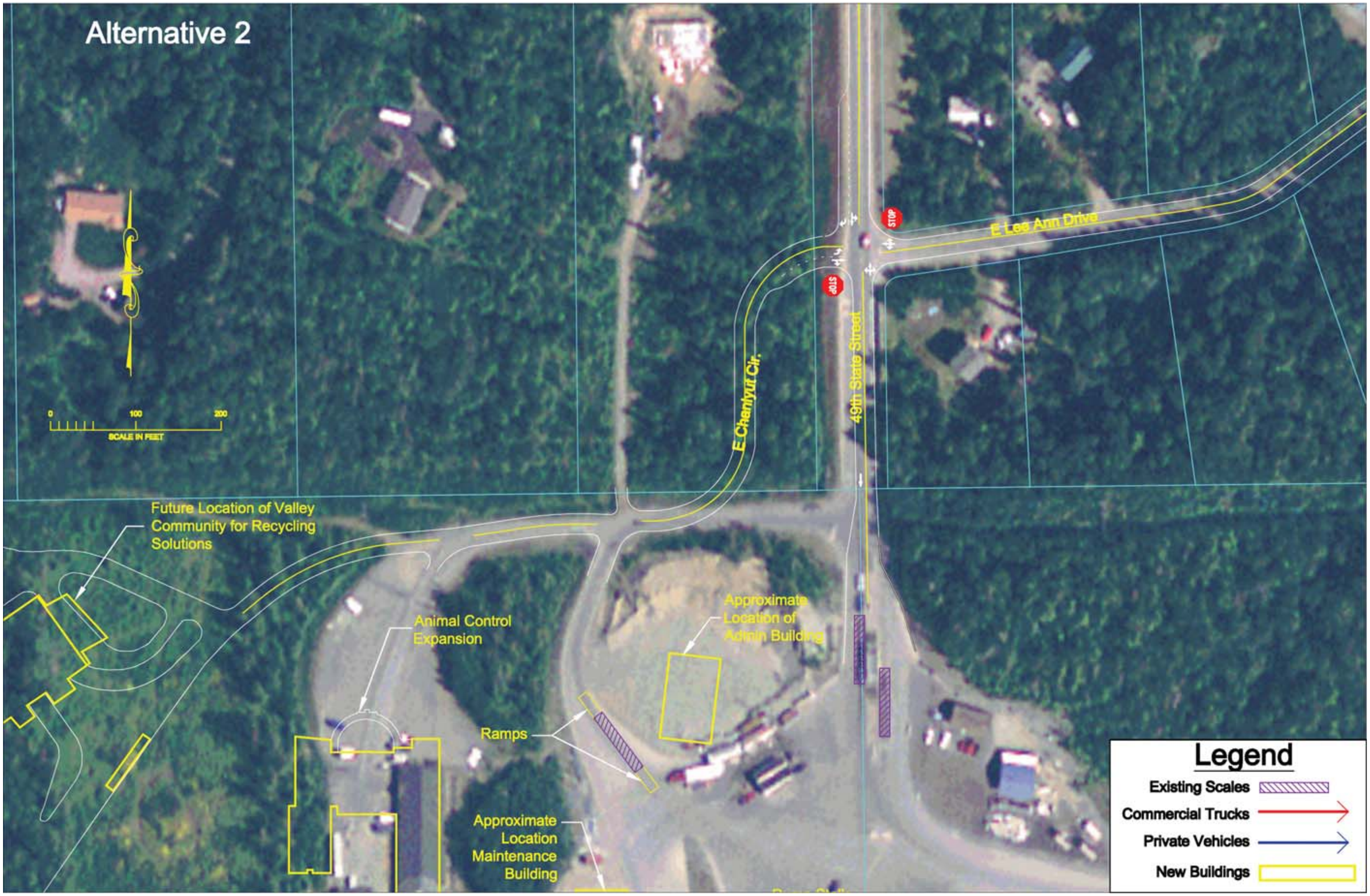
In **Alternative 3**, the entry scale to the landfill is moved further south from the intersection of 49th State Street and Chanlyut Circle, to provide entry queue storage onsite. A right turn lane is added to the eastbound approach to the intersection of 49th State Street and Chanlyut Circle. This alternative would probably require automation of the inbound scale and advance signals that prompt movement onto and off of the scale unless the scale house is relocated as well. There should be at least 2 vehicle storage lengths between the scale and the wait line for unloading even though computations show that there is rarely a wait to unload once past the inbound scale. If the scale house is not relocated, the outbound scale would not be moved so that the storage distance between the scale and the unloading area would be preserved. In addition, additional outbound queue storage may have to be developed on site

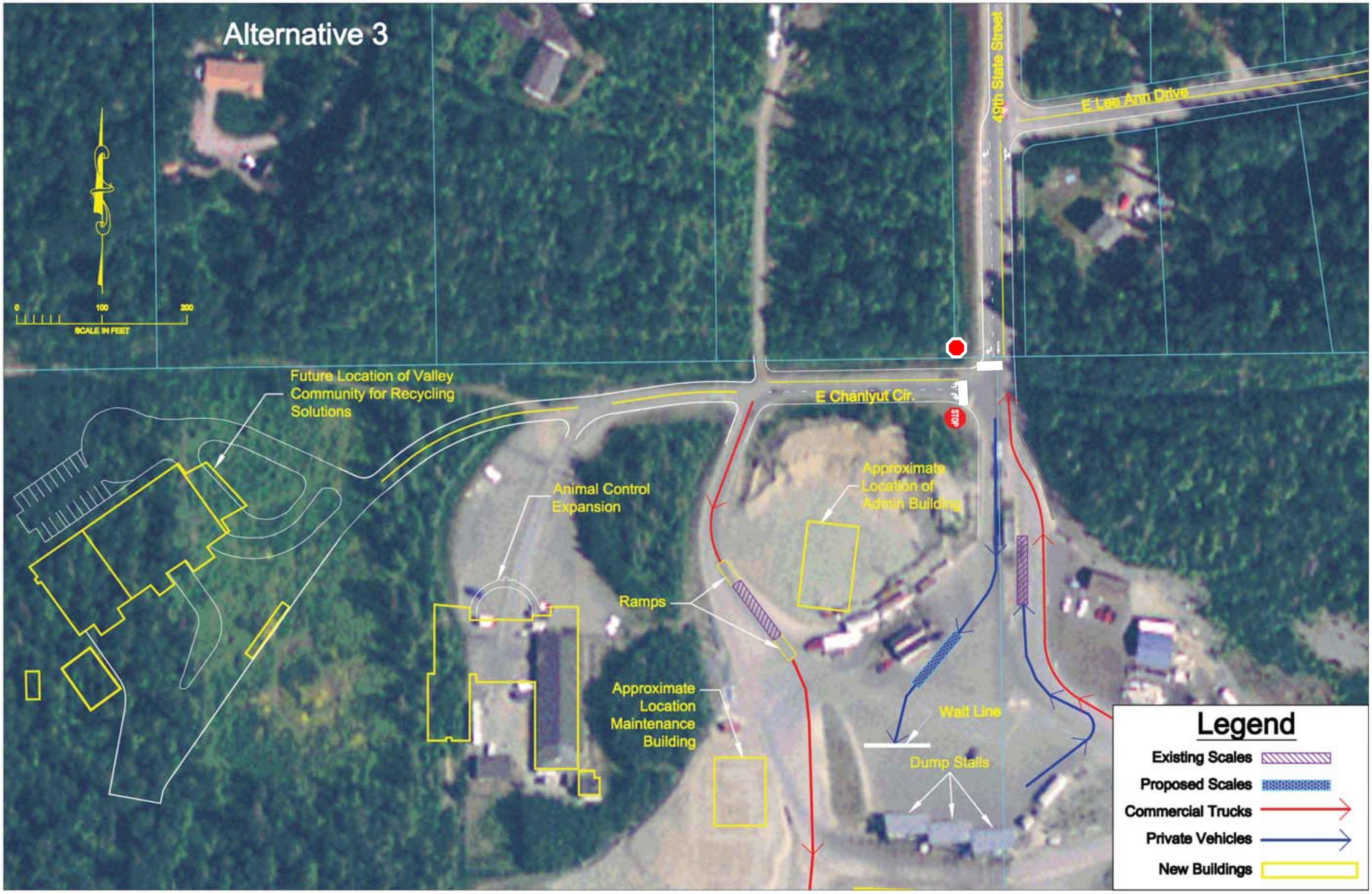
Alternative 4 provides a connection between VCRS and the landfill, allowing the capture trips from recycling side to bypass the intersection of 49th State Street and Chanlyut Circle, and proceed more or less directly to the landfill. Vehicles entering from the recycling site would have to be weighed either at the existing scale or at an additional scale located somewhere between VCRS and the landfill. The path of the recycle vehicles to the unloading area conflicts with the path of the commercial trucks. Even though the number of vehicles from both VCRS and the commercial scale are few (about 10 each in 2019), the implications from an accident are major. Some form of traffic control (stop sign) would be required for one or both approaches. An additional scale, if installed, would probably require an automated process.

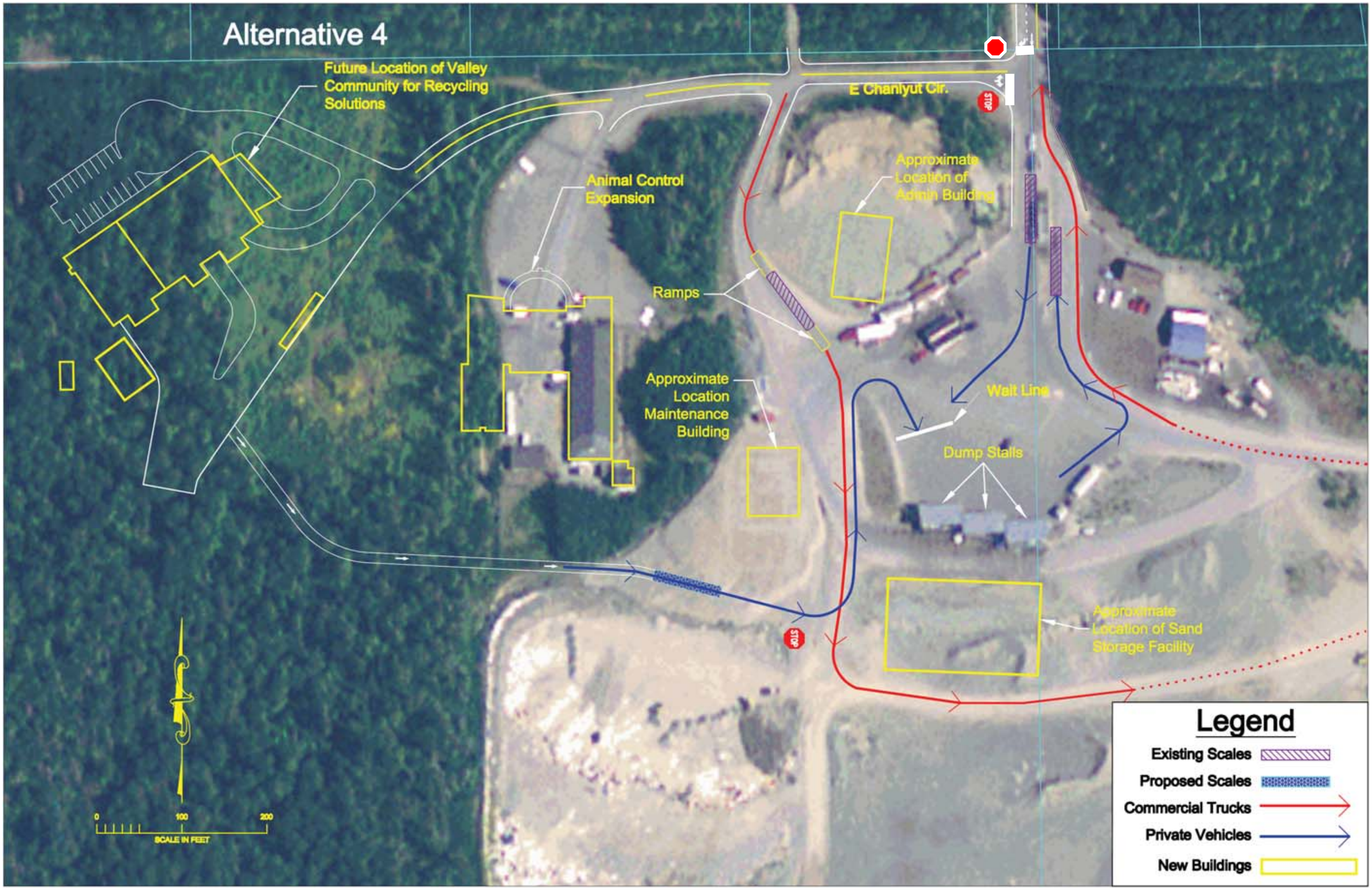
If a second scale were installed for the vehicles arriving from VCRS, during peak hours some of the inbound traffic could be rerouted to this scale, thus reducing the landfill queue on 49th State Street and effectively doubling the service rate from 96.5 vehicles per hour to 193 vehicles per hour. Although this would reduce queues lengths that rarely would extend to Chanlyut Circle, there are other issues that may make this unfeasible. Specifically the conflicts at the intersection of the commercial truck route and the second inbound access greatly increase beyond the 20 vehicles described above. In addition, a conflict point is created at the waiting line for the unloading area between the southbound and eastbound traffic streams.

Under **all alternatives**, volumes and operations of the 49th State Street and Chanlyut Circle intersection would be LOS B in 2019. Also, the operations of Palmer Wasilla Highway and 49th State Street intersection in 2019 PM peak hour with relocated VCRS facility satisfies AASHTO's LOS recommendation of C or better for arterials. As such this alternative will not adversely impact operations to the extent requiring action at the Palmer Wasilla Highway and 49th State Street intersection.


Alternative 1
E Douglas Street
49th State Street
Increase Existing SBRT Lane to 450 Ft.
E Lee Ann Drive
0
100
200
SCALE IN FEET
Channelize EB Approach, Add 150 Ft. Right Turn Lane
Future Location of Valley Community for Recycling Solutions
E Chanlyut Cir.
STOP
Animal Control Expansion
Approximate Location of Admin Building
Ramps
Legend
Existing Scales
Commercial Trucks
Private Vehicles
New Buildings


Alternative 2
0
100
200
SCALE IN FEET
Future Location of Valley Community for Recycling Solutions
Animal Control Expansion
Ramps
Approximate Location Maintenance Building
Approximate Location of Admin Building
E Chanlyut Cir.
49th State Street
E Lee Ann Drive
STOP
STOP
Legend
Existing Scales
Commercial Trucks
Private Vehicles
New Buildings


Alternative 3
0
100
200
SCALE IN FEET
49th State Street
E Lee Ann Drive
E Chanlyut Cir.
STOP
Future Location of Valley Community for Recycling Solutions
Animal Control Expansion
Approximate Location of Admin Building
Ramps
Approximate Location Maintenance Building
Wait Line
Dump Stalls
Legend
Existing Scales
Proposed Scales
Commercial Trucks
Private Vehicles
New Buildings


Alternative 4
Future Location of Valley Community for Recycling Solutions
E Chanlyut Cir.
STOP
Animal Control Expansion
Approximate Location of Admin Building
Ramps
Approximate Location Maintenance Building
Wait Line
Dump Stalls
STOP
Approximate Location of Sand Storage Facility
0
100
200
SCALE IN FEET
Legend
Existing Scales
Proposed Scales
Commercial Trucks
Private Vehicles
New Buildings

Recommendations

During a client review of the draft report, MSB Transportation Planning staff indicated that the scales have a finite life and that scales replacements are likely within period of this study (2009 to 2019). As such, it would be economical to implement Alternative 3, scales relocation, during that changeover. In addition, a process point alternative; that is, demand management, service time reduction, or additional, parallel scales, would have to be implemented as well.

During the interim between now and the scale relocation, traffic operations at the Chanlyut / 49th State Street intersection should be monitored. If incoming scale queues spill back to block off the right-turn lane, then Alternative 1, should be constructed.

If scales were to be eliminated as the process point alternative, and instead flat fees were to be charged, then scale relocation would become unnecessary and Alternative 1 would likely be adequate for 2019 planning horizon.

1 Introduction

1.1 Project Description

As the Mat-Su Borough population grows, Borough government departments can expect increased demand for their services. This traffic study analyzes the current demand on the Borough Solid Waste Services Landfill, the Animal Control Shelter, and the voluntary recycling program, Valley Community for Recycling Solutions (VCRS).

The VCRS is currently located near the intersection of Palmer Wasilla Highway and 49th State Street, but is planned to be relocated to a parcel west of the Animal Shelter and Landfill. With all three of these programs soon to be located adjacent to each other on the same site, the combined effect of existing traffic volumes is considered in this report, as well as the impact of future traffic volumes on local intersections external to the site and circulation internal to the site.

1.2 Design Year

The design year for this traffic study was established to be 2019, a 10 year planning horizon. The midlife of this study is 2014.

1.3 Location

The Mat-Su Solid Waste Landfill Facility is located west of the City of Palmer CBD, and is accessed from the Palmer-Wasilla Highway via 49th State Street. The following figures present the location, Mat-Su Borough vicinity and study area vicinity maps for this study.

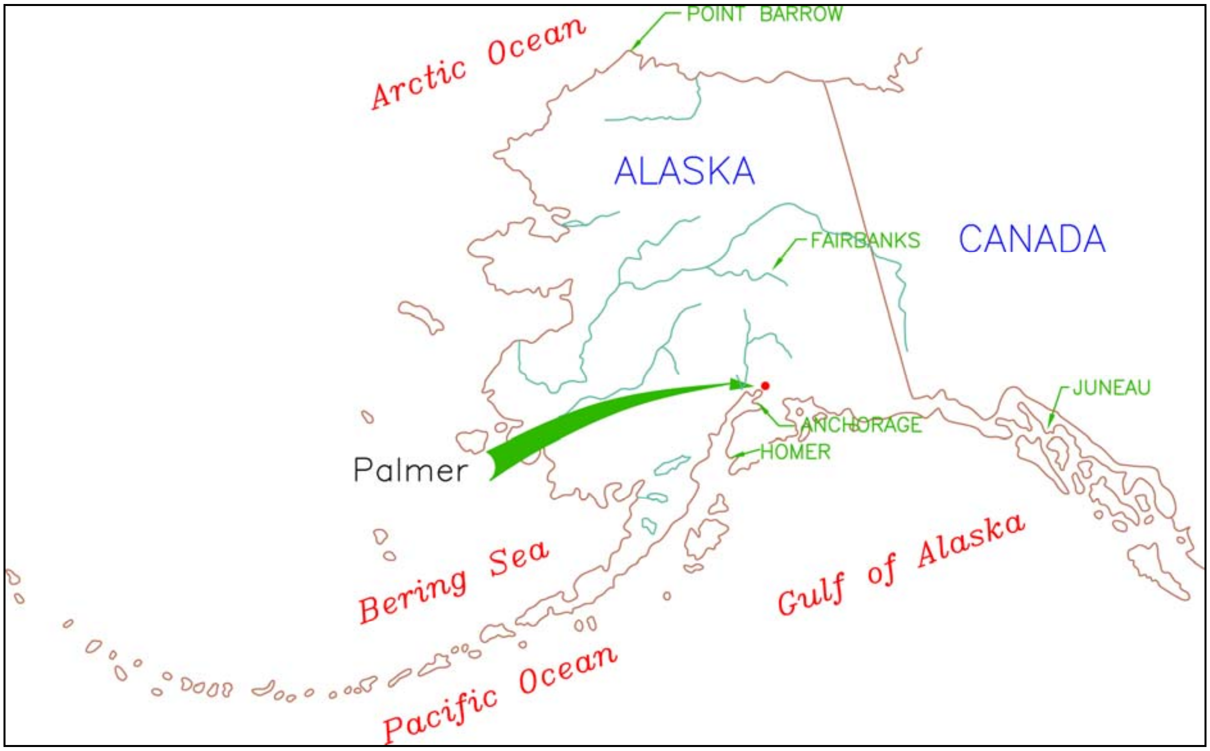


Figure 1- Location Map

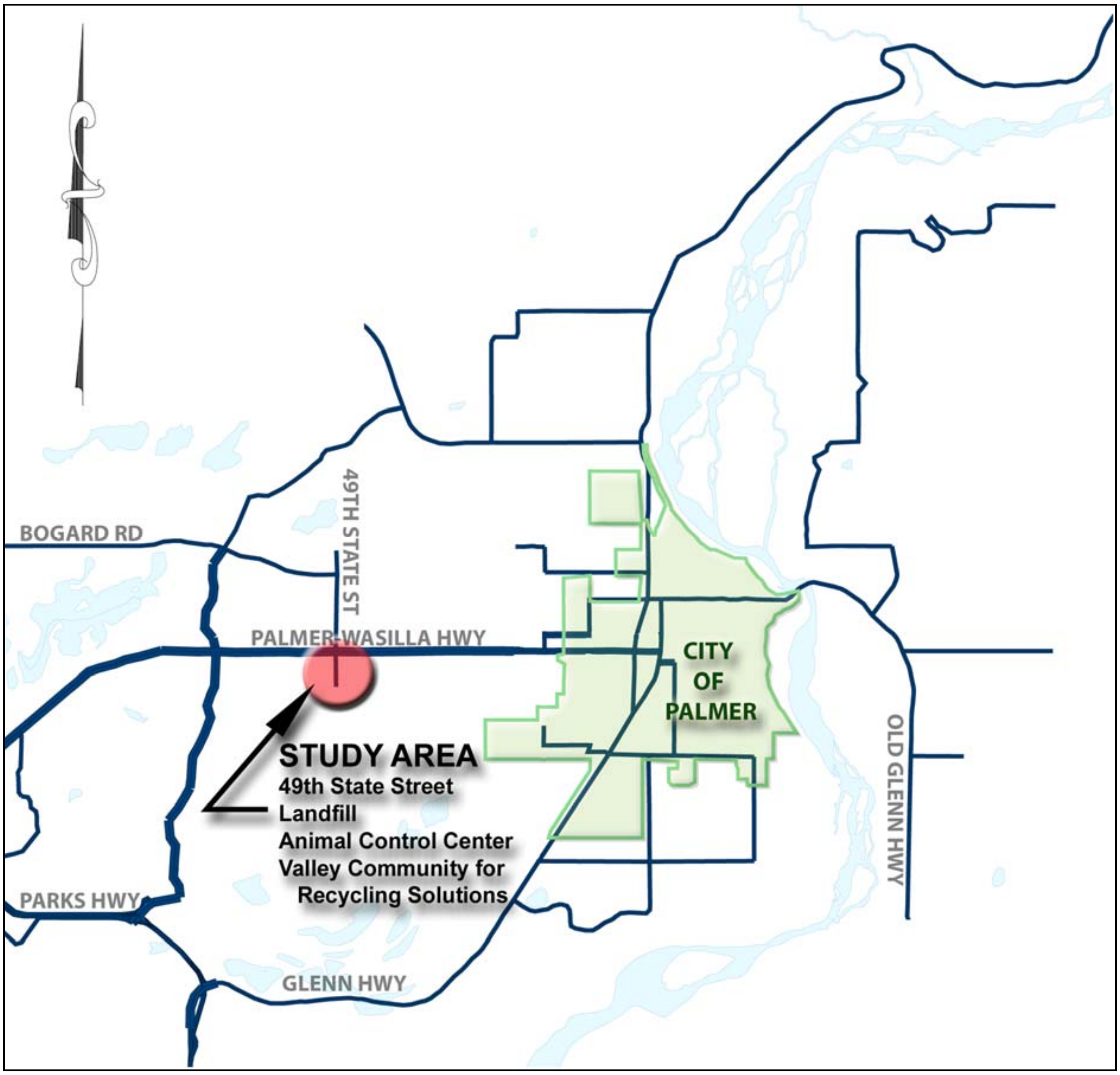


Figure 2- Study Vicinity Map

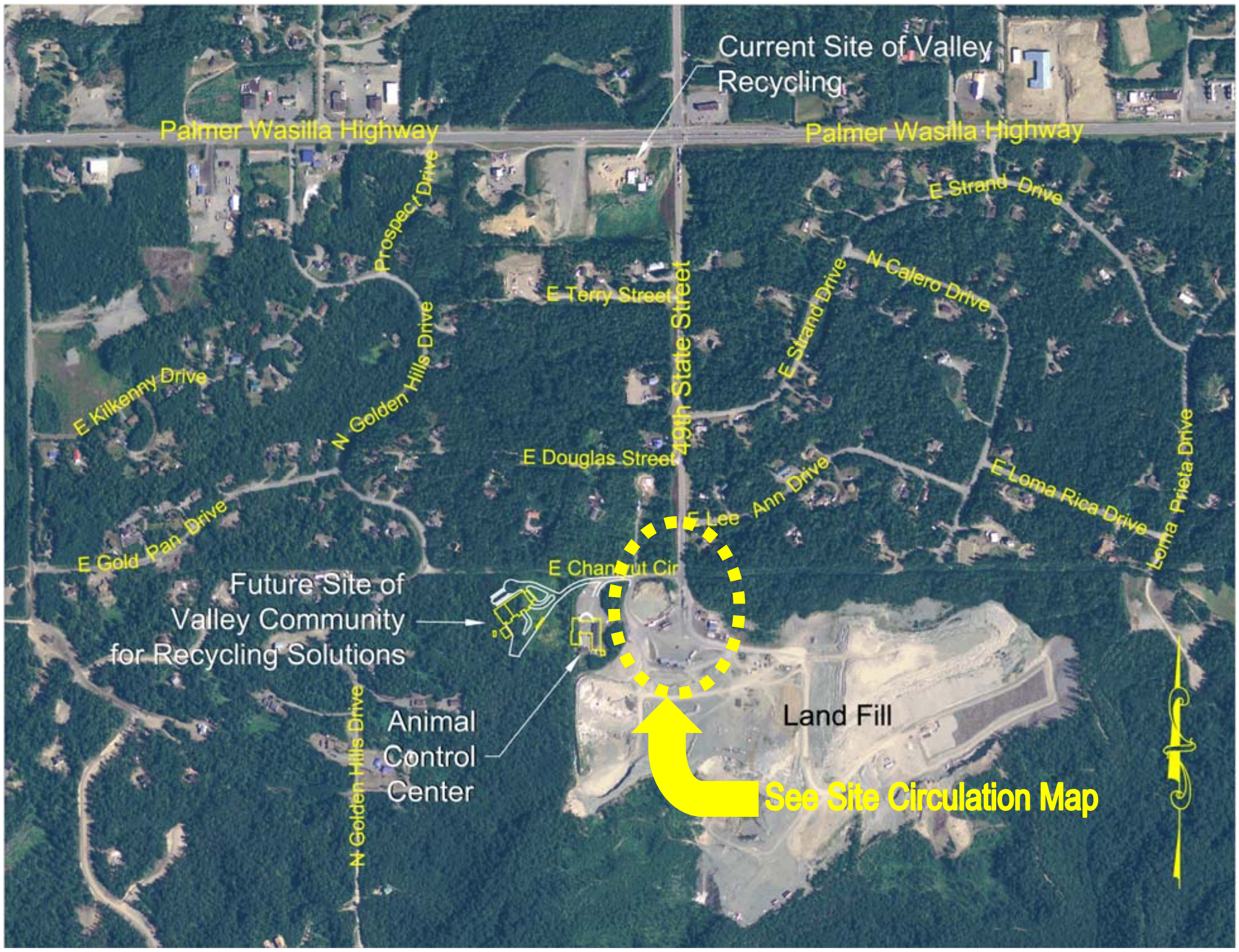


Figure 3 – Study Area Vicinity Map

1.4 Site Description

The following figure presents the site circulation and details for the landfill.

Figure 4 – Site Circulation and Detailed Features

The observed commercial vehicles are primarily solid waste refuse collectors. These vehicles enter a separate entrance with self-serve weigh-in scale, shown below in the following photographs. After weigh in they proceed to the eastern area of the landfill to dump their loads.

Figure 5- Commercial Scale, Looking South From On Ramp (self serve weigh-in panel on left)

Figure 6- Commercial Scale, Looking North

Private vehicles may include businesses that must weigh at the main entrance. Normal private vehicles (cars, pickups, cars with trailers) dump their refuse in 1 of 3 buildings, each holding 4 stalls (12 total). Oversize vehicles would proceed to the eastern landfill area.

2 Highway, Street and Intersections

2.1 Inventory

2.1.1 Street and Highway Geometrics and Attributes

2.1.1.1 49th State Street

The Mat Su Borough LRTP lists 49th State Street as a major collector; as such its primary purpose is to move traffic between neighborhoods or from neighborhoods to arterials. South of Palmer Wasilla Highway (PWH), 49th State Street is a two lane paved facility with a posted speed limit of 30 mph, located about 2 miles from Hemmer Road, and just over a mile from Trunk Road. Its terminus on the south side of PWH is the MSB Landfill.

2.1.1.2 Palmer Wasilla Highway

Palmer Wasilla Highway is listed as a major arterial in the Mat-Su Borough LRTP; its purpose is to provide through traffic movement within and across the Borough. In the project area, the speed limit is 55 mph. It is a two lane paved facility with bike trails/pedestrian facilities on both sides of the highway.

2.1.1.3 Chanlyut Circle

Chanlyut Circle is not listed in the Mat-Su Borough LRTP; therefore it is a local road. Currently it provides access to the Borough Animal Shelter, but in the near future, it will also provide access to the relocated Recycling Center. It may be extended westward to provide access to other land parcels, but currently, no plans exist for such expansion. It is a two lane paved road without pedestrian facilities. The posted speed limit is 25 mph.

2.1.2 Intersection Attributes

2.1.2.1 49th State Street/Chanlyut Circle

The intersection of 49th State Street and Chanlyut Circle is a “T” intersection; Chanlyut Circle forms the stem of the “T”. The southbound approach of 49th State Street is stop controlled, as is the eastbound approach of Chanlyut Circle. The southbound approach also has a right turn auxiliary lane. The northbound approach coming from the landfill site is a free, or uncontrolled approach.

2.1.2.2 49th State Street/Lee Ann Drive

This "T" intersection is located about 300' north of the Landfill entrance. The Lee Ann Drive approach is stop controlled. Queues from the landfill entrance could impact this intersection. The taper for the right turn lane at 49th State Street and Chanlyut begins north of this intersection.

2.1.2.3 49th State Street/Douglas Street

This is also a "T" intersection about 300' north of the intersection of 49th State Street/Lee Ann and thus about 600' north of the Landfill access. Douglas Street is stop controlled, and is a local street providing access for a residential area on the west side of 49th State Street.

2.1.2.4 Palmer Wasilla Highway/49th State Street

Palmer Wasilla Highway/49th State Street is a signalized intersection. Palmer Wasilla Highway is the main street, with left and right turn lanes for both east and westbound traffic. Main Street through traffic has one lane in either direction. Main street left turns are protected-permissive; there are no minor street left turn phases. The minor street northbound approach has a single lane approach for all movements, the minor street southbound approach has a left turn, and through-right lane.

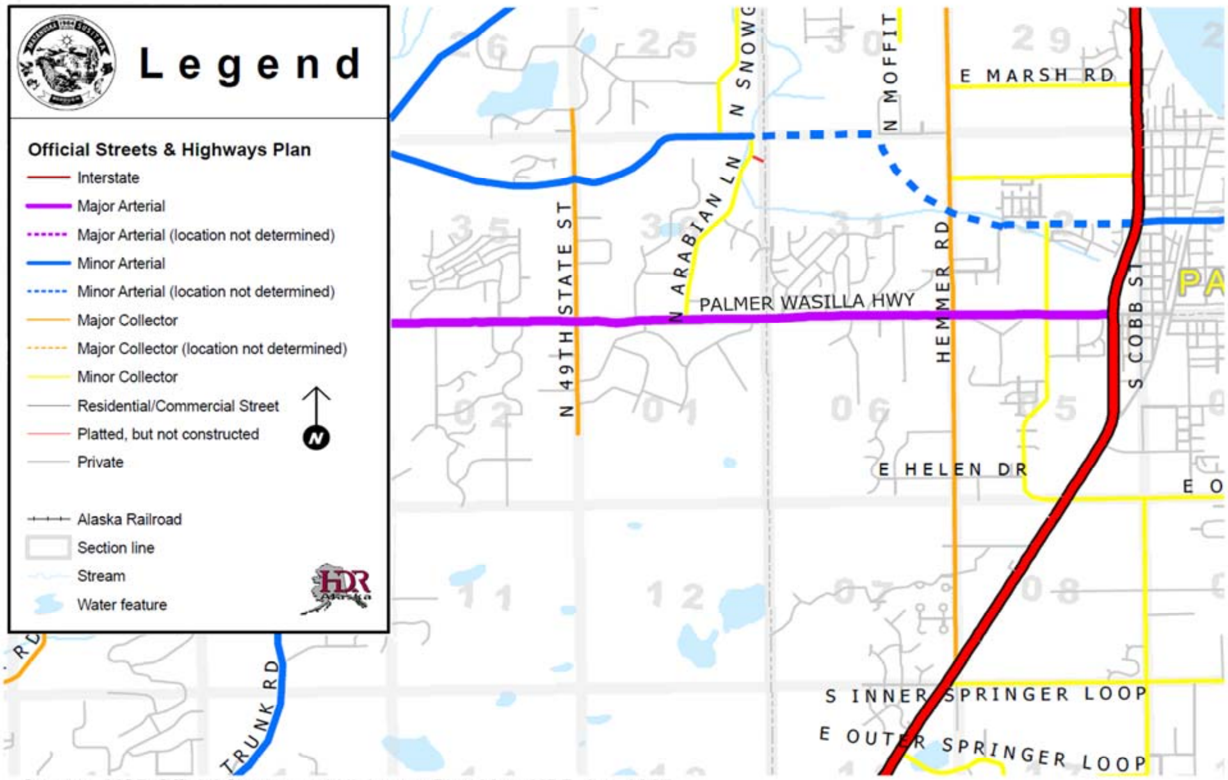
2.2 Planning Background

2.2.1 MSB LRTP

The 2007 Mat Su Borough Long Range Transportation Plan (LRTP) *Base Level Projects,* indicates that Palmer Wasilla Highway will be expanded to 4 lanes and Bogard Road will be extended from 49th State Street to the Glenn Highway. The LRTP also shows separated pathway development along the Bogard Road corridor, in addition to the existing pathway along the Palmer Wasilla Highway.

2.2.2 MSB Official Streets and Highway Plan

Figure 7 presents the MSB Official Streets and Highway Plan (OSHP) in the study area, which depicts the functional classification of study area streets. 49th State Street is functionally classified as a major collector, and Palmer Wasilla Highway is a major arterial.



Source: MSB Official Streets and Highways Plan Map, HDR, Inc. 2007

Figure 7 – MSB OSHP

The State of Alaska Department of Transportation and Public Facilities functionally classifies 49th Street as a Rural Local Road south of Palmer Wasilla Highway and as a Rural Minor Collector north of Palmer Wasilla Highway, and Palmer Wasilla Highway as a Rural Minor Arterial.

2.2.3 Studies regarding Population Growth

The Institute of Social and Economic Research (ISER) and the University of Alaska Anchorage published a report prepared for Chugach Electric Association in September

2005 entitled “Economic Projections for Alaska and the Southern Rail belt 2005-2030”. In it, they discuss population growth in the Mat-Su Borough over the next 25 years (to 2030). Their base case assumption is that average annual population growth in the Mat-Su Borough between 2010 and 2020, generally the time period of this study, will be about 3.5%.

2.2.4 SWS Plans

CH2MHill performed a study in 2006 examining long term plans for the central landfill. Though waste volume grew at 5.3% annually from 1995 to 2005, CH2MHill’s report assumes further growth rates in line with the 3.5% used by Kinney Engineering for this report. Expansion plans for the landfill include adequate access roads, with the internal road network expanding as the landfill changes.

During the client review of the draft report, the MSB Transportation Planning staff indicated that the scales for the facility will likely be replaced with this study duration (2009 to 2019).

2.2.5 Valley Recycle Plans

Valley Recycling plans to move from their current location on the southwest corner of PWH and 49th State Street to a new site adjacent to the borough animal shelter on Chanlyut Circle. Plans for the new building have been drawn. Funding has been obtained, and construction is expected to start in Spring 2009. The kinds and amounts of recycled items are expected to increase, and new jobs related to recycling are expected to develop. There will be a classroom in the new building which will draw field trips from various schools.

2.2.6 Animal Control Plans

The MSB Animal Shelter is currently undergoing construction and expansion. Renovation to the existing structure is underway and is expected to be complete in Spring 2009.

2.2.7 Results of the Scoping Meeting

Minutes of the scoping meeting for this project may be found in Appendix A - Scoping Meeting Agenda and Minutes. No other construction plans were known within the study area.

2.2.8 SWS Time and Motion Study

A time and motion study was conducted at the Central Landfill scale house by Solid Waste Division personnel. It was conducted over a two day period and a sample of 65 vehicles was used as the study group for both the vehicles timed on the basis of the attendant weighing the vehicle in and the attendant evaluating the load on the basis of volume. The time required to estimate volume was 31 seconds and time to weigh a vehicle was 13 seconds.

2.3 Background Traffic Volumes

2.3.1 ADOT/PF Traffic Data

The following table presents 10 years of ADOT/PF Average Annual Daily Traffic (AADT) counts for Palmer Wasilla Highway (PWH) in the study area, and 49th State Street (north of PWH). The count data from the ADOT/PF Permanent Traffic Recorder (PTR) is located in Appendix C - DOT/PF Palmer Wasilla Highway PTR Information.

1997 AADT	1998 AADT	1999 AADT	2000 AADT	2001 AADT	2002 AADT	2003 AADT	2004 AADT	2005 AADT	2006 AADT	2007 AADT	Avg
136800 Palmer Wasilla Highway											
11303	11998	12415	12550	12806	14014	13765	14197	14414	14364	13230	13320
136805 49th State Street (North of PWH)											
No Data	No Data	No Data	No Data	No Data	No Data	3893	4358	4420	4012	3910	4119

Source: ADOT&PF Central Region Report

Table 1 – ADOT/PF Historical AADTs

2.3.2 MSB Traffic Counts

The Mat-Su Borough performed a seven day count in August 2008 of 49th State Street south of Palmer Wasilla Highway. Counts provided both Animal Shelter and Landfill daily and hourly volumes. Volumes were not seasonally adjusted, but the ADOT PTR information indicates August volumes are 112% of AADT, so the MSB counts may be used without adjustment, and results will be conservative, or tending toward worst case. A copy of the counts is in Appendix B - MSB Traffic Count-49th State Street.

2.3.3 Permanent Traffic Recorder Data

ADOT maintains a Permanent Traffic Recorder (PTR) on Palmer Wasilla Highway between 49th State Street and Trunk Road. The data presented includes the %AADT for traffic on each day of the week, and each month of the year. It also lists the highest travel days and hours, with the corresponding %AADT for each. A copy of the PTR information for 2007 is contained in Appendix C - DOT/PF Palmer Wasilla Highway PTR Information.

2.4 Field Traffic Data

Figure 8 on page 16 shows turning movement counts performed by Kinney Engineering, LLC for this project. The turning movement count at the Palmer-Wasilla Highway and 49th State Street was obtained from the traffic analysis report for Bogard Road by DOWL. The date and /or hour of each count is listed in the figure.

2.4.1 Landfill Volume Count

The August 2008 MSB count of 49th State Street showed the highest volume leaving the landfill occurred on Saturday at 2 pm. A total of 92 vehicles were counted going north on 49th State Street. During that same hour, 34 trips were counted going to and from the borough animal shelter. We assumed that there were no pass by or capture trips from the animal shelter to the landfill, so one half of the animal shelter trips were subtracted from the 92 northbound trips to determine that 75 vehicles visited the landfill during that hour. From our observations, we determined that about 6% of total vehicles are commercial vehicles using the commercial scales, so about 5 vehicles of the 75 using the landfill turned right on Chanlyut Circle to access the commercial scales. A total of 70 vehicles use the landfill residential scales for our design hour base count.

2.4.2 Recycling Center Volume Count

Kinney Engineering counted the traffic at Valley Recycling one Saturday in January, and recorded a peak hour volume of 95 vehicle trips, 47 in and 48 out. On another occasion, we counted the number of vehicles that made either a left turn from 49th State Street onto PWH and an immediate left into the current recycling center, or a right turn from the recycling center and then an immediate right onto 49th State Street. These vehicles were considered to be captured trips, vehicles that would access both the landfill and the new recycling center site on the same trip if the sites were adjacent to one another. The MSB Solid Waste Department provided scale counts for the same time period. We computed that about 9% of the landfill trips also visit the recycling center. As such, once these facilities are located next to one another, we can expect that 14% of VCRS trips will be captured by the landfill (volumes comparable to 9% of landfill trips captured by VCRS). This has the effect of volume reduction on the streets and intersections serving the complex, but complicates site circulation issues.

2.4.3 Animal Shelter Volume Count

As mentioned in Section 2.4.2, the animal shelter traffic was counted in August 2008 at the same time as the landfill count. The highest peak hour for the shelter was on a Friday between 4 pm and 5 pm, for a total 38 vehicle trips. The next highest hour coincided with the highest hour recorded at the landfill, that is, on Saturday at 2 pm, with

34 vehicle trips, 17 inbound and 17 outbound. We are assuming no captured trips between the animal shelter and the landfill.

However, the Animal Shelter expansion was under construction during the counts.

2.4.4 Bogard Road Counts

In November, 2006, DOWL Engineers collected AM and PM peak turning movement counts at Palmer Wasilla Highway/49th State Street as part of the Bogard Road Extension Project. These counts are used as a basis for our analysis. The PM Peak values were used as a conservative case, even though the landfill peak hour is a Saturday.

Figure 8- Most Current Turning Movements, Composite Map

2.4.5 Queue Studies

Kinney Engineering recorded service (processing) times for vehicles at the MSB Landfill. Vehicles were timed during three stages: the entrance, in which the vehicle moves from a stop onto the inbound scale and is weighed; the unloading, in which the vehicle leaves the scale and moves to the unloading stalls where refuse is unloaded and then moves into the departure queue, and finally the departure, where the vehicle moves onto the outbound scale, is reweighed, pays the accessed fee, and exits the landfill.   The following photographs show each stage.

Figure 9- Stage 1, Entrance and Scales

Figure 10- Stage 2, Dumping Area, 12 Stalls in 3 Groups

Figure 11- Stage 3, Channelized Aisle to Scale

Figure 12- Stage 3 Scale

A statistically valid number of recorded observations were made for each stage. Any statistical outliers in the data were removed, and the average of the remaining data was used in probability models for each stage. The queue storage area was measured for each stage, and an average vehicle length of 30’ was used to convert the storage area to number of queued vehicles. This is a slightly longer length of vehicle than is normally used in traffic studies, but it allows for some vehicles to be towing trailers, or have objects extending over their bumpers and tailgates.

The average service times, queue lengths, and volume counts were used in a random arrival, random service, and single queue distribution probability model to determine the probability of queues exceeding the queue storage and causing interference at intersections or other stages.

The following table presents the measured length of storage in feet, the storage length in number of vehicles which includes the vehicle(s) being serviced, and the average service time for each stage. Inbound storage for stage 1 is measured from the north edge of the inbound scale nearest Chanlyut Circle to the south side of Chanlyut Circle. Stage 2 queue storage is measured from the back (south) edge of the scale to the unloading area where vehicles will wait for an unloading stall, is along a roadway defined by concrete barriers and plastic cones. The queue area for stage 3 is measured from the outer edge of the unloading area to the south edge of the outbound scale, along the outbound roadway defined by concrete barriers and plastic cones.

Stage	**Available Queue Storage (ft)**	**Storage (number of vehicles)**	**Average Service (Process) Time**
1-entrance	90’ (Chanlyut Circle to inbound scale) 426’ (Lee Ann Drive to inbound scale) 481’ (SBRT taper to inbound scale)	3 (Chanlyut Cir. To Scale)	37.30 sec (move onto scale, weigh-in, move off of scale)
2-unloading refuse	216’ (inbound scale to wait line)	7	4.64 min (average time to unload refuse)
3-exit	290’ (dump area to outbound scale)	10	40.18 sec (move onto scale, weigh-out payment, move off of scale)

Table 2 – Current Landfill Storage Data and Service Times

Appendix D contains the service time data summary that was collected by Kinney Engineering, LLC.

These key queue distances are depicted in the following figure.

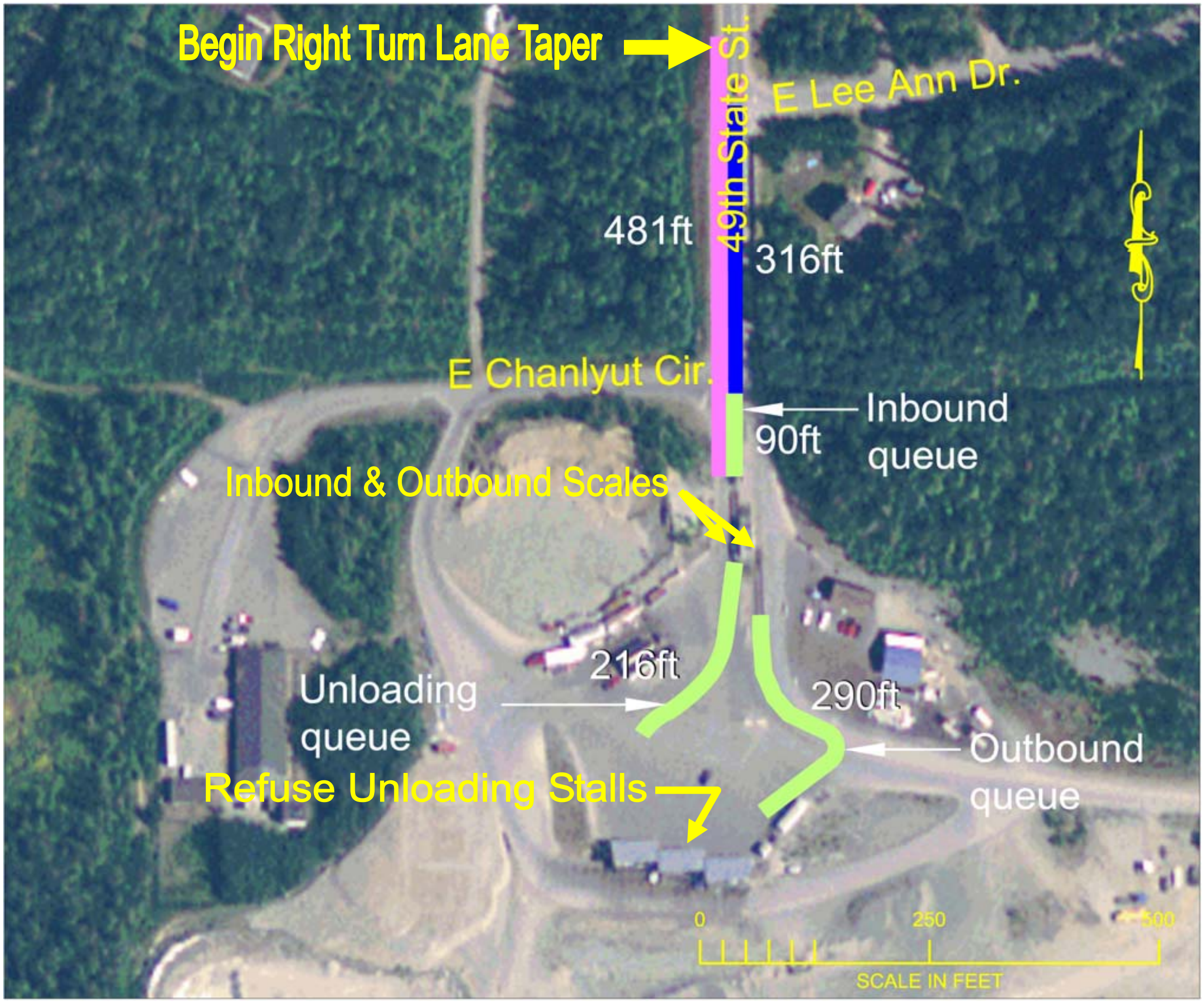


Figure 13 – Queue Storage Areas

2.5 Crash Studies

Both 49th State Street south of PWH and the PWH and 49th State Street intersection were evaluated for problematic crash rates. In no case was there a location with an above average crash rate. As such, it is unlikely that relocation of the facilities in the proposed site would significantly increase crashes.

3 Traffic Forecasts

3.1 Annual Growth Rate Model

ADOT/PF maintains historical average annual daily traffic (AADT) volume information at various points along the Palmer Wasilla Highway, and also counts the traffic on 49th State Street north of the Palmer Wasilla Highway. From those historical counts, we can develop a reasonable prediction of the AADT for future years. ADOT/PF counts the Palmer Wasilla Highway at the junction with Hemmer Road, about 0.86 miles west of the PWH/Glennallen Hwy, and at the junction with Trunk Road, about 3 miles further west. The intersection of Palmer Wasilla Highway and 49th State Street falls between these two count points. We calculated the growth rates for both 9 and 10 year intervals at each location, from 1997 to 2006, and from 1997 to 2007, because ADTs dropped from 2006 to 2007 at both count locations. The ADOT Permanent Traffic Recorder data, located near Hemmer Road, also showed a similar drop in ADT for the same year. This drop could be a temporary result of construction at some point on the highway, or a trend of reduced travel in response to the increased cost of travel during that time. The average 9 year growth rate was 2.8%; the average 10 year growth rate was 2.04%.

3.1.1 MSB TransCad Model

The Matanuska-Susitna Borough TransCad model forecasts future roadway volumes in year 2025 based on projected household and employment growth. Figure 14 shows the predicted 2025 volumes from the model for the portion of the Palmer-Wasilla Highway in the project area. From these volumes, we can derive an annual growth rate by dividing the 2025 volume by a past year volume, and solving for the nth root where n is the number of years. So for instance, if we want the average annual growth rate from 1997 to 2025, we divide the 2025 volume from the TransCad model by the ADOT volume from 1997, and find the 28th root. Doing this for the time periods from 1997 to 2006 at each of the ADOT count locations described in Section 2.3.1, including the PTR counts, yields an average annual growth rate of 3.485%, which may be rounded to 3.5% per year.

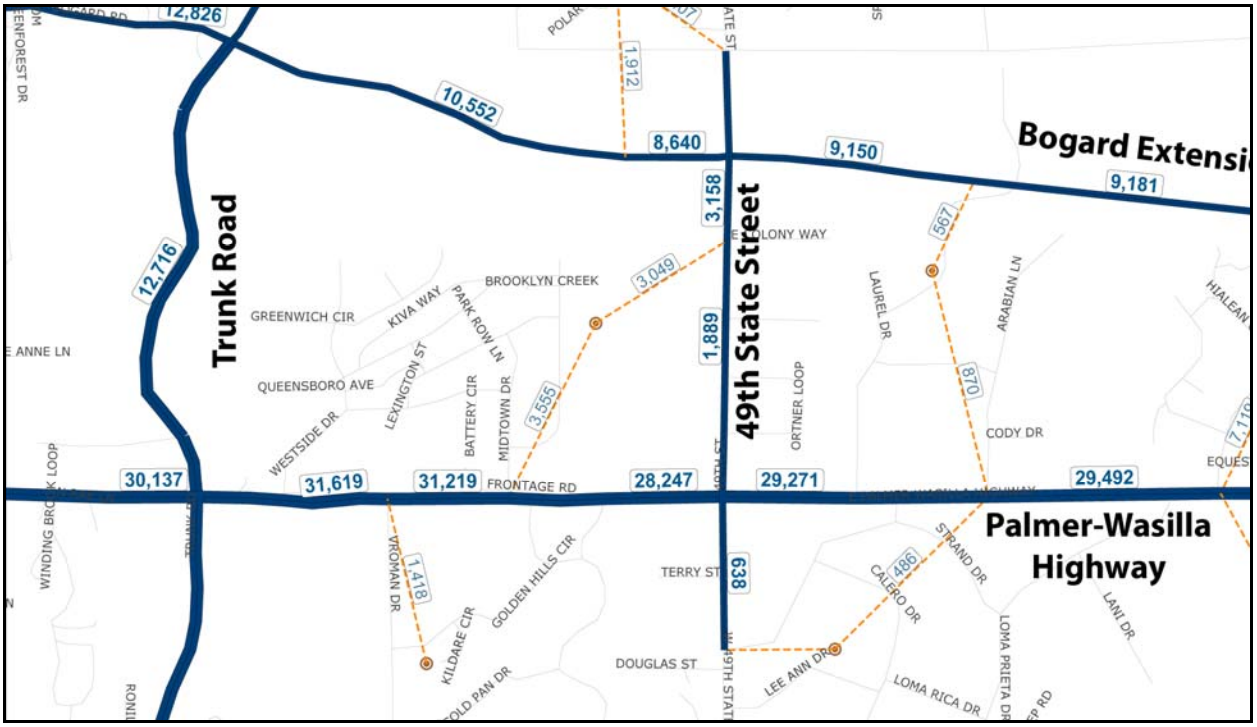


Figure 14 – AADT Volume Map from the 2025 MSB Traffic Model

3.2 Trip Generation

The ITE Trip Generation Manual does not have trip generation rates for landfills, animal shelters or recycling centers. It seems reasonable to assume that as the population of the Mat-Su Borough grows, there will be a corresponding growth in site traffic volumes at each of these facilities. Accordingly, we have used 3.5% as our annual growth rate in site traffic for this report, to reflect the ISER estimate of population growth described in Section 2.2.3. Background traffic rates are also assumed to grow at 3.5% per year to match the Mat-Su Borough TransCad model predictions. The following table summarizes trip generation estimates for each facility.

Facility	**2008 Trips in**	**2008 Trips out**	**2009 Trips in**	**2009 Trips out**	**2014 Trips in**	**2014 Trips out**	**2019 Trips in**	**2019 Trips out**
Valley Recycling	47	48	49	50	58	59	69	70
MSB Landfill	75	75	78	78	93	93	110	110
MSB Animal Shelter	17	17	18	18	21	21	25	25

Table 3 – Trip Generation Estimates

3.3 Trip Distribution

Trips into and out of the landfill, animal shelter, and new recycling site are distributed to the road system in the same percentages that exist currently. This is particularly relevant at the intersection of the Palmer-Wasilla Highway and 49th State Street.

3.4 Combined Forecasts (AADT and Peak Hour)

Figure 15 shows the forecast AADT for the roads in the project area. The 2009, 2014, and 2019 peak hour turning movement forecasts for the study area are shown in Figure 16, Figure 17, and Figure 18, respectively, beginning on page 26. These forecasts reflect a 9% capture of the VCRS trips by the landfill. The animal shelter trips are assumed to be unlinked to either of the other facilities.

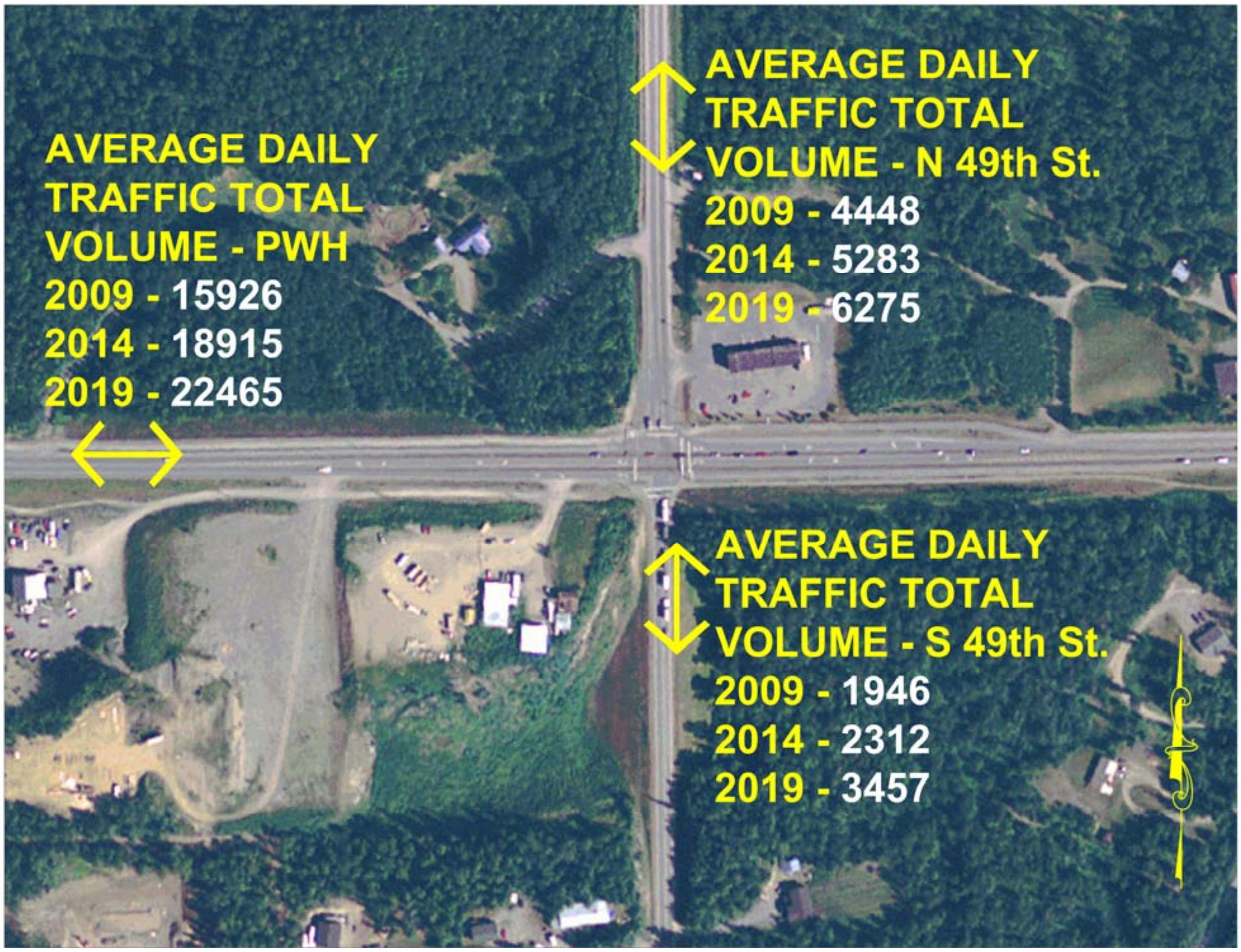


Figure 15 – Current and Future Average Daily Traffic

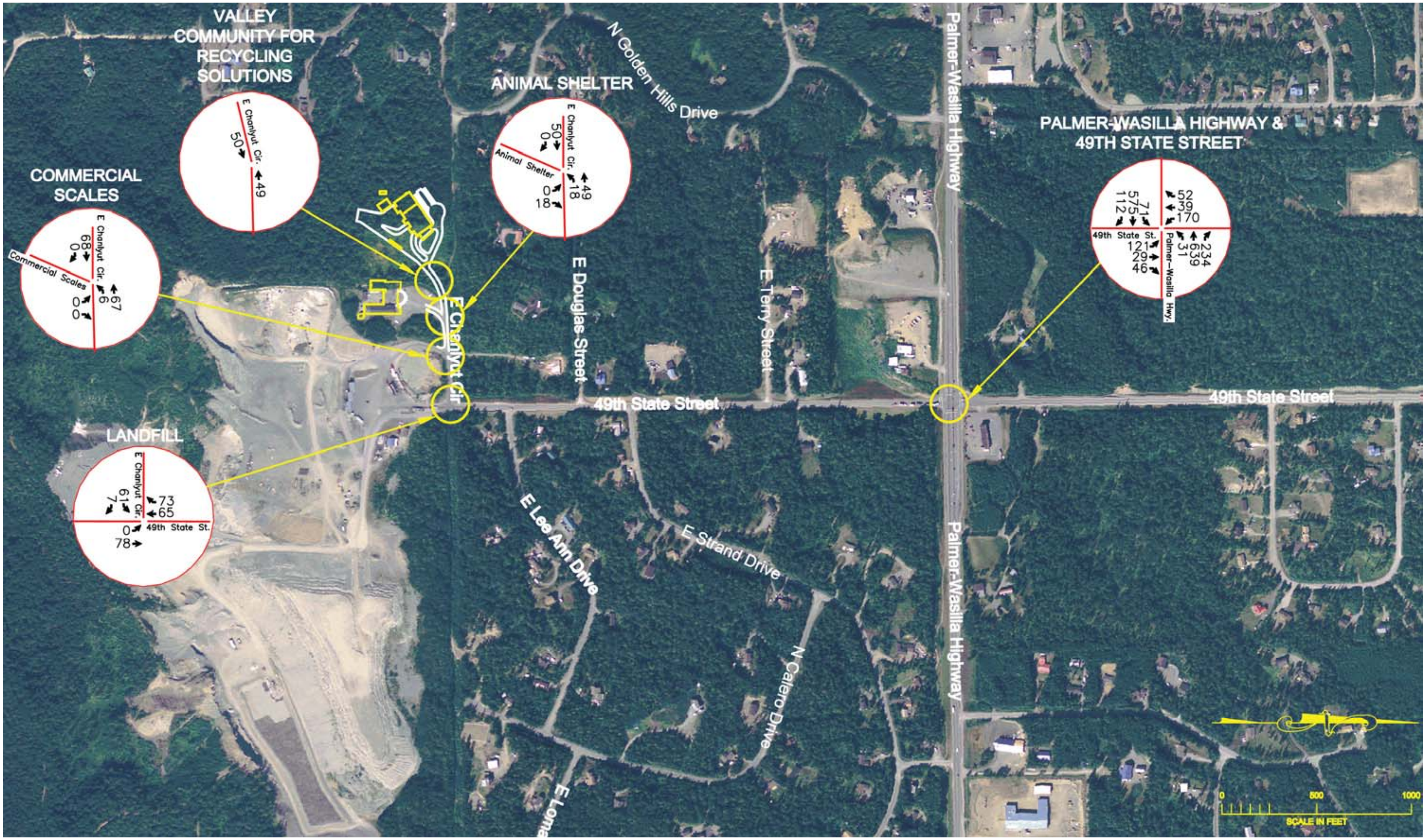


Figure 16- 2009 Forecasted Peak Hour Turning Movements (After Relocation of VCRS)

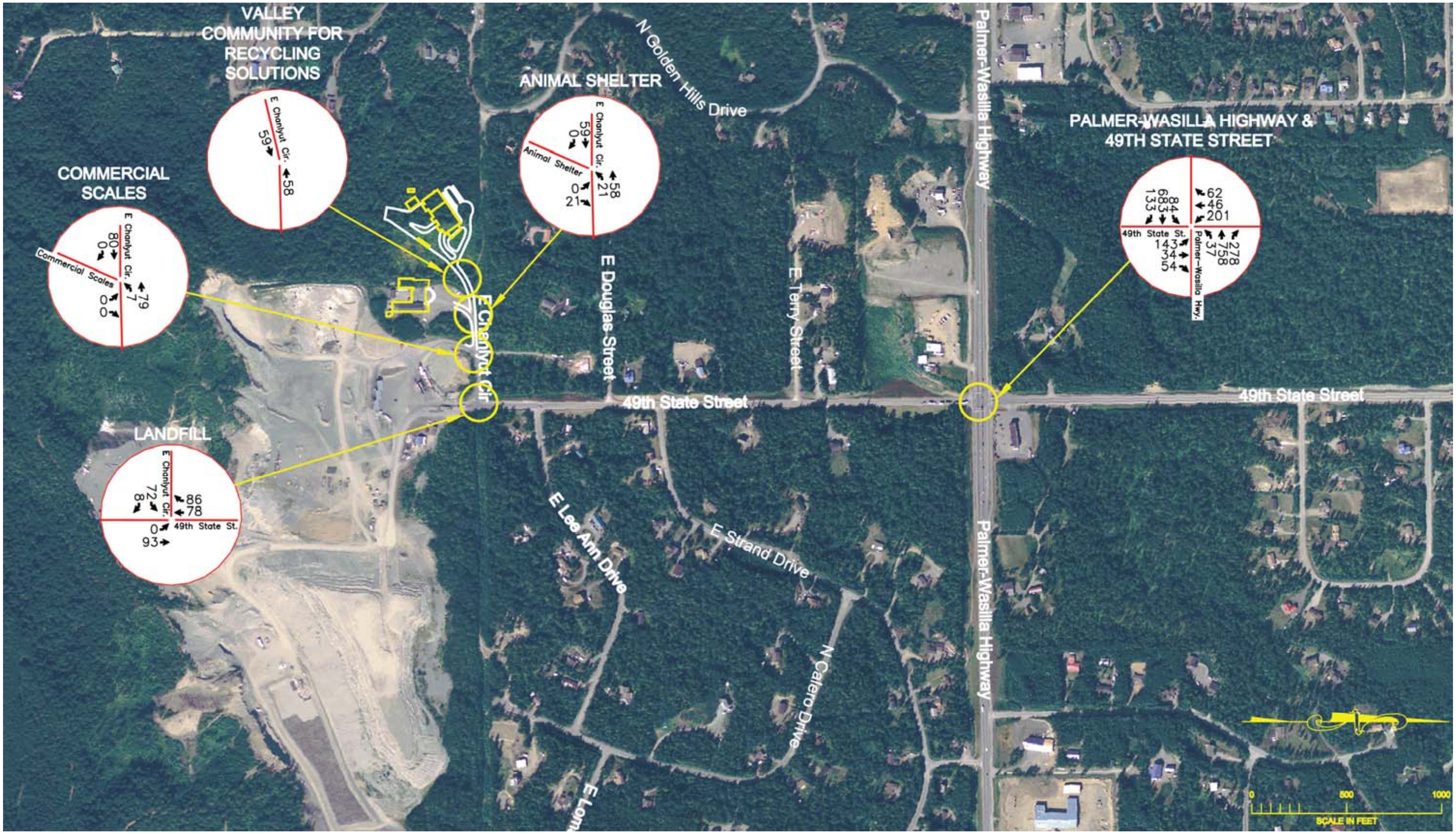


Figure 17- 2014 Forecasted Peak Hour Turning Movements

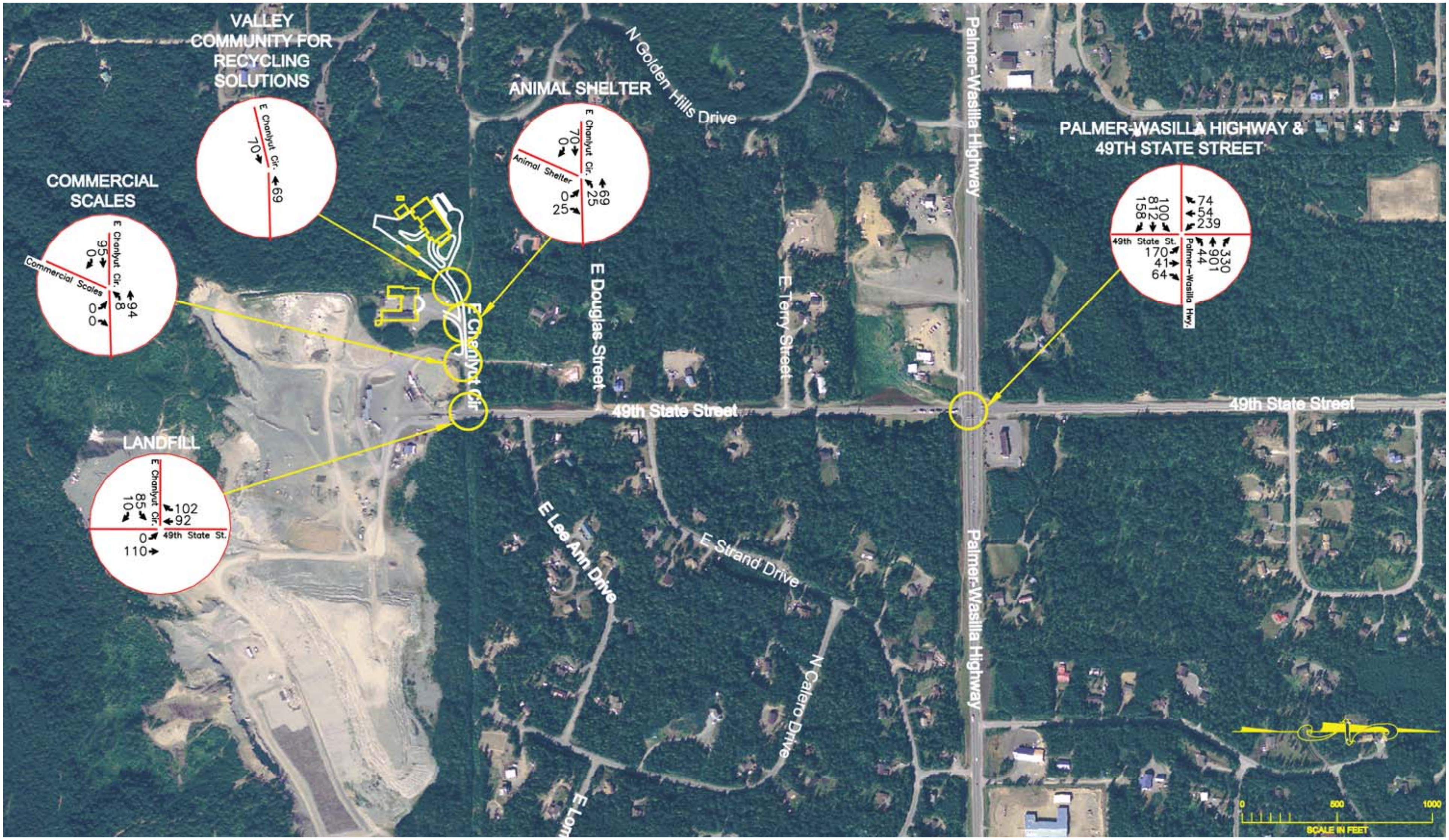


Figure 18- 2019 Forecasted Peak Hour Turning Movements

4 Operational Analyses

4.1 <u>Site Circulation, Access Analysis</u>

4.1.1 Process Description

A landfill user goes through a three stage process to deposit refuse in the landfill. In stage one, his vehicle is weighed at the entrance, whereupon he proceeds to stage two and unloads his vehicle. Finally, his vehicle is weighed again at the exit, and he is charged a fee based on the difference between the vehicle's initial and final weight. Each stage has unique service times and storage areas. Kinney Engineering collected a statistically significant number of observations of vehicle service times in each stage, summarized in Table 2 on page 20, above. Linking these observations together with existing counts, we are able to generate average service times, average queue wait times, and probabilities of queue lengths exceeding available storage for each stage.

We used a probability model based on random arrival, random service, and number of channel, commonly known as M/M/C queuing model, to generate queue measures. There is one channel, or C, for stages 1 and 3 (scales), and stage 2 has 12 channels (number of bins to dump refuse).

4.1.2 Current and Future Queue Lengths

Table 4 shows the queue performance measures for each stage in 2009 during a peak hour (typically, a summer Saturday afternoon when the landfill and VCRS are open).

Stage	**Arrivals (veh/hr)**	**Service rate (veh/hr)**	**Average Time in Stage**	**Critical Length**	**Available queue storage vehicles (feet)**	**Probability of exceeding queue storage**
1 Inbound Scale	72	96.5, C=1	2.5 minutes in queue and weighing	Scale to Chanlyut	3 vehicles (90 ft.)	23%
				Scale to Lee Ann	14 vehicles (420 ft.)	1%
				Scale to SBRT entrance	16 vehicles (480 ft.)	1%
2 Unloading	72	155.2, C=12	4.7 minutes in queue and unloading	Scale to dump area wait area	7 vehicles (216 ft.)	0%
3 Outbound Scale	72	89.6, C=1	3.4 minutes in queue weighing and payment	Dump area wait area to Scale	10 vehicles (290 ft.)	7%

Table 4 – 2009 Design Hour Queue Lengths

As Table 4 shows, queues will back up to Chanlyut about 23% of the time after the relocation of the VCRS in 2009.

The following table presents 2014 queuing for the facility stages, assuming the landfill demand and VCRS demand will expand at the same rate of forecasted population growth, or about 3.5% per year.

Stage	**Arrivals (veh/hr)**	**Service rate (veh/hr)**	**Average Time in Stage**	**Critical Length**	**Available queue storage vehicles (feet)**	**Probability of exceeding queue storage**
1 Inbound Scale	85	96.5, C=1	5.2 minutes in queue and weighing	Scale to Chanlyut	3 vehicles (90 ft.)	53%
				Scale to Lee Ann	14 vehicles (420 ft.)	13%
				Scale to SBRT entrance	16 vehicles (480 ft.)	10%
2 Unloading	85	155.2, C=12	4.7 minutes in queue and unloading	Scale to dump area wait area	7 vehicles (216 ft.)	0%
3 Outbound Scale	85	89.6, C=1	13.0 minutes in queue and weighing and payment	Dump area wait area to Scale	10 vehicles (290 ft.)	53%

Table 5 – 2014 Design Hour Queue Lengths

The results above indicate that the inbound queue will cause upstream blocks at key points for a substantial portion of the peak hour. Intersection blockage (Chanlyut and Lee Ann) may be solved by cooperation and courtesy gaps extended by queued vehicles that would allow the side street to enter through the queue. However, this won’t work with the blockage of the SBRT queue, which would be about 10% of the peak time.

Of significantly more concern is the outbound scale queue. As the demand increases, queues will exceed the available storage over 50% of the time, which will become the choke point of the entire private vehicle stage chain. Vehicles that can’t enter the outbound scale queue, will have to dwell in the unloading area, which in turn prohibits waiting vehicles from unloading causing that queue to back up to inbound scales.

The following table presents 2019 queues.

Stage	Arrivals (veh/hr)	Service rate (veh/hr)	Average Time in Stage	Critical Length	Available queue storage vehicles (feet)	Probability of exceeding queue storage
1 Inbound Scale	101*	96.5, C=1	8* minutes in queue and weighing	Scale to Chanlyut	3 vehicles (90 ft.)	67%*
				Scale to Lee Ann	14 vehicles (420 ft.)	27%*
				Scale to SBRT entrance	16 vehicles (480 ft.)	23%*
2 Unloading	101*	155.2, C=12	4.7* minutes in queue and unloading	Scale to dump area wait area	7 vehicles (216 ft.)	1%*
3 Outbound Scale	101*	89.6, C=1	100* minutes in queue and weighing and payment	Dump area wait area to Scale	10 vehicles (290 ft.)	92%*

*101 vph demand cannot be served. The analysis is performed for 89 vph service rate (constrained by outbound scale service rate).

Table 6 – 2019 Design Hour Queue Lengths

4.1.3 Queue Impacts

Probabilistic queuing analysis presents impacts in terms of the likelihood or probability that a queue will spill back beyond the storage capacity. Usually we would select a desired maximum of 5% probability that the queue storage will be exceeded as a good design value. As such, Table 4 above indicates that both Stage 1 and 3 queues storage lengths will be exceeded more than 5% of the time in 2009. By 2014, if traffic growth continues as projected, queues into the facility will frequently back beyond the SBRT lane. Also the queue at the outbound scale will frequently back into the unloading area. Finally, in 2019, projected demand cannot be met, and interior queues will cause overall failure.

Drivers with both refuse and recycling loads may decide that they can avoid waiting in the landfill queue by going to the recycling center first with a southbound right turn, and then make an eastbound right turn to the landfill scale at Chanlyut Circle and 49th State Street after unloading recyclables. With the current single eastbound lane approach, these vehicles, which are part of the landfill queue, would cause delay to the eastbound left turn vehicles coming from the animal shelter and VCRS, as they wait to enter the inbound scales. Other drivers who are waiting in the queue for the landfill may resent yielding their place in line to the eastbound right turn traffic, particularly if it is perceived that people are attempting to jump ahead in line. Such resentment may lead to drivers ignoring the southbound stop sign and block the intersection.

4.1.4 Circulation

Currently, onsite circulation may be described as two concentric loop routes. The commercial vehicles enter at the commercial scales and traverse an outer loop south of the unloading site for the general vehicles. They are weighed at entry, and proceed to the landfill cell currently being filled. After emptying their loads, they leave via a “free”, or uncontrolled, lane adjacent to the entry scale for the private vehicles, since their tare weight is known to the landfill staff. Other vehicles enter directly south of the intersection of 49th State Street and Chanlyut Circle, and follow a loop to the refuse unloading site and the exit scale. After they are weighed and have paid, they leave via the uncontrolled northbound approach of 49th State Street and Chanlyut Circle. Interaction between private and commercial vehicles is kept to a minimum by this arrangement. One major advantage of the current circulation pattern is that private traffic is separated from commercial traffic. Figure 19 shows the approximate circulation paths.

Figure 19 – Current Circulation Paths

4.2 Intersection Current and Future Traffic Operations

4.2.1 Intersection and Roadway Performance Objectives

Operation quality on facilities is generally assessed during future peak hours as a indication of performance. (AASHTO) *Geometric Design of Highway and Streets 2004*, Exhibit 2-32 provides guidelines for design levels of services of functionally classed facilities. AASHTO states urban and suburban freeway and arterial facilities should operate at a level of service (LOS) C or better during a design life. Collector and local street facilities should operate at LOS D or better during the design life. This study adopts these objectives for this analysis as well. These performance objectives apply to roadways and to intersections.

In addition, volume to capacity (v/c) ratios and 95th percentile (traffic volume percentile) queues are used for performance measures at intersections. The v/c ratios should always be less than one (meaning that demand is less than capacity), and desirably should be 0.85 or less to accommodate unforeseen circumstances or events that impact operations. Long queues may block upstream intersections or ramps and may cause an increase in rear-end or sideswipe collisions.

4.2.2 49th State Street/Chanlyut Circle

With such relatively low traffic volumes at this intersection, standard performance measures of effectiveness such as Level of Service (LOS) and volume to capacity (v/c), as calculated by Synchro, are excellent (LOS A), but fail to take into account the delay created for southbound vehicles by the process of weighing each vehicle as it enters the landfill area. As such, the intersection southbound and eastbound movements are controlled by the Stage 1 operations in times of higher traffic flow. Acceptable operation of this intersection is determined to a large extent by the average service time for each entering vehicle.

Volumes at this intersection depend upon alternative configurations (see Section 5.2, on page 40) and will have minor variations from what is depicted in Figure 16 through Figure 18. Volumes and operations at this intersection are discussed for each alternative under its respective section..

4.2.3 Palmer Wasilla Highway/49th State Street

Once the VCRS is relocated, the traffic patterns at this intersection will not vary between alternatives.

The PM Peak traffic volumes collected by DOWL at this intersection were increased from 2006 to 2019 using the 3.5% annual growth rate. The total combined volumes for the Landfill and animal shelter were added to the PWH intersection in the existing turning movement proportions at the intersection. For instance, the eastbound right turn volume at PWH and 49th State Street is 60% of the traffic going south on 49th State Street, which includes the westbound left turn, the southbound through, and the eastbound right turn. Therefore, 60% of the inbound traffic for the landfill and the animal shelter was added to the eastbound right turn, 11% (the westbound left turn ratio) was added to the westbound left turn, and 29% added to the southbound through movement. Similar distributions of the outbound traffic from the landfill and animal shelter were made to the northbound approach. The trips from VCRS were assigned to the eastbound right turn and westbound left turn for arriving trips, and to the northbound left and right turn for outbound trips, in the same proportions as they arrived and left on Palmer Wasilla Highway. This procedure was followed for the base year, midlife year, and design year, and the combined volumes appear in Figure 16, Figure 17 and Figure 18.

Synchro generates Highway Capacity Manual reports, and the report for the intersection of Palmer Wasilla Highway and 49th State Street for 2019 volumes, operated as a semi-actuated, uncoordinated signal, with current lane configurations, is as follows:

HCM level of service	C
HCM average control delay	32.0 sec/veh
HCM volume to capacity ratio	0.92

Given these results for 2019, with a single through lane on each main street approach, we can assume results for the intervening years of 2009 and 2014 will be equally acceptable, and therefore Synchro analysis for those years was not done. No remediation will be necessary at this intersection due to this project.

4.2.4 49th State Street Segment

The 49th State Street segment is a shorter lower speed road. As such, level of service would be controlled by intersection operations. As a check, Planning LOS on page 69 in Appendix E - Capacity Analysis and Level of Service provides planning level of service for roadway segments. Based upon future 2019 AADT of 3500 (Figure 15 on page 25) this segment would have LOS C. Therefore, operations on the streets and intersections are all acceptable other than those involving site queue impacts.

5 Alternatives

The above section indicates that the future increases in landfill traffic and the relocated VCRS facility will likely cause operational problems at the entrance to the landfill resulting in long queues that spill back to block streets and turn lanes. In addition, internal circulation aisles will not have enough storage between stages and queues may impact upstream stages.

The following alternatives accommodate, fully or in part, 2019 demands for landfill, animal control center, and the VCRS facilities. There are two classes of alternatives, those that improve the process points through efficiency measures; and a second class that would improve site and roadway geometrics.

5.1 Process Point Alternatives

The limiting factors in this study are the vehicle service times at each stage of the process of using the landfill, in particular the inbound weighing and outbound weighing and paying. The service times place a finite limit on the number of vehicles that can be served in an hour, which at current levels are much less than the 2019 peak demand of 101 vph. A large part of the total service time is controlled by the vehicle driver, by how fast he/she gets on and off the scale. This is evidenced by the difference between the inbound vehicle service times observed by Kinney Engineering (37.3 sec/veh, which translates to 96.5 veh/hr), and the Time and Motion Study done by Solid Waste Division personnel, which found an average employee service time of 13 seconds per vehicle when loads were weighed, as opposed to an average service time of 31 seconds when attendants estimated the cubic yardage of each load. Once the hourly vehicle arrival rate exceeds the hourly vehicle service rate, the queue length theoretically reaches infinity. In reality, the queue continues to grow until the arrival rate declines below the service rate, and the backlog of vehicles slowly clears. We have prepared 3 process alternatives, of which one will have to be implemented between 2009 and 2014 to prevent breakdown of site circulation.

5.1.1 Process Point Alternative 1: Demand Management

Reduction of peak hour visits, and consequently queues may be accomplished by demand management instead of site or road improvements. For instance, increasing the number of households serviced by commercial waste vehicles might help reduce the number of private trips required. Establishing higher fees for peak hour usage might encourage people to make their trips to the landfill in off peak hours, reducing the peak hour arrival rate, and in turn may fund additional hours of operation. Otherwise improvements will have to be made to the constraint service points, that is, the inbound and outbound scale processes.

5.1.2 Process Point Alternative 2: Decrease Service Times

The average inbound scale service time is 37.3 seconds, or about 96.5 vehicles per hour. The average outbound scale service time is 40.2 seconds or 89.6 vehicles per hour. Facility demand will be 101 vph in 2019.

In order to reduce the probability of backup into the unloading area from the outbound scale from 92% to 5% in 2019, the average outbound scale service time would have to be reduced from 40.2 seconds to 27.7 seconds per vehicle. If so, only 5% of queues would exceed available storage of 10 vehicles, an acceptable level.

Also, to reduce the spillback queue at the inbound scale so that the queue only extends into the Chanlyut intersection about 5% of time, then the service time at the inbound scale should be reduced from 37.3 seconds to 19.6 seconds per vehicle. The service time needed to restrict blockage of SBRT lane to about 5% of the time would be about 30.2 seconds per vehicle.

The time reduction alternatives presuppose that there are no efficiencies realized from improved human performance. As such, the reductions for inbound and outbound scale service times would only be attained with increased staff or through technology. However, one option for decreasing service times would be to eliminate the scales and move to a flat rate. Under this option, the outbound service time would be eliminated and queues would not back into unloading zone. The inbound service time would include move-up time, the transaction time for paying the flat fee, and finally the move-off time. If this could not be accomplished in 30 seconds, then a second station could be mobilized during peak times.

5.1.3 Process Point Alternative 3: Increase Scale Service Channels

Adding an additional scale at the outbound scale station would eliminate almost all exiting queues over the available 10 vehicle storage length. Similarly, a second scale at the entrance would reduce the queue spillback to Chanlyut Street (3 vehicles) to about

5% of the time; and practically eliminate queues back to Lee Ann Street or the beginning of the SBRT lane.

5.2 Site and Roadway Modification Alternatives

The following 4 alternatives are proposed in addition to the process point alternatives described above.

5.2.1 Alternative 1

Alternative 1 consists of adding a right turn lane to the eastbound approach of 49th State Street and Chanlyut Circle, and lengthening the right turn lane of the southbound approach to the same intersection, to reduce delay to the eastbound left turn traffic, and reduce the chance of blockage of the southbound right turn lane by the overflow landfill entry queue. This alternative's longer SBRT lane may defer the entrance process point improvements until after 2014.

The eastbound right turn vehicles would encounter a maximum queue of the vehicle being weighed, plus the three vehicles waiting in the 90 feet between the scale and Chanlyut Circle. The arrival rate for the eastbound right turn in 2016 is about 9 vehicles per hour. By the rules of stop sign control, the southbound vehicles would have to yield to the eastbound right turn vehicles upon their arrival. The wait time for the eastbound right turn to enter the queue would be about 45 seconds, given driver adherence to rules of right of way. The queue storage for the eastbound right turn could be satisfied by a lane length of 150'. It is entirely possible that some drivers would elect to take advantage of the eastbound right turn service time without actually going to VCRS.

Figure 20 presents Alternative 1.

During peak periods, VCRS traffic that also wish visit the landfill would rely on the inbound queue to let them into the line, perhaps ahead of many others.

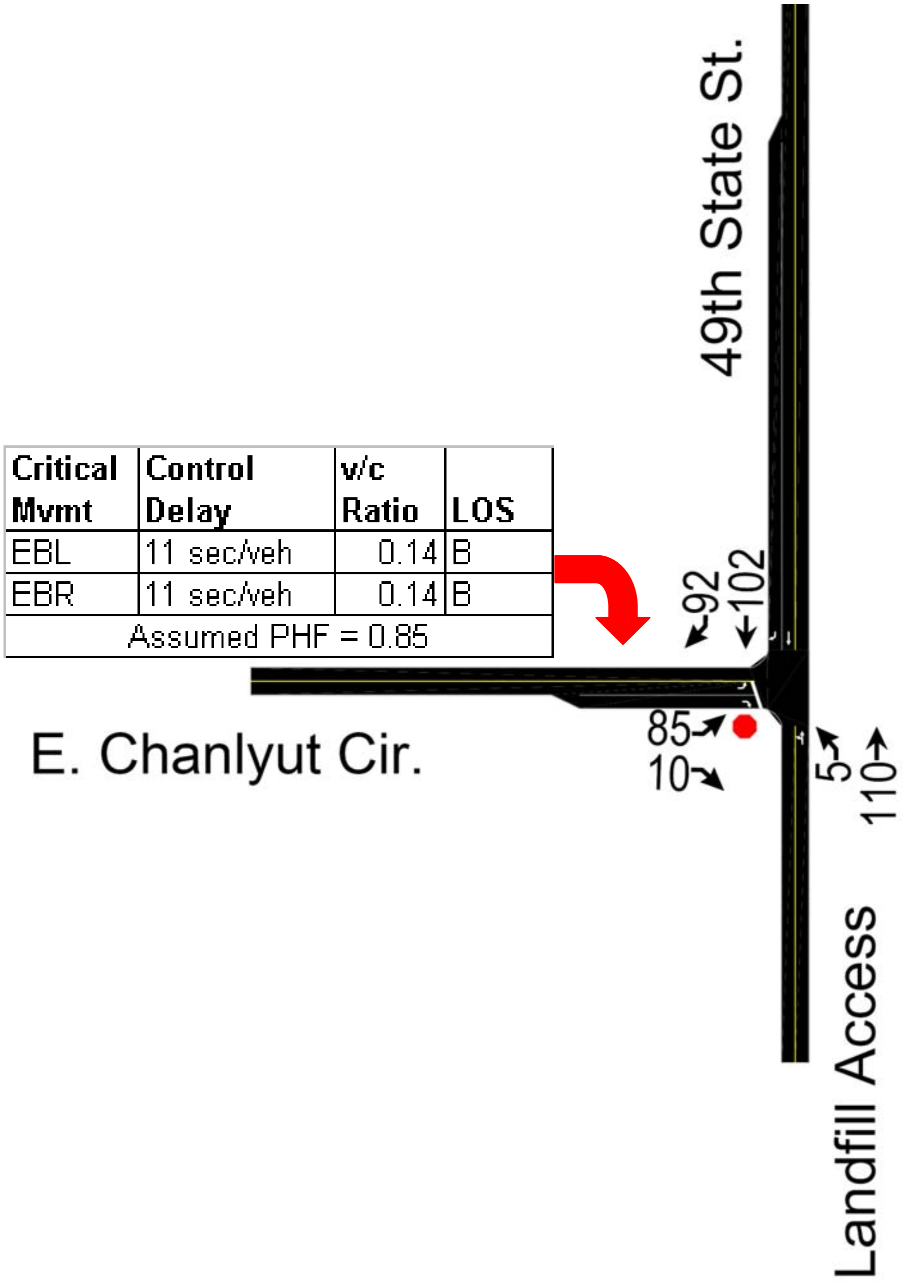
Figure 20- Alternative 1

The Palmer Wasilla Highway and 49th State Street in 2019 would have performance measures as follows for the PM peak hour with relocated VCRS facility (from Section 4.2.3 on page 36).

HCM level of service	C
HCM average control delay	32.0 sec/veh
HCM volume to capacity ratio	0.92

This level of service satisfies AASHTO's LOS recommendation of C or better for arterials. As such this alternative will not adversely impact operations to the extent requiring action at the Palmer Wasilla Highway and 49th State Street intersection.

The following figure presents the East Chanlyut Circle and 49th State Street intersection 2019 peak hour volumes, (from Figure 18 on page 28 with adjustments) and operational performance. All critical movements are shown to be LOS B which exceeds the minimum LOS of D for collector streets discussed under Section 4.2.1 on page 35.



Critical Mvmt	Control Delay	v/c Ratio	LOS
EBL	11 sec/veh	0.14	B
EBR	11 sec/veh	0.14	B
Assumed PHF = 0.85			

Figure 21- 2019 Operations at Chanlyut Circle and 49th State Street

5.2.2 Alternative 2

Alternative 2, Figure 22 below on the next page, requires purchase of additional right of way in order to sweep Chanlyut Circle north to intersect with Lee Ann Drive. This alternative would add a right turn lane to the eastbound approach, and maintain the right turn lane for the southbound approach. The queue storage requirements on both approaches is less than 100 feet, and deceleration is not required for lower speed streets. However, a minimum lane length of 100 feet for both approach right turn lanes is recommend for large vehicles.

This intersection would probably be a two way stop controlled intersection, although if there were enough right of way, a roundabout may be a good alternative. The landfill queue storage would be uninterrupted from the scale to the Chanlyut Circle/ Lee Ann Drive, for about 420 feet. With Alternative 2, and one of the process point alternatives, the queue from the inbound scale would only occasionally spillback to the Chanlyut/Lee Anne intersection. The egress traffic from the stop control approaches would not be impeded by queues into the landfill, and the eastbound right turn traffic coming from VCRS would be joining the back of the landfill queue. Finally, this alternative increases spacing between conflicting movements in and out of the landfill. As an example of this benefit, an outbound vehicle that wishes to visit the VCRS or animal shelter after exiting the landfill turns into the Chanlyut approach 400 feet downstream from the landfill scale and queues formed while awaiting gaps to turn would not impact the landfill exit.

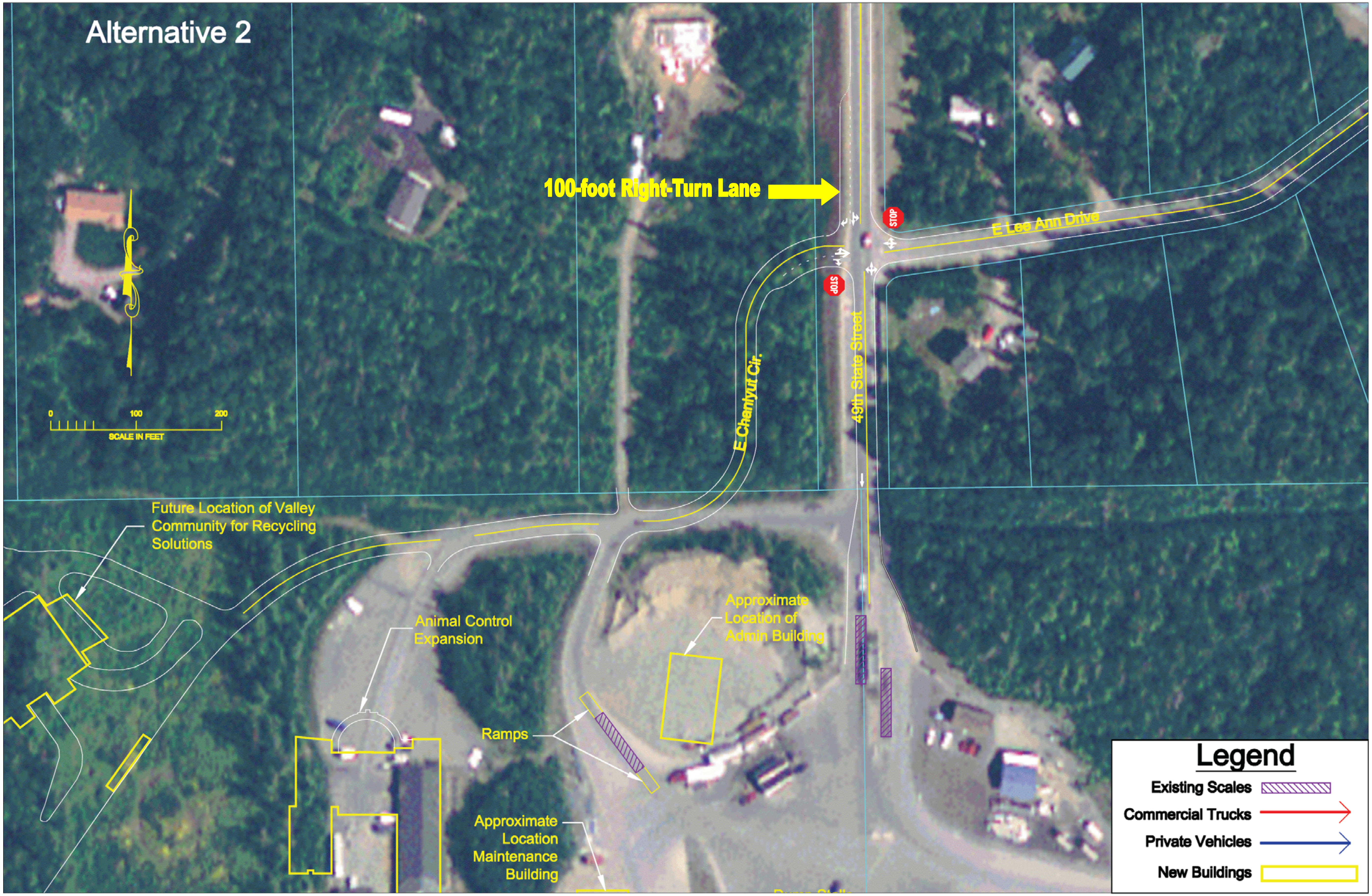


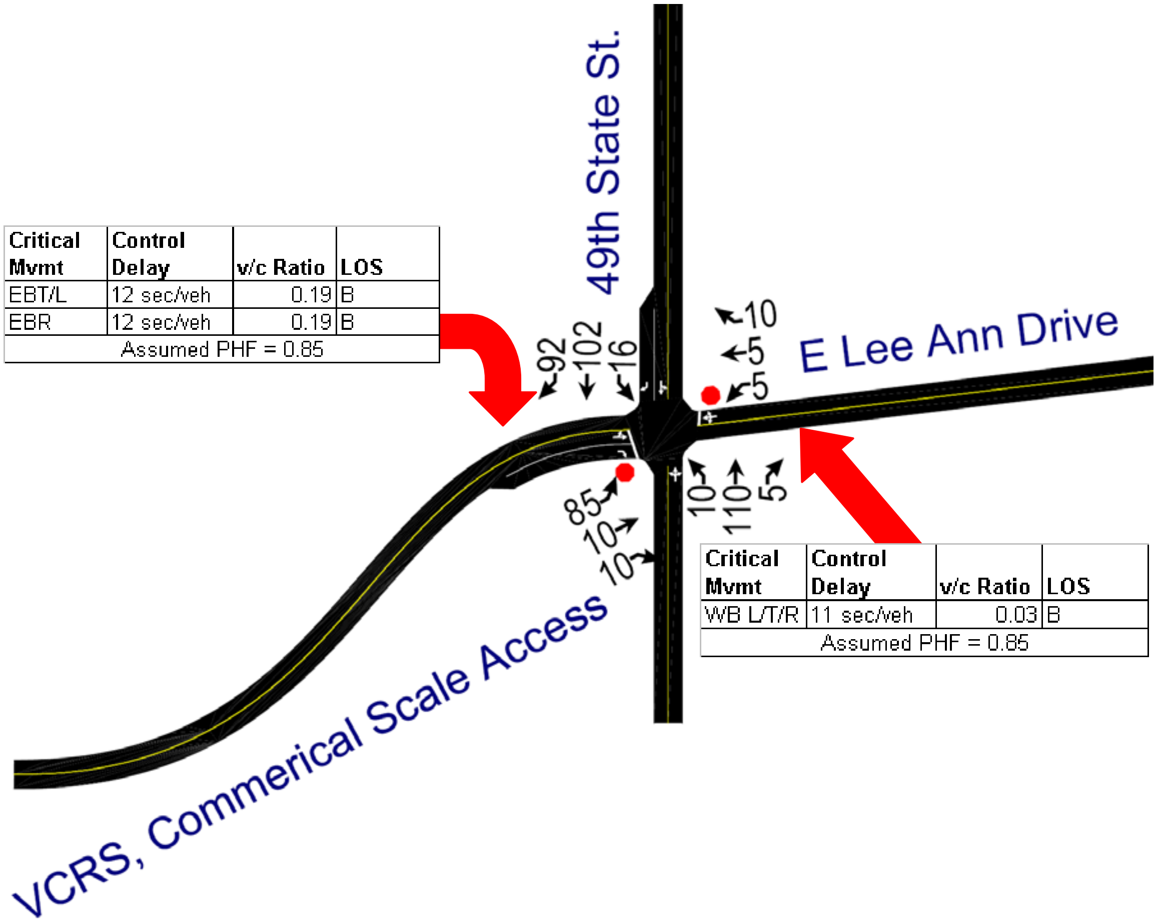
Figure 22- Alternative 2

The Palmer Wasilla Highway and 49th State Street in 2019 would have performance measures as follows for the PM peak hour with relocated VCRS facility (from Section 4.2.3 on page 36).

HCM level of service	C
HCM average control delay	32.0 sec/veh
HCM volume to capacity ratio	0.92

This level of service satisfies AASHTO's LOS recommendation of C or better for arterials. As such this alternative will not adversely impact operations to the extent requiring action at the Palmer Wasilla Highway and 49th State Street intersection.

The critical intersection of this alternative will be the VCRS/Commercial Scale access, 49th State Street, and East Lee Ann Drive intersection. The following figure presents 2019 volumes that are computed from Figure 18 on page 28 and from trip generation distribution estimates of the residences along Lee Ann Drive. The figure also summarizes operational performance. All critical movements are shown to be LOS B which exceeds the minimum LOS of D for collector streets discussed under Section 4.2.1 on page 35.



Critical Mvmt	Control Delay	v/c Ratio	LOS
EBT/L	12 sec/veh	0.19	B
EBR	12 sec/veh	0.19	B
Assumed PHF = 0.85			

Critical Mvmt	Control Delay	v/c Ratio	LOS
WB L/T/R	11 sec/veh	0.03	B
Assumed PHF = 0.85			

Figure 23- 2019 Operations at Access, E Lee Ann Drive, and 49th State Street

Exhibit 9-75 in AASHTO's *A Policy on the Geometric Design of Highways and Streets* provides volume level guidance on whether left-turn lanes for major street approaches to unsignalized intersections are recommended. The volume levels shown above do not satisfies volume thresholds in Exhibit 9-75, and therefore northbound and southbound left turn lanes are not needed.

5.2.3 Alternative 3

In Alternative 3, the entry scale to the landfill is moved further south from the intersection of 49th State Street and Chanlyut Circle, to provide entry queue storage onsite. A right turn lane is added to the eastbound approach to the intersection of 49th State Street and Chanlyut Circle. This alternative would probably require automation of the inbound scale and advance signals that prompt movement onto and off of the scale unless the scale house is relocated as well. There should be at least 2 vehicle storage lengths between the scale and the wait line for unloading even though computations show that there is rarely a wait to unload once past the inbound scale. If the scale house is not relocated, the outbound scale would not be moved so that the storage distance between the scale and the unloading area would be preserved. In addition, additional outbound queue storage may have to be developed on site

Under this Alternative, volumes and operations of the 49th State Street and Chanlyut Circle intersection (critical intersection) would be similar to that presented in Figure 21 on page 43, which is LOS B in 2019. Also, the operations of Palmer Wasilla Highway and 49th State Street intersection in 2019 PM peak hour with relocated VCRS facility satisfies AASHTO's LOS recommendation of C or better for arterials. As such this alternative will not adversely impact operations to the extent requiring action at the Palmer Wasilla Highway and 49th State Street intersection.

Alternative 3 is presented in Figure 24 on the next page.

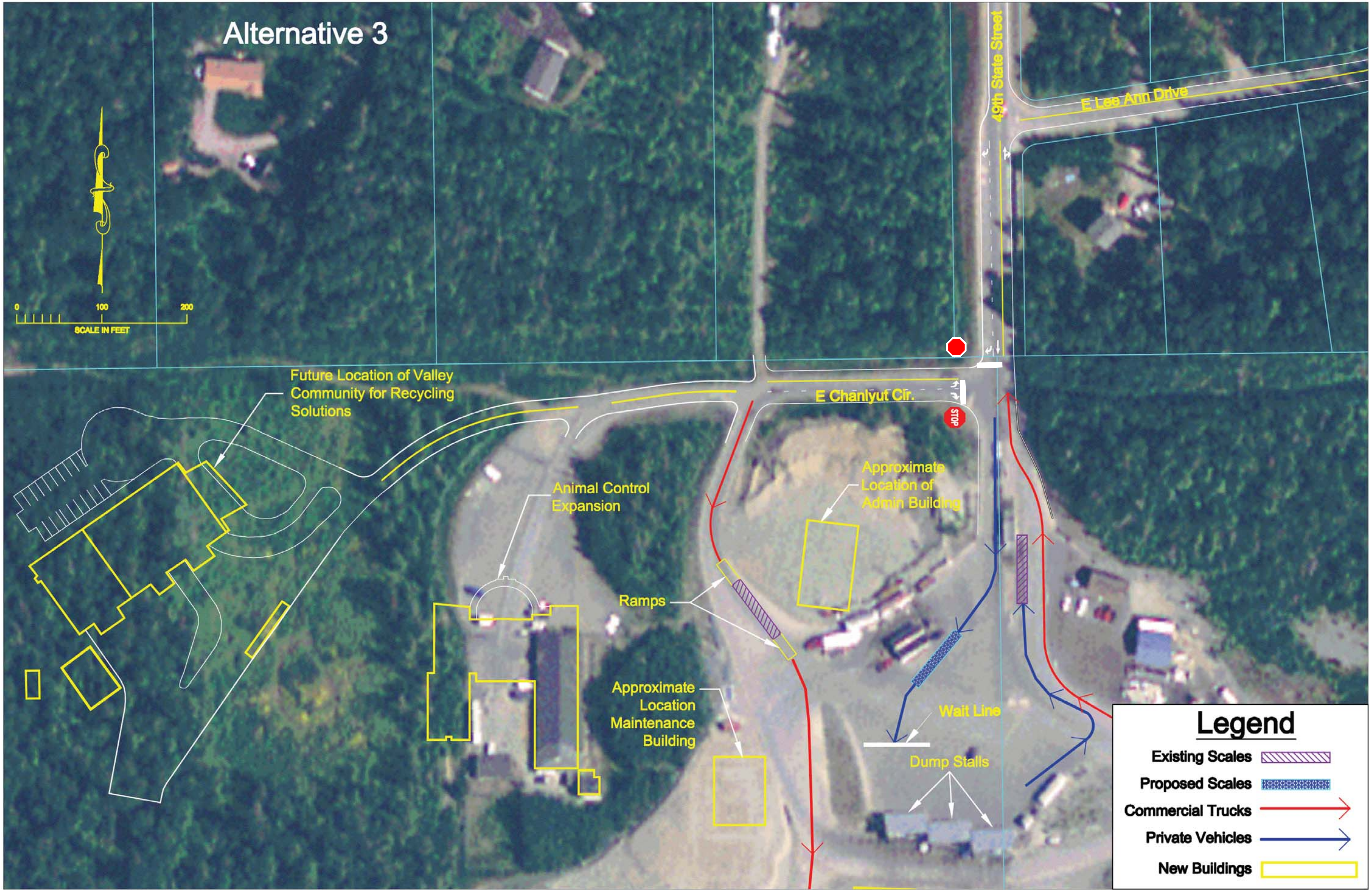


Figure 24- Alternative 3

5.2.4 Alternative 4

Alternative 4, shown in Figure 25 on the following page, provides a connection between VCRS and the landfill, allowing the capture trips from recycling to bypass the intersection of 49th State Street and Chanlyut Circle, and proceed more or less directly to the landfill. Vehicles entering from the recycling site would have to be weighed either at the existing scale or at an additional scale located somewhere between VCRS and the landfill. As shown in Figure 25, the path of the recycle vehicles to the unloading area conflicts with the path of the commercial trucks. Even though the number of vehicles from both VCRS and the commercial scale are few (about 10 each in 2019), the implications from an accident are major. Some form of traffic control (stop sign) would be required for one or both approaches. As in Alternative 3, the additional scale, if installed, would probably require an automated process.

If a second scale were installed for the vehicles arriving from VCRS, during peak hours some of the inbound traffic could be rerouted to this scale, thus reducing the landfill queue on 49th State Street and effectively doubling the service rate from 96.5 vehicles per hour to 193 vehicles per hour. Although this would reduce queues lengths that rarely would extend to Chanlyut Circle, there are other issues that may make this unfeasible. Specifically the conflicts at the intersection of the commercial truck route and the second inbound access greatly increase beyond the 20 vehicles described above. In addition, a conflict point is created at the waiting line for the unloading area between the southbound and eastbound traffic streams.

Under this Alternative, volumes and operations of the 49th State Street and Chanlyut Circle intersection (critical intersection) would be similar to that presented in Figure 21 on page 43, which is LOS B in 2019. Also, the operations of Palmer Wasilla Highway and 49th State Street intersection in 2019 PM peak hour with relocated VCRS facility satisfies AASHTO's LOS recommendation of C or better for arterials. As such this alternative will not adversely impact operations to the extent requiring action at the Palmer Wasilla Highway and 49th State Street intersection.

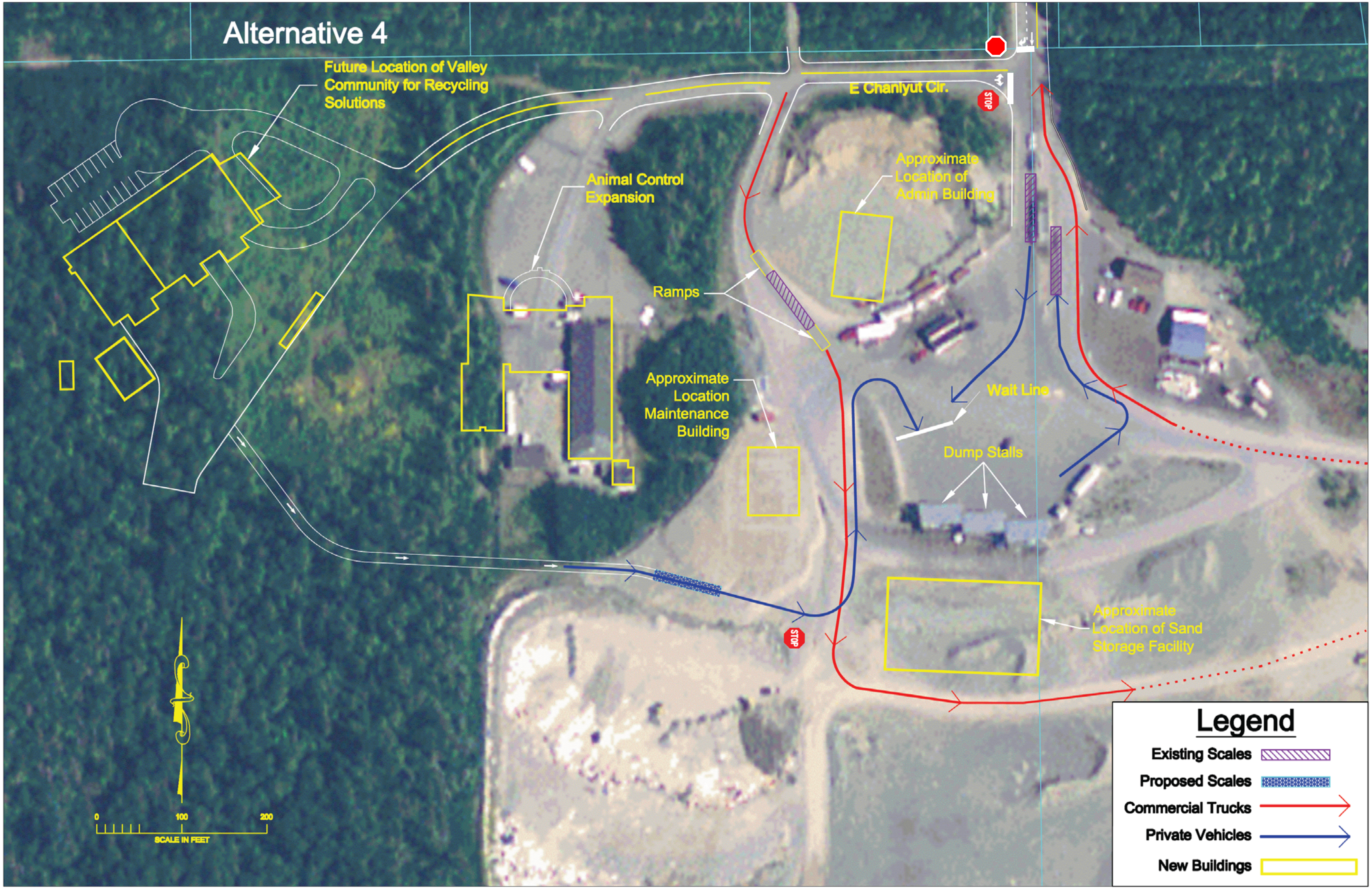


Figure 25- Alternative 4

5.3 Summary of Alternatives

We have prepared a summary table of the advantages and disadvantages of each of the site and roadway modification alternatives.

Alternative	**Advantage**	**Disadvantage**
Alternative 1- Add EBRT lane, lengthen SBRT at 49th/Chanlyut.	--ample ROW exists --reduces delay to EBLT traffic --may delay process point improvements past 2014	--may create driver "ill will" by VCRS traffic joining front of queue. --conflicting movements close to landfill exit.
Alternative 2- Relocating Chanlyut Circle to intersect with 49th State Street at Lee Ann Drive.	--uninterrupted queue storage for landfill --increased spacing between conflicting movements in and out of landfill --landfill traffic from VCRS joins back, not front, of queue	--requires ROW purchase and significant road construction --also requires a process point alternative by 2014
Alternative 3- Move entry scale further south from intersection.	--moves part of landfill queue onsite --EBRT joins end, not front, of queue	--probably requires automation of entry scale and signals to prompt movement --also requires a process point alternative by 2014
Alternative 4- Connect VCRS and landfill	--reduces or eliminates EBRT at 49th State St/Chanlyut Cir. --second entry scale for recyclers serves as process point alternative implementation.	--introduces conflicts between commercial and private vehicles --creates a conflict point at unloading between WB and EB traffic streams --requires second entry scale with automation

Table 7 – Site and Roadway Modification Alternative Summary

None of these alternatives prelude the need for process point alternative implementation at both the entry and outbound stage sometime near the midlife year 2014. Process point alternatives include demand management measures, service time reduction, and increasing scale service channels (adding additional scales). In terms of cost and effort, the process point alternatives may well be worth implementing first.

6 Recommendations

With the relocation of the VCRS to a parcel adjoining the landfill and Animal Control, and increasing population growth in the MSB, access issues, specifically queues, for this complex are forecasted to worsen. Queuing analyses indicate that the queues at the scales are the system constraint, and that peak time queues will likely grow longer each year with increased demand.

During a client review of the draft report, MSB Planning staff indicated that the scales have a finite life and that scales replacements are likely within period of this study (2009 to 2019). As such, it would be economical to implement Alternative 3, scales relocation, during that changeover. In addition, a process point alternative; that is, demand management, service time reduction, or additional, parallel scales, would have to be implemented as well.

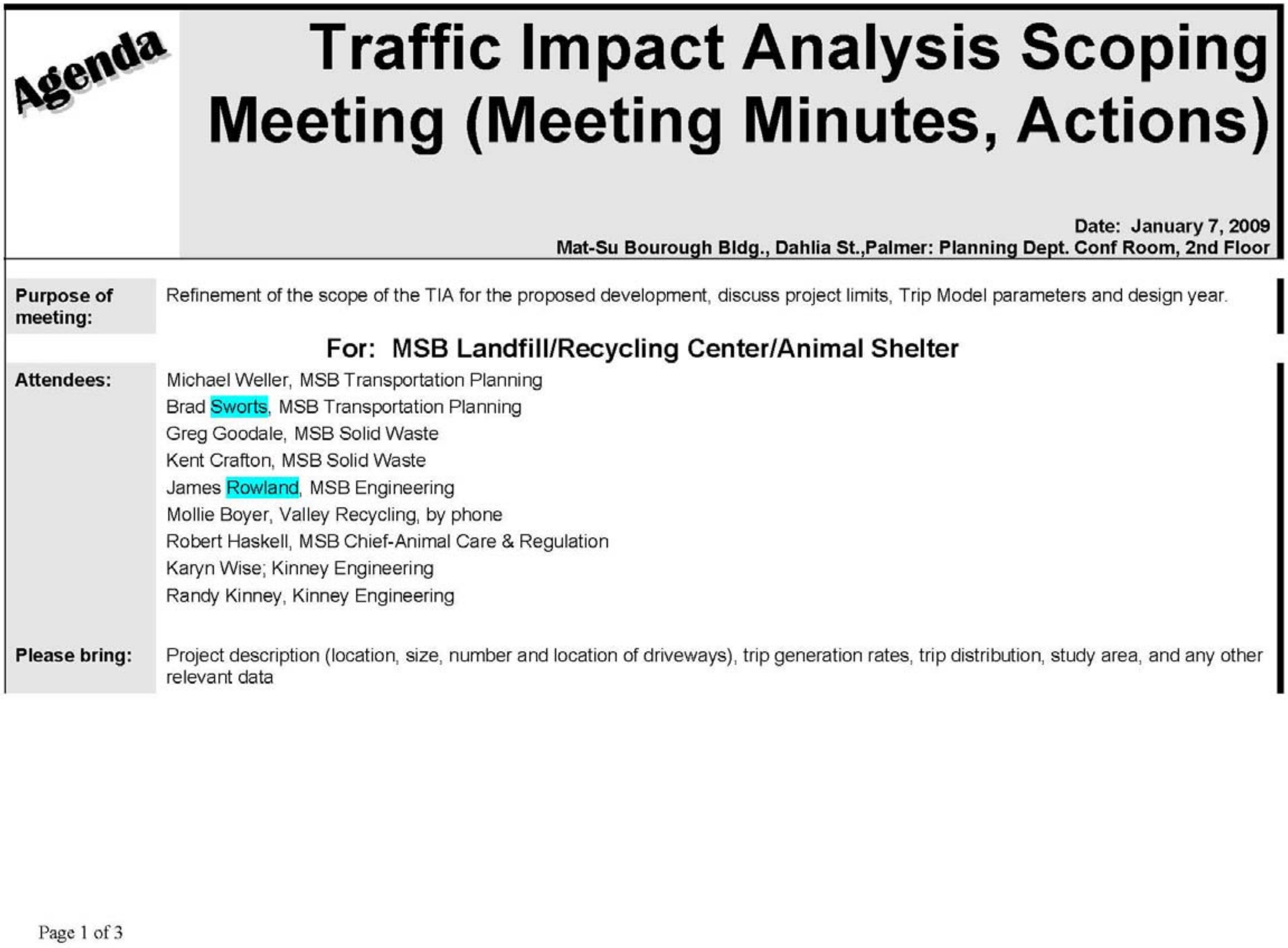
During the interim between now and the scale relocation, traffic operations at the Chanlyut / 49th State Street intersection should be monitored. If incoming scale queues spill back to block off the right-turn lane, then Alternative 1, should be constructed.

If scales were to be eliminated as the process point alternative, and instead flat fees were to be charged, then scale relocation would become unnecessary and Alternative 1 would likely be adequate for 2019 planning horizon.

7 References

1. *Alaska Preconstruction Manual* (PCM) by DOT&PF.
2. *Alaska Traffic Accidents,* DOT&PF Statewide Planning.
3. *Alaska Traffic Manual (ATM)*, State of Alaska DOT&PF.
4. American Association of State Highway and Transportation Officials (AASHTO) *A Policy on the Geometric Design of Highways and Streets*, (GDHS) 2001.
5. *Central Region Annual Traffic Volume Report* for the years between 1992 and 2007, published by DOT&PF.
6. *Highway Capacity Manual 2000* (HCM2000), TRB.
7. *Highway Capacity Software* 2000 (HCS), McTrans.
8. *Highway Safety Improvement Program Handbook* (HSIPHB) published by the State of Alaska, Department of Transportation and Public Facilities with supplement rates provide by Central Region Traffic and Safety.
9. *Manual of Traffic Signal Design*, Second Edition, by James H. Kell and Iris J. Fullerton, Institute of Transportation Engineers.
10. *Manual on Uniform Traffic Control Devices (MUTCD)*, FHWA.
11. Matanuska Susitna Borough *Long Range Transportation Plan* 2007, HDR-Alaska
12. NCHRP Report 162, *Methods for Evaluating Highway Safety Improvements*, Laughland, *et. al*.
13. NCHRP Report 279 *Intersection Channelization Design Guide*.
14. *NCHRP Report 457, Engineering Study Guide for Evaluating Intersection Improvements*, TRB, 2001.
15. NCHRP Synthesis 225 *Left-Turn Treatments at Intersections*.
16. *Official Streets and Highways Plan*, (OSHP) Matanuska Susitna Borough
17. Synchro and SimTraffic, Trafficware.
18. *Traffic Engineering Handbook*, Fourth and Fifth editions, Institute of Transportation Engineers (ITE).

Appendix A - Scoping Meeting Agenda and Minutes



Agenda

Traffic Impact Analysis Scoping Meeting (Meeting Minutes, Actions)

Date: January 7, 2009
Mat-Su Bourough Bldg., Dahlia St.,Palmer: Planning Dept. Conf Room, 2nd Floor

Purpose of meeting: Refinement of the scope of the TIA for the proposed development, discuss project limits, Trip Model parameters and design year.

For: MSB Landfill/Recycling Center/Animal Shelter

Attendees:
Michael Weller, MSB Transportation Planning
Brad Sworts, MSB Transportation Planning
Greg Goodale, MSB Solid Waste
Kent Crafton, MSB Solid Waste
James Rowland, MSB Engineering
Mollie Boyer, Valley Recycling, by phone
Robert Haskell, MSB Chief-Animal Care & Regulation
Karyn Wise; Kinney Engineering
Randy Kinney, Kinney Engineering

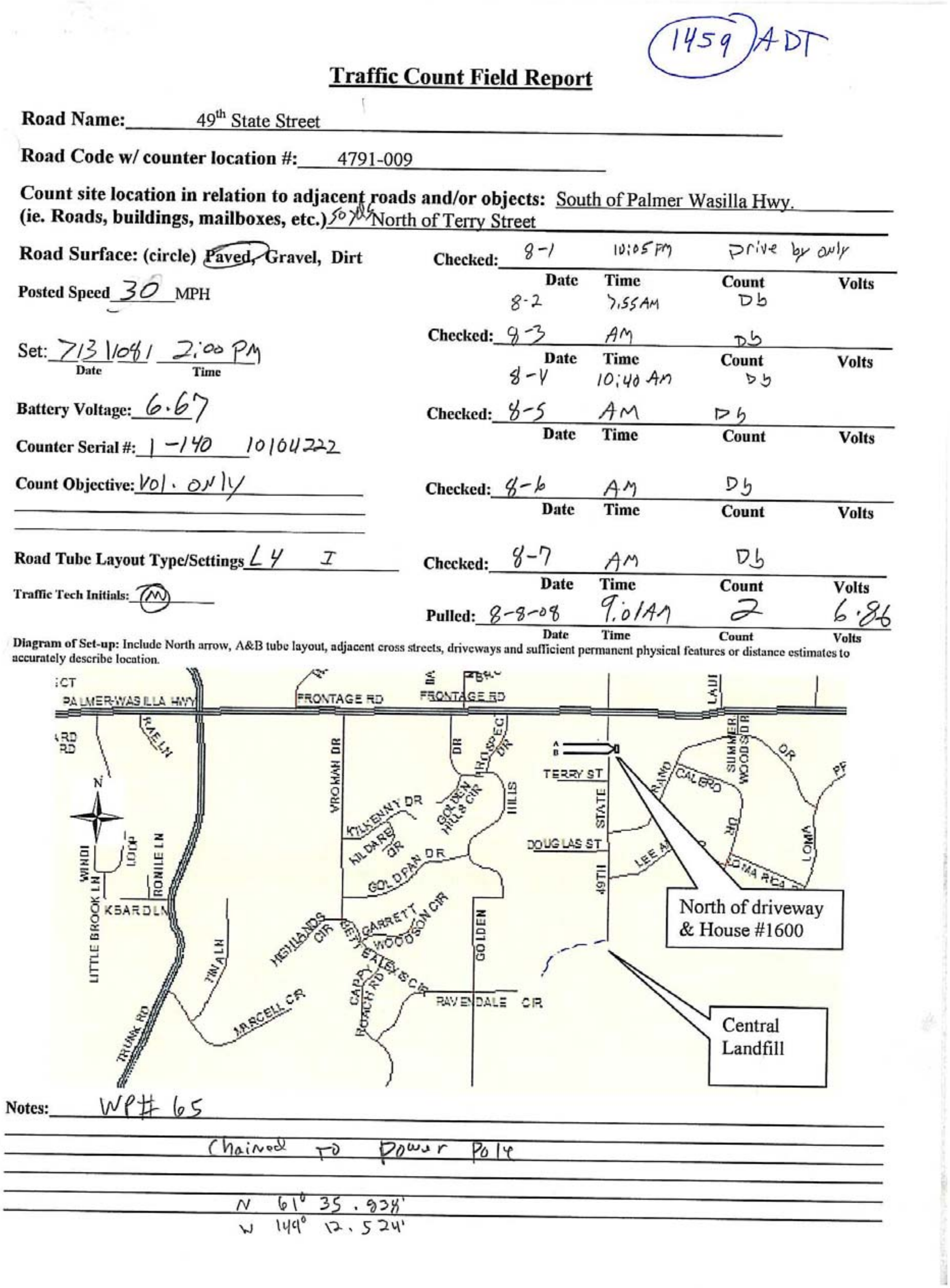
Please bring: Project description (location, size, number and location of driveways), trip generation rates, trip distribution, study area, and any other relevant data

Page 1 of 3

Agenda topics	Proposed:	Resolution:
Study Area - Intersections to be Studied	*TBD at Meeting*	Study intersections should include LeeAnn and 49th State, Douglas and 49th State, in addition to the signalized intersection of 49th State and Palmer Wasilla Highway.
Design Year	*Verify 2019.*	10 years is a reasonable study period.
Trip Generation Rates➔	*Propose to use Trip Gen 7th ed., where possible, observed rates if existing. Potential for trip "capture", or sharing, rate,*	Anecdotal data on volumes and peak hours is very specific, see Existing Data.
Trip Distribution and Assignment➔	*Propose to distribute trips to borough areas similar to modeling procedures. Trips then can be assigned to routes.*	Distribution to reflect current directional distribution on PWH. Current recycling trips will move to 49th State St. Bogard Road Extension will change volumes on North 49th State St., anticipated to go down.
Operational Evaluation	*Use MSB operational performance critieria.*	ADOT performance criteria similar and would be acceptable.
Existing Data - volumes, geometrics, accidents➔	*Propose to collect TMC at intersections where MSB data is unavailable. Collect available data pertaining to project from MSB, ADOT.Radar data collector on 49th St for ADT.*	Solid Waste observes 600 trips per weekend day, 400 on weekday. 17% are commercial trips (to other scale) Animal Shelter gets 50-80 trips/day, with a peak in the AM and another around 5 PM. Recycling gets ~400 trips during four days of service, Hours of service are 9-6 Wed-Fri, 11-3 Saturday. Some history of accidents at intersection of 49th State and PWH,left turing vehicle from side street, andrear end from signal turning red on highway. ADOT willl probably have statistics.
Traffic Growth➔	*Background Traffic; MSB model? Future traffic Growth rate will be developed from ADOT ADT information and MSB model runs.*	Solid Waste expects 6-7% growth matching Mat-Su Valley growth rate. Recycling hopes to increase the types of materials recycled to include glass and plastics after they move to their new location (20% per year).
Other Development to be Included➔	*Consider impact on residential neighborhood*	Already get calls from 1 resident on LeeAnn about number of vehicles on 49th State St.

Agenda topics	**Proposed:**	**Resolution:**
Construction Projects Within Study Area	*Any anticipated construction projects?*	None known.
Circulation Issues	*On-site circulation to be evaluated.*	Main access in future will continue to be along 49th State Rd. Perhaps a connection between new recycling site and landfill would be helpful to reduce traffic along access road to recycling, animal shelter and commercial landfill scales. Queue study needed to determine length of right turn lane into recycling/animal control, and internal queue lengths of residential dumping. Residential dumping may change to a tipping floor system like MOA which would change queueing somewhat.
Other:	*As noted:*	Must be aware of school buses that will occasionally be present in vehicle stream, due to field trips to animal shelter and/or recycling center. Also some chance that road along the section line currently serving as entrance to animal shelter and future recycling may be extended to provide connection to other developments in the future. Trailhead to Crevasse-Morraine trail is accessed along 49th Street and Douglas, or LeeAnn. Trailhead may move in the future further east, and access will change to Loma Prieta, or France, out of project area.
Action Items:	1) Mollie Boyer to provide square footage of new recycling building. (done by e-mail sent 1-7-09; it is 23,000 sf) 2) Robert Haskell to provide square footage of animal shelter (done by e-mail sent 1-8-09 , it is 14,000 sf) 3) Michael Weller to provide traffic data and release form for MSB model use (done by e-mail sent 1-8-09). 4) Greg Goodale to provide time and motion study (pending). He sent (through Mike) the MSB Cell Sequencing Report. 5) Karyn and Randy will obtain crash information; and will contact Eileen Probasco about facilities plan.	

Appendix B - MSB Traffic Count-49th State Street



1459 ADT

Traffic Count Field Report

Road Name: 49th State Street

Road Code w/ counter location #: 4791-009

Count site location in relation to adjacent roads and/or objects: South of Palmer Wasilla Hwy.
(ie. Roads, buildings, mailboxes, etc.) 50 yds North of Terry Street

Road Surface: (circle) [✓ Paved], Gravel, Dirt

Posted Speed 30 MPH

Set: 7/31/08 2:00 PM
Date Time

Battery Voltage: 6.67

Counter Serial #: 1-140 10104222

Count Objective: Vol. only

Road Tube Layout Type/Settings L4 I

Traffic Tech Initials: M

	Date	Time	Count	Volts
Checked:	8-1	10:05 PM	Drive by only	
	8-2	7:55 AM	Db	
Checked:	8-3	AM	Db	
	8-4	10:40 AM	Db	
Checked:	8-5	AM	Db	
Checked:	8-6	AM	Db	
Checked:	8-7	AM	Db	
Pulled:	8-8-08	9:01AM	2	6.86

Diagram of Set-up: Include North arrow, A&B tube layout, adjacent cross streets, driveways and sufficient permanent physical features or distance estimates to accurately describe location.

Notes: WP# 65

Chained to Power Pole

N 61° 35.938'
W 149° 12.524'

Station Name:
Site ID:47)900000
Start Date/Time:01-08-2008 00:00
End Date/Time:31-08-2008 23:59

August 2008	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	Total
Fri 1	9	3	1	6	7	7	37	60	59	84	107	134	149	129	139	131	127	103	62	30	35	27	25	5	1476
Sat 2	8	4	7	1	3	6	8	17	33	114	186	224	219	198	223	213	123	80	42	31	22	27	13	14	1816
Sun 3	9	4	3	0	3	2	5	14	17	49	107	89	125	158	182	177	123	32	37	26	23	29	17	9	1240
Mon 4	8	6	3	0	8	11	31	59	83	65	106	148	158	123	163	118	121	130	48	39	26	17	10	5	1486
Tue 5	5	3	1	4	7	10	23	66	60	78	115	104	136	120	143	154	113	99	65	43	28	28	21	9	1435
Wed 6	6	1	2	7	6	11	23	49	54	48	124	143	109	140	126	121	130	137	53	35	30	23	9	13	1400
Thu 7	4	0	5	0	3	11	18	38	65	94	93	131	134	165	131	100	121	79	55	34	27	25	19	8	1360
Fri 8	7	4	3	0	8	7	19	52	50																150
Sat 9																									
Sun 10																									
Mon 11																									
Tue 12																									
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Thu 28																									
Fri 29																									
Sat 30																									
Sun 31																									
Percentages	0.54%	0.24%	0.24%	0.17%	0.43%	0.63%	1.58%	3.43%	4.06%	5.13%	8.09%	9.39%	9.94%	9.97%	10.68%	9.78%	8.28%	6.37%	3.49%	2.30%	1.84%	1.70%	1.10%	0.61%	100.00%
Hour Totals	56	25	25	18	45	65	164	355	421	532	838	973	1030	1033	1107	1014	858	660	362	238	191	176	114	63	10363

Printed on 08-Aug-08 at 10:57

Monthly Volume

Traffic Count Field Report

(483) ADT ON EXIT ONLY
X 2 = (986)

Road Name: 49th State Street

Road Code w/ counter location #: 4791-010

Count site location in relation to adjacent roads and/or objects: 50 ft South of ~~Palmer Wasilla Hwy.~~ Leann
(ie. Roads, buildings, mailboxes, etc.) 100 yds North of land fil

Road Surface: (circle) [✓ Paved,] Gravel, Dirt

Posted Speed 30 MPH

Set: 7/31/08 / 1:30 PM
Date Time

Battery Voltage: 6.42

Counter Serial #: 1-242 10103425

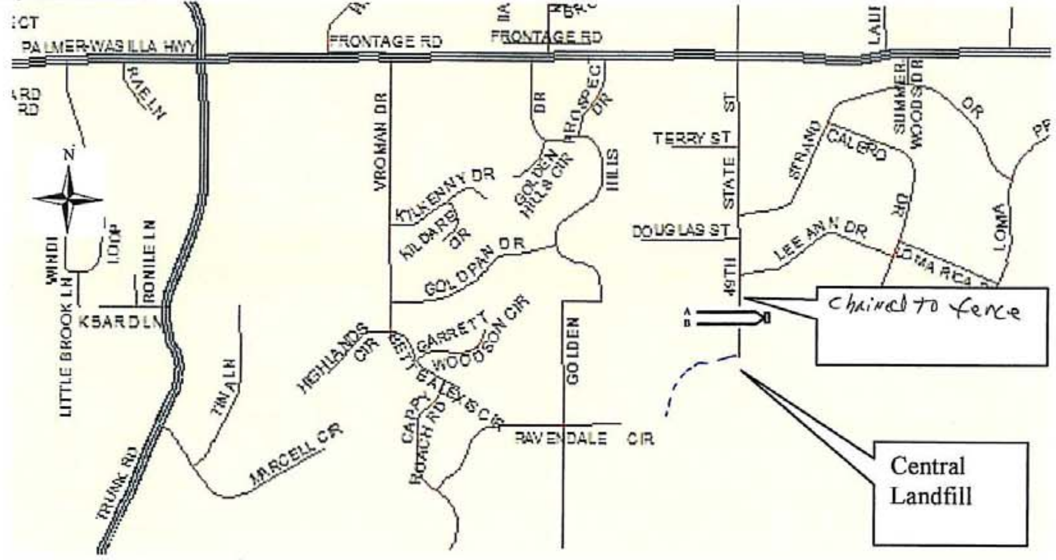
* **Count Objective:** Vol ON EXIT ONLY *

Road Tube Layout Type/Settings L4 I

Traffic Tech Initials: (N)

Checked:	8-1-08	10:00 PM	Drive by only	
	Date	**Time**	**Count**	**Volts**
	8-2-08	7:50 AM	Db	
Checked:	8-3	AM	Db	
	Date	**Time**	**Count**	**Volts**
	8-4	10:43	AM Db	
Checked:	8-5	AM	Db	
	Date	**Time**	**Count**	**Volts**
Checked:	8-6	AM	Db	
	Date	**Time**	**Count**	**Volts**
Checked:	8-7	AM	Db	
	Date	**Time**	**Count**	**Volts**
Pulled:	8-8-08	9:17 AM	15	6.23
	Date	**Time**	**Count**	**Volts**

Diagram of Set-up: Include North arrow, A&B tube layout, adjacent cross streets, driveways and sufficient permanent physical features or distance estimates to accurately describe location.



Chained to fence

Central Landfill

Notes: WP# 67
N 61° 35.569'
W 149° 12.517'

Station Name:
Site ID:4)1000000
Start Date/Time.01-08-2008 00:00
End Date/Time:31-08-2008 23:59

August 2008	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	Total
Fri 1	0	0	0	1	1	0	1	11	23	29	41	60	62	56	63	55	54	28	19	6	0	0	2	1	513
Sat 2	1	1	1	0	0	0	0	2	8	33	75	87	81	82	92	82	56	11	3	4	0	2	1	0	622
Sun 3	2	0	0	0	0	0	0	2	3	15	20	35	53	65	57	79	57	3	3	1	1	1	1	0	398
Mon 4	1	1	1	0	0	3	0	12	25	31	40	65	62	53	65	42	44	50	12	6	2	2	1	2	520
Tue 5	1	0	0	1	0	0	1	20	15	31	46	47	51	43	60	63	47	31	13	9	8	1	0	1	489
Wed 6	0	0	0	2	0	1	0	11	11	13	44	63	36	58	50	45	52	43	12	4	2	2	1	1	451
Thu 7	0	0	1	0	0	1	1	5	18	45	40	51	64	63	48	34	47	25	11	5	0	1	1	0	461
Fri 8	1	1	0	0	0	0	1	11	10																24
Sat 9																									
Sun 10																									
Mon 11																									
Tue 12																									
Wed 13																									
Thu 14																									
Fri 15																									
Sat 16																									
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Sat 23																									
Sun 24																									
Mon 25																									
Tue 26																									
Wed 27																									
Thu 28																									
Fri 29																									
Sat 30																									
Sun 31																									
Percentages	0.17%	0.09%	0.09%	0.12%	0.03%	0.14%	0.12%	2.13%	3.25%	5.66%	8.80%	11.73%	11.76%	12.08%	12.51%	11.50%	10.26%	5.49%	2.10%	1.01%	0.37%	0.26%	0.20%	0.14%	100.00%
Hour Totals	6	3	3	4	1	5	4	74	113	197	306	408	409	420	435	400	357	191	73	35	13	9	7	5	3478

Printed on 08-Aug-08 at 10:58 Monthly Volume Page 1 of 1

(213) ADT

Traffic Count Field Report

Road Name: Chanlyut Circle

Road Code w/ counter location #: 6210-002

Count site location in relation to adjacent roads and/or objects: South of Palmer Wasilla Hwy.
(ie. Roads, buildings, mailboxes, etc.) **road to animal care**

Road Surface: (circle) [✓ **Paved**] **Gravel, Dirt**

Posted Speed 25 MPH

Set: 7/31/08/ 12:55PM
Date Time

Battery Voltage: 6.61

Counter Serial #: 1-264 10118596

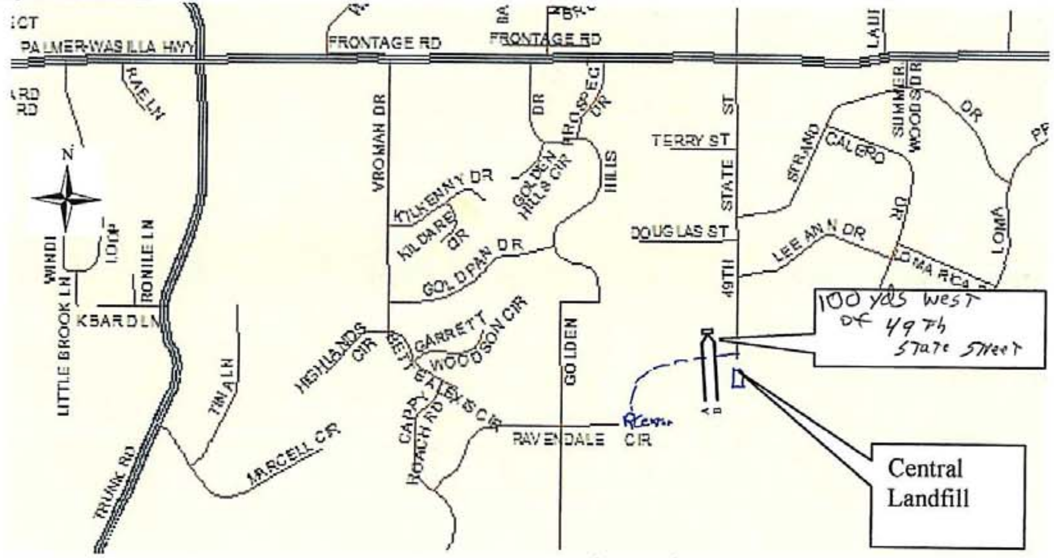
Count Objective: Vol. only

Road Tube Layout Type/Settings L4 I

Traffic Tech Initials: (N)

Checked:	8-1	10:10 PM	Drive by only	
	Date	**Time**	**Count**	**Volts**
	8-2	8:00AM	Db	
Checked:	8-3	AM	Db	
	Date	**Time**	**Count**	**Volts**
	8-4	8:48AM	DD	
Checked:	8-5	AM	Db	
	Date	**Time**	**Count**	**Volts**
	8-6	AM	Db	
Checked:	8-7	AM	Db	
	Date	**Time**	**Count**	**Volts**
Checked:				
	Date	**Time**	**Count**	**Volts**
Pulled:	8-8-08	9:10AM	9	6.61
	Date	**Time**	**Count**	**Volts**

Diagram of Set-up: Include North arrow, A&B tube layout, adjacent cross streets, driveways and sufficient permanent physical features or distance estimates to accurately describe location.



Notes: WP# 66

N 61° 35.527'
W 149' 12.653'

Station Name:
Site ID:6)0200000
Start Date/Time:01-08-2008 00:00
End Date/Time:31-08-2008 23:59

August 2008	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	Total
Fri 1	0	0	0	0	3	2	19	38	26	14	17	13	15	17	22	32	38	19	14	9	0	0	2	1	301
Sat 2	2	0	0	0	0	0	2	6	7	0	16	25	22	20	34	24	18	11	9	5	0	3	0	0	204
Sun 3	0	0	0	0	0	0	0	5	1	0	3	8	3	13	11	5	13	2	4	1	1	0	0	0	70
Mon 4	2	0	0	0	0	8	10	10	18	24	19	25	27	15	23	12	24	23	8	9	2	1	0	3	263
Tue 5	0	0	0	0	0	1	5	13	3	15	34	27	31	20	9	32	14	26	19	11	14	1	0	0	275
Wed 6	0	0	0	0	0	2	1	11	2	6	6	24	13	22	27	21	25	9	3	3	3	2	1	0	181
Thu 7	0	0	0	0	0	4	2	6	15	8	28	13	13	22	17	16	22	11	16	6	0	0	0	0	199
Fri 8	0	0	0	0	0	0	5	18	2																25
Sat 9																									
Sun 10																									
Mon 11																									
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Mon 25																									
Tue 26																									
Wed 27																									
Thu 28																									
Fri 29																									
Sat 30																									
Sun 31																									
Percentages	0.26%	0.00%	0.00%	0.00%	0.20%	1.12%	2.90%	7.05%	4.87%	4.41%	8.10%	8.89%	8.17%	8.50%	9.42%	9.35%	10.14%	6.65%	4.81%	2.90%	1.32%	0.46%	0.20%	0.26%	100.00%
Hour Totals	4	0	0	0	3	17	44	107	74	67	123	135	124	129	143	142	154	101	73	44	20	7	3	4	1518

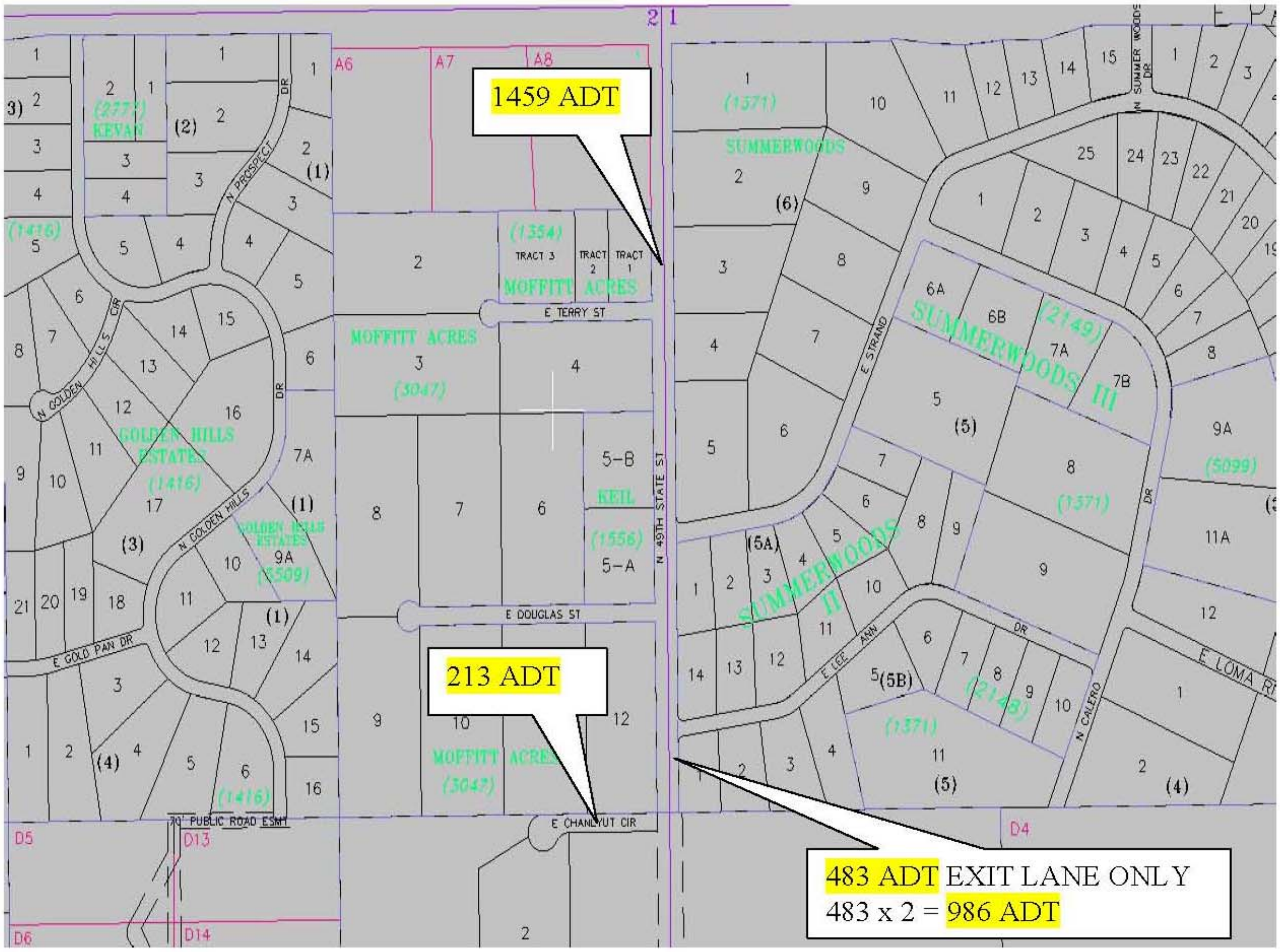
Traffic Data for MSB Landfill Area

Data collected 8/1-8/8 2008

ADT = Average daily traffic

Not adjusted for seasonal variances

mw

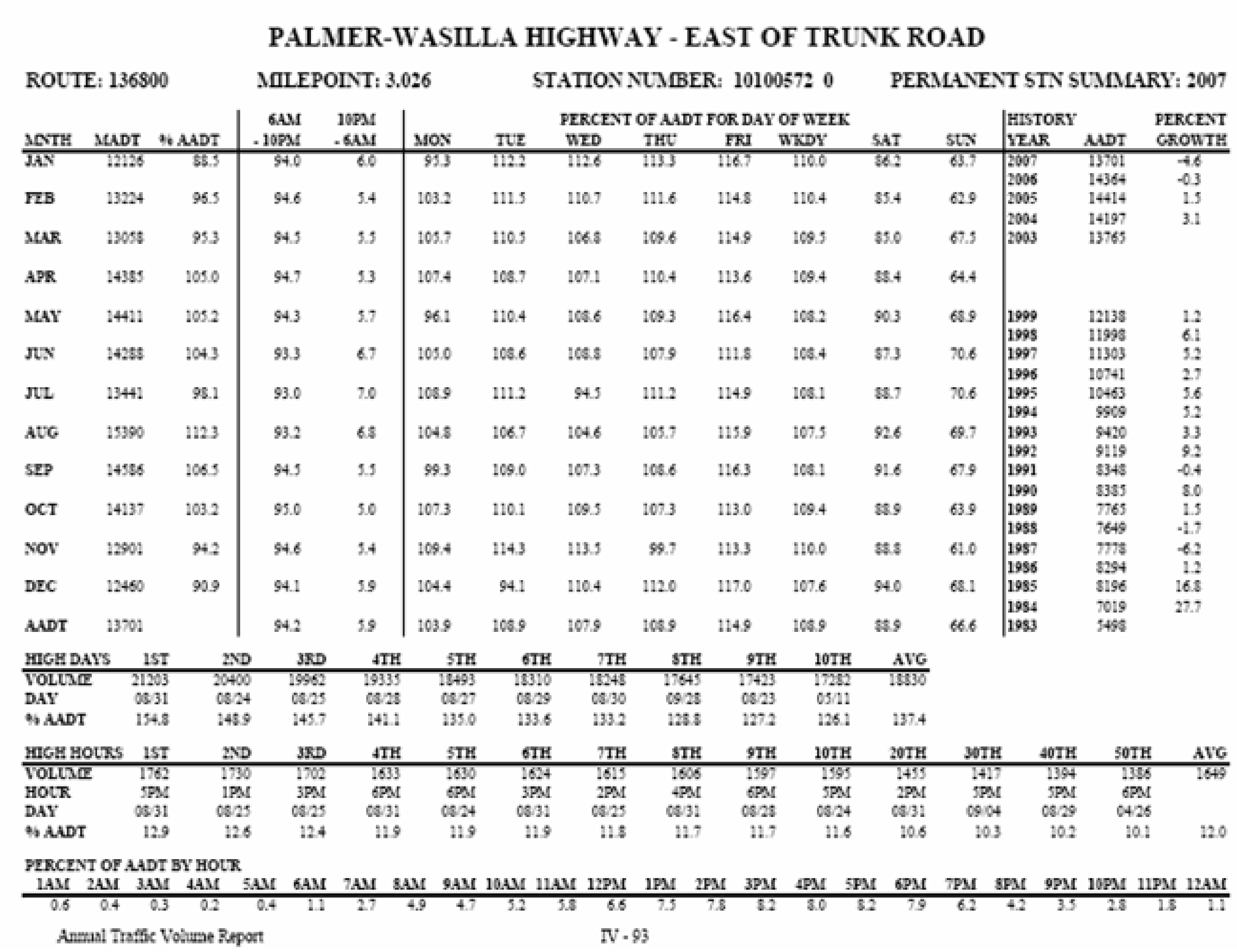


1459 ADT

213 ADT

483 ADT EXIT LANE ONLY
483 x 2 = 986 ADT

Appendix C - DOT/PF Palmer Wasilla Highway PTR Information



PALMER-WASILLA HIGHWAY - EAST OF TRUNK ROAD

ROUTE: 136800 MILEPOINT: 3.026 STATION NUMBER: 10100572 0 PERMANENT STN SUMMARY: 2007

MNTH	MADT	% AADT	6AM - 10PM	10PM - 6AM	MON	TUE	WED	THU	FRI	WKDY	SAT	SUN
					PERCENT OF AADT FOR DAY OF WEEK							
JAN	12126	88.5	94.0	6.0	95.3	112.2	112.6	113.3	116.7	110.0	86.2	63.7
FEB	13224	96.5	94.6	5.4	103.2	111.5	110.7	111.6	114.8	110.4	85.4	62.9
MAR	13058	95.3	94.5	5.5	105.7	110.5	106.8	109.6	114.9	109.5	85.0	67.5
APR	14385	105.0	94.7	5.3	107.4	108.7	107.1	110.4	113.6	109.4	88.4	64.4
MAY	14411	105.2	94.3	5.7	96.1	110.4	108.6	109.3	116.4	108.2	90.3	68.9
JUN	14288	104.3	93.3	6.7	105.0	108.6	108.8	107.9	111.8	108.4	87.3	70.6
JUL	13441	98.1	93.0	7.0	108.9	111.2	94.5	111.2	114.9	108.1	88.7	70.6
AUG	15390	112.3	93.2	6.8	104.8	106.7	104.6	105.7	115.9	107.5	92.6	69.7
SEP	14586	106.5	94.5	5.5	99.3	109.0	107.3	108.6	116.3	108.1	91.6	67.9
OCT	14137	103.2	95.0	5.0	107.3	110.1	109.5	107.3	113.0	109.4	88.9	63.9
NOV	12901	94.2	94.6	5.4	109.4	114.3	113.5	99.7	113.3	110.0	88.8	61.0
DEC	12460	90.9	94.1	5.9	104.4	94.1	110.4	112.0	117.0	107.6	94.0	68.1
AADT	13701		94.2	5.9	103.9	108.9	107.9	108.9	114.9	108.9	88.9	66.6

HISTORY YEAR	AADT	PERCENT GROWTH
2007	13701	-4.6
2006	14364	-0.3
2005	14414	1.5
2004	14197	3.1
2003	13765	
1999	12138	1.2
1998	11998	6.1
1997	11303	5.2
1996	10741	2.7
1995	10463	5.6
1994	9909	5.2
1993	9420	3.3
1992	9119	9.2
1991	8348	-0.4
1990	8383	8.0
1989	7765	1.5
1988	7649	-1.7
1987	7778	-6.2
1986	8294	1.2
1985	8196	16.8
1984	7019	27.7
1983	5498	

HIGH DAYS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH	9TH	10TH	AVG
VOLUME	21203	20400	19962	19335	18493	18310	18248	17645	17423	17282	18830
DAY	08/31	08/24	08/25	08/28	08/27	08/29	08/30	09/28	08/23	05/11	
% AADT	154.8	148.9	145.7	141.1	135.0	133.6	133.2	128.8	127.2	126.1	137.4

HIGH HOURS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH	9TH	10TH	20TH	30TH	40TH	50TH	AVG
VOLUME	1762	1730	1702	1633	1630	1624	1615	1606	1597	1595	1455	1417	1394	1386	1649
HOUR	5PM	1PM	3PM	6PM	6PM	3PM	2PM	4PM	6PM	5PM	2PM	5PM	5PM	6PM	
DAY	08/31	08/25	08/25	08/31	08/24	08/31	08/25	08/31	08/28	08/24	08/31	09/04	08/29	04/26	
% AADT	12.9	12.6	12.4	11.9	11.9	11.9	11.8	11.7	11.7	11.6	10.6	10.3	10.2	10.1	12.0

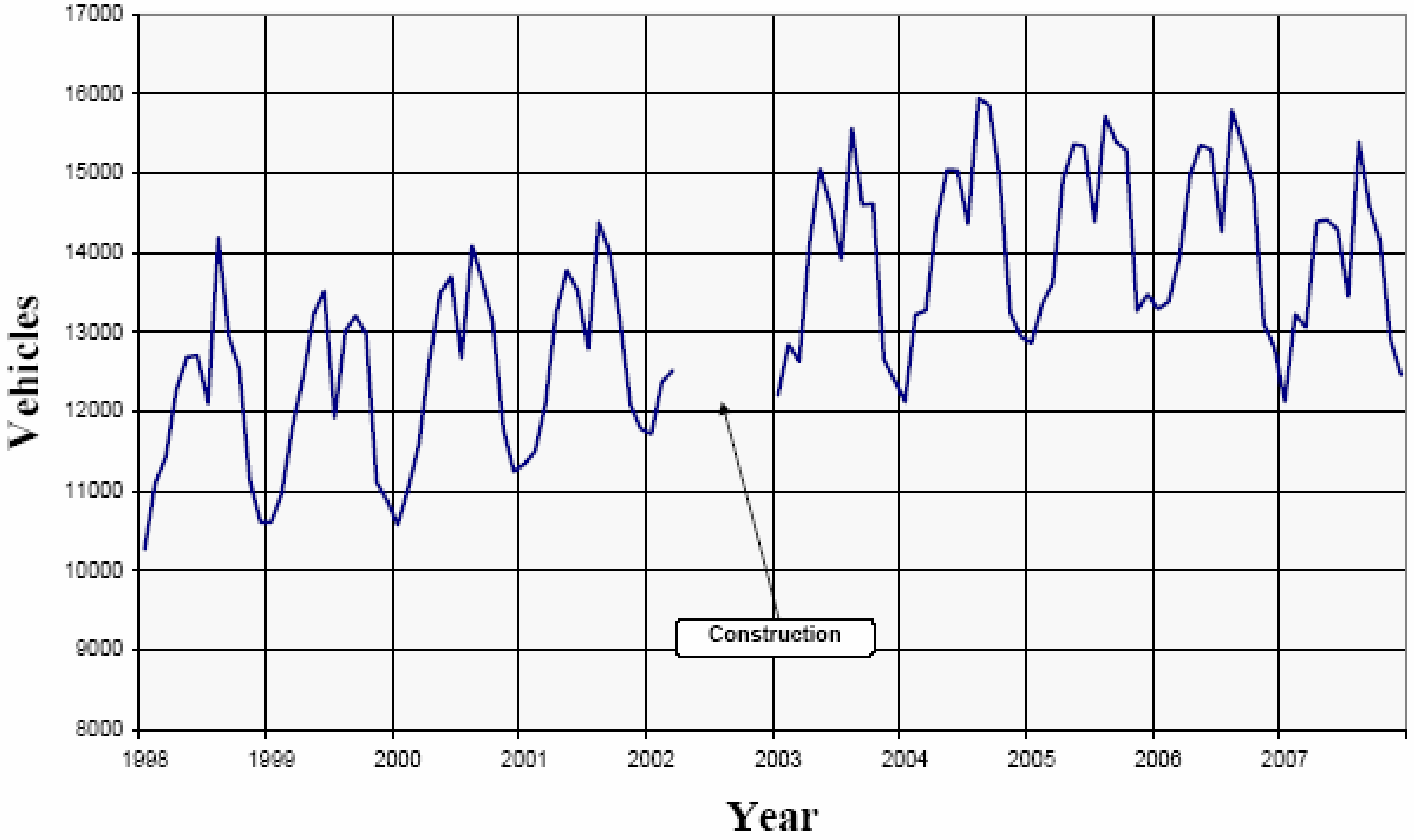
PERCENT OF AADT BY HOUR

1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM
0.6	0.4	0.3	0.2	0.4	1.1	2.7	4.9	4.7	5.2	5.8	6.6	7.5	7.8	8.2	8.0	8.2	7.9	6.2	4.2	3.5	2.8	1.8	1.1

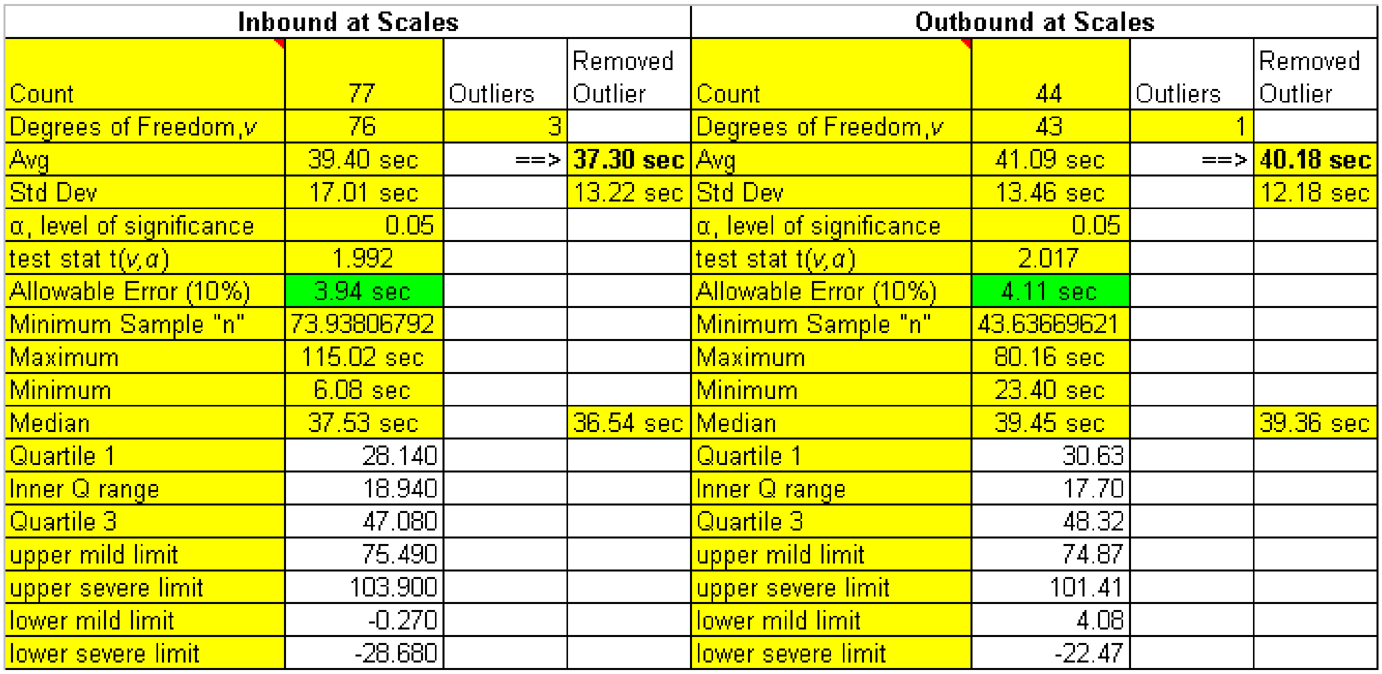
Annual Traffic Volume Report IV - 93

Palmer-Wasilla Highway – East of Trunk Road

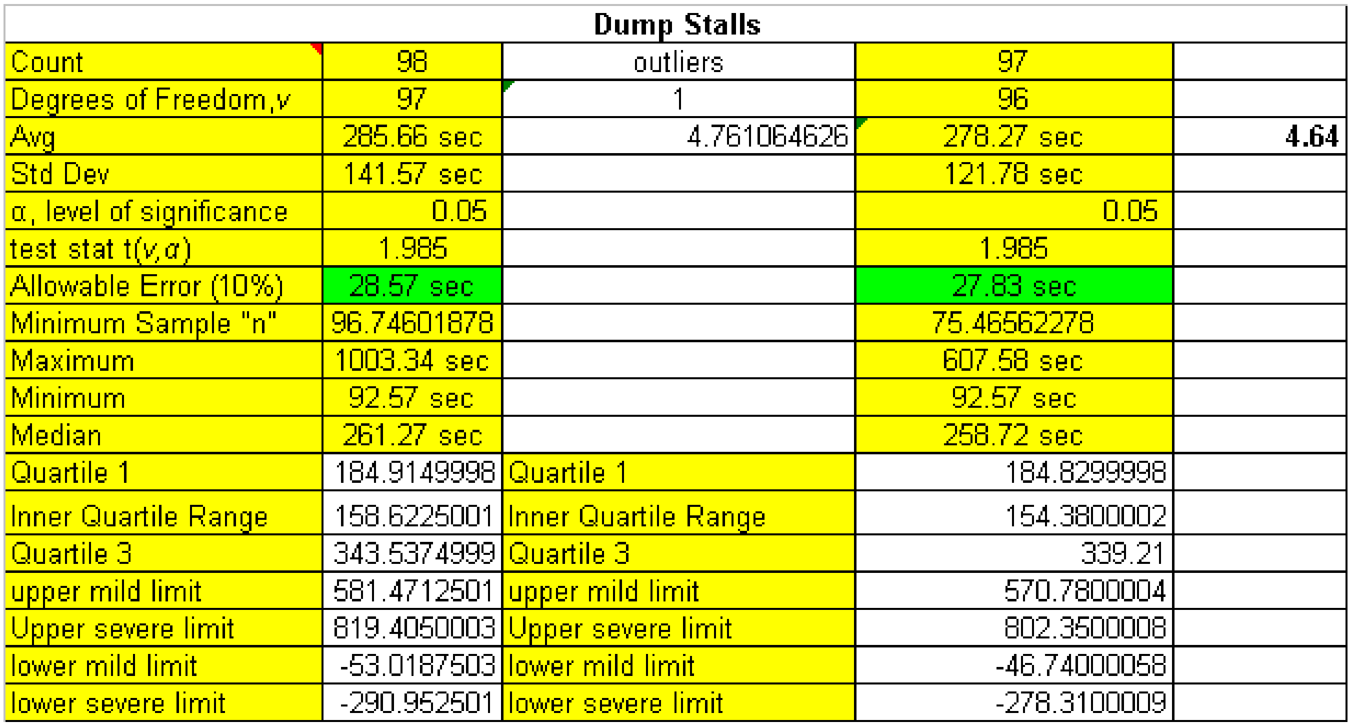
Monthly Average Daily Traffic



Appendix D - Service Times



Inbound at Scales				Outbound at Scales			
Count	77	Outliers	Removed Outlier	Count	44	Outliers	Removed Outlier
Degrees of Freedom,v	76	3		Degrees of Freedom,v	43	1	
Avg	39.40 sec	==>	**37.30 sec**	Avg	41.09 sec	==>	**40.18 sec**
Std Dev	17.01 sec		13.22 sec	Std Dev	13.46 sec		12.18 sec
α, level of significance	0.05			α, level of significance	0.05		
test stat $t(v,\alpha)$	1.992			test stat $t(v,\alpha)$	2.017		
Allowable Error (10%)	3.94 sec			Allowable Error (10%)	4.11 sec		
Minimum Sample "n"	73.93806792			Minimum Sample "n"	43.63669621		
Maximum	115.02 sec			Maximum	80.16 sec		
Minimum	6.08 sec			Minimum	23.40 sec		
Median	37.53 sec		36.54 sec	Median	39.45 sec		39.36 sec
Quartile 1	28.140			Quartile 1	30.63		
Inner Q range	18.940			Inner Q range	17.70		
Quartile 3	47.080			Quartile 3	48.32		
upper mild limit	75.490			upper mild limit	74.87		
upper severe limit	103.900			upper severe limit	101.41		
lower mild limit	-0.270			lower mild limit	4.08		
lower severe limit	-28.680			lower severe limit	-22.47		



Dump Stalls				
Count	98	outliers	97	
Degrees of Freedom,v	97	1	96	
Avg	285.66 sec	4.761064626	278.27 sec	**4.64**
Std Dev	141.57 sec		121.78 sec	
α, level of significance	0.05		0.05	
test stat $t(v,\alpha)$	1.985		1.985	
Allowable Error (10%)	28.57 sec		27.83 sec	
Minimum Sample "n"	96.74601878		75.46562278	
Maximum	1003.34 sec		607.58 sec	
Minimum	92.57 sec		92.57 sec	
Median	261.27 sec		258.72 sec	
Quartile 1	184.9149998	Quartile 1	184.8299998	
Inner Quartile Range	158.6225001	Inner Quartile Range	154.3800002	
Quartile 3	343.5374999	Quartile 3	339.21	
upper mild limit	581.4712501	upper mild limit	570.7800004	
Upper severe limit	819.4050003	Upper severe limit	802.3500008	
lower mild limit	-53.0187503	lower mild limit	-46.74000058	
lower severe limit	-290.952501	lower severe limit	-278.3100009	

Appendix E - Capacity Analysis and Level of Service

Freeways

Freeways use density in passenger cars per mile per lane. Levels of services are defined as follows by HCM2000.

- LOS A: ≤11 passenger cars/mile/lane
- LOS B: >11 - 18 passenger cars/mile/lane
- LOS C: >18 - 26 passenger cars/mile/lane
- LOS D: >26 - 35 passenger cars/mile/lane
- LOS E: >35-45 passenger cars/mile/lane
- LOS F: >45 passenger cars/mile/lane

For merge and diverge ramp terminal areas, the following LOS criteria from HCM 2000, Exhibit 25-4 applies:

- LOS A: ≤10 passenger cars/mile/lane
- LOS B: >10 - 20 passenger cars/mile/lane
- LOS C: >20 - 28 passenger cars/mile/lane
- LOS D: >28 - 35 passenger cars/mile/lane
- LOS E: >35 passenger cars/mile/lane
- LOS F: Demand exceeds capacity

Two-Lane Highways

The methods for this analysis are found in Chapters 12 and 20 in the HCM2000. HCM provides two levels of service (LOS) descriptions for two lane highways according to its class. Class I highways are higher speed, higher mobility two-lane highways, suitable for longer trips. Class II highways are lower speed and oriented towards access and shorter trips.

Class I uses two performance measures for level of service, percent time spent following (PTSF) and average travel speed (ATS) (mph). The following level of service (LOS) table is reproduced from Exhibit 20-2 of HCM2000. The operational level of service for a two-lane highway would be the least LOS rating of either the PTSF and ATS ratings.

LOS	**Percent Time Spent Following**	**Average Travel Speed (mph_**
A	≤ 35	>55
B	>35-50	>50-55
C	>50-56	>45-50
D	>65-80	>40-45
E	>80	≤40

Two-Lane Class I Highway LOS

The LOS for two-lane, Class II highways uses PTSF for LOS ratings. LOS for Class II highways is as follows:

LOS A: ≤40 Percent Time Following

LOS B: >40 and ≤55 Percent Time Following

LOS C: >55 and ≤70 Percent Time Following

LOS D: >70 and ≤55 Percent Time Following

LOS E: >85 Percent Time Following

Signalized Intersections

The following narrative from Chapter 9 of the 1997 HCM defines LOS for signalized intersections. (Note that these definitions have not changed with the 2000 edition of HCM)

- LOS A describes operations with very low control delay, up to 10 seconds per vehicle. This level of service occurs when progression is extremely favorable and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.

- LOS B describes operations with control delay greater than 10 and up to 20 seconds per vehicle. This level generally occurs with good progression, short cycle lengths, or both. More vehicles stop than with LOS A, causing higher levels of average delay.

- LOS C describes operations with control delay greater than 20 and up to 35 seconds per vehicle. These higher delays may result from fair progression, longer cycle lengths, or both. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant at this level, though many still pass through the intersection without stopping.

- LOS D describes operations with control delay greater than 35 and up to 55 seconds per vehicle. At level D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high v/c ratios. Many vehicles stop and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

- LOS E describes operations with control delay greater than 55 and up to 80 seconds per vehicle. This level is considered by many agencies to be the limit of acceptable delay. These high delay values generally indicate poor progression, long cycle lengths, and high v/c ratios. Individual cycle failures are frequent occurrences.

- LOS F describes operations with control delay in excess of 80 seconds per vehicle. This level, considered unacceptable to most drivers, often occurs with over saturation, that is, when arrival flow rates exceed the capacity of the intersection. It may also occur at high v/c ratios below 1.0 with many individual cycle failures. Poor progression and long cycle lengths may also be major contributing factors to such delay.

Unsignalized Intersections

Intersection capacity analysis was performed in accordance with the procedures outlined in Transportation Research Board Highway Capacity Manual 2000 (HCM) for interrupted flow facilities, using Highway Capacity Software 2000 by McTrans.

The operational performance measures used for this intersection analysis are levels of service, control delay (seconds delay per vehicle), and volume to capacity ratio, v/c. A common limit for v/c values is 0.85, or 85% of capacity. This upper value represents good design practice, in that there is some reserve capacity to absorb surges in volumes or flow turbulence.

The methodology for unsignalized intersections only computes LOS for the minor movements of the intersection, which include the minor street approaches under sign control, or major movements that must yield to oncoming traffic, such as left-turning traffic. Unsignalized LOS is defined as follows (HCM Exhibit 17-2):

- LOS A: ≤10 seconds of control delay per vehicle
- LOS B: >10 and ≤15 seconds of control delay per vehicle
- LOS C: >15 and ≤25 seconds of control delay per vehicle
- LOS D: >25 and ≤35 seconds of control delay per vehicle
- LOS E: >35 and ≤50 seconds of control delay per vehicle
- LOS F: >50 seconds of control delay per vehicle

Pedestrian Crossing Performance Measures

The minimum gap time for crossing uncontrolled streets is computed with the following formula (from ITE's *A Program for School Crossing* and HCM 2000 Chapter 18, Equation 18-17 and 18-20):

$$t_G = \frac{L}{S_P} + t_s + 2(N-1)$$

Where:

t_G= critical gap for single pedestrian crossing (seconds)

L= width of crossing (feet)

S_P= walking speed (fps), assumed to b 3.5 fps (from ITE)

t_s= startup time (sec), 3 seconds (from ITE)

N= spatial distribution of pedestrians (rows), N=1, up to 5 children in one crossing.

Percent pedestrian delay, $D_{\%}$, is directly computed from a pedestrian gap study as:

$$D_{\%} = \frac{Time_{Total} - \sum (Gaps \geq t_G)}{Time_{Total}}$$

Where:

$Time_{Total}$= total observation time (seconds)

$\sum Gaps \geq t_G$= sum of individual gap recordings that are equal to or greater than the critical gap crossing (seconds)

The following figure is from *A Program for School Crossing Protection*, Institute of Transportation Engineers (ITE), 1971, which indicates when control (schools) may be needed.

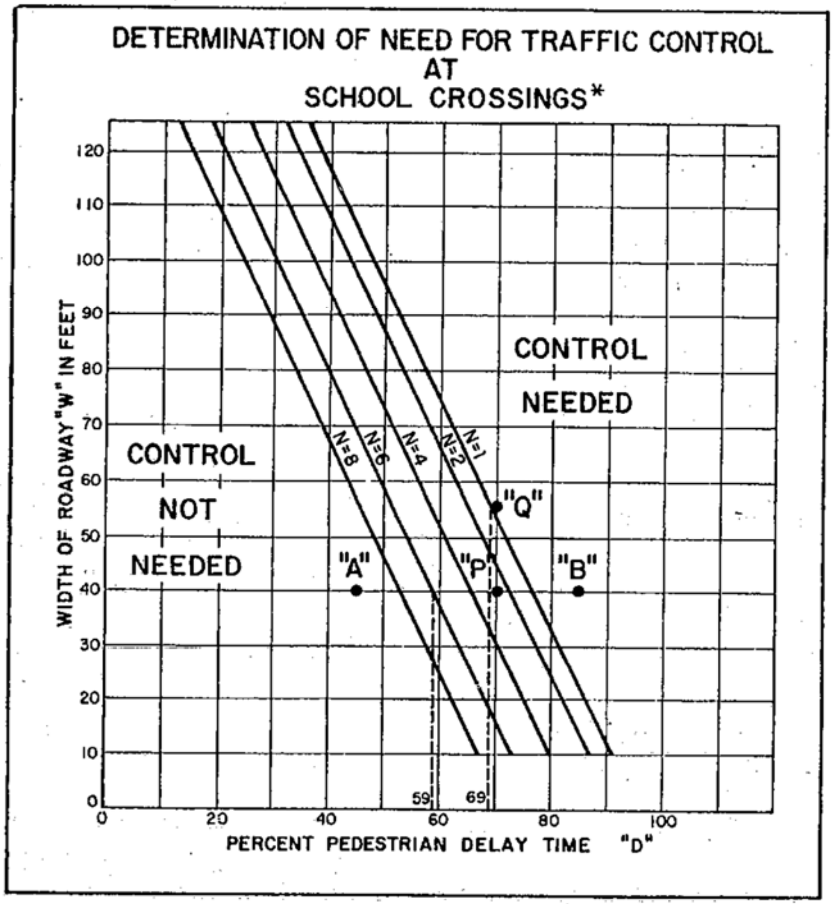


Exhibit No. 2

*See Appendix B, "Analysis of School Crossings at Signalized Intersections", for equation of the family of lines and for the assumption upon which they are plotted.

Exhibit No. 2 From ITE "A Program for School Crossing Protection"

The MUTCD Warrant 5, School Crossing establishes that a signal should be considered where available safe crossing gaps are less than 1 gap per minute on the average, and 20 or more children use the crossing. MUTCD suggests other remedial measures be considered such as signage and flashing beacons, reduced speed zones, crossing guards, and grade separated crossings. Also, ITE's *School Trip Safety Program Guidelines* indicates that there should be at least one gap per minute

Number of adequate crossing gaps per minute, A_{gap} is computed as:

$$A_{gap} = \frac{\sum (Gaps \ge t_G)}{t_G} x \frac{60}{Time_{Total}}$$

If a pedestrian gap study is not available, or if delay and adequate crossing are to be established for future traffic flows, then this information can be computed upon the basis that gaps generally are well modeled with a negative exponential distribution.

For a negative exponential distribution, the probability that a gap exceeds any value “t” is calculated as:

$$P(h \geq t_G) = e^{-vt_G}$$

Where:

t is the critical time, seconds

h is any gap, seconds

v is the vehicular flow rate, vehicles per second (volume in an hour divided by 3,600 seconds). The value v is also the gap flow rate (1 vehicle ≈ 1 gap).

The estimated frequency of gaps in any time bin, h, would be the product of the probability of h by the Volume, V, or:

$$N_h = P(h) \times V$$

And if:

$$P(h) = P(t_{h-i}) - P(t_{h+i})$$

Then:

$$P(h) = e^{-vt_{h-i}} - e^{-vt_{h+i}}$$

Where:

v is the forecasted vehicular and gap flow rate, vehicles (gaps) per second,

t_{h+1}, t_{h-1} are the time bins immediately adjacent to the bin of interest, h.

The following presents the pedestrian unsignalized crossing delay equation from HCM2000. HCM2000 based this equation on pedestrian delay equations in Gerlough & Huber 1975 Special Report 165 *Traffic Flow Theory A Monograph*.

$$d_p = \frac{1}{v}\left(e^{vt_G} - vt_G - 1\right)$$

Where:

d_P= average pedestrian delay (seconds)

v= vehicular flow rate (vehicles per second)

Gerlough and Huber's derivation for Equation 3 assumes that traffic gaps are in a random traffic flow state, and gaps distributions are represented well by the negative exponential distribution.

HCM Exhibit 18-13 provides pedestrian unsignalized crossing LOS based on delay. This is summarized the following table.

LOS	**Average Delay per Pedestrian**	**HCM2000 Comments on Risk**
A	<5 seconds	Low likelihood of accepting gaps that are less than t_G
B	≥5 and ≤10 seconds	-
C	>10 and ≤20 seconds	Moderate likelihood of accepting gaps that are less than t_G
D	>20 and ≤30 seconds	-
E	>30 and ≤45 seconds	High likelihood of accepting gaps that are less than t_G
F	>45 seconds	Very high likelihood of accepting gaps that are less than t_G

Pedestrian LOS

Urban Streets, Generalized Planning Level Analysis

The Florida DOT Quality/Level of Service Manual provides planning level LOS for various facilities. This is most appropriate for corridor planning, and also for facilities that are not well analyzed in HCM2000.

The following figure is an excerpt from that manual describing LOS methods for urban facilities.

TABLE 4 – 1

GENERALIZED ANNUAL AVERAGE DAILY VOLUMES FOR FLORIDA'S URBANIZED AREAS*

UNINTERRUPTED FLOW HIGHWAYS

Lanes	Divided	A	B	C	D	E
		Level of Service				
2	Undivided	2,200	7,600	15,000	21,300	27,100
4	Divided	20,400	33,000	47,800	61,800	70,200
6	Divided	30,500	49,500	71,600	92,700	105,400

STATE TWO-WAY ARTERIALS

Class I (>0.00 to 1.99 signalized intersections per mile)

Lanes	Divided	A	B	C	D	E
		Level of Service				
2	Undivided	**	4,200	13,800	16,400	16,900
4	Divided	4,800	29,300	34,700	35,700	***
6	Divided	7,300	44,700	52,100	53,500	***
8	Divided	9,400	58,000	66,100	67,800	***

Class II (2.00 to 4.50 signalized intersections per mile)

Lanes	Divided	A	B	C	D	E
		Level of Service				
2	Undivided	**	1,900	11,200	15,400	16,300
4	Divided	**	4,100	26,000	32,700	34,500
6	Divided	**	6,500	40,300	49,200	51,800
8	Divided	**	8,500	53,300	63,800	67,000

Class III (more than 4.5 signalized intersections per mile and not within primary city central business district of an urbanized area over 750,000)

Lanes	Divided	A	B	C	D	E
		Level of Service				
2	Undivided	**	**	5,300	12,600	15,500
4	Divided	**	**	12,400	28,900	32,800
6	Divided	**	**	19,500	44,700	49,300
8	Divided	**	**	25,800	58,700	63,800

Class IV (more than 4.5 signalized intersections per mile and within primary city central business district of an urbanized area over 750,000)

Lanes	Divided	A	B	C	D	E
		Level of Service				
2	Undivided	**	**	5,200	13,700	15,000
4	Divided	**	**	12,300	30,300	31,700
6	Divided	**	**	19,100	45,800	47,600
8	Divided	**	**	25,900	59,900	62,200

NON-STATE ROADWAYS

Major City/County Roadways

Lanes	Divided	A	B	C	D	E
		Level of Service				
2	Undivided	**	**	9,100	14,600	15,600
4	Divided	**	**	21,400	31,100	32,900
6	Divided	**	**	33,400	46,800	49,300

Other Signalized Roadways
(signalized intersection analysis)

Lanes	Divided	A	B	C	D	E
		Level of Service				
2	Undivided	**	**	4,800	10,000	12,600
4	Divided	**	**	11,100	21,700	25,200

Source: Florida Department of Transportation 05/17/07
Systems Planning Office
605 Suwannee Street, MS 19
Tallahassee, FL 32399-0450
http://www.dot.state.fl.us/planning/systems/sm/los/default.htm

FREEWAYS

Interchange spacing ≥ 2 mi. apart

Lanes	A	B	C	D	E
	Level of Service				
4	23,800	39,600	55,200	67,100	74,600
6	36,900	61,100	85,300	103,600	115,300
8	49,900	82,700	115,300	140,200	156,000
10	63,000	104,200	145,500	176,900	196,400
12	75,900	125,800	175,500	213,500	237,100

Interchange spacing < 2 mi. apart

Lanes	A	B	C	D	E
	Level of Service				
4	22,000	36,000	52,000	67,200	76,500
6	34,800	56,500	81,700	105,800	120,200
8	47,500	77,000	111,400	144,300	163,900
10	60,200	97,500	141,200	182,600	207,600
12	72,900	118,100	170,900	221,100	251,200

BICYCLE MODE

(**Note**: Level of service for the bicycle mode in this table is based on roadway geometrics at 40 mph posted speed and traffic conditions, not number of bicyclists using the facility.) (Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Paved Shoulder/ Bicycle Lane Coverage	A	B	C	D	E
	Level of Service				
0-49%	**	**	3,200	13,800	>13,800
50-84%	**	2,500	4,100	>4,100	***
85-100%	3,100	7,200	>7,200	***	***

PEDESTRIAN MODE

(**Note:** Level of service for the pedestrian mode in this table is based on roadway geometrics at 40 mph posted speed and traffic conditions, not number of pedestrians using the facility.) (Multiply motorized vehicle volumes shown below by number of directional roadway lanes to determine two-way maximum service volumes.)

Sidewalk Coverage	A	B	C	D	E
	Level of Service				
0-49%	**	**	**	6,400	15,500
50-84%	**	**	**	9,900	19,000
85-100%	**	2,200	11,300	>11,300	***

BUS MODE (Scheduled Fixed Route)

Level of Service (Buses per hour)

(**Note:** Buses per hour shown are only for the **peak hour** in the **single direction** of the higher traffic flow.)

Sidewalk Coverage	A	B	C	D	E
	Level of Service				
0-84%	**	>5	≥4	≥3	≥2
85-100%	>6	>4	≥3	≥2	≥1

ARTERIAL/NON-STATE ROADWAY ADJUSTMENTS

(alter corresponding volume by the indicated percent)

Lanes	Median	Left Turn Lanes	Adjustment Factors
2	Divided	Yes	+5%
2	Undivided	No	-20%
Multi	Undivided	Yes	-5%
Multi	Undivided	No	-25%

ONE-WAY FACILITIES

Multiply the corresponding two-directional volumes in this table by 0.6.

---

* Values shown are presented as two-way annual average daily volumes for levels of service and are for the automobile/truck modes unless specifically stated. Although presented as daily volumes, they actually represent peak hour direction conditions with applicable K and D factors applied. This table does not constitute a standard and should be used only for general planning applications. The computer models from which this table is derived should be used for more specific planning applications. The table and deriving computer models should not be used for corridor or intersection design, where more refined techniques exist. Level of service letter grade thresholds are probably not comparable across modes and, therefore, cross modal comparisons should be made with caution. Furthermore, combining levels of service of different modes into one overall roadway level of service is not recommended. Calculations are based on planning applications of the Highway Capacity Manual, Bicycle LOS Model, Pedestrian LOS Model and Transit Capacity and Quality of Service Manual, respectively for the automobile/truck, bicycle, pedestrian and bus modes.

**Cannot be achieved using table input value defaults.

***Not applicable for that level of service letter grade. For automobile/truck modes, volumes greater than level of service D become F because intersection capacities have been reached. For bicycle and pedestrian modes, the level of service letter grade (including F) is not achievable, because there is no maximum vehicle volume threshold using table input value defaults.

Planning LOS

Appendix F - Equations for M/M/C Queuing Analyses

M/M/1, ρ<1

$$\overline{Q} = \frac{\rho^2}{1-\rho}$$

Average queue length

$$\overline{w} = \frac{\lambda}{\mu(\mu-\lambda)}$$

Average wait time in queue

$$\bar{t} = \frac{1}{\mu-\lambda}$$

Average time in system

$$where:$$

$$\lambda \Longrightarrow arrival(veh/\sec)$$

$$\mu \Longrightarrow service(veh/\sec)$$

$$\rho = \frac{\lambda}{\mu} \Rightarrow \rho \le 1$$

M/M/N, ρ/N<1

$$P_0 = \frac{1}{\sum_{n_c=0}^{N-1} \frac{\rho^{n_c}}{n_c!} + \frac{\rho^N}{N!\left(1-\frac{\rho}{N}\right)}}$$

Probability of 0 units in system, n_c is channel

$$P_n = \frac{\rho^n P_0}{n!} \Rightarrow n \le N$$

$$P_n = \frac{\rho^n P_0}{N^{n-N} N!} \Rightarrow n \ge N$$

Probability of “n” units in system

$$P_{n>N} = \frac{\rho^{N+1} P_0}{N!N\left(1-\frac{\rho}{N}\right)}$$

Probability of “n” units > number of channels, or probability of wait

$$\overline{Q} = \frac{\rho^{N+1} P_0}{N!N}\left[\frac{1}{\left(1-\frac{\rho}{N}\right)^2}\right]$$

Average queue length

$$\overline{Q} = \frac{\rho^{N+1} P_0}{N!N}\left[\frac{1}{\left(1-\frac{\rho}{N}\right)^2}\right]$$

Average queue length

$$\overline{w} = \frac{\rho+\overline{Q}}{\lambda} - \frac{1}{\mu}$$

Average wait time in queue

$$\bar{t} = \frac{\rho+\overline{Q}}{\lambda}$$

Average time in system

APPENDIX E – HELP MODEL ANALYSIS

Memorandum

Date: May 20, 2020

To: Fred Doran, PE

From: Gina Tinio, EIT

Subject: HELP Model Analysis
Central Landfill
Project No. 120344

INTRODUCTION

This memorandum presents the results of the Hydrologic Evaluation of Landfill Performance (HELP) Model analysis for the Matanuska-Susitna Borough Central Landfill (Landfill). The analysis evaluated the leachate management system components, including leachate quantities at each stage of landfill development, maximum leachate recirculation rate, and leachate collection pipe sizing and material type.

METHODOLOGY

The following analyses were performed utilizing the HELP Model Version 3.07, which was developed by the United States Army Corps Engineers (USACE) for the United States Environmental Protection Agency (USEPA) Risk Reduction Engineering Laboratory in November of 1997. The HELP model is a hydrologic model of water movement across, into, through, and out of landfills. The model uses climatologic, soil, and design data in a daily sequential analysis that accounts for the effects of surface storage, runoff, infiltration, evapotranspiration, percolation, soil moisture storage, and lateral drainage.

The HELP Model was used to estimate amounts of leachate generation, leachate recirculation, and maximum daily head on the liner system that may be expected during various stages of landfill development for the Matanuska-Susitna Borough Central Landfill (Landfill). Three different landfill development design simulations were run which include the following:

1. Active Filling
2. Intermediate Cover; and

3. Final Cover.

The simulations were modeled on a per acre basis and results were then multiplied by the area of each phase in acres to quantify volumes associated with the leachate management system. The approximate area of each phase is shown in Table 1.

Table 1: Area of Landfill Phases

Phase	I	II	III
Area (Acres)	42	113	123

DESIGN CRITERIA

The HELP Model requires climatological, vegetative, soil, and design data specific to the landfill site. The following sections document the basis for data selection and the layer profiles used in the HELP Model analyses.

Weather Data

The required weather data for the HELP Model includes daily precipitation values, mean monthly temperatures, and solar radiation representative of the landfill site. These values may be entered by the user, synthetically generated by the program, or default data supplied with the program may be used. The HELP Model Version 3.07 does not include Palmer, Alaska, as a default location, so Bethel, Alaska, was selected as the default location for temperature and solar radiation data. Bethel, Alaska, is the closest location relative to the landfill site for solar and temperature data in the program. The model does not include any Alaska locations for synthetic precipitation data, so Medford, Oregon, was selected. Palmer, Alaska, precipitation data was then manually input into the HELP Model to simulate site specific weather conditions. Precipitation data was taken from monthly averages from 1981 to 2010. The average monthly values are presented in Table 2 and supporting documentation is included in Attachment 1.

Table 2: Precipitation Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average Annual
Inches	1.06	0.93	0.68	0.34	0.72	1.23	2.05	2.61	2.50	1.56	1.04	1.28	16.00

The peak daily precipitation was modified to be 2.69 inches for the initial and intermediate conditions, which corresponds to the upper bound of the 24-hour, 25-year storm event 90% confidence interval. For the final cover condition, the peak daily precipitation was modified to be 3.47 inches, which corresponds to the upper bound of the 24-hour, 100-year storm event 90% confidence interval.

Landfill Development

Three scenarios of landfill development design simulations were performed to calculate leachate generation rates for sizing the collection system. The three scenarios include:

1. Active Filling. The first stage of landfill development is after an initial 10-foot-thick lift of waste has been placed in a cell.
2. Intermediate cover. This stage of landfill development represents areas that have reached intermediate grades and intermediate cover soils have been placed over the waste. The intermediate waste thicknesses was modeled at 20 feet.
3. Final cover. The final stage of landfill development is when an area has reached final grade and receives its final cover. The final waste thicknesses was modeled at 192 feet, which reflects the maximum waste thickness measured from the top of the drainage layer to the top of final intermediate cover.

Landfill Liner Design Parameters

The landfill design for Landfill consists of the following layers from top to bottom:

- 6 inches of earthen material;

- 18 inches of granular drainage material;
- 40 mil LLDPE flexible membrane liner;
- 6 inches of leveling course;
- Waste and intermediate cover;
- 18 inches of granular drainage material;
- Geotextile fabric;
- 60 mil HDPE flexible membrane liner;
- Geosynthetic clay liner;
- 6 inches of sand leveling course; and
- Prepared subgrade.

Note that geotextiles are not modeled as a part of the HELP model analysis. Additionally, the sand leveling course and prepared subgrade below the geosynthetic clay liner are not included in the model, as the program does not allow multiple sequencing barrier layers.

Additional Design Assumptions

1. The program initialized soil moisture content by setting moisture content at field capacity and running the program from the first year of climatological data.
2. Evaporative zone depth was estimated to be:
    a. 6 inches for active filling. This depth is equal to the thickness of the daily cover soil layer.
    b. 12 inches for intermediate cover condition. This depth is equal to the thickness of the intermediate cover soil layer and includes the influence of plant roots extending into the intermediate cover soil layer; and
    c. 24 inches for final cover condition.
3. Percent of area where runoff is possible was assumed to be:
    a. 0 percent for active filling.
    b. 100 percent for intermediate and final cover conditions.

4. SCS runoff curve numbers were calculated by the HELP Model based on default soil data, vegetative cover, and user inputted surface slope.
    a. The soil texture used to compute the curve number was bare group B soil, consistent with the daily and intermediate cover in the active and intermediate scenarios.
    b. The soil textured used to compute the curve number for the final cover scenario was a good stand of grass.
    c. A conservative slope length of 1,500 ft was used. This reflects the maximum final cover slope length on the east side of the landfill.
    d. For the initial and intermediate condition scenarios, a surface slope of 2% was used. This is consistent with typical landfill construction surface slopes.
    e. For the final cover scenario, a surface slope of 4% was used.
5. The default growing period for Bethel, Alaska, was used for the landfill location.
6. The vegetative cover was modeled as:
    a. Bare ground for active filling and intermediate cover conditions
    b. Good stand of grass for final cover conditions
7. Maximum leaf area index of:
    a. Bare ground for active filling and intermediate cover conditions
    b. Good stand of grass for final cover conditions
8. The effective saturated hydraulic conductivity of the granular drainage material was set to 1.0×10^{-1} cm/s (minimum from Cell 4 design specification).
9. The effective saturated hydraulic conductivity of the geosynthetic clay liner was set to 5.0×10^{-9} cm/s in accordance with Geosynthetic Institute GRI-GCL3 Standard Specification.
10. Geomembrane placement was assumed to be good with one installation defect per acre and one pinhole per acre.

11. Active and intermediate conditions were modeled over a time span of five years of data generation, and the final cover condition was modeled over a time span of 30 years of data generation.

RESULTS

Hydraulic Head on Liner

The HELP Model was used to calculate the amount of percolation through the liner system and the maximum daily hydraulic head over the liner for each stage of landfill development. The model calculates the depth of the hydraulic head on the liner as a function of the drainage slope, slope length, permeability of the drainage material, and the amount of leachate reintroduced into the landfill.

Results demonstrate conformance with the Alaska Department of Environmental Conservation Solid Waste Management Rule 18 AAC 60.330, which requires less than 12 inches head of leachate over the liner. Detailed HELP modeling reports are included as Attachment 2. A summary of results is presented in Table 3.

Maximum Leachate Recirculation Rate

The HELP model allows for inclusion of leachate application rates as a percentage of leachate collected from the drainage layer and applied back into the landfill, also referred to as recirculation. During active filling (Scenario 1), a recirculation rate of 94 percent (approximately 516,000 cubic feet or 3,860,000 gallons per open acre of active landfill cell per year) was included in the model while still maintaining less than 12 inches of head on the liner (10.875 inches). During the intermediate cover condition, 100 percent of the volume of leachate collected from the drainage layer (approximately 374,000 cubic feet or 2,801,00 gallons per open acre of active landfill cell per year) was included in the model while maintaining less than 12 inches of head on the liner (7.628 inches). Table 3 provides a summary of head and the liner and leachate generation rates per acre for reach scenario.

Table 3: HELP Modeling Results

Scenario	Leachate Recirculation (%)	Max Head (in)	Average Head (in)	Average Annual Leachate Recirculated (gals/acre)	Average Annual Leachate Collected (gals/acre)
Active Filling	94	10.875	7.039	3,859,816	246,371
Intermediate Cover	100	7.628	4.675	2,800,972	-
Final Cover	0	9.939	6.337	-	0.02

Leachate Generation

The HELP Model calculated a peak daily volume and annual average volume of leachate collected from the drainage layer and volume recirculated over the modeled period. Scenarios 1 and 2 were modeled for 5 years since this represents a conservative time period for active filling conditions and intermediate slopes. Scenario 3 was modeled for 30 years to evaluate the post-closure period requirements.

Table 4 presents estimated annual and peak daily leachate generation assuming no leachate is recirculated back into the landfill. These values are useful for evaluating leachate storage and treatment options. The peak volume of leachate generated over a 24-hour period is 5,274 gallons per acre, assuming no leachate is recirculated.

Table 4: Per Acre Leachate Generation

Scenario	Average Annual Leachate Collected (cubic feet/acre)	Average Annual Leachate Collected (gals/acre)	Peak Daily Leachate Generated (cubic feet/acre)	Peak Daily Leachate Generated (gals/acre)
Active Filling	36,432	272,532	705	5,274
Intermediate Cover	16,438	122,965	450	3,366
Final Cover	0.020	0.150	0.002	0.015

Attachment 1 – Weather Data
Attachment 2 – HELP Modeling Reports

Climate Palmer - Alaska

	Jan (January)	Feb (February)	Mar (March)	Apr (April)	May (May)	Jun (June)
Average high in °F	23	28	37	48	60	66
Average low in °F	12	15	22	32	42	50
Av. precipitation in inch	1.06	0.93	0.68	0.34	0.72	1.23
Av. snowfall in inch	9	8	7	2	0	0

	Jul (July)	Aug (August)	Sep (September)	Oct (October)	Nov (November)	Dec (December)
Average high in °F	67	65	56	42	28	26
Average low in °F	53	51	44	30	17	15
Av. precipitation in inch	2.05	2.61	2.50	1.56	1.04	1.28
Av. snowfall in inch	0	0	0	6	10	12

Palmer weather averages

Annual high temperature	46°F
Annual low temperature	32°F
Average annual precip.	16 inch
Av. annual snowfall	54 inch

Station Data

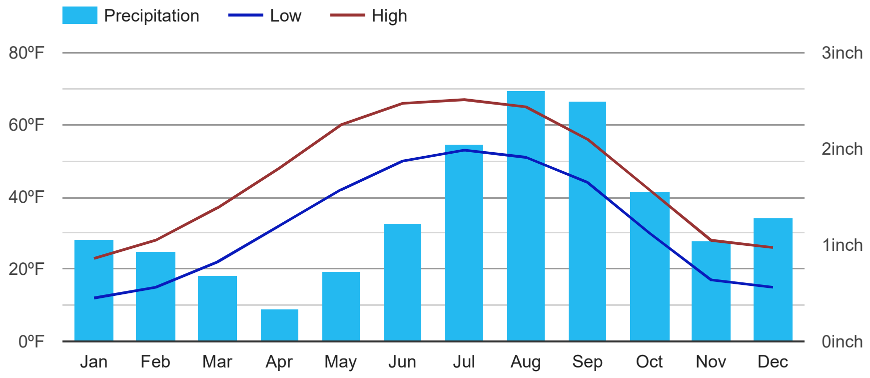
Monthly averages Palmer
Longitude: -149.113, Latitude: 61.5997
Average weather Palmer, AK - 99645

Monthly: 1981-2010 normals
History: 2007-2019

Abbreviations

Average precipitation in : Av. precipitation in
Jan (January): January, Feb (February): February, ...

Palmer Climate Graph - Alaska Climate Chart



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↑
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\HELP3\INITIAL.D4
TEMPERATURE DATA FILE:      C:\HELP3\INITIAL.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\INITIAL.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\INITIAL.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\INIT160.D10
OUTPUT DATA FILE:           C:\HELP3\INIT160.OUT


TIME:  13: 2     DATE:   5/ 4/2020


******************************************************************************

     TITLE:  MAT-SU LANDFILL ACTIVE FILLING CONDITION

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   8
           THICKNESS                   =      6.00   INCHES
```

```
POROSITY                    =      0.4630 VOL/VOL
FIELD CAPACITY              =      0.2320 VOL/VOL
WILTING POINT               =      0.1160 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.1621 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.369999994000E-03 CM/SEC


                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                   =    120.00   INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
WILTING POINT               =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     18.00   INCHES
POROSITY                    =      0.4170 VOL/VOL
FIELD CAPACITY              =      0.0450 VOL/VOL
WILTING POINT               =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000001000     CM/SEC
SLOPE                       =      4.00   PERCENT
DRAINAGE LENGTH             =    160.0    FEET


                        LAYER  4
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
```

```
   INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY       =  3 - GOOD


                           LAYER  5
                           --------

                 TYPE 3 - BARRIER SOIL LINER
                 MATERIAL TEXTURE NUMBER   0
   THICKNESS                   =      0.24   INCHES
   POROSITY                    =      0.7500 VOL/VOL
   FIELD CAPACITY              =      0.7470 VOL/VOL
   WILTING POINT               =      0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.499999997000E-08 CM/SEC



           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
          SPECIFIED CURVE NUMBER OF 86.0, A SURFACE SLOPE
          OF  2.% AND A SLOPE LENGTH OF 1500. FEET.

SCS RUNOFF CURVE NUMBER             =     84.90
FRACTION OF AREA ALLOWING RUNOFF    =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
EVAPORATIVE ZONE DEPTH              =      6.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      0.973  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =      2.778  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.696  INCHES
INITIAL SNOW WATER                  =      1.607  INCHES
INITIAL WATER IN LAYER MATERIALS    =     37.003  INCHES
TOTAL INITIAL WATER                 =     38.610  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR



            EVAPOTRANSPIRATION AND WEATHER DATA
            ----------------------------------
```

```
    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BETHEL                ALASKA

        STATION LATITUDE                         =  60.78 DEGREES
        MAXIMUM LEAF AREA INDEX                  =   0.00
        START OF GROWING SEASON (JULIAN DATE)    =    184
        END OF GROWING SEASON (JULIAN DATE)      =    225
        EVAPORATIVE ZONE DEPTH                   =   6.0  INCHES
        AVERAGE ANNUAL WIND SPEED                =  12.90 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  75.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  78.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  83.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  80.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    MEDFORD             OREGON

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
    1.06        0.93        0.68        0.34        0.72        1.23
    2.05        2.61        2.50        1.56        1.04        1.28


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BETHEL              ALASKA

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
    4.90        5.70       10.70       23.40       40.30       50.60
   54.70       52.80       45.00       29.70       17.50        4.80


    NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BETHEL              ALASKA
               AND STATION LATITUDE  =  60.78 DEGREES


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
```

```
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           16.51           59931.316   100.00

  RUNOFF                                   0.000              0.000     0.00

  EVAPOTRANSPIRATION                       7.669          27837.207    46.45

  DRAINAGE COLLECTED FROM LAYER  3         8.8412         32093.447    53.55

  PERC./LEAKAGE THROUGH LAYER  5           0.000016           0.058     0.00

  AVG. HEAD ON TOP OF LAYER  4             0.1713

  CHANGE IN WATER STORAGE                  0.000              0.582     0.00

  SOIL WATER AT START OF YEAR             37.003         134319.969

  SOIL WATER AT END OF YEAR               37.003         134320.547

  SNOW WATER AT START OF YEAR              1.607           5833.651     9.73

  SNOW WATER AT END OF YEAR                1.607           5833.651     9.73

  ANNUAL WATER BUDGET BALANCE              0.0000             0.020     0.00

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    2
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           16.85           61165.508   100.00

  RUNOFF                                   0.000              0.000     0.00

  EVAPOTRANSPIRATION                       6.814          24733.717    40.44

  DRAINAGE COLLECTED FROM LAYER  3         9.4566         34327.543    56.12

  PERC./LEAKAGE THROUGH LAYER  5           0.000017           0.062     0.00

  AVG. HEAD ON TOP OF LAYER  4             0.1824
```

```
  CHANGE IN WATER STORAGE                  0.580         2104.186      3.44

  SOIL WATER AT START OF YEAR             37.003       134320.547

  SOIL WATER AT END OF YEAR               37.389       135720.969

  SNOW WATER AT START OF YEAR              1.607         5833.651      9.54

  SNOW WATER AT END OF YEAR                1.801         6537.427     10.69

  ANNUAL WATER BUDGET BALANCE              0.0000           0.002      0.00

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    3
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           17.57          63779.121    100.00

  RUNOFF                                   0.000            0.000      0.00

  EVAPOTRANSPIRATION                       5.372         19499.645     30.57

  DRAINAGE COLLECTED FROM LAYER  3        10.5497        38295.473     60.04

  PERC./LEAKAGE THROUGH LAYER  5           0.000019         0.069      0.00

  AVG. HEAD ON TOP OF LAYER  4             0.2026

  CHANGE IN WATER STORAGE                  1.648         5983.897      9.38

  SOIL WATER AT START OF YEAR             37.389       135720.969

  SOIL WATER AT END OF YEAR               38.301       139033.844

  SNOW WATER AT START OF YEAR              1.801         6537.427     10.25

  SNOW WATER AT END OF YEAR                2.537         9208.442     14.44

  ANNUAL WATER BUDGET BALANCE              0.0000           0.037      0.00

*******************************************************************************
```

```
*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    4
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           19.89          72200.687    100.00

  RUNOFF                                   0.000             0.000      0.00

  EVAPOTRANSPIRATION                       8.235         29893.785     41.40

  DRAINAGE COLLECTED FROM LAYER  3        13.3908        48608.777     67.32

  PERC./LEAKAGE THROUGH LAYER  5           0.000024          0.087      0.00

  AVG. HEAD ON TOP OF LAYER  4             0.2577

  CHANGE IN WATER STORAGE                 -1.736         -6301.982     -8.73

  SOIL WATER AT START OF YEAR             38.301        139033.844

  SOIL WATER AT END OF YEAR               38.023        138024.641

  SNOW WATER AT START OF YEAR              2.537          9208.442     12.75

  SNOW WATER AT END OF YEAR                1.079          3915.669      5.42

  ANNUAL WATER BUDGET BALANCE              0.0000            0.021      0.00

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    5
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           17.34          62944.215    100.00

  RUNOFF                                   0.000             0.000      0.00

  EVAPOTRANSPIRATION                       7.475         27135.564     43.11

  DRAINAGE COLLECTED FROM LAYER  3         7.9437        28835.756     45.81
```

```
  PERC./LEAKAGE THROUGH LAYER  5           0.000014          0.052      0.00

  AVG. HEAD ON TOP OF LAYER  4             0.1529

  CHANGE IN WATER STORAGE                  1.921          6972.825     11.08

  SOIL WATER AT START OF YEAR             38.023        138024.641

  SOIL WATER AT END OF YEAR               38.044        138100.422

  SNOW WATER AT START OF YEAR              1.079          3915.669      6.22

  SNOW WATER AT END OF YEAR                2.979         10812.708     17.18

  ANNUAL WATER BUDGET BALANCE              0.0000            0.018      0.00

*******************************************************************************




*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 0.89     1.06     0.58     0.33     0.82     1.05
                           1.21     3.46     4.29     1.55     0.90     1.49

    STD. DEVIATIONS        0.26     0.32     0.24     0.19     0.79     1.06
                           1.57     1.26     1.59     0.91     0.31     0.31

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 0.312    0.326    0.351    0.382    0.048    1.335
```

```
                           0.499    1.256    1.158    0.765    0.455    0.226

    STD. DEVIATIONS        0.049    0.041    0.086    0.094    0.080    0.503
                           0.458    0.524    0.478    0.119    0.187    0.051

  LATERAL DRAINAGE COLLECTED FROM LAYER  3
  ----------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.2111   2.1321   1.5201
                           0.8368   0.6664   2.3848   2.1318   0.1533   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.1665   0.5428   0.2070
                           0.6544   0.7388   0.8717   1.6901   0.3355   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  5
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  4
  -------------------------------------
    AVERAGES               0.0000   0.0000   0.0000   0.0497   0.4861   0.3581
                           0.1908   0.1519   0.5618   0.4860   0.0361   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0392   0.1237   0.0488
                           0.1492   0.1684   0.2054   0.3853   0.0790   0.0000

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------
                                     INCHES            CU. FEET       PERCENT
                               -------------------   -------------   ---------
 PRECIPITATION                  17.63    (   1.328)      64004.2     100.00

 RUNOFF                          0.000   (  0.0000)         0.00       0.000

 EVAPOTRANSPIRATION              7.113   (  1.0978)      25819.98     40.341
```

```
 LATERAL DRAINAGE COLLECTED     10.03642 (  2.10118)     36432.195   56.92160
   FROM LAYER  3

 PERCOLATION/LEAKAGE THROUGH     0.00002 (  0.00000)         0.066     0.00010
   LAYER  5

 AVERAGE HEAD ON TOP             0.193 (    0.040)
   OF LAYER  4

 CHANGE IN WATER STORAGE         0.483   (  1.4657)       1751.90      2.737

*******************************************************************************


↑
******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH    5
   ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------    -------------
      PRECIPITATION                              2.69          9764.700

      RUNOFF                                     0.000            0.0000

      DRAINAGE COLLECTED FROM LAYER  3           0.19423        705.04028

      PERCOLATION/LEAKAGE THROUGH LAYER  5       0.000000          0.00130

      AVERAGE HEAD ON TOP OF LAYER  4            1.373

      MAXIMUM HEAD ON TOP OF LAYER  4            2.502

      LOCATION OF MAXIMUM HEAD IN LAYER  3
            (DISTANCE FROM DRAIN)               13.9 FEET

      SNOW WATER                                 3.82         13867.8398


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.4630

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.1160

       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
```

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                    ASCE Journal of Environmental Engineering
                    Vol. 119, No. 2, March 1993, pp. 262-270.

******************************************************************************



↑
******************************************************************************

               FINAL WATER STORAGE AT END OF YEAR    5
    ----------------------------------------------------------------------
                LAYER        (INCHES)       (VOL/VOL)
                -----        --------       ---------
                  1            2.0142         0.3357

                  2           35.0399         0.2920

                  3            0.8100         0.0450

                  4            0.0000         0.0000

                  5            0.1800         0.7500

               SNOW WATER      2.979

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******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\HELP3\INITIAL.D4
TEMPERATURE DATA FILE:      C:\HELP3\INITIAL.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\INITIAL.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\INITIAL.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\INIT160.D10
OUTPUT DATA FILE:           C:\HELP3\INIT160.OUT


TIME:  13:19     DATE:   5/ 4/2020


******************************************************************************

     TITLE:  MAT-SU LANDFILL ACTIVE FILLING CONDITION

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   8
           THICKNESS                   =      6.00   INCHES
```

```
  POROSITY                    =      0.4630 VOL/VOL
  FIELD CAPACITY              =      0.2320 VOL/VOL
  WILTING POINT               =      0.1160 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.1621 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.369999994000E-03 CM/SEC


                          LAYER  2
                          --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER  18
  THICKNESS                   =    120.00   INCHES
  POROSITY                    =      0.6710 VOL/VOL
  FIELD CAPACITY              =      0.2920 VOL/VOL
  WILTING POINT               =      0.0770 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.3326 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
NOTE:   94.00 PERCENT OF THE DRAINAGE COLLECTED FROM LAYER # 3
         IS RECIRCULATED INTO THIS LAYER.


                          LAYER  3
                          --------

              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   0
  THICKNESS                   =     18.00   INCHES
  POROSITY                    =      0.4170 VOL/VOL
  FIELD CAPACITY              =      0.0450 VOL/VOL
  WILTING POINT               =      0.0180 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.0707 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.100000001000     CM/SEC
  SLOPE                       =      4.00   PERCENT
  DRAINAGE LENGTH             =    160.0    FEET
NOTE:   94.00 PERCENT OF THE DRAINAGE COLLECTED FROM THIS
         LAYER IS RECIRCULATED INTO LAYER #  2.


                          LAYER  4
                          --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
```

```
   THICKNESS                   =      0.06   INCHES
   POROSITY                    =      0.0000 VOL/VOL
   FIELD CAPACITY              =      0.0000 VOL/VOL
   WILTING POINT               =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY       =  3 - GOOD



                           LAYER  5
                           --------

                 TYPE 3 - BARRIER SOIL LINER
                 MATERIAL TEXTURE NUMBER   0
   THICKNESS                   =      0.24   INCHES
   POROSITY                    =      0.7500 VOL/VOL
   FIELD CAPACITY              =      0.7470 VOL/VOL
   WILTING POINT               =      0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.499999997000E-08 CM/SEC



           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
          SPECIFIED CURVE NUMBER OF 86.0, A SURFACE SLOPE
          OF  2.% AND A SLOPE LENGTH OF 1500. FEET.

SCS RUNOFF CURVE NUMBER             =     84.90
FRACTION OF AREA ALLOWING RUNOFF    =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
EVAPORATIVE ZONE DEPTH              =      6.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      0.973  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =      2.778  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.696  INCHES
INITIAL SNOW WATER                  =      1.607  INCHES
INITIAL WATER IN LAYER MATERIALS    =     42.333  INCHES
TOTAL INITIAL WATER                 =     43.940  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR
```

```
               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BETHEL                ALASKA

        STATION LATITUDE                       =  60.78 DEGREES
        MAXIMUM LEAF AREA INDEX                =   0.00
        START OF GROWING SEASON (JULIAN DATE)  =    184
        END OF GROWING SEASON (JULIAN DATE)    =    225
        EVAPORATIVE ZONE DEPTH                 =   6.0  INCHES
        AVERAGE ANNUAL WIND SPEED              =  12.90 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  75.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  78.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  83.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  80.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    MEDFORD             OREGON

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  1.06        0.93        0.68        0.34        0.72        1.23
  2.05        2.61        2.50        1.56        1.04        1.28


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BETHEL              ALASKA

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  4.90        5.70       10.70       23.40       40.30       50.60
 54.70       52.80       45.00       29.70       17.50        4.80


    NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BETHEL              ALASKA
               AND STATION LATITUDE  =  60.78 DEGREES
```

```
*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           16.51          59931.316    100.00

  RUNOFF                                   0.000             0.000      0.00

  EVAPOTRANSPIRATION                       7.669         27837.207     46.45

  RECIRCULATION INTO LAYER  2             90.169006     327313.500    546.15

  DRAINAGE COLLECTED FROM LAYER  3         5.7555        20892.346     34.86

  RECIRCULATION FROM LAYER  3             90.169006     327313.500    546.15

  PERC./LEAKAGE THROUGH LAYER  5           0.000188          0.684      0.00

  AVG. HEAD ON TOP OF LAYER  4             1.8537

  CHANGE IN WATER STORAGE                  2.960         10744.728     17.93

  SOIL WATER AT START OF YEAR             42.333        153668.531

  SOIL WATER AT END OF YEAR               45.293        164413.250

  SNOW WATER AT START OF YEAR              1.607          5833.651      9.73

  SNOW WATER AT END OF YEAR                1.607          5833.651      9.73

  ANNUAL WATER BUDGET BALANCE              0.1257          456.352      0.76

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*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    2
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           16.85          61165.508    100.00

  RUNOFF                                   0.000             0.000      0.00
```

```
  EVAPOTRANSPIRATION                          6.814         24733.717     40.44

  RECIRCULATION INTO LAYER  2               123.488007     448261.469    732.87

  DRAINAGE COLLECTED FROM LAYER  3            7.8822        28612.430     46.78

  RECIRCULATION FROM LAYER  3               123.488007     448261.469    732.87

  PERC./LEAKAGE THROUGH LAYER  5              0.000271          0.983      0.00

  AVG. HEAD ON TOP OF LAYER  4                2.5397

  CHANGE IN WATER STORAGE                     2.068          7507.894     12.27

  SOIL WATER AT START OF YEAR                45.293        164413.250

  SOIL WATER AT END OF YEAR                  47.167        171217.375

  SNOW WATER AT START OF YEAR                 1.607          5833.651      9.54

  SNOW WATER AT END OF YEAR                   1.801          6537.427     10.69

  ANNUAL WATER BUDGET BALANCE                 0.0855          310.486      0.51

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                         ANNUAL TOTALS FOR YEAR    3
------------------------------------------------------------------------------
                                            INCHES          CU. FEET     PERCENT
                                           --------        ----------    -------
  PRECIPITATION                              17.57          63779.121    100.00

  RUNOFF                                      0.000             0.000      0.00

  EVAPOTRANSPIRATION                          5.372         19499.645     30.57

  RECIRCULATION INTO LAYER  2               144.080811     523013.344    820.04

  DRAINAGE COLLECTED FROM LAYER  3            9.1966        33383.820     52.34

  RECIRCULATION FROM LAYER  3               144.080811     523013.344    820.04

  PERC./LEAKAGE THROUGH LAYER  5              0.000327          1.187      0.00

  AVG. HEAD ON TOP OF LAYER  4                2.9635
```

```
  CHANGE IN WATER STORAGE                  2.915         10582.174     16.59

  SOIL WATER AT START OF YEAR             47.167        171217.375

  SOIL WATER AT END OF YEAR               49.347        179128.531

  SNOW WATER AT START OF YEAR              1.801          6537.427     10.25

  SNOW WATER AT END OF YEAR                2.537          9208.442     14.44

  ANNUAL WATER BUDGET BALANCE              0.0860          312.295      0.49

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                          ANNUAL TOTALS FOR YEAR    4
--------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           19.89          72200.687    100.00

  RUNOFF                                   0.000             0.000      0.00

  EVAPOTRANSPIRATION                       8.235         29893.785     41.40

  RECIRCULATION INTO LAYER  2            187.973648     682344.312    945.07

  DRAINAGE COLLECTED FROM LAYER  3        11.9983        43553.914     60.32

  RECIRCULATION FROM LAYER  3            187.973648     682344.312    945.07

  PERC./LEAKAGE THROUGH LAYER  5           0.000461          1.674      0.00

  AVG. HEAD ON TOP OF LAYER  4             3.8587

  CHANGE IN WATER STORAGE                 -0.439         -1593.703     -2.21

  SOIL WATER AT START OF YEAR             49.347        179128.531

  SOIL WATER AT END OF YEAR               50.366        182827.594

  SNOW WATER AT START OF YEAR              2.537          9208.442     12.75

  SNOW WATER AT END OF YEAR                1.079          3915.669      5.42
```

```
  ANNUAL WATER BUDGET BALANCE              0.0950          345.019      0.48

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                          ANNUAL TOTALS FOR YEAR    5
--------------------------------------------------------------------------------
                                             INCHES         CU. FEET     PERCENT
                                            --------       ----------    -------
  PRECIPITATION                               17.34         62944.215    100.00

  RUNOFF                                       0.000            0.000      0.00

  EVAPOTRANSPIRATION                           7.475        27135.564     43.11

  RECIRCULATION INTO LAYER  2                165.007996    598979.000    951.60

  DRAINAGE COLLECTED FROM LAYER  3            10.5324       38232.691     60.74

  RECIRCULATION FROM LAYER  3                165.007996    598979.000    951.60

  PERC./LEAKAGE THROUGH LAYER  5               0.000383         1.389      0.00

  AVG. HEAD ON TOP OF LAYER  4                 3.3982

  CHANGE IN WATER STORAGE                     -0.497        -1804.679     -2.87

  SOIL WATER AT START OF YEAR                 50.366       182827.594

  SOIL WATER AT END OF YEAR                   47.969       174125.891

  SNOW WATER AT START OF YEAR                  1.079         3915.669      6.22

  SNOW WATER AT END OF YEAR                    2.979        10812.708     17.18

  ANNUAL WATER BUDGET BALANCE                 -0.1710        -620.753     -0.99

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```
         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    5
--------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 0.89     1.06     0.58     0.33     0.82     1.05
                           1.21     3.46     4.29     1.55     0.90     1.49

    STD. DEVIATIONS        0.26     0.32     0.24     0.19     0.79     1.06
                           1.57     1.26     1.59     0.91     0.31     0.31

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 0.312    0.326    0.351    0.382    0.048    1.335
                           0.499    1.256    1.158    0.765    0.455    0.226

    STD. DEVIATIONS        0.049    0.041    0.086    0.094    0.080    0.503
                           0.458    0.524    0.478    0.119    0.187    0.051

  LATERAL DRAINAGE RECIRCULATED INTO LAYER  2
  -------------------------------------------
    TOTALS                10.8182   8.8565   8.7921   7.6070   9.8987  10.9146
                          12.0920  12.0476  14.7720  17.5624  15.1041  13.6785

    STD. DEVIATIONS        4.2922   3.3643   3.1295   2.5717   2.9304   2.5372
                           2.3954   3.4809   4.5544   5.1619   4.0473   3.4158

  LATERAL DRAINAGE COLLECTED FROM LAYER  3
  ----------------------------------------
    TOTALS                 0.6905   0.5653   0.5612   0.4856   0.6318   0.6967
                           0.7718   0.7690   0.9429   1.1210   0.9641   0.8731

    STD. DEVIATIONS        0.2740   0.2147   0.1998   0.1641   0.1870   0.1619
                           0.1529   0.2222   0.2907   0.3295   0.2583   0.2180

  LATERAL DRAINAGE RECIRCULATED FROM LAYER  3
  -------------------------------------------
    TOTALS                10.8182   8.8565   8.7921   7.6070   9.8987  10.9146
                          12.0920  12.0476  14.7720  17.5624  15.1041  13.6785
```

```
   STD. DEVIATIONS        4.2922   3.3643   3.1295   2.5717   2.9304   2.5372
                          2.3954   3.4809   4.5544   5.1619   4.0473   3.4158

 PERCOLATION/LEAKAGE THROUGH LAYER  5
 ------------------------------------
   TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
              AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  4
 -------------------------------------
   AVERAGES               2.6236   2.3574   2.1322   1.9063   2.4006   2.7352
                          2.9325   2.9218   3.7019   4.2592   3.7851   3.3173

   STD. DEVIATIONS        1.0409   0.8869   0.7590   0.6445   0.7107   0.6358
                          0.5809   0.8442   1.1413   1.2519   1.0143   0.8284

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------
                                   INCHES            CU. FEET       PERCENT
                              -------------------   -------------   ---------
 PRECIPITATION                 17.63    (   1.328)      64004.2     100.00

 RUNOFF                         0.000   (  0.0000)          0.00      0.000

 EVAPOTRANSPIRATION             7.113   (  1.0978)      25819.98     40.341

 DRAINAGE RECIRCULATED        142.14389 ( 37.67066)    515982.312  806.16980
   INTO LAYER  2

 LATERAL DRAINAGE COLLECTED     9.07301 (  2.40451)     32935.043   51.45765
   FROM LAYER  3

 DRAINAGE RECIRCULATED        142.14389 ( 37.67066)    515982.312  806.16980
   FROM LAYER  3
```

```
 PERCOLATION/LEAKAGE THROUGH     0.00033 (  0.00010)         1.183     0.00185
   LAYER  5

 AVERAGE HEAD ON TOP             2.923 (    0.774)
   OF LAYER  4

 CHANGE IN WATER STORAGE         1.401   (  1.7434)       5087.28      7.948

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                PEAK DAILY VALUES FOR YEARS    1 THROUGH    5
   ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
      PRECIPITATION                              2.69          9764.700

      RUNOFF                                     0.000            0.0000

      DRAINAGE RECIRCULATED INTO LAYER  2        0.93633       3398.86523

      DRAINAGE COLLECTED FROM LAYER  3           0.05977        216.94884

      DRAINAGE RECIRCULATED FROM LAYER  3        0.93633       3398.86523

      PERCOLATION/LEAKAGE THROUGH LAYER  5       0.000003         0.00989

      AVERAGE HEAD ON TOP OF LAYER  4            7.039

      MAXIMUM HEAD ON TOP OF LAYER  4           10.875

      LOCATION OF MAXIMUM HEAD IN LAYER  3
            (DISTANCE FROM DRAIN)               36.2 FEET

      SNOW WATER                                 3.82         13867.8398


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.4630

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.1160

       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
```

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                       ASCE Journal of Environmental Engineering
                       Vol. 119, No. 2, March 1993, pp. 262-270.

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                   FINAL WATER STORAGE AT END OF YEAR    5
    ----------------------------------------------------------------------
                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1            2.0142         0.3357

                      2           43.8878         0.3657

                      3            1.8865         0.1048

                      4            0.0000         0.0000

                      5            0.1800         0.7500

                  SNOW WATER       2.979

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:    C:\HELP3\INTERMED.D4
TEMPERATURE DATA FILE:      C:\HELP3\INTERMED.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\INTERMED.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\INTERMED.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\2INTE160.D10
OUTPUT DATA FILE:           C:\HELP3\2INTE160.OUT


TIME:  16:25     DATE:   5/20/2020


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     TITLE:  MAT-SU LANDFILL INTERMEDIATE COVER CONDITION

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   8
           THICKNESS                   =     12.00   INCHES
```

```
POROSITY                    =      0.4630 VOL/VOL
FIELD CAPACITY              =      0.2320 VOL/VOL
WILTING POINT               =      0.1160 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.1974 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.369999994000E-03 CM/SEC



                        LAYER  2
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                   =    240.00   INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
WILTING POINT               =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC



                        LAYER  3
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     18.00   INCHES
POROSITY                    =      0.4170 VOL/VOL
FIELD CAPACITY              =      0.0450 VOL/VOL
WILTING POINT               =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000001000     CM/SEC
SLOPE                       =      4.00   PERCENT
DRAINAGE LENGTH             =    160.0    FEET



                        LAYER  4
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
```

```
   INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY       =  3 - GOOD


                            LAYER  5
                            --------

                  TYPE 3 - BARRIER SOIL LINER
                  MATERIAL TEXTURE NUMBER   0
   THICKNESS                   =      0.24   INCHES
   POROSITY                    =      0.7500 VOL/VOL
   FIELD CAPACITY              =      0.7470 VOL/VOL
   WILTING POINT               =      0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.499999997000E-08 CM/SEC


           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
          SPECIFIED CURVE NUMBER OF 86.0, A SURFACE SLOPE
          OF  2.% AND A SLOPE LENGTH OF 1500. FEET.

SCS RUNOFF CURVE NUMBER              =     84.90
FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =     12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      2.369  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      5.556  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      1.392  INCHES
INITIAL SNOW WATER                   =      1.607  INCHES
INITIAL WATER IN LAYER MATERIALS     =     73.439  INCHES
TOTAL INITIAL WATER                  =     75.046  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR


            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------
```

```
         NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                  BETHEL                ALASKA

             STATION LATITUDE                       =  60.78 DEGREES
             MAXIMUM LEAF AREA INDEX                =   0.00
             START OF GROWING SEASON (JULIAN DATE)  =    184
             END OF GROWING SEASON (JULIAN DATE)    =    225
             EVAPORATIVE ZONE DEPTH                 =  12.0  INCHES
             AVERAGE ANNUAL WIND SPEED              =  12.90 MPH
             AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  75.00 %
             AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  78.00 %
             AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  83.00 %
             AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  80.00 %



         NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    MEDFORD             OREGON

                  NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       1.06        0.93        0.68        0.34        0.72        1.23
       2.05        2.61        2.50        1.56        1.04        1.28



         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BETHEL              ALASKA

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       4.90        5.70       10.70       23.40       40.30       50.60
      54.70       52.80       45.00       29.70       17.50        4.80



         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BETHEL              ALASKA
                    AND STATION LATITUDE  =  60.78 DEGREES



*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
```

```
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           16.51          59931.316    100.00

  RUNOFF                                   3.383         12281.097     20.49

  EVAPOTRANSPIRATION                       8.669         31469.055     52.51

  DRAINAGE COLLECTED FROM LAYER  3         4.4572        16179.498     27.00

  PERC./LEAKAGE THROUGH LAYER  5           0.000008          0.030      0.00

  AVG. HEAD ON TOP OF LAYER  4             0.0862

  CHANGE IN WATER STORAGE                  0.000             1.606      0.00

  SOIL WATER AT START OF YEAR             73.439        266582.156

  SOIL WATER AT END OF YEAR               73.439        266583.781

  SNOW WATER AT START OF YEAR              1.607          5833.651      9.73

  SNOW WATER AT END OF YEAR                1.607          5833.651      9.73

  ANNUAL WATER BUDGET BALANCE              0.0000            0.030      0.00

*******************************************************************************



*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    2
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           16.85          61165.508    100.00

  RUNOFF                                   4.380         15898.184     25.99

  EVAPOTRANSPIRATION                       8.643         31372.676     51.29

  DRAINAGE COLLECTED FROM LAYER  3         3.1623        11479.095     18.77

  PERC./LEAKAGE THROUGH LAYER  5           0.000006          0.022      0.00

  AVG. HEAD ON TOP OF LAYER  4             0.0608
```

```
  CHANGE IN WATER STORAGE                      0.665          2415.530      3.95

  SOIL WATER AT START OF YEAR                 73.439        266583.781

  SOIL WATER AT END OF YEAR                   73.911        268295.531

  SNOW WATER AT START OF YEAR                  1.607          5833.651      9.54

  SNOW WATER AT END OF YEAR                    1.801          6537.427     10.69

  ANNUAL WATER BUDGET BALANCE                  0.0000            0.001      0.00

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                          ANNUAL TOTALS FOR YEAR    3
------------------------------------------------------------------------------
                                             INCHES          CU. FEET     PERCENT
                                            --------        ----------    -------
  PRECIPITATION                               17.57          63779.121    100.00

  RUNOFF                                       4.354         15804.095     24.78

  EVAPOTRANSPIRATION                           6.533         23716.424     37.19

  DRAINAGE COLLECTED FROM LAYER  3             5.1685        18761.521     29.42

  PERC./LEAKAGE THROUGH LAYER  5               0.000010          0.035      0.00

  AVG. HEAD ON TOP OF LAYER  4                 0.0999

  CHANGE IN WATER STORAGE                      1.514          5497.010      8.62

  SOIL WATER AT START OF YEAR                 73.911        268295.531

  SOIL WATER AT END OF YEAR                   74.689        271121.531

  SNOW WATER AT START OF YEAR                  1.801          6537.427     10.25

  SNOW WATER AT END OF YEAR                    2.537          9208.442     14.44

  ANNUAL WATER BUDGET BALANCE                  0.0000            0.035      0.00

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                          ANNUAL TOTALS FOR YEAR    4
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           19.89          72200.687    100.00

  RUNOFF                                   4.824         17510.082     24.25

  EVAPOTRANSPIRATION                      10.287         37342.996     51.72

  DRAINAGE COLLECTED FROM LAYER  3         6.6672        24201.891     33.52

  PERC./LEAKAGE THROUGH LAYER  5           0.000012          0.043      0.00

  AVG. HEAD ON TOP OF LAYER  4             0.1284

  CHANGE IN WATER STORAGE                 -1.888         -6854.312     -9.49

  SOIL WATER AT START OF YEAR             74.689        271121.531

  SOIL WATER AT END OF YEAR               74.259        269560.000

  SNOW WATER AT START OF YEAR              2.537          9208.442     12.75

  SNOW WATER AT END OF YEAR                1.079          3915.669      5.42

  ANNUAL WATER BUDGET BALANCE              0.0000           -0.011      0.00

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                          ANNUAL TOTALS FOR YEAR    5
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           17.34          62944.215    100.00

  RUNOFF                                   2.998         10882.966     17.29

  EVAPOTRANSPIRATION                       9.155         33233.090     52.80

  DRAINAGE COLLECTED FROM LAYER  3         3.1869        11568.364     18.38
```

```
  PERC./LEAKAGE THROUGH LAYER  5           0.000006          0.022      0.00

  AVG. HEAD ON TOP OF LAYER  4             0.0618

  CHANGE IN WATER STORAGE                  2.000          7259.728     11.53

  SOIL WATER AT START OF YEAR             74.259        269560.000

  SOIL WATER AT END OF YEAR               74.359        269922.687

  SNOW WATER AT START OF YEAR              1.079          3915.669      6.22

  SNOW WATER AT END OF YEAR                2.979         10812.708     17.18

  ANNUAL WATER BUDGET BALANCE              0.0000            0.046      0.00

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        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    5
------------------------------------------------------------------------------

                        JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                        -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                0.89     1.06     0.58     0.33     0.82     1.05
                          1.21     3.46     4.29     1.55     0.90     1.49

    STD. DEVIATIONS       0.26     0.32     0.24     0.19     0.79     1.06
                          1.57     1.26     1.59     0.91     0.31     0.31

  RUNOFF
  ------
    TOTALS                0.000    0.000    0.023    1.723    0.937    0.102
                          0.160    0.391    0.506    0.000    0.145    0.000

    STD. DEVIATIONS       0.000    0.000    0.052    0.922    0.782    0.216
                          0.228    0.264    0.413    0.000    0.138    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                0.312    0.326    0.351    0.382    0.048    2.033
```

```
                           0.982    1.286    1.451    0.803    0.456    0.226

    STD. DEVIATIONS        0.049    0.041    0.086    0.094    0.080    0.398
                           0.824    0.685    0.343    0.103    0.189    0.051

  LATERAL DRAINAGE COLLECTED FROM LAYER  3
  ----------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.8144
                           0.7259   0.1096   1.0950   1.5006   0.2828   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.3300
                           0.5310   0.1387   0.5533   1.1209   0.5786   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  5
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  4
  -------------------------------------
    AVERAGES               0.0000   0.0000   0.0000   0.0000   0.0000   0.1919
                           0.1655   0.0250   0.2579   0.3421   0.0666   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0777
                           0.1211   0.0316   0.1303   0.2555   0.1363   0.0000

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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------
                                     INCHES            CU. FEET       PERCENT
                               -------------------   -------------   ---------
 PRECIPITATION                  17.63    (   1.328)      64004.2     100.00

 RUNOFF                          3.988   (  0.7634)      14475.28     22.616

 EVAPOTRANSPIRATION              8.658   (  1.3616)      31426.85     49.101
```

```
 LATERAL DRAINAGE COLLECTED      4.52840 (  1.47098)     16438.074   25.68282
   FROM LAYER  3

 PERCOLATION/LEAKAGE THROUGH     0.00001 (  0.00000)         0.030     0.00005
   LAYER  5

 AVERAGE HEAD ON TOP             0.087 (    0.028)
   OF LAYER  4

 CHANGE IN WATER STORAGE         0.458   (  1.5207)       1663.91      2.600

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                PEAK DAILY VALUES FOR YEARS    1 THROUGH    5
   ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------    -------------
      PRECIPITATION                              2.69          9764.700

      RUNOFF                                     1.325         4810.1763

      DRAINAGE COLLECTED FROM LAYER  3           0.12395        449.95428

      PERCOLATION/LEAKAGE THROUGH LAYER  5       0.000000         0.00079

      AVERAGE HEAD ON TOP OF LAYER  4            0.876

      MAXIMUM HEAD ON TOP OF LAYER  4            1.637

      LOCATION OF MAXIMUM HEAD IN LAYER  3
            (DISTANCE FROM DRAIN)               10.3 FEET

      SNOW WATER                                 3.82         13867.8398


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.3679

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.1160

       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
```

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                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.


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                   FINAL WATER STORAGE AT END OF YEAR    5
    ----------------------------------------------------------------------
                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1            3.2889         0.2741

                      2           70.0799         0.2920

                      3            0.8100         0.0450

                      4            0.0000         0.0000

                      5            0.1800         0.7500

                  SNOW WATER       2.979

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:    C:\HELP3\INTERMED.D4
TEMPERATURE DATA FILE:      C:\HELP3\INTERMED.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\INTERMED.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\INTERMED.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\2INTE160.D10
OUTPUT DATA FILE:           C:\HELP3\2INTE160.OUT



TIME:  10:39     DATE:   5/ 4/2020




******************************************************************************

     TITLE:  MAT-SU LANDFILL INTERMEDIATE COVER CONDITION

******************************************************************************



     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
             COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.



                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   8
           THICKNESS                   =     12.00   INCHES
```

```
  POROSITY                    =      0.4630 VOL/VOL
  FIELD CAPACITY              =      0.2320 VOL/VOL
  WILTING POINT               =      0.1160 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.1974 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.369999994000E-03 CM/SEC



                          LAYER  2
                          --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER  18
  THICKNESS                   =    240.00   INCHES
  POROSITY                    =      0.6710 VOL/VOL
  FIELD CAPACITY              =      0.2920 VOL/VOL
  WILTING POINT               =      0.0770 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.3101 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
NOTE:  100.00 PERCENT OF THE DRAINAGE COLLECTED FROM LAYER # 3
         IS RECIRCULATED INTO THIS LAYER.



                          LAYER  3
                          --------

              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER   0
  THICKNESS                   =     18.00   INCHES
  POROSITY                    =      0.4170 VOL/VOL
  FIELD CAPACITY              =      0.0450 VOL/VOL
  WILTING POINT               =      0.0180 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.0574 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.100000001000     CM/SEC
  SLOPE                       =      4.00   PERCENT
  DRAINAGE LENGTH             =    160.0    FEET
NOTE:  100.00 PERCENT OF THE DRAINAGE COLLECTED FROM THIS
         LAYER IS RECIRCULATED INTO LAYER #  2.



                          LAYER  4
                          --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
```

```
   THICKNESS                     =      0.06   INCHES
   POROSITY                      =      0.0000 VOL/VOL
   FIELD CAPACITY                =      0.0000 VOL/VOL
   WILTING POINT                 =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT    =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.     =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY           =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS      =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY         =  3 - GOOD


                            LAYER  5
                            --------

                  TYPE 3 - BARRIER SOIL LINER
                  MATERIAL TEXTURE NUMBER   0
   THICKNESS                     =      0.24   INCHES
   POROSITY                      =      0.7500 VOL/VOL
   FIELD CAPACITY                =      0.7470 VOL/VOL
   WILTING POINT                 =      0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT    =      0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. COND.     =  0.499999997000E-08 CM/SEC



           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
          SPECIFIED CURVE NUMBER OF 86.0, A SURFACE SLOPE
          OF  2.% AND A SLOPE LENGTH OF 1500. FEET.

SCS RUNOFF CURVE NUMBER             =     84.90
FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
EVAPORATIVE ZONE DEPTH              =     12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      2.369  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =      5.556  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      1.392  INCHES
INITIAL SNOW WATER                  =      1.607  INCHES
INITIAL WATER IN LAYER MATERIALS    =     78.001  INCHES
TOTAL INITIAL WATER                 =     79.608  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR
```

```
               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BETHEL                ALASKA

        STATION LATITUDE                        =  60.78 DEGREES
        MAXIMUM LEAF AREA INDEX                 =   0.00
        START OF GROWING SEASON (JULIAN DATE)   =    184
        END OF GROWING SEASON (JULIAN DATE)     =    225
        EVAPORATIVE ZONE DEPTH                  =  12.0  INCHES
        AVERAGE ANNUAL WIND SPEED               =  12.90 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  75.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  78.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  83.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  80.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    MEDFORD             OREGON

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  1.06        0.93        0.68        0.34        0.72        1.23
  2.05        2.61        2.50        1.56        1.04        1.28


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BETHEL              ALASKA

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  4.90        5.70       10.70       23.40       40.30       50.60
 54.70       52.80       45.00       29.70       17.50        4.80


    NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BETHEL              ALASKA
               AND STATION LATITUDE  =  60.78 DEGREES
```

```
*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                            INCHES          CU. FEET     PERCENT
                                           --------        ----------    -------
  PRECIPITATION                             16.51           59931.316    100.00

  RUNOFF                                     3.383          12281.097     20.49

  EVAPOTRANSPIRATION                         8.669          31469.055     52.51

  RECIRCULATION INTO LAYER  2               37.283405     135338.766    225.82

  DRAINAGE COLLECTED FROM LAYER  3           0.0000             0.000      0.00

  RECIRCULATION FROM LAYER  3               37.283405     135338.766    225.82

  PERC./LEAKAGE THROUGH LAYER  5             0.000065           0.237      0.00

  AVG. HEAD ON TOP OF LAYER  4               0.7207

  CHANGE IN WATER STORAGE                    4.406          15993.635     26.69

  SOIL WATER AT START OF YEAR               78.001         283144.250

  SOIL WATER AT END OF YEAR                 82.407         299137.906

  SNOW WATER AT START OF YEAR                1.607           5833.651      9.73

  SNOW WATER AT END OF YEAR                  1.607           5833.651      9.73

  ANNUAL WATER BUDGET BALANCE                0.0516           187.292      0.31

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    2
-------------------------------------------------------------------------------
                                            INCHES          CU. FEET     PERCENT
                                           --------        ----------    -------
  PRECIPITATION                             16.85           61165.508    100.00

  RUNOFF                                     4.380          15898.184     25.99
```

```
  EVAPOTRANSPIRATION                         8.643          31372.676     51.29

  RECIRCULATION INTO LAYER  2              55.094719     199993.828    326.97

  DRAINAGE COLLECTED FROM LAYER  3           0.0000             0.000      0.00

  RECIRCULATION FROM LAYER  3              55.094719     199993.828    326.97

  PERC./LEAKAGE THROUGH LAYER  5             0.000099           0.360      0.00

  AVG. HEAD ON TOP OF LAYER  4               1.0661

  CHANGE IN WATER STORAGE                    3.777          13711.146     22.42

  SOIL WATER AT START OF YEAR               82.407         299137.906

  SOIL WATER AT END OF YEAR                 85.990         312145.281

  SNOW WATER AT START OF YEAR                1.607           5833.651      9.54

  SNOW WATER AT END OF YEAR                  1.801           6537.427     10.69

  ANNUAL WATER BUDGET BALANCE                0.0505           183.142      0.30

*******************************************************************************


*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    3
-------------------------------------------------------------------------------
                                          INCHES         CU. FEET     PERCENT
                                         --------       ----------    -------
  PRECIPITATION                             17.57          63779.121    100.00

  RUNOFF                                     4.354          15804.095     24.78

  EVAPOTRANSPIRATION                         6.533          23716.424     37.19

  RECIRCULATION INTO LAYER  2              79.268555     287744.844    451.16

  DRAINAGE COLLECTED FROM LAYER  3           0.0000             0.000      0.00

  RECIRCULATION FROM LAYER  3              79.268555     287744.844    451.16

  PERC./LEAKAGE THROUGH LAYER  5             0.000149           0.541      0.00

  AVG. HEAD ON TOP OF LAYER  4               1.5332
```

```
  CHANGE IN WATER STORAGE                  6.569         23844.197     37.39

  SOIL WATER AT START OF YEAR             85.990        312145.281

  SOIL WATER AT END OF YEAR               91.823        333318.437

  SNOW WATER AT START OF YEAR              1.801          6537.427     10.25

  SNOW WATER AT END OF YEAR                2.537          9208.442     14.44

  ANNUAL WATER BUDGET BALANCE              0.1140          413.864      0.65

*******************************************************************************



*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    4
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           19.89          72200.687    100.00

  RUNOFF                                   4.824         17510.082     24.25

  EVAPOTRANSPIRATION                      10.287         37342.996     51.72

  RECIRCULATION INTO LAYER  2            135.567825     492111.219    681.59

  DRAINAGE COLLECTED FROM LAYER  3         0.0000            0.000      0.00

  RECIRCULATION FROM LAYER  3            135.567825     492111.219    681.59

  PERC./LEAKAGE THROUGH LAYER  5           0.000281          1.019      0.00

  AVG. HEAD ON TOP OF LAYER  4             2.6159

  CHANGE IN WATER STORAGE                  4.558         16546.576     22.92

  SOIL WATER AT START OF YEAR             91.823        333318.437

  SOIL WATER AT END OF YEAR               97.840        355157.812

  SNOW WATER AT START OF YEAR              2.537          9208.442     12.75

  SNOW WATER AT END OF YEAR                1.079          3915.669      5.42
```

```
  ANNUAL WATER BUDGET BALANCE              0.2204          800.017      1.11

*******************************************************************************



*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    5
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           17.34          62944.215    100.00

  RUNOFF                                   2.998         10882.966     17.29

  EVAPOTRANSPIRATION                       9.155         33233.090     52.80

  RECIRCULATION INTO LAYER  2            208.536835     756988.687   1202.63

  DRAINAGE COLLECTED FROM LAYER  3         0.0000            0.000      0.00

  RECIRCULATION FROM LAYER  3            208.536835     756988.687   1202.63

  PERC./LEAKAGE THROUGH LAYER  5           0.000475          1.724      0.00

  AVG. HEAD ON TOP OF LAYER  4             4.0351

  CHANGE IN WATER STORAGE                  5.046         18316.727     29.10

  SOIL WATER AT START OF YEAR             97.840        355157.812

  SOIL WATER AT END OF YEAR              100.986        366577.500

  SNOW WATER AT START OF YEAR              1.079          3915.669      6.22

  SNOW WATER AT END OF YEAR                2.979         10812.708     17.18

  ANNUAL WATER BUDGET BALANCE              0.1404          509.709      0.81

*******************************************************************************




*******************************************************************************
```

```
         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 0.89     1.06     0.58     0.33     0.82     1.05
                           1.21     3.46     4.29     1.55     0.90     1.49

    STD. DEVIATIONS        0.26     0.32     0.24     0.19     0.79     1.06
                           1.57     1.26     1.59     0.91     0.31     0.31

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.023    1.723    0.937    0.102
                           0.160    0.391    0.506    0.000    0.145    0.000

    STD. DEVIATIONS        0.000    0.000    0.052    0.922    0.782    0.216
                           0.228    0.264    0.413    0.000    0.138    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 0.312    0.326    0.351    0.382    0.048    2.033
                           0.982    1.286    1.451    0.803    0.456    0.226

    STD. DEVIATIONS        0.049    0.041    0.086    0.094    0.080    0.398
                           0.824    0.685    0.343    0.103    0.189    0.051

  LATERAL DRAINAGE RECIRCULATED INTO LAYER  2
  -------------------------------------------
    TOTALS                 7.6167   6.9397   7.6167   7.3710   7.6167   7.3527
                           8.4689   8.5754   8.8349  10.7382  10.8286  11.1907

    STD. DEVIATIONS        5.3722   4.8778   5.3721   5.1988   5.3721   5.3700
                           5.6981   5.9978   6.1455   7.0109   6.7135   6.9350

  LATERAL DRAINAGE COLLECTED FROM LAYER  3
  ----------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  LATERAL DRAINAGE RECIRCULATED FROM LAYER  3
  -------------------------------------------
    TOTALS                 7.6167   6.9397   7.6167   7.3710   7.6167   7.3527
                           8.4689   8.5754   8.8349  10.7382  10.8286  11.1907
```

```
    STD. DEVIATIONS        5.3722   4.8778   5.3721   5.1988   5.3721   5.3700
                           5.6981   5.9978   6.1455   7.0109   6.7135   6.9350

  PERCOLATION/LEAKAGE THROUGH LAYER  5
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
              AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  4
  -------------------------------------
    AVERAGES               1.7364   1.7364   1.7364   1.7363   1.7363   1.7320
                           1.9306   1.9549   2.0812   2.4480   2.5508   2.5511

    STD. DEVIATIONS        1.2247   1.2247   1.2247   1.2247   1.2247   1.2650
                           1.2990   1.3673   1.4477   1.5983   1.5815   1.5810

*******************************************************************************



*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------
                                      INCHES            CU. FEET      PERCENT
                                 -------------------  -------------  ---------
 PRECIPITATION                     17.63    (   1.328)      64004.2     100.00

 RUNOFF                             3.988   (  0.7634)      14475.28     22.616

 EVAPOTRANSPIRATION                 8.658   (  1.3616)      31426.85     49.101

 DRAINAGE RECIRCULATED            103.15027 ( 69.59768)    374435.469  585.01727
   INTO LAYER  2

 LATERAL DRAINAGE COLLECTED         0.00000 (  0.00000)         0.000    0.00000
   FROM LAYER  3

 DRAINAGE RECIRCULATED            103.15027 ( 69.59768)    374435.469  585.01727
   FROM LAYER  3
```

```
 PERCOLATION/LEAKAGE THROUGH     0.00021 (  0.00017)         0.776     0.00121
   LAYER  5

 AVERAGE HEAD ON TOP             1.994 (    1.346)
   OF LAYER  4

 CHANGE IN WATER STORAGE         4.871   (  1.0516)      17682.46     27.627

*******************************************************************************


↑
******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH    5
   ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
      PRECIPITATION                              2.69          9764.700

      RUNOFF                                     1.325         4810.1763

      DRAINAGE RECIRCULATED INTO LAYER  2        0.66146       2401.09497

      DRAINAGE COLLECTED FROM LAYER  3           0.00000          0.00000

      DRAINAGE RECIRCULATED FROM LAYER  3        0.66146       2401.09497

      PERCOLATION/LEAKAGE THROUGH LAYER  5       0.000002         0.00569

      AVERAGE HEAD ON TOP OF LAYER  4            4.675

      MAXIMUM HEAD ON TOP OF LAYER  4            7.628

      LOCATION OF MAXIMUM HEAD IN LAYER  3
            (DISTANCE FROM DRAIN)               29.2 FEET

      SNOW WATER                                 3.82         13867.8398


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.3679

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.1160

       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
```

```
                           ASCE Journal of Environmental Engineering
                           Vol. 119, No. 2, March 1993, pp. 262-270.

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******************************************************************************

                  FINAL WATER STORAGE AT END OF YEAR    5
    ----------------------------------------------------------------------
                   LAYER        (INCHES)       (VOL/VOL)
                   -----        --------       ---------
                     1            3.2889         0.2741

                     2           94.9689         0.3957

                     3            2.5477         0.1415

                     4            0.0000         0.0000

                     5            0.1800         0.7500

                  SNOW WATER      2.979

******************************************************************************
******************************************************************************
```

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\HELP3\FINAL.D4
TEMPERATURE DATA FILE:      C:\HELP3\FINAL.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\FINAL.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\FINAL.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\FINAL.D10
OUTPUT DATA FILE:           C:\HELP3\FINAL.OUT


TIME:  17:15     DATE:   5/ 4/2020


******************************************************************************

     TITLE:  MAT-SU LANDFILL FINAL COVER CONDITION

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   8
           THICKNESS                   =      6.00   INCHES
```

```
    POROSITY                    =      0.4630 VOL/VOL
    FIELD CAPACITY              =      0.2320 VOL/VOL
    WILTING POINT               =      0.1160 VOL/VOL
    INITIAL SOIL WATER CONTENT  =      0.1905 VOL/VOL
    EFFECTIVE SAT. HYD. COND.   =  0.369999994000E-03 CM/SEC
  NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
           FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.



                            LAYER  2
                            --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER   0
    THICKNESS                   =     18.00   INCHES
    POROSITY                    =      0.4170 VOL/VOL
    FIELD CAPACITY              =      0.0450 VOL/VOL
    WILTING POINT               =      0.0180 VOL/VOL
    INITIAL SOIL WATER CONTENT  =      0.0488 VOL/VOL
    EFFECTIVE SAT. HYD. COND.   =  0.100000001000     CM/SEC
    SLOPE                       =      4.00   PERCENT
    DRAINAGE LENGTH             =    160.0    FEET



                            LAYER  3
                            --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
    THICKNESS                   =      0.04   INCHES
    POROSITY                    =      0.0000 VOL/VOL
    FIELD CAPACITY              =      0.0000 VOL/VOL
    WILTING POINT               =      0.0000 VOL/VOL
    INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
    EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
    FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
    FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
    FML PLACEMENT QUALITY       =  4 - POOR



                            LAYER  4
                            --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
```

```
              MATERIAL TEXTURE NUMBER   8
THICKNESS                   =      6.00   INCHES
POROSITY                    =      0.4630 VOL/VOL
FIELD CAPACITY              =      0.2320 VOL/VOL
WILTING POINT               =      0.1160 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2320 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.369999994000E-03 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   8
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4630 VOL/VOL
FIELD CAPACITY              =      0.2320 VOL/VOL
WILTING POINT               =      0.1160 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2320 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.369999994000E-03 CM/SEC


                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                   =   2304.00   INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
WILTING POINT               =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     18.00   INCHES
POROSITY                    =      0.4170 VOL/VOL
FIELD CAPACITY              =      0.0450 VOL/VOL
WILTING POINT               =      0.0180 VOL/VOL
```

```
   INITIAL SOIL WATER CONTENT  =      0.0450 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.100000001000     CM/SEC
   SLOPE                       =      4.00   PERCENT
   DRAINAGE LENGTH             =    160.0    FEET



                           LAYER  8
                           --------

               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                   =      0.06   INCHES
   POROSITY                    =      0.0000 VOL/VOL
   FIELD CAPACITY              =      0.0000 VOL/VOL
   WILTING POINT               =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
   FML PLACEMENT QUALITY       =  3 - GOOD



                           LAYER  9
                           --------

                 TYPE 3 - BARRIER SOIL LINER
                 MATERIAL TEXTURE NUMBER   0
   THICKNESS                   =      0.24   INCHES
   POROSITY                    =      0.7500 VOL/VOL
   FIELD CAPACITY              =      0.7470 VOL/VOL
   WILTING POINT               =      0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.499999997000E-08 CM/SEC




           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
          SPECIFIED CURVE NUMBER OF 86.0, A SURFACE SLOPE
          OF  4.% AND A SLOPE LENGTH OF 1500. FEET.

SCS RUNOFF CURVE NUMBER             =     85.20
```

```
   FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH              =     24.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE   =      2.021  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE  =     10.284  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      1.020  INCHES
   INITIAL SNOW WATER                  =      1.607  INCHES
   INITIAL WATER IN LAYER MATERIALS    =    679.955  INCHES
   TOTAL INITIAL WATER                 =    681.562  INCHES
   TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BETHEL                ALASKA

        STATION LATITUDE                       =  60.78 DEGREES
        MAXIMUM LEAF AREA INDEX                =   3.50
        START OF GROWING SEASON (JULIAN DATE)  =    184
        END OF GROWING SEASON (JULIAN DATE)    =    225
        EVAPORATIVE ZONE DEPTH                 =  24.0  INCHES
        AVERAGE ANNUAL WIND SPEED              =  12.90 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  75.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  78.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  83.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  80.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    MEDFORD             OREGON

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  1.06        0.93        0.68        0.34        0.72        1.23
  2.05        2.61        2.50        1.56        1.04        1.28


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BETHEL              ALASKA

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)
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```
     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       4.90        5.70       10.70       23.40       40.30       50.60
      54.70       52.80       45.00       29.70       17.50        4.80


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BETHEL              ALASKA
                    AND STATION LATITUDE  =  60.78 DEGREES



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                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           17.15          62254.520    100.00

  RUNOFF                                   3.256         11819.186     18.99

  EVAPOTRANSPIRATION                       8.313         30176.988     48.47

  DRAINAGE COLLECTED FROM LAYER  2         5.7916        21023.621     33.77

  PERC./LEAKAGE THROUGH LAYER  3           0.000007          0.027      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.1128

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.023      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.004      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                 -0.211          -765.260     -1.23

  SOIL WATER AT START OF YEAR            681.347       2473291.000

  SOIL WATER AT END OF YEAR              681.137       2472525.500

  SNOW WATER AT START OF YEAR              1.607          5833.651      9.37

  SNOW WATER AT END OF YEAR                1.607          5833.651      9.37

  ANNUAL WATER BUDGET BALANCE              0.0000           -0.043      0.00
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                         ANNUAL TOTALS FOR YEAR    2
-------------------------------------------------------------------------------
                                             INCHES          CU. FEET     PERCENT
                                            --------        ----------    -------
  PRECIPITATION                               16.85          61165.508    100.00

  RUNOFF                                       3.412         12385.293     20.25

  EVAPOTRANSPIRATION                           7.552         27413.736     44.82

  DRAINAGE COLLECTED FROM LAYER  2             5.1570        18719.791     30.61

  PERC./LEAKAGE THROUGH LAYER  3               0.000007          0.024      0.00

  AVG. HEAD ON TOP OF LAYER  3                 0.1002

  DRAINAGE COLLECTED FROM LAYER  7             0.0000            0.020      0.00

  PERC./LEAKAGE THROUGH LAYER  9               0.000001          0.003      0.00

  AVG. HEAD ON TOP OF LAYER  8                 0.0000

  CHANGE IN WATER STORAGE                      0.729          2646.615      4.33

  SOIL WATER AT START OF YEAR                681.137       2472525.500

  SOIL WATER AT END OF YEAR                  681.672       2474468.500

  SNOW WATER AT START OF YEAR                  1.607          5833.651      9.54

  SNOW WATER AT END OF YEAR                    1.801          6537.427     10.69

  ANNUAL WATER BUDGET BALANCE                  0.0000            0.050      0.00

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                         ANNUAL TOTALS FOR YEAR    3
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                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           17.57          63779.121    100.00

  RUNOFF                                   3.279         11902.514     18.66

  EVAPOTRANSPIRATION                       5.963         21644.273     33.94

  DRAINAGE COLLECTED FROM LAYER  2         6.8639        24916.098     39.07

  PERC./LEAKAGE THROUGH LAYER  3           0.000009          0.032      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.1333

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.028      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.004      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                  1.465          5316.191      8.34

  SOIL WATER AT START OF YEAR            681.672       2474468.500

  SOIL WATER AT END OF YEAR              682.400       2477113.750

  SNOW WATER AT START OF YEAR              1.801          6537.427     10.25

  SNOW WATER AT END OF YEAR                2.537          9208.442     14.44

  ANNUAL WATER BUDGET BALANCE              0.0000            0.011      0.00

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                          ANNUAL TOTALS FOR YEAR    4
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           19.89          72200.687    100.00

  RUNOFF                                   3.892         14128.229     19.57

  EVAPOTRANSPIRATION                       9.472         34384.551     47.62

  DRAINAGE COLLECTED FROM LAYER  2         8.3944        30471.543     42.20
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  PERC./LEAKAGE THROUGH LAYER  3           0.000011          0.039      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.1629

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.034      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.004      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                 -1.869         -6783.635     -9.40

  SOIL WATER AT START OF YEAR            682.400       2477113.750

  SOIL WATER AT END OF YEAR              681.990       2475622.750

  SNOW WATER AT START OF YEAR              2.537          9208.442     12.75

  SNOW WATER AT END OF YEAR                1.079          3915.669      5.42

  ANNUAL WATER BUDGET BALANCE              0.0000           -0.037      0.00

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                          ANNUAL TOTALS FOR YEAR    5
------------------------------------------------------------------------------
                                          INCHES          CU. FEET     PERCENT
                                         --------        ----------    -------
  PRECIPITATION                            18.12          65775.625    100.00

  RUNOFF                                   2.870          10416.285     15.84

  EVAPOTRANSPIRATION                       8.321          30203.686     45.92

  DRAINAGE COLLECTED FROM LAYER  2         4.8925         17759.646     27.00

  PERC./LEAKAGE THROUGH LAYER  3           0.000006          0.023      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.0952

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.019      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.003      0.00
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  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                  2.037          7395.986     11.24

  SOIL WATER AT START OF YEAR            681.990       2475622.750

  SOIL WATER AT END OF YEAR              682.127       2476121.750

  SNOW WATER AT START OF YEAR              1.079          3915.669      5.95

  SNOW WATER AT END OF YEAR                2.979         10812.708     16.44

  ANNUAL WATER BUDGET BALANCE              0.0000           -0.004      0.00

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                          ANNUAL TOTALS FOR YEAR    6
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           10.20          37026.008    100.00

  RUNOFF                                   4.110         14919.498     40.29

  EVAPOTRANSPIRATION                       3.754         13627.629     36.81

  DRAINAGE COLLECTED FROM LAYER  2         2.7832        10103.009     27.29

  PERC./LEAKAGE THROUGH LAYER  3           0.000004          0.014      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.0546

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.012      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.002      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                 -0.447         -1624.078     -4.39

  SOIL WATER AT START OF YEAR            682.127       2476121.750

  SOIL WATER AT END OF YEAR              681.529       2473949.750

  SNOW WATER AT START OF YEAR              2.979         10812.708     29.20
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  SNOW WATER AT END OF YEAR                3.130         11360.559     30.68

  ANNUAL WATER BUDGET BALANCE              0.0000           -0.062      0.00

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                          ANNUAL TOTALS FOR YEAR    7
-------------------------------------------------------------------------------
                                        INCHES          CU. FEET     PERCENT
                                       --------        ----------    -------
  PRECIPITATION                         24.92          90459.617    100.00

  RUNOFF                                 7.175         26045.891     28.79

  EVAPOTRANSPIRATION                     9.895         35920.520     39.71

  DRAINAGE COLLECTED FROM LAYER  2      10.1934        37002.191     40.90

  PERC./LEAKAGE THROUGH LAYER  3         0.000013          0.046      0.00

  AVG. HEAD ON TOP OF LAYER  3           0.1962

  DRAINAGE COLLECTED FROM LAYER  7       0.0000            0.042      0.00

  PERC./LEAKAGE THROUGH LAYER  9         0.000001          0.004      0.00

  AVG. HEAD ON TOP OF LAYER  8           0.0000

  CHANGE IN WATER STORAGE               -2.344         -8509.229     -9.41

  SOIL WATER AT START OF YEAR          681.529       2473949.750

  SOIL WATER AT END OF YEAR            681.685       2474518.000

  SNOW WATER AT START OF YEAR            3.130         11360.559     12.56

  SNOW WATER AT END OF YEAR              0.629          2283.034      2.52

  ANNUAL WATER BUDGET BALANCE            0.0001            0.201      0.00

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                          ANNUAL TOTALS FOR YEAR    8
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           16.61          60294.309    100.00

  RUNOFF                                   3.504         12718.188     21.09

  EVAPOTRANSPIRATION                       6.879         24969.205     41.41

  DRAINAGE COLLECTED FROM LAYER  2         6.3496        23049.115     38.23

  PERC./LEAKAGE THROUGH LAYER  3           0.000008          0.029      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.1225

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.026      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.003      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                 -0.122          -442.227     -0.73

  SOIL WATER AT START OF YEAR            681.685       2474518.000

  SOIL WATER AT END OF YEAR              681.562       2474069.000

  SNOW WATER AT START OF YEAR              0.629          2283.034      3.79

  SNOW WATER AT END OF YEAR                0.631          2289.904      3.80

  ANNUAL WATER BUDGET BALANCE              0.0000           -0.002      0.00

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                          ANNUAL TOTALS FOR YEAR    9
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           15.52          56337.605    100.00
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  RUNOFF                                   1.975          7168.051     12.72

  EVAPOTRANSPIRATION                       7.279         26422.861     46.90

  DRAINAGE COLLECTED FROM LAYER  2         5.5855        20275.471     35.99

  PERC./LEAKAGE THROUGH LAYER  3           0.000007          0.026      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.1082

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.023      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.003      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                  0.681          2471.336      4.39

  SOIL WATER AT START OF YEAR            681.562       2474069.000

  SOIL WATER AT END OF YEAR              681.906       2475320.250

  SNOW WATER AT START OF YEAR              0.631          2289.904      4.06

  SNOW WATER AT END OF YEAR                0.967          3509.883      6.23

  ANNUAL WATER BUDGET BALANCE              0.0000           -0.140      0.00

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                          ANNUAL TOTALS FOR YEAR   10
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           16.70          60621.008    100.00

  RUNOFF                                   2.294          8326.901     13.74

  EVAPOTRANSPIRATION                       7.786         28261.469     46.62

  DRAINAGE COLLECTED FROM LAYER  2         4.2838        15550.221     25.65

  PERC./LEAKAGE THROUGH LAYER  3           0.000006          0.021      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.0829
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  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.017      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.004      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                  2.337          8482.311     13.99

  SOIL WATER AT START OF YEAR            681.906       2475320.250

  SOIL WATER AT END OF YEAR              681.923       2475380.250

  SNOW WATER AT START OF YEAR              0.967          3509.883      5.79

  SNOW WATER AT END OF YEAR                3.287         11932.372     19.68

  ANNUAL WATER BUDGET BALANCE              0.0000            0.088      0.00

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                          ANNUAL TOTALS FOR YEAR   11
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           15.56          56482.812    100.00

  RUNOFF                                   6.246         22671.586     40.14

  EVAPOTRANSPIRATION                       6.445         23396.611     41.42

  DRAINAGE COLLECTED FROM LAYER  2         4.1989        15242.148     26.99

  PERC./LEAKAGE THROUGH LAYER  3           0.000005          0.020      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.0818

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.017      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.003      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                 -1.330         -4827.645     -8.55
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  SOIL WATER AT START OF YEAR            681.923       2475380.250

  SOIL WATER AT END OF YEAR              682.784       2478507.000

  SNOW WATER AT START OF YEAR              3.287         11932.372     21.13

  SNOW WATER AT END OF YEAR                1.096          3977.885      7.04

  ANNUAL WATER BUDGET BALANCE              0.0000            0.092      0.00

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                          ANNUAL TOTALS FOR YEAR   12
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           13.10          47553.000    100.00

  RUNOFF                                   3.255         11815.114     24.85

  EVAPOTRANSPIRATION                       7.557         27432.793     57.69

  DRAINAGE COLLECTED FROM LAYER  2         3.0748        11161.594     23.47

  PERC./LEAKAGE THROUGH LAYER  3           0.000004          0.016      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.0598

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.012      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.004      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                 -0.787         -2856.515     -6.01

  SOIL WATER AT START OF YEAR            682.784       2478507.000

  SOIL WATER AT END OF YEAR              682.368       2476996.000

  SNOW WATER AT START OF YEAR              1.096          3977.885      8.37

  SNOW WATER AT END OF YEAR                0.725          2632.393      5.54

  ANNUAL WATER BUDGET BALANCE              0.0000            0.000      0.00
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                      ANNUAL TOTALS FOR YEAR   13
-------------------------------------------------------------------------------
                                        INCHES        CU. FEET     PERCENT
                                       --------      ----------    -------
  PRECIPITATION                          14.67        53252.098    100.00

  RUNOFF                                  2.523        9157.834     17.20

  EVAPOTRANSPIRATION                      6.963       25274.764     47.46

  DRAINAGE COLLECTED FROM LAYER  2        5.3135      19287.846     36.22

  PERC./LEAKAGE THROUGH LAYER  3          0.000007        0.025      0.00

  AVG. HEAD ON TOP OF LAYER  3            0.1027

  DRAINAGE COLLECTED FROM LAYER  7        0.0000          0.021      0.00

  PERC./LEAKAGE THROUGH LAYER  9          0.000001        0.004      0.00

  AVG. HEAD ON TOP OF LAYER  8            0.0000

  CHANGE IN WATER STORAGE                -0.129        -468.194     -0.88

  SOIL WATER AT START OF YEAR           682.368     2476996.000

  SOIL WATER AT END OF YEAR             681.619     2474275.750

  SNOW WATER AT START OF YEAR             0.725        2632.393      4.94

  SNOW WATER AT END OF YEAR               1.346        4884.483      9.17

  ANNUAL WATER BUDGET BALANCE             0.0000         -0.177      0.00

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                      ANNUAL TOTALS FOR YEAR   14
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-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           10.69          38804.703    100.00

  RUNOFF                                   1.843          6691.423     17.24

  EVAPOTRANSPIRATION                       4.918         17850.895     46.00

  DRAINAGE COLLECTED FROM LAYER  2         3.6285        13171.343     33.94

  PERC./LEAKAGE THROUGH LAYER  3           0.000005          0.017      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.0711

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.015      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.003      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                  0.301          1090.954      2.81

  SOIL WATER AT START OF YEAR            681.619       2474275.750

  SOIL WATER AT END OF YEAR              680.711       2470980.750

  SNOW WATER AT START OF YEAR              1.346          4884.483     12.59

  SNOW WATER AT END OF YEAR                2.554          9270.442     23.89

  ANNUAL WATER BUDGET BALANCE              0.0000            0.070      0.00

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                          ANNUAL TOTALS FOR YEAR   15
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           14.68          53288.414    100.00

  RUNOFF                                   2.676          9713.694     18.23

  EVAPOTRANSPIRATION                       7.434         26984.105     50.64
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  DRAINAGE COLLECTED FROM LAYER  2         4.4974        16325.490     30.64

  PERC./LEAKAGE THROUGH LAYER  3           0.000006          0.021      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.0880

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.018      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.003      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                  0.073           265.137      0.50

  SOIL WATER AT START OF YEAR            680.711       2470980.750

  SOIL WATER AT END OF YEAR              681.309       2473151.250

  SNOW WATER AT START OF YEAR              2.554          9270.442     17.40

  SNOW WATER AT END OF YEAR                2.029          7364.979     13.82

  ANNUAL WATER BUDGET BALANCE              0.0000           -0.033      0.00

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                          ANNUAL TOTALS FOR YEAR   16
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           18.70         67881.016    100.00

  RUNOFF                                   4.898         17780.273     26.19

  EVAPOTRANSPIRATION                       7.389         26821.268     39.51

  DRAINAGE COLLECTED FROM LAYER  2         6.0095        21814.375     32.14

  PERC./LEAKAGE THROUGH LAYER  3           0.000008          0.028      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.1164

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.024      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.004      0.00
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  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                  0.404          1464.941      2.16

  SOIL WATER AT START OF YEAR            681.309       2473151.250

  SOIL WATER AT END OF YEAR              682.807       2478588.000

  SNOW WATER AT START OF YEAR              2.029          7364.979     10.85

  SNOW WATER AT END OF YEAR                0.935          3393.118      5.00

  ANNUAL WATER BUDGET BALANCE              0.0000            0.131      0.00

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                          ANNUAL TOTALS FOR YEAR   17
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                            6.71          24357.297    100.00

  RUNOFF                                   1.930          7006.661     28.77

  EVAPOTRANSPIRATION                       3.716         13487.886     55.38

  DRAINAGE COLLECTED FROM LAYER  2         2.2498         8166.740     33.53

  PERC./LEAKAGE THROUGH LAYER  3           0.000003          0.012      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.0442

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.009      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.003      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                 -1.186         -4303.947    -17.67

  SOIL WATER AT START OF YEAR            682.807       2478588.000

  SOIL WATER AT END OF YEAR              680.541       2470364.000
```

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  SNOW WATER AT START OF YEAR              0.935          3393.118     13.93

  SNOW WATER AT END OF YEAR                2.015          7313.168     30.02

  ANNUAL WATER BUDGET BALANCE              0.0000           -0.056      0.00

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                          ANNUAL TOTALS FOR YEAR   18
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        ---------       ----------    -------
  PRECIPITATION                            9.58          34775.398    100.00

  RUNOFF                                   2.045          7422.304     21.34

  EVAPOTRANSPIRATION                       5.473         19867.318     57.13

  DRAINAGE COLLECTED FROM LAYER  2         2.0272         7358.789     21.16

  PERC./LEAKAGE THROUGH LAYER  3           0.000003          0.011      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.0397

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.008      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.003      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                  0.035           126.942      0.37

  SOIL WATER AT START OF YEAR            680.541       2470364.000

  SOIL WATER AT END OF YEAR              681.421       2473557.000

  SNOW WATER AT START OF YEAR              2.015          7313.168     21.03

  SNOW WATER AT END OF YEAR                1.170          4247.243     12.21

  ANNUAL WATER BUDGET BALANCE              0.0000            0.035      0.00

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                          ANNUAL TOTALS FOR YEAR   19
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           17.82          64686.621    100.00

  RUNOFF                                   3.095         11233.452     17.37

  EVAPOTRANSPIRATION                       7.875         28584.586     44.19

  DRAINAGE COLLECTED FROM LAYER  2         6.0785        22065.051     34.11

  PERC./LEAKAGE THROUGH LAYER  3           0.000008          0.028      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.1176

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.024      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.004      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                  0.772          2803.564      4.33

  SOIL WATER AT START OF YEAR            681.421       2473557.000

  SOIL WATER AT END OF YEAR              681.888       2475253.000

  SNOW WATER AT START OF YEAR              1.170          4247.243      6.57

  SNOW WATER AT END OF YEAR                1.475          5354.783      8.28

  ANNUAL WATER BUDGET BALANCE              0.0000           -0.063      0.00

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                          ANNUAL TOTALS FOR YEAR   20
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           17.73          64359.906    100.00
```

```
  RUNOFF                                   2.791          10133.074     15.74

  EVAPOTRANSPIRATION                      10.440          37896.406     58.88

  DRAINAGE COLLECTED FROM LAYER  2         3.6608         13288.829     20.65

  PERC./LEAKAGE THROUGH LAYER  3           0.000005           0.018      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.0702

  DRAINAGE COLLECTED FROM LAYER  7         0.0000             0.013      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001           0.005      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                  0.838           3041.615      4.73

  SOIL WATER AT START OF YEAR            681.888        2475253.000

  SOIL WATER AT END OF YEAR              682.365        2476985.500

  SNOW WATER AT START OF YEAR              1.475           5354.783      8.32

  SNOW WATER AT END OF YEAR                1.836           6663.817     10.35

  ANNUAL WATER BUDGET BALANCE              0.0000            -0.037      0.00

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                          ANNUAL TOTALS FOR YEAR   21
-------------------------------------------------------------------------------
                                        INCHES          CU. FEET     PERCENT
                                       --------        ----------    -------
  PRECIPITATION                         25.32           91911.625    100.00

  RUNOFF                                 5.127          18611.855     20.25

  EVAPOTRANSPIRATION                    10.892          39536.898     43.02

  DRAINAGE COLLECTED FROM LAYER  2      10.7789         39127.340     42.57

  PERC./LEAKAGE THROUGH LAYER  3         0.000013           0.048      0.00
```

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  AVG. HEAD ON TOP OF LAYER  3            0.2081

  DRAINAGE COLLECTED FROM LAYER  7        0.0000            0.044      0.00

  PERC./LEAKAGE THROUGH LAYER  9          0.000001          0.004      0.00

  AVG. HEAD ON TOP OF LAYER  8            0.0000

  CHANGE IN WATER STORAGE                -1.478         -5364.717     -5.84

  SOIL WATER AT START OF YEAR           682.365       2476985.500

  SOIL WATER AT END OF YEAR             681.863       2475164.250

  SNOW WATER AT START OF YEAR             1.836          6663.817      7.25

  SNOW WATER AT END OF YEAR               0.860          3120.525      3.40

  ANNUAL WATER BUDGET BALANCE             0.0001            0.203      0.00

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                          ANNUAL TOTALS FOR YEAR   22
------------------------------------------------------------------------------
                                        INCHES          CU. FEET     PERCENT
                                       --------        ----------    -------
  PRECIPITATION                          21.17          76847.102    100.00

  RUNOFF                                  3.138         11391.223     14.82

  EVAPOTRANSPIRATION                     11.160         40511.137     52.72

  DRAINAGE COLLECTED FROM LAYER  2        5.3803        19530.611     25.41

  PERC./LEAKAGE THROUGH LAYER  3          0.000007          0.025      0.00

  AVG. HEAD ON TOP OF LAYER  3            0.1047

  DRAINAGE COLLECTED FROM LAYER  7        0.0000            0.021      0.00

  PERC./LEAKAGE THROUGH LAYER  9          0.000001          0.004      0.00

  AVG. HEAD ON TOP OF LAYER  8            0.0000

  CHANGE IN WATER STORAGE                 1.492          5414.158      7.05
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  SOIL WATER AT START OF YEAR            681.863      2475164.250

  SOIL WATER AT END OF YEAR              682.044      2475819.000

  SNOW WATER AT START OF YEAR              0.860         3120.525      4.06

  SNOW WATER AT END OF YEAR                2.171         7879.759     10.25

  ANNUAL WATER BUDGET BALANCE              0.0000          -0.053      0.00

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                          ANNUAL TOTALS FOR YEAR   23
-------------------------------------------------------------------------------
                                         INCHES         CU. FEET     PERCENT
                                        --------       ----------    -------
  PRECIPITATION                           12.26         44503.801    100.00

  RUNOFF                                   3.348        12152.770     27.31

  EVAPOTRANSPIRATION                       7.275        26407.336     59.34

  DRAINAGE COLLECTED FROM LAYER  2         3.2078       11644.252     26.16

  PERC./LEAKAGE THROUGH LAYER  3           0.000004         0.016      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.0625

  DRAINAGE COLLECTED FROM LAYER  7         0.0000           0.012      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001         0.004      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                 -1.570        -5700.480    -12.81

  SOIL WATER AT START OF YEAR            682.044      2475819.000

  SOIL WATER AT END OF YEAR              681.783      2474871.750

  SNOW WATER AT START OF YEAR              2.171         7879.759     17.71

  SNOW WATER AT END OF YEAR                0.861         3126.659      7.03
```

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  ANNUAL WATER BUDGET BALANCE              0.0000           -0.093      0.00

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                          ANNUAL TOTALS FOR YEAR   24
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           17.29          62762.703    100.00

  RUNOFF                                   3.035         11016.222     17.55

  EVAPOTRANSPIRATION                       8.470         30747.002     48.99

  DRAINAGE COLLECTED FROM LAYER  2         5.2622        19101.684     30.43

  PERC./LEAKAGE THROUGH LAYER  3           0.000007          0.025      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.1012

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.021      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.004      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                  0.523          1897.791      3.02

  SOIL WATER AT START OF YEAR            681.783       2474871.750

  SOIL WATER AT END OF YEAR              682.369       2477001.000

  SNOW WATER AT START OF YEAR              0.861          3126.659      4.98

  SNOW WATER AT END OF YEAR                0.798          2895.060      4.61

  ANNUAL WATER BUDGET BALANCE              0.0000           -0.019      0.00

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                       ANNUAL TOTALS FOR YEAR   25
-------------------------------------------------------------------------------
                                        INCHES         CU. FEET     PERCENT
                                       --------       ----------    -------
  PRECIPITATION                          18.90         68607.008    100.00

  RUNOFF                                  3.088        11209.370     16.34

  EVAPOTRANSPIRATION                      7.662        27812.826     40.54

  DRAINAGE COLLECTED FROM LAYER  2        7.3422       26652.172     38.85

  PERC./LEAKAGE THROUGH LAYER  3          0.000009         0.034      0.00

  AVG. HEAD ON TOP OF LAYER  3            0.1416

  DRAINAGE COLLECTED FROM LAYER  7        0.0000           0.030      0.00

  PERC./LEAKAGE THROUGH LAYER  9          0.000001         0.004      0.00

  AVG. HEAD ON TOP OF LAYER  8            0.0000

  CHANGE IN WATER STORAGE                 0.808         2932.414      4.27

  SOIL WATER AT START OF YEAR           682.369      2477001.000

  SOIL WATER AT END OF YEAR             682.477      2477390.750

  SNOW WATER AT START OF YEAR             0.798         2895.060      4.22

  SNOW WATER AT END OF YEAR               1.498         5437.753      7.93

  ANNUAL WATER BUDGET BALANCE             0.0001           0.190      0.00

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                       ANNUAL TOTALS FOR YEAR   26
-------------------------------------------------------------------------------
                                        INCHES         CU. FEET     PERCENT
                                       --------       ----------    -------
  PRECIPITATION                          13.42         48714.613    100.00

  RUNOFF                                  4.962        18012.961     36.98

  EVAPOTRANSPIRATION                      4.997        18139.443     37.24
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  DRAINAGE COLLECTED FROM LAYER  2         4.4314        16086.002     33.02

  PERC./LEAKAGE THROUGH LAYER  3           0.000006          0.021      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.0866

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.018      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.003      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                 -0.971         -3523.790     -7.23

  SOIL WATER AT START OF YEAR            682.477       2477390.750

  SOIL WATER AT END OF YEAR              681.910       2475332.000

  SNOW WATER AT START OF YEAR              1.498          5437.753     11.16

  SNOW WATER AT END OF YEAR                1.094          3972.677      8.16

  ANNUAL WATER BUDGET BALANCE              0.0000           -0.024      0.00

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                          ANNUAL TOTALS FOR YEAR   27
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           10.58          38405.406    100.00

  RUNOFF                                   2.630          9545.321     24.85

  EVAPOTRANSPIRATION                       5.523         20050.154     52.21

  DRAINAGE COLLECTED FROM LAYER  2         2.8546        10362.299     26.98

  PERC./LEAKAGE THROUGH LAYER  3           0.000004          0.014      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.0560

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.012      0.00
```

```
  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.003      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                 -0.428         -1552.336     -4.04

  SOIL WATER AT START OF YEAR            681.910       2475332.000

  SOIL WATER AT END OF YEAR              681.451       2473668.750

  SNOW WATER AT START OF YEAR              1.094          3972.677     10.34

  SNOW WATER AT END OF YEAR                1.125          4083.574     10.63

  ANNUAL WATER BUDGET BALANCE              0.0000           -0.046      0.00

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                          ANNUAL TOTALS FOR YEAR   28
------------------------------------------------------------------------------
                                         INCHES         CU. FEET     PERCENT
                                        --------       ----------    -------
  PRECIPITATION                           20.27         73580.133    100.00

  RUNOFF                                   4.452        16160.196     21.96

  EVAPOTRANSPIRATION                       8.170        29657.270     40.31

  DRAINAGE COLLECTED FROM LAYER  2         2.9136       10576.277     14.37

  PERC./LEAKAGE THROUGH LAYER  3           0.000004          0.015      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.0565

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.011      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.003      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                  4.735        17186.283     23.36

  SOIL WATER AT START OF YEAR            681.451       2473668.750

  SOIL WATER AT END OF YEAR              681.891       2475264.750
```

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  SNOW WATER AT START OF YEAR                1.125          4083.574      5.55

  SNOW WATER AT END OF YEAR                  5.420         19673.979     26.74

  ANNUAL WATER BUDGET BALANCE                0.0000            0.087      0.00

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                          ANNUAL TOTALS FOR YEAR   29
------------------------------------------------------------------------------
                                           INCHES          CU. FEET     PERCENT
                                          --------        ----------   -------
  PRECIPITATION                              8.08          29330.410    100.00

  RUNOFF                                     3.663         13298.250     45.34

  EVAPOTRANSPIRATION                         6.094         22121.936     75.42

  DRAINAGE COLLECTED FROM LAYER  2           3.0184        10956.649     37.36

  PERC./LEAKAGE THROUGH LAYER  3             0.000004          0.016      0.00

  AVG. HEAD ON TOP OF LAYER  3               0.0592

  DRAINAGE COLLECTED FROM LAYER  7           0.0000            0.012      0.00

  PERC./LEAKAGE THROUGH LAYER  9             0.000001          0.004      0.00

  AVG. HEAD ON TOP OF LAYER  8               0.0000

  CHANGE IN WATER STORAGE                   -4.696        -17046.385    -58.12

  SOIL WATER AT START OF YEAR              681.891       2475264.750

  SOIL WATER AT END OF YEAR                680.891       2471633.000

  SNOW WATER AT START OF YEAR                5.420         19673.979     67.08

  SNOW WATER AT END OF YEAR                  1.724          6259.367     21.34

  ANNUAL WATER BUDGET BALANCE                0.0000           -0.056      0.00

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                          ANNUAL TOTALS FOR YEAR   30
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           11.42          41454.598    100.00

  RUNOFF                                   1.006          3653.490      8.81

  EVAPOTRANSPIRATION                       6.277         22784.221     54.96

  DRAINAGE COLLECTED FROM LAYER  2         2.0535         7454.063     17.98

  PERC./LEAKAGE THROUGH LAYER  3           0.000003          0.011      0.00

  AVG. HEAD ON TOP OF LAYER  3             0.0397

  DRAINAGE COLLECTED FROM LAYER  7         0.0000            0.007      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000001          0.004      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                  2.083          7562.750     18.24

  SOIL WATER AT START OF YEAR            680.891       2471633.000

  SOIL WATER AT END OF YEAR              681.584       2474149.250

  SNOW WATER AT START OF YEAR              1.724          6259.367     15.10

  SNOW WATER AT END OF YEAR                3.115         11305.887     27.27

  ANNUAL WATER BUDGET BALANCE              0.0000            0.062      0.00

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         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH   30
-------------------------------------------------------------------------------
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```
                       JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                       -------  -------  -------  -------  -------  -------
PRECIPITATION
-------------
  TOTALS                 1.05     1.03     0.61     0.33     0.73     0.87
                         1.96     2.24     2.91     1.69     1.09     1.21

  STD. DEVIATIONS        0.38     0.50     0.31     0.16     0.47     0.67
                         2.57     2.38     1.75     0.98     0.40     0.60

RUNOFF
------
  TOTALS                 0.000    0.030    0.114    1.309    0.784    0.119
                         0.327    0.249    0.255    0.115    0.082    0.000

  STD. DEVIATIONS        0.000    0.165    0.368    1.008    0.868    0.211
                         0.605    0.428    0.393    0.298    0.170    0.001

EVAPOTRANSPIRATION
------------------
  TOTALS                 0.314    0.295    0.393    0.405    0.119    1.388
                         0.971    1.071    1.125    0.626    0.370    0.253

  STD. DEVIATIONS        0.044    0.048    0.083    0.120    0.161    0.435
                         0.971    0.829    0.549    0.248    0.115    0.053

LATERAL DRAINAGE COLLECTED FROM LAYER  2
----------------------------------------
  TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0679   2.1703
                         0.5067   0.6805   0.9190   0.5546   0.0435   0.0000

  STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.2896   0.6092
                         1.0185   1.0731   0.9376   0.7895   0.1053   0.0000

PERCOLATION/LEAKAGE THROUGH LAYER  3
------------------------------------
  TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER  7
----------------------------------------
  TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
```

```
  PERCOLATION/LEAKAGE THROUGH LAYER  9
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  3
  -------------------------------------
    AVERAGES               0.0000   0.0000   0.0000   0.0000   0.0155   0.5112
                           0.1155   0.1551   0.2165   0.1264   0.0103   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0660   0.1435
                           0.2322   0.2446   0.2209   0.1800   0.0248   0.0000

  DAILY AVERAGE HEAD ON TOP OF LAYER  8
  -------------------------------------
    AVERAGES               0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   30
-------------------------------------------------------------------------------
                                      INCHES            CU. FEET      PERCENT
                               -------------------   -------------   ---------
 PRECIPITATION                  15.72    (   4.522)      57049.1     100.00

 RUNOFF                          3.384   (  1.3175)      12283.57     21.532

 EVAPOTRANSPIRATION              7.331   (  1.8785)      26612.99     46.649

 LATERAL DRAINAGE COLLECTED      4.94256 (  2.20715)     17941.479   31.44919
   FROM LAYER  2
```

```
 PERCOLATION/LEAKAGE THROUGH     0.00001 (  0.00000)         0.023     0.00004
   LAYER  3

 AVERAGE HEAD ON TOP             0.096 (    0.042)
   OF LAYER  3

 LATERAL DRAINAGE COLLECTED      0.00001 (  0.00000)         0.020    0.00003
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.004     0.00001
   LAYER  9

 AVERAGE HEAD ON TOP             0.000 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE         0.058   (  1.7120)        211.02      0.370

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                PEAK DAILY VALUES FOR YEARS    1 THROUGH   30
   ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------    -------------
      PRECIPITATION                              3.47         12596.101

      RUNOFF                                     1.997         7250.1348

      DRAINAGE COLLECTED FROM LAYER  2           0.89675       3255.20630

      PERCOLATION/LEAKAGE THROUGH LAYER  3       0.000001         0.00391

      AVERAGE HEAD ON TOP OF LAYER  3            6.337

      MAXIMUM HEAD ON TOP OF LAYER  3            9.939

      LOCATION OF MAXIMUM HEAD IN LAYER  2
            (DISTANCE FROM DRAIN)               34.3 FEET

      DRAINAGE COLLECTED FROM LAYER  7           0.00000          0.00207

      PERCOLATION/LEAKAGE THROUGH LAYER  9       0.000000         0.00002

      AVERAGE HEAD ON TOP OF LAYER  8            0.000

      MAXIMUM HEAD ON TOP OF LAYER  8            0.009
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      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)                0.0 FEET

      SNOW WATER                                 6.27         22769.7109


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.2351

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0456


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.


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                   FINAL WATER STORAGE AT END OF YEAR   30
    ----------------------------------------------------------------------
                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1            1.1746         0.1958

                      2            1.0832         0.0602

                      3            0.0000         0.0000

                      4            1.3920         0.2320

                      5            2.7840         0.2320

                      6          672.7681         0.2920

                      7            0.8100         0.0450

                      8            0.0000         0.0000

                      9            0.1800         0.7500
```

```
                  SNOW WATER       3.115

*******************************************************************************
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APPENDIX F – LEACHATE TREATMENT COST ESTIMATES

OPTION 2 - CONSTRUCTION COSTS

Item No.	Item Description		Capital Cost
1	MISC. SITE DEVELOPMENT COST	$	67,697
2	DEMOLITION	$	2,500
3	SITE WORK	$	320,525
4	ACCESS ROAD	$	-
5	LEACHATE PIPE FROM EXISTING LEACHATE FORCE MAIN TO (UST) LEACHATE TANK	$	20,803
6	CONCENTRATE TRANSPORT TO LANDFILL OPEN FACE, EQUIPMENT	$	117,500
7	PROCESS EQUIPMENT SYSTEM - LEACHATE (SKIDS, TANKS, HMI, SENSORS)	$	1,490,000
8	EYE WASH/SHOWER STATION, OVERALL PROCESS SENSORS, METERS, TRANSFER PUMPS	$	48,000
9	INTERIOR TANKS, MIXERS, WATER HEATER, AND SUPPORT STRUCTURES	$	91,000
10	MEP - POWER TO THE BUILDING	$	30,000
11	WASTEWATER TREAMTMENT BUILDING	$	441,750
12	CONTINGENCIES (13%) on Balance of Plant and (6%) on PROCESS EQUIP	$	237,571
13	Engineering (12%) on Balance of Plant Minus PROCESS EQUIP	$	136,773
14	Engineering Review and CM During Design (25% of Design Fee)	$	34,193
15	PROCESS Design (Skid, PLC, CIP System, Sensors)	$	192,000
16	Constr (Contract) Management (Admin) during Construction for Engineer (6.88%)	$	94,761
17	Contract Administration during Construction for the MANUFACTURER TEAM (2.4%)	$	30,637
18	Comissioning, Training, Trouble Shooting for PROCESS EQUIP Supplier	$	70,603

	TOTAL ESTIMATED CONSTRUCTION COST	**$**	**3,426,314**

OPTION 2 - ANNUAL O&M COSTS

Item No.	Item Description		Equivalent Uniform Annualized Cost
1	EQUIPMENT MAINTENANCE	$	15,000
2	SUPPLIES (CHEMICALS, CIP, ETC.)	$	17,000
3	UTILITIES (ELECTRICAL, NG, ETC.)	$	100
4	LABOR (Operating and Maintaining the Treatment Plant (2.5 hr/day, 5 days/week)	$	70,630

	TOTAL ESTIMATED O&M COSTS	**$**	**102,730**

OPTION 3 - CONSTRUCTION COSTS

Item No.	Item Description	Capital Cost
1	MISC. SITE DEVELOPMENT COST	$ 67,697
2	DEMOLITION	$ 2,500
3	SITE WORK	$ 324,525
4	ACCESS ROAD	$ -
5	EFFLUENT (PERMEATE) OUTFALL STRUCTURE	$ 25,400
6	EFFLUENT (PERMEATE) PIPE TO OUTFALL	$ 250,250
7	LEACHATE PIPE FROM EXISTING LEACHATE FORCE MAIN TO (UST) LEACHATE TANK	$ 20,803
8	CONCENTRATE TRANSPORT TO LANDFILL OPEN FACE, EQUIPMENT	$ 117,500
9	PROCESS EQUIPMENT SYSTEM - LEACHATE (SKIDS, TANKS, HMI, SENSORS)	$ 1,718,000
10	PROC. EQUIP INTERCONNECTION (MEP)	$ 65,000
11	EYE WASH/SHOWER STATION, OVERALL PROCESS SENSORS, METERS, TRANSFER PUMPS	$ 48,000
12	INTERIOR TANKS, MIXERS, WATER HEATER, AND SUPPORT STRUCTURES	$ 91,000
13	MEP - POWER TO THE BUILDING	$ 30,000
14	WASTEWATER TREAMTMENT BUILDING	$ 441,750
15	EXTERIOR TANKS AND SUPPORT STRUCTURES	$ 178,000
16	CONTINGENCIES (13%) on Balance of Plant and (6%) on PROCESS EQUIP	$ 314,000
17	Engineering Review and CM During Design (25% of Design Fee)	$ 57,250
18	Constr (Contract) Management (Admin) during Construction for Engineer (6.88%)	$ 133,790
19	Contract Administration during Construction for the MANUFACTURER TEAM (2.4%)	$ 45,870
20	Comissioning, Training, Trouble Shooting for PROCESS EQUIP Supplier	$ 70,603

	TOTAL ESTIMATED CONSTRUCTION COST	**$ 4,001,938**

OPTION 3 - COSTS OF PREVIOUSLY PERFORMED ENGINEERING (NOT APPLIED TO LIFE-CYCLE COST ANALYSIS)

Item No.	Item Description	Cost
1	Parametric Field Study (Includes Equip and Shipping to Site and Back)	$ 219,125
2	Engineering (12%) on Balance of Plant Minus PROCESS EQUIP	$ 229,000
3	PROCESS Design (Skid, PLC, CIP System, Sensors)	$ 192,000
4	Phase I PER and Review includes PROCESS EQUIP MANUFACTURER and Engineer	$ 133,300

	TOTAL COST OF PREVIOUSLY PERFORMED ENGINEERING	**$ 773,425**

OPTION 3 - ANNUAL O&M COSTS

Item No.	Item Description	Equivalent Uniform Annualized Cost
1	EQUIPMENT MAINTENANCE	$ 12,801
2	SUPPLIES (CHEMICALS, CIP, ETC.)	$ 15,459
3	UTILITIES (ELECTRICAL, NG, ETC.)	$ 20,632
4	LABOR (Operating and Maintaining the Treatment Plant (2.5 hr/day, 5 days/week)	$ 70,630
5	LEACHBUSTER SKID (Membrane Replacement and Supplies)	$ 36,589
6	LEACHBUSTER SYSTEM TECHNICAL SUPPORT	$ 7,400

	TOTAL ESTIMATED O&M COSTS	**$ 163,511**

Matanuska Susitna Borough
Palmer Central Landfill
Leachate Treatment vs. Electricity Generation

Year	Cost to Haul	Cost to Reduce Leachate Vol.	Difference	Leachate Gallons	Cost Delta*Volume
2020	$ 262,400.00	$ 302,730.00	-$ 40,330.00	3,200,000.00	-1.29E+11
2021	$ 268,020.00	$ 304,926.28	-$ 36,906.28	3,200,000.00	-1.18E+11
2022	$ 299,420.00	$ 307,169.56	-$ 7,749.56	3,500,000.00	-2.71E+10
2023	$ 305,820.00	$ 309,470.85	-$ 3,650.85	3,500,000.00	-1.28E+10
2024	$ 312,370.00	$ 311,811.18	$ 558.82	3,500,000.00	1.96E+09
2025	$ 319,050.00	$ 314,201.58	$ 4,848.42	3,500,000.00	1.70E+10
2026	$ 325,880.00	$ 316,643.14	$ 9,236.86	3,500,000.00	3.23E+10
2027	$ 332,850.00	$ 319,146.95	$ 13,703.05	3,500,000.00	4.80E+10
2028	$ 339,980.00	$ 321,694.13	$ 18,285.87	3,500,000.00	6.40E+10
2029	$ 347,250.00	$ 324,295.81	$ 22,954.19	3,500,000.00	8.03E+10
2030	$ 354,680.00	$ 326,953.17	$ 27,726.83	3,500,000.00	9.70E+10
2031	$ 362,270.00	$ 329,677.40	$ 32,592.60	3,500,000.00	1.14E+11
2032	$ 465,180.00	$ 332,449.72	$ 132,730.28	4,400,000.00	5.84E+11
2033	$ 475,130.00	$ 335,281.36	$ 139,848.64	4,400,000.00	6.15E+11
2034	$ 485,300.00	$ 338,173.60	$ 147,126.40	4,400,000.00	6.47E+11
2035	$ 495,680.00	$ 341,137.73	$ 154,542.27	4,400,000.00	6.80E+11
2036	$ 506,290.00	$ 344,155.09	$ 162,134.91	4,400,000.00	7.13E+11
2037	$ 517,130.00	$ 347,237.01	$ 169,892.99	4,400,000.00	7.48E+11
2038	$ 528,190.00	$ 350,394.88	$ 177,795.12	4,400,000.00	7.82E+11
2039	$ 539,500.00	$ 353,610.12	$ 185,889.88	4,400,000.00	8.18E+11
Total	**$ 7,842,390.00**	**$ 6,531,159.58**	**$ 1,311,230.42**	**76,600,000.00**	**5.76E+12**

Net Present Value = $911,526.95
Annual Benefit = $45,576.35

APPENDIX G – EXISTING LANDFILL GAS MONITORING INFORMATION

BURNS McDONNELL

March 20, 2020

Mr. Evan Miller
Municipal Landfill Specialist
Alaska Department of Environmental Conservation
555 Cordova Street
Anchorage, AK 99501

Re: Matanuska-Susitna Borough Palmer Central Landfill
I. Control of Explosive Gases Response Plan and II. Plan to Deliver Long-Term Landfill Gas (LFG) Management Plan

Dear Mr. Miller:

On behalf of Matanuska-Susitna Borough (MSB), Burns & McDonnell has prepared this Control of Explosive Gases Response Plan (Response Plan) to address LFG migration at the Palmer Central Landfill (Landfill). This Response Plan specifically addresses actions required by Alaska Department of Environmental Conservation (ADEC) in response to the January 23, 2020 exceedance. This Response Plan also outlines general actions for MSB to monitor, evaluate, and mitigate future potential methane migration detected at the Landfill. Additionally, Burns & McDonnell has begun work on a Long-Term Landfill Gas Management Plan (Management Plan) for MSB that will present the design of infrastructure to more efficiently collect and control LFG emissions in the future. Both Plans are presented in this letter.

On January 23, 2020, the routine monthly LFG monitoring was performed by Shannon & Wilson, Inc. at the Landfill. During the sampling event, methane levels were detected at 22 percent by volume or 440 percent of the lower explosive limit (LEL) at gas monitoring probe CLFP-3. The results were submitted to ADEC on January 24, 2020. ADEC responded with a letter dated January 30, 2020 in which ADEC found the Landfill to be in violation of Title 18, Chapter 60 of the Alaska Administrative Code (AAC) due to the results of the January 23, 2020 sampling event.

REGULATORY REQUIREMENTS

Title 18, Chapter 60 of the Alaska Administrative Code (AAC), Section 350 (18 AAC 60.350) defines a methane gas exceedance from a municipal solid waste landfill as 100 percent of the LEL at the facility boundary and 25 percent LEL within facility structures, which are equivalent to methane concentrations of 5 percent and 1.25 percent by volume, respectively.

Regulation 18 AAC 60.350(c) requires notification to ADEC by both phone and writing and implementing actions to protect public health, safety and welfare in the event of an exceedance. Additionally, a long-term remediation plan is required to be implemented within 60 days.

ADEC's January 30, 2020 letter to MSB specifically outlines the following requirements the Landfill must meet:

- Dissipate the gas concentration in CLFP-3.
- Monitor methane concentrations at CLFP-3 daily and submit results the same day to ADEC.
- Continue to dissipate any concentrations of methane exceeding the LEL.
- For public safety, contact and inform all residents living within a half mile radius of CLFP-3 probe of the potential safety hazard.
- Offer and expedite methane testing for all notified residents by a third-party contractor.

- For any structures within a 1,000-foot radius of CLFP-3, provide sampling by a third-party contractor. If methane is detected in any structure, move an additional 500 feet in the quadrant of the radius centered on the detection.
- Notify ADEC via phone and email for any exceedances of 10 percent LEL in any structure.
- Submit a daily report by 4PM each day, including all sampling results from any location, all ongoing corrective measures, name, address, and phone number of all contacted neighbors, and a plan for the next day's operation.
- A long-term remediation plan must be implemented no later than March 23, 2020.

I. CONTROL OF EXPLOSIVE GASES RESPONSE PLAN

On January 31, 2020, MSB began sampling passive LFG vents 1 through 7 and gas monitoring probes CLFP-1 through 6 daily using an RKI Eagle gas analyzer. Landfill gas vents 1-7 emit LFG collected passively from a collection grid beneath the final cover of Cell 2A and are intended to vent landfill gas from the underlying waste mass. Gas monitoring probes CLFP-1 and CLFP-2 are located west of Cell 1 at the northwest corner of the Facility. Gas monitoring probes CLFP-3, CLFP-4, CLFP-5, and CLFP-6 are located outside the limits of waste along the northern extent of the Facility and serve as perimeter methane monitoring compliance points. See Attachment 1 for figures indicating the location of the Landfill, the locations of vents and gas monitoring probes at the Landfill, and the locations of adjacent properties relative to monitoring probe CLFP-3.

On January 30, 2020, MSB began contacting all property owners within 1,000 feet of CLFP-3 by telephone. On January 31, 2020, a notification letter was sent via certified mail to all property owners within a half-mile radius of probe CLFP-3 to inform them of the exceedance and to offer methane testing through a third-party contractor at the owners' structures. To date, 102 property owners have been contacted, and 42 properties have been tested.

All property owner structures within a 1,000-foot radius of CLFP-3 were offered methane monitoring through a third-party contractor. As of the date of this letter, testing has been completed at all but one of the 14 properties within this radius. The remaining property owner has declined monitoring. Methane has been detected at only one residence, 9750 East LeeAnn Drive, within about 300 feet of CLFP-3. The initial reading on February 3, 2020 from this residence was 16 percent LEL. MSB furnished the resident a dedicated, continuous methane monitoring device set to emit an audible warning tone at 25 percent LEL. Methane has not been detected at the residence since February 20, 2020. Daily monitoring has been offered by MSB to this resident. MSB and the resident also developed the following action plan in the event of a tone from the monitoring device:

- Exit the structure.
- Call 911.
- Call MSB solid waste staff.

One residence, at 9355 East Douglas Street and about 2,000 feet from Cell 1 of the Landfill, was monitored on February 18, 2020. Readings varying between 0 and 10 percent LEL were detected in a basement floor drain. The potential for this methane detection resulting from the home's septic system was considered. The drain trap was filled with water and subsequent monitoring (February 22 and 27, 2020) indicated that the methane concentration declined to no detection. Daily monitoring has been offered to this resident.

In an effort to mitigate the migration of LFG from the Landfill, MSB has completed the following short-term actions:

- On February 4, 2020, MSB inspected the Cell 2A vents to verify operation and they were found to be blocked with snow and ice at the ground surface. Once this was cleared, the vents began emitting LFG as designed. These vents are connected to a horizontal passive LFG collection grid immediately beneath the final cap and influence the upper waste mass. It is suspected that the combination of weather conditions and frost depth led to freezing of condensate within the LFG at this point.

- On February 4, 2020, a portable blower was attached to Vent 1 in Cell 2A to impart a vacuum on the waste mass. The other vent pipes were capped to prevent oxygen intrusion from ambient air. The blower is rated at 80 standard cubic feet per minute (SCFM) and may be moved to other vents to create a more centralized extraction from Cell 2A. If oxygen levels increase, the blower may be shut down or moved to a different vent. Blower shutdowns and transfers between vents are documented in the monitoring data presented in Attachment 2.

- On February 6, 2020, a portable blower was connected to CLFP-3 to impart a vacuum on the probe to intercept LFG migrating toward the north property boundary at this location. This blower is rated also at 80 SCFM.

- The blowers will continue to be operated to dissipate methane concentration at the facility's property boundary. If the oxygen content in the Cell 2A vent blower exceeds 10 percent, the blower will be shut off to prevent ambient air intrusion into the waste mass. The vent caps will be removed to allow passive venting until oxygen readings decline below 10 percent and gas pressure returns to the vent system. The blower will then be restarted.

- The blower at CLFP-3 is likely pulling LFG toward the property boundary from Cell 1 and/or Cell 2A. Because the methane concentration at CLFP-3 has stabilized between seven and nine percent by volume since early February, MSB is proposing to disconnect this blower and monitor the response. If approved by ADEC, the following steps will be followed for disconnecting the CLFP-3 blower:

    - Sample CLFP-3 to determine baseline methane concentration.
    - Disconnect the blower from CLFP-3.
    - After disconnecting the blower allow the probe to rest for one hour. Connect purge pump; set to 3 liters per minute; then gather baseline, 10-minute, and 20-minute purge data.
    - Sample CLFP-3 on a bi-hourly (every other hour) basis between 6am and 6pm, utilizing the baseline, 10-minute, 20-minute process.
    - After 24 hours, if readings are trending downward, continue with sampling every four hours between 6am and 6pm with the blower remaining disconnected.

- If, at any time, methane concentrations are above the original baseline (when blower was connected) for three consecutive readings, reconnect the blower to CLFP-3.
- If methane concentrations stabilize within 0.5% concentration by volume and the concentration is greater than 25% of LEL for three consecutive samples, connect the blower to gas monitoring well CLFG-1 within Cell 1.
- If the blower is operating at CLFG-1, sample CLFG-1 at the same frequency as CLFP-3. If the blower is connected, the baseline, 10-minute, and 20-minute purging process is not necessary. Collect sample from blower sampling port while the blower is operating.
- If the blower is operating at CLFG-1 and methane concentrations are below 25% LEL at CLFG-3 for 48 consecutive hours, disconnect the blower from CLFG-1.
- The blower on Cell 2A Vent 2 will continue to operate.
- Reconvene with ADEC to determine future steps if methane concentrations remain below 25% LEL at CLFP-3 for 48 hours after the blower is disconnected from CLFG-1.
- ADEC will be provided daily updates and will be immediately notified of any exceedances as required.

MSB will continue to conduct daily sampling at the six probe and seven vent locations, and for any structure where methane has been detected, daily monitoring has been offered by MSB. The sampling results, call logs for neighbors, and the next day's plans have been, and will continue to be, submitted by MSB to ADEC before 4PM each day until LFG monitoring reverts to the regular frequency. The most recent monitoring and call log information is provided in Attachment 2 and Attachment 3 provides resident/structure locations, contact information, and the current status of monitoring.

Table 1: Methane Action Concentrations

Location	Methane Concentration	Action	Requirement
Property Boundary	>100 percent LEL (5 percent by volume)	• Notify ADEC and neighbors • Sample inside structures	18 AAC 60.350
Inside Structures	>25 percent LEL (1.25 percent by volume)	• Notify 911 immediately • Evacuate and ventilate structure • Notify ADEC within 24-hours • Mitigate • Offer daily sampling • Submit report daily	18 AAC 60.350
Inside Structures	>10 percent LEL (0.5 percent by volume)	• Notify ADEC • Mitigate • Offer daily sampling • Submit report daily	ADEC Requirement

As the short-term Response Plan is executed as described above, or if LFG migration occurs in the future, the following actions, notifications, and submittals shall be made based on the monitoring results as defined in Table 1. A flowchart is included in Attachment 4 to outline specific actions for MSB in the event of future methane concentration exceedances.

Where methane gas concentrations are found to exceed 25 percent of LEL in structures on the Landfill or adjacent property:

- Emergency contacts presented in Table 2 will be contacted immediately.
- The structures, including the crawl space and basement areas, will be evacuated and ventilated immediately.
- The ADEC will be contacted immediately (as practically possible) of the detection by phone and in writing (e-mail is acceptable).
- For off-site structures, continuous methane monitoring will be provided using a plug-in, AC-powered methane detector that sounds an alarm at or below 25 percent of the LEL and has a maximum sampling interval of five minutes. MSB will also offer daily monitoring.
- Structure occupancy can occur when methane concentrations decline to less than 25 percent LEL.

Table 2: Emergency Contact Information

District 1, Fire Station 3-1 717 S Cobb St Palmer, AK 99645 Staff: (907) 745-3709; Emergency: 911	**Matanuska-Susitna Borough Public Works** Mr. Terry Dolan, Director of Public Works 1420 South Industrial Way Palmer, AK, 99645 Phone: (907) 861-7756
District 1, Fire Station 5-1 1911 S Terrace Ct Palmer, AK 99645 Staff: (907) 861-8320; Emergency: 911	**Matanuska-Susitna Borough Public Works Solid Waste Division** Mr. Macey "Butch" Shapiro and Mr. Brett Olson 350 East Dahlia Ave Palmer, AK 99645 Phone: (907) 861-7604

If methane gas concentrations are found to exceed any of the limits set forth in Table 1, the following steps for mitigation and monitoring will be taken:

- The gas monitoring probes and vents will be sampled daily and reported to ADEC the same day by 4PM.
- A short-term action will be developed, communicated to ADEC, and implemented to mitigate and monitor the landfill gas migration.
- Neighbors within a 1,000-foot radius (see Attachment 2) will be contacted to inform them of the potential methane migration and to schedule sampling at their structures.

- Neighbors within a half-mile radius (see Attachment 3) will be contacted to inform them of the potential methane migration and to offer methane sampling at their structures.
- After the daily methane concentration falls below LEL at the property boundary, and below detection in structures, for seven consecutive days, MSB will continue to sample the gas at the established locations at a frequency of once per week. MSB reporting to ADEC will be once per week.
- After the weekly methane concentration falls below LEL at the property boundary, and below detection in structures, for four consecutive weeks, MSB will resume regularly scheduled monitoring frequency. At this point, the normal operations will be resumed for the LFG control system. MSB will confer with ADEC as to when monitoring will return to monthly monitoring.

II. LONG-TERM GAS REMEDIATION AND MANAGEMENT PLAN

MSB has retained Burns & McDonnell to develop a gas collection and control system (GCCS) design as part of a *Landfill Development and Landfill Gas Management Plan*. Work on the development plan is ongoing and is expected to be complete by May 2020. Conceptually, the development plan will include the installation of large-diameter, deep vent wells within Cells 1 and 2A. The well spacing will be determined by a specified radius of influence to access LFG generated throughout the waste mass. The development plan will also consider whether these wells will vent passively or be connected for combustion at a flare. Construction of the gas collection system is anticipated to be completed in the 2021-2022 construction season, or when funds become available. Table 3 outlines the likely components of the GCCS with their intended purpose. Attachment 5 provides the scope of work and deliverables for the Burns 7 McDonnell *Landfill Gas Management Plan*. In the meantime, the Response Plan being implemented (i.e., extraction blowers on monitorng probes and Cell 2A vents) will continue until the Table 1 action levels are met. Subsequently, the steps outlined in the Attachment 4 flowchart will be followed.

Table 3: GCCS Components and Function

Component	Purpose and Function
Gas Extraction Well	To access the depth of waste mass to capture generated LFG. Note that in future GCCS design, besides a vertical well, extraction can occur from leachate collection lines and dedicated horizontal gas collectors.
Wellhead	Valve and monitoring station connected to the top of the well to control system extraction point vacuum based on flow and methane content available from the well. Ports are available to measure vacuum, flow rate, methane concentration, and temperature.
Lateral and Manifold Piping	Network of pipes that impart a vacuum at each wellhead and direct collected LFG from the wells to the landfill perimeter where the manifold carries LFG to the flare station or other emissions control device. Pipe depth and slope considers impacts from frost and condensate.

Condensate Management	LFG has a high moisture content and elevated temperature (typically 80 – 120F) due to the waste degradation process. This moisture condensates with change in temperature as the gas travels from the warm landfill to the piping at the cooler wellhead and lateral/manifold pipe backfill soils. Pipe slope and depth is designed to collect condensate at low point sumps. From there, condensate is pumped to the Landfill's leachate management system.
Flare Skid	Although collected LFG can vent passively, combustion of LFG is an efficient method to reduce odor and methane migration and emissions. A flare skid typically has the following components: • Blower(s) to impart a vacuum on the LFG collection piping. • Additional condensate collection from a knockout pot and traps at low points on the skid piping. • Valving to control vacuum and liquids movement. • Flame arrestor to prevent flame migration into the skid and collection field. • Flow meter, vacuum gauges, data recorder to monitor and document system operation. • Portable nitrogen and propane bottles to operate actuating valve for system shutdown and for system start-up, respectively. • Controls and control panel to manage system electric demand and start-up/operation/shut-down. • Flare to combust LFG. At this location, an enclosed flare is recommended to obstruct flame visibility.
Note: All above ground and buried piping will address impacts from frost and cold air temperatures through use of insulation, heat trace, and pipe burial depth.	

Thank you for your attention as MSB has worked through this occurrence of LFG migration. MSB is committed to safety and to controlling subsurface LFG migration at the Landfill. As of the date of this Response and Management Plan letter, MSB has complied with the requirements of the January 30, 2020 ADEC letter. The Long-Term Response and Remediation Plans outlined above are intended to meet the

March 23, 2020 regulatory date. If you have any questions or need further information, please contact Fred Doran at 952-656-3616 or fdoran@burnsmcd.com.

Sincerely,

Tom Waller

Fred Doran
Project Manager

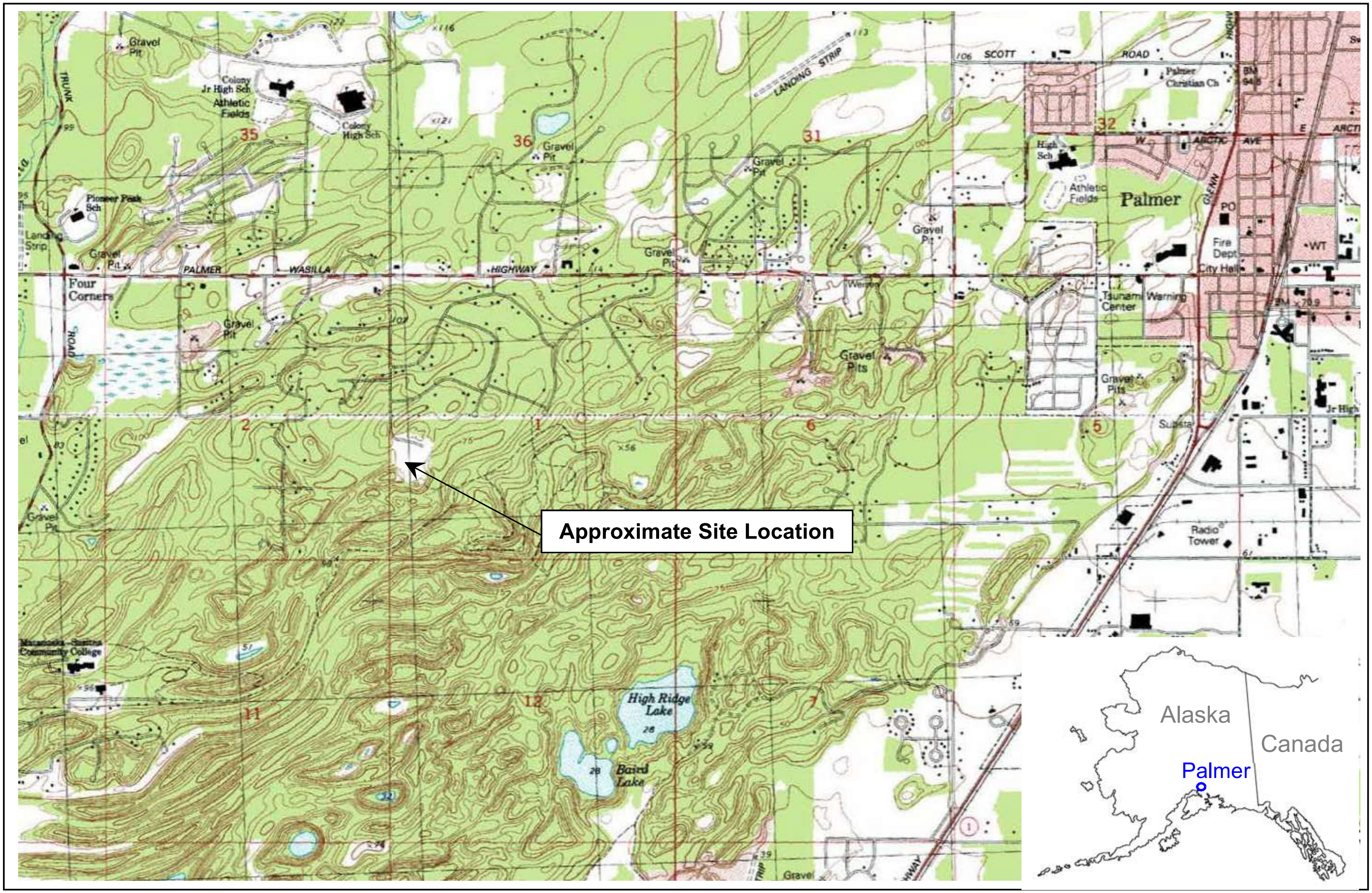
Tom Waller, PE
QA/QC Engineer

Thomas C Waller IV
Date 3/20/2020
No. EV 127387

knm/FJD

Enclosures:
Attachment 1 – Site Figures
Attachment 2 – Daily Gas Monitoring Results
Attachment 3 – Call Logs and Contact Information
Attachment 4 – Methane Monitoring Flowchart
Attachment 5 – LFG Management Plan Objectives
cc: Mike Campfield, PE, Matanuska-Susitna Borough
Macey "Butch" Shapiro, Solid Waste Manager, Matanuska-Susitna Borough
Brett Olson, Solid Waste Environmental Section Supervisor, Matanuska-Susitna Borough
Tonya Koller, Project Engineer, Burns & McDonnell
Scott A. Martin, Project Engineer, Burns & McDonnell

ATTACHMENT 1



From U.S. Geological Survey
Anchorage C-6 SW Quadrangle
Contour Interval 5 Meters

0 0.5 1.0

Approximate Scale in Miles

2 inches equals approximately 1 mile

N

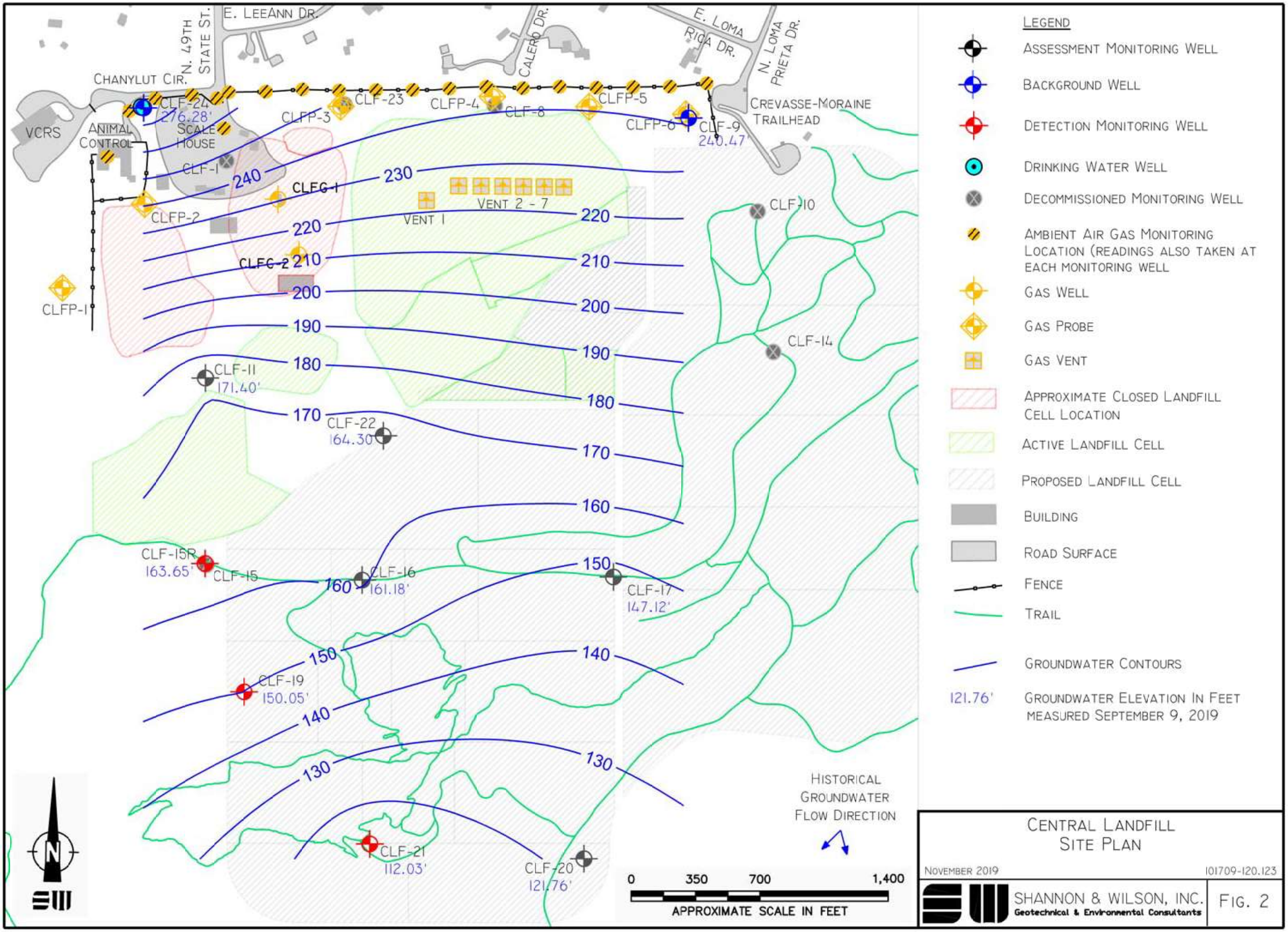
Central Landfill
Palmer, Alaska

VICINITY MAP

November 2019 101709-120.123

SHANNON & WILSON, INC.
Geotechnical & Environmental Consultants

Fig. 1



Central Landfill
Site Plan

November 2019

101709-120.123

Shannon & Wilson, Inc.
Geotechnical & Environmental Consultants

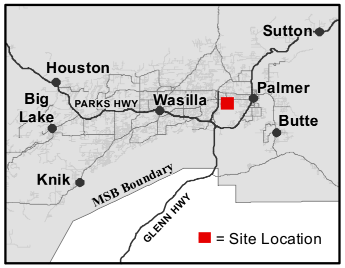
Fig. 2

Central Landfill Gas Probe 3

Legend

- ⊕ Gas Probe
- ⬚ Half Mile Buffer
- - - Gate
- ×—× Fence
- - - Trails

MSB GIS Division - January 2020



M:\Product\Public_Works\Solid_Waste\Central_Landfill\GasProbe3\CLF_Gas_Probe3_halfMiBuffer.mxd

ATTACHMENT 2

Attachment 2 - Call Log

Within 1,000' Radius of CLFP-3

	OWNER	SITE ADDRESS	PRIMARY OWNER'S ADDRESS	Phone Number	Approximate Feet From Probe	Date	Time	Answer?	Person Contacted	Voicemail Left?	Duration of Discussion	Sampling Required?	Samples Taken?	Notes
1	TESCH DANA & KAYLIN	9750 E LEE ANN DR	9750 E LEE ANN DR, PALMER, AK 99645	907-717-8499(Dana)	288'	1/30/2020	5:01 PM	No	NA	Yes	NA	Yes		
						1/31/2020	8:23 AM	No	NA	Yes	NA			
						1/31/2020	9:46 PM	Yes	Dana Tesch	No	2		Yes	Sampled 1/31/2020 16%LEL in addition that has no slab, doors and windows sealed shut with insulation plastic. Provided resident with 25% LEL meter and work and personal numbers to call Brett Olson if the alarm went off. Will check in with resident tomorrow.
				717-8498 (Kaylin)		1/30/2020	5:04 PM	No	NA	Yes	NA			
						1/31/2020	8:25 AM	No	NA	Yes	NA			
						2/1/2020	2:15 PM	Yes	Dana Tesch	No	1		Yes	Resampled 2/1/2020. 12% LEL in addition. Lower than previous days result but higher than 10% notification threshold. Notified Lori Aldrich via text message, which she confirmed was fine for weekends for this instance.
2	JOHNSON LARRY A	9700 E LEE ANN DR	PO BOX 672594, CHUGIAK, AK 99567	907-688-3538 863-3538	350'	1/30/2020	5:14 PM	Yes	Larry Johnson	No	6	Yes	Yes	0% methane detected
3	LINN TOSHA NICOLE	9650 E LEE ANN DR	9650 E LEE ANN DR, PALMER, AK 99645	907-521-7282	400'	1/30/2020	5:26 PM	Yes	Tosha Linn	No	2	Yes	Yes	Sampled 1/30/2020, No methane detections.
4	BREHM KURT E & TAMMY D	9600 E LEE ANN DR	9600 E LEE ANN DR, PALMER, AK 99645	907-354-3554 (Kurt)	566'	1/30/2020	5:38 PM	Yes	Kurt Brehm	No	2	Yes		Call wife, Tammy, Kurt works evenings.
				354-3553 (Tammy)		1/30/2020	17:40	Yes	Tammy Brehm	No	2		Yes	Sampled 1/30/2020, No methane detections
5	LOCKLEAR DAVID L & L P	9800 E LEE ANN DR	9800 E LEE ANN DR, PALMER, AK 99645	907-707-4805	500'	1/30/2020	6:22 PM	Yes	David Locklear	No	1	Yes		Worried this is a scam, will call the landfill in the morning to verify.
						1/31/2020	12:41 PM	Yes	David Locklear	No	4		Yes	Father of Darel, when Darels house is sampled, come sample his house as well. Doesn't want anyone inside (no crawlspace, basements in home) but would appreciate ambient air sampling.) 0% methane detected.
6	HAGERDON PAUL	1200 N CALERO DR	PO BOX 3378, PALMER, AK 99645	907-745-7285	605'	1/31/2020	8:33 AM	No	NA	Yes	NA	Yes		
						2/1/2020	12:08 P{M	No	NA	Yes	NA			Property posted no trespassing with chain acrossed driveway, no sign of recent activity, neighbor Greg Avila said that he is a summer time only resident.
						2/6/2020	9:22 AM	Yes	Paul Hagerdon	No	13	Yes	Yes	0% methane detected
7	ATHANAS AARON B	9701 E LEE ANN DR	9751 E LEE ANN DR PALMER AK 99645	907-306-0449	650'	1/31/2020	2:01 PM	No	NA	No	NA	Yes		Number received from Barb Oulette
			9751 E LEE ANN DR PALMER AK 99645	907-306-0449	678'	1/31/2020	2:01 PM	No	NA	No	NA			Number not in service.
				907-232-4895		2/1/2020	12:12 PM	No	Russell Joyce	Yes	NA			Real estate agent listed for one of the properties. Attempted to contact realtor.
						2/1/2020	1:52 PM	No	Russell Joyce	No	1			Informed agent that I had received Mr. Athanas's phone number from Ms. Ouellette.
						2/1/2020	2:16 PM	No	NA	Yes	NA			
8	STARK HEATHER	9830 E LEE ANN DR	PO BOX 2756, PALMER, AK 99645	907-360-4444	680'	1/31/2020	10:30 AM	No	NA	Yes	NA	Yes	Yes	Darel Locklear's girlfriend, sampled together. 0% methane detected
9	DEPRIEST THOMAS D HAZEN TRACY ANN	9601 E LEE ANN DR	2918 CASCADE RDG E WENATCHEE WA 98802	907-240-1748 (Real Estate Agent)	711'	1/31/2020	5:30 PM	Yes	Real Estate Agent - Amy Peltier	No	2	Yes		Real Estate agent will be contacting owner for permission to open house to sampling.
						2/1/2020	10:25 AM	Yes	Real Estate Agent - Amy Peltier	No	2			Real Estate agent provided contact information of somebody to let samplers into house.
						2/1/2020	10:29 AM	No	Jim Jett - Property	No	NA			Representative did not answer, no voicemail setup
						2/1/2020	1:37 PM	No	Jim Jett - Property	No	NA			Representative did not answer, no voicemail setup
						2/1/2020	110:44	Yes	Jim Jett - Property	No	5		Yes	0% methane detected
10	OUELLETTE MARK& BARBARA A	9651 E LEE ANN DR	PO BOX 4158 PALMER AK 99645-4158	907-841-0936 (Mark)	730'	1/31/2020	2:08 PM	Yes	Mark Ouellette	No	4	Yes		Scheduled for 1/31/2020, available until 4:00 PM
						1/31/2020	2:15 PM	Yes	Barb Ouellette	No	4			Available until 4:00 PM
				907-841-2404 (Barbara)		1/31/2020	5:49 PM	Yes	Barb Ouellette	No	1			Scheduled for 2/1/2020 at 1:30 PM
						2/1/2020	1:24 PM	Yes	Barb Ouellette	No	1		Yes	Called enroute to house, house sampled 0% methane.
11	LOCKLEAR DAREL	9860 E LEE ANN DR	PO BOX 2756, PALMER, AK 99645	907-414-0369	750'	1/31/2020	10:47 AM	Yes	Darel Locklear	No	3	Yes	Yes	0% methane detected
12	MARTIN ISAAC J & KATHERIN	9815 E LEE ANN DR	PO BOX 914 PALMER AK 99645-8071	907-355-3505 (Isaac)	794'	1/31/2020	5:35 PM	No	NA	Yes	NA	Yes		
						2/1/2020	12:15 PM	No	NA	Yes	NA			
				Kaite		2/6/2020	12:36 PM	Yes	Katie Martin	NA	3		Yes	0% methane. Chris Miller is current tenant. 907-830-6270
13	HOLLIBAUGH TERRY R & KIMB	9900 E LEE ANN DR	9900 E LEE ANN DR, PALMER, AK 99645	907-232-1119 (KIM)	861'	1/31/2020	12:15 PM	Yes	Kim Hollibaugh	No	6	Yes		
				907-982-2568 (TERRY)									Yes	0% methane detected
14	AVILA GREGORIO	9930 E LEE ANN DR	9930 E LEE ANN DR, PALMER, AK 99645	907-232-3087	942'	1/31/2020	12:24 PM	No	NA	No	NA	Yes		Voicemail not setup
						1/31/2020	5:48 PM	Yes	Gregorio Avila	No	NA			
						2/1/2020	12:18 PM	Yes	Gregorio Avila	No	1		Yes	0%methane detected
15	BECK ROY A & CAROLYN L	1290 N CALERO DR	1290 N CALERO DR, PALMER, AK 99645	907-745-3064	945'	1/31/2020	12:35 PM	Yes	Roy Beck	No	3	Yes	Yes	0% methane detected

Attachment 2 - Call Log

Outside 1000' Radius of CLFP-3

	OWNER	SITE ADDRESS	PRIMARY OWNER'S ADDRESS	Phone Number	Approximate Feet From Probe	Date	Time	Answer?	Person Contacted	Voicemail Left?	Duration of Discussion	Sampling Required?	Samples Taken?	Notes
1	HURT DAVID & AMY	10240 E STRAND DR	#B 10240 E STRAND DR, PALMER, AK 99645											
2	FREY MARGARET EST	1551 N 49TH STATE STREET	% JOHN FREY 629 TAYLOR ST, ANCHORAGE, AK 99508	NO BUILDING										
3	TESTER JARED & TAREN	10000 E STRAND DR	10000 E STRAND DR, PALMER, AK 99645											
4	ANDERSON VERNON J	10005 E STRAND DR	10005 E STRAND DR, PALMER, AK 99645											
5	GRANGER CRAIG D	10030 E STRAND DR	10030 E STRAND DR, PALMER, AK 99645											
6	BRYANT CHRISTOPHER W SMITH DONALD L	10060 E STRAND DR	10060 E STRAND DR, PALMER, AK 99645											
7	ANDERSON JOS R & JENNIFER L	10120 E LOMA RICA DR	10120 E LOMA RICA DR, PALMER, AK 99645											
8	APEL ROB A & REBECCA S	10120 E STRAND DR	10120 E STRAND DR, PALMER, AK 99645											
9	GOODWIN ANDREW S & TINA M	10121 E LOMA RICA DR	10121 E LOMA RICA DR, PALMER, AK 99645											
10	DORMAN TOBIN I & SIERRA D	10180 E STRAND DR	10180 E STRAND DR, PALMER, AK 99645											
11	MALONE ANTHONY P STEWART KYLE D	10202 E LOMA RICA DR	10202 E LOMA RICA DR, PALMER, AK 99645											
12	WAKEFIELD MARK	10210 E STRAND DR	10210 E STRAND DR, PALMER, AK 99645											
13	CLARK PROPERTIES LLC	10150 E STRAND DR	1025 COVILLE LN, PALMER, AK 99645											
14	HALE ERIC N	9660 E STRAND DR	10250 E OLIVEWOOD DR, PALMER, AK 99645											
15	LABBY M SCOTT & SUZAN K	1105 N GOLDEN HILLS DR	1105 N GOLDEN HILLS DR PALMER AK 99645-8912											
16	MARGARET EST	1150 N GOLDEN HILLS DR	1150 N GOLDEN HILLS DR PALMER AK 99645											
17	KOSTEK DIANE L KOSTEK AUTUMN F	1200 N GOLDEN HILLS DR	1200 N GOLDEN HILLS DR PALMER AK 99645-8915											
18	DEVEAUX LEROY A & JESSICA	1251 N CALERO DR	1251 N CALERO DR, PALMER, AK 99645											
19	OLSON TREVOR G & RACHEL J	1260 N GOLDEN HILLS DR	1260 N GOLDEN HILLS DR PALMER AK 99645											
20	HART RACHEL	1275 N GOLDEN HILLS DR	1275 N GOLDEN HILLS DR PALMER AK 99645-8915											
21	JOHNSON RACHEL ADAMS	1300 N GOLDEN HILLS DR	1300 N GOLDEN HILLS DR PALMER AK 99645											
22	MARCIEL THOS F	1400 N LOMA PRIETA DR	1400 LOMA PRIETA DR, PALMER, AK 99645	907-301-3309		2/14/2020	2:26 PM	Yes	Thomas Marciel	NA	2	No	Yes	0% methane
23	RUNYAN RICHARD W	1401 N 49TH STATE ST	1400 N 49TH ST PALMER AK 99645-8847											
24	YANUSZ RICHARD J& LUANN M	1435 N GOLDEN HILLS DR	1435 N GOLDEN HILLS DR PALMER AK 99645											
25	REBER THOMAS	1521 N CALERO DR	1461 N CALERO DR, PALMER, AK 99645	NO BUILDING										
26	REBER THOMAS	1491 N CALERO DR	1461 N CALERO DR, PALMER, AK 99645 - DUPLICATE	NO BUILDING										
27	REBER THOMAS	1461 N CALERO DR	1461 N CALERO DR, PALMER, AK 99645 - DUPLICATE			2/6/2020	8:05 AM	Yes	Tom Reber	NA	13	No	Yes	0% methane
28	WEBSTER TERRY & MARVELLA	9400 E TERRY ST	1535 N GOLDEN HILLS DR PALMER AK 99645	907-746-2790		2/6/2020	11:27 AM	Yes	Marvella Webster	NA	3	No	Yes	0% methane
29	WEBSTER TERRY L& MARVELLA	1535 N GOLDEN HILLS DR	1535 N GOLDEN HILLS DR PALMER AK 99645 - DUPLICATE	907-746-2790										
30	BASHAW BRIAN D	1551 N CALERO DR	1551 N CALERO DR, PALMER, AK 99645											
31	WRIGHT MICHAEL & KIMBERLY BOHLING WILLIAM J & DEANN A L REV LVG TR AGRMT	1565 N GOLDEN HILLS DR	1570 N VIA TUBERTAMA GREEN VALLEY AZ 85614-3996											
32	CAMBRON ROBERT A II & JEN	1581 N CALERO DR	1581 N CALERO DR, PALMER, AK 99645	907-529-7867		2/4/2020	2:22 PM	Yes	Robert Cambron	NA	5	No	Yes	0% methane
33	WEEKS LEO A JR & JAMI D	1620 N CALERO DR	1620 N CALERO DR, PALMER, AK 99645	912-271-4454		2/4/2020	2:09 PM	Yes	Jami Weeks	NA	2	No	Yes	0% methane
34	FRALEY RICHARD	1680 N CALERO DR	1680 N CALERO DR, PALMER, AK 99645	907-982-4804		2/18/2020	9:05 AM	Yes	Patty Mason	NA	5	No	Pending	Friday 2/21/20 at 1pm
35	HANSEN LEVI J SIPES MELANIE A	1750 N SUMMERWOODS DR	1750 N SUMMERWOODS DR, PALMER, AK 99645	907-799-0130		2/3/2020	11:04 AM	Yes	Melanie Hansen	NA	3	No	Yes	0% methane
36	FLETCHER CLIFFORD M JR &	10270 E STRAND DR	19532 SECOND ST, EAGLE RIVER, AK 99577											
37	MORRIS BRYAN H & RENEE	1601 N 49TH STATE STREET	1979 S SWEETIE PIE ST, WASILLA, AK 99654											
38	WEIR GRANT & LINDA FAM TR WEIR LINDA A EST	9470 E PALMER-WASILLA HWY	200 NE 8TH ST FRUITLAND ID 83619-5055											
39	DEPRIEST THOMAS D HAZEN TRACH ANN	9601 E LEE ANN DR	2918 CASCADE RIDGE, EAST WENATCHEE, WA 98802											
40	MATANUSKA-SUSITNA BOROUGH	9465 E CHANLYUT CIR	350 E DAHLIA AVE PALMER AK 99645-6488										Yes	No call-went during business hours, 0% methane
41	MATANUSKA-SUSITNA BOROUGH	9470 E CHANLYUT CIR	350 E DAHLIA AVE PALMER AK 99645-6488										Yes	No call-went during business hours, 0% methane
42	MATANUSKA-SUSITNA BOROUGH	1201 N 49TH STATE ST	350 E DAHLIA AVE PALMER AK 99645-6488										Yes	No call-went during business hours, 0% methane
43	FORSYTH ZACHARY J & JESSI	1251 N LOMA PRIETA DR	3959 S UPPER MEADOW CIR, WASILLA, AK 99623	NO BUILDING										

Attachment 2 - Call Log

Outside 1000' Radius of CLFP-3

	OWNER	SITE ADDRESS	PRIMARY OWNER'S ADDRESS	Phone Number	Approximate Feet From Probe	Date	Time	Answer?	Person Contacted	Voicemail Left?	Duration of Discussion	Sampling Required?	Samples Taken?	Notes
44	SPAHR DON & KATHERINE	1671 N CALERO DR	5571 KENNYHILL DR, ANCHORAGE, AK 99504	NO BUILDING										
45	WRIGHT JAS L & REBECCA G	9760 E STRAND DR	6174 MANDIE LN, MILTON, FL 32570	907-632-4256		2/10/2020	1:29 PM	Yes	Rebecca Wright	NA	5	No		Call son, James, at 907-521-3717 or DIL Michelle at 907-903-5483 to schedule.
				907-521-3717		2/10/2020	3:17 PM	Yes	Michael Wright	NA	3	No	Yes	0% methane detected
46	MOFFITT HOUSE LLC	1600 N 49TH STATE ST	6250 N LOSSING RD PALMER AK 99645											
47	MICHELSEN KIM T	1205 N GOLDEN HILLS DR	6931 SERENITY CIR ANCHORAGE AK 99502-1847											
48	LAUGHLIN BRIAN	755 N GOLDEN HILLS DR	755 N GOLDEN HILLS DR PALMER AK 99645											
49	HODGSON GUNNER D & THERES	9545 E TERRY ST	8905 GOLD PAN DR PALMER AK 99645-											
50	FORSYTH ZACHARY J & JESSI	9200 E STARBEARER CIR	9200 E STARBEARER CIR PALMER AK 99645-9653											
51	LOGSDON TARA LOGSDON ADRIENNE	9355 E DOUGLAS ST	9355 E DOUGLAS ST PALMER AK 99645	907-232-6739		2/17/2020	12:37 PM	No	Tara Logsdon	Yes	-	No	Yes	
				907-414-8010 Adrian (Mom)		2/18/2020	8:05 AM	Yes	Tara Logsdon	NA	1			Will call back, taking daughter to school
														0 to 10% LEL detected in utility room drain. 0% methane rest of house. Advised resident to ensure P Trap is full
52	BRISKE WILLIAM K	9370 E PALMER-WASILLA HWY	9370 E PALMER WASILLA HWY PALMER AK 99645-7326											
53	VANDER BIE RYAN C	9405 E DOUGLAS ST	9405 E DOUGLAS ST PALMER AK 99645-7476	907-782-7367		3/16/2020	12:58 PM	Yes	Ryan Vanderbie	Yes	2	No	Pending	Scheduled for 3/16/20 at 4pm
54	DUSENBERY RAMSEY	9500 E DOUGLAS ST	9500 E DOUGLAS ST PALMER AK 99645											
55	EVANS HARRY G	9600 E STRAND DR	9600 E STRAND DR, PALMER, AK 99645	907-230-8458		2/5/2020	11:28 AM	Yes	Harry Evans	NA	2	No	Yes	0% methane
56	RINDONE P RENEE	9630 E STRAND DR	9630 E STRAND DR, PALMER, AK 99645											
57	B & R LLC	9550 E PALMER-WASILLA HWY	9646 W AIRCRAFT CT WASILLA AK 99623											
58	WEEKS MICAH & ANGELA	9700 E STRAND DR	9700 E STRAND DR, PALMER, AK 99645	307-752-5524		2/5/2020	1:25 PM	Yes	Angie Weeks	NA	5	No	Yes	0% methane
59	ATHANAS AARON B	9751 E LEE ANN DR	9751 E LEE ANN DR, PALMER, AK 99645											
60	ATHANAS AARON B	9701 E LEE ANN DR	9751 E LEE ANN DR, PALMER, AK 99645 - DUPLICATE											
61	LITTLE JJ	9815 E STRAND DR	9815 E STRAND DR, PALMER, AK 99645											
62	ST SAVIOUR ADAM	9825 E LEE ANN DR	9825 E LEE ANN DR, PALMER, AK 99645	907-942-0595		2/25/2020	11:12 AM	Yes	Adam St Saviour	NA	6	No	Pending	Scheduled for Thursday 2/27/20 at 2PM
63	ALLEN RITA K	9845 E LEE ANN DR	9845 E LEE ANN DR, PALMER, AK 99645											
64	MILLETTE MATTHEW J	9850 E STRAND DR	9850 E STRAND DR, PALMER, AK 99645											
65	HOUK DONALD R & GISILE	9905 E LEE ANN DR	9905 E LEE ANN DR, PALMER, AK 99645	907-232-6536		2/7/2020	9:26 AM	Yes	Don Houck	NA	1	No	Yes	0% methane detected
66	HADDOCK MICHAEL E & KRIST	9905 E STRAND DR	9905 E STRAND DR, PALMER, AK 99645	907-707-9357		2/4/2020	12:57 PM	Yes	Kristy Haddock	NA	1	No	Yes	0% methane detected
67	WIRTANEN KEVIN R & ANDREA	SUMMERWOODS BLOCK 3 LOT	9925 E STRAND DR, PALMER, AK 99645	NO BUILDING										
68	WIRTANEN KEVIN R & ANDREA	9925 E STRAND DR	9925 E STRAND DR, PALMER, AK 99645 - DUPLICATE											
69	TROUTNER JOHN R & S M	9955 E STRAND DR	9955 E STRAND DR, PALMER, AK 99645											
70	CARLSON SYLVIA	9975 E STRAND DR	9975 E STRAND DR, PALMER, AK 99645											
71	GRIFFITH PETER & BRIANA	9845 E STRAND DR	APT 4, 6810 CRANBERRY ST, ANCHORAGE, AK 99502	NO BUILDING										
72	MOUNCE ROBERT LEON	1405 N GOLDEN HILLS DR	GENERAL DELIVERY PALMER AK 99645-											
73	GRAUVOGEL LAURA	1420 N CALERO DR	PO BOX 1062, PALMER, AK 99645	907-982-5347 cell or 907-746-2125 home		2/10/2020	1:51 PM	Yes	Laura Grauvogel	NA	4	No	Yes	0% methane
74	DENNIS JAS & NANCY	1351 N LOMA PRIETA DR	PO BOX 1429, PALMER, AK 99645	NO BUILDING										
75	DENNIS JAS & NANCY	1301 N LOMA PRIETA DR	PO BOX 1429, PALMER, AK 99645 - DUPLICATE											
76	BILL ANN MARIE C SURVIVOR	605 N GOLDEN HILLS DR	PO BOX 1463 PALMER AK 99645											
77	WALKER JAS L & CHRISTINE F	1641 N CALERO DR	PO BOX 1693, PALMER, AK 99645	NO BUILDING										
78	WALKER JAS L & CHRISTINE F	1611 N CALERO DR	PO BOX 1693, PALMER, AK 99645 - DUPLICATE	907-982-5187		2/7/2020	10:43 AM	Yes	Christine Walker	NA	1	No	Yes	0% methane
79	CLARKSON URIAH J & JESSICA	10300 E STRAND DR	PO BOX 1805, PALMER, AK 99645	907-631-8118		3/16/2020	1:54 PM	Yes	Uriah Clarkson	NA	3	No	Pending	Scheduled for 3/25/20 at 3PM
80	BUIRGE DAVID C REV TR BUIRGE KATHLEEN A REV TR BUIRGE DAVID C	1005 N GOLDEN HILLS DR	PO BOX 2428 PALMER AK 99645-2428	907-841-7349		2/14/2020	11:06 AM	Yes	David Buirge	NA	2	No	Pending	2/14/20 4PM
81	OLD APOSTOLIC LUTHERN CHR	9405 E TERRY ST	PO BOX 2658 PALMER AK 99645-2658											
82	BUTCHER AARON R NIEMI COURTNEY C	10090 E STRAND DR	PO BOX 2662, PALMER AK 99645											
83	DURFEE JOHN & DOROTHY	9551 E CHANLYUT CIR	PO BOX 2688 PALMER AK 99645-2688											
84	SHAY GWYNNE B	9820 E STRAND DR	PO BOX 2768, KODIAK, AK 99615											
85	OLIVER DAVID A & YVONNE M	1295 N GOLDEN HILLS DR	PO BOX 2858 PALMER AK 99645-2858											

Attachment 2 - Call Log

Outside 1000' Radius of CLFP-3

	OWNER	SITE ADDRESS	PRIMARY OWNER'S ADDRESS	Phone Number	Approximate Feet From Probe	Date	Time	Answer?	Person Contacted	Voicemail Left?	Duration of Discussion	Sampling Required?	Samples Taken?	Notes
86	BESS HOWARD H & DARLENE W	1505 N GOLDEN HILLS DR	PO BOX 2888 PALMER AK 99645-2888	907-746-1089		2/3/2020	4:26 PM	Yes	Howard Bess	NA	2	No	Yes	0% methane detected.
87	GILLETTE THOMAS P & MICHE	1355 N GOLDEN HILLS DR	PO BOX 2964 PALMER AK 99645											
88	SMOOT DAVID S	9505 E TERRY ST	PO BOX 2983 PALMER AK 99645-2983											
89	MELTON DEE L & MARLA M	1450 N 49TH STATE ST	PO BOX 3237 PALMER AK 99645-3237											
90	MELTON DEE L & MARLA M		PO BOX 3237 PALMER AK 99645-3237 - DUPLICATE											
91	HINDIN HOWARD & CAROLEE	9730 E STRAND DR	PO BOX 3693, PALMER, AK 99645	907-746-3921		2/10/2020	11:56 AM	Yes	Howard Hindin	NA	3	No	Yes	0% methane detected
						2/11/2020	9:21 AM	Yes	Howard Hindin	NA	1			Rescheduled to 2/12/20 at 2PM
92	OUELLETTE MARK & BARBARA	9651 E LEE ANN DR	PO BOX 4158, PALMER, AK 99645											
93	KEIL GLEN D JR & PEGGY J	9400 E DOUGLAS ST	PO BOX 470 PALMER AK 99645-0470	907-355-4495		3/2/2020	3:56 PM	Yes	Peggy Keil	NA	4	No	Pending	Friday 3/6/20 at 1pm
94	DAVIES STEPHEN L & F N	9875 E STRAND DR	PO BOX 4813, PALMER, AK 99645											
95	WESSEL JOHN D	9790 E STRAND DR	PO BOX 506, PALMER, AK 99645											
96	MACAULY ALEXANDER S	9725 E STRAND DR	PO BOX 711, PALMER, AK 99645											
97	DARRELL COLLEEN K C	1230 N GOLDEN HILLS DR	PO BOX 804 PALMER AK 99645-0804											
98	BEUCLER JOS A JOHNSON LARRY M	1701 N 49TH STATE STREET	PO BOX 870610, WASILLA, AK 99687	NO BUILDING										
99	BEUCLER JOS A JOHNSON LARRY M	1651 N 49TH STATE STREET	PO BOX 870610, WASILLA, AK 99687 - DUPLICATE	NO BUILDING										
100	RANDOLPH RUSSELL & ELAINE	1500 N CALERO DR	PO BOX 871910, WASILLA, AK 99687											
101	MACKRETH WM J	1401 N CALERO DR	PO BOX 873405, WASILLA, AK 99687	907-795-8506		2/11/2020	11:47 AM	Yes	Alison Mackreth	NA	2	No	Pending	Very busy schedule, house very dirty. Will call back when house is clean and available.
102	DISHNEAU GARRY E SR & P A	1225 N GOLDEN HILLS DR	PO BOX 873523 WASILLA AK 99687-3523											
103	DISHNEAU GARRY SR & PAT	1255 N GOLDEN HILLS DR	PO BOX 873523 WASILLA AK 99687-3523 - DUPLICATE											
104	SAWYER RONNIE L	9350 E DOUGLAS ST	PO BOX 876055 WASILLA AK 99687-6055											
105	MARTIN ISAAC J & KATHERIN	9815 E LEE ANN DR	PO BOX 914, PALMER, AK 99645											
106	FITCH ROB & KAREN	955 N GOLDEN HILLS DR	STE 117 PMB 217 19 COLONNADE WAY STATE COLLEGE PA 16803-2319											
107	SKY HIGH BEAR MOUNTAIN LL	1155 N GOLDEN HILLS DR	STE 210 3241 GOLDEN LANTERN LAGUNA NIGUEL CA 92677											
108	OUZTS KYLE M REV TR/TRE	10201 E LOMA RICA DR	STE 3 PMB 616, 1150 S COLONY WAY, PALMER, AK 99645											
109	SMITH MICHAEL E	1501 N 49TH STATE STREET	STE B PMB 583, 2521 E MOUNTAIN VILLAGE D, WASILLA, AK 99654	907-841-5342		2/6/2020	1:50 PM	Yes	Michael Smith	NA	3	No	No	Discussed issue with Brett Olson, decided he did not want sampling.

ATTACHMENT 3

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
1290 Calero	1/31/2020	1700	-	0		No methane detections across property
9750 E Lee Ann Dr	1/31/2020	1405	-	16		
9800 E Lee Ann Dr.	1/31/2020	1600	-	0		No methane detections across property
9830 E Lee Ann Dr.	1/31/2020	1556	-	0		No methane detections across property
9860 E Lee Ann Dr.	1/31/2020	1606	-	0		No methane detections across property
CLF Cold Storage	1/31/2020	1740	-	0		No methane detections across property
CLF Ops Portable	1/31/2020	1730	-	0		No methane detections across property
CLFP-3 10-Min	1/31/2020	1619	-	38		
CLFP-3 20-Min	1/31/2020	1629	-	14	Left valve open	
CLFP-3 Baseline	1/31/2020	1605	-	10		
Vent 1 10-Min	1/31/2020	1233	64.5	-		
Vent 1 20-Min	1/31/2020	1245	65	-		
Vent 1 Baseline	1/31/2020	1220	64.5	-		
Vent 2 10-Min	1/31/2020	1300	66.5	-		
Vent 2 20-Min	1/31/2020	1212	66.5	-		
Vent 2 Baseline	1/31/2020	1248	66.5	-		
Vent 3 10-Min	1/31/2020	1328	67.5	-		
Vent 3 20-Min	1/31/2020	1339	67.5	-		
Vent 4 10-Min	1/31/2020	1419	61.5	-		
Vent 4 20-Min	1/31/2020	1430	61	-		
Vent 4 Baseline	1/31/2020	1406	63.5	-		
Vent 5 10-Min	1/31/2020	1446	57	-		
Vent 5 20-Min	1/31/2020	1458	57	-		
Vent 5 Baseline	1/31/2020	1435	57	-		
Vent 6 10-Min	1/31/2020	1511	54	-		
Vent 6 20-Min	1/31/2020	1522	54	-		
Vent 6 Baseline	1/31/2020	1500	54	-		
Vent 7 10-Min	1/31/2020	1537	44	-		
Vent 7 20-Min	1/31/2020	1548	44.5	-		
Vent 7 Baseline	1/31/2020	1525	41	-		
Vent3 Baseline	1/31/2020	1316	68	-		
9465 E Chanylut Loop (VCRS)	2/1/2020	1520	-	0		No methane detections across property
9470 E Chanylut Loop (Animal Control)	2/1/2020	1550	-	0		No methane detections across property
9601 E Lee Ann Dr.	2/1/2020	1400	-	0		No methane detections across property
9651 E Lee Ann Dr.	2/1/2020	1330	-	0		No methane detections across property
9750 E Lee Ann Dr. (Resample)	2/1/2020	1425	-	12	Reminded resident to install monitor (stated he would after we left), follow up on Monday, remind resident to call if alarm goes off.	DEC notified at 14:54
9930 E Lee Ann Dr.	2/1/2020	1315	-	0		No methane detections across property
CLFG-1 10-Min	2/1/2020	932	69	-		
CLFG-1 20-Min	2/1/2020	942	67	-		
CLFG-1 Baseline	2/1/2020	919	65	-		
CLFG-1 Baseline	2/1/2020	945	43	-		
CLFG-2 10-Min	2/1/2020	955	35	-		
CLFG-2 20-Min	2/1/2020	1005	36	-		
CLFP-2 10-Min	2/1/2020	853	-	0		
CLFP-2 20-Min	2/1/2020	903	-	0		
CLFP-2 Baseline	2/1/2020	843	-	0		
CLFP-3 10-Min	2/1/2020	816	-	0	Left valve open	
CLFP-3 20-Min	2/1/2020	827	-	2	Left valve open	
CLFP-3 Baseline	2/1/2020	806	-	0	Left valve open	
CLFP-4 10-Min	2/1/2020	1121	-	0		
CLFP-4 20-Min	2/1/2020	1131	-	2		
CLFP-4 Baseline	2/1/2020	1111	-	0		
CLFP-5 10-Min	2/1/2020	1145	-	1		
CLFP-5 20-Min	2/1/2020	1155	-	2		
CLFP-5 Baseline	2/1/2020	1135	-	0		
CLFP-3 1 HR Purge	2/2/2020	1208	-	65		
CLFP-3 10-Min	2/2/2020	1058	-	29		
CLFP-3 20 Min Purge	2/2/2020	1228	-	40		
CLFP-3 20-Min	2/2/2020	1108	5	-	Purged 1 HR	Notified ADEC
CLFP-3 30 Min Purge	2/2/2020	1259	-	19	Removed sample valve assembly/cap to encourage venting overnight.	
CLFP-3 Baseline	2/2/2020	1048	-	0		
CLFP-6 10-Min	2/2/2020	1028	-	3		
CLFP-6 20-Min	2/2/2020	1038	-	0		
CLFP-6 Baseline	2/2/2020	1018	-	0		
9750 E Lee Ann Dr	2/3/2020	1315	-	16		
9750 E Lee Ann Dr	2/3/2020	1812	-	14		
CLFP-1 10-Min	2/3/2020	1725	-	0		
CLFP-1 20-Min	2/3/2020	1739	-	0		
CLFP-1 Baseline	2/3/2020	1712	-	0		

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
CLFP-2 10-Min	2/3/2020	1439	-	1		
CLFP-2 20-Min	2/3/2020	1451	-	2		
CLFP-2 Baseline	2/3/2020	1428	-	0		
CLFP-3 10-Min	2/3/2020	809	7.5	-		
CLFP-3 20-Min	2/3/2020	819	11.5	-	Connect purge pump	Notified ADEC
CLFP-3 Baseline	2/3/2020	757	-	4		
CLFP-4 10-Min	2/3/2020	1641	-	0		
CLFP-4 20-Min	2/3/2020	1654	-	0		
CLFP-4 Baseline	2/3/2020	1627	-	0		
CLFP-5 10-Min	2/3/2020	1605	-	0		
CLFP-5 20-Min	2/3/2020	1618	-	0		
CLFP-5 Baseline	2/3/2020	1554	-	0		
CLFP-6 10-Min	2/3/2020	1521	-	0		
CLFP-6 20-Min	2/3/2020	1532	-	0		
CLFP-6 Baseline	2/3/2020	1511	-	0		
1515 N Golden Hills Dr	2/4/2020	1430	-	0		
1750 N Summerwoods Dr	2/4/2020	1300	-	0		
9700 E Lee Ann	2/4/2020	1200	-	0		
9750 E Lee Ann Dr	2/4/2020	1230	-	8		
9905 Strand Dr	2/4/2020	1345	-	0		
CLFP-1 10-Min	2/4/2020	1715	-	0		
CLFP-1 20-Min	2/4/2020	1727	-	0		
CLFP-1 Baseline	2/4/2020	1702	-	0		
CLFP-2 10-Min	2/4/2020	1755	-	0		
CLFP-2 20-Min	2/4/2020	1805	-	0		
CLFP-2 Baseline	2/4/2020	1745	-	0		
CLFP-3	2/4/2020	735	8.3	-	Continued to purge	Notified ADEC
CLFP-3	2/4/2020	815	-	5		
CLFP-3	2/4/2020	1025	-	92		
CLFP-3	2/4/2020	1640	25	-		
CLFP-3	2/4/2020	1650	21	-		
CLFP-3	2/4/2020	1705	16.5	-		
CLFP-3	2/4/2020	1717	10.5	-		
CLFP-3	2/4/2020	1721	9.5	-		
CLFP-3	2/4/2020	1725	7.5	-		
CLFP-3	2/4/2020	1801	5	-		
CLFP-3	2/4/2020	1839	6	-		
CLFP-3	2/4/2020	1849	10.5	-		
CLFP-3	2/4/2020	1919	6	-		
CLFP-3	2/4/2020	1956	2.3	-		
CLFP-3	2/4/2020	2007	2.6	-		
CLFP-3 10-Min	2/4/2020	1129	-	25		
CLFP-3 10-Min	2/4/2020	1848	10.5	-		
CLFP-3 20-Min	2/4/2020	1858	6	-		
CLFP-3 20-Min Purge	2/4/2020	1149	-	36		
CLFP-3 Baseline	2/4/2020	1119	-	25		
CLFP-3 Baseline	2/4/2020	1834	6	-		
CLFP-4 10-Min	2/4/2020	1822	-	0		
CLFP-4 20-Min	2/4/2020	1832	-	0		
CLFP-4 Baseline	2/4/2020	1812	-	0		
CLFP-5 10-Min	2/4/2020	1839	-	0		
CLFP-5 20-Min	2/4/2020	1850	-	0		
CLFP-5 Baseline	2/4/2020	1826	-	0		
CLFP-6 10-Min	2/4/2020	1758	-	0		
CLFP-6 20-Min	2/4/2020	1812	-	0		
CLFP-6 Baseline	2/4/2020	1745	-	0		
Ice blockages removed	2/4/2020					
1581 N. Calero Dr	2/5/2020	1200	-	0		
1620 N. Calero Dr	2/5/2020	100	-	0		
9600 E Strand Dr	2/5/2020	1630	-	0		
9750 E Lee Ann Dr	2/5/2020	1328	-	6		
CLFP-1 10-Min	2/5/2020	1538	-	0		
CLFP-1 20-Min	2/5/2020	1552	-	0		
CLFP-1 Baseline	2/5/2020	1525	-	0		
CLFP-2 10-Min	2/5/2020	918	-	0		
CLFP-2 20-Min	2/5/2020	929	-	0		
CLFP-2 Baseline	2/5/2020	906	-	2		
CLFP-3	2/5/2020	1550	11.5	-		
CLFP-3 10-Min	2/5/2020	652	-	16		
CLFP-3 10-Min	2/5/2020	910	-	5		
CLFP-3 10-Min	2/5/2020	1345	6.5	-		
CLFP-3 20-Min	2/5/2020	702	-	14		
CLFP-3 20-Min	2/5/2020	920	-	44		

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
CLFP-3 20-Min	2/5/2020	1359	-	66		
CLFP-3 Baseline	2/5/2020	642	-	22		
CLFP-3 Baseline	2/5/2020	900	-	13		
CLFP-3 Baseline	2/5/2020	1332	-	51		
CLFP-4 10-Min	2/5/2020	1059	-	0		
CLFP-4 20-Min	2/5/2020	1112	-	0		
CLFP-4 Baseline	2/5/2020	1048	-	0		
CLFP-5 10-Min	2/5/2020	1133	-	0		
CLFP-5 20-Min	2/5/2020	1145	-	0		
CLFP-5 Baseline	2/5/2020	1122	-	0		
CLFP-6 10-Min	2/5/2020	1448	-	0		
CLFP-6 20-Min	2/5/2020	1459	-	0		
CLFP-6 Baseline	2/5/2020	1434	-	0		
Vent 1	2/5/2020	1525	50	-		
Vent 3	2/5/2020	1529	62.5	-		
Vent 4	2/5/2020	1531	61	-		
Vent 5	2/5/2020	1533	60	-		
Vent 6	2/5/2020	1535	60	-		
Vent 7	2/5/2020	1537	53			
CLFP-1 10-Min	2/6/2020	1641	-	0		
CLFP-1 20-Min	2/6/2020	1700	-	0		
CLFP-1 Baseline	2/6/2020	1629	-	0		
CLFP-2 10-Min	2/6/2020	1856	-	0		
CLFP-2 20-Min	2/6/2020	1909	-	0		
CLFP-2 Baseline	2/6/2020	1844	-	0		
CLFP-3	2/6/2020	711	-	29		
CLFP-3	2/6/2020	1117	-	66		
CLFP-3	2/6/2020	1352	12	-	Pre-start Blower	
CLFP-3	2/6/2020	1354	13.5	-	Blower started	
CLFP-3	2/6/2020	1400	14.5	-	Blower on	
CLFP-3	2/6/2020	1420	15	-	Blower on	
CLFP-3	2/6/2020	1540	15	-		
CLFP-3	2/6/2020	1748	14.4	-	Blower on	
CLFP-3	2/6/2020	1932	14	-	Blower on	
CLFP-3	2/6/2020	2119	13	-	Blower on	
CLFP-4 10-Min	2/6/2020	1726	-	0		
CLFP-4 20-Min	2/6/2020	1739	-	0		
CLFP-4 Baseline	2/6/2020	1714	-	0		
CLFP-5 10-Min	2/6/2020	1604	-	0		
CLFP-5 20-Min	2/6/2020	1616	-	0		
CLFP-5 Baseline	2/6/2020	1553	-	0		
CLFP-6 10-Min	2/6/2020	1532	-	0		
CLFP-6 20-Min	2/6/2020	1544	-	0		
CLFP-6 Baseline	2/6/2020	1521	-	0		
Vent 1	2/6/2020	934	48.5	-		
Vent 1	2/6/2020	1944	49	-		
Vent 1	2/6/2020	2110	42	-		
Vent 2	2/6/2020	1020	-	0		
Vent 3	2/6/2020	1010	-	0		
Vent 4	2/6/2020	1000	62	-		
Vent 4	2/6/2020	1105	-	0		
Vent 5	2/6/2020	935	57	-		
Vent 5	2/6/2020	1100	52	-		
Vent 5	2/6/2020	1258	55	-		
Vent 5	2/6/2020	2002	59.5	-		
Vent 5	2/6/2020	2107	57	-		
Vent 6	2/6/2020	940	55	-		
Vent 6	2/6/2020	1058	54.5	-		
Vent 6	2/6/2020	1300	55	-		
Vent 6	2/6/2020	2004	35	-		
Vent 6	2/6/2020	2104	54.5	-		
Vent 7	2/6/2020	950	50	-		
Vent 7	2/6/2020	1057	48.5	-		
Vent 7	2/6/2020	1302	50.5	-		
Vent 7	2/6/2020	2007	50.5	-		
Vent 7	2/6/2020	2100	53.5	-		
1461 Calero Dr	2/7/2020	1200	-	0		
1611 N Calero Dr	2/7/2020	1345	-	0		
9400 Terry St	2/7/2020	1300	-	0		
9700 E Strand Dr	2/7/2020	1230	-	0		
9750 E Lee Ann Dr	2/7/2020	1110	-	8		
9815 E Lee Ann Dr	2/7/2020	1320	-	0		
CLFP-1 10-Min	2/7/2020	1138	-	0		

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
CLFP-1 20-Min	2/7/2020	1150	-	0		
CLFP-1 Baseline	2/7/2020	1127	-	0		
CLFP-2 10-Min	2/7/2020	805	-	0		
CLFP-2 10-Min	2/7/2020	1028	-	0		
CLFP-2 20-Min	2/7/2020	816	-	0		
CLFP-2 20-Min	2/7/2020	1044	-	0		
CLFP-2 Baseline	2/7/2020	754	-	0		
CLFP-2 Baseline	2/7/2020	1015	-	0		
CLFP-3	2/7/2020	614	13.5	-	Blower on	
CLFP-3	2/7/2020	729	13	-	Blower on	
CLFP-3	2/7/2020	838	12	-		
CLFP-3	2/7/2020	1133	11.5	-	Blower on	
CLFP-3	2/7/2020	1256	11.5	-		
CLFP-3	2/7/2020	1419	11	-	Blower on	
CLFP-3	2/7/2020	1507	11.5	-	Blower on	
CLFP-3	2/7/2020	1708	11.5	-	Blower on	
CLFP-3	2/7/2020	1828	11.5	-	Blower on	
CLFP-3	2/7/2020	1919	11.5	-	Blower on	
CLFP-4 10-Min	2/7/2020	1201	-	0		
CLFP-4 10-Min	2/7/2020	1347	-	0		
CLFP-4 10-Min	2/7/2020	1535	-	0		
CLFP-4 20-Min	2/7/2020	1212	-	0		
CLFP-4 20-Min	2/7/2020	1359	-	0		
CLFP-4 20-Min	2/7/2020	1546	-	0		
CLFP-4 Baseline	2/7/2020	1150	-	0		
CLFP-4 Baseline	2/7/2020	1335	-	0		
CLFP-4 Baseline	2/7/2020	1524	-	0		
CLFP-5 10-Min	2/7/2020	1532	-	0		
CLFP-5 20-Min	2/7/2020	1545	-	0		
CLFP-5 Baseline	2/7/2020	1520	-	0		
CLFP-6 10-Min	2/7/2020	1606	-	0		
CLFP-6 20-Min	2/7/2020	1619	-	0		
CLFP-6 Baseline	2/7/2020	1554	-	0		
Vent 1	2/7/2020	621	52	-		
Vent 1	2/7/2020	824	50	-		
Vent 1	2/7/2020	948	49	-		
Vent 1	2/7/2020	1128	46	-		
Vent 1	2/7/2020	1247	45	-	Blower on	
Vent 1	2/7/2020	1402	46	-		
Vent 1	2/7/2020	1518	46.5	-		
Vent 1	2/7/2020	1724	47.5	-		
Vent 1	2/7/2020	1840	47.5	-		
Vent 1	2/7/2020	1934	47	-		
Vent 1	2/7/2020	2045	47	-		
Vent 5	2/7/2020	630	61.5	-		
Vent 5	2/7/2020	826	54	-		
Vent 5	2/7/2020	956	60	-		
Vent 5	2/7/2020	1242	56	-		
Vent 5	2/7/2020	1404	54	-	Capped	
Vent 5	2/7/2020	1516	54	-		
Vent 5	2/7/2020	1719	55	-		
Vent 5	2/7/2020	1837	56.5	-		
Vent 5	2/7/2020	1931	56.5	-		
Vent 5	2/7/2020	2043	57	-		
Vent 6	2/7/2020	634	54	-		
Vent 6	2/7/2020	828	54	-		
Vent 6	2/7/2020	1002	60	-		
Vent 6	2/7/2020	1118	29	-	Fluctuating between 0 and 29% by volume, capped.	
Vent 6	2/7/2020	1240	57	-		
Vent 6	2/7/2020	1406	51	-	Blower on	
Vent 6	2/7/2020	1514	55	-		
Vent 6	2/7/2020	1717	59.5	-		
Vent 6	2/7/2020	1835	57	-		
Vent 6	2/7/2020	1928	55	-		
Vent 6	2/7/2020	2040	57.5	-		
Vent 7	2/7/2020	638	52	-		
Vent 7	2/7/2020	831	48	-		
Vent 7	2/7/2020	1012	49.5	-		
Vent 7	2/7/2020	1111	49	-		
Vent 7	2/7/2020	1236	45.5	-		
Vent 7	2/7/2020	1409	-	0		
CLFP-1 10-Min	2/8/2020	1313	-	0		

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
CLFP-1 20-Min	2/8/2020	1326	-	0		
CLFP-1 Baseline	2/8/2020	1301	-	0		
CLFP-2 10-Min	2/8/2020	1556	-	0		
CLFP-2 20-Min	2/8/2020	1608	-	0		
CLFP-2 Baseline	2/8/2020	1544	-	0		
CLFP-3	2/8/2020	600	12.5	-	Blower on	
CLFP-3	2/8/2020	827	11.5	-	Blower on	
CLFP-3	2/8/2020	1017	12.5	-	Blower on	
CLFP-3	2/8/2020	1415	10.2	-		
CLFP-3	2/8/2020	1714	10	-		
CLFP-3	2/8/2020	1824	10	-	Blower on	
CLFP-3	2/8/2020	1924	9.5	-		
CLFP-3	2/8/2020	2056	9	-	Blower on	
CLFP-4 10-Min	2/8/2020	1033	-	0		
CLFP-4 10-Min	2/8/2020	1557	-	0		
CLFP-4 20-Min	2/8/2020	1043	-	0		
CLFP-4 20-Min	2/8/2020	1611	-	0		
CLFP-4 Baseline	2/8/2020	1023	-	0		
CLFP-4 Baseline	2/8/2020	1545	-	0		
CLFP-5 10-Min	2/8/2020	1509	-	0		
CLFP-5 20-Min	2/8/2020	1522	-	0		
CLFP-5 Baseline	2/8/2020	1456	-	0		
CLFP-6 10-Min	2/8/2020	1436	-	0		
CLFP-6 20-Min	2/8/2020	1447	-	0		
CLFP-6 Baseline	2/8/2020	1424	-	0		
Vent 1	2/8/2020	615	55	-		
Vent 1	2/8/2020	820	53.5	-		
Vent 1	2/8/2020	1058	54.5	-		
Vent 1	2/8/2020	1548	38.5	-		
Vent 1	2/8/2020	1726	42.5	-		
Vent 1	2/8/2020	1836	45.5	-		
Vent 1	2/8/2020	1936	43	-		
Vent 1	2/8/2020	2049	42.5	-		
Vent 5	2/8/2020	620	60.5	-		
Vent 5	2/8/2020	800	61.5	-		
Vent 5	2/8/2020	1101	56.5	-		
Vent 5	2/8/2020	1520	38.6	-		
Vent 5	2/8/2020	1722	8.5	-	Capped	
Vent 6	2/8/2020	625	56.5	-		
Vent 6	2/8/2020	810	55	-		
Vent 6	2/8/2020	1105	55	-		
Vent 6	2/8/2020	1504	40.2	-		
Vent 6	2/8/2020	1720	52	-		
Vent 6	2/8/2020	1833	52.5	-		
Vent 6	2/8/2020	1933	46.5	-		
Vent 6	2/8/2020	2045	-	0	Capped	
CLFP-1 10-Min	2/9/2020	1341	-	0		
CLFP-1 20-Min	2/9/2020	1353	-	0		
CLFP-1 Baseline	2/9/2020	1329	-	0		
CLFP-2 10-Min	2/9/2020	1026	-	0		
CLFP-2 20-Min	2/9/2020	1038	-	0		
CLFP-2 Baseline	2/9/2020	1013	-	0		
CLFP-3	2/9/2020	657	9	-	Blower on	
CLFP-3	2/9/2020	829	8.5	-	Blower on	
CLFP-3	2/9/2020	1205	7.5	-	Blower on	
CLFP-3	2/9/2020	1501	-	97	Blower on	
CLFP-3	2/9/2020	1600	8	-	Blower on	
CLFP-3	2/9/2020	1725	8.5	-	Blower on	
CLFP-3	2/9/2020	1836	8	-	Blower on	
CLFP-3	2/9/2020	1955	9	-	Blower on	
CLFP-3	2/9/2020	2044	9	-	Blower on	
CLFP-4 10-Min	2/9/2020	1059	-	0		
CLFP-4 10-Min	2/9/2020	1741	-	0		
CLFP-4 20-Min	2/9/2020	1111	-	0		
CLFP-4 20-Min	2/9/2020	1753	-	0		
CLFP-4 Baseline	2/9/2020	1049	-	0		
CLFP-4 Baseline	2/9/2020	1730	-	0		
CLFP-5 10-Min	2/9/2020	1133	-	0		
CLFP-5 20-Min	2/9/2020	1145	-	0		
CLFP-5 Baseline	2/9/2020	1121	-	0		
CLFP-6 10-Min	2/9/2020	1423	-	0		
CLFP-6 20-Min	2/9/2020	1434	-	0		
CLFP-6 Baseline	2/9/2020	1412	-	0		

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
Vent 1	2/9/2020	708	43	-		
Vent 1	2/9/2020	824	42.5	-		
Vent 1	2/9/2020	940	41.5	-		
Vent 1	2/9/2020	1158	40.5	-		
Vent 1	2/9/2020	1453	34.5	-		
Vent 1	2/9/2020	1609	43	-		
Vent 1	2/9/2020	1718	46	-		
Vent 1	2/9/2020	1800	44	-		
Vent 1	2/9/2020	1950	47.5	-		
Vent 1	2/9/2020	2039	48.5	-		
CLFP-1 10-Min	2/10/2020	1229	-	0		
CLFP-1 20-Min	2/10/2020	1241	-	0		
CLFP-1 Baseline	2/10/2020	1217	-	0		
CLFP-2 10-Min	2/10/2020	1533	-	0		
CLFP-2 20-Min	2/10/2020	1545	-	0		
CLFP-2 Baseline	2/10/2020	1521	-	0		
CLFP-3	2/10/2020	607	9.5	-	Blower on	
CLFP-3	2/10/2020	802	9.5	-	Blower on	
CLFP-3	2/10/2020	1016	9.5	-	Blower on	
CLFP-3	2/10/2020	1332	9.4	-	Blower on	
CLFP-3	2/10/2020	1456	9	-	Blower on	
CLFP-5 10-Min	2/10/2020	1450	-	0		
CLFP-5 20-Min	2/10/2020	1503	-	0		
CLFP-5 Baseline	2/10/2020	1437	-	0		
CLFP-6 10-Min	2/10/2020	1418	-	0		
CLFP-6 20-Min	2/10/2020	1430	-	0		
CLFP-6 Baseline	2/10/2020	1406	-	0		
Vent 1	2/10/2020	617	52	-		
Vent 1	2/10/2020	824	52	-		
Vent 1	2/10/2020	1022	49.5	-		
Vent 1	2/10/2020	1510	48	-		
Vent 1	2/10/2020	1606	39.5	-		
CLFG-1	2/11/2020	1655	59.6	-		
CLFG-1	2/11/2020	1711	60.3	-		
CLFP-1 10-Min	2/11/2020	1305	-	0		
CLFP-1 20-Min	2/11/2020	1316	-	0		
CLFP-1 Baseline	2/11/2020	1255	-	0		
CLFP-2 10-Min	2/11/2020	1335	-	0		
CLFP-2 20-Min	2/11/2020	1346	-	0		
CLFP-2 Baseline	2/11/2020	1324	-	0		
CLFP-3	2/11/2020	646	8	-	Blower on	
CLFP-3	2/11/2020	835	8.5	-	Blower on	
CLFP-3	2/11/2020	925	9	-	Blower on	
CLFP-3	2/11/2020	1115	8.5	-	Blower on	
CLFP-3	2/11/2020	1416	9.2	-	Blower on	
CLFP-3	2/11/2020	1822	10.5	-		
CLFP-4 10-Min	2/11/2020	909	-	0		
CLFP-4 10-Min	2/11/2020	1541	-	0		
CLFP-4 20-Min	2/11/2020	920	-	0		
CLFP-4 20-Min	2/11/2020	1552	-	0		
CLFP-4 Baseline	2/11/2020	857	-	0		
CLFP-4 Baseline	2/11/2020	1528	-	0		
CLFP-5 10-Min	2/11/2020	1509	-	0		
CLFP-5 20-Min	2/11/2020	1521	-	0		
CLFP-5 Baseline	2/11/2020	1456	-	0		
CLFP-6 10-Min	2/11/2020	1437	-	0		
CLFP-6 20-Min	2/11/2020	1449	-	0		
CLFP-6 Baseline	2/11/2020	1426	-	0		
Vent 1	2/11/2020	653	47	-		
Vent 1	2/11/2020	840	49.5	-		
Vent 1	2/11/2020	939	49	-		
Vent 1	2/11/2020	1120	51	-		
Vent 1	2/11/2020	1817	57	-		
CLFP-1 10-Min	2/12/2020	1335	-	0		
CLFP-1 20-Min	2/12/2020	1346	-	0		
CLFP-1 Baseline	2/12/2020	1324	-	0		
CLFP-2 10-Min	2/12/2020	1405	-	0		
CLFP-2 20-Min	2/12/2020	1416	-	0		
CLFP-2 Baseline	2/12/2020	1354	-	0		
CLFP-3	2/12/2020	630	12	-	Blower on	
CLFP-3	2/12/2020	740	12	-	Blower on	
CLFP-3	2/12/2020	936	13	-	Blower on	
CLFP-3	2/12/2020	1050	12	-	Blower on	

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
CLFP-3	2/12/2020	1808	10	-	Blower on	
CLFP-4 10-Min	2/12/2020	811	-	0		
CLFP-4 20-Min	2/12/2020	821	-	0		
CLFP-4 Baseline	2/12/2020	800	-	0		
CLFP-5 10-Min	2/12/2020	1504	-	0		
CLFP-5 20-Min	2/12/2020	1515	-	0		
CLFP-5 Baseline	2/12/2020	1453	-	0		
CLFP-6 10-Min	2/12/2020	1436	-	0		
CLFP-6 20-Min	2/12/2020	1447	-	0		
CLFP-6 Baseline	2/12/2020	1425	-	0		
Vent 1	2/12/2020	635	59	-		
Vent 1	2/12/2020	743	58.5	-		
Vent 1	2/12/2020	944	59.5	-		
Vent 1	2/12/2020	1055	56.5	-		
Vent 1	2/12/2020	1605	45.9	-		
Vent 1	2/12/2020	1803	52.5	-		
Vent 5	2/12/2020	1558	49.8	-		
Vent 6	2/12/2020	1551	47.4	-		
Vent 7	2/12/2020	1545	40.8	-		
CLFP-1 10-Min	2/13/2020	1538	-	0		
CLFP-1 20-Min	2/13/2020	1548	-	0		
CLFP-1 Baseline	2/13/2020	1528	-	0		
CLFP-2 10-Min	2/13/2020	1510	-	1		
CLFP-2 20-Min	2/13/2020	1520	-	1		
CLFP-2 Baseline	2/13/2020	1500	-	0		
CLFP-3	2/13/2020	614	8	-	Blower on	
CLFP-3	2/13/2020	800	7.5	-	Blower on	
CLFP-3	2/13/2020	953	8	-	Blower on	
CLFP-3	2/13/2020	1211	8	-	Blower on	
CLFP-3	2/13/2020	1428	7.5	-	Blower on	
CLFP-4 10-Min	2/13/2020	1447	-	0		
CLFP-4 20-Min	2/13/2020	1457	-	0		
CLFP-4 Baseline	2/13/2020	1437	-	0		
CLFP-5 10-Min	2/13/2020	1257	-	0		
CLFP-5 20-Min	2/13/2020	1307	-	0		
CLFP-5 Baseline	2/13/2020	1247	-	0		
CLFP-6 10-Min	2/13/2020	1052	-	0		
CLFP-6 20-Min	2/13/2020	1102	-	0		
CLFP-6 Baseline	2/13/2020	1042	-	0		
Vent 1	2/13/2020	620	42	-		
Vent 1	2/13/2020	812	42.5	-		
Vent 1	2/13/2020	1001	43	-		
Vent 1	2/13/2020	1218	43	-		
Vent 1	2/13/2020	1512	45.5	-		
Vent 6	2/13/2020	628	45	-		
Vent 6	2/13/2020	817	50.5	-		
Vent 6	2/13/2020	1010	44	-		
Vent 6	2/13/2020	1223	51	-		
Vent 6	2/13/2020	1515	54	-		
Vent 7	2/13/2020	632	36	-		
vent 7	2/13/2020	823	35.5	-		
Vent 7	2/13/2020	1014	36.5			
Vent 7	2/13/2020	1228	34.5	-		
Vent 7	2/13/2020	1517	38.5	-		
CLFP-1 10-Min	2/14/2020	1500	-	0		
CLFP-1 20-Min	2/14/2020	1510	-	0		
CLFP-1 Baseline	2/14/2020	1449	-	0		
CLFP-2 10-Min	2/14/2020	1500	-	0		
CLFP-2 20-Min	2/14/2020	1512	-	0		
CLFP-2 Baseline	2/14/2020	1437	-	0		
CLFP-3	2/14/2020	852	9.5	-	Blower on	
CLFP-3	2/14/2020	1123	9.5	-	Blower on	
CLFP-3	2/14/2020	1245	9.5	-	Blower on	
CLFP-3	2/14/2020	1614	9	-	Blower on	
CLFP-3	2/14/2020	1749	9	-		
CLFP-4 10-Min	2/14/2020	1424	-	0		
CLFP-4 20-Min	2/14/2020	1435	-	0		
CLFP-4 Baseline	2/14/2020	1413	-	0		
CLFP-5 10-Min	2/14/2020	1357	-	0		
CLFP-5 20-Min	2/14/2020	1408	-	0		
CLFP-5 Baseline	2/14/2020	1345	-	0		
CLFP-6 10-Min	2/14/2020	1326	-	0		
CLFP-6 20-Min	2/14/2020	1337	-	0		

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
CLFP-6 Baseline	2/14/2020	1314	-	0		
Vent 1	2/14/2020	632	50	-		
Vent 1	2/14/2020	856	50.5	-		
Vent 1	2/14/2020	1028	51.5	-		
Vent 1	2/14/2020	1251	50	-		
Vent 1	2/14/2020	1623	48.5	-		
Vent 1	2/14/2020	1746	49.5	-		
Vent 6	2/14/2020	634	55.5	-		
Vent 6	2/14/2020	904	54	-		
Vent 6	2/14/2020	1037	54	-		
Vent 6	2/14/2020	1256	54	-		
Vent 6	2/14/2020	1630	52.5	-		
Vent 6	2/14/2020	1743	55.5	-		
Vent 7	2/14/2020	636	36	-		
Vent 7	2/14/2020	912	35	-		
Vent 7	2/14/2020	1041	35.5	-		
Vent 7	2/14/2020	1259	36.5	-		
Vent 7	2/14/2020	1634	35	-		
Vent 7	2/14/2020	1740	38	-		
CLFP-1 10-Min	2/15/2020	1513	-	0		
CLFP-1 20-Min	2/15/2020	1523	-	0		
CLFP-1 Baseline	2/15/2020	1503	-	0		
CLFP-2 10-Min	2/15/2020	1439	-	0		
CLFP-2 20-Min	2/15/2020	1452	-	0		
CLFP-2 Baseline	2/15/2020	1425	-	0		
CLFP-3	2/15/2020	746	9	-	Blower on	
CLFP-3	2/15/2020	845	9.5	-	Blower on	
CLFP-3	2/15/2020	1022	9	-	Blower on	
CLFP-3	2/15/2020	1234	9	-		
CLFP-3	2/15/2020	1538	8.4	-	Blower on	
CLFP-3	2/15/2020	1613	8.5	-	Blower on	
CLFP-3	2/15/2020	1745	8.5	-	Blower on	
CLFP-4 10-Min	2/15/2020	1513	-	0		
CLFP-4 20-Min	2/15/2020	1529	-	0		
CLFP-4 Baseline	2/15/2020	1500	-	0		
CLFP-5 10-Min	2/15/2020	1330	-	0		
CLFP-5 20-Min	2/15/2020	1340	-	0		
CLFP-5 Baseline	2/15/2020	1320	-	0		
CLFP-6 10-Min	2/15/2020	1105	-	0		
CLFP-6 20-Min	2/15/2020	1115	-	0		
CLFP-6 Baseline	2/15/2020	1055	-	0		
Vent 1	2/15/2020	637	50	-		
Vent 1	2/15/2020	852	49	-		
Vent 1	2/15/2020	1028	47.5	-		
Vent 1	2/15/2020	1239	47	-		
Vent 1	2/15/2020	1545	37.3	-		
Vent 1	2/15/2020	1621	45	-		
Vent 1	2/15/2020	1740	45	-		
Vent 3	2/15/2020	1304	64.5	-	Uncapped	
Vent 3	2/15/2020	1555	56.5	-		
Vent 3	2/15/2020	1738	60.5	-		
Vent 4	2/15/2020	1045	55.5	-		
Vent 4	2/15/2020	1245	55.3	-		
Vent 4	2/15/2020	1600	47.9	-		
Vent 4	2/15/2020	1736	54	-		
Vent 5	2/15/2020	904	55	-		
Vent 5	2/15/2020	1033	53.5	-		
Vent 5	2/15/2020	1250	53	-		
Vent 5	2/15/2020	1606	46.2	-		
Vent 5	2/15/2020	1735	51.5	-		
Vent 6	2/15/2020	646	54	-		
Vent 6	2/15/2020	857	51			
Vent 6	2/15/2020	1037	44.5	-		
Vent 6	2/15/2020	1254	45.2	-		
Vent 6	2/15/2020	1612	40.3	-		
Vent 6	2/15/2020	1733	45.5	-		
Vent 7	2/15/2020	650	36	-		
Vent 7	2/15/2020	900	34.5	-		
Vent 7	2/15/2020	1040	33.5	-		
Vent 7	2/15/2020	1300	34	-		
Vent 7	2/15/2020	1618	31.2	-		
Vent 7	2/15/2020	1730	34	-		
CLFP-1 10-Min	2/16/2020	1403	-	0		

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
CLFP-1 20-Min	2/16/2020	1414	-	0		
CLFP-1 Baseline	2/16/2020	1352	-	0		
CLFP-2 10-Min	2/16/2020	1445	-	0		
CLFP-2 20-Min	2/16/2020	1456	-	0		
CLFP-2 Baseline	2/16/2020	1434	-	0		
CLFP-3	2/16/2020	608	7.5	-	Blower on	
CLFP-3	2/16/2020	802	7.5	-		
CLFP-3	2/16/2020	1000	7.5	-	Blower on	
CLFP-3	2/16/2020	1231	7	-	Blower on	
CLFP-3	2/16/2020	1531	6.5	-	Blower on	
CLFP-3	2/16/2020	1747	7	-	Blower on	
CLFP-4 10-Min	2/16/2020	1251	-	0		
CLFP-4 20-Min	2/16/2020	1302	-	0		
CLFP-4 Baseline	2/16/2020	1239	-	0		
CLFP-5 10-Min	2/16/2020	1321	-	0		
CLFP-5 20-Min	2/16/2020	1332	-	0		
CLFP-5 Baseline	2/16/2020	1310	-	0		
CLFP-6 10-Min	2/16/2020	1055	-	0		
CLFP-6 20-Min	2/16/2020	1105	-	0		
CLFP-6 Baseline	2/16/2020	1045	-	0		
Vent 1	2/16/2020	615	41.5	-		
Vent 1	2/16/2020	754	40.5	-		
Vent 1	2/16/2020	1007	39.5	-		
Vent 1	2/16/2020	1224	38.5	-		
Vent 1	2/16/2020	1505	39.5	-		
Vent 1	2/16/2020	1739	41	-		
Vent 2	2/16/2020	1509	50.5	-		
Vent 3	2/16/2020	748	56	-		
Vent 3	2/16/2020	1014	54.5	-		
Vent 3	2/16/2020	1221	41	-		
Vent 3	2/16/2020	1512	54.5	-		
Vent 3	2/16/2020	1729	53	-		
Vent 4	2/16/2020	744	52	-		
Vent 4	2/16/2020	1018	47.5	-		
Vent 4	2/16/2020	1218	43	-		
Vent 4	2/16/2020	1515	49	-		
Vent 4	2/16/2020	1727	52.5	-		
Vent 5	2/16/2020	742	48.5	-		
Vent 5	2/16/2020	1021	43.5	-		
Vent 5	2/16/2020	1216	44	-		
Vent 5	2/16/2020	1517	46	-		
Vent 5	2/16/2020	1725	49	-		
Vent 6	2/16/2020	740	42	-		
Vent 6	2/16/2020	1024	40.5	-		
Vent 6	2/16/2020	1214	29.5	-		
Vent 6	2/16/2020	1521	47	-		
Vent 6	2/16/2020	1723	44	-		
Vent 7	2/16/2020	737	31.5	-		
Vent 7	2/16/2020	1027	29.5	-		
Vent 7	2/16/2020	1212	28.5	-		
Vent 7	2/16/2020	1524	32	-		
Vent 7	2/16/2020	1720	34.5	-		
CLFP-1 10-Min	2/17/2020	1549	-	0		
CLFP-1 20-Min	2/17/2020	1559	-	0		
CLFP-1 Baseline	2/17/2020	1539	-	0		
CLFP-2 10-Min	2/17/2020	1617	-	0		
CLFP-2 20-Min	2/17/2020	1627	-	0		
CLFP-2 Baseline	2/17/2020	1607	-	0		
CLFP-3	2/17/2020	607	8	-	Blower on	
CLFP-3	2/17/2020	855	7.5	-	Blower on	
CLFP-3	2/17/2020	1029	8	-		
CLFP-3	2/17/2020	1232	7.5	-	Blower on	
CLFP-3	2/17/2020	1432	8	-		
CLFP-4 10-Min	2/17/2020	1318	-	0		
CLFP-4 20-Min	2/17/2020	1326	-	0		
CLFP-4 Baseline	2/17/2020	1305	-	0		
CLFP-5 10-Min	2/17/2020	1121	-	0		
CLFP-5 20-Min	2/17/2020	1131	-	0		
CLFP-5 Baseline	2/17/2020	1111	-	0		
Vent 1	2/17/2020	616	44.5	-		
Vent 1	2/17/2020	903	25	-		
Vent 1	2/17/2020	1238	44	-		
Vent 1	2/17/2020	1438	-	-	Generator malfunction, took offline	

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
Vent 2	2/17/2020	1508	-	-	Uncapped	
Vent 3	2/17/2020	621	49.5	-		
Vent 3	2/17/2020	907	41	-		
Vent 3	2/17/2020	1242	21	-		
Vent 3	2/17/2020	1513	57	-		
Vent 4	2/17/2020	625	53	-		
Vent 4	2/17/2020	909	48.5	-		
Vent 4	2/17/2020	1246	45.7	-		
Vent 4	2/17/2020	1517	53	-		
Vent 5	2/17/2020	629	44.5	-		
Vent 5	2/17/2020	911	40	-		
Vent 5	2/17/2020	1251	42	-		
Vent 5	2/17/2020	1520	45	-		
Vent 6	2/17/2020	634	43	-		
Vent 6	2/17/2020	915	44.5	-		
Vent 6	2/17/2020	1254	42.5	-		
Vent 7	2/17/2020	639	29.5	-		
Vent 7	2/17/2020	917	29.5	-		
Vent 7	2/17/2020	1258	32	-		
CLFP-1 10-Min	2/18/2020	658	-	0		
CLFP-1 20-Min	2/18/2020	708	-	0		
CLFP-1 Baseline	2/18/2020	648	-	0		
CLFP-2 10-Min	2/18/2020	1118	-	0		
CLFP-2 20-Min	2/18/2020	1128	-	0		
CLFP-2 Baseline	2/18/2020	1108	-	0		
CLFP-3	2/18/2020	558	7	-	Blower on	
CLFP-3	2/18/2020	824	7.5	-		
CLFP-3	2/18/2020	1034	7	-	Blower on	
CLFP-3	2/18/2020	1207	7.5	-	Blower on	
CLFP-3	2/18/2020	1417	8	-		
CLFP-3	2/18/2020	1554	8.5	-	Blower on	
CLFP-3	2/18/2020	1649	8.5	-	Blower on	
CLFP-4 10-Min	2/18/2020	1020	-	0		
CLFP-4 20-Min	2/18/2020	1030	-	0		
CLFP-4 Baseline	2/18/2020	1010	-	0		
CLFP-5 10-Min	2/18/2020	950	-	0		
CLFP-5 20-Min	2/18/2020	1000	-	0		
CLFP-5 Baseline	2/18/2020	940	-	0		
CLFP-6 10-Min	2/18/2020	922	-	0		
CLFP-6 20-Min	2/18/2020	932	-	0		
CLFP-6 Baseline	2/18/2020	912	-	0		
Vent 1	2/18/2020	829	59.5	-		
Vent 1	2/18/2020	1211	59.5	-		
Vent 1	2/18/2020	1354	62	-		
Vent 1	2/18/2020	1645	60.5	-		
Vent 2	2/18/2020	831	61.5	-		
Vent 2	2/18/2020	1216	63.5	-		
Vent 2	2/18/2020	1356	66.5	-		
Vent 2	2/18/2020	1536	44	-	Blower moved from vent 1 to vent 2	
Vent 2	2/18/2020	1643	54.5	-		
Vent 3	2/18/2020	606	12	-		
Vent 3	2/18/2020	834	49.5	-		
Vent 3	2/18/2020	1218	58	-		
Vent 3	2/18/2020	1400	59.5	-		
vent 4	2/18/2020	610	8	-		
Vent 4	2/18/2020	835	51	-		
Vent 4	2/18/2020	1222	55.5	-		
Vent 4	2/18/2020	1402	62	-		
Vent 5	2/18/2020	614	12.5	-		
Vent 5	2/18/2020	837	53.5	-		
Vent 5	2/18/2020	1224	53.5	-		
Vent 5	2/18/2020	1405	55.5	-		
Vent 5	2/18/2020	1543	57	-		
Vent 5	2/18/2020	1641	57	-		
Vent 6	2/18/2020	619	36	-		
Vent 6	2/18/2020	839	50	-		
Vent 6	2/18/2020	1227	53.5	-		
Vent 6	2/18/2020	1408	55	-		
Vent 6	2/18/2020	1545	57.5	-		
Vent 6	2/18/2020	1639	50.5	-		
Vent 7	2/18/2020	624	39	-		
Vent 7	2/18/2020	840	44	-		
Vent 7	2/18/2020	1230	46	-		

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
Vent 7	2/18/2020	1410	48	-		
Vent 7	2/18/2020	1546	48.5	-		
Vent 7	2/18/2020	1637	44.5	-		
CLFP-1 10-Min	2/19/2020	921	-	0		
CLFP-1 20-Min	2/19/2020	931	-	0		
CLFP-1 Baseline	2/19/2020	911	-	0		
CLFP-2 10-Min	2/19/2020	947	-	0		
CLFP-2 20-Min	2/19/2020	957	-	0		
CLFP-2 Baseline	2/19/2020	937	-	0		
CLFP-3	2/19/2020	613	9.5	-	Generator died overnight, took baseline measurments and 2 10-minute purges	
CLFP-3	2/19/2020	624	10	-		
CLFP-3	2/19/2020	636	10	-	Blower connected	
CLFP-3	2/19/2020	827	9	-	Blower on	
CLFP-3	2/19/2020	1002	8.5	-		
CLFP-3	2/19/2020	1233	8	-	Blower on	
CLFP-3	2/19/2020	1550	8.5	-	Blower on	
CLFP-3	2/19/2020	1646	8.5	-	Blower on	
CLFP-4 10-Min	2/19/2020	1218	-	0		
CLFP-4 20-Min	2/19/2020	1228	-	0		
CLFP-4 Baseline	2/19/2020	1208	-	0		
CLFP-5 10-Min	2/19/2020	1145	-	0		
CLFP-5 20-Min	2/19/2020	1155	-	0		
CLFP-5 Baseline	2/19/2020	1135	-	0		
CLFP-6 10-Min	2/19/2020	1115	-	0		
CLFP-6 20-Min	2/19/2020	1125	-	0		
CLFP-6 Baseline	2/19/2020	1105	-	0		
Vent 1	2/19/2020	834	59.4	-		
Vent 2	2/19/2020	620	63	-	Generator died overnight	
Vent 2	2/19/2020	840	38.5	-		
Vent 2	2/19/2020	1008	45.5	-		
Vent 2	2/19/2020	1240	48	-		
Vent 2	2/19/2020	1555	49.5	-		
Vent 2	2/19/2020	1642	51	-		
Vent 5	2/19/2020	642	61	-		
Vent 6	2/19/2020	645	57	-		
Vent 6	2/19/2020	850	26	-		
Vent 7	2/19/2020	648	50	-		
Vent 7	2/19/2020	853	44.5	-		
CLFP-1 10-Min	2/20/2020	953	-	0		
CLFP-1 20-Min	2/20/2020	1003	-	0		
CLFP-1 Baseline	2/20/2020	943	-	0		
CLFP-2 10-Min	2/20/2020	1625	-	0		
CLFP-2 20-Min	2/20/2020	1636	-	0		
CLFP-2 Baseline	2/20/2020	1614	-	0		
CLFP-3	2/20/2020	557	10.5	-	Blower on	
CLFP-3	2/20/2020	902	10.5	-	Blower on	
CLFP-3	2/20/2020	1148	11	-		
CLFP-3	2/20/2020	1438	10.5	-	Blower on	
CLFP-3	2/20/2020	1709	10	-	Blower on	
CLFP-4 10-Min	2/20/2020	1349	-	0		
CLFP-4 20-Min	2/20/2020	1359	-	0		
CLFP-4 Baseline	2/20/2020	1339	-	0		
CLFP-5 10-Min	2/20/2020	1515	-	0		
CLFP-5 20-Min	2/20/2020	1525	-	0		
CLFP-5 Baseline	2/20/2020	1501	-	0		
CLFP-6 10-Min	2/20/2020	1218	-	0		
CLFP-6 20-Min	2/20/2020	1228	-	0		
CLFP-6 Baseline	2/20/2020	1208	-	0		
Vent 2	2/20/2020	608	65	-		
Vent 2	2/20/2020	909	60.5	-		
Vent 2	2/20/2020	1153	60	-		
Vent 2	2/20/2020	1430	59	-		
Vent 2	2/20/2020	1703	56	-		
CLFP-1 10-Min	2/21/2020	1155	-	0		
CLFP-1 20-Min	2/21/2020	1205	-	0		
CLFP-1 Baseline	2/21/2020	1145	-	0		
CLFP-2 10-Min	2/21/2020	1605	-	0		
CLFP-2 20-Min	2/21/2020	1615	-	0		
CLFP-2 Baseline	2/21/2020	1555	-	0		
CLFP-3	2/21/2020	610	9.5	-	Blower on	
CLFP-3	2/21/2020	853	9	-		
CLFP-3	2/21/2020	1118	9	-	Blower on	
CLFP-3	2/21/2020	1449	9	-	Blower on	

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
CLFP-3	2/21/2020	1644	8.5	-	Blower on	
CLFP-4 10-Min	2/21/2020	1533	-	0		
CLFP-4 20-Min	2/21/2020	1543	-	0		
CLFP-4 Baseline	2/21/2020	1523	-	0		
CLFP-5 10-Min	2/21/2020	1510	-	0		
CLFP-5 20-Min	2/21/2020	1520	-	0		
CLFP-5 Baseline	2/21/2020	1500	-	0		
CLFP-6 10-Min	2/21/2020	947	-	0		
CLFP-6 20-Min	2/21/2020	957	-	0		
CLFP-6 Baseline	2/21/2020	937	-	0		
Vent 2	2/21/2020	615	52	-		
Vent 2	2/21/2020	902	50	-		
Vent 2	2/21/2020	1124	51	-		
Vent 2	2/21/2020	1453	49.5	-		
Vent 2	2/21/2020	1641	49	-		
CLFP-1 10-Min	2/22/2020	1017	-	0		
CLFP-1 20-Min	2/22/2020	1028	-	0		
CLFP-1 Baseline	2/22/2020	1006	-	0		
CLFP-2 10-Min	2/22/2020	1044	-	0		
CLFP-2 20-Min	2/22/2020	1055	-	0		
CLFP-2 Baseline	2/22/2020	1033	-	0		
CLFP-3	2/22/2020	853	7.5	-	Blower on	
CLFP-3	2/22/2020	1110	6.5	-	Blower on	
CLFP-3	2/22/2020	1310	7	-	Blower on	
CLFP-3	2/22/2020	1503	6.5	-	Blower on	
CLFP-3	2/22/2020	1644	6.5	-	Blower on	
CLFP-4 10-Min	2/22/2020	1331	-	0		
CLFP-4 20-Min	2/22/2020	1342	-	0		
CLFP-4 Baseline	2/22/2020	1320	-	0		
CLFP-5 10-Min	2/22/2020	1359	-	0		
CLFP-5 20-Min	2/22/2020	1410	-	0		
CLFP-5 Baseline	2/22/2020	1348	-	0		
CLFP-6 10-Min	2/22/2020	1443	-	0		
CLFP-6 20-Min	2/22/2020	1454	-	0		
CLFP-6 Baseline	2/22/2020	1432	-	0		
Vent 2	2/22/2020	849	42.5	-		
Vent 2	2/22/2020	1107	48	-		
Vent 2	2/22/2020	1305	46.5	-	Generator on Vent 2 went down, discovered at 1100, replaced with new rental at 1230	
Vent 2	2/22/2020	1500	42	-		
Vent 2	2/22/2020	1640	43.5	-		
CLFP-1 10-Min	2/23/2020	1121	-	0		
CLFP-1 20-Min	2/23/2020	1132	-	0		
CLFP-1 Baseline	2/23/2020	1109	-	0		
CLFP-2 10-Min	2/23/2020	1155	-	0		
CLFP-2 20-Min	2/23/2020	1207	-	0		
CLFP-2 Baseline	2/23/2020	1142	-	0		
CLFP-3	2/23/2020	713	6.5	-		
CLFP-3	2/23/2020	909	6	-	Blower on	
CLFP-3	2/23/2020	1057	6	-	Blower on	
CLFP-3	2/23/2020	1253	5.5	-	Blower on	
CLFP-3	2/23/2020	1515	-	60	Blower on	
CLFP-3	2/23/2020	1636	5	-	Blower on	
CLFP-4 10-Min	2/23/2020	1309	-	0		
CLFP-4 20-Min	2/23/2020	1320	-	0		
CLFP-4 Baseline	2/23/2020	1258	-	0		
CLFP-5 10-Min	2/23/2020	1336	-	0		
CLFP-5 20-Min	2/23/2020	1347	-	0		
CLFP-5 Baseline	2/23/2020	1325	-	0		
CLFP-6 10-Min	2/23/2020	1406	-	0		
CLFP-6 20-Min	2/23/2020	1417	-	0		
CLFP-6 Baseline	2/23/2020	1354	-	0		
Vent 2	2/23/2020	708	42	-		
Vent 2	2/23/2020	856	39.5	-		
Vent 2	2/23/2020	1050	40.5	-		
Vent 2	2/23/2020	1250	38	-		
Vent 2	2/23/2020	1509	29	-		
Vent 2	2/23/2020	1630	39	-		
CLFP-1 10-Min	2/24/2020	941	-	0		
CLFP-1 20-Min	2/24/2020	951	-	0		
CLFP-1 Baseline	2/24/2020	931	-	0		
CLFP-2 10-Min	2/24/2020	1300	-	0		
CLFP-2 20-Min	2/24/2020	1310	-	0		
CLFP-2 Baseline	2/24/2020	1250	-	0		

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
CLFP-3	2/24/2020	608	5.5	-	Blower on	
CLFP-3	2/24/2020	834	5.5	-	Blower on	
CLFP-3	2/24/2020	1105	6	-	Blower on	
CLFP-3	2/24/2020	1558	6.5	-	Blower on	
CLFP-4 10-Min	2/24/2020	1134	-	0		
CLFP-4 20-Min	2/24/2020	1144	-	0		
CLFP-4 Baseline	2/24/2020	1124	-	0		
CLFP-5 10-Min	2/24/2020	1200	-	0		
CLFP-5 20-Min	2/24/2020	1210	-	0		
CLFP-5 Baseline	2/24/2020	1150	-	0		
CLFP-6 10-Min	2/24/2020	1223	-	0		
CLFP-6 20-Min	2/24/2020	1233	-	0		
CLFP-6 Baseline	2/24/2020	1213	-	0		
Vent 2	2/24/2020	620	45	-		
Vent 2	2/24/2020	847	44.5	-		
Vent 2	2/24/2020	1112	46.5	-		
Vent 2	2/24/2020	1602	50	-		
CLFP-1 10-Min	2/25/2020	1421	-	0		
CLFP-1 20-Min	2/25/2020	1433	-	0		
CLFP-1 Baseline	2/25/2020	1410	-	0		
CLFP-2 10-Min	2/25/2020	1548	-	0		
CLFP-2 20-Min	2/25/2020	1600	-	0		
CLFP-2 Baseline	2/25/2020	1537	-	0		
CLFP-3	2/25/2020	602	10.5	-	Blower on	
CLFP-3	2/25/2020	1147	10	-	Blower on	
CLFP-3	2/25/2020	1534	-	0		
CLFP-4 10-Min	2/25/2020	1350	-	0		
CLFP-4 20-Min	2/25/2020	1401	-	0		
CLFP-4 Baseline	2/25/2020	1339	-	0		
CLFP-5 10-Min	2/25/2020	1324	-	0		
CLFP-5 20-Min	2/25/2020	1335	-	0		
CLFP-5 Baseline	2/25/2020	1313	-	0		
CLFP-6 10-Min	2/25/2020	1256	-	0		
CLFP-6 20-Min	2/25/2020	1308	-	0		
CLFP-6 Baseline	2/25/2020	1246	-	0		
Vent 2	2/25/2020	612	60	-		
Vent 2	2/25/2020	1240	52.5	-		
CLFP-1	2/26/2020	1401	-	0		
CLFP-1	2/26/2020	1412	-	0		
CLFP-1	2/26/2020	1424	-	0		
CLFP-2	2/26/2020	1430	-	0		
CLFP-2	2/26/2020	1441	-	0		
CLFP-2	2/26/2020	1452	-	0		
CLFP-3	2/26/2020	750	9	-		
CLFP-3	2/26/2020	750	9	-		
CLFP-3	2/26/2020	1020	8.5	-		
CLFP-3	2/26/2020	1020	8.5	-		
CLFP-3	2/26/2020	1122	8.5	-		
CLFP-3	2/26/2020	1122	8.5	-		
CLFP-3	2/26/2020	1323	8	-		
CLFP-3	2/26/2020	1553	8	-		
CLFP-4	2/26/2020	1326	-	0		
CLFP-4	2/26/2020	1337	-	0		
CLFP-4	2/26/2020	1348	-	0		
CLFP-5	2/26/2020	1222	-	0		
CLFP-5	2/26/2020	1234	-	0		
CLFP-5	2/26/2020	1246	-	0		
CLFP-5 10-Min	2/26/2020	1234	-	0		
CLFP-5 20-Min	2/26/2020	1246	-	0		
CLFP-5 Baseline	2/26/2020	1222	-	0		
CLFP-6	2/26/2020	1154	-	0		
CLFP-6	2/26/2020	1205	-	0		
CLFP-6	2/26/2020	1216	-	0		
CLFP-6 10-Min	2/26/2020	1205	-	0		
CLFP-6 20-Min	2/26/2020	1216	-	0		
CLFP-6 Baseline	2/26/2020	1154	-	0		
Vent 1	2/26/2020	1048	59.5	-		
Vent 1	2/26/2020	1048	59.5	-		
Vent 1	2/26/2020	1309	55.5	-		
Vent 1	2/26/2020	1546	56.5	-		
Vent 1	2/26/2020	1546	56.5	-		
Vent 2	2/26/2020	1030	46.5	-		
Vent 2	2/26/2020	1030	46.5	-		

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
Vent 2	2/26/2020	1132	50.5	-		
Vent 2	2/26/2020	1132	50.5	-		
Vent 2	2/26/2020	1311	46	-		
Vent 2	2/26/2020	1548	47	-		
Vent 5	2/26/2020	1037	50.5	-		
Vent 5	2/26/2020	1040	49.5	-		
Vent 5	2/26/2020	1315	48	-		
Vent 5	2/26/2020	1545	50.5	-		
Vent 6	2/26/2020	1040	49.5	-		
Vent 6	2/26/2020	1040	49.5	-		
Vent 6	2/26/2020	1317	46	-		
Vent 6	2/26/2020	1543	47.5	-		
CLFP-1	2/27/2020	1508	-	0		
CLFP-1	2/27/2020	1519	-	0		
CLFP-1	2/27/2020	1531	-	0		
CLFP-2	2/27/2020	1040	-	0		
CLFP-2	2/27/2020	1050	-	0		
CLFP-2	2/27/2020	1100	-	0		
CLFP-3	2/27/2020	530	8.5	-		
CLFP-3	2/27/2020	856	8	-		
CLFP-3	2/27/2020	1123	8	-		
CLFP-3	2/27/2020	1330	7.5	-		
CLFP-3	2/27/2020	1535	7	-		
CLFP-4	2/27/2020	1440	-	0		
CLFP-4	2/27/2020	1451	-	0		
CLFP-4	2/27/2020	1502	-	0		
CLFP-5	2/27/2020	1302	-	0		
CLFP-5	2/27/2020	1313	-	0		
CLFP-5	2/27/2020	1325	-	0		
CLFP-6	2/27/2020	1234	-	0		
CLFP-6	2/27/2020	1246	-	0		
CLFP-6	2/27/2020	1257	-	0		
Vent 1	2/27/2020	914	57.5	-		
Vent 1	2/27/2020	1132	58	-		
Vent 1	2/27/2020	1344	54.5	-		
Vent 1	2/27/2020	1538	53.5	-		
Vent 2	2/27/2020	542	46	-		
Vent 2	2/27/2020	918	45.5	-		
Vent 2	2/27/2020	1137	46	-		
Vent 2	2/27/2020	1342	43	-		
Vent 5	2/27/2020	921	48.5	-		
Vent 5	2/27/2020	1140	51	-		
Vent 5	2/27/2020	1339	47	-		
Vent 6	2/27/2020	928	45.5	-		
Vent 6	2/27/2020	1144	46.5	-		
Vent 6	2/27/2020	1336	46	-		
Vent 6	2/27/2020	1538	-	-		
CLFP-1	2/28/2020	1451	-	0		
CLFP-1	2/28/2020	1502	-	0		
CLFP-1	2/28/2020	1514	-	0		
CLFP-2	2/28/2020	1220	-	0		
CLFP-2	2/28/2020	1230	-	0		
CLFP-2	2/28/2020	1240	-	0		
CLFP-3	2/28/2020	550	7.5	-		
CLFP-3	2/28/2020	754	7.5	-		
CLFP-3	2/28/2020	1051	7	-		
CLFP-3	2/28/2020	1336	6	-		
CLFP-3	2/28/2020	1555	6	-		
CLFP-4	2/28/2020	1248	-	0		
CLFP-4	2/28/2020	1258	-	0		
CLFP-4	2/28/2020	1308	-	0		
CLFP-5	2/28/2020	1417	-	0		
CLFP-5	2/28/2020	1429	-	0		
CLFP-5	2/28/2020	1441	-	0		
CLFP-6	2/28/2020	1350	-	0		
CLFP-6	2/28/2020	1401	-	0		
CLFP-6	2/28/2020	1412	-	0		
Vent 1	2/28/2020	740	57.5	-		
Vent 1	2/28/2020	1055	52.5	-		
Vent 1	2/28/2020	1119	55	-		
Vent 1	2/28/2020	1340	55.5	-		
Vent 1	2/28/2020	1536	52	-		
Vent 2	2/28/2020	555	42	-		

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
Vent 2	2/28/2020	744	42.5	-		
Vent 2	2/28/2020	1100	35.5	-		
Vent 2	2/28/2020	1122	34	-		
Vent 2	2/28/2020	1342	41	-		
Vent 2	2/28/2020	1538	48	-		
Vent 3	2/28/2020	1540	43	-		
Vent 4	2/28/2020	1542	47.5	-		
Vent 5	2/28/2020	749	47.5	-		
Vent 5	2/28/2020	1105	45.5	-		
Vent 5	2/28/2020	1544	40.5	-		
Vent 6	2/28/2020	1130	45.5	-		
Vent 6	2/28/2020	1345	46.5	-		
Vent 6	2/28/2020	1546	43	-		
Vent 7	2/28/2020	1134	33.5	-		
Vent 7	2/28/2020	1548	32.5	-		
CLFP-1	2/29/2020	1450	-	0		
CLFP-1	2/29/2020	1501	-	0		
CLFP-1	2/29/2020	1512	-	0		
CLFP-2	2/29/2020	1131	-	0		
CLFP-2	2/29/2020	1141	-	0		
CLFP-2	2/29/2020	1151	-	0		
CLFP-3	2/29/2020	550	7.5	-		
CLFP-3	2/29/2020	800	8	-		
CLFP-3	2/29/2020	1045	7.5	-		
CLFP-3	2/29/2020	1201	7.5	-		
CLFP-3	2/29/2020	1441	7	-		
CLFP-3	2/29/2020	1605	8	-		
CLFP-4	2/29/2020	850	-	0		
CLFP-4	2/29/2020	900	-	0		
CLFP-4	2/29/2020	910	-	0		
CLFP-5	2/29/2020	1334	-	0		
CLFP-5	2/29/2020	1346	-	0		
CLFP-5	2/29/2020	1357	-	0		
CLFP-6	2/29/2020	1400	-	0		
CLFP-6	2/29/2020	1411	-	0		
CLFP-6	2/29/2020	1422	-	0		
Vent 1	2/29/2020	815	65	-		
Vent 1	2/29/2020	1057	61	-		
Vent 1	2/29/2020	1438	54	-		
Vent 1	2/29/2020	1602	52.5	-		
Vent 2	2/29/2020	818	66.5	-		
Vent 2	2/29/2020	1105	64.5	-		
Vent 2	2/29/2020	1436	52.5	-		
Vent 2	2/29/2020	1600	53	-		
Vent 3	2/29/2020	820	60.5	-		
Vent 3	2/29/2020	1111	53.5	-		
Vent 3	2/29/2020	1434	53.5	-		
Vent 3	2/29/2020	1558	53	-		
Vent 4	2/29/2020	823	57.5	-		
Vent 4	2/29/2020	1115	55.5	-		
Vent 4	2/29/2020	1432	50	-		
Vent 4	2/29/2020	1557	55.5	-		
Vent 5	2/29/2020	826	51	-		
Vent 5	2/29/2020	1120	49	-		
Vent 5	2/29/2020	1428	47	-		
Vent 5	2/29/2020	1555	53	-		
Vent 6	2/29/2020	829	53	-		
Vent 6	2/29/2020	1124	48.5	-		
Vent 6	2/29/2020	1428	47	-		
Vent 6	2/29/2020	1554	47	-		
Vent 7	2/29/2020	833	39.5	-		
Vent 7	2/29/2020	1131	37.5	-		
Vent 7	2/29/2020	1426	39	-		
Vent 7	2/29/2020	1552	40	-		
CLFP-1	3/1/2020	1219	-	0		
CLFP-1	3/1/2020	1230	-	0		
CLFP-1	3/1/2020	1241	-	0		
CLFP-2	3/1/2020	1247	-	0		
CLFP-2	3/1/2020	1258	-	0		
CLFP-2	3/1/2020	1309	-	0		
CLFP-3	3/1/2020	642	9.5	-		
CLFP-3	3/1/2020	931	9.5	-		
CLFP-3	3/1/2020	1059	9.5	-		

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
CLFP-3	3/1/2020	1312	7	-		
CLFP-3	3/1/2020	1605	8	-		
CLFP-4	3/1/2020	1416	-	0		
CLFP-4	3/1/2020	1427	-	0		
CLFP-4	3/1/2020	1438	-	0		
CLFP-5	3/1/2020	1351	-	0		
CLFP-5	3/1/2020	1402	-	0		
CLFP-5	3/1/2020	1413	-	0		
CLFP-6	3/1/2020	1325	-	0		
CLFP-6	3/1/2020	1336	-	0		
CLFP-6	3/1/2020	1347	-	0		
Vent 1	3/1/2020	637	60	-		
Vent 2	3/1/2020	637	60	-		
Vent 2	3/1/2020	926	51.5	-		
Vent 2	3/1/2020	1104	46	-		
Vent 2	3/1/2020	1319	43.5	-		
Vent 2	3/1/2020	1558	48	-		
Vent 3	3/1/2020	633	61	-		
Vent 4	3/1/2020	631	58	-		
Vent 5	3/1/2020	629	52	-		
Vent 6	3/1/2020	626	50.5	-		
Vent 7	3/1/2020	624	45.5	-		
CLFP-1	3/2/2020	1010	-	0		
CLFP-1	3/2/2020	1020	-	0		
CLFP-1	3/2/2020	1030	-	0		
CLFP-2	3/2/2020	926	-	0		
CLFP-2	3/2/2020	936	-	0		
CLFP-2	3/2/2020	946	-	0		
CLFP-3	3/2/2020	845	8	-		
CLFP-3	3/2/2020	950	8	-		
CLFP-3	3/2/2020	1427	8	-		
CLFP-4	3/2/2020	900	-	0		
CLFP-4	3/2/2020	910	-	0		
CLFP-4	3/2/2020	920	-	0		
CLFP-5	3/2/2020	1036	-	0		
CLFP-5	3/2/2020	1046	-	0		
CLFP-5	3/2/2020	1056	-	0		
CLFP-6	3/2/2020	1059	-	0		
CLFP-6	3/2/2020	1109	-	0		
CLFP-6	3/2/2020	1119	-	0		
Vent 2	3/2/2020	840	49.5	-		
Vent 2	3/2/2020	1421	48	-		
Vent 2	3/2/2020	1625	48.7	-		
CLFP-1	3/3/2020	1224	-	0		
CLFP-1	3/3/2020	1234	-	0		
CLFP-1	3/3/2020	1244	-	0		
CLFP-2	3/3/2020	1345	-	0		
CLFP-2	3/3/2020	1355	-	0		
CLFP-2	3/3/2020	1405	-	0		
CLFP-3	3/3/2020	618	8.5	-		
CLFP-3	3/3/2020	820	7.5	-		
CLFP-3	3/3/2020	1251	8.5	-		
CLFP-3	3/3/2020	1632	8	-		
CLFP-4	3/3/2020	1428	-	0		
CLFP-4	3/3/2020	1438	-	0		
CLFP-4	3/3/2020	1448	-	0		
CLFP-5	3/3/2020	1500	-	0		
CLFP-5	3/3/2020	1510	-	0		
CLFP-5	3/3/2020	1520	-	0		
CLFP-6	3/3/2020	1257	-	0		
CLFP-6	3/3/2020	1307	-	0		
CLFP-6	3/3/2020	1317	-	0		
Vent 2	3/3/2020	627	46	-		
Vent 2	3/3/2020	810	45.5	-		
Vent 2	3/3/2020	1322	49.5	-		
CLFP-1	3/4/2020	1001	-	0		
CLFP-1	3/4/2020	1011	-	0		
CLFP-1	3/4/2020	1021	-	0		
CLFP-2	3/4/2020	1135	-	0		
CLFP-2	3/4/2020	1145	-	0		
CLFP-2	3/4/2020	1155	-	0		
CLFP-3	3/4/2020	554	8	-		
CLFP-3	3/4/2020	747	8	-		

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
CLFP-3	3/4/2020	1030	7.5	-		
CLFP-4	3/4/2020	1205	-	0		
CLFP-4	3/4/2020	1215	-	0		
CLFP-4	3/4/2020	1225	-	0		
CLFP-5	3/4/2020	1349	-	0		
CLFP-5	3/4/2020	1359	-	0		
CLFP-5	3/4/2020	1409	-	0		
CLFP-6	3/4/2020	1045	-	0		
CLFP-6	3/4/2020	1055	-	0		
CLFP-6	3/4/2020	1105	-	0		
Vent-2	3/4/2020	602	43	-		
Vent-2	3/4/2020	742	43.5	-		
Vent-2	3/4/2020	1235	41.5	-		
Vent-2	3/4/2020	1545	37.5	-		
CLFP-1	3/5/2020	1010	-	0		
CLFP-1	3/5/2020	1021	-	0		
CLFP-1	3/5/2020	1032	-	0		
CLFP-2	3/5/2020	1040	-	0		
CLFP-2	3/5/2020	1051	-	0		
CLFP-2	3/5/2020	1102	-	0		
CLFP-3	3/5/2020	556	7	-		
CLFP-3	3/5/2020	1107	6.5	-		
CLFP-3	3/5/2020	1413	7	-		
CLFP-3	3/5/2020	1550	7	-		
CLFP-4	3/5/2020	1235	-	0		
CLFP-4	3/5/2020	1246	-	0		
CLFP-4	3/5/2020	1257	-	0		
CLFP-5	3/5/2020	1205	-	0		
CLFP-5	3/5/2020	1217	-	0		
CLFP-5	3/5/2020	1228	-	0		
CLFP-6	3/5/2020	1136	-	0		
CLFP-6	3/5/2020	1148	-	0		
CLFP-6	3/5/2020	1159	-	0		
Vent-2	3/5/2020	1610	47	-		
CLFP-1	3/6/2020	1432	-	0		
CLFP-1	3/6/2020	1443	-	0		
CLFP-1	3/6/2020	1455	-	0		
CLFP-2	3/6/2020	1502	-	0		
CLFP-2	3/6/2020	1513	-	0		
CLFP-2	3/6/2020	1524	-	0		
CLFP-3	3/6/2020	557	8	-		
CLFP-3	3/6/2020	800	8	-		
CLFP-3	3/6/2020	1401	7	-		
CLFP-3	3/6/2020	1548	7	-		
CLFP-4	3/6/2020	1308	-	0		
CLFP-4	3/6/2020	1319	-	0		
CLFP-4	3/6/2020	1330	-	0		
CLFP-5	3/6/2020	1237	-	0		
CLFP-5	3/6/2020	1248	-	0		
CLFP-5	3/6/2020	1259	-	0		
CLFP-6	3/6/2020	1208	-	0		
CLFP-6	3/6/2020	1219	-	0		
CLFP-6	3/6/2020	1230	-	0		
Vent-2	3/6/2020	610	54.5	-		
Vent-2	3/6/2020	755	50.5	-		
Vent-2	3/6/2020	1411	47.5	-		
Vent-2	3/6/2020	1543	46	-		
CLFP-1	3/7/2020	947	-	0		
CLFP-1	3/7/2020	957	-	0		
CLFP-1	3/7/2020	1007	-	0		
CLFP-2	3/7/2020	1106	-	0		
CLFP-2	3/7/2020	1116	-	0		
CLFP-2	3/7/2020	1126	-	0		
CLFP-3	3/7/2020	900	10.5	-		
CLFP-3	3/7/2020	1012	9.5	-		
CLFP-3	3/7/2020	1130	5	-		
CLFP-3	3/7/2020	1229	5	-		
CLFP-3	3/7/2020	1334	8.5	-		
CLFP-3	3/7/2020	1536	8.5	-		
CLFP-4	3/7/2020	1205	-	0		
CLFP-4	3/7/2020	1215	-	0		
CLFP-4	3/7/2020	1225	-	0		
CLFP-5	3/7/2020	1312	-	0		

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
CLFP-5	3/7/2020	1322	-	0		
CLFP-5	3/7/2020	1332	-	0		
CLFP-6	3/7/2020	1017	-	0		
CLFP-6	3/7/2020	1027	-	0		
CLFP-6	3/7/2020	1037	-	0		
Vent-2	3/7/2020	927	52	-		
Vent-2	3/7/2020	1042	51	-		
Vent-2	3/7/2020	1234	41	-		
Vent-2	3/7/2020	1543	56	-		
CLFP-1	3/8/2020	1035	-	0		
CLFP-1	3/8/2020	1047	-	0		
CLFP-1	3/8/2020	1058	-	0		
CLFP-2	3/8/2020	1104	-	0		
CLFP-2	3/8/2020	1115	-	0		
CLFP-2	3/8/2020	1126	-	0		
CLFP-3	3/8/2020	603	9	-		
CLFP-3	3/8/2020	858	9	-		
CLFP-3	3/8/2020	1131	7.5	-		
CLFP-3	3/8/2020	1448	8.5	-		
CLFP-3	3/8/2020	1535	8.5	-		
CLFP-4	3/8/2020	1138	-	0		
CLFP-4	3/8/2020	1149	-	0		
CLFP-4	3/8/2020	1200	-	0		
CLFP-5	3/8/2020	1204	-	0		
CLFP-5	3/8/2020	1215	-	0		
CLFP-5	3/8/2020	1226	-	0		
CLFP-6	3/8/2020	1231	-	0		
CLFP-6	3/8/2020	1246	-	0		
CLFP-6	3/8/2020	1257	-	0		
Vent-2	3/8/2020	557	58	-		
Vent-2	3/8/2020	853	57	-		
Vent-2	3/8/2020	1135	52	-		
Vent-2	3/8/2020	1454	54.5	-		
Vent-2	3/8/2020	1530	56	-		
CLFP-1	3/9/2020	910	-	0		
CLFP-1	3/9/2020	920	-	0		
CLFP-1	3/9/2020	930	-	0		
CLFP-2	3/9/2020	1128	-	0		
CLFP-2	3/9/2020	1138	-	0		
CLFP-2	3/9/2020	1148	-	0		
CLFP-3	3/9/2020	603	9	-		
CLFP-3	3/9/2020	1152	8.5	-		
CLFP-4	3/9/2020	1158	-	0		
CLFP-4	3/9/2020	1208	-	0		
CLFP-4	3/9/2020	1218	-	0		
CLFP-5	3/9/2020	1036	-	0		
CLFP-5	3/9/2020	1046	-	0		
CLFP-5	3/9/2020	1056	-	0		
CLFP-6	3/9/2020	1010	-	0		
CLFP-6	3/9/2020	1020	-	0		
CLFP-6	3/9/2020	1030	-	0		
Vent-2	3/9/2020	610	58.5	-		
Vent-2	3/9/2020	1225	52.5	-		
CLFP-1	3/10/2020	1350	-	0		
CLFP-1	3/10/2020	1401	-	0		
CLFP-1	3/10/2020	1412	-	0		
CLFP-2	3/10/2020	1430	-	0		
CLFP-2	3/10/2020	1441	-	0		
CLFP-2	3/10/2020	1452	-	0		
CLFP-3	3/10/2020	732	8.5	-		
CLFP-3	3/10/2020	1105	8.5	-		
CLFP-3	3/10/2020	1338	7	-		
CLFP-3	3/10/2020	1610	7.5	-		
CLFP-4	3/10/2020	1222	-	0		
CLFP-4	3/10/2020	1233	-	0		
CLFP-4	3/10/2020	1244	-	0		
CLFP-5	3/10/2020	1152	-	0		
CLFP-5	3/10/2020	1203	-	0		
CLFP-5	3/10/2020	1214	-	0		
CLFP-6	3/10/2020	1122	-	0		
CLFP-6	3/10/2020	1133	-	0		
CLFP-6	3/10/2020	1144	-	0		
Vent-2	3/10/2020	725	48	-		

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
Vent-2	3/10/2020	1100	44.5	-		
Vent-2	3/10/2020	1605	41.5	-		
CLFP-1	3/11/2020	858	-	0		
CLFP-1	3/11/2020	910	-	0		
CLFP-1	3/11/2020	921	-	0		
CLFP-2	3/11/2020	1327	-	0		
CLFP-2	3/11/2020	1338	-	0		
CLFP-2	3/11/2020	1350	-	0		
CLFP-3	3/11/2020	706	6	-		
CLFP-3	3/11/2020	844	6	-		
CLFP-3	3/11/2020	1047	5	-		
CLFP-3	3/11/2020	1205	5.5	-		
CLFP-3	3/11/2020	1522	5.5	-		
CLFP-4	3/11/2020	1135	-	0		
CLFP-4	3/11/2020	1146	-	0		
CLFP-4	3/11/2020	1157	-	0		
CLFP-5	3/11/2020	1012	-	0		
CLFP-5	3/11/2020	1023	-	0		
CLFP-5	3/11/2020	1034	-	0		
CLFP-6	3/11/2020	947	-	0		
CLFP-6	3/11/2020	958	-	0		
CLFP-6	3/11/2020	1009	-	0		
Vent-1	3/11/2020	1517	50	-		
Vent-2	3/11/2020	659	36	-		
Vent-2	3/11/2020	848	35	-		
Vent-2	3/11/2020	1039	30	-		
Vent-2	3/11/2020	1201	30.5	-		
Vent-2	3/11/2020	1515	41	-		
Vent-3	3/11/2020	1513	40.5	-		
Vent-4	3/11/2020	1512	47	-		
Vent-5	3/11/2020	1511	39.5	-		
Vent-6	3/11/2020	1510	42	-		
Vent-7	3/11/2020	1509	32.5	-		
CLFP-1	3/12/2020	1052	-	0		
CLFP-1	3/12/2020	1103	-	0		
CLFP-1	3/12/2020	1114	-	0		
CLFP-2	3/12/2020	1120	-	0		
CLFP-2	3/12/2020	1131	-	0		
CLFP-2	3/12/2020	1148	-	0		
CLFP-3	3/12/2020	824	5	-		
CLFP-3	3/12/2020	1041	5	-		
CLFP-3	3/12/2020	1254	5	-		
CLFP-3	3/12/2020	1600	-	97		
CLFP-4	3/12/2020	926	-	0		
CLFP-4	3/12/2020	939	-	0		
CLFP-4	3/12/2020	950	-	0		
CLFP-5	3/12/2020	902	-	0		
CLFP-5	3/12/2020	913	-	0		
CLFP-5	3/12/2020	924	-	0		
CLFP-6	3/12/2020	835	-	0		
CLFP-6	3/12/2020	846	-	0		
CLFP-6	3/12/2020	857	-	0		
Vent-1	3/12/2020	1310	49.5	-		
Vent-2	3/12/2020	828	41	-		
Vent-2	3/12/2020	1044	36.5	-		
Vent-2	3/12/2020	1309	41.5	-		
Vent-2	3/12/2020	1556	39.5	-		
Vent-3	3/12/2020	1308	45.5	-		
Vent-4	3/12/2020	1307	51	-		
Vent-5	3/12/2020	1305	42	-		
Vent-6	3/12/2020	1303	42	-		
Vent-7	3/12/2020	1301	34	-		
CLFP-1	3/13/2020	1250	-	0		
CLFP-1	3/13/2020	1300	-	0		
CLFP-1	3/13/2020	1310	-	0		
CLFP-2	3/13/2020	1355	-	0		
CLFP-2	3/13/2020	1405	-	0		
CLFP-2	3/13/2020	1415	0.1	2		
CLFP-3	3/13/2020	600	6	-		
CLFP-3	3/13/2020	1319	6	-		
CLFP-3	3/13/2020	1559	6	-		
CLFP-4	3/13/2020	1430	-	0		
CLFP-4	3/13/2020	1440	-	0		

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
CLFP-4	3/13/2020	1450	-	0		
CLFP-5	3/13/2020	1517	-	0		
CLFP-5	3/13/2020	1527	-	0		
CLFP-5	3/13/2020	1537	-	0		
CLFP-6	3/13/2020	1325	-	0		
CLFP-6	3/13/2020	1335	-	0		
CLFP-6	3/13/2020	1345	-	0		
Vent-1	3/13/2020	925	53	-		
Vent-1	3/13/2020	1204	53	-		
Vent-1	3/13/2020	1544	48.5	-		
Vent-2	3/13/2020	927	53.5	-		
Vent-2	3/13/2020	1207	55	-		
Vent-2	3/13/2020	1547	57	-		
Vent-3	3/13/2020	928	52.5	-		
Vent-3	3/13/2020	1210	55.5	-		
Vent-3	3/13/2020	1552	55	-		
Vent-4	3/13/2020	930	53.5	-		
Vent-4	3/13/2020	1212	51	-		
Vent-4	3/13/2020	1552	49.5	-		
Vent-5	3/13/2020	931	46	-		
Vent-5	3/13/2020	1215	48	-		
Vent-5	3/13/2020	1554	50	-		
Vent-6	3/13/2020	932	41.5	-		
Vent-6	3/13/2020	1217	47.5	-		
Vent-6	3/13/2020	1556	50	-		
Vent-7	3/13/2020	933	35	-		
Vent-7	3/13/2020	1220	38	-		
Vent-7	3/13/2020	1558	41.5	-		
CLFP-1	3/14/2020	1030	-	0		
CLFP-1	3/14/2020	1040	-	0		
CLFP-1	3/14/2020	1050	-	0		
CLFP-2	3/14/2020	1148	-	0		
CLFP-2	3/14/2020	1158	-	0		
CLFP-2	3/14/2020	1208	-	0		
CLFP-3	3/14/2020	550	7	-		
CLFP-3	3/14/2020	946	6.5	-		
CLFP-3	3/14/2020	1142	6.5	-		
CLFP-4	3/14/2020	1357	-	0		
CLFP-4	3/14/2020	1407	-	0		
CLFP-4	3/14/2020	1417	-	0		
CLFP-5	3/14/2020	1430	-	0		
CLFP-5	3/14/2020	1440	-	0		
CLFP-5	3/14/2020	1450	-	0		
CLFP-6	3/14/2020	1100	-	0		
CLFP-6	3/14/2020	1110	-	0		
CLFP-6	3/14/2020	1120	-	0		
Vent-1	3/14/2020	927	40.5	-		
Vent-1	3/14/2020	1316	41.5	-		
Vent-2	3/14/2020	929	56.5	-		
Vent-2	3/14/2020	1320	56.5	-		
Vent-3	3/14/2020	932	60.5	-		
Vent-3	3/14/2020	1322	61.5	-		
Vent-4	3/14/2020	936	51	-		
Vent-4	3/14/2020	1324	52.5	-		
Vent-5	3/14/2020	938	49.5	-		
Vent-5	3/14/2020	1326	53.5	-		
Vent-6	3/14/2020	940	47	-		
Vent-6	3/14/2020	1328	52.5	-		
Vent-7	3/14/2020	942	38.5	-		
Vent-7	3/14/2020	1330	44.5	-		
CLFP-1	3/15/2020	1206	-	0		
CLFP-1	3/15/2020	1216	-	0		
CLFP-1	3/15/2020	1226	-	0		
CLFP-2	3/15/2020	1406	-	0		
CLFP-2	3/15/2020	1416	-	0		
CLFP-2	3/15/2020	1426	-	0		
CLFP-3	3/15/2020	830	8	-		
CLFP-3	3/15/2020	1507	7.5	-		
CLFP-4	3/15/2020	1333	-	0		
CLFP-4	3/15/2020	1343	-	0		
CLFP-4	3/15/2020	1353	-	0		
CLFP-5	3/15/2020	1302	-	0		
CLFP-5	3/15/2020	1312	-	0		

Gas Monitoring Results

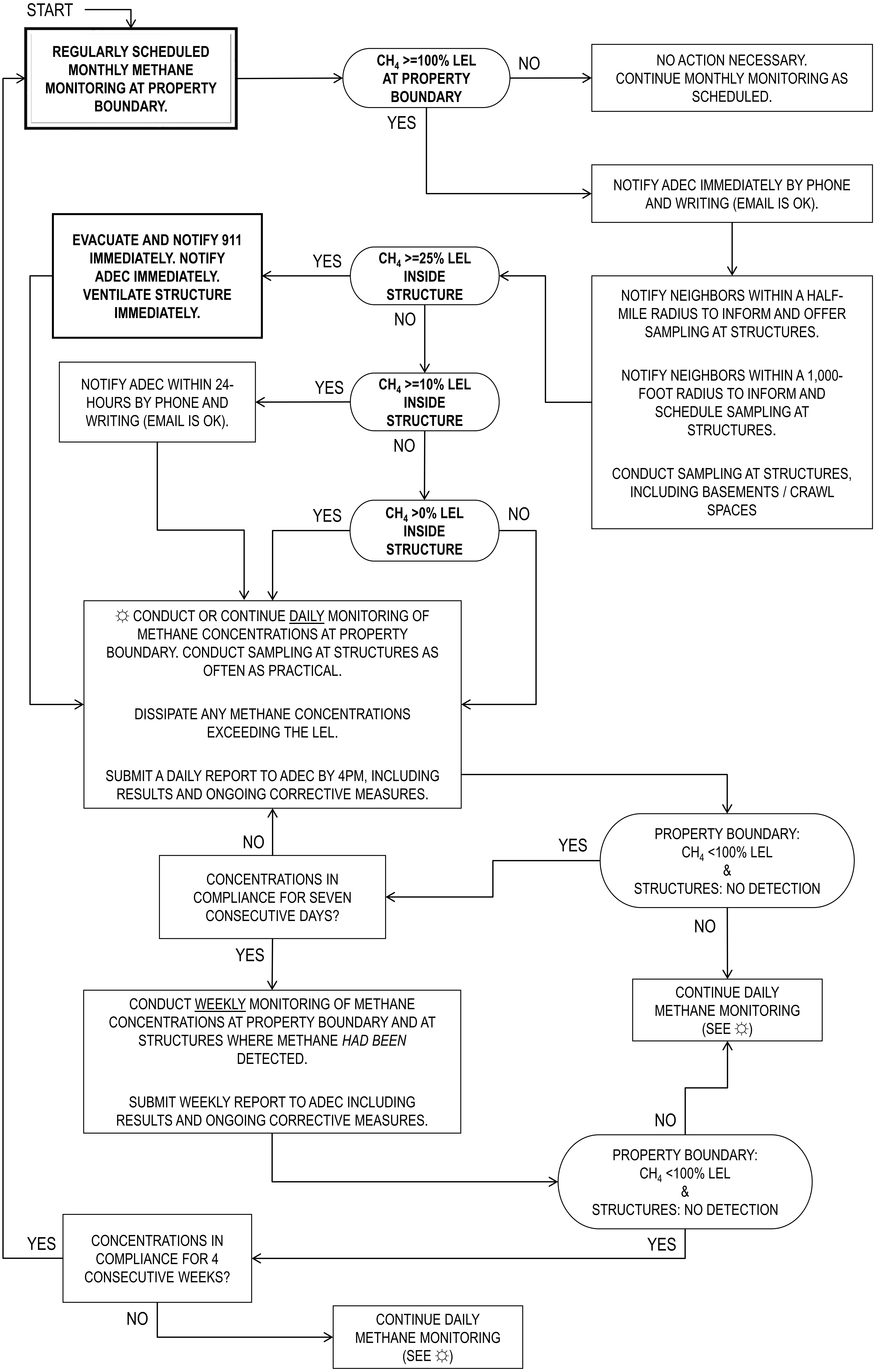
Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
CLFP-5	3/15/2020	1322	-	0		
CLFP-6	3/15/2020	1237	-	0		
CLFP-6	3/15/2020	1247	-	0		
CLFP-6	3/15/2020	1257	-	0		
Vent-1	3/15/2020	831	42.5	-		
Vent-1	3/15/2020	1451	44.5	-		
Vent-2	3/15/2020	837	59	-		
Vent-2	3/15/2020	1453	60.5	-		
Vent-3	3/15/2020	841	63.5	-		
Vent-3	3/15/2020	1455	65	-		
Vent-4	3/15/2020	844	53	-		
Vent-4	3/15/2020	1457	57	-		
Vent-5	3/15/2020	847	50.5	-		
Vent-5	3/15/2020	1500	53.5	-		
Vent-6	3/15/2020	850	48	-		
Vent-6	3/15/2020	1502	52.5	-		
Vent-7	3/15/2020	853	39.5	-		
Vent-7	3/15/2020	1505	47.5	-		
CLFP-1	3/16/2020	836	-	0		
CLFP-1	3/16/2020	846	-	0		
CLFP-1	3/16/2020	856	-	0		
CLFP-2	3/16/2020	1102	-	0		
CLFP-2	3/16/2020	1112	-	0		
CLFP-2	3/16/2020	1122	-	0		
CLFP-3	3/16/2020	810	8	-		
CLFP-4	3/16/2020	1140	-	0		
CLFP-4	3/16/2020	1150	-	0		
CLFP-4	3/16/2020	1200	-	0		
CLFP-5	3/16/2020	1001	-	0		
CLFP-5	3/16/2020	1011	-	0		
CLFP-5	3/16/2020	1021	-	0		
CLFP-6	3/16/2020	910	-	0		
CLFP-6	3/16/2020	920	-	0		
CLFP-6	3/16/2020	930	-	0		
Vent-1	3/16/2020	810	43	-		
Vent-1	3/16/2020	1241	39.5	-		
Vent-2	3/16/2020	806	56.5	-		
Vent-2	3/16/2020	1244	57	-		
Vent-3	3/16/2020	804	67.5	-		
Vent-3	3/16/2020	1247	63.5	-		
Vent-4	3/16/2020	802	55	-		
Vent-4	3/16/2020	1248	56	-		
Vent-5	3/16/2020	800	54	-		
Vent-5	3/16/2020	1250	56.5	-		
Vent-6	3/16/2020	757	53.5	-		
Vent-6	3/16/2020	1251	56	-		
Vent-7	3/16/2020	754	46	-		
Vent-7	3/16/2020	1253	47	-		
CLFP-1	3/17/2020	945	-	0		
CLFP-1	3/17/2020	955	-	0		
CLFP-1	3/17/2020	1005	-	0		
CLFP-2	3/17/2020	1147	-	0		
CLFP-2	3/17/2020	1157	0.1	2		
CLFP-2	3/17/2020	1207	0.1	2		
CLFP-3	3/17/2020	1227	9	-		
CLFP-3	3/17/2020	1603	9.5	-		
CLFP-4	3/17/2020	1232	-	0		
CLFP-4	3/17/2020	1242	-	0		
CLFP-4	3/17/2020	1252	-	0		
CLFP-5	3/17/2020	1035	-	0		
CLFP-5	3/17/2020	1045	-	0		
CLFP-5	3/17/2020	1055	-	0		
CLFP-6	3/17/2020	1012	-	0		
CLFP-6	3/17/2020	1022	-	0		
CLFP-6	3/17/2020	1032	-	0		
Vent-1	3/17/2020	1314	47	-		
Vent-1	3/17/2020	1620	47.5	-		
Vent-2	3/17/2020	1313	63	-		
Vent-2	3/17/2020	1618	61.5	-		
Vent-3	3/17/2020	1311	66.5	-		
Vent-3	3/17/2020	1617	67.5	-		
Vent-4	3/17/2020	1310	57.5	-		
Vent-4	3/17/2020	1615	60	-		

Gas Monitoring Results

Location	Date	Time	Methane Concentation	Methane (% LEL)	Mitigation Activities	Notes
Vent-5	3/17/2020	1309	58	-		
Vent-5	3/17/2020	1612	60	-		
Vent-6	3/17/2020	1306	57	-		
Vent-6	3/17/2020	1612	58	-		
Vent-7	3/17/2020	1305	50	-		
Vent-7	3/17/2020	1610	50.5	-		
CLFP-1	3/18/2020	1012	-	0		
CLFP-1	3/18/2020	1022	-	0		
CLFP-1	3/18/2020	1032	-	0		
CLFP-2	3/18/2020	1530	-	0		
CLFP-2	3/18/2020	1555	-	0		
CLFP-2	3/18/2020	1610	-	0		
CLFP-3	3/18/2020	1041	8	-		
CLFP-3	3/18/2020	1737	8	-		
CLFP-4	3/18/2020	1618	-	0		
CLFP-4	3/18/2020	1630	-	0		
CLFP-4	3/18/2020	1642	-	0		
CLFP-5	3/18/2020	1110	-	0		
CLFP-5	3/18/2020	1120	-	0		
CLFP-5	3/18/2020	1130	-	0		
CLFP-6	3/18/2020	1046	-	0		
CLFP-6	3/18/2020	1056	-	0		
CLFP-6	3/18/2020	1106	-	0		
Vent-1	3/18/2020	1725	33.4	-		
Vent-2	3/18/2020	1716	0	-		
Vent-3	3/18/2020	1709	48.6	-		
Vent-4	3/18/2020	1704	46	-		
Vent-5	3/18/2020	1700	46.4	-		
Vent-6	3/18/2020	1655	45	-		
Vent-7	3/18/2020	1648	37.7	-		
CLFP-1	3/19/2020	914	-	0		
CLFP-1	3/19/2020	924	-	0		
CLFP-1	3/19/2020	934	-	0		
CLFP-2	3/19/2020	1325	-	0		
CLFP-2	3/19/2020	1335	-	0		
CLFP-2	3/19/2020	1345	-	0		
CLFP-3	3/19/2020	549	8.5	-		
CLFP-3	3/19/2020	1355	8.5	-		
CLFP-4	3/19/2020	1156	-	0		
CLFP-4	3/19/2020	1206	-	0		
CLFP-4	3/19/2020	1216	-	0		
CLFP-5	3/19/2020	1220	-	0		
CLFP-5	3/19/2020	1230	-	0		
CLFP-5	3/19/2020	1240	-	0		
CLFP-6	3/19/2020	945	-	0		
CLFP-6	3/19/2020	955	-	0		
CLFP-6	3/19/2020	1005	-	0		
Vent-1	3/19/2020	1413	45	-		
Vent-2	3/19/2020	1411	62	-		
Vent-3	3/19/2020	1410	61.5	-		
Vent-4	3/19/2020	1409	58	-		
Vent-5	3/19/2020	1407	55.5	-		
Vent-6	3/19/2020	1406	55	-		
Vent-7	3/19/2020	1404	49	-		

ATTACHMENT 4

MATSU PALMER CENTRAL LANDFILL
METHANE MONITORING CONTINGENCY FLOW CHART



Notes:
1. A methane concentration of 5% by volume in air is equal to 100% of the lower explosive limit (LEL) of methane.
2. If methane is detected in any structures within a 1,000-foot radius, move 500 feet in quadrant of radius centered on the detection.

3/20/2020 11:32 AM

ATTACHMENT 5

Scope of 2020 Central Landfill Development Plan applicable to Long-Term Gas Management

LANDFILL GAS MANAGEMENT PLAN

Objective 10: Active LFG Management Plan Evaluation

Burns & McDonnell will work with MSB to design a LFG Management Plan that proactively addresses current passive conditions and odor management and can be easily converted to future active conditions. Consideration will also be given to potential beneficial LFG reuse projects (i.e., evaporation for leachate, heat for a shop floor, etc.) and any impacts that implementing leachate recirculation may have on LFG production. If a beneficial reuse project is identified, we will provide recommendations and design for accelerated LFG collection (e.g., horizontal gas collectors as waste fills).

With residential areas to the north and commercial/ residential areas to the west, east and northeast, LFG odor control is important. The existing crown vent system in Cell 2A does not impact LFG generation deeper in the waste. Therefore, the path of least resistance for deeper generated gas is through the perimeter anchor trench and subsurface soils. Burns & McDonnell will review recent odor complaints, gas probe monitoring data, ambient air monitoring results, and the Cell 2A closure design. Recommendations will subsequently be provided to mitigate any existing odor control problems.

As future cells are brought to closure, deep well vents should be installed at the time of closure in lieu of the surface vents to both: 1) properly vent the landfill and prevent lateral migration of LFG; and 2) allow efficient conversion from a passive to an active LFG collection system when the system is required by New Source Performance Standards (NSPS), or a beneficial reuse is implemented. Consideration will be given in the LFG Management Plan to address potential odor or LFG migration issues.

As part of this task, Burns & McDonnell will describe the LFG collection and control system (GCCS), conceptually locating wells within the disposal cells, lateral locations to deliver LFG to the perimeter manifold, the route of that manifold to a flare or beneficial reuse, and condensate sumps along the manifold route. Design criteria will be outlined (e.g., manifold slope with counter flow gas and condensate). A phased GCCS will be provided to match the Landfill Development Plan cell sequencing.

Early active LFG collection methods such as horizontal collection may be necessary for odor or migration mitigation, or to support beneficial reuse. The LFG management Plan will present those methods.

Deliverables: Burns & McDonnell will develop a conceptual LFG Management Plan that includes the overall layout of the proposed GCCS for both passive and active conditions considering potential options for end use and/or control systems, NSPS compliance status, and timing for implementation. Preliminary cost estimates for the GCCS system will be developed and included along with the conceptual design.

Objective 12: LFG Collection System Design

Burns & McDonnell will design any potential future gas system to comply with state and federal regulations as well as consider future operations (such as cleanout access and recommended flare types). Burns & McDonnell has direct experience with the design and operation of LFG systems in cold, windy climates and will apply our knowledge to your system design.

Subsequent to the completion of the conceptual GCCS for Objective 10, Burns & McDonnell will complete a detailed design of the wells (location, depth, material), and laterals and manifold (location, slope, diameter, material) for Phase 1. LFG collection will lead towards the western side of the Landfill and will generally parallel leachate collection. Further, as described in Objective 10, any future LFG vents that are installed should be deep collection vents to allow for better LFG management during passive conditions and ease of conversion to an active system as needed.

A LFG model that is developed in this project will define the projected generation of LFG; however, not all LFG produced will be able to be collected. The model output will be adjusted for collection rates depending on when collection is implemented (i.e., during operation vs. after closure). If an end use is defined, proactive gas collection should occur while filling is completed (i.e., installation of horizontal gas collection laterals) to maximize collection efficiencies. A typical design will be provided.

Deliverables: Burns & McDonnell will develop a Landfill Gas System Design Plan that includes design for an active landfill gas collection and control system (GCCS) as well as capital and operating costs and all design criteria utilized for the development of the Plan.

Objective 13: LFG Control and Movement System Design

Utilizing the Landfill Gas System Design plan developed in Objective 12, Burns & McDonnell will research and provide recommendations for a control and movement system (i.e., a flare station with blowers, condensate removal, monitoring, controls, etc.). Initial considerations would be for an enclosed flare here due to the weather impacts in winter (such as wind) in additional to concealing the flame from the neighbors. The flare would be designed based on the modeling results and would allow for flexibility of LFG flow. Additional considerations would be given to control and movement systems needed for end use options.

Deliverables: Burns & McDonnell will develop a Landfill Gas Control and Movement Plan that includes design criteria for a control and movement system(s) as well as capital and operating costs and all assumptions utilized for the development of the Plan.

Objective 15: LFG Management Implementation Schedule Development

A timeline for all aspects of the Landfill Gas Management Plan will be developed and presented within the final draft report. All assumptions and methodology utilized will be included within the discussion. Particular items included will be: New Source Performance Standards (NSPS) compliance; Tier II monitoring; active LFG system installation (if necessary); and potential end-use implementation.

Deliverables: Burns & McDonnell will develop an Implementation Timeline for all aspects of the Landfill Gas Management Plan.

Central Landfill Gas Monitoring Results

Date:___________________________ Instrument:_____________________________

Sampler:________________________ Calibration Date:________________________

Location	Time	Methane (Percent By Volume)	Methane (Percent Lower Explosive Limit)	Carbon Dioxide (Percent)	Presure (Inches of Mercury)	Oxygen (Percent)
Scalehouse						
Ambient Air						
Crawlspace 1						
Crawlspace 2						
Crawlspace 3						
Animal Shelter						
Ambient Air						
Crawlspace 1						
Crawlspace 2						
Crawlspace 3						
CLF Entrance Gate						
Ambient Air						
Gas Monitoring Locations						
CLFP-1						
CLFP-2						
CLFP-3						
CLFP-4						
CLFP-5						
CLFP-6						
CLFG-1						
CLFG-2						
Northern Perimeter Ambient Air						
Animal Shelter (AS)						
200 FT. E of AS						
400 FT. E of AS						
600 FT. E of AS						
800 FT. E of AS						
1000 FT. E of AS						
1200 FT. E of AS						
1400 FT. E of AS						
1600 FT. E of AS						
1800 FT. E of AS						
2000 FT. E of AS						
2200 FT. E of AS						
2400 FT. E of AS						
2600 FT. E of AS						
2800 FT. E of AS						
3000 FT. E of AS						
3200 FT. E of AS						
3400 FT. E of AS						

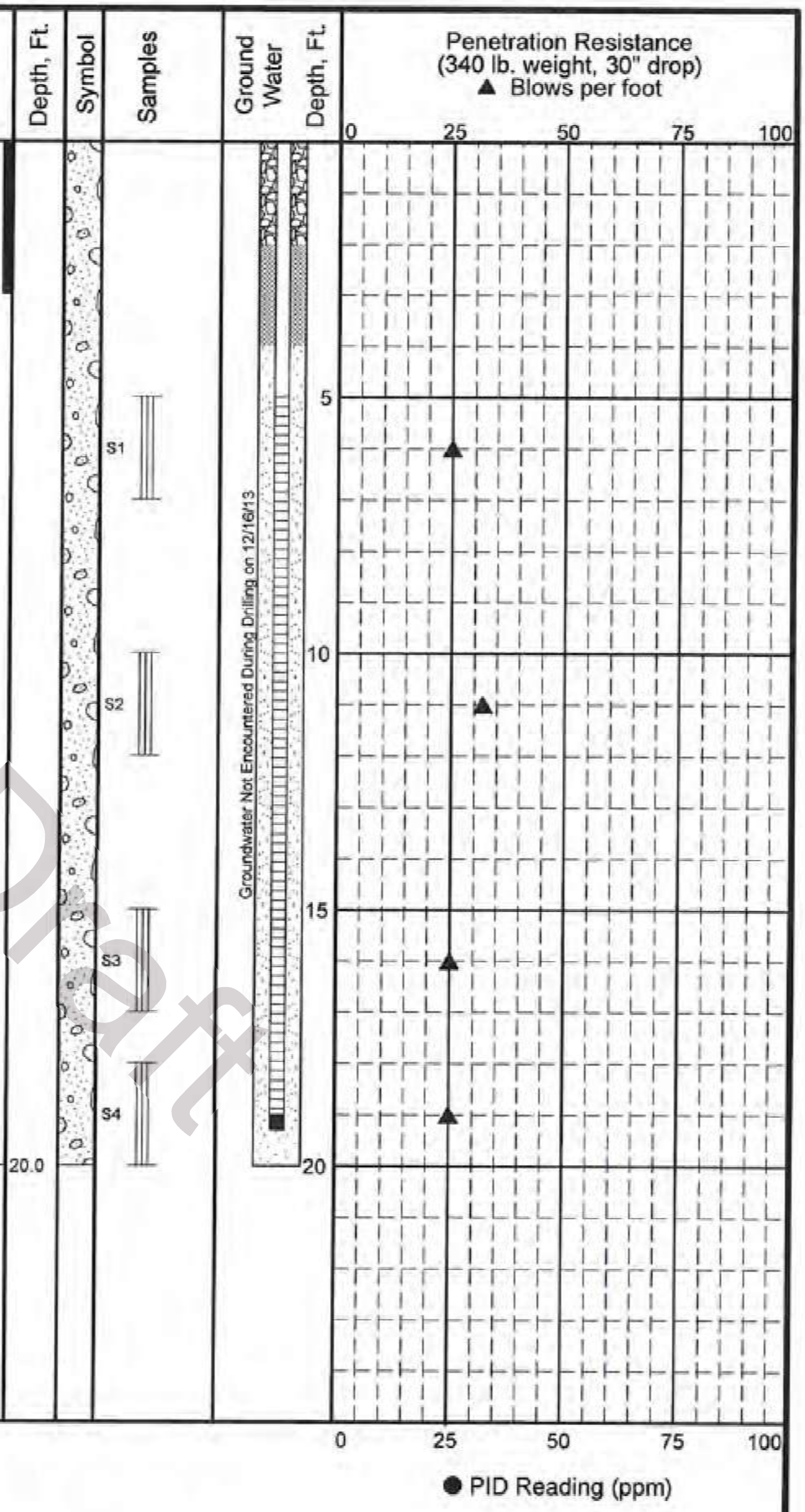
MATERIAL DESCRIPTION

Elevation: 285 Ft.

Medium dense, brown, *Sand with Silt and Gravel (SP)*; frozen to moist

Cobble layer 3 inches thick at approximately 11.7 feet below ground surface

Bottom of Boring
Boring Completed 12/16/13



LEGEND

- * Sample not recovered
- Ⅲ 3" O.D. Split Spoon Sample
- ■ Frozen

- ▯ Solid Casing, Sand Pack
- ▨ Solid Casing and Annular Seal
- ▤ Slotted Section, Filter Sand
- ▧ Solid Casing, Cuttings Backfill

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. USC letter symbol based on visual classification.

Central Landfill
Palmer, Alaska

LOG OF BORING GP-1

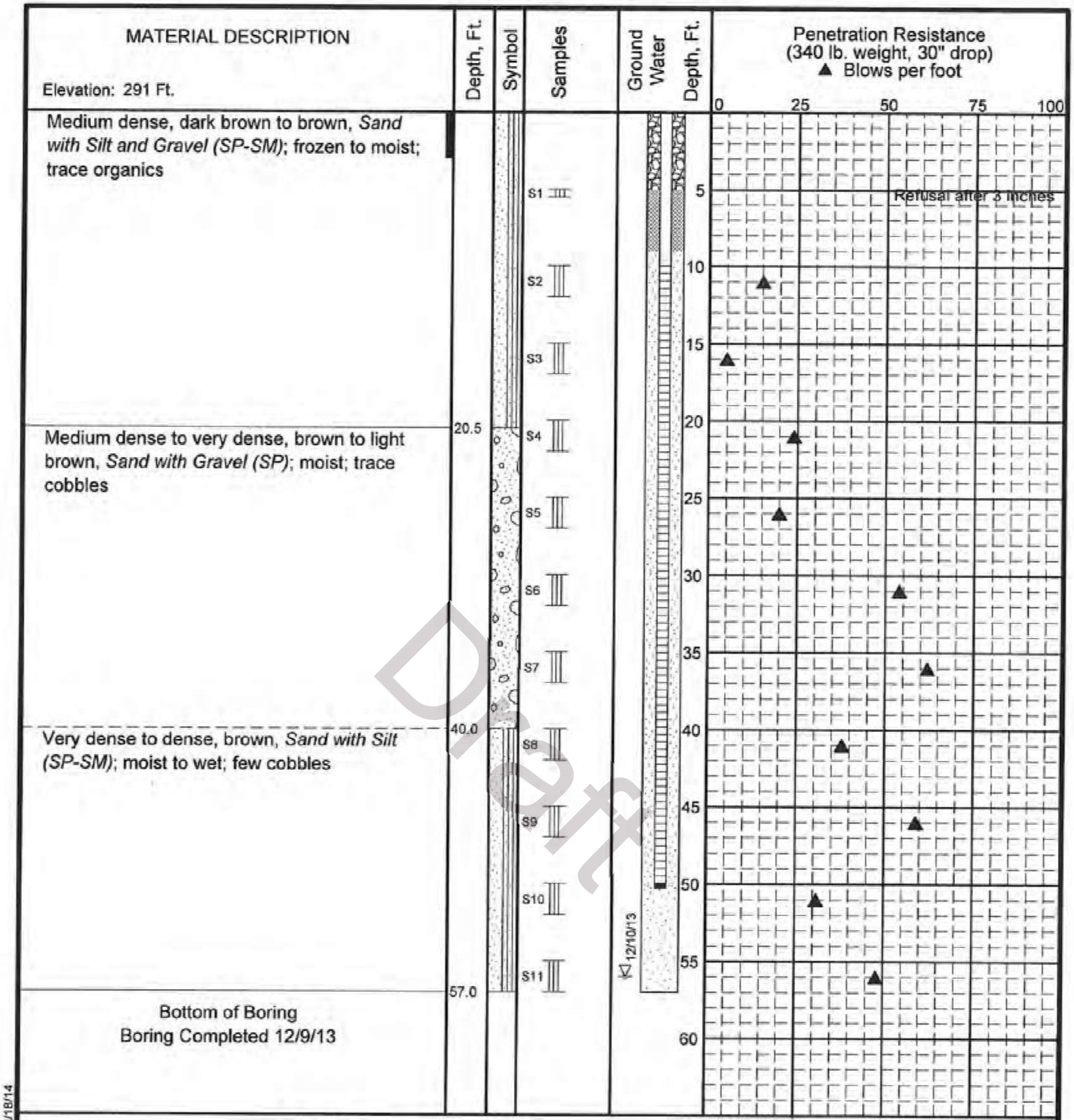
February 2014 32-1-17594-006

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 2-1

ENVIRONMENTAL LOG BORING LOGS.GPJ S&W GEO1.GDT 2/18/14

MATERIAL DESCRIPTION Elevation: 291 Ft.	Depth, Ft.
Medium dense, dark brown to brown, *Sand with Silt and Gravel (SP-SM)*; frozen to moist; trace organics	
Medium dense to very dense, brown to light brown, *Sand with Gravel (SP)*; moist; trace cobbles	20.5
Very dense to dense, brown, *Sand with Silt (SP-SM)*; moist to wet; few cobbles	40.0
Bottom of Boring Boring Completed 12/9/13	57.0



LEGEND

- * Sample not recovered
- ⌶ 3" O.D. Split Spoon Sample
- ▮ Frozen
- ⊻ Ground Water Level At Time Of Drilling
- ▯ Solid Casing, Sand Pack
- ▨ Solid Casing and Annular Seal
- ▤ Slotted Section, Filter Sand
- ▩ Solid Casing, Cuttings Backfill

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
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4. USC letter symbol based on visual classification.

Central Landfill
Palmer, Alaska

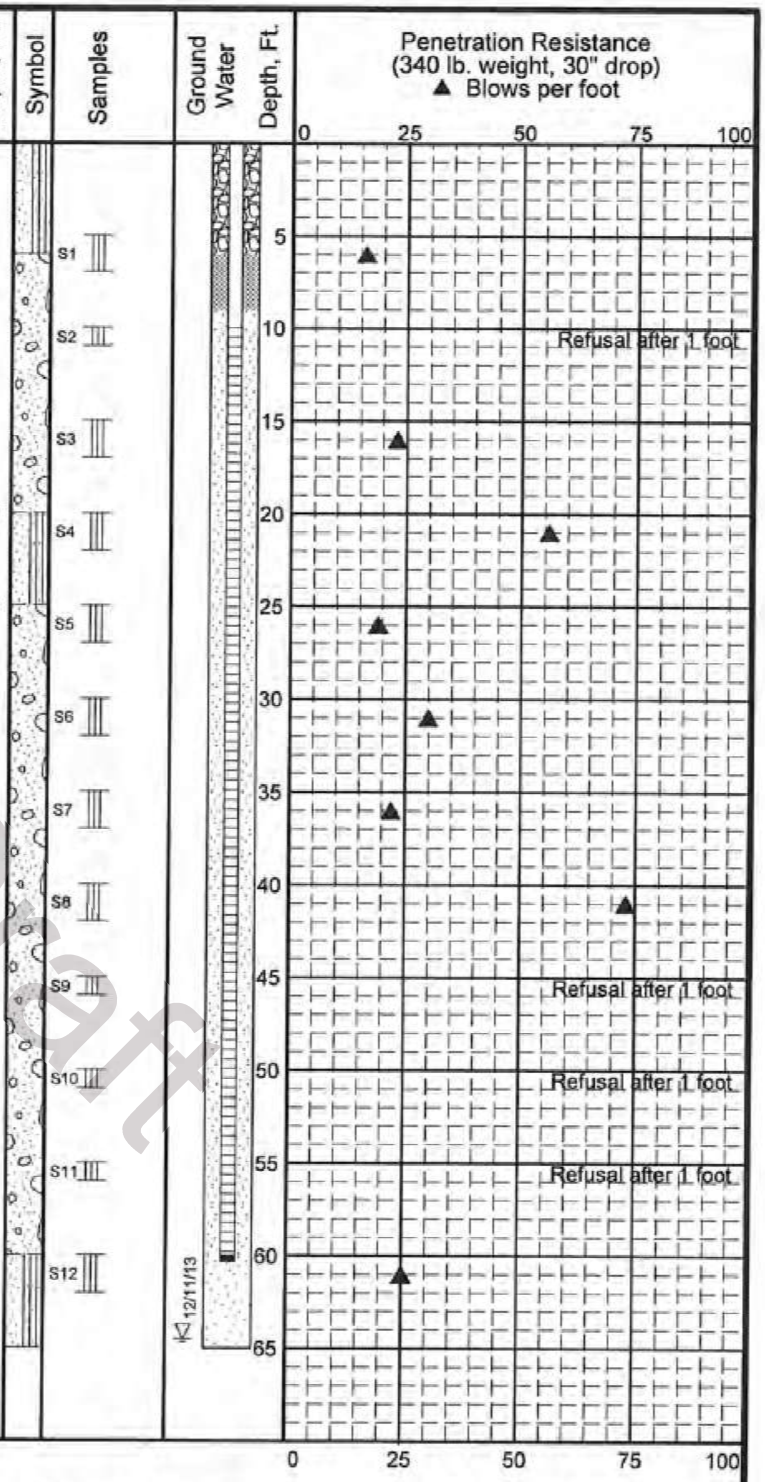
LOG OF BORING GP-2

February 2014 32-1-17594-006

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 2-2

MATERIAL DESCRIPTION Elevation: 306 Ft.	Depth, Ft.
Medium dense, brown, *Silt with Sand (SP-SM)*; frozen to moist, trace organics	
Medium dense, brown, *Sand with Gravel (SP)*; moist; trace cobbles	6.0
Very dense, brown, *Sand with Silt and Gravel (SP-SM)*; moist; few cobbles	20.0
Medium dense to very dense, brown, *Sand with Gravel (SP)*; moist; few cobbles	25.0
Medium dense, brown, *Sand with Silt (SP-SM)*; moist to wet	60.0
Bottom of Boring Boring Completed 12/11/13	65.0



LEGEND

* Sample not recovered
Ⅲ 3" O.D. Split Spoon Sample
▮ Frozen
⊻ Ground Water Level At Time Of Drilling
▭ Solid Casing, Sand Pack
▨ Solid Casing and Annular Seal
⊟ Slotted Section, Filter Sand
⊠ Solid Casing, Cuttings Backfill

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. USC letter symbol based on visual classification.

Central Landfill
Palmer, Alaska

LOG OF BORING GP-3

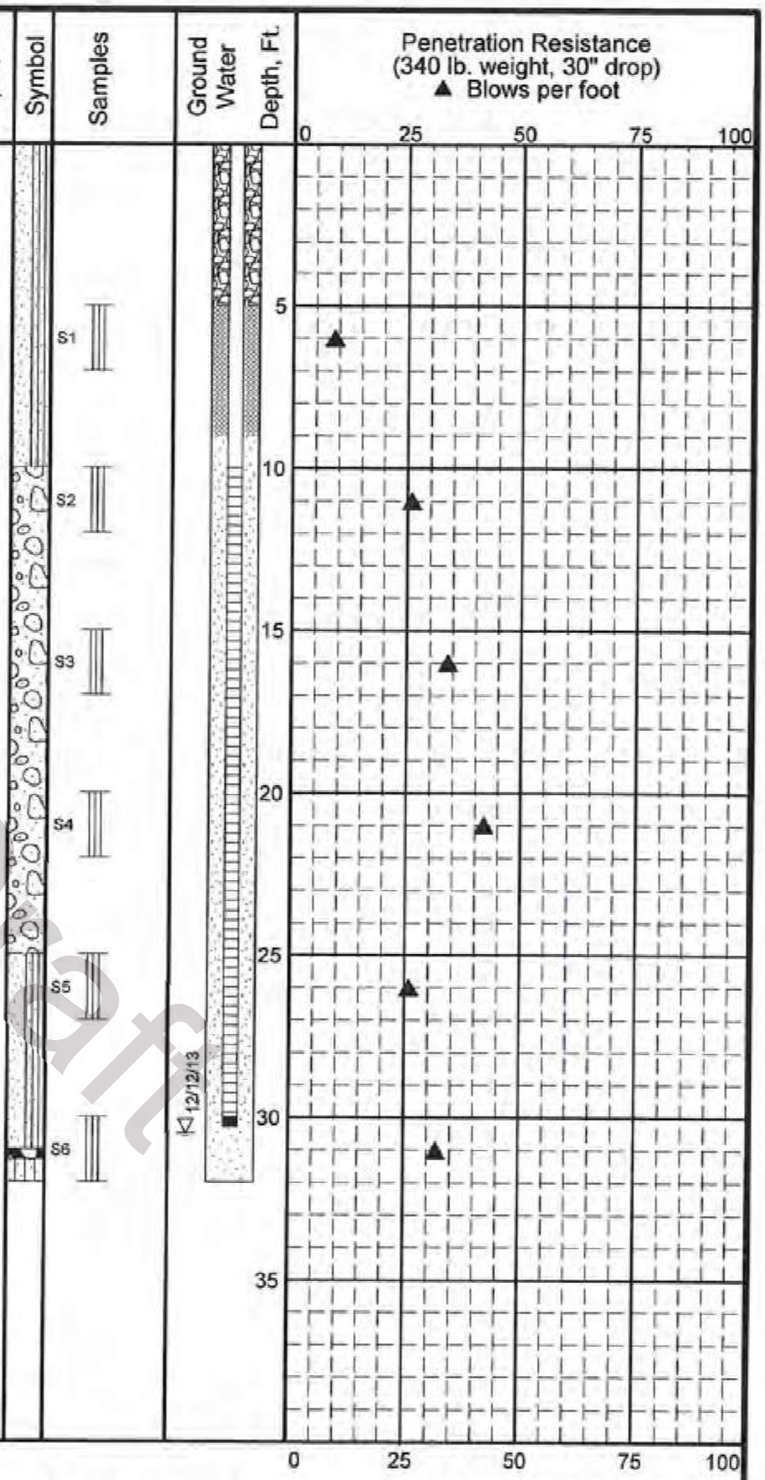
February 2014 32-1-17594-006

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 2-3

MATERIAL DESCRIPTION Elevation: 268 Ft.	Depth, Ft.
Loose, dark brown to brown, *Sand with Silt (SP-SM)*; frozen to moist; trace gravel and organics	
Medium dense, brown, *Sand with Gravel (SP)*; moist	10.0
Cobble layer at 22 feet below ground surface	
Brown, *Sand with Gravel (SP)*; moist; trace cobbles	25.0
Cobble layer	31.0
Brown, *Silt with Sand (ML)*; moist to wet; trace gravel	31.3
	32.0

Bottom of Boring
Boring Completed 12/12/13



LEGEND

- * Sample not recovered
- Ⅲ 3" O.D. Split Spoon Sample
- ■ Frozen
- ⊻ Ground Water Level At Time Of Drilling
- ▯ Solid Casing, Sand Pack
- ▨ Solid Casing and Annular Seal
- ▤ Slotted Section, Filter Sand
- ▧ Solid Casing, Cuttings Backfill
- ● PID Reading (ppm)

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. USC letter symbol based on visual classification.

Central Landfill
Palmer, Alaska

LOG OF BORING GP-4

February 2014 32-1-17594-006

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 2-4

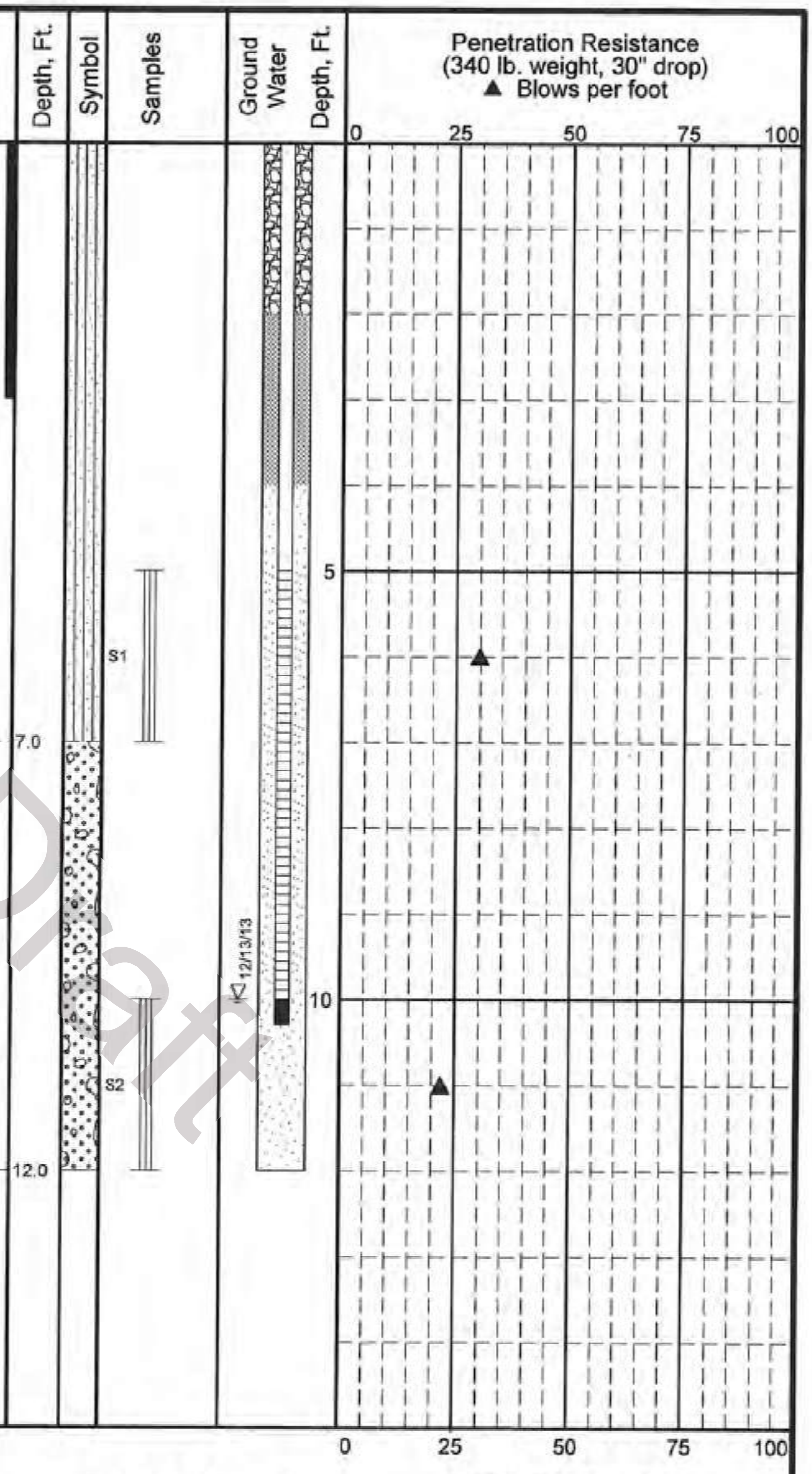
MATERIAL DESCRIPTION

Elevation: 255 Ft.

Medium dense, brown, *Silt with Sand (ML)*; frozen to moist; trace organics

Medium dense, brown, *Sand with Gravel (SP)*; moist to wet

Bottom of Boring
Boring Completed 12/13/13



LEGEND

* Sample not recovered
Ⅲ 3" O.D. Split Spoon Sample

■ Frozen

⊻ Ground Water Level At Time Of Drilling

Solid Casing, Sand Pack
Solid Casing and Annular Seal
Slotted Section, Filter Sand
Solid Casing, Cuttings Backfill

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. USC letter symbol based on visual classification.

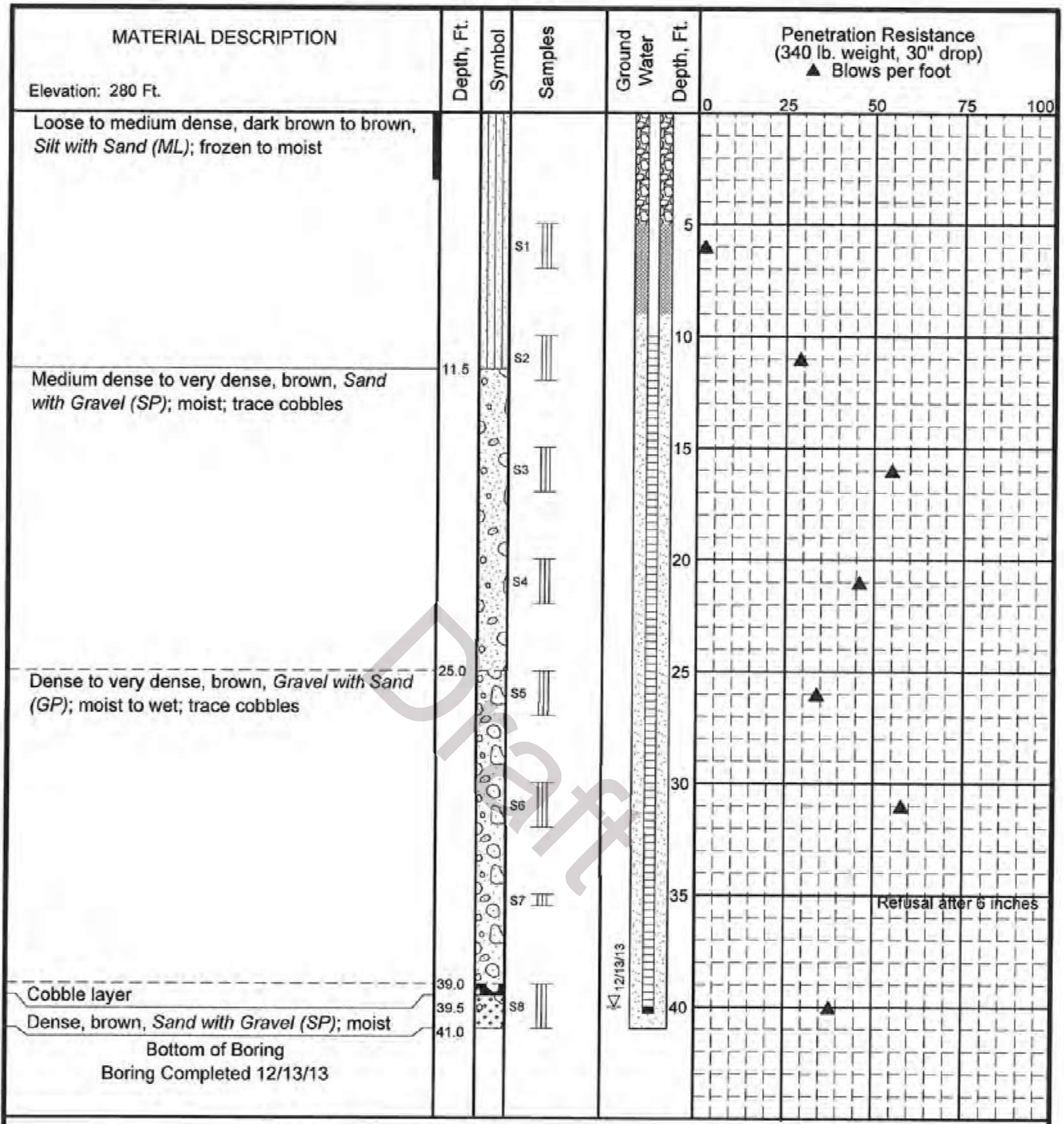
Central Landfill
Palmer, Alaska

LOG OF BORING GP-5

February 2014 32-1-17594-006

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 2-5



Loose to medium dense, dark brown to brown, *Silt with Sand (ML)*; frozen to moist

Medium dense to very dense, brown, *Sand with Gravel (SP)*; moist; trace cobbles

Dense to very dense, brown, *Gravel with Sand (GP)*; moist to wet; trace cobbles

Cobble layer

Dense, brown, *Sand with Gravel (SP)*; moist

Bottom of Boring
Boring Completed 12/13/13

LEGEND

- * Sample not recovered
- Ⅲ 3" O.D. Split Spoon Sample
- ■ Frozen
- ▽ Ground Water Level At Time Of Drilling
- ▯ Solid Casing, Sand Pack
- ▨ Solid Casing and Annular Seal
- ▤ Slotted Section, Filter Sand
- ⊠ Solid Casing, Cuttings Backfill

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. USC letter symbol based on visual classification.

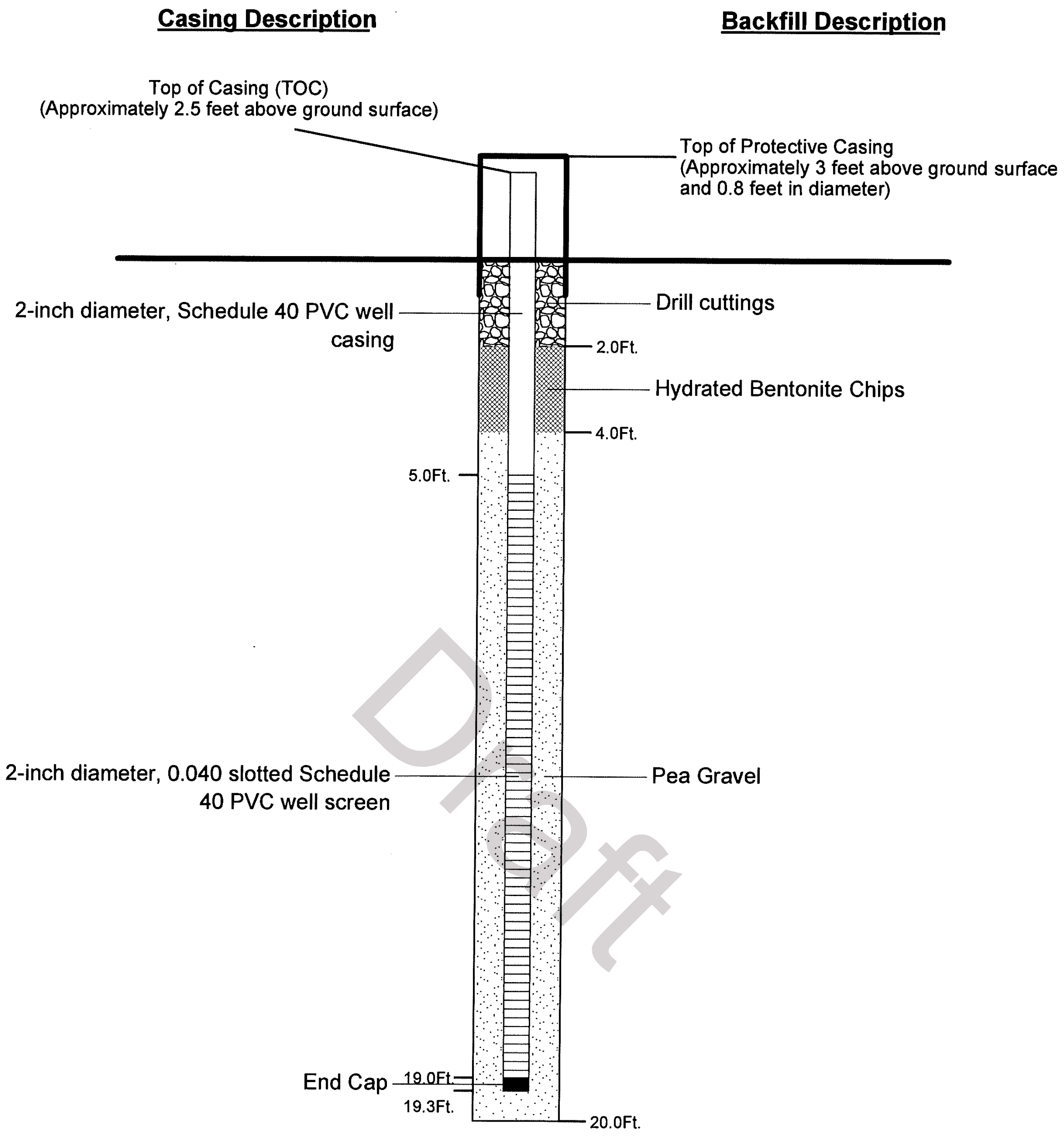
Central Landfill
Palmer, Alaska

LOG OF BORING GP-6

February 2014 32-1-17594-006

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 2-6



LEGEND

⊻ Groundwater Level ATD

NOTE: All joints use threaded connections.

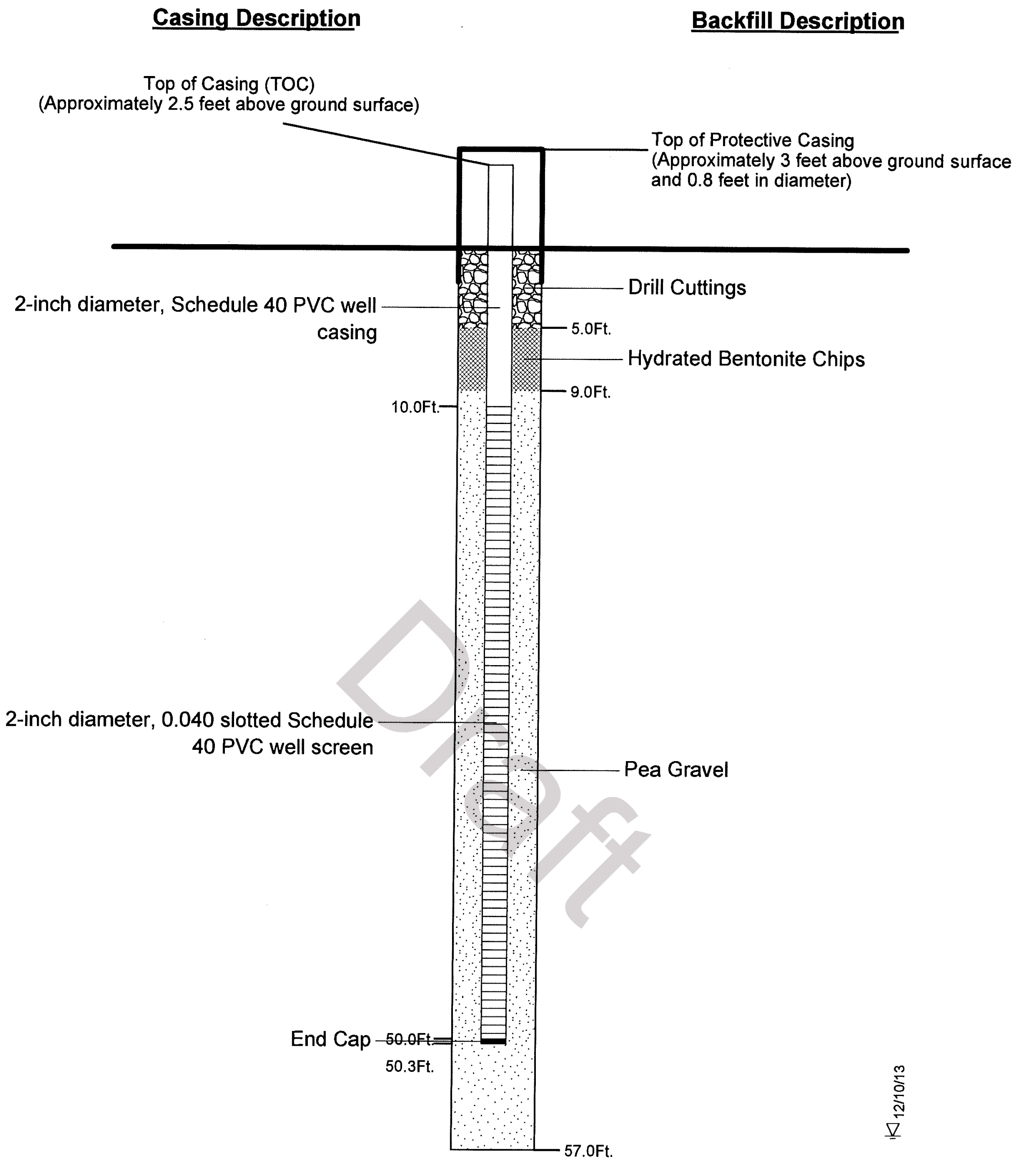
Central Landfill
Palmer, Alaska

MONITORING WELL GP-1 CONSTRUCTION DETAIL

February 2014 32-1-17594-006

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Fig. 2-7



LEGEND

∇ Groundwater Level ATD

NOTE: All joints use threaded connections.

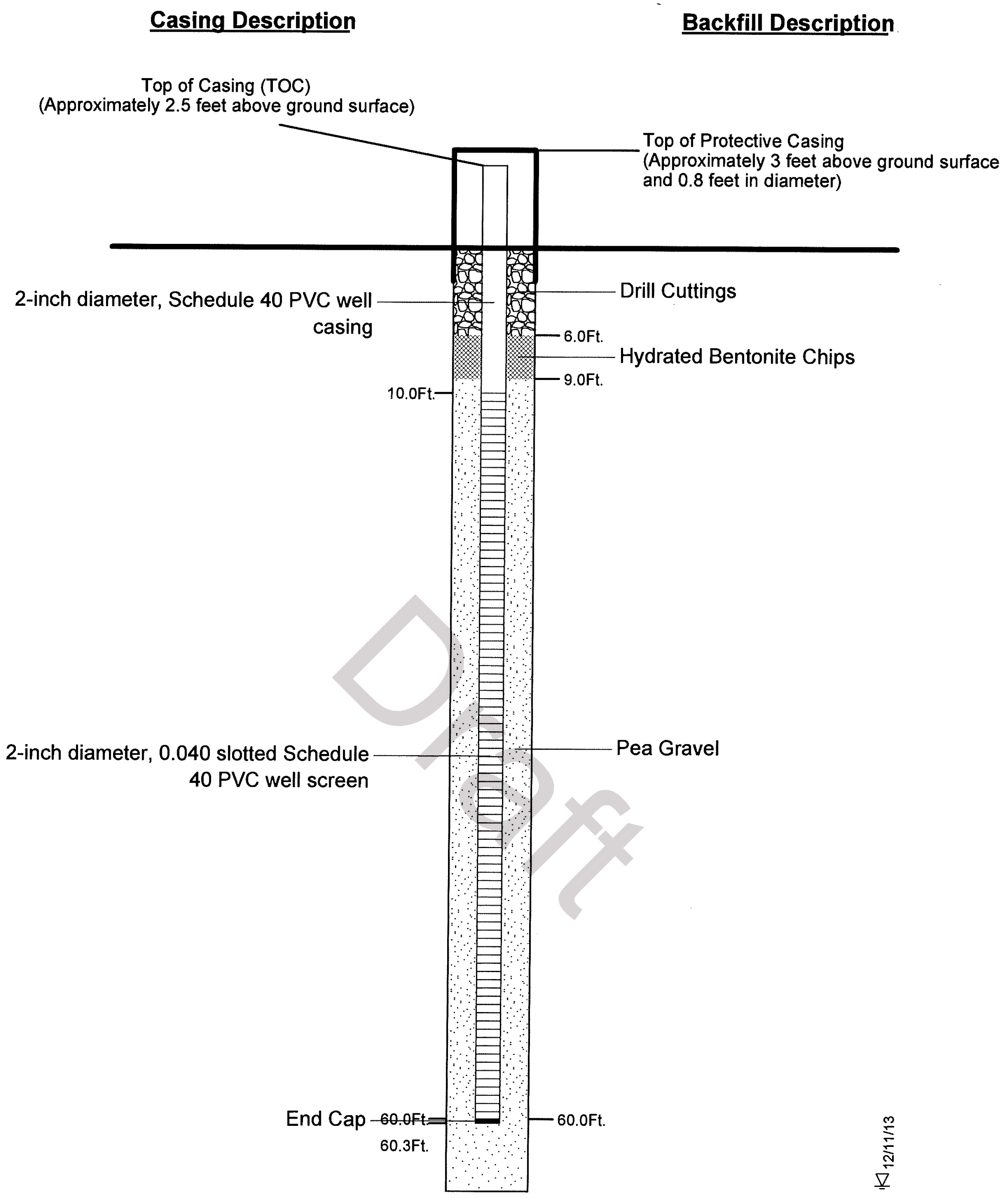
Central Landfill
Palmer, Alaska

MONITORING WELL GP-2
CONSTRUCTION DETAIL

February 2014 32-1-17594-006

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Fig. 2-8



LEGEND

⊻ Groundwater Level ATD

NOTE: All joints use threaded connections.

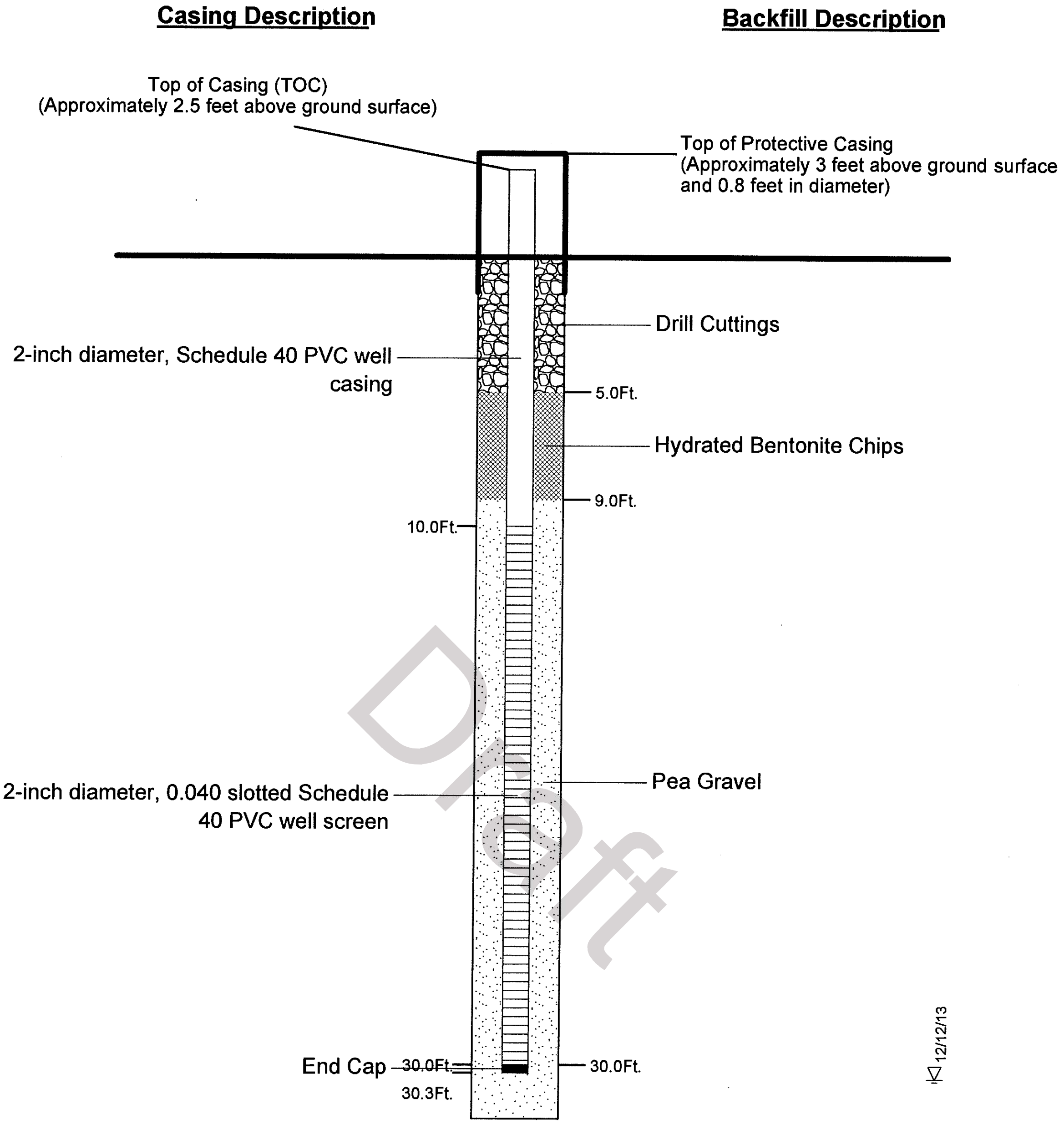
Central Landfill
Palmer, Alaska

MONITORING WELL GP-3
CONSTRUCTION DETAIL

February 2014 32-1-17594-006

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Fig. 2-9



LEGEND

∇ Groundwater Level ATD

NOTE: All joints use threaded connections.

Central Landfill
Palmer, Alaska

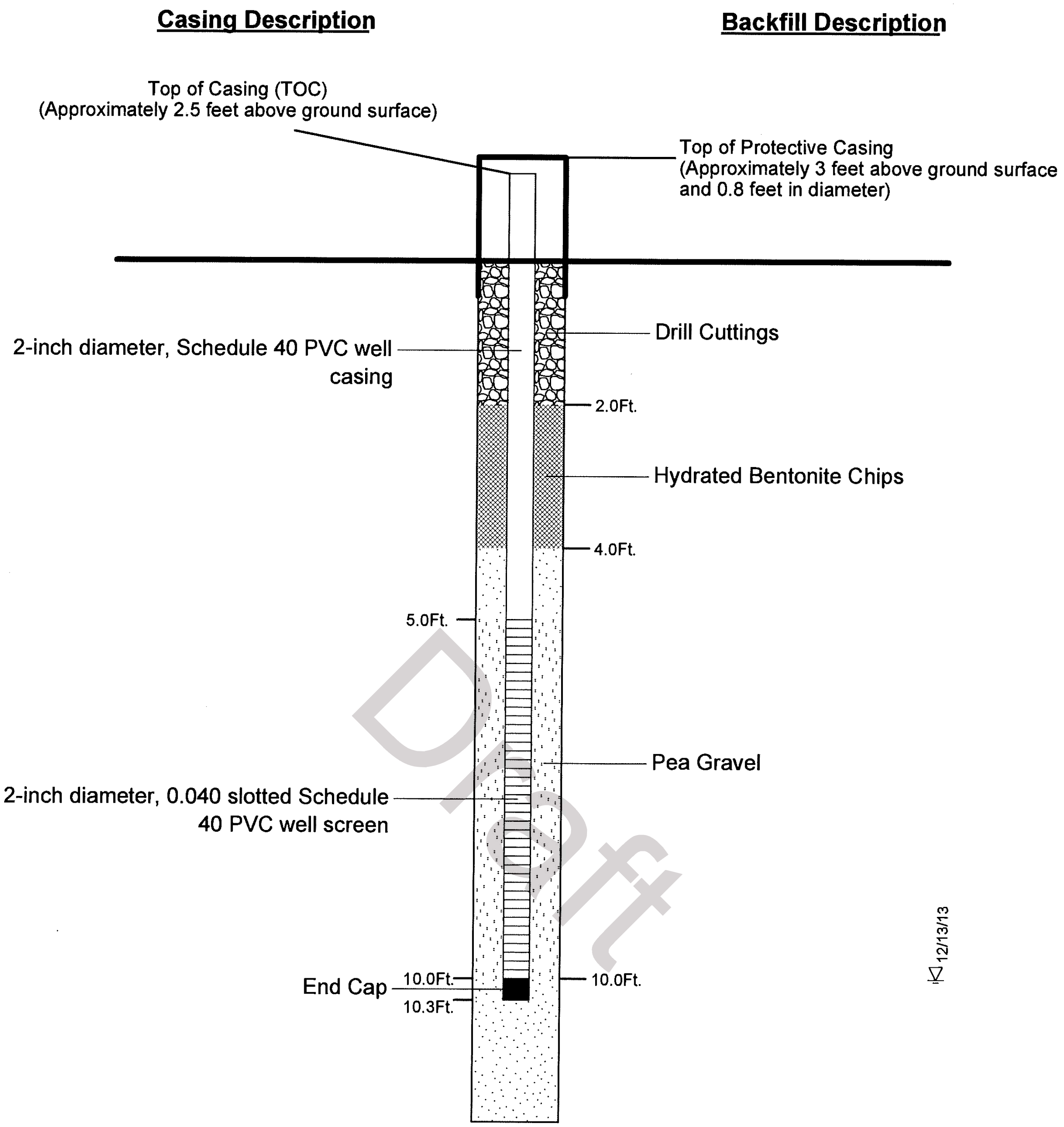
MONITORING WELL GP-4 CONSTRUCTION DETAIL

February 2014

32-1-17594-006

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Fig. 2-10



LEGEND

⊻ Groundwater Level ATD

NOTE: All joints use threaded connections.

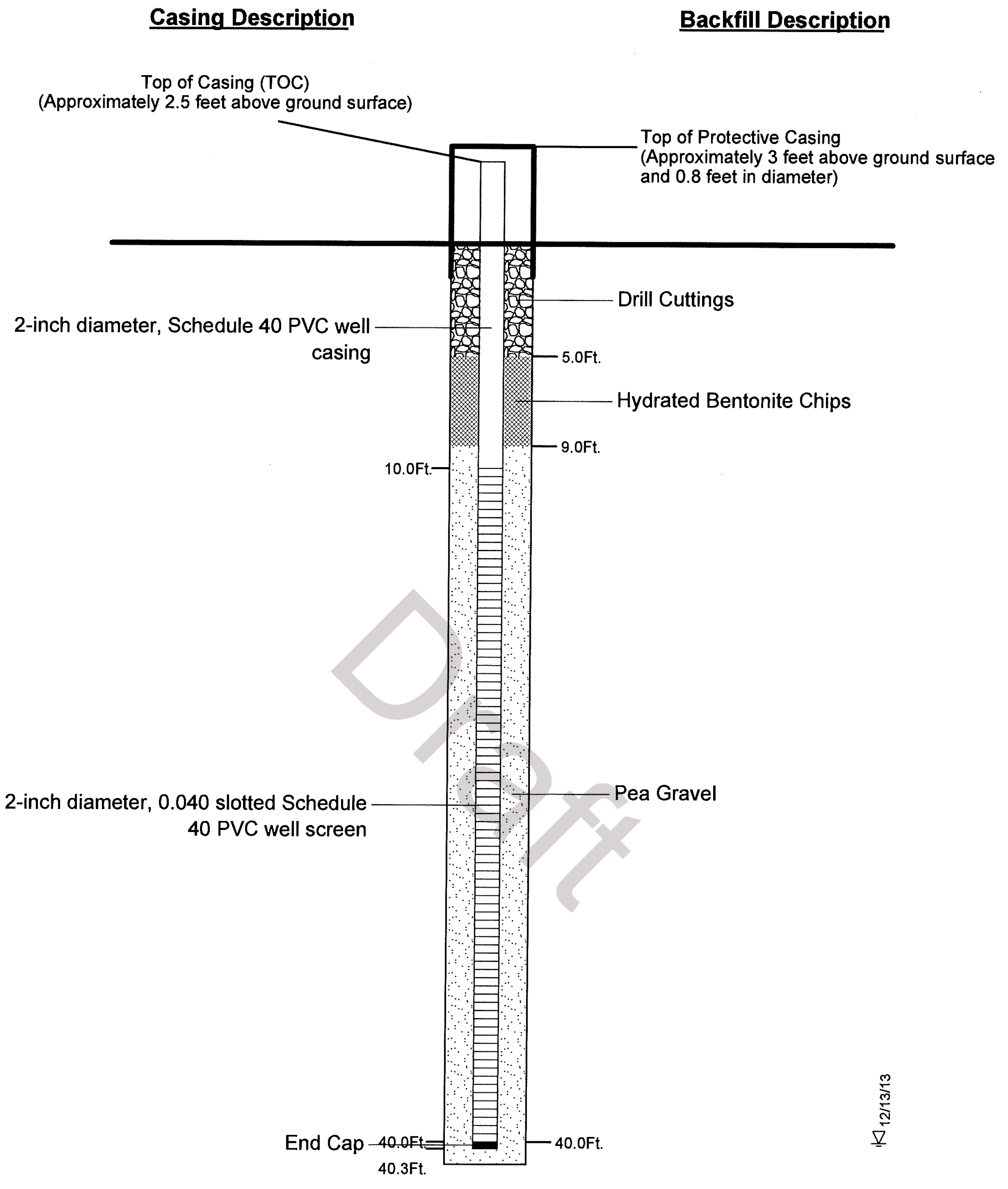
Central Landfill
Palmer, Alaska

**MONITORING WELL GP-5
CONSTRUCTION DETAIL**

February 2014 32-1-17594-006

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Fig. 2-11



LEGEND

▽ Groundwater Level ATD

NOTE: All joints use threaded connections.

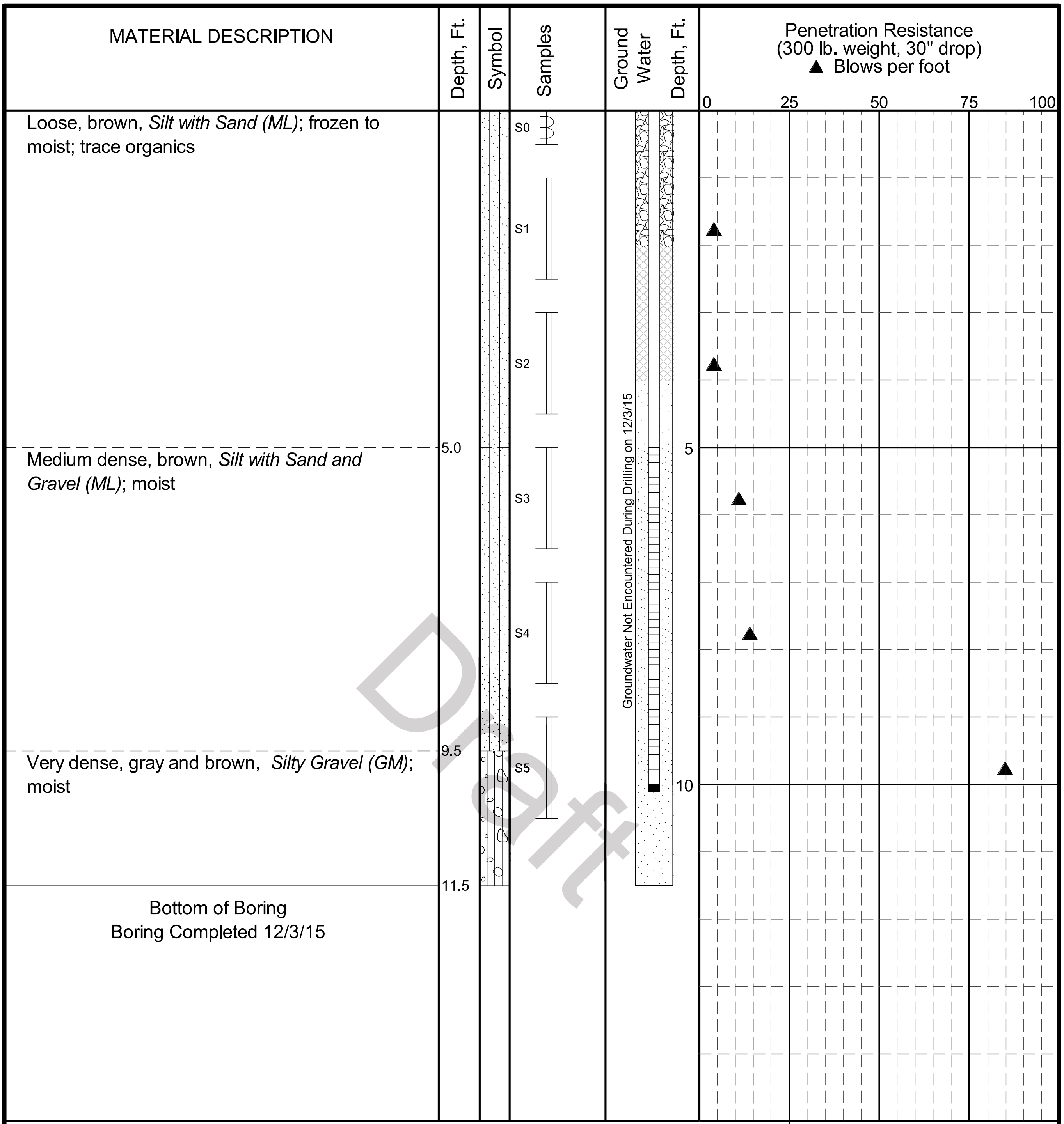
Central Landfill
Palmer, Alaska

MONITORING WELL GP-6 CONSTRUCTION DETAIL

February 2014 32-1-17594-006

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Fig. 2-12



MATERIAL DESCRIPTION

Loose, brown, *Silt with Sand (ML)*; frozen to moist; trace organics

Medium dense, brown, *Silt with Sand and Gravel (ML)*; moist

Very dense, gray and brown, *Silty Gravel (GM)*; moist

Bottom of Boring
Boring Completed 12/3/15

LEGEND

* Sample not recovered
Ш 3" O.D. Split Spoon Sample

▯ Solid Casing, Pea Gravel Pack
▩ Solid Casing and Annular Seal
▤ Slotted Section, Pea Gravel Pack
▨ Solid Casing, Cuttings Backfill

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. USC letter symbol based on visual classification.

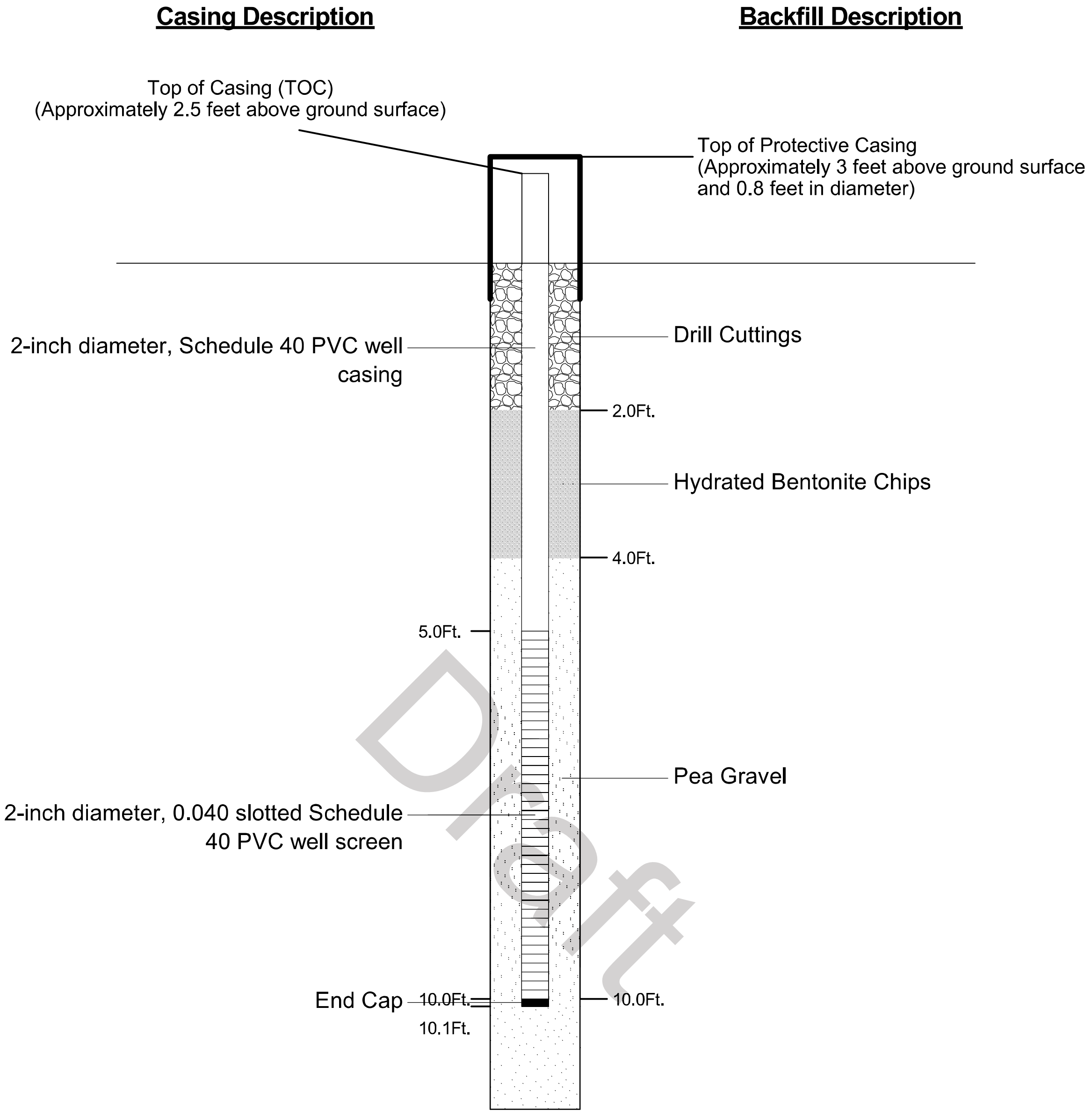
Central Landfill
Palmer, Alaska

LOG OF BORING GP-5R

January 2016 32-1-17769

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Fig. 2-1



LEGEND

▽ Groundwater Level ATD

NOTE: All joints use threaded connections.

Central Landfill
Palmer, Alaska

MONITORING WELL GP-5R
CONSTRUCTION DETAIL

January 2016
32-1-17769

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Fig. 2-2

Table 4.1

MONITORING WELL RECORD DRAWING & CONSTRUCTION LOG

PF 'CT NAME Central Landfill Gas Study PROJECT NO. ANC 31771.A0

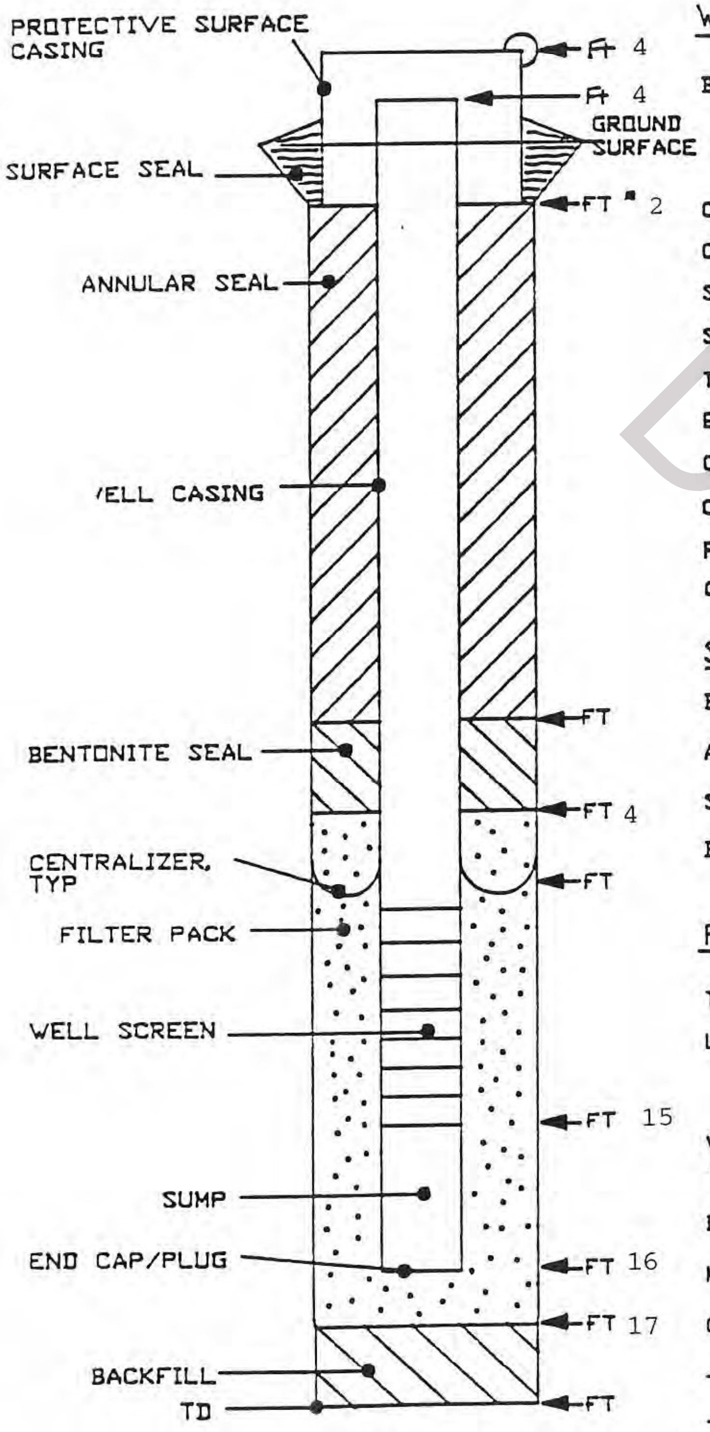
WELL NO. Gas Well 1 FIELD OBSERVERS Kelly Leseman

ELEV, NGVD (top of well casing) ________ SURFACE ELEV, NGVD 300'

WATER LEVEL ELEV/DATE, NGVD N/A START DATE 3/18/91

DRILLING CONTRACTOR Discovery Drilling FINISH DATE 3/18/91

DRILLING METHOD Hollow Stem Auger



NOT TO SCALE

* DEPTHS BELOW GROUND SURFACE

WELL CONSTRUCTION MATERIALS

BOREHOLE DIA(S) 8 INCHES TO 16 FT BGS

________ INCHES TO ________ FT BGS

________ INCHES TO ________ FT BGS

CASING TYPE Sch 80 PVC DIAMETER 1/2" I.D

COUPLING TYPE Treaded

SCREEN TYPE Sch 80 PVC DIAMETER 1/2" I.D

SLOT SIZE .020 SCREEN LENGTH 11'

TOP CAP TYPE Threaded Stopcock

END CAP/PLUG TYPE Threaded Plug

CENTRALIZER TYPE N/A

CENTRALIZER LOCATION(S) N/A

FILTER PACK TYPE Pea Gravel

GRADATION 0'25"

SEAL(S)

BENTONITE Hydrated Pellets

ANNULAR Bentonite

SURFACE Cement with 5% Bentonite

BACKFILL N/A

PROTECTIVE CASING

TYPE Steel DIAMETER 6"

LENGTH ABOVE (G.S.) 4'

BELOW (G.S.) 2'

WELL DEVELOPMENT

DATE N/A

METHOD

COMMENTS

Table 4.2

MONITORING WELL RECORD DRAWING & CONSTRUCTION LOG

PI :CT NAME Cental Landfill Gas Study PROJECT NO. ANC 31771.A0

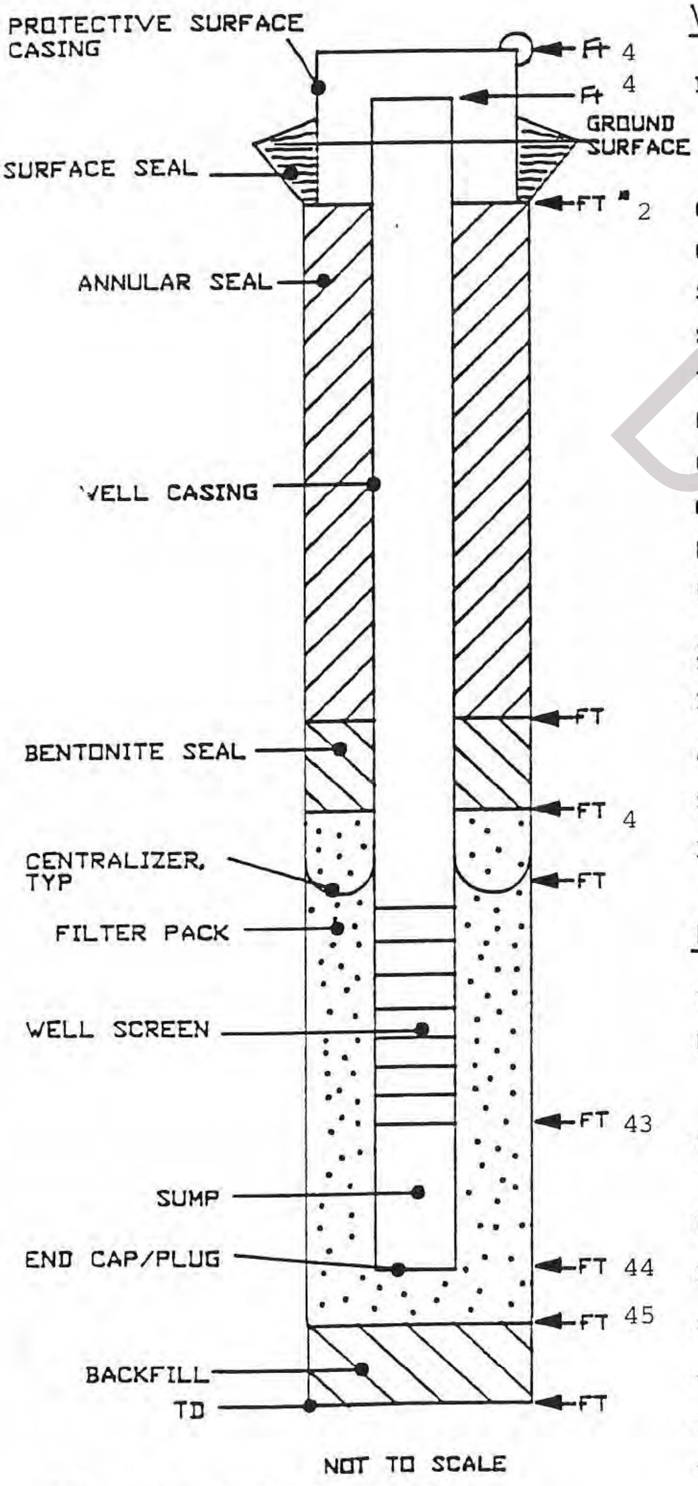
WELL NO. Gas Well 2 FIELD OBSERVERS Kelly Leseman

ELEV, NGVD (top of well casing) ______ SURFACE ELEV, NGVD 290'

WATER LEVEL ELEV/DATE, NGVD N/A START DATE 3/18/91

DRILLING CONTRACTOR Discovery Drilling FINISH DATE 3/18 91

DRILLING METHOD Hollow stem Auger



* DEPTHS BELOW GROUND SURFACE

WELL CONSTRUCTION MATERIALS

BOREHOLE DIA(S) 8 INCHES TO 43 FT BGS

______ INCHES TO ______ FT BGS

______ INCHES TO ______ FT BGS

CASING TYPE Sch 80 PVC DIAMETER 1/2 I.D

COUPLING TYPE Threaded

SCREEN TYPE Sch 80 PVC DIAMETER 1/2" I.D

SLOT SIZE .020 SCREEN LENGTH 30'

TOP CAP TYPE Threaded Stopcock

END CAP/PLUG TYPE Threaded Plug

CENTRALIZER TYPE N/A

CENTRALIZER LOCATION(S) N/A

FILTER PACK TYPE Pea Gravel

GRADATION 0.25"

SEAL(S)

BENTONITE Hydrated Pellets

ANNULAR Bentonite

SURFACE Cement with 5% Bentonite

BACKFILL N/A

PROTECTIVE CASING

TYPE Steel DIAMETER 6"

LENGTH ABOVE (G.S.) 4'

BELOW (G.S.) 2'

WELL DEVELOPMENT

DATE N/A

METHOD

COMMENTS

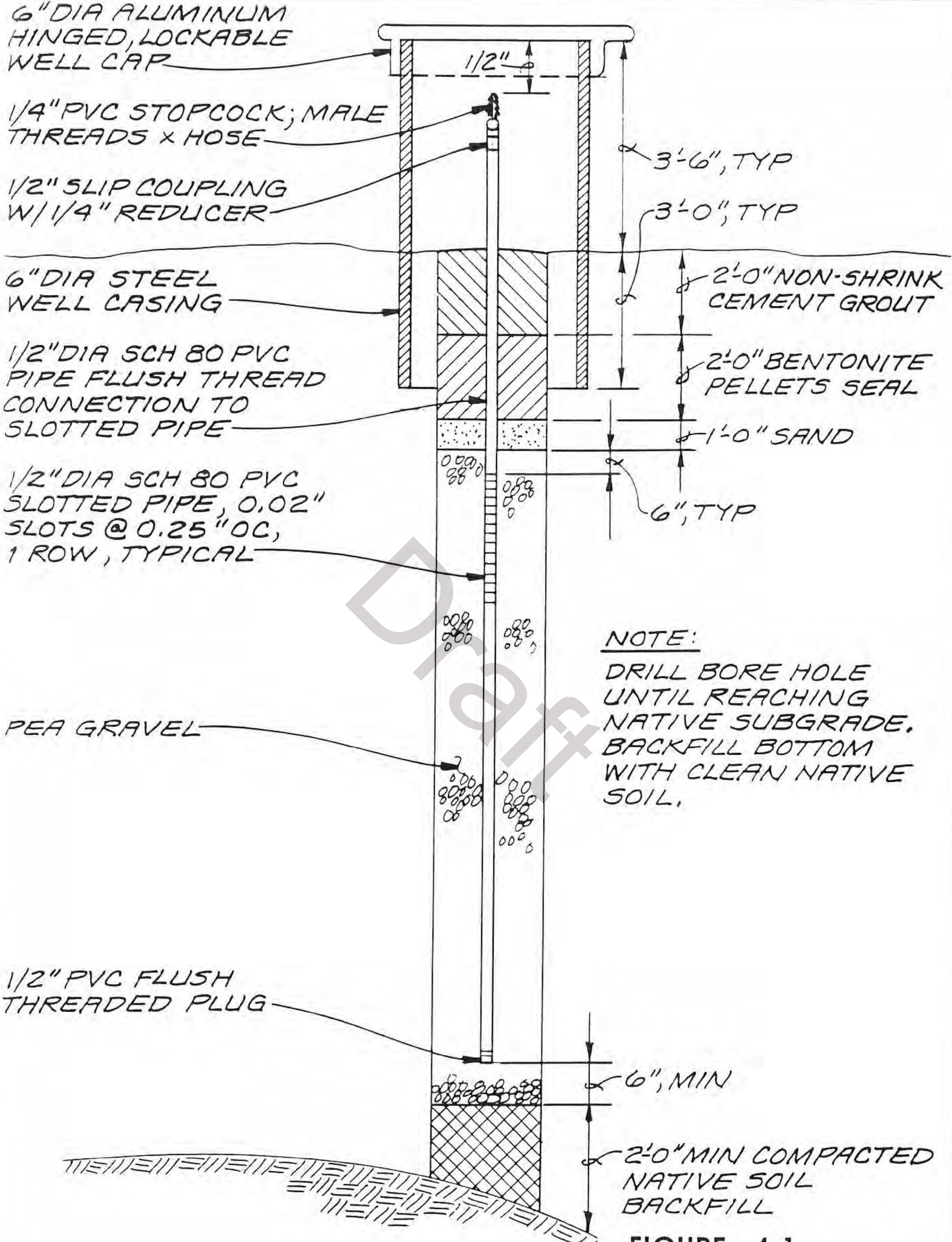


FIGURE 4.1
LANDFILL GAS PROBE-TYPICAL
CENTRAL LANDFILL
PALMER, ALASKA

CH2M HILL

Division of Environmental Health

SOLID WASTE PROGRAM

Gas Monitoring Plan Checklist

July 2019

The Alaska Department of Environmental Conservation (ADEC) Solid Waste Program has provided this checklist to outline the minimum required content for a landfill explosive gas monitoring plan. The Solid Waste Program can and will require additional information on a site specific basis. This checklist is not intended as a comprehensive explosive gas monitoring guidance. For additional guidance please refer to other Solid Waste Program guidance documents.

CHECKLIST DESCRIPTION		PAGE/SECTION
Project Management		
1.	Title page	DP
2.	Distribution list	
3.	Table of contents	DP
4.	Project/task organization – identify key project team members and their respective roles and responsibilities (facility manager, operator, environmental project manager, field sampler, etc). This may be provided in table format.	RP
5.	List of acronyms and abbreviations	DP
Background		
6.	State purpose of plan, decisions to be made, or outcome to be achieved	DP 5.0
7.	Background information – historical, scientific, and regulatory perspective for the monitoring project including:	
	a. Facility location, local geology and hydrogeology, details on any site investigations pertaining to gas migration, and gas monitoring program history	DP 5.1-5.2
	b. Provide gas well and gas probe logs and any additional installation information	Add to DP
8.	Cite applicable regulatory criteria	RP PG 1
Project/Task Description		
9.	Provide summary of the monitoring program and monitoring network (purpose and intent, active vs inactive monitoring locations, monitoring location rationale, etc.)	DP 5.1
10.	Facility map with all monitoring locations and all structures on and within one-quarter mile of the facility	RP App 1, Fig 3
11.	Details on the specific locations for each monitoring point within each structure.	Insert
12.	Monitoring schedule information	Insert
	a. Frequency of scheduled monitoring events	
	b. Timing of scheduled monitoring events (or an acceptable range)	
	c. Any weather conditions that must be met for sampling events (if ambient air sampling is still applicable)	
Special Training/Certification		
13.	Identify any specialized training or certifications required and provide documentation of that training for project team members	NA
14.	Outline any confined space access requirements and required trainings	Insert
Field Sampling		
15.	Gas meter and other monitoring equipment (include manufacturer manual - suggested)	Insert

DP: Development Plan   RP: 2020-03-20 B&M Response Plan   Insert: Verbiage provided by Brett

CHECKLIST DESCRIPTION		PAGE/SECTION
16.	Instrument checks, operation, and calibration procedures	Insert
17.	Field sampling procedures	Insert
	a. Structures	
	b. Ambient air	
	c. Gas probes	
	d. Gas vents/wells	
18.	Identify how gas concentrations will be measured at the various types of monitoring locations	Insert
19.	Provide copy of gas monitoring logs and field forms	Insert
20.	Identify how exceedances of the applicable limits will be identified and documented, and the process for determining corrective action	RP PG 5
Data Management Describe how data will be managed from the initial monitoring to final reporting.		
21.	Record keeping	Insert
22.	Data storage and retrieval – all historical data should be available	Insert
Gas Management Planning		
23.	If you are currently performing ambient air monitoring:	
	a. Include an ambient air monitoring plan which includes the monitoring locations and intervals	Insert
	b. Include a proposed timeline for the installation of gas probes and a gas probe monitoring plan	NA
24.	Include a plan and timeline for how exceedances of 18 AAC 60.350 will be handled	
	a. Within 60 days of an exceedance the owner or operator shall implement an approved long-term remediation plan for the methane gas releases, place a copy in the operating record, and submit written notification to the department that the plan has been implemented	RP
25.	Include a gas management plan that will be implemented until a remediation plan can be developed	NA
	a. Owner or operator shall take all necessary steps to reduce or dissipate the concentrations of methane to ensure public health, safety, and welfare.	
26.	Include a plan and timeline for how a long-term remediation plan will be developed and implemented within 60 days of detecting an exceedance of methane concentration standards	NA
Reporting		
27.	Provide a reporting schedule and frequency of reporting	Insert
28.	Include a statement that the Solid Waste Program will be notified immediately by telephone and in writing if levels exceed limits listed in 18 AAC 60.350	RP PG 5

Instruction Manual
Eagle Series

Portable Multi-Gas Detector

Part Number: 71-0028RK

Revision: Q

Released: 5/26/20

www.rkiinstruments.com

WARNING

Read and understand this instruction manual before operating instrument. Improper use of the gas monitor could result in bodily harm or death.

Periodic calibration and maintenance of the gas monitor is essential for proper operation and correct readings. Please calibrate and maintain this instrument regularly! Frequency of calibration depends upon the type of use you have and the sensor types. Typical calibration frequencies for most applications are between 1 and 3 months, but can be required more often or less often based on your usage.

Warranty

RKI Instruments, Inc. warranties gas alarm equipment manufactured by RKI and sold by RKI to be free from defects in materials and workmanship for a period of one year from date of shipment from RKI Instruments, Inc. Any parts found defective within that period will be repaired or replaced, at our option, free of charge. This warranty does not apply to items that are subject to deterioration or consumption in normal service, and which must be cleaned, repaired, or replaced routinely. Those items include, but are not limited to:

- absorbent cartridges
- pump diaphragms and valves
- lamp bulbs and fuses
- filter elements
- batteries

This warranty is voided by mechanical damage, misuse, alteration, rough handling, or repairs not in accordance with the operator's manual. This warranty indicates the full extent of our liability. We are not responsible for removal or replacement costs, local repair costs, transportation costs, or contingent expenses incurred without our prior approval.

> THIS WARRANTY IS IN LIEU OF ANY OTHER WARRANTIES AND REPRESENTATIONS, EXPRESSED OR IMPLIED, AND ALL OTHER OBLIGATIONS OR LIABILITIES ON THE PART OF RKI INSTRUMENTS, INC. INCLUDING BUT NOT LIMITED TO THE WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL RKI INSTRUMENTS, INC. BE LIABLE FOR INDIRECT, INCIDENTAL, OR CONSEQUENTIAL LOSS OR DAMAGE OF ANY KIND CONNECTED WITH THE USE OF ITS PRODUCTS OR FAILURE OF ITS PRODUCTS TO FUNCTION OR OPERATE PROPERLY.

This warranty covers instruments and parts sold to end users by authorized distributors, dealers, and representatives of RKI Instruments, Inc.

We do not assume indemnification for any accident or damage caused by the operation of this gas monitor. Our warranty is limited to replacement of parts or our complete goods.

Table of Contents

Introduction

Overview

The RKI Eagle is the most advanced portable gas detection system available. The Eagle is built for rugged reliability and ease of use and includes the latest innovations in gas detection technology:

- Simultaneous detection of one to six gases. Standard target gases include combustible gas (% LEL and ppm), oxygen deficiency, carbon monoxide, and hydrogen sulfide.
- Powerful sample-drawing pump with up to 125-foot range.
- Dot-matrix liquid crystal display (LCD) for complete, understandable information at a glance.
- Microprocessor control for all functions, including data logging and user-adjustable alarms.
- Visible and audible alarms for hazardous conditions and malfunctions.
- UL and CSA classified. Intrinsic safety for Class I, Division I, Groups A, B, C, and D hazardous atmospheres (standard 4-gas model and non-standard toxic gas versions). Consult RKI Instrument, Inc. for classification of other Eagle versions.
- Tough case with a balanced, light-weight design.

WARNING: ***The Eagle detects a combination of combustible gas, oxygen deficiency, hydrogen sulfide and carbon monoxide, or other toxic gases which can be lethal. When using the Eagle, you must follow the instructions and warnings in this manual to assure proper and safe operation of the unit and to minimize the risk of personal injury. Be sure to maintain and periodically calibrate the Eagle as described in this manual.***

About this Manual

This manual is intended for use with all Eagle models. Examples used in this manual are for the standard four-gas model (combustible gas, oxygen, carbon monoxide, and hydrogen sulfide). Differences between the standard four-gas model and other Eagle models are noted where applicable.

Specifications

Table 1 lists physical and environmental specifications for the Eagle. Table 2 lists specifications for the Eagle's standard sensors.

Table 1: Eagle Specifications

Target Gases[1]	• Combustible gas • Oxygen (O_2) • Carbon monoxide (CO) • Hydrogen sulfide (H_2S)
Case	High-impact polycarbonate-polyester blend
Safety/Regulatory[2]	CSA/NTRL and UL classified intrinsically safe (Class I, Division 1, Groups A, B, C, and D)
Dimensions	10.5 in. x 5.9 in. x 7.0 in. (26.7 cm x 15.0 cm x 17.8 cm)
Weight	5 lbs. (2.25 kg)
Power	Four D-size batteries (alkaline or Ni-Cd)
Continuous Operating Hours	Alkaline: 30 hours (minimum) Ni-Cd: 18 hours (minimum)[3]
Operating Temperature	14°F to 104°F (-10°C to 40°C)
Humidity	0 to 95% (non-condensing)
Standard Accessories	• Shoulder strap • Alkaline batteries • Hydrophobic probe • 5-foot hose
Optional Accessories	• Ni-Cd batteries • Battery charger (115 VAC) • Continuous operation adapter (115 VAC or 12 VDC) • Dilution fitting (1:1 or 3:1) • Remote alarm • Data logger

[1] Appendices C, D, E, and F describe the Eagle's non-standard sensors.

[2] Consult RKI Instruments, Inc. for regulatory classifications of versions other than the standard 4-gas and non-standard toxic gas versions.

[3] Based on RKI part number 49-1240RK.

Table 2: Standard Sensor Specifications

	Combustible Gas (%LEL[1])	Combustible Gas (PPM[2])	Oxygen	Hydrogen Sulfide	Carbon Monoxide
Range	0 to 100% LEL	Depends on target gas[4]	0 to 40% O_2	0 to 100 ppm	0 to 500 ppm
Alarm 1	10% LEL	5000 ppm	19.5% O_2 (decreasing)	10.0 ppm	25 ppm
Alarm 2	50% LEL	25,000 ppm	23.5% O_2 (increasing)	30.0 ppm	50 ppm
TWA Alarm	N/A	N/A	N/A	10.0 ppm	25 ppm
STEL Alarm	N/A	N/A	N/A	15.0 ppm	400 ppm
Detection Principle	Catalytic combustion	Catalytic combustion	Electro-chemical	Electro-chemical	Electro-chemical
Response Time (to 90%)[5]	30 seconds	30 seconds	30 seconds	30 seconds	30 seconds
Accuracy (of fullscale)	± 5% of reading or ± 2% LEL (whichever is greater)	± 25 ppm or ± 5% of reading (whichever is greater) under ideal conditions	± 0.5% O_2	± 5% of reading or ± 2 ppm H_2S (whichever is greater)	± 5% of reading or ± 5 ppm CO (whichever is greater)

1 LEL (Lower Explosive Limit)

2 PPM (Parts Per Million)

3 Alarms settings are user adjustable. See "Updating the Alarm Point Settings" on page 34.

4 The PPM range represents the same range as 0 to 100% LEL for that gas. For example, 100% LEL for methane = 5% by volume = 50,000 PPM. Therefore, the PPM range for methane is 0 to 50,000.

5 With the Eagle's standard hose and probe attached.

Description

Case

The Eagle has a plastic case with a full-sized handle. The high-visibility case is shielded to reduce radio frequency and electromagnetic interference (RFI/EMI). The system is light-weight and balanced, which makes the Eagle easy to carry and use for extended periods. A foam rubber gasket between the top and bottom case components is water- and dust-resistant. You can set the case into 2.5 in. of water without damage.

Control Panel

The control panel is at the top of the Eagle. The touch-pad buttons reduce the risk of accidental activation. The dot matrix display simultaneously shows the gas reading for all installed sensors. (For the 5- and 6-gas versions, the Eagle displays the gas reading of four channels. Use the AIR/▲ and SHIFT/▼ buttons to scroll to the non-displayed channels.) The display also shows information for each of the Eagle's program modes.

Buttons

The control panel includes the following six buttons.

Table 3: Eagle Button Functions

Button	**Function(s)**
POWER/ENTER	• turns the Eagle on and off. • used during setup and calibration.
RESET/SILENCE	silences and resets audible alarm if the Eagle is programmed for latching alarms and the Alarm Silence option is on [1]
DISP/ADJ	• activates display modes • enters instructions into the Eagle's microprocessor
LEL/PPM	switches combustible gas detection ranges between %LEL (lower explosive limit) and PPM (parts per million)[2]
AIR/▲	• activates the demand-zero function (automatically adjusts the Eagle in fresh-air conditions) • scrolls through the display and settings modes
SHIFT/▼	• scrolls through the calibration and settings modes • enters instructions into the Eagle's microprocessor

1 The Eagle's alarms are user-adjustable. See "Setup Mode" on page 27.

2 The LEL range is commonly used for safety applications; the PPM range can be used for environmental or other special applications.

Alarm Lights

Two ultra-bright, red, light-emitting diodes (LEDs) provide visual indications for gas alarms and instrument malfunctions. They are mounted on the top rear of the case for greatest visibility.

Battery Charger Connector

The battery charger connector is at the top right rear of the case. The external battery charger connects to this connector to recharge nickel-cadmium (Ni-Cd) batteries. The continuous operation adapter also connects to the battery charger connector.

Interface Port

The interface port is for the **optional** data logging or remote buzzer. The port is mounted on the top left rear of the case. When the Data Logging option is installed, the Eagle records gas concentrations at programmed intervals and stores reading data. You can download data through the interface port to a PC for use in data analysis programs. Data retrieval requires the Eagle Data Downloader Kit (with PC connection cable and software).

The optional remote buzzer also connects to the interface port. The remote buzzer is for use in applications where a remote alarm indication is required.

Buzzer

A solid-state electronic buzzer is mounted inside the top of the case. The buzzer sounds for gas alarms, malfunction, low battery voltage, and as an indicator during use of the Eagle's many display and adjustment options.

Sample-Drawing System

The sample-drawing system includes the pump, sensor block and connections, internal filter and charcoal scrubber, and the external hose, probe, and hydrophobic filter. This system provides continuous flow of sampled air to the sensors while keeping out liquids and dust.

With proper setup, the system can draw a sample flow from up to 125 feet away. Consult RKI Instruments, Inc. for sample flow distances longer than 125 feet.

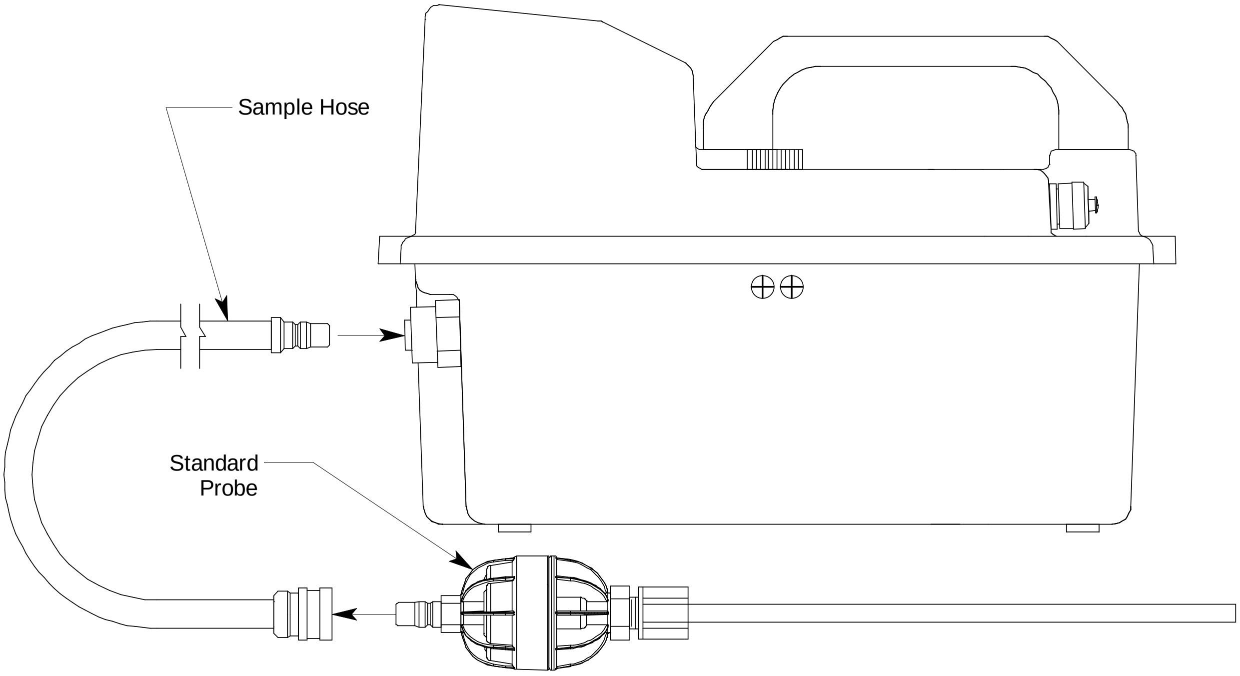
Hose and Probe

A 5 foot polyurethane sample hose and a 10 inch hydrophobic probe are included as standard. The hose has a male quick connect fitting on one end and a female quick connect fitting on the other end. The probe has a male quick connect fitting. Normally, the male end of sample hose is installed in the Eagle inlet fitting and the probe is installed in the female end of the hose. However, if the sample hose is not needed for monitoring a particular area, the probe may be installed directly to the inlet fitting. Sample hose lengths are available from 5 feet (standard length) to 125 feet (see "Appendix A: Parts List" on page 50).

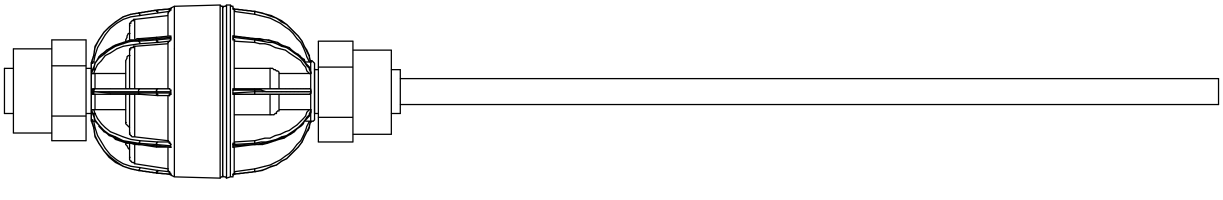
CAUTION: *Sample hose lengths of more than 125 feet are not recommended for the Eagle because of flow rate reduction and increased response time. Consult RKI Instruments, Inc. for hose lengths longer than 125 feet.*

The standard probe includes a replaceable particle filter and hydrophobic filter disk that prevent particulates and water from entering the Eagle's flow system. See

“Replacing the Probe’s Particle Filter and Hydrophobic Filter Disk” on page 46 for instructions to replace the particle filter and hydrophobic filter disk.



A super toxic probe is included with instruments that require it. It has a plastic fitting and is connected to the inlet of the Eagle with a tubing stub. See “Appendix C: Non-Standard Toxic Gas Sensors” on page 54 for more information about the super toxic probe and where to use it.



Sensors

This section describes the Eagle’s standard sensors. Non-standard sensors are described in Appendices C, D, E, and F. Your specific Eagle model may not include all of the sensors described below. Under normal conditions, the Eagle’s standard sensors have an operating life of approximately two years.

Combustible Gas Sensor

The combustible gas (LEL) sensor is mounted with the flame arrestor down in the sensor block to allow the sample flow to diffuse into the sensor. Five pins extend from the top of the sensor. The sensor cable connects to the pins on one end and terminates in a four-position connector, which plugs into the **COMB** socket on the analog print circuit board (PCB).

The LEL sensor detects combustible gas and vapors in the atmosphere with a catalytic platinum element. The reaction of gas with oxygen on the catalyst causes a change in the resistance of the element, which is converted by the Eagle into a reading of combustible gas concentration.

Oxygen Sensor

The oxygen (O_2) sensor is mounted face down in the sensor block to allow the sample flow to diffuse into the sensor. A multi-pin plug connects the O_2 sensor to the **CN2** socket on the analog PCB.

The O_2 sensor is an electrochemical cell, which reacts to the oxygen in the atmosphere and produces a voltage proportional to the oxygen concentration. This voltage is converted by the Eagle into a reading of oxygen concentration.

Standard Toxic Sensors (CO and H_2S)

The CO and H_2S sensors are physically very similar. They have cylindrical bodies and are mounted face down in the sensor block. A three-position connector from each sensor plugs into **EC1** or **EC2** socket on the analog PCB. The sensor connected to the **EC1** socket displays as channel 3; the sensor connected to the **EC2** socket displays as channel 4.

The toxics sensors are electrochemical cells, which react to the target gas in the atmosphere, producing a current proportional to the concentration of gas. The current is converted by the Eagle into a reading of target gas concentration.

Circuit Boards

The Eagle circuit boards analyze, record, control, store, and display the information collected.

The analog PCB is mounted perpendicular to the base of the instrument case. It is located in the same half of the case as the sensors and sample-drawing system. The sensor leads connect to the analog PCB.

The main PCB is mounted in the top half of the case. It includes the methane elimination and CAL/SETUP switches.

CAUTION: *The circuit boards should be serviced only by authorized repair personnel.*

Methane Elimination Switch

The methane elimination switch (SW1) is mounted near the top right corner of the main PCB.

For applications where methane is an interfering gas, you can set the methane elimination switch to eliminate most response to methane (see “Appendix B: Methane Elimination” on page 52). An *external* methane elimination switch is available as an *option*.

CAL/SETUP Switch

The CAL / SETUP switch (SW2) is mounted near the middle left edge of the main PCB.

This switch controls the Eagle functions available to the user by disabling the SHIFT / ▼ button. Without the use of this button, the user is unable to enter Calibration or Setup mode. (Display mode is available with either switch setting.) See “Setting User Access” on page 18 to change the switch setting.

Operation

The Eagle has four operating modes: normal operating mode, display mode, setup mode, and calibration mode. This section describes the Eagle in normal operating mode. It includes procedures to start up the Eagle, set various detection options for the combustible gas channel, and shut down the Eagle.

NOTE: The screens illustrated in this section are intended as examples only. The screens displayed by your Eagle model may be slightly different.

Starting Up the Eagle

1. Connect the sample hose to the Eagle’s quick connect inlet fitting.
2. Connect the hydrophobic filter and probe tip to the sample hose’s quick connect fitting.
3. Press and briefly hold down the POWER / ENTER button. If the Lunch Break feature is on (see page 35), the Resume Datalog screen displays. (If the Lunch Break feature is off, the Battery Voltage screen displays.)

```
RESUME DATALOG ?
              5
   YES: AIR
   NO : DISPLAY
```

   - Press the AIR / ▲ button to continue accumulating time-weighted average (TWA) and PEAK readings from the last time the Eagle was used. (The short-term exposure limit [STEL] reading is reset each time the Eagle is turned on.) If you do not press the AIR / ▲ or DISP / ADJ button within 5 seconds, the Eagle automatically resumes readings.
   - Press the DISP / ADJ button to restart these measurements.

4. The Battery Voltage screen displays the minimum usable and actual battery voltage (for example, 6.0V). If the battery voltage is too low, the Eagle will not

continue.

```
    BATTERY
    MIN. 4.5V
    BATTERY
    NOW  6.0V
```

NOTE: The following screen only displays if the data logging option is installed. If the data logging option is not installed, the Self Diagnosis screen displays after the Battery Voltage screen.

5. If the data logging option is installed, the date and time screen shows the instrument’s date and time as set in Setup mode. The data logging option uses this information to record the time and date of sample and alarm events.

```
   Apr 17 1998
      14:30
```

6. The Eagle does a self-diagnosis and alerts you if a malfunction occurs.

```
       SELF
    DIAGNOSIS
    10 SECONDS
      TO GO
```

```
    STAND BY

   <CH4><OXY>
   <H2S><CO>
```

7. When the Eagle successfully completes its self-diagnosis, **OK** replaces **STAND BY**, then the normal operating screen displays. The normal screen displays fresh-air concentrations for all gases. The Eagle sounds a double tone to indicate it is in normal operation.

```
CH4      0 LEL%
OXY   20.9 VOL%
H2S    0.0 PPM
CO       0 PPM
```

CAUTION: *Do not use gas from a cigarette lighter to test response to combustibles. Exposing the combustible gas sensor to uncontrolled high concentrations of gas will reduce response and sensor life.*

8. Verify that the Eagle is operating correctly. Use the RKI Check Kit to easily verify correct operation of the Eagle.

WARNING: If the Eagle does not respond to verification, take it to a known "fresh-air" environment, then perform the demand zero procedure described in "Preparing for Calibration" on page 42. Repeat step 4 before using the Eagle in a potentially hazardous location.

Normal Operation

The Eagle continuously monitors the sampled atmosphere and displays the gas concentrations present for its target gases. In a low-light environment, press any button to turn on the display backlight. (See "Updating the Back Light Setting" on page 37 to program backlight duration.) If the Confirmation Beep is turned on, the Eagle beeps once every 15 minutes to verify that it's functioning.

To use the probe, insert it into the monitoring area and wait a few seconds for response.

NOTE: Response time increases with the length of the sample hose. Very long sample hoses may require several seconds to show response at the Eagle.

Monitoring Combustible Gas in the PPM Range

1. Start the Eagle in the LEL range as described in "Starting Up the Eagle" on page 15.
2. Allow the combustibles sensor to stabilize (3 to 5 minutes).
3. Press the LEL / PPM button to switch the units from %LEL to ppm.
4. If the PPM reading is not zero, take the Eagle to a fresh air environment and perform the demand zero as described in "Preparing for Calibration" on page 42.

NOTE: For the data logging **option**, combustible gas readings are logged in %LEL regardless of the LEL / PPM setting.

Monitoring Combustible Gases Other than Methane

If the combustible sensor is calibrated to methane (CH_4), use Table 4 to determine the response of other combustible gases. This table is based on Eagles in full response mode (methane elimination switch set to **CH4**) calibrated to methane. Multiply the display reading by the factor in the appropriate column in the table. For example, if you are detecting hexane and the display reads 10% LEL, the actual hexane reading is 10% x 2.14 = 21% LEL hexane.

WARNING: The Eagle's alarms are initiated by the DISPLAY reading not the FACTORED reading. If you are monitoring for hexane as in the example above and the low alarm is set for 10% LEL, the Eagle will initiate a low alarm at 21% LEL hexane (display reading of 10% LEL).

To determine the concentration of other combustible gases with the Eagle in methane elimination mode, see Table 7 on page 53.

Table 4: Full Response Mode Conversion Factors (Methane Calibration)

Target Gas	LEL Factor	PPM Factor
Acetone	1.40	0.70
Benzene	1.75	0.42
Butyl Acrylate	3.95	1.34
Butyl Acetate	3.38	0.88
2-Butyl Alcohol	1.94	0.66
1-Butyl Alcohol	2.65	0.74
Cyclohexane	1.82	0.47
Cumene	3.90	0.70
Ethylene Dichloride	2.75	3.41
Ethyl Alcohol	1.38	0.91
Ethyl Chloride	1.26	0.96
Ethyl Acrylate	2.45	0.69
Hexane	2.44	0.54
Hydrogen	1.16	0.93
Isobutane	1.61	0.58
Isopropanol	2.22	0.89
Methane	1.00	1.00
Methanol	1.23	1.48
Methyl Acetate	1.37	0.85
Methyl Acrylate	1.10	0.62
Methyl Ethyl Ketone	2.53	0.71
Methyl Isobutyl Ketone	2.53	0.61
Mixed Xylenes	2.36	0.52
Nonane	2.87	0.46
Pentane	1.95	0.59
Propane	1.50	0.63
Styrene	2.94	0.53
Toluene	2.16	0.48
Vinyl Acetate Monomer	1.48	0.77

Setting User Access

The CAL / SETUP switch controls the Eagle functions available to the user. The switch setting does not affect the Eagle's ability to display gas readings or indicate alarms.

1. Turn off the Eagle.
2. Unscrew the two large screws on the top of the case.
3. Turn over the top half of the case.
4. Locate the CAL / SETUP switch (SW2) near the middle along one edge of the main processor board.

CAUTION: *The Methane Elimination switch (SW1) is on the opposite edge of the board near the front end. DO NOT confuse these two switches.*

---

5. Place the CAL / SETUP switch in the appropriate position.
   - To give the Eagle access to all modes, place the switch in the ON position.
   - To limit the Eagle to normal operating and display modes, place the switch in

the OFF position. (The Eagle prevents access to the setup and calibration modes by disabling the SHIFT/▼ button.)

6. Place the top of the case in its original position, then secure it with the large screws you loosened in step 2.
7. Turn on the Eagle.

NOTE: Make sure the Eagle's calibration is current and the setup options are appropriate and safe for the operating environment before placing the CAL/SETUP switch in the OFF position.

Turning Off the Eagle

Press and hold down the POWER/ENTER button until **GOOD-BYE** displays, then release the button.

Alarms

Alarm Indications

This section describes the Eagle’s audible and visual alarm indications for gas, over range, low flow, low battery, and sensor failure alarms. This section also describes how to reset gas alarms.

The default alarm settings are listed in Table 2 on page 10. The alarm settings are user-adjustable as described in “Updating the Alarm Point Settings” on page 34.

NOTE: The screens illustrated in this section are intended as examples only. The screens displayed by your Eagle model may be slightly different.

First Gas Alarm

If a channel’s gas reading exceeds (falls below for the oxygen) the first alarm setting :

```
CH4     10  LEL%ALM1
OXY   20.9  VOL%
H2S    0.0  PPM
CO       0  PPM
```

- **ALM1** displays in the alarm field for that channel.
- The channel’s display line flashes.
- The buzzer sounds a pulsed tone.
- The alarm lights flash.

Second Gas Alarm

If a channel’s gas reading exceeds the second alarm setting:

```
CH4     50  LEL%ALM2
OXY   20.9  VOL%
H2S    0.0  PPM
CO       0  PPM
```

- **ALM2** displays in the alarm field for that channel.
- The channel’s display line flashes.
- The buzzer sounds a pulsed tone.
- The alarm lights flash.

STEL Alarm (Toxics Only)

If a toxic gas channel’s average gas reading for the past 15 minutes exceeds the STEL alarm setting:

```
CH4      0 LEL%
OXY   20.9 VOL%
H2S   15.0 PPM STEL
CO       0 PPM
```

- **STEL** displays in the alarm field for that channel.
- The channel’s display line flashes.
- The buzzer sounds a pulsed tone.
- The alarm lights flash.

TWA Alarm (Toxics Only)

If a toxic gas channel’s average gas reading for the past 8 hours exceeds the TWA alarm setting:

```
CH4      0 LEL%
OXY   20.9 VOL%
H2S   10.0 PPM TWA
CO       0 PPM
```

- **TWA** displays in the alarm field for that channel.
- The channel’s display line flashes.
- The buzzer sounds a pulsed tone.
- The alarm lights flash.

Over Range Alarm

If a channel’s gas reading exceeds that channel’s full-scale setting:

```
CH4      0 LEL%
OXY   40.0 VOL%OVER
H2S    0.0 PPM
CO       0 PPM
```

- **OVER** displays in the alarm field for that channel.
- The channel’s display line flashes.
- The buzzer sounds a pulsed tone.
- The alarm lights flash.

Low Flow Alarm

If the Eagle’s sample system becomes restricted or blocked (for example plugged probe, fouled filter, pinched tubing):

```
        FAIL
  LOW FLOW LEVEL
```

- The message **FAIL LOW FLOW LEVEL** replaces the normal screen.
- The buzzer sounds a steady tone.
- The alarm lights are on continuously.
- The pump automatically shuts off to prevent damage.

Correct the flow blockage. Press the RESET/SILENCE button to turn off the alarms and restart the pump. If low flow conditions still exist, the Eagle will go into alarm again. If the condition cannot be corrected immediately, take the Eagle out of service to a non-hazardous area.

Low Battery Warning

When the battery charge drops near the lower limit, the Eagle displays the following screen. For alkaline batteries, you have approximately 3 hours of use remaining; for Ni-Cd batteries you have approximately 15 minutes of use remaining.

```
B CH4      0 LEL%
A OXY   20.9 VOL%
T H2S    0.0 PPM
• CO       0 PPM
```

Low Battery Warning

Low Battery Alarm

When the battery voltage drops to the minimum limit, the following screen displays, the alarm lights are on continuously, and the buzzer sounds a steady tone. The Eagle is not operational as a gas monitoring device when this screen displays.

```
     BATTERY
     MIN. 4.5V
     CHANGE
     BATTERY
```

Low Battery ALARM

NOTE: If you are using the data logging accessory and the Eagle goes into Low Battery ALARM, shut off the Eagle in order to save the current data logging session.

Sensor Failure Alarm and Emergency Operation

The Eagle continuously monitors itself for proper operation. If a malfunction occurs, the Eagle alerts you with audible and visual alarms.

If a sensor fails during start-up or normal operation:

```
   FAIL
  SENSOR
<    ><OXY>
<    ><   >
```

- The message **FAIL SENSOR** displays.
- The failed sensor displays in parenthesis.
- The buzzer sounds a steady tone.
- The alarms lights flash.

If the sensor failed during start-up, the Eagle continues to normal operation and **xxxxx** replaces the failed sensor's gas reading.

If the sensor fails during normal operation and you want to continue monitoring for the remaining target gases, turn the Eagle off and on again. In the normal operation screen, **xxxxx** replaces the failed sensor's gas reading.

```
CH4     0 LEL%
OXY xxxxx VOL%
H2S   0.0 PPM
CO      0 PPM
```

Resetting Gas Alarms

You can set the Eagle's gas alarms for latching or self-resetting alarms (see "Updating the Alarm Latching Setting" on page 36).

Self-Resetting Alarms

Self-resetting alarms automatically shut off and reset when the gas reading falls below (or rises above for oxygen) the alarm setting. You cannot silence or reset self-resetting alarms.

Latching Alarms

You can set latching alarms with or without Alarm Silence (see "Updating the Alarm Silence Setting" on page 36).

With Alarm Silence On:

When the Eagle goes into gas alarm, press the RESET/SILENCE button to silence the buzzer. The LEDs continue to flash, and the Eagle continues to display the current alarm level.

The gas reading must fall below (or rise above for oxygen) the low alarm (ALM1) setting before you can reset the alarm. Press the RESET/SILENCE button to reset the alarm. The LEDs turn off and the Eagle returns to the normal screen.

With Alarm Silence Off:

The gas reading must fall below (or rise above for oxygen) the low alarm (ALM1) setting before you can reset the alarm. Press the RESET/SILENCE button to reset the alarm. The LEDs and buzzer turn off, and the Eagle returns to the normal screen.

NOTE: With Alarm Silence off, you cannot silence the buzzer while the gas reading is above (below for oxygen) the low alarm (ALM1) setting.

Display Mode

In display mode, you can:

- set user and station IDs
- view peak readings
- view elapsed operating time
- view TWA and STEL readings *(toxic gases only)*
- view battery voltage
- view date and time *(data logging option only)*
- clear the data log *(data logging option only)*
- display remaining log time *(data logging option only)*

Entering Display Mode

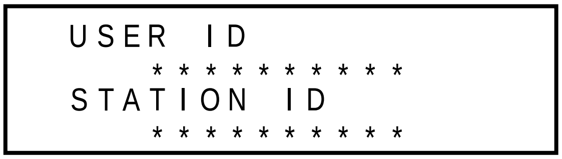
Press the DISP / ADJ button to enter Display Mode. To scroll from one screen to the next press the DISP / ADJ button.

NOTE: Each screen displays for 20 seconds. If you do not press the DISP / ADJ button to scroll to the next screen within 20 seconds, the Eagle automatically returns to the normal operating screen.

User and Station ID Screen

This screen displays only if the user ID function is activated (see “Turning the User ID Function On or Off” on page 36). Each ID contains 10 characters. Uppercase letters, numbers, asterisks (*), and a blank space are available characters.

Use this screen to identify the user, the location, or other information. If your Eagle includes the data logging option, the User and Station ID provide a way to identify the user and location of exposure. The User and Station ID are saved to the data logger when you turn off the Eagle, so you can update the IDs for each data logging session.



```
USER ID
    **********
STATION ID
    **********
```

To enter a user and station ID:

To scroll to the next screen at any time, press the DISP / ADJ button.

1. With the User and Station ID screen displayed, press the POWER / ENTER button. The first User ID character flashes (* is default).
2. Press the AIR / ▲ and SHIFT / ▼ buttons to scroll through the available characters. (The asterisk and blank space are between the set of letters and numbers.)
3. With the desired character displayed, press the POWER / ENTER button to save the character and go to the next one.
4. Repeat steps 2 and 3 for the remaining 19 characters.
5. After you enter the last character, the Peak screen displays.

Peak Screen

The Peak screen displays the highest (lowest for O_2) concentrations detected since the Eagle was turned on. Peak readings are stored in the Eagle's memory until a higher level is detected, you reset them, or the Eagle is turned off. To reset the peak readings while using the Eagle, press and hold the RESET / SILENCE button while in the Peak screen until you hear a beep, then release it.

The Lunchbreak "RESUME" option enables the Eagle to remember peak readings when it is turned off. See "Starting Up the Eagle" on page 15.

```
P CH4      0 LEL%
E OXY   20.9 VOL%
A H2S    0.0 PPM
K CO       0 PPM
```

Elapsed Time Screen

The Elapsed Time screen displays the time in minutes since the Eagle was turned on.

```
   TIME IN
  OPERATION
     240
   MINUTES
```

TWA/STEL Screen

The TWA / STEL screen displays the time-weighted average (TWA) and the short-term exposure limit (STEL) readings *for toxic gases only*.

The TWA reading is the average reading *during the last 8 hours*. If 8 hours have not elapsed since the last time the TWA / STEL reading was cleared, the average is still calculated over 8 hours. The missing readings are assigned a 0 value.

The STEL reading is the average reading *during the last 15 minutes*.

```

      TWA    STEL
H2S   0.0     0.0 PPM
CO      0       0 PPM
```

Battery Voltage Screen

The Battery Voltage screen displays the minimum operating voltage and the current battery voltage. New alkaline batteries typically measure 6.0 V; fully-charged Ni-Cd batteries typically measure 5.2 V.

```
BATTERY
MIN. 4.5V
BATTERY
NOW  6.0V
```

NOTE: The remaining screens only display if your Eagle includes the data logging option. If your Eagle does not include the data logging option, press the DISP/ADJ button to return to the normal screen.

Date/Time Screen

The date/time screen displays the current date and time. You can set the date and time in Calibration or Setup mode (see page 39).

```
APR 17 1998
   14:30
```

Clear Data Logger Screens

CAUTION: *Once you clear the data logger, you cannot retrieve any data previously stored in the data logger.*

The Clear Data Logger screens allow you to clear the data logger storage to make room for new data. Instead of having to manually clear data, the Eagle can overwrite the oldest data when the data log is full (see page 38).

```
CLEAR DATA
 LOGGER ?
YES: AIR
NO : DISPLAY
```

To clear the data log:

1. With the above screen displayed, press the AIR/▲ button. A confirmation message displays.

```
 ARE YOU
  SURE ?
YES: AIR
NO : DISPLAY
```

2. Press the AIR/▲ button to confirm that you want to clear the data log.

3. The Eagle displays **CLEARING DATA**, then displays **CLEARED OK**. The data log is cleared and the remaining log time value is reset.

Remaining Log Time Screen

The Remaining Log Time screen displays the time remaining until the Data Logger memory is full. The remaining time depends on how often the Eagles stores data to the data log and how many channels are active.

```
 LOG TIME
   300.0
  HOURS
REMAINING
```

Setup Mode

In setup mode, you can:

- update the battery type setting
- update channel settings
- update the combustible gas channel’s units of measure
- update the alarm point settings
- update the Eagle’s serial number
- turn the lunch break function on or off
- update the alarm latching setting
- update the alarm silence setting
- turn the user ID function on or off
- update the auto calibration settings
- update the back light setting
- turn the auto fresh air function on or off
- update the data interval time setting *(data logging option only)*
- update the log data over write setting *(data logging option only)*
- update the time calibration setting *(data logging option only)*
- update the date and time settings *(data logging option only)*
- turn each channel’s zero follower on or off
- turn the confirmation beep on or off
- return to default settings (three default options)

Tips for Using Setup Mode

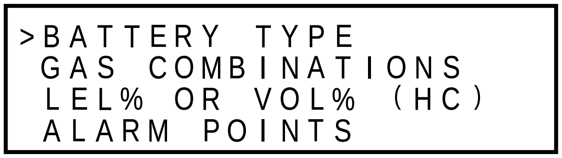
- To enter a menu item, use the AIR/▲ or SHIFT/▼ button to place the cursor next to the menu item, then press the POWER/ENTER button.
- To exit setup mode and return to normal operation, from the main menu place the prompt next to the last menu option, **START MEASUREMENT**, then press the POWER/ENTER button.

Entering Setup Mode

WARNING: ***The Eagle does not detect gas or display readings while in setup mode. The CAL/SETUP switch (SW2) must be in the ON position to enter setup mode.***

---

1. Take the Eagle to a non-hazardous location, and turn the power off.
2. Press and hold down the AIR/▲ and SHIFT/▼ buttons, then press the POWER/ ENTER button.
3. The main menu displays. It displays four menu options at a time. Press the AIR/ ▲ or SHIFT/▼ button to view additional menu options.



```
>BATTERY TYPE
 GAS COMBINATIONS
 LEL% OR VOL% (HC)
 ALARM POINTS
```

Updating the Battery Type Setting

This setting allows you to select between alkaline and Ni-Cd batteries. This setting helps the Eagle give low battery *warning* and low battery *alarm* indications at the appropriate times. This setting has no effect on battery charging.

1. From the main menu, select the **BATTERY TYPE** menu option.

```
    BATTERY TYPE


      ALKALINE
```

2. Press the AIR/▲ or SHIFT/▼ button to display the desired setting.

CAUTION: *This setting should always match the type of batteries (alkaline or Ni-Cd) installed in the Eagle. If this setting does not match the installed batteries, the time between low battery **warning** and low battery **alarm** may be less than expected.*

---

3. Press the POWER/ENTER button to save the setting and return to the main menu.

Updating Channel Settings

This procedure describes how to update channel settings for the combustible gas, oxygen, and toxic gas channels.

CAUTION: *Verify that the correct sensor is installed before you update a channel's settings.*

Updating Combustible Gas Channel Settings

This section describes how to update the target gas label, set a custom gas label, and update the fullscale PPM setting for the combustible gas channel.

Updating the Target Gas Label

1. From the main menu, select the **GAS COMBINATIONS** menu option.

```
>  CH4
   OXY
   H2S
   CO
```

2. Use the AIR/▲ or SHIFT/▼ button to place the cursor next to the combustible gas channel (in this example CH4).
3. Press the POWER/ENTER button. The combustible gas target gas label flashes.
4. Press the AIR/▲ or SHIFT/▼ buttons to scroll through available combustible gas target gas labels (**CH4**, **HEX**, **H2**, *****, and **NOT USED**).

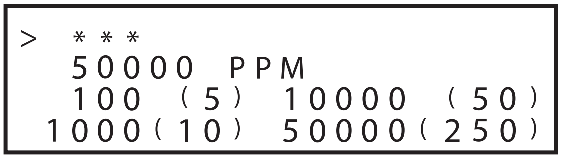
NOTE: Select the **HEX** or ***** setting for Methane Elimination (see "Appendix B: Methane Elimination" on page 52 for more information).

---

5. Press the POWER/ENTER button to save the new target gas label.
6. A screen displays that shows the fullscale PPM setting, which corresponds to 100% LEL, and the increments for the selected target gas label.

   The number in parenthesis indicates the display increment for that portion of the PPM range. In the example below, the PPM reading would display in increments of:

   - 5 from 0 to 100 ppm
   - 10 from 100 to 1000 PPM
   - 50 from 1000 to 10,000 PPM
   - 250 from 10,000 to 50,000 PPM



```
>  ***
   50000 PPM
   100  (5)  10000  (50)
  1000(10)  50000(250)
```

7. If you entered a label other than *****, continue with step 8. If you entered *****, go to the next section, "Setting a custom target gas label."

8. Press the POWER/ENTER button to return to the Gas Combinations menu.
9. To exit the Gas Combinations menu, press the SHIFT/▼ button until the cursor is next to **ESCAPE**.
10. Press the POWER/ENTER button. The message **SAVING DATA** displays, then the main menu displays.

Setting a Custom Target Gas Label

1. With the cursor next to the target gas label setting (***), press the POWER/ENTER button. The first asterisk flashes.
2. Press the AIR/▲ and SHIFT/▼ buttons to display the desired character. Available characters are A through Z, 0 through 9, and a blank space.
3. Press the POWER/ENTER button to save the displayed character. The next character flashes.
4. Repeat steps 2 and 3 to enter the remaining characters. When you enter the last character, the cursor flashes.

Updating the Fullscale PPM Setting

CAUTION: *The fullscale PPM setting must correspond to 100% LEL for the target gas in order for the Eagle to display accurate PPM readings for the combustible gas channel.*

1. Press the SHIFT/▼ button to move the cursor to the second line, then press the POWER/ENTER button. The fullscale setting flashes.

   The maximum fullscale setting for the combustible gas channel is 50,000 ppm; the minimum setting is 1000 ppm. The default setting is 50,000 ppm.
2. Press the AIR/▲ and SHIFT/▼ buttons to display the desired fullscale setting (see Table 5), then press the POWER/ENTER button to save the setting. The cursor flashes.

Table 5: Fullscale PPM Readings Equivalent to 100% LEL

Target Gas	Fullscale Setting
Methane (CH_4)	50,000 ppm
Hexane	11,000 ppm
Hydrogen	40,000 ppm
Pentane	15,000 ppm
Styrene	9,000 ppm
IPA	20,000 ppm
Isobutane	18,000 ppm
Propane	21,000 ppm
Propylene	20,000 ppm

Table 5: Fullscale PPM Readings Equivalent to 100% LEL

Target Gas	Fullscale Setting
Toluene	11,000 ppm
Ethane	30,000 ppm
Ethanol	33,000 ppm
Benzene	12,000 ppm

Returning to the Main Menu

1. Press the SHIFT/▼ button. The **ESCAPE** message displays.
2. Press the POWER/ENTER button to save the new setting. The **OTHER GAS SET** message displays, then the Gas Combinations menu displays.
3. To exit the Gas Combinations menu, press the SHIFT/▼ button until the cursor is next to **ESCAPE**.
4. Press the POWER/ENTER button. The message **SAVING DATA** displays, then the main menu displays.

Updating Oxygen Channel Settings

This section describes how to update the target gas label, fullscale setting, and display increment setting for the oxygen channel.

Updating the Target Gas Label

1. From the main menu, select the **GAS COMBINATIONS** menu option.

```
  CH4
> OXY
  H2S
  CO
```

2. Use the AIR/▲ or SHIFT/▼ button to place the cursor next to the oxygen channel.
3. Press the POWER/ENTER button. The oxygen target gas label flashes.
4. Press the AIR/▲ or SHIFT/▼ buttons to cycle through the oxygen target gas labels (**OXY**, *******, and **NOT USED**).

CAUTION: *The* ********* *setting is not intended for customer setup. Contact RKI Instruments, Inc. before using this setting for the oxygen channel.*

---

5. Press the POWER/ENTER button to enter the new target gas label.
6. To exit the Gas Combinations menu, press the SHIFT/▼ button until the cursor is next to **ESCAPE**.
7. Press the POWER/ENTER button. The **SAVING DATA** message displays, then the main menu displays.

Updating the Fullscale Setting

1. Press the SHIFT/▼ button to move the cursor to the second line, then press the POWER/ENTER button. The fullscale setting flashes.

   The maximum fullscale setting for the oxygen channel is 40.0 VOL%; the minimum setting is 25.0 VOL%. The default setting is 40.0 VOL%.

2. Press the AIR/▲ and SHIFT/▼ buttons to display the desired fullscale setting, then press the POWER/ENTER button to save the setting. The cursor flashes.

Updating the Display Increment Setting

1. Press the SHIFT/▼ button to move the cursor to the third line, then press the POWER/ENTER button. The display increment setting flashes. The allowable settings are 0.2 VOL% (default) and 0.5 VOL%.
2. Press the AIR/▲ or SHIFT/▼ button to display the desired display increment setting, then press the POWER/ENTER button to save the setting. The prompt flashes.

Returning to the Main Menu

1. Press the SHIFT/▼ button. The **ESCAPE** message displays.
2. Press the POWER/ENTER button to save the new settings. The **OTHER GAS SET** message displays, then the Gas Combinations menu displays.
3. To exit the Gas Combinations menu, press the SHIFT/▼ button until the cursor is next to **ESCAPE**.
4. Press the POWER/ENTER button. The message **SAVING DATA** displays, then the main menu displays.

Updating Toxic Channel Settings

This section describes how to update the target gas label, set a custom gas label, and update the fullscale and display increment settings for a toxic gas channel.

Updating the Target Gas Label

1. From the main menu, select the **GAS COMBINATIONS** menu option.
2. Press the POWER/ENTER button to display the Gas Combinations menu.

```
  CH4
  OXY
> H2S
  CO
```

3. Use the AIR/▲ or SHIFT/▼ button to place the cursor next to the toxic gas channel.
4. Press the POWER/ENTER button. The toxic target gas label flashes.
5. Press the AIR/▲ or SHIFT/▼ buttons to cycle through the available target gas labels for the toxic gas channel (**H2S**, **CO**, **SO2**, **Cl2**, **NH3**, **CO2 (5.00%)**, **CO2 (10000 PPM)**, **CO2 (5000 PPM)**, *******, and **NOT USED**).
6. Press the POWER/ENTER button to save the new target gas label.
7. If you entered a label other than *******, continue with step 8. If you entered *******, go to the next section, "Setting a custom target gas label."

8. To exit the Gas Combinations menu, press the SHIFT/▼button until the cursor is next to **ESCAPE**.
9. Press the POWER/ENTER button. The message **SAVING DATA** displays, then the main menu displays.

Setting a Custom Target Gas Label

```
>  ***
   10.0   PPM
    0.1   PPM
```

1. With the prompt next to the target gas label setting (***), press the POWER/ENTER button. The first asterisk flashes.
2. Press the AIR/▲ and SHIFT/▼buttons to display the desired character. Available characters are A through Z, 0 through 9, and a blank space.
3. Press the POWER/ENTER button to save the displayed character. The next character flashes.
4. Repeat steps 2 and 3 to enter the remaining characters. When you enter the last character, the cursor flashes.

Updating the Fullscale Setting

1. Press the SHIFT/▼button to move the cursor to the second line, then press the POWER/ENTER button. The fullscale setting flashes.

   The maximum fullscale setting for a toxic gas channel is 1000 PPM; the minimum setting is 1.00 PPM. The default setting is 10.0 PPM.
2. Press the AIR/▲ and SHIFT/▼buttons to display the desired fullscale setting, then press the POWER/ENTER button to save the setting. The prompt flashes.

NOTE: The display increment setting automatically updates its default setting as you change the fullscale setting.

Updating the Display Increment Setting

1. Press the SHIFT/▼button to move the cursor to the third line, then press the POWER/ENTER button. The display increment setting flashes.

   The minimum display increment setting is 0.1 PPM; the maximum display increment setting is 2.5 PPM.
2. Press the AIR/▲ and SHIFT/▼buttons to display the desired display increment setting, then press the POWER/ENTER button to save the setting. The prompt flashes.

Returning to the Main Menu

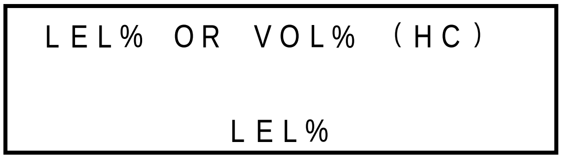
1. Press the SHIFT/▼button. The **ESCAPE** message displays.
2. Press the POWER/ENTER button to save the new settings. The **OTHER GAS SET** message displays, then the Gas Combinations menu displays.
3. To exit the Gas Combinations menu, press the SHIFT/▼button until the cursor is next to **ESCAPE**.

4. Press the POWER/ENTER button. The message **SAVING DATA** displays, then the main menu displays.

Updating Combustible Gas Channel Units of Measure

This setting allows you to display the combustible gas reading in percentage of LEL or percentage of volume. The detection range remains the same. If 100% LEL equals 5% by volume, then fullscale on the volumetric display is 5%.

1. From the main menu, select the **LEL% OR VOL% (HC)** menu option.



```
LEL% OR VOL% (HC)


        LEL%
```

2. Press the AIR/▲ or SHIFT/▼button to display the desired setting.

NOTE: The data logging option logs all combustible gas readings in LEL% regardless of this setting.

---

3. Press the POWER/ENTER button to save the setting and return to the main menu.

Updating the Alarm Point Settings

Each of the Eagle's gas detection channels includes low and high gas alarms. The combustible gas channel also includes low and high alarms for PPM readings; the toxic gas channels also include STEL and TWA alarms.

This screen allows you to update one or more alarm points.

1. From the main menu, select the **ALARM POINTS** menu option.

```
> CH4
  OXY
  H2S
  CO
```

2. Select the channel of the alarm point you want to update. The channel's Set Low Alarm Point screen displays (in this example for the combustible gas channel).

```
SET ALARM
<CH4>LEL
LOW ALARM
  10 LEL%
```

NOTE: The Eagle displays the set alarm point screens for each channel in the following sequence: low alarm, high alarm, TWA alarm (toxics only), and STEL alarm (toxics only).

---

3. Use the AIR/▲ and SHIFT/▼buttons to display the desired setting.
4. Press the POWER/ENTER button to save the new alarm point and scroll to the next alarm point screen.

5. Repeat step 3 and 4 to update all alarm points for this channel.
6. Press the POWER/ENTER button again to return to the Set Alarm Points menu.
7. Repeat steps 2 through 6 until all desired alarm points are updated. Make sure you return to the Set Alarm Points menu to continue.
8. To exit the Set Alarm Points menu, press the SHIFT/▼ button until the cursor is next to **ESCAPE**.
9. Press the POWER/ENTER button to save the settings and return to the main menu.

Updating the Eagle's Serial Number

Every Eagle is programmed with a unique serial number. The Data Logging option includes the serial number in its log data for identification purposes. The serial number setting accepts numeric (0 through 9) and alpha (A through Z) characters.

NOTE: The serial number is factory set and should not need to be changed. However, if you "reset all defaults," the serial number is reset to **********.

---

1. From the main menu, select the **SERIAL NO.** menu option.

```
    SET
 SERIAL No

  X#####
```

2. Press the AIR/▲ and SHIFT/▼ buttons to display the desired character, then press the POWER/ENTER button to save the character. The next character flashes.
3. Repeat step 2 to enter the remaining characters. The main menu displays after you enter the last character.

Updating the Lunch Break Setting

OFF (default): The Eagle automatically starts new TWA and PEAK reading collection at start up.

ON: The **RESUME** screen displays during start up. From this screen, you can choose to continue accumulating TWA and PEAK readings from the last time the Eagle was used or start collecting new readings.

1. From the main menu, select the **LUNCH BREAK** menu option.

```
LUNCH BREAK


    OFF
```

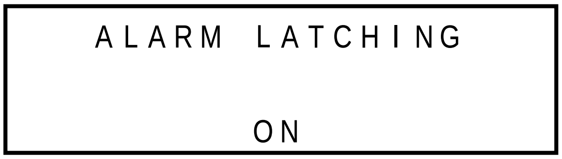
2. Press the AIR/▲ or SHIFT/▼ button to display the desired setting.
3. Press the POWER/ENTER button to save the setting and return to the main menu.

Updating the Alarm Latching Setting

ON: The Eagle remains in alarm condition until the alarm condition passes *and* the RESET/SILENCE is pressed.

OFF: The Eagle automatically resets its alarm when the alarm condition passes.

1. From the main menu, select the **ALARM LATCHING** menu option.



ALARM LATCHING

ON

2. Press the AIR/▲ or SHIFT/▼ button to display the desired setting.
3. Press the POWER/ENTER button to save the setting and return to the main menu.

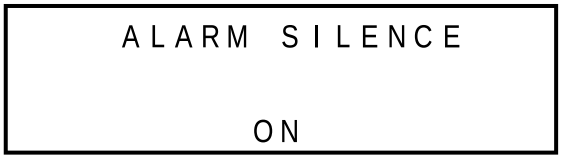
Updating the Alarm Silence Setting

NOTE: This feature works only when Alarm Latching is turned on.

ON: Press the RESET/SILENCE button to silence the buzzer during an alarm. The LEDs continue to flash, and the display continues to show the level of alarm. When the gas concentration falls below the low alarm level, press the RESET/SILENCE button to turn off the LEDs and remove the **ALM1** message.

OFF: You cannot silence the buzzer.

1. From the main menu, select the **ALARM SILENCE** menu option.



ALARM SILENCE

ON

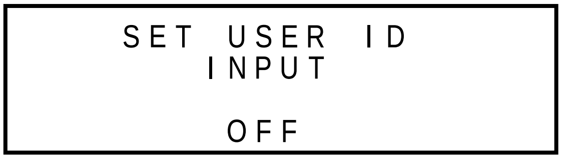
2. Press the AIR/▲ or SHIFT/▼ button to display the desired setting.
3. Press the POWER/ENTER button to save the setting and return to the main menu.

Turning the User ID Function On or Off

ON: The **User and Station ID** screen displays during start up. From this screen, you can enter user, location, or other information at the beginning of each gas detection session (see page 24).

OFF (default): The **User and Station ID** screen does not display during start up.

1. From the main menu, select the **USER ID** menu option.



SET USER ID
INPUT

OFF

2. Press the AIR/▲ or SHIFT/▼ button to display the desired setting.

3. Press the POWER/ENTER button to save the setting and return to the main menu.

Updating the Auto Calibration Settings

The auto calibration setting is the calibration gas concentration you are using to calibrate each channel.

The Eagle includes default auto calibration settings for most target gases. For gases without default auto calibration, the setting is 0.

NOTE: You can also update auto calibration settings in Calibration mode. If you update auto calibration settings in Calibration mode, you must continue with the calibration procedure. Updating these settings in Setup mode allows you to update the settings without calibrating the sensors.

---

1. From the main menu, select the **AUTO CALIBRATION** menu option. (To display the combustible gas channel in PPM, press the LEL/PPM button.)

```
C CH4     50 LEL%
A OXY   12.0 VOL%
L H2S   25.0 PPM
. CO      50 PPM
```

2. Press and hold the SHIFT/▼ button, then press the DISP/ADJ button. The Auto Calibration screen for the combustible gas channel displays.

```
 AUTO  CALIBRATION
       <CH4>

       50 LEL%
```

3. Press the AIR/▲ or SHIFT/▼ button to display the desired setting.
4. Press the POWER/ENTER button to save the new setting. The Auto Calibration screen for the next channel displays.
5. Repeat steps 4 and 5 for the remaining channels.
6. Press the POWER/ENTER button to return to the main Auto Calibration screen.
7. Press the POWER/ENTER button to return to the main menu.

Updating the Back Light Setting

This setting defines how long the LCD backlight stays on when you press any button. The minimum setting is off; the maximum setting is 10 minutes. The default setting is 15 seconds.

1. From the main menu, select the **LCD BACK LIGHT TIME** menu option.

```
   LCD BACK LIGHT
        TIME

         15 SEC
```

2. Press the AIR/▲ and SHIFT/▼ buttons to display the desired setting.

3. Press the POWER/ENTER button to save the setting and return to the main menu.

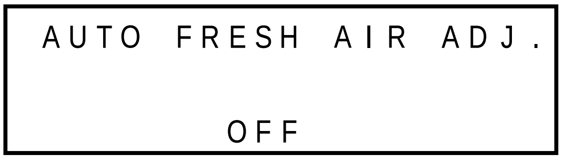
Turning the Auto Fresh Air Function On or Off

WARNING: ***If Auto Fresh Air Adjust is ON, you must start the Eagle in a "fresh-air" environment. If the Eagle is started in the presence of a target gas, the readings and alarms will not be accurate or reliable.***

ON: The Eagle automatically sets the fresh air reading for all channels during the start-up sequence.

OFF (default): You must press the AIR/▲ button to set the fresh air reading for all channels.

1. From the main menu, select the **AUTO FRESH AIR ADJ.** menu option.



```
AUTO FRESH AIR ADJ.

      OFF
```

2. Press the AIR/▲ or SHIFT/▼button to display the desired setting.
3. Press the POWER/ENTER button to enter the setting and return to the main menu.

Updating the Interval Time Setting *(Data Log Option)*

This setting defines how often the Eagle saves readings to the Data Logger. The minimum setting is 10 seconds; the maximum setting is 5 minutes. The default setting is 5 minutes.

1. From the main menu, select the **INTERVAL TIME** menu option.

```
SET DATA LOGGER
 INTERVAL TIME

      5 MIN
```

2. Press the AIR/▲ and SHIFT/▼buttons to display the desired setting.
3. Press the POWER/ENTER button to save the setting and return to the main menu.

Updating Log Data Over Write Setting *(Data Log Option)*

ON: The Eagle writes over the oldest data with new data when the Data Logger memory is full.

OFF: The Eagle stops writing data when the Data Logger memory is full.

1. From the main menu, select the **LOG DATA OVER WRITE** menu option.

```
LOGGER DATA
OVER WRITE

    ON
```

2. Press the AIR/▲ or SHIFT/▼ button to display the desired setting.
3. Press the POWER/ENTER button to save the setting and return to the main menu.

Updating the Time Calibration Setting *(Data Log Option)*

This setting indicates how often the Eagle alerts you to needed calibration. The minimum setting is 1 day; the maximum setting is 180 days. The default setting is "off".

Tip: Press and hold the AIR/▲ or SHIFT/▼ button to rapidly scroll through settings.

1. From the main menu, select the **TIME CALIBRATION** menu option.

```
SET CALIBRATION
 REQUEST TIME

     off DAYS
```

2. Press the AIR/▲ and SHIFT/▼ buttons to display the desired setting.
3. Press the POWER/ENTER button to save the setting and return to the main menu.

Updating the Date and Time Settings *(Data Log Option)*

The Data Logger uses the date and time to identify entries.

1. From the main menu, select the **DATE/TIME** menu option.

```
APR 17 1998
   14:30
```

2. Press the AIR/▲ or SHIFT/▼ button to display the desired month.
3. Press the POWER/ENTER button to save the setting. The day setting flashes.
4. Repeat steps 2 and 3 to enter the day, year, hours, and minutes settings. The main menu displays after you enter the minutes setting.

Updating the Zero Follow Settings

The Zero Follow setting is not intended for customer setup. The default setting for most target gases is ON. The default setting for carbon dioxide sensors and some configurations of non-standard toxic gas sensors is OFF. The oxygen sensor does not include this feature.

CAUTION: *Contact RKI, Instruments Inc. before changing this setting.*

Updating the Confirmation Beep Setting

ON: The Eagle beeps once every 15 minutes to verify that it is operating.

OFF (default): The Eagle does not sound a confirmation beep.

1. From the main menu, select the **CONFIRMATION BEEP** menu option.

```
  CONFIRMATION BEEP


          OFF
```

2. Press the AIR/▲ or SHIFT/▼ button to display the desired setting.
3. Press the POWER/ENTER button to save the setting and return to the main menu.

Returning to Default Settings

Each of the parameters in Setup mode has a default setting. The Eagle includes three different options for returning default settings: reset all default settings, reset the default alarm point settings only, and reset the default oxygen zero setting only.

CAUTION: *If you reset **all** default settings, any changes made in setup mode or normal operation, including calibration settings, will be lost.*

To reset all default settings:

1. From the main menu, select the **DEFAULT** menu option.
2. Press the POWER/ENTER button to display the Set Default All screen.

```
     SET DEFAULT
         ALL
      YES: AIR
      NO : DISPLAY
```

3. Press the AIR/▲ button to reset all parameters to their default settings. The messages **SAVING DATA** and **END** display, then the main menu displays.

To reset all default alarm point settings:

1. From the main menu, select the **DEFAULT** menu option. The Set Default All screen displays.
2. Press the DISP/ADJ button to display the Set Default Alarm screen.

```
     SET DEFAULT
        ALARM
      YES: AIR
      NO : DISPLAY
```

3. Press the AIR/▲ button to reset all alarm points to their default settings. The messages **SAVING DATA** and **END** display, then the main menu displays.

To reset the oxygen zero setting:

1. From the main menu, select the **DEFAULT** menu option. The Set Default All screen displays.
2. Press the DISP / ADJ button. The Set Default Alarm screen displays.
3. Press the DISP / ADJ button to display the Set Default Oxygen Zero screen.

```
SET DEFAULT
  OXY ZERO
 YES: AIR
 NO : DISPLAY
```

4. Press the AIR / ▲ button to reset the oxygen zero setting to its default value. The messages **SAVING DATA** and **END** display, then the main menu displays.

Calibration

Calibrate the Eagle when you replace a sensor. Also calibrate the Eagle periodically to assure proper sensor response.

You can program the Eagle to notify you when it is due for calibration (see “Updating the Time Calibration Setting” on page 39). The frequency of calibration depends upon the amount and type of use. A typical calibration frequency is once per month.

Calibration Supplies and Equipment

To calibrate the Eagle, you need:

- Known calibrating samples of target gases. The combustible and toxic gas samples should have concentrations between 10 and 50% of the full scale value. For example, if you are calibrating the catalytic combustible gas channel, your calibration cylinder should have a combustible gas concentration between 10% LEL and 50% LEL.

NOTE: If your catalytic combustible channel is calibrated to something other than methane, use an appropriate gas cylinder to perform the calibration.

- An oxygen-free source, such as 100% nitrogen or CO in a nitrogen balance
- A demand-flow regulator to provide adequate sample gas flow

WARNING: ***RKI Instruments, Inc. recommends that you dedicate a regulator for use with chlorine (Cl_2) gas and that you do not use that dedicated regulator for any other gases, particularly hydrogen sulfide (H_2S).***

You can use the RKI Four-Gas Cylinder to adjust all the sensors at the same time with no need for a zero-oxygen source. This section includes instructions for calibration with the demand-flow regulator and RKI Four-Gas Cylinder. This section also includes instructions for calibration with individual cylinders.

Preparing for Calibration

1. Take the Eagle to a non-hazardous location with fresh-air conditions.
2. Turn on the Eagle and allow one minute for warm up.
3. Press and hold the AIR/▲ button until a tone sounds.

   The Eagle automatically sets the combustible gas and toxics readings to zero and the oxygen reading to 20.9%.
4. Screw the regulator into the calibration cylinder.
5. Connect the calibration tubing to the regulator.
6. Press and hold the SHIFT/▼ button, then press the DISP/ADJ button. The Calibration menu displays.

Calibrating the Eagle

NOTE: The following screens illustrate a four-gas Eagle with the data logging option and are intended as examples only. Your Eagle may display slightly different screens.

```
>AUTO CALIBRATION
 SINGLE CALIBRATION
 DATE/TIME
 NORMAL OPERATION
```

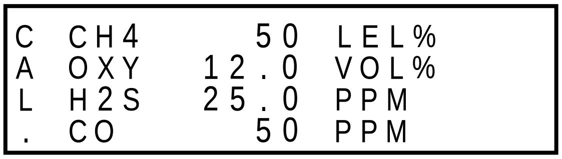
The Eagle's Calibration menu includes two methods of calibration: Auto Calibration and Single Calibration.

- **Auto Calibration:** This method allows you to calibrate all four sensors simultaneously. It is designed for use with the RKI Four-Gas Calibration Cylinder and is the quickest and easiest method to calibrate the Eagle.
- **Single Calibration:** This method allows you to calibrate one sensor at a time. Use this method if you are only calibrating one or two sensors, if you are calibrating non-standard toxic sensors, or if you are not using the RKI Four-Gas Calibration Cylinder.

Calibrating with the Auto Calibration Method

This section describes calibration using the Auto Calibration method. To calibrate using the Single Calibration method, see "Calibrating with the Single Calibration Method" on page 43.

1. Use the AIR/▲ and SHIFT/▼ button to place the cursor next to the **AUTO CALIBRATION** menu option.
2. Press the POWER/ENTER button to display the Calibration Values screen.



```
C CH4     50 LEL%
A OXY   12.0 VOL%
L H2S   25.0 PPM
. CO      50 PPM
```

The gas concentrations displayed in the Calibration Values screen must match the gas concentrations listed on the Four-Gas Calibration Cylinder. If *all* concentrations match, go to step 7. If *one or more* concentrations do not match, continue with step 3.

3. To adjust the values on the screen, hold down the SHIFT/▼ button, and press the DISP/ADJ button. The Auto Calibration screen for the combustible gas channel displays.

```
AUTO  CALIBRATION
      <CH4>

      50 LEL%
```

4. Use the AIR/▲ (increase) and SHIFT/▼ (decrease) buttons to set the correct combustible gas value.
5. Press the POWER/ENTER button to save the new setting. The Auto Calibration screen for the next channel displays.
6. Repeat steps 4 and 5 to set the correct values for the remaining channels and return to the Calibration Values screen.

NOTE: The RKI Four Gas Cylinder contains approximately 12% O_2 by volume. Be sure to set the “OXY” reading to agree with the concentration listed on the cylinder’s label, not zero.

---

7. With the Calibration Values screen displayed, press the POWER/ENTER button. The gas readings flash.
8. Connect the tubing from the regulator to the Eagle’s probe.Wait approximately 1 minute or until the readings stabilize.
9. Press the POWER/ENTER button to set the calibration to the programmed values.

   If a sensor(s) cannot calibrate to the proper value, **FAIL PUSH AIR KEY** displays and the Eagle lists the sensor(s) that failed to calibrate. The buzzer and alarm lights activate. Press the AIR/▼ button to reset the alarm and return to the Calibration menu. Replace the failed sensor(s), then repeat calibration.
10. **AUTO CALIBRATION END** displays, then the Calibration menu displays.
11. Disconnect the tubing from the probe.
12. Unscrew the regulator from the calibration cylinder.
13. Press the SHIFT/▼ button to place the prompt next to the **NORMAL OPERATION** menu option, then press the POWER/ENTER button to return to the normal screen.

Calibrating with the Single Calibration Method

This section describes calibration using the Single Calibration method. To calibrate using the Auto Calibration method, see “Calibrating with the Auto Calibration Method” on page 42.

CAUTION: *The single calibration method does not have a "FAIL" notification. Replace sensors that cannot be set to agree with the calibration source, then recalibrate.*

1. Use the AIR/▲ and SHIFT/▼ buttons to place the cursor next to the **SINGLE CALIBRATION** menu option.

```
 AUTO CALIBRATION
>SINGLE CALIBRATION
 DATE/TIME
 NORMAL OPERATION
```

2. Press the POWER/ENTER button to display the Single Calibration menu.

```
> CH4
  OXY
  H2S
  CO
```

3. Use the AIR/▲ or SHIFT/▼ button to place the cursor next to the channel to calibrate (in this example the combustible gas channel).
4. Press the POWER/ENTER button. The Single Calibration screen displays for the channel you selected. The gas reading flashes.

```
 CH4   CALIBRATION
          0 LEL%
    APPLY GAS/
    ADJ/ENTER
```

5. Connect the tubing from the regulator to the Eagle's probe.

NOTE: The combustible gas sensor is a general hydrocarbon sensor that responds to most flammable vapors and gases; the response will vary depending upon the substance. For best results, calibrate the Eagle to the target gas or vapor.

6. If necessary, use the AIR/▲ (increase) and SHIFT/▼ (decrease) buttons to adjust the reading to match the concentration listed on the calibration cylinder.
7. Press the POWER/ENTER button to set the span value. **SINGLE CALIBRATION END** displays, then the Single Calibration menu displays.
8. Disconnect the tubing from the probe.
9. Repeat steps 3 through 8 for any other channels you want to calibrate. Make sure you use an appropriate calibration cylinder for each channel.

CAUTION: *When calibrating the oxygen channel, verify the concentration of oxygen listed on the cylinder's label. For oxygen-free samples (100% nitrogen for example), set the oxygen span setting to 0.0%.*

10. After the last channel is calibrated, disconnect the calibration tubing from the probe, then unscrew the regulator from the calibration cylinder.
11. With the Single Calibration menu displayed, press the SHIFT / ▼ button until the cursor is next to **ESCAPE**.
12. Press the POWER / ENTER button to return to the Calibration menu.
13. Press the SHIFT / ▼ button to place the cursor next to the **NORMAL OPERATION** menu option, then press the POWER / ENTER button to return to the normal screen.

Maintenance

Displaying the Battery Voltage

Check the battery voltage periodically. Replace or recharge the batteries before the voltage drops to 4.5 V.

WARNING: ***Take the Eagle to a non-hazardous location before replacing or recharging the batteries.***

To display the battery voltage:

1. From the normal screen, press the DISP / ADJ button to enter display mode.
2. Press the DISP / ADJ button until the Battery Voltage screen displays.

```
BATTERY
MIN.  4.5V
BATTERY
NOW   6.0V
```

3. To exit display mode, press the DISP / ADJ button until the normal screen displays.

Replacing Alkaline Batteries

1. Turn off the Eagle.
2. Unscrew the two large screws on the top of the case, then carefully lift the top of the case and lay it aside.
3. Remove the batteries and verify that the battery compartment and electrical contacts are clean.
4. Insert fresh batteries following the label on the inside of the case.
5. Place the top of the case in its original position, then secure it with the large screws you loosened in step 1.

Recharging Ni-Cd Batteries

1. Turn off the Eagle.
2. Plug the cord from the charger into the Eagle’s battery charger connector.
3. Plug in the AC line cord or 12 VDC supply to the charger. A full charge takes approximately 8 to 12 hours.

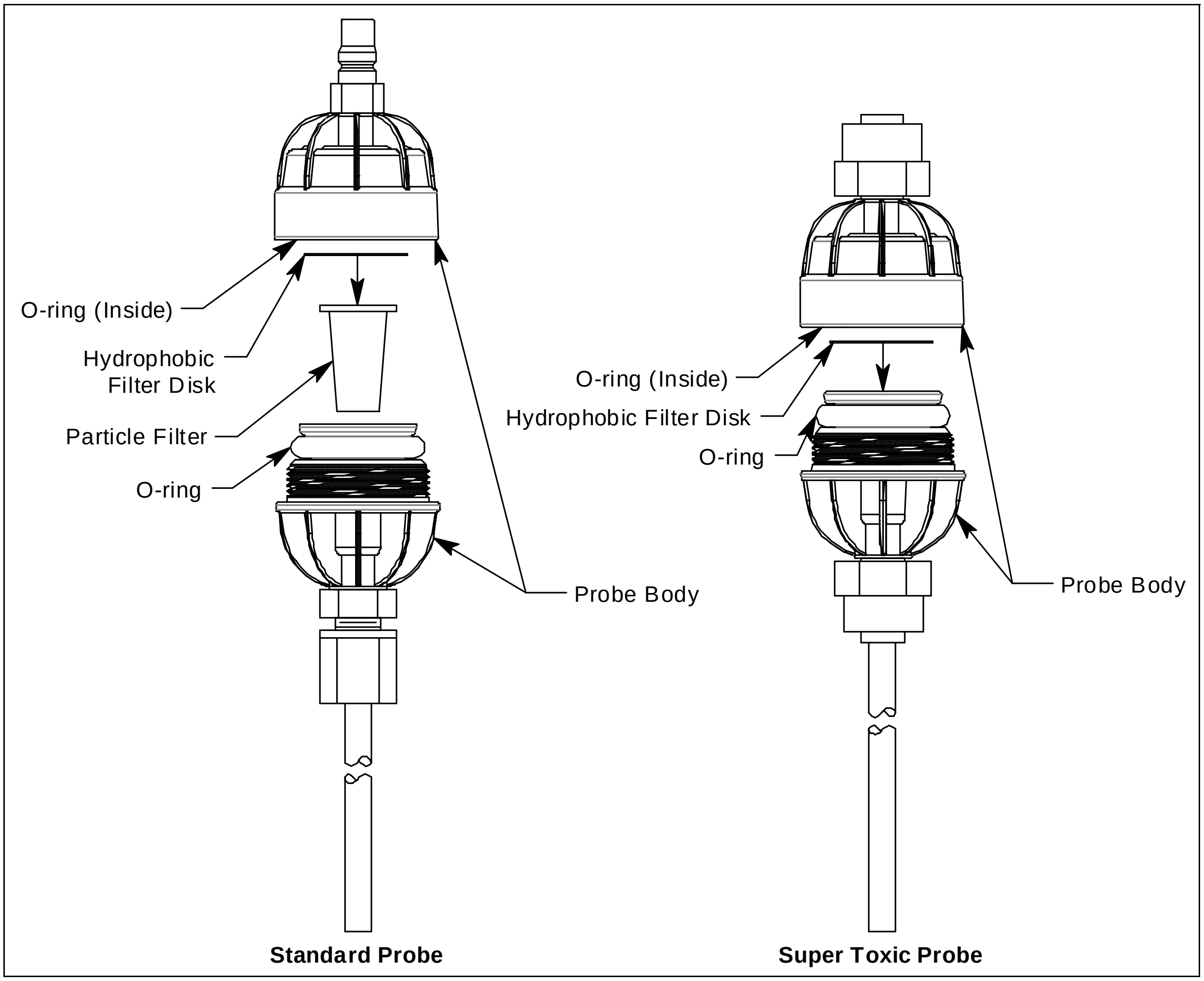
4. Unplug the supply and the charger before using the Eagle. See the charger label for directions.

NOTE: Setup mode allows you to select between alkaline and Ni-Cd batteries. The two types of batteries have unique low battery alarm characteristics. To prevent unexpected low battery alarms, always make sure the battery type setting in Setup mode matches the type of batteries installed in the Eagle.

Replacing the Probe’s Particle Filter and Hydrophobic Filter Disk

Inspect the probe’s internal components if you notice that the Eagle’s pump sounds bogged down or if an unexplained low flow alarm occurs. Replace the particle filter if it appears to be dirty. Replace the hydrophobic filter disk if it appears dirty or saturated with liquid. Replace the O-rings in the probe if either of them appears damaged.

1. Grasp each end of the clear probe body firmly and unscrew the two halves from each other. One half includes a plastic tube fitting and the probe tube. The other half includes a metal fitting that mates with the sample hose or Eagle inlet fitting if it is a standard probe. This half has a plastic fitting if it is a super toxic probe.



2. Remove the white hydrophobic filter disk from the top of the particle filter or from the probe body.
3. Remove the particle filter from the probe body (if installed).
4. Clean the inside of the probe body if necessary.
5. Hold the probe half that has the plastic tube fitting and the probe tube with the fitting and tube facing down.
6. Place the new cone-shaped particle filter into the probe body so that the wide part of the filter is facing up.

NOTE: If you have an Eagle that requires a super toxic probe, do not install the particle filter.

---

7. Place the new filter disk flat on top of the particle filter. Make sure it is centered over the particle filter (if installed).
8. Carefully screw the other half of the probe body onto the half with the filter disk and particle filter (if installed) while keeping the probe oriented vertically to keep the disk centered.
9. When you feel the O-ring being compressed, grasp both ends of the probe and tighten them together very firmly to ensure a seal.
10. To test the seal, do the following.
    - install the probe on the Eagle
    - startup the Eagle
    - confirm that a low flow alarm occurs when you cover the end of the probe tube with your finger
    - if a low flow alarm does not occur, hand tighten the probe further
    - if a low flow alarm still does not occur when you cover the probe tube with your finger, disassemble the probe, inspect the placement of the O-rings and filter disk, reassemble the probe, and re-test it.

Replacing Sensors

Electrochemical sensors (O_2, H_2S, and CO) gradually deteriorate, regardless of use, and require periodic replacement. Combustibles sensor life is typically related to usage, but certain conditions may affect duration.

The Eagle sensors are easy to replace but do not contain user-serviceable components. For genuine RKI sensors, call RKI or your local distributor. All sensors are covered by a limited warranty; see warranty for details.

CAUTION: *Avoid pulling on sensor wires. Always unplug at the connector.*

Replacing the Combustibles Sensor

Replace the combustibles sensor when:

- The combustibles channel cannot be calibrated correctly.
- The LEL reading cannot be set to 0 by the Demand Zero command.

To replace the combustibles sensor:

1. Take the Eagle to a non-hazardous location, and turn the power off.
2. Unscrew the two large screws on the top of the case, then carefully lift the top of the case and lay it aside.
3. Unplug the four-wire connector (red / white / green / black) from the circuit board.
4. Locate the combustibles sensor. With the batteries closest to you, the combustibles sensor is at the top left corner of the sensor block.
5. Remove the two screws in the oval keeper plate, and remove the sensor from the sensor block.
6. Unplug the cable socket from the top of the sensor. Retain the oval keeper plate for use with the replacement sensor.
7. Install the replacement sensor in reverse order.

Replacing the Oxygen Sensor

Replace the oxygen sensor when:

- The O_2 channel cannot be set to 0.0% on an oxygen-free sample.
- The O_2 display cannot be set to 20.9% by the Demand Zero command.
- The O_2 reading drifts noticeably. For example, if the O_2 reading varies from 20.5 to 21.5 while you view the display for a few seconds.

To replace the oxygen sensor:

1. Take the Eagle to a non-hazardous location, and turn the power off.
2. Unscrew the two large screws on the top of the case, then carefully lift the top of the case and lay it aside.
3. Locate the oxygen sensor. With the batteries closest to you, the oxygen sensor is at the bottom left corner of the sensor block.
4. Unplug the cable leading from the oxygen sensor at the large multi-pin connector.
5. Loosen the screws on the metal strap that covers the oxygen sensor.
6. Push the strap toward the screw that is furthest away from the battery compartment.
7. Swing the strap aside.
8. Remove the oxygen sensor.
9. Install the replacement sensor in reverse order.

Replacing the H_2S or CO Sensor

Replace the H_2S or CO sensor when:

- The H_2S or CO channel cannot be calibrated correctly.
- The H_2S or CO reading cannot be set to 0 by the Demand Zero command.

NOTE: Allow up to 1/2 hour after you replace the H_2S or CO sensor, or if charged batteries have not been installed for an extended period, for the channel to show a normal response, then calibrate the sensor.

To replace the H_2S or CO sensor:

1. Take the Eagle to a non-hazardous location, and turn the power off.
2. Unscrew the two large screws on the top of the case, then carefully lift the top of the case and lay it aside.
3. Locate the toxic gas sensor you intend to replace. With the batteries closest to you, the sensor for Channel 3 is at the top right corner of the sensor block, and the sensor for Channel 4 is at the bottom right corner of the sensor block. Note the color of the leads extending from the sensor you intend to replace.
4. Unplug the appropriate sensor connector from the circuit board. Use the color of the leads to determine the appropriate connector.
5. Remove the sensor from the sensor block. If necessary, wiggle the sensor to work it out of the seal.
6. Install the replacement sensor in reverse order.

CAUTION: *Verify that you install the H_2S or CO sensor in the appropriate flow block position. The Eagle will display inaccurate H_2S and CO readings if the sensors are not installed in the correct flow block positions.*

CAUTION: *The Eagle continues to display H_2S and CO readings in the same channels as it did previously regardless of which socket (EC1 or EC2) the sensor is wired to or into which flow block position the sensor is installed. However, the H_2S and CO reading will be inaccurate due to the charcoal filter installed before the CO flow block position.*

Appendix A: Parts List

Table 6 lists part numbers for the Eagle's replacement parts and accessories.

Table 6: Parts List

Part Number	Description
07-7008RK	O-ring for top case thumbscrews
07-7210RK	O-ring for inlet fitting half of probe
07-7304RK	O-ring for tube half of probe
13-0100RK	Shoulder strap
13-1080RK	Thumbscrew, captive, 1/4-20, for top case
20-0640RK	Carrying case (for Eagle and standard accessories)
20-0642RK	Carrying case (for Eagle, standard accessories, and calibration kit)
30-0600RK-01	Pump
33-0156RK-01	Filter element (for hydrophobic filter; pack of 5)
33-0160RK	Filter, internal dust filter
33-1200RK	Particle filter for standard probe
33-6091RK	Filter, charcoal filter
35-0110RK	Dummy sensor, toxic gas sensor position
35-0111RK	Dummy sensor, oxygen sensor position
35-0112RK	Dummy sensor, combustible gas sensor position
49-1140RK	Alkaline battery, D-size (total of 4 required)
49-1240RK	Ni-Cd battery, D-size (total of 4 required)
49-2149RK	Battery charger, 220 VAC
49-2150RK	Battery charger, 115 VAC (with alkaline battery recognition)
49-2151RK	Battery charger, 12 VDC (with cigarette lighter plug)
49-2152RK	Continuous operation adapter, 115 VAC (with 20-foot cable)
49-2153RK	Continuous operation adapter, 12 VDC (with cigarette lighter plug)
52-0206RK	Lapel buzzer
52-2034RK	Remote audible alarm (with 20-foot cable)
52-2035RK	Remote audible alarm and strobe light (with 20-foot cable)
57-0012RK	Datalogging board (also requires 82-5007RK)
62-0125RK	Sensor, combustible gas (hydrocarbon)

Table 6: Parts List (cont.)

Part Number	**Description**
65-0601RK	Sensor, oxygen
65-2005RK	Sensor, carbon monoxide
65-2035RK	Sensor, hydrogen sulfide
71-0028RK	Eagle Instruction Manual
80-0131RK-10	Probe, 10-inch hydrophobic (standard probe)
80-0132RK-10	Probe, 10-inch hydrophobic, super toxic (for Br_2, ClO_2, HBr, or HCL)
80-05XXRK	Sample hose. Replace “XX” with length in feet. 5 foot hose is standard. Available lengths for the Eagle are 3, 4, 5, 6, 10, 15, 20, 25, 30, 35, 40, 50, 75, 100, and 125 feet.
81-0154RK-02	Calibration cylinder, 4-gas (CH_4; O_2; CO; H_2S), 58 liter
81-1054RK	Regulator, demand-flow type, for 58- and 103-liter calibration cylinders (cylinders with internal threads)
82-5007RK	Datalogging software and cable (also requires 57-0012RK)

Appendix B: Methane Elimination

For applications where methane is an interfering gas, you can set the Eagle to eliminate most response to methane. The methane elimination switch is a standard feature on the circuit board inside the top of the Eagle's case. An *external* switch is available as an *option*.

For methane elimination mode detection, the combustible gas channel must be set up as **HEX** or ******* (see "Updating Channel Settings" on page 29). Eagles with the external methane elimination switch are factory-set with the correct display.

Setting up for Methane Elimination Mode

1. Take the Eagle to a fresh-air environment. Set the internal methane elimination switch to the **HEX ON** position or the external switch to Methane Response Off.

CAUTION: *If the Eagle is equipped with an external methane elimination switch, do not adjust the internal switch. The internal switch should always be in the* ***CH4*** *position.*

2. Allow 2 minutes for the combustibles sensor to stabilize.
3. Perform the demand zero procedure as described in "Preparing for Calibration" on page 42.

WARNING: ***DO NOT adjust the switch after re-zeroing the Eagle.***

WARNING: ***Response to CH_4 is greatly reduced when the internal switch is set to "HEX ON" or the external switch is set to "Methane Response Off". If used for methane detection, the internal switch must be set to "CH4" or the external switch set to "Methane Response On".***

Operating with Methane Response Off

Monitor for combustible gas as you normally would. When the Eagle is operating in Methane Elimination mode, response to methane is reduced by 90% or more. Response to hexane is reduced slightly (approximately 15%). To convert readings for most common combustible gases, see Table 7 on page 53.

Returning to Methane Response Mode

1. Take the Eagle to a fresh-air environment. Set the internal methane elimination switch to the **CH4** position or the external switch to Methane Response On.
2. Allow 2 minutes for the combustibles sensor to stabilize.
3. Perform the demand zero procedure as described in "Preparing for Calibration" on page 42.

Monitoring Combustible Gases Other Than Hexane

Use Table 7 to determine the concentration of combustible gases other than hexane. This table is based on the Eagle being in methane elimination mode (methane elimination switch set to **HEX ON**) and calibrated to hexane. Multiply the display reading by the factor in the appropriate column. For example, if you are using the Eagle to detect toluene and the display reads 10% LEL, the actual toluene reading is 10% x 0.67 = 7% LEL toluene.

To determine the concentration of other combustible gases with the Eagle in full response mode and calibrated to methane, see Table 4 on page 18.

Table 7: Methane Elimination Mode Conversion Factors (Hexane Calibration)

Target Gas	LEL Factor	PPM Factor	Target Gas	LEL Factor	PPM Factor
Acetone	.63	2.53	Isopropanol	.73	.96
Benzene	.95	1.06	Methane	No Response	No Response
Butyl Acrylate	**	1.23	Methanol	.6	2.02
Butyl Acetate	1.45	3.30	Methyl Acetate	.56	1.20
2-Butyl Alcohol	1.5	3.41	Methyl Acrylate	.65	1.20
1-Butyl Alcohol	2.10	2.02	Methyl Ethyl Keytone	.99	1.94
Cyclohexane	.93	1.26	Methyl Isobutyl Keytone	.99	1.03
Cumene	1.96	.96	Mixed Xylenes	.99	1.06
Ethylene Dichloride	1.85	.85	Nonane	1.43	1.52
Ethyl Alcohol	.68	1.23	Pentane	.76	1.04
Ethyl Chloride	.57	.60	Propane	.63	1.20
Ethyl Acrylate	1.19	2.53	Styrene	1.37	1.14
Hydrogen	.44	1.36	Toluene	.67	1.45
Isobutane	.71	1.16	Vinyl Acetate Monomer	1.18	1.97

** Vapor pressure too low for significant LEL reading.

WARNING: ***The Eagle's alarms are initiated by the DISPLAY reading not the FACTORED reading. If you are monitoring for toluene as in the above example and the low alarm is set for 10% LEL, the Eagle will initiate a low alarm at 7% LEL toluene (display reading of 10% LEL).***

Appendix C: Non-Standard Toxic Gas Sensors

Appendix C describes the Eagle's non-standard, electrochemical toxic gas sensors (sensors other than CO or H_2S). This appendix also desribes calibrating and replacing non-standard toxic gas sensors.

Specifications

Table 8 lists specifications for the non-standard toxic gas sensors. The alarm settings are user-adjustable (see "Updating the Alarm Point Settings" on page 34).

Table 8: Non-Standard Toxic Gas Sensors Specifications

Target Gas	Range	Alarm 1	Alarm 2	TWA Alarm	STEL Alarm
Ammonia	0 to 75.0 ppm	12.0 ppm	25.0 ppm	25.0 ppm	35.0 ppm
Arsine	0 to 1.00 ppm	0.05 ppm	0.10 ppm	0.05 ppm	OFF
Arsine	0 to 200 ppb[1]	50 ppb	100 ppb	50 ppb	OFF
Bromine*	0 to 1.00 ppm	0.05 ppm	0.10 ppm	0.10 ppm	OFF
Chlorine	0 to 3.00 ppm	0.50 ppm	1.50 ppm	0.50 ppm	1.00 ppm
Chlorine Dioxide*	0 to 1.00 ppm	0.10 ppm	0.30 ppm	0.10 ppm	0.30 ppm
Diborane	0 - 300 ppb[1]	50 ppb	100 ppb	100 ppb	OFF
Fluorine**	0 to 3.00 ppm	0.50 ppm	1.00 ppm	1.00 ppm	2.00 ppm
Hydrogen Bromide*	0 to 9.00 ppm	1.00 ppm	2.00 ppm	OFF	3.00 ppm
Hydrogen Chloride*	0 to 15.0 ppm	2.0 ppm	5.0 ppm	OFF	OFF
Hydrogen Cyanide	0 to 30 ppm	3.0 ppm	5.0 ppm	OFF	4.7 ppm
Hydrogen Fluoride**	0 to 9.00 ppm	1.00 ppm	2.00 ppm	1.00 ppm	2.00 ppm
Hydrogen Peroxide**	0 to 3.00 ppm	0.50 ppm	1.00 ppm	1.00 ppm	OFF
Hydrogen Selenide**	0 to 200 ppb[1]	50 ppb	100 ppb	50 ppb	100 ppb
Hydrogen Sulfide	0 to 1.00 ppm	0.10 ppm	0.30 ppm	0.50 ppm	0.50 ppm
Hydrogen Sulfide	0 to 30.0 ppm	10 ppm	15 ppm	10 ppm	15 ppm
Nitric Oxide	0 to 100 ppm	10 ppm	25 ppm	25 ppm	50 ppm
Nitrogen Dioxide	0 to 15.0 ppm	1.0 ppm	3.0 ppm	3.0 ppm	5.0 ppm

Table 8: Non-Standard Toxic Gas Sensors Specifications

Target Gas	Range	Alarm 1	Alarm 2	TWA Alarm	STEL Alarm
Ozone**	0 to 1.00 ppm	0.10 ppm	0.30 ppm	0.08 ppm	0.10 ppm
Phosphine	0 to 1.00 ppm	0.10 ppm	0.30 ppm	0.30 ppm	1.00 ppm
Silane	0 to 15.0 ppm	2.0 ppm	5.0 ppm	5.0 ppm	5.0 ppm
Sulfur Dioxide	0 to 10.0 ppm	1.0 ppm	2.0 ppm	2.0 ppm	5.0 ppm
Sulfur Dioxide	0 to 15 ppm	1.0 ppm	2.0 ppm	2.0 ppm	5.0 ppm

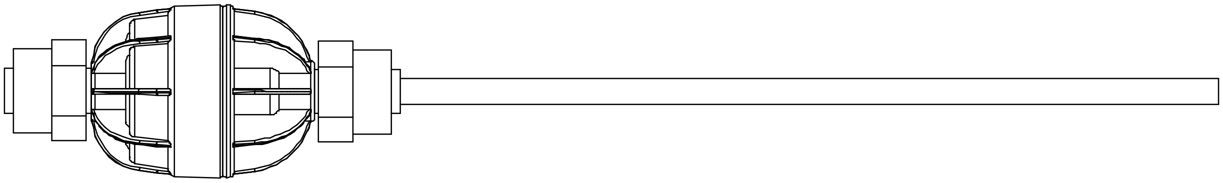
[1] ppb (parts per billion)

*Use the super toxic probe (particle filter removed) when monitoring for these gases.

**Do not use a probe when monitoring for these gases. The probe will absorb the gas sample.

Hose and Probe

Some super toxic gases require a super toxic probe with a plastic fitting instead of the standard hose with the metal fitting. This super toxic probe does not have a particle filter installed. Use a short tubing stub to connect the super toxic probe to the inlet of the Eagle.



Other super toxic gases cannot be measured with a probe at all. In both cases, a 3 foot Teflon hose is included with the instrument instead of the standard hose. See the above table for the gases that fall into either category.

Description

Non-standard toxic gas sensors are mounted in the front half of the instrument case. These sensors each include a dedicated amplifier with ZERO and SPAN controls. A bracket secures the sensor / amplifier assembly to the instrument case. A flow adapter connected to the sensor allows the sample to flow through the non-standard toxic gas sensor. A seven-position connector plugs into the **EC3** (channel 3) or **EC4** (channel 4) socket on the analog PCB.

Keeping Fresh Batteries in a Non-Standard Toxic Eagle

The non-standard toxic sensors require a bias voltage to maintain proper operation. This bias voltage is maintained even when the Eagle is turned off as long as the batteries in the Eagle have enough voltage to operate the Eagle (4.5 volts or greater). Once the batteries are drained to the point that they will not operate the Eagle, they will no longer provide a reliable bias voltage to the non-standard toxic sensors. When the Eagle indicates a dead battery alarm, change the batteries as soon as possible to maintain the bias voltage.

If the Eagle is stored for an extended period, check the battery voltage monthly. If the battery voltage is close to 4.5 volts, replace the batteries. A set of batteries with full capacity will maintain a bias voltage on non-standard toxic sensors in a stored Eagle for at least 3 months.

WARNING: ***If the non-standard toxic sensors are allowed to be without a bias voltage for an extended period, they will deteriorate and no longer operate properly. Be sure to keep fresh batteries in the Eagle when it is not being used or if it is stored.***

Calibrating Non-Standard Toxic Gas Sensors

Recommended calibration frequency for non-standard toxics sensors is 3 to 6 months.

1. Navigate to the Single Calibration screen as described in "Calibrating with the Single Calibration Method" on page 43.
2. At the Single Calibration screen, press the SHIFT/▼ button to scroll down to the appropriate gas, then press the POWER/ENTER button.
3. Screw the regulator to the appropriate calibration cylinder.

WARNING: ***RKI Instruments, Inc. recommends that you dedicate a regulator for use with chlorine (Cl_2) gas and that you do not use that dedicated regulator for any other gases, particularly hydrogen sulfide (H_2S).***

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4. Connect the tubing from the regulator to the Eagle's probe. Allow 2 minutes for the reading to stabilize.
5. If necessary, use the AIR/▲ (increase) and SHIFT/▼ (decrease) buttons to adjust the reading to match the concentration listed on the calibration cylinder.

   Go to the next section, "Adjusting the Sensor Controls," if you are unable to match the reading to the concentration of the cylinder.
6. Press the POWER/ENTER button to set the span value. **SINGLE CALIBRATION END** displays, then the Single Calibration menu displays.
7. Disconnect the tubing from the probe.
8. Unscrew the regulator from the calibration cylinder.
9. With the Single Calibration menu displayed, press the SHIFT/▼ button until the cursor is next to **ESCAPE**.
10. Press the POWER/ENTER button to return to the Calibration menu.
11. Press the SHIFT/▼ button to place the cursor next to the **NORMAL OPERATION** menu option, then press the POWER/ENTER button to return to the normal screen.

Adjusting the Sensor Controls

CAUTION: *Only perform the following steps if you are unable to set the correct calibration reading with the AIR/▲ and SHIFT/▼buttons.*

---

1. Use the AIR/▲ and SHIFT/▼ buttons to set the reading to the middle of the

range in which you can currently adjust the reading. For example, if you can set the reading from a minimum of 1.0 ppm to a maximum of 3.0 ppm, set the display to 2.0 ppm.

2. Unscrew the two large screws on the top of the case, then carefully lift the top of the case and lay it aside.
3. Locate the sensor in the front half of the bottom case. The sensor with wires connected to **EC3** on the analog PCB displays its reading on the third line of the screen. The sensor connected to **EC4** on the analog PCB displays its reading on the fourth line of the screen.
4. Adjust the sensor's **SPAN** control one turn and observe the display reading. Continue to adjust the **SPAN** control until the display reading matches the concentration of the calibration cylinder.

   The **SPAN** control is located next to the sensor on the side closest to the front of the instrument.
5. Press the POWER/ENTER button to set the span value. **SINGLE CALIBRATION END** displays, then the Single Calibration menu displays.
6. Place the top of the case in its original position, then secure it with the large screws you loosened in step 2.
7. Disconnect the tubing from the probe, then unscrew the regulator from the calibration cylinder.
8. With the Single Calibration menu displayed, press the SHIFT/▼ button until the cursor is next to **ESCAPE**.
9. Press the POWER/ENTER button to return to the Calibration menu.
10. Press the SHIFT/▼ button to place the cursor next to the **NORMAL OPERATION** menu option, then press the POWER/ENTER button to return to the normal screen.

NOTE: If a non-standard toxics channel displays **Zero Fail** after the Demand Zero procedure, adjust the ZERO control (next to SPAN) until the reading displays the smallest increment above 0.0. For example, 0.01 or 0.1. Repeat Demand Zero.

Replacing Non-Standard Toxic Gas Sensors

Replace the non-standard toxic gas sensor when:

- The toxic gas channel cannot be calibrated correctly.
- The toxic gas reading cannot be set to zero by the Demand Zero command or zero potentiometer.

NOTE: RKI Instruments, Inc. recommends that you return the Eagle for replacement of the non-standard toxic gas sensor. The following procedure is provided to allow you to replace the sensor if necessary.

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1. Take the Eagle to a non-hazardous location, and turn the power off.
2. Unscrew the two large screws on the top of the case, then carefully lift the top of

the case and lay it aside.

3. In the front half of the bottom case, locate the sensor you want to replace. The sensor with wires connected to **EC3** on the analog PCB displays its reading on the third line of the screen. The sensor connected to **EC4** on the analog PCB displays its reading on the fourth line of the screen.
4. Remove the two screws at the base of the bracket.
5. Lift the sensor assembly up enough to remove the flow adapter (two screws). The flow adapter is attached to the sensor.

CAUTION: *Avoid pulling on sensor wires. Always unplug at the connector.*

6. Disconnect the connector from the analog PCB. Note to which socket (**EC3** or **EC4**) the connector is connected.
7. Remove the sensor assembly from the instrument case.
8. Remove the two screws that secure the sensor assembly to the bracket.
9. Remove the two screws that secure the sensor to the amplifier, then remove the sensor from the amplifier. Retain the amplifier for use with the replacement sensor.
10. Install the replacement sensor in reverse order.

NOTE: Allow up to 4 hours after you replace a non-standard toxic gas sensor, or if charged batteries have not been installed for an extended period, for the channel to show a normal response, then calibrate the sensor.

Parts List

Table 9 lists part numbers for replacement parts and accessories of the Eagle's non-standard toxic gas sensors.

Table 9: Parts List: Non-Standard Toxic Gas Sensors

Part Number	**Description**
06-1273RK	Tubing, 1/4 in. x 1/8 in. PTFE (order by foot; 3 ft. standard; consult RKI Instruments, Inc., for lengths longer than 3 ft.)
81-0149RK-02	Calibration cylinder, 58-liter, 5 ppm H_2S in nitrogen
81-0170RK-02	Calibration cylinder, 58-liter, 5 ppm SO_2 in nitrogen
81-0176RK-02	Calibration cylinder, 58-liter, 25 ppm NH_3 in nitrogen
81-0185RK-02	Calibration cylinder, 58-liter, 0.5 ppm PH_3 in nitrogen
81-0192RK-02	Calibration cylinder, 58-liter, 2 ppm Cl_2 in nitrogen
81-0195RK-02	Calibration cylinder, 58-liter, 5 ppm HCl in nitrogen
ES-237-H2S	Sensor, hydrogen sulfide, 0 to 30.0 ppm range

Table 9: Parts List: Non-Standard Toxic Gas Sensors

Part Number	Description
ES-238-SO2	Sensor, sulphur dioxide, 0 to 10 ppm range
ES-23A-NO	Sensor, nitric oxide
ES-23AH-ASH3	Sensor, arsine, 0 to 1.00 ppm range
ES-23AHS-ASH3	Sensor, arsine, 0 to 0.20 ppm range
ES-23AH-CL2	Sensor, chlorine (used for certain chlorine applications and for chlorine dioxide)
ES-23AH-H2S	Sensor, hydrogen sulfide, 0 to 1.00 ppm range
ES-23AH-NO2	Sensor, nitrogen dioxide
ES-23AH-O3	Sensor, ozone, 0 to 5.00 ppm range
ES-23AH-PH3	Sensor, phosphine
ES-23AH-SIH4	Sensor, silane
ES-23AY-B2H6	Sensor, diborane
ES-23DH-H2O2	Sensor, hydrogen peroxide
ES-23DH-HCN	Sensor, hydrogen cyanide
ES-23E-HBR	Sensor, hydrogen bromide
ES-23E-SO2	Sensor, sulfur dioxide, 0 to 15 ppm range
ES-23R-NH3	Sensor, ammonia
ES-23SD-H2SE	Sensor, hydrogen selenide
ES-K233-BR2	Sensor, bromine
ES-K233-CL2	Sensor, chlorine (standard chlorine sensor)
ES-K233-F2	Sensor, fluorine
ES-K233-HCL	Sensor, hydrogen chloride
ES-K233-HF	Sensor, hydrogen fluoride
ES-K239C-O3	Sensor, ozone, 0 to 1.00 ppm range

Appendix D: Carbon Dioxide Sensors

Appendix D describes the Eagle’s infrared carbon dioxide (CO_2) sensors. It also describes calibrating and replacing CO_2 sensors.

Specifications

Table 10 lists specifications for the carbon dioxide sensors. The alarm settings are user-adjustable (see “Updating the Alarm Point Settings” on page 34).

Table 10: Carbon Dioxide Sensor Specifications

Range	Alarm 1	Alarm 2	TWA Alarm	STEL Alarm
0 - 5000 ppm	OFF	OFF	OFF	OFF
0 - 10,000 ppm	5000 ppm	OFF	5000 ppm	OFF
0 - 5.00% CO2	0.50% CO2	3.00% CO2	0.50% CO2	3.00% CO2
0 - 20.0%	OFF	OFF	OFF	OFF
0 - 60.0%	OFF	OFF	OFF	OFF

Description

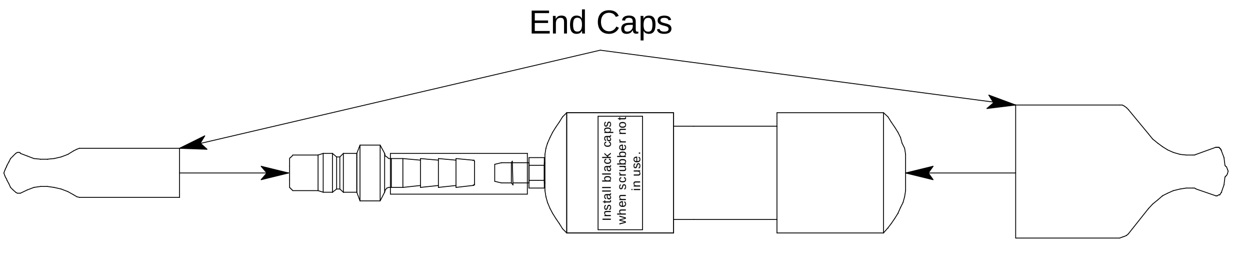
The Eagle uses an infrared sensor to detect carbon dioxide. The carbon dioxide sensor includes a dedicated amplifier with ZERO and SPAN controls. A bracket secures the sensor / amplifier assembly to the instrument case. A four-position connector plugs into the **EC3** (channel 3) or **EC4** (channel 4) socket on the analog PCB.

CO_2 Scrubber

A carbon dioxide scrubber is mounted to the exterior front of Eagles that are factory-shipped with carbon dioxide sensors for the ranges 0 - 5,000 ppm, 0 - 10,000 ppm, and 0 - 5%.

NOTE: Eagles with a range of 0 - 20% and 0 - 60% CO_2 do not include a scrubber since the normal background of CO_2 in air is negligible when compared to the full scale of these units.

This scrubber is for use when setting the carbon dioxide sensor’s zero reading only. Two black vinyl caps cover either end of the carbon dioxide scrubber. To prolong the life of the scrubber, be sure the caps are installed while the scrubber is not in use or while it is being stored. Replace the scrubber when it turns from white to a violet color.



CAUTION: *Do not connect the probe to the scrubber during normal operation or when setting the span reading during calibration.*

Normal Operation of Carbon Dioxide Sensors

Carbon dioxide is a background gas in fresh air. Table 11 indicates typical fresh air readings for each of the Eagle's carbon dioxide sensors.

Table 11: Carbon Dioxide Fresh Air Readings

Range	Approximate Fresh Air Reading
0 - 5000 ppm	400 ppm
0 - 10,000 ppm	400 ppm
0 - 5.00%	0.04%
0 - 20.0 & 0 - 60.0%	0.0%

Demand Zero for Carbon Dioxide Sensors

When setting the zero reading, the carbon dioxide scrubber mounted to the front of the Eagle allows you to eliminate carbon dioxide normally found in fresh air.

NOTE: When performing a demand zero with a 0 - 20% or 0 - 60% CO_2 unit, the use of a scrubber is not required.

1. Remove the black caps from the ends of the carbon dioxide scrubber. Be sure to grab the scrubber by the Eagle fitting so that the fitting and tubing do not come off.
2. Connect the carbon dioxide scrubber directly to the Eagle's inlet fitting.
3. Wait one minute for the fresh air sample to flow through the carbon dioxide scrubber, then press the AIR/▲ button to set the zero reading.

   If the carbon dioxide sensor fails when you press the AIR/▲ button, use the zero control (marked **F. ZERO**) on the amplifier to adjust the reading to zero.

CAUTION: *Do not adjust the coarse zero potentiometer (marked **C.ZERO**).*

4. Remove the scrubber from the inlet fitting.
5. Put the caps back on the scrubber.

Calibrating Carbon Dioxide Sensors

Recommended calibration frequency for carbon dioxide sensors is once every 3 months. Enter Calibration mode and calibrate carbon dioxide sensors as described in the Calibration section of this manual. Use the Auto Calibration method if a calibration cylinder is available that includes all target gases for your Eagle. Use the Single Calibration method if you are using a carbon dioxide calibration cylinder.

NOTE: If you are using the Auto Calibration method, go to the Calibration Values screen, verify that the carbon dioxide value matches the concentration of carbon dioxide in the four-gas calibration cylinder, then proceed with step 2.

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1. At the Single Calibration screen, press the SHIFT/▼ button to scroll down to the carbon dioxide channel, then press the POWER/ENTER button.
2. Screw the regulator to the appropriate calibration cylinder.
3. Connect the tubing from the regulator to the Eagle's probe. Allow 1 minute for the reading to stabilize.
4. If necessary, use the AIR/▲ (increase) and SHIFT/▼ (decrease) buttons to adjust the carbon dioxide reading to match the concentration listed on the calibration cylinder.

   Go to the next section, "Adjusting the sensor potentiometers," if you are unable to match the reading to the concentration of the calibration cylinder.
5. Press the POWER/ENTER button to set the span value. **SINGLE CALIBRATION END** displays, then the Single Calibration menu displays.
6. Disconnect the tubing from the probe, then unscrew the regulator from the cylinder.
7. With the Single Calibration menu displayed, press the SHIFT/▼ button until the prompt is next to the last channel, then press the SHIFT/▼ button again. The **ESCAPE** message displays.
8. Press the POWER/ENTER button to return to the Calibration menu.
9. Press the SHIFT/▼ button to place the prompt next to the **NORMAL OPERATION** menu option, then press the POWER/ENTER button to return to the normal screen.

Adjusting the Sensor Controls

CAUTION: *Only perform the following steps if you are unable to set the correct calibration reading with the AIR/▲ and SHIFT/▼buttons.*

---

1. Use the AIR/▲ and SHIFT/▼ buttons to set the reading to the middle of the range in which you can currently adjust the reading. For example, if you can set the reading from a minimum of 1.00% CO_2 to a maximum of 3.00% CO_2, set the display to 2.00% CO_2.
2. Unscrew the two large screws on the top of the case, then carefully lift the top of the case and lay it aside.

3. Locate the carbon dioxide sensor in the front half of the bottom case. A sensor with wires connected to **EC3** on the analog PCB displays its reading on the third line of the screen. A sensor connected to **EC4** on the analog PCB displays its reading on the fourth line of the screen.
4. Adjust the carbon dioxide sensor's **SPAN** control one turn and observe the display reading. Continue to adjust the **SPAN** control until the display reading matches the concentration of the calibration cylinder.

   The **SPAN** control is located on the top edge of the amplifier and is the control closest to the front of the instrument. (The front of the instrument has the scrubber attached to it.)
5. Press the POWER/ENTER button to set the span value. **SINGLE CALIBRATION END** displays, then the Single Calibration menu displays.
6. Place the top of the case in its original position, then secure it with the large screws you loosened in step 5.
7. Disconnect the tubing from the probe.
8. Unscrew the regulator from the calibration cylinder.
9. With the Single Calibration menu displayed, press the SHIFT/▼ button until the prompt is next to the last channel, then press the SHIFT/▼ button again. The **ESCAPE** message displays.
10. Press the POWER/ENTER button to return to the Calibration menu.
11. Press the SHIFT/▼ button to place the prompt next to the **NORMAL OPERATION** menu option, then press the POWER/ENTER button to return to the normal screen.

Replacing Carbon Dioxide Sensors

Return the Eagle to RKI Instruments, Inc. for replacement of the carbon dioxide sensor when:

- The carbon dioxide channel cannot be calibrated correctly.
- The carbon dioxide reading cannot be set to zero by the Demand Zero command or zero potentiometer.

Parts List

Table 12 lists part numbers for replacement parts and accessories of the Eagle's carbon dioxide sensors.

Table 12: Parts List: Carbon Dioxide Sensors

Part Number	Description
33-6010RK-01	Scrubber, carbon dioxide
81-0070RK-03	Calibration cylinder, 103-liter (2000 ppm CO_2)
81-0071RK-03	Calibration cylinder, 103-liter (5000 ppm CO_2)
81-0072RK-03	Calibration cylinder, 103-liter (2.5% CO_2)
81-0073RK-03	Calibration cylinder, 103-liter (15% CO_2)
81-1054RK	Regulator, demand-flow type, for 58- and 103-liter calibration cylinders (cylinders with internal threads)

Appendix E: Infrared Methane Sensors

This appendix describes the Eagle's infrared methane sensors. This appendix also describes calibrating and replacing the infrared methane sensors.

Target Gases

The infrared methane sensors are setup for and factory-calibrated to methane.

The infrared methane sensor also responds to the following combustible gases: ethane, hexane, IPA, isobutane, MEK, propane, toluene.

The infrared methane sensor does not respond to or responds poorly to the following combustible gases: acetylene, hydrogen, styrene.

Specifications

Table 13 lists specifications for the infrared methane sensors. The alarm settings are user-adjustable (see "Updating the Alarm Point Settings" on page 34.)

Table 13: Infrared Methane Sensor Specifications

Range	Increment	Alarm 1	Alarm 2	TWA	STEL
0 to 100.0% LEL CH_4 0 to 50,000 ppm	0.5% LEL 100 ppm	10.0% LEL 5,000 ppm	50.0% LEL 25,000 ppm	N/A N/A	N/A N/A
0 to 100.0% Volume CH_4	0.5% Volume	10.0% VOL	20.0% VOL	N/A	N/A
Autoranging %LEL/%Volume					
0 to 100% LEL	1% LEL	10% LEL	50% LEL	N/A	N/A
0 to 50,000 ppm	500 ppm	5,000 ppm	25,000 ppm	N/A	N/A
0 to 100.0% Volume	0.5% Volume	N/A	N/A	N/A	N/A

Description

The infrared methane sensor is mounted in the front half of the instrument case. The sensor is attached and wired to a dedicated amplifier, which includes ZERO and SPAN controls. A bracket secures the sensor / amplifier assembly to the instrument case.

Eagles with a 0 to 100% LEL infrared methane sensor do not include the standard catalytic combustible gas sensor. In these models, the infrared methane sensor is wired to the **EC4** socket on the analog PCB and the gas reading is displayed in channel 1. This sensor is also capable of measuring in the PPM range.

Eagles with a 0 to 100% Volume CH_4 infrared methane sensor may also include the standard combustible gas sensor. Table 14 lists the sensor configuration for 0 to 100% Volume CH_4 Eagles. Not all channels may be active in your Eagle.

Table 14: Sensor Configuration for Infrared Methane Sensors (0 to 100% Volume)

Channel	Sensor	Analog PCB Socket
1	Standard combustible gas (0 to 100% LEL)	COMB

Table 14: Sensor Configuration for Infrared Methane Sensors (0 to 100% Volume)

Channel	Sensor	Analog PCB Socket
2	Infrared methane (0 to 100% Vol. CH_4)	EC4
3	Oxygen	CN2
4	Toxic gas or infrared carbon dioxide	EC1, EC2, or EC3

Calibrating Infrared Methane Sensors

Recommended calibration frequency for the infrared methane sensor is once every 3 months. Enter Calibration mode and calibrate the infrared methane sensor using the same procedure as the standard combustible gas sensor (see “Calibration” on page 41).

NOTE: The 0 to 100% Volume CH_4 version of the infrared methane sensor requires the use of a sample bag due to the type of calibration cylinder used. See Table 15 on page 67 for ordering information.

Adjusting the Sensor Controls

CAUTION: *Only perform the following steps if you are unable to set the correct calibration reading with the AIR/▲ and SHIFT/▼buttons.*

1. Use the AIR/▲ and SHIFT/▼ buttons to set the reading to the middle of the range in which you can currently adjust the reading. For example, if you can set the reading from a minimum of 10% LEL to a maximum of 40% LEL, set the display to 25% LEL.
2. Unscrew the two large screws on the top of the case, then carefully lift the top of the case and lay it aside.
3. Locate the infrared methane sensor in the front half of the bottom case. It is connected to the **EC4** socket on the analog PCB.
4. Adjust the sensor’s **SPAN** control one turn and observe the display reading. Continue to adjust the **SPAN** control until the display reading matches the concentration of the calibration cylinder.

   The **SPAN** control is on the top edge of the amplifier and is the control closest to the front of the instrument.
5. Place the top of the case in its original position, then secure it with the large screws you loosened in step 5.
6. Continue with the normal calibration procedure.

Replacing Infrared Methane Sensors

Return the Eagle to RKI Instruments, Inc. for replacement of the infrared methane sensor when:

- The infrared methane channel cannot be calibrated correctly.
- The infrared methane reading cannot be set to zero by the Demand Zero command.

Parts List

Table 15 lists part numbers for accessories needed to calibrate the Eagle’s infrared 100% volume methane sensor.

Table 15: Parts List: Infrared Methane Sensors

Part Number	Description
81-0015RK-01	Calibration cylinder, 34-liter,50% volume CH_4
81-1001RK	Dispensing valve (for 34-liter calibration cylinders)
81-1126RK	Calibration sample bag, tedlar (9 in. x 9 in.)
81-1127RK	Calibration sample bag, tedlar (12 in. x 12 in.)

Appendix F: Infrared Hydrocarbon Sensor

This appendix describes the Eagle's infrared hydrocarbon (HC) sensor. This appendix also describes calibrating and replacing the infrared HC sensor.

Target Gases

The infrared HC sensor is a general hydrocarbon sensor and is factory-calibrated to isobutane.

Specifications

Table 16 lists specifications for the infrared HC sensor. The alarm settings are user-adjustable (see "Updating the Alarm Point Settings" on page 34.)

Table 16: Infrared HC Sensor Specifications

Range	Increment	Alarm 1	Alarm 2	TWA	STEL
0 to 100% LEL HC 0 to 18,000 PPM	1% LEL 200 ppm	10% LEL 1,800 ppm	50% LEL 9,000 ppm	N/A N/A	N/A N/A
0 to 30.0% Volume HC	0.5% Volume	N/A	N/A	N/A	N/A

Description

The infrared HC sensor is mounted in the front half of the instrument case. The sensor is attached and wired to a dedicated amplifier, which includes ZERO and SPAN controls. A bracket secures the sensor / amplifier assembly to the instrument case.

The infrared HC sensor is wired to the **EC4** socket on the analog PCB and the gas reading is displayed in channel 1. The HC channel can also be displayed in PPM by using the LEL / PPM button.

Eagles with an infrared HC sensor do not include the standard catalytic combustible gas sensor. Table 17 lists the sensor configuration for Eagles that include this sensor. Not all channels may be active in your Eagle.

Table 17: Sensor Configuration for Eagles with Infrared HC Sensors

Channel	Sensor	Analog PCB Socket
1	Infrared HC	EC4
2	Oxygen	CN2
3	Toxic gas or infrared carbon dioxide	EC1, EC2, or EC3
4	Toxic gas or infrared carbon dioxide	EC1, EC2, or EC3

Calibrating the Infrared HC Sensor

Recommended calibration frequency for the infrared HC sensor is once every 3 months. Enter Calibration mode and calibrate the infrared HC sensor using the same procedure as the standard combustible gas sensor (see “Calibration” on page 41).

Be sure to use 50% LEL isobutane to calibrate the infrared HC sensor, not methane. If calibrating only an infrared HC channel, use a 50% LEL isobutane cylinder and the single calibration method. If calibrating multiple channels that include infrared HC, oxygen, CO, or H_2S, use a 4-gas mix calibration cylinder with isobutane and the auto calibration method. If calibrating other channel types, use an appropriate calibration cylinder and the single calibration method.

Adjusting the Sensor Controls

CAUTION: *Only perform the following steps if you are unable to set the correct calibration reading with the AIR/▲ and SHIFT/▼buttons.*

---

1. Use the AIR/▲ and SHIFT/▼ buttons to set the reading to the middle of the range in which you can currently adjust the reading. For example, if you can set the reading from a minimum of 10% LEL to a maximum of 40% LEL, set the display to 25% LEL.
2. Unscrew the two large screws on the top of the case, then carefully lift the top of the case and lay it aside.
3. Locate the infrared HC sensor in the front half of the bottom case. It is connected to the **EC4** socket on the analog PCB.
4. Adjust the sensor’s **SPAN** control one turn and observe the display reading. Continue to adjust the **SPAN** control until the display reading matches the concentration of the calibration cylinder.

   The **SPAN** control is on the top edge of the amplifier and is the control closest to the front of the instrument.
5. Place the top of the case in its original position, then secure it with the large screws you loosened in step 5.
6. Continue with the normal calibration procedure.

Replacing the Infrared HC Sensor

Return the Eagle to RKI Instruments, Inc. for replacement of the infrared HC sensor when:

- The infrared HC channel cannot be calibrated correctly.
- The infrared HC reading cannot be set to zero by the Demand Zero command.

Parts List

Table 18 lists part numbers for replacement parts and accessories of the Eagle's infrared HC sensor.

Table 18: Parts List: Infrared HC Sensors

Part Number	Description
06-1248RK-03	Tubing, 3/16" x 5/16", polyurethane, 3 foot length, for calibration kit
81-0018RK	Calibration cylinder, 50% LEL isobutane in air, 17 liter steel
81-0018RK-01	Calibration cylinder, 50% LEL isobutane in air, 34 liter steel
81-0018RK-03	Calibration cylinder, 50% LEL isobutane in air, 103 liter steel
81-1054RK	Regulator, demand flow, for 34AL/58/103 liter calibration cylinders (cylinders with internal threads)
81-1055RK	Regulator, demand flow, for 17 liter and 34 liter steel calibration cylinders (cylinders with internal threads)
81-0158RK-02	Four-gas calibration cylinder, 50% LEL isobutane/12% O_2/50 ppm CO/25 ppm H_2S, 58 liter aluminum
81-0158RK-04	Four-gas calibration cylinder, 50% LEL isobutane/12% O_2/50 ppm CO/25 ppm H_2S, 34 liter aluminum

Appendix G: Eagle Tank Tester Model

The Eagle Tank Tester model is intended for checking tanks or vessels that may contain residual hydrocarbon vapors or water or may have been purged of oxygen. You can also use this model as a standard Eagle gas monitor by connecting the standard hose and probe and updating the oxygen alarms to the default settings.

Description

The tank tester model has an additional socket on the front on the housing to accommodate connection of the float probe assembly. This model includes the following non-standard components.

Float Probe Assembly

The float probe assembly helps prevent liquid from being drawn into the Eagle. The float probe assembly is 12-feet long. A quick disconnect fitting at one end of the assembly connects to the Eagle's inlet fitting. The same end of the probe also includes a short wire that terminates in a jack. This jack connects to the float probe socket that is adjacent to the Eagle's inlet fitting. The float probe switch at the opposite end of the 12-foot cable shuts off the pump if the probe begins to be submerged into a liquid.

To use the float probe assembly:

CAUTION: *Drawing water, gasoline, or other liquids into the Eagle will cause damage.*

1. Attach the quick disconnect fitting to the Eagle's standard inlet fitting.
2. Attach the jack to the socket that is adjacent to the inlet fitting.
3. Lower the probe into the tank or vessel. Lower the probe *very slowly* to allow the float switch to activate if necessary.

Dilution Fitting (1:1)

CAUTION: *When measuring oxygen readings, remove the dilution fitting or use your finger to seal the small dilution hole on the side of the dilution fitting.*

The standard combustible gas sensor requires oxygen to operate. In environments where there is not enough oxygen to operate the combustible gas sensor, (for example a tank purged with an inerting gas), the 1:1 dilution fitting adds sufficient oxygen by blending ambient air with the incoming sample. The standard dilution fitting dilutes at a ratio of 1:1 (one part air to one part sample).

To attach the dilution fitting:

1. Attach the dilution fitting's quick disconnect fitting to the Eagle's inlet fitting.
2. Attach the hose to the opposite end of the dilution fitting.

NOTE: When using the dilution fitting, multiply the combustible gas reading (LEL or PPM) by 2 to determine the actual combustible gas concentration. Always remove the dilution fitting or seal the dilution hole to measure for oxygen.

Alarms

The Eagle Tank Tester model has two alarms for oxygen. They are factory-set at 5.0% by volume (increasing) and 19.5% by volume (decreasing).

The *increasing* alarm is used to monitor a purged vessel to alert you to a rising oxygen condition. The *decreasing* alarm is generally used for confined space entry to warn you of dangerously low breathing levels.

ANY oxygen level is either above or below one of these alarm levels, so the Eagle Tank Tester version *will* go into alarm when first turned on. To silence the alarm, press the RESET button. The audible alarm silences, but the alarm lights continue to flash and the display screen continues to indicate an oxygen alarm. If one of the alarm levels is newly exceeded, the audible alarm sounds again.

To eliminate an oxygen alarm that is not being used:

Either the increasing or decreasing oxygen alarm can be turned off in Setup mode (see "Updating the Alarm Point Settings" on page 34). Turning off the alarm clears the alarm lights and display of an unnecessary alarm.

Calibration

Use a hexane calibrating source to calibrate the combustible gas LEL range. Use a 100% nitrogen calibrating source to set the zero reading for the oxygen channel. RKI Instruments, Inc. recommends using the Single Calibration method to calibrate the Eagle Tank Tester model. See "Calibration" on page 41.

Parts List

Table 19 lists part numbers for replacement parts and accessories of the Eagle's Tank Tester model.

Table 19: Parts List: Eagle Tank Tester Model

Part Number	Description
80-0405RK	Dilution fitting (1:1)
80-0802RK	Float probe (12-foot)

Appendix H: Five-Gas and Six-Gas Models

Overview

The standard Eagle gas monitor includes one to four channels and displays gas readings for all channels simultaneously. Some Eagle models include five or six channels; however, the Eagle is only capable of displaying gas readings for four of the channels at any one time.

Five- and six-gas Eagle models include up to four sensors in the standard sensor block. The additional sensor(s) are mounted in the front half of the instrument case and are wired to sockets **EC3** (channel 5) and **EC4** (channel 6) on the analog PCB.

NOTE: The data logging accessory is not available for the Eagle's five- and six-gas models.

Displaying Additional Channels

The normal screen displays a cursor (>) at the far left to indicate that additional channels can be displayed.

- A cursor to the left of the *last* channel displayed indicates that additional channels are available *after* the currently displayed channels. Press the SHIFT/▼ button to display the remaining channels.

```
  CH4      0  LEL%
  OXY   20.9  VOL%
  H2S    0.0  PPM
> CO       0  PPM
```

- A cursor to the left of the *first* channel displayed indicates that additional channels are available *before* the currently displayed channels. Press the AIR/▲ button to display the remaining channels.

```
> CH4      0  LEL%
  OXY   20.9  VOL%
  H2S    0.0  PPM
  CO       0  PPM
```

- Cursors to the left of the *first and last* channels displayed indicate that additional channels are available *before and after* the currently displayed channels. Press the AIR/▲ and SHIFT/▼ buttons to display the remaining channels.

```
> CH4      0  LEL%
  OXY   20.9  VOL%
  H2S    0.0  PPM
> CO       0  PPM
```

Alarms

If the Eagle recognizes an alarm condition for a non-displayed channel, the cursor flashes and the standard audible and visual alarms initiate.

- If the alarm occurs for a channel before the top displayed channel, the cursor in the first line flashes. Press the AIR/▲ button to display the channel in alarm.
- If the alarm occurs for a channel after the bottom displayed channel, the cursor in the last line flashes. Press the SHIFT/▼ button to display the channel in alarm.

Calibration, Display, and Setup Modes

For screens in these modes that display all active channels, a cursor displays:

- in the top line if channels are available before the top line. Press the AIR/▲ button to display the additional channel(s).
- in the bottom line if channels are available after the bottom line. Press the SHIFT/▼ button to display the additional channel(s).
- in the top and bottom lines if channels are available before the top line *and* after the bottom line. Press the AIR/▲ and SHIFT/▼ buttons to display the additional channels.

Appendix I: Eagle Transformer Gas Tester Model

This Eagle Transformer Gas Tester Model is specially set up for electrical transformer gas testing. Large electrical transformers are filled with oil which surrounds the transformer coils, and they have an inert gas head space above the oil. When a transformer begins to fail, electrical arcing between the conductors of the coils can cause flammable gases to form in the head space. By testing the head space for these gases, and recording trends of the readings, an early warning of transformer failure can be determined, and the transformer can be removed from service before it explodes.

Description

This combustible sensor, which is a catalytic combustion type, is calibrated to and the instrument is setup for hydrogen with a range of 0 - 5.00% volume. Since the headspace being tested is filled with nitrogen, there is not oxygen in the test sample. The catalytic sensor requires oxygen in order to operate, so the instrument is supplied with a snap-on dilution fitting with a dilution ratio of 1:1 (one part air to one part sample). This fitting blends the sample with ambient air before entering the instrument, which provides sufficient oxygen for the sensor to work. The instrument is also supplied with a sample bag.

Operation

1. Turn the instrument on and allow it to warm up.
2. Attach the dilution fitting directly to the front of the instrument, and the plastic probe to the dilution fitting.
3. Press the “AIR” button in fresh air to zero the instrument.
4. Connect the deflated sample bag to the sample valve on the transformer, and open the valve slightly to fill the sample bag. Close off the sample bag and remove it from the transformer valve.
5. Attach the sample bag to the EAGLE probe, and open the sample bag.

   The sample will now be drawn into the instrument. After about 45 seconds note and record the display reading. Compare this reading to historical data to determine the condition of the transformer.

NOTE: The Eagle can be calibrated either with or without the dilution fitting in place. If calibrated without the dilution fitting in place, then display readings must be doubled to determine the actual gas concentration. If calibrated with the dilution fitting in place, then the sample bag must be used during calibration, and the display readings will be the actual gas concentrations.

CAUTION: *If the dilution fitting is in place for calibration, do not use a demand flow regulator. Use a sample bag. The use of a demand flow regulator with a dilution fitting when calibrating will result in an inaccurate calibration.*

Alarms

All the gas alarms on the Transformer Gas Tester are set to OFF.

Part List

Table 20: Parts List: Eagle Tank Tester Model

Part Number	Description
80-0405RK	Dilution fitting (1:1)
81-1126RK	Sample bag, 9” x 9”, tedlar

Appendix J: Eagle Transformer Gas Tester Model TRB

The TRB Eagle is specially set up for electrical transformer gas testing. Large electrical transformers are filled with oil which surrounds the transformer coils and they have an inert gas head space above the oil. When a transformer begins to fail, electrical arcing between the coil conductors can cause flammable gases to form in the head space. By testing the head space for these gases and recording trends of the readings, an early warning of transformer failure can be detected and the transformer can be removed from service before an explosion occurs.

Table 21: TRB Eagle Specifications

Target Gas	Range	Alarm 1	Alarm 2	TWA Alarm	STEL Alarm
Hydrogen	0 to 5% volume*	OFF	OFF	N/A	N/A
Oxygen**	0 to 40% volume	OFF	OFF	N/A	N/A
* If the reading is displayed in ppm, the range is 0 - 50,000 ppm. ** Oxygen is an optional target gas.					

Description

The TRB Eagle can have either an LEL channel only or an LEL channel and an oxygen channel. The LEL channel is setup for 0 - 5% volume hydrogen as standard but can be setup for any combustible gas.

This TRB Eagle utilizes a catalytic combustion sensor which requires oxygen to be present in the sample to work properly. Since the head space being tested is filled with nitrogen, there is no oxygen in the test sample. The instrument is equipped with an internal dilution fitting that blends the sample with 50% air before it reaches the combustible sensor, providing sufficient oxygen for the sensor to work properly.

This instrument is designed to draw from a head space that is either at a slight positive pressure or slight vacuum relative to atmosphere. It is equipped with two pumps: one to draw the sample from the head space and one to route the sample to the sensor(s). It is also equipped with a special hose barb inlet fitting for 1/4” I.D. flexible tubing and does not include a hose or probe.

Operation

1. Turn the instrument on and allow it to warm up.
2. Press the AIR button while in a fresh air environment to zero the instrument.
3. Connect the sample tubing to the TRB Eagle inlet fitting.
4. Connect the sample tubing to the sample source.
5. Allow the instrument to draw sample for 1 minute. Note and record the display reading. Compare this reading to historical data to determine the condition of the transformer.

Calibration

Because of the internal construction of the TRB Eagle, it is not necessary to use a gas bag to calibrate the unit. A demand flow regulator may be used to calibrate it. Follow the instructions in “Calibration” on page 41 to calibrate the unit.

Alarms

All of the gas alarms on the TRB Eagle are set to OFF.

Parts List

Table 22: Parts List for TRB Eagle

Part Number	Description
81-1054RK	Regulator, demand-flow type (for 58- and 103-liter calibration cylinders)
81-1055RK	Regulator, demand-flow type (for 17- and 34-liter steel cylinders)

Appendix K: Installing the Data Logger Board

This appendix describes the procedure to install the Eagle's data logger board. The data logging feature is an *optional* accessory.

NOTE: Although the data logger board may be installed in the field, RKI Instruments, Inc. recommends that you return the Eagle to the factory for data logger board installation.

1. Take the Eagle to a non-hazardous location, and turn the power off.
2. Unscrew the two large screws on the top of the case, then carefully lift the top of the case and lay it aside.
3. Unplug the ribbon cable from the main circuit board in the top case.
4. Remove the two screws, flat washers, and lock washers that hold the main circuit board in the top case.
5. Slowly pull the main circuit board from the top case far enough to allow room to install the Data Logger board. Avoid pulling so far that you disconnect any of the four cables on the main circuit board.
6. Plug the Data Logger board into the main circuit board at **CN1A**, **CN1B**, **CN1C**, and **CN1D.**
7. Reassemble the main circuit board to the top case with the screws and lock washers removed in step 4.
8. Plug in the ribbon cable.
9. Reassemble and secure the top case to the bottom case.
10. Start the Eagle and program the Data Logger functions as described in "Setup Mode" on page 27.

APPENDIX H – CONDENSATE CALCUATIONS

Mat-Su Central Landfill Development Plan
Projected Condensate Generation

Year	Disposal Quantity	Total LFG Generation	LFG Collection	Condensate Generation	
	(US Tons)	*(CFM)*	*(75% Collection Eff.)*	*(GPD)*	*(GPY)*
2019	57,270.51	320.31	240.23	64.00	17,709.89
2020	57,843.22	327.83	245.87	65.50	18,125.96
2021	58,421.65	335.35	251.51	67.00	18,541.45
2022	59,005.86	342.85	257.14	68.50	18,956.46
2023	59,595.92	350.35	262.76	70.00	19,371.08
2024	60,191.88	357.84	268.38	71.50	19,785.38
2025	60,793.80	365.33	274.00	72.99	20,199.46
2026	61,401.74	372.82	279.61	74.49	20,613.40
2027	62,015.76	380.31	285.23	75.99	21,027.29
2028	62,635.91	387.79	290.84	77.48	21,441.19
2029	63,262.27	395.28	296.46	78.98	21,855.21
2030	63,894.90	402.77	302.08	80.47	22,269.41
2031	64,533.84	410.27	307.70	81.97	22,683.88
2032	65,179.18	417.77	313.33	83.47	23,098.70
2033	65,830.97	425.28	318.96	84.97	23,513.94
2034	66,489.28	432.80	324.60	86.47	23,929.69
2035	67,154.18	440.33	330.25	87.98	24,346.02
2036	67,825.72	447.87	335.90	89.49	24,763.00
2037	68,503.98	455.43	341.57	91.00	25,180.72
2038	69,189.02	463.00	347.25	92.51	25,599.25
2039	69,880.91	470.58	352.94	94.02	26,018.66
2040	70,579.71	478.18	358.64	95.54	26,439.04
2041	71,285.51	485.81	364.35	97.07	26,860.44
2042	71,998.37	493.45	370.09	98.59	27,282.95
2043	72,718.35	501.11	375.83	100.12	27,706.63
2044	73,445.53	508.80	381.60	101.66	28,131.57
2045	74,179.99	516.51	387.38	103.20	28,557.82
2046	74,921.79	524.24	393.18	104.74	28,985.47
2047	75,671.01	532.00	399.00	106.30	29,414.59
2048	76,427.72	539.79	404.84	107.85	29,845.23
2049	77,191.99	547.61	410.71	109.41	30,277.48
2050	77,963.91	555.46	416.59	110.98	30,711.41
2051	78,743.55	563.33	422.50	112.56	31,147.07
2052	79,530.99	571.25	428.44	114.14	31,584.55
2053	80,326.30	579.19	434.40	115.72	32,023.90
2054	81,129.56	587.18	440.38	117.32	32,465.21
2055	81,940.86	595.19	446.39	118.92	32,908.53
2056	82,760.27	603.25	452.44	120.53	33,353.93
2057	83,587.87	611.34	458.51	122.15	33,801.48
2058	84,423.75	619.48	464.61	123.77	34,251.26
2059	85,267.99	627.65	470.74	125.41	34,703.31
2060	-	635.87	476.90	127.05	35,157.72

Notes: Peak Interpolated Condensate Quantity = 0.27 gpd/cfm
(- 30F temp difference from wells to skid)

Avg Interpolated Condensate Quantity = 0.20 gpd/cfm
(- 20F temp difference from wells to skid)

APPENDIX I – LANDFILL GAS MODELING

Memorandum

Date: April 17, 2020

To: Matanuska Susitna Borough, MSB Central Landfill

From: Burns & McDonnell

Subject: Mat-Su LFG Modeling Memorandum

The Matanuska Susitna Borough (MSB) Central Landfill has accepted municipal solid waste (MSW) since 1980. Burns & McDonnell modeled the landfill gas generation rates at the MSB Central Landfill for four different scenarios using the USEPA LandGEM modeling spreadsheet.

(1) Base Case (BC), (2) Base Case with Leachate Recirculation (LR), (3) Base Case with Organics Diversion (OD), and (4) Base Case with Leachate Recirculation and Organics Diversion.

The solid waste acceptance rate for each case was assumed to increase by 1% annually. The following LandGEM inputs were kept constant for all cases: Potential Methane Generation Capacity, L_o (m^3/Mg) = 100; NMOC Concentration (ppmv as hexane) = 838 (AP-42); and Methane Content (% by volume) = 50. Due to the arid conditions of the site, a methane generation rate of 0.02 $year^{-1}$ was used for the waste in place prior to 2020 for all cases, but the methane generation rate, k, for waste placed after 2020 varied from case-to-case as presented below. The methane generation rate, k, is correlated with the amount of moisture present in the waste, which is the main factor affecting the generation of landfill gas.

<u>(1) Base Case (BC)</u>

For the Case 1, it was assumed that leachate recirculation would not take place, and no organics would be diverted. The general operations of the landfill were assumed to remain consistent with current operations. Due to the arid conditions of the site, a methane generation rate of 0.02 $year^{-1}$ was used for the (1) Base Case for the waste placed before and after 2020.

<u>(2) Base Case (BC) with Leachate Recirculation (LR)</u>

For the Case 2, it was assumed that leachate recirculation would take place, but no organics would be diverted. Due to the arid conditions of the site, a methane generation rate of 0.02 $year^{-1}$ was used for the waste in place prior to 2020. The amount of leachate to be recirculated was assumed to be great enough to increase the methane generation rate to 0.04 $year^{-1}$ which increases the rate at which landfill gas is generated in the landfill compared to Case 1.

<u>(3) Base Case (BC) with Organics Diversion (OD)</u>

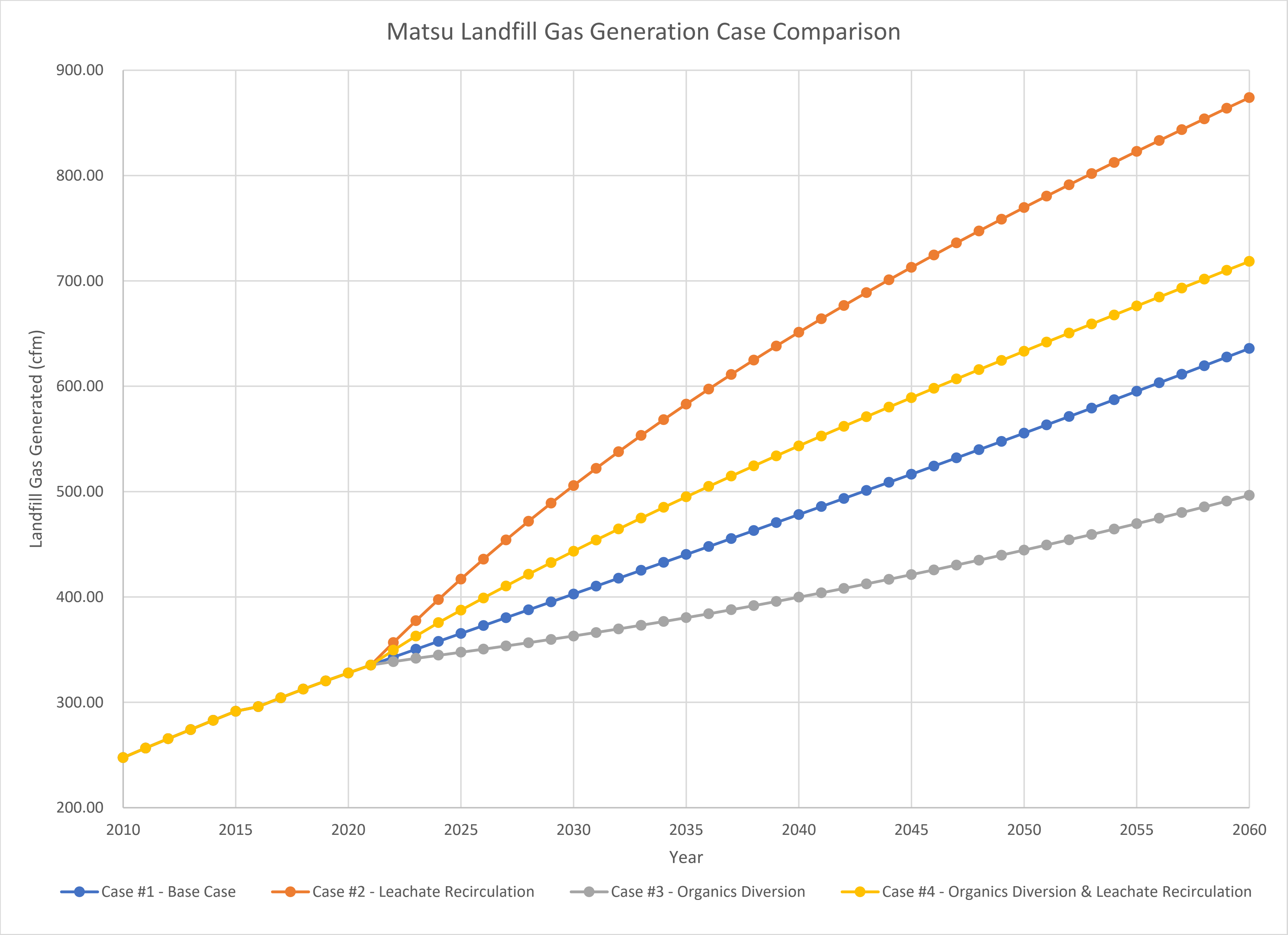
For the Case 3, it was assumed that leachate recirculation would not take place, but a portion of the organics would be diverted from the landfill. Due to the arid conditions of the site, a methane generation rate of 0.02 $year^{-1}$ was used for the waste in place prior to 2020. A recent waste characterization study completed by MSB determined that approximately 20% of the MSW accepted at the landfill is compostable; for modeling purposes, only 50% of the compostable waste is diverted. Therefore, a total of 10% of the total waste stream was assumed to be diverted. The diverted waste stream was assumed to be 50% paper and 50% food waste. Paper waste is assumed to have a k value between 0.04 and 0.05 year^{-1}, and food waste is assumed to have a k value between 0.06 and 0.12 year^{-1}. Accounting for the amount of compostable waste removed from the MSW stream, the resultant methane generation rate for the waste placed after 2020 was calculated to be 0.014 year^{-1} which decreases the rate at which landfill gas is generated in the landfill compared to Case 1.

(4) Base Case (BC) with Leachate Recirculation (LR) and Organics Diversion (OD)
For Case 4, it was assumed that both leachate recirculation and organics diversion would take place. Accounting for both an added moisture content due to leachate recirculation and a decrease in moisture content due to the removal of organics, the resultant methane generation rate, k, for the waste placed after 2020 was calculated to be 0.03 year^{-1}. This k value will increase the amount of landfill gas generated from the landfill from Case 1 but will result in less gas than Case 2.

The following table provides the model parameters and select generation rates for each case. Note that these are not rates of gas collected which would depend on the number of collectors installed at the time.

Parameter	**(1) Base Case**	**(2) BC + LR**	**(3) BC + OD**	**(4) BC + LR + OD**
Methane Generation Rate k (year^{-1}) Years 1980-2020	0.02	0.02	0.02	0.02
Methane Generation Rate k (year^{-1}) Years 2021+	0.02	0.04	0.014	0.03
LFG cfm 2030	403	506	363	443
LFG cfm 2040	478	651	400	543
LFG cfm 2050	556	770	444	633

Attachment 1: Mat-Su Landfill Gas Generation Case Comparison Chart & Table
Attachment 2: LandGEM Output Reports



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MatSu Landfill Gas Generation Case Comparison Table

	CASE 1				CASE 2	
Year	MSW - Bulk 1% inc Base	Gas Generated Base Case (no LR, no OD)	MSW - Bulk thru 2020 1% inc	bulk LFG thru 2020 k = 0.02	Recirculation 2021+ k = 0.04	Gas Generated with LR (No OD)
units	short tons	cfm LFG	short tons	cfm LFG	cfm LFG	cfm LFG
1980	13,362	-	13,362	-	-	-
1981	14,876	3.24	14,876	3.24	-	3.24
1982	17,211	6.77	17,211	6.77	-	6.77
1983	20,679	10.81	20,679	10.81	-	10.81
1984	25,469	15.60	25,469	15.60	-	15.60
1985	30,082	21.46	30,082	21.46	-	21.46
1986	32,061	28.32	32,061	28.32	-	28.32
1987	32,151	35.52	32,151	35.52	-	35.52
1988	31,014	42.60	31,014	42.60	-	42.60
1989	31,542	49.27	31,542	49.27	-	49.27
1990	32,540	55.93	32,540	55.93	-	55.93
1991	31,782	62.70	31,782	62.70	-	62.70
1992	32,834	69.16	32,834	69.16	-	69.16
1993	35,461	75.74	35,461	75.74	-	75.74
1994	35,727	82.82	35,727	82.82	-	82.82
1995	34,234	89.84	34,234	89.84	-	89.84
1996	34,250	96.35	34,250	96.35	-	96.35
1997	35,966	102.73	35,966	102.73	-	102.73
1998	40,615	109.41	40,615	109.41	-	109.41
1999	41,771	117.07	41,771	117.07	-	117.07
2000	45,758	124.87	45,758	124.87	-	124.87
2001	53,948	133.48	53,948	133.48	-	133.48
2002	53,948	143.90	53,948	143.90	-	143.90
2003	53,948	154.11	53,948	154.11	-	154.11
2004	91,484	164.12	91,484	164.12	-	164.12
2005	91,484	183.03	91,484	183.03	-	183.03
2006	91,484	201.55	91,484	201.55	-	201.55
2007	59,099	219.71	59,099	219.71	-	219.71
2008	54,834	229.67	54,834	229.67	-	229.67
2009	57,067	238.40	57,067	238.40	-	238.40
2010	57,727	247.50	57,727	247.50	-	247.50
2011	58,934	256.58	58,934	256.58	-	256.58
2012	58,602	265.45	58,602	265.45	-	265.45
2013	58,796	274.10	58,796	274.10	-	274.10
2014	58,654	282.91	58,654	282.91	-	282.91
2015	41,744	291.51	41,744	291.51	-	291.51
2016	59,174	295.85	59,174	295.85	-	295.85
2017	58,799	304.32	58,799	304.32	-	304.32
2018	57,671	312.53	57,671	312.53	-	312.53
2019	57,271	320.31	57,271	320.31	-	320.31
2020	57,843	327.83	57,843	327.83	-	327.83

MatSu Landfill Gas Generation Case Comparison Table

	CASE 1				CASE 2	
Year	MSW - Bulk 1% inc Base	Gas Generated Base Case (no LR, no OD)	MSW - Bulk thru 2020 1% inc	bulk LFG thru 2020 k = 0.02	Recirculation 2021+ k = 0.04	Gas Generated with LR (No OD)
units	short tons	cfm LFG	short tons	cfm LFG	cfm LFG	cfm LFG
2021	58,422	335.35		335.35	-	335.35
2022	59,006	342.85		328.71	28.04	356.75
2023	59,596	350.35		322.20	55.26	377.46
2024	60,192	357.84		315.82	81.70	397.52
2025	60,794	365.33		309.56	107.39	416.95
2026	61,402	372.82		303.43	132.35	435.79
2027	62,016	380.31		297.43	156.64	454.06
2028	62,636	387.79		291.54	180.26	471.80
2029	63,262	395.28		285.76	203.25	489.02
2030	63,895	402.77		280.10	225.65	505.75
2031	64,534	410.27		274.56	247.47	522.03
2032	65,179	417.77		269.12	268.74	537.86
2033	65,831	425.28		263.79	289.49	553.28
2034	66,489	432.80		258.57	309.73	568.30
2035	67,154	440.33		253.45	329.50	582.95
2036	67,826	447.87		248.43	348.81	597.24
2037	68,504	455.43		243.51	367.69	611.20
2038	69,189	463.00		238.69	386.15	624.84
2039	69,881	470.58		233.96	404.22	638.18
2040	70,580	478.18		229.33	421.91	651.24
2041	71,286	485.81		224.79	439.24	664.03
2042	71,998	493.45		220.34	456.23	676.57
2043	72,718	501.11		215.98	472.90	688.88
2044	73,446	508.80		211.70	489.26	700.96
2045	74,180	516.51		207.51	505.33	712.84
2046	74,922	524.24		203.40	521.12	724.52
2047	75,671	532.00		199.37	536.65	736.02
2048	76,428	539.79		195.42	551.92	747.35
2049	77,192	547.61		191.55	566.96	758.52
2050	77,964	555.46		187.76	581.78	769.54
2051	78,744	563.33		184.04	596.39	780.43
2052	79,531	571.25		180.40	610.80	791.20
2053	80,326	579.19		176.83	625.02	801.85
2054	81,130	587.18		173.32	639.07	812.39
2055	81,941	595.19		169.89	652.95	822.84
2056	82,760	603.25		166.53	666.68	833.21
2057	83,588	611.34		163.23	680.26	843.49
2058	84,424	619.48		160.00	693.71	853.70
2059	85,268	627.65		156.83	707.03	863.86

MatSu Landfill Gas Generation Case Comparison Table

		CASE 3		CASE 4	
Year	MSW - Bulk 1% inc reduced	bulk reduced LFG 2021+ k = 0.014	Gas Generated with OD (No LR)	bulk LFG 2021+ k = 0.03042	Gas Generated with OD & LR
units	short tons	cfm LFG	cfm LFG	cfm LFG	cfm LFG
1980		-	-	-	-
1981		-	3.24	-	3.24
1982		-	6.77	-	6.77
1983		-	10.81	-	10.81
1984		-	15.60	-	15.60
1985		-	21.46	-	21.46
1986		-	28.32	-	28.32
1987		-	35.52	-	35.52
1988		-	42.60	-	42.60
1989		-	49.27	-	49.27
1990		-	55.93	-	55.93
1991		-	62.70	-	62.70
1992		-	69.16	-	69.16
1993		-	75.74	-	75.74
1994		-	82.82	-	82.82
1995		-	89.84	-	89.84
1996		-	96.35	-	96.35
1997		-	102.73	-	102.73
1998		-	109.41	-	109.41
1999		-	117.07	-	117.07
2000		-	124.87	-	124.87
2001		-	133.48	-	133.48
2002		-	143.90	-	143.90
2003		-	154.11	-	154.11
2004		-	164.12	-	164.12
2005		-	183.03	-	183.03
2006		-	201.55	-	201.55
2007		-	219.71	-	219.71
2008		-	229.67	-	229.67
2009		-	238.40	-	238.40
2010		-	247.50	-	247.50
2011		-	256.58	-	256.58
2012		-	265.45	-	265.45
2013		-	274.10	-	274.10
2014		-	282.91	-	282.91
2015		-	291.51	-	291.51
2016		-	295.85	-	295.85
2017		-	304.32	-	304.32
2018		-	312.53	-	312.53
2019		-	320.31	-	320.31
2020		-	327.83	-	327.83

MatSu Landfill Gas Generation Case Comparison Table

		CASE 3		CASE 4	
Year	MSW - Bulk 1% inc reduced	bulk reduced LFG 2021+ k = 0.014	Gas Generated with OD (No LR)	bulk LFG 2021+ k = 0.03042	Gas Generated with OD & LR
units	short tons	cfm LFG	cfm LFG	cfm LFG	cfm LFG
2021	56,669	-	335.35	-	335.35
2022	56,056	9.90	338.61	20.77	349.48
2023	55,424	19.56	341.76	40.70	362.90
2024	54,173	28.97	344.78	59.80	375.62
2025	54,714	38.02	347.59	77.87	387.43
2026	55,262	47.04	350.48	95.59	399.02
2027	55,814	56.03	353.45	112.98	410.41
2028	56,372	64.98	356.52	130.06	421.59
2029	56,936	73.91	359.67	146.83	432.59
2030	57,505	82.80	362.90	163.30	443.40
2031	58,080	91.67	366.23	179.49	454.05
2032	58,661	100.51	369.63	195.40	464.52
2033	59,248	109.32	373.12	211.05	474.84
2034	59,840	118.12	376.69	226.45	485.02
2035	60,439	126.89	380.34	241.60	495.05
2036	61,043	135.64	384.07	256.52	504.95
2037	61,654	144.37	387.88	271.21	514.72
2038	62,270	153.08	391.77	285.68	524.37
2039	62,893	161.77	395.74	299.95	533.91
2040	63,522	170.45	399.78	314.02	543.35
2041	64,157	179.12	403.91	327.90	552.68
2042	64,799	187.77	408.11	341.59	561.93
2043	65,447	196.41	412.39	355.11	571.08
2044	66,101	205.04	416.74	368.46	580.16
2045	66,762	213.66	421.17	381.65	589.16
2046	67,430	222.28	425.68	394.69	598.09
2047	68,104	230.89	430.26	407.58	606.95
2048	68,785	239.49	434.91	420.34	615.76
2049	69,473	248.09	439.64	432.96	624.51
2050	70,168	256.68	444.44	445.45	633.21
2051	70,869	265.28	449.32	457.83	641.87
2052	71,578	273.87	454.27	470.09	650.49
2053	72,294	282.46	459.29	482.25	659.07
2054	73,017	291.06	464.39	494.30	667.62
2055	73,747	299.66	469.55	506.25	676.15
2056	74,484	308.27	474.80	518.12	684.65
2057	75,229	316.88	480.11	529.90	693.13
2058	75,981	325.50	485.50	541.60	701.60
2059	76,741	334.12	490.95	553.23	710.06

LandGEM
Landfill Gas Emissions Model
Version 3.02

U.S. Environmental Protection Agency
Office of Research and Development
National Risk Management Research Laboratory (NRMRL)
and
Clean Air Technology Center (CATC)
Research Triangle Park, North Carolina

May 2005

Summary Report

Landfill Name or Identifier: Matsu Case 1 - Base Case

Date: Friday, April 17, 2020

Description/Comments:

Matsu Landfill Gas Modeling - January 2020
Case 1 - Base Case
Assuming 1% increase annually

About LandGEM:

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n}\sum_{j=0.1}^{1} kL_o\left(\frac{M_i}{10}\right)e^{-kt_{ij}}$$

Where,

Q_{CH4} = annual methane generation in the year of the calculation (*m^3/year*)
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate (*$year^{-1}$*)
L_o = potential methane generation capacity (*m^3/Mg*)

M_i = mass of waste accepted in the i^{th} year (*Mg*)
t_{ij} = age of the j^{th} section of waste mass M_i accepted in the i^{th} year (*decimal years*, e.g., 3.2 years)

LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on EPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate. Defaults for estimating emissions for this type of operation are being developed to include in LandGEM along with defaults for convential landfills (no leachate or liquid additions) for developing emission inventories and determining CAA applicability. Refer to the Web site identified above for future updates.

Input Review

LANDFILL CHARACTERISTICS

Landfill Open Year	**1980**	
Landfill Closure Year (with 80-year limit)	**2059**	
Actual Closure Year (without limit)	***2059***	
Have Model Calculate Closure Year?	**No**	
Waste Design Capacity		*short tons*

MODEL PARAMETERS

Methane Generation Rate, k	**0.020**	*$year^{-1}$*
Potential Methane Generation Capacity, L_o	**100**	*m^3/Mg*
NMOC Concentration	**838**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	**Carbon dioxide**
Gas / Pollutant #4:	**NMOC**

WASTE ACCEPTANCE RATES

Year	**Waste Accepted**		**Waste-In-Place**	
	(Mg/year)	***(short tons/year)***	***(Mg)***	***(short tons)***
1980	12,147	13,362	0	0
1981	13,524	14,876	12,147	13,362
1982	15,646	17,211	25,671	28,238
1983	18,799	20,679	41,317	45,449
1984	23,154	25,469	60,116	66,128
1985	27,347	30,082	83,270	91,597
1986	29,146	32,061	110,617	121,679
1987	29,228	32,151	139,764	153,740
1988	28,195	31,014	168,992	185,891
1989	28,675	31,542	197,186	216,905
1990	29,582	32,540	225,861	248,447
1991	28,893	31,782	255,443	280,987
1992	29,849	32,834	284,335	312,769
1993	32,237	35,461	314,185	345,603
1994	32,479	35,727	346,422	381,064
1995	31,122	34,234	378,901	416,791
1996	31,136	34,250	410,023	451,025
1997	32,696	35,966	441,159	485,275
1998	36,923	40,615	473,855	521,241
1999	37,974	41,771	510,778	561,856
2000	41,598	45,758	548,752	603,627
2001	49,044	53,948	590,350	649,385
2002	49,044	53,948	639,394	703,333
2003	49,044	53,948	688,437	757,281
2004	83,167	91,484	737,481	811,229
2005	83,167	91,484	820,648	902,713
2006	83,167	91,484	903,815	994,197
2007	53,726	59,099	986,983	1,085,681
2008	49,849	54,834	1,040,709	1,144,780
2009	51,879	57,067	1,090,558	1,199,614
2010	52,472	57,719	1,142,437	1,256,681
2011	52,391	57,630	1,194,910	1,314,400
2012	52,216	57,437	1,247,300	1,372,030
2013	53,451	58,796	1,299,516	1,429,467
2014	53,322	58,654	1,352,967	1,488,264
2015	37,949	41,744	1,406,289	1,546,918
2016	53,795	59,174	1,444,238	1,588,662
2017	53,453	58,799	1,498,033	1,647,836
2018	52,428	57,671	1,551,486	1,706,635
2019	52,064	57,271	1,603,914	1,764,306

WASTE ACCEPTANCE RATES (Continued)

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
2020	52,585	57,843	1,655,978	1,821,576
2021	53,111	58,422	1,708,563	1,879,419
2022	53,642	59,006	1,761,674	1,937,841
2023	54,178	59,596	1,815,315	1,996,847
2024	54,720	60,192	1,869,493	2,056,443
2025	55,267	60,794	1,924,213	2,116,635
2026	55,820	61,402	1,979,480	2,177,429
2027	56,378	62,016	2,035,300	2,238,830
2028	56,942	62,636	2,091,678	2,300,846
2029	57,511	63,262	2,148,620	2,363,482
2030	58,086	63,895	2,206,131	2,426,744
2031	58,667	64,534	2,264,217	2,490,639
2032	59,254	65,179	2,322,884	2,555,173
2033	59,846	65,831	2,382,138	2,620,352
2034	60,445	66,489	2,441,985	2,686,183
2035	61,049	67,154	2,502,429	2,752,672
2036	61,660	67,826	2,563,479	2,819,827
2037	62,276	68,504	2,625,138	2,887,652
2038	62,899	69,189	2,687,415	2,956,156
2039	63,528	69,881	2,750,314	3,025,345
2040	64,163	70,580	2,813,842	3,095,226
2041	64,805	71,286	2,878,005	3,165,806
2042	65,453	71,998	2,942,810	3,237,091
2043	66,108	72,718	3,008,263	3,309,090
2044	66,769	73,446	3,074,371	3,381,808
2045	67,436	74,180	3,141,140	3,455,254
2046	68,111	74,922	3,208,576	3,529,434
2047	68,792	75,671	3,276,687	3,604,355
2048	69,480	76,428	3,345,479	3,680,026
2049	70,175	77,192	3,414,958	3,756,454
2050	70,876	77,964	3,485,133	3,833,646
2051	71,585	78,744	3,556,009	3,911,610
2052	72,301	79,531	3,627,594	3,990,354
2053	73,024	80,326	3,699,895	4,069,885
2054	73,754	81,130	3,772,919	4,150,211
2055	74,492	81,941	3,846,673	4,231,340
2056	75,237	82,760	3,921,165	4,313,281
2057	75,989	83,588	3,996,401	4,396,042
2058	76,749	84,424	4,072,390	4,479,629
2059	77,516	85,268	4,149,139	4,564,053

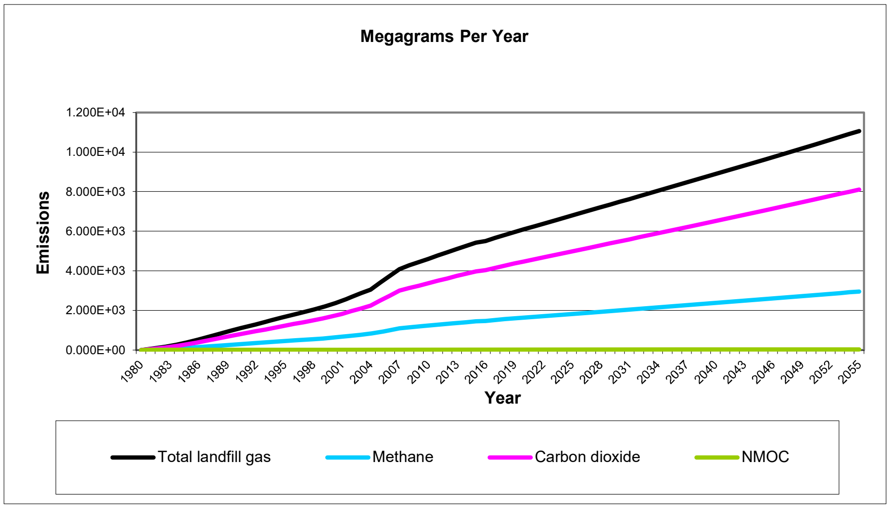
Pollutant Parameters

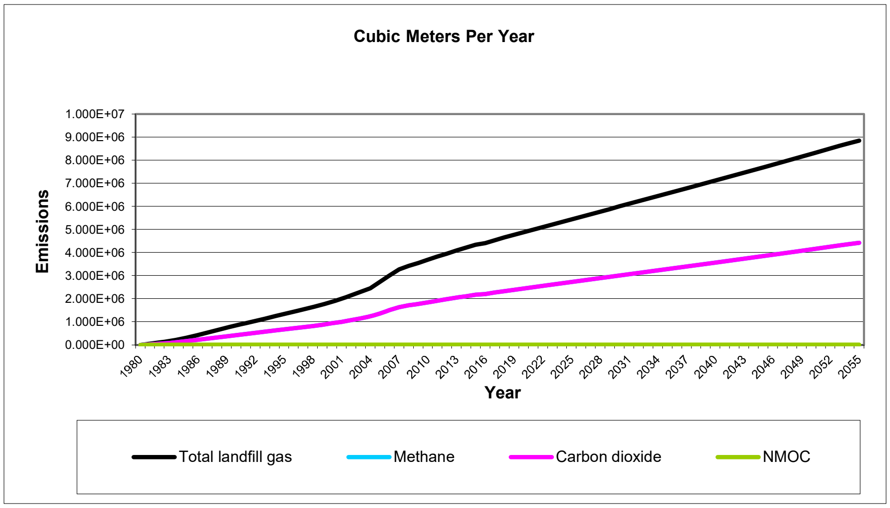
	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Gases	Total landfill gas		0.00		
	Methane		16.04		
	Carbon dioxide		44.01		
	NMOC	4,000	86.18		
Pollutants	1,1,1-Trichloroethane (methyl chloroform) - HAP	0.48	133.41		
	1,1,2,2-Tetrachloroethane - HAP/VOC	1.1	167.85		
	1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	2.4	98.97		
	1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.20	96.94		
	1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.41	98.96		
	1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.18	112.99		
	2-Propanol (isopropyl alcohol) - VOC	50	60.11		
	Acetone	7.0	58.08		
	Acrylonitrile - HAP/VOC	6.3	53.06		
	Benzene - No or Unknown Co-disposal - HAP/VOC	1.9	78.11		
	Benzene - Co-disposal - HAP/VOC	11	78.11		
	Bromodichloromethane - VOC	3.1	163.83		
	Butane - VOC	5.0	58.12		
	Carbon disulfide - HAP/VOC	0.58	76.13		
	Carbon monoxide	140	28.01		
	Carbon tetrachloride - HAP/VOC	4.0E-03	153.84		
	Carbonyl sulfide - HAP/VOC	0.49	60.07		
	Chlorobenzene - HAP/VOC	0.25	112.56		
	Chlorodifluoromethane	1.3	86.47		
	Chloroethane (ethyl chloride) - HAP/VOC	1.3	64.52		
	Chloroform - HAP/VOC	0.03	119.39		
	Chloromethane - VOC	1.2	50.49		
	Dichlorobenzene - (HAP for para isomer/VOC)	0.21	147		
	Dichlorodifluoromethane	16	120.91		
	Dichlorofluoromethane - VOC	2.6	102.92		
	Dichloromethane (methylene chloride) - HAP	14	84.94		
	Dimethyl sulfide (methyl sulfide) - VOC	7.8	62.13		
	Ethane	890	30.07		
	Ethanol - VOC	27	46.08		

Pollutant Parameters (Continued)

		Gas / Pollutant Default Parameters:		***User-specified Pollutant Parameters:***	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Pollutants	Ethyl mercaptan (ethanethiol) - VOC	2.3	62.13		
	Ethylbenzene - HAP/VOC	4.6	106.16		
	Ethylene dibromide - HAP/VOC	1.0E-03	187.88		
	Fluorotrichloromethane - VOC	0.76	137.38		
	Hexane - HAP/VOC	6.6	86.18		
	Hydrogen sulfide	36	34.08		
	Mercury (total) - HAP	2.9E-04	200.61		
	Methyl ethyl ketone - HAP/VOC	7.1	72.11		
	Methyl isobutyl ketone - HAP/VOC	1.9	100.16		
	Methyl mercaptan - VOC	2.5	48.11		
	Pentane - VOC	3.3	72.15		
	Perchloroethylene (tetrachloroethylene) - HAP	3.7	165.83		
	Propane - VOC	11	44.09		
	t-1,2-Dichloroethene - VOC	2.8	96.94		
	Toluene - No or Unknown Co-disposal - HAP/VOC	39	92.13		
	Toluene - Co-disposal - HAP/VOC	170	92.13		
	Trichloroethylene (trichloroethene) - HAP/VOC	2.8	131.40		
	Vinyl chloride - HAP/VOC	7.3	62.50		
	Xylenes - HAP/VOC	12	106.16		

Graphs


Megagrams Per Year
1.200E+04
1.000E+04
8.000E+03
6.000E+03
4.000E+03
2.000E+03
0.000E+00
Emissions
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
2025
2028
2031
2034
2037
2040
2043
2046
2049
2052
2055
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


Cubic Meters Per Year
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9.000E+06
8.000E+06
7.000E+06
6.000E+06
5.000E+06
4.000E+06
3.000E+06
2.000E+06
1.000E+06
0.000E+00
Emissions
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
2025
2028
2031
2034
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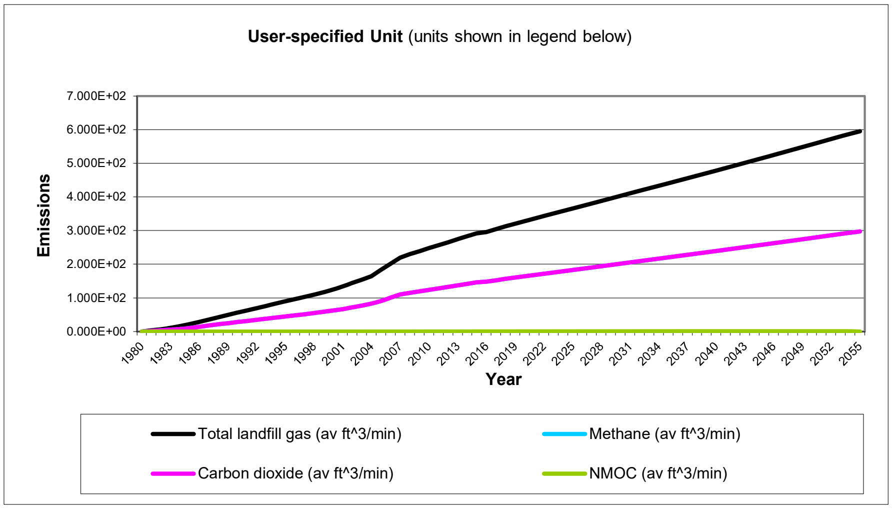
2055
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


User-specified Unit (units shown in legend below)
7.000E+02
6.000E+02
5.000E+02
4.000E+02
3.000E+02
2.000E+02
1.000E+02
0.000E+00
Emissions
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
2025
2028
2031
2034
2037
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2043
2046
2049
2052
2055
Year
Total landfill gas (av ft^3/min)
Methane (av ft^3/min)
Carbon dioxide (av ft^3/min)
NMOC (av ft^3/min)

Results

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1980	0	0	0	0	0	0
1981	6.014E+01	4.815E+04	3.235E+00	1.606E+01	2.408E+04	1.618E+00
1982	1.259E+02	1.008E+05	6.774E+00	3.363E+01	5.041E+04	3.387E+00
1983	2.009E+02	1.608E+05	1.081E+01	5.365E+01	8.042E+04	5.403E+00
1984	2.900E+02	2.322E+05	1.560E+01	7.745E+01	1.161E+05	7.800E+00
1985	3.988E+02	3.194E+05	2.146E+01	1.065E+02	1.597E+05	1.073E+01
1986	5.263E+02	4.215E+05	2.832E+01	1.406E+02	2.107E+05	1.416E+01
1987	6.602E+02	5.287E+05	3.552E+01	1.763E+02	2.643E+05	1.776E+01
1988	7.918E+02	6.341E+05	4.260E+01	2.115E+02	3.170E+05	2.130E+01
1989	9.157E+02	7.333E+05	4.927E+01	2.446E+02	3.666E+05	2.463E+01
1990	1.040E+03	8.324E+05	5.593E+01	2.777E+02	4.162E+05	2.797E+01
1991	1.165E+03	9.332E+05	6.270E+01	3.113E+02	4.666E+05	3.135E+01
1992	1.285E+03	1.029E+06	6.916E+01	3.433E+02	5.146E+05	3.458E+01
1993	1.408E+03	1.127E+06	7.574E+01	3.760E+02	5.636E+05	3.787E+01
1994	1.539E+03	1.233E+06	8.282E+01	4.112E+02	6.163E+05	4.141E+01
1995	1.670E+03	1.337E+06	8.984E+01	4.460E+02	6.685E+05	4.492E+01
1996	1.791E+03	1.434E+06	9.635E+01	4.783E+02	7.170E+05	4.817E+01
1997	1.909E+03	1.529E+06	1.027E+02	5.100E+02	7.645E+05	5.137E+01
1998	2.033E+03	1.628E+06	1.094E+02	5.432E+02	8.142E+05	5.470E+01
1999	2.176E+03	1.742E+06	1.171E+02	5.812E+02	8.712E+05	5.854E+01
2000	2.321E+03	1.858E+06	1.249E+02	6.199E+02	9.292E+05	6.244E+01
2001	2.481E+03	1.987E+06	1.335E+02	6.627E+02	9.933E+05	6.674E+01
2002	2.675E+03	2.142E+06	1.439E+02	7.144E+02	1.071E+06	7.195E+01
2003	2.864E+03	2.294E+06	1.541E+02	7.651E+02	1.147E+06	7.706E+01
2004	3.050E+03	2.443E+06	1.641E+02	8.148E+02	1.221E+06	8.206E+01
2005	3.402E+03	2.724E+06	1.830E+02	9.087E+02	1.362E+06	9.151E+01
2006	3.746E+03	3.000E+06	2.016E+02	1.001E+03	1.500E+06	1.008E+02
2007	4.084E+03	3.270E+06	2.197E+02	1.091E+03	1.635E+06	1.099E+02
2008	4.269E+03	3.418E+06	2.297E+02	1.140E+03	1.709E+06	1.148E+02
2009	4.431E+03	3.548E+06	2.384E+02	1.184E+03	1.774E+06	1.192E+02
2010	4.600E+03	3.684E+06	2.475E+02	1.229E+03	1.842E+06	1.238E+02
2011	4.769E+03	3.819E+06	2.566E+02	1.274E+03	1.909E+06	1.283E+02
2012	4.934E+03	3.951E+06	2.655E+02	1.318E+03	1.975E+06	1.327E+02
2013	5.095E+03	4.080E+06	2.741E+02	1.361E+03	2.040E+06	1.371E+02
2014	5.258E+03	4.211E+06	2.829E+02	1.405E+03	2.105E+06	1.415E+02
2015	5.418E+03	4.339E+06	2.915E+02	1.447E+03	2.169E+06	1.458E+02
2016	5.499E+03	4.403E+06	2.958E+02	1.469E+03	2.202E+06	1.479E+02
2017	5.656E+03	4.529E+06	3.043E+02	1.511E+03	2.265E+06	1.522E+02
2018	5.809E+03	4.651E+06	3.125E+02	1.552E+03	2.326E+06	1.563E+02
2019	5.953E+03	4.767E+06	3.203E+02	1.590E+03	2.384E+06	1.602E+02
2020	6.093E+03	4.879E+06	3.278E+02	1.628E+03	2.440E+06	1.639E+02
2021	6.233E+03	4.991E+06	3.353E+02	1.665E+03	2.496E+06	1.677E+02
2022	6.372E+03	5.103E+06	3.429E+02	1.702E+03	2.551E+06	1.714E+02
2023	6.512E+03	5.214E+06	3.504E+02	1.739E+03	2.607E+06	1.752E+02
2024	6.651E+03	5.326E+06	3.578E+02	1.777E+03	2.663E+06	1.789E+02
2025	6.790E+03	5.437E+06	3.653E+02	1.814E+03	2.719E+06	1.827E+02
2026	6.929E+03	5.549E+06	3.728E+02	1.851E+03	2.774E+06	1.864E+02
2027	7.069E+03	5.660E+06	3.803E+02	1.888E+03	2.830E+06	1.902E+02
2028	7.208E+03	5.772E+06	3.878E+02	1.925E+03	2.886E+06	1.939E+02
2029	7.347E+03	5.883E+06	3.953E+02	1.962E+03	2.942E+06	1.976E+02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2030	7.486E+03	5.995E+06	4.028E+02	2.000E+03	2.997E+06	2.014E+02
2031	7.625E+03	6.106E+06	4.103E+02	2.037E+03	3.053E+06	2.051E+02
2032	7.765E+03	6.218E+06	4.178E+02	2.074E+03	3.109E+06	2.089E+02
2033	7.904E+03	6.330E+06	4.253E+02	2.111E+03	3.165E+06	2.126E+02
2034	8.044E+03	6.441E+06	4.328E+02	2.149E+03	3.221E+06	2.164E+02
2035	8.184E+03	6.554E+06	4.403E+02	2.186E+03	3.277E+06	2.202E+02
2036	8.324E+03	6.666E+06	4.479E+02	2.224E+03	3.333E+06	2.239E+02
2037	8.465E+03	6.778E+06	4.554E+02	2.261E+03	3.389E+06	2.277E+02
2038	8.605E+03	6.891E+06	4.630E+02	2.299E+03	3.445E+06	2.315E+02
2039	8.746E+03	7.004E+06	4.706E+02	2.336E+03	3.502E+06	2.353E+02
2040	8.888E+03	7.117E+06	4.782E+02	2.374E+03	3.558E+06	2.391E+02
2041	9.029E+03	7.230E+06	4.858E+02	2.412E+03	3.615E+06	2.429E+02
2042	9.171E+03	7.344E+06	4.934E+02	2.450E+03	3.672E+06	2.467E+02
2043	9.314E+03	7.458E+06	5.011E+02	2.488E+03	3.729E+06	2.506E+02
2044	9.457E+03	7.573E+06	5.088E+02	2.526E+03	3.786E+06	2.544E+02
2045	9.600E+03	7.687E+06	5.165E+02	2.564E+03	3.844E+06	2.583E+02
2046	9.744E+03	7.802E+06	5.242E+02	2.603E+03	3.901E+06	2.621E+02
2047	9.888E+03	7.918E+06	5.320E+02	2.641E+03	3.959E+06	2.660E+02
2048	1.003E+04	8.034E+06	5.398E+02	2.680E+03	4.017E+06	2.699E+02
2049	1.018E+04	8.150E+06	5.476E+02	2.719E+03	4.075E+06	2.738E+02
2050	1.032E+04	8.267E+06	5.555E+02	2.758E+03	4.133E+06	2.777E+02
2051	1.047E+04	8.384E+06	5.633E+02	2.797E+03	4.192E+06	2.817E+02
2052	1.062E+04	8.502E+06	5.712E+02	2.836E+03	4.251E+06	2.856E+02
2053	1.077E+04	8.620E+06	5.792E+02	2.875E+03	4.310E+06	2.896E+02
2054	1.091E+04	8.739E+06	5.872E+02	2.915E+03	4.370E+06	2.936E+02
2055	1.106E+04	8.858E+06	5.952E+02	2.955E+03	4.429E+06	2.976E+02
2056	1.121E+04	8.978E+06	6.032E+02	2.995E+03	4.489E+06	3.016E+02
2057	1.136E+04	9.099E+06	6.113E+02	3.035E+03	4.549E+06	3.057E+02
2058	1.151E+04	9.220E+06	6.195E+02	3.075E+03	4.610E+06	3.097E+02
2059	1.167E+04	9.341E+06	6.277E+02	3.116E+03	4.671E+06	3.138E+02
2060	1.182E+04	9.464E+06	6.359E+02	3.157E+03	4.732E+06	3.179E+02
2061	1.158E+04	9.276E+06	6.233E+02	3.094E+03	4.638E+06	3.116E+02
2062	1.136E+04	9.093E+06	6.109E+02	3.033E+03	4.546E+06	3.055E+02
2063	1.113E+04	8.913E+06	5.988E+02	2.973E+03	4.456E+06	2.994E+02
2064	1.091E+04	8.736E+06	5.870E+02	2.914E+03	4.368E+06	2.935E+02
2065	1.069E+04	8.563E+06	5.754E+02	2.856E+03	4.282E+06	2.877E+02
2066	1.048E+04	8.394E+06	5.640E+02	2.800E+03	4.197E+06	2.820E+02
2067	1.027E+04	8.227E+06	5.528E+02	2.744E+03	4.114E+06	2.764E+02
2068	1.007E+04	8.065E+06	5.419E+02	2.690E+03	4.032E+06	2.709E+02
2069	9.872E+03	7.905E+06	5.311E+02	2.637E+03	3.952E+06	2.656E+02
2070	9.676E+03	7.748E+06	5.206E+02	2.585E+03	3.874E+06	2.603E+02
2071	9.485E+03	7.595E+06	5.103E+02	2.533E+03	3.797E+06	2.551E+02
2072	9.297E+03	7.445E+06	5.002E+02	2.483E+03	3.722E+06	2.501E+02
2073	9.113E+03	7.297E+06	4.903E+02	2.434E+03	3.649E+06	2.451E+02
2074	8.932E+03	7.153E+06	4.806E+02	2.386E+03	3.576E+06	2.403E+02
2075	8.755E+03	7.011E+06	4.711E+02	2.339E+03	3.505E+06	2.355E+02
2076	8.582E+03	6.872E+06	4.617E+02	2.292E+03	3.436E+06	2.309E+02
2077	8.412E+03	6.736E+06	4.526E+02	2.247E+03	3.368E+06	2.263E+02
2078	8.246E+03	6.603E+06	4.436E+02	2.202E+03	3.301E+06	2.218E+02
2079	8.082E+03	6.472E+06	4.348E+02	2.159E+03	3.236E+06	2.174E+02
2080	7.922E+03	6.344E+06	4.262E+02	2.116E+03	3.172E+06	2.131E+02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2081	7.765E+03	6.218E+06	4.178E+02	2.074E+03	3.109E+06	2.089E+02
2082	7.612E+03	6.095E+06	4.095E+02	2.033E+03	3.048E+06	2.048E+02
2083	7.461E+03	5.974E+06	4.014E+02	1.993E+03	2.987E+06	2.007E+02
2084	7.313E+03	5.856E+06	3.935E+02	1.953E+03	2.928E+06	1.967E+02
2085	7.168E+03	5.740E+06	3.857E+02	1.915E+03	2.870E+06	1.928E+02
2086	7.026E+03	5.626E+06	3.780E+02	1.877E+03	2.813E+06	1.890E+02
2087	6.887E+03	5.515E+06	3.706E+02	1.840E+03	2.758E+06	1.853E+02
2088	6.751E+03	5.406E+06	3.632E+02	1.803E+03	2.703E+06	1.816E+02
2089	6.617E+03	5.299E+06	3.560E+02	1.768E+03	2.649E+06	1.780E+02
2090	6.486E+03	5.194E+06	3.490E+02	1.733E+03	2.597E+06	1.745E+02
2091	6.358E+03	5.091E+06	3.421E+02	1.698E+03	2.546E+06	1.710E+02
2092	6.232E+03	4.990E+06	3.353E+02	1.665E+03	2.495E+06	1.676E+02
2093	6.108E+03	4.891E+06	3.287E+02	1.632E+03	2.446E+06	1.643E+02
2094	5.988E+03	4.795E+06	3.221E+02	1.599E+03	2.397E+06	1.611E+02
2095	5.869E+03	4.700E+06	3.158E+02	1.568E+03	2.350E+06	1.579E+02
2096	5.753E+03	4.607E+06	3.095E+02	1.537E+03	2.303E+06	1.548E+02
2097	5.639E+03	4.515E+06	3.034E+02	1.506E+03	2.258E+06	1.517E+02
2098	5.527E+03	4.426E+06	2.974E+02	1.476E+03	2.213E+06	1.487E+02
2099	5.418E+03	4.338E+06	2.915E+02	1.447E+03	2.169E+06	1.457E+02
2100	5.310E+03	4.252E+06	2.857E+02	1.418E+03	2.126E+06	1.429E+02
2101	5.205E+03	4.168E+06	2.801E+02	1.390E+03	2.084E+06	1.400E+02
2102	5.102E+03	4.086E+06	2.745E+02	1.363E+03	2.043E+06	1.373E+02
2103	5.001E+03	4.005E+06	2.691E+02	1.336E+03	2.002E+06	1.345E+02
2104	4.902E+03	3.925E+06	2.637E+02	1.309E+03	1.963E+06	1.319E+02
2105	4.805E+03	3.848E+06	2.585E+02	1.283E+03	1.924E+06	1.293E+02
2106	4.710E+03	3.772E+06	2.534E+02	1.258E+03	1.886E+06	1.267E+02
2107	4.617E+03	3.697E+06	2.484E+02	1.233E+03	1.848E+06	1.242E+02
2108	4.525E+03	3.624E+06	2.435E+02	1.209E+03	1.812E+06	1.217E+02
2109	4.436E+03	3.552E+06	2.387E+02	1.185E+03	1.776E+06	1.193E+02
2110	4.348E+03	3.482E+06	2.339E+02	1.161E+03	1.741E+06	1.170E+02
2111	4.262E+03	3.413E+06	2.293E+02	1.138E+03	1.706E+06	1.146E+02
2112	4.177E+03	3.345E+06	2.248E+02	1.116E+03	1.673E+06	1.124E+02
2113	4.095E+03	3.279E+06	2.203E+02	1.094E+03	1.639E+06	1.102E+02
2114	4.014E+03	3.214E+06	2.159E+02	1.072E+03	1.607E+06	1.080E+02
2115	3.934E+03	3.150E+06	2.117E+02	1.051E+03	1.575E+06	1.058E+02
2116	3.856E+03	3.088E+06	2.075E+02	1.030E+03	1.544E+06	1.037E+02
2117	3.780E+03	3.027E+06	2.034E+02	1.010E+03	1.513E+06	1.017E+02
2118	3.705E+03	2.967E+06	1.993E+02	9.896E+02	1.483E+06	9.967E+01
2119	3.632E+03	2.908E+06	1.954E+02	9.700E+02	1.454E+06	9.770E+01
2120	3.560E+03	2.850E+06	1.915E+02	9.508E+02	1.425E+06	9.576E+01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1980	0	0	0	0	0	0
1981	4.407E+01	2.408E+04	1.618E+00	1.446E-01	4.035E+01	2.711E-03
1982	9.227E+01	5.041E+04	3.387E+00	3.028E-01	8.448E+01	5.676E-03
1983	1.472E+02	8.042E+04	5.403E+00	4.831E-01	1.348E+02	9.056E-03
1984	2.125E+02	1.161E+05	7.800E+00	6.974E-01	1.946E+02	1.307E-02
1985	2.923E+02	1.597E+05	1.073E+01	9.593E-01	2.676E+02	1.798E-02
1986	3.857E+02	2.107E+05	1.416E+01	1.266E+00	3.532E+02	2.373E-02
1987	4.838E+02	2.643E+05	1.776E+01	1.588E+00	4.430E+02	2.977E-02
1988	5.803E+02	3.170E+05	2.130E+01	1.905E+00	5.313E+02	3.570E-02
1989	6.711E+02	3.666E+05	2.463E+01	2.203E+00	6.145E+02	4.129E-02
1990	7.619E+02	4.162E+05	2.797E+01	2.500E+00	6.976E+02	4.687E-02
1991	8.541E+02	4.666E+05	3.135E+01	2.803E+00	7.820E+02	5.254E-02
1992	9.420E+02	5.146E+05	3.458E+01	3.092E+00	8.625E+02	5.795E-02
1993	1.032E+03	5.636E+05	3.787E+01	3.386E+00	9.446E+02	6.347E-02
1994	1.128E+03	6.163E+05	4.141E+01	3.703E+00	1.033E+03	6.941E-02
1995	1.224E+03	6.685E+05	4.492E+01	4.016E+00	1.120E+03	7.528E-02
1996	1.312E+03	7.170E+05	4.817E+01	4.307E+00	1.202E+03	8.074E-02
1997	1.399E+03	7.645E+05	5.137E+01	4.593E+00	1.281E+03	8.609E-02
1998	1.490E+03	8.142E+05	5.470E+01	4.891E+00	1.365E+03	9.168E-02
1999	1.595E+03	8.712E+05	5.854E+01	5.234E+00	1.460E+03	9.811E-02
2000	1.701E+03	9.292E+05	6.244E+01	5.582E+00	1.557E+03	1.046E-01
2001	1.818E+03	9.933E+05	6.674E+01	5.967E+00	1.665E+03	1.119E-01
2002	1.960E+03	1.071E+06	7.195E+01	6.433E+00	1.795E+03	1.206E-01
2003	2.099E+03	1.147E+06	7.706E+01	6.890E+00	1.922E+03	1.291E-01
2004	2.236E+03	1.221E+06	8.206E+01	7.337E+00	2.047E+03	1.375E-01
2005	2.493E+03	1.362E+06	9.151E+01	8.182E+00	2.283E+03	1.534E-01
2006	2.746E+03	1.500E+06	1.008E+02	9.011E+00	2.514E+03	1.689E-01
2007	2.993E+03	1.635E+06	1.099E+02	9.823E+00	2.740E+03	1.841E-01
2008	3.129E+03	1.709E+06	1.148E+02	1.027E+01	2.865E+03	1.925E-01
2009	3.247E+03	1.774E+06	1.192E+02	1.066E+01	2.973E+03	1.998E-01
2010	3.371E+03	1.842E+06	1.238E+02	1.106E+01	3.087E+03	2.074E-01
2011	3.495E+03	1.909E+06	1.283E+02	1.147E+01	3.200E+03	2.150E-01
2012	3.616E+03	1.975E+06	1.327E+02	1.187E+01	3.311E+03	2.224E-01
2013	3.734E+03	2.040E+06	1.371E+02	1.225E+01	3.419E+03	2.297E-01
2014	3.854E+03	2.105E+06	1.415E+02	1.265E+01	3.529E+03	2.371E-01
2015	3.971E+03	2.169E+06	1.458E+02	1.303E+01	3.636E+03	2.443E-01
2016	4.030E+03	2.202E+06	1.479E+02	1.323E+01	3.690E+03	2.479E-01
2017	4.145E+03	2.265E+06	1.522E+02	1.360E+01	3.795E+03	2.550E-01
2018	4.257E+03	2.326E+06	1.563E+02	1.397E+01	3.898E+03	2.619E-01
2019	4.363E+03	2.384E+06	1.602E+02	1.432E+01	3.995E+03	2.684E-01
2020	4.466E+03	2.440E+06	1.639E+02	1.466E+01	4.089E+03	2.747E-01
2021	4.568E+03	2.496E+06	1.677E+02	1.499E+01	4.182E+03	2.810E-01
2022	4.670E+03	2.551E+06	1.714E+02	1.533E+01	4.276E+03	2.873E-01
2023	4.772E+03	2.607E+06	1.752E+02	1.566E+01	4.370E+03	2.936E-01
2024	4.874E+03	2.663E+06	1.789E+02	1.600E+01	4.463E+03	2.999E-01
2025	4.977E+03	2.719E+06	1.827E+02	1.633E+01	4.556E+03	3.061E-01
2026	5.078E+03	2.774E+06	1.864E+02	1.667E+01	4.650E+03	3.124E-01
2027	5.180E+03	2.830E+06	1.902E+02	1.700E+01	4.743E+03	3.187E-01
2028	5.282E+03	2.886E+06	1.939E+02	1.734E+01	4.837E+03	3.250E-01
2029	5.384E+03	2.942E+06	1.976E+02	1.767E+01	4.930E+03	3.312E-01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2030	5.486E+03	2.997E+06	2.014E+02	1.801E+01	5.023E+03	3.375E-01
2031	5.589E+03	3.053E+06	2.051E+02	1.834E+01	5.117E+03	3.438E-01
2032	5.691E+03	3.109E+06	2.089E+02	1.868E+01	5.210E+03	3.501E-01
2033	5.793E+03	3.165E+06	2.126E+02	1.901E+01	5.304E+03	3.564E-01
2034	5.896E+03	3.221E+06	2.164E+02	1.935E+01	5.398E+03	3.627E-01
2035	5.998E+03	3.277E+06	2.202E+02	1.969E+01	5.492E+03	3.690E-01
2036	6.101E+03	3.333E+06	2.239E+02	2.002E+01	5.586E+03	3.753E-01
2037	6.204E+03	3.389E+06	2.277E+02	2.036E+01	5.680E+03	3.816E-01
2038	6.307E+03	3.445E+06	2.315E+02	2.070E+01	5.775E+03	3.880E-01
2039	6.410E+03	3.502E+06	2.353E+02	2.104E+01	5.869E+03	3.943E-01
2040	6.514E+03	3.558E+06	2.391E+02	2.138E+01	5.964E+03	4.007E-01
2041	6.618E+03	3.615E+06	2.429E+02	2.172E+01	6.059E+03	4.071E-01
2042	6.722E+03	3.672E+06	2.467E+02	2.206E+01	6.154E+03	4.135E-01
2043	6.826E+03	3.729E+06	2.506E+02	2.240E+01	6.250E+03	4.199E-01
2044	6.931E+03	3.786E+06	2.544E+02	2.275E+01	6.346E+03	4.264E-01
2045	7.036E+03	3.844E+06	2.583E+02	2.309E+01	6.442E+03	4.328E-01
2046	7.141E+03	3.901E+06	2.621E+02	2.344E+01	6.538E+03	4.393E-01
2047	7.247E+03	3.959E+06	2.660E+02	2.378E+01	6.635E+03	4.458E-01
2048	7.353E+03	4.017E+06	2.699E+02	2.413E+01	6.732E+03	4.523E-01
2049	7.459E+03	4.075E+06	2.738E+02	2.448E+01	6.830E+03	4.589E-01
2050	7.566E+03	4.133E+06	2.777E+02	2.483E+01	6.928E+03	4.655E-01
2051	7.674E+03	4.192E+06	2.817E+02	2.518E+01	7.026E+03	4.721E-01
2052	7.781E+03	4.251E+06	2.856E+02	2.554E+01	7.125E+03	4.787E-01
2053	7.890E+03	4.310E+06	2.896E+02	2.589E+01	7.224E+03	4.854E-01
2054	7.998E+03	4.370E+06	2.936E+02	2.625E+01	7.323E+03	4.921E-01
2055	8.108E+03	4.429E+06	2.976E+02	2.661E+01	7.423E+03	4.988E-01
2056	8.217E+03	4.489E+06	3.016E+02	2.697E+01	7.524E+03	5.055E-01
2057	8.328E+03	4.549E+06	3.057E+02	2.733E+01	7.625E+03	5.123E-01
2058	8.438E+03	4.610E+06	3.097E+02	2.769E+01	7.726E+03	5.191E-01
2059	8.550E+03	4.671E+06	3.138E+02	2.806E+01	7.828E+03	5.260E-01
2060	8.662E+03	4.732E+06	3.179E+02	2.843E+01	7.931E+03	5.329E-01
2061	8.490E+03	4.638E+06	3.116E+02	2.786E+01	7.774E+03	5.223E-01
2062	8.322E+03	4.546E+06	3.055E+02	2.731E+01	7.620E+03	5.120E-01
2063	8.157E+03	4.456E+06	2.994E+02	2.677E+01	7.469E+03	5.018E-01
2064	7.996E+03	4.368E+06	2.935E+02	2.624E+01	7.321E+03	4.919E-01
2065	7.837E+03	4.282E+06	2.877E+02	2.572E+01	7.176E+03	4.822E-01
2066	7.682E+03	4.197E+06	2.820E+02	2.521E+01	7.034E+03	4.726E-01
2067	7.530E+03	4.114E+06	2.764E+02	2.471E+01	6.895E+03	4.632E-01
2068	7.381E+03	4.032E+06	2.709E+02	2.422E+01	6.758E+03	4.541E-01
2069	7.235E+03	3.952E+06	2.656E+02	2.374E+01	6.624E+03	4.451E-01
2070	7.092E+03	3.874E+06	2.603E+02	2.327E+01	6.493E+03	4.363E-01
2071	6.951E+03	3.797E+06	2.551E+02	2.281E+01	6.365E+03	4.276E-01
2072	6.814E+03	3.722E+06	2.501E+02	2.236E+01	6.238E+03	4.192E-01
2073	6.679E+03	3.649E+06	2.451E+02	2.192E+01	6.115E+03	4.109E-01
2074	6.546E+03	3.576E+06	2.403E+02	2.148E+01	5.994E+03	4.027E-01
2075	6.417E+03	3.505E+06	2.355E+02	2.106E+01	5.875E+03	3.948E-01
2076	6.290E+03	3.436E+06	2.309E+02	2.064E+01	5.759E+03	3.869E-01
2077	6.165E+03	3.368E+06	2.263E+02	2.023E+01	5.645E+03	3.793E-01
2078	6.043E+03	3.301E+06	2.218E+02	1.983E+01	5.533E+03	3.718E-01
2079	5.923E+03	3.236E+06	2.174E+02	1.944E+01	5.423E+03	3.644E-01
2080	5.806E+03	3.172E+06	2.131E+02	1.906E+01	5.316E+03	3.572E-01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2081	5.691E+03	3.109E+06	2.089E+02	1.868E+01	5.211E+03	3.501E-01
2082	5.578E+03	3.048E+06	2.048E+02	1.831E+01	5.108E+03	3.432E-01
2083	5.468E+03	2.987E+06	2.007E+02	1.795E+01	5.007E+03	3.364E-01
2084	5.360E+03	2.928E+06	1.967E+02	1.759E+01	4.907E+03	3.297E-01
2085	5.254E+03	2.870E+06	1.928E+02	1.724E+01	4.810E+03	3.232E-01
2086	5.150E+03	2.813E+06	1.890E+02	1.690E+01	4.715E+03	3.168E-01
2087	5.048E+03	2.758E+06	1.853E+02	1.657E+01	4.622E+03	3.105E-01
2088	4.948E+03	2.703E+06	1.816E+02	1.624E+01	4.530E+03	3.044E-01
2089	4.850E+03	2.649E+06	1.780E+02	1.592E+01	4.440E+03	2.983E-01
2090	4.754E+03	2.597E+06	1.745E+02	1.560E+01	4.352E+03	2.924E-01
2091	4.660E+03	2.546E+06	1.710E+02	1.529E+01	4.266E+03	2.866E-01
2092	4.567E+03	2.495E+06	1.676E+02	1.499E+01	4.182E+03	2.810E-01
2093	4.477E+03	2.446E+06	1.643E+02	1.469E+01	4.099E+03	2.754E-01
2094	4.388E+03	2.397E+06	1.611E+02	1.440E+01	4.018E+03	2.700E-01
2095	4.301E+03	2.350E+06	1.579E+02	1.412E+01	3.938E+03	2.646E-01
2096	4.216E+03	2.303E+06	1.548E+02	1.384E+01	3.860E+03	2.594E-01
2097	4.133E+03	2.258E+06	1.517E+02	1.356E+01	3.784E+03	2.542E-01
2098	4.051E+03	2.213E+06	1.487E+02	1.329E+01	3.709E+03	2.492E-01
2099	3.971E+03	2.169E+06	1.457E+02	1.303E+01	3.635E+03	2.443E-01
2100	3.892E+03	2.126E+06	1.429E+02	1.277E+01	3.563E+03	2.394E-01
2101	3.815E+03	2.084E+06	1.400E+02	1.252E+01	3.493E+03	2.347E-01
2102	3.739E+03	2.043E+06	1.373E+02	1.227E+01	3.424E+03	2.300E-01
2103	3.665E+03	2.002E+06	1.345E+02	1.203E+01	3.356E+03	2.255E-01
2104	3.593E+03	1.963E+06	1.319E+02	1.179E+01	3.290E+03	2.210E-01
2105	3.522E+03	1.924E+06	1.293E+02	1.156E+01	3.224E+03	2.166E-01
2106	3.452E+03	1.886E+06	1.267E+02	1.133E+01	3.161E+03	2.124E-01
2107	3.384E+03	1.848E+06	1.242E+02	1.110E+01	3.098E+03	2.082E-01
2108	3.317E+03	1.812E+06	1.217E+02	1.088E+01	3.037E+03	2.040E-01
2109	3.251E+03	1.776E+06	1.193E+02	1.067E+01	2.976E+03	2.000E-01
2110	3.186E+03	1.741E+06	1.170E+02	1.046E+01	2.918E+03	1.960E-01
2111	3.123E+03	1.706E+06	1.146E+02	1.025E+01	2.860E+03	1.921E-01
2112	3.062E+03	1.673E+06	1.124E+02	1.005E+01	2.803E+03	1.883E-01
2113	3.001E+03	1.639E+06	1.102E+02	9.849E+00	2.748E+03	1.846E-01
2114	2.941E+03	1.607E+06	1.080E+02	9.654E+00	2.693E+03	1.810E-01
2115	2.883E+03	1.575E+06	1.058E+02	9.463E+00	2.640E+03	1.774E-01
2116	2.826E+03	1.544E+06	1.037E+02	9.275E+00	2.588E+03	1.739E-01
2117	2.770E+03	1.513E+06	1.017E+02	9.092E+00	2.536E+03	1.704E-01
2118	2.715E+03	1.483E+06	9.967E+01	8.912E+00	2.486E+03	1.670E-01
2119	2.662E+03	1.454E+06	9.770E+01	8.735E+00	2.437E+03	1.637E-01
2120	2.609E+03	1.425E+06	9.576E+01	8.562E+00	2.389E+03	1.605E-01


LandGEM - Version 3.02

US EPA Office of Research and Development

CLEAN
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LandGEM
Landfill Gas Emissions Model
Version 3.02

U.S. Environmental Protection Agency
Office of Research and Development
National Risk Management Research Laboratory (NRMRL)
and
Clean Air Technology Center (CATC)
Research Triangle Park, North Carolina

May 2005

Summary Report

Landfill Name or Identifier: Matsu Case 2 - Recirculation Case

Date: Friday, April 17, 2020

Description/Comments:
Matsu Landfill Gas Modeling - revised March 2020
Case 2 - Recirculation Case starting in 2021
Assuming enough leachate is recirculated to increase k value

About LandGEM:

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} k L_o \left(\frac{M_i}{10} \right) e^{-k t_{ij}}$$

Where,
Q_{CH4} = annual methane generation in the year of the calculation *(m^3/year)*
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate *(year^{-1})*
L_o = potential methane generation capacity *(m^3/Mg)*
M_i = mass of waste accepted in the ith year *(Mg)*
t_{ij} = age of the jth section of waste mass M_i accepted in the ith year *(decimal years*, e.g., 3.2 years)

LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on EPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate. Defaults for estimating emissions for this type of operation are being developed to include in LandGEM along with defaults for convential landfills (no leachate or liquid additions) for developing emission inventories and determining CAA applicability. Refer to the Web site identified above for future updates.

Input Review

LANDFILL CHARACTERISTICS

Landfill Open Year	**1980**	
Landfill Closure Year (with 80-year limit)	**2059**	
Actual Closure Year (without limit)	***2059***	
Have Model Calculate Closure Year?	**No**	
Waste Design Capacity		*short tons*

MODEL PARAMETERS

Methane Generation Rate, k	**0.040**	*$year^{-1}$*
Potential Methane Generation Capacity, L_o	**100**	*m^3/Mg*
NMOC Concentration	**838**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	**Carbon dioxide**
Gas / Pollutant #4:	**NMOC**

WASTE ACCEPTANCE RATES

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
1980	0	0	0	0
1981	0	0	0	0
1982	0	0	0	0
1983	0	0	0	0
1984	0	0	0	0
1985	0	0	0	0
1986	0	0	0	0
1987	0	0	0	0
1988	0	0	0	0
1989	0	0	0	0
1990	0	0	0	0
1991	0	0	0	0
1992	0	0	0	0
1993	0	0	0	0
1994	0	0	0	0
1995	0	0	0	0
1996	0	0	0	0
1997	0	0	0	0
1998	0	0	0	0
1999	0	0	0	0
2000	0	0	0	0
2001	0	0	0	0
2002	0	0	0	0
2003	0	0	0	0
2004	0	0	0	0
2005	0	0	0	0
2006	0	0	0	0
2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	0	0	0	0
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0

WASTE ACCEPTANCE RATES (Continued)

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
2020	0	0	0	0
2021	53,111	58,422	0	0
2022	53,642	59,006	53,111	58,422
2023	54,178	59,596	106,752	117,428
2024	54,720	60,192	160,930	177,023
2025	55,267	60,794	215,650	237,215
2026	55,820	61,402	270,917	298,009
2027	56,378	62,016	326,737	359,411
2028	56,942	62,636	383,115	421,427
2029	57,511	63,262	440,057	484,063
2030	58,086	63,895	497,568	547,325
2031	58,667	64,534	555,654	611,220
2032	59,254	65,179	614,321	675,754
2033	59,846	65,831	673,575	740,933
2034	60,445	66,489	733,422	806,764
2035	61,049	67,154	793,866	873,253
2036	61,660	67,826	854,916	940,407
2037	62,276	68,504	916,575	1,008,233
2038	62,899	69,189	978,852	1,076,737
2039	63,528	69,881	1,041,751	1,145,926
2040	64,163	70,580	1,105,279	1,215,807
2041	64,805	71,286	1,169,442	1,286,386
2042	65,453	71,998	1,234,247	1,357,672
2043	66,108	72,718	1,299,700	1,429,670
2044	66,769	73,446	1,365,808	1,502,389
2045	67,436	74,180	1,432,577	1,575,834
2046	68,111	74,922	1,500,013	1,650,014
2047	68,792	75,671	1,568,124	1,724,936
2048	69,480	76,428	1,636,915	1,800,607
2049	70,175	77,192	1,706,395	1,877,035
2050	70,876	77,964	1,776,570	1,954,227
2051	71,585	78,744	1,847,446	2,032,191
2052	72,301	79,531	1,919,031	2,110,934
2053	73,024	80,326	1,991,332	2,190,465
2054	73,754	81,130	2,064,356	2,270,792
2055	74,492	81,941	2,138,110	2,351,921
2056	75,237	82,760	2,212,602	2,433,862
2057	75,989	83,588	2,287,838	2,516,622
2058	76,749	84,424	2,363,827	2,600,210
2059	77,516	85,268	2,440,576	2,684,634

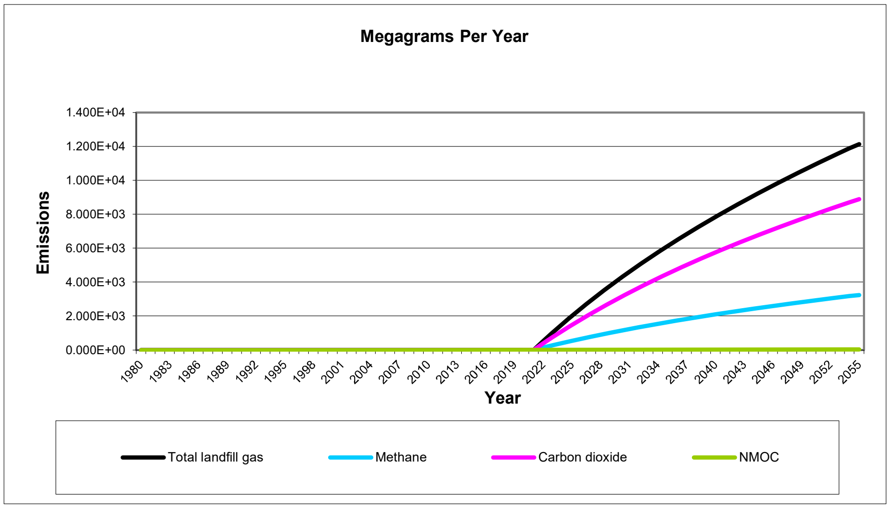
Pollutant Parameters

	Gas / Pollutant Default Parameters:			***User-specified Pollutant Parameters:***	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Gases	Total landfill gas		0.00		
	Methane		16.04		
	Carbon dioxide		44.01		
	NMOC	4,000	86.18		
Pollutants	1,1,1-Trichloroethane (methyl chloroform) - HAP	0.48	133.41		
	1,1,2,2-Tetrachloroethane - HAP/VOC	1.1	167.85		
	1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	2.4	98.97		
	1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.20	96.94		
	1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.41	98.96		
	1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.18	112.99		
	2-Propanol (isopropyl alcohol) - VOC	50	60.11		
	Acetone	7.0	58.08		
	Acrylonitrile - HAP/VOC	6.3	53.06		
	Benzene - No or Unknown Co-disposal - HAP/VOC	1.9	78.11		
	Benzene - Co-disposal - HAP/VOC	11	78.11		
	Bromodichloromethane - VOC	3.1	163.83		
	Butane - VOC	5.0	58.12		
	Carbon disulfide - HAP/VOC	0.58	76.13		
	Carbon monoxide	140	28.01		
	Carbon tetrachloride - HAP/VOC	4.0E-03	153.84		
	Carbonyl sulfide - HAP/VOC	0.49	60.07		
	Chlorobenzene - HAP/VOC	0.25	112.56		
	Chlorodifluoromethane	1.3	86.47		
	Chloroethane (ethyl chloride) - HAP/VOC	1.3	64.52		
	Chloroform - HAP/VOC	0.03	119.39		
	Chloromethane - VOC	1.2	50.49		
	Dichlorobenzene - (HAP for para isomer/VOC)	0.21	147		
	Dichlorodifluoromethane	16	120.91		
	Dichlorofluoromethane - VOC	2.6	102.92		
	Dichloromethane (methylene chloride) - HAP	14	84.94		
	Dimethyl sulfide (methyl sulfide) - VOC	7.8	62.13		
	Ethane	890	30.07		
	Ethanol - VOC	27	46.08		

Pollutant Parameters (Continued)

	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Pollutants	Ethyl mercaptan (ethanethiol) - VOC	2.3	62.13		
	Ethylbenzene - HAP/VOC	4.6	106.16		
	Ethylene dibromide - HAP/VOC	1.0E-03	187.88		
	Fluorotrichloromethane - VOC	0.76	137.38		
	Hexane - HAP/VOC	6.6	86.18		
	Hydrogen sulfide	36	34.08		
	Mercury (total) - HAP	2.9E-04	200.61		
	Methyl ethyl ketone - HAP/VOC	7.1	72.11		
	Methyl isobutyl ketone - HAP/VOC	1.9	100.16		
	Methyl mercaptan - VOC	2.5	48.11		
	Pentane - VOC	3.3	72.15		
	Perchloroethylene (tetrachloroethylene) - HAP	3.7	165.83		
	Propane - VOC	11	44.09		
	t-1,2-Dichloroethene - VOC	2.8	96.94		
	Toluene - No or Unknown Co-disposal - HAP/VOC	39	92.13		
	Toluene - Co-disposal - HAP/VOC	170	92.13		
	Trichloroethylene (trichloroethene) - HAP/VOC	2.8	131.40		
	Vinyl chloride - HAP/VOC	7.3	62.50		
	Xylenes - HAP/VOC	12	106.16		

Graphs


Megagrams Per Year
Emissions
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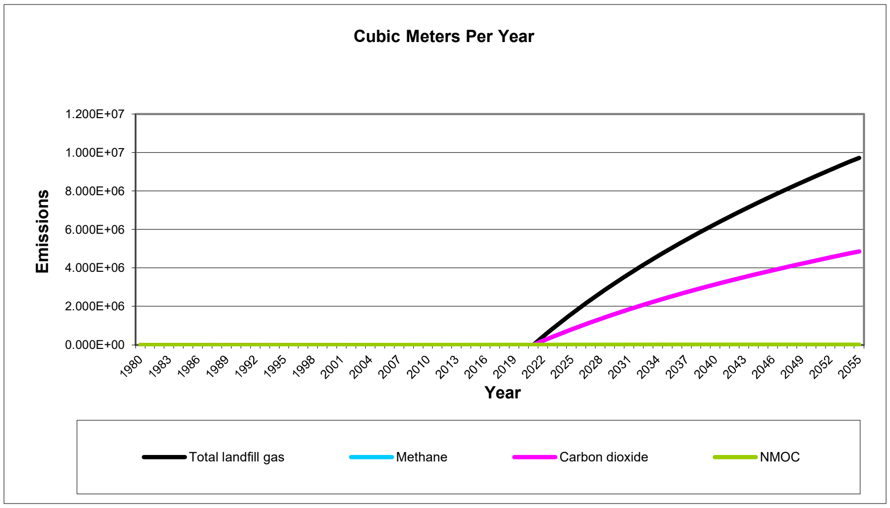
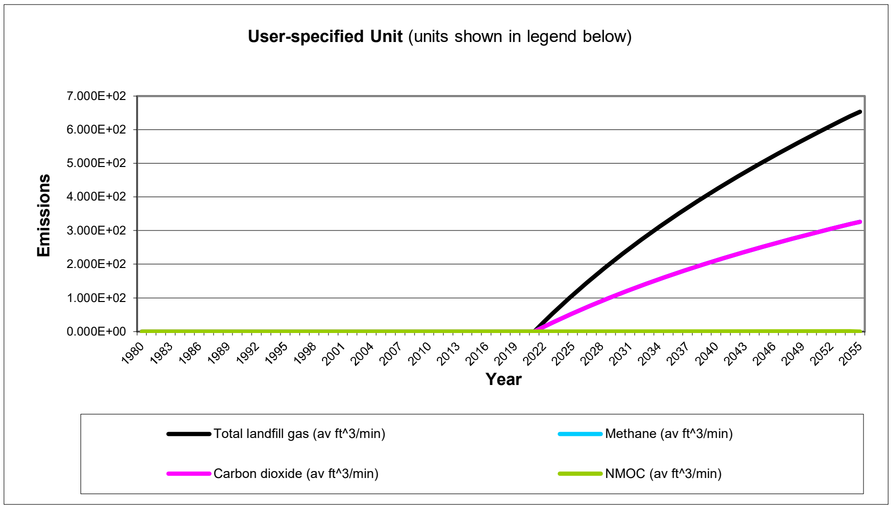
1.200E+04
1.000E+04
8.000E+03
6.000E+03
4.000E+03
2.000E+03
0.000E+00
1980 1983 1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016 2019 2022 2025 2028 2031 2034 2037 2040 2043 2046 2049 2052 2055
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


Cubic Meters Per Year
Emissions
1.200E+07
1.000E+07
8.000E+06
6.000E+06
4.000E+06
2.000E+06
0.000E+00
1980 1983 1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016 2019 2022 2025 2028 2031 2034 2037 2040 2043 2046 2049 2052 2055
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


User-specified Unit (units shown in legend below)
Emissions
7.000E+02
6.000E+02
5.000E+02
4.000E+02
3.000E+02
2.000E+02
1.000E+02
0.000E+00
1980 1983 1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016 2019 2022 2025 2028 2031 2034 2037 2040 2043 2046 2049 2052 2055
Year
Total landfill gas (av ft^3/min)
Methane (av ft^3/min)
Carbon dioxide (av ft^3/min)
NMOC (av ft^3/min)

Results

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1980	0	0	0	0	0	0
1981	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1982	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1983	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1984	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1985	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1986	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1987	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1988	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1989	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1990	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1991	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1992	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1993	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1994	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1995	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1996	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1997	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1998	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1999	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2001	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2002	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2003	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2004	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2005	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2006	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2007	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2008	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2009	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2010	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2011	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2012	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2013	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2014	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2015	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2016	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2017	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2018	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2019	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2020	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2021	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2022	5.212E+02	4.173E+05	2.804E+01	1.392E+02	2.087E+05	1.402E+01
2023	1.027E+03	8.225E+05	5.526E+01	2.744E+02	4.112E+05	2.763E+01
2024	1.519E+03	1.216E+06	8.170E+01	4.056E+02	6.080E+05	4.085E+01
2025	1.996E+03	1.598E+06	1.074E+02	5.331E+02	7.991E+05	5.369E+01
2026	2.460E+03	1.970E+06	1.324E+02	6.571E+02	9.849E+05	6.618E+01
2027	2.911E+03	2.331E+06	1.566E+02	7.776E+02	1.166E+06	7.832E+01
2028	3.350E+03	2.683E+06	1.803E+02	8.949E+02	1.341E+06	9.013E+01
2029	3.778E+03	3.025E+06	2.033E+02	1.009E+03	1.513E+06	1.016E+02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	***(m^3/year)***	***(av ft^3/min)***	***(Mg/year)***	***(m^3/year)***	***(av ft^3/min)***
2030	4.194E+03	3.358E+06	2.256E+02	1.120E+03	1.679E+06	1.128E+02
2031	4.600E+03	3.683E+06	2.475E+02	1.229E+03	1.842E+06	1.237E+02
2032	4.995E+03	4.000E+06	2.687E+02	1.334E+03	2.000E+06	1.344E+02
2033	5.381E+03	4.308E+06	2.895E+02	1.437E+03	2.154E+06	1.447E+02
2034	5.757E+03	4.610E+06	3.097E+02	1.538E+03	2.305E+06	1.549E+02
2035	6.124E+03	4.904E+06	3.295E+02	1.636E+03	2.452E+06	1.647E+02
2036	6.483E+03	5.191E+06	3.488E+02	1.732E+03	2.596E+06	1.744E+02
2037	6.834E+03	5.472E+06	3.677E+02	1.825E+03	2.736E+06	1.838E+02
2038	7.177E+03	5.747E+06	3.862E+02	1.917E+03	2.874E+06	1.931E+02
2039	7.513E+03	6.016E+06	4.042E+02	2.007E+03	3.008E+06	2.021E+02
2040	7.842E+03	6.279E+06	4.219E+02	2.095E+03	3.140E+06	2.110E+02
2041	8.164E+03	6.537E+06	4.392E+02	2.181E+03	3.269E+06	2.196E+02
2042	8.480E+03	6.790E+06	4.562E+02	2.265E+03	3.395E+06	2.281E+02
2043	8.790E+03	7.038E+06	4.729E+02	2.348E+03	3.519E+06	2.365E+02
2044	9.094E+03	7.282E+06	4.893E+02	2.429E+03	3.641E+06	2.446E+02
2045	9.392E+03	7.521E+06	5.053E+02	2.509E+03	3.760E+06	2.527E+02
2046	9.686E+03	7.756E+06	5.211E+02	2.587E+03	3.878E+06	2.606E+02
2047	9.974E+03	7.987E+06	5.366E+02	2.664E+03	3.993E+06	2.683E+02
2048	1.026E+04	8.214E+06	5.519E+02	2.740E+03	4.107E+06	2.760E+02
2049	1.054E+04	8.438E+06	5.670E+02	2.815E+03	4.219E+06	2.835E+02
2050	1.081E+04	8.659E+06	5.818E+02	2.888E+03	4.329E+06	2.909E+02
2051	1.108E+04	8.876E+06	5.964E+02	2.961E+03	4.438E+06	2.982E+02
2052	1.135E+04	9.091E+06	6.108E+02	3.032E+03	4.545E+06	3.054E+02
2053	1.162E+04	9.302E+06	6.250E+02	3.103E+03	4.651E+06	3.125E+02
2054	1.188E+04	9.511E+06	6.391E+02	3.173E+03	4.756E+06	3.195E+02
2055	1.214E+04	9.718E+06	6.530E+02	3.242E+03	4.859E+06	3.265E+02
2056	1.239E+04	9.922E+06	6.667E+02	3.310E+03	4.961E+06	3.333E+02
2057	1.264E+04	1.012E+07	6.803E+02	3.377E+03	5.062E+06	3.401E+02
2058	1.289E+04	1.032E+07	6.937E+02	3.444E+03	5.162E+06	3.469E+02
2059	1.314E+04	1.052E+07	7.070E+02	3.510E+03	5.261E+06	3.535E+02
2060	1.339E+04	1.072E+07	7.202E+02	3.576E+03	5.360E+06	3.601E+02
2061	1.286E+04	1.030E+07	6.920E+02	3.435E+03	5.149E+06	3.460E+02
2062	1.236E+04	9.895E+06	6.649E+02	3.301E+03	4.948E+06	3.324E+02
2063	1.187E+04	9.507E+06	6.388E+02	3.171E+03	4.754E+06	3.194E+02
2064	1.141E+04	9.134E+06	6.137E+02	3.047E+03	4.567E+06	3.069E+02
2065	1.096E+04	8.776E+06	5.897E+02	2.928E+03	4.388E+06	2.948E+02
2066	1.053E+04	8.432E+06	5.666E+02	2.813E+03	4.216E+06	2.833E+02
2067	1.012E+04	8.101E+06	5.443E+02	2.702E+03	4.051E+06	2.722E+02
2068	9.721E+03	7.784E+06	5.230E+02	2.596E+03	3.892E+06	2.615E+02
2069	9.339E+03	7.479E+06	5.025E+02	2.495E+03	3.739E+06	2.512E+02
2070	8.973E+03	7.185E+06	4.828E+02	2.397E+03	3.593E+06	2.414E+02
2071	8.621E+03	6.904E+06	4.639E+02	2.303E+03	3.452E+06	2.319E+02
2072	8.283E+03	6.633E+06	4.457E+02	2.213E+03	3.316E+06	2.228E+02
2073	7.959E+03	6.373E+06	4.282E+02	2.126E+03	3.186E+06	2.141E+02
2074	7.647E+03	6.123E+06	4.114E+02	2.042E+03	3.061E+06	2.057E+02
2075	7.347E+03	5.883E+06	3.953E+02	1.962E+03	2.941E+06	1.976E+02
2076	7.059E+03	5.652E+06	3.798E+02	1.885E+03	2.826E+06	1.899E+02
2077	6.782E+03	5.431E+06	3.649E+02	1.812E+03	2.715E+06	1.824E+02
2078	6.516E+03	5.218E+06	3.506E+02	1.740E+03	2.609E+06	1.753E+02
2079	6.260E+03	5.013E+06	3.368E+02	1.672E+03	2.507E+06	1.684E+02
2080	6.015E+03	4.816E+06	3.236E+02	1.607E+03	2.408E+06	1.618E+02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2081	5.779E+03	4.628E+06	3.109E+02	1.544E+03	2.314E+06	1.555E+02
2082	5.552E+03	4.446E+06	2.987E+02	1.483E+03	2.223E+06	1.494E+02
2083	5.335E+03	4.272E+06	2.870E+02	1.425E+03	2.136E+06	1.435E+02
2084	5.126E+03	4.104E+06	2.758E+02	1.369E+03	2.052E+06	1.379E+02
2085	4.925E+03	3.943E+06	2.650E+02	1.315E+03	1.972E+06	1.325E+02
2086	4.732E+03	3.789E+06	2.546E+02	1.264E+03	1.894E+06	1.273E+02
2087	4.546E+03	3.640E+06	2.446E+02	1.214E+03	1.820E+06	1.223E+02
2088	4.368E+03	3.497E+06	2.350E+02	1.167E+03	1.749E+06	1.175E+02
2089	4.196E+03	3.360E+06	2.258E+02	1.121E+03	1.680E+06	1.129E+02
2090	4.032E+03	3.229E+06	2.169E+02	1.077E+03	1.614E+06	1.085E+02
2091	3.874E+03	3.102E+06	2.084E+02	1.035E+03	1.551E+06	1.042E+02
2092	3.722E+03	2.980E+06	2.003E+02	9.942E+02	1.490E+06	1.001E+02
2093	3.576E+03	2.864E+06	1.924E+02	9.552E+02	1.432E+06	9.620E+01
2094	3.436E+03	2.751E+06	1.849E+02	9.177E+02	1.376E+06	9.243E+01
2095	3.301E+03	2.643E+06	1.776E+02	8.818E+02	1.322E+06	8.880E+01
2096	3.172E+03	2.540E+06	1.706E+02	8.472E+02	1.270E+06	8.532E+01
2097	3.047E+03	2.440E+06	1.640E+02	8.140E+02	1.220E+06	8.198E+01
2098	2.928E+03	2.344E+06	1.575E+02	7.820E+02	1.172E+06	7.876E+01
2099	2.813E+03	2.253E+06	1.513E+02	7.514E+02	1.126E+06	7.567E+01
2100	2.703E+03	2.164E+06	1.454E+02	7.219E+02	1.082E+06	7.271E+01
2101	2.597E+03	2.079E+06	1.397E+02	6.936E+02	1.040E+06	6.985E+01
2102	2.495E+03	1.998E+06	1.342E+02	6.664E+02	9.989E+05	6.712E+01
2103	2.397E+03	1.919E+06	1.290E+02	6.403E+02	9.597E+05	6.448E+01
2104	2.303E+03	1.844E+06	1.239E+02	6.152E+02	9.221E+05	6.196E+01
2105	2.213E+03	1.772E+06	1.191E+02	5.911E+02	8.859E+05	5.953E+01
2106	2.126E+03	1.702E+06	1.144E+02	5.679E+02	8.512E+05	5.719E+01
2107	2.043E+03	1.636E+06	1.099E+02	5.456E+02	8.178E+05	5.495E+01
2108	1.963E+03	1.572E+06	1.056E+02	5.242E+02	7.858E+05	5.280E+01
2109	1.886E+03	1.510E+06	1.015E+02	5.037E+02	7.550E+05	5.073E+01
2110	1.812E+03	1.451E+06	9.747E+01	4.839E+02	7.253E+05	4.874E+01
2111	1.741E+03	1.394E+06	9.365E+01	4.649E+02	6.969E+05	4.683E+01
2112	1.672E+03	1.339E+06	8.998E+01	4.467E+02	6.696E+05	4.499E+01
2113	1.607E+03	1.287E+06	8.645E+01	4.292E+02	6.433E+05	4.323E+01
2114	1.544E+03	1.236E+06	8.306E+01	4.124E+02	6.181E+05	4.153E+01
2115	1.483E+03	1.188E+06	7.980E+01	3.962E+02	5.939E+05	3.990E+01
2116	1.425E+03	1.141E+06	7.667E+01	3.807E+02	5.706E+05	3.834E+01
2117	1.369E+03	1.096E+06	7.367E+01	3.657E+02	5.482E+05	3.683E+01
2118	1.316E+03	1.053E+06	7.078E+01	3.514E+02	5.267E+05	3.539E+01
2119	1.264E+03	1.012E+06	6.800E+01	3.376E+02	5.061E+05	3.400E+01
2120	1.214E+03	9.724E+05	6.534E+01	3.244E+02	4.862E+05	3.267E+01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1980	0	0	0	0	0	0
1981	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1982	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1983	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1984	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1985	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1986	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1987	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1988	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1989	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1990	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1991	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1992	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1993	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1994	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1995	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1996	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1997	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1998	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1999	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2001	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2002	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2003	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2004	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2005	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2006	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2007	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2008	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2009	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2010	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2011	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2012	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2013	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2014	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2015	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2016	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2017	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2018	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2019	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2020	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2021	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2022	3.820E+02	2.087E+05	1.402E+01	1.254E+00	3.497E+02	2.350E-02
2023	7.528E+02	4.112E+05	2.763E+01	2.471E+00	6.892E+02	4.631E-02
2024	1.113E+03	6.080E+05	4.085E+01	3.652E+00	1.019E+03	6.846E-02
2025	1.463E+03	7.991E+05	5.369E+01	4.801E+00	1.339E+03	8.999E-02
2026	1.803E+03	9.849E+05	6.618E+01	5.917E+00	1.651E+03	1.109E-01
2027	2.134E+03	1.166E+06	7.832E+01	7.003E+00	1.954E+03	1.313E-01
2028	2.455E+03	1.341E+06	9.013E+01	8.059E+00	2.248E+03	1.511E-01
2029	2.769E+03	1.513E+06	1.016E+02	9.087E+00	2.535E+03	1.703E-01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2030	3.074E+03	1.679E+06	1.128E+02	1.009E+01	2.814E+03	1.891E-01
2031	3.371E+03	1.842E+06	1.237E+02	1.106E+01	3.086E+03	2.074E-01
2032	3.661E+03	2.000E+06	1.344E+02	1.201E+01	3.352E+03	2.252E-01
2033	3.943E+03	2.154E+06	1.447E+02	1.294E+01	3.611E+03	2.426E-01
2034	4.219E+03	2.305E+06	1.549E+02	1.385E+01	3.863E+03	2.596E-01
2035	4.488E+03	2.452E+06	1.647E+02	1.473E+01	4.110E+03	2.761E-01
2036	4.751E+03	2.596E+06	1.744E+02	1.559E+01	4.350E+03	2.923E-01
2037	5.009E+03	2.736E+06	1.838E+02	1.644E+01	4.586E+03	3.081E-01
2038	5.260E+03	2.874E+06	1.931E+02	1.726E+01	4.816E+03	3.236E-01
2039	5.506E+03	3.008E+06	2.021E+02	1.807E+01	5.041E+03	3.387E-01
2040	5.747E+03	3.140E+06	2.110E+02	1.886E+01	5.262E+03	3.536E-01
2041	5.983E+03	3.269E+06	2.196E+02	1.964E+01	5.478E+03	3.681E-01
2042	6.215E+03	3.395E+06	2.281E+02	2.040E+01	5.690E+03	3.823E-01
2043	6.442E+03	3.519E+06	2.365E+02	2.114E+01	5.898E+03	3.963E-01
2044	6.665E+03	3.641E+06	2.446E+02	2.187E+01	6.102E+03	4.100E-01
2045	6.884E+03	3.760E+06	2.527E+02	2.259E+01	6.303E+03	4.235E-01
2046	7.099E+03	3.878E+06	2.606E+02	2.330E+01	6.499E+03	4.367E-01
2047	7.310E+03	3.993E+06	2.683E+02	2.399E+01	6.693E+03	4.497E-01
2048	7.518E+03	4.107E+06	2.760E+02	2.467E+01	6.884E+03	4.625E-01
2049	7.723E+03	4.219E+06	2.835E+02	2.535E+01	7.071E+03	4.751E-01
2050	7.925E+03	4.329E+06	2.909E+02	2.601E+01	7.256E+03	4.875E-01
2051	8.124E+03	4.438E+06	2.982E+02	2.666E+01	7.438E+03	4.998E-01
2052	8.320E+03	4.545E+06	3.054E+02	2.731E+01	7.618E+03	5.119E-01
2053	8.514E+03	4.651E+06	3.125E+02	2.794E+01	7.795E+03	5.238E-01
2054	8.705E+03	4.756E+06	3.195E+02	2.857E+01	7.971E+03	5.355E-01
2055	8.894E+03	4.859E+06	3.265E+02	2.919E+01	8.144E+03	5.472E-01
2056	9.081E+03	4.961E+06	3.333E+02	2.980E+01	8.315E+03	5.587E-01
2057	9.266E+03	5.062E+06	3.401E+02	3.041E+01	8.484E+03	5.701E-01
2058	9.450E+03	5.162E+06	3.469E+02	3.101E+01	8.652E+03	5.813E-01
2059	9.631E+03	5.261E+06	3.535E+02	3.161E+01	8.818E+03	5.925E-01
2060	9.811E+03	5.360E+06	3.601E+02	3.220E+01	8.983E+03	6.036E-01
2061	9.426E+03	5.149E+06	3.460E+02	3.094E+01	8.631E+03	5.799E-01
2062	9.057E+03	4.948E+06	3.324E+02	2.972E+01	8.292E+03	5.571E-01
2063	8.701E+03	4.754E+06	3.194E+02	2.856E+01	7.967E+03	5.353E-01
2064	8.360E+03	4.567E+06	3.069E+02	2.744E+01	7.655E+03	5.143E-01
2065	8.032E+03	4.388E+06	2.948E+02	2.636E+01	7.354E+03	4.941E-01
2066	7.717E+03	4.216E+06	2.833E+02	2.533E+01	7.066E+03	4.748E-01
2067	7.415E+03	4.051E+06	2.722E+02	2.434E+01	6.789E+03	4.562E-01
2068	7.124E+03	3.892E+06	2.615E+02	2.338E+01	6.523E+03	4.383E-01
2069	6.845E+03	3.739E+06	2.512E+02	2.246E+01	6.267E+03	4.211E-01
2070	6.576E+03	3.593E+06	2.414E+02	2.158E+01	6.021E+03	4.046E-01
2071	6.319E+03	3.452E+06	2.319E+02	2.074E+01	5.785E+03	3.887E-01
2072	6.071E+03	3.316E+06	2.228E+02	1.992E+01	5.558E+03	3.735E-01
2073	5.833E+03	3.186E+06	2.141E+02	1.914E+01	5.340E+03	3.588E-01
2074	5.604E+03	3.061E+06	2.057E+02	1.839E+01	5.131E+03	3.448E-01
2075	5.384E+03	2.941E+06	1.976E+02	1.767E+01	4.930E+03	3.312E-01
2076	5.173E+03	2.826E+06	1.899E+02	1.698E+01	4.737E+03	3.182E-01
2077	4.970E+03	2.715E+06	1.824E+02	1.631E+01	4.551E+03	3.058E-01
2078	4.775E+03	2.609E+06	1.753E+02	1.567E+01	4.372E+03	2.938E-01
2079	4.588E+03	2.507E+06	1.684E+02	1.506E+01	4.201E+03	2.823E-01
2080	4.408E+03	2.408E+06	1.618E+02	1.447E+01	4.036E+03	2.712E-01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	***(m^3/year)***	***(av ft^3/min)***	***(Mg/year)***	***(m^3/year)***	***(av ft^3/min)***
2081	4.235E+03	2.314E+06	1.555E+02	1.390E+01	3.878E+03	2.606E-01
2082	4.069E+03	2.223E+06	1.494E+02	1.336E+01	3.726E+03	2.503E-01
2083	3.910E+03	2.136E+06	1.435E+02	1.283E+01	3.580E+03	2.405E-01
2084	3.756E+03	2.052E+06	1.379E+02	1.233E+01	3.439E+03	2.311E-01
2085	3.609E+03	1.972E+06	1.325E+02	1.185E+01	3.305E+03	2.220E-01
2086	3.468E+03	1.894E+06	1.273E+02	1.138E+01	3.175E+03	2.133E-01
2087	3.332E+03	1.820E+06	1.223E+02	1.093E+01	3.051E+03	2.050E-01
2088	3.201E+03	1.749E+06	1.175E+02	1.051E+01	2.931E+03	1.969E-01
2089	3.076E+03	1.680E+06	1.129E+02	1.009E+01	2.816E+03	1.892E-01
2090	2.955E+03	1.614E+06	1.085E+02	9.698E+00	2.706E+03	1.818E-01
2091	2.839E+03	1.551E+06	1.042E+02	9.318E+00	2.599E+03	1.747E-01
2092	2.728E+03	1.490E+06	1.001E+02	8.952E+00	2.498E+03	1.678E-01
2093	2.621E+03	1.432E+06	9.620E+01	8.601E+00	2.400E+03	1.612E-01
2094	2.518E+03	1.376E+06	9.243E+01	8.264E+00	2.306E+03	1.549E-01
2095	2.419E+03	1.322E+06	8.880E+01	7.940E+00	2.215E+03	1.488E-01
2096	2.324E+03	1.270E+06	8.532E+01	7.629E+00	2.128E+03	1.430E-01
2097	2.233E+03	1.220E+06	8.198E+01	7.330E+00	2.045E+03	1.374E-01
2098	2.146E+03	1.172E+06	7.876E+01	7.042E+00	1.965E+03	1.320E-01
2099	2.062E+03	1.126E+06	7.567E+01	6.766E+00	1.888E+03	1.268E-01
2100	1.981E+03	1.082E+06	7.271E+01	6.501E+00	1.814E+03	1.219E-01
2101	1.903E+03	1.040E+06	6.985E+01	6.246E+00	1.742E+03	1.171E-01
2102	1.828E+03	9.989E+05	6.712E+01	6.001E+00	1.674E+03	1.125E-01
2103	1.757E+03	9.597E+05	6.448E+01	5.766E+00	1.609E+03	1.081E-01
2104	1.688E+03	9.221E+05	6.196E+01	5.540E+00	1.545E+03	1.038E-01
2105	1.622E+03	8.859E+05	5.953E+01	5.322E+00	1.485E+03	9.977E-02
2106	1.558E+03	8.512E+05	5.719E+01	5.114E+00	1.427E+03	9.585E-02
2107	1.497E+03	8.178E+05	5.495E+01	4.913E+00	1.371E+03	9.210E-02
2108	1.438E+03	7.858E+05	5.280E+01	4.721E+00	1.317E+03	8.848E-02
2109	1.382E+03	7.550E+05	5.073E+01	4.535E+00	1.265E+03	8.502E-02
2110	1.328E+03	7.253E+05	4.874E+01	4.358E+00	1.216E+03	8.168E-02
2111	1.276E+03	6.969E+05	4.683E+01	4.187E+00	1.168E+03	7.848E-02
2112	1.226E+03	6.696E+05	4.499E+01	4.023E+00	1.122E+03	7.540E-02
2113	1.178E+03	6.433E+05	4.323E+01	3.865E+00	1.078E+03	7.245E-02
2114	1.131E+03	6.181E+05	4.153E+01	3.713E+00	1.036E+03	6.960E-02
2115	1.087E+03	5.939E+05	3.990E+01	3.568E+00	9.953E+02	6.688E-02
2116	1.044E+03	5.706E+05	3.834E+01	3.428E+00	9.563E+02	6.425E-02
2117	1.003E+03	5.482E+05	3.683E+01	3.293E+00	9.188E+02	6.173E-02
2118	9.641E+02	5.267E+05	3.539E+01	3.164E+00	8.828E+02	5.931E-02
2119	9.263E+02	5.061E+05	3.400E+01	3.040E+00	8.482E+02	5.699E-02
2120	8.900E+02	4.862E+05	3.267E+01	2.921E+00	8.149E+02	5.475E-02

LandGEM - Version 3.02

US EPA Office of Research and Development

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LandGEM
Landfill Gas Emissions Model
Version 3.02

U.S. Environmental Protection Agency
Office of Research and Development
National Risk Management Research Laboratory (NRMRL)
and
Clean Air Technology Center (CATC)
Research Triangle Park, North Carolina

May 2005

Summary Report

Landfill Name or Identifier: Matsu Case 3 - Reduction - Part 1 Bulk

Date: Friday, April 17, 2020

Description/Comments:
Matsu Landfill Gas Modeling - revised March 2020
Case 3 - Reduction Case - Part 1 with Bulk Waste
Assuming 20% of waste is compostable and 50% of that is diverted (aka 10%)
Assuming half of what is diverted is paper and half is food waste,
Bulk - lower k value without degradeables; only starting in 2021

About LandGEM:

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} kL_o \left(\frac{M_i}{10} \right) e^{-kt_{ij}}$$

Where,
Q_{CH4} = annual methane generation in the year of the calculation *(m^3/year)*
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate *($year^{-1}$)*
L_o = potential methane generation capacity *(m^3/Mg)*

M_i = mass of waste accepted in the i^{th} year *(Mg)*
t_{ij} = age of the j^{th} section of waste mass M_i accepted in the i^{th} year (*decimal years*, e.g., 3.2 years)

LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on EPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate. Defaults for estimating emissions for this type of operation are being developed to include in LandGEM along with defaults for convential landfills (no leachate or liquid additions) for developing emission inventories and determining CAA applicability. Refer to the Web site identified above for future updates.

Input Review

LANDFILL CHARACTERISTICS

Landfill Open Year	**1980**	
Landfill Closure Year (with 80-year limit)	**2059**	
Actual Closure Year (without limit)	***2059***	
Have Model Calculate Closure Year?	**No**	
Waste Design Capacity		*short tons*

MODEL PARAMETERS

Methane Generation Rate, k	**0.014**	*$year^{-1}$*
Potential Methane Generation Capacity, L_o	**100**	*m^3/Mg*
NMOC Concentration	**838**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	**Carbon dioxide**
Gas / Pollutant #4:	**NMOC**

WASTE ACCEPTANCE RATES

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
1980	0	0	0	0
1981	0	0	0	0
1982	0	0	0	0
1983	0	0	0	0
1984	0	0	0	0
1985	0	0	0	0
1986	0	0	0	0
1987	0	0	0	0
1988	0	0	0	0
1989	0	0	0	0
1990	0	0	0	0
1991	0	0	0	0
1992	0	0	0	0
1993	0	0	0	0
1994	0	0	0	0
1995	0	0	0	0
1996	0	0	0	0
1997	0	0	0	0
1998	0	0	0	0
1999	0	0	0	0
2000	0	0	0	0
2001	0	0	0	0
2002	0	0	0	0
2003	0	0	0	0
2004	0	0	0	0
2005	0	0	0	0
2006	0	0	0	0
2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	0	0	0	0
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0

WASTE ACCEPTANCE RATES (Continued)

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
2020	0	0	0	0
2021	51,517	56,669	0	0
2022	50,960	56,056	51,517	56,669
2023	50,386	55,424	102,477	112,725
2024	49,248	54,173	152,863	168,149
2025	49,740	54,714	202,110	222,321
2026	50,238	55,262	251,851	277,036
2027	50,740	55,814	302,089	332,297
2028	51,248	56,372	352,829	388,112
2029	51,760	56,936	404,076	444,484
2030	52,278	57,505	455,836	501,420
2031	52,800	58,080	508,114	558,925
2032	53,328	58,661	560,914	617,006
2033	53,862	59,248	614,243	675,667
2034	54,400	59,840	668,105	734,915
2035	54,944	60,439	722,505	794,755
2036	55,494	61,043	777,449	855,194
2037	56,049	61,654	832,943	916,237
2038	56,609	62,270	888,992	977,891
2039	57,175	62,893	945,601	1,040,161
2040	57,747	63,522	1,002,776	1,103,054
2041	58,325	64,157	1,060,523	1,166,576
2042	58,908	64,799	1,118,848	1,230,732
2043	59,497	65,447	1,177,755	1,295,531
2044	60,092	66,101	1,237,252	1,360,978
2045	60,693	66,762	1,297,344	1,427,079
2046	61,300	67,430	1,358,037	1,493,841
2047	61,913	68,104	1,419,336	1,561,270
2048	62,532	68,785	1,481,249	1,629,374
2049	63,157	69,473	1,543,781	1,698,159
2050	63,789	70,168	1,606,938	1,767,632
2051	64,427	70,869	1,670,727	1,837,799
2052	65,071	71,578	1,735,153	1,908,668
2053	65,722	72,294	1,800,224	1,980,246
2054	66,379	73,017	1,865,945	2,052,540
2055	67,043	73,747	1,932,324	2,125,557
2056	67,713	74,484	1,999,367	2,199,303
2057	68,390	75,229	2,067,080	2,273,788
2058	69,074	75,981	2,135,470	2,349,017
2059	69,765	76,741	2,204,544	2,424,998

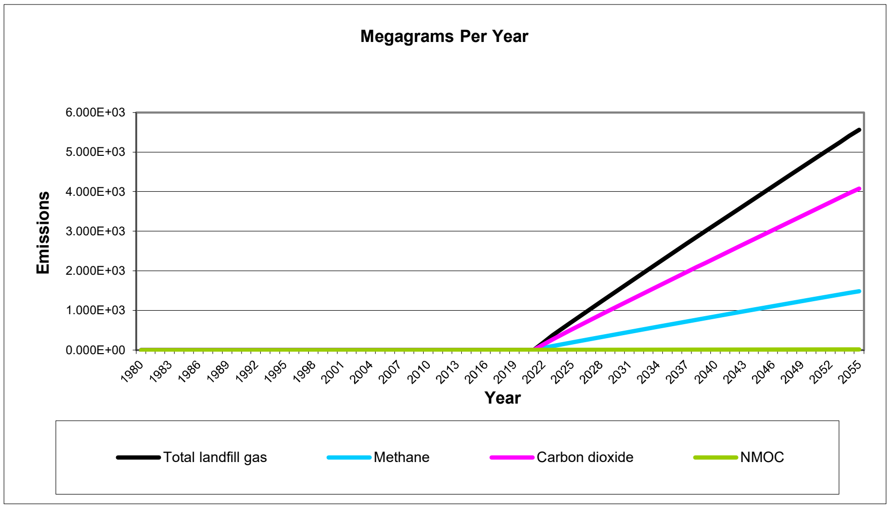
Pollutant Parameters

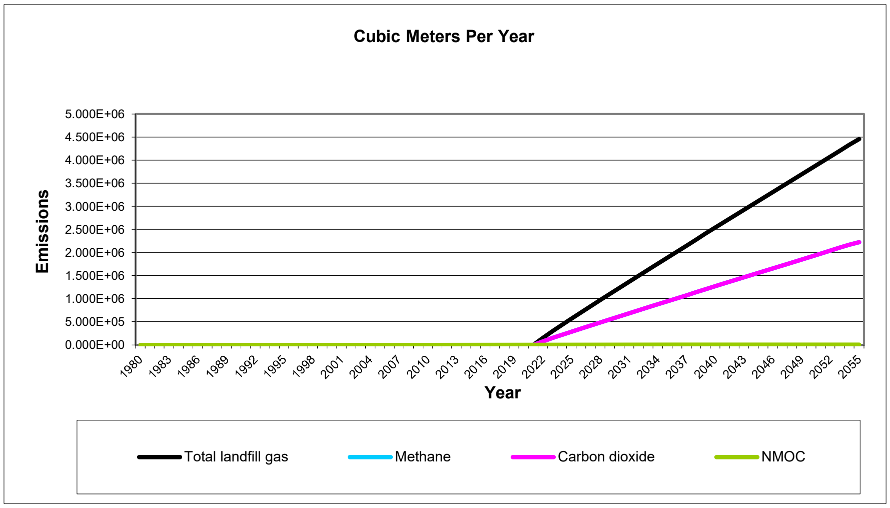
		Gas / Pollutant Default Parameters:		***User-specified Pollutant Parameters:***	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Gases	Total landfill gas		0.00		
	Methane		16.04		
	Carbon dioxide		44.01		
	NMOC	4,000	86.18		
Pollutants	1,1,1-Trichloroethane (methyl chloroform) - HAP	0.48	133.41		
	1,1,2,2-Tetrachloroethane - HAP/VOC	1.1	167.85		
	1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	2.4	98.97		
	1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.20	96.94		
	1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.41	98.96		
	1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.18	112.99		
	2-Propanol (isopropyl alcohol) - VOC	50	60.11		
	Acetone	7.0	58.08		
	Acrylonitrile - HAP/VOC	6.3	53.06		
	Benzene - No or Unknown Co-disposal - HAP/VOC	1.9	78.11		
	Benzene - Co-disposal - HAP/VOC	11	78.11		
	Bromodichloromethane - VOC	3.1	163.83		
	Butane - VOC	5.0	58.12		
	Carbon disulfide - HAP/VOC	0.58	76.13		
	Carbon monoxide	140	28.01		
	Carbon tetrachloride - HAP/VOC	4.0E-03	153.84		
	Carbonyl sulfide - HAP/VOC	0.49	60.07		
	Chlorobenzene - HAP/VOC	0.25	112.56		
	Chlorodifluoromethane	1.3	86.47		
	Chloroethane (ethyl chloride) - HAP/VOC	1.3	64.52		
	Chloroform - HAP/VOC	0.03	119.39		
	Chloromethane - VOC	1.2	50.49		
	Dichlorobenzene - (HAP for para isomer/VOC)	0.21	147		
	Dichlorodifluoromethane	16	120.91		
	Dichlorofluoromethane - VOC	2.6	102.92		
	Dichloromethane (methylene chloride) - HAP	14	84.94		
	Dimethyl sulfide (methyl sulfide) - VOC	7.8	62.13		
	Ethane	890	30.07		
	Ethanol - VOC	27	46.08		

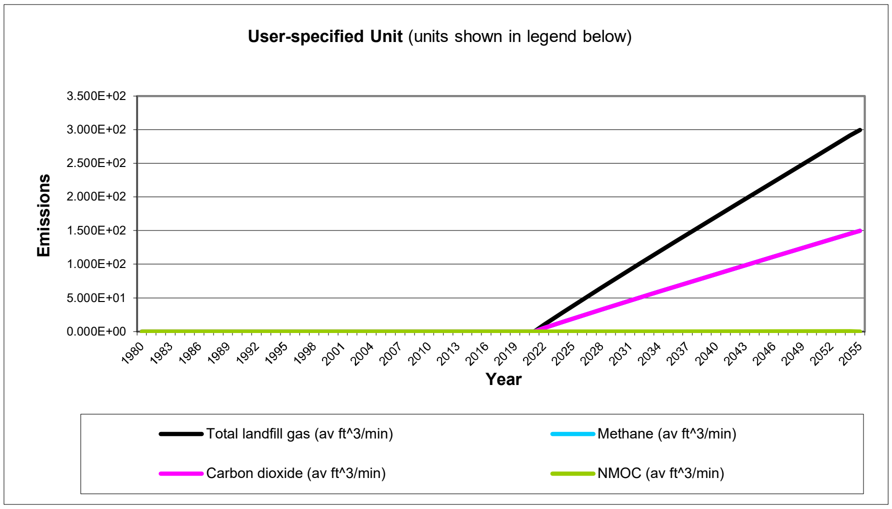
Pollutant Parameters (Continued)

	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Pollutants	Ethyl mercaptan (ethanethiol) - VOC	2.3	62.13		
	Ethylbenzene - HAP/VOC	4.6	106.16		
	Ethylene dibromide - HAP/VOC	1.0E-03	187.88		
	Fluorotrichloromethane - VOC	0.76	137.38		
	Hexane - HAP/VOC	6.6	86.18		
	Hydrogen sulfide	36	34.08		
	Mercury (total) - HAP	2.9E-04	200.61		
	Methyl ethyl ketone - HAP/VOC	7.1	72.11		
	Methyl isobutyl ketone - HAP/VOC	1.9	100.16		
	Methyl mercaptan - VOC	2.5	48.11		
	Pentane - VOC	3.3	72.15		
	Perchloroethylene (tetrachloroethylene) - HAP	3.7	165.83		
	Propane - VOC	11	44.09		
	t-1,2-Dichloroethene - VOC	2.8	96.94		
	Toluene - No or Unknown Co-disposal - HAP/VOC	39	92.13		
	Toluene - Co-disposal - HAP/VOC	170	92.13		
	Trichloroethylene (trichloroethene) - HAP/VOC	2.8	131.40		
	Vinyl chloride - HAP/VOC	7.3	62.50		
	Xylenes - HAP/VOC	12	106.16		

Graphs


Megagrams Per Year
Emissions
6.000E+03
5.000E+03
4.000E+03
3.000E+03
2.000E+03
1.000E+03
0.000E+00
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
2025
2028
2031
2034
2037
2040
2043
2046
2049
2052
2055
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


Cubic Meters Per Year
Emissions
5.000E+06
4.500E+06
4.000E+06
3.500E+06
3.000E+06
2.500E+06
2.000E+06
1.500E+06
1.000E+06
5.000E+05
0.000E+00
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
2025
2028
2031
2034
2037
2040
2043
2046
2049
2052
2055
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


User-specified Unit (units shown in legend below)
Emissions
3.500E+02
3.000E+02
2.500E+02
2.000E+02
1.500E+02
1.000E+02
5.000E+01
0.000E+00
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
2025
2028
2031
2034
2037
2040
2043
2046
2049
2052
2055
Year
Total landfill gas (av ft^3/min)
Methane (av ft^3/min)
Carbon dioxide (av ft^3/min)
NMOC (av ft^3/min)

Results

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1980	0	0	0	0	0	0
1981	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1982	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1983	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1984	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1985	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1986	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1987	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1988	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1989	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1990	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1991	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1992	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1993	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1994	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1995	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1996	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1997	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1998	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1999	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2001	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2002	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2003	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2004	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2005	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2006	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2007	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2008	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2009	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2010	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2011	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2012	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2013	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2014	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2015	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2016	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2017	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2018	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2019	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2020	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2021	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2022	1.841E+02	1.474E+05	9.905E+00	4.917E+01	7.371E+04	4.952E+00
2023	3.636E+02	2.911E+05	1.956E+01	9.711E+01	1.456E+05	9.780E+00
2024	5.384E+02	4.311E+05	2.897E+01	1.438E+02	2.156E+05	1.448E+01
2025	7.067E+02	5.659E+05	3.802E+01	1.888E+02	2.829E+05	1.901E+01
2026	8.743E+02	7.001E+05	4.704E+01	2.335E+02	3.501E+05	2.352E+01
2027	1.041E+03	8.339E+05	5.603E+01	2.782E+02	4.169E+05	2.801E+01
2028	1.208E+03	9.671E+05	6.498E+01	3.226E+02	4.836E+05	3.249E+01
2029	1.374E+03	1.100E+06	7.391E+01	3.669E+02	5.500E+05	3.695E+01

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2030	1.539E+03	1.232E+06	8.280E+01	4.111E+02	6.162E+05	4.140E+01
2031	1.704E+03	1.364E+06	9.167E+01	4.551E+02	6.822E+05	4.583E+01
2032	1.868E+03	1.496E+06	1.005E+02	4.990E+02	7.479E+05	5.025E+01
2033	2.032E+03	1.627E+06	1.093E+02	5.428E+02	8.135E+05	5.466E+01
2034	2.195E+03	1.758E+06	1.181E+02	5.864E+02	8.790E+05	5.906E+01
2035	2.358E+03	1.888E+06	1.269E+02	6.299E+02	9.442E+05	6.344E+01
2036	2.521E+03	2.019E+06	1.356E+02	6.734E+02	1.009E+06	6.782E+01
2037	2.683E+03	2.149E+06	1.444E+02	7.167E+02	1.074E+06	7.218E+01
2038	2.845E+03	2.278E+06	1.531E+02	7.600E+02	1.139E+06	7.654E+01
2039	3.007E+03	2.408E+06	1.618E+02	8.031E+02	1.204E+06	8.089E+01
2040	3.168E+03	2.537E+06	1.705E+02	8.462E+02	1.268E+06	8.523E+01
2041	3.329E+03	2.666E+06	1.791E+02	8.893E+02	1.333E+06	8.956E+01
2042	3.490E+03	2.795E+06	1.878E+02	9.322E+02	1.397E+06	9.389E+01
2043	3.651E+03	2.923E+06	1.964E+02	9.751E+02	1.462E+06	9.821E+01
2044	3.811E+03	3.052E+06	2.050E+02	1.018E+03	1.526E+06	1.025E+02
2045	3.971E+03	3.180E+06	2.137E+02	1.061E+03	1.590E+06	1.068E+02
2046	4.131E+03	3.308E+06	2.223E+02	1.104E+03	1.654E+06	1.111E+02
2047	4.291E+03	3.436E+06	2.309E+02	1.146E+03	1.718E+06	1.154E+02
2048	4.451E+03	3.564E+06	2.395E+02	1.189E+03	1.782E+06	1.197E+02
2049	4.611E+03	3.692E+06	2.481E+02	1.232E+03	1.846E+06	1.240E+02
2050	4.771E+03	3.820E+06	2.567E+02	1.274E+03	1.910E+06	1.283E+02
2051	4.931E+03	3.948E+06	2.653E+02	1.317E+03	1.974E+06	1.326E+02
2052	5.090E+03	4.076E+06	2.739E+02	1.360E+03	2.038E+06	1.369E+02
2053	5.250E+03	4.204E+06	2.825E+02	1.402E+03	2.102E+06	1.412E+02
2054	5.410E+03	4.332E+06	2.911E+02	1.445E+03	2.166E+06	1.455E+02
2055	5.570E+03	4.460E+06	2.997E+02	1.488E+03	2.230E+06	1.498E+02
2056	5.730E+03	4.588E+06	3.083E+02	1.530E+03	2.294E+06	1.541E+02
2057	5.890E+03	4.716E+06	3.169E+02	1.573E+03	2.358E+06	1.584E+02
2058	6.050E+03	4.844E+06	3.255E+02	1.616E+03	2.422E+06	1.627E+02
2059	6.210E+03	4.973E+06	3.341E+02	1.659E+03	2.486E+06	1.671E+02
2060	6.371E+03	5.101E+06	3.428E+02	1.702E+03	2.551E+06	1.714E+02
2061	6.280E+03	5.028E+06	3.379E+02	1.677E+03	2.514E+06	1.689E+02
2062	6.190E+03	4.957E+06	3.330E+02	1.653E+03	2.478E+06	1.665E+02
2063	6.101E+03	4.886E+06	3.283E+02	1.630E+03	2.443E+06	1.641E+02
2064	6.014E+03	4.816E+06	3.236E+02	1.606E+03	2.408E+06	1.618E+02
2065	5.928E+03	4.747E+06	3.189E+02	1.583E+03	2.373E+06	1.595E+02
2066	5.843E+03	4.679E+06	3.144E+02	1.561E+03	2.340E+06	1.572E+02
2067	5.760E+03	4.612E+06	3.099E+02	1.539E+03	2.306E+06	1.549E+02
2068	5.677E+03	4.546E+06	3.055E+02	1.517E+03	2.273E+06	1.527E+02
2069	5.596E+03	4.481E+06	3.011E+02	1.495E+03	2.241E+06	1.505E+02
2070	5.516E+03	4.417E+06	2.968E+02	1.473E+03	2.209E+06	1.484E+02
2071	5.437E+03	4.354E+06	2.925E+02	1.452E+03	2.177E+06	1.463E+02
2072	5.360E+03	4.292E+06	2.884E+02	1.432E+03	2.146E+06	1.442E+02
2073	5.283E+03	4.230E+06	2.842E+02	1.411E+03	2.115E+06	1.421E+02
2074	5.208E+03	4.170E+06	2.802E+02	1.391E+03	2.085E+06	1.401E+02
2075	5.133E+03	4.110E+06	2.762E+02	1.371E+03	2.055E+06	1.381E+02
2076	5.060E+03	4.052E+06	2.722E+02	1.352E+03	2.026E+06	1.361E+02
2077	4.987E+03	3.994E+06	2.683E+02	1.332E+03	1.997E+06	1.342E+02
2078	4.916E+03	3.937E+06	2.645E+02	1.313E+03	1.968E+06	1.322E+02
2079	4.846E+03	3.880E+06	2.607E+02	1.294E+03	1.940E+06	1.304E+02
2080	4.777E+03	3.825E+06	2.570E+02	1.276E+03	1.912E+06	1.285E+02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2081	4.708E+03	3.770E+06	2.533E+02	1.258E+03	1.885E+06	1.267E+02
2082	4.641E+03	3.716E+06	2.497E+02	1.240E+03	1.858E+06	1.248E+02
2083	4.575E+03	3.663E+06	2.461E+02	1.222E+03	1.832E+06	1.231E+02
2084	4.509E+03	3.611E+06	2.426E+02	1.204E+03	1.805E+06	1.213E+02
2085	4.445E+03	3.559E+06	2.391E+02	1.187E+03	1.780E+06	1.196E+02
2086	4.381E+03	3.508E+06	2.357E+02	1.170E+03	1.754E+06	1.179E+02
2087	4.319E+03	3.458E+06	2.323E+02	1.154E+03	1.729E+06	1.162E+02
2088	4.257E+03	3.409E+06	2.290E+02	1.137E+03	1.704E+06	1.145E+02
2089	4.196E+03	3.360E+06	2.258E+02	1.121E+03	1.680E+06	1.129E+02
2090	4.136E+03	3.312E+06	2.225E+02	1.105E+03	1.656E+06	1.113E+02
2091	4.077E+03	3.265E+06	2.193E+02	1.089E+03	1.632E+06	1.097E+02
2092	4.019E+03	3.218E+06	2.162E+02	1.073E+03	1.609E+06	1.081E+02
2093	3.961E+03	3.172E+06	2.131E+02	1.058E+03	1.586E+06	1.066E+02
2094	3.904E+03	3.126E+06	2.101E+02	1.043E+03	1.563E+06	1.050E+02
2095	3.849E+03	3.082E+06	2.071E+02	1.028E+03	1.541E+06	1.035E+02
2096	3.794E+03	3.038E+06	2.041E+02	1.013E+03	1.519E+06	1.021E+02
2097	3.739E+03	2.994E+06	2.012E+02	9.988E+02	1.497E+06	1.006E+02
2098	3.686E+03	2.951E+06	1.983E+02	9.845E+02	1.476E+06	9.915E+01
2099	3.633E+03	2.909E+06	1.955E+02	9.705E+02	1.455E+06	9.774E+01
2100	3.581E+03	2.868E+06	1.927E+02	9.566E+02	1.434E+06	9.634E+01
2101	3.530E+03	2.827E+06	1.899E+02	9.429E+02	1.413E+06	9.496E+01
2102	3.480E+03	2.786E+06	1.872E+02	9.294E+02	1.393E+06	9.360E+01
2103	3.430E+03	2.746E+06	1.845E+02	9.161E+02	1.373E+06	9.227E+01
2104	3.381E+03	2.707E+06	1.819E+02	9.030E+02	1.354E+06	9.095E+01
2105	3.332E+03	2.668E+06	1.793E+02	8.901E+02	1.334E+06	8.965E+01
2106	3.285E+03	2.630E+06	1.767E+02	8.774E+02	1.315E+06	8.837E+01
2107	3.238E+03	2.593E+06	1.742E+02	8.649E+02	1.296E+06	8.710E+01
2108	3.192E+03	2.556E+06	1.717E+02	8.525E+02	1.278E+06	8.586E+01
2109	3.146E+03	2.519E+06	1.693E+02	8.403E+02	1.260E+06	8.463E+01
2110	3.101E+03	2.483E+06	1.668E+02	8.283E+02	1.242E+06	8.342E+01
2111	3.057E+03	2.448E+06	1.645E+02	8.165E+02	1.224E+06	8.223E+01
2112	3.013E+03	2.413E+06	1.621E+02	8.048E+02	1.206E+06	8.105E+01
2113	2.970E+03	2.378E+06	1.598E+02	7.933E+02	1.189E+06	7.989E+01
2114	2.927E+03	2.344E+06	1.575E+02	7.819E+02	1.172E+06	7.875E+01
2115	2.886E+03	2.311E+06	1.552E+02	7.708E+02	1.155E+06	7.762E+01
2116	2.844E+03	2.278E+06	1.530E+02	7.597E+02	1.139E+06	7.651E+01
2117	2.804E+03	2.245E+06	1.508E+02	7.489E+02	1.123E+06	7.542E+01
2118	2.764E+03	2.213E+06	1.487E+02	7.382E+02	1.106E+06	7.434E+01
2119	2.724E+03	2.181E+06	1.466E+02	7.276E+02	1.091E+06	7.328E+01
2120	2.685E+03	2.150E+06	1.445E+02	7.172E+02	1.075E+06	7.223E+01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1980	0	0	0	0	0	0
1981	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1982	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1983	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1984	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1985	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1986	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1987	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1988	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1989	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1990	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1991	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1992	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1993	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1994	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1995	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1996	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1997	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1998	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1999	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2001	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2002	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2003	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2004	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2005	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2006	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2007	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2008	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2009	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2010	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2011	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2012	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2013	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2014	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2015	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2016	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2017	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2018	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2019	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2020	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2021	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2022	1.349E+02	7.371E+04	4.952E+00	4.428E-01	1.235E+02	8.300E-03
2023	2.664E+02	1.456E+05	9.780E+00	8.745E-01	2.440E+02	1.639E-02
2024	3.946E+02	2.156E+05	1.448E+01	1.295E+00	3.613E+02	2.428E-02
2025	5.179E+02	2.829E+05	1.901E+01	1.700E+00	4.742E+02	3.186E-02
2026	6.408E+02	3.501E+05	2.352E+01	2.103E+00	5.867E+02	3.942E-02
2027	7.632E+02	4.169E+05	2.801E+01	2.505E+00	6.988E+02	4.695E-02
2028	8.852E+02	4.836E+05	3.249E+01	2.905E+00	8.105E+02	5.445E-02
2029	1.007E+03	5.500E+05	3.695E+01	3.304E+00	9.218E+02	6.193E-02

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2030	1.128E+03	6.162E+05	4.140E+01	3.702E+00	1.033E+03	6.939E-02
2031	1.249E+03	6.822E+05	4.583E+01	4.098E+00	1.143E+03	7.682E-02
2032	1.369E+03	7.479E+05	5.025E+01	4.493E+00	1.254E+03	8.423E-02
2033	1.489E+03	8.135E+05	5.466E+01	4.887E+00	1.364E+03	9.161E-02
2034	1.609E+03	8.790E+05	5.906E+01	5.280E+00	1.473E+03	9.898E-02
2035	1.728E+03	9.442E+05	6.344E+01	5.673E+00	1.583E+03	1.063E-01
2036	1.848E+03	1.009E+06	6.782E+01	6.064E+00	1.692E+03	1.137E-01
2037	1.967E+03	1.074E+06	7.218E+01	6.454E+00	1.801E+03	1.210E-01
2038	2.085E+03	1.139E+06	7.654E+01	6.843E+00	1.909E+03	1.283E-01
2039	2.204E+03	1.204E+06	8.089E+01	7.232E+00	2.018E+03	1.356E-01
2040	2.322E+03	1.268E+06	8.523E+01	7.620E+00	2.126E+03	1.428E-01
2041	2.440E+03	1.333E+06	8.956E+01	8.008E+00	2.234E+03	1.501E-01
2042	2.558E+03	1.397E+06	9.389E+01	8.394E+00	2.342E+03	1.574E-01
2043	2.675E+03	1.462E+06	9.821E+01	8.781E+00	2.450E+03	1.646E-01
2044	2.793E+03	1.526E+06	1.025E+02	9.167E+00	2.557E+03	1.718E-01
2045	2.910E+03	1.590E+06	1.068E+02	9.552E+00	2.665E+03	1.791E-01
2046	3.028E+03	1.654E+06	1.111E+02	9.937E+00	2.772E+03	1.863E-01
2047	3.145E+03	1.718E+06	1.154E+02	1.032E+01	2.880E+03	1.935E-01
2048	3.262E+03	1.782E+06	1.197E+02	1.071E+01	2.987E+03	2.007E-01
2049	3.379E+03	1.846E+06	1.240E+02	1.109E+01	3.094E+03	2.079E-01
2050	3.496E+03	1.910E+06	1.283E+02	1.148E+01	3.201E+03	2.151E-01
2051	3.614E+03	1.974E+06	1.326E+02	1.186E+01	3.309E+03	2.223E-01
2052	3.731E+03	2.038E+06	1.369E+02	1.224E+01	3.416E+03	2.295E-01
2053	3.848E+03	2.102E+06	1.412E+02	1.263E+01	3.523E+03	2.367E-01
2054	3.965E+03	2.166E+06	1.455E+02	1.301E+01	3.630E+03	2.439E-01
2055	4.082E+03	2.230E+06	1.498E+02	1.340E+01	3.737E+03	2.511E-01
2056	4.199E+03	2.294E+06	1.541E+02	1.378E+01	3.845E+03	2.583E-01
2057	4.316E+03	2.358E+06	1.584E+02	1.417E+01	3.952E+03	2.655E-01
2058	4.434E+03	2.422E+06	1.627E+02	1.455E+01	4.060E+03	2.728E-01
2059	4.551E+03	2.486E+06	1.671E+02	1.494E+01	4.167E+03	2.800E-01
2060	4.669E+03	2.551E+06	1.714E+02	1.532E+01	4.275E+03	2.872E-01
2061	4.602E+03	2.514E+06	1.689E+02	1.510E+01	4.214E+03	2.831E-01
2062	4.536E+03	2.478E+06	1.665E+02	1.489E+01	4.154E+03	2.791E-01
2063	4.472E+03	2.443E+06	1.641E+02	1.468E+01	4.094E+03	2.751E-01
2064	4.408E+03	2.408E+06	1.618E+02	1.447E+01	4.036E+03	2.712E-01
2065	4.345E+03	2.373E+06	1.595E+02	1.426E+01	3.978E+03	2.673E-01
2066	4.283E+03	2.340E+06	1.572E+02	1.406E+01	3.921E+03	2.635E-01
2067	4.221E+03	2.306E+06	1.549E+02	1.385E+01	3.865E+03	2.597E-01
2068	4.161E+03	2.273E+06	1.527E+02	1.366E+01	3.810E+03	2.560E-01
2069	4.101E+03	2.241E+06	1.505E+02	1.346E+01	3.755E+03	2.523E-01
2070	4.043E+03	2.209E+06	1.484E+02	1.327E+01	3.702E+03	2.487E-01
2071	3.985E+03	2.177E+06	1.463E+02	1.308E+01	3.649E+03	2.452E-01
2072	3.928E+03	2.146E+06	1.442E+02	1.289E+01	3.597E+03	2.417E-01
2073	3.872E+03	2.115E+06	1.421E+02	1.271E+01	3.545E+03	2.382E-01
2074	3.817E+03	2.085E+06	1.401E+02	1.253E+01	3.494E+03	2.348E-01
2075	3.762E+03	2.055E+06	1.381E+02	1.235E+01	3.444E+03	2.314E-01
2076	3.708E+03	2.026E+06	1.361E+02	1.217E+01	3.395E+03	2.281E-01
2077	3.655E+03	1.997E+06	1.342E+02	1.200E+01	3.347E+03	2.249E-01
2078	3.603E+03	1.968E+06	1.322E+02	1.182E+01	3.299E+03	2.216E-01
2079	3.551E+03	1.940E+06	1.304E+02	1.166E+01	3.252E+03	2.185E-01
2080	3.501E+03	1.912E+06	1.285E+02	1.149E+01	3.205E+03	2.154E-01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2081	3.451E+03	1.885E+06	1.267E+02	1.132E+01	3.159E+03	2.123E-01
2082	3.401E+03	1.858E+06	1.248E+02	1.116E+01	3.114E+03	2.092E-01
2083	3.353E+03	1.832E+06	1.231E+02	1.100E+01	3.070E+03	2.063E-01
2084	3.305E+03	1.805E+06	1.213E+02	1.085E+01	3.026E+03	2.033E-01
2085	3.257E+03	1.780E+06	1.196E+02	1.069E+01	2.983E+03	2.004E-01
2086	3.211E+03	1.754E+06	1.179E+02	1.054E+01	2.940E+03	1.975E-01
2087	3.165E+03	1.729E+06	1.162E+02	1.039E+01	2.898E+03	1.947E-01
2088	3.120E+03	1.704E+06	1.145E+02	1.024E+01	2.856E+03	1.919E-01
2089	3.075E+03	1.680E+06	1.129E+02	1.009E+01	2.816E+03	1.892E-01
2090	3.031E+03	1.656E+06	1.113E+02	9.948E+00	2.775E+03	1.865E-01
2091	2.988E+03	1.632E+06	1.097E+02	9.806E+00	2.736E+03	1.838E-01
2092	2.945E+03	1.609E+06	1.081E+02	9.666E+00	2.697E+03	1.812E-01
2093	2.903E+03	1.586E+06	1.066E+02	9.527E+00	2.658E+03	1.786E-01
2094	2.862E+03	1.563E+06	1.050E+02	9.391E+00	2.620E+03	1.760E-01
2095	2.821E+03	1.541E+06	1.035E+02	9.257E+00	2.583E+03	1.735E-01
2096	2.780E+03	1.519E+06	1.021E+02	9.125E+00	2.546E+03	1.710E-01
2097	2.741E+03	1.497E+06	1.006E+02	8.994E+00	2.509E+03	1.686E-01
2098	2.701E+03	1.476E+06	9.915E+01	8.866E+00	2.473E+03	1.662E-01
2099	2.663E+03	1.455E+06	9.774E+01	8.739E+00	2.438E+03	1.638E-01
2100	2.625E+03	1.434E+06	9.634E+01	8.614E+00	2.403E+03	1.615E-01
2101	2.587E+03	1.413E+06	9.496E+01	8.491E+00	2.369E+03	1.592E-01
2102	2.550E+03	1.393E+06	9.360E+01	8.369E+00	2.335E+03	1.569E-01
2103	2.514E+03	1.373E+06	9.227E+01	8.250E+00	2.302E+03	1.546E-01
2104	2.478E+03	1.354E+06	9.095E+01	8.132E+00	2.269E+03	1.524E-01
2105	2.442E+03	1.334E+06	8.965E+01	8.016E+00	2.236E+03	1.502E-01
2106	2.407E+03	1.315E+06	8.837E+01	7.901E+00	2.204E+03	1.481E-01
2107	2.373E+03	1.296E+06	8.710E+01	7.788E+00	2.173E+03	1.460E-01
2108	2.339E+03	1.278E+06	8.586E+01	7.677E+00	2.142E+03	1.439E-01
2109	2.306E+03	1.260E+06	8.463E+01	7.567E+00	2.111E+03	1.418E-01
2110	2.273E+03	1.242E+06	8.342E+01	7.459E+00	2.081E+03	1.398E-01
2111	2.240E+03	1.224E+06	8.223E+01	7.352E+00	2.051E+03	1.378E-01
2112	2.208E+03	1.206E+06	8.105E+01	7.247E+00	2.022E+03	1.358E-01
2113	2.177E+03	1.189E+06	7.989E+01	7.143E+00	1.993E+03	1.339E-01
2114	2.145E+03	1.172E+06	7.875E+01	7.041E+00	1.964E+03	1.320E-01
2115	2.115E+03	1.155E+06	7.762E+01	6.941E+00	1.936E+03	1.301E-01
2116	2.085E+03	1.139E+06	7.651E+01	6.841E+00	1.909E+03	1.282E-01
2117	2.055E+03	1.123E+06	7.542E+01	6.744E+00	1.881E+03	1.264E-01
2118	2.025E+03	1.106E+06	7.434E+01	6.647E+00	1.854E+03	1.246E-01
2119	1.996E+03	1.091E+06	7.328E+01	6.552E+00	1.828E+03	1.228E-01
2120	1.968E+03	1.075E+06	7.223E+01	6.458E+00	1.802E+03	1.211E-01

LandGEM - Version 3.02

US EPA Office of Research and Development

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LandGEM
Landfill Gas Emissions Model
Version 3.02

U.S. Environmental Protection Agency
Office of Research and Development
National Risk Management Research Laboratory (NRMRL)
and
Clean Air Technology Center (CATC)
Research Triangle Park, North Carolina

May 2005

Summary Report

Landfill Name or Identifier: Matsu Case 3 - Reduction - Part 1 Bulk

Date: Friday, April 17, 2020

Description/Comments:
Matsu Landfill Gas Modeling - revised March 2020
Case 4 - Organics Diversion and Leachate Recirculation
Base Case #1 through 2020;
Recirculation and reduction using k = 0.03 calculated

About LandGEM:

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} kL_o \left(\frac{M_i}{10} \right) e^{-kt_{ij}}$$

Where,
Q_{CH4} = annual methane generation in the year of the calculation *(m^3/year)*
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate *(year^{-1})*
L_o = potential methane generation capacity *(m^3/Mg)*

M_i = mass of waste accepted in the ith year *(Mg)*
t_{ij} = age of the jth section of waste mass M_i accepted in the ith year (*decimal years*, e.g., 3.2 years)

LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on EPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate. Defaults for estimating emissions for this type of operation are being developed to include in LandGEM along with defaults for convential landfills (no leachate or liquid additions) for developing emission inventories and determining CAA applicability. Refer to the Web site identified above for future updates.

Input Review

LANDFILL CHARACTERISTICS

Landfill Open Year	**1980**	
Landfill Closure Year (with 80-year limit)	**2059**	
Actual Closure Year (without limit)	***2059***	
Have Model Calculate Closure Year?	**No**	
Waste Design Capacity		*short tons*

MODEL PARAMETERS

Methane Generation Rate, k	**0.030**	*$year^{-1}$*
Potential Methane Generation Capacity, L_o	**100**	*m^3/Mg*
NMOC Concentration	**838**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	**Carbon dioxide**
Gas / Pollutant #4:	**NMOC**

WASTE ACCEPTANCE RATES

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
1980	0	0	0	0
1981	0	0	0	0
1982	0	0	0	0
1983	0	0	0	0
1984	0	0	0	0
1985	0	0	0	0
1986	0	0	0	0
1987	0	0	0	0
1988	0	0	0	0
1989	0	0	0	0
1990	0	0	0	0
1991	0	0	0	0
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2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	0	0	0	0
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0

WASTE ACCEPTANCE RATES (Continued)

Year	**Waste Accepted**		**Waste-In-Place**	
	(Mg/year)	***(short tons/year)***	***(Mg)***	***(short tons)***
2020	0	0	0	0
2021	51,517	56,669	0	0
2022	50,960	56,056	51,517	56,669
2023	50,386	55,424	102,477	112,725
2024	49,248	54,173	152,863	168,149
2025	49,740	54,714	202,110	222,321
2026	50,238	55,262	251,851	277,036
2027	50,740	55,814	302,089	332,297
2028	51,248	56,372	352,829	388,112
2029	51,760	56,936	404,076	444,484
2030	52,278	57,505	455,836	501,420
2031	52,800	58,080	508,114	558,925
2032	53,328	58,661	560,914	617,006
2033	53,862	59,248	614,243	675,667
2034	54,400	59,840	668,105	734,915
2035	54,944	60,439	722,505	794,755
2036	55,494	61,043	777,449	855,194
2037	56,049	61,654	832,943	916,237
2038	56,609	62,270	888,992	977,891
2039	57,175	62,893	945,601	1,040,161
2040	57,747	63,522	1,002,776	1,103,054
2041	58,325	64,157	1,060,523	1,166,576
2042	58,908	64,799	1,118,848	1,230,732
2043	59,497	65,447	1,177,755	1,295,531
2044	60,092	66,101	1,237,252	1,360,978
2045	60,693	66,762	1,297,344	1,427,079
2046	61,300	67,430	1,358,037	1,493,841
2047	61,913	68,104	1,419,336	1,561,270
2048	62,532	68,785	1,481,249	1,629,374
2049	63,157	69,473	1,543,781	1,698,159
2050	63,789	70,168	1,606,938	1,767,632
2051	64,427	70,869	1,670,727	1,837,799
2052	65,071	71,578	1,735,153	1,908,668
2053	65,722	72,294	1,800,224	1,980,246
2054	66,379	73,017	1,865,945	2,052,540
2055	67,043	73,747	1,932,324	2,125,557
2056	67,713	74,484	1,999,367	2,199,303
2057	68,390	75,229	2,067,080	2,273,788
2058	69,074	75,981	2,135,470	2,349,017
2059	69,765	76,741	2,204,544	2,424,998

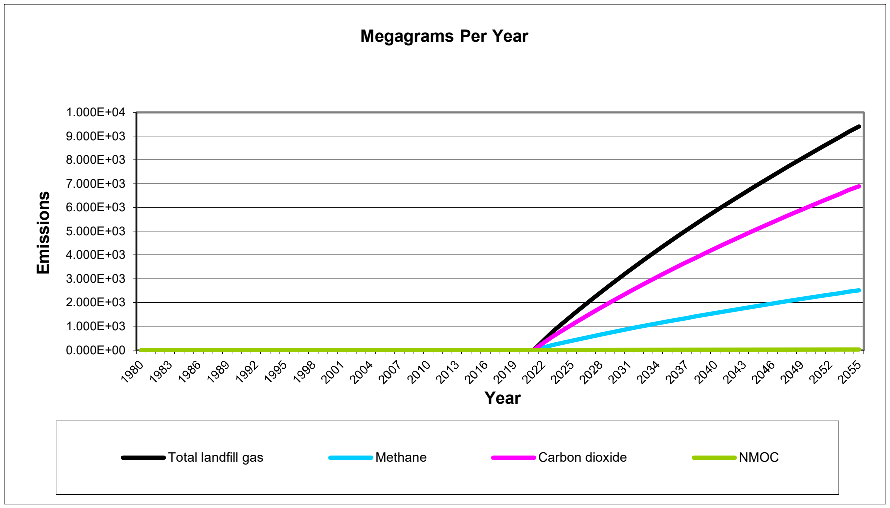
Pollutant Parameters

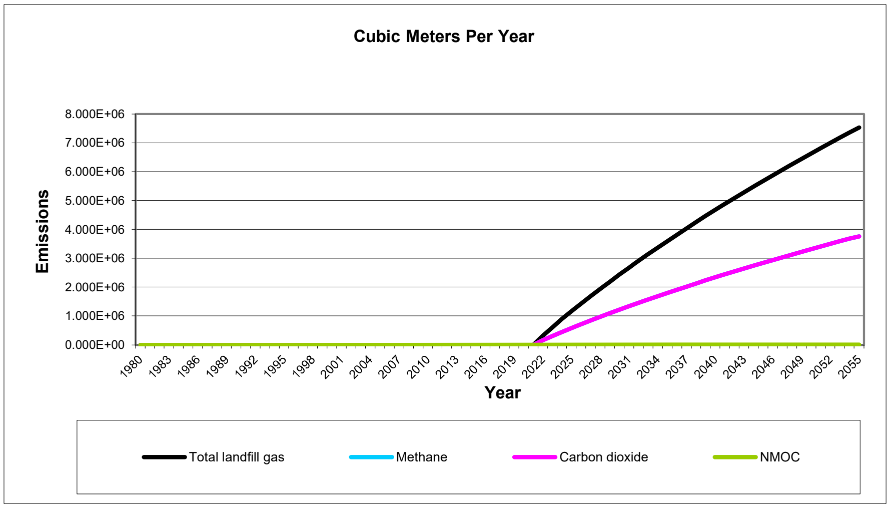
	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Gases	Total landfill gas		0.00		
	Methane		16.04		
	Carbon dioxide		44.01		
	NMOC	4,000	86.18		
Pollutants	1,1,1-Trichloroethane (methyl chloroform) - HAP	0.48	133.41		
	1,1,2,2-Tetrachloroethane - HAP/VOC	1.1	167.85		
	1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	2.4	98.97		
	1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.20	96.94		
	1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.41	98.96		
	1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.18	112.99		
	2-Propanol (isopropyl alcohol) - VOC	50	60.11		
	Acetone	7.0	58.08		
	Acrylonitrile - HAP/VOC	6.3	53.06		
	Benzene - No or Unknown Co-disposal - HAP/VOC	1.9	78.11		
	Benzene - Co-disposal - HAP/VOC	11	78.11		
	Bromodichloromethane - VOC	3.1	163.83		
	Butane - VOC	5.0	58.12		
	Carbon disulfide - HAP/VOC	0.58	76.13		
	Carbon monoxide	140	28.01		
	Carbon tetrachloride - HAP/VOC	4.0E-03	153.84		
	Carbonyl sulfide - HAP/VOC	0.49	60.07		
	Chlorobenzene - HAP/VOC	0.25	112.56		
	Chlorodifluoromethane	1.3	86.47		
	Chloroethane (ethyl chloride) - HAP/VOC	1.3	64.52		
	Chloroform - HAP/VOC	0.03	119.39		
	Chloromethane - VOC	1.2	50.49		
	Dichlorobenzene - (HAP for para isomer/VOC)	0.21	147		
	Dichlorodifluoromethane	16	120.91		
	Dichlorofluoromethane - VOC	2.6	102.92		
	Dichloromethane (methylene chloride) - HAP	14	84.94		
	Dimethyl sulfide (methyl sulfide) - VOC	7.8	62.13		
	Ethane	890	30.07		
	Ethanol - VOC	27	46.08		

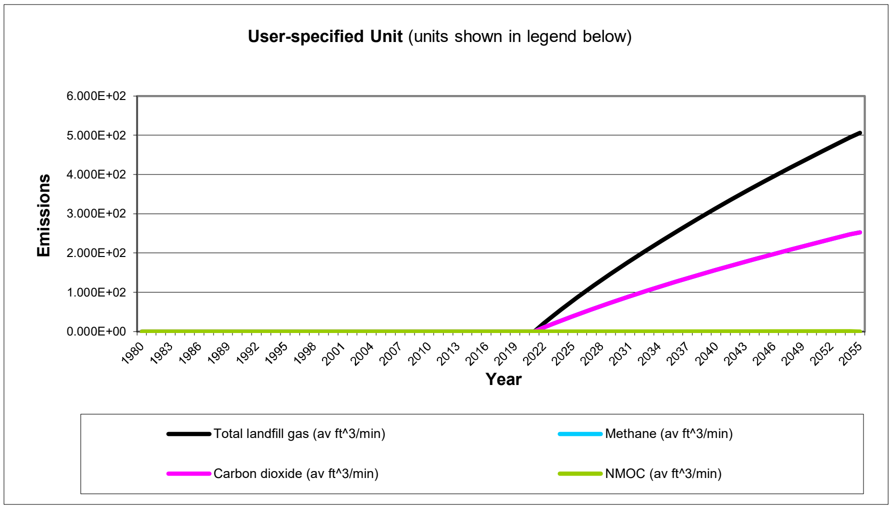
Pollutant Parameters (Continued)

		Gas / Pollutant Default Parameters:		*User-specified Pollutant Parameters:*	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Pollutants	Ethyl mercaptan (ethanethiol) - VOC	2.3	62.13		
	Ethylbenzene - HAP/VOC	4.6	106.16		
	Ethylene dibromide - HAP/VOC	1.0E-03	187.88		
	Fluorotrichloromethane - VOC	0.76	137.38		
	Hexane - HAP/VOC	6.6	86.18		
	Hydrogen sulfide	36	34.08		
	Mercury (total) - HAP	2.9E-04	200.61		
	Methyl ethyl ketone - HAP/VOC	7.1	72.11		
	Methyl isobutyl ketone - HAP/VOC	1.9	100.16		
	Methyl mercaptan - VOC	2.5	48.11		
	Pentane - VOC	3.3	72.15		
	Perchloroethylene (tetrachloroethylene) - HAP	3.7	165.83		
	Propane - VOC	11	44.09		
	t-1,2-Dichloroethene - VOC	2.8	96.94		
	Toluene - No or Unknown Co-disposal - HAP/VOC	39	92.13		
	Toluene - Co-disposal - HAP/VOC	170	92.13		
	Trichloroethylene (trichloroethene) - HAP/VOC	2.8	131.40		
	Vinyl chloride - HAP/VOC	7.3	62.50		
	Xylenes - HAP/VOC	12	106.16		

Graphs


Megagrams Per Year
Emissions
1.000E+04
9.000E+03
8.000E+03
7.000E+03
6.000E+03
5.000E+03
4.000E+03
3.000E+03
2.000E+03
1.000E+03
0.000E+00
1980 1983 1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016 2019 2022 2025 2028 2031 2034 2037 2040 2043 2046 2049 2052 2055
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


Cubic Meters Per Year
Emissions
8.000E+06
7.000E+06
6.000E+06
5.000E+06
4.000E+06
3.000E+06
2.000E+06
1.000E+06
0.000E+00
1980 1983 1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016 2019 2022 2025 2028 2031 2034 2037 2040 2043 2046 2049 2052 2055
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


User-specified Unit (units shown in legend below)
Emissions
6.000E+02
5.000E+02
4.000E+02
3.000E+02
2.000E+02
1.000E+02
0.000E+00
1980 1983 1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016 2019 2022 2025 2028 2031 2034 2037 2040 2043 2046 2049 2052 2055
Year
Total landfill gas (av ft^3/min)
Methane (av ft^3/min)
Carbon dioxide (av ft^3/min)
NMOC (av ft^3/min)

Results

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1980	0	0	0	0	0	0
1981	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1982	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1983	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1984	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1985	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1986	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1987	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1988	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1989	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1990	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1991	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1992	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1993	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1994	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1995	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1996	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1997	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1998	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1999	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2001	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2002	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2003	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2004	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2005	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2006	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2007	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2008	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2009	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2010	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2011	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2012	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2013	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2014	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2015	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2016	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2017	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2018	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2019	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2020	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2021	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2022	3.861E+02	3.092E+05	2.077E+01	1.031E+02	1.546E+05	1.039E+01
2023	7.565E+02	6.058E+05	4.070E+01	2.021E+02	3.029E+05	2.035E+01
2024	1.111E+03	8.900E+05	5.980E+01	2.969E+02	4.450E+05	2.990E+01
2025	1.447E+03	1.159E+06	7.787E+01	3.866E+02	5.794E+05	3.893E+01
2026	1.777E+03	1.423E+06	9.559E+01	4.746E+02	7.113E+05	4.779E+01
2027	2.100E+03	1.682E+06	1.130E+02	5.609E+02	8.408E+05	5.649E+01
2028	2.417E+03	1.936E+06	1.301E+02	6.457E+02	9.678E+05	6.503E+01
2029	2.729E+03	2.185E+06	1.468E+02	7.289E+02	1.093E+06	7.341E+01

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2030	3.035E+03	2.430E+06	1.633E+02	8.107E+02	1.215E+06	8.165E+01
2031	3.336E+03	2.671E+06	1.795E+02	8.911E+02	1.336E+06	8.974E+01
2032	3.632E+03	2.908E+06	1.954E+02	9.701E+02	1.454E+06	9.770E+01
2033	3.923E+03	3.141E+06	2.111E+02	1.048E+03	1.571E+06	1.055E+02
2034	4.209E+03	3.370E+06	2.264E+02	1.124E+03	1.685E+06	1.132E+02
2035	4.490E+03	3.596E+06	2.416E+02	1.199E+03	1.798E+06	1.208E+02
2036	4.768E+03	3.818E+06	2.565E+02	1.274E+03	1.909E+06	1.283E+02
2037	5.041E+03	4.036E+06	2.712E+02	1.346E+03	2.018E+06	1.356E+02
2038	5.310E+03	4.252E+06	2.857E+02	1.418E+03	2.126E+06	1.428E+02
2039	5.575E+03	4.464E+06	2.999E+02	1.489E+03	2.232E+06	1.500E+02
2040	5.836E+03	4.674E+06	3.140E+02	1.559E+03	2.337E+06	1.570E+02
2041	6.094E+03	4.880E+06	3.279E+02	1.628E+03	2.440E+06	1.639E+02
2042	6.349E+03	5.084E+06	3.416E+02	1.696E+03	2.542E+06	1.708E+02
2043	6.600E+03	5.285E+06	3.551E+02	1.763E+03	2.643E+06	1.776E+02
2044	6.848E+03	5.484E+06	3.685E+02	1.829E+03	2.742E+06	1.842E+02
2045	7.094E+03	5.680E+06	3.817E+02	1.895E+03	2.840E+06	1.908E+02
2046	7.336E+03	5.874E+06	3.947E+02	1.960E+03	2.937E+06	1.973E+02
2047	7.576E+03	6.066E+06	4.076E+02	2.024E+03	3.033E+06	2.038E+02
2048	7.813E+03	6.256E+06	4.203E+02	2.087E+03	3.128E+06	2.102E+02
2049	8.047E+03	6.444E+06	4.330E+02	2.149E+03	3.222E+06	2.165E+02
2050	8.279E+03	6.630E+06	4.455E+02	2.212E+03	3.315E+06	2.227E+02
2051	8.509E+03	6.814E+06	4.578E+02	2.273E+03	3.407E+06	2.289E+02
2052	8.737E+03	6.996E+06	4.701E+02	2.334E+03	3.498E+06	2.350E+02
2053	8.963E+03	7.177E+06	4.822E+02	2.394E+03	3.589E+06	2.411E+02
2054	9.187E+03	7.357E+06	4.943E+02	2.454E+03	3.678E+06	2.471E+02
2055	9.410E+03	7.535E+06	5.063E+02	2.513E+03	3.767E+06	2.531E+02
2056	9.630E+03	7.711E+06	5.181E+02	2.572E+03	3.856E+06	2.591E+02
2057	9.849E+03	7.887E+06	5.299E+02	2.631E+03	3.943E+06	2.650E+02
2058	1.007E+04	8.061E+06	5.416E+02	2.689E+03	4.030E+06	2.708E+02
2059	1.028E+04	8.234E+06	5.532E+02	2.747E+03	4.117E+06	2.766E+02
2060	1.050E+04	8.406E+06	5.648E+02	2.804E+03	4.203E+06	2.824E+02
2061	1.018E+04	8.154E+06	5.479E+02	2.720E+03	4.077E+06	2.739E+02
2062	9.878E+03	7.910E+06	5.314E+02	2.638E+03	3.955E+06	2.657E+02
2063	9.582E+03	7.673E+06	5.155E+02	2.559E+03	3.836E+06	2.578E+02
2064	9.295E+03	7.443E+06	5.001E+02	2.483E+03	3.721E+06	2.500E+02
2065	9.016E+03	7.220E+06	4.851E+02	2.408E+03	3.610E+06	2.425E+02
2066	8.746E+03	7.003E+06	4.706E+02	2.336E+03	3.502E+06	2.353E+02
2067	8.484E+03	6.794E+06	4.565E+02	2.266E+03	3.397E+06	2.282E+02
2068	8.230E+03	6.590E+06	4.428E+02	2.198E+03	3.295E+06	2.214E+02
2069	7.983E+03	6.393E+06	4.295E+02	2.132E+03	3.196E+06	2.148E+02
2070	7.744E+03	6.201E+06	4.166E+02	2.069E+03	3.101E+06	2.083E+02
2071	7.512E+03	6.015E+06	4.042E+02	2.007E+03	3.008E+06	2.021E+02
2072	7.287E+03	5.835E+06	3.921E+02	1.946E+03	2.918E+06	1.960E+02
2073	7.069E+03	5.660E+06	3.803E+02	1.888E+03	2.830E+06	1.902E+02
2074	6.857E+03	5.491E+06	3.689E+02	1.832E+03	2.745E+06	1.845E+02
2075	6.651E+03	5.326E+06	3.579E+02	1.777E+03	2.663E+06	1.789E+02
2076	6.452E+03	5.167E+06	3.471E+02	1.723E+03	2.583E+06	1.736E+02
2077	6.259E+03	5.012E+06	3.367E+02	1.672E+03	2.506E+06	1.684E+02
2078	6.071E+03	4.862E+06	3.266E+02	1.622E+03	2.431E+06	1.633E+02
2079	5.889E+03	4.716E+06	3.169E+02	1.573E+03	2.358E+06	1.584E+02
2080	5.713E+03	4.575E+06	3.074E+02	1.526E+03	2.287E+06	1.537E+02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2081	5.542E+03	4.438E+06	2.982E+02	1.480E+03	2.219E+06	1.491E+02
2082	5.376E+03	4.305E+06	2.892E+02	1.436E+03	2.152E+06	1.446E+02
2083	5.215E+03	4.176E+06	2.806E+02	1.393E+03	2.088E+06	1.403E+02
2084	5.058E+03	4.051E+06	2.722E+02	1.351E+03	2.025E+06	1.361E+02
2085	4.907E+03	3.929E+06	2.640E+02	1.311E+03	1.965E+06	1.320E+02
2086	4.760E+03	3.811E+06	2.561E+02	1.271E+03	1.906E+06	1.280E+02
2087	4.617E+03	3.697E+06	2.484E+02	1.233E+03	1.849E+06	1.242E+02
2088	4.479E+03	3.586E+06	2.410E+02	1.196E+03	1.793E+06	1.205E+02
2089	4.345E+03	3.479E+06	2.338E+02	1.161E+03	1.739E+06	1.169E+02
2090	4.214E+03	3.375E+06	2.267E+02	1.126E+03	1.687E+06	1.134E+02
2091	4.088E+03	3.274E+06	2.200E+02	1.092E+03	1.637E+06	1.100E+02
2092	3.966E+03	3.176E+06	2.134E+02	1.059E+03	1.588E+06	1.067E+02
2093	3.847E+03	3.080E+06	2.070E+02	1.028E+03	1.540E+06	1.035E+02
2094	3.732E+03	2.988E+06	2.008E+02	9.968E+02	1.494E+06	1.004E+02
2095	3.620E+03	2.899E+06	1.948E+02	9.669E+02	1.449E+06	9.738E+01
2096	3.511E+03	2.812E+06	1.889E+02	9.379E+02	1.406E+06	9.446E+01
2097	3.406E+03	2.727E+06	1.833E+02	9.098E+02	1.364E+06	9.163E+01
2098	3.304E+03	2.646E+06	1.778E+02	8.826E+02	1.323E+06	8.888E+01
2099	3.205E+03	2.566E+06	1.724E+02	8.561E+02	1.283E+06	8.622E+01
2100	3.109E+03	2.490E+06	1.673E+02	8.305E+02	1.245E+06	8.364E+01
2101	3.016E+03	2.415E+06	1.623E+02	8.056E+02	1.208E+06	8.113E+01
2102	2.926E+03	2.343E+06	1.574E+02	7.814E+02	1.171E+06	7.870E+01
2103	2.838E+03	2.272E+06	1.527E+02	7.580E+02	1.136E+06	7.634E+01
2104	2.753E+03	2.204E+06	1.481E+02	7.353E+02	1.102E+06	7.406E+01
2105	2.670E+03	2.138E+06	1.437E+02	7.133E+02	1.069E+06	7.184E+01
2106	2.590E+03	2.074E+06	1.394E+02	6.919E+02	1.037E+06	6.968E+01
2107	2.513E+03	2.012E+06	1.352E+02	6.712E+02	1.006E+06	6.760E+01
2108	2.437E+03	1.952E+06	1.311E+02	6.511E+02	9.759E+05	6.557E+01
2109	2.364E+03	1.893E+06	1.272E+02	6.316E+02	9.467E+05	6.361E+01
2110	2.294E+03	1.837E+06	1.234E+02	6.126E+02	9.183E+05	6.170E+01
2111	2.225E+03	1.782E+06	1.197E+02	5.943E+02	8.908E+05	5.985E+01
2112	2.158E+03	1.728E+06	1.161E+02	5.765E+02	8.641E+05	5.806E+01
2113	2.094E+03	1.676E+06	1.126E+02	5.592E+02	8.382E+05	5.632E+01
2114	2.031E+03	1.626E+06	1.093E+02	5.425E+02	8.131E+05	5.463E+01
2115	1.970E+03	1.577E+06	1.060E+02	5.262E+02	7.887E+05	5.299E+01
2116	1.911E+03	1.530E+06	1.028E+02	5.104E+02	7.651E+05	5.141E+01
2117	1.854E+03	1.484E+06	9.973E+01	4.951E+02	7.422E+05	4.987E+01
2118	1.798E+03	1.440E+06	9.675E+01	4.803E+02	7.199E+05	4.837E+01
2119	1.744E+03	1.397E+06	9.385E+01	4.659E+02	6.984E+05	4.692E+01
2120	1.692E+03	1.355E+06	9.104E+01	4.520E+02	6.774E+05	4.552E+01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1980	0	0	0	0	0	0
1981	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1982	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1983	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1984	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1985	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1986	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1987	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1988	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1989	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1990	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1991	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1992	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1993	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1994	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1995	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1996	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1997	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1998	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1999	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2001	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2002	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2003	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2004	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2005	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2006	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2007	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2008	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2009	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2010	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2011	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2012	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2013	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2014	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2015	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2016	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2017	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2018	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2019	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2020	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2021	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2022	2.830E+02	1.546E+05	1.039E+01	9.287E-01	2.591E+02	1.741E-02
2023	5.544E+02	3.029E+05	2.035E+01	1.820E+00	5.076E+02	3.411E-02
2024	8.146E+02	4.450E+05	2.990E+01	2.673E+00	7.458E+02	5.011E-02
2025	1.061E+03	5.794E+05	3.893E+01	3.481E+00	9.711E+02	6.525E-02
2026	1.302E+03	7.113E+05	4.779E+01	4.273E+00	1.192E+03	8.010E-02
2027	1.539E+03	8.408E+05	5.649E+01	5.051E+00	1.409E+03	9.468E-02
2028	1.772E+03	9.678E+05	6.503E+01	5.814E+00	1.622E+03	1.090E-01
2029	2.000E+03	1.093E+06	7.341E+01	6.564E+00	1.831E+03	1.230E-01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2030	2.224E+03	1.215E+06	8.165E+01	7.300E+00	2.037E+03	1.368E-01
2031	2.445E+03	1.336E+06	8.974E+01	8.024E+00	2.239E+03	1.504E-01
2032	2.662E+03	1.454E+06	9.770E+01	8.736E+00	2.437E+03	1.637E-01
2033	2.875E+03	1.571E+06	1.055E+02	9.435E+00	2.632E+03	1.769E-01
2034	3.085E+03	1.685E+06	1.132E+02	1.012E+01	2.824E+03	1.898E-01
2035	3.291E+03	1.798E+06	1.208E+02	1.080E+01	3.013E+03	2.025E-01
2036	3.494E+03	1.909E+06	1.283E+02	1.147E+01	3.199E+03	2.150E-01
2037	3.694E+03	2.018E+06	1.356E+02	1.212E+01	3.383E+03	2.273E-01
2038	3.892E+03	2.126E+06	1.428E+02	1.277E+01	3.563E+03	2.394E-01
2039	4.086E+03	2.232E+06	1.500E+02	1.341E+01	3.741E+03	2.514E-01
2040	4.278E+03	2.337E+06	1.570E+02	1.404E+01	3.916E+03	2.631E-01
2041	4.467E+03	2.440E+06	1.639E+02	1.466E+01	4.090E+03	2.748E-01
2042	4.653E+03	2.542E+06	1.708E+02	1.527E+01	4.260E+03	2.863E-01
2043	4.837E+03	2.643E+06	1.776E+02	1.588E+01	4.429E+03	2.976E-01
2044	5.019E+03	2.742E+06	1.842E+02	1.647E+01	4.595E+03	3.088E-01
2045	5.199E+03	2.840E+06	1.908E+02	1.706E+01	4.760E+03	3.198E-01
2046	5.376E+03	2.937E+06	1.973E+02	1.765E+01	4.923E+03	3.308E-01
2047	5.552E+03	3.033E+06	2.038E+02	1.822E+01	5.083E+03	3.416E-01
2048	5.726E+03	3.128E+06	2.102E+02	1.879E+01	5.243E+03	3.522E-01
2049	5.898E+03	3.222E+06	2.165E+02	1.936E+01	5.400E+03	3.628E-01
2050	6.068E+03	3.315E+06	2.227E+02	1.991E+01	5.556E+03	3.733E-01
2051	6.236E+03	3.407E+06	2.289E+02	2.047E+01	5.710E+03	3.837E-01
2052	6.404E+03	3.498E+06	2.350E+02	2.102E+01	5.863E+03	3.939E-01
2053	6.569E+03	3.589E+06	2.411E+02	2.156E+01	6.015E+03	4.041E-01
2054	6.733E+03	3.678E+06	2.471E+02	2.210E+01	6.165E+03	4.142E-01
2055	6.896E+03	3.767E+06	2.531E+02	2.263E+01	6.314E+03	4.242E-01
2056	7.058E+03	3.856E+06	2.591E+02	2.316E+01	6.462E+03	4.342E-01
2057	7.218E+03	3.943E+06	2.650E+02	2.369E+01	6.609E+03	4.441E-01
2058	7.378E+03	4.030E+06	2.708E+02	2.421E+01	6.755E+03	4.539E-01
2059	7.536E+03	4.117E+06	2.766E+02	2.473E+01	6.900E+03	4.636E-01
2060	7.693E+03	4.203E+06	2.824E+02	2.525E+01	7.044E+03	4.733E-01
2061	7.463E+03	4.077E+06	2.739E+02	2.449E+01	6.833E+03	4.591E-01
2062	7.239E+03	3.955E+06	2.657E+02	2.376E+01	6.628E+03	4.454E-01
2063	7.022E+03	3.836E+06	2.578E+02	2.305E+01	6.430E+03	4.320E-01
2064	6.812E+03	3.721E+06	2.500E+02	2.236E+01	6.237E+03	4.191E-01
2065	6.608E+03	3.610E+06	2.425E+02	2.169E+01	6.050E+03	4.065E-01
2066	6.410E+03	3.502E+06	2.353E+02	2.104E+01	5.869E+03	3.943E-01
2067	6.218E+03	3.397E+06	2.282E+02	2.041E+01	5.693E+03	3.825E-01
2068	6.032E+03	3.295E+06	2.214E+02	1.980E+01	5.522E+03	3.711E-01
2069	5.851E+03	3.196E+06	2.148E+02	1.920E+01	5.357E+03	3.599E-01
2070	5.676E+03	3.101E+06	2.083E+02	1.863E+01	5.196E+03	3.492E-01
2071	5.505E+03	3.008E+06	2.021E+02	1.807E+01	5.041E+03	3.387E-01
2072	5.341E+03	2.918E+06	1.960E+02	1.753E+01	4.890E+03	3.285E-01
2073	5.181E+03	2.830E+06	1.902E+02	1.700E+01	4.743E+03	3.187E-01
2074	5.025E+03	2.745E+06	1.845E+02	1.649E+01	4.601E+03	3.092E-01
2075	4.875E+03	2.663E+06	1.789E+02	1.600E+01	4.463E+03	2.999E-01
2076	4.729E+03	2.583E+06	1.736E+02	1.552E+01	4.330E+03	2.909E-01
2077	4.587E+03	2.506E+06	1.684E+02	1.505E+01	4.200E+03	2.822E-01
2078	4.450E+03	2.431E+06	1.633E+02	1.460E+01	4.074E+03	2.737E-01
2079	4.316E+03	2.358E+06	1.584E+02	1.417E+01	3.952E+03	2.655E-01
2080	4.187E+03	2.287E+06	1.537E+02	1.374E+01	3.834E+03	2.576E-01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2081	4.061E+03	2.219E+06	1.491E+02	1.333E+01	3.719E+03	2.499E-01
2082	3.940E+03	2.152E+06	1.446E+02	1.293E+01	3.607E+03	2.424E-01
2083	3.822E+03	2.088E+06	1.403E+02	1.254E+01	3.499E+03	2.351E-01
2084	3.707E+03	2.025E+06	1.361E+02	1.217E+01	3.394E+03	2.281E-01
2085	3.596E+03	1.965E+06	1.320E+02	1.180E+01	3.293E+03	2.212E-01
2086	3.488E+03	1.906E+06	1.280E+02	1.145E+01	3.194E+03	2.146E-01
2087	3.384E+03	1.849E+06	1.242E+02	1.111E+01	3.098E+03	2.082E-01
2088	3.282E+03	1.793E+06	1.205E+02	1.077E+01	3.005E+03	2.019E-01
2089	3.184E+03	1.739E+06	1.169E+02	1.045E+01	2.915E+03	1.959E-01
2090	3.089E+03	1.687E+06	1.134E+02	1.014E+01	2.828E+03	1.900E-01
2091	2.996E+03	1.637E+06	1.100E+02	9.833E+00	2.743E+03	1.843E-01
2092	2.906E+03	1.588E+06	1.067E+02	9.539E+00	2.661E+03	1.788E-01
2093	2.819E+03	1.540E+06	1.035E+02	9.253E+00	2.581E+03	1.734E-01
2094	2.735E+03	1.494E+06	1.004E+02	8.976E+00	2.504E+03	1.682E-01
2095	2.653E+03	1.449E+06	9.738E+01	8.707E+00	2.429E+03	1.632E-01
2096	2.573E+03	1.406E+06	9.446E+01	8.446E+00	2.356E+03	1.583E-01
2097	2.496E+03	1.364E+06	9.163E+01	8.193E+00	2.286E+03	1.536E-01
2098	2.422E+03	1.323E+06	8.888E+01	7.947E+00	2.217E+03	1.490E-01
2099	2.349E+03	1.283E+06	8.622E+01	7.709E+00	2.151E+03	1.445E-01
2100	2.279E+03	1.245E+06	8.364E+01	7.478E+00	2.086E+03	1.402E-01
2101	2.210E+03	1.208E+06	8.113E+01	7.254E+00	2.024E+03	1.360E-01
2102	2.144E+03	1.171E+06	7.870E+01	7.037E+00	1.963E+03	1.319E-01
2103	2.080E+03	1.136E+06	7.634E+01	6.826E+00	1.904E+03	1.280E-01
2104	2.018E+03	1.102E+06	7.406E+01	6.621E+00	1.847E+03	1.241E-01
2105	1.957E+03	1.069E+06	7.184E+01	6.423E+00	1.792E+03	1.204E-01
2106	1.898E+03	1.037E+06	6.968E+01	6.231E+00	1.738E+03	1.168E-01
2107	1.842E+03	1.006E+06	6.760E+01	6.044E+00	1.686E+03	1.133E-01
2108	1.786E+03	9.759E+05	6.557E+01	5.863E+00	1.636E+03	1.099E-01
2109	1.733E+03	9.467E+05	6.361E+01	5.687E+00	1.587E+03	1.066E-01
2110	1.681E+03	9.183E+05	6.170E+01	5.517E+00	1.539E+03	1.034E-01
2111	1.631E+03	8.908E+05	5.985E+01	5.351E+00	1.493E+03	1.003E-01
2112	1.582E+03	8.641E+05	5.806E+01	5.191E+00	1.448E+03	9.731E-02
2113	1.534E+03	8.382E+05	5.632E+01	5.036E+00	1.405E+03	9.439E-02
2114	1.488E+03	8.131E+05	5.463E+01	4.885E+00	1.363E+03	9.156E-02
2115	1.444E+03	7.887E+05	5.299E+01	4.738E+00	1.322E+03	8.882E-02
2116	1.401E+03	7.651E+05	5.141E+01	4.596E+00	1.282E+03	8.616E-02
2117	1.359E+03	7.422E+05	4.987E+01	4.459E+00	1.244E+03	8.358E-02
2118	1.318E+03	7.199E+05	4.837E+01	4.325E+00	1.207E+03	8.107E-02
2119	1.278E+03	6.984E+05	4.692E+01	4.196E+00	1.170E+03	7.864E-02
2120	1.240E+03	6.774E+05	4.552E+01	4.070E+00	1.135E+03	7.629E-02

LandGEM - Version 3.02

US EPA Office of Research and Development

CLEAN AIR TECHNOLOGY CENTER

LandGEM
Landfill Gas Emissions Model
Version 3.02

U.S. Environmental Protection Agency
Office of Research and Development
National Risk Management Research Laboratory (NRMRL)
and
Clean Air Technology Center (CATC)
Research Triangle Park, North Carolina

May 2005

EPA

Summary Report

Landfill Name or Identifier: Matsu - bulk through 2024 base cases

Date: Friday, April 17, 2020

Description/Comments:
Matsu Landfill Gas Modeling - January 2020
Base Case for others - starting "other" scenarios in 2021
Assuming 1% increase annually

About LandGEM:

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n}\sum_{j=0.1}^{1} kL_o\left(\frac{M_i}{10}\right)e^{-kt_{ij}}$$

Where,
Q_{CH4} = annual methane generation in the year of the calculation (*m^3/year*)
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate (*$year^{-1}$*)
L_o = potential methane generation capacity (*m^3/Mg*)

M_i = mass of waste accepted in the ith year (*Mg*)
t_{ij} = age of the jth section of waste mass M_i accepted in the ith year (*decimal years*, e.g., 3.2 years)

LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on EPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate. Defaults for estimating emissions for this type of operation are being developed to include in LandGEM along with defaults for convential landfills (no leachate or liquid additions) for developing emission inventories and determining CAA applicability. Refer to the Web site identified above for future updates.

Input Review

LANDFILL CHARACTERISTICS		
Landfill Open Year	**1980**	
Landfill Closure Year (with 80-year limit)	**2020**	
Actual Closure Year (without limit)	***2020***	
Have Model Calculate Closure Year?	**No**	
Waste Design Capacity		*short tons*
MODEL PARAMETERS		
Methane Generation Rate, k	**0.020**	*$year^{-1}$*
Potential Methane Generation Capacity, L_o	**100**	*m^3/Mg*
NMOC Concentration	**838**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	**Carbon dioxide**
Gas / Pollutant #4:	**NMOC**

WASTE ACCEPTANCE RATES

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
1980	12,147	13,362	0	0
1981	13,524	14,876	12,147	13,362
1982	15,646	17,211	25,671	28,238
1983	18,799	20,679	41,317	45,449
1984	23,154	25,469	60,116	66,128
1985	27,347	30,082	83,270	91,597
1986	29,146	32,061	110,617	121,679
1987	29,228	32,151	139,764	153,740
1988	28,195	31,014	168,992	185,891
1989	28,675	31,542	197,186	216,905
1990	29,582	32,540	225,861	248,447
1991	28,893	31,782	255,443	280,987
1992	29,849	32,834	284,335	312,769
1993	32,237	35,461	314,185	345,603
1994	32,479	35,727	346,422	381,064
1995	31,122	34,234	378,901	416,791
1996	31,136	34,250	410,023	451,025
1997	32,696	35,966	441,159	485,275
1998	36,923	40,615	473,855	521,241
1999	37,974	41,771	510,778	561,856
2000	41,598	45,758	548,752	603,627
2001	49,044	53,948	590,350	649,385
2002	49,044	53,948	639,394	703,333
2003	49,044	53,948	688,437	757,281
2004	83,167	91,484	737,481	811,229
2005	83,167	91,484	820,648	902,713
2006	83,167	91,484	903,815	994,197
2007	53,726	59,099	986,983	1,085,681
2008	49,849	54,834	1,040,709	1,144,780
2009	51,879	57,067	1,090,558	1,199,614
2010	52,472	57,719	1,142,437	1,256,681
2011	52,391	57,630	1,194,910	1,314,400
2012	52,216	57,437	1,247,300	1,372,030
2013	53,451	58,796	1,299,516	1,429,467
2014	53,322	58,654	1,352,967	1,488,264
2015	37,949	41,744	1,406,289	1,546,918
2016	53,795	59,174	1,444,238	1,588,662
2017	53,453	58,799	1,498,033	1,647,836
2018	52,428	57,671	1,551,486	1,706,635
2019	52,064	57,271	1,603,914	1,764,306

WASTE ACCEPTANCE RATES (Continued)

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
2020	52,585	57,843	1,655,978	1,821,576
2021	0	0	1,708,563	1,879,419
2022	0	0	1,708,563	1,879,419
2023	0	0	1,708,563	1,879,419
2024	0	0	1,708,563	1,879,419
2025	0	0	1,708,563	1,879,419
2026	0	0	1,708,563	1,879,419
2027	0	0	1,708,563	1,879,419
2028	0	0	1,708,563	1,879,419
2029	0	0	1,708,563	1,879,419
2030	0	0	1,708,563	1,879,419
2031	0	0	1,708,563	1,879,419
2032	0	0	1,708,563	1,879,419
2033	0	0	1,708,563	1,879,419
2034	0	0	1,708,563	1,879,419
2035	0	0	1,708,563	1,879,419
2036	0	0	1,708,563	1,879,419
2037	0	0	1,708,563	1,879,419
2038	0	0	1,708,563	1,879,419
2039	0	0	1,708,563	1,879,419
2040	0	0	1,708,563	1,879,419
2041	0	0	1,708,563	1,879,419
2042	0	0	1,708,563	1,879,419
2043	0	0	1,708,563	1,879,419
2044	0	0	1,708,563	1,879,419
2045	0	0	1,708,563	1,879,419
2046	0	0	1,708,563	1,879,419
2047	0	0	1,708,563	1,879,419
2048	0	0	1,708,563	1,879,419
2049	0	0	1,708,563	1,879,419
2050	0	0	1,708,563	1,879,419
2051	0	0	1,708,563	1,879,419
2052	0	0	1,708,563	1,879,419
2053	0	0	1,708,563	1,879,419
2054	0	0	1,708,563	1,879,419
2055	0	0	1,708,563	1,879,419
2056	0	0	1,708,563	1,879,419
2057	0	0	1,708,563	1,879,419
2058	0	0	1,708,563	1,879,419
2059	0	0	1,708,563	1,879,419

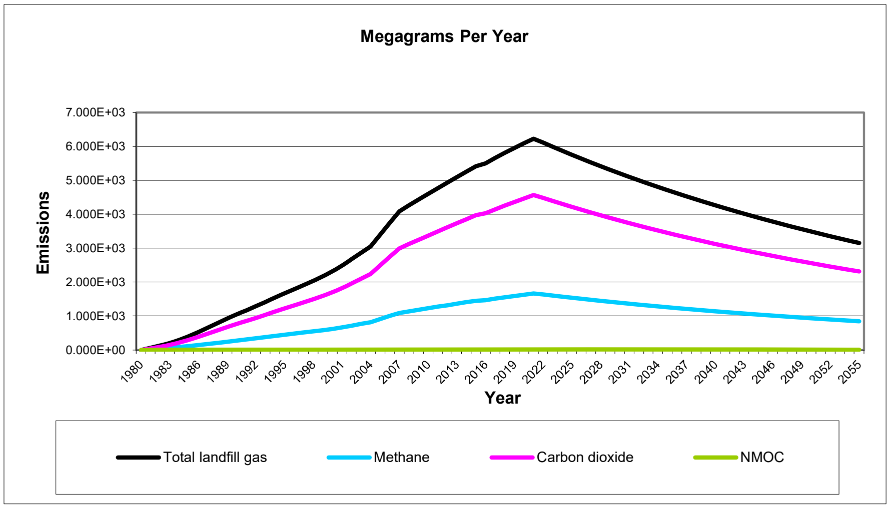
Pollutant Parameters

	Gas / Pollutant Default Parameters:			User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Gases	Total landfill gas		0.00		
	Methane		16.04		
	Carbon dioxide		44.01		
	NMOC	4,000	86.18		
Pollutants	1,1,1-Trichloroethane (methyl chloroform) - HAP	0.48	133.41		
	1,1,2,2-Tetrachloroethane - HAP/VOC	1.1	167.85		
	1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	2.4	98.97		
	1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.20	96.94		
	1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.41	98.96		
	1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.18	112.99		
	2-Propanol (isopropyl alcohol) - VOC	50	60.11		
	Acetone	7.0	58.08		
	Acrylonitrile - HAP/VOC	6.3	53.06		
	Benzene - No or Unknown Co-disposal - HAP/VOC	1.9	78.11		
	Benzene - Co-disposal - HAP/VOC	11	78.11		
	Bromodichloromethane - VOC	3.1	163.83		
	Butane - VOC	5.0	58.12		
	Carbon disulfide - HAP/VOC	0.58	76.13		
	Carbon monoxide	140	28.01		
	Carbon tetrachloride - HAP/VOC	4.0E-03	153.84		
	Carbonyl sulfide - HAP/VOC	0.49	60.07		
	Chlorobenzene - HAP/VOC	0.25	112.56		
	Chlorodifluoromethane	1.3	86.47		
	Chloroethane (ethyl chloride) - HAP/VOC	1.3	64.52		
	Chloroform - HAP/VOC	0.03	119.39		
	Chloromethane - VOC	1.2	50.49		
	Dichlorobenzene - (HAP for para isomer/VOC)	0.21	147		
	Dichlorodifluoromethane	16	120.91		
	Dichlorofluoromethane - VOC	2.6	102.92		
	Dichloromethane (methylene chloride) - HAP	14	84.94		
	Dimethyl sulfide (methyl sulfide) - VOC	7.8	62.13		
	Ethane	890	30.07		
	Ethanol - VOC	27	46.08		

Pollutant Parameters (Continued)

	Gas / Pollutant Default Parameters:			***User-specified Pollutant Parameters:***	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Pollutants	Ethyl mercaptan (ethanethiol) - VOC	2.3	62.13		
	Ethylbenzene - HAP/VOC	4.6	106.16		
	Ethylene dibromide - HAP/VOC	1.0E-03	187.88		
	Fluorotrichloromethane - VOC	0.76	137.38		
	Hexane - HAP/VOC	6.6	86.18		
	Hydrogen sulfide	36	34.08		
	Mercury (total) - HAP	2.9E-04	200.61		
	Methyl ethyl ketone - HAP/VOC	7.1	72.11		
	Methyl isobutyl ketone - HAP/VOC	1.9	100.16		
	Methyl mercaptan - VOC	2.5	48.11		
	Pentane - VOC	3.3	72.15		
	Perchloroethylene (tetrachloroethylene) - HAP	3.7	165.83		
	Propane - VOC	11	44.09		
	t-1,2-Dichloroethene - VOC	2.8	96.94		
	Toluene - No or Unknown Co-disposal - HAP/VOC	39	92.13		
	Toluene - Co-disposal - HAP/VOC	170	92.13		
	Trichloroethylene (trichloroethene) - HAP/VOC	2.8	131.40		
	Vinyl chloride - HAP/VOC	7.3	62.50		
	Xylenes - HAP/VOC	12	106.16		

Graphs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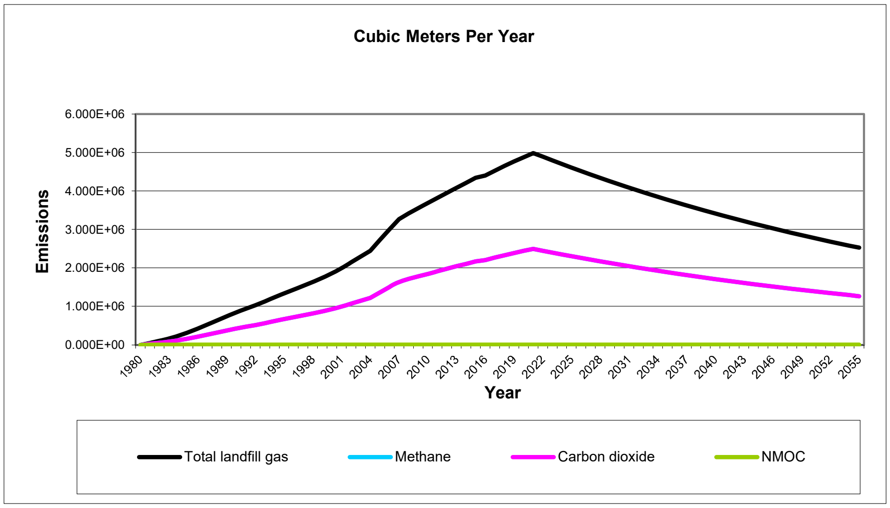
6.000E+03
5.000E+03
4.000E+03
3.000E+03
2.000E+03
1.000E+03
0.000E+00
1980 1983 1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016 2019 2022 2025 2028 2031 2034 2037 2040 2043 2046 2049 2052 2055
Year
Total landfill gas
Methane
Carbon dioxide
NMOC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Emissions
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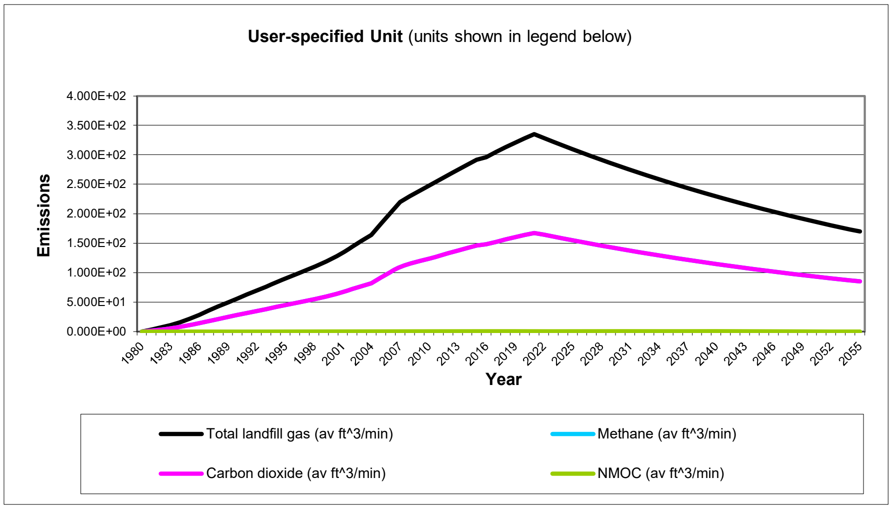
4.000E+06
3.000E+06
2.000E+06
1.000E+06
0.000E+00
1980 1983 1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016 2019 2022 2025 2028 2031 2034 2037 2040 2043 2046 2049 2052 2055
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


User-specified Unit (units shown in legend below)
Emissions
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2.500E+02
2.000E+02
1.500E+02
1.000E+02
5.000E+01
0.000E+00
1980 1983 1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016 2019 2022 2025 2028 2031 2034 2037 2040 2043 2046 2049 2052 2055
Year
Total landfill gas (av ft^3/min)
Methane (av ft^3/min)
Carbon dioxide (av ft^3/min)
NMOC (av ft^3/min)

Results

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1980	0	0	0	0	0	0
1981	6.014E+01	4.815E+04	3.235E+00	1.606E+01	2.408E+04	1.618E+00
1982	1.259E+02	1.008E+05	6.774E+00	3.363E+01	5.041E+04	3.387E+00
1983	2.009E+02	1.608E+05	1.081E+01	5.365E+01	8.042E+04	5.403E+00
1984	2.900E+02	2.322E+05	1.560E+01	7.745E+01	1.161E+05	7.800E+00
1985	3.988E+02	3.194E+05	2.146E+01	1.065E+02	1.597E+05	1.073E+01
1986	5.263E+02	4.215E+05	2.832E+01	1.406E+02	2.107E+05	1.416E+01
1987	6.602E+02	5.287E+05	3.552E+01	1.763E+02	2.643E+05	1.776E+01
1988	7.918E+02	6.341E+05	4.260E+01	2.115E+02	3.170E+05	2.130E+01
1989	9.157E+02	7.333E+05	4.927E+01	2.446E+02	3.666E+05	2.463E+01
1990	1.040E+03	8.324E+05	5.593E+01	2.777E+02	4.162E+05	2.797E+01
1991	1.165E+03	9.332E+05	6.270E+01	3.113E+02	4.666E+05	3.135E+01
1992	1.285E+03	1.029E+06	6.916E+01	3.433E+02	5.146E+05	3.458E+01
1993	1.408E+03	1.127E+06	7.574E+01	3.760E+02	5.636E+05	3.787E+01
1994	1.539E+03	1.233E+06	8.282E+01	4.112E+02	6.163E+05	4.141E+01
1995	1.670E+03	1.337E+06	8.984E+01	4.460E+02	6.685E+05	4.492E+01
1996	1.791E+03	1.434E+06	9.635E+01	4.783E+02	7.170E+05	4.817E+01
1997	1.909E+03	1.529E+06	1.027E+02	5.100E+02	7.645E+05	5.137E+01
1998	2.033E+03	1.628E+06	1.094E+02	5.432E+02	8.142E+05	5.470E+01
1999	2.176E+03	1.742E+06	1.171E+02	5.812E+02	8.712E+05	5.854E+01
2000	2.321E+03	1.858E+06	1.249E+02	6.199E+02	9.292E+05	6.244E+01
2001	2.481E+03	1.987E+06	1.335E+02	6.627E+02	9.933E+05	6.674E+01
2002	2.675E+03	2.142E+06	1.439E+02	7.144E+02	1.071E+06	7.195E+01
2003	2.864E+03	2.294E+06	1.541E+02	7.651E+02	1.147E+06	7.706E+01
2004	3.050E+03	2.443E+06	1.641E+02	8.148E+02	1.221E+06	8.206E+01
2005	3.402E+03	2.724E+06	1.830E+02	9.087E+02	1.362E+06	9.151E+01
2006	3.746E+03	3.000E+06	2.016E+02	1.001E+03	1.500E+06	1.008E+02
2007	4.084E+03	3.270E+06	2.197E+02	1.091E+03	1.635E+06	1.099E+02
2008	4.269E+03	3.418E+06	2.297E+02	1.140E+03	1.709E+06	1.148E+02
2009	4.431E+03	3.548E+06	2.384E+02	1.184E+03	1.774E+06	1.192E+02
2010	4.600E+03	3.684E+06	2.475E+02	1.229E+03	1.842E+06	1.238E+02
2011	4.769E+03	3.819E+06	2.566E+02	1.274E+03	1.909E+06	1.283E+02
2012	4.934E+03	3.951E+06	2.655E+02	1.318E+03	1.975E+06	1.327E+02
2013	5.095E+03	4.080E+06	2.741E+02	1.361E+03	2.040E+06	1.371E+02
2014	5.258E+03	4.211E+06	2.829E+02	1.405E+03	2.105E+06	1.415E+02
2015	5.418E+03	4.339E+06	2.915E+02	1.447E+03	2.169E+06	1.458E+02
2016	5.499E+03	4.403E+06	2.958E+02	1.469E+03	2.202E+06	1.479E+02
2017	5.656E+03	4.529E+06	3.043E+02	1.511E+03	2.265E+06	1.522E+02
2018	5.809E+03	4.651E+06	3.125E+02	1.552E+03	2.326E+06	1.563E+02
2019	5.953E+03	4.767E+06	3.203E+02	1.590E+03	2.384E+06	1.602E+02
2020	6.093E+03	4.879E+06	3.278E+02	1.628E+03	2.440E+06	1.639E+02
2021	6.233E+03	4.991E+06	3.353E+02	1.665E+03	2.496E+06	1.677E+02
2022	6.109E+03	4.892E+06	3.287E+02	1.632E+03	2.446E+06	1.644E+02
2023	5.989E+03	4.795E+06	3.222E+02	1.600E+03	2.398E+06	1.611E+02
2024	5.870E+03	4.700E+06	3.158E+02	1.568E+03	2.350E+06	1.579E+02
2025	5.754E+03	4.607E+06	3.096E+02	1.537E+03	2.304E+06	1.548E+02
2026	5.640E+03	4.516E+06	3.034E+02	1.506E+03	2.258E+06	1.517E+02
2027	5.528E+03	4.427E+06	2.974E+02	1.477E+03	2.213E+06	1.487E+02
2028	5.419E+03	4.339E+06	2.915E+02	1.447E+03	2.169E+06	1.458E+02
2029	5.311E+03	4.253E+06	2.858E+02	1.419E+03	2.127E+06	1.429E+02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2030	5.206E+03	4.169E+06	2.801E+02	1.391E+03	2.084E+06	1.401E+02
2031	5.103E+03	4.086E+06	2.746E+02	1.363E+03	2.043E+06	1.373E+02
2032	5.002E+03	4.005E+06	2.691E+02	1.336E+03	2.003E+06	1.346E+02
2033	4.903E+03	3.926E+06	2.638E+02	1.310E+03	1.963E+06	1.319E+02
2034	4.806E+03	3.848E+06	2.586E+02	1.284E+03	1.924E+06	1.293E+02
2035	4.711E+03	3.772E+06	2.534E+02	1.258E+03	1.886E+06	1.267E+02
2036	4.617E+03	3.697E+06	2.484E+02	1.233E+03	1.849E+06	1.242E+02
2037	4.526E+03	3.624E+06	2.435E+02	1.209E+03	1.812E+06	1.218E+02
2038	4.436E+03	3.552E+06	2.387E+02	1.185E+03	1.776E+06	1.193E+02
2039	4.349E+03	3.482E+06	2.340E+02	1.162E+03	1.741E+06	1.170E+02
2040	4.262E+03	3.413E+06	2.293E+02	1.139E+03	1.707E+06	1.147E+02
2041	4.178E+03	3.346E+06	2.248E+02	1.116E+03	1.673E+06	1.124E+02
2042	4.095E+03	3.279E+06	2.203E+02	1.094E+03	1.640E+06	1.102E+02
2043	4.014E+03	3.214E+06	2.160E+02	1.072E+03	1.607E+06	1.080E+02
2044	3.935E+03	3.151E+06	2.117E+02	1.051E+03	1.575E+06	1.058E+02
2045	3.857E+03	3.088E+06	2.075E+02	1.030E+03	1.544E+06	1.038E+02
2046	3.780E+03	3.027E+06	2.034E+02	1.010E+03	1.514E+06	1.017E+02
2047	3.706E+03	2.967E+06	1.994E+02	9.898E+02	1.484E+06	9.969E+01
2048	3.632E+03	2.909E+06	1.954E+02	9.702E+02	1.454E+06	9.771E+01
2049	3.560E+03	2.851E+06	1.916E+02	9.510E+02	1.425E+06	9.578E+01
2050	3.490E+03	2.794E+06	1.878E+02	9.322E+02	1.397E+06	9.388E+01
2051	3.421E+03	2.739E+06	1.840E+02	9.137E+02	1.370E+06	9.202E+01
2052	3.353E+03	2.685E+06	1.804E+02	8.956E+02	1.342E+06	9.020E+01
2053	3.287E+03	2.632E+06	1.768E+02	8.779E+02	1.316E+06	8.841E+01
2054	3.221E+03	2.580E+06	1.733E+02	8.605E+02	1.290E+06	8.666E+01
2055	3.158E+03	2.529E+06	1.699E+02	8.435E+02	1.264E+06	8.495E+01
2056	3.095E+03	2.478E+06	1.665E+02	8.268E+02	1.239E+06	8.326E+01
2057	3.034E+03	2.429E+06	1.632E+02	8.104E+02	1.215E+06	8.162E+01
2058	2.974E+03	2.381E+06	1.600E+02	7.943E+02	1.191E+06	8.000E+01
2059	2.915E+03	2.334E+06	1.568E+02	7.786E+02	1.167E+06	7.842E+01
2060	2.857E+03	2.288E+06	1.537E+02	7.632E+02	1.144E+06	7.686E+01
2061	2.801E+03	2.243E+06	1.507E+02	7.481E+02	1.121E+06	7.534E+01
2062	2.745E+03	2.198E+06	1.477E+02	7.333E+02	1.099E+06	7.385E+01
2063	2.691E+03	2.155E+06	1.448E+02	7.187E+02	1.077E+06	7.239E+01
2064	2.638E+03	2.112E+06	1.419E+02	7.045E+02	1.056E+06	7.095E+01
2065	2.585E+03	2.070E+06	1.391E+02	6.906E+02	1.035E+06	6.955E+01
2066	2.534E+03	2.029E+06	1.363E+02	6.769E+02	1.015E+06	6.817E+01
2067	2.484E+03	1.989E+06	1.336E+02	6.635E+02	9.945E+05	6.682E+01
2068	2.435E+03	1.950E+06	1.310E+02	6.503E+02	9.748E+05	6.550E+01
2069	2.387E+03	1.911E+06	1.284E+02	6.375E+02	9.555E+05	6.420E+01
2070	2.339E+03	1.873E+06	1.259E+02	6.248E+02	9.366E+05	6.293E+01
2071	2.293E+03	1.836E+06	1.234E+02	6.125E+02	9.180E+05	6.168E+01
2072	2.248E+03	1.800E+06	1.209E+02	6.003E+02	8.999E+05	6.046E+01
2073	2.203E+03	1.764E+06	1.185E+02	5.885E+02	8.820E+05	5.926E+01
2074	2.159E+03	1.729E+06	1.162E+02	5.768E+02	8.646E+05	5.809E+01
2075	2.117E+03	1.695E+06	1.139E+02	5.654E+02	8.475E+05	5.694E+01
2076	2.075E+03	1.661E+06	1.116E+02	5.542E+02	8.307E+05	5.581E+01
2077	2.034E+03	1.628E+06	1.094E+02	5.432E+02	8.142E+05	5.471E+01
2078	1.993E+03	1.596E+06	1.073E+02	5.325E+02	7.981E+05	5.363E+01
2079	1.954E+03	1.565E+06	1.051E+02	5.219E+02	7.823E+05	5.256E+01
2080	1.915E+03	1.534E+06	1.030E+02	5.116E+02	7.668E+05	5.152E+01

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	***(m ^{3} /year)***	***(av ft^3/min)***	***(Mg/year)***	***(m ^{3} /year)***	***(av ft^3/min)***
2081	1.877E+03	1.503E+06	1.010E+02	5.015E+02	7.516E+05	5.050E+01
2082	1.840E+03	1.473E+06	9.900E+01	4.915E+02	7.367E+05	4.950E+01
2083	1.804E+03	1.444E+06	9.704E+01	4.818E+02	7.222E+05	4.852E+01
2084	1.768E+03	1.416E+06	9.512E+01	4.722E+02	7.079E+05	4.756E+01
2085	1.733E+03	1.388E+06	9.324E+01	4.629E+02	6.938E+05	4.662E+01
2086	1.699E+03	1.360E+06	9.139E+01	4.537E+02	6.801E+05	4.570E+01
2087	1.665E+03	1.333E+06	8.958E+01	4.447E+02	6.666E+05	4.479E+01
2088	1.632E+03	1.307E+06	8.781E+01	4.359E+02	6.534E+05	4.390E+01
2089	1.600E+03	1.281E+06	8.607E+01	4.273E+02	6.405E+05	4.304E+01
2090	1.568E+03	1.256E+06	8.437E+01	4.188E+02	6.278E+05	4.218E+01
2091	1.537E+03	1.231E+06	8.270E+01	4.106E+02	6.154E+05	4.135E+01
2092	1.507E+03	1.206E+06	8.106E+01	4.024E+02	6.032E+05	4.053E+01
2093	1.477E+03	1.183E+06	7.945E+01	3.945E+02	5.913E+05	3.973E+01
2094	1.448E+03	1.159E+06	7.788E+01	3.866E+02	5.795E+05	3.894E+01
2095	1.419E+03	1.136E+06	7.634E+01	3.790E+02	5.681E+05	3.817E+01
2096	1.391E+03	1.114E+06	7.483E+01	3.715E+02	5.568E+05	3.741E+01
2097	1.363E+03	1.092E+06	7.334E+01	3.641E+02	5.458E+05	3.667E+01
2098	1.336E+03	1.070E+06	7.189E+01	3.569E+02	5.350E+05	3.595E+01
2099	1.310E+03	1.049E+06	7.047E+01	3.499E+02	5.244E+05	3.523E+01
2100	1.284E+03	1.028E+06	6.907E+01	3.429E+02	5.140E+05	3.454E+01
2101	1.258E+03	1.008E+06	6.771E+01	3.361E+02	5.038E+05	3.385E+01
2102	1.233E+03	9.877E+05	6.636E+01	3.295E+02	4.939E+05	3.318E+01
2103	1.209E+03	9.682E+05	6.505E+01	3.230E+02	4.841E+05	3.253E+01
2104	1.185E+03	9.490E+05	6.376E+01	3.166E+02	4.745E+05	3.188E+01
2105	1.162E+03	9.302E+05	6.250E+01	3.103E+02	4.651E+05	3.125E+01
2106	1.139E+03	9.118E+05	6.126E+01	3.041E+02	4.559E+05	3.063E+01
2107	1.116E+03	8.937E+05	6.005E+01	2.981E+02	4.469E+05	3.002E+01
2108	1.094E+03	8.760E+05	5.886E+01	2.922E+02	4.380E+05	2.943E+01
2109	1.072E+03	8.587E+05	5.769E+01	2.864E+02	4.293E+05	2.885E+01
2110	1.051E+03	8.417E+05	5.655E+01	2.808E+02	4.208E+05	2.828E+01
2111	1.030E+03	8.250E+05	5.543E+01	2.752E+02	4.125E+05	2.772E+01
2112	1.010E+03	8.087E+05	5.433E+01	2.698E+02	4.043E+05	2.717E+01
2113	9.899E+02	7.927E+05	5.326E+01	2.644E+02	3.963E+05	2.663E+01
2114	9.703E+02	7.770E+05	5.220E+01	2.592E+02	3.885E+05	2.610E+01
2115	9.511E+02	7.616E+05	5.117E+01	2.540E+02	3.808E+05	2.559E+01
2116	9.322E+02	7.465E+05	5.016E+01	2.490E+02	3.732E+05	2.508E+01
2117	9.138E+02	7.317E+05	4.916E+01	2.441E+02	3.659E+05	2.458E+01
2118	8.957E+02	7.172E+05	4.819E+01	2.392E+02	3.586E+05	2.410E+01
2119	8.780E+02	7.030E+05	4.724E+01	2.345E+02	3.515E+05	2.362E+01
2120	8.606E+02	6.891E+05	4.630E+01	2.299E+02	3.446E+05	2.315E+01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	***(m^3/year)***	***(av ft^3/min)***	***(Mg/year)***	***(m^3/year)***	***(av ft^3/min)***
1980	0	0	0	0	0	0
1981	4.407E+01	2.408E+04	1.618E+00	1.446E-01	4.035E+01	2.711E-03
1982	9.227E+01	5.041E+04	3.387E+00	3.028E-01	8.448E+01	5.676E-03
1983	1.472E+02	8.042E+04	5.403E+00	4.831E-01	1.348E+02	9.056E-03
1984	2.125E+02	1.161E+05	7.800E+00	6.974E-01	1.946E+02	1.307E-02
1985	2.923E+02	1.597E+05	1.073E+01	9.593E-01	2.676E+02	1.798E-02
1986	3.857E+02	2.107E+05	1.416E+01	1.266E+00	3.532E+02	2.373E-02
1987	4.838E+02	2.643E+05	1.776E+01	1.588E+00	4.430E+02	2.977E-02
1988	5.803E+02	3.170E+05	2.130E+01	1.905E+00	5.313E+02	3.570E-02
1989	6.711E+02	3.666E+05	2.463E+01	2.203E+00	6.145E+02	4.129E-02
1990	7.619E+02	4.162E+05	2.797E+01	2.500E+00	6.976E+02	4.687E-02
1991	8.541E+02	4.666E+05	3.135E+01	2.803E+00	7.820E+02	5.254E-02
1992	9.420E+02	5.146E+05	3.458E+01	3.092E+00	8.625E+02	5.795E-02
1993	1.032E+03	5.636E+05	3.787E+01	3.386E+00	9.446E+02	6.347E-02
1994	1.128E+03	6.163E+05	4.141E+01	3.703E+00	1.033E+03	6.941E-02
1995	1.224E+03	6.685E+05	4.492E+01	4.016E+00	1.120E+03	7.528E-02
1996	1.312E+03	7.170E+05	4.817E+01	4.307E+00	1.202E+03	8.074E-02
1997	1.399E+03	7.645E+05	5.137E+01	4.593E+00	1.281E+03	8.609E-02
1998	1.490E+03	8.142E+05	5.470E+01	4.891E+00	1.365E+03	9.168E-02
1999	1.595E+03	8.712E+05	5.854E+01	5.234E+00	1.460E+03	9.811E-02
2000	1.701E+03	9.292E+05	6.244E+01	5.582E+00	1.557E+03	1.046E-01
2001	1.818E+03	9.933E+05	6.674E+01	5.967E+00	1.665E+03	1.119E-01
2002	1.960E+03	1.071E+06	7.195E+01	6.433E+00	1.795E+03	1.206E-01
2003	2.099E+03	1.147E+06	7.706E+01	6.890E+00	1.922E+03	1.291E-01
2004	2.236E+03	1.221E+06	8.206E+01	7.337E+00	2.047E+03	1.375E-01
2005	2.493E+03	1.362E+06	9.151E+01	8.182E+00	2.283E+03	1.534E-01
2006	2.746E+03	1.500E+06	1.008E+02	9.011E+00	2.514E+03	1.689E-01
2007	2.993E+03	1.635E+06	1.099E+02	9.823E+00	2.740E+03	1.841E-01
2008	3.129E+03	1.709E+06	1.148E+02	1.027E+01	2.865E+03	1.925E-01
2009	3.247E+03	1.774E+06	1.192E+02	1.066E+01	2.973E+03	1.998E-01
2010	3.371E+03	1.842E+06	1.238E+02	1.106E+01	3.087E+03	2.074E-01
2011	3.495E+03	1.909E+06	1.283E+02	1.147E+01	3.200E+03	2.150E-01
2012	3.616E+03	1.975E+06	1.327E+02	1.187E+01	3.311E+03	2.224E-01
2013	3.734E+03	2.040E+06	1.371E+02	1.225E+01	3.419E+03	2.297E-01
2014	3.854E+03	2.105E+06	1.415E+02	1.265E+01	3.529E+03	2.371E-01
2015	3.971E+03	2.169E+06	1.458E+02	1.303E+01	3.636E+03	2.443E-01
2016	4.030E+03	2.202E+06	1.479E+02	1.323E+01	3.690E+03	2.479E-01
2017	4.145E+03	2.265E+06	1.522E+02	1.360E+01	3.795E+03	2.550E-01
2018	4.257E+03	2.326E+06	1.563E+02	1.397E+01	3.898E+03	2.619E-01
2019	4.363E+03	2.384E+06	1.602E+02	1.432E+01	3.995E+03	2.684E-01
2020	4.466E+03	2.440E+06	1.639E+02	1.466E+01	4.089E+03	2.747E-01
2021	4.568E+03	2.496E+06	1.677E+02	1.499E+01	4.182E+03	2.810E-01
2022	4.478E+03	2.446E+06	1.644E+02	1.470E+01	4.100E+03	2.755E-01
2023	4.389E+03	2.398E+06	1.611E+02	1.440E+01	4.018E+03	2.700E-01
2024	4.302E+03	2.350E+06	1.579E+02	1.412E+01	3.939E+03	2.647E-01
2025	4.217E+03	2.304E+06	1.548E+02	1.384E+01	3.861E+03	2.594E-01
2026	4.133E+03	2.258E+06	1.517E+02	1.357E+01	3.784E+03	2.543E-01
2027	4.051E+03	2.213E+06	1.487E+02	1.330E+01	3.710E+03	2.492E-01
2028	3.971E+03	2.169E+06	1.458E+02	1.303E+01	3.636E+03	2.443E-01
2029	3.893E+03	2.127E+06	1.429E+02	1.278E+01	3.564E+03	2.395E-01

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2030	3.816E+03	2.084E+06	1.401E+02	1.252E+01	3.493E+03	2.347E-01
2031	3.740E+03	2.043E+06	1.373E+02	1.227E+01	3.424E+03	2.301E-01
2032	3.666E+03	2.003E+06	1.346E+02	1.203E+01	3.357E+03	2.255E-01
2033	3.593E+03	1.963E+06	1.319E+02	1.179E+01	3.290E+03	2.211E-01
2034	3.522E+03	1.924E+06	1.293E+02	1.156E+01	3.225E+03	2.167E-01
2035	3.452E+03	1.886E+06	1.267E+02	1.133E+01	3.161E+03	2.124E-01
2036	3.384E+03	1.849E+06	1.242E+02	1.111E+01	3.098E+03	2.082E-01
2037	3.317E+03	1.812E+06	1.218E+02	1.089E+01	3.037E+03	2.041E-01
2038	3.251E+03	1.776E+06	1.193E+02	1.067E+01	2.977E+03	2.000E-01
2039	3.187E+03	1.741E+06	1.170E+02	1.046E+01	2.918E+03	1.961E-01
2040	3.124E+03	1.707E+06	1.147E+02	1.025E+01	2.860E+03	1.922E-01
2041	3.062E+03	1.673E+06	1.124E+02	1.005E+01	2.804E+03	1.884E-01
2042	3.001E+03	1.640E+06	1.102E+02	9.850E+00	2.748E+03	1.846E-01
2043	2.942E+03	1.607E+06	1.080E+02	9.655E+00	2.694E+03	1.810E-01
2044	2.884E+03	1.575E+06	1.058E+02	9.464E+00	2.640E+03	1.774E-01
2045	2.827E+03	1.544E+06	1.038E+02	9.277E+00	2.588E+03	1.739E-01
2046	2.771E+03	1.514E+06	1.017E+02	9.093E+00	2.537E+03	1.704E-01
2047	2.716E+03	1.484E+06	9.969E+01	8.913E+00	2.487E+03	1.671E-01
2048	2.662E+03	1.454E+06	9.771E+01	8.737E+00	2.437E+03	1.638E-01
2049	2.609E+03	1.425E+06	9.578E+01	8.564E+00	2.389E+03	1.605E-01
2050	2.558E+03	1.397E+06	9.388E+01	8.394E+00	2.342E+03	1.573E-01
2051	2.507E+03	1.370E+06	9.202E+01	8.228E+00	2.295E+03	1.542E-01
2052	2.457E+03	1.342E+06	9.020E+01	8.065E+00	2.250E+03	1.512E-01
2053	2.409E+03	1.316E+06	8.841E+01	7.905E+00	2.205E+03	1.482E-01
2054	2.361E+03	1.290E+06	8.666E+01	7.749E+00	2.162E+03	1.452E-01
2055	2.314E+03	1.264E+06	8.495E+01	7.595E+00	2.119E+03	1.424E-01
2056	2.268E+03	1.239E+06	8.326E+01	7.445E+00	2.077E+03	1.396E-01
2057	2.223E+03	1.215E+06	8.162E+01	7.297E+00	2.036E+03	1.368E-01
2058	2.179E+03	1.191E+06	8.000E+01	7.153E+00	1.996E+03	1.341E-01
2059	2.136E+03	1.167E+06	7.842E+01	7.011E+00	1.956E+03	1.314E-01
2060	2.094E+03	1.144E+06	7.686E+01	6.872E+00	1.917E+03	1.288E-01
2061	2.053E+03	1.121E+06	7.534E+01	6.736E+00	1.879E+03	1.263E-01
2062	2.012E+03	1.099E+06	7.385E+01	6.603E+00	1.842E+03	1.238E-01
2063	1.972E+03	1.077E+06	7.239E+01	6.472E+00	1.806E+03	1.213E-01
2064	1.933E+03	1.056E+06	7.095E+01	6.344E+00	1.770E+03	1.189E-01
2065	1.895E+03	1.035E+06	6.955E+01	6.218E+00	1.735E+03	1.166E-01
2066	1.857E+03	1.015E+06	6.817E+01	6.095E+00	1.700E+03	1.143E-01
2067	1.820E+03	9.945E+05	6.682E+01	5.975E+00	1.667E+03	1.120E-01
2068	1.784E+03	9.748E+05	6.550E+01	5.856E+00	1.634E+03	1.098E-01
2069	1.749E+03	9.555E+05	6.420E+01	5.740E+00	1.601E+03	1.076E-01
2070	1.714E+03	9.366E+05	6.293E+01	5.627E+00	1.570E+03	1.055E-01
2071	1.680E+03	9.180E+05	6.168E+01	5.515E+00	1.539E+03	1.034E-01
2072	1.647E+03	8.999E+05	6.046E+01	5.406E+00	1.508E+03	1.013E-01
2073	1.615E+03	8.820E+05	5.926E+01	5.299E+00	1.478E+03	9.933E-02
2074	1.583E+03	8.646E+05	5.809E+01	5.194E+00	1.449E+03	9.736E-02
2075	1.551E+03	8.475E+05	5.694E+01	5.091E+00	1.420E+03	9.543E-02
2076	1.521E+03	8.307E+05	5.581E+01	4.990E+00	1.392E+03	9.354E-02
2077	1.490E+03	8.142E+05	5.471E+01	4.892E+00	1.365E+03	9.169E-02
2078	1.461E+03	7.981E+05	5.363E+01	4.795E+00	1.338E+03	8.988E-02
2079	1.432E+03	7.823E+05	5.256E+01	4.700E+00	1.311E+03	8.810E-02
2080	1.404E+03	7.668E+05	5.152E+01	4.607E+00	1.285E+03	8.635E-02

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2081	1.376E+03	7.516E+05	5.050E+01	4.515E+00	1.260E+03	8.464E-02
2082	1.349E+03	7.367E+05	4.950E+01	4.426E+00	1.235E+03	8.297E-02
2083	1.322E+03	7.222E+05	4.852E+01	4.338E+00	1.210E+03	8.132E-02
2084	1.296E+03	7.079E+05	4.756E+01	4.253E+00	1.186E+03	7.971E-02
2085	1.270E+03	6.938E+05	4.662E+01	4.168E+00	1.163E+03	7.813E-02
2086	1.245E+03	6.801E+05	4.570E+01	4.086E+00	1.140E+03	7.659E-02
2087	1.220E+03	6.666E+05	4.479E+01	4.005E+00	1.117E+03	7.507E-02
2088	1.196E+03	6.534E+05	4.390E+01	3.926E+00	1.095E+03	7.358E-02
2089	1.172E+03	6.405E+05	4.304E+01	3.848E+00	1.073E+03	7.213E-02
2090	1.149E+03	6.278E+05	4.218E+01	3.772E+00	1.052E+03	7.070E-02
2091	1.126E+03	6.154E+05	4.135E+01	3.697E+00	1.031E+03	6.930E-02
2092	1.104E+03	6.032E+05	4.053E+01	3.624E+00	1.011E+03	6.793E-02
2093	1.082E+03	5.913E+05	3.973E+01	3.552E+00	9.909E+02	6.658E-02
2094	1.061E+03	5.795E+05	3.894E+01	3.482E+00	9.713E+02	6.526E-02
2095	1.040E+03	5.681E+05	3.817E+01	3.413E+00	9.521E+02	6.397E-02
2096	1.019E+03	5.568E+05	3.741E+01	3.345E+00	9.332E+02	6.270E-02
2097	9.991E+02	5.458E+05	3.667E+01	3.279E+00	9.148E+02	6.146E-02
2098	9.793E+02	5.350E+05	3.595E+01	3.214E+00	8.966E+02	6.025E-02
2099	9.599E+02	5.244E+05	3.523E+01	3.150E+00	8.789E+02	5.905E-02
2100	9.409E+02	5.140E+05	3.454E+01	3.088E+00	8.615E+02	5.788E-02
2101	9.223E+02	5.038E+05	3.385E+01	3.027E+00	8.444E+02	5.674E-02
2102	9.040E+02	4.939E+05	3.318E+01	2.967E+00	8.277E+02	5.561E-02
2103	8.861E+02	4.841E+05	3.253E+01	2.908E+00	8.113E+02	5.451E-02
2104	8.686E+02	4.745E+05	3.188E+01	2.851E+00	7.953E+02	5.343E-02
2105	8.514E+02	4.651E+05	3.125E+01	2.794E+00	7.795E+02	5.237E-02
2106	8.345E+02	4.559E+05	3.063E+01	2.739E+00	7.641E+02	5.134E-02
2107	8.180E+02	4.469E+05	3.002E+01	2.685E+00	7.489E+02	5.032E-02
2108	8.018E+02	4.380E+05	2.943E+01	2.631E+00	7.341E+02	4.932E-02
2109	7.859E+02	4.293E+05	2.885E+01	2.579E+00	7.196E+02	4.835E-02
2110	7.703E+02	4.208E+05	2.828E+01	2.528E+00	7.053E+02	4.739E-02
2111	7.551E+02	4.125E+05	2.772E+01	2.478E+00	6.914E+02	4.645E-02
2112	7.401E+02	4.043E+05	2.717E+01	2.429E+00	6.777E+02	4.553E-02
2113	7.255E+02	3.963E+05	2.663E+01	2.381E+00	6.642E+02	4.463E-02
2114	7.111E+02	3.885E+05	2.610E+01	2.334E+00	6.511E+02	4.375E-02
2115	6.970E+02	3.808E+05	2.559E+01	2.288E+00	6.382E+02	4.288E-02
2116	6.832E+02	3.732E+05	2.508E+01	2.242E+00	6.256E+02	4.203E-02
2117	6.697E+02	3.659E+05	2.458E+01	2.198E+00	6.132E+02	4.120E-02
2118	6.564E+02	3.586E+05	2.410E+01	2.154E+00	6.010E+02	4.038E-02
2119	6.434E+02	3.515E+05	2.362E+01	2.112E+00	5.891E+02	3.958E-02
2120	6.307E+02	3.446E+05	2.315E+01	2.070E+00	5.775E+02	3.880E-02

APPENDIX J – LFG BENEFICIAL USE FEASIBILITY

Summary Table - 20-year Evaluation Period

Project	Capital Cost	Simple Payback	Project Net Present Value	Average Annual Project Present Value	Net Present Value to Mat-Su	Average Annual Present Value to Mat-Su	Net Present Value to Medical Center	Average Annual Present Value to Medical Center
LFG to Electricity at Landfill	$3,275,268	9.7	$5,003,198	$250,160	$5,003,198	$250,160	N/A	N/A
LFG to Electricity and Leachate Evaporation at Landfill	$7,221,039	13.3	$2,866,383	$143,319	$2,866,383	$143,319	N/A	N/A
LFG CHP at Medical Center	$6,326,083	10.8	$7,526,786	$376,339	$6,413,477	$320,674	$1,113,310	$55,665
Direct Use in Boiler at Medical Center	$4,189,810	11.9	$2,797,812	$139,891	$1,863,550	$93,177	$934,263	$46,713

Matanuska-Susitna Borough Palmer Central Landfill
LFG Beneficial Use Feasibility Study
Pro Forma - LFG to Electricity Generation at Landfill

Inflation Rate: 2.14%

	LFG to Hosptial CHP System																			
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
	2021	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
Collected LFG	252	257	263	268	274	280	285	291	296	302	308	313	319	325	330	334	334	334	334	334
% CH4 on LHV Basis	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%
% Up Time	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%
Annual SCF	121,617,924	124,340,089	127,059,655	129,777,186	132,493,242	135,208,374	137,923,130	140,638,050	143,353,672	146,070,525	148,789,135	151,510,023	154,233,704	156,960,692	159,691,491	161,552,305	161,552,305	161,552,305	161,552,305	161,552,305
MBtu/hour (LHV)	7,254	7,416	7,579	7,741	7,903	8,065	8,227	8,389	8,550	8,713	8,875	9,037	9,199	9,362	9,525	9,636	9,636	9,636	9,636	9,636
Annual MMBtu	58,462	59,770	61,078	62,384	63,690	64,995	66,300	67,605	68,910	70,216	71,523	72,831	74,140	75,451	76,764	76,737	76,737	76,737	76,737	76,737
kW/hour (Jenbacher J416 GENSET)	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141
Load Based on LFG Avaliblity	75%	77%	79%	80%	82%	84%	85%	87%	89%	90%	92%	94%	95%	97%	99%	100%	100%	100%	100%	100%
Annual kW	6,922,462	7,077,407	7,232,204	7,386,885	7,541,482	7,696,027	7,850,550	8,005,083	8,159,655	8,314,298	8,469,040	8,623,912	8,778,944	8,934,163	9,089,600	9,195,517	9,195,517	9,195,517	9,195,517	9,195,517
Expenses																				
Engine Operation (Hours)	8,059.20	16,118.40	24,177.60	32,236.80	40,296.00	48,355.20	56,414.40	64,473.60	72,532.80	80,592.00	88,651.20	96,710.40	104,769.60	112,828.80	120,888.00	128,947.20	137,006.40	145,065.60	153,124.80	161,184.00
Engine Operation Cost	$ 193,379.96	$ 197,518.30	$ 201,745.19	$ 206,062.53	$ 210,472.27	$ 214,976.38	$ 219,576.87	$ 224,275.82	$ 229,075.32	$ 233,977.53	$ 238,984.65	$ 244,098.92	$ 249,322.64	$ 254,658.15	$ 260,107.83	$ 265,674.14	$ 271,359.56	$ 277,166.66	$ 283,098.03	$ 289,156.32
Major Overhaul @ 60,000 hours								$ 414,605							$ 480,846					
Capital Expenses	$ 203,021	$ 203,021	$ 203,021	$ 203,021	$ 203,021	$ 203,021	$ 203,021	$ 203,021	$ 203,021	$ 203,021	$ 203,021	$ 203,021	$ 203,021	$ 203,021	$ 203,021	$ 203,021	$ 203,021	$ 203,021	$ 203,021	$ 203,021
Total LFG Expense	*$ 396,401*	*$ 400,539*	*$ 404,766*	*$ 409,084*	*$ 413,493*	*$ 417,997*	*$ 422,598*	*$ 841,902*	*$ 432,096*	*$ 436,999*	*$ 442,006*	*$ 447,120*	*$ 452,344*	*$ 457,679*	*$ 943,975*	*$ 468,695*	*$ 474,381*	*$ 480,188*	*$ 486,119*	*$ 492,177*
Total Annual Costs	*$ (396,401)*	*$ (400,539)*	*$ (404,766)*	*$ (409,084)*	*$ (413,493)*	*$ (417,997)*	*$ (422,598)*	*$ (841,902)*	*$ (432,096)*	*$ (436,999)*	*$ (442,006)*	*$ (447,120)*	*$ (452,344)*	*$ (457,679)*	*$ (943,975)*	*$ (468,695)*	*$ (474,381)*	*$ (480,188)*	*$ (486,119)*	*$ (492,177)*
Revenue																				
Electricity Rate (distributed power)	$ 0.07985	$ 0.0816	$ 0.0833	$ 0.0851	$ 0.0869	$ 0.0888	$ 0.0907	$ 0.0926	$ 0.0946	$ 0.0966	$ 0.0987	$ 0.1008	$ 0.1029	$ 0.1052	$ 0.1074	$ 0.1097	$ 0.1120	$ 0.1144	$ 0.1169	$ 0.1194
Annual Revenue (electricity)	$ 552,759	$ 577,225	$ 602,473	$ 628,527	$ 655,413	$ 683,157	$ 711,787	$ 741,330	$ 771,816	$ 803,273	$ 835,733	$ 869,228	$ 903,790	$ 939,453	$ 976,251	$ 1,008,762	$ 1,030,350	$ 1,052,399	$ 1,074,921	$ 1,097,924
Total Revenue	*$ 552,759*	*$ 577,225*	*$ 602,473*	*$ 628,527*	*$ 655,413*	*$ 683,157*	*$ 711,787*	*$ 741,330*	*$ 771,816*	*$ 803,273*	*$ 835,733*	*$ 869,228*	*$ 903,790*	*$ 939,453*	*$ 976,251*	*$ 1,008,762*	*$ 1,030,350*	*$ 1,052,399*	*$ 1,074,921*	*$ 1,097,924*
Net Revenues	*$ 156,358*	*$ 176,685*	*$ 197,706*	*$ 219,443*	*$ 241,920*	*$ 265,160*	*$ 289,189*	*$ (100,572)*	*$ 339,719*	*$ 366,274*	*$ 393,727*	*$ 422,108*	*$ 451,446*	*$ 481,773*	*$ 32,277*	*$ 540,067*	*$ 555,969*	*$ 572,212*	*$ 588,802*	*$ 605,747*
Cummulative Net Revenue	*$ 156,358*	*$ 333,043*	*$ 530,749*	*$ 750,192*	*$ 992,112*	*$ 1,257,272*	*$ 1,546,461*	*$ 1,445,889*	*$ 1,785,609*	*$ 2,151,883*	*$ 2,545,610*	*$ 2,967,718*	*$ 3,419,164*	*$ 3,900,938*	*$ 3,933,214*	*$ 4,473,282*	*$ 5,029,251*	*$ 5,601,462*	*$ 6,190,264*	*$ 6,796,011*

Matanuska-Susitna Borough Palmer Central Landfill
LFG Beneficial Use Feasibility Study

Pro Forma - LFG to Electicity Generation and Leachate Evaporation at Landfill

Inflation Rate: 2.14%

	LFG to Hosptial CHP System																			
	Year 1 2021	**Year 2 2022**	**Year 3 2023**	**Year 4 2024**	**Year 5 2025**	**Year 6 2026**	**Year 7 2027**	**Year 8 2028**	**Year 9 2029**	**Year 10 2030**	**Year 11 2031**	**Year 12 2032**	**Year 13 2033**	**Year 14 2034**	**Year 15 2035**	**Year 16 2036**	**Year 17 2037**	**Year 18 2038**	**Year 19 2039**	**Year 20 2040**
Collected LFG	252	257	263	268	274	280	285	291	296	302	308	313	319	325	330	334	334	334	334	334
% CH4 on LHV Basis	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%
CHP % Up Time	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%
Annual SCF	120,295,990	122,988,566	125,678,572	128,366,565	131,053,098	133,738,718	136,423,965	139,109,376	141,795,480	144,482,802	147,171,861	149,863,175	152,557,251	155,254,597	157,955,714	159,796,302	159,796,302	159,796,302	159,796,302	159,796,302
MBtu/hour (LHV)	7,254	7,416	7,579	7,741	7,903	8,065	8,227	8,389	8,550	8,713	8,875	9,037	9,199	9,362	9,525	9,636	9,636	9,636	9,636	9,636
Annual MMBtu	57,826	59,121	60,414	61,706	62,997	64,288	65,579	66,870	68,161	69,453	70,746	72,039	73,334	74,631	75,929	75,903	75,903	75,903	75,903	75,903
Pro-Rated Evap % Uptime	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%
kW/hour (Jenbacher J416 GENSET)	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141
Load Based on LFG Avaliblity	75%	77%	79%	80%	82%	84%	85%	87%	89%	90%	92%	94%	95%	97%	99%	100%	100%	100%	100%	100%
Annual kW	6,847,218	7,000,478	7,153,593	7,306,593	7,459,509	7,612,374	7,765,218	7,918,071	8,070,963	8,223,925	8,376,985	8,530,174	8,683,520	8,837,053	8,990,800	9,095,565	9,095,565	9,095,565	9,095,565	9,095,565
Heat Recovery MBtu/hour	2,951	3,017	3,083	3,148	3,214	3,280	3,346	3,412	3,478	3,544	3,610	3,676	3,742	3,808	3,874	3,919	3,919	3,919	3,919	3,919
Leachate Evaporation (gpd)	3,764	3,848	3,932	4,017	4,101	4,185	4,269	4,353	4,437	4,521	4,605	4,689	4,773	4,858	4,942	5,000	5,000	5,000	5,000	5,000
Leachate Evaporation (gpy)	1,212,715.64	1,239,859.76	1,266,977.97	1,294,075.89	1,321,159.10	1,348,233.09	1,375,303.34	1,402,375.22	1,429,454.10	1,456,545.25	1,483,653.93	1,510,785.32	1,537,944.57	1,565,136.78	1,592,367.00	1,610,922.15	1,610,922.15	1,610,922.15	1,610,922.15	1,610,922.15
Leachate Avoided Costs ($/gallon)	$ 0.0820	$ 0.0838	$ 0.0855	$ 0.0874	$ 0.0892	$ 0.0912	$ 0.0931	$ 0.0951	$ 0.0971	$ 0.0992	$ 0.1013	$ 0.1035	$ 0.1057	$ 0.1080	$ 0.1103	$ 0.1127	$ 0.1151	$ 0.1175	$ 0.1200	$ 0.1226
Leachate Avoided Costs (Annual)	$ 99,442.68	$ 103,844.21	$ 108,386.36	$ 113,073.58	$ 117,910.47	$ 122,901.76	$ 128,052.33	$ 133,367.21	$ 138,851.60	$ 144,510.87	$ 150,350.54	$ 156,376.32	$ 162,594.10	$ 169,009.94	$ 175,630.11	$ 181,478.93	$ 185,362.58	$ 189,329.34	$ 193,380.99	$ 197,519.34
Expenses																				
Engine Operation (Hours)	7,971.60	15,943.20	23,914.80	31,886.40	39,858.00	47,829.60	55,801.20	63,772.80	71,744.40	79,716.00	87,687.60	95,659.20	103,630.80	111,602.40	119,574.00	127,545.60	135,517.20	143,488.80	151,460.40	159,432.00
Engine Operation Cost	$ 191,278.01	$ 195,371.36	$ 199,552.30	$ 203,822.72	$ 208,184.53	$ 212,639.68	$ 217,190.17	$ 221,838.04	$ 226,585.37	$ 231,434.30	$ 236,386.99	$ 241,445.67	$ 246,612.61	$ 251,890.12	$ 257,280.57	$ 262,786.38	$ 268,410.00	$ 274,153.98	$ 280,020.87	$ 286,013.32
Major Overhaul @ 60,000 hours								$ 414,605								$ 491,136				
Capital Expenses	$ 447,604	$ 447,604	$ 447,604	$ 447,604	$ 447,604	$ 447,604	$ 447,604	$ 447,604	$ 447,604	$ 447,604	$ 447,604	$ 447,604	$ 447,604	$ 447,604	$ 447,604	$ 447,604	$ 447,604	$ 447,604	$ 447,604	$ 447,604
Leachate OPEX	$ 25,224	$ 25,764	$ 26,316	$ 26,879	$ 27,454	$ 28,042	$ 28,642	$ 29,255	$ 29,881	$ 30,520	$ 31,173	$ 31,840	$ 32,522	$ 33,218	$ 33,928	$ 34,655	$ 35,396	$ 36,154	$ 36,927	$ 37,718
Total LFG Expense	*$ 664,106*	*$ 668,740*	*$ 673,472*	*$ 678,305*	*$ 683,242*	*$ 688,285*	*$ 693,436*	*$ 1,113,302*	*$ 704,070*	*$ 709,558*	*$ 715,164*	*$ 720,890*	*$ 726,738*	*$ 732,712*	*$ 738,813*	*$ 1,236,181*	*$ 751,410*	*$ 757,911*	*$ 764,552*	*$ 771,335*
Total Annual Costs	*$ (664,106)*	*$ (668,740)*	*$ (673,472)*	*$ (678,305)*	*$ (683,242)*	*$ (688,285)*	*$ (693,436)*	*$ (1,113,302)*	*$ (704,070)*	*$ (709,558)*	*$ (715,164)*	*$ (720,890)*	*$ (726,738)*	*$ (732,712)*	*$ (738,813)*	*$ (1,236,181)*	*$ (751,410)*	*$ (757,911)*	*$ (764,552)*	*$ (771,335)*
Revenue																				
Electricity Rate (distributed power)	$ 0.07985	$ 0.0816	$ 0.0833	$ 0.0851	$ 0.0869	$ 0.0888	$ 0.0907	$ 0.0926	$ 0.0946	$ 0.0966	$ 0.0987	$ 0.1008	$ 0.1029	$ 0.1052	$ 0.1074	$ 0.1097	$ 0.1120	$ 0.1144	$ 0.1169	$ 0.1194
Annual Revenue (electricity)	$ 546,750	$ 570,951	$ 595,924	$ 621,695	$ 648,289	$ 675,732	$ 704,050	$ 733,272	$ 763,426	$ 794,542	$ 826,649	$ 859,780	$ 893,966	$ 929,241	$ 965,640	$ 997,798	$ 1,019,150	$ 1,040,960	$ 1,063,237	$ 1,085,990
Leachate Avoided Cost	$ 99,442.68	$ 103,844.21	$ 108,386.36	$ 113,073.58	$ 117,910.47	$ 122,901.76	$ 128,052.33	$ 133,367.21	$ 138,851.60	$ 144,510.87	$ 150,350.54	$ 156,376.32	$ 162,594.10	$ 169,009.94	$ 175,630.11	$ 181,478.93	$ 185,362.58	$ 189,329.34	$ 193,380.99	$ 197,519.34
Total Revenue	*$ 646,193*	*$ 674,795*	*$ 704,310*	*$ 734,769*	*$ 766,199*	*$ 798,633*	*$ 832,103*	*$ 866,639*	*$ 902,278*	*$ 939,053*	*$ 977,000*	*$ 1,016,156*	*$ 1,056,560*	*$ 1,098,251*	*$ 1,141,270*	*$ 1,179,276*	*$ 1,204,513*	*$ 1,230,290*	*$ 1,256,618*	*$ 1,283,509*
Net Revenues	*$ (17,913)*	*$ 6,055*	*$ 30,838*	*$ 56,463*	*$ 82,957*	*$ 110,348*	*$ 138,667*	*$ (246,662)*	*$ 198,208*	*$ 229,494*	*$ 261,836*	*$ 295,266*	*$ 329,822*	*$ 365,540*	*$ 402,457*	*$ (56,904)*	*$ 453,103*	*$ 472,378*	*$ 492,066*	*$ 512,175*
Cummulative Net Revenue	*$ (17,913)*	*$ (11,858)*	*$ 18,980*	*$ 75,443*	*$ 158,400*	*$ 268,749*	*$ 407,416*	*$ 160,754*	*$ 358,962*	*$ 588,456*	*$ 850,292*	*$ 1,145,558*	*$ 1,475,380*	*$ 1,840,919*	*$ 2,243,376*	*$ 2,186,472*	*$ 2,639,575*	*$ 3,111,953*	*$ 3,604,019*	*$ 4,116,193*

Matanuska-Susitna Borough Palmer Central Landfill
LFG Beneficial Use Feasibility Study

Pro Forma - LFG to Combined Heat and Power at Medical Center

Inflation Rate: 2.14%

	LFG to Hosptial CHP System																			
	Year 1 2021	**Year 2 2022**	**Year 3 2023**	**Year 4 2024**	**Year 5 2025**	**Year 6 2026**	**Year 7 2027**	**Year 8 2028**	**Year 9 2029**	**Year 10 2030**	**Year 11 2031**	**Year 12 2032**	**Year 13 2033**	**Year 14 2034**	**Year 15 2035**	**Year 16 2036**	**Year 17 2037**	**Year 18 2038**	**Year 19 2039**	**Year 20 2040**
Collected LFG	252	257	263	268	274	280	285	291	296	302	308	313	319	325	330	334	334	334	334	334
% CH4 on LHV Basis	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%
% Up Time	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%
Annual SCF	120,295,990	122,988,566	125,678,572	128,366,565	131,053,098	133,738,718	136,423,965	139,109,376	141,795,480	144,482,802	147,171,861	149,863,175	152,557,251	155,254,597	157,955,714	159,796,302	159,796,302	159,796,302	159,796,302	159,796,302
MBtu/hour (LHV)	7,254	7,416	7,579	7,741	7,903	8,065	8,227	8,389	8,550	8,713	8,875	9,037	9,199	9,362	9,525	9,636	9,636	9,636	9,636	9,636
Annual MMBtu	57,826	59,121	60,414	61,706	62,997	64,288	65,579	66,870	68,161	69,453	70,746	72,039	73,334	74,631	75,929	75,903	75,903	75,903	75,903	75,903
kW/hour (Jenbacher J416 GENSET)	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141	1,141
Load Based on LFG Avaliblity	75%	77%	79%	80%	82%	84%	85%	87%	89%	90%	92%	94%	95%	97%	99%	100%	100%	100%	100%	100%
Annual kW	6,847,218	7,000,478	7,153,593	7,306,593	7,459,509	7,612,374	7,765,218	7,918,071	8,070,963	8,223,925	8,376,985	8,530,174	8,683,520	8,837,053	8,990,800	9,095,565	9,095,565	9,095,565	9,095,565	9,095,565
Heat Recovery MBtu/hour	2,951	3,017	3,083	3,148	3,214	3,280	3,346	3,412	3,478	3,544	3,610	3,676	3,742	3,808	3,874	3,919	3,919	3,919	3,919	3,919
Pro-Rated Waste Heat Use (MMBtu/year)	29,935	30,464	30,991	31,519	32,046	32,573	33,100	33,627	34,154	34,681	35,209	35,737	36,265	36,795	37,325	37,686	37,686	37,686	37,686	37,686
Pro-Rated Waste Heat Use (CCF/year)	299,352.30	304,635.61	309,913.88	315,188.19	320,459.65	325,729.31	330,998.24	336,267.49	341,538.10	346,811.10	352,087.51	357,368.34	362,654.59	367,947.26	373,247.33	376,858.89	376,858.89	376,858.89	376,858.89	376,858.89
Natural Gas Cost (CCF)	$ 0.8526	$ 0.8709	$ 0.8895	$ 0.9085	$ 0.9280	$ 0.9479	$ 0.9681	$ 0.9889	$ 1.0100	$ 1.0316	$ 1.0537	$ 1.0763	$ 1.0993	$ 1.1228	$ 1.1468	$ 1.1714	$ 1.1964	$ 1.2221	$ 1.2482	$ 1.2749
Hospital Market Rate Discount	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Hospital Annual Savings	$ 51,047.35	$ 53,059.99	$ 55,134.49	$ 57,272.76	$ 59,476.77	$ 61,748.54	$ 64,090.17	$ 66,503.80	$ 68,991.66	$ 71,556.04	$ 74,199.29	$ 76,923.86	$ 79,732.25	$ 82,627.06	$ 85,610.94	$ 88,289.12	$ 90,178.50	$ 92,108.32	$ 94,079.44	$ 96,092.74
Expenses																				
Engine Operation (Hours)	7,971.60	15,943.20	23,914.80	31,886.40	39,858.00	47,829.60	55,801.20	63,772.80	71,744.40	79,716.00	87,687.60	95,659.20	103,630.80	111,602.40	119,574.00	127,545.60	135,517.20	143,488.80	151,460.40	159,432.00
Engine Operation Cost	$ 191,278.01	$ 195,371.36	$ 199,552.30	$ 203,822.72	$ 208,184.53	$ 212,639.68	$ 217,190.17	$ 221,838.04	$ 226,585.37	$ 231,434.30	$ 236,386.99	$ 241,445.67	$ 246,612.61	$ 251,890.12	$ 257,280.57	$ 262,786.38	$ 268,410.00	$ 274,153.98	$ 280,020.87	$ 286,013.32
Major Overhaul @ 60,000 hours								$ 414,605								$ 491,136				
Capital Expenses	$ 392,129	$ 392,129	$ 392,129	$ 392,129	$ 392,129	$ 392,129	$ 392,129	$ 392,129	$ 392,129	$ 392,129	$ 392,129	$ 392,129	$ 392,129	$ 392,129	$ 392,129	$ 392,129	$ 392,129	$ 392,129	$ 392,129	$ 392,129
Total LFG Expense	$ 583,407	$ 587,500	$ 591,681	$ 595,952	$ 600,314	$ 604,769	$ 609,319	$ 1,028,572	$ 618,714	$ 623,563	$ 628,516	$ 633,575	$ 638,742	$ 644,019	$ 649,410	$ 1,146,051	$ 660,539	$ 666,283	$ 672,150	$ 678,142
Total Annual Costs	$ (583,407)	$ (587,500)	$ (591,681)	$ (595,952)	$ (600,314)	$ (604,769)	$ (609,319)	$ (1,028,572)	$ (618,714)	$ (623,563)	$ (628,516)	$ (633,575)	$ (638,742)	$ (644,019)	$ (649,410)	$ (1,146,051)	$ (660,539)	$ (666,283)	$ (672,150)	$ (678,142)
Revenue																				
Electricity Rate (distributed power)	$ 0.07985	$ 0.0816	$ 0.0833	$ 0.0851	$ 0.0869	$ 0.0888	$ 0.0907	$ 0.0926	$ 0.0946	$ 0.0966	$ 0.0987	$ 0.1008	$ 0.1029	$ 0.1052	$ 0.1074	$ 0.1097	$ 0.1120	$ 0.1144	$ 0.1169	$ 0.1194
Annual Revenue (electricity)	$ 546,750	$ 570,951	$ 595,924	$ 621,695	$ 648,289	$ 675,732	$ 704,050	$ 733,272	$ 763,426	$ 794,542	$ 826,649	$ 859,780	$ 893,966	$ 929,241	$ 965,640	$ 997,798	$ 1,019,150	$ 1,040,960	$ 1,063,237	$ 1,085,990
Thermal Payment (Heat)	$ 204,189.40	$ 212,239.94	$ 220,537.95	$ 229,091.04	$ 237,907.08	$ 246,994.17	$ 256,360.67	$ 266,015.20	$ 275,966.64	$ 286,224.14	$ 296,797.16	$ 307,695.44	$ 318,929.01	$ 330,508.22	$ 342,443.76	$ 353,156.47	$ 360,714.01	$ 368,433.29	$ 376,317.77	$ 384,370.97
Total Revenue	$ 750,940	$ 783,190	$ 816,462	$ 850,786	$ 886,196	$ 922,726	$ 960,411	$ 999,287	$ 1,039,393	$ 1,080,766	$ 1,123,446	$ 1,167,475	$ 1,212,895	$ 1,259,749	$ 1,308,084	$ 1,350,954	$ 1,379,864	$ 1,409,394	$ 1,439,555	$ 1,470,361
Net Revenues	$ 167,533	$ 195,690	$ 224,780	$ 254,834	$ 285,882	$ 317,957	$ 351,092	$ (29,285)	$ 420,678	$ 457,203	$ 494,930	$ 533,900	$ 574,153	$ 615,730	$ 658,674	$ 204,903	$ 719,325	$ 743,110	$ 767,405	$ 792,219
Cummulative Net Revenue	$ 167,533	$ 363,223	$ 588,003	$ 842,837	$ 1,128,720	$ 1,446,677	$ 1,797,768	$ 1,768,484	$ 2,189,162	$ 2,646,364	$ 3,141,295	$ 3,675,195	$ 4,249,348	$ 4,865,079	$ 5,523,752	$ 5,728,655	$ 6,447,980	$ 7,191,091	$ 7,958,495	$ 8,750,714

Matanuska-Susitna Borough Palmer Central Landfill
LFG Beneficial Use Feasibility Study

Pro Forma - LFG to Direct Use in a Boiler at Medical Center

Inflation Rate: 2.14%

	LFG to Hosptial CHP System																			
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
	2021	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
Collected LFG	252	257	263	268	274	280	285	291	296	302	308	313	319	325	330	336	342	347	353	359
% CH4 on LHV Basis	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
% Up Time	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%
MBtu/hour (HHV)	7,636	7,807	7,977	8,148	8,319	8,489	0	8,660	8,830	9,001	9,171	9,342	9,513	9,684	9,855	10,198	10,370	10,542	10,715	10,888
Pro-Rated Gas Use (MMBtu/year as NG)	53,788	54,380	54,973	55,565	56,156	56,747	27,301	57,339	57,930	58,521	59,113	59,705	60,298	60,891	61,485	63,626	64,699	65,774	66,852	67,932
Pro-Rated Gas Use (CCF/year as NG)	537,875.68	543,804.15	549,726.95	555,645.33	561,560.49	567,473.63	273,010.17	573,385.96	579,298.65	585,212.87	591,129.76	597,050.48	602,976.17	608,907.94	614,846.90	636,258.00	646,990.85	657,744.49	668,520.85	679,321.83
Natural Gas Cost (CCF)	$ 0.8526	$ 0.8709	$ 0.8895	$ 0.9085	$ 0.9280	$ 0.9479	$ 0.9681	$ 0.9889	$ 1.0100	$ 1.0316	$ 1.0537	$ 1.0763	$ 1.0993	$ 1.1228	$ 1.1468	$ 1.1714	$ 1.1964	$ 1.2221	$ 1.2482	$ 1.2749
Hospital Market Rate Discount	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Hospital Annual Savings	$ 45,860.89	$ 47,358.61	$ 48,898.93	$ 50,483.08	$ 52,112.34	$ 53,788.02	$ 26,431.06	$ 56,699.42	$ 58,509.98	$ 60,372.22	$ 62,287.65	$ 64,257.83	$ 66,284.35	$ 68,368.86	$ 70,513.06	$ 74,530.09	$ 77,409.17	$ 80,379.88	$ 83,445.12	$ 86,607.88
Expenses																				
Operation Cost	$ 73,124.03	$ 76,287.23	$ 77,919.78	$ 79,587.26	$ 81,290.43	$ 83,030.04	$ 84,806.89	$ 86,621.75	$ 88,475.46	$ 90,368.83	$ 92,302.73	$ 94,278.01	$ 96,295.56	$ 98,356.28	$ 100,461.10	$ 102,610.97	$ 104,806.85	$ 107,049.71	$ 109,340.58	$ 111,680.47
Capital Expenses	$ 329,499	$ 329,499	$ 329,499	$ 329,499	$ 329,499	$ 329,499	$ 329,499	$ 329,499	$ 329,499	$ 329,499	$ 329,499	$ 329,499	$ 329,499	$ 329,499	$ 329,499	$ 329,499	$ 329,499	$ 329,499	$ 329,499	$ 329,499
Total LFG Expense	*$ 402,623*	*$ 405,786*	*$ 407,419*	*$ 409,086*	*$ 410,789*	*$ 412,529*	*$ 414,306*	*$ 416,121*	*$ 417,974*	*$ 419,868*	*$ 421,802*	*$ 423,777*	*$ 425,795*	*$ 427,855*	*$ 429,960*	*$ 432,110*	*$ 434,306*	*$ 436,549*	*$ 438,840*	*$ 441,179*
Total Annual Costs	*$ (402,623)*	*$ (405,786)*	*$ (407,419)*	*$ (409,086)*	*$ (410,789)*	*$ (412,529)*	*$ (414,306)*	*$ (416,121)*	*$ (417,974)*	*$ (419,868)*	*$ (421,802)*	*$ (423,777)*	*$ (425,795)*	*$ (427,855)*	*$ (429,960)*	*$ (432,110)*	*$ (434,306)*	*$ (436,549)*	*$ (438,840)*	*$ (441,179)*
Revenue																				
Total Revenue	*$ 412,748*	*$ 426,228*	*$ 440,090*	*$ 454,348*	*$ 469,011*	*$ 484,092*	*$ 237,880*	*$ 510,295*	*$ 526,590*	*$ 543,350*	*$ 560,589*	*$ 578,320*	*$ 596,559*	*$ 615,320*	*$ 634,618*	*$ 670,771*	*$ 696,683*	*$ 723,419*	*$ 751,006*	*$ 779,471*
Net Revenues	*$ 10,125*	*$ 20,441*	*$ 32,672*	*$ 45,261*	*$ 58,222*	*$ 71,563*	*$ (176,426)*	*$ 94,174*	*$ 108,615*	*$ 123,482*	*$ 138,787*	*$ 154,543*	*$ 170,765*	*$ 187,464*	*$ 204,657*	*$ 238,661*	*$ 262,377*	*$ 286,870*	*$ 312,166*	*$ 338,291*
Cummulative Net Revenue	*$ 10,125*	*$ 30,566*	*$ 63,238*	*$ 108,499*	*$ 166,721*	*$ 238,284*	*$ 61,858*	*$ 156,032*	*$ 264,647*	*$ 388,129*	*$ 526,917*	*$ 681,460*	*$ 852,225*	*$ 1,039,689*	*$ 1,244,347*	*$ 1,483,007*	*$ 1,745,384*	*$ 2,032,254*	*$ 2,344,421*	*$ 2,682,712*

Matanuska-Susitna Borough Palmer Central Landfill
LFG Beneficial Use Feasibility Study

LFG to Electricity Generation at Landfill

Subcontractor	NO	Item	In Base Bid?	Unit	Quantity	Unit Price	Unit Total	Subtotal
Pipeline	1	Pipeline Sub & Directional Drill Sub Mobilization and Demobilization	Y	LS				
	2	Survey (initial and as-constructed) -	Y	LS				
	3	Installation of LFG Pipeline (0'-6' bgs) *SIZE as 8"and Directional Drilling*	Y	LF				
	4	Pipeline Rock Excavation	N	CY				
	5	Condensate pipe (Dual Contain) connection to Existing Sewer Manhole	Y	LF				
	6	Metallic Wire / Metallic Warning Tape - plastic pipe locator	Y	LF				
	7	Communication Line	Y	LF				
	8	Condensate Sumps	Y	LS				
	9	Erosion Control, Seeding, Fertilizer and Mulch	Y	Acres^{P}				
	10	Spoils delivery to Landfill	Y	Trips to LF				
	11	DOT Pipeline Integrity Pressure Testing ***(Initial Only)***	Y	Annual				
Pipeline Subtotal								**$0**
Compressor Skid	1	LFG Compressor and Dryer Package & Startup	Y	LS	1		$250,000	$250,000
	2	Delivery + Crane	Y	LS	1		$20,000	$20,000
	3	Control Panel & Elecrical	Y	LS	1		$35,000	$35,000
	4	Mechanical Installation, Commissioning (Allowance- Man Hours)	Y	LS			$75,000	$75,000
	5	Cedar Fence or Chain Link Fence with Wind Screen	Y	LF	75	$85	$6,375	$6,375
	6	Concrete Pads	Y	LS	2		$18,000	$18,000
	7	Enclosed Building	Y	LS	1		$35,000	$35,000
Booster Compressor Skid Subtotal								**$439,375**
Genset	1	JMC416 Genset	Y	LS			$960,180	$960,180
	2	Genset Procurement	Y	LS			$48,009	$48,009
	3	Soil Borings Geotech Report	Y	LS			$6,500	$6,500
	4	Sitework Sub: Genset Foundation, Fencing & Rock Surfacing	Y	LS			$45,200	$45,200
	5	Rigging Sub: Rig, Unload, Set & Assemble Genset Module Components	Y	LS			$12,000	$12,000
Genset Subtotal								**$1,071,889**
Site Install	1	U/G Piping Sub: Furnish, Install & Start-up	Y	LS			$65,000	$65,000
	2	Mechanical / A/G Piping Sub: Furnish, Install & Start-up	Y	LS			$250,000	$250,000
	3	Electrical / Controls Sub: Furnish, Install & Start-up	Y	LS			$145,000	$145,000
	4	MEA Interconnection Charge	Y	LS			$20,000	$20,000
CHP Subtotal								**$480,000**
Design / Const Services	1	Permitting (Task 1)	Y	LS	1	$50,000	$50,000	$50,000
	2	Engineering Project & Office Management	Y	LS	1	$45,000	$45,000	$45,000
	3	Genset / Civil / Structural Design	Y	LS	1	$10,000	$10,000	$10,000
	4	Genset Design / Submittal Review	Y	LS	1	$15,000	$15,000	$15,000
	5	Landfill-Genset-Controls Integration Design	Y	LS	1	$75,000	$75,000	$75,000
	6	Mechanical / Piping Design	Y	LS	1	$35,000	$35,000	$35,000
	7	Electrical Design (includes Utility Interconnection)	Y	LS	1	$50,000	$50,000	$50,000
	8	Construction Project Management	Y	LS	1	$25,000	$25,000	$25,000
	9	Construction Supt / Field labor / Per Diem	Y	LS	4	$33,750	$135,000	$135,000
	10	Stack Text & Commissioning	Y	LS	1	$50,000	$50,000	$50,000
	11	General Conditions - bonds, insurance, and warrranty				10%	$2,481,264	$248,126
Design / Const Services Subtotal								**$738,126**
		Escalation				2.5%	$2,729,390	$68,235
		Contingency and Profit				17.5%	$2,729,390	$477,643
							Total Project Cost	**$3,275,268**

Annual = Annual Allowance
CY = Cubic Yards
LS = Lump Sum
LF = Linear Feet
EA = Each
TONS = Tons
MH = Man Hours

Matanuska-Susitna Borough Palmer Central Landfill
LFG Beneficial Use Feasibility Study

LFG to Electicity Generation and Leachate Evaporation at Landfill

Subcontractor	NO	Item	In Base Bid?	Unit	Quantity	Unit Price	Unit Total	Subtotal
Pipeline	1	Pipeline Sub & Directional Drill Sub Mobilization and Demobilization	Y	LS				
	2	Survey (initial and as-constructed) -	Y	LS				
	3	Installation of LFG Pipeline (0'-6' bgs) *SIZE as 8"and Directional Drilling*	Y	LF				
	4	Pipeline Rock Excavation	N	CY				
	5	Metallic Wire / Metallic Warning Tape - plastic pipe locator	Y	LF				
	6	Communication Line	Y	LF				
	7	Erosion Control, Seeding, Fertilizer and Mulch	Y	Acres^{P}				
	8	Spoils delivery to Landfill	Y	Trips to LF				
	9	DOT Pipeline Integrity Pressure Testing ***(Initial Only)***	Y	Annual				
Pipeline Subtotal								**$0**
Compressor Skid	1	LFG Compressor and Dryer Package & Startup	Y	LS	1		$363,000	$363,000
	2	Delivery + Crane	Y	LS	1		$20,000	$20,000
	3	Control Panel & Electrical	Y	LS	1		$35,000	$35,000
	4	Mechanical Installation, Commissioning (Allowance- Man Hours)	Y	LS			$75,000	$75,000
	5	Cedar Fence or Chain Link Fence with Wind Screen	Y	LF	75	$85	$6,375	$6,375
	6	Concrete Pads	Y	LS	2		$18,000	$18,000
	7	Enclosed Building	Y	LS	1	$50,000	$50,000	$50,000
Booster Compressor Skid Subtotal								**$567,375**
Genset	1	JMC416 Genset	Y	LS			$960,180	$960,180
	2	Genset Procurement	Y	LS			$48,009	$48,009
	3	Soil Borings Geotech Report	Y	LS			$6,500	$6,500
	4	Pump House & Genset Foundations	Y	LS			$29,250	$29,250
	5	Sitework Sub: Genset Foundation, Fencing & Rock Surfacing	Y	LS			$45,200	$45,200
	6	Rigging Sub: Rig, Unload, Set & Assemble Genset Module Components	Y	LS			$12,000	$12,000
Genset Subtotal								**$1,101,139**
CHP								
	1	Leachate Evap System	Y	LS			$2,761,970	$2,761,970
	2	Mechanical / A/G Piping Sub: Furnish, Install & Start-up	Y	LS			$250,000	$250,000
	3	Electrical / Controls Sub: Furnish, Install & Start-up	Y	LS			$145,000	$145,000
	4	MEA Interconnection Charge	Y	LS			$20,000	$20,000
CHP Subtotal								**$3,176,970**
Design / Const Services	1	Permitting (Task 1)	Y	LS	1	$50,000	$50,000	$50,000
	2	ROW (Task 2)	Y	LS	1	$50,000	$50,000	$50,000
	3	Pipeline Design	Y	LS	1	$40,000	$40,000	$40,000
	4	Landfill Electrical Design	Y	LS	1	$15,000	$15,000	$15,000
	5	Engineering Project & Office Management	Y	LS	1	$45,000	$45,000	$45,000
	6	Genset / CHP Civil / Structural Design	Y	LS	1	$10,000	$10,000	$10,000
	7	Genset Design / Submittal Review	Y	LS	1	$15,000	$15,000	$15,000
	8	Landfill-Genset-CHP Controls Integration Design	Y	LS	1	$75,000	$75,000	$75,000
	9	CHP Mechanical / Piping Design	Y	LS	1	$65,000	$65,000	$65,000
	10	CHP Electrical Design (includes Utility Interconnection)	Y	LS	1	$50,000	$50,000	$50,000
	11	Construction Project Management	Y	LS	1	$25,000	$25,000	$25,000
	12	Construction Supt / Field labor / Per Diem	Y	LS	4	$33,750	$135,000	$135,000
	13	Stack Text & Commissioning	Y	LS	1	$50,000	$50,000	$50,000
	14	General Conditions - bonds, insurance, and warrranty				10.0%	$5,470,484	$547,048
Design / Const Services Subtotal								**$1,172,048**
		Escalation				2.5%	$6,017,532	$150,438
		Contingency and Profit				17.5%	$6,017,532	$1,053,068

Total Project Cost **$7,221,039**

Annual = Annual Allowance
CY = Cubic Yards
LS = Lump Sum
LF = Linear Feet
EA = Each
TONS = Tons
MH = Man Hours

Matanuska-Susitna Borough Palmer Central Landfill
LFG Beneficial Use Feasibility Study

LFG to Combined Heat and Power at Medical Center

Subcontractor	NO	Item	In Base Bid?	Unit	Quantity	Unit Price	Unit Total	Subtotal
Pipeline	1	Pipeline Sub & Directional Drill Sub Mobilization and Demobilization	Y	LS	1		$57,000	$57,000
	2	Survey (initial and as-constructed) -	Y	LS	1	$35,000	$35,000	$35,000
	3	Installation of LFG Pipeline (0'-6' bgs) *<u>SIZE as 8"and Directional Drilling</u>*	Y	LF	16500	$85	$1,402,500	$1,402,500
	4	Pipeline Rock Excavation	N	CY	0	$0	$0	$0
	5	Metallic Wire / Metallic Warning Tape - plastic pipe locator	Y	LF	16500	$0.25	$4,125	$4,125
	6	Communication Line	Y	LF	16500	$5	$82,500	$82,500
	7	Erosion Control, Seeding, Fertilizer and Mulch	Y	Acres^P	7.57575758	$3,500	$26,515	$26,515
	8	Spoils delivery to Landfill	Y	Trips to LF	733.333333	$70	$51,333	$51,333
	9	DOT Pipeline Integrity Pressure Testing ***(Initial Only)***	Y	Annual	1	$25,000	$25,000	$25,000
Pipeline Subtotal								**$1,683,973**
Compressor Skid	1	LFG Compressor and Dryer Package & Startup	Y	LS	1		$363,000	$363,000
	2	Delivery + Crane	Y	LS	1		$20,000	$20,000
	3	Control Panel & Electrical	Y	LS	1		$35,000	$35,000
	4	Mechanical Installation, Commissioning (Allowance- Man Hours)	Y	LS			$75,000	$75,000
	5	Cedar Fence or Chain Link Fence with Wind Screen	Y	LF	75	$85	$6,375	$6,375
	6	Concrete Pads	Y	LS	2		$18,000	$18,000
	7	Enclosed Building	Y	LS	1	$50,000	$50,000	$50,000
Booster Compressor Skid Subtotal								**$567,375**
Genset	1	JMC416 Genset	Y	LS			$960,180	$960,180
	2	Genset Procurement	Y	LS			$48,009	$48,009
	3	Soil Borings Geotech Report	Y	LS			$6,500	$6,500
	4	Pump House & Genset Foundations	Y	LS			$29,250	$29,250
	5	Sitework Sub: Genset Foundation, Fencing & Rock Surfacing	Y	LS			$45,200	$45,200
	6	Rigging Sub: Rig, Unload, Set & Assemble Genset Module Components	Y	LS			$12,000	$12,000
Genset Subtotal								**$1,101,139**
CHP	1	U/G Piping Sub: Furnish, Install & Start-up	Y	LS			$65,000	$65,000
	2	JMC416 Exhaust Heat Recovery Unit + Install	Y	LS			$153,000	$153,000
	3	Mechanical / A/G Piping Sub: Furnish, Install & Start-up	Y	LS			$432,000	$432,000
	4	Electrical / Controls Sub: Furnish, Install & Start-up	Y	LS			$145,000	$145,000
	5	MEA Interconnection Charge	Y	LS			$20,000	$20,000
CHP Subtotal								**$815,000**
Design / Const Services	1	Permitting (Task 1)	Y	LS	1	$50,000	$50,000	$50,000
	2	ROW (Task 2)	Y	LS	1	$50,000	$50,000	$50,000
	3	Pipeline Design	Y	LS	1	$40,000	$40,000	$40,000
	4	Landfill Electrical Design	Y	LS	1	$15,000	$15,000	$15,000
	5	Engineering Project & Office Management	Y	LS	1	$45,000	$45,000	$45,000
	6	Genset / CHP Civil / Structural Design	Y	LS	1	$10,000	$10,000	$10,000
	7	Genset Design / Submittal Review	Y	LS	1	$15,000	$15,000	$15,000
	8	Landfill-Genset-CHP Controls Integration Design	Y	LS	1	$75,000	$75,000	$75,000
	9	CHP Mechanical / Piping Design	Y	LS	1	$65,000	$65,000	$65,000
	10	CHP Electrical Design (includes Utility Interconnection)	Y	LS	1	$50,000	$50,000	$50,000
	11	Construction Project Management	Y	LS	1	$25,000	$25,000	$25,000
	12	Construction Supt / Field labor / Per Diem	Y	LS	4	$33,750	$135,000	$135,000
	13	Stack Text & Commissioning	Y	LS	1	$50,000	$50,000	$50,000
	14	General Conditions - bonds, insurance, and warrranty				10.0%	$4,792,487	$479,249
Design / Const Services Subtotal								**$1,104,249**
		Escalation				2.5%	$5,271,736	$131,793
		Contingency and Profit				17.5%	$5,271,736	$922,554

Total Project Cost **$6,326,083**

Annual = Annual Allowance
CY = Cubic Yards
LS = Lump Sum
LF = Linear Feet
EA = Each
TONS = Tons
MH = Man Hours

Matanuska-Susitna Borough Palmer Central Landfill
LFG Beneficial Use Feasibility Study

LFG to Direct Use in a Boiler at Medical Center

Subcontractor	NO	Item	In Base Bid?	Unit	Quantity	Unit Price	Unit Total	Subtotal
Pipeline	1	Pipeline Sub & Directional Drill Sub Mobilization and Demobilization	Y	LS	1		$57,000	$57,000
	2	Survey (initial and as-constructed) -	Y	LS	1	$35,000	$35,000	$35,000
	3	Installation of LFG Pipeline (0'-6' bgs) *SIZE as 8"and Directional Drilling*	Y	LF	16500	$85	$1,402,500	$1,402,500
	4	Pipeline Rock Excavation	N	CY	0	$0	$0	$0
	5	Metallic Wire / Metallic Warning Tape - plastic pipe locator	Y	LF	16500	$0.25	$4,125	$4,125
	6	Communication Line	Y	LF	16500	$5	$82,500	$82,500
	7	Erosion Control, Seeding, Fertilizer and Mulch	Y	Acres^{P}	7.57575758	$3,500	$26,515	$26,515
	8	Spoils delivery to Landfill	Y	Trips to LF	733.333333	$70	$51,333	$51,333
	9	DOT Pipeline Integrity Pressure Testing ***(Initial Only)***	Y	Annual	1	$25,000	$25,000	$25,000
Pipeline Subtotal								**$1,683,973**
Compressor Skid	1	LFG Compressor and Dryer Package & Startup	Y	LS	1		$354,500	$354,500
	2	Delivery + Crane	Y	LS	1		$20,000	$20,000
	3	Control Panel & Elecrical	Y	LS	1		$35,000	$35,000
	4	Dedicated LFG Boiler	Y	LS	1		$325,000	$325,000
	5	Mechanical Installation, Commissioning (Allowance- Man Hours)	Y	LS			$200,000	$200,000
	6	Cedar Fence or Chain Link Fence with Wind Screen	Y	LF	75	$85	$6,375	$6,375
	7	Concrete Pads	Y	LS	2		$18,000	$18,000
	8	Enclosed Building	Y	LS	1	$50,000	$50,000	$50,000
Booster Compressor Skid & Dedicated Boilers Subtotal								**$1,008,875**
Genset	1	JMC416 Genset	Y	LS				
	2	Genset Procurement	Y	LS				
	3	Soil Borings Geotech Report	Y	LS				
	4	Pump House & Genset Foundations	Y	LS				
	5	Sitework Sub: Genset Foundation, Fencing & Rock Surfacing	Y	LS				
	6	Rigging Sub: Rig, Unload, Set & Assemble Genset Module Components	Y	LS				
Genset Subtotal								**$0**
CHP	1	U/G Piping Sub: Furnish, Install & Start-up	Y	LS				
	2	JMC416 Exhaust Heat Recovery Unit + Install	Y	LS				
	3	Mechanical / A/G Piping Sub: Furnish, Install & Start-up	Y	LS				
	4	Electrical / Controls Sub: Furnish, Install & Start-up	Y	LS				
	5	MEA Interconnection Charge	Y	LS				
CHP Subtotal								**$0**
Design / Const Services	1	Permitting (Task 1)	Y	LS	1	$50,000	$50,000	$50,000
	2	ROW (Task 2)	Y	LS	1	$50,000	$50,000	$50,000
	3	Pipeline Design	Y	LS	1	$40,000	$40,000	$40,000
	4	Landfill & Hospital Electrical Design	Y	LS	1	$30,000	$30,000	$30,000
	5	Engineering Project & Office Management	Y	LS	1	$35,000	$35,000	$35,000
	6	Genset / CHP Civil / Structural Design	Y	LS	1	$0	$0	$0
	7	Genset Design / Submittal Review	Y	LS	1	$0	$0	$0
	8	Landfill-Boiler Controls Integration Design	Y	LS	1	$35,000	$35,000	$35,000
	9	Mechanical / Piping Design	Y	LS	1	$65,000	$65,000	$65,000
	10	CHP Electrical Design (includes Utility Interconnection)	Y	LS	1	$0	$0	$0
	11	Construction Project Management	Y	LS	1	$25,000	$25,000	$25,000
	12	Construction Supt / Field labor / Per Diem	Y	LS	3	$33,750	$101,250	$101,250
	12	Stack Text & Commissioning	Y	LS	1	$50,000	$50,000	$50,000
	13	General Conditions - bonds, insurance, and warrranty				10.0%	$3,174,098	$317,410
Design / Const Services Subtotal								**$798,660**
		Escalation				2.5%	$3,491,508	$87,288
		Contingency and Profit				17.5%	$3,491,508	$611,014
							Total Project Cost	**$4,189,810**

Annual = Annual Allowance
CY = Cubic Yards
LS = Lump Sum
LF = Linear Feet
EA = Each
TONS = Tons
MH = Man Hours

APPENDIX K – CH2M C&D CELL DEVELOPMENT PLAN

Final

Matanuska-Susitna Borough Central Landfill Development Plan

Prepared for

Matanuska-Susitna Borough
Solid Waste Division

October 2014

CH2MHILL®

949 E. 36th Avenue Suite 500
Anchorage, AK 99508

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Acronyms and Abbreviations

24/7	24 hours a day, seven days a week
AAC	Alaska Administrative Code
ADC	alternative daily cover
ADEC	Alaska Department of Environmental Conservation
ADOL	Alaska Department of Labor and Workforce Development, Research and Analysis Section
ATL	Air Toxics Ltd.
AWWU	Anchorage Water and Wastewater Utility
BOD	biochemical oxygen demand
BTU	British thermal units
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CO_2e	carbon dioxide equivalent
COD	chemical oxygen demand
CY	cubic yard
EPA	U.S. Environmental Protection Agency
GHG	greenhouse gas
gpd	gallons per day
HELP	Hydrologic Evaluation Landfill Performance
IC	internal combustion
INORG	inorganic
ISER	Institute of Social and Economic Research
kW	kilowatt
lb	pound(s)
LandGEM	Landfill Gas Emissions Model (EPA)
LFGCCS	landfill gas collection control system
LFGTE	landfill gas to energy
m^3	cubic meters
m^3/mg	cubic meters per milligram(s)
Mg	megagram
mg/L	milligrams per liter
MBR	membrane bioreactor
MSB	Matanuska-Susitna Borough
MSW	municipal solid waste

MW	megawatt
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NMOC	non-methane organic compounds
NSPS	New Source Performance Standards
O&G	oil and grease
O&M	operations and maintenance
OOC	organochlorine compound
PEST	pesticide
PV	present value
RAD	radiation units
SBR	sequencing batch reactor
SVOC	semivolatile organic compound
SWD	Solid Waste Division
TDS	total dissolved solids
TOC	total organic carbon
TSS	total suspended solids
VOC	volatile organic compound
WQ	water quality
WQS	water quality standards

Executive Summary

The Matanuska-Susitna Borough (MSB) selected CH2M HILL to perform the following tasks:

- Evaluate future cell sequencing
- Evaluate total site soil balance
- Update budgetary cost estimates for onsite leachate treatment
- Evaluate the feasibility for onsite co-treatment of septage and leachate
- Evaluate the potential for methane capture and use
- Re-evaluate the existing formula for annual contribution to closure fund.

Using updated cell development criteria, site topographic data and civil design software, the CH2M HILL team created a future landfill development concept. The projected life of the landfill (151 years) with this revised development plan increased significantly from the previous 2006 plan for three main reasons: 1) the bottom of the landfill was dropped from 20-foot separation to groundwater to the regulatory required 10-foot separation, 2) increased waste placement density from improved field compaction, and 3) revised 3:1 side slopes confirmed stable via stability analysis. The proposed cell sequence stays east of the existing power line for the duration of development, and away from trailhead and Crevasse Moraine trails for as long as possible. With the updated side slopes and higher waste density, our analysis indicates that the current cell (Cell 3) may have up to 8 more years of capacity.

In addition to the longer landfill life, the updated development criteria yields a positive soil balance of approximately 9 million cubic yards (CY) over the life of the landfill. This additional gravel can be made available for other MSB projects.

The required annual contribution to closure for the final landfill cell has decreased dramatically because of the longer landfill life. However, this analysis assumes that interim cells are closed sequentially and federal regulations (40 Code of Federal Regulations [CFR] 258.71) require that MSB maintain sufficient funds to close the largest landfill cell open at any time during the active landfill life. Additional financial evaluation and planning is recommended to ensure that MSB has sufficient funds available for the interim cell closures.

It is CH2M HILL's recommendation that the MSB co-treat leachate and septage at the landfill. We understand that the MSB is planning to build a septage treatment facility somewhere within the MSB and is targeting MSB land. Sufficient land is available at the landfill and locating this facility at the centrally located landfill should minimize the average transport cost for haulers.

Co-treatment of leachate with pre-treated septage is feasible with commercially available biological package treatment systems. The recommended treatment process for this combined wastewater is a sequencing batch reactor (SBR). The permitted effluent discharge limits that will apply at the point of compliance will depend on Alaska Department of Environmental Conservation's (ADEC's) comfort level with the proposed treatment system. For planning purposes, the most stringent discharge criteria (drinking water standards) were used.

If the septage facility is not located at the landfill, then we recommend evaluating the costs of hauling leachate to the septage facility for co-treatment versus costs of construction and operation of an onsite leachate evaporator. Construction of both the septage treatment facility and the leachate evaporator at the landfill is not recommended because it would be redundant.

U.S. Environmental Protection Agency's (EPA's) screening model Landfill Gas Emissions Model (LandGEM) indicates that landfill gas generation at the Central Landfill may have reached a point where it can be beneficially used, either as fuel (for example, for leachate evaporation) or for generation of power. The Central Landfill is currently subject to the Greenhouse Gas (GHG) Reporting Rule (40 Code of Federal Regulations [CFR] 98, Subpart HH) and MSB needs to prepare a monitoring plan and submit an annual emission report to be compliant with this federal requirement. Our estimates indicate that the Central Landfill has not yet reached the New Source Performance Standards (NSPS) (40 CFR 60, Subpart WWW) limits requiring installation of landfill gas collection and control, but MSB should confirm this assumption by completing and submitting a design capacity report to ADEC. The Central Landfill is currently not subject to National Emissions Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 63, Subpart AAAA) because the design capacity of the landfill is estimated to be below the NSPS regulatory thresholds. A landfill gas feasibility study involving installation of vertical gas collection wells is recommended when gas quality measurements from the passive gas vents to be installed on Cell 2A indicate good gas quality. Grant funding is available for alternative energy/GHG reduction projects of this type.

SECTION 1

Landfill Development Plan

The following landfill development plan provides a summary of the data, assumptions, and approaches that were used during the development of the conceptual layout for the Matanuska-Susitna Borough (MSB) Central Landfill. This includes a summary of baseline values used to determine future requirements, utilize existing site conditions, and assemble landfill elements to offer the MSB Solid Waste Division (SWD) a development plan that optimizes available horizontal and vertical space and gravel resources that can be used for other projects within the MSB. This development plan should be used by the MSB as the roadmap by which development of the cells proceed.

1.1 Air Space Requirements and Future Cell Sizing

In order to optimize site development, estimated yearly quantities of waste and associated daily/intermediate cover and final cover/bottom liner soils were projected to determine future airspace and related material needs. Concurrently, the future landfill boundary was established, followed by generating preliminary landfill liner and final cover system grades. This includes determining the baseline for incoming waste, the estimated daily cover soil to waste ratio, projected growth rates, available airspace, and finally establishing the criteria for future cell development.

1.1.1 Baseline Incoming Waste Volume

Incoming waste tonnages were provided by the MSB through Years 2007 to 2014. Additionally, historical in-place density information was provided and included data from Years 2009 to 2014. The information included a historical comparison of monthly incoming waste with associated monthly volumes which were developed by the MSB through comparing before and after waste placement land surveys. This information provided the basis for determining the average density of in-place waste.

While the 2009 through 2014 mass and volume comparisons were available for several months and years, only the September 2013 to May 2014 (end of record) information was used to estimate future in-place waste density. Following the contract change in September 2013, an average waste density of 1,400 pounds (lbs) of municipal solid waste (MSW) and daily cover soil per cubic yard (CY) of airspace was achieved. It is understood that similar compaction equipment and methods will be used in the future, so this density was used for future planning purposes. A summary of waste, volume, and density under the new service contract is shown in Table 1-1.

TABLE 1-1

Baseline Annual Incoming Waste Volume and Density

Matanuska-Susitna Borough Central Landfill Development Plan

Year	Month	Days Worked	MSW/ Residential Waste (lb)	Survey Data Volume (CY)	Density [a] (lb/CY)
2013	September	29	11519480	8321	1384
	October	31	11010840	8174	1347
	November	29	8491460	6907	1229
	December	30	8355880	7156	1167
2014	January	30	8780820	5690	1543
	February	28	7215340	4955	1456
	March	31	8158680	5600	1456

TABLE 1-1

Baseline Annual Incoming Waste Volume and Density

Matanuska-Susitna Borough Central Landfill Development Plan

Year	Month	Days Worked	MSW/ Residential Waste (lb)	Survey Data Volume (CY)	Density [a] (lb/CY)
	April	30	9620400	5583	1723
	May	30	11496340	8606	1335
				Average Density	1400

Notes

[a] Density reported is the weight of MSW per CY of airspace used, where the airspace includes daily and intermediate cover soils as well as MSW.

1.1.2 Daily Cover Soil-to-Waste Ratio

In order to estimate the daily and intermediate soil needs, a soil to waste ratio was developed that relates those materials to incoming waste quantities. The MSB does not currently track actual cover soil use, so estimates were developed based on typical daily fill operations. The MSB indicated that for each 10-foot-thick daily lift, an approximate 100-foot by 50-foot working face is covered with an alternative daily cover (ADC), and the remaining exposed surface is covered with soil. The working face was modeled as the two exposed sides of the daily lift. Calculations of exposed waste for each daily cell indicate that the ADC is generally large enough to cover the entire sloped face of the working landfill.

To estimate the daily cover soil usage, the working deck was assumed to be covered daily to allow subsequent travel over the previous day’s cell. Based on landfill operational experience, up to 1 foot of soil may be required on the top deck of the previous day’s lift in order to provide adequate support for vehicular travel over waste. In order to provide a conservative usage of daily cover soil, a minimum of 1 foot was assumed over the day’s lift. Additionally, a minimum of 6-inches of soil was assumed to be placed over the working face at least 10 percent of the time to account for periods of inclement weather or other conditions that could impact the deployment of ADC for the day. An average daily waste volume of approximately 278 CY and a fill depth of 10 feet results in a top deck area of approximately 750 square feet. An assumed 1-foot-thick daily cover on the top deck and a 6-inch layer over the working face 10 percent of the time results in an average of about 31 CY of cover soil needed daily, or 11,100 CY over a 359-day work year.

Using the estimated daily cover soil usage and the yearly waste records from 2007 through 2013, the average computed soil to waste ratio was 0.16, or a little more than 1:5 (soil:waste).

1.1.3 Solid Waste Growth Rates

The incoming volume of waste is expected to increase as the population in the Matanuska-Susitna Valley grows. Future solid waste growth rates were estimated using predictions for population growth rates from the Alaska Department of Labor and Workforce Development, Research and Analysis Section (ADOL). These ADOL rates were based on standard population growth and did not take into account the potential increases that could be realized should the Knik Arm Bridge be constructed. In order to account for the potential increase in growth because of the bridge, the additional percentage points related to bridge construction were determined starting from the present through year 2030, at which time the growth projections reverted to the standard ADOL growth rates.

The bridge-related population growth was developed from the *Environmental Impact Statement Memorandum on the Economic and Demographic Impacts of a Knik Arm Bridge* prepared by the Institute of Social and Economic Research (ISER) at the University of Alaska, Anchorage, dated 2005. Bridge-related population growth was obtained by isolating the growth attributed to the bridge. The resulting bridge-related growth rates were then added to the more recent ADOL population growth rates. The resulting yearly growth rates are presented in Table 1-2 below. Population estimates using these growth rates are provided in Appendix A.

TABLE 1-2

Matanuska-Susitna Growth Projections

Matanuska-Susitna Borough Central Landfill Development Plan

Year	Matanuska-Susitna Projection	5-Yearly Growth Rate [a]	Yearly Growth Rate	Yearly Growth Rate Attributable to Bridge [b]	Yearly Growth Rate with Bridge
July 1, 2012	93,801	--	--	--	--
July 1, 2017	105,617	12.60%	2.40%	0.08%	2.48%
July 1, 2022	117,845	11.58%	2.21%	0.17%	2.38%
July 1, 2027	130,254	10.53%	2.02%	0.32%	2.35%
July 1, 2032	142,615	9.49%	1.83%	0.28%	2.11%
July 1, 2037	154,692	8.47%	1.64%	--	1.64%
July 1, 2042	166,338	7.53%	1.46%	---	1.46%

Notes

[a] Source: ADOL, 2014

[b] Source: ISER, 2005

1.1.4 Airspace Requirements

Landfill airspace requirements were forecast using the MSW to airspace density, growth rates, and daily cover soil-to-waste ratio (with ADC) discussed in Section 1.1.3. Airspace requirements are shown by year in Appendix A. The calculation of average waste density is shown in Table 1-3.

TABLE 1-3

Average Weight of Municipal Solid Waste per Cubic Yard of Airspace

Matanuska-Susitna Borough Central Landfill Development Plan

Item	Value	Unit	Source/Notes
Average Weight of MSW	57,866	tons	MSB records from 2007 to 2013; MSW only
In-place volume of MSW	82,665	CY	MSB records from 2007 to 2013; includes MSW and daily cover soil
Density of MSW	1,400	lb/CY	Weight of MSW (not including cover soil) per CY of air space

1.1.5 Future Cell Sizing

For planning purposes, it was decided that each future landfill cell should have a life of approximately 5 to 7 years. The future capacity for each cell was computed using the forecast airspace requirements and estimated landfill and final cover liner systems. Future cell sizing is presented in Appendix C.

1.1.6 Cell Development Criteria

The following future cell development criteria were used for this project.

Property Boundaries. The Central Landfill property boundary was obtained from the MSB. The additional 190 acres on the east side of the property—parcels C2, C3, and C4—will not be used for landfilling waste. Per direction from the MSB, future development is limited to the area east of the existing Matanuska Electric Association 100-foot power line easement.

Buffer Zones Between New Cells and Residential Areas. Buffer zones are measured from the cell boundary to the facility boundary. The north boundary will have a 300-foot buffer from existing residential property. The buffer on the east, west, and south sides will be 100 feet, which exceeds the 50 feet required by permit for non-residential land.

Maximum Height Limit. The landfill height was assumed to be at a maximum elevation of 355 feet above mean sea level per North American Vertical Datum 1988, which is based on a recent waiver received by the MSB. This will require a permit modification, as the permitted elevation is 340 feet above mean sea level based on a locally established datum, and a waiver would be required for each cell, similar to the waiver for Cell 2A.

Stormwater Collection. The goal for stormwater control is to prevent ponding and erosion. It is assumed that stormwater will be routed to ditches for infiltration or discharge to the south of the site. Depending on changes in regulations, future stormwater may be re-circulated onto the waste in the lined cells.

Depth to Groundwater. The depth to groundwater was optimized to meet the minimum regulatory 10-foot separation from liner to high groundwater elevation. There are no hydrogeologic investigation or associated hydrographs available that identify the high groundwater elevation throughout the year; therefore, the high groundwater elevations are a compilation of the highest groundwater elevations between the available June 22, 2005, and March 11, 2014, groundwater maps (Shannon & Wilson, Inc. 2005; 2014).

Desired Soil Balance. The MSB can use an unlimited supply of soil (gravel) and would like to maximize positive soil balance in order to use gravel as a resource that can be used elsewhere within the MSB. The rate of use would equal the rate of excavation. Calculations used to determine soil balance currently assume that no stockpiling is required for such “resource” soils and that only soils needed for use at the landfill are to be stockpiled.

Leachate Collection System, Bottom Grades. Leachate will drain via gravity to a low spot within each landfill cell where it will then be collected in a sump and pumped into a leachate collection header. The header and subheaders will generally gravity flow to the east and south, providing a cost savings by not requiring a force main throughout the site. The slope for leachate collection system piping for future cells should be a minimum of 1.5 percent.

Location of Leachate Treatment System. The leachate treatment system is currently planned for the approximate 34-acre treatment area in the west of the site.

Bottom Liner Section. It was assumed that the bottom liner section would be the same as the one used for the first lined cell at the Central Landfill (Cell 2B). From the bottom up, the liner section will entail a prepared subgrade, 6-inch sand leveling course, geosynthetic clay liner, flexible membrane liner, and a 2-foot layer of granular drainage material.

Final Cover Section. The specific final cover section has not yet been designed but the following section is assumed using standard practice and regulatory guidance from Alaska Administrative Code (AAC) 18 AAC 60.395. From the bottom up, the final cover section will include a prepared subgrade, 6-inch leveling course, flexible membrane liner, 18-inch layer of granular drainage material, and 6 inches of earthen material capable of sustaining native plant growth, for a total soil thickness of 2.5 feet.

Cell Berm Slopes. Cell separation/stormwater control berms will have 2 horizontal (H):1 vertical (V) interior slopes, and 3H:1V exterior slopes. At a minimum, their height must be 5 feet above the granular drainage material in the cell.

Interior Landfill Slopes. Interior landfill slopes separating the three major landfill sections and around the landfill perimeter will be a maximum 3H:1V.

Final Cover Slopes. For the interior slopes between the cells and the exterior final slopes, a maximum of 3H:1V side slopes will be used. Benching will be assumed at one bench every 30 feet in elevation, with at least one 12-foot-wide bench placed mid-slope when height exceeds 60 feet. For design purposes, an effective slope of

3.2H:1V was used, which accounts for minimum intermediate benching requirements by taking the average slope from top to toe including the benches.

Access Roads. It was assumed that access roads will have a maximum grade of 7 percent on straight stretches and 5 percent on curves. Haul roads will be a minimum of 30 feet wide (not including ditches) to accommodate 2-way traffic. Service roads should be 20 feet wide and have a maximum grade of 12 percent.

1.2 MSW Landfill Development Basis

1.2.1 Methodology for Developing Landfill Bottom Grading and Final Grading Plans

The general methodology below was used to develop the landfill development grading plans for the Central Landfill:

- Develop a perimeter berm road set back from the property line as necessary to provide the appropriate buffer distance and to allow the cut and fill slopes to catch the existing ground within the site property boundary.
- Develop interior berm roads between each phase to provide for access, surface stormwater drainage, and leachate conveyance pipes.
- Develop overall bottom grades for the landfill that are a minimum of approximately 10 feet above the regional groundwater elevation and that provide adequate slope for leachate collection.
- Develop an overall final grading plan to a permitted maximum elevation of 355 feet.
- Calculate the amount of soil excavation and embankment fill between the existing ground topography and the bottom grading plan for total landfill development.
- Calculate the total landfill volume (air space) between the bottom grading plan and the final grading plan.
- Calculate the total soil required for the bottom liner, final cover, and daily cover.
- Estimate the amount of surplus soil available for offsite use by deducting the total soil required for bottom liner, final cover, and daily cover from the net amount of soil excavated for total landfill development (that is, surplus soil from excavation).
- Develop cell sequencing plan and determine the limits of individual landfill cells to provide approximately 5 to 7 years of life in each cell based on an assumed solid waste growth rate.

1.2.2 Perimeter and Interior Berm Roads

To define the horizontal limits of the MSW landfill, a perimeter berm road alignment was established to maximize the available property and establish the limits for the landfill. The horizontal alignment was set back from the property boundary to ensure sufficient buffer distance from the edge of waste to the property boundary (300-foot buffer in residential and 100-foot buffer for non-residential), maintain space for existing landfill facilities (construction and demolition waste disposal, asbestos disposal, and stockpiles) in the northwest of the site, and to allow space for an approximate 34-acre treatment area in the west of the site. The perimeter berm road alignment can be seen in Figure 2. The road embankment outside cut and fill slopes (3H:1V) catch the existing ground within the site property boundary. An approximate minimum 400-foot turning radius was used for the perimeter berm road alignment to allow for two-way haul truck traffic based on a selected AASHTO 74-foot-long semitrailer turning geometry. The vertical alignment of the perimeter berm road allows drainage to flow generally from north to south. The vertical alignment results in a high point at an elevation of approximately 295 feet at the northwest and a low point at an elevation of approximately 215 feet at the southeast, with the perimeter berm road draining from both sides of the northwest high point down along east and west sides of the landfill to the southeast low point. Perimeter berm road and ditches maintain a minimum 1 percent flow slope. Maximum perimeter berm road grades are 7 percent along straight portions and 5 percent on curves. The typical perimeter berm road section consists of a 30-foot-wide roadway (2x 12-foot lane and 3-foot shoulder with 1.5 percent centerline crown), a 10-foot-wide 3H:1V slope v-ditch on both sides of the roadway, and a 10-foot-wide area for liner anchor trench construction.

To provide corridors for access, surface stormwater drainage, and leachate conveyance pipes, an interior north berm (running west-east) and interior east berm (running north-south) was established within the perimeter berm road footprint, as shown in Figure 2. The location of the interior berm roads were selected to convey flows to the low point to the south, partition the landfill for future landfill sequencing to keep northeast trailheads open until final development, and in general maximize existing soil excavation. The interior berm road width provides adequate space for a section similar to the typical perimeter berm road section. Specific ditch and anchor trench sizing should be developed during final design. The interior berm roads, along with the perimeter berm road, define three main landfill sections, the existing landfill area, Phase 1 area to the south, and the Phase 2 area to the east. The interior north berm road drains from west to east and the interior east berm drains from north to south to convey surface stormwater and leachate to the southeast low point.

1.2.3 Stormwater

Stormwater runoff from future cells is directed to the perimeter and interior berm road ditches. In general, stormwater flows to the low point at the southeast. Stormwater will be routed under the perimeter road via culvert to the outside of the landfill for infiltration into existing natural basins. Stormwater may also discharge to the outside of the landfill footprint at intermediate locations along the perimeter berm. Specific infiltration areas may need to be developed during final design. Additional stormwater discharge locations may need to be identified if, during detail design, the stormwater volume exceeds the ditch capacity.

1.2.4 Bottom Grading Plan

The bottom grading plan (Figure 2) was developed so that bottom grades for the landfill are a minimum of approximately 10 feet above the assumed regional groundwater elevation and provide adequate slope for leachate collection. Based on highest groundwater elevations measured on June 22, 2005, and March 11, 2014 (Shannon & Wilson, Inc., 2005; 2014), groundwater generally slopes from north to south, with approximate elevations ranging from 230 feet at the north to 125 feet at the south, as shown on Figure 1. Minimum landfill bottom grades were developed by projecting the assumed regional groundwater surface up 10 feet to meet the minimum 10-foot separation requirement. As such, the landfill bottom also slopes to the south and allows leachate to be collected and removed at the south side of each landfill phase. Bottom grading plan side slopes from perimeter and interior berm roads are 3H:1V down to each landfill phase bottom. The depth of the landfill bottom ranges from approximately 20 to 100 feet below the elevation of the perimeter berm road, with the shallowest depth at the northeast of landfill Phase 2 and the deepest depth at the southwest of landfill Phase 1. The landfill floor of each phase was developed to optimize the separation between high groundwater and the bottom of the landfill and, therefore, does not have a uniform grade. However, when each 5-year cell is developed, the grades for each cell can be generated uniformly provided they do not exceed the minimum separation depth between the groundwater and bottom of landfill.

1.2.5 Leachate Collection

The bottom grading plan allows future leachate collection systems to drain at a minimum of 1.5 percent. Leachate would be collected at the south side of each landfill section and removed from the landfill using pumps in each cell or series of cells. The pumps would discharge leachate into a leachate transmission pipe located in the perimeter and interior berm roads then to the leachate equalization lagoon at the 34-acre treatment area on the west side of the site, where it would be pumped to the proposed leachate treatment system.

1.2.6 Final Grading Plan

The final grading plan was developed with ridges running east-west at the maximum elevation of 355 feet. The northern ridge is generally located in the middle of the existing landfill area and northern portion of landfill Phase 2, and the southern ridge is in the middle of Phase 2 and the southerly portion of Phase 2. Final cover top grades slope down from either side of the ridges at 4 percent. As shown in Figure 3, the intermediate final grading plan fills the existing landfill area and landfill Phases 1 and 2 to the maximum elevation and leaves interior berm roads open for access and surface stormwater conveyance. Figure 4 shows the ultimate final grading plan, which fills over the interior berm roads left open in the intermediate final grading plan. The ultimate final grading plan develops two swales that drain final cover stormwater flows collected from the middle of the landfill to the east and west perimeter berm road. As filling over the interior berm roads will bury the leachate transmission pipes with as much as 120 feet of waste, provisions for accessing and maintaining these lines should be developed if the ultimate final grading plan is implemented.

Steeper final cover slopes were evaluated in order to further optimize the quantity of airspace available within the landfill. A preliminary geotechnical analysis was performed using the revised bottom liner and final cover grades (Appendix B). The analysis demonstrated that 3H:1V slopes meet the minimum factors of safety of 1.5 and 1.0 for static and seismic conditions; therefore, intermediate and ultimate final grading plan side slopes were modeled using this criterion. As shown on Figures 3 and 4, the slopes were modeled at an approximate effective 3.2H: 1V slope. This effective slope accounts for an actual final side slope of 3H:1V, which includes minimum intermediate benching requirements. The final grading plan with a maximum permitted elevation of 355 feet, and bottom grading plan with a minimum 10-feet groundwater separation, represents a maximized landfill development.

1.3 MSW Conceptual Development Results

1.3.1 Excavation and Airspace Volumes

Computer-aided engineering/computer-aided drafting software was used to prepare a digital terrain model design surface for the existing ground surface from the most recent available aerial topography. Digital terrain model design surfaces were also created for the bottom grading plan, including the perimeter and interior berm roads, and the final grading plan, both with and without the valley fills. These surfaces were used to compute the excavation and embankment volume between the existing ground and the bottom grading plan, the airspace between the bottom grading plan and the final grading plan, and the airspace in the valley fills.

The excavation and embankment volumes between existing ground and the landfill bottom grading plan (bottom of bottom liner) including the perimeter and interior berm roads are presented below:

Total Excavation (cut)	21,830,000 CY
Total Embankment (fill)	2,680,000 CY
Net Excavation	**19,150,000 CY**

The net excavation represents the volume of gravel that would be available for landfill liner and cover construction and daily cover. Surplus gravel remaining after these needs are met would be available for other offsite uses.

1.3.2 Development Scenario 1: Standard Landfill Bury and Compact, Airspace Volume and Soil Balance

The total air space volume between the landfill bottom-grading plan (bottom of bottom flexible membrane liner) and the final grading plan (top of final cover) with the valley fill is presented below. The bottom liner leveling course was excluded from the computations because it lies immediately below the bottom of the bottom liner system. The final cover leveling course was also excluded from the computations assuming that the final daily/intermediate cover could be used as the leveling course. The following is a summary of volumes:

Landfill Air Space with Valley Fills	59,354,000 CY
Bottom Liner Volume (2.0 feet thick)	855,000 CY
Final Cover Volume (2.0 feet thick)	942,000 CY
Net Air Space with Valley Fills	**57,557,000 CY**

The population, MSW disposal, air space, and cover soil requirements forecast table indicates that this air space volume provides landfill capacity for approximately 40.9 million tons of waste and would last into year 2168. Cover soil, liner, and final cover soil requirements for this waste volume are presented below:

Cover Soil	7,974,000 CY
Bottom Liner Soil (2 feet)	855,000 CY
Bottom Liner Leveling Soil (0.5 feet)	214,000 CY
Final Cover Soil	942,000 CY
Total Soil Requirement	**9,985,000 CY**

The net soil balance for the final grading plan with the valley fills is shown below:

Net Excavation	19,150,000 CY
Total Soil Requirement	9,985,000CY
Net Soil Surplus	**9,165,000 CY**

The conceptual development plan with the valley fills results in a net soil surplus of about 9.2 million CY. This volume of soil could be removed for offsite uses over the course of the landfill life.

1.3.3 Development Scenario 2: Waste to Energy in Year 2040, Airspace Volume and Soil Balance

With the waste to energy option, the total airspace volume remains the same as noted above, for a net air space of 59,354,000.

The population, MSW disposal, air space, and cover soil requirements forecast table indicates that the air space volume provides landfill capacity to accept an equivalent of 399,500,000 tons of waste and would last into year 2317. Note, the quantity of waste would be reduced by about 90 percent when the waste to energy system begins operation. While the tonnage that can be processed is relatively high, the resulting airspace is substantially reduced. The following are the total soil requirements with the valley fills:

Cover Soil	21,500,000 CY
Bottom Liner Soil (2 feet)	855,000 CY
Final Cover Soil	942,000 CY
Total Soil Requirement	**23,297,000 CY**

For the final grading plan with the valley fills, the net soil balance would be as follows:

Net Excavation	19,150,000 CY
Total Soil Requirement	23,297,000 CY
Net Soil Deficiency	**(4,147,000) CY**

The additional daily cover soil needed to cover the ash results in a net soil deficiency of about 4.2 million CY. Note that projecting this far into the future (past year 2300) is generally inaccurate and the results should be considered general level of magnitude.

1.4 Municipal Solid Waste Landfill Cell Sequencing Plan

The cell sequencing plan was developed so that the next new cell would be located east of existing cells, which would then proceed immediately to the south, then to the west. Cells 4 through 7 will be developed east of Cell 3. Once these cells are filled, operations will move to the south into the Phase 1 development area starting with Cell 8, where subsequent cells will proceed south in rows from east to west. Each cell will be developed and closed in numerical order. Cells in the Phase 2 development area would be developed after those in Phase 1 are completed in order to preserve the trail system along the eastern portion of the property as long as possible. The Phase 2 development would start with Cell 25, then continue north, ending with Cell 29.

1.4.1 Methodology for Cell Sequencing

The perimeter and interior berm roads will form the boundary of the some of the future cells in the Phase 1 and Phase 2 areas. Other cell boundaries were established to provide enough air space capacity in each cell for approximately 5 to 7 years of landfill operation.

1.4.2 Cell Sequencing Plan

The sequencing plan is shown in Figure 5. The currently active cell is Cell 3. Cells 4 through 7 are east of the existing landfill. Landfill Phase 1 development comprises Cells 8 through 24; Landfill Phase 2 development comprises Cells 25 to 29.

1.4.3 Cell Capacity and Service Life

The capacity of each cell without the valley fills and the year in which each would be filled are presented in Table 1-4. The scenario with valley fills would provide approximately 4 additional years of airspace.

TABLE 1-4
Matanuska-Susitna Borough Central Landfill Development Plan without Valley Fills
Matanuska-Susitna Borough Central Landfill Development Plan

Cell Number	Waste and Cover Soil Volume (CY)	Average Annual Waste and Soil Volume (CY)	Start Date	End Date	Cell Life (Years)
LANDFILL SECTION 1					
3	848,000	95,400	May 2013	August 2022	9
4	495,000	116,700	August 2022	February 2027	5
5	580,000	126,339	February 2027	October 2031	5
6	567,000	136,500	October 2031	February 2036	5
7	1,114,000	149,800	February 2036	July 2043	7
LANDFILL SECTION 2					
8	924,000	167,800	July 2043	April 2049	6
9	865,000	181,300	April 2049	March 2054	5
10	863,000	188,700	March 2054	December 2058	5
11	1,300,000	209,200	December 2058	May 2065	6
12	1,109,000	224,700	May 2065	June 2070	5
13	1,245,000	241,000	June 2070	September 2075	5
14	1,235,000	259,800	September 2075	July 2080	5
15	2,074,000	285,700	July 2080	January 2088	7
16	1,423,000	310,600	January 2088	September 2092	5
17	1,519,000	330,800	September 2092	May 2097	5
18	1,778,000	355,400	May 2097	June 2102	5
19	2,001,000	387,700	June 2102	October 2107	5
20	2,057,000	412,900	October 2107	November 2112	5
21	2,206,000	445,000	November 2112	December 2117	5
22	2,333,000	486,500	December 2117	November 2122	5
23	3,073,000	521,000	November 2122	December 2128	6
24	3,277,000	577,400	December 2128	November 2134	6

TABLE 1-4

Matanuska-Susitna Borough Central Landfill Development Plan without Valley Fills

Matanuska-Susitna Borough Central Landfill Development Plan

Cell Number	Waste and Cover Soil Volume (CY)	Average Annual Waste and Soil Volume (CY)	Start Date	End Date	Cell Life (Years)
LANDFILL SECTION 3					
25	2,956,000	628,800	November 2134	October 2139	5
26	3,933,000	665,000	October 2139	October 2145	6
27	4,279,000	728,500	October 2145	November 2151	6
28	4,655,000	796,900	November 2151	November 2157	6
29	5,297,000	879,700	November 2164	November 2164	6
TOTAL	**47,946,389**		**2013**	**2164**	**151**

SECTION 2

Onsite Leachate Management

2.1 Leachate Volumes

A preliminary evaluation of leachate generation was performed using the Hydrologic Evaluation Landfill Performance (HELP) model. The HELP model was developed by the U.S. Army Engineer waterways Experimental Station for the U.S. Environmental Protection Agency (EPA) and has been in use since 1984.

The HELP model is a quasi-two-dimensional hydrogeologic water balance model developed specifically to perform municipal landfill evaluations. Weather, soil, and design data representative of the MSB Landfill were entered into the model. The HELP model uses solution techniques that account for the effect of surface storage, snow melt, surface runoff, infiltration, evapotranspiration, vegetative growth, soil moisture storage, lateral subsurface drainage, leachate recirculation (if any) unsaturated vertical drainage, and leakage through soil, geomembrane, or composite liners.

The HELP model was used to estimate leachate production at the end of the estimated 20-year design life for the treatment system. This corresponds to the estimated leachate flow from Cells 4-7 in 2035. A summary of the HELP model results is included in Appendix D. Table 2-1 summarizes the estimated annual historical leachate generation rates together with 2035 design volume.

TABLE 2-1

Actual and Estimated Leachate Generation (2035) at Central Landfill

Matanuska-Susitna Borough Central Landfill Development Plan

Year	Cells Open	Actual Annual Leachate Generation (gallons)
2005	2B	339,080
2006	2B	258,082
2007	2B	284,000
2008	2B	420,000
2009	2B, 3	600,250
2010	2B, 3	1,015,286
2011	2B, 3	1,106,395
2012	2B, 3	1,650,942
2013	2B, 3	1,645,772
		Estimated Annual Leachate Generation (gallons)
2035	6, 7	3,400,000

Adding a 20 percent factor of safety on the HELP estimate to account for peak periods yields a total annual leachate generation of approximately 4,000,000 gallons. The estimated average flow of leachate was estimated at 11,000 gallons per day (gpd) (but could be as high as 13,000 gallons if higher rainfall data from the last 2 years is taken into account), while the projected peak flow (based on 24-hour/25-year storm and newly opened cell) could reach 450,000 gpd (312 gallons per minute).

An average flow of 13,000 gpd was used to estimate the mass loading for onsite leachate treatment, while peak flow was used to determine the required equalization/storage volume.

2.2 Leachate Influent Characteristics and Effluent Limits

Leachate will collect a variety of dissolved organic and inorganic contaminants resulting from the dissolution and degradation of the MSW. The characteristics of leachate will vary over time and characteristics will change with the composition of the waste, age and degree of compaction. The concentrations of chemicals detected will vary dependent on the age of landfill, amount of annual precipitation, and landfill operation methods (leachate recirculation or bioreactor landfill).

MSB landfill leachate characterization data for 2012 and 2013 is summarized in Table 2-2 below. A detailed characterization report is included in Appendix E. The last 2 years of characterization data are evaluated because they are related to current waste placement operations in Cell 3, with the highest strength leachate concentrations. This table does not include all the regulated metals because only zinc exceeded the discharge permit limits from the Anchorage Water and Wastewater Utility (AWWU). Table 2-2 also shows the current AWWU permit discharge limits for the leachate generated at the site.

TABLE 2-2
Historical Leachate Characteristics and Current AWWU Discharge Limits
Matanuska-Susitna Borough Central Landfill Development Plan

Parameter	BOD mg/L	TSS mg/L	pH	O&G mg/L	Zinc mg/L
2012					
March	477	348	7.1	57.9	0.244
June	15,200	260	6.3	104	1.39
September	49	124	6.7	5.1	0.05
December	23,300	130	6.2	128	6.56
2013					
March	21,100	140	6.5	97	3.36
June	15,300	510	6.3	40.1	5.27
September	10,800	215	6,6	99.8	2.37
December	24,300	487	6,5	90.6	8.13
Permit Limits	**n/a**	**n/a**	**>5 & <12.5**	**250**	**5.62**

Notes:
BOD = biochemical oxygen demand
mg/L = milligrams per liter
n/a = not available
O&G = oil and grease
TSS = total suspended solids

Data in Table 2-2 is only for parameters currently monitored in MSB's groundwater monitoring program.

Other parameters of interest to onsite treatment are not measured routinely. Those parameters were extracted from typical values listed in the literature and summarized in Table 2-3. For example, the importance of hardness and other related compounds may be important in selecting the materials of construction for leachate storage and transmission, while ammonia, nitrogen, and phosphorus are critical for the biological type system. Additional importance is related to the fact that treated effluent (biological system) will be discharged to ground and therefore nitrate content becomes a critical parameter in the effluent.

It is recommended that a complete scan of characterization be conducted before detailed design of any treatment system.

TABLE 2-3
Typical Leachate Characteristics Reported in the Literature
Matanuska-Susitna Borough Central Landfill Development Plan

Parameter	New Landfill (less than 2 years) Range	New Landfill (less than 2 years) Typical	Mature Landfill (more than 10 years)
pH	4.5 – 7.5	6	6.6 -7.5
BOD	2,000 – 30,000	10,000	100 - 200
COD	3,000 – 60,000	18,000	100 - 500
TOC	1,500 – 20,000	6,000	80 - 160
TSS	200 -2,000	500	100 - 400
TDS	2,000 – 10,000	6,000	>10,000
Chloride	200 – 3,000	500	100 - 400
Sulfate	50 – 1,000	300	20 - 50
Organic Nitrogen	10 - 800	200	80 - 120
Nitrate	5 - 40	25	5 - 10
Total phosphorus	5 - 100	30	5 - 10
Orthophosphates	4 - 80	20	4 - 8
Alkalinity	1,000 – 10,000	3,000	200 – 1,000
Total hardness	300 – 10,000	3,500	200 - 500
Calcium	200 – 3,000	1,000	100 - 400
Magnesium	50 – 1,500	250	50 - 200
Potassium	200 – 1,000	300	50 - 400
Sodium	200 – 2,500	500	100 - 200
Total Iron	50 - 1,200	60	20 - 200

Notes:
COD = chemical oxygen demand
TOC = total organic carbon
TDS = total dissolved solids

Source: Handbook of Solid Waste Management, Tchobanoglous, Kreith, Second Edition, 2002

CH2M HILL conducted research on regulatory criteria and held a meeting on July 17, 2014, with MSB and the Alaska Department of Environmental Conservation (ADEC) wastewater division staff to confirm compliance criteria. A meeting summary is included in Appendix F. ADEC advised that for planning purposes, CH2M HILL and MSB should use the more stringent of the drinking water standards (18 AAC 80) and water quality standards (18 AAC 70) for both septage and leachate. CH2M HILL has assembled these standards in Table 2-4. It was generally agreed that the point of compliance could be set at groundwater monitoring wells at the downgradient property boundary.

TABLE 2-4
Onsite Treatment Compliance Criteria for Planning Purposes
Matanuska-Susitna Borough Central Landfill Development Plan

Pollutant	Type of Pollutant	mg/L	Notes	Limit Source	Hardness Dependent Resulting Most Stringent Criterion*
Alachlor	PEST	0.002		AK WQ	
Aldicarb	PEST	0.003		AK WQ	
Aldicarb Sulfone	PEST	0.002		AK WQ	
Aldicarb Sulfoxide	PEST	0.004		AK WQ	
Ammonia	INORG		pH and temperature dependent		
Antimony	INORG	0.006		AK WQ	
Arsenic*	INORG	0.010		ADEC WQS	Drinking water standard
Asbestos	INORG	0.007	million fibers/ liter (for fibers longer than 10 micrometers)	AK WQ	
Atrazine	PEST	0.003		AK WQ	
BOD		TBD		TBD	
Barium	INORG	2.000		AK WQ	
Benzene	VOC	0.005		AK WQ	
Benzo(a)Pyrene	SVOC	0.000		AK WQ	
Beryllium	INORG	0.004		AK WQ	
Bromate	DBP	0.010		AK WQ	
Cadmium*	INORG	0.000		AK WQ	Chronic Aquatic Life criteria
Carbofuran	PEST	0.040		AK WQ	
Carbon Tetrachloride	VOC	0.005		AK WQ	
Chlordane	PEST, SVOC	0.002		AK WQ	
Chlorides	INORG	<250mg/L		18 AAC 70	
Chromium (total)	INORG	0.100	total recoverable	AK WQ	
Chromium (III)*	INORG	0.067		ADEC WQS	Chronic Aquatic Life criteria
Chromium (VI)*	INORG	0.011		ADEC WQS	Chronic Aquatic Life criteria
Copper*	INORG	0.007		ADEC WQS	Chronic Aquatic Life criteria
Cyanide (as free cyanide, as CN/l)	INORG	0.200		AK WQ	
Dalapon	PEST	0.200		AK WQ	
Dibromo-chloropropane	PEST	0.000		AK WQ	
Dichlorobenzene 1,2-	VOC, SVOC	0.600		AK WQ	
Dichlorobenzene 1,4-	VOC, SVOC	0.075		AK WQ	
Dichloroethane 1,2-	VOC	0.005		AK WQ	
Dichloroethylene 1,1-	VOC	0.007		AK WQ	

TABLE 2-4

Onsite Treatment Compliance Criteria for Planning Purposes

Matanuska-Susitna Borough Central Landfill Development Plan

Pollutant	Type of Pollutant	mg/L	Notes	Limit Source	Hardness Dependent Resulting Most Stringent Criterion*
Dichloroethylene cis-1,2-	VOC	0.070		AK WQ	
Dichloroethylene trans-1,2-	VOC	0.100		AK WQ	
Dichlorophenoxy 2,4-Acetic Acid (2,4-D)	PEST	0.070		AK WQ	
Dichloropropane 1,2-	VOC	0.005		AK WQ	
Di(2-ethylhexyl) Adipate	OOC	0.400		AK WQ	
Di(2-ethylhexyl) Phthalate	SVOC, OOC	0.006		AK WQ	
Dioxin (2,3,7,8-TCDD)	OOC	0.000		AK WQ	
Diquat	PEST	0.020		AK WQ	
Endothall	PEST	0.100		AK WQ	
Endrin	PEST, SVOC	0.002		AK WQ	
Ethylbenzene	VOC	0.700		AK WQ	
Ethylene Dibromide	PEST	0.000		AK WQ	
Fecal Coliform	MICROORG	<3FC/100 mL	30 day mean, MPN Technique	18 AAC 70	
Fluoride	INORG	4.000		AK WQ	
Glyphosate	PEST	0.700		AK WQ	
Gross alpha	RAD	0.015	(pCi/l)	AK WQ	
Gross beta	RAD	0.004	millirems	AK WQ	
Heptachlor	PEST, SVOC	0.000		AK WQ	
Heptachlor Epoxide	PEST, SVOC	0.000		AK WQ	
Hexachloro-benzene	SVOC	0.001		AK WQ	
Hexachloro-cyclopentadiene	SVOC	0.050		AK WQ	
Lead*	INORG	0.002		ADEC WQS	Chronic Aquatic Life criteria
Lindane (gamma-BHC)	PEST, SVOC	0.000		AK WQ	
Mercury*	INORG	0.001		ADEC WQS	Chronic Aquatic Life criteria
Methoxychlor	PEST	0.040		AK WQ	
Methylene Chloride (Dichloromethane)	VOC	0.005		AK WQ	
Monochloro-benzene	VOC	0.100		AK WQ	
Nickel*	INORG	0.040		ADEC WQS	Chronic Aquatic Life criteria
Nitrate (as nitrogen)	INORG	10.000		AK WQ	
Nitrite (as nitrogen)	INORG	1.000		AK WQ	

TABLE 2-4

Onsite Treatment Compliance Criteria for Planning Purposes

Matanuska-Susitna Borough Central Landfill Development Plan

Pollutant	Type of Pollutant	mg/L	Notes	Limit Source	Hardness Dependent Resulting Most Stringent Criterion*
Total Nitrate and Nitrite (as nitrogen)	INORG	10.000		AK WQ	
Oil & Grease		No visible sheen		18 AAC 70	
Oxamyl (Vydate)	PEST	0.200		AK WQ	
pH		>6, <8.5			
Pentachloro-phenol	PEST	0.001		AK WQ	
Picloram	PEST	0.500		AK WQ	
Polychlorinated Biphenyls (PCBs)	SVOC	0.001		AK WQ	
Radium-226 and -228 (combined)	RAD	0.005	(pCi/l)	AK WQ	
Selenium	INORG	0.050	ADEC Toxics book says more information is needed to determine most stringent criteria	AK WQ	
Simazine	PEST	0.004		AK WQ	
Silver*	INORG	0.002		ADEC WQS	Acute Aquatic Life criteria
Strontium-90	RAD	0.008	(pCi/l)	AK WQ	
Styrene	OOC	0.100		AK WQ	
Sulfates	INORG	<250mg/L		18 AAC 70	
TDS		<500mg/L		18 AAC 70	
TSS		0.015		CH2M HILL, 2006	
Tetrachloro-ethylene	VOC	0.005		AK WQ	
Thallium	INORG	0.002		AK WQ	
Toluene	VOC	1.000		AK WQ	
Toxaphene	PEST	0.003		AK WQ	
Trichlorobenzene 1,2,4-	SVOC	0.070		AK WQ	
richloroethane 1,1,1-	VOC	0.200		AK WQ	
Trichloroethane 1,1,2-	VOC	0.005		AK WQ	
Trichloro-ethylene	VOC	0.005		AK WQ	
Trichloro-phenoxy 2,4,5-)-Propionic Acid (2,4,5-TP)	PEST	0.050		AK WQ	
Tritium	RAD	20.000	(pCi/l)	AK WQ	
Uranium	RAD	0.030		AK WQ	
Vinyl Chloride	VOC	0.002		AK WQ	

TABLE 2-4
Onsite Treatment Compliance Criteria for Planning Purposes
Matanuska-Susitna Borough Central Landfill Development Plan

Pollutant	Type of Pollutant	mg/L	Notes	Limit Source	Hardness Dependent Resulting Most Stringent Criterion*
Xylenes (total)	VOC	10.000		AK WQ	
Zinc*	INORG	0.093		ADEC WQS	Acute Aquatic Life criteria

Notes:

* Hardness dependent limits. Assumed average hardness of 74 mg/L for calculation of the limits. If this changes, recalculate limits in "ADEC WQS" and re-evaluate most stringent criterion.

Metal limits shown as "total recoverable": There are no direct effluent limits for BOD and TSS, but dissolved oxygen and turbidity would be measured at downgradient monitoring wells.

18 AAC 70 = Water Quality Standards, Fresh Water Uses, (A) Water Supply, (i) Drinking, Culinary, & Food Processing

ADEC WQS = Alaska Department of Environmental Conservation Water Quality Standards

AK WQ = Alaska Water Quality Criteria Manual for Toxic & Other Deleterious Organic and Inorganic Substances

INORG = inorganic
OOC = organochlorine compound
PEST = pesticide
RAD = radiation units
SVOC = semivolatile organic compound
VOC = volatile organic compound

These drinking water limits were generated using a guidance information provided by the ADEC and would apply at the point of compliance in groundwater monitoring wells at the property boundary. Because attenuation would occur between the point of discharge and the point of compliance, the end of pipe limits may be higher than the drinking water limits. CH2M HILL recommends modeling be conducted to estimate the required end of pipe limits.

It is recommended to execute a detailed characterization of the leachate once the final treatment option is selected.

2.3 Onsite Leachate Biological Treatment

CH2M HILL prescreened several leachate treatment options before selecting the most viable from technical and economical point of view. The onsite leachate treatment option that was recommended in 2006 (anaerobic bioreactor, aerobic lagoon, and wetland polishing) was analyzed for potential update for the current basis of design conditions, but was rejected because of high costs and inability to meet today’s more stringent discharge requirements. Specifically, it was anticipated that the performance of standard surface flow treatment wetlands in winter would not meet the discharge criteria at the expected flow rates.

Additionally, advancements in the wastewater treatment technology have made other treatment options technically and economically feasible, as seen throughout many installations in US and abroad. CH2M HILL selected membrane bioreactor (MBR) for further evaluation, leachate treatment only, for the following reasons:

- Small footprint of the system
- System flexibility with changing influent conditions
- Need to ensure full nitrification/denitrification and produce effluent below 10 mg/L of nitrates and low turbidity levels

Today many manufacturers offer packaged MBR systems, capable to be housed in a small building, and providing healthy competition among vendors. The choice of packaged MBR system was based on the following advantages:

- Factory pre-assembled, which reduces on-site assembly time and costs
- Skid mounted for quick installation
- Factory tested for reliable system start-up and commissioning
- Space-saving compact design
- Pre-programmed control system for reliable operation and system troubleshooting
- User-friendly touch screen Human-Machine Interface for easy operation
- High-quality ancillary components for long lasting performance and minimal maintenance

The proposed two trains of MBR system will have the following components:

- Influent 2-millimeter rotary drum screen with re-screening system for improved membrane life
- Anoxic/Aerobic suspended growth-activated sludge biological treatment system for BOD removal, nitrification, and denitrification
- Hollow fiber, submerged membrane filtration for liquid solids separation
- Chemical-cleaning dosing skids
- Automation, control, and monitoring systems

Biological sludge produced by the system will be dewatered by natural system in the initial years (Geotubes® and sludge storage in dedicated area of the landfill until spring thaw), and in the final years (space provided in the building) by centrifuge. Further optimization of the dewatering approach could be explored during detailed design, if biological treatment is the selected leachate management approach.

2.4 Onsite Leachate Evaporation

Evaporation is very effective at reducing the volume of leachate. The most common type of leachate evaporation process is single stage flash evaporation. In this process the liquid mixture is heated and enters a flash chamber at a reduced pressure. The liquid partially vaporizes and the vapor comes to equilibrium with the residual liquid at the new lower temperature and pressure. The resulting liquid product is referred to as concentrate. The concentrate can be placed back into the waste mass of the landfill under the MSB's EPA Research, Development and Demonstration permit, which allows the placement of free liquids into the landfill.

An advantage of the evaporation process is the ability to reduce large volumes of leachate to more manageable quantities. Typically the footprint for an evaporation treatment system is small compared to other treatment systems.

In order to determine more precisely the size of the system, percentage of feasible leachate reduction, power requirements, and likelihood of scale formation, a sample of MSB leachate was tested. Boil testing indicated that volume reduction via evaporation could be as high as 96 percent (Appendix G). Testing also confirmed the need to address scaling and foaming. Consequently, the addition of an anti-foaming system is recommended. Additionally, higher-grade materials of construction are recommended to minimize impacts of scaling as the age of the landfill increases.

Table 2-5 summarizes the selected values for the design of the evaporation system evaluated in this study.

TABLE 2-5
Design Parameters for Leachate Evaporation
Matanuska-Susitna Borough Central Landfill Development Plan

Parameter	Flow gpd: 13,000	mg/L	lbs/day
BOD5 (2030)		13,000	1,407
TSS (2015)		500	36.8
TSS (2030)		500	54.1
NH4-N (2015)		288	21.2
NH4-N (2030)		260	28.1
TKN (2015)		474	34.9
TKN (2030)		304	32.9
TP (2015)		30	2.2
TP (2030)		30	3.2
PO4 (2015)		20	1.5
PO4 (2030)		20	2.2
Alkalinity (2015)		1,000	74
Alkalinity (2030)		1,000	108
Temperature (C)	15		

The selection of two identical evaporation systems, each one treating half of the leachate flows in 2035, was guided by several factors, including:

- Ability to service anyone of the two units while the second is operating
- Adaptability to lower initial leachate flows

The selected identical evaporators include the following components and accessories:

- Leachate Feed Holding Tank
- Air Diaphragm Feed Pump
- Holding Tank low level shutoff
- Two identical Evaporators (easy cleaning cycle of each one allows
- High temperature Exhaust Stack
- Digital Combustion Analysis Kit
- Auto-Dump/Auto-Restart
- Residue Holding Tank
- Residue Pumps (air diaphragm)
- Anti-Foam System
- Foam-Away Drums (startup)
- Ethernet Hub that allows for remote connection to PLC by Vendor Service Engineers

- On-board diagnostics that monitor level controls for correct operation and system shutdown
- Display scrolls showing Fluid Temperature, Air Temperature, and Mist Pad Pressure
- Normal operation and alarm conditions are displayed on interface panel as text messages
- Gas volume meter to monitor system throughput
- Mist Eliminator System to capture entrained water droplets
- Pressure Differential Sensor that is interfaced to the PLC to monitor the condition of the Mist Eliminator Pad, which will shut down the system when the pad requires cleaning
- Primary Low-Low Liquid Level shutdown of heat source with tuning fork level probe
- Redundant Low-Low liquid level shutdown with thermocouple and temperature controller
- High Auto Liquid Level to initiate and stop fill sequence
- High-High Liquid Level shutdown, which serves as redundancy for High AutoFill Level
- Insulation rated at up to 450F on all six sides
- Outer Skins constructed of 304 Stainless Steel (inner body Molybdenum alloys)
- Front panel Oil Weir and Decanting System
- Control Panel that meets NEMA 4 and UL standards; panel includes easy-to-read display with text messaging and digital display on temperature controllers
- Forced Draft Burner configuration to prevent flame impingement on the heat exchanger(s)

2.5 Evaluation of Leachate and Septage Co-treatment

Leachate and septage co-treatment was also evaluated. The basis of design of the co-treatment facility is a combination of the data on leachate characteristics from Table 2-1 and pretreated septage characteristics from the HDR Alaska study on regional septage treatment facility (Appendix H). The proposed co-treatment system was evaluated based on data from Table 2 of HDR report (2030 pretreated septage flows and loading). Septage and leachate co-treatment was evaluated based on data summarized in Table 2-6.

The proposed treatment system is a sequencing batch reactor (SBR). The SBR system has inherent simplicity (all unit process steps occur within the reactors), and the need for secondary clarifiers and a sludge recycle system are eliminated. The system offers high flexibility since the process steps are controlled by time (treatment step durations can be field adjusted to match plant operation with current hydraulic and organic loads). The flexible treatment steps allow the operator more process control than conventional systems that used fixed anoxic and aerobic volumes.

Combining both pre-treated septage and leachate has the beneficial effect of reducing the strength of the leachate, and thus providing better conditions for treatment. The SBR system would be enclosed in a building, eliminating the potential negative impact of the winter temperatures.

TABLE 2-6
Basis of Design Septage/Leachate Co-Treatment
Matanuska-Susitna Borough Central Landfill Development Plan

	Combined Septage & Leachate					
		Summer/Fall			Winter/Spring	
Parameter	**Flow gpd**	**mg/L**	**lbs/day**	**Flow gpd**	**mg/L**	**lbs/day**
2015	**161,836**			**49,436**		
2030	**250,994**			**85,053**		
BOD5 (2015)	613	1,182	1,594	187	2,043	841
BOD5 (2030)		1,147	2,398		1,819	1,288
TSS (2015)		500	674		500	206
TSS (2030)		500	1,045		500	354
NH4-N (2015)		41	84.9		67	27.4
NH4-N (2030)		61	127.2		62	44.3
TKN (2015)		88	119.0		94	38.8
TKN (2030)		68	141.9		80	56.8
TP (2015)		21	27.7		21	8.5
TP (2030)		21	42.9		12	8.5
PO4 (2015)		15	20.6		15	6.3
PO4 (2030)		15	31.9		15	10.8
Alkalinity (2015)		548	739		664	273.6
Alkalinity (2030)		547	1,143		550	389.9
Temperature (^{0}C)	15			8		

Slug feed control strategy to maximize aeration cycle time (65 percent) and reduce basin footprint as much as possible, considering this SBR will be housed indoors. The system will handle the maximum hydraulic requirements as well as the effluent requirements at the conditions specified in Table 2-6 for the combined septage and leachate.

The proposed SBR system will have the following components:

- Three tank SBR system with jet aeration (50 x 30 x 16 foot)
- Three jet recirculation pumps and one common spar
- Three waste activated sludge pumps and one common spare
- Four Blowers (one as a spare)
- One set of valves, which will allow for pump isolation and vac-flush
- Three Vari-Cant jet aeration headers with 12 Model 40 jet aerators per header
- Three decanters
- Three Influent distribution manifolds
- Three sludge collection manifolds

- In-basin air and liquid piping
- 304 stainless steel supports and mounting hardware
- Instrumentation & controls
- Centrifuge dewatering system (1,580 lbs/day solids) including all associated accessories and conditioning chemical system
- Sludge co-disposal with MSW at the Central Landfill

A proposed location for the septage treatment facility is shown on Figure 2. Septage would be truck hauled to the facility and received and pre-treated as described in Appendix H. Leachate would be pumped to the septage treatment facility and combined with pre-treated septage prior to the SBR biological treatment. Treated effluent would be discharged to ground via buried leach field, compliance would be monitored in groundwater monitoring wells at the property boundary.

In 2005, the annual leachate flow of 339,000 gallons (Table 2-1) was approximately 3 percent of the estimated 13,600,000 gallons of septage generated within MSB in that same year (Appendix H). The estimated annual leachate flow in 2035 of 4,000,000 gallons (Table 2-1) is approximately 10 percent of the estimated 38,000,000 gallons estimated within MSB in 2030 (Appendix H). At these low percentages, the higher strength leachate is not expected to cause problems for the biological treatment.

TABLE 2-7
Summary of Co-Treatment and Separate Leachate and Septage Treatment
Matanuska-Susitna Borough Central Landfill Development Plan

	Advantages	Disadvantages	Cost (millions) [a]	Required Land (acres)
Separate Leachate and Septage Treatment	Lower cost to MSB SWD Operational control	Higher overall cost and additional facility for MSB to maintain	$60.4 [b]	30
Leachate and Septage Co-treatment	Treats two waste streams together	Possible more stringent discharge criteria with the addition of leachate	$40.9	25

Note:

[a] Total present value of capital and 20 years of annual operations and maintenance (Section 2.6 and Appendix I).

[b] Sum of total present value for leachate evaporation and septage SBR. Septage SBR costs from HDR, 2013 (Appendix H). Annual O&M costs were increased to $1M based on CH2M HILL experience.

2.6 Cost Analysis for Onsite Leachate Management

Table 2-8 shows an analysis of present value (PV) of capital and operations and maintenance (O&M) costs for three onsite leachate management options: 1) evaporation (leachate only), 2) MBR biological treatment (leachate only), and 3) SBR co-treatment (septage and leachate). Costs for septage SBR treatment are included for comparison. It is assumed that this project would be eligible for Alaska Clean Water Loan with an interest rate of 1.5 percent. Cost estimate details are provided in Appendixes H and I.

TABLE 2-8
Summary of Leachate Treatment Cost Analysis
Matanuska-Susitna Borough Central Landfill Development Plan

Option	Capital Cost (Millions)	Annual O&M Cost (Millions)	PV of O&M Costs (20 years) (Millions)	Total PV (Millions)
Leachate Evaporation	$3	$1.4	$23.2	$26.2
Leachate MBR	$16	$1.0	$17.0	$33.0
Septage SBR [a]	$17	$1.0	$17.2	$34.2
Septage and Leachate SBR	$19	$1.3	$21.9	$40.9

[a] Septage SBR costs from HDR, 2013 (Appendix H). Annual O&M costs were increased to $1M based on CH2M HILL experience.

2.7 Conclusions and Recommendations for Onsite Leachate Management

CH2M HILL recommends that the MSB co-treat leachate and pre-treated septage using SBR biological treatment. We understand that the MSB is planning to build a septage treatment facility somewhere within the MSB and is targeting MSB land. Sufficient land is available at the landfill, and locating this facility at the centrally located landfill should minimize the transport cost for haulers. It is logical and feasible to co-treat these waste streams.

If the current leachate disposal at the AWWU becomes unavailable before the proposed MSB septage treatment facility is constructed, then we recommend evaluation of other interim offsite treatment options.

If the septage facility is not located at the landfill, then we recommend evaluating the costs of hauling leachate to the septage facility for co-treatment versus costs of construction and operation of an onsite leachate evaporator. Construction of both the septage treatment facility and the leachate evaporator at the landfill is not recommended because it would be redundant.

SECTION 3

Closure Fund Contribution

The CH2M HILL team calculated the required closure fund contribution to ensure that there are adequate funds available for closure and post-closure with a zero balance at the end of the period. The contribution is targeted so that the annual contribution is the same each year on a dollar per ton basis in real terms (that is, the contribution increases each year along with forecast inflation). An abbreviated summary of closure and post-closure costs (through 2024) is shown in Table 3-1. The assumed scope and cost estimate for closure is included in Appendix J. The complete table of closure contributions is included in Appendix K.

TABLE 3-1
Calculation of Closure Fund Contributions
Matanuska-Susitna Borough Central Landfill Development Plan

Year	Closure Cost	Post-Closure Cost	Closure Fund Contribution	End-Year Closure Fund Balance	Per-ton Contribution	Per-ton Contribution (2014$)
2014	$0	$0	$9,562	$3,934,996	$0.16	$0.16
2015	$0	$0	$10,034	$4,063,230	$0.16	$0.16
2016	$0	$0	$10,529	$4,195,814	$0.17	$0.16
2017	$0	$0	$11,049	$4,332,903	$0.17	$0.16
2018	$0	$0	$11,584	$4,474,647	$0.17	$0.16
2019	$0	$0	$12,144	$4,621,213	$0.18	$0.16
2020	$0	$0	$12,732	$4,772,772	$0.18	$0.16
2021	$0	$0	$13,348	$4,929,503	$0.19	$0.16
2022	$0	$0	$13,994	$5,091,591	$0.19	$0.16
2023	$0	$0	$14,666	$5,259,224	$0.20	$0.16
2024	$0	$0	$15,370	$5,432,601	$0.20	$0.16

Estimated costs, in 2014 dollars, are as follows. Closure costs, including contingency, administration, and technical and professional expenses, are approximately $17.3 million. Annual post-closure maintenance and monitoring costs are $175,000, and there is a $37,000 charge for post-closure certification anticipated in 2200, the last year of post-closure.

The following key assumptions formed the basis of the analysis:

- Annual inflation: 2.4 percent
- Annual interest on invested funds: 3.0 percent
- Current fund balance: $3,876,843 as of June 30, 2014
- Year of closure: 2170
- Post-closure period: 2071 to 2200

Given these assumptions, CH2M HILL determined that the required closure fund contribution in 2014 is $9,562, which corresponds to $0.16 per ton. Annual costs, contributions, fund balances, and per-ton contributions are shown in Appendix K.

SECTION 4

Evaluation of Methane Capture and Recovery

4.1 Site Background and Operations

The Central Landfill is a Class I landfill under ADEC Solid Waste Regulations (18 AAC 60), owned and operated by the MSB. Figure 1 shows the existing conditions and layout of the landfill.

Cells 1 and 2A are unlined disposal cells that were initially placed into operation in the 1980s. Cell 1 was closed in 1988, and Cell 2A was operated until late 2003. A partial final closure project will close Cell 2A in 2014. Cell 2B, a lined disposal cell, was operated from 2004 until late 2008, and currently has interim cover. The MSB operated lined Cell 3 Phase 1 from late 2008 until late 2010, and is now operating in lined Cell 3 Phase 2.

The Central Landfill does not have an existing gas management system installed. Cell 1 has a gas monitoring well for gas sampling (MSB, 2014a). When Cell 2A receives final cover, a passive gas venting system will be installed (HDR, 2012).

4.2 Historical Waste Disposal

The Central Landfill began waste disposal operations in 1980 in Cell 1. However, waste disposal records are not available until 2000, the year the MSB started using a Waste Works database to track incoming waste. Based on historical waste disposal data, approximately 207,601 short tons of waste were landfilled from 2000 to 2003 in the unlined landfill (Cells 1/2A). From 2004 until July 2014, an additional 744,275 short tons of waste were landfilled at the lined landfill (Cells 2B/3) (MSB, 2014b).

Table 1 of Appendix L shows the estimated waste disposal for operating years 1980 through 1999 based on the estimated population served by the landfill in each year, and the values for national average per capita waste disposal rates found in Table HH-2 to Subpart HH of Code of Federal Regulations (CFR) 40 CFR 98 and Equation HH-2 to Subpart HH of 40 CFR 98. Using this methodology, an estimated 603,627 short tons of waste were landfilled at the Central Landfill from 1980 to 1999.

Table 2 of Appendix L shows the estimated waste disposal for operating years 2000 to 2013, based on historical data records for the unlined and lined landfill disposal cells, and operating years 2000 and 2007 through June 2014. Waste disposal in operating years 2001 through 2006 and July 2014 were estimated based on calculated constant average waste disposal rates for missing years of data based on the historical data records. From 2000 to 2013, an estimated 887,111 short tons of waste were landfilled at the Central Landfill.

From 1980 to 2013, a total estimated 1,490,738 short tons (1,352,375 metric tons) of waste were landfilled at the Central Landfill.

4.3 Estimated Landfill Gas Generation

Using EPA's Landfill Gas Emissions Model (LandGEM) version 3.02, CH2M HILL estimated the landfill gas emissions at the Central Landfill based on historical waste disposal records and estimates, and future waste disposal projections (see Section 1.1, and Appendix A). LandGEM is based on a first-order decomposition rate equation for quantifying emission from the decomposition of landfilled waste in MSW landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills, and LandGEM is considered a screening tool that provides better estimates with better input data.

The first-order decomposition rate equation is:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} k * L_0 \left(\frac{M_i}{10}\right) e^{-k*t_{ij}}$$

Where,

Q_{CH4} = annual methane generation in the year of calculation (m^3/year)
i = 1-year time increment
n = (year of the calculation) – (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate ($year^{-1}$)
L_o = potential methane generation capacity (m^3/mg)
M_i = mass of waste accepted in the i^{th} year (mg)
t_{ij} = age of the j^{th} section of waste mass M_i accepted in the i^{th} year

The following is a summary of LandGEM input data used and default selections based on 40 CFR 60.754 to model gas generation at the Central Landfill:

- *Initial Year of Waste Acceptance* = 1980
- *Mass of waste accepted, M_i* = waste acceptance rates for Years 1980 to 1999 are estimated per Eq. HH-2 to Subpart HH of 40 CFR 98. Waste acceptance rates for Years 2000 and 2007 to 2013 are based on MSB data records. Waste acceptance for Years 2001 to 2006 are estimated per Eq. HH-3 to Subpart HH of 40 CFR 98. Waste acceptance rates for 2014 to 2059 (maximum 80-year model run) are estimates based on population growth projects and waste data for 2013 (that is, input waste acceptance data is based on historical waste disposal records and future waste acceptance projections for the Central Landfill).
- *Methane generation rate constant, k* = 0.02 $year^{-1}$ for landfills located in geographical areas with 30 year annual average precipitation of less than 25 inches (40 CFR 60.754)
- *Potential methane generation capacity, L_o* = 170 m^3/mg (40 CFR 60.754)

LandGEM modeling results are included in Appendix M. In 2014, total landfill gas emissions are estimated at 482 cubic feet per minute (cfm). Peak generation is estimated to occur in 2060 with emissions of 1,481 cfm.

It is important to note that the predicted landfill gas emissions are only predictions. Better input data from site-specific studies will increase the accuracy of LandGEM predictions. In addition, the projected gas emissions overestimate what the MSB can expect to collect for an end-use option. A conservative assumption for gas capture from a landfill gas collection system is 50 to 75 percent of the projected gas generation rate (that is, collection efficiency of 50 to 70 percent), with the high-end value being at landfill closure with final cover because higher vacuums can be applied to the collection system. Lastly, gas quality (that is, percent methane by volume in landfill gas) will also play an important factor when evaluating end-use options.

4.4 Air Regulatory Status

The EPA has developed several regulatory documents that affect MSW disposal facilities. In particular, landfill gas is currently regulated by three separate regulations that set limits of emissions, operational standards, and other regulatory requirements that landfills must meet. These regulations include the mandatory Greenhouse Gas (GHG) Reporting Rule, the New Source Performance Standards (NSPS), and the National Emissions Standards for Hazardous Air Pollutants (NESHAP). Brief descriptions of these regulations, and the Central Landfill's current status under these regulations, are provided in the following sections.

4.4.1 Greenhouse Gas Reporting Rule (40 CFR 98, Subpart HH)

Owners and operators of landfills that accepted MSW on or after January 1, 1980, and that generate methane in amounts equal to or greater than 25,000 metric tons of carbon dioxide equivalent (CO_2e) must report GHG emissions annually using the EPA's electronic GHG Reporting Tool (e-GGRT), and have a GHG Monitoring Plan (and all revisions and addenda) on file at the facility. For additional information on the GHG Reporting Rule and its program, refer to http://www.epa.gov/ghgreporting/index.html.

Central Landfill Status:

Using the EPA's GHG Reporting Rule applicability tool, the Central Landfill is subject to the GHG Reporting Rule. A preliminary estimate of MSW landfill CO_2e emissions (intended for screening purposes only) is included in Appendix M. Emissions are estimated at 77,859 metric tons of CO_2e for Reporting Year 2014.

Per 40 CFR 98.3, the MSB will need to prepare a written GHG Monitoring Plan containing the required elements set forth in 40 CFR 98.3(g)(5)(i) and submit annual emission reports electronically to EPA, meeting the requirements of 40 CFR 98.3(c).

4.4.2 NSPS (40 CFR 60, Subpart WWW)

On March 12, 1996, the EPA promulgated the NSPS and Emissions Guidelines for new and existing landfills under Section III (b) of the Clean Air Act. The basis for this legislation was the EPA's determination that MSW landfills generate a significant quantity of air pollution that is potentially detrimental to public health. The NSPS are intended to control non-methane organic compounds (NMOC) and methane emissions from MSW landfills. NMOC include VOCs, hazardous air pollutants, and odorous compounds. The rules include provisions for "existing" and "new" landfills. The Emissions Guidelines applies to existing landfills that were permitted before May 30, 1991, and have not been modified or reconstructed since that date. The NSPS applies to new landfills that were permitted, modified, or reconstructed on or after May 30, 1991.

The ADEC chose not to implement the NSPS rules for existing landfills under Alaska regulations, so the requirements of that regulation are implemented under the Federal Implementation Plan, 40 CFR Part 62, Subpart GGG. The provisions for new landfills are implemented by the ADEC under 18 AAC 50.040(a)(2)(II).

Per 40 CFR 60.757(a), an initial design capacity report is required for landfills to determine if they surpass the thresholds of 2.5 million megagrams (Mg) and 2.5 million cubic meters (m^3) of MSW. If below regulatory thresholds, an amended design capacity report is to be submitted to ADEC providing notification of an increase in design capacity of the landfill, within 90 days of an increase in design capacity of the landfill to or above 2.5 million Mg and 2.5 million m^3. This design capacity increase could be attributed to an increase in the permitted volume of the landfill (for example, cell expansions) and/or an increase in density as documented in the annual recalculation required by 40 CFR 60.758(f) for landfills below the regulatory thresholds.

If the design capacity thresholds are exceeded by a facility, NSPS regulations require landfills to either calculate an NMOC emission rate for the landfill, or install a collection and control system that captures the gas generated within the facility (that is, landfill gas collection control system [LFGCCS]) per 40 CFR 60.752(b).

The NMOC emission rate report shall contain an annual or 5-year estimate of the NMOC emission rates at the landfill. If NMOC emissions are below 50 Mg/year*, the landfill is not required to install an LFGCCS. Per 40 CFR 60.754(a), the landfill is required to submit revised NMOC emission reports to the ADEC in accordance with 40 CFR 60.752(b)(1)(ii) until such time as the calculated NMOC emission rate is equal to or greater than 50 Mg/year, or the landfill is closed.

In addition, air regulations require that any landfill that exceeds the design capacity thresholds must apply for a Part 70 (also known as Title V) air quality operating permit. These landfills are deemed NSPS sites. In Alaska, Title V permitting is implemented under 18 AAC 50.326, and permits are issued by the ADEC Division of Air Quality.

Central Landfill Status:

Based on CH2M HILL's review of historical landfill documents and interviews with facility operators, a design capacity report for the Central Landfill has not been submitted to the ADEC.

Based on historical waste disposal and future waste projections for Cell 1, Cell 2A, Cell 2B, and Cell 3, CH2M HILL estimates that approximately 1,490,738 short tons (1,352,375 metric tons = 1,352,375 Mg) of waste were landfilled between 1980 and 2013, and approximately 598,255 short tons (542,728 metric tons = 542,728 Mg) of waste is anticipated to be landfilled at Cell 3 between 2014 and 2022. Therefore, CH2M HILL estimates that the current mass design capacity of the landfill is 1,895,103 Mg, which is below the regulatory threshold of 2.5 million Mg.

Assuming an average waste density of 1,400 pounds per CY, CH2M HILL estimates the current volume design capacity of the landfill is 2,281,646 m^3, which is below the regulatory threshold of 2.5 million m^3.

CH2M HILL recommends that the MSB complete a design capacity report and submit it to ADEC to demonstrate that the landfill, as currently permitted, has a design capacity less than regulatory thresholds of 2.5 million Mg and 2.5 million m^3. Updated design capacity reports should be submitted to ADEC as new cells are designed, constructed, and permitted.

When the 2.5 million Mg and 2.5 million m^3 regulatory thresholds are exceeded, the MSB is required to apply for a Title V permit [18 AAC 50.326(c)] and should complete a Tier 1 NMOC emissions report [40 CFR 60.754] to assess NMOC emissions at the landfill. If NMOC emissions exceed the regulatory threshold of 50 Mg/year*, the MSB is required to install a LFGCCS per 40 CFR 60.752(b)(2(ii) unless Tier 2 or Tier 3 NMOC testing [40 CFR 60.757(c)(1)/(2)] can demonstrate that a more site-specific calculation of the NMOC emission rate is less than the regulatory threshold.

*Note: new NSPS for landfills are being proposed by EPA to reduce the NMOC emissions threshold to 40 Mg/year. Refer to http://www.epa.gov/ttn/atw/landfill/landflpg.html for more information on the proposed rulemaking.

4.4.3 NESHAP (40 CFR 63, Subpart AAAA)

NSPS sites that are above the regulatory thresholds for design capacity and NMOC emissions are subject to the monitoring, recordkeeping, and reporting requirements for MSW landfills contained in 40 CFR 63, Subpart AAAA. These requirements include the submittal of a compliance report every 6 months, beginning 180 days after the startup of the LFGCCS, among other requirements such as the development of a written Startup, Shutdown and Malfunction Plan when air control devices (that is, the LFGCCS) are not operating.

Central Landfill Status:

The Central Landfill is currently not subject to NESHAP requirements because the design capacity of the landfill is below the NSPS regulatory thresholds.

4.5 Landfill Gas Capture and Destruction

4.5.1 Landfill Gas Collection Systems

There are two types of landfill gas collection systems: (1) passive collection systems that rely solely on positive pressure within the landfill to move the gas rather than using gas moving mechanical equipment (blowers or compressors) and (2) active collection systems that use gas moving equipment (blowers or compressors) to mechanically create a pressure gradient (vacuum) within the landfill to extract gas. Typically, well-designed active collection systems are more efficient than passive collection systems because of the ability to control pressure gradient within the landfill, and thus the gas flow from the system.

Passive collection systems are typically operated as venting systems, and consist of vertical vents installed within gravel trenches, as shown in Figure 7. They are primarily designed as a means of safely venting buildup of gas pressure from the landfill at final closure and can also help reduce the potential for offsite (subsurface) migration of gas. Gas vents can be designed to freely vent to the atmosphere, or use vent flares for odor and emissions control at the passive outlets with an igniter powered by solar panels or propane. These systems can be retrofitted for connection to an active collection system as well.

Active collection systems typically use horizontal collectors (perforated pipe installed within a gravel trench) for short-term, sacrificial use, and vertical gas extraction wells for long-term use. Typical details for horizontal and vertical gas extraction wells are shown in Figures 8 and 9, respectively. An example layout of an active collection system using vertical gas extraction wells is shown in Figure 10. Horizontal collectors should be designed with sufficient slope to allow drainage of gas condensate and leachate and to allow for differential settlement. Solid pipe sections should be installed at the end of the horizontal collectors to discourage air infiltration through the side slopes of the landfill. Landfill gas can typically be extracted after 25 feet of waste is placed over the horizontal collector pipe. Gas collected from horizontal collectors is typically of lower quality (that is, percent methane) and quantity than vertical wells because of the difficulty of maintaining uniform vacuum over the entire length of the collector, and lower gas flows to reduce the potential for air intrusion.

Vertical gas wells in an active collection system are typically drilled to around 75 percent of the landfill depth to avoid damaging the bottom liner system. The spacing of the wells depends on landfill characteristics such as waste density, landfill gas generation rates, proximity to side slopes, and the amount of applied vacuum on the well by the gas mover. Vertical gas wells are often only installed in areas of the landfill that have reached final grade because they are susceptible to damage by heavy equipment, and may impede filling operations.

The sizing of gas collection piping and gas mover equipment is very important in an active gas collection system. NSPS regulations require gas to be collected at an extraction rate sufficient to maintain negative pressure at all wellheads in the collection system without causing air infiltration. Typically, these systems are sized to handle the maximum expected flow rates over the expected lifespan of the collection equipment. Piping is often sized so that the total pressure head loss from the blower (gas mover) to the furthest wellhead is less than 10 percent of the applied vacuum (often 60 inches of water column), and gas velocity in piping traveling with and against the flow direction of condensate is maintained at or below 45 and 35 feet per second, respectively. The gas mover and control equipment (flare) are sized to handle the maximum expected gas flow rate over the area of the landfill that warrants control for the intended use period of the equipment, often 15 years or less.

Some advantages and disadvantages of passive and active gas collection systems are shown in Table 4-1.

TABLE 4-1
Advantages and Disadvantages of Passive and Active Gas Collection Systems
Matanuska-Susitna Borough Central landfill Development Plan

Passive Gas Collection System		Active Gas Collection System	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
Low capital cost Low operating costs Simplicity of technology	Gas collection inefficiencies Condensate removal Relies on positive pressures for operation Minimum capacity Odors Limited gas migration control More difficult to be NSPS compliant	Maximum capacity Functions with various gas systems Maintains vacuum on landfill Good gas migration control Odor control through flare Easier to be NSPS compliant	Higher capital cost Higher operating costs More complex technology

4.5.2 Landfill Gas Control Devices

Landfill gas control devices and mechanical gas collection equipment are designed and sized to handle the maximum expected gas flow rate over the area of the landfill that warrants control for the intended use period of the equipment, typically 15 years or less.

A flare station is a common emission control device that destroys landfill gas with no energy recovery. Flares can be sized to handle gas flow rates of 30 to 6,000 cfm. Flares are primarily used at landfills for air emissions control but can also be used as a backup control device to a landfill gas end-use systems for when the system is offline or gas generation exceeds the capacity of the end-use system.

The two main types of flares that are used at landfills are: (1) open (candlestick) flares and (2) enclosed flares. Flare selection is usually based on the applicable regulatory requirements and end-use goals for landfill gas collection at the landfill. Under NSPS regulations (40 CFR 60, Subpart WWW), flare stations must be capable of combusting landfill gas at a wide range of flow rates and be designed to meet the requirements specified in 40 CFR 60.752(b)(2)(iii). For example, the flare must be designed and operated to reduce NMOC by 98 percent by weight (that is, 98 percent destruction efficiency). Typically both open and enclosed flares meet this requirement.

Open flares are often selected over enclosed flares because they are generally less expensive and easier to operate than enclosed flares. However, enclosed flares offer a more controlled combustion environment and are less susceptible to weather conditions because combustion occurs within the stack and the intake of air can be adjusted based on operating conditions. Additionally, enclosed flares can be sampled for emissions control validation.

4.6 Landfill Gas End-use Opportunities

Landfill gas is typically an underutilized byproduct of waste decomposition at landfills. Significant advancements in gas conversion techniques now allow landfill operators to use gas generated at landfills for beneficial end-uses that may be profitable for the landfill owner.

Landfill gas is comprised of methane, carbon dioxide, and several other constituents lumped together as balanced gas. Methane is typically the primary gas constituent accounting for an average percentage by volume of 50 percent. Landfill gas has a heating value of approximately 500 British thermal units (BTU) per cubic foot when the methane concentration is 50 percent. For comparison, natural gas has a heating value of roughly 1,000 BTU per cubic foot. The energy potential of landfill gas allows it to be used for beneficial end-uses.

Generally, there are three main end-use opportunities for landfill gas: (1) landfill gas to energy (LFGTE), (2) direct use as fuel, and (3) gas stream modifications.

The selection of a recovery technique (end-use opportunity) versus a control technique (gas flare) is highly dependent on such factors such as gas flow, gas quality, market conditions, and environmental impacts. If landfill characteristics are such that landfill gas generation and/or quality are low/poor, flaring is often best suited for a landfill. However, if a landfill has good gas generation rates and gas quality, and a demand by customers for LFGTE or gas supply (direct use or gas stream modification), an energy recovery system may be feasible.

4.6.1 Landfill Gas to Energy

Internal combustion (IC) engines are the most common type of technology used today to convert landfill gas into electricity. IC engines are modular, and come in a wide variety of sizes to meet the needs of LFGTE projects. For example, General Electric (GE) Jenbacher IC engines are available from 335 kilowatts (gas flow of 105 cfm at) to 2,700 kilowatts (gas flow of 785 cfm). Most models can operate with methane levels as low as 40 percent. IC engines can be ordered as containerized units, or installed inside of a building. Containerized units are attractive for landfill operators because generator sets can be added easily to match increased rates of landfill gas production as a LFGTE project grows. Otherwise, a building would need to be sized to accommodate the expected generator sets to manage the maximum landfill gas generation rate anticipated over the life of the project.

The IC engines will require routine maintenance such as oil changes and periodic engine overhauls every few years by a qualified maintenance technician. IC engines are also susceptible to damage from high concentrations of hydrogen sulfide and siloxanes – typical contaminants in landfill gas derived from mixed solid waste (that is, other waste than MSW such as construction and demolition waste). Testing can be conducted to screen the levels of these contaminants in landfill gas. If contaminant levels are elevated, an iron sponge for low concentrations, or scrubber for higher concentrations can be added to pre-treat the landfill gas before sending to the IC engines.

The use of IC engines is widespread because they have relatively low capital costs, high thermal efficiency, low emissions that can meet NSPS regulations for gas destruction and require minimal pre-treatment of landfill gas. Typical landfill gas pre-treatment consists of a coalescent filter to decrease moisture and particulate levels, and a blower to compress the gas to the fuel pressure required by the IC engine.

Since landfill gas is produces 24 hours a day, seven days a week (24/7), the electricity generated from IC engines should go to end-users who have a 24/7 demand. The end-user could be the landfill itself or an electric utility company.

4.6.2 Direct Use

Landfill gas may be used for a variety of direct use options if the conversion technology is available to make use of the gas. Some creative uses of landfill gas include heating greenhouses, producing electricity and heat in a cogeneration application (that is, combined heat and power project), fueling boiler systems, fueling boiler/steam turbine systems, fueling and/or providing heat to leachate evaporation systems, and fueling heaters or dryer systems (for example, building heaters, brick kilns, drying of biosolids at a waste water treatment plant).

Since landfill gas is produced 24/7, any direct use option should be continuous. The landfill itself or other local nearby industries/facilities can benefit from the use of landfill gas to help offset their fuel and/or heating costs. Unused landfill gas, as a result of load swings, excess gas generation, batch operations, or equipment/process downtime, will need to be combusted in a flare station.

For more information on example projects today, refer to EPA's listing of landfill gas energy project profiles assembled as part of their landfill methane outreach program: http://www.epa.gov/lmop/projects-candidates/profiles.html.

4.6.3 Gas Stream Modifications

The last potential end-use option for landfill gas is gas stream modifications. Gas stream modification consists of refining the landfill gas stream to a higher quality of gas such as natural gas. When the gas stream is refined, it may be conveyed to end-users through an existing or new gas transmission line. The end-user could be the landfill itself or the local gas utility company. However, CH2M HILL does not recommend this end-use alternative for the MSB because of the relatively high capital costs incurred to refine landfill gas to a higher quality product, and the current relatively inexpensive price of natural gas locally.

4.7 Landfill Gas Development Project Costs

In general, each landfill gas development project involves project evaluation, purchase and installation of equipment (capital costs), and the expense of operating and maintaining the project (O&M costs).

The first step in implementing a landfill gas development project is to complete a project evaluation, or feasibility study to assess the project potential. A typical desktop feasibility study is outlined in Section 4.8 below.

The next step in project evaluation is to assess the likely capital and O&M costs for a landfill development project. Table 4-2 below illustrates some typical capital and O&M costs of landfill gas development projects approximated by the EPA's Landfill Methane Outreach Program (EPA, 2009). Costs shown are adjusted for inflation from 2010 to 2014 dollars, rounded up to the nearest $10 amount.

TABLE 4-2
Capital and O&M Costs of Landfill Gas Development Projects
Matanuska-Susitna Borough Central landfill Development Plan

Item	Capital Costs	Annual O&M Costs
Landfill Gas Collection and Flare System	$26,160 per acre	$4,470 per acre
LFGTE System		
Microturbine (1 MW or less)	$6,000 per kW capacity	$420 per kW capacity
Small IC Engine (1 MW or less)	$2,510 per kW capacity	$230 per kW capacity
IC Engine (800 kW or greater)	$1,860 per kW capacity	$200 per kW capacity
Gas Turbine (3 MW or greater)	$1,530 per kW capacity	$150 per kW capacity
Direct-use Project Components		
Gas Compression and Treatment	$1,050 per standard cfm of landfill gas	$100 per standard cfm of landfill gas
Gas Pipeline and Condensate Management System	$359,700 per mile of pipeline	Negligible
End-of-pipeline Combustion Equipment Modifications (if needed)	Varies; usually borne by end-user	Negligible

* Costs in 2014 dollars
kW: kilowatt
MW: megawatt
Source: EPA, 2009

4.8 Landfill Gas Development Feasibility Study

Before pursuing a landfill gas development project, CH2M HILL recommends the MSB perform a feasibility study to assess its viability. At a minimum, a feasibility study should include the following:

- Assessment of the gas quantity and quality being generated at the landfill
- Identification and assessment of potential end-users and their needs
- Selection of appropriate equipment to match the gas generation characteristics of the landfill over the expected life of the project
- Identification of any regulatory issues or requirements that could impact the project
- Evaluation of the expected capital and O&M costs of project
- Development of procurement strategy for the project, including identifying potential private developers or parties to assist with financing, ownership, and/or operations
- Development of a financial plan and implementation schedule for the project
- Comparison of landfill gas development project versus other landfill gas development alternatives and a traditional LFGCCS, based on both monetary and non-monetary criteria

4.9 Landfill Gas Testing Program

CH2M HILL recommends the MSB conduct a landfill gas testing program before pursuing a landfill gas development project to evaluate the actual quantity and quality of gas that could be recovered from the landfill. Described below is a summary of a testing program for Cells 2A and 2B that is generally based on EPA's Method 2E, a test method for determination of landfill gas production flow rates. A copy of this test method is included in Appendix N.

4.9.1 Overview of Testing Program

This testing program is an EPA Method 2E-based testing program designed to assess the sustainable landfill gas generation rates and average radius of influence for vertical gas collection wells if installed at Cells 2A and 2B. Because the testing program will likely take place following partial final closure at Cell 2A, and Cell 2B is still anticipated to have interim cover, the results should indicate what the MSB can expect for sustainable gas flow rates from wells in closed and unclosed areas of the landfill.

This testing program assumes there are no gas extraction wells installed at the landfill before implementing this testing program. Any wells installed as part of the testing program should become permanent wells of a future active gas collection system at the landfill because gas extraction wells are a relatively high capital investment.

In addition to assessing the performance of an active gas collection system, a gas meter (for example, Landtec GEM2000 Plus) will be used to measure the concentrations of methane, carbon dioxide, oxygen, and hydrogen sulfide in the landfill gas. Gas samples will also be collected per Air Toxics Ltd. (ATL) Method @71 (see Appendix N), and tested in a laboratory for siloxanes concentrations in the landfill gas. As noted previously, hydrogen sulfide and siloxanes can be harmful to LFGTE equipment. Results from monitoring the methane, carbon dioxide, and oxygen levels in landfill gas should indicate what stage biodegradation of waste and gas generation the landfill is experiencing.

A study of MSW decomposition by Augenstein and Pacey in 2001 (see Appendix O) suggests there are five stages of biodegradation: (I) aerobic; (II) acidogenic; (III) exponential growth; (IV) stationary; and (V) endogenic decay. Gas development projects should occur during the stationary stage of biodegradation when methane levels are stable and at their highest levels.

There are five overall steps to this testing program:

1. Prepare design documents for construction of two sets of three cluster vertical gas extraction wells (one set per disposal area) with associated shallow and deep gas pressure probes, and an above ground temporary PVC collection network.
2. Construct the landfill gas vertical extraction wells, gas pressure probes, and above ground temporary collection network.
3. Prepare a sampling and testing plan for the EPA Method 2E-based testing program that includes gas meter measurements and gas sampling and testing for landfill gas constituents.
4. Conduct the landfill gas testing program in accordance with the sampling and testing plan. The testing program is likely to take approximately 12 weeks. Equipment necessary for testing includes the following:
    a. A portable blower system with a gas condensate knock-out drum, gas flow meter, and a gas sampling port that can be powered by a portable generator system. This blower system will be used to apply vacuum to the test wells and will vent gas to the atmosphere.
    b. A portable generator system for powering the blower system.
    c. A gas meter that is capable of measuring the concentrations of methane, carbon dioxide, oxygen, and hydrogen sulfide in landfill gas. Calibration gas will also be needed to calibrate the meter.
    d. For siloxanes sampling, a sample train per ATL Method @71, an explosion proof purge pump for evacuating wells before sampling, and a gas meter for extracting samples from the wells and through the sample train.
5. Prepare a test report that summarizes the results of the testing program, and recommendations for landfill gas development at the MSB's Central Landfill.

Before implementing this landfill gas testing program, CH2M HILL recommends the MSB evaluate the quality of landfill gas venting from the passive venting system to be installed in Cell 2A as part of the partial final closure project for that area.

4.9.2 Engineer's Order-of-Magnitude Cost Estimate for Cells 2A and 2B Landfill Gas Testing Program and Well Installations

CH2M HILL has prepared a conservative rough order of magnitude cost opinion to complete the landfill gas testing program described above for Cells 2A and 2B, including installing six permanent vertical gas extraction wells. This cost estimate is included in Appendix P. The project total, including a 30 percent contingency, is approximately $800,000.

SECTION 5

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Figures

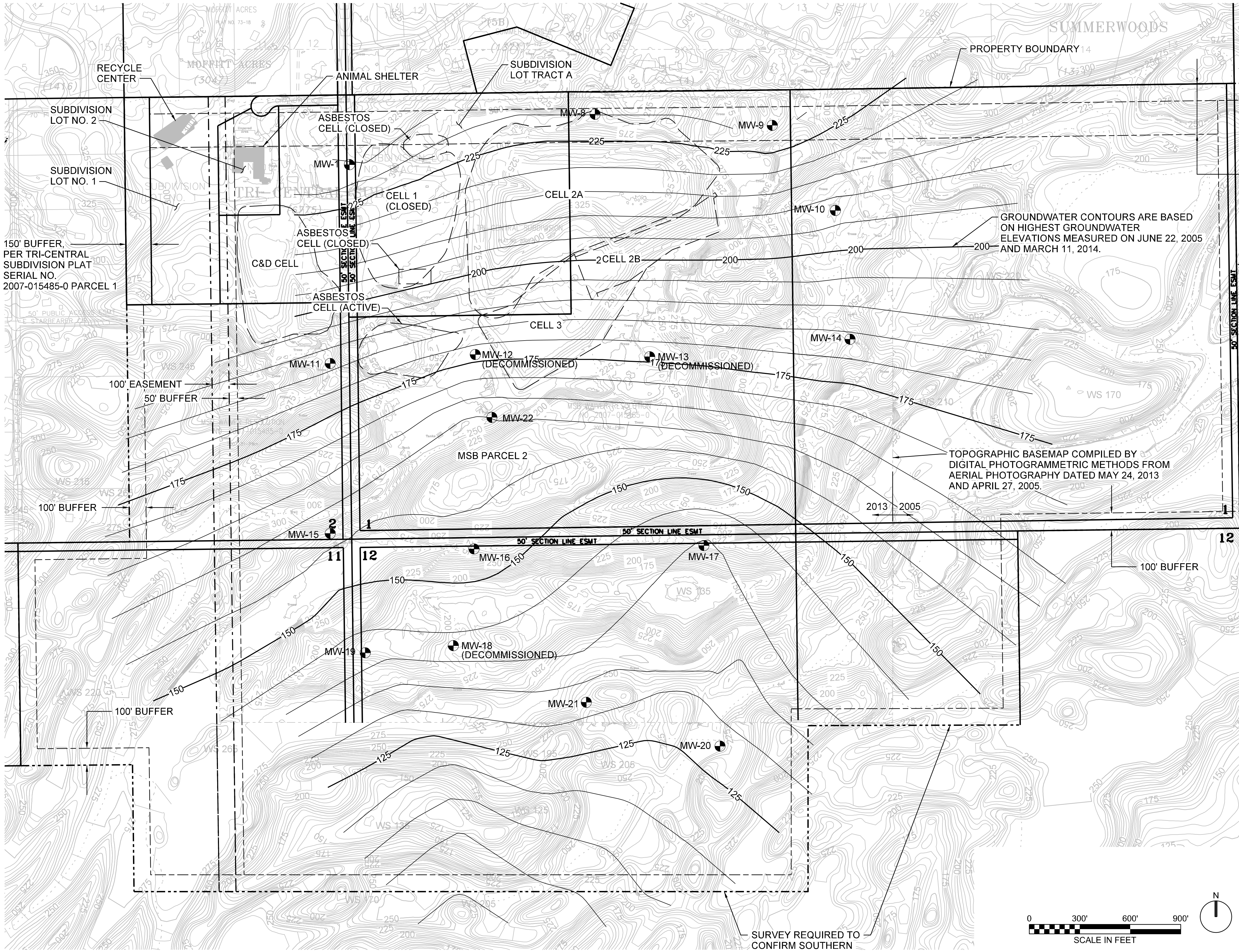


FIGURE 1
EXISTING SITE PLAN
MATANUSKA-SUSITNA BOROUGH
CENTRAL LANDFILL EXPANSION
PALMER, ALASKA

CH2MHILL®

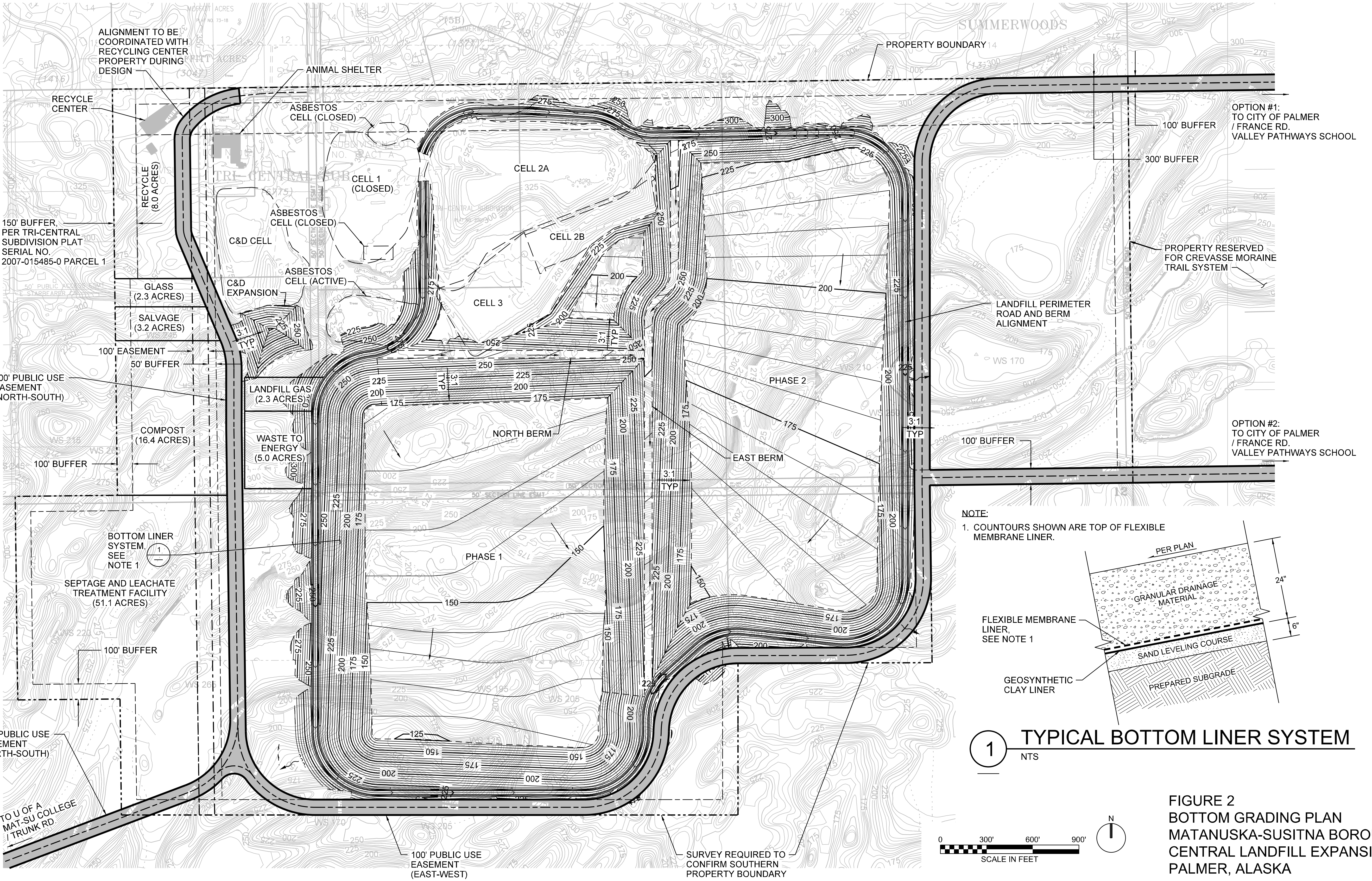


FIGURE 2
BOTTOM GRADING PLAN
MATANUSKA-SUSITNA BOROUGH
CENTRAL LANDFILL EXPANSION
PALMER, ALASKA

CH2MHILL®

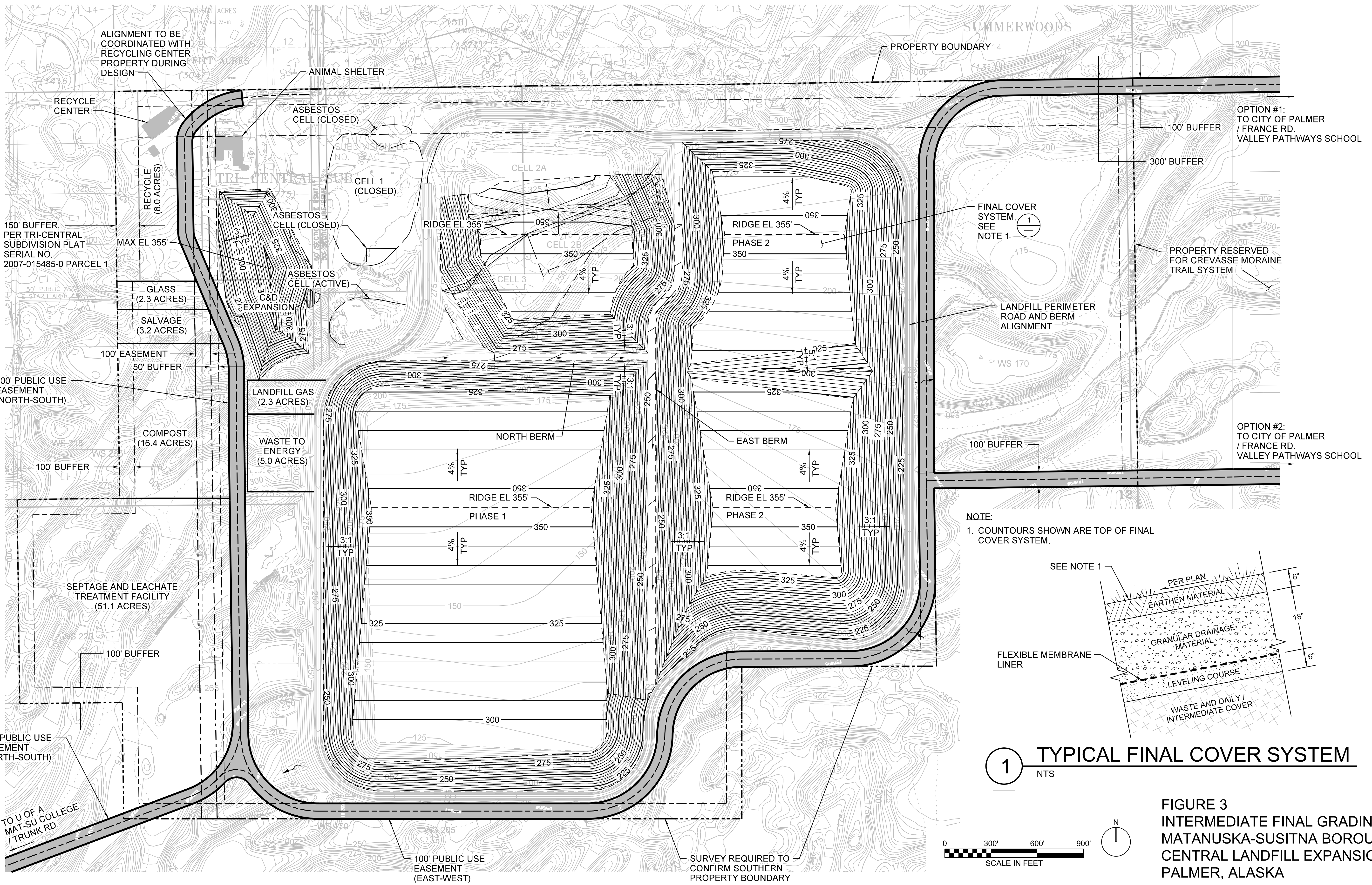


FIGURE 3
INTERMEDIATE FINAL GRADING PLAN
MATANUSKA-SUSITNA BOROUGH
CENTRAL LANDFILL EXPANSION
PALMER, ALASKA

CH2MHILL®

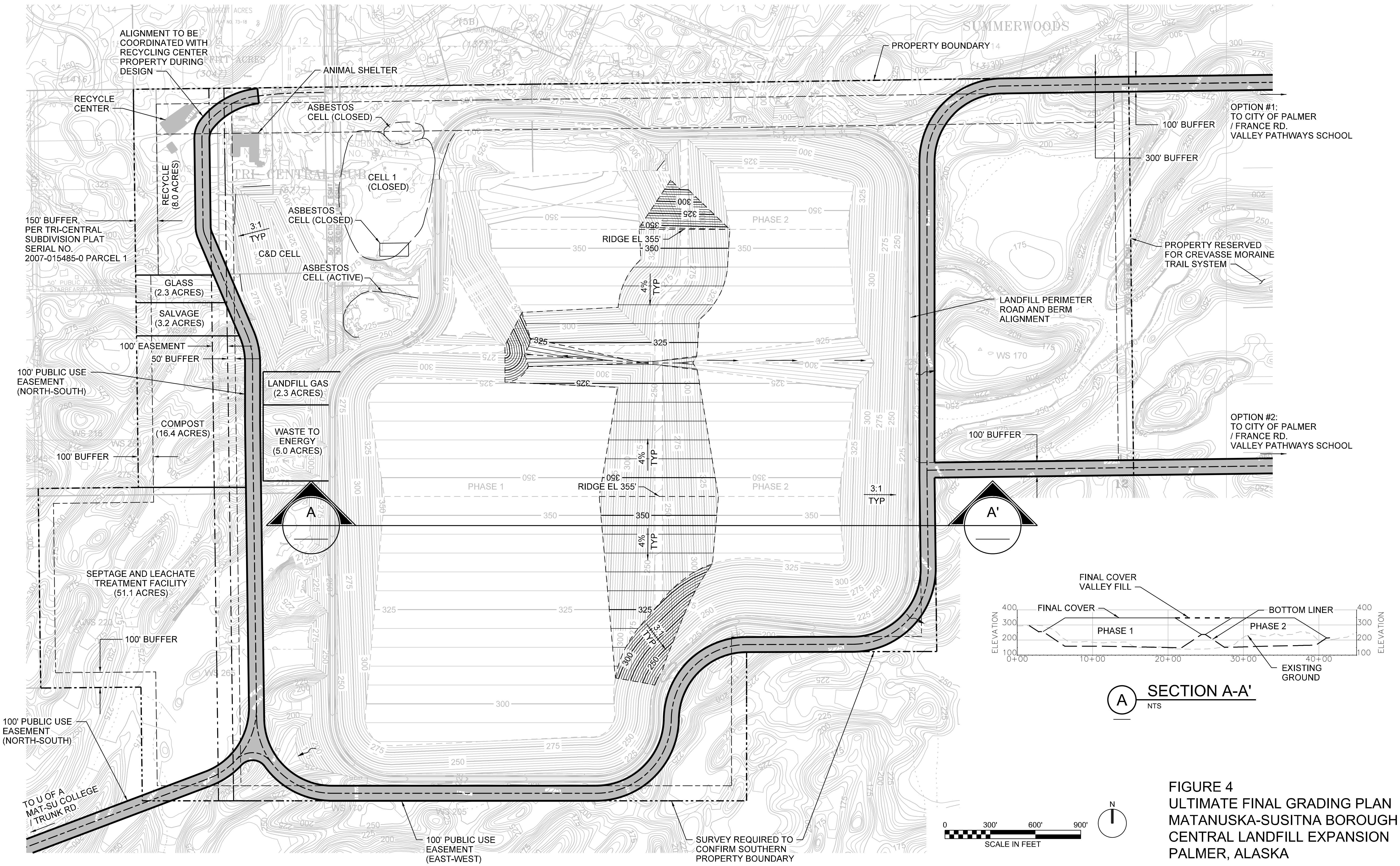
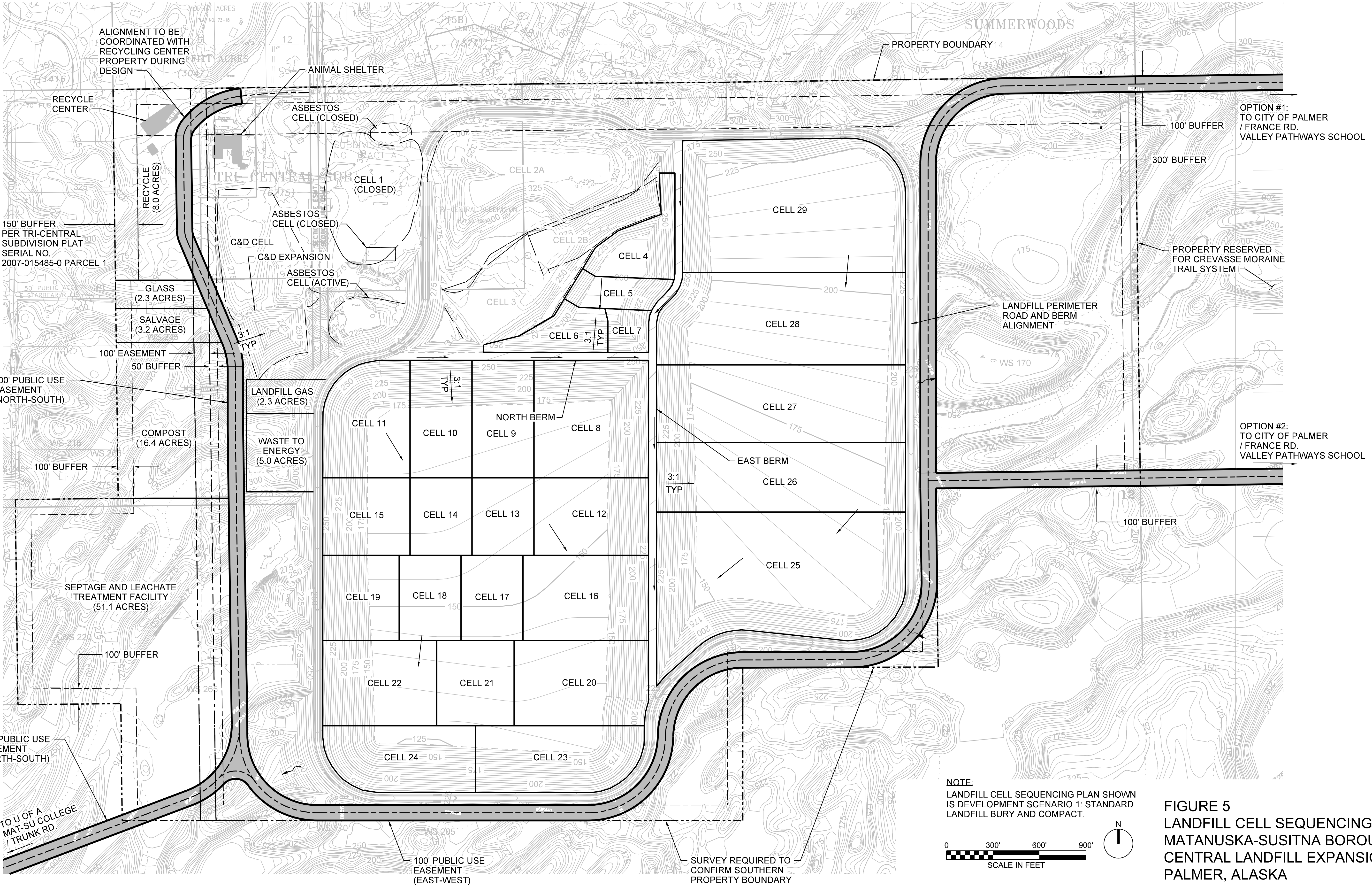


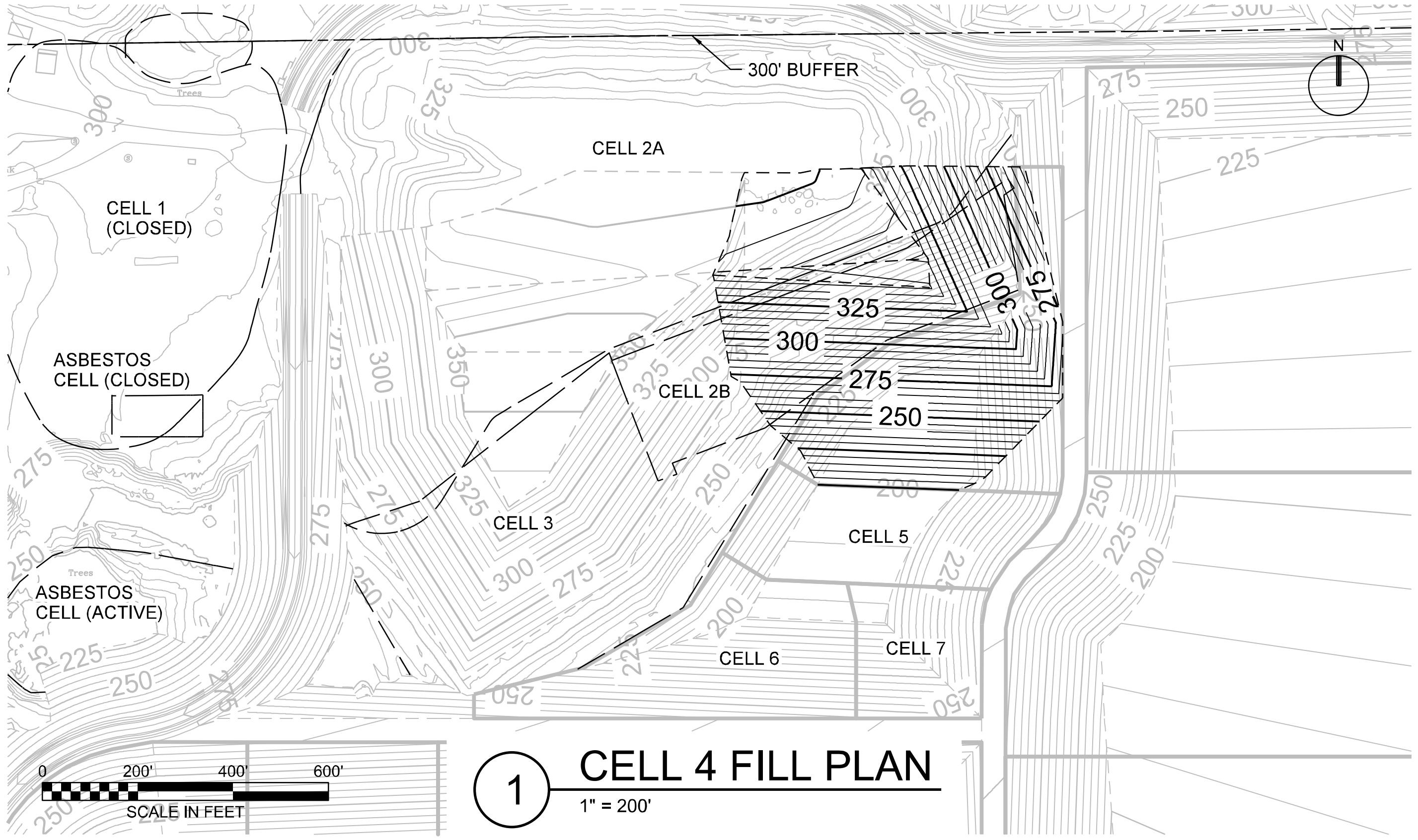
FIGURE 4
ULTIMATE FINAL GRADING PLAN
MATANUSKA-SUSITNA BOROUGH
CENTRAL LANDFILL EXPANSION
PALMER, ALASKA



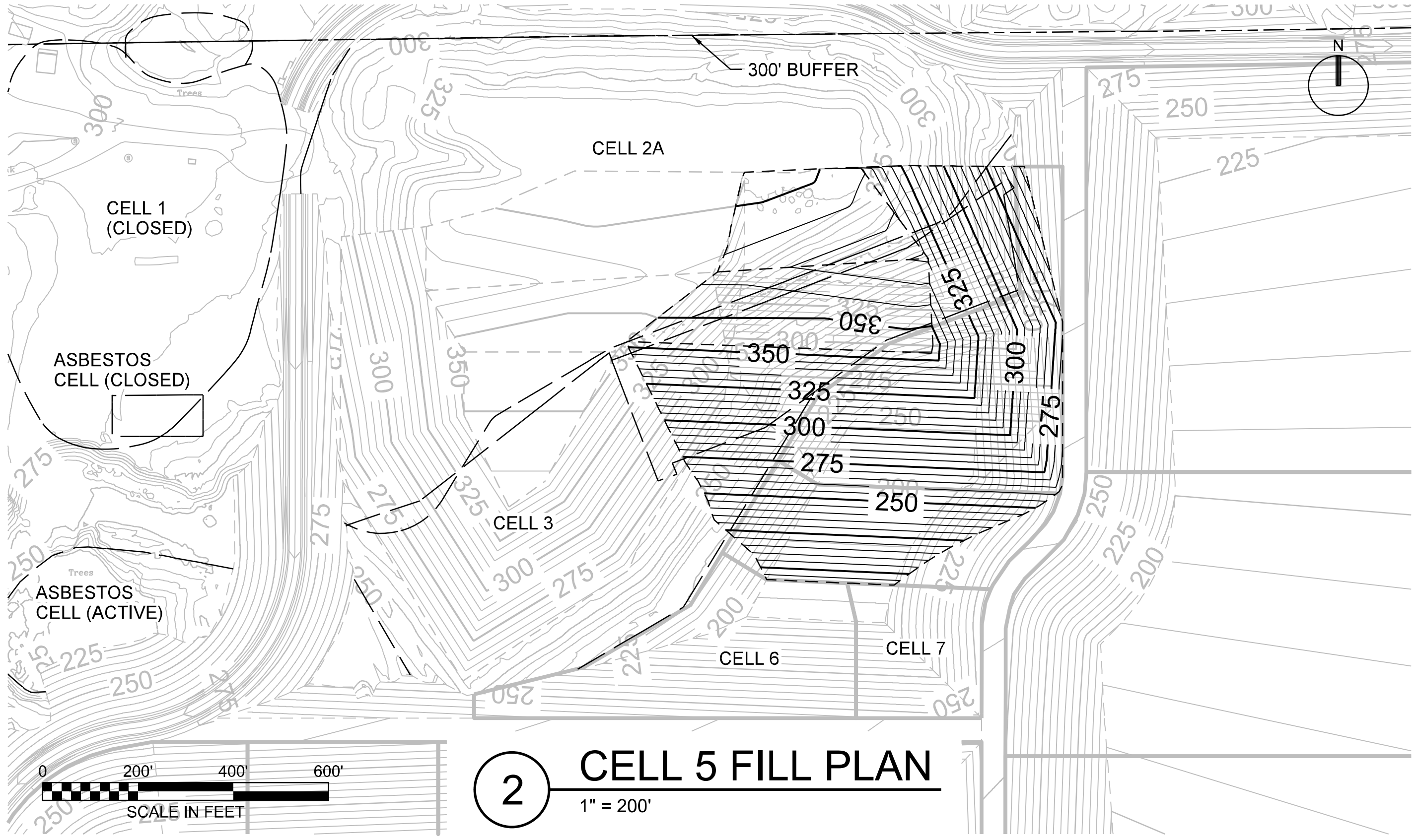
NOTE:
LANDFILL CELL SEQUENCING PLAN SHOWN IS DEVELOPMENT SCENARIO 1: STANDARD LANDFILL BURY AND COMPACT.

FIGURE 5
LANDFILL CELL SEQUENCING PLAN
MATANUSKA-SUSITNA BOROUGH
CENTRAL LANDFILL EXPANSION
PALMER, ALASKA

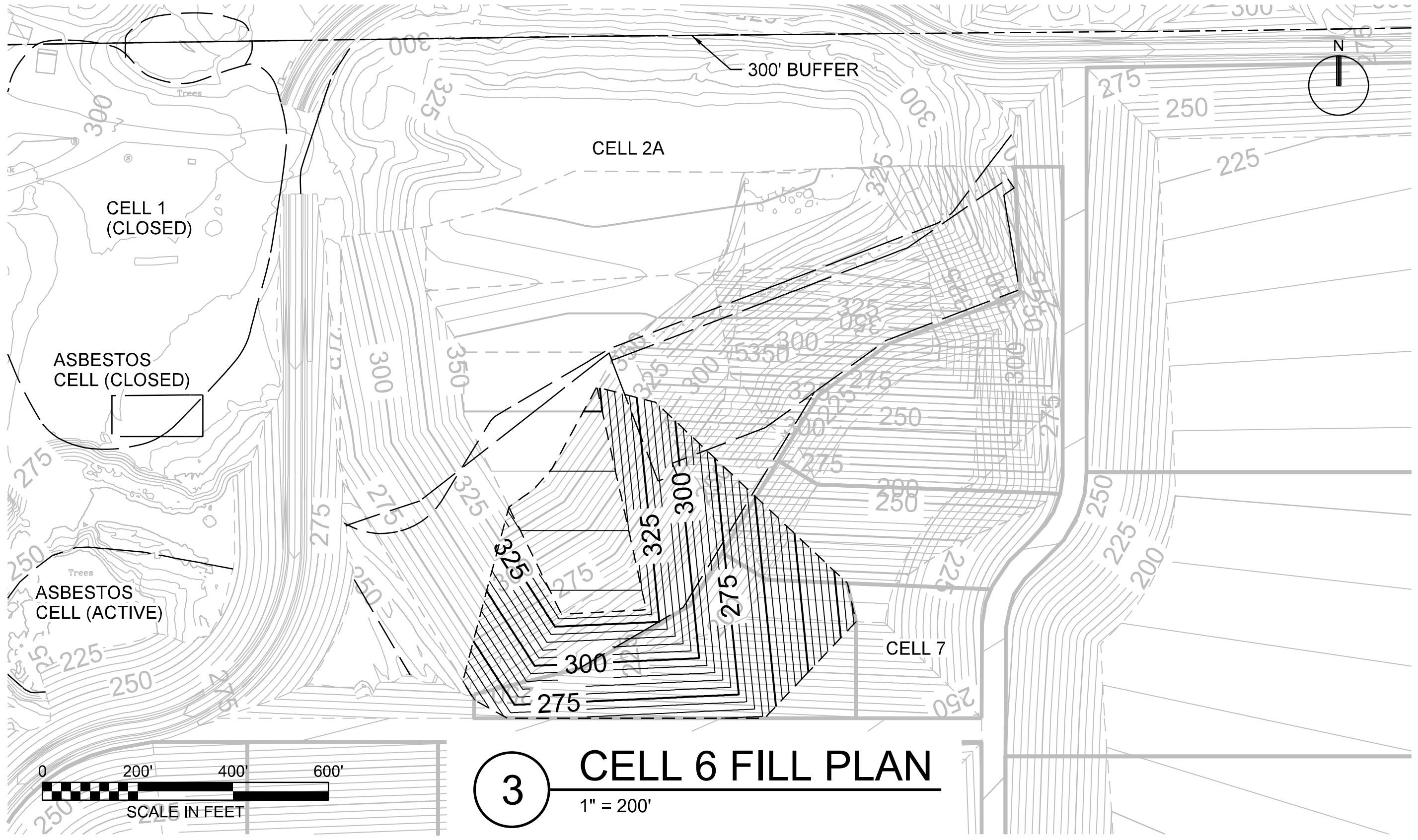
CH2MHILL®



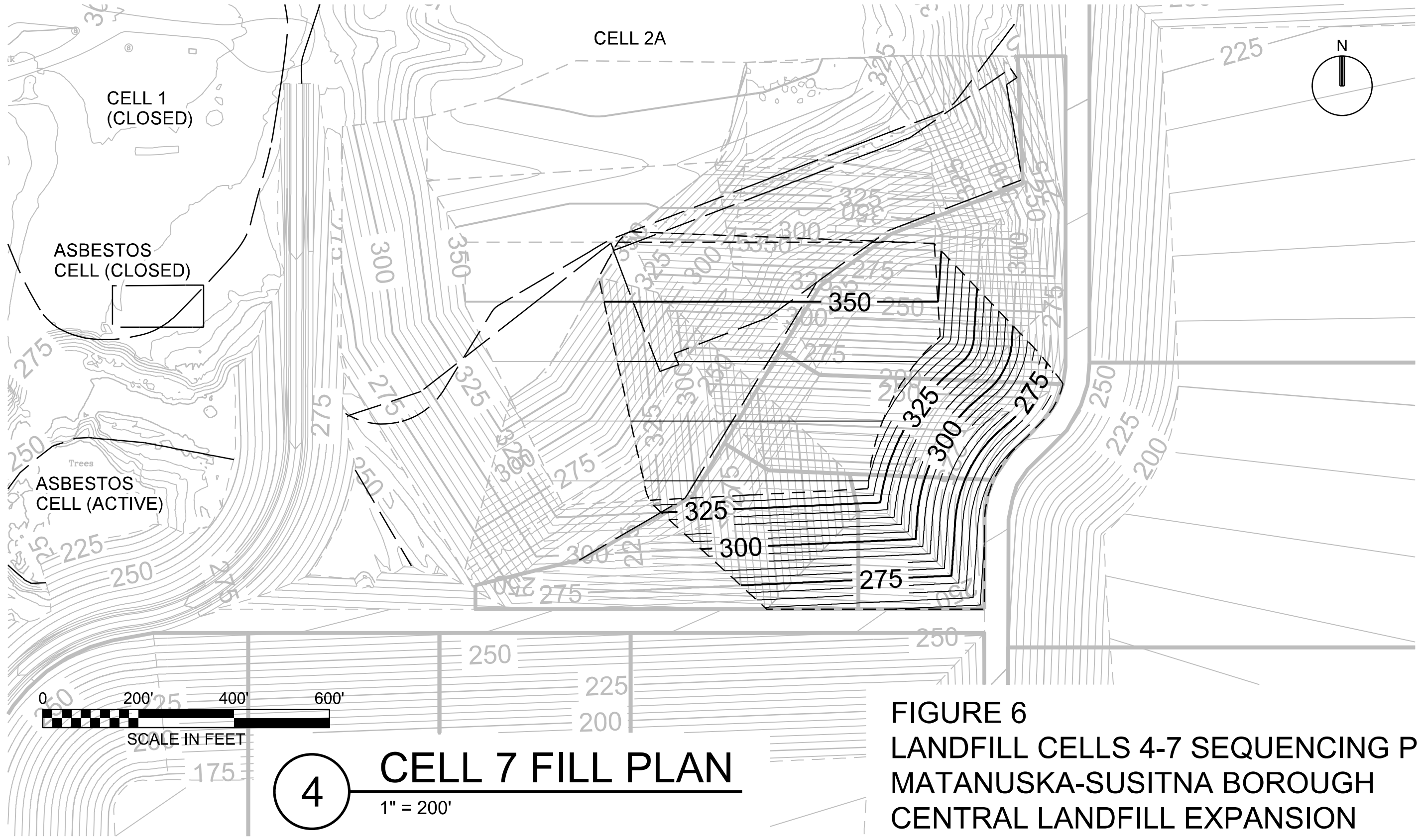
① CELL 4 FILL PLAN
1" = 200'



② CELL 5 FILL PLAN
1" = 200'

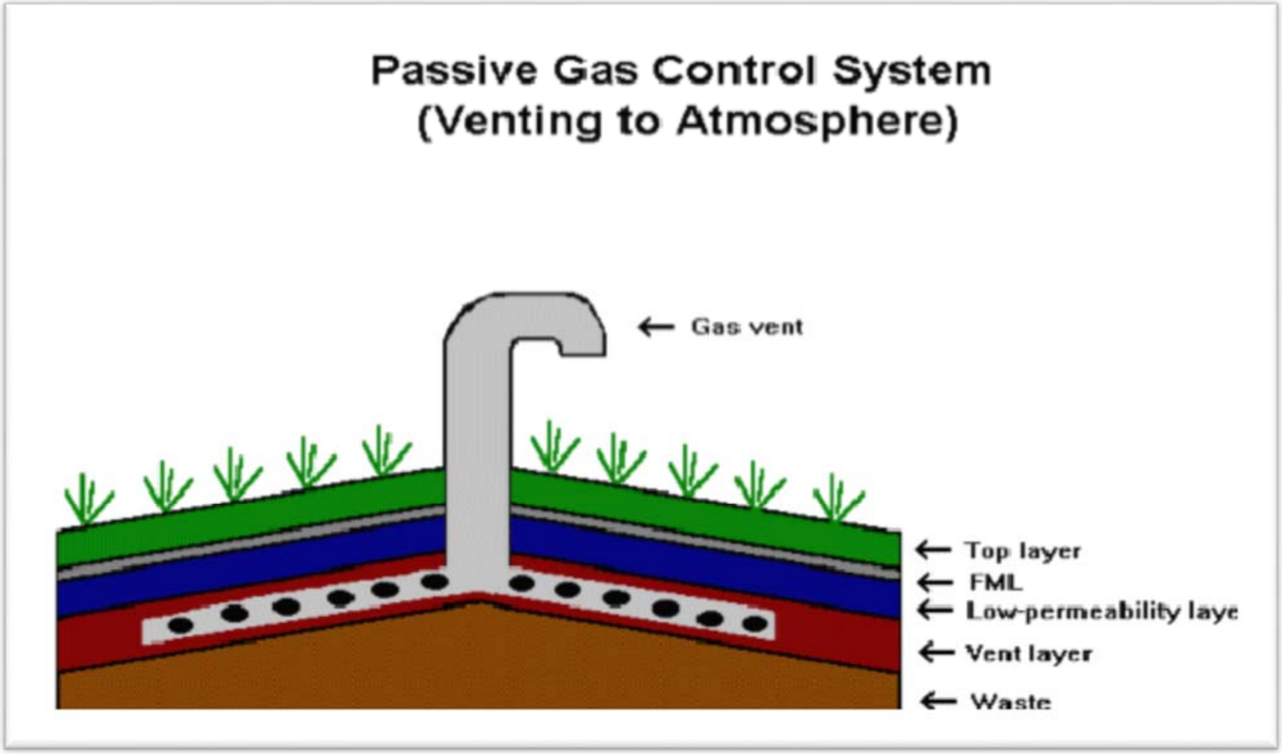


③ CELL 6 FILL PLAN
1" = 200'



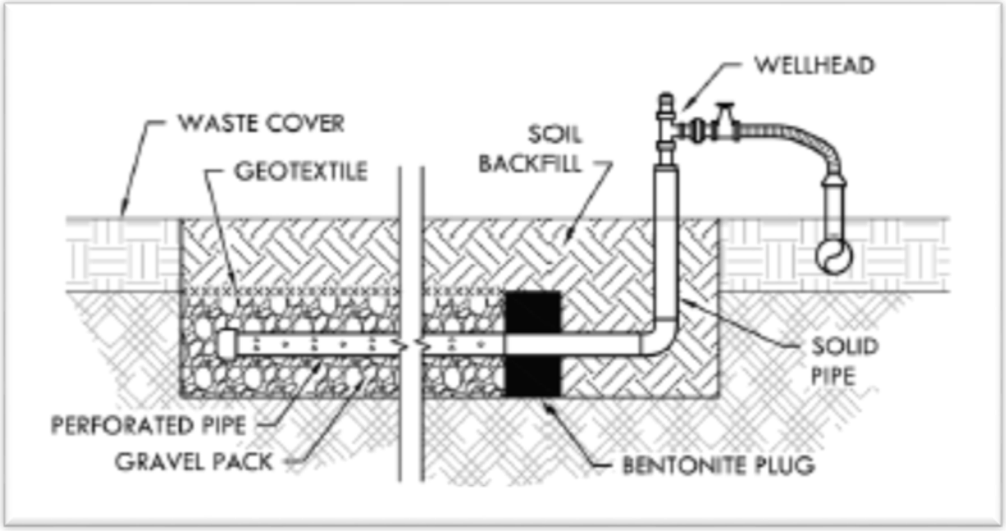
④ CELL 7 FILL PLAN
1" = 200'

FIGURE 6
LANDFILL CELLS 4-7 SEQUENCING PLAN
MATANUSKA-SUSITNA BOROUGH
CENTRAL LANDFILL EXPANSION
PALMER, ALASKA



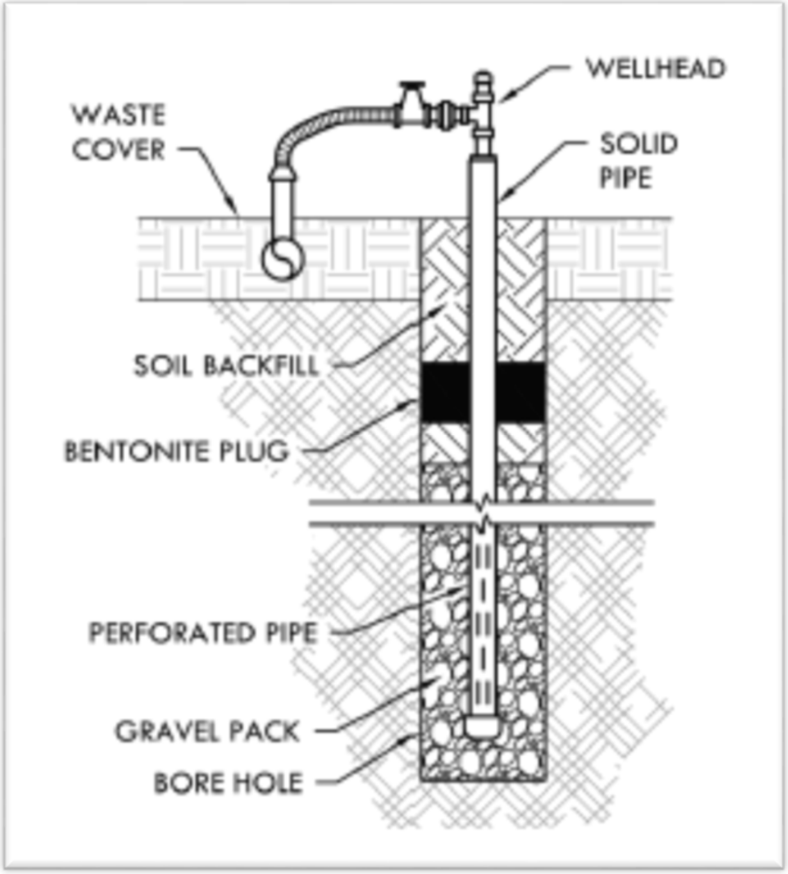
Source: http://www.epa.gov/region6/6pd/pd-u-sw/fig5.gif

FIGURE 7
Passive Gas Control System
Matanuska-Susitna Borough Central Landfill Development Plan



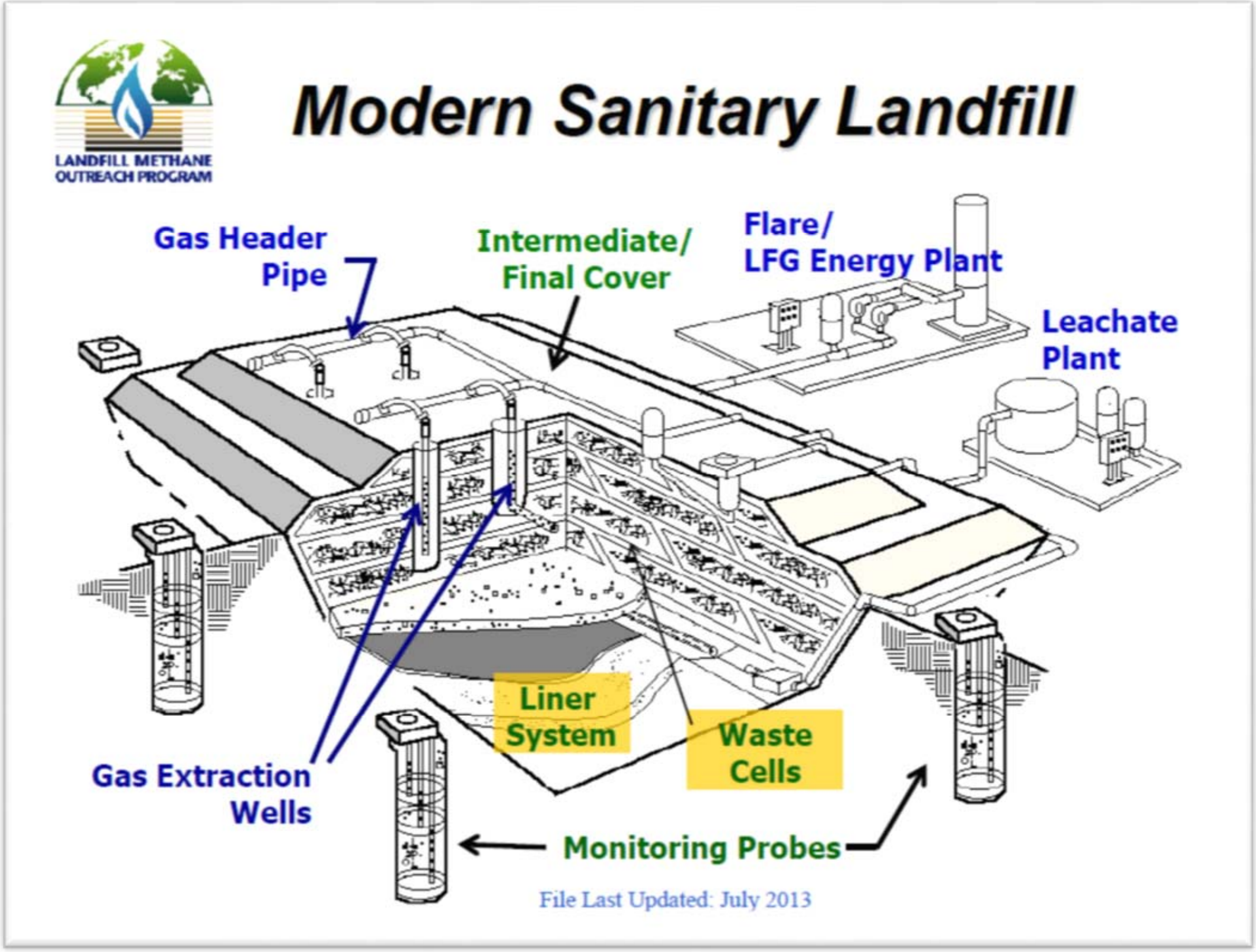
Source: https://www.globalmethane.org/documents/toolsres_lfg_ibpgch3.pdf

FIGURE 8
Horizontal Gas Collection Well
Matanuska-Susitna Borough Central Landfill Development Plan



Source: https://www.globalmethane.org/documents/toolsres_lfg_ibpgch3.pdf

FIGURE 9
Vertical Gas Collection Well
Matanuska-Susitna Borough Central Landfill Development Plan



Source: http://www.epa.gov/lmop/publications-tools/index.html

FIGURE 10
Active Gas Control System
Matanuska-Susitna Borough Central Landfill Development Plan

Appendix A
Population, MSW Disposal, Landfill Air Space Requirements, and Cover Soil Requirements Forecast

MATANUSKA-SUSITNA BOROUGH

Table A-1

Population, MSW Disposal, Landfill Air Space Requirements, and Cover Soil Requirements Forecast

				Landfilling Only					Landfilling with WTE[7]			
	Population[1,2]	MSW Disposal		Landfill Air Space Required			Cover Soil Required		Landfill Air Space Required		Cover Soil Required	
Year[6]		Yearly MSW (tons)	Cumulative MSW (tons)	Yearly Airspace [3] (CY)	Average Daily Airspace [9] (CY)	Cumulative Air Space (CY)	Yearly Cover Soil [4] (CY)	Cumulative Cover Soil (CY)	Yearly Airspace [3] (CY)	Cumulative Air Space (CY)	Yearly Cover Soil [4] (CY)	Cumulative Cover Soil (CY)
2013	96,125	58,796		83,995	234		11,466					
2014	98,507	60,253	60,253	86,076	240	86,076	11,750	11,750	86,076	86,076	11,750	11,750
2015	100,948	61,746	121,999	88,209	246	174,285	12,041	23,791	88,209	174,285	12,041	23,791
2016	103,450	63,276	185,275	90,395	252	264,679	12,340	36,131	90,395	264,679	12,340	36,131
2017	106,013	64,844	250,120	92,634	258	357,314	12,645	48,776	92,634	357,314	12,645	48,776
2018	108,538	66,388	316,508	94,841	264	452,154	12,947	61,723	94,841	452,154	12,947	61,723
2019	111,123	67,970	384,478	97,100	270	549,254	13,255	74,978	97,100	549,254	13,255	74,978
2020	113,770	69,588	454,066	99,412	277	648,666	13,571	88,548	99,412	648,666	13,571	88,548
2021	116,479	71,246	525,312	101,780	284	750,446	13,894	102,442	101,780	750,446	13,894	102,442
2022	119,253	72,943	598,255	104,204	290	854,650	14,225	116,666	104,204	854,650	14,225	116,666
2023	122,050	74,653	672,908	106,648	297	961,297	14,558	131,225	106,648	961,297	14,558	131,225
2024	124,912	76,404	749,312	109,149	304	1,070,446	14,900	146,124	109,149	1,070,446	14,900	146,124
2025	127,842	78,196	827,508	111,708	311	1,182,155	15,249	161,373	111,708	1,182,155	15,249	161,373
2026	130,840	80,030	907,538	114,328	318	1,296,483	15,607	176,980	114,328	1,296,483	15,607	176,980
2027	133,908	81,907	989,444	117,009	326	1,413,492	15,973	192,953	117,009	1,413,492	15,973	192,953
2028	136,733	83,634	1,073,079	119,478	333	1,532,970	16,310	209,263	119,478	1,532,970	16,310	209,263
2029	139,618	85,399	1,158,478	121,998	340	1,654,968	16,654	225,916	121,998	1,654,968	16,654	225,916
2030	142,563	87,200	1,245,678	124,572	347	1,779,540	17,005	242,921	124,572	1,779,540	17,005	242,921
2031	145,571	89,040	1,334,718	127,200	354	1,906,740	17,364	260,285	127,200	1,906,740	17,364	260,285
2032	148,642	90,918	1,425,637	129,883	362	2,036,624	17,730	278,015	129,883	2,036,624	17,730	278,015
2033	151,078	92,409	1,518,045	132,012	368	2,168,636	18,021	296,036	132,012	2,168,636	18,021	296,036
2034	153,554	93,923	1,611,968	134,176	374	2,302,812	18,316	314,352	134,176	2,302,812	18,316	314,352
2035	156,071	95,463	1,707,431	136,375	380	2,439,187	18,616	332,968	136,375	2,439,187	18,616	332,968
2036	158,629	97,027	1,804,458	138,610	386	2,577,797	18,921	351,890	138,610	2,577,797	18,921	351,890
2037	161,229	98,618	1,903,076	140,882	392	2,718,680	19,232	371,121	140,882	2,718,680	19,232	371,121
2038	163,587	100,060	2,003,135	142,942	398	2,861,622	19,513	390,634	142,942	2,861,622	19,513	390,634
2039	165,979	101,523	2,104,658	145,033	404	3,006,655	19,798	410,432	145,033	3,006,655	19,798	410,432
2040	168,406	103,007	2,207,666	147,153	410	3,153,808	20,088	430,520	14,715	3,021,370	5,468	415,900
2041	170,868	104,514	2,312,179	149,305	416	3,303,113	20,381	450,901	14,931	3,036,300	5,548	421,448
2042	173,367	106,042	2,418,221	151,489	422	3,454,602	20,679	471,581	15,149	3,051,449	5,629	427,077
2043	175,902	107,593	2,525,814	153,704	428	3,608,306	20,982	492,562	15,370	3,066,820	5,711	432,789
2044	178,474	109,166	2,634,980	155,951	434	3,764,257	21,289	513,851	15,595	3,082,415	5,795	438,583
2045	181,084	110,762	2,745,742	158,232	441	3,922,489	21,600	535,451	15,823	3,098,238	5,880	444,463
2046	183,732	112,382	2,858,124	160,546	447	4,083,035	21,916	557,367	16,055	3,114,293	5,966	450,429
2047	186,419	114,025	2,972,150	162,893	454	4,245,928	22,236	579,603	16,289	3,130,582	6,053	456,482
2048	189,145	115,693	3,087,842	165,275	460	4,411,203	22,561	602,164	16,528	3,147,109	6,141	462,623
2049	191,911	117,385	3,205,227	167,692	467	4,578,896	22,891	625,056	16,769	3,163,879	6,231	468,854
2050	194,717	119,101	3,324,328	170,144	474	4,749,040	23,226	648,282	17,014	3,180,893	6,322	475,176
2051	197,565	120,843	3,445,171	172,632	481	4,921,673	23,566	671,847	17,263	3,198,156	6,415	481,591
2052	200,454	122,610	3,567,781	175,157	488	5,096,829	23,910	695,758	17,516	3,215,672	6,509	488,100
2053	203,385	124,403	3,692,183	177,718	495	5,274,548	24,260	720,018	17,772	3,233,444	6,604	494,703
2054	206,359	126,222	3,818,405	180,317	502	5,454,865	24,615	744,632	18,032	3,251,476	6,700	501,404
2055	209,377	128,068	3,946,473	182,954	510	5,637,818	24,975	769,607	18,295	3,269,771	6,798	508,202
2056	212,438	129,940	4,076,413	185,629	517	5,823,447	25,340	794,947	18,563	3,288,334	6,898	515,100
2057	215,545	131,840	4,208,254	188,344	525	6,011,791	25,710	820,657	18,834	3,307,168	6,999	522,098
2058	218,697	133,768	4,342,022	191,098	532	6,202,889	26,086	846,743	19,110	3,326,278	7,101	529,199
2059	221,895	135,724	4,477,747	193,892	540	6,396,781	26,468	873,211	19,389	3,345,667	7,205	536,404
2060	225,139	137,709	4,615,456	196,727	548	6,593,508	26,855	900,066	19,673	3,365,340	7,310	543,714
2061	228,432	139,723	4,755,179	199,604	556	6,793,112	27,248	927,314	19,960	3,385,300	7,417	551,131

MATANUSKA-SUSITNA BOROUGH

Table A-1

Population, MSW Disposal, Landfill Air Space Requirements, and Cover Soil Requirements Forecast

				Landfilling Only					Landfilling with WTE[7]			
	Population[1,2]	MSW Disposal		Landfill Air Space Required			Cover Soil Required		Landfill Air Space Required		Cover Soil Required	
Year[6]		Yearly MSW (tons)	Cumulative MSW (tons)	Yearly Airspace [3] (CY)	Average Daily Airspace [9] (CY)	Cumulative Air Space (CY)	Yearly Cover Soil [4] (CY)	Cumulative Cover Soil (CY)	Yearly Airspace [3] (CY)	Cumulative Air Space (CY)	Yearly Cover Soil [4] (CY)	Cumulative Cover Soil (CY)
2062	231,772	141,766	4,896,945	202,523	564	6,995,635	27,646	954,960	20,252	3,405,553	7,525	558,656
2063	235,161	143,839	5,040,784	205,485	572	7,201,120	28,050	983,010	20,548	3,426,101	7,635	566,292
2064	238,600	145,943	5,186,726	208,489	581	7,409,609	28,460	1,011,470	20,849	3,446,950	7,747	574,039
2065	242,089	148,077	5,334,803	211,538	589	7,621,147	28,877	1,040,347	21,154	3,468,104	7,860	581,899
2066	245,629	150,242	5,485,045	214,631	598	7,835,779	29,299	1,069,646	21,463	3,489,567	7,975	589,875
2067	249,221	152,439	5,637,484	217,770	607	8,053,549	29,727	1,099,373	21,777	3,511,344	8,092	597,967
2068	252,865	154,668	5,792,152	220,954	615	8,274,503	30,162	1,129,535	22,095	3,533,439	8,210	606,177
2069	256,563	156,930	5,949,082	224,185	624	8,498,688	30,603	1,160,138	22,419	3,555,858	8,330	614,507
2070	260,315	159,225	6,108,307	227,464	634	8,726,152	31,051	1,191,189	22,746	3,578,604	8,452	622,959
2071	264,121	161,553	6,269,859	230,790	643	8,956,942	31,505	1,222,694	23,079	3,601,683	8,576	631,535
2072	267,984	163,915	6,433,775	234,165	652	9,191,107	31,965	1,254,659	23,416	3,625,100	8,701	640,236
2073	271,902	166,312	6,600,087	237,589	662	9,428,696	32,433	1,287,092	23,759	3,648,859	8,828	649,065
2074	275,878	168,744	6,768,831	241,063	671	9,669,759	32,907	1,319,999	24,106	3,672,965	8,958	658,022
2075	279,913	171,212	6,940,043	244,588	681	9,914,348	33,388	1,353,387	24,459	3,697,424	9,089	667,111
2076	284,006	173,715	7,113,759	248,165	691	10,162,513	33,876	1,387,264	24,816	3,722,240	9,221	676,332
2077	288,159	176,256	7,290,014	251,794	701	10,414,306	34,372	1,421,635	25,179	3,747,420	9,356	685,689
2078	292,373	178,833	7,468,848	255,476	712	10,669,782	34,874	1,456,510	25,548	3,772,967	9,493	695,182
2079	296,648	181,448	7,650,296	259,212	722	10,928,994	35,384	1,491,894	25,921	3,798,889	9,632	704,813
2080	300,986	184,102	7,834,397	263,002	733	11,191,996	35,902	1,527,796	26,300	3,825,189	9,773	714,586
2081	305,387	186,794	8,021,191	266,848	743	11,458,844	36,427	1,564,223	26,685	3,851,874	9,916	724,502
2082	309,853	189,525	8,210,716	270,750	754	11,729,595	36,960	1,601,183	27,075	3,878,949	10,061	734,562
2083	314,384	192,297	8,403,013	274,709	765	12,004,304	37,500	1,638,683	27,471	3,906,420	10,208	744,770
2084	318,981	195,109	8,598,121	278,727	776	12,283,031	38,048	1,676,731	27,873	3,934,292	10,357	755,127
2085	323,646	197,962	8,796,083	282,802	788	12,565,833	38,605	1,715,336	28,280	3,962,572	10,508	765,636
2086	328,378	200,856	8,996,939	286,938	799	12,852,771	39,169	1,754,505	28,694	3,991,266	10,662	776,298
2087	333,180	203,794	9,200,733	291,134	811	13,143,904	39,742	1,794,247	29,113	4,020,380	10,818	787,116
2088	338,052	206,774	9,407,507	295,391	823	13,439,295	40,323	1,834,570	29,539	4,049,919	10,976	798,092
2089	342,996	209,797	9,617,304	299,710	835	13,739,006	40,913	1,875,483	29,971	4,079,890	11,137	809,229
2090	348,011	212,865	9,830,169	304,093	847	14,043,099	41,511	1,916,994	30,409	4,110,299	11,300	820,529
2091	353,100	215,978	10,046,147	308,540	859	14,351,639	42,118	1,959,113	30,854	4,141,153	11,465	831,993
2092	358,264	219,136	10,265,283	313,052	872	14,664,691	42,734	2,001,847	31,305	4,172,458	11,632	843,626
2093	363,503	222,341	10,487,624	317,629	885	14,982,320	43,359	2,045,206	31,763	4,204,221	11,803	855,428
2094	368,818	225,592	10,713,216	322,274	898	15,304,594	43,993	2,089,199	32,227	4,236,449	11,975	867,404
2095	374,211	228,891	10,942,107	326,987	911	15,631,581	44,636	2,133,835	32,699	4,269,147	12,150	879,554
2096	379,684	232,238	11,174,345	331,768	924	15,963,349	45,289	2,179,124	33,177	4,302,324	12,328	891,882
2097	385,236	235,634	11,409,978	336,620	938	16,299,969	45,951	2,225,075	33,662	4,335,986	12,508	904,390
2098	390,869	239,080	11,649,058	341,542	951	16,641,511	46,623	2,271,698	34,154	4,370,140	12,691	917,081
2099	396,585	242,576	11,891,634	346,537	965	16,988,048	47,305	2,319,003	34,654	4,404,794	12,877	929,958
2100	402,384	246,123	12,137,757	351,604	979	17,339,652	47,997	2,367,000	35,160	4,439,954	13,065	943,023
2101	408,268	249,722	12,387,478	356,746	994	17,696,398	48,699	2,415,699	35,675	4,475,629	13,256	956,279
2102	414,238	253,374	12,640,852	361,962	1,008	18,058,360	49,411	2,465,109	36,196	4,511,825	13,450	969,729
2103	420,296	257,079	12,897,931	367,255	1,023	18,425,615	50,133	2,515,243	36,726	4,548,551	13,647	983,376
2104	426,442	260,838	13,158,769	372,626	1,038	18,798,241	50,866	2,566,109	37,263	4,585,813	13,846	997,222
2105	432,677	264,652	13,423,421	378,075	1,053	19,176,316	51,610	2,617,719	37,807	4,623,621	14,049	1,011,271
2106	439,005	268,522	13,691,943	383,603	1,069	19,559,919	52,365	2,670,084	38,360	4,661,981	14,254	1,025,525
2107	445,424	272,449	13,964,392	389,213	1,084	19,949,131	53,131	2,723,215	38,921	4,700,902	14,463	1,039,987
2108	451,938	276,433	14,240,825	394,904	1,100	20,344,036	53,908	2,777,122	39,490	4,740,393	14,674	1,054,661
2109	458,546	280,475	14,521,300	400,679	1,116	20,744,714	54,696	2,831,818	40,068	4,780,461	14,889	1,069,550
2110	465,252	284,577	14,805,877	406,538	1,132	21,151,252	55,496	2,887,314	40,654	4,821,114	15,106	1,084,656

MATANUSKA-SUSITNA BOROUGH

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				Landfilling Only					Landfilling with WTE[7]			
	Population[1,2]	MSW Disposal		Landfill Air Space Required			Cover Soil Required		Landfill Air Space Required		Cover Soil Required	
Year[6]		Yearly MSW (tons)	Cumulative MSW (tons)	Yearly Airspace [3] (CY)	Average Daily Airspace [9] (CY)	Cumulative Air Space (CY)	Yearly Cover Soil [4] (CY)	Cumulative Cover Soil (CY)	Yearly Airspace [3] (CY)	Cumulative Air Space (CY)	Yearly Cover Soil [4] (CY)	Cumulative Cover Soil (CY)
2111	472,055	288,738	15,094,615	412,483	1,149	21,563,735	56,307	2,943,621	41,248	4,862,363	15,327	1,099,983
2112	478,958	292,960	15,387,575	418,515	1,166	21,982,250	57,131	3,000,751	41,851	4,904,214	15,551	1,115,535
2113	485,962	297,244	15,684,819	424,635	1,183	22,406,884	57,966	3,058,717	42,463	4,946,678	15,779	1,131,313
2114	493,068	301,591	15,986,410	430,844	1,200	22,837,728	58,814	3,117,531	43,084	4,989,762	16,009	1,147,323
2115	500,278	306,001	16,292,411	437,144	1,218	23,274,872	59,674	3,177,205	43,714	5,033,476	16,244	1,163,566
2116	507,594	310,476	16,602,886	443,537	1,235	23,718,409	60,546	3,237,751	44,354	5,077,830	16,481	1,180,047
2117	515,016	315,016	16,917,902	450,022	1,254	24,168,431	61,432	3,299,183	45,002	5,122,832	16,722	1,196,769
2118	522,547	319,622	17,237,524	456,603	1,272	24,625,035	62,330	3,361,513	45,660	5,168,493	16,967	1,213,736
2119	530,189	324,296	17,561,820	463,280	1,290	25,088,315	63,241	3,424,754	46,328	5,214,821	17,215	1,230,951
2120	537,942	329,038	17,890,859	470,055	1,309	25,558,369	64,166	3,488,920	47,005	5,261,826	17,466	1,248,417
2121	545,808	333,850	18,224,708	476,928	1,328	26,035,298	65,104	3,554,025	47,693	5,309,519	17,722	1,266,139
2122	553,789	338,732	18,563,440	483,902	1,348	26,519,200	66,057	3,620,081	48,390	5,357,909	17,981	1,284,120
2123	561,887	343,685	18,907,125	490,979	1,368	27,010,179	67,022	3,687,104	49,098	5,407,007	18,244	1,302,364
2124	570,104	348,711	19,255,836	498,158	1,388	27,508,337	68,003	3,755,106	49,816	5,456,823	18,511	1,320,875
2125	578,441	353,810	19,609,646	505,443	1,408	28,013,780	68,997	3,824,103	50,544	5,507,367	18,781	1,339,656
2126	586,899	358,984	19,968,629	512,834	1,429	28,526,613	70,006	3,894,109	51,283	5,558,650	19,056	1,358,712
2127	595,481	364,233	20,332,863	520,333	1,449	29,046,946	71,030	3,965,139	52,033	5,610,684	19,335	1,378,047
2128	604,189	369,559	20,702,422	527,942	1,471	29,574,888	72,068	4,037,207	52,794	5,663,478	19,617	1,397,665
2129	613,024	374,963	21,077,385	535,662	1,492	30,110,550	73,122	4,110,329	53,566	5,717,044	19,904	1,417,569
2130	621,989	380,447	21,457,832	543,495	1,514	30,654,046	74,191	4,184,520	54,350	5,771,394	20,195	1,437,764
2131	631,084	386,010	21,843,842	551,443	1,536	31,205,488	75,276	4,259,797	55,144	5,826,538	20,491	1,458,255
2132	640,312	391,654	22,235,496	559,506	1,559	31,764,995	76,377	4,336,174	55,951	5,882,489	20,790	1,479,045
2133	649,676	397,382	22,632,878	567,688	1,581	32,332,683	77,494	4,413,668	56,769	5,939,257	21,094	1,500,140
2134	659,176	403,193	23,036,070	575,989	1,604	32,908,672	78,627	4,492,295	57,599	5,996,856	21,403	1,521,543
2135	668,815	409,088	23,445,159	584,412	1,628	33,493,084	79,777	4,572,072	58,441	6,055,298	21,716	1,543,258
2136	678,595	415,071	23,860,230	592,958	1,652	34,086,042	80,943	4,653,015	59,296	6,114,593	22,033	1,565,292
2137	688,518	421,140	24,281,370	601,629	1,676	34,687,671	82,127	4,735,142	60,163	6,174,756	22,356	1,587,647
2138	698,586	427,299	24,708,668	610,427	1,700	35,298,098	83,328	4,818,470	61,043	6,235,799	22,682	1,610,330
2139	708,802	433,547	25,142,215	619,353	1,725	35,917,450	84,547	4,903,017	61,935	6,297,734	23,014	1,633,344
2140	719,167	439,887	25,582,102	628,410	1,750	36,545,860	85,783	4,988,800	62,841	6,360,575	23,351	1,656,695
2141	729,683	446,319	26,028,421	637,599	1,776	37,183,459	87,037	5,075,837	63,760	6,424,335	23,692	1,680,387
2142	740,353	452,846	26,481,267	646,923	1,802	37,830,381	88,310	5,164,147	64,692	6,489,027	24,039	1,704,425
2143	751,180	459,468	26,940,735	656,383	1,828	38,486,764	89,601	5,253,749	65,638	6,554,666	24,390	1,728,815
2144	762,164	466,187	27,406,921	665,981	1,855	39,152,745	90,912	5,344,660	66,598	6,621,264	24,747	1,753,562
2145	773,309	473,004	27,879,925	675,720	1,882	39,828,464	92,241	5,436,901	67,572	6,688,836	25,109	1,778,671
2146	784,617	479,920	28,359,845	685,601	1,910	40,514,065	93,590	5,530,491	68,560	6,757,396	25,476	1,804,147
2147	796,091	486,938	28,846,784	695,626	1,938	41,209,691	94,958	5,625,450	69,563	6,826,958	25,848	1,829,995
2148	807,732	494,059	29,340,843	705,798	1,966	41,915,489	96,347	5,721,797	70,580	6,897,538	26,226	1,856,221
2149	819,544	501,283	29,842,126	716,119	1,995	42,631,609	97,756	5,819,553	71,612	6,969,150	26,610	1,882,831
2150	831,528	508,614	30,350,740	726,591	2,024	43,358,200	99,185	5,918,738	72,659	7,041,809	26,999	1,909,830
2151	843,687	516,051	30,866,791	737,216	2,054	44,095,416	100,636	6,019,374	73,722	7,115,531	27,394	1,937,224
2152	856,025	523,598	31,390,389	747,996	2,084	44,843,412	102,107	6,121,481	74,800	7,190,330	27,794	1,965,018
2153	868,542	531,254	31,921,643	758,934	2,114	45,602,347	103,601	6,225,082	75,893	7,266,224	28,201	1,993,219
2154	881,243	539,023	32,460,665	770,032	2,145	46,372,379	105,116	6,330,198	77,003	7,343,227	28,613	2,021,832
2155	894,130	546,905	33,007,570	781,293	2,176	47,153,672	106,653	6,436,850	78,129	7,421,356	29,032	2,050,864
2156	907,204	554,902	33,562,472	792,717	2,208	47,946,389	108,212	6,545,062	79,272	7,500,628	29,456	2,080,320
2157	920,471	563,017	34,125,489	804,309	2,240	48,750,699	109,795	6,654,857	80,431	7,581,059	29,887	2,110,207
2158	933,931	571,250	34,696,739	816,071	2,273	49,566,770	111,400	6,766,257	81,607	7,662,666	30,324	2,140,530
2159	947,588	579,603	35,276,342	828,004	2,306	50,394,774	113,029	6,879,286	82,800	7,745,466	30,767	2,171,298

MATANUSKA-SUSITNA BOROUGH
Table A-1
Population, MSW Disposal, Landfill Air Space Requirements, and Cover Soil Requirements Forecast

				Landfilling Only					Landfilling with WTE[7]			
	Population[1,2]	MSW Disposal		Landfill Air Space Required			Cover Soil Required		Landfill Air Space Required		Cover Soil Required	
Year[6]		Yearly MSW (tons)	Cumulative MSW (tons)	Yearly Airspace [3] (CY)	Average Daily Airspace [9] (CY)	Cumulative Air Space (CY)	Yearly Cover Soil [4] (CY)	Cumulative Cover Soil (CY)	Yearly Airspace [3] (CY)	Cumulative Air Space (CY)	Yearly Cover Soil [4] (CY)	Cumulative Cover Soil (CY)
2160	961,444	588,079	35,864,420	840,112	2,340	51,234,886	114,682	6,993,968	84,011	7,829,478	31,217	2,202,515
2161	975,503	596,678	36,461,098	852,397	2,374	52,087,283	116,359	7,110,327	85,240	7,914,717	31,674	2,234,189
2162	989,768	605,403	37,066,502	864,862	2,409	52,952,145	118,061	7,228,388	86,486	8,001,204	32,137	2,266,326
2163	1,004,242	614,256	37,680,758	877,509	2,444	53,829,654	119,787	7,348,175	87,751	8,088,955	32,607	2,298,932
2164	1,018,927	623,238	38,303,996	890,341	2,480	54,719,995	121,539	7,469,713	89,034	8,177,989	33,084	2,332,016
2165	1,033,827	632,352	38,936,349	903,360	2,516	55,623,355	123,316	7,593,029	90,336	8,268,325	33,567	2,365,583
2166	1,048,944	641,599	39,577,948	916,570	2,553	56,539,925	125,119	7,718,148	91,657	8,359,982	34,058	2,399,642
2167	1,064,283	650,981	40,228,929	929,973	2,590	57,469,898	126,949	7,845,097	92,997	8,452,979	34,556	2,434,198
2168	1,079,846	660,501	40,889,429	943,572	2,628	58,413,470	128,805	7,973,902	94,357	8,547,336	35,062	2,469,260
2169	1,095,637	670,159	41,559,588						95,737	8,643,073	35,574	2,504,834
2170	1,111,658	679,959	42,239,547						97,137	8,740,210	36,095	2,540,928
2171	1,127,914	689,902	42,929,449						98,557	8,838,768	36,622	2,577,551
2172	1,144,408	699,990	43,629,439						99,999	8,938,766	37,158	2,614,709
2173	1,161,142	710,226	44,339,666						101,461	9,040,227	37,701	2,652,410
2174	1,178,122	720,612	45,060,278						102,945	9,143,172	38,253	2,690,662
2175	1,195,350	731,150	45,791,427						104,450	9,247,622	38,812	2,729,474
2176	1,212,829	741,841	46,533,268						105,977	9,353,599	39,379	2,768,854
2177	1,230,565	752,689	47,285,958						107,527	9,461,126	39,955	2,808,809
2178	1,248,559	763,696	48,049,653						109,099	9,570,225	40,540	2,849,349
2179	1,266,817	774,863	48,824,517						110,695	9,680,920	41,132	2,890,481
2180	1,285,342	786,194	49,610,711						112,313	9,793,234	41,734	2,932,215
2181	1,304,137	797,691	50,408,402						113,956	9,907,189	42,344	2,974,559
2182	1,323,208	809,355	51,217,757						115,622	10,022,812	42,963	3,017,522
2183	1,342,557	821,191	52,038,948						117,313	10,140,125	43,592	3,061,114
2184	1,362,189	833,199	52,872,147						119,028	10,259,153	44,229	3,105,343
2185	1,382,109	845,383	53,717,530						120,769	10,379,922	44,876	3,150,219
2186	1,402,319	857,745	54,575,275						122,535	10,502,457	45,532	3,195,751
2187	1,422,825	870,288	55,445,563						124,327	10,626,784	46,198	3,241,949
2188	1,443,632	883,014	56,328,577						126,145	10,752,929	46,873	3,288,822
2189	1,464,742	895,926	57,224,503						127,989	10,880,918	47,559	3,336,381
2190	1,486,161	909,028	58,133,531						129,861	11,010,779	48,254	3,384,635
2191	1,507,893	922,320	59,055,851						131,760	11,142,539	48,960	3,433,595
2192	1,529,943	935,808	59,991,659						133,687	11,276,226	49,676	3,483,271
2193	1,552,315	949,492	60,941,151						135,642	11,411,868	50,402	3,533,673
2194	1,575,015	963,376	61,904,527						137,625	11,549,493	51,139	3,584,812
2195	1,598,047	977,464	62,881,991						139,638	11,689,131	51,887	3,636,699
2196	1,621,415	991,757	63,873,748						141,680	11,830,810	52,646	3,689,345
2197	1,645,125	1,006,260	64,880,008						143,751	11,974,562	53,416	3,742,761
2198	1,669,182	1,020,974	65,900,983						145,853	12,120,415	54,197	3,796,958
2199	1,693,590	1,035,904	66,936,887						147,986	12,268,402	54,989	3,851,947
2200	1,718,356	1,051,052	67,987,939						150,150	12,418,552	55,793	3,907,740
2201	1,743,483	1,066,422	69,054,361						152,346	12,570,898	56,609	3,964,350
2202	1,768,978	1,082,016	70,136,377						154,574	12,725,472	57,437	4,021,787
2203	1,794,846	1,097,839	71,234,216						156,834	12,882,306	58,277	4,080,064
2204	1,821,092	1,113,892	72,348,108						159,127	13,041,433	59,129	4,139,193
2205	1,847,722	1,130,181	73,478,289						161,454	13,202,888	59,994	4,199,187
2206	1,874,742	1,146,708	74,624,997						163,815	13,366,703	60,871	4,260,058
2207	1,902,156	1,163,476	75,788,473						166,211	13,532,914	61,761	4,321,819
2208	1,929,971	1,180,489	76,968,962						168,641	13,701,555	62,664	4,384,484

MATANUSKA-SUSITNA BOROUGH
Table A-1
Population, MSW Disposal, Landfill Air Space Requirements, and Cover Soil Requirements Forecast

				Landfilling Only					Landfilling with WTE[7]			
	Population[1,2]	MSW Disposal		Landfill Air Space Required			Cover Soil Required		Landfill Air Space Required		Cover Soil Required	
Year[6]		Yearly MSW (tons)	Cumulative MSW (tons)	Yearly Airspace [3] (CY)	Average Daily Airspace [9] (CY)	Cumulative Air Space (CY)	Yearly Cover Soil [4] (CY)	Cumulative Cover Soil (CY)	Yearly Airspace [3] (CY)	Cumulative Air Space (CY)	Yearly Cover Soil [4] (CY)	Cumulative Cover Soil (CY)
2209	1,958,193	1,197,752	78,166,714						171,107	13,872,663	63,581	4,448,064
2210	1,986,828	1,215,267	79,381,981						173,610	14,046,272	64,510	4,512,575
2211	2,015,882	1,233,038	80,615,018						176,148	14,222,420	65,454	4,578,029
2212	2,045,360	1,251,068	81,866,087						178,724	14,401,144	66,411	4,644,440
2213	2,075,269	1,269,363	83,135,449						181,338	14,582,482	67,382	4,711,822
2214	2,105,616	1,287,925	84,423,374						183,989	14,766,471	68,367	4,780,189
2215	2,136,407	1,306,758	85,730,132						186,680	14,953,151	69,367	4,849,556
2216	2,167,647	1,325,867	87,055,999						189,410	15,142,560	70,382	4,919,938
2217	2,199,345	1,345,255	88,401,254						192,179	15,334,740	71,411	4,991,348
2218	2,231,506	1,364,927	89,766,181						194,990	15,529,729	72,455	5,063,803
2219	2,264,138	1,384,886	91,151,067						197,841	15,727,570	73,514	5,137,318
2220	2,297,246	1,405,137	92,556,205						200,734	15,928,304	74,589	5,211,907
2221	2,330,839	1,425,685	93,981,889						203,669	16,131,973	75,680	5,287,588
2222	2,364,923	1,446,533	95,428,422						206,648	16,338,621	76,787	5,364,374
2223	2,399,505	1,467,685	96,896,108						209,669	16,548,290	77,910	5,442,284
2224	2,434,593	1,489,147	98,385,255						212,735	16,761,026	79,049	5,521,333
2225	2,470,195	1,510,923	99,896,179						215,846	16,976,872	80,205	5,601,538
2226	2,506,316	1,533,018	101,429,196						219,003	17,195,874	81,378	5,682,916
2227	2,542,966	1,555,435	102,984,631						222,205	17,418,079	82,568	5,765,484
2228	2,580,152	1,578,180	104,562,812						225,454	17,643,534	83,775	5,849,259
2229	2,617,882	1,601,258	106,164,070						228,751	17,872,285	85,000	5,934,259
2230	2,656,163	1,624,673	107,788,743						232,096	18,104,381	86,243	6,020,502
2231	2,695,005	1,648,431	109,437,174						235,490	18,339,871	87,504	6,108,007
2232	2,734,414	1,672,536	111,109,710						238,934	18,578,805	88,784	6,196,790
2233	2,774,399	1,696,994	112,806,704						242,428	18,821,233	90,082	6,286,873
2234	2,814,969	1,721,809	114,528,513						245,973	19,067,205	91,399	6,378,272
2235	2,856,133	1,746,987	116,275,500						249,570	19,316,775	92,736	6,471,008
2236	2,897,898	1,772,533	118,048,033						253,219	19,569,994	94,092	6,565,100
2237	2,940,274	1,798,453	119,846,486						256,922	19,826,916	95,468	6,660,568
2238	2,983,270	1,824,752	121,671,238						260,679	20,087,595	96,864	6,757,432
2239	3,026,895	1,851,435	123,522,674						264,491	20,352,085	98,280	6,855,713
2240	3,071,157	1,878,509	125,401,183						268,358	20,620,444	99,718	6,955,430
2241	3,116,067	1,905,979	127,307,161						272,283	20,892,726	101,176	7,056,606
2242	3,161,633	1,933,850	129,241,011						276,264	21,168,991	102,655	7,159,261
2243	3,207,866	1,962,129	131,203,140						280,304	21,449,295	104,156	7,263,418
2244	3,254,775	1,990,821	133,193,961						284,403	21,733,698	105,680	7,369,097
2245	3,302,369	2,019,933	135,213,894						288,562	22,022,260	107,225	7,476,322
2246	3,350,660	2,049,470	137,263,364						292,781	22,315,041	108,793	7,585,115
2247	3,399,657	2,079,440	139,342,804						297,063	22,612,104	110,384	7,695,499
2248	3,449,370	2,109,848	141,452,651						301,407	22,913,511	111,998	7,807,497
2249	3,499,811	2,140,700	143,593,351						305,814	23,219,325	113,636	7,921,132
2250	3,550,988	2,172,004	145,765,355						310,286	23,529,611	115,297	8,036,430
2251	3,602,915	2,203,765	147,969,120						314,824	23,844,435	116,983	8,153,413
2252	3,655,600	2,235,991	150,205,111						319,427	24,163,862	118,694	8,272,107
2253	3,709,056	2,268,688	152,473,798						324,098	24,487,960	120,430	8,392,537
2254	3,763,294	2,301,863	154,775,661						328,838	24,816,798	122,191	8,514,727
2255	3,818,325	2,335,523	157,111,184						333,646	25,150,444	123,977	8,638,705
2256	3,874,160	2,369,676	159,480,860						338,525	25,488,969	125,790	8,764,495
2257	3,930,813	2,404,327	161,885,187						343,475	25,832,444	127,630	8,892,125

MATANUSKA-SUSITNA BOROUGH

Table A-1

Population, MSW Disposal, Landfill Air Space Requirements, and Cover Soil Requirements Forecast

				Landfilling Only					Landfilling with WTE[7]			
	Population[1,2]	MSW Disposal		Landfill Air Space Required			Cover Soil Required		Landfill Air Space Required		Cover Soil Required	
Year[6]		Yearly MSW (tons)	Cumulative MSW (tons)	Yearly Airspace [3] (CY)	Average Daily Airspace [9] (CY)	Cumulative Air Space (CY)	Yearly Cover Soil [4] (CY)	Cumulative Cover Soil (CY)	Yearly Airspace [3] (CY)	Cumulative Air Space (CY)	Yearly Cover Soil [4] (CY)	Cumulative Cover Soil (CY)
2258	3,988,293	2,439,486	164,324,673						348,498	26,180,942	129,496	9,021,621
2259	4,046,614	2,475,159	166,799,832						353,594	26,534,537	131,390	9,153,011
2260	4,105,788	2,511,353	169,311,185						358,765	26,893,301	133,311	9,286,322
2261	4,165,827	2,548,077	171,859,262						364,011	27,257,312	135,261	9,421,583
2262	4,226,744	2,585,337	174,444,599						369,334	27,626,646	137,238	9,558,821
2263	4,288,552	2,623,143	177,067,742						374,735	28,001,381	139,245	9,698,067
2264	4,351,264	2,661,501	179,729,243						380,214	28,381,595	141,282	9,839,348
2265	4,414,892	2,700,421	182,429,664						385,774	28,767,370	143,347	9,982,696
2266	4,479,452	2,739,909	185,169,573						391,416	29,158,785	145,444	10,128,139
2267	4,544,955	2,779,975	187,949,548						397,139	29,555,924	147,570	10,275,710
2268	4,611,416	2,820,626	190,770,174						402,947	29,958,871	149,728	10,425,438
2269	4,678,849	2,861,873	193,632,047						408,839	30,367,710	151,918	10,577,356
2270	4,747,268	2,903,722	196,535,769						414,817	30,782,527	154,139	10,731,496
2271	4,816,687	2,946,183	199,481,952						420,883	31,203,411	156,393	10,887,889
2272	4,887,122	2,989,265	202,471,217						427,038	31,630,449	158,680	11,046,569
2273	4,958,587	3,032,978	205,504,195						433,283	32,063,731	161,001	11,207,570
2274	5,031,096	3,077,329	208,581,524						439,618	32,503,350	163,355	11,370,925
2275	5,104,666	3,122,329	211,703,853						446,047	32,949,397	165,744	11,536,669
2276	5,179,312	3,167,987	214,871,840						452,570	33,401,966	168,167	11,704,837
2277	5,255,050	3,214,312	218,086,152						459,187	33,861,154	170,627	11,875,463
2278	5,331,894	3,261,316	221,347,468						465,902	34,327,056	173,122	12,048,585
2279	5,409,863	3,309,006	224,656,473						472,715	34,799,771	175,653	12,224,238
2280	5,488,972	3,357,394	228,013,867						479,628	35,279,399	178,222	12,402,460
2281	5,569,237	3,406,489	231,420,356						486,641	35,766,040	180,828	12,583,288
2282	5,650,676	3,456,302	234,876,658						493,757	36,259,797	183,472	12,766,760
2283	5,733,306	3,506,844	238,383,502						500,978	36,760,775	186,155	12,952,915
2284	5,817,145	3,558,125	241,941,627						508,304	37,269,079	188,877	13,141,793
2285	5,902,209	3,610,155	245,551,782						515,736	37,784,815	191,639	13,333,432
2286	5,988,518	3,662,947	249,214,729						523,278	38,308,093	194,442	13,527,874
2287	6,076,088	3,716,510	252,931,239						530,930	38,839,023	197,285	13,725,159
2288	6,164,939	3,770,857	256,702,096						538,694	39,377,717	200,170	13,925,329
2289	6,255,089	3,825,998	260,528,095						546,571	39,924,288	203,097	14,128,426
2290	6,346,558	3,881,946	264,410,041						554,564	40,478,852	206,067	14,334,492
2291	6,439,364	3,938,712	268,348,753						562,673	41,041,525	209,080	14,543,573
2292	6,533,527	3,996,308	272,345,061						570,901	41,612,426	212,138	14,755,710
2293	6,629,067	4,054,746	276,399,807						579,249	42,191,676	215,240	14,970,950
2294	6,726,004	4,114,039	280,513,846						587,720	42,779,396	218,387	15,189,337
2295	6,824,359	4,174,199	284,688,045						596,314	43,375,710	221,581	15,410,918
2296	6,924,152	4,235,238	288,923,283						605,034	43,980,744	224,821	15,635,739
2297	7,025,404	4,297,170	293,220,454						613,881	44,594,625	228,108	15,863,847
2298	7,128,137	4,360,008	297,580,462						622,858	45,217,484	231,444	16,095,291
2299	7,232,372	4,423,765	302,004,227						631,966	45,849,450	234,828	16,330,119
2300	7,338,131	4,488,454	306,492,681						641,208	46,490,658	238,262	16,568,382
2301	7,445,437	4,554,089	311,046,769						650,584	47,141,242	241,746	16,810,128
2302	7,554,312	4,620,683	315,667,452						660,098	47,801,339	245,282	17,055,410
2303	7,664,779	4,688,252	320,355,704						669,750	48,471,090	248,868	17,304,278
2304	7,776,862	4,756,808	325,112,512						679,544	49,150,634	252,508	17,556,786
2305	7,890,583	4,826,367	329,938,880						689,481	49,840,115	256,200	17,812,986
2306	8,005,967	4,896,944	334,835,823						699,563	50,539,678	259,946	18,072,932

MATANUSKA-SUSITNA BOROUGH
Table A-1
Population, MSW Disposal, Landfill Air Space Requirements, and Cover Soil Requirements Forecast

				Landfilling Only					Landfilling with WTE[7]			
	Population[1,2]	MSW Disposal		Landfill Air Space Required			Cover Soil Required		Landfill Air Space Required		Cover Soil Required	
Year[6]		Yearly MSW (tons)	Cumulative MSW (tons)	Yearly Airspace [3] (CY)	Average Daily Airspace [9] (CY)	Cumulative Air Space (CY)	Yearly Cover Soil [4] (CY)	Cumulative Cover Soil (CY)	Yearly Airspace [3] (CY)	Cumulative Air Space (CY)	Yearly Cover Soil [4] (CY)	Cumulative Cover Soil (CY)
2307	8,123,039	4,968,552	339,804,375						709,793	51,249,471	263,748	18,336,680
2308	8,241,823	5,041,207	344,845,582						720,172	51,969,644	267,604	18,604,284
2309	8,362,343	5,114,925	349,960,507						730,704	52,700,347	271,518	18,875,802
2310	8,484,626	5,189,721	355,150,228						741,389	53,441,736	275,488	19,151,290
2311	8,608,697	5,265,610	360,415,838						752,230	54,193,966	279,516	19,430,806
2312	8,734,583	5,342,610	365,758,448						763,230	54,957,196	283,604	19,714,410
2313	8,862,309	5,420,735	371,179,183						774,391	55,731,587	287,751	20,002,161
2314	8,991,903	5,500,003	376,679,185						785,715	56,517,301	291,959	20,294,120
2315	9,123,392	5,580,429	382,259,615						797,204	57,314,505	296,228	20,590,348
2316	9,256,804	5,662,032	387,921,647						808,862	58,123,367	300,560	20,890,908
2317	9,392,166	5,744,828	393,666,475						820,690	58,944,057	304,955	21,195,863
2318	9,529,509	5,828,835	399,495,310						832,691	59,776,748	309,414	21,505,277

[1] 2005 to 2030 Population Source: *Memorandum on the Economic and Demographic Impacts of a Knik Arm Bridge* ; Scott Goldsmith, ISER University of Alaska Anchorage; September 2005; Table 22A. Matanuska-Susitna Borough Census Area 2005 Knik Arm Base Case With Bridge; Page 88.

[2] 2032 growth rate and beyond assumed to be same as Alaska Department of Labor and Workforce Development, Research and Analysis Section data	1.64%
[3] Pounds of MSW per CY of Air Space =	1400
[4] Cover Soil to Air Space Ratio =	14%
[5] Cover Soil to Air Space Ratio (Ash) =	37%

[6] Base year assumed 2013

[7] Landfilling with WTE begins 2040. Assume 90% reduction in waste volume.

[8] Total airspace (including liner system and cover system) available is 56,570,000 CY, which includes 1,860,000 CY of liner/cover system soils

[9] Based on 359 day year

CY = cubic yards

MATANUSKA-SUSITNA BOROUGH

Table A-2

Population, C&D Disposal, Landfill Air Space Requirements, and Cover Soil Requirements Forecast

				Landfilling Only			
	Population[1,2]	C&D Disposal		Landfill Air Space Required		Cover Soil Required	
Year[6]		Yearly C&D (tons)	Cumulative C&D (tons)	Yearly Airspace [3] (CY)	Cumulative Air Space (CY)	Yearly Cover Soil [4] (CY)	Cumulative Cover Soil (CY)
2013	96,125	11,631					
2014	98,507	11,919	11,919	14,324	14,324	3,282	3,282
2015	100,948	12,214	24,133	14,679	29,004	3,363	6,646
2016	103,450	12,517	36,650	15,043	44,047	3,447	10,092
2017	106,013	12,827	49,477	15,416	59,463	3,532	13,625
2018	108,538	13,133	62,610	15,783	75,246	3,616	17,241
2019	111,123	13,445	76,055	16,159	91,404	3,702	20,943
2020	113,770	13,766	89,821	16,544	107,948	3,791	24,734
2021	116,479	14,094	103,915	16,938	124,886	3,881	28,615
2022	119,253	14,429	118,344	17,341	142,227	3,973	32,588
2023	122,050	14,768	133,111	17,748	159,975	4,067	36,655
2024	124,912	15,114	148,225	18,164	178,139	4,162	40,817
2025	127,842	15,468	163,694	18,590	196,729	4,260	45,076
2026	130,840	15,831	179,525	19,026	215,755	4,359	49,436
2027	133,908	16,202	195,727	19,472	235,227	4,462	53,897
2028	136,733	16,544	212,271	19,883	255,110	4,556	58,453
2029	139,618	16,893	229,164	20,302	275,413	4,652	63,105
2030	142,563	17,250	246,414	20,731	296,143	4,750	67,855
2031	145,571	17,613	264,027	21,168	317,311	4,850	72,705
2032	148,642	17,985	282,012	21,615	338,926	4,953	77,658
2033	151,078	18,280	300,292	21,969	360,895	5,034	82,691
2034	153,554	18,579	318,872	22,329	383,224	5,116	87,808
2035	156,071	18,884	337,756	22,695	405,919	5,200	93,008
2036	158,629	19,193	356,949	23,067	428,986	5,285	98,293
2037	161,229	19,508	376,457	23,445	452,431	5,372	103,665
2038	163,587	19,793	396,250	23,788	476,219	5,450	109,115
2039	165,979	20,083	416,333	24,136	500,354	5,530	114,646
2040	168,406	20,376	436,710	24,489	524,843	5,611	120,257
2041	170,868	20,674	457,384	24,847	549,690	5,693	125,950
2042	173,367	20,977	478,361	25,210	574,900	5,776	131,726
2043	175,902	21,283	499,644	25,579	600,478	5,861	137,587
2044	178,474	21,595	521,239	25,953	626,431	5,947	143,533
2045	181,084	21,910	543,149	26,332	652,763	6,033	149,567
2046	183,732	22,231	565,380	26,717	679,481	6,122	155,689

MATANUSKA-SUSITNA BOROUGH

Table A-2

Population, C&D Disposal, Landfill Air Space Requirements, and Cover Soil Requirements Forecast

				Landfilling Only			
	Population[1,2]	**C&D Disposal**		**Landfill Air Space Required**		**Cover Soil Required**	
Year[6]		Yearly C&D (tons)	Cumulative C&D (tons)	Yearly Airspace [3] (CY)	Cumulative Air Space (CY)	Yearly Cover Soil [4] (CY)	Cumulative Cover Soil (CY)
2047	186,419	22,556	587,936	27,108	706,589	6,211	161,900
2048	189,145	22,886	610,822	27,504	734,093	6,302	168,202

[1] 2005 to 2030 Population Source: *Memorandum on the Economic and Demographic Impacts of a Knik Arm Bridge* ; Scott Goldsmith, ISER University of Alaska Anchorage; September 2005; Table 22A. Matanuska-Susitna Borough Census Area 2005 Knik Arm Base Case With Bridge; Page 88.

[2] 2032 growth rate and beyond assumed to be same as Alaska Department of Labor and Workforce Development, Research and Analysis Section data	1.64%
[3] Pounds of C&D per cy of Air Space =	1664
[4] Cover Soil to Air Space Ratio =	23%

[6] Base year assumed 2013

[6] Total airspace available is 690,000 cubic yards. Assume 1 foot of cover over C&D is adequate for final cover.

CY = cubic yards

Appendix B
Matanuska-Susitna Landfill: Stability Evaluation Technical Memorandum

Matanuska-Susitna Landfill: Stability Evaluation

PREPARED FOR: Wright, Shannon/SAC
COPY TO: Harris, Dean/SAC

PREPARED BY: Mayer, Andrew/SAC
DATE: July 28, 2014
PROJECT NUMBER: 496410

This memorandum was prepared to summarize a stability analysis performed on three cross sections of the Matanuska-Susitna Borough Central Landfill. Material properties, geotechnical design criteria, and analyses are summarized below.

Material Properties

Material properties are based on properties used for previous studies. The landfill is comprised of waste overlying an impermeable barrier of a geosynthetic clay liner, granular drain material and an HDPE geomembrane, which overlies native soil.

TABLE 1
Material Properties for Analysis
Mat-Su Landfill

Material/Interface	Peak Friction Angle/ Cohesion Intercept	Residual Friction Angle/ Cohesion Intercept	Unit Weight (pcf)
GCL/HDPE	26˚, 500 psf	10˚, 500 psf	120
HDPE/ Granular Drain Material	28˚, 0 psf	28˚, 0 psf	120
Native Soil	35˚, 0 psf	35˚, 0 psf	130
Waste	20˚, 600 psf	20˚, 600 psf	75

Design Criteria

Shear strength and other stability considerations for geotechnical evaluation are based on previous studies (CH2M HILL, 2010). Mohr-Coulomb effective stress failure criterion was used for all analyses.

Three failure scenarios were considered for analysis of each landfill cross section. The slope stability software SLIDE was used to evaluate a circular slope failure, a block failure near or through the lining material, and failure through the lining. Static and seismic loading were evaluated for each failure mechanism. A minimum factor of safety of 1.5 and 1.0 are required for static and seismic conditions, respectively.

Stark (1994) recommended the use of residual shear strength along the side slopes to account for "down-drag" shearing or the displacements exerted on the lining system due to the settlement of landfill waste. The critical component of the lining system along the side slopes is the GCL at residual internal shear strength. Lining along the base will not be subject to downdrag and therefore the critical component to be considered is the interface strength of the HDPE geomembrane with the granular drain material.

Water level is conservatively assumed to be 6 feet above the lowest point of the landfill lining. This is not anticipated to occur in landfill operations but is intended to be a worst case scenario.

A horizontal pseudo static coefficient of 0.13, approximately half of the site peak ground acceleration, 0.25g, of the 50 year recurrence earthquake, is used for seismic analyses.

Results

SLIDE output results can be found in Attachment 1 of this memo and are summarized in tabular format below.

TABLE 2
SLIDE ANALYSIS RESULTS
Mat-Su Landfill – Cross Section A

Slip Surface	Case	Analysis Method	Required Factor of Safety	Computed Factor of Safety
Circular	Static	Spencer	1.5	2.0
	Seismic	Spencer	1.0	1.4
Block	Static	Spencer	1.5	2.1
	Seismic	Spencer	1.0	1.5
Lining System	Static	Spencer	1.5	2.1
	Seismic	Spencer	1.0	1.4

Note: Seismic analysis performed using horizontal pseudo-static coefficient of 0.13.

TABLE 3
SLIDE ANALYSIS RESULTS
Mat-Su Landfill – Cross Section B

Slip Surface	Case	Analysis Method	Required Factor of Safety	Computed Factor of Safety
Circular	Static	Spencer	1.5	2.0
	Seismic	Spencer	1.0	1.3
Block	Static	Spencer	1.5	2.2
	Seismic	Spencer	1.0	1.5
Lining System	Static	Spencer	1.5	2.2
	Seismic	Spencer	1.0	1.4

Note: Seismic analysis performed using horizontal pseudo-static coefficient of 0.13.

TABLE 4
SLIDE ANALYSIS RESULTS
Mat-Su Landfill – Cross Section D

Slip Surface	Case	Analysis Method	Required Factor of Safety	Computed Factor of Safety
Circular	Static	Spencer	1.5	2.1
	Seismic	Spencer	1.0	1.4
Block	Static	Spencer	1.5	2.1
	Seismic	Spencer	1.0	1.4
Lining System	Static	Spencer	1.5	2.1
	Seismic	Spencer	1.0	1.5

Note: Seismic analysis performed using horizontal pseudo-static coefficient of 0.13.

Conclusions

Acceptable factors of safety were calculated for cross sections A, B, and D for each of the considered potential failure modes. The computed factors of safety are similar in all each of the three cases and are well above required limits.

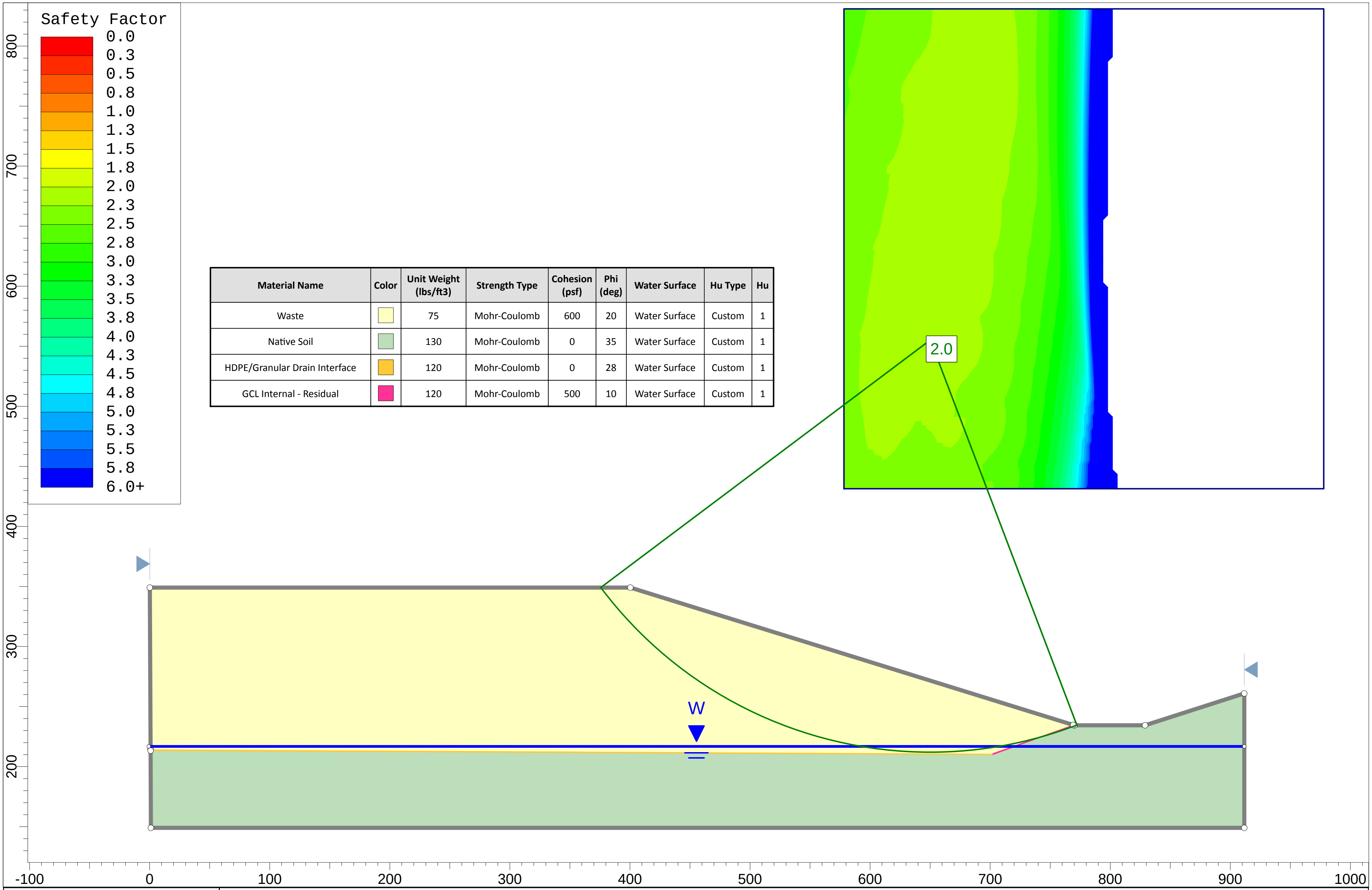
References

CH2M HILL (2010). Slope Stability Evaluation, Leachate Collection System Improvements Design Project, Prepared for Mat-Su Borough, Alaska. October 2010.

Rocscience, Inc. (2014). SLIDE Computer Software. Version 6.029, Build date: April 25, 2014.

Attachment 1

SLIDE OUTPUT



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project	Matanuska-Susitna Borough Central Landfill
Case	**Section A Circular Failure - Static**
Description	

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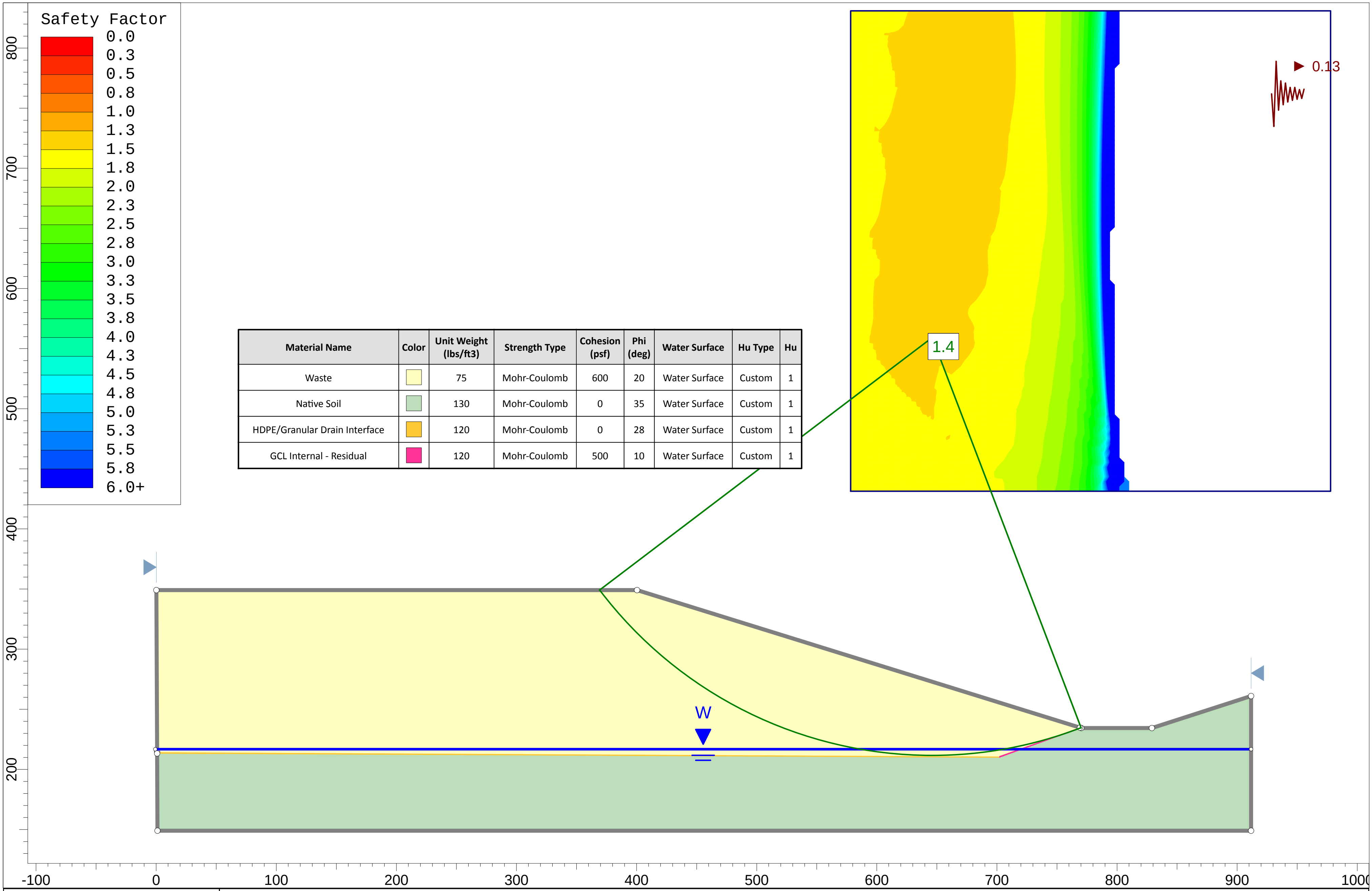

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project	Matanuska-Susitna Borough Central Landfill				
Case	**Section A Circular Failure - Seismic**				
Description					
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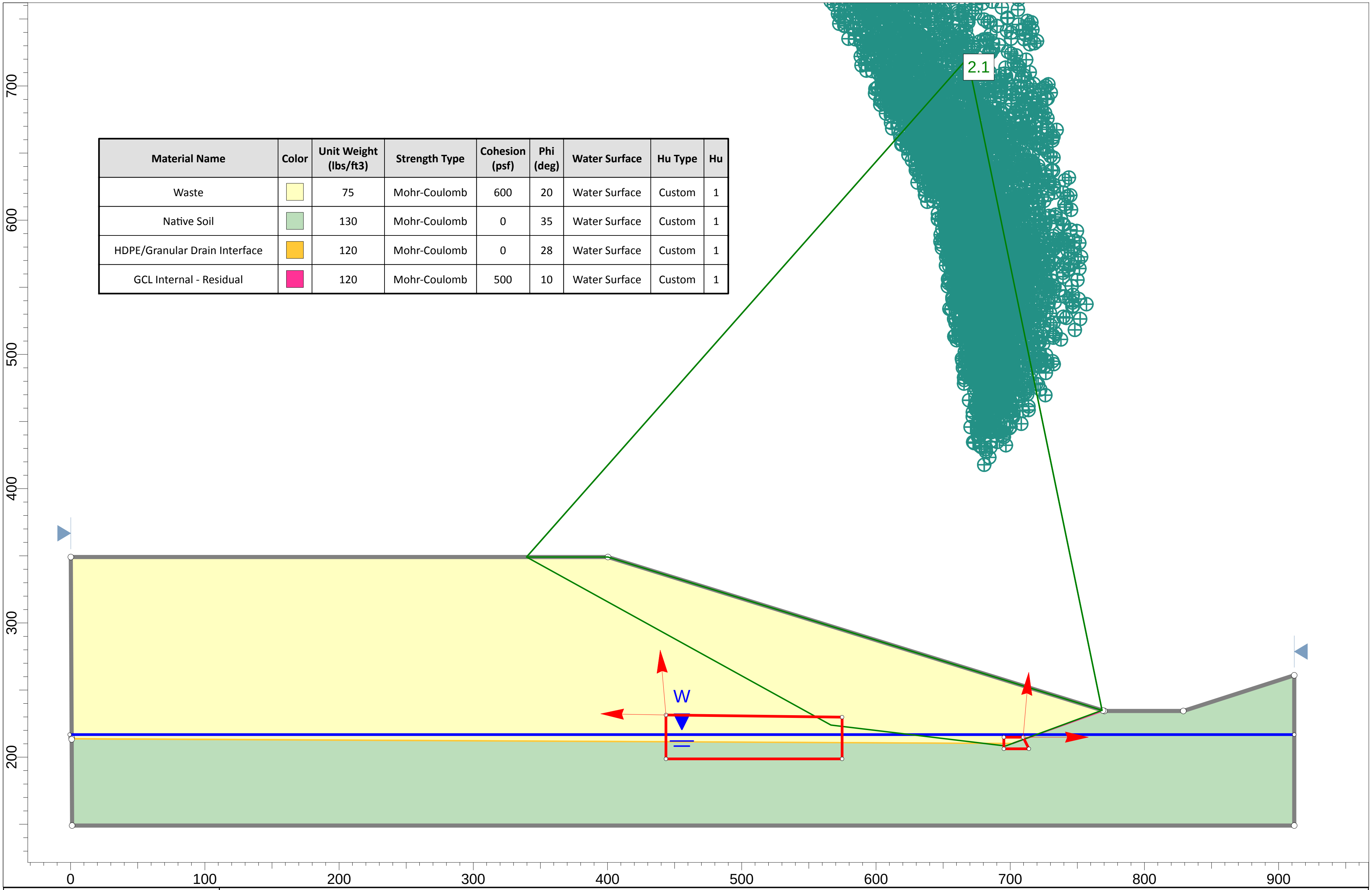

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟥	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project	Matanuska-Susitna Borough Central Landfill
Case	**Section A Block Failure - Static**
Description	

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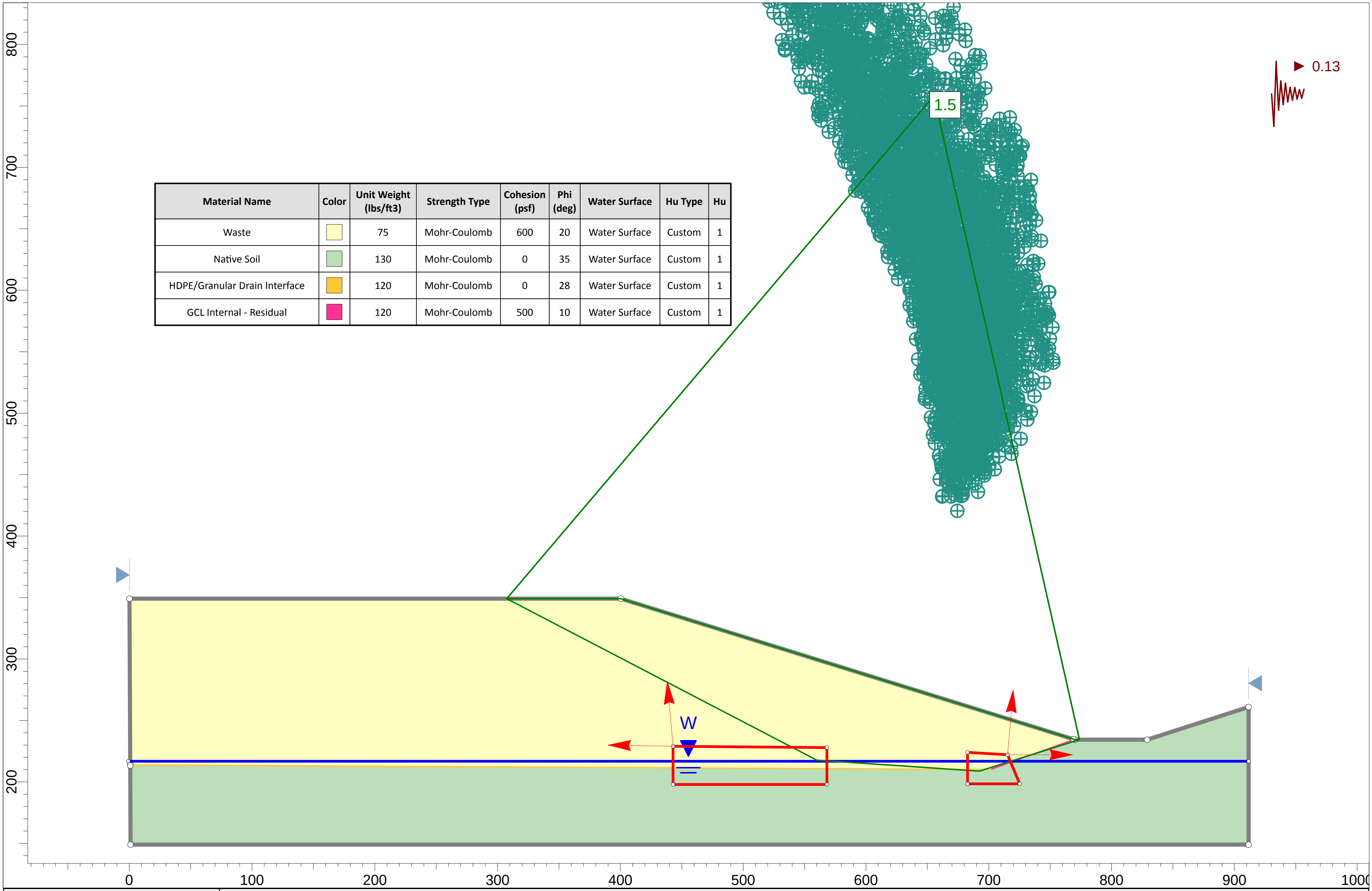

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project Matanuska-Susitna Borough Central Landfill

Case **Section A Block Failure - Seismic**

Description

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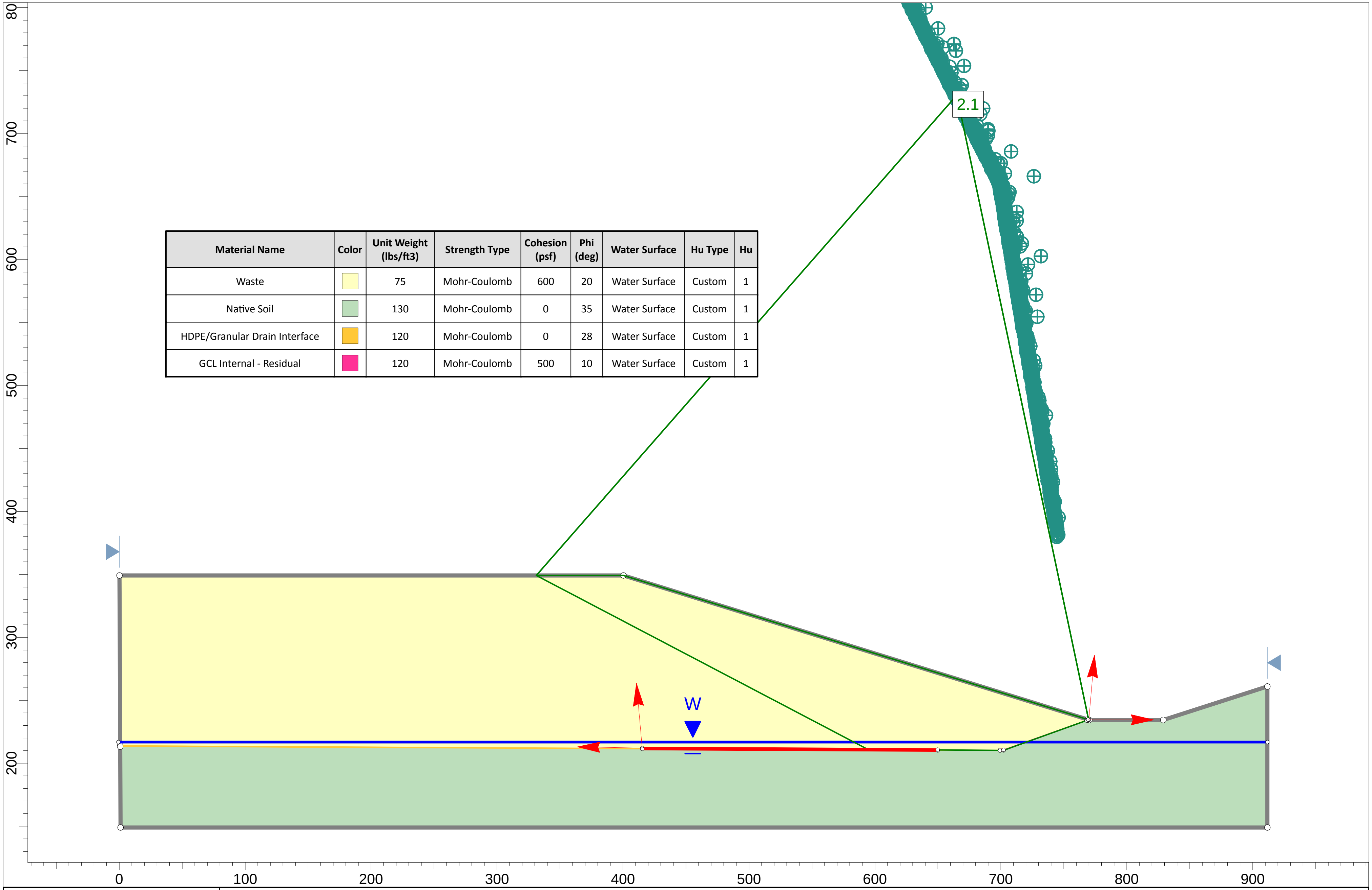


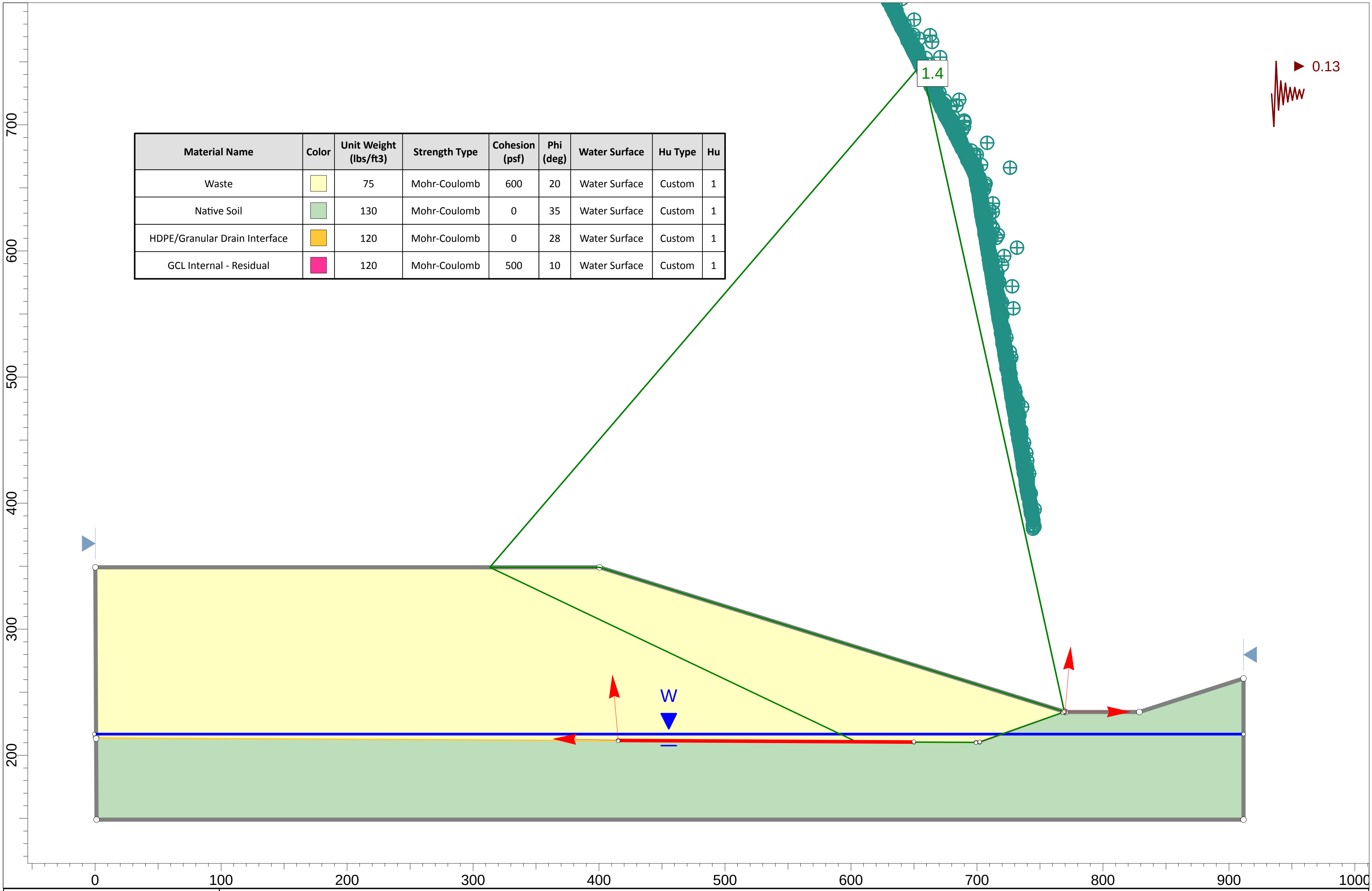
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project	Matanuska-Susitna Borough Central Landfill
Case	**Section A Lining Failure - Static**
Description	

Date 7/25/2014 2:17:58 PM *Scale:* 1:1239 *File Name* Section A.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟥	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project Matanuska-Susitna Borough Central Landfill

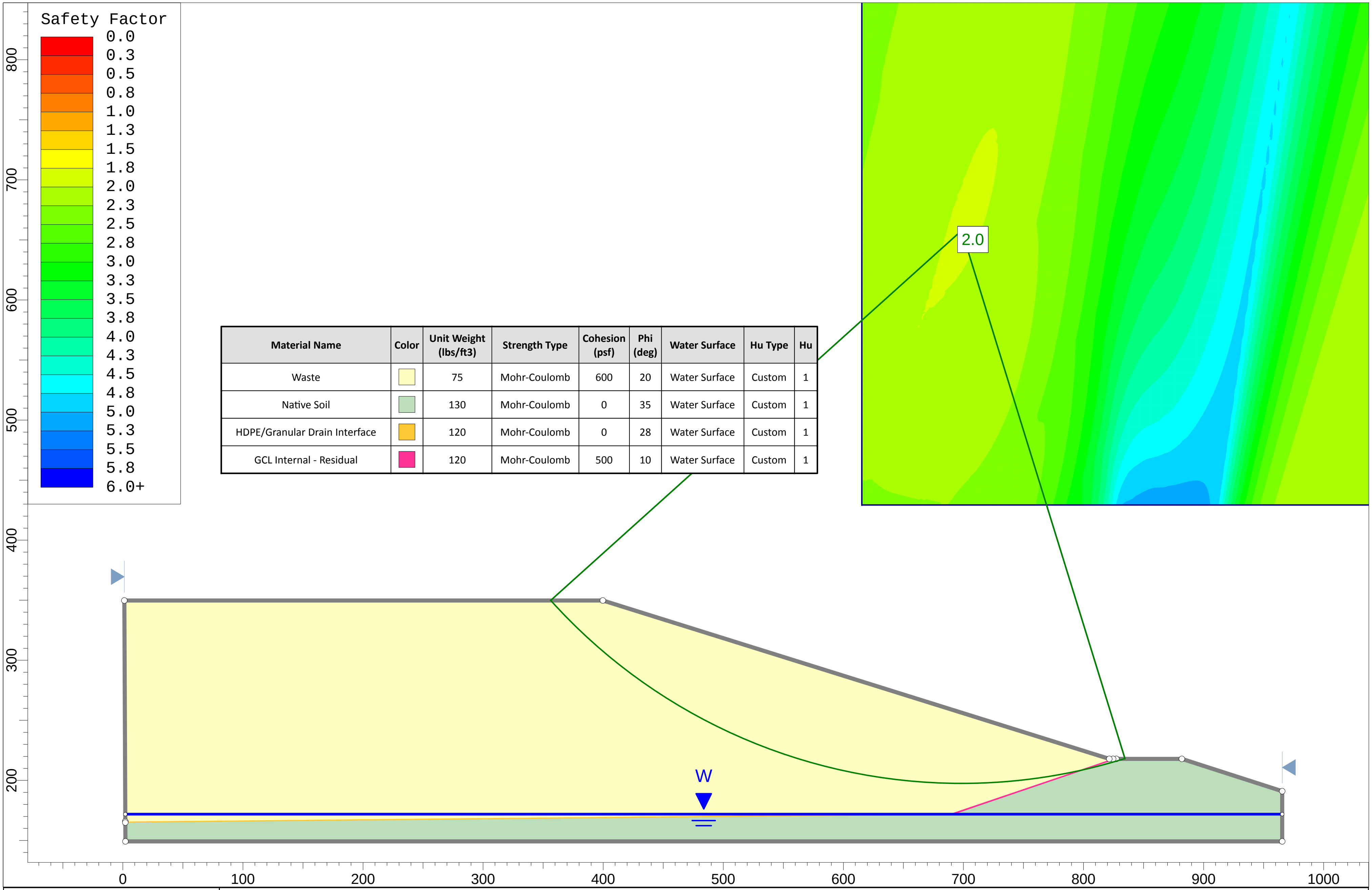
Case **Section A Lining Failure - Seismic**

Description

Date 7/25/2014 2:19:26 PM

Scale: 1:1239

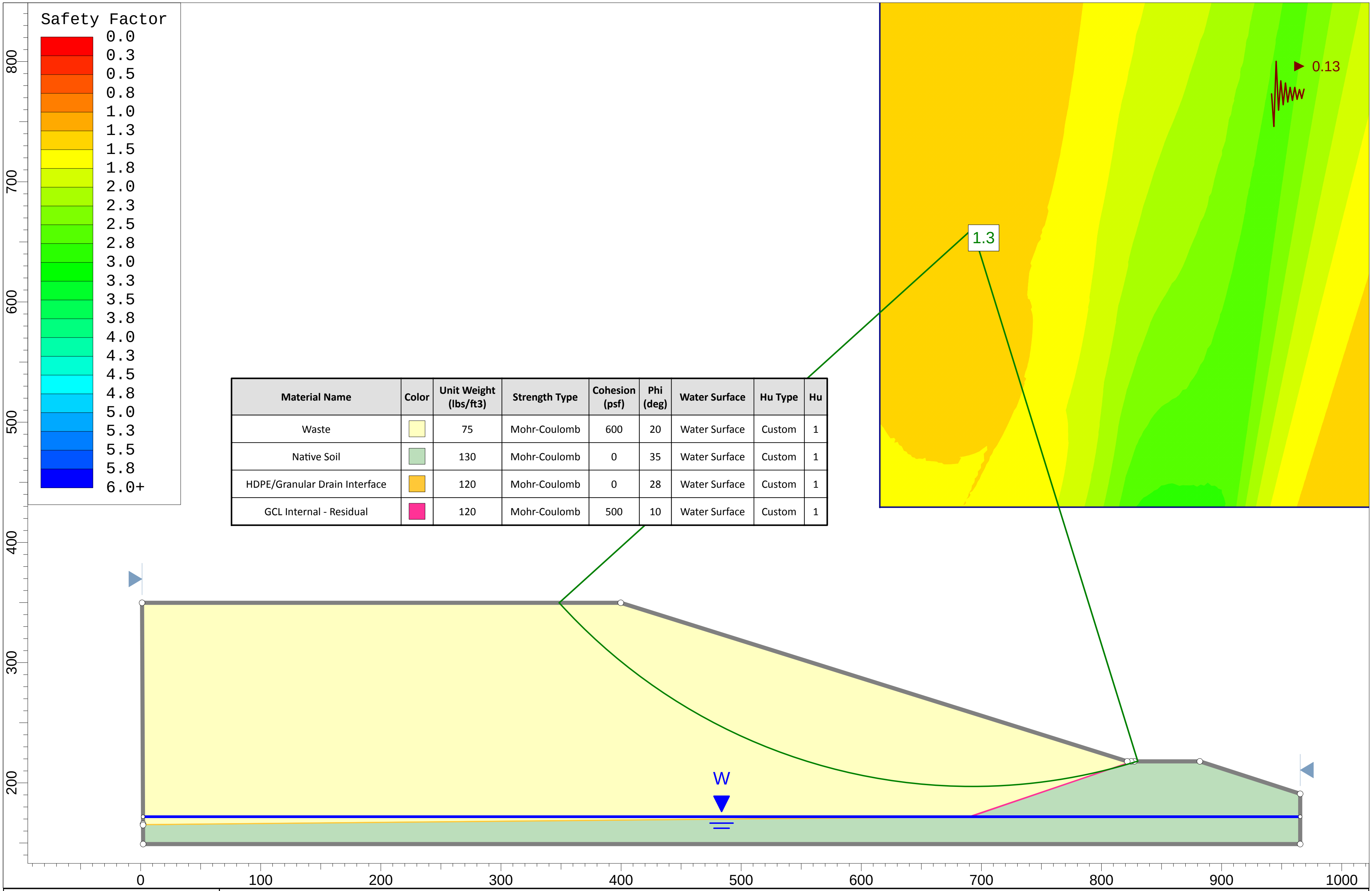
File Name Section A.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL
SLIDEINTERPRET 6.029

Project Matanuska-Susitna Borough Central Landfill
Case **Section B Circular Failure - Static**
Description
Date 7/28/2014 2:03:00 PM *Scale:* 1:1300 *File Name* Section B circular.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

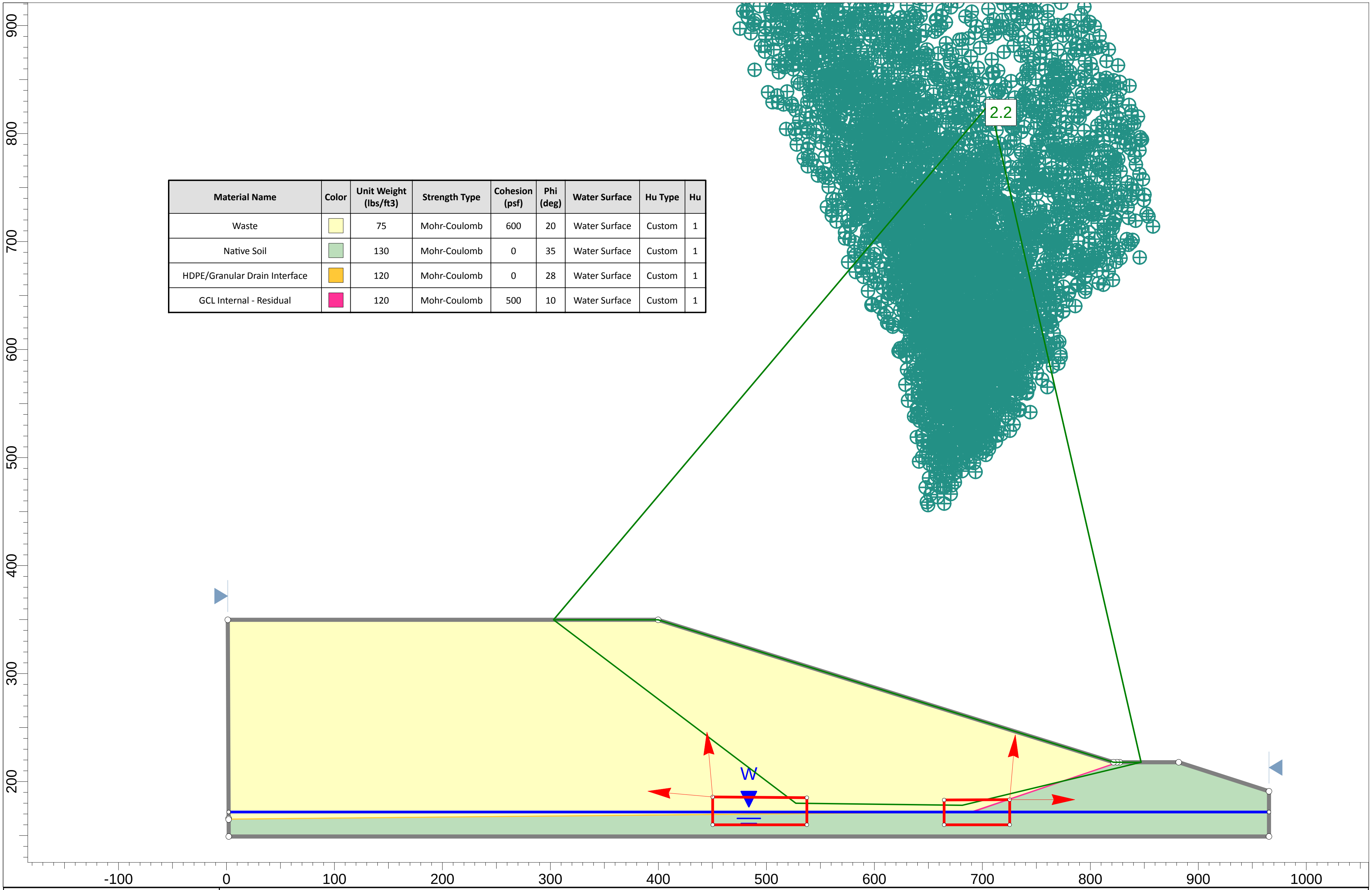
SLIDEINTERPRET 6.029

Project Matanuska-Susitna Borough Central Landfill

Case **Section B Circular Failure - Seismic**

Description

Date 7/28/2014 2:01:02 PM *Scale:* 1:1300 *File Name* Section B circular.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟥	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project Matanuska-Susitna Borough Central Landfill

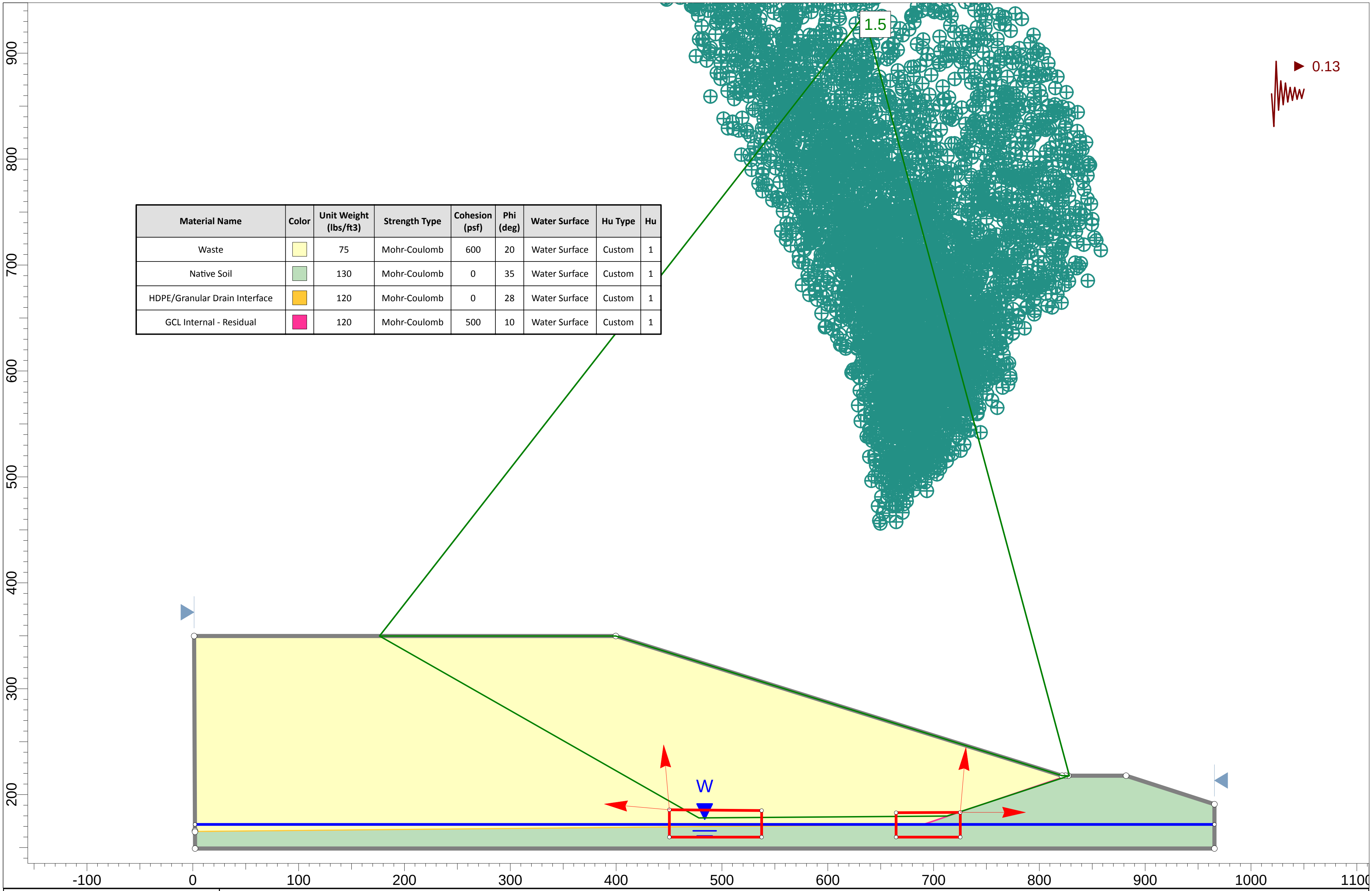
Case **Section B Block Failure - Static**

Description

Date 7/24/2014 8:22:01 AM

Scale: 1:1446

File Name Section B block seismic.slim



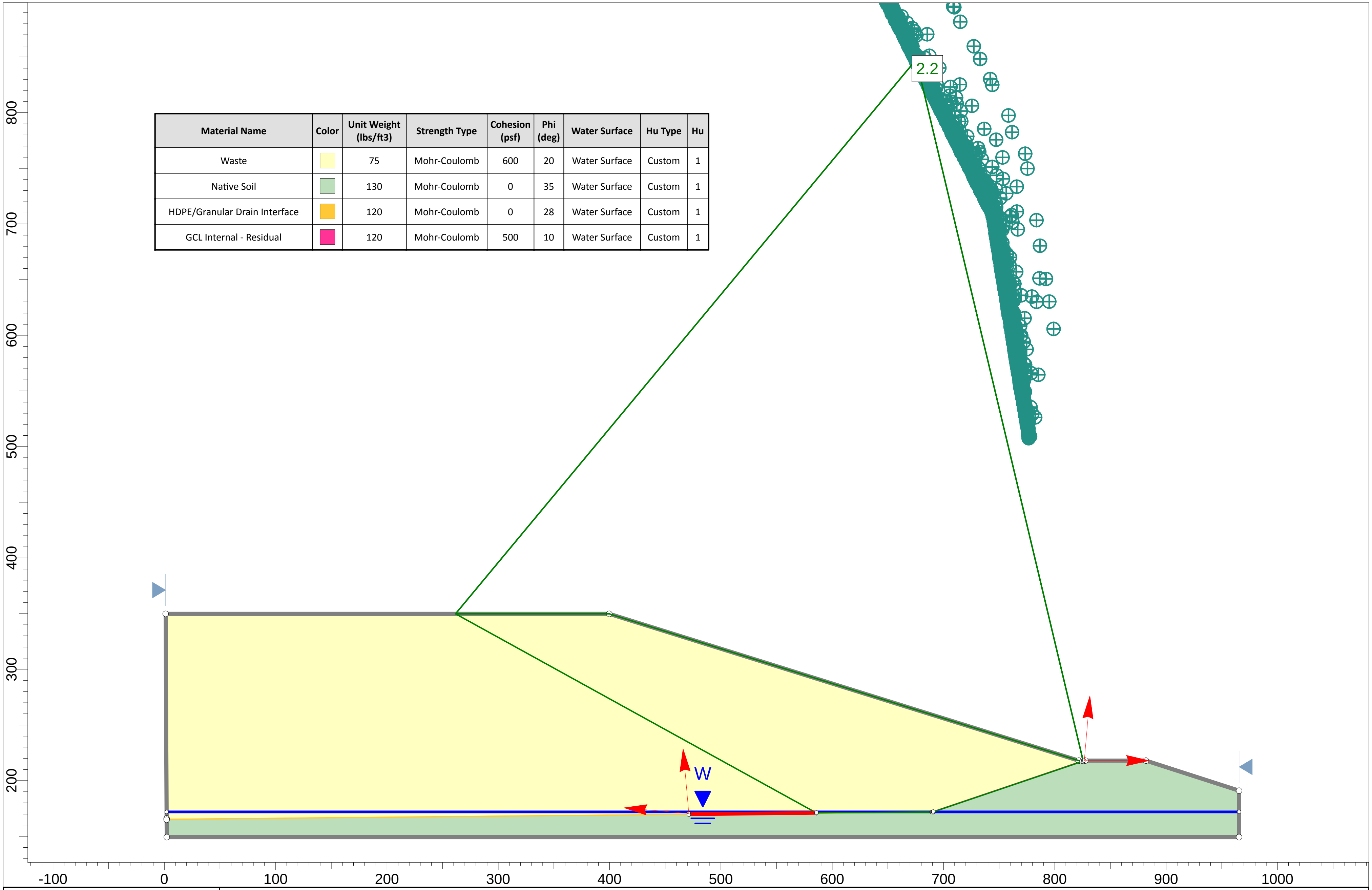
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟥	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project	Matanuska-Susitna Borough Central Landfill
Case	**Section B Block Failure - Seismic**
Description	

Date 7/24/2014 8:16:47 AM *Scale:* 1:1476 *File Name* Section B block seismic.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟥	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

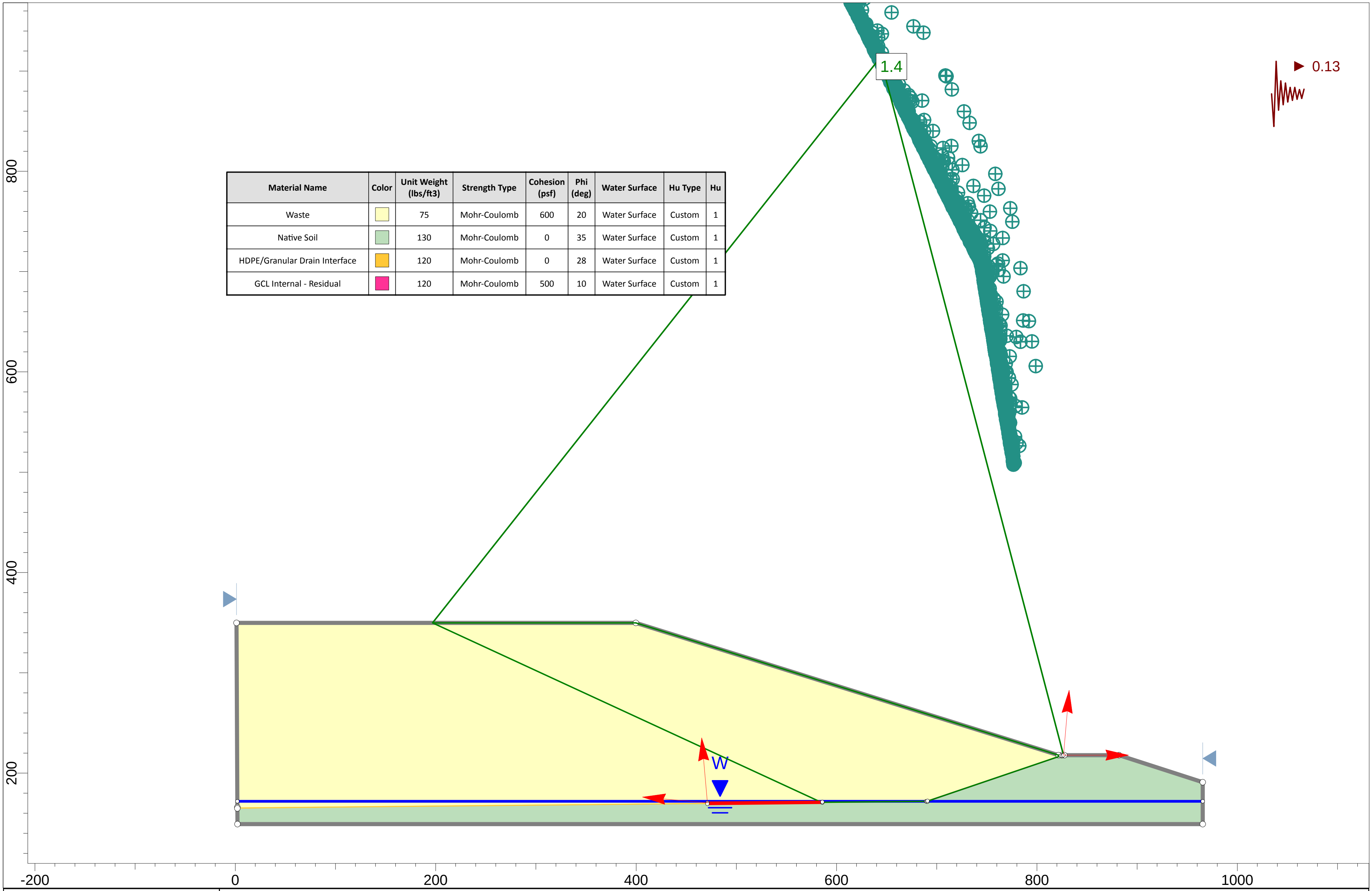
SLIDEINTERPRET 6.029

Project Matanuska-Susitna Borough Central Landfill

Case **Section B Lining Failure - Static**

Description

Date 7/24/2014 7:49:39 AM *Scale:* 1:1402 *File Name* Section B.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟧	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

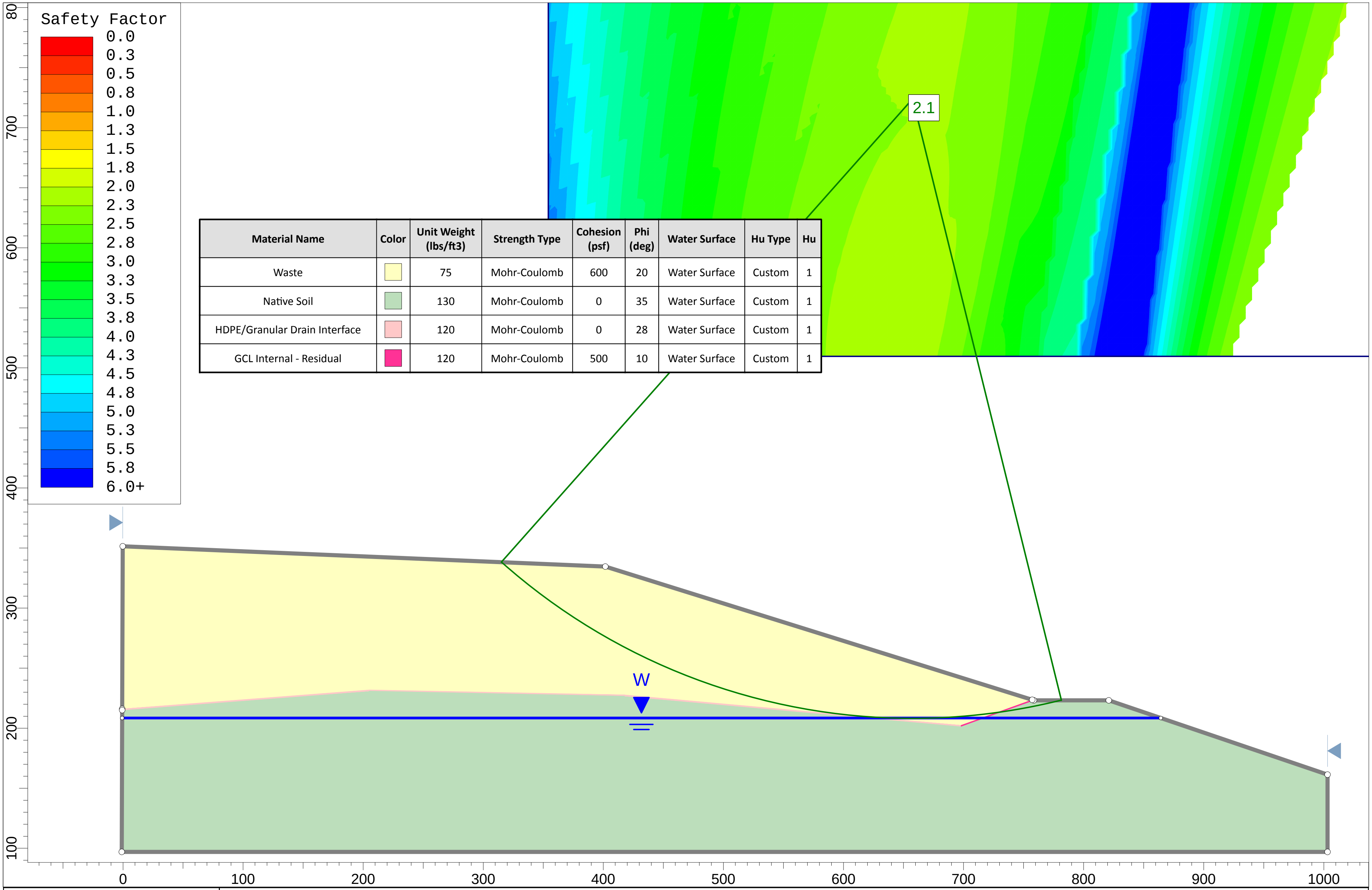
SLIDEINTERPRET 6.029

Project Matanuska-Susitna Borough Central Landfill

Case **Section B Lining Failure - Seismic**

Description

Date 7/24/2014 7:44:23 AM *Scale:* 1:1558 *File Name* Section B.slim



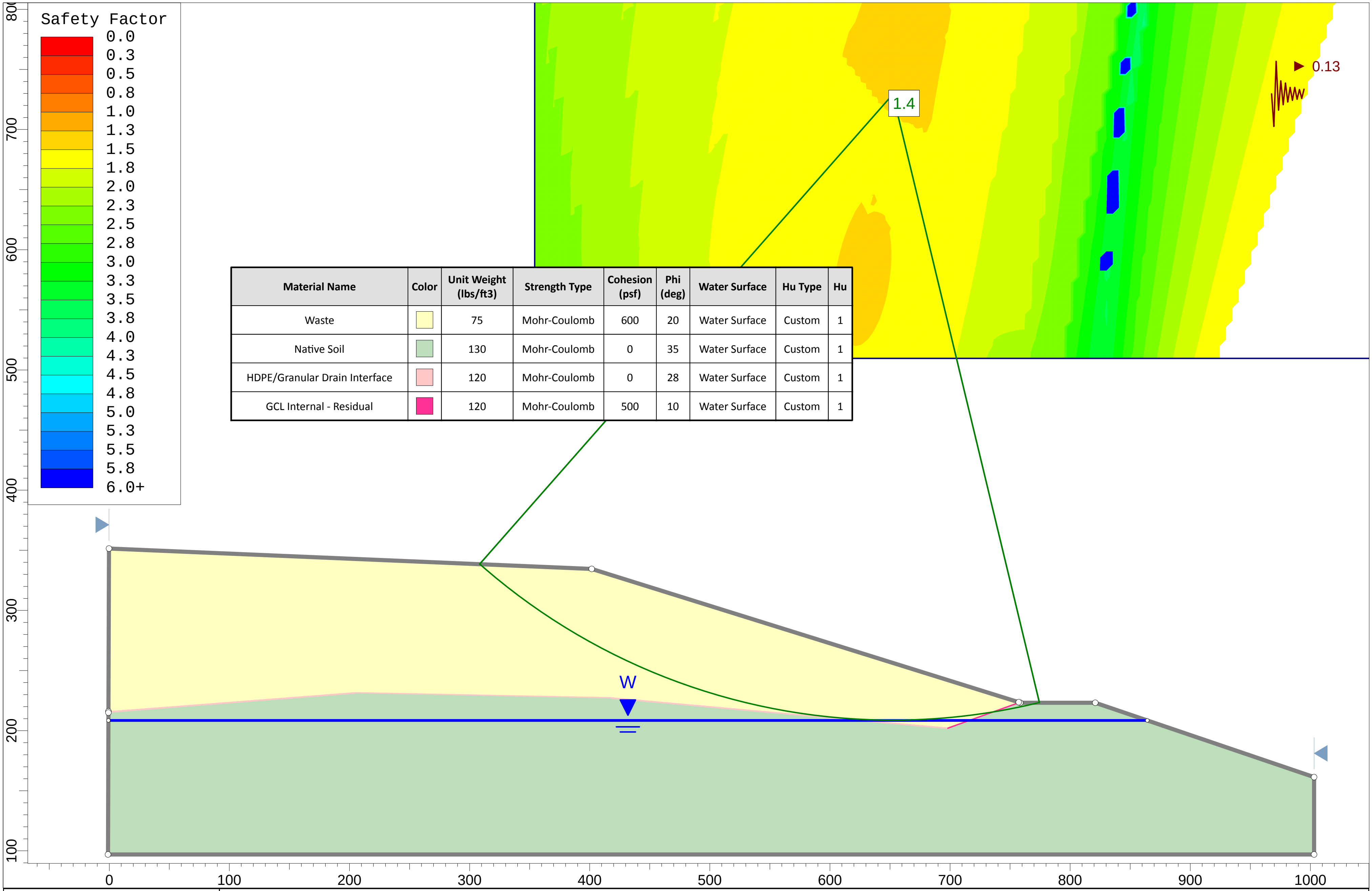
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟥	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project	Matanuska-Sisitna Borough Central Landfill
Case	**Section D Circular Failure - Static**
Description	

Date 7/28/2014 12:51:48 PM *Scale:* 1:1300 *File Name* Section D.slim



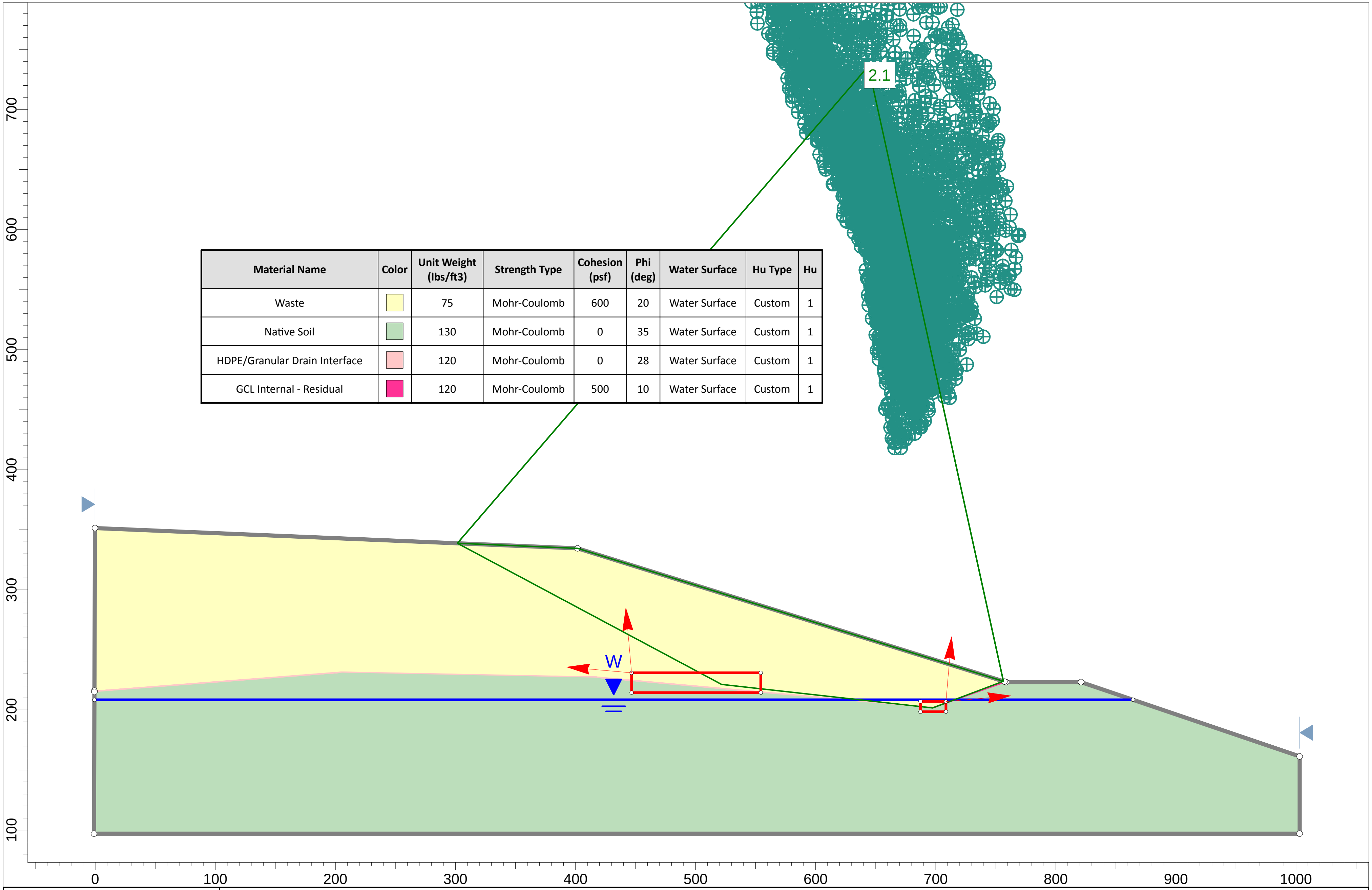
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	▨	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project	Matanuska-Sisitna Borough Central Landfill
Case	**Section D Circular Failure - Seismic**
Description	

Date 7/28/2014 12:49:40 PM *Scale:* 1:1300 *File Name* Section D.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟥	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

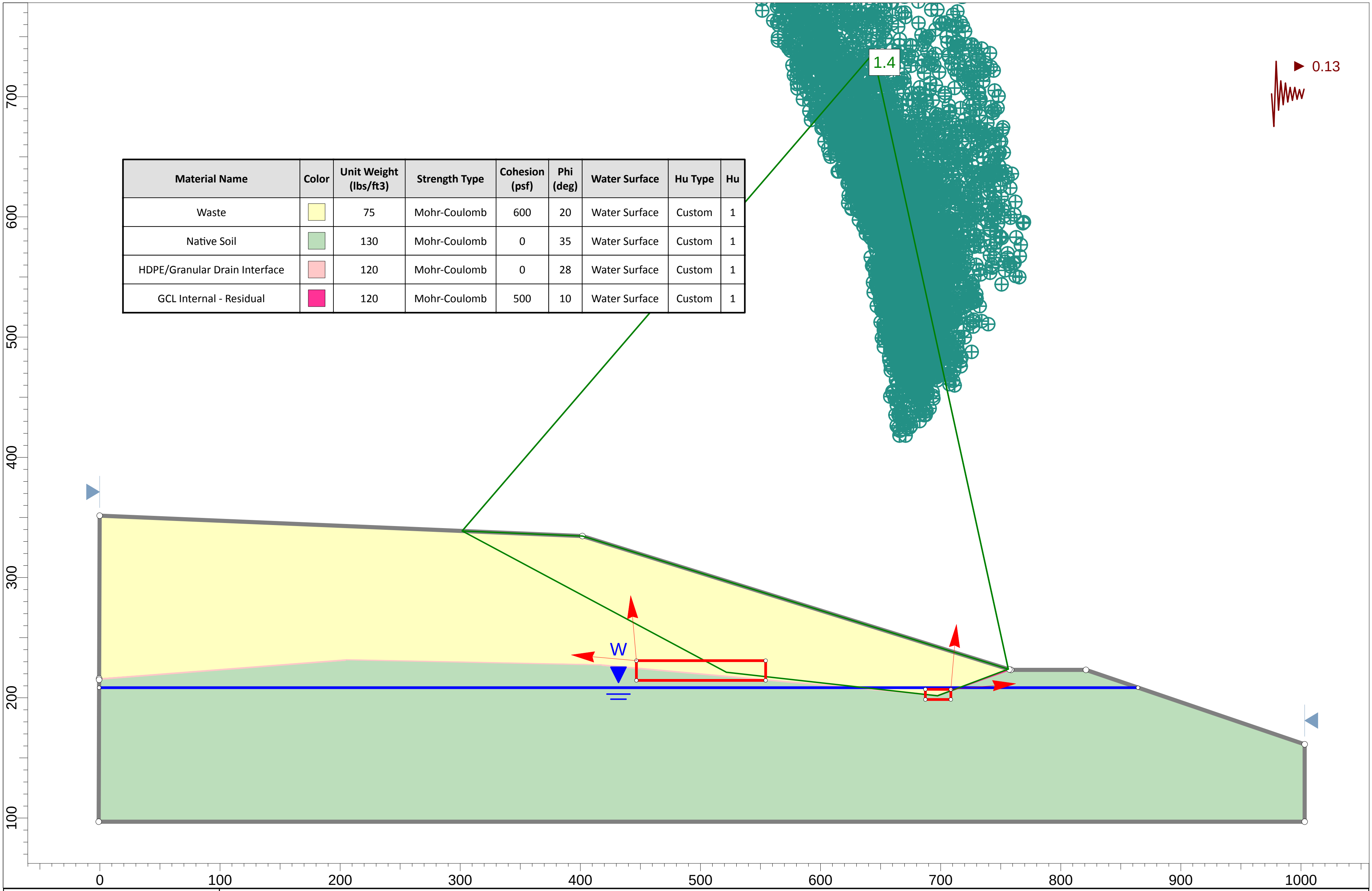
SLIDEINTERPRET 6.029

Project Matanuska-Sisitna Borough Central Landfill

Case **Section D Block Failure - Static**

Description

Date 7/28/2014 12:57:44 PM *Scale:* 1:1300 *File Name* Section D.slim



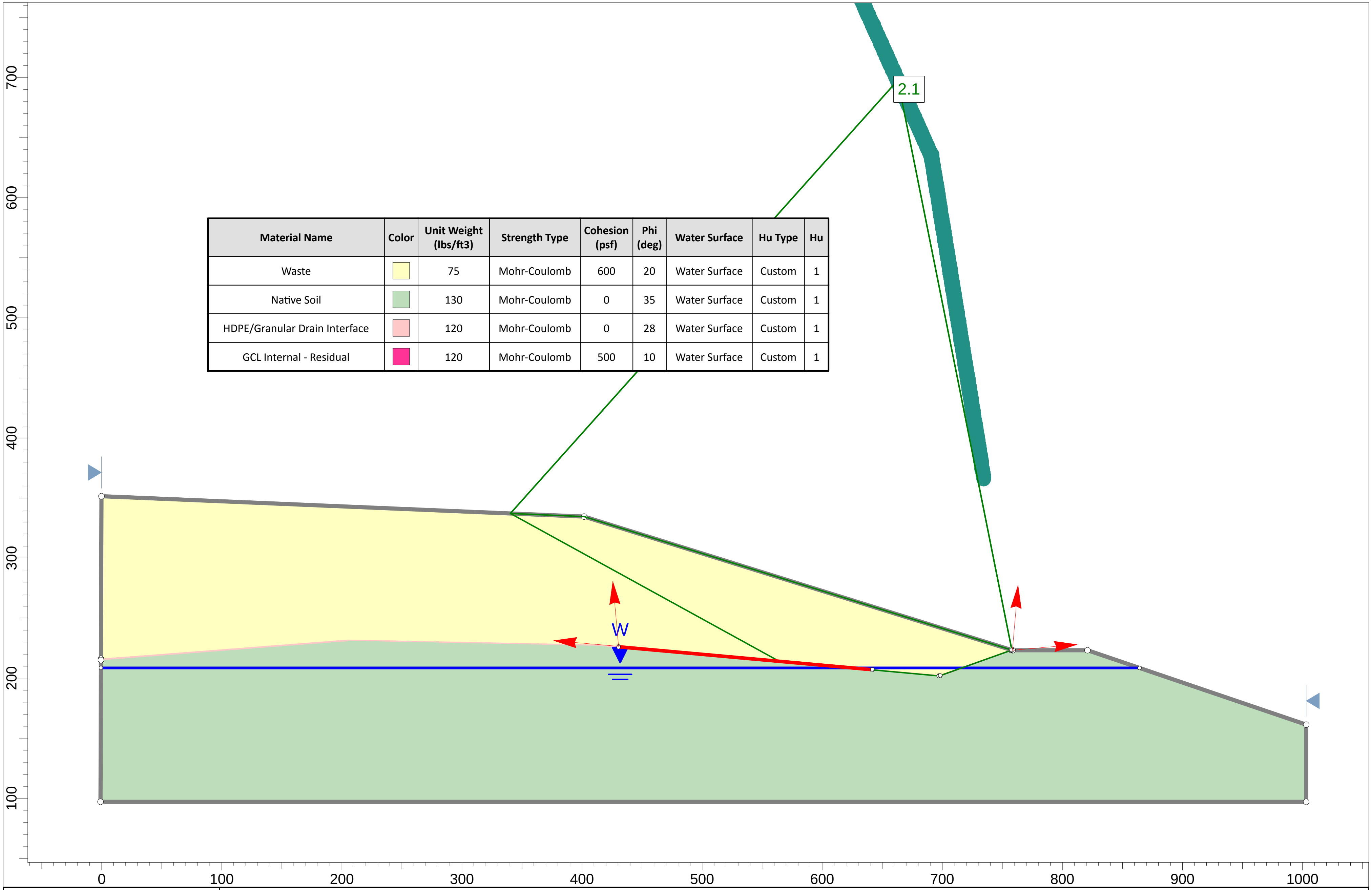
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟥	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project	Matanuska-Sisitna Borough Central Landfill
Case	**Section D Block Failure - Seismic**
Description	

Date 7/28/2014 12:59:27 PM *Scale:* 1:1300 *File Name* Section D.slim



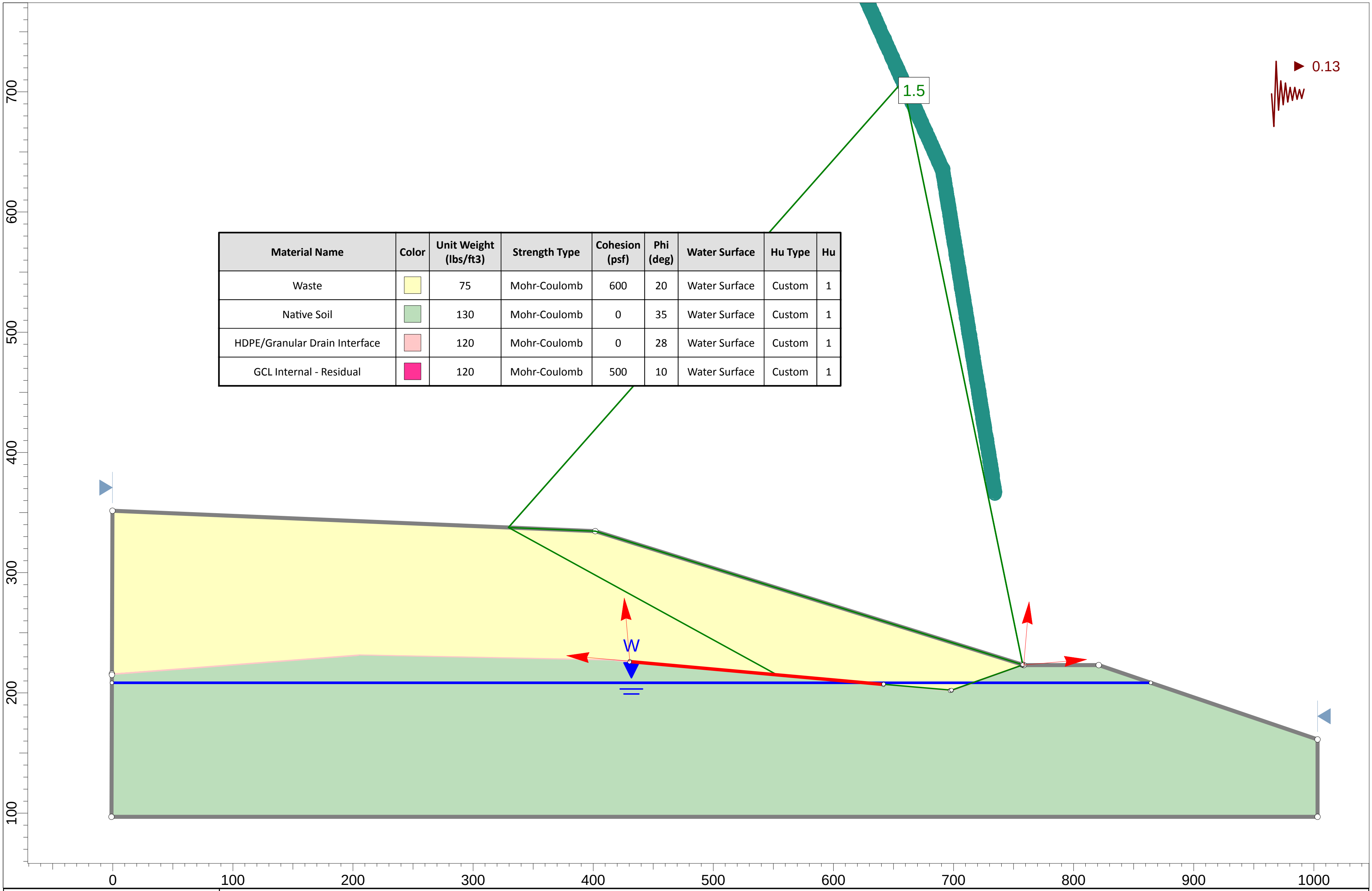
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟥	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟥	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project	Matanuska-Sisitna Borough Central Landfill
Case	**Section D Lining Failure - Static**
Description	

Date	7/28/2014 1:04:05 PM	*Scale:*	1:1300	*File Name*	Section D.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Waste	🟨	75	Mohr-Coulomb	600	20	Water Surface	Custom	1
Native Soil	🟩	130	Mohr-Coulomb	0	35	Water Surface	Custom	1
HDPE/Granular Drain Interface	🟥	120	Mohr-Coulomb	0	28	Water Surface	Custom	1
GCL Internal - Residual	🟪	120	Mohr-Coulomb	500	10	Water Surface	Custom	1

CH2MHILL

SLIDEINTERPRET 6.029

Project Matanuska-Sisitna Borough Central Landfill

Case **Section D Lining Failure - Seismic**

Description

Date 7/28/2014 1:02:56 PM *Scale:* 1:1300 *File Name* Section D.slim

Appendix C
Estimated Life of MSW Cells

Matanuska-Susitna Central Landfill
Table C-1
Estimated Life of MSW Cells w/o Valley Fills

			Cell Volume										
Year	Cell	Total Volume Above Liner 1 (cy)	Area, Bottom Liner (sf)	Total Volume of Bottom Liner Soil (cy)	Area, Final Cover (sf)	Total Volume of Final Cover 2 (cy)	Total Airspace Required[3] (cy)	Total Daily / Intermediate Cover Soils (cy)	Net volume at beginning of year (cy)	Net volume at end of year (cy)	Cumulative Net Volume Used (cy)	Start/Full Dates	Cell Life (Years)
EXISTING LANDFILL AREA													
2013	3[4]	880,567	-	-	442,842	32,803	33,138	4,524	847,764	814,626	33,138	May-13	
2014							86,076	11,750	814,626	728,550	119,213		
2015							88,209	12,041	728,550	640,342	207,422		
2016							90,395	12,340	640,342	549,947	297,817		
2017							92,634	12,645	549,947	457,313	390,451		
2018							94,841	12,947	457,313	362,472	485,292		
2019							97,100	13,255	362,472	265,372	582,391		
2020							99,412	13,571	265,372	165,960	681,804		
2021							101,780	13,894	165,960	64,181	783,583		
2022							64,181	8,761	64,181	0	847,764	Aug-22	9.2
	Total						**847,764**	**115,727**					
2022	4	522,859	212,465	15,738	170,263	12,612	40,023	5,463	494,509	454,486	40,023	Aug-22	
2023							106,648	14,558	454,486	347,838	146,671		
2024							109,149	14,900	347,838	238,689	255,819		
2025							111,708	15,249	238,689	126,981	367,528		
2026							114,328	15,607	126,981	12,653	481,856		
2027							12,652	1,727	12,653	0	494,508	Feb-27	4.5
	Total						**494,508**	**67,504**					
2027	5	595,005	128,514	9,520	79,020	5,853	104,357	14,246	579,632	475,275	104,357	Feb-27	
2028							119,478	16,310	475,275	355,797	223,835		
2029							121,998	16,654	355,797	233,799	345,833		
2030							124,572	17,005	233,799	109,227	470,405		
2031							109,227	14,910	109,227	0	579,632	Oct-31	4.7
	Total						**579,632**	**79,124**					
2031	6	588,977	166,611	12,342	125,731	9,313	17,973	2,453	567,322	549,349	17,973	Oct-31	
2032							129,883	17,730	549,349	419,466	147,856		
2033							132,012	18,021	419,466	287,454	279,868		
2034							134,176	18,316	287,454	153,278	414,044		
2035							136,375	18,616	153,278	16,902	550,420		
2036							16,902	2,307	16,902	0	567,322	Feb-36	4.3
	Total						**567,322**	**77,444**					
2036	7	1,114,301	78,134	5,788	324,776	24,057	121,708	16,614	1,084,456	962,748	121,708	Feb-36	
2037							140,882	19,232	962,748	821,866	262,590		
2038							142,942	19,513	821,866	678,923	405,533		
2039							145,033	19,798	678,923	533,891	550,565		
2040							147,153	20,088	533,891	386,737	697,719		
2041							149,305	20,381	386,737	237,432	847,024		
2042							151,489	20,679	237,432	85,943	998,512		
2043							85,944	11,732	85,943	0	1,084,456	Jul-43	7.4
	Total						**1,084,456**	**148,037**					
FUTURE LANDFILL PHASE 1													
2043	8	967,004	579,484	42,925	-	-	67,760	9,250	924,079	856,319	67,760	Jul-43	
2044							155,951	21,289	856,319	700,368	223,712		
2045							158,232	21,600	700,368	542,136	381,944		
2046							160,546	21,916	542,136	381,590	542,489		
2047							162,893	22,236	381,590	218,697	705,383		
2048							165,275	22,561	218,697	53,421	870,658		
2049							53,421	7,292	53,421	0	924,079	Apr-49	5.8

Matanuska-Susitna Central Landfill
Table C-1
Estimated Life of MSW Cells w/o Valley Fills

			Cell Volume										
Year	Cell	Total Volume Above Liner 1 (cy)	Area, Bottom Liner (sf)	Total Volume of Bottom Liner Soil (cy)	Area, Final Cover (sf)	Total Volume of Final Cover 2 (cy)	Total Airspace Required^3 (cy)	Total Daily / Intermediate Cover Soils (cy)	Net volume at beginning of year (cy)	Net volume at end of year (cy)	Cumulative Net Volume Used (cy)	Start/Full Dates	Cell Life (Years)
	Total						**924,079**	**126,144**					
2049	9	888,704	309,863	22,953	12,568	931	114,271	15,599	864,820	750,549	114,271	Apr-49	
2050							170,144	23,226	750,549	580,405	284,415		
2051							172,632	23,566	580,405	407,772	457,048		
2052							175,157	23,910	407,772	232,616	632,205		
2053							177,718	24,260	232,616	54,897	809,923		
2054							54,897	7,494	54,897	0	864,820	Mar-54	4.9
	Total						**864,820**	**118,055**					
2054	10	891,498	310,130	22,973	80,012	5,927	125,420	17,121	862,599	737,179	125,420	Mar-54	
2055							182,954	24,975	737,179	554,225	308,374		
2056							185,629	25,340	554,225	368,596	494,003		
2057							188,344	25,710	368,596	180,252	682,346		
2058							180,252	24,606	180,252	0	862,598	Dec-58	4.7
	Total						**862,598**	**117,752**					
2058	11	1,349,976	412,114	30,527	256,964	19,034	10,845	1,480	1,300,415	1,289,569	10,845	Dec-58	
2059							193,892	26,468	1,289,569	1,095,677	204,738		
2060							196,727	26,855	1,095,677	898,950	401,465		
2061							199,604	27,248	898,950	699,346	601,069		
2062							202,523	27,646	699,346	496,823	803,592		
2063							205,485	28,050	496,823	291,338	1,009,077		
2064							208,489	28,460	291,338	82,849	1,217,566		
2065							82,849	11,310	82,849	0	1,300,415	May-65	6.5
	Total						**1,300,415**	**177,517**					
2065	12	1,136,637	377,291	27,947	-	-	128,689	17,567	1,108,690	980,000	128,689	May-65	
2066							214,631	29,299	980,000	765,369	343,321		
2067							217,770	29,727	765,369	547,599	561,091		
2068							220,954	30,162	547,599	326,644	782,045		
2069							224,185	30,603	326,644	102,459	1,006,231		
2070							102,459	13,986	102,459	0	1,108,690	Jun-70	5.1
	Total						**1,108,690**	**151,345**					
2070	13	1,270,283	200,032	14,817	143,001	10,593	125,005	17,064	1,244,873	1,119,868	125,005	Jun-70	
2071							230,790	31,505	1,119,868	889,079	355,795		
2072							234,165	31,965	889,079	654,914	589,959		
2073							237,589	32,433	654,914	417,325	827,548		
2074							241,063	32,907	417,325	176,261	1,068,612		
2075							176,262	24,061	176,261	0	1,244,873	Sep-75	5.3
	Total						**1,244,873**	**169,935**					
2075	14	1,262,732	200,020	14,816	172,926	12,809	68,327	9,327	1,235,106	1,166,780	68,327	Sep-75	
2076							248,165	33,876	1,166,780	918,615	316,492		
2077							251,794	34,372	918,615	666,821	568,286		
2078							255,476	34,874	666,821	411,345	823,762		
2079							259,212	35,384	411,345	152,133	1,082,973		
2080							152,133	20,767	152,133	0	1,235,106	Jul-80	4.9
	Total						**1,235,106**	**168,602**					
2080	15	2,131,590	289,575	21,450	483,394	35,807	110,870	15,135	2,074,333	1,963,463	110,870	Jul-80	
2081							266,848	36,427	1,963,463	1,696,615	377,718		
2082							270,750	36,960	1,696,615	1,425,865	648,468		
2083							274,709	37,500	1,425,865	1,151,156	923,177		
2084							278,727	38,048	1,151,156	872,429	1,201,904		

Matanuska-Susitna Central Landfill
Table C-1
Estimated Life of MSW Cells w/o Valley Fills

			Cell Volume										
Year	Cell	Total Volume Above Liner 1 (cy)	Area, Bottom Liner (sf)	Total Volume of Bottom Liner Soil (cy)	Area, Final Cover (sf)	Total Volume of Final Cover 2 (cy)	Total Airspace Required^3 (cy)	Total Daily / Intermediate Cover Soils (cy)	Net volume at beginning of year (cy)	Net volume at end of year (cy)	Cumulative Net Volume Used (cy)	Start/Full Dates	Cell Life (Years)
2085							282,802	38,605	872,429	589,627	1,484,706		
2086							286,938	39,169	589,627	302,689	1,771,644		
2087							291,134	39,742	302,689	11,555	2,062,778		
2088							11,555	1,577	11,555	0	2,074,333	Jan-88	7.5
	Total						**2,074,333**	**283,163**					
2088	16	1,456,140	453,926	33,624	-	-	283,836	38,746	1,422,516	1,138,680	283,836	Jan-88	
2089							299,710	40,913	1,138,680	838,969	583,546		
2090							304,093	41,511	838,969	534,876	887,640		
2091							308,540	42,118	534,876	226,336	1,196,180		
2092							226,337	30,897	226,336	0	1,422,516	Sep-92	4.7
	Total						**1,422,516**	**194,185**					
2092	17	1,546,321	220,053	16,300	145,576	10,783	86,715	11,837	1,519,237	1,432,522	86,715	Sep-92	
2093							317,629	43,359	1,432,522	1,114,893	404,345		
2094							322,274	43,993	1,114,893	792,619	726,619		
2095							326,987	44,636	792,619	465,632	1,053,606		
2096							331,768	45,289	465,632	133,863	1,385,374		
2097							133,863	18,273	133,863	0	1,519,237	May-97	4.7
	Total						**1,519,237**	**207,388**					
2097	18	1,810,193	212,284	15,725	220,070	16,301	202,757	27,678	1,778,167	1,575,410	202,757	May-97	
2098							341,542	46,623	1,575,410	1,233,868	544,299		
2099							346,537	47,305	1,233,868	887,331	890,835		
2100							351,604	47,997	887,331	535,727	1,242,440		
2101							356,746	48,699	535,727	178,982	1,599,185		
2102							178,982	24,432	178,982	0	1,778,167	Jun-02	5.1
	Total						**1,778,167**	**242,734**					
2102	19	2,062,744	279,843	20,729	555,786	41,169	182,980	24,978	2,000,846	1,817,865	182,980	Jun-02	
2103							367,255	50,133	1,817,865	1,450,610	550,235		
2104							372,626	50,866	1,450,610	1,077,984	922,861		
2105							378,075	51,610	1,077,984	699,910	1,300,936		
2106							383,603	52,365	699,910	316,307	1,684,539		
2107							316,306	43,178	316,307	0	2,000,845	Oct-07	5.3
	Total						**2,000,845**	**273,131**					
2107	20	2,093,014	483,292	35,799	-	-	72,906	9,952	2,057,215	1,984,308	72,906	Oct-07	
2108							394,904	53,908	1,984,308	1,589,404	467,811		
2109							400,679	54,696	1,589,404	1,188,725	868,489		
2110							406,538	55,496	1,188,725	782,187	1,275,027		
2111							412,483	56,307	782,187	369,704	1,687,510		
2112							369,704	50,468	369,704	0	2,057,214	Nov-12	5.1
	Total						**2,057,214**	**280,826**					
2112	21	2,250,587	275,105	20,378	322,878	23,917	48,810	6,663	2,206,292	2,157,482	48,810	Nov-12	
2113							424,635	57,966	2,157,482	1,732,847	473,445		
2114							430,844	58,814	1,732,847	1,302,003	904,289		
2115							437,144	59,674	1,302,003	864,859	1,341,433		
2116							443,537	60,546	864,859	421,322	1,784,970		
2117							421,322	57,514	421,322	0	2,206,292	Dec-17	5.1
	Total						**2,206,292**	**301,176**					
2117	22	2,416,422	413,909	30,660	717,024	53,113	28,700	3,918	2,332,649	2,303,949	28,700	Dec-17	
2118							456,603	62,330	2,303,949	1,847,346	485,303		
2119							463,280	63,241	1,847,346	1,384,066	948,583		

Matanuska-Susitna Central Landfill
Table C-1
Estimated Life of MSW Cells w/o Valley Fills

			Cell Volume										
Year	Cell	Total Volume Above Liner 1 (cy)	Area, Bottom Liner (sf)	Total Volume of Bottom Liner Soil (cy)	Area, Final Cover (sf)	Total Volume of Final Cover 2 (cy)	Total Airspace Required^3 (cy)	Total Daily / Intermediate Cover Soils (cy)	Net volume at beginning of year (cy)	Net volume at end of year (cy)	Cumulative Net Volume Used (cy)	Start/Full Dates	Cell Life (Years)
2120							470,055	64,166	1,384,066	914,011	1,418,638		
2121							476,928	65,104	914,011	437,083	1,895,566		
2122							437,083	59,665	437,083	0	2,332,649	Nov-22	5.0
	Total						**2,332,649**	**318,425**					
2122	23	3,145,709	459,266	34,020	527,436	39,069	46,820	6,391	3,072,620	3,025,800	46,820	Nov-22	
2123							490,979	67,022	3,025,800	2,534,822	537,798		
2124							498,158	68,003	2,534,822	2,036,663	1,035,957		
2125							505,443	68,997	2,036,663	1,531,221	1,541,399		
2126							512,834	70,006	1,531,221	1,018,387	2,054,233		
2127							520,333	71,030	1,018,387	498,054	2,574,566		
2128							498,054	67,988	498,054	0	3,072,620	Dec-28	6.0
	Total						**3,072,620**	**419,437**					
2128	24	3,412,244	412,349	30,544	1,408,187	104,310	29,888	4,080	3,277,390	3,247,501	29,888	Dec-28	
2129							535,662	73,122	3,247,501	2,711,839	565,550		
2130							543,495	74,191	2,711,839	2,168,344	1,109,045		
2131							551,443	75,276	2,168,344	1,616,902	1,660,488		
2132							559,506	76,377	1,616,902	1,057,395	2,219,994		
2133							567,688	77,494	1,057,395	489,707	2,787,682		
2134							489,707	66,849	489,707	0	3,277,389	Nov-34	5.9
	Total						**3,277,389**	**447,390**					
FUTURE LANDFILL PHASE 2													
2134	25	3,097,417	1,347,630	99,824	558,783	41,391	86,282	11,778	2,956,201	2,869,919	86,282	Nov-34	
2135							584,412	79,777	2,869,919	2,285,507	670,695		
2136							592,958	80,943	2,285,507	1,692,549	1,263,653		
2137							601,629	82,127	1,692,549	1,090,920	1,865,282		
2138							610,427	83,328	1,090,920	480,493	2,475,708		
2139							480,493	65,591	480,493	0	2,956,201	Oct-39	4.9
	Total						**2,956,201**	**403,545**					
2139	26	4,026,232	733,822	54,357	522,853	38,730	138,860	18,955	3,933,145	3,794,285	138,860	Oct-39	
2140							628,410	85,783	3,794,285	3,165,876	767,269		
2141							637,599	87,037	3,165,876	2,528,277	1,404,868		
2142							646,923	88,310	2,528,277	1,881,354	2,051,791		
2143							656,383	89,601	1,881,354	1,224,972	2,708,173		
2144							665,981	90,912	1,224,972	558,991	3,374,154		
2145							558,990	76,307	558,991	0	3,933,145	Oct-45	6.1
	Total						**3,933,145**	**536,905**					
2145	27	4,392,656	814,495	60,333	721,736	53,462	116,729	15,934	4,278,861	4,162,132	116,729	Oct-45	
2146							685,601	93,590	4,162,132	3,476,532	802,330		
2147							695,626	94,958	3,476,532	2,780,905	1,497,956		
2148							705,798	96,347	2,780,905	2,075,107	2,203,754		
2149							716,119	97,756	2,075,107	1,358,988	2,919,873		
2150							726,591	99,185	1,358,988	632,397	3,646,465		
2151							632,396	86,327	632,397	0	4,278,861	Nov-51	6.0
	Total						**4,278,861**	**584,098**					
2151	28	4,792,427	941,318	69,727	917,896	67,992	104,820	14,309	4,654,707	4,549,888	104,820	Nov-51	
2152							747,996	102,107	4,549,888	3,801,891	852,816		
2153							758,934	103,601	3,801,891	3,042,957	1,611,751		
2154							770,032	105,116	3,042,957	2,272,924	2,381,783		
2155							781,293	106,653	2,272,924	1,491,632	3,163,076		

Matanuska-Susitna Central Landfill
Table C-1
Estimated Life of MSW Cells w/o Valley Fills

			Cell Volume										
Year	Cell	Total Volume Above Liner 1 (cy)	Area, Bottom Liner (sf)	Total Volume of Bottom Liner Soil (cy)	Area, Final Cover (sf)	Total Volume of Final Cover 2 (cy)	Total Airspace Required[3] (cy)	Total Daily / Intermediate Cover Soils (cy)	Net volume at beginning of year (cy)	Net volume at end of year (cy)	Cumulative Net Volume Used (cy)	Start/Full Dates	Cell Life (Years)
2156							792,717	108,212	1,491,632	698,914	3,955,793		
2157							698,914	95,407	698,914	0	4,654,707	Nov-57	6.0
	Total						**4,654,707**	**635,404**					
2157	29	5,505,059	1,228,350	90,989	1,587,132	117,565	105,396	14,387	5,296,505	5,191,109	105,396	Nov-57	
2158							816,071	111,400	5,191,109	4,375,038	921,466		
2159							828,004	113,029	4,375,038	3,547,034	1,749,471		
2160							840,112	114,682	3,547,034	2,706,922	2,589,583		
2161							852,397	116,359	2,706,922	1,854,524	3,441,980		
2162							864,862	118,061	1,854,524	989,663	4,306,842		
2163							877,509	119,787	989,663	112,154	5,184,351		
2164							112,153	15,310	112,154	0	5,296,505	Feb-64	6.3
	Total						**5,296,505**	**723,015**					
		55,607,298	**11,539,872**	**854,805**	**10,496,852**	**777,545**	**53,974,945**	**431,073**					**150.8**

[1] Total volume available, including soils above flexible membrane component of liner and to top of final cover.

[2] Total quantity of cover soils assumed 2.5 ft thick: 6" leveling layer, 18" low-permeability infiltration layer, and 6" erosion control layer; calculation only includes 2 ft of soil considering that the leveling layer is part of the daily cover previously placed.

[3] Includes daily/intermediate cover soils and MSW

[4] Bottom liner not included in Cells 1-3 since they have been constructed.

cy = cubic yards
sf = square feet

Matanuska-Susitna Central Landfill

Table C-2

Estimated Life of MSW Cells with Valley Fills

			Cell Volume										
Year	Cell	Total Volume Above Liner 1 (cy)	Area, Bottom Liner (sf)	Total Volume of Bottom Liner Soil (cy)	Area, Final Cover (sf)	Total Volume of Final Cover 2 (cy)	Total Airspace Required[3] (cy)	Total Daily / Intermediate Cover Soils (cy)	Net volume at beginning of year (cy)	Net volume at end of year (cy)	Cumulative Net Volume Used (cy)	Start/Full Dates	Cell Life (Years)
							EXISTING LANDFILL AREA						
2013	3[4]	880,567	-	-	442,842	32,803	33,138	4,524	847,764	814,626	33,138	May-13	
2014							86,076	11,750	814,626	728,550	119,213		
2015							88,209	12,041	728,550	640,342	207,422		
2016							90,395	12,340	640,342	549,947	297,817		
2017							92,634	12,645	549,947	457,313	390,451		
2018							94,841	12,947	457,313	362,472	485,292		
2019							97,100	13,255	362,472	265,372	582,391		
2020							99,412	13,571	265,372	165,960	681,804		
2021							101,780	13,894	165,960	64,181	783,583		
2022							64,181	8,761	64,181	0	847,764	Aug-22	9.2
	Total						**847,764**	**115,727**					
2022	4	522,859	212,465	15,738	170,263	12,612	40,023	5,463	494,509	454,486	40,023	Aug-22	
2023							106,648	14,558	454,486	347,838	146,671		
2024							109,149	14,900	347,838	238,689	255,819		
2025							111,708	15,249	238,689	126,981	367,528		
2026							114,328	15,607	126,981	12,653	481,856		
2027							12,652	1,727	12,653	0	494,508	Feb-27	4.5
	Total						**494,508**	**67,504**					
2027	5	595,005	128,514	9,520	79,020	5,853	104,357	14,246	579,632	475,275	104,357	Feb-27	
2028							119,478	16,310	475,275	355,797	223,835		
2029							121,998	16,654	355,797	233,799	345,833		
2030							124,572	17,005	233,799	109,227	470,405		
2031							109,227	14,910	109,227	0	579,632	Oct-31	4.7
	Total						**579,632**	**79,124**					
2031	6	588,977	166,611	12,342	125,731	9,313	17,973	2,453	567,322	549,349	17,973	Oct-31	
2032							129,883	17,730	549,349	419,466	147,856		
2033							132,012	18,021	419,466	287,454	279,868		
2034							134,176	18,316	287,454	153,278	414,044		
2035							136,375	18,616	153,278	16,902	550,420		
2036							16,902	2,307	16,902	0	567,322	Feb-36	4.3
	Total						**567,322**	**77,444**					
2036	7	1,114,301	78,134	5,788	324,776	24,057	121,708	16,614	1,084,456	962,748	121,708	Feb-36	
2037							140,882	19,232	962,748	821,866	262,590		
2038							142,942	19,513	821,866	678,923	405,533		
2039							145,033	19,798	678,923	533,891	550,565		
2040							147,153	20,088	533,891	386,737	697,719		
2041							149,305	20,381	386,737	237,432	847,024		
2042							151,489	20,679	237,432	85,943	998,512		
2043							85,944	11,732	85,943	0	1,084,456	Jul-43	7.4
	Total						**1,084,456**	**148,037**					
							FUTURE LANDFILL PHASE 1						
2043	8	967,004	579,484	42,925	-	-	67,760	9,250	924,079	856,319	67,760	Jul-43	
2044							155,951	21,289	856,319	700,368	223,712		
2045							158,232	21,600	700,368	542,136	381,944		
2046							160,546	21,916	542,136	381,590	542,489		
2047							162,893	22,236	381,590	218,697	705,383		
2048							165,275	22,561	218,697	53,421	870,658		

Matanuska-Susitna Central Landfill
Table C-2
Estimated Life of MSW Cells with Valley Fills

Year	Cell	Total Volume Above Liner 1 (cy)	Cell Volume								Cumulative Net Volume Used (cy)	Start/Full Dates	Cell Life (Years)
			Area, Bottom Liner (sf)	Total Volume of Bottom Liner Soil (cy)	Area, Final Cover (sf)	Total Volume of Final Cover 2 (cy)	Total Airspace Required^3 (cy)	Total Daily / Intermediate Cover Soils (cy)	Net volume at beginning of year (cy)	Net volume at end of year (cy)			
2049							53,421	7,292	53,421	0	924,079	Apr-49	5.8
	Total						**924,079**	**126,144**					
2049	9	888,704	309,863	22,953	12,568	931	114,271	15,599	864,820	750,549	114,271	Apr-49	
2050							170,144	23,226	750,549	580,405	284,415		
2051							172,632	23,566	580,405	407,772	457,048		
2052							175,157	23,910	407,772	232,616	632,205		
2053							177,718	24,260	232,616	54,897	809,923		
2054							54,897	7,494	54,897	0	864,820	Mar-54	4.9
	Total						**864,820**	**118,055**					
2054	10	891,498	310,130	22,973	80,012	5,927	125,420	17,121	862,599	737,179	125,420	Mar-54	
2055							182,954	24,975	737,179	554,225	308,374		
2056							185,629	25,340	554,225	368,596	494,003		
2057							188,344	25,710	368,596	180,252	682,346		
2058							180,252	24,606	180,252	0	862,598	Dec-58	4.7
	Total						**862,598**	**117,752**					
2058	11	1,349,976	412,114	30,527	256,964	19,034	10,845	1,480	1,300,415	1,289,569	10,845	Dec-58	
2059							193,892	26,468	1,289,569	1,095,677	204,738		
2060							196,727	26,855	1,095,677	898,950	401,465		
2061							199,604	27,248	898,950	699,346	601,069		
2062							202,523	27,646	699,346	496,823	803,592		
2063							205,485	28,050	496,823	291,338	1,009,077		
2064							208,489	28,460	291,338	82,849	1,217,566		
2065							82,849	11,310	82,849	0	1,300,415	May-65	6.5
	Total						**1,300,415**	**177,517**					
2065	12	1,136,637	377,291	27,947	-	-	128,689	17,567	1,108,690	980,000	128,689	May-65	
2066							214,631	29,299	980,000	765,369	343,321		
2067							217,770	29,727	765,369	547,599	561,091		
2068							220,954	30,162	547,599	326,644	782,045		
2069							224,185	30,603	326,644	102,459	1,006,231		
2070							102,459	13,986	102,459	0	1,108,690	Jun-70	5.1
	Total						**1,108,690**	**151,345**					
2070	13	1,270,283	200,032	14,817	143,001	10,593	125,005	17,064	1,244,873	1,119,868	125,005	Jun-70	
2071							230,790	31,505	1,119,868	889,079	355,795		
2072							234,165	31,965	889,079	654,914	589,959		
2073							237,589	32,433	654,914	417,325	827,548		
2074							241,063	32,907	417,325	176,261	1,068,612		
2075							176,262	24,061	176,261	0	1,244,873	Sep-75	5.3
	Total						**1,244,873**	**169,935**					
2075	14	1,262,732	200,020	14,816	172,926	12,809	68,327	9,327	1,235,106	1,166,780	68,327	Sep-75	
2076							248,165	33,876	1,166,780	918,615	316,492		
2077							251,794	34,372	918,615	666,821	568,286		
2078							255,476	34,874	666,821	411,345	823,762		
2079							259,212	35,384	411,345	152,133	1,082,973		
2080							152,133	20,767	152,133	0	1,235,106	Jul-80	4.9
	Total						**1,235,106**	**168,602**					
2080	15	2,131,590	289,575	21,450	483,394	35,807	110,870	15,135	2,074,333	1,963,463	110,870	Jul-80	
2081							266,848	36,427	1,963,463	1,696,615	377,718		
2082							270,750	36,960	1,696,615	1,425,865	648,468		

Matanuska-Susitna Central Landfill

Table C-2

Estimated Life of MSW Cells with Valley Fills

			Cell Volume										
Year	Cell	Total Volume Above Liner 1 (cy)	Area, Bottom Liner (sf)	Total Volume of Bottom Liner Soil (cy)	Area, Final Cover (sf)	Total Volume of Final Cover 2 (cy)	Total Airspace Required[3] (cy)	Total Daily / Intermediate Cover Soils (cy)	Net volume at beginning of year (cy)	Net volume at end of year (cy)	Cumulative Net Volume Used (cy)	Start/Full Dates	Cell Life (Years)
2083							274,709	37,500	1,425,865	1,151,156	923,177		
2084							278,727	38,048	1,151,156	872,429	1,201,904		
2085							282,802	38,605	872,429	589,627	1,484,706		
2086							286,938	39,169	589,627	302,689	1,771,644		
2087							291,134	39,742	302,689	11,555	2,062,778		
2088							11,555	1,577	11,555	0	2,074,333	Jan-88	7.5
	Total						**2,074,333**	**283,163**					
2088	16	1,456,140	453,926	33,624	-	-	283,836	38,746	1,422,516	1,138,680	283,836	Jan-88	
2089							299,710	40,913	1,138,680	838,969	583,546		
2090							304,093	41,511	838,969	534,876	887,640		
2091							308,540	42,118	534,876	226,336	1,196,180		
2092							226,337	30,897	226,336	0	1,422,516	Sep-92	4.7
	Total						**1,422,516**	**194,185**					
2092	17	1,546,321	220,053	16,300	145,576	10,783	86,715	11,837	1,519,237	1,432,522	86,715	Sep-92	
2093							317,629	43,359	1,432,522	1,114,893	404,345		
2094							322,274	43,993	1,114,893	792,619	726,619		
2095							326,987	44,636	792,619	465,632	1,053,606		
2096							331,768	45,289	465,632	133,863	1,385,374		
2097							133,863	18,273	133,863	0	1,519,237	May-97	4.7
	Total						**1,519,237**	**207,388**					
2097	18	1,810,193	212,284	15,725	220,070	16,301	202,757	27,678	1,778,167	1,575,410	202,757	May-97	
2098							341,542	46,623	1,575,410	1,233,868	544,299		
2099							346,537	47,305	1,233,868	887,331	890,835		
2100							351,604	47,997	887,331	535,727	1,242,440		
2101							356,746	48,699	535,727	178,982	1,599,185		
2102							178,982	24,432	178,982	0	1,778,167	Jun-02	5.1
	Total						**1,778,167**	**242,734**					
2102	19	2,062,744	279,843	20,729	555,786	41,169	182,980	24,978	2,000,846	1,817,865	182,980	Jun-02	
2103							367,255	50,133	1,817,865	1,450,610	550,235		
2104							372,626	50,866	1,450,610	1,077,984	922,861		
2105							378,075	51,610	1,077,984	699,910	1,300,936		
2106							383,603	52,365	699,910	316,307	1,684,539		
2107							316,306	43,178	316,307	0	2,000,845	Oct-07	5.3
	Total						**2,000,845**	**273,131**					
2107	20	2,093,014	483,292	35,799	-	-	72,906	9,952	2,057,215	1,984,308	72,906	Oct-07	
2108							394,904	53,908	1,984,308	1,589,404	467,811		
2109							400,679	54,696	1,589,404	1,188,725	868,489		
2110							406,538	55,496	1,188,725	782,187	1,275,027		
2111							412,483	56,307	782,187	369,704	1,687,510		
2112							369,704	50,468	369,704	0	2,057,214	Nov-12	5.1
	Total						**2,057,214**	**280,826**					
2112	21	2,250,587	275,105	20,378	322,878	23,917	48,810	6,663	2,206,292	2,157,482	48,810	Nov-12	
2113							424,635	57,966	2,157,482	1,732,847	473,445		
2114							430,844	58,814	1,732,847	1,302,003	904,289		
2115							437,144	59,674	1,302,003	864,859	1,341,433		
2116							443,537	60,546	864,859	421,322	1,784,970		
2117							421,322	57,514	421,322	0	2,206,292	Dec-17	5.1
	Total						**2,206,292**	**301,176**					

Matanuska-Susitna Central Landfill

Table C-2

Estimated Life of MSW Cells with Valley Fills

			Cell Volume										
Year	Cell	Total Volume Above Liner 1 (cy)	Area, Bottom Liner (sf)	Total Volume of Bottom Liner Soil (cy)	Area, Final Cover (sf)	Total Volume of Final Cover 2 (cy)	Total Airspace Required[3] (cy)	Total Daily / Intermediate Cover Soils (cy)	Net volume at beginning of year (cy)	Net volume at end of year (cy)	Cumulative Net Volume Used (cy)	Start/Full Dates	Cell Life (Years)
2117	22	2,416,422	413,909	30,660	717,024	53,113	28,700	3,918	2,332,649	2,303,949	28,700	Dec-17	
2118							456,603	62,330	2,303,949	1,847,346	485,303		
2119							463,280	63,241	1,847,346	1,384,066	948,583		
2120							470,055	64,166	1,384,066	914,011	1,418,638		
2121							476,928	65,104	914,011	437,083	1,895,566		
2122							437,083	59,665	437,083	0	2,332,649	Nov-22	5.0
	Total						**2,332,649**	**318,425**					
2122	23	3,145,709	459,266	34,020	527,436	39,069	46,820	6,391	3,072,620	3,025,800	46,820	Nov-22	
2123							490,979	67,022	3,025,800	2,534,822	537,798		
2124							498,158	68,003	2,534,822	2,036,663	1,035,957		
2125							505,443	68,997	2,036,663	1,531,221	1,541,399		
2126							512,834	70,006	1,531,221	1,018,387	2,054,233		
2127							520,333	71,030	1,018,387	498,054	2,574,566		
2128							498,054	67,988	498,054	0	3,072,620	Dec-28	6.0
	Total						**3,072,620**	**419,437**					
2128	24	3,412,244	412,349	30,544	1,408,187	104,310	29,888	4,080	3,277,390	3,247,501	29,888	Dec-28	
2129							535,662	73,122	3,247,501	2,711,839	565,550		
2130							543,495	74,191	2,711,839	2,168,344	1,109,045		
2131							551,443	75,276	2,168,344	1,616,902	1,660,488		
2132							559,506	76,377	1,616,902	1,057,395	2,219,994		
2133							567,688	77,494	1,057,395	489,707	2,787,682		
2134							489,707	66,849	489,707	0	3,277,389	Nov-34	5.9
	Total						**3,277,389**	**447,390**					
FUTURE LANDFILL PHASE 2													
2134	25	3,097,417	1,347,630	99,824	558,783	41,391	86,282	11,778	2,956,201	2,869,919	86,282	Nov-34	
2135							584,412	79,777	2,869,919	2,285,507	670,695		
2136							592,958	80,943	2,285,507	1,692,549	1,263,653		
2137							601,629	82,127	1,692,549	1,090,920	1,865,282		
2138							610,427	83,328	1,090,920	480,493	2,475,708		
2139							480,493	65,591	480,493	0	2,956,201	Oct-39	4.9
	Total						**2,956,201**	**403,545**					
2139	26	4,026,232	733,822	54,357	522,853	38,730	138,860	18,955	3,933,145	3,794,285	138,860	Oct-39	
2140							628,410	85,783	3,794,285	3,165,876	767,269		
2141							637,599	87,037	3,165,876	2,528,277	1,404,868		
2142							646,923	88,310	2,528,277	1,881,354	2,051,791		
2143							656,383	89,601	1,881,354	1,224,972	2,708,173		
2144							665,981	90,912	1,224,972	558,991	3,374,154		
2145							558,990	76,307	558,991	0	3,933,145	Oct-45	6.1
	Total						**3,933,145**	**536,905**					
2145	27	4,392,656	814,495	60,333	721,736	53,462	116,729	15,934	4,278,861	4,162,132	116,729	Oct-45	
2146							685,601	93,590	4,162,132	3,476,532	802,330		
2147							695,626	94,958	3,476,532	2,780,905	1,497,956		
2148							705,798	96,347	2,780,905	2,075,107	2,203,754		
2149							716,119	97,756	2,075,107	1,358,988	2,919,873		
2150							726,591	99,185	1,358,988	632,397	3,646,465		
2151							632,396	86,327	632,397	0	4,278,861	Nov-51	6.0
	Total						**4,278,861**	**584,098**					
2151	28	4,792,427	941,318	69,727	917,896	67,992	104,820	14,309	4,654,707	4,549,888	104,820	Nov-51	

Matanuska-Susitna Central Landfill
Table C-2
Estimated Life of MSW Cells with Valley Fills

Year	Cell	Total Volume Above Liner 1 (cy)	Cell Volume								Cumulative Net Volume Used (cy)	Start/Full Dates	Cell Life (Years)
			Area, Bottom Liner (sf)	Total Volume of Bottom Liner Soil (cy)	Area, Final Cover (sf)	Total Volume of Final Cover 2 (cy)	Total Airspace Required[3] (cy)	Total Daily / Intermediate Cover Soils (cy)	Net volume at beginning of year (cy)	Net volume at end of year (cy)			
2152							747,996	102,107	4,549,888	3,801,891	852,816		
2153							758,934	103,601	3,801,891	3,042,957	1,611,751		
2154							770,032	105,116	3,042,957	2,272,924	2,381,783		
2155							781,293	106,653	2,272,924	1,491,632	3,163,076		
2156							792,717	108,212	1,491,632	698,914	3,955,793		
2157							698,914	95,407	698,914	0	4,654,707	Nov-57	6.0
	Total						**4,654,707**	**635,404**					
2157	29	5,505,059	1,228,350	90,989	1,587,132	117,565	105,396	14,387	5,296,505	5,191,109	105,396	Nov-57	
2158							816,071	111,400	5,191,109	4,375,038	921,466		
2159							828,004	113,029	4,375,038	3,547,034	1,749,471		
2160							840,112	114,682	3,547,034	2,706,922	2,589,583		
2161							852,397	116,359	2,706,922	1,854,524	3,441,980		
2162							864,862	118,061	1,854,524	989,663	4,306,842		
2163							877,509	119,787	989,663	112,154	5,184,351		
2164							112,153	15,310	112,154	0	5,296,505	Feb-64	6.3
	Total						**5,296,505**	**723,015**					
FUTURE LANDFILL VALLEY FILLS													
2164		3,747,000	-	-	2,215,818	164,135	778,187	106,229	3,582,865	2,804,678	778,187	Feb-64	
2165							903,360	123,316	2,804,678	1,901,318	1,681,547		
2166							916,570	125,119	1,901,318	984,748	2,598,117		
2167							929,973	126,949	984,748	54,775	3,528,091		
2168							54,774	7,477	54,775	0	3,582,865	Jan-68	3.9
	Total						**3,582,865**	**489,090**					
	Grand Total	**59,354,298**	**11,539,872**	**854,805**	**12,712,670**	**941,679**	**57,557,810**	**920,162**					

[1] Total volume available, including soils above flexible membrane component of liner and to top of final cover.

[2] Total quantity of cover soils assumed 2.5 ft thick: 6" leveling layer, 18" low-permeability infiltration layer, and 6" erosion control layer; calculation only includes 2 ft of soil considering that the leveling layer is part of the daily cover previously placed.

[3] Includes daily/intermediate cover soils and MSW

[4] Bottom liner not included in Cells 1-3 since they have been constructed.

cy = cubic yards
sf = square feet

Appendix D
HELP Modeling Results

(Select output files are included here. Full output is available upon request from CH2M HILL.)

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\matsu\P1.D4
TEMPERATURE DATA FILE:      C:\matsu\T1.D7
SOLAR RADIATION DATA FILE:  C:\matsu\s1.D13
EVAPOTRANSPIRATION DATA:    C:\matsu\e1.D11
SOIL AND DESIGN DATA FILE:  C:\matsu\futbotnw.D10
OUTPUT DATA FILE:           C:\matsu\futbotnw.OUT


TIME:  16:42     DATE:   8/20/2014


******************************************************************************

     TITLE:  Mat-Su Future Cells Bottom No Waste

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER   0
           THICKNESS                  =     24.00   INCHES
           POROSITY                   =      0.3970 VOL/VOL
           FIELD CAPACITY             =      0.0320 VOL/VOL
           WILTING POINT              =      0.0130 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0391 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000001000     CM/SEC
           SLOPE                      =      4.00   PERCENT
           DRAINAGE LENGTH            =    200.0    FEET
```

```
                           LAYER  2
                           --------

               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                  =      0.08   INCHES
   POROSITY                   =      0.0000 VOL/VOL
   FIELD CAPACITY             =      0.0000 VOL/VOL
   WILTING POINT              =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY        =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
   FML PLACEMENT QUALITY       =  3 - GOOD



                           LAYER  3
                           --------

                 TYPE 3 - BARRIER SOIL LINER
                 MATERIAL TEXTURE NUMBER  17
   THICKNESS                  =      0.25   INCHES
   POROSITY                   =      0.7500 VOL/VOL
   FIELD CAPACITY             =      0.7470 VOL/VOL
   WILTING POINT              =      0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC




           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER             =     80.40
FRACTION OF AREA ALLOWING RUNOFF    =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
EVAPORATIVE ZONE DEPTH              =      8.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      0.427  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =      3.176  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.104  INCHES
INITIAL SNOW WATER                  =      1.478  INCHES
INITIAL WATER IN LAYER MATERIALS    =      1.127  INCHES
TOTAL INITIAL WATER                 =      2.604  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR



            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          BETHEL                ALASKA
```

```
             STATION LATITUDE                       =  60.78 DEGREES
             MAXIMUM LEAF AREA INDEX                =   0.00
             START OF GROWING SEASON (JULIAN DATE)  =    184
             END OF GROWING SEASON (JULIAN DATE)    =    225
             EVAPORATIVE ZONE DEPTH                 =   8.0  INCHES
             AVERAGE ANNUAL WIND SPEED              =  12.90 MPH
             AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  75.00 %
             AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  78.00 %
             AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  83.00 %
             AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  80.00 %


         NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    MEDFORD             OREGON

                  NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       0.84        0.84        0.72        0.44        0.66        1.31
       2.06        2.29        2.59        1.74        1.09        1.22


         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BETHEL              ALASKA

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      14.10       18.20       26.30       37.30       47.80       55.10
      58.10       55.90       48.00       33.90       20.70       16.20


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BETHEL              ALASKA
                    AND STATION LATITUDE  =  60.78 DEGREES



*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           16.68         60548.406    100.00

  RUNOFF                                   0.000            0.000      0.00

  EVAPOTRANSPIRATION                       6.777        24601.559     40.63

  DRAINAGE COLLECTED FROM LAYER  1         9.9027       35946.801     59.37

  PERC./LEAKAGE THROUGH LAYER  3           0.000026         0.095      0.00
```

```
  DRAINAGE COLLECTED FROM LAYER  1        11.5010        41748.469     64.50

  PERC./LEAKAGE THROUGH LAYER  3           0.000029          0.104      0.00

  AVG. HEAD ON TOP OF LAYER  2             0.2750

  CHANGE IN WATER STORAGE                  0.942          3420.119      5.28

  SOIL WATER AT START OF YEAR              1.377          4997.279

  SOIL WATER AT END OF YEAR                2.233          8105.950

  SNOW WATER AT START OF YEAR              1.185          4302.502      6.65

  SNOW WATER AT END OF YEAR                1.271          4613.951      7.13

  ANNUAL WATER BUDGET BALANCE              0.0000            0.007      0.00

*******************************************************************************




*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH   20
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 0.84     0.95     0.58     0.45     0.69     0.75
                           1.70     2.12     2.90     1.99     1.11     1.15

    STD. DEVIATIONS        0.32     0.43     0.27     0.18     0.44     0.70
                           1.80     2.07     1.87     1.17     0.41     0.46

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 0.440    0.479    0.485    0.151    0.407    0.486
                           0.357    0.487    0.523    0.524    0.379    0.373

    STD. DEVIATIONS        0.060    0.068    0.125    0.094    0.373    0.386
                           0.315    0.420    0.283    0.257    0.093    0.074

  LATERAL DRAINAGE COLLECTED FROM LAYER  1
  ----------------------------------------
    TOTALS                 0.0000   0.0000   0.2364   0.5760   2.7031   0.4222
```

```
                           1.3514   1.4517   2.1802   1.0614   0.1182   0.0001

    STD. DEVIATIONS        0.0000   0.0000   0.5250   1.0349   0.9253   0.7726
                           1.4738   1.6976   1.4406   1.2370   0.2131   0.0004

  PERCOLATION/LEAKAGE THROUGH LAYER  3
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  2
  -------------------------------------
    AVERAGES               0.0000   0.0000   0.0674   0.1696   0.7703   0.1243
                           0.3851   0.4137   0.6420   0.3024   0.0348   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.1496   0.3047   0.2637   0.2275
                           0.4200   0.4837   0.4242   0.3525   0.0628   0.0001

*******************************************************************************



*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   20
-------------------------------------------------------------------------------
                                     INCHES            CU. FEET       PERCENT
                               -------------------   -------------   ---------
 PRECIPITATION                  15.24    (   3.800)      55313.9     100.00

 RUNOFF                          0.000   (  0.0000)          0.00      0.000

 EVAPOTRANSPIRATION              5.092   (  1.0139)      18484.79     33.418

 LATERAL DRAINAGE COLLECTED     10.10076 (  3.64993)     36665.750   66.28663
   FROM LAYER  1

 PERCOLATION/LEAKAGE THROUGH     0.00003 (  0.00001)         0.097     0.00018
   LAYER  3

 AVERAGE HEAD ON TOP             0.242 (    0.087)
   OF LAYER  2

 CHANGE IN WATER STORAGE         0.045   (  1.2219)        163.30      0.295

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              PEAK DAILY VALUES FOR YEARS    1 THROUGH   20
   ------------------------------------------------------------------------
                                                 (INCHES)      (CU. FT.)
                                                ----------    -------------
      PRECIPITATION                               3.00         10890.000

      RUNOFF                                      0.000            0.0000

      DRAINAGE COLLECTED FROM LAYER  1            0.93303       3386.90479

      PERCOLATION/LEAKAGE THROUGH LAYER  3        0.000003         0.01241

      AVERAGE HEAD ON TOP OF LAYER  2             8.242

      MAXIMUM HEAD ON TOP OF LAYER  2            12.854

      LOCATION OF MAXIMUM HEAD IN LAYER  1
            (DISTANCE FROM DRAIN)                43.8 FEET

      SNOW WATER                                  5.05         18347.8535


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                   0.3970

      MINIMUM VEG. SOIL WATER (VOL/VOL)                   0.0130


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

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                   FINAL WATER STORAGE AT END OF YEAR   20
    ----------------------------------------------------------------------
                    LAYER       (INCHES)       (VOL/VOL)
                    -----       --------       ---------
                      1           2.0455         0.0852

                      2           0.0000         0.0000

                      3           0.1875         0.7500

                  SNOW WATER      1.271

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\matsu\P1.D4
TEMPERATURE DATA FILE:      C:\matsu\T1.D7
SOLAR RADIATION DATA FILE:  C:\matsu\s1.D13
EVAPOTRANSPIRATION DATA:    C:\matsu\e1.D11
SOIL AND DESIGN DATA FILE:  C:\matsu\futssnw.D10
OUTPUT DATA FILE:           C:\matsu\futssnw.OUT


TIME:  14:52     DATE:   8/20/2014


******************************************************************************

     TITLE:  Mat-Su Future Cells SS No Waste

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER   0
           THICKNESS                   =     24.00   INCHES
           POROSITY                    =      0.3970 VOL/VOL
           FIELD CAPACITY              =      0.0320 VOL/VOL
           WILTING POINT               =      0.0130 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0391 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.100000001000     CM/SEC
           SLOPE                       =     33.00   PERCENT
           DRAINAGE LENGTH             =    100.0    FEET
```

```
                           LAYER  2
                           --------

               TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER  35
   THICKNESS                   =      0.08   INCHES
   POROSITY                    =      0.0000 VOL/VOL
   FIELD CAPACITY              =      0.0000 VOL/VOL
   WILTING POINT               =      0.0000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
   FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
   FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
   FML PLACEMENT QUALITY       =  3 - GOOD



                           LAYER  3
                           --------

                 TYPE 3 - BARRIER SOIL LINER
                 MATERIAL TEXTURE NUMBER  17
   THICKNESS                   =      0.25   INCHES
   POROSITY                    =      0.7500 VOL/VOL
   FIELD CAPACITY              =      0.7470 VOL/VOL
   WILTING POINT               =      0.4000 VOL/VOL
   INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
   EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC




           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER              =     82.40
FRACTION OF AREA ALLOWING RUNOFF     =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =      8.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      0.427  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      3.176  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.104  INCHES
INITIAL SNOW WATER                   =      1.478  INCHES
INITIAL WATER IN LAYER MATERIALS     =      1.127  INCHES
TOTAL INITIAL WATER                  =      2.604  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR



            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          BETHEL                      ALASKA
```

```
             STATION LATITUDE                       =  60.78 DEGREES
             MAXIMUM LEAF AREA INDEX                =   0.00
             START OF GROWING SEASON (JULIAN DATE)  =    184
             END OF GROWING SEASON (JULIAN DATE)    =    225
             EVAPORATIVE ZONE DEPTH                 =   8.0  INCHES
             AVERAGE ANNUAL WIND SPEED              =  12.90 MPH
             AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  75.00 %
             AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  78.00 %
             AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  83.00 %
             AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  80.00 %


         NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    MEDFORD             OREGON

                  NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       0.84        0.84        0.72        0.44        0.66        1.31
       2.06        2.29        2.59        1.74        1.09        1.22


         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BETHEL              ALASKA

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      14.10       18.20       26.30       37.30       47.80       55.10
      58.10       55.90       48.00       33.90       20.70       16.20


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BETHEL              ALASKA
                    AND STATION LATITUDE  =  60.78 DEGREES



*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           16.68          60548.406    100.00

  RUNOFF                                   0.000             0.000      0.00

  EVAPOTRANSPIRATION                       6.777         24601.559     40.63

  DRAINAGE COLLECTED FROM LAYER  1         9.9027        35946.895     59.37

  PERC./LEAKAGE THROUGH LAYER  3           0.000002          0.008      0.00
```

```
  DRAINAGE COLLECTED FROM LAYER  1        11.5010        41748.566     64.50

  PERC./LEAKAGE THROUGH LAYER  3           0.000002          0.008      0.00

  AVG. HEAD ON TOP OF LAYER  2             0.0197

  CHANGE IN WATER STORAGE                  0.942          3420.119      5.28

  SOIL WATER AT START OF YEAR              1.377          4997.279

  SOIL WATER AT END OF YEAR                2.233          8105.950

  SNOW WATER AT START OF YEAR              1.185          4302.502      6.65

  SNOW WATER AT END OF YEAR                1.271          4613.951      7.13

  ANNUAL WATER BUDGET BALANCE              0.0000            0.006      0.00

*******************************************************************************




*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH   20
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 0.84     0.95     0.58     0.45     0.69     0.75
                           1.70     2.12     2.90     1.99     1.11     1.15

    STD. DEVIATIONS        0.32     0.43     0.27     0.18     0.44     0.70
                           1.80     2.07     1.87     1.17     0.41     0.46

  RUNOFF
  ------
    TOTALS                 0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 0.440    0.479    0.485    0.151    0.407    0.486
                           0.357    0.487    0.523    0.524    0.379    0.373

    STD. DEVIATIONS        0.060    0.068    0.125    0.094    0.373    0.386
                           0.315    0.420    0.283    0.257    0.093    0.074

  LATERAL DRAINAGE COLLECTED FROM LAYER  1
  ----------------------------------------
    TOTALS                 0.0000   0.0000   0.2992   0.5357   2.7253   0.4107
```

```
                           1.3964   1.5595   2.2038   0.9192   0.0510   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.6008   1.0000   0.9489   0.7758
                           1.5495   1.8320   1.5862   1.1624   0.1013   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  3
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  2
  -------------------------------------
    AVERAGES               0.0000   0.0000   0.0058   0.0112   0.0588   0.0088
                           0.0278   0.0314   0.0456   0.0180   0.0010   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0116   0.0214   0.0214   0.0173
                           0.0310   0.0375   0.0330   0.0227   0.0020   0.0000

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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   20
-------------------------------------------------------------------------------
                                     INCHES            CU. FEET       PERCENT
                               -------------------   -------------   ---------
 PRECIPITATION                  15.24    (   3.800)      55313.9     100.00

 RUNOFF                          0.000   (  0.0000)          0.00      0.000

 EVAPOTRANSPIRATION              5.092   (  1.0139)      18484.79     33.418

 LATERAL DRAINAGE COLLECTED     10.10078 (   3.64995)    36665.840   66.28680
   FROM LAYER  1

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.008     0.00001
   LAYER  3

 AVERAGE HEAD ON TOP             0.017 (    0.006)

 CHANGE IN WATER STORAGE         0.045   (  1.2219)        163.30      0.295

*******************************************************************************
```

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                PEAK DAILY VALUES FOR YEARS    1 THROUGH   20
   ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
      PRECIPITATION                              3.00         10890.000

      RUNOFF                                     0.000            0.0000

      DRAINAGE COLLECTED FROM LAYER  1           3.13158      11367.63180

      PERCOLATION/LEAKAGE THROUGH LAYER  3       0.000001         0.00284

      AVERAGE HEAD ON TOP OF LAYER  2            2.144

      MAXIMUM HEAD ON TOP OF LAYER  2            3.586

      LOCATION OF MAXIMUM HEAD IN LAYER  1
            (DISTANCE FROM DRAIN)                0.0 FEET

      SNOW WATER                                 5.05         18347.8535


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.3970

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0130


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.


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                  FINAL WATER STORAGE AT END OF YEAR   20
    ----------------------------------------------------------------------
                   LAYER        (INCHES)       (VOL/VOL)
                   -----        --------       ---------
                     1            2.0455         0.0852

                     2            0.0000         0.0000

                     3            0.1875         0.7500

                  SNOW WATER      1.271

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**               FOR USEPA RISK REDUCTION ENGINEERING LABORATORY            **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************



PRECIPITATION DATA FILE:    C:\matsu\P1.D4
TEMPERATURE DATA FILE:      C:\matsu\T1.D7
SOLAR RADIATION DATA FILE:  C:\matsu\s1.D13
EVAPOTRANSPIRATION DATA:    C:\matsu\e1.D11
SOIL AND DESIGN DATA FILE:  C:\matsu\scen1.D10
OUTPUT DATA FILE:           C:\matsu\scen1.OUT



TIME:  14:19     DATE:   8/20/2014



******************************************************************************

     TITLE:  Mat-Su Future Cells SS 40' of Waste, Scenario 5B Final Cover

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   2
           THICKNESS                   =      6.00   INCHES
           POROSITY                    =      0.4370 VOL/VOL
           FIELD CAPACITY              =      0.0620 VOL/VOL
           WILTING POINT               =      0.0240 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0858 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.579999993000E-02 CM/SEC



                                   LAYER  2
                                   --------
```

```
            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   1
THICKNESS                   =      6.00   INCHES
POROSITY                    =      0.4170 VOL/VOL
FIELD CAPACITY              =      0.0450 VOL/VOL
WILTING POINT               =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0363 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.999999978000E-02 CM/SEC
SLOPE                       =     33.00   PERCENT
DRAINAGE LENGTH             =    100.0    FEET


                        LAYER  3
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  4
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  16
THICKNESS                   =      0.25   INCHES
POROSITY                    =      0.4270 VOL/VOL
FIELD CAPACITY              =      0.4180 VOL/VOL
WILTING POINT               =      0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000001000E-06 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   2
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4370 VOL/VOL
FIELD CAPACITY              =      0.0620 VOL/VOL
WILTING POINT               =      0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0620 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.579999993000E-02 CM/SEC
```

```
                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    480.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC




                        LAYER  7
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.3970 VOL/VOL
FIELD CAPACITY              =      0.0320 VOL/VOL
WILTING POINT               =      0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0320 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000001000     CM/SEC
SLOPE                       =     33.00   PERCENT
DRAINAGE LENGTH             =    100.0    FEET




                        LAYER  8
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.08   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD




                        LAYER  9
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.25   INCHES
POROSITY                    =      0.7500 VOL/VOL
```

```
       FIELD CAPACITY              =     0.7470 VOL/VOL
       WILTING POINT               =     0.4000 VOL/VOL
       INITIAL SOIL WATER CONTENT  =     0.7500 VOL/VOL
       EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC




               GENERAL DESIGN AND EVAPORATIVE ZONE DATA
               ----------------------------------------

     NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
              SOIL DATA BASE USING SOIL TEXTURE # 2 WITH A
              POOR STAND OF GRASS, A SURFACE SLOPE OF 33.%
              AND A SLOPE LENGTH OF  100. FEET.

    SCS RUNOFF CURVE NUMBER              =     76.20
    FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
    AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
    EVAPORATIVE ZONE DEPTH               =      8.0    INCHES
    INITIAL WATER IN EVAPORATIVE ZONE    =      0.553  INCHES
    UPPER LIMIT OF EVAPORATIVE STORAGE   =      3.456  INCHES
    LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.180  INCHES
    INITIAL SNOW WATER                   =      1.478  INCHES
    INITIAL WATER IN LAYER MATERIALS     =     37.579  INCHES
    TOTAL INITIAL WATER                  =     39.057  INCHES
    TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR



                EVAPOTRANSPIRATION AND WEATHER DATA
                -----------------------------------

     NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
              BETHEL                ALASKA

         STATION LATITUDE                       =  60.78 DEGREES
         MAXIMUM LEAF AREA INDEX                =   0.00
         START OF GROWING SEASON (JULIAN DATE)  =    184
         END OF GROWING SEASON (JULIAN DATE)    =    225
         EVAPORATIVE ZONE DEPTH                 =   8.0  INCHES
         AVERAGE ANNUAL WIND SPEED              =  12.90 MPH
         AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  75.00 %
         AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  78.00 %
         AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  83.00 %
         AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  80.00 %


     NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
              COEFFICIENTS FOR    MEDFORD             OREGON

              NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

 JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
 -------     -------     -------     -------     -------     -------
   0.84        0.84        0.72        0.44        0.66        1.31
   2.06        2.29        2.59        1.74        1.09        1.22
```

```
*******************************************************************************

         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH   20
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 0.84     0.95     0.58     0.45     0.69     0.75
                           1.70     2.12     2.90     1.99     1.11     1.15

    STD. DEVIATIONS        0.32     0.43     0.27     0.18     0.44     0.70
                           1.80     2.07     1.87     1.17     0.41     0.46

  RUNOFF
  ------
    TOTALS                 0.000    0.013    0.744    0.392    0.085    0.000
                           0.076    0.065    0.067    0.092    0.126    0.010

    STD. DEVIATIONS        0.000    0.035    0.546    0.791    0.096    0.000
                           0.136    0.130    0.132    0.280    0.276    0.021

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 0.440    0.479    0.485    0.176    0.830    0.596
                           0.654    0.741    0.842    0.632    0.390    0.373

    STD. DEVIATIONS        0.060    0.068    0.125    0.130    0.403    0.498
                           0.534    0.602    0.467    0.326    0.113    0.074

  LATERAL DRAINAGE COLLECTED FROM LAYER  2
  ----------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0885   1.8106   0.2112
                           1.0302   1.0909   1.7125   0.8312   0.1010   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.3959   0.6482   0.4678
                           1.1599   1.4391   1.2194   1.0488   0.1980   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  4
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  LATERAL DRAINAGE COLLECTED FROM LAYER  7
  ----------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  9
```

```
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  3
  -------------------------------------
    AVERAGES               0.0000   0.0000   0.0000   0.0175   0.3466   0.0417
                           0.1973   0.2086   0.3385   0.1596   0.0200   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0782   0.1243   0.0924
                           0.2225   0.2752   0.2410   0.2025   0.0391   0.0000

  DAILY AVERAGE HEAD ON TOP OF LAYER  8
  -------------------------------------
    AVERAGES               0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************



*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   20
-------------------------------------------------------------------------------
                                     INCHES            CU. FEET       PERCENT
                               -------------------   -------------   ---------
 PRECIPITATION                  15.24    (   3.800)      55313.9     100.00

 RUNOFF                          1.670   (  1.1436)       6062.46     10.960

 EVAPOTRANSPIRATION              6.638   (  1.4316)      24094.38     43.559

 LATERAL DRAINAGE COLLECTED      6.87616 (  2.84239)     24960.457   45.12507
   FROM LAYER  2

 PERCOLATION/LEAKAGE THROUGH     0.00011 (  0.00005)         0.400     0.00072
   LAYER  4

 AVERAGE HEAD ON TOP             0.111 (    0.046)
   OF LAYER  3

 LATERAL DRAINAGE COLLECTED      0.00011 (  0.00005)         0.395    0.00071
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.005     0.00001
   LAYER  9
```

```
 AVERAGE HEAD ON TOP              0.000 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE          0.054   (  1.0642)        196.24      0.355

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```

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                PEAK DAILY VALUES FOR YEARS    1 THROUGH   20
   ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
      PRECIPITATION                              3.00        10890.000

      RUNOFF                                     1.121        4067.7922

      DRAINAGE COLLECTED FROM LAYER  2           1.08655      3944.18896

      PERCOLATION/LEAKAGE THROUGH LAYER  4       0.000030        0.10774

      AVERAGE HEAD ON TOP OF LAYER  3            6.841

      MAXIMUM HEAD ON TOP OF LAYER  3           12.441

      LOCATION OF MAXIMUM HEAD IN LAYER  2
            (DISTANCE FROM DRAIN)                0.0 FEET

      DRAINAGE COLLECTED FROM LAYER  7           0.00002         0.05665

      PERCOLATION/LEAKAGE THROUGH LAYER  9       0.000000        0.00002

      AVERAGE HEAD ON TOP OF LAYER  8            0.000

      MAXIMUM HEAD ON TOP OF LAYER  8            0.038

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)                0.0 FEET

      SNOW WATER                                 5.05        18347.8535


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.3932

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0225


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

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******************************************************************************

                   FINAL WATER STORAGE AT END OF YEAR   20
    ----------------------------------------------------------------------
                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1            1.6299         0.2716

                      2            0.3909         0.0651

                      3            0.0000         0.0000

                      4            0.1067         0.4270

                      5            0.7440         0.0620

                      6           35.0400         0.0730

                      7            0.7680         0.0320

                      8            0.0000         0.0000

                      9            0.1875         0.7500

                  SNOW WATER       1.271

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************




PRECIPITATION DATA FILE:    C:\matsu\P1.D4
TEMPERATURE DATA FILE:      C:\matsu\T1.D7
SOLAR RADIATION DATA FILE:  C:\matsu\s1.D13
EVAPOTRANSPIRATION DATA:    C:\matsu\e1.D11
SOIL AND DESIGN DATA FILE:  C:\matsu\scen2.D10
OUTPUT DATA FILE:           C:\matsu\scen2.OUT



TIME:  14:29     DATE:   8/20/2014



******************************************************************************

     TITLE:  Mat-Su Future Cells Bottom 60 Feet Waste Final Cover

******************************************************************************



     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.



                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   2
           THICKNESS                  =      6.00   INCHES
           POROSITY                   =      0.4370 VOL/VOL
           FIELD CAPACITY             =      0.0620 VOL/VOL
           WILTING POINT              =      0.0240 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0858 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.579999993000E-02 CM/SEC



                                   LAYER  2
                                   --------
```

```
            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   1
THICKNESS                   =      6.00   INCHES
POROSITY                    =      0.4170 VOL/VOL
FIELD CAPACITY              =      0.0450 VOL/VOL
WILTING POINT               =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0536 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.999999978000E-02 CM/SEC
SLOPE                       =      4.00   PERCENT
DRAINAGE LENGTH             =    200.0    FEET


                        LAYER  3
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.08   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      0.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      0.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  4 - POOR


                        LAYER  4
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.25   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   2
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4370 VOL/VOL
FIELD CAPACITY              =      0.0620 VOL/VOL
WILTING POINT               =      0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0620 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.579999993000E-02 CM/SEC
```

```
                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    480.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC



                        LAYER  7
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.3970 VOL/VOL
FIELD CAPACITY              =      0.0320 VOL/VOL
WILTING POINT               =      0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0320 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000001000     CM/SEC
SLOPE                       =      4.00   PERCENT
DRAINAGE LENGTH             =    200.0    FEET



                        LAYER  8
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.08   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD



                        LAYER  9
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.25   INCHES
POROSITY                    =      0.7500 VOL/VOL
```

```
      FIELD CAPACITY              =      0.7470 VOL/VOL
      WILTING POINT               =      0.4000 VOL/VOL
      INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
      EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC




              GENERAL DESIGN AND EVAPORATIVE ZONE DATA
              ----------------------------------------

    NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
             SOIL DATA BASE USING SOIL TEXTURE # 2 WITH A
             POOR STAND OF GRASS, A SURFACE SLOPE OF  4.%
             AND A SLOPE LENGTH OF  100. FEET.

   SCS RUNOFF CURVE NUMBER             =     74.60
   FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH              =      8.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE   =      0.553  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE  =      3.456  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.180  INCHES
   INITIAL SNOW WATER                  =      1.478  INCHES
   INITIAL WATER IN LAYER MATERIALS    =     37.763  INCHES
   TOTAL INITIAL WATER                 =     39.241  INCHES
   TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR



               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BETHEL                 ALASKA

        STATION LATITUDE                       =  60.78 DEGREES
        MAXIMUM LEAF AREA INDEX                =   0.00
        START OF GROWING SEASON (JULIAN DATE)  =    184
        END OF GROWING SEASON (JULIAN DATE)    =    225
        EVAPORATIVE ZONE DEPTH                 =   8.0  INCHES
        AVERAGE ANNUAL WIND SPEED              =  12.90 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  75.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  78.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  83.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  80.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    MEDFORD             OREGON

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  0.84        0.84        0.72        0.44        0.66        1.31
  2.06        2.29        2.59        1.74        1.09        1.22
```

```
         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BETHEL              ALASKA

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      14.10       18.20       26.30       37.30       47.80       55.10
      58.10       55.90       48.00       33.90       20.70       16.20


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BETHEL              ALASKA
                    AND STATION LATITUDE  =  60.78 DEGREES



*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                         INCHES         CU. FEET     PERCENT
                                        --------       ----------    -------
  PRECIPITATION                           16.68         60548.406    100.00

  RUNOFF                                   1.228         4456.134      7.36

  EVAPOTRANSPIRATION                       8.654        31414.291     51.88

  DRAINAGE COLLECTED FROM LAYER  2         6.8010       24687.682     40.77

  PERC./LEAKAGE THROUGH LAYER  4           0.000053         0.191      0.00

  AVG. HEAD ON TOP OF LAYER  3             1.6811

  DRAINAGE COLLECTED FROM LAYER  7         0.0001           0.182      0.00

  PERC./LEAKAGE THROUGH LAYER  9           0.000002         0.009      0.00

  AVG. HEAD ON TOP OF LAYER  8             0.0000

  CHANGE IN WATER STORAGE                 -0.003           -9.901     -0.02

  SOIL WATER AT START OF YEAR             37.763       137080.687

  SOIL WATER AT END OF YEAR               37.761       137070.781

  SNOW WATER AT START OF YEAR              1.478         5364.229      8.86

  SNOW WATER AT END OF YEAR                1.478         5364.229      8.86

  ANNUAL WATER BUDGET BALANCE              0.0000           0.010      0.00

*******************************************************************************
```

```
*******************************************************************************

        AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH   20
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 0.84     0.95     0.58     0.45     0.69     0.75
                           1.70     2.12     2.90     1.99     1.11     1.15

    STD. DEVIATIONS        0.32     0.43     0.27     0.18     0.44     0.70
                           1.80     2.07     1.87     1.17     0.41     0.46

  RUNOFF
  ------
    TOTALS                 0.000    0.014    0.754    0.397    0.086    0.000
                           0.059    0.137    0.180    0.150    0.126    0.010

    STD. DEVIATIONS        0.000    0.035    0.552    0.790    0.093    0.000
                           0.110    0.480    0.358    0.493    0.276    0.021

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 0.440    0.479    0.485    0.176    0.969    0.604
                           0.726    0.790    0.913    0.660    0.389    0.373

    STD. DEVIATIONS        0.060    0.068    0.125    0.130    0.387    0.503
                           0.600    0.621    0.536    0.305    0.112    0.074

  LATERAL DRAINAGE COLLECTED FROM LAYER  2
  ----------------------------------------
    TOTALS                 0.0879   0.0322   0.0144   0.0261   0.7757   0.7065
                           0.6469   0.8146   1.1774   1.1578   0.5840   0.2376

    STD. DEVIATIONS        0.0588   0.0215   0.0097   0.0923   0.2556   0.1746
                           0.3850   0.6333   0.7509   0.6898   0.3850   0.1548

  PERCOLATION/LEAKAGE THROUGH LAYER  4
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  LATERAL DRAINAGE COLLECTED FROM LAYER  7
  ----------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  9
```

```
    ------------------------------------
      TOTALS                0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

      STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


  -------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
  -------------------------------------------------------------------------------


    DAILY AVERAGE HEAD ON TOP OF LAYER  3
    -------------------------------------
      AVERAGES              0.2505   0.1007   0.0410   0.0770   2.2178   2.0803
                            1.8803   2.4153   3.6641   3.4114   1.7235   0.6770

      STD. DEVIATIONS       0.1677   0.0675   0.0275   0.2717   0.7303   0.5141
                            1.1453   2.0023   2.4725   2.1636   1.1390   0.4411

    DAILY AVERAGE HEAD ON TOP OF LAYER  8
    -------------------------------------
      AVERAGES              0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

      STD. DEVIATIONS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                            0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  *******************************************************************************



  *******************************************************************************

       AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   20
  -------------------------------------------------------------------------------
                                        INCHES            CU. FEET      PERCENT
                                  -------------------   -------------   ---------
   PRECIPITATION                   15.24    (   3.800)     55313.9     100.00

   RUNOFF                           1.912   (  1.4313)      6939.82     12.546

   EVAPOTRANSPIRATION               7.004   (  1.5645)     25424.77     45.964

   LATERAL DRAINAGE COLLECTED       6.26107 (  2.16301)    22727.668   41.08850
     FROM LAYER  2

   PERCOLATION/LEAKAGE THROUGH      0.00005 (  0.00002)        0.177     0.00032
     LAYER  4

   AVERAGE HEAD ON TOP              1.545 (    0.560)
     OF LAYER  3

   LATERAL DRAINAGE COLLECTED       0.00005 (  0.00002)        0.168    0.00030
     FROM LAYER  7

   PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)        0.009     0.00002
     LAYER  9
```

```
 AVERAGE HEAD ON TOP               0.000 (    0.000)
   OF LAYER  8

 CHANGE IN WATER STORAGE          0.061   (  1.1305)        221.51      0.400

*******************************************************************************
```

```
******************************************************************************

               PEAK DAILY VALUES FOR YEARS    1 THROUGH   20
   ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
     PRECIPITATION                               3.00        10890.000

     RUNOFF                                      1.679        6095.8481

     DRAINAGE COLLECTED FROM LAYER  2            0.10731       389.55002

     PERCOLATION/LEAKAGE THROUGH LAYER  4        0.000001        0.00370

     AVERAGE HEAD ON TOP OF LAYER  3            12.000

     MAXIMUM HEAD ON TOP OF LAYER  3            17.662

     LOCATION OF MAXIMUM HEAD IN LAYER  2
           (DISTANCE FROM DRAIN)                52.6 FEET

     DRAINAGE COLLECTED FROM LAYER  7            0.00000         0.00323

     PERCOLATION/LEAKAGE THROUGH LAYER  9        0.000000        0.00002

     AVERAGE HEAD ON TOP OF LAYER  8             0.000

     MAXIMUM HEAD ON TOP OF LAYER  8             0.000

     LOCATION OF MAXIMUM HEAD IN LAYER  7
           (DISTANCE FROM DRAIN)                 0.0 FEET

     SNOW WATER                                  5.05        18347.8535


     MAXIMUM VEG. SOIL WATER (VOL/VOL)                   0.4320

     MINIMUM VEG. SOIL WATER (VOL/VOL)                   0.0225


      ***  Maximum heads are computed using McEnroe's equations.  ***

           Reference:  Maximum Saturated Depth over Landfill Liner
                       by Bruce M. McEnroe, University of Kansas
                       ASCE Journal of Environmental Engineering
                       Vol. 119, No. 2, March 1993, pp. 262-270.


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                   FINAL WATER STORAGE AT END OF YEAR   20
    ----------------------------------------------------------------------
                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1            1.6299         0.2716

                      2            0.6336         0.1056

                      3            0.0000         0.0000

                      4            0.1875         0.7500

                      5            0.7440         0.0620

                      6           35.0400         0.0730

                      7            0.7680         0.0320

                      8            0.0000         0.0000

                      9            0.1875         0.7500

                  SNOW WATER       1.271

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**               FOR USEPA RISK REDUCTION ENGINEERING LABORATORY            **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************




PRECIPITATION DATA FILE:    C:\matsu\P1.D4
TEMPERATURE DATA FILE:      C:\matsu\T1.D7
SOLAR RADIATION DATA FILE:  C:\matsu\s1.D13
EVAPOTRANSPIRATION DATA:    C:\matsu\e1.D11
SOIL AND DESIGN DATA FILE:  C:\matsu\scen4.D10
OUTPUT DATA FILE:           C:\matsu\scen4.OUT



TIME:  14:35     DATE:   8/20/2014




******************************************************************************

     TITLE:  Mat-Su Future Cells SS 40' of Waste, Scenario 4 Interim Covr

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.



                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   2
           THICKNESS                   =     12.00   INCHES
           POROSITY                    =      0.4370 VOL/VOL
           FIELD CAPACITY              =      0.0620 VOL/VOL
           WILTING POINT               =      0.0240 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0775 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.579999993000E-02 CM/SEC



                                   LAYER  2
                                   --------
```

```
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    480.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC




                        LAYER  3
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.3970 VOL/VOL
FIELD CAPACITY              =      0.0320 VOL/VOL
WILTING POINT               =      0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0443 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000001000     CM/SEC
SLOPE                       =      4.00   PERCENT
DRAINAGE LENGTH             =    100.0    FEET




                        LAYER  4
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.08   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD




                        LAYER  5
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.25   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC
```

```
              GENERAL DESIGN AND EVAPORATIVE ZONE DATA
              ----------------------------------------

    NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
             SOIL DATA BASE USING SOIL TEXTURE # 2 WITH A
             POOR STAND OF GRASS, A SURFACE SLOPE OF  4.%
             AND A SLOPE LENGTH OF  100. FEET.

   SCS RUNOFF CURVE NUMBER             =     74.60
   FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH              =      8.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE   =      0.565  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE  =      3.496  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.192  INCHES
   INITIAL SNOW WATER                  =      1.478  INCHES
   INITIAL WATER IN LAYER MATERIALS    =     37.220  INCHES
   TOTAL INITIAL WATER                 =     38.698  INCHES
   TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR



               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BETHEL                ALASKA

        STATION LATITUDE                       =  60.78 DEGREES
        MAXIMUM LEAF AREA INDEX                =   0.00
        START OF GROWING SEASON (JULIAN DATE)  =    184
        END OF GROWING SEASON (JULIAN DATE)    =    225
        EVAPORATIVE ZONE DEPTH                 =   8.0  INCHES
        AVERAGE ANNUAL WIND SPEED              =  12.90 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  75.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  78.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  83.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  80.00 %


    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    MEDFORD             OREGON

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  0.84        0.84        0.72        0.44        0.66        1.31
  2.06        2.29        2.59        1.74        1.09        1.22


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BETHEL              ALASKA
```

```
             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      14.10       18.20       26.30       37.30       47.80       55.10
      58.10       55.90       48.00       33.90       20.70       16.20


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BETHEL              ALASKA
                    AND STATION LATITUDE  =  60.78 DEGREES



*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           16.68          60548.406    100.00

  RUNOFF                                   1.226          4451.605      7.35

  EVAPOTRANSPIRATION                       8.616         31276.062     51.65

  DRAINAGE COLLECTED FROM LAYER  3         6.8400        24829.275     41.01

  PERC./LEAKAGE THROUGH LAYER  5           0.000009          0.032      0.00

  AVG. HEAD ON TOP OF LAYER  4             0.0830

  CHANGE IN WATER STORAGE                 -0.002            -8.572     -0.01

  SOIL WATER AT START OF YEAR             37.220        135110.312

  SOIL WATER AT END OF YEAR               37.218        135101.734

  SNOW WATER AT START OF YEAR              1.478          5364.229      8.86

  SNOW WATER AT END OF YEAR                1.478          5364.229      8.86

  ANNUAL WATER BUDGET BALANCE              0.0000            0.004      0.00

*******************************************************************************



*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    2
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           16.26          59023.809    100.00
```

```
         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH   20
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 0.84     0.95     0.58     0.45     0.69     0.75
                           1.70     2.12     2.90     1.99     1.11     1.15

    STD. DEVIATIONS        0.32     0.43     0.27     0.18     0.44     0.70
                           1.80     2.07     1.87     1.17     0.41     0.46

  RUNOFF
  ------
    TOTALS                 0.000    0.013    0.746    0.394    0.084    0.000
                           0.059    0.049    0.050    0.088    0.126    0.010

    STD. DEVIATIONS        0.000    0.035    0.546    0.794    0.094    0.000
                           0.109    0.101    0.111    0.267    0.276    0.021

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 0.440    0.479    0.485    0.177    0.852    0.597
                           0.673    0.753    0.858    0.639    0.392    0.373

    STD. DEVIATIONS        0.060    0.068    0.125    0.136    0.412    0.502
                           0.549    0.621    0.482    0.327    0.117    0.074

  LATERAL DRAINAGE COLLECTED FROM LAYER  3
  ----------------------------------------
    TOTALS                 0.0476   0.0306   0.0258   0.0512   1.3978   0.4114
                           0.7014   0.9441   1.6097   1.2354   0.3027   0.0851

    STD. DEVIATIONS        0.0113   0.0054   0.0037   0.1391   0.5185   0.4339
                           0.7707   1.1062   1.3942   1.4173   0.3434   0.0324

  PERCOLATION/LEAKAGE THROUGH LAYER  5
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  4
  -------------------------------------
    AVERAGES               0.0068   0.0048   0.0037   0.0075   0.1992   0.0606
                           0.0999   0.1345   0.2370   0.1760   0.0446   0.0121

    STD. DEVIATIONS        0.0016   0.0008   0.0005   0.0205   0.0739   0.0639
                           0.1098   0.1576   0.2053   0.2019   0.0506   0.0046
```

```
*******************************************************************************


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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   20
-------------------------------------------------------------------------------
                                     INCHES            CU. FEET       PERCENT
                               -------------------   -------------   ---------
 PRECIPITATION                  15.24    (   3.800)      55313.9     100.00

 RUNOFF                          1.618   (  1.1346)       5872.58     10.617

 EVAPOTRANSPIRATION              6.719   (  1.4772)      24391.17     44.096

 LATERAL DRAINAGE COLLECTED      6.84279 (  2.81500)     24839.342   44.90611
   FROM LAYER  3

 PERCOLATION/LEAKAGE THROUGH     0.00001 (  0.00000)         0.032     0.00006
   LAYER  5

 AVERAGE HEAD ON TOP             0.082 (    0.034)
   OF LAYER  4

 CHANGE IN WATER STORAGE         0.058   (  1.0426)        210.82      0.381
*******************************************************************************
```

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******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH   20
   ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------    -------------
      PRECIPITATION                              3.00         10890.000

      RUNOFF                                     1.123         4075.1460

      DRAINAGE COLLECTED FROM LAYER  3           0.29836       1083.05505

      PERCOLATION/LEAKAGE THROUGH LAYER  5       0.000000         0.00118

      AVERAGE HEAD ON TOP OF LAYER  4            1.318

      MAXIMUM HEAD ON TOP OF LAYER  4            2.329

      LOCATION OF MAXIMUM HEAD IN LAYER  3
            (DISTANCE FROM DRAIN)               11.5 FEET

      SNOW WATER                                 5.05         18347.8535


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.3955

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0240

       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.

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******************************************************************************

                  FINAL WATER STORAGE AT END OF YEAR   20
    ----------------------------------------------------------------------
                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1            2.2754         0.1896

                      2           35.0400         0.0730

                      3            1.0858         0.0452

                      4            0.0000         0.0000

                      5            0.1875         0.7500

                  SNOW WATER       1.271

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 ******************************************************************************
 **                                                                          **
 **                                                                          **
 **              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
 **                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
 **                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
 **                    USAE WATERWAYS EXPERIMENT STATION                     **
 **             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
 **                                                                          **
 **                                                                          **
 ******************************************************************************
 ******************************************************************************




 PRECIPITATION DATA FILE:    C:\matsu\P1.D4
 TEMPERATURE DATA FILE:      C:\matsu\T1.D7
 SOLAR RADIATION DATA FILE:  C:\matsu\s1.D13
 EVAPOTRANSPIRATION DATA:    C:\matsu\e1.D11
 SOIL AND DESIGN DATA FILE:  C:\matsu\scen5a.D10
 OUTPUT DATA FILE:           C:\matsu\scen5a.OUT



 TIME:  14:39     DATE:   8/20/2014




 ******************************************************************************

      TITLE:  Mat-Su Future Cells Bottom No Waste

 ******************************************************************************



      NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
               COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.



                                    LAYER  1
                                    --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   2
            THICKNESS                  =     12.00   INCHES
            POROSITY                   =      0.4370 VOL/VOL
            FIELD CAPACITY             =      0.0620 VOL/VOL
            WILTING POINT              =      0.0240 VOL/VOL
            INITIAL SOIL WATER CONTENT  =      0.0775 VOL/VOL
            EFFECTIVE SAT. HYD. COND.   =  0.579999993000E-02 CM/SEC



                                    LAYER  2
                                    --------
```

```
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    480.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC




                        LAYER  3
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.3970 VOL/VOL
FIELD CAPACITY              =      0.0320 VOL/VOL
WILTING POINT               =      0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0444 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000001000     CM/SEC
SLOPE                       =      4.00   PERCENT
DRAINAGE LENGTH             =    200.0    FEET




                        LAYER  4
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.08   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD




                        LAYER  5
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.25   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC
```

```
               GENERAL DESIGN AND EVAPORATIVE ZONE DATA
               ----------------------------------------

     NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
              SOIL DATA BASE USING SOIL TEXTURE # 2 WITH A
              POOR STAND OF GRASS, A SURFACE SLOPE OF 33.%
              AND A SLOPE LENGTH OF  100. FEET.

    SCS RUNOFF CURVE NUMBER               =    76.20
    FRACTION OF AREA ALLOWING RUNOFF      =   100.0    PERCENT
    AREA PROJECTED ON HORIZONTAL PLANE    =     1.000  ACRES
    EVAPORATIVE ZONE DEPTH                =     8.0    INCHES
    INITIAL WATER IN EVAPORATIVE ZONE     =     0.565  INCHES
    UPPER LIMIT OF EVAPORATIVE STORAGE    =     3.496  INCHES
    LOWER LIMIT OF EVAPORATIVE STORAGE    =     0.192  INCHES
    INITIAL SNOW WATER                    =     1.478  INCHES
    INITIAL WATER IN LAYER MATERIALS      =    37.224  INCHES
    TOTAL INITIAL WATER                   =    38.702  INCHES
    TOTAL SUBSURFACE INFLOW               =     0.00   INCHES/YEAR




                EVAPOTRANSPIRATION AND WEATHER DATA
                -----------------------------------

     NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
              BETHEL                ALASKA

         STATION LATITUDE                         =  60.78 DEGREES
         MAXIMUM LEAF AREA INDEX                  =   0.00
         START OF GROWING SEASON (JULIAN DATE)    =    184
         END OF GROWING SEASON (JULIAN DATE)      =    225
         EVAPORATIVE ZONE DEPTH                   =   8.0  INCHES
         AVERAGE ANNUAL WIND SPEED                =  12.90 MPH
         AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  75.00 %
         AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  78.00 %
         AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  83.00 %
         AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  80.00 %



     NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
              COEFFICIENTS FOR    MEDFORD             OREGON

              NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
    0.84        0.84        0.72        0.44        0.66        1.31
    2.06        2.29        2.59        1.74        1.09        1.22



     NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
              COEFFICIENTS FOR    BETHEL              ALASKA
```

```
             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      14.10       18.20       26.30       37.30       47.80       55.10
      58.10       55.90       48.00       33.90       20.70       16.20


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BETHEL              ALASKA
                    AND STATION LATITUDE  =  60.78 DEGREES



*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           16.68          60548.406    100.00

  RUNOFF                                   1.285          4663.983      7.70

  EVAPOTRANSPIRATION                       8.616         31276.062     51.65

  DRAINAGE COLLECTED FROM LAYER  3         6.7814        24616.627     40.66

  PERC./LEAKAGE THROUGH LAYER  5           0.000016          0.057      0.00

  AVG. HEAD ON TOP OF LAYER  4             0.1647

  CHANGE IN WATER STORAGE                 -0.002            -8.322     -0.01

  SOIL WATER AT START OF YEAR             37.224        135122.984

  SOIL WATER AT END OF YEAR               37.222        135114.656

  SNOW WATER AT START OF YEAR              1.478          5364.229      8.86

  SNOW WATER AT END OF YEAR                1.478          5364.229      8.86

  ANNUAL WATER BUDGET BALANCE              0.0000            0.000      0.00

*******************************************************************************



*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    2
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           16.26          59023.809    100.00
```

```
       AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH   20
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                  0.84     0.95     0.58     0.45     0.69     0.75
                           1.70     2.12     2.90     1.99     1.11     1.15

   STD. DEVIATIONS         0.32     0.43     0.27     0.18     0.44     0.70
                           1.80     2.07     1.87     1.17     0.41     0.46

 RUNOFF
 ------
   TOTALS                  0.000    0.013    0.746    0.394    0.085    0.000
                           0.077    0.065    0.067    0.093    0.126    0.010

   STD. DEVIATIONS         0.000    0.035    0.546    0.794    0.096    0.000
                           0.137    0.131    0.131    0.281    0.276    0.021

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                  0.440    0.479    0.485    0.177    0.852    0.594
                           0.672    0.756    0.860    0.638    0.393    0.373

   STD. DEVIATIONS         0.060    0.068    0.125    0.134    0.411    0.504
                           0.547    0.620    0.482    0.324    0.119    0.074

 LATERAL DRAINAGE COLLECTED FROM LAYER  3
 ----------------------------------------
   TOTALS                  0.0482   0.0308   0.0259   0.0415   1.3229   0.4876
                           0.6144   0.9378   1.5816   1.2736   0.3336   0.0880

   STD. DEVIATIONS         0.0127   0.0062   0.0042   0.0954   0.4891   0.4228
                           0.6774   1.0739   1.4071   1.3931   0.3651   0.0365

 PERCOLATION/LEAKAGE THROUGH LAYER  5
 ------------------------------------
   TOTALS                  0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

   STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
             AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  4
 -------------------------------------
   AVERAGES                0.0137   0.0096   0.0074   0.0122   0.3770   0.1436
                           0.1751   0.2672   0.4657   0.3629   0.0982   0.0251

   STD. DEVIATIONS         0.0036   0.0019   0.0012   0.0281   0.1394   0.1245
                           0.1930   0.3060   0.4143   0.3970   0.1075   0.0104
```

```
*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   20
-------------------------------------------------------------------------------
                                     INCHES            CU. FEET       PERCENT
                               -------------------   -------------   ---------
 PRECIPITATION                  15.24    (   3.800)      55313.9     100.00

 RUNOFF                          1.676   (  1.1430)       6082.29     10.996

 EVAPOTRANSPIRATION              6.718   (  1.4723)      24387.83     44.090

 LATERAL DRAINAGE COLLECTED      6.78587 (  2.76977)     24632.711   44.53255
   FROM LAYER  3

 PERCOLATION/LEAKAGE THROUGH     0.00002 (  0.00001)         0.058     0.00011
   LAYER  5

 AVERAGE HEAD ON TOP             0.163 (    0.067)
   OF LAYER  4

 CHANGE IN WATER STORAGE         0.058   (  1.0433)        211.06      0.382
*******************************************************************************
```

```
******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH   20
   ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
      PRECIPITATION                              3.00         10890.000

      RUNOFF                                     1.123         4075.1477

      DRAINAGE COLLECTED FROM LAYER  3           0.25918        940.83954

      PERCOLATION/LEAKAGE THROUGH LAYER  5       0.000001         0.00225

      AVERAGE HEAD ON TOP OF LAYER  4            2.290

      MAXIMUM HEAD ON TOP OF LAYER  4            4.092

      LOCATION OF MAXIMUM HEAD IN LAYER  3
            (DISTANCE FROM DRAIN)               21.0 FEET

      SNOW WATER                                 5.05         18347.8535


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.3955

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0240


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.


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                   FINAL WATER STORAGE AT END OF YEAR   20
    ----------------------------------------------------------------------
                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1            2.2754         0.1896

                      2           35.0400         0.0730

                      3            1.0906         0.0454

                      4            0.0000         0.0000

                      5            0.1875         0.7500

                  SNOW WATER       1.271

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:    C:\matsu\P1.D4
TEMPERATURE DATA FILE:      C:\matsu\T1.D7
SOLAR RADIATION DATA FILE:  C:\matsu\s1.D13
EVAPOTRANSPIRATION DATA:    C:\matsu\e1.D11
SOIL AND DESIGN DATA FILE:  C:\matsu\scen5b.D10
OUTPUT DATA FILE:           C:\matsu\scen5b.OUT



TIME:  14:47     DATE:   8/20/2014




******************************************************************************

     TITLE:  Mat-Su Future Cells SS 40' of Waste, Scenario 5B

******************************************************************************



     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.



                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   2
           THICKNESS                   =    12.00   INCHES
           POROSITY                    =     0.4370 VOL/VOL
           FIELD CAPACITY              =     0.0620 VOL/VOL
           WILTING POINT               =     0.0240 VOL/VOL
           INITIAL SOIL WATER CONTENT  =     0.0775 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.579999993000E-02 CM/SEC



                                   LAYER  2
                                   --------
```

```
          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                   =    480.00   INCHES
POROSITY                    =      0.1680 VOL/VOL
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC




                        LAYER  3
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.3970 VOL/VOL
FIELD CAPACITY              =      0.0320 VOL/VOL
WILTING POINT               =      0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0442 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000001000     CM/SEC
SLOPE                       =     33.00   PERCENT
DRAINAGE LENGTH             =    100.0    FEET




                        LAYER  4
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.08   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD




                        LAYER  5
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.25   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC
```

```
              GENERAL DESIGN AND EVAPORATIVE ZONE DATA
              ----------------------------------------

    NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
             SOIL DATA BASE USING SOIL TEXTURE # 2 WITH A
             POOR STAND OF GRASS, A SURFACE SLOPE OF 33.%
             AND A SLOPE LENGTH OF  100. FEET.

   SCS RUNOFF CURVE NUMBER             =     76.20
   FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
   EVAPORATIVE ZONE DEPTH              =      8.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE   =      0.565  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE  =      3.496  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE  =      0.192  INCHES
   INITIAL SNOW WATER                  =      1.478  INCHES
   INITIAL WATER IN LAYER MATERIALS    =     37.218  INCHES
   TOTAL INITIAL WATER                 =     38.695  INCHES
   TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR




               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             BETHEL                ALASKA

        STATION LATITUDE                       =  60.78 DEGREES
        MAXIMUM LEAF AREA INDEX                =   0.00
        START OF GROWING SEASON (JULIAN DATE)  =    184
        END OF GROWING SEASON (JULIAN DATE)    =    225
        EVAPORATIVE ZONE DEPTH                 =   8.0  INCHES
        AVERAGE ANNUAL WIND SPEED              =  12.90 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  75.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  78.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  83.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  80.00 %



    NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    MEDFORD             OREGON

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  0.84        0.84        0.72        0.44        0.66        1.31
  2.06        2.29        2.59        1.74        1.09        1.22



    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR    BETHEL              ALASKA
```

```
             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      14.10       18.20       26.30       37.30       47.80       55.10
      58.10       55.90       48.00       33.90       20.70       16.20


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    BETHEL              ALASKA
                    AND STATION LATITUDE  =  60.78 DEGREES



*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           16.68          60548.406    100.00

  RUNOFF                                   1.285          4663.983      7.70

  EVAPOTRANSPIRATION                       8.616         31276.062     51.65

  DRAINAGE COLLECTED FROM LAYER  3         6.7816        24617.105     40.66

  PERC./LEAKAGE THROUGH LAYER  5           0.000003          0.011      0.00

  AVG. HEAD ON TOP OF LAYER  4             0.0110

  CHANGE IN WATER STORAGE                 -0.002            -8.752     -0.01

  SOIL WATER AT START OF YEAR             37.218        135099.859

  SOIL WATER AT END OF YEAR               37.215        135091.109

  SNOW WATER AT START OF YEAR              1.478          5364.229      8.86

  SNOW WATER AT END OF YEAR                1.478          5364.229      8.86

  ANNUAL WATER BUDGET BALANCE              0.0000           -0.004      0.00

*******************************************************************************



*******************************************************************************

                          ANNUAL TOTALS FOR YEAR    2
-------------------------------------------------------------------------------
                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                           16.26          59023.809    100.00
```

```
         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH   20
-------------------------------------------------------------------------------

                         JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                         -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                 0.84     0.95     0.58     0.45     0.69     0.75
                           1.70     2.12     2.90     1.99     1.11     1.15

    STD. DEVIATIONS        0.32     0.43     0.27     0.18     0.44     0.70
                           1.80     2.07     1.87     1.17     0.41     0.46

  RUNOFF
  ------
    TOTALS                 0.000    0.013    0.746    0.394    0.085    0.000
                           0.077    0.065    0.067    0.093    0.126    0.010

    STD. DEVIATIONS        0.000    0.035    0.546    0.794    0.096    0.000
                           0.137    0.131    0.131    0.281    0.276    0.021

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 0.440    0.479    0.485    0.177    0.852    0.594
                           0.672    0.756    0.860    0.638    0.393    0.373

    STD. DEVIATIONS        0.060    0.068    0.125    0.134    0.411    0.504
                           0.547    0.620    0.482    0.324    0.119    0.074

  LATERAL DRAINAGE COLLECTED FROM LAYER  3
  ----------------------------------------
    TOTALS                 0.0462   0.0298   0.0253   0.0649   1.4254   0.3782
                           0.7606   0.9434   1.5893   1.1575   0.2844   0.0811

    STD. DEVIATIONS        0.0117   0.0058   0.0040   0.2017   0.5290   0.4277
                           0.8083   1.1072   1.3409   1.3566   0.3305   0.0316

  PERCOLATION/LEAKAGE THROUGH LAYER  5
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  4
  -------------------------------------
    AVERAGES               0.0009   0.0006   0.0005   0.0013   0.0273   0.0075
                           0.0145   0.0181   0.0314   0.0222   0.0056   0.0016

    STD. DEVIATIONS        0.0002   0.0001   0.0001   0.0040   0.0101   0.0085
                           0.0155   0.0212   0.0265   0.0260   0.0065   0.0006
```

```
*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   20
-------------------------------------------------------------------------------
                                      INCHES           CU. FEET      PERCENT
                               -------------------   -------------   ---------
 PRECIPITATION                  15.24    (   3.800)      55313.9     100.00

 RUNOFF                          1.676   (  1.1430)       6082.29     10.996

 EVAPOTRANSPIRATION              6.718   (  1.4723)      24387.83     44.090

 LATERAL DRAINAGE COLLECTED      6.78600 (  2.77122)     24633.168   44.53338
   FROM LAYER  3

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)         0.011     0.00002
   LAYER  5

 AVERAGE HEAD ON TOP             0.011 (    0.004)
   OF LAYER  4

 CHANGE IN WATER STORAGE         0.058   (  1.0441)        210.64      0.381
*******************************************************************************
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******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH   20
   ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
      PRECIPITATION                              3.00         10890.000

      RUNOFF                                     1.123         4075.1477

      DRAINAGE COLLECTED FROM LAYER  3           0.34132       1238.99670

      PERCOLATION/LEAKAGE THROUGH LAYER  5       0.000000         0.00017

      AVERAGE HEAD ON TOP OF LAYER  4            0.202

      MAXIMUM HEAD ON TOP OF LAYER  4            0.401

      LOCATION OF MAXIMUM HEAD IN LAYER  3
            (DISTANCE FROM DRAIN)                0.0 FEET

      SNOW WATER                                 5.05         18347.8535


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.3955

      MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.0240


       ***  Maximum heads are computed using McEnroe's equations.  ***

            Reference:  Maximum Saturated Depth over Landfill Liner
                        by Bruce M. McEnroe, University of Kansas
                        ASCE Journal of Environmental Engineering
                        Vol. 119, No. 2, March 1993, pp. 262-270.


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******************************************************************************

                   FINAL WATER STORAGE AT END OF YEAR   20
    ----------------------------------------------------------------------
                    LAYER        (INCHES)       (VOL/VOL)
                    -----        --------       ---------
                      1            2.2754         0.1896

                      2           35.0400         0.0730

                      3            1.0820         0.0451

                      4            0.0000         0.0000

                      5            0.1875         0.7500

                   SNOW WATER      1.271

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******************************************************************************
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Appendix E
December 2013 CLF Leachate Report

(Summary sheets only, full laboratory results on file at MSB SWD)

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

ALASKA
CALIFORNIA
COLORADO
FLORIDA
MISSOURI
OREGON
WASHINGTON
WISCONSIN

January 15, 2013

Matanuska-Susitna Borough
Department of Public Works
350 East Dahlia Avenue
Palmer, Alaska 99645-6488

Attn: Mr. Jason Garner

RE: SEPTEMBER 2013 CENTRAL LANDFILL LEACHATE MONITORING ANALYTICAL RESULTS, MATANUSKA-SUSITNA BOROUGH, ALASKA

Shannon & Wilson, Inc. is pleased to submit the analytical results for the December 19, 2013 leachate sampling event at Central Landfill. Samples were collected from the below-ground leachate tank. The Anchorage Water & Wastewater Utility Industrial Pretreatment Program report, a Volatile and Semivolatile Organic Compounds table, the chain-of-custody form, and the laboratory report including method and detection limits from SGS North America, Inc. are provided as attachments.

If you have any questions regarding this sampling event, please do not hesitate to contact Shayla Marshall or the undersigned at your convenience.

Sincerely,

SHANNON & WILSON, INC.

Dane Palmer

Dane Palmer
Environmental Engineer, E.I.T.

Enclosures:
AWWU Industrial Pretreatment Program Report
Volatile and Semivolatile Organic Compound Analytical Results Table
SGS laboratory report

5430 FAIRBANKS STREET•SUITE 3
ANCHORAGE, ALASKA 99518
907-561-2120 • FAX 907-561-4483

MATANUSKA-SUSITNA BOROUGH - DEPARTMENT OF PUBLIC WORKS
CENTRAL LANDFILL LEACHATE
ANCHORAGE WATER & WASTEWATER UTILITY INDUSTRIAL PRETREATMENT PROGRAM REPORT

Parameter	**Arsenic**	**Beryllium**	**BOD**	**Soluble BOD**	**Cadmium**	**Chromium**	**Copper**	**Cyanide**	**Lead**	**Mercury**	**Nickel**	**Oil & Grease**	**pH**	**Settleable matter**	**Silver**	**TAH***	**TSS**	**Zinc**
STORET (mg/L)	1002	1012	310	NA	1027	1034	1042	720	1051	71900	1067	3582	406	NA	1077	NA	530	1092
Permit Limit	3.7 mg/L	14.5 mg/L	NA	NA	0.69 mg/L	2.77 mg/L	3.38 mg/L	1.7 mg/L	0.69 mg/L	0.2 mg/L	3.88 mg/L	250 mg/L	>5.0, <12.5	NA	2.5 mg/L	5.0 mg/L	NA	5.62 mg/L
6/26/2009	0.0103	ND	1,130	-	ND	0.00786	0.00618	0.0019 J	0.00041	ND	0.0264	16.1	6.00	ND	ND	0.103	59.0	0.0114
9/16/2009	0.0182 J	ND	1,400	-	ND	0.00997 J	0.00704	0.0065	0.00105	ND	0.0634	19.1	6.20	ND	ND	0.200	55.0	0.0650
12/10/2009	0.0377	ND	19,100	-	0.00118 J	0.0455	0.0199	0.0085	0.00625	ND	0.199	171	6.70	ND	ND	0.114	172	0.583
3/24/2010	0.0109	ND	744	-	0.000189 J	0.0103	0.0200	ND	0.00252	ND	0.0379	17.7	7.10	ND	ND	0.00636	8.60	0.110
6/28/2010	0.0311	ND	6,750	6,870	0.00149 J	0.0329	0.0174	ND	0.00486	ND	0.154	33.6	7.12	ND	ND	0.435	170	0.634
9/20/2010	0.0260	ND	3,680	3,960	0.00102 J	0.0339	0.0247	0.0069 J	0.00630	ND	0.144	49.2	6.80	ND	ND	0.371	165	0.654
12/29/2010	0.0421	ND	2,580	2,420	0.00125 J	0.0613	0.0389	0.028	0.00886	ND	0.285	36.7	6.79	ND	ND	0.182	76	0.434
3/31/2011	0.00431 J	ND	149	123	0.000561	0.00703	0.0564	ND	0.00298	ND	0.0296	ND, B	7.50	ND	ND	0.00345 J	15.9	0.109
6/27/2011	0.0245 J	ND	2,090	3,370	0.000780 J	0.0560	0.0675	0.031	0.00643	ND	0.159	14.5	6.90	ND	ND	0.0601	135	0.473
9/29/2011	ND	ND	5,680	5,520	ND	0.0231	0.0128	0.051	0.00222	ND	0.0893	70.7	7.00	0.200	ND	1.14	205	0.201
12/6/2011	0.0539	ND	8,330	7,690	0.00108 J	0.0814	0.0281	0.031	0.00809	ND	0.422	86.3	6.60	ND	ND	2.04	176	0.409
3/29/2012	0.00819	0.000230 J	477	498	0.00106	0.0245	0.111	ND B	0.00846	ND	0.0422	57.9	7.10	0.200	ND	0.00727	348	0.244
6/4/2012	0.0376	ND	15,200	14,600	ND	0.160	0.0409	0.021	0.00322	ND	0.522	104	6.30	0.100	ND	0.780	260	1.39
9/12/2012	0.00342 J	ND	49.0	39.6	ND	0.00397	0.0136	ND	0.00234	ND	0.00841	5.10	6.70	0.500	ND	0.0294 J	124	0.0529
12/19/2012	0.0687 J	ND	23,100	24,500	ND	0.371	0.0719	0.19	0.0103	ND	1.18	128	6.20	ND	ND	0.763	130	**6.56**
3/28/2013	0.0445 J	ND	21,100	20,000	ND	0.254	0.0410	0.035	0.00459 J	ND	0.900	97.0	6.50	ND	ND	ND	140	3.36
6/17/2013	0.0410	ND	15,300	15,300	ND	0.287	0.0867	0.040	0.0128	ND,B	0.883	40.1	6.30	0.200	ND	0.586	510	5.27
9/25/2013	0.0318	ND	10,800	10,500	ND	0.176	0.0236	0.017	0.00517	0.000164 J	0.565	99.8	6.60	ND	ND	0.622	215	2.37
12/19/2013	0.0465	ND	24,300 †	21,700 †	0.000665 J	0.393	0.0276	0.017	0.00973	0.00115	1.18	90.6	6.50	ND	ND	0.878	487	**8.13**

Notes:

All concentrations reported in mg/L except pH

Shaded and bold values indicate concentration is greater than AWWU limit

<	= Less than
>	= Greater than
*	= Total Aromatic Hydrocarbon (TAH) result is sum of benzene (78124), toluene (78131), ethylbenzene (34371), & xylenes (81551) concentration results
-	= Sample not analyzed for this parameter
mg/L	= Milligrams per liter
NA	= Not Applicable
ND	= Not Detected
J	= Analyte detected, but at a concentration less than the detection limit
B	= Concentration reported in project sample was within five times the concentration reported in the method blank; project sample concentration is considered not detected.
†	= Sample was collected on December 21, 2013

MATANUSKA-SUSTINA BOROUGH - DEPARTMENT OF PUBLIC WORKS
CENTRAL LANDFILL LEACHATE
VOLATILE & SEMIVOLATILE ORGANIC COMPOUND ANALYTICAL RESULTS

Parameter	6/26/2009	9/16/2009	12/10/2009	3/24/2010	6/28/2010	9/20/2010	12/29/2010	3/31/2011	6/27/2011	9/29/2011	12/6/2011	3/29/2012	6/4/2012	9/12/2012	12/19/2012	3/28/2013	6/17/2013	9/25/2013	12/19/2013
Acetophenone* - µg/L	9.82 J	ND	ND	ND	ND	ND	169	ND	ND	145	ND	ND	ND	ND	ND	151 J	ND	ND	ND
Acetone - µg/L	635	2,160	21,400	2,100	27,100	ND	5,320	181	5,100	19,800	28,800	115	12,100	64.7	18,500	14,000	11,400	13,200	19200 J
Benzene - µg/L	8.68	14.8	13.2	0.580	16.2	48.0	8.9	0.250 J	5.10	23.5	26.0	0.170 J	23.5	1.13	18.6	17.3	38.9	16.7	27.1 J
Benzyl alcohol* - µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	360	451 J	ND	436 J-
Bis(2-ethylhexyl)phthalate* - µg/L	ND	ND	ND	ND	ND	ND	ND	ND	3.46 J	ND	ND	7.04 J	ND	ND	ND	ND	ND	11.9	ND
Benzoic acid* - µg/L	ND	ND	15,300	1,900	ND	3,910	318 J	ND	3,800	ND	ND	163	ND	21.9 J	ND	ND	7,510	934	657 J-
2-Butanone (MEK) - µg/L	321	2,620	39,700	2,580	23,200	13,000	9,560	153	6,340	24,200	43,700	117	18,600	92.6	ND	20,900	15,100	14,400	19,800
Carbon disulfide -µg/L	1.83 J	1.67 J	ND	18.2	ND	160 J	ND	ND	28.2	ND	1.61 J	ND B	ND	5.91	1.09 J	ND	18.7 J	ND	ND
Chloroethane - µg/L	5.18	30.9	ND	1.53	ND	ND	6.60 J	ND	ND	ND	8.79	ND	ND	ND	ND	ND	9.00 J	ND	ND
Chloroform - µg/L	1.63	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.850 J	ND	ND	ND	ND	ND	ND	ND	ND
Chloromethane - µg/L	ND	9.07	28.0	ND	43.2	ND	5.90 J	ND	10.4	ND	5.78	ND	18.0 J	ND	4.87	8.00 J	8.30 J	ND	ND
1,4-Dichlorobenzene - µg/L	0.270 J	0.690	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane - µg/L	ND	28.8	8.80 J	2.67	ND	ND	5.10 J	ND	ND	ND	5.73	ND	ND	0.540 J	6.11	6.40 J	9.70 J	ND	ND
1,2-Dichloroethane - µg/L	4.91	7.29	ND	1.12	ND	ND	4.90 J	ND	ND	ND	11.9	ND	11.5 J	1.20	17.4	25.9	22.6	ND	ND
1,1-Dichloroethene - µg/L	14.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	0.730 J	1.73	8.40 J	0.450 J	16.2 J	ND	8.30 J	ND	ND	ND	ND	ND	ND	ND	4.01	4.80 J	7.40 J	9.10 J	ND
trans-1,2-Dichloroethene	0.920 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.84	ND	ND	ND	1.81	ND	ND	ND	ND
Dichlorodifluoromethane - µg/L	ND	4.98	ND	ND	ND	ND	ND	ND	ND	ND	2.00	ND	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate* - µg/L	ND	4.04 J	ND	ND	ND	ND	ND	ND	12.1	49.8 J	47.3 J	3.47 J	ND	3.67 J	98.4 J	64.8 J	ND	52.5	76.2 J-
Dimethylphthalate* - µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	46.1 J	ND	30.0 J	9.29 J	25.1 J-
Ethylbenzene - µg/L	4.11	9.38	ND	ND	10.2 J	ND	4.40 J	ND	ND	19.5 J	16.0	ND	ND	0.680 J	18.0	13.1	24.1	13.8	20.8
2-Hexanone - µg/L	5.84 J	ND	1,280	105	529	ND	249	6.13 J	59.7 J	ND	495 J	ND	ND	ND	578 J	503	391	271	ND
Isophorone* - µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	141 J	ND	ND	ND
Methyl iodide - µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	20.6	ND	ND
2-Methylphenol (o-Cresol)* - µg/L	ND	ND	ND	ND	ND	ND	46.0 J	ND	ND	75.2 J	225	ND	ND	ND	ND	ND	ND	ND	ND
3&4-Methylphenol (p&m-Cresol)* - µg/L	75.9	ND	13,800	1,190	10,400	7,090	4,750	ND	2,400	11,600	12,600	65.6	11,400	ND	17,900	14,700	11,700	12,100	15,500 J-
4-Methyl-2-pentanone (MIBK) - µg/L	49.9	68.3	747	58.7	651	324 J	267	3.81 J	169	544	765	4.78 J	301 J	4.59 J	443 J	460 J	278	269	ND
Methyl-t-butyl ether - µg/L	19.1	10.3	ND	ND	ND	ND	ND	ND	ND	ND	9.45	ND	ND	ND	16.5	21.2 J	19.0 J	ND	ND
Methylene chloride - µg/L	105	130	241	34.0	136	226 J	93.4	2.60 J	259	668	221 J	ND B	147 J	6.55	251 J	182	214	85.8	170
N-Nitrosodimethylamine* - µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Napthalene* - µg/L	ND	ND	ND	ND	ND	ND	ND	ND	90,900	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
di-n-Octylphthalate* - µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenol* - µg/L	398	429	259	139 J	697 J	725	804	ND	172 J	996	1,290	9.41 J	1,420	ND	2,570	1,720	1,600	1,310	1,370 J-
Styrene - µg/L	2.14	5.24	ND	ND	ND	ND	ND	ND	ND	ND	2.48	0.420 J	ND	ND	2.89	ND	ND	ND	ND
Tetrachloroethene - µg/L	11.7	13.8	ND	0.720 J	ND	ND	4.80 J	ND	ND	ND	14.3	ND	ND	0.870 J	9.75	7.10 J	5.00 J	6.50 J	ND
Toluene - µg/L	65.9	134	101	4.60	377	144	152	3.20	55.0	1,010	1,930	7.10	757	25.0	669	467	416	540	759
1,1,1-Trichloroethane - µg/L	13.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.390 J	ND	ND	ND	ND	ND
Trichloroethene - µg/L	3.81	ND	18.4 J	0.760 J	17.2 J	ND	9.60 J	ND	ND	17.5 J	14.1	ND	ND	0.840 J	7.28	11.0	8.50 J	10.6	ND
Trichlorofluoromethane - µg/L	29.6	9.43	ND	ND	ND	ND	ND	ND	5.30 J	ND	7.05	ND	ND	0.700 J	3.84	ND	ND	ND	ND
2,4,5-Trichlorophenol* - µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride - µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.70 J	ND
Xylenes, total - µg/L	24.7	42.2	ND	1.18 J	32.0 J	179 J	16.9 J	ND	ND	84.0 J	71.0	ND	ND	2.55	57.2	46.1	107	51.0	71.0

Notes:

* = Semivolatile Organic Compound
µg/L = Micrograms per liter
ND = Not Detected
J = Analyte detected, but at a concentration less than the detection limit
J- = Analyte may be biased low due to matrix interference
B = Concentration reported in project sample was within five times the concentration reported in the trip blank; project sample concentration is considered not detected.

Appendix F
ADEC Meeting Summary – July 2014

MSB Central Landfill Planning Discharge Limits for Treated Leachate and Septage

ATTENDEES:	Clint Adler/ADEC ES&PR Gene McCabe/ADEC ES&PR Mike Campfield/MSB Cap.Proj.	A. Kantardjieff/CH2MHILL Katie Winter/CH2M HILL Cory Hinds/CH2M HILL
COPY TO:	Oran Woolley/ADEC ES&PR Melinda Smodey/ADEC WW Project file	

PREPARED BY: Cory Hinds/CH2M HILL

DATE: July 17, 2014

PROJECT NUMBER: 496410

The following is a summary of discussion:

1. Introductions
    a. Clint is the chief technical engineer for ADEC Engineering Support & Plan Review (ES&PR) and supports Oran and others with technical reviews
    b. Gene is the manager of the ES&PR department which issues wastewater discharge authorizations
    c. Mike is the MSB project manager and a member of the MSB Wastewater & Septage Advisory Board
    d. Cory is the CH2M HILL project manager
    e. Katie is working for Cory determine numerical discharge limits
    f. Alexandra is a CH2M HILL wastewater treatment expert

2. Background (see also Attachment A, sent prior to the meeting)
    a. This is a planning study to evaluate long-term development of landfill cells and leachate treatment at the Central Landfill in Palmer.
    b. Both leachate and septage are currently hauled to Anchorage. There is pressure to keep and manage both of these waste streams in Mat-Su. MSB is considering treatment of leachate on site at the Central Landfill. MSB is also considering co-treatment of leachate and pre-treated septage at the Central Landfill. The decision on leachate treatment and co-treatment of leachate and septage has not yet been made. Depending on the outcome of this study, other possible studies, and funding, MSB may pursue design and construction of a leachate or leachate and septage treatment plant starting in the next couple years.
    c. CH2M HILL needs a reasonable understanding of expected discharge limits in order to price various treatment options.
3. Proposed Solution
    a. CH2M HILL is evaluating two possible treatments for leachate only:
        i. Biological treatment (MBR or SBR package treatment) with subsurface discharge
        ii. Leachate evaporation and recirculation of concentrate back to landfill
    b. CH2M HILL is also evaluating biological co-treatment of pre-treated septage and leachate by activated sludge, aeration and clarifier and subsurface discharge
    c. CH2M HILL presented proposed design discharge limits and point of compliance as described in Attachment A.

4. ADEC response and suggestions
    a. The CH2M HILL-proposed design discharge limits appear to be similar to the domestic wastewater limits in Article 2 of the Wastewater Disposal regulations (18 AAC 72). These are not appropriate because leachate is an industrial source. Similarly, because septage will be from all over the MSB, the septage will be considered coming from non-domestic sources.
    b. The appropriate regulations are Articles 5 and 6 for Nondomestic Wastewater (18 AAC 72) which include a more engineering-centric approach.
    c. CH2M HILL's proposed approach for point of compliance in downgradient monitoring wells on MSB property appears reasonable and has been approved by ADEC before. Upgradient monitoring wells can be used for comparison.
    d. For planning purposes, CH2M HILL/MSB can use the more stringent of the drinking water standards (18 AAC 80) and water quality standards (18 AAC 70) for both septage and leachate.

Appendix A

MSB Leachate and Septage Treatment: Background and Proposed Solution

Background:

CH2M HILL is under contract to the Mat-Su Borough (MSB) for long-term development planning at the Central LF in Palmer. The MSB will use the planning documents to make development decisions and obtain funding.

The MSB is currently trucking leachate to Anchorage where co-treatment of leachate, septage, and domestic sewage occurs at the Anchorage WWTP. Recently Anchorage has given MSB notice that the delivery of leachate to Anchorage will need to stop in the near future. Therefore, MSB is evaluating onsite leachate treatment options at the Central Landfill.

MSB also currently hauls septage to Anchorage and is receiving pressure from AWWU and local septage haulers to provide local treatment options. HDR Alaska has conducted several septage handling and disposal studies with economic analysis (2007, 2013) and recommends construction of a regional septage treatment facility with septage pretreatment followed by primary, secondary, and tertiary wastewater treatment to applicable discharge standards. MSB has added to CH2M HILL's scope the evaluation of co-location and treatment of septage and leachate treatment at the Central Landfill. Depending on the outcome of the CH2M HILL study and other considerations, MSB may or may not decide to pursue co-treatment of septage and leachate at the Central Landfill or another location.

CH2M HILL is contacting ADEC, on behalf of MSB, to discuss the proposed treatment processes, discharge limits, and compliance points summarized below to estimate order of magnitude treatment costs for comparative purposes.

Proposed Solution:

1. Treatment options for landfill leachate only
    a. Biological treatment using MBRor SBR Packaged Plant (primary, secondary, and tertiary) and subsurface discharge at the Central Landfill
    b. Evaporation (natural gas, landfill gas) and recirculation of concentrate back onto landfill
2. Treatment options for co-treatment of landfill leachate and septage
    a. Pre-treatment of septage to include screening/grit removal, equalization, and solids removal
    b. Co-treatment of pretreated septage and raw leachate with activated sludge (primary and secondary) with aeration and clarifier (tertiary) and subsurface discharge. Proposed treatment might be SBR, depending on costs.
3. Proposed design discharge limits protective of human health and environment (subsurface)

    BOD_5 – 30 mg/L (monthly average)

    TSS – 30 mg/L (monthly average)

    NO_3-N – 10 mg/L (monthly average)

    Metals < Maximum Contaminant Limits
4. Compliance
    a. Limits: as above
    b. Point of compliance: groundwater monitoring wells down gradient from subsurface discharge and within property boundary

Appendix G
Evaporation Boil Tests Results

ENCON
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Hooksett, NH 03106 USA
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Fax: (603) 627-9520

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July 17, 2014

Alexandra Kantardjieff, P.E., M.Sc.A., BCEE
Senior Technologist
CH2M HILL
3120 Poplarwoods Boulevard, Suite 214
Raleigh, NC 27604

Dear Alexandra:

Please find attached results from the evaporation bench scale tests of the wastewater sample submitted from the Matanuska-Susitna Landfill.

As we discussed, the purpose of this test is to simulate the effects of boiling their wastewater in the **ENCON** Thermal Evaporator System to anticipate the effectiveness and expected reduction percentage. If issues with their application are identified in the bench scale test, we can establish simple procedures ahead of time to minimize operational problems once the system is installed.

The following is a summary of results based on an initial sample volume of 400 milliliters each:

Sample #	Sample Name	Suspended Solids % by Volume	Free Oil % by Volume	Temp.(F) Initial/Final	pH Initial/Final	Residue Volume/% Reduction
1	**Landfill Leachate** opaque, dark grey	throughout sample	<1% floating on top	213.2/222.6	6.5/7.0	25 mL 93.75%

Reduction %: Based on the sample provided and the results of the boil analysis, you will achieve a reduction percentage of approximately 96+% on the water portion of your waste stream.

Sample #	Sample Name	Beginning Chlorides	Ending Chlorides
1	**Landfill Leachate**	356 ppm	5,696 ppm

Corrosion: The initial concentration of inorganic chlorides in your wastewater sample was 356 ppm. Considering this, the pH, the anticipated reduction percentages and the expected increase in chloride concentrations in the future we recommend that the tank and heat exchanger be constructed of the optional 6% Moly Super Stainless Alloy. We also strongly recommend that they monitor the pH in your system during full-scale operation to verify that it is always in a neutral to alkaline condition (7-10).

Foaming: There was a foaming condition seen during the testing process. It did require the addition of anti-foam. We tested 2 different formulations and found the HT-50 controlled the foaming completely. We strongly recommend that they use the optional anti-foam addition system and an appropriate high temperature anti-foam.

CH2M HILL
July 17, 2014
Page 2 of 2

Solids Removal/Coating: There were visible suspended solids seen in their sample prior to evaporation and some coating at the end of the testing process. If there is a presence of settled solids in their full-scale operation, we recommend feeding the wastewater to the evaporator from above the settled solids. We also strongly recommend that any solids in their evaporator be evacuated before they encroach on the heat exchanger. To minimize solids precipitating out of solution inside the evaporator we recommend the use of the optional Auto-Dump/Auto-Restart feature and regular scheduled cleanings of the evaporator.

Oil Removal: There was a very small amount of free oil in their wastewater sample. If there is visible free-floating oil in their full-scale operation, we strongly recommend that the evaporator be fed from below the floating oil layer in order to minimize the frequency of decanting. In addition we recommend that they monitor the build-up of floating oil in the evaporator and limit the oil build-up to not more than 2 inches.

End Point: End point for their evaporation cycle will be based on reaching a high fluid temperature. Based on the results of our boil analyses, we would recommend establishing a high temperature endpoint of 222F and evacuating at the end of this cycle. This could potentially be modified upward/downward at some point in the future based on observation of full-scale operation.

Regulatory: Please note that in most cases the wastewater processed through our **ENCON** Evaporators is non-hazardous and also exempt from air quality requirements. If the subject wastewater requires permits and/or exemption certificates, it is the responsibility of the customer to secure appropriate exemptions or permits.

Note: Due to our knowledge that the residue will be recycled back into the landfill and that this will increase the level of incoming contaminants being fed to evaporator in the future, we strongly recommend that they consider including the optional elevated tank height and auto-wash of level probes as part of their evaporator package.

Based on tests performed the above referenced waste stream is qualified as a feasible application for the **ENCON** Thermal Evaporator System. Please inform us if chemistry changes are made to the tested applications or if additional waste streams are being considered for the evaporator.

We look forward to continuing to work with you and other key personnel at **CH2M Hill** on the implementation of an **ENCON** evaporator system.

Sincerely,
ENCON Evaporators

Mary Ann Rattay

Mary Ann Rattay

Appendix H
2013 MSB Septage Handling and Disposal Plan

Memorandum

To: Michael J. Campfield, P.E.
Matanuska-Susitna Borough

From: Christopher Clark, P.E., HDR
J. Ryan Moyers, P.E., HDR

Date: February 19, 2013 (Revised March 19 & May 20, 2013)

Subject: Preliminary Engineering Technical Memorandum – Update to the 2007 Septage Handling and Disposal Plan

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Background and Introduction

In 2006, HDR was contracted by the Matanuska-Susitna Borough (MSB) Public Works Department to develop a Septage Handling and Disposal Plan (2007 Study) that would assess the current septage handling and treatment practices in the Borough, and develop MSB-based alternatives for the future. The resulting septage study evaluated four (4) alternatives including maintaining the existing hauling practices (Option 1), installing a septage consolidation facility and bulk haul to Anchorage (Option 2), constructing a co-treatment facility with the City of Palmer (Option 3), and constructing an independent regional septage facility (Option 4) to handle current and future septage loads in the MSB.

HDR's 2007 Study recommended that two of the four options be further explored; constructing a co-treatment facility with the City of Palmer (Option 3) and constructing an independent regional septage facility (Option 4). Both options would make the MSB independent of the Municipality of Anchorage (MOA) for septage disposal which may be advantageous in the future. The costs of these alternatives, as given in the 2007 Study, were found to be comparable to the 2007 cost of transporting and disposing of septage in Anchorage. The 2007 Study estimated that a regional septage treatment facility could be paid off in 20 years if septage haulers paid $166 for each load of septage that was disposed at the regional facility. This analysis did not take into account potential grants or funding that may be available to the MSB for the project, and represented the feasibility of a MSB-based septage treatment and disposal facility funded solely by the MSB.

In 2010, the MSB, in cooperation with the Cities of Palmer and Wasilla, completed a Regional Wastewater and Septage Treatment Study to address the short term regulatory compliance and capacity needs for the Palmer and Wasilla wastewater treatment plants (WWTP). Additionally, this study addressed the long-term regional needs for a wastewater and septage treatment system in the core area between Palmer and Wasilla. Long-term solutions presented in the 2010 study included either improvements to the City of Palmer WWTP to accommodate 4.0 million gallons per day (MGD) or constructing a new regional 4.0MGD WWTP at a central location. The total project cost of constructing a regional wastewater and septage facility including conveyance piping was estimated to be $119 to $132 million and was dependent upon the location and the treatment process selected. The 2010 Regional Wastewater and Septage Study did not evaluate separate septage treatment options but included septage receiving and pretreatment facilities at the larger regional WWTP alternatives. The septage receiving station considered in the 2010 study consisted of a dual bay septage receiving area with hot water wash stations and pretreatment facilities (including coarse screening, flow attenuation, fine screening and grit removal, and metering of the septage flows into the larger wastewater treatment process). The septage receiving /pretreatment station alone was estimated to cost approximately $7,133,000 (2010 dollars). The MSB Assembly formed a Wastewater and Septage Advisory Board to begin long-term wastewater and septage treatment planning.

The MSB has chosen to revisit the options available for an MSB-based regional septage facility. In 2012, the MSB Assembly adopted a resolution (2012-RS-083) that endorsed continued planning for a regional wastewater treatment facility. The resolution indicated that the MSB will be 'selecting a site for a future regional wastewater treatment facility that will be used at a minimum for future septage service'. As the MSB begins to seek funding for the site selection it has requested HDR complete an update to the 2007 Study cost estimates. Due to modifications to the fee structure at the septage receiving facilities in Anchorage, increases in fuel prices, and general operational changes, the updated cost estimates for the septage treatment facility have changed significantly from those calculated in 2007. Updating the cost information from 2007 to the present day ensures that current information is available for the planning process and provides more meaningful information to determine the feasibility of a septage treatment facility in the MSB.

This memorandum provides planning level costs for an independent regional septage facility including updated cost for the aerated lagoon system for secondary wastewater treatment as presented in the 2007 Study (Option 4), as well as a conceptual level analysis of an advanced treatment system (activated sludge process) capable of achieving more stringent tertiary treatment requirements if surface water discharge is required. This analysis has been completed using the same design criteria (projected flows, wastewater characteristics, etc.) provided in the 2007 Study.

Design Criteria

Septage is the concentrated sewage settled in the bottom of a septic tank and contains 70 percent of the suspended solids, oil, and grease of sewage. Septage is a highly variable organic waste that often contains large amounts of grease, grit, hair, and debris and is characterized by an objectionable odor and appearance, a resistance to settling and dewatering, and the potential to foam. These characteristics make septage difficult to handle and treat. The major reason for providing adequate treatment and disposal systems is to protect public health and the environment, as septage may harbor disease-causing viruses, bacteria, and parasites.

Factors that affect the physical characteristics of septage include septic tank size, design, and pumping frequency; user habits; water supply characteristics and piping materials; the presence of water conservation fixtures and garbage disposals; the use of household chemicals and water softeners; and climate. Septage must be pumped from a septic tank on a periodic basis depending on sewage production and the size of the septic tank. This memorandum uses the population growth and septage loading and strength as defined in the 2007 Study. The recommended rate of pump-out is every 12 to 24 months according to haulers operating within MSB. In 2005, approximately 13.6 million gallons of septage was pumped within the MSB annually. Based on HDR's 2007 Study it was estimated that septage production would increase to 38.1 million gallons per year by 2030. The design criteria from the 2007 Study are outlined in Tables 1 through 3 below.

Table 1 – 2030 Influent Raw Septage Flows and Loading

Flow	BOD		TSS	
GPD	mg/L	lbs/day	mg/L	lbs/day
238,000	2,255	4,482	7,138	14,178

Table 2 - 2030 Pretreated Septage Flows and Loading

Flow	BOD		TSS		Ammonia-N		Temperature (^{o}C)	
GPD	mg/L	lbs/day	mg/L	Min	mg/L	lbs/day	Min	Max
238,000	500	994	500	994	50	99	8	15

Table 3 - 2030 Design Effluent Criteria[1]

<table>
<tr><th rowspan="2">Parameter</th><th rowspan="2">Units</th><th rowspan="2">Secondary Limits (Average Monthly)</th><th colspan="2">Tertiary Limits (Average Monthly)</th></tr>
<tr><th></th><th></th></tr>
<tr><td>Biological Oxygen Demand (BOD_5)</td><td>mg/L</td><td>30</td><td colspan="2">15</td></tr>
<tr><td>Total Suspended Solids (TSS)</td><td>mg/L</td><td>30</td><td colspan="2">15</td></tr>
<tr><td rowspan="2">Ammonia as (N)</td><td rowspan="2">mg/L</td><td rowspan="2">-</td><td>Summer</td><td>Winter</td></tr>
<tr><td>1.7</td><td>8.7</td></tr>
<tr><td>Fecal Coliform</td><td>FC/100 ml</td><td>20</td><td colspan="2">20</td></tr>
<tr><td>pH</td><td>S.U.</td><td>6.5-8.5</td><td colspan="2">6.5-8.5</td></tr>
</table>

[1] Effluent criteria based on City of Palmer’s current Alaska Pollutant Discharge Elimination System (APDES) permit.

Septage Handling and Disposal Alternatives

This section provides updated evaluation and costs of two primary septage handling and disposal alternatives from the 2007 Study:

- Option 1 – Maintain Existing Hauling Practices
- Option 4 – Construct an Independent Regional Septage Facility

Option 1 – Maintain Existing Hauling Practices

The 2007 Study included a detailed analysis of the cost associated with the current septage hauling practices. In 2005, the estimated costs associated with hauling and disposal of septage were estimated at $825,000 and the current (2013) cost of transport and disposal of MSB septage is estimated at $1.4 million per year. This cost is a compilation of labor for the round trip from the MSB to the septage receiving facility in Anchorage, the cost of running and maintaining the septage trucks, and the current AWWU tipping fee. By 2030, the increase in septage production in the MSB will bring the total transport and disposal cost to an estimated $4.6 million per year. This cost is paid directly by septage haulers, and indirectly by MSB residents with septic tanks, who currently (2013) pay an average of $250 for each 1,000 gallon septic tank pumping.

In addition to direct costs to haulers and MSB residents, there are other important factors which affect the sustainability of the septage hauling practice and the triple bottom line to the MSB. The advantages of keeping existing haul practices include:

- *No capital and O&M costs to the MSB*

  Septage haulers and residents will continue to meet the cost of septage handling and disposal at no additional cost to the MSB.

- *No additional land use*

  No land will be occupied with treating and handling septage that could be used for other development.

- *No ADEC regulations*

  No additional permits are required for meeting EPA and ADEC regulations for storing, treating, or discharging septage.

The disadvantages of keeping existing haul practices include:

- *Reliance on MOA and being less able to adapt to changes in regulatory environment*

  The MSB is dependent on the MOA to continue to accept septage from outside of the MOA. If the MOA changes its policy the MSB would need to seek other disposal options. The timeframe for this might not be ideal for the MSB. The MSB could be forced into choosing a less efficient and economic solution at a time when funding is difficult to obtain.

- *Cost efficiency*

  The current cost of transporting septage comprises 72% of the total cost of transport and disposal costs. Designed around a competitive tipping fee in comparison to the existing disposal costs, a regional septage treatment facility could pay for itself.

- *Environmental Impact*

  Without a regional septage facility, MSB septage flows will continue to be treated only to the current primary treatment level of the Asplund WWTP. Furthermore septage hauled to Anchorage accounts for 1.1 million miles per year travelled on the Glenn Highway between Palmer and Anchorage. This contributes to wear and tear on the roadway network (and subsequently increased costs to maintain) as well as increased burning of fossil fuels.

Using the population predictions developed in the 2007 Study, HDR has updated current septage production and associated costs based on the 2013 MSB population, hauling costs (fuel) and current AWWU tipping fees (Table 4).

Table 4 - Turpin Street Disposal Estimated Cost (Option 1)

Transport and Disposal Cost - AWWU Turpin Street	Year 2005	Year 2013	Year 2030
Estimated Annual Septage Production (gallons/year)	13,596,389	17,761,301	38,102,185
No. of Average Hauler Loads (2,867 gallons per load)	4,742	6,195	13,290
Annual Mileage for Septage Delivery (miles)	379,390	495,607	1,063,193
Annual Fuel Consumption (gallons/year)	75,878	99,121	212,639
Cost per Trip	**$174**	**$229**	**$348**[3]
Annual Disposal Cost	**$825,200**	**$1,418,700**	**$4,624,900**

1. Septic haulers pay a monthly customer charge of $7.46, plus a usage charge of $21.66 per 1,000 gallons of estimated discharge per trip (these fee's includes AWWU's proposed 2013 rate hike). Estimated discharge is calculated at 87% of tank capacity for most of the year. During the times when seasonal weight restrictions are in effect, the estimated discharge is calculated at 50% of tank capacity.
2. Year 2013 cost of hauling is $172 per trip for fuel, and operations and maintenance and does not include the AWWU tipping fee.
3. Year 2030 disposal cost per trip has been estimated based on a 2.5% annual increase from current cost per trip.

Option 4 – Construct an Independent Regional Septage Facility

In an effort to gain independence from the MOA and avoid hauling septage to Anchorage, the 2007 Study evaluated the construction costs associated with an independent regional septage treatment facility (Option 4 in the 2007 Study). For consistency with the 2007 Study, this update memorandum continues to identify an independent regional septage facility as Option 4.

The following elements are required for Option 4:

- Site for the independent treatment facility
- Receiving and pretreatment facility
- Secondary/tertiary treatment facility
- Effluent discharge location – subsurface (percolation cell) or surface discharge
- Solids handling
- Discharge permit

Option 4 is further broken down in this memorandum as Option 4A, 4B, or 4C as shown in Figure 1 depending on the level of treatment and method of disposal.

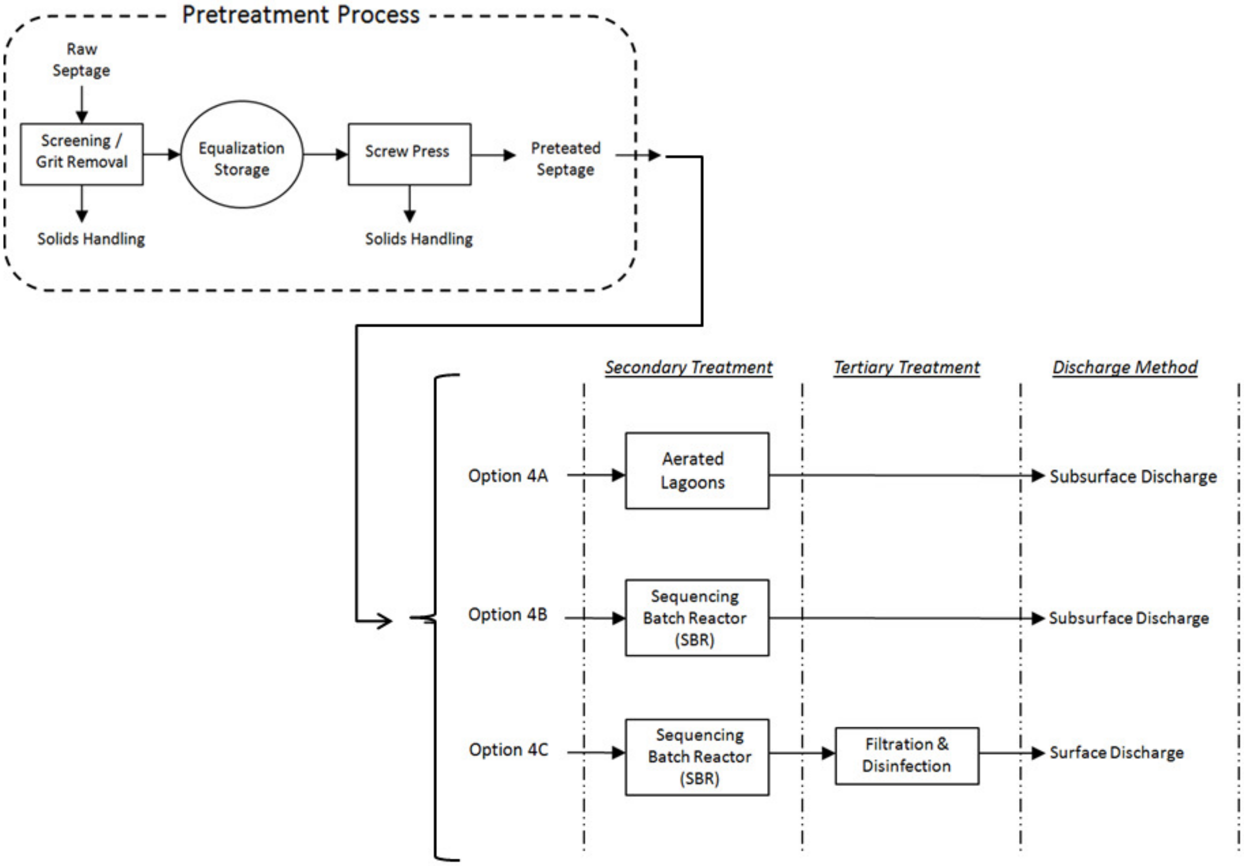

Figure 1 - Independent Regional Septage Treatment Facility Process Flow Options.

Option 4 Septage Receiving and Pretreatment

Regardless of the treatment process selected for secondary or tertiary treatment of the septage flows, septage receiving and pretreatment facilities will be required to remove a portion of the solids from the high-strength septage to create a more manageable/treatable wastewater flow. Removing septage solids through pretreatment and sending only the liquid portion to the wastewater treatment facility significantly reduces the waste load to the treatment facility and allows for design of downstream treatment processes more typical of domestic wastewater flows and strength.

Receiving station and odor control

A receiving station must be built at the septage pretreatment site to receive septage from the hauling trucks. The primary functions of a receiving station are the transfer of septage from hauler trucks, preliminary treatment of septage (i.e. screening and grit removal), and storage and equalization of septage flows. Receiving station design should encourage simple and reliable operation, and have the flexibility to accommodate varying flow and loading conditions. Odor control is essential for any waste handling operation, especially in the case of septage. Septage processing can result in the release of odors causing complaints from local residents. For septage receiving units, the best approach to control odors is to cover the sources of odor emissions and to exhaust this air to a suitable control system. Due to the concern of odor problems associated with septage receiving, only septage receiving units that provide a completely enclosed system should be investigated.

Equalization

An equalization tank is used at treatment plants to control influent flow rates and allows for a reduction in required downstream unit process capacity. The cost for a 150,000-gallon equalization tank is provided in the pretreatment cost estimate.

Septage conditioning

Septage has poor dewatering characteristics and needs conditioning prior to dewatering. The conditioning process must fundamentally alter the sludge structure so that the solid and liquid portions are more easily separated. This is typically accomplished through chemical means and the amount of chemical required is based on the load and its characteristics. A combination of lime and ferric chloride has been successfully used as well as certain polymers. The current trend in conditioning is to use polymers, and for this memorandum it will be assumed that polymers will be used for conditioning the septage prior to solid/liquid separation.

Solid/liquid separation

A number of mechanical septage dewatering systems are available. The degree of dewatering accomplished is a function of conditioning chemical, admixtures of other sludges, and the dewatering process used. Typically, dewatered septage (sludge cake) has a solids content of approximately 20 to 40 percent. Feasible options for the MSB include using screw or rotary presses. Standard equipment for septage dewatering includes a sludge feed pump, a polymer makeup system, a control panel, miscellaneous field instrumentation, a conveyor, and a truck/disposal bin. A screw press can produce Class A or Class B biosolids, depending on the process and the required product.

The requirements for Class A and Class B biosolids are outlined in EPA regulations 40 CFR Part 503. Class A biosolids contain no detectible levels of pathogens and have been treated to meet vector attraction reduction requirements. Class B biosolids have been treated but still may contain pathogens. There are buffer, public access, and crop harvesting restrictions for Class B biosolids. Either Class A or Class B biosolids from the screw press can be disposed of at the MSB landfill, but if the landfill is the ultimate disposal site it would not be worth the extra cost to produce the class A solids. Class A biosolids can be land applied as well as distributed to the public as fertilizer and offer more options for ultimate disposal than Class B biosolids. Producing Class A biosolids may provide cost savings and flexibility for biosolids management depending on the treatment process and the quality of the final product, and can generate revenue in some cases (distributed to the public as fertilizer, etc.). However, Class A solids treatment technologies generally require increased capital and operations and maintenance (O&M) costs for processing. Class B biosolids have historically been the predominant class of biosolids produced in the US. The cost estimate provided in Table 5 below for the septage pretreatment system assumes Class B biosolids as the basis of design but also includes an additional option for achieving Class A solids.

A conservative concentration of 500 mg/L for both BOD and TSS is assumed for the pretreated septage (the liquid filtrate from the screw press) based on estimated performance data received from the manufacturer of the FKC screw press and pretreatment equipment. This pretreated septage is further treated as described in following sections of this memorandum. Figure 2 below provides a general schematic of the pretreatment process described above and Figure 3 provides a typical screw press dewatering process flow diagram utilizing polymer for sludge conditioning (Class B solids option).

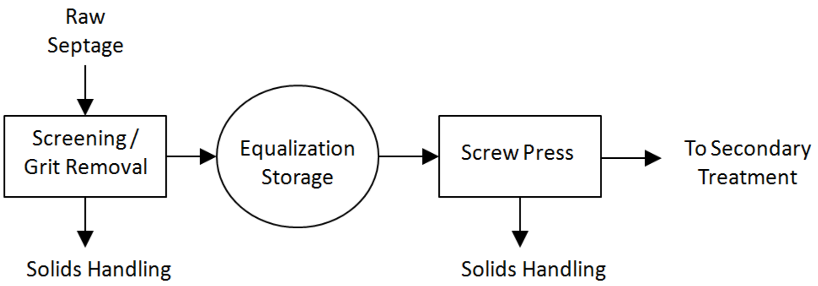

Figure 2 - Pretreatment Process

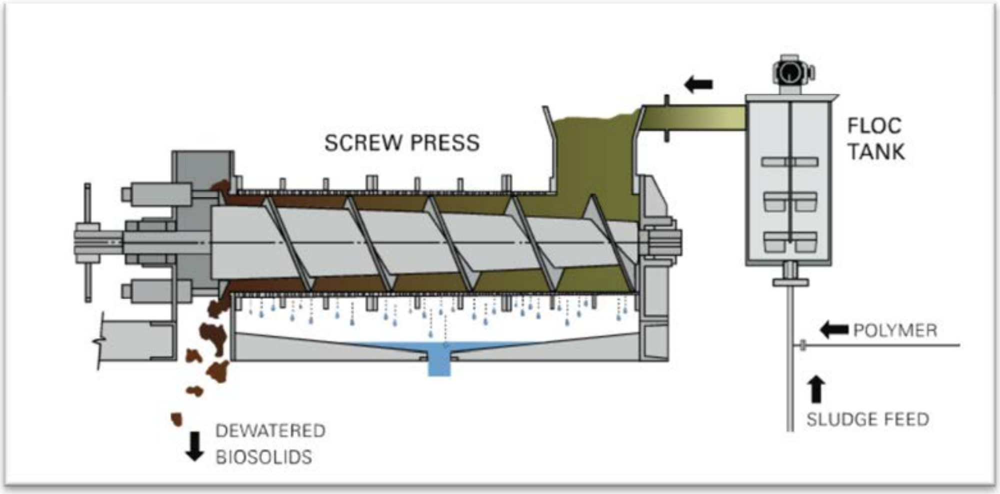

Figure 3 - Typical Screw Press Dewatering Process Flow Diagram

In general, a screw press is a contained unit where sludge that has been conditioned with a polymer is fed onto a screw-like drum that spins and transports sludge towards a discharge point. While the screw conveyor slowly turns, the screw pitch and drum diameter are decreased, which increases pressure on the sludge. The increased pressure forces water from the sludge, which is then filtered through small wire screening. A screw press can generally achieve high dewatered solids concentrations and offers very low maintenance and simple operation. A skid-mounted system is available that includes the screw press, flocculation tank, sludge pump, control panel, and polymer system (This skid-mounted system is the basis for the 'Screw Press' item in the Table 5 cost estimate.)

As discussed above, Class A biosolids can also be produced with the screw press equipment. In this process, lime is added to liquid biosolids to raise the pH to 12 to meet EPA vector attraction reduction requirements. The lime treated biosolids are then flocculated with polymer, pre-thickened in a rotary screen thickener, and then fed to a steam heated screw press. Inside the screw press the biosolids are dewatered and heated to meet EPA pathogen reduction requirements. Screw press outlet consistencies are usually 30 to 50% dry solids. Figure 4 below provides a typical screw press dewatering process flow diagram for Class A biosolids production. Equipment required for the Class A option includes the screw press mounted on a skid, flocculation tank, rotary screen thickener (RST), lime bag dump station with lime conveyor and inductor tank, boiler skid, Class A control panel, 15-foot screw conveyor, sludge pump, lime/sludge mixing tank, a recirculation pump, and polymer system.

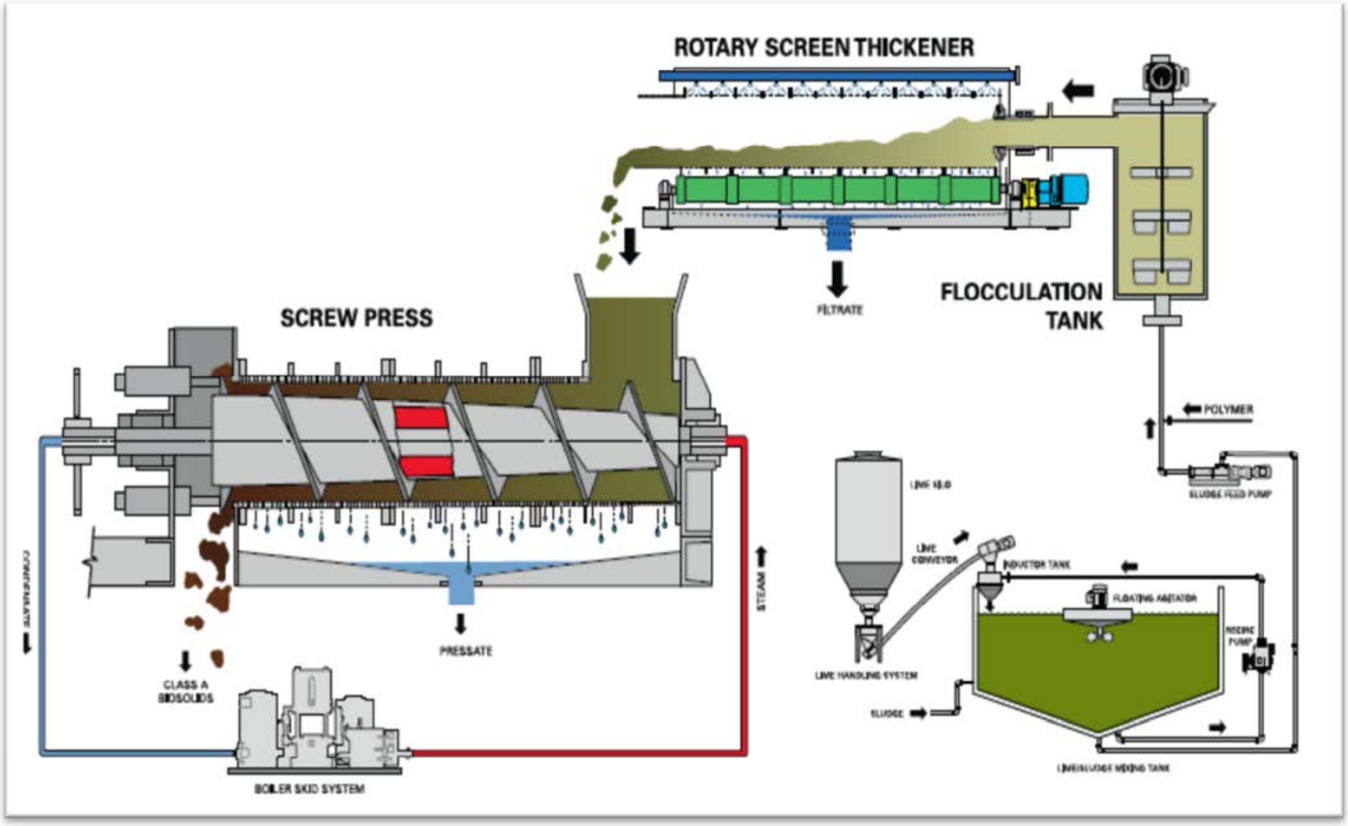

Figure 4 - Simultaneous Dewatering and Pasteurization –Class A Process

Costs for the receiving and pretreatment processes of a septage treatment facility are estimated in Table 5. The cost for pretreatment as presented in Table 5 is applied to each of the secondary and tertiary treatment process alternatives evaluated in the following sections.

Table 5 – Pretreatment Order of Magnitude Capital Cost Estimate

Item	Item Detail	Quantity	Unit	Unit Price	Total
Septage Pretreatment	Influent Screening	1	LS	$225,000	$225,000
	Grit Removal	1	LS	$200,000	$200,000
	Equalization Storage / Concrete Structure	430	CY	$900	$387,000
	Odor Control Towers and Fans	1	EA	$213,800	$213,800
	Screw Press	1	EA	$1,100,000	$1,100,000
	Screw Press - Class A Biosolids Option	1	LS	$400,000	$400,000
	Treatment Building	1,215	SF	$225	$273,400
	Misc. Site Work	1	15% of	$2,799,175	$419,900
	Misc. Equipment	1	20% of	$2,799,175	$559,800
				Subtotal [1,2]	**$3,778,900**

1. Per the Association of Advancement of Cost Estimating, Recommended Practice 17R-97 for Planning Level project this constitutes a Class 5 cost estimate with a Value of 5 with an implied Accuracy Range is +50% to -25%
2. This probable construction cost is an Order of Magnitude cost opinion in 2013 dollars, and does not include inflation, financing costs or operation and maintenance costs. This opinion assumes that a local general contractor will prime the project. It has been prepared for guidance in project evaluation and funding at the time of the estimate. Contractor bids and final construction costs will depend on actual labor and material costs, actual site conditions, productivity, fuel and expendable pricing, competitive market conditions, final project scope, final schedule and other variable factors. As a result, the final project costs will vary from this estimate.

Option 4A – Secondary Treatment by Aerated Lagoons

As previously presented in the 2007 Study, one option for secondary treatment of pretreated septage is an aerated lagoon system. This memorandum provides updated costs to the 2007 Study's aerated lagoon secondary treatment option. This design is based around peak BOD and TSS loading coming to the plant between the months of May through October (identified in the 2007 Study as the 'summer months' when septage hauling is approximately 3 times more than in the 'winter months' of November through April.) Aerated lagoons can be operated on a flow-through or solids recycle basis, with oxygen for wastewater conversion provided through surface aerators of diffused air units. Depending on the hydraulic detention time of the lagoon, effluent water quality can achieve up to 95 percent BOD removal with most of the solids settling out prior to discharge. Lagoon type systems are common for wastewater treatment in Alaska, however, limited operational flexibility and cold climate conditions make it more difficult, if not impossible, to meet higher tertiary treatment requirements outlined in the following section. Figure 5 below shows a general design schematic for a typical cold climate aerated lagoon system.

Options for discharge of treated effluent from an aerated lagoon include discharge to percolation cells or constructed wetlands. The treatment design evaluated in the 2007 Study assumed secondary treatment of wastewater would be required and the conceptual design was for BOD and TSS removal only; which is typical of cold climate lagoon systems. Based on recent regulatory changes, if the MSB seeks to discharge the treated effluent to a surface water (stream, river, etc.) this could result in more stringent permit limits. Depending on the receiving stream, more restrictive effluent limits could include the requirement to achieve some level of nutrient removal. Wastewater treatment facilities in Alaska that discharge to receiving waters that contain salmon are receiving more stringent seasonal limits for ammonia nitrogen when spawning may occur. Nitrogen is not typically removed in a secondary treatment process, especially a cold climate aerated lagoon system. The removal of nitrogen from the wastewater stream is achieved through biological processes called nitrification/denitrification. If nitrification/denitrification is necessary for the discharge permit (dependent upon ADEC requirements) then this design (2007 Option 4) may need to be modified into a lagoon activated sludge system (as discussed in the 2010 Regional Wastewater and Septage Treatment Study). In general, to achieve biological nitrogen removal in an aerated lagoon system several operating conditions must be maintained including temperature control (warmer temperatures are required to achieve nitrification), removal of settled solids from the lagoon bottom, and the recycling of beneficial microbes (activated sludge) back into the treatment process.

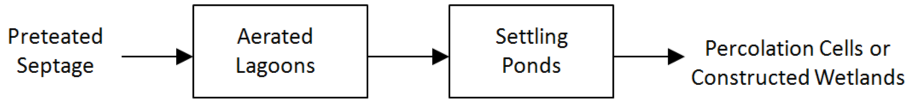

Figure 5 – Option 4A Septage Filtrate Aerated, Partially Mixed Lagoon Treatment Process

Table 6 shows the design criteria for the aerated lagoon system. Equipment typically required for aerated lagoons includes lining systems, inlet and outlet structures, hydraulic controls, floating dividers and baffles, and aeration equipment.

Table 6 – 2030 Design Criteria for Conventional Septage Treatment

Aeration Requirement:	993 lb X 2.25 = 2,235 lb/day
Volume Requirement:	3.84 million gallons (514,016 ft^3 with effective depth of 9 feet)
Aeration Area:	1.31 acres x 2 (approximately 3 acres total req'd)
Configurations:	Four aerated lagoon cells operated in series or parallel, followed by settling ponds.
Discharge	To percolation cell or constructed wetlands

Advantages and disadvantages of aerated, partial mix lagoons are listed below[1]:

[1] EPA Wastewater Technology Fact Sheet – Aerated, Partial Mix Lagoons

Aerated Lagoon Process Advantages

- An aerated lagoon can usually discharge throughout the winter
- Sludge disposal may be necessary but the quantity will be relatively small compared to other secondary treatment processes
- Aerated lagoons are relatively simple treatment processes compared to advanced treatment alternatives (more simple operation, less equipment typically, less maintenance, etc.)

Aerated Lagoon Process Disadvantages

- Aerated lagoons are not typically effective in removing ammonia nitrogen or phosphorous, unless designed for nitrification (challenging in cold climates)
- Effluent nitrate levels may cause ground water contamination – unless designed for nitrification/denitrification
- Reduced rates of biological activity occur during cold weather
- Mosquito and similar insect vectors can be a problem if vegetation on the dikes and berms is not properly maintained

- Sludge accumulation rates will be higher in cold climates because low temperature inhibits anaerobic reactions
- Would need to be converted/changed to a lagoon activated sludge (LAS) process to achieve reliable, significant biological nitrogen removal
- Many of the advantages typically cited for aerated lagoons (reduced capital costs, ease and cost of operation and maintenance, etc.) are not as prevalent if the system has to be converted to a more complex LAS process. The LAS system more closely resembles other, mechanical treatment processes in terms of equipment required, operational complexity, etc.

The primary disadvantage of aerated lagoon systems is the lack of ability to achieve enhanced (tertiary) treatment required to meet lower effluent limits if surface water discharge is required. As this will be a new facility and not a retro-fit to an existing lagoon system such as the City of Palmer WWTP, mechanical treatment options should be evaluated due to their ability to provide enhanced treatment and offer more operational flexibility compared to aerated lagoon systems. In order to provide a cost comparison between these more advanced treatment processes and the conventional aerated lagoon process, two alternatives (one secondary and one tertiary) are evaluated in following section of this memorandum.

Table 7 – Option 4A Aerated Lagoon Order of Magnitude Capital Cost Estimate

Item	Item Detail	Quantity	Unit	Unit Price	Total
Lagoon Treatment	Excavation	50,767	CY	$5.00	$253,800
	Load and Haul Excavated Material	25,384	CY	$10.2	$257,800
	Backfill with Selective Material	12,692	CY	$3.7	$47,500
	Structural Fill	6,346	CY	$25.7	$162,800
	Membrane Liner and Geotextile Fabric	198,632	SF	$5.6	$1,115,500
	Insulated Lagoon Covers (4-inch, installed)	165,527	SF	$5.6	$929,600
	Gravel Drain Bed	10,153	CY	$18.0	$183,100
	Aeration Equipment - Blowers	2	EA	$40,000	$80,000
	Aeration Equipment - Pipe	11,423	FT	$20	$228,500
Sludge Storage Facilities	Covered Sludge Storage Area	1,600	SF	$125	$200,000
Constructed Percolation Cells or Wetlands	Vegetation Planting	87	1,000 SF	$400	$34,800
	Excavation	25,384	CY	$5.00	$126,900
	Load and Haul Excavated Material	12,692	CY	$10.2	$128,900
	Backfill with Selective Material	6,346	CY	$3.7	$23,700
	Structural Fill	3,173	CY	$25.7	$81,400
	Membrane liner and Geotextile Fabric	43,560	SF	$5.6	$244,600
	Discharge Permit Plan Approval and Permit	80	HR	$150	$12,000
	Monitoring Wells	4	EA	$7,500	$30,000
Miscellaneous	Yard Piping	1	5% of	$4,140,982	$207,000
	Misc. Site Work	1	15% of	$4,140,982	$621,100
	Misc. Equipment	1	20% of	$4,140,982	$828,200
				Subtotal	**$5,797,400**

Table 8 – Order of Magnitude Cost Estimate for Pretreatment and Aerated Lagoon Treatment

Summary of Costs		
Aerated Lagoon Capital Cost (Secondary Treatment)		$5,797,400
Pretreatment Capital Costs		$3,778,900
Total Capital Cost		$9,576,300
Preliminary Engineering and Design (10%)	0.1	$957,700
Construction Management (10%)	0.1	$957,700
Direct Allocation & Allocated Funds During Construction Charges (17%)	0.17	$1,628,000
Administration (5%)	0.05	$478,800
Contingency (25%)	0.25	$2,394,100
Total Capital Construction Costs		**$15,992,200**
Payoff Period (yr)	20.00	
Interest Rate	1.5%	
Capital Cost to Payoff Each Year		$931,500
Estimated Annual O&M[3]		$440,000
Equivalent Annual Cost [1, 2]		**$1,371,500**

1. Per the Association of Advancement of Cost Estimating, Recommended Practice 17R-97 for Planning Level project this constitutes a Class 5 cost estimate with a Value of 5 with an implied Accuracy Range is +50% to -25%
2. This probable construction cost is an Order of Magnitude cost opinion in 2013 dollars, and does not include future inflation, financing costs or operation and maintenance costs. This opinion assumes that a local general contractor will prime the project. It has been prepared for guidance in project evaluation and funding at the time of the estimate. Contractor bids and final construction costs will depend on actual labor and material costs, actual site conditions, productivity, fuel and expendable pricing, competitive market conditions, final project scope, final schedule and other variable factors. As a result, the final project costs will vary from this estimate.
3. Estimated Annual O&M costs have been updated from the 2007 Study (as presented in Appendix 8 of the original study). Costs have been updated to include increases in chemical costs, power costs, etc.

Options 4B and 4C – Secondary Treatment by Sequencing Batch Reactor (SBR)

More advanced wastewater treatment processes such as an activated sludge process would be necessary to achieve better effluent water quality than what is possible from an aerated lagoon. There are a number of available activated sludge process alternatives including conventional activated sludge, lagoon activated sludge, sequencing batch reactor, and membrane bioreactor. The determination of the best available technology for a regional septage treatment facility would be impacted by the final site selected, discharge limits, etc. and should be evaluated in a more detailed engineering study. In order to provide a preliminary cost comparison between an advanced treatment process and the conventional aerated lagoon process presented in the 2007 study, a conceptual design cost estimate has been developed for a sequencing batch reactor.

A sequencing batch reactor (SBR) is an activated sludge batch-treatment process (fill-and-draw). The process involves fives steps including filling, aeration, settling, decanting and idling which all occur in the same tank in sequential order. SBRs can be designed and operated to enhance removal of nitrogen, phosphorus, and ammonia, in addition to removing TSS and BOD. The intermittent flow SBR accepts influent only at specified intervals and, in general, follows the five-step sequence. There are usually two units in parallel with one unit open for intake while the other runs through the remainder of the cycle.

Option 4B consists of the SBR directly followed by discharge to a percolation cell (or constructed wetland). The advantage of this method of secondary treatment is that it requires a much smaller site than a lagoon.

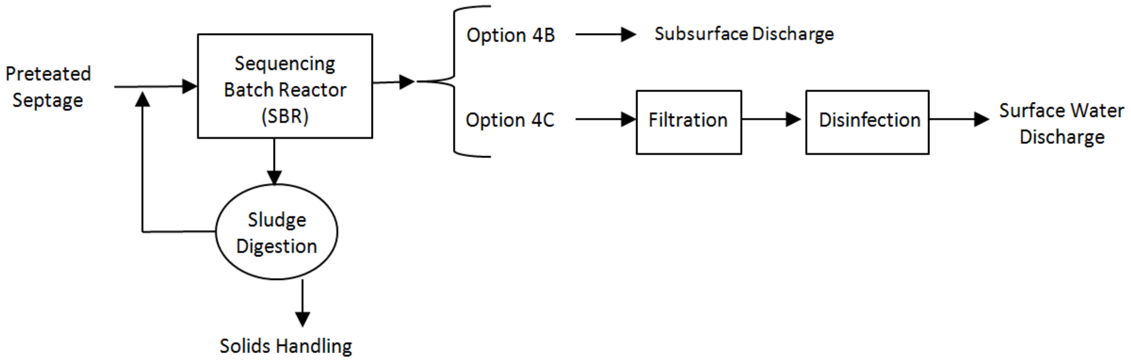

Figure 4 – Septage Filtrate Sequencing Batch Reactor Treatment Process

An SBR with filtration and disinfection (Option 4C) will typically produce an effluent of less than 15 mg/L BOD, 15 mg/L TSS, and 2 mg/L total nitrogen. These values will allow the proposed wastewater treatment plant to discharge to surface water discharge based on the assumed tertiary treatment requirements (15 mg/L BOD and TSS discharge limits). Solids produced by the system can be further treated for beneficial use (biosolids/composting) or delivered to the MSB landfill for disposal. See Attachment A to this report with design information from Aqua-Aerobic Systems, Inc., a manufacturer of one SBR system available.

Table 9 - 2030 Design Criteria for SBR Treatment [1]

Basin Geometry	38ft x 38ft x 21ft (W x L x D)
Number of Basins	2
Number of Cycles	2 per day
Treatment Cycle Duration	12.0 hrs
Food to Mass	0.198 lbs COD/lb MLSS-day
MLSS Concentration	4,500 mg/L
Hydraulic Retention Time	1.905 days
Solids Retention Time	8.4 days
Oxygen Required	2,940 lb/day
Air Flowrate/Basin	472 SCFM
Post-SBR Equalization	56,000 gallons
AquaDisk Total Filter Area	43.2 ft^2
AquaDisk Total Max Flow	165.4 gpm

[1] AquaSBR (2012)

Advantages and disadvantages of aerated, partial mix lagoons are listed below[1]:

SBR Process Advantages

- Equalization, primary clarification (in most cases), biological treatment, and secondary clarification can be achieved in a single reactor vessels
- With filtration and disinfection components the SBR process can produce effluent meeting tertiary limits
- No secondary clarifiers and return activated sludge lines

- Operating flexibility and control
- Reduced plant footprint
- Potential capital cost savings by eliminating clarifiers and other equipment

SBR Process Disadvantages

- Increased level of sophistication is required (compared to conventional lagoon systems) including supervisory control and data acquisition computer systems
- Higher level of maintenance associated with more sophisticated controls, automated switches, and automated valves
- Potential of discharging floating or settled sludge during the draw or decant phase with some SBR configurations
- Potential plugging of aeration devices during selected operating cycles, depending on the aeration system used by the manufacturer
- Potential requirement for equalization after the SBR, depending on the downstream processes

[1] EPA Wastewater Technology Fact Sheet – Sequencing Batch Reactors

Two cost estimates are presented in Tables 10 through 13. The first two tables represent the preliminary order of magnitude cost associated with Option 4B – a mechanical wastewater treatment process (SBR without filtration or disinfection) which can achieve secondary effluent limits similar to the aerated lagoon configuration. Tables 12 and 13 present the preliminary order of magnitude cost associated with Option 4C – a mechanical wastewater treatment process (SBR with filtration and disinfection) which can achieve tertiary effluent limits that would likely be required for any new wastewater treatment facility discharging to surface water.

Table 10 – Option 4B SBR (Secondary Treatment) Order of Magnitude Capital Cost Estimate

Item	Item Detail	Quantity	Unit	Unit Price	Total
SBR Treatment	Treatment Building	9,600	SF	$225	$2,160,000
	SBR Equipment (Diffusers, Blowers, Decanter, Transfer Pumps, etc.)	1	LS	$725,000	$725,000
	Digester Equipment (Diffusers, Blowers, Transfer Pumps, etc.)	1	LS	$350,000	$350,000
	Concrete Tanks (2 x SBR + 1 x Digester)	565	CY	$900.00	$508,500
Sludge Storage Facilities	Covered Sludge Storage Area	1,600	SF	$125	$200,000
Constructed Percolation Cells or Wetlands	Vegetation Planting	87	1,000 SF	$400	$34,800
	Excavation	25,384	CY	$5.00	$126,900
	Load and Haul Excavated Material	12,692	CY	$10.2	$128,900
	Backfill with Selective Material	6,346	CY	$3.7	$23,700
	Structural Fill	3,173	CY	$25.7	$81,400
	Membrane liner and Geotextile Fabric	43,560	SF	$5.6	$244,800
	Discharge Permit Plan Approval and Permit	80	HR	$150	$12,000
Miscellaneous	Yard Piping	1	5% of	$4,596,100	$229,800
	Misc. Site Work	1	15% of	$4,596,100	$689,400
	Misc. Equipment	1	20% of	$4,596,100	$919,200
				Subtotal	**$6,434,600**

Table 11 – Order of Magnitude Cost Estimate for Pretreatment and SBR Secondary Treatment

Summary of Costs		
SBR Only Capital Cost (Secondary Treatment)		$6,434,600
Pretreatment Capital Costs		$3,778,900
Total Capital Cost		$10,213,400
Preliminary Engineering and Design (10%)	0.1	$1,021,300
Construction Management (10%)	0.1	$1,021,300
Direct Allocation & Allocated Funds During Construction Charges (17%)	0.17	$1,736,300
Administration (5%)	0.05	$510,700
Contingency (25%)	0.25	$2,553,400
Total Capital Construction Costs		**$17,056,500**
Payoff Period (yr)	20.00	
Interest Rate	1.5%	
Capital Cost to Payoff Each Year		$993,500
Estimated Annual O&M[3]		$500,000
Equivalent Annual Cost [1, 2]		**$1,493,500**

1. Per the Association of Advancement of Cost Estimating, Recommended Practice 17R-97 for Planning Level project this constitutes a Class 5 cost estimate with a Value of 5 with an implied Accuracy Range is +50% to -25%
2. This probable construction cost is an Order of Magnitude cost opinion in 2013 dollars, and does not include future inflation, financing costs or operation and maintenance costs. This opinion assumes that a local general contractor will prime the project. It has been prepared for guidance in project evaluation and funding at the time of the estimate. Contractor bids and final construction costs will depend on actual labor and material costs, actual site conditions, productivity, fuel and expendable pricing, competitive market conditions, final project scope, final schedule and other variable factors. As a result, the final project costs will vary from this estimate.

3. Detailed Operation and Maintenance costs have not been developed for this conceptual design memorandum. An estimated annual value of $500,000 has been used for analysis based on chemical costs, power usage, sludge disposal, sampling and monitoring, and maintenance from similar sized SBR facilities. A detailed evaluation of site specific O&M costs should be included in the Preliminary Engineering for the facility.

Table 12 – Option 4C SBR (Tertiary Treatment) Order of Magnitude Capital Cost Estimate

Item	Item Detail	Quantity	Unit	Unit Price	Total
SBR Treatment	Treatment Building	16,000	SF	$225	$3,600,000
	SBR Equipment (Diffusers, Blowers, Decanter, Transfer Pumps, etc.)	1	LS	$725,000	$725,000
	Digester Equipment (Diffusers, Blowers, Transfer Pumps, etc.)	1	LS	$350,000	$350,000
	Equalization Basin Equipment and Tertiary Disk Filters	1	LS	$300,000	$300,000
	Concrete Tanks (2 x SBR + 1 x Digester)	565	CY	$900.00	$508,500
	Concrete Tanks (Post-Equalization Basin)	74	CY	$900.00	$66,600
	UV Disinfection	1	LS	$100,000	$100,000
	Outfall Pipe	1,000	LF	$150	$150,000
	Discharge Permit Plan Approval and Permit	80	HR	$150	$12,000
Sludge Storage Facilities	Covered Sludge Storage Area	1,600	SF	$125	$200,000
Miscellaneous	Yard Piping	1	5% of	$6,012,100	$300,605
	Misc. Site Work	1	15% of	$6,012,100	$901,815
	Misc. Equipment	1	20% of	$6,012,100	$1,202,420
			Subtotal		**$8,416,940**

Table 13 – Order of Magnitude Cost Estimate for Pretreatment and SBR Tertiary Treatment

Summary of Costs		
SBR, Filtration, and Disinfection Capital Cost (Tertiary Treatment)		$8,416,900
Pretreatment Capital Costs		$3,778,900
Total Capital Cost		$12,195,800
Preliminary Engineering and Design (10%)	0.1	$1,219,600
Construction Management (10%)	0.1	$1,219,600
Direct Allocation & Allocated Funds During Construction Charges (17%)	0.17	$2,073,300
Administration (5%)	0.05	$609,800
Contingency (25%)	0.25	$3,049,000
Total Capital Construction Costs		**$20,367,000**
Payoff Period (yr)	20.00	
Interest Rate	1.5%	
Capital Cost to Payoff Each Year		$1,186,300
Estimated Annual O&M[3]		$650,000
Equivalent Annual Cost [1, 2]		**$1,836,300**

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estimate. Contractor bids and final construction costs will depend on actual labor and material costs, actual site conditions, productivity, fuel and expendable pricing, competitive market conditions, final project scope, final schedule and other variable factors. As a result, the final project costs will vary from this estimate.

3. Detailed Operation and Maintenance costs have not been developed for this conceptual design memorandum. An estimated annual value of $650,000 has been used for analysis based on chemical costs, power usage, sludge disposal, sampling and monitoring, and maintenance from similar sized SBR facilities. A detailed evaluation of site specific O&M costs should be included in the Preliminary Engineering for the facility.

Recommendation

A regional septage treatment facility offers MSB independent septage disposal and treatment ownership and management. While this memorandum does not include funding opportunities as part of the cost analysis, the MSB will likely be eligible for Alaska Clean Water Fund loans (current interest rate of 1.5%) as well as possible grants through the Alaska Department of Environmental Conservation's (ADEC) Municipal Grants and Loans Program and other Federal programs. Loans can finance up to 100 percent of a project's eligible costs for planning, design and construction of publicly owned facilities. If the MSB were to acquire a $17.1 million loan from ADEC at 1.5% interest, the treatment facility could pay for itself with tipping fees shown in Table 14. This analysis includes $500,000 per year in operating costs and illustrates the economic feasibility of a MSB regional septage treatment facility. The tipping fee in Table 14 represents the fee required to payoff a 1.5% loan based on the constant tipping fee from 2013 through the year listed and includes a 2.5% inflation rate. For example, to pay off a $17.1 million dollar loan with $500,000 per year operating expenditures by 2020 would require a tipping fee of $354. These tipping fees can be related to the cost of existing hauling practices (MOA disposal) of $229 per trip as shown in Table 4.

Table 14 - Tipping Fee Required for 1.5% Loan Repayment

Year	Deliveries per Year	Tipping Fee Required for Payoff ($17.1 Million)
2013	6,589	$2,703
2014	6,983	$1,360
2015	7,378	$912
2016	7,772	$689
2017	8,166	$555
2018	8,560	$466
2019	8,954	$402
2020	9,348	$354
2021	9,743	$318
2022	10,137	$288
2023	10,531	$264
2024	10,925	$244
Current Tipping Cost Shown in Table 4		**$229**
2025	11,319	$227
2026	11,713	$213
2027	12,108	$201
2028	12,502	$190
2029	12,896	$180
2030	13,290	$172

Table 15 - Memorandum Cost Summary

Alternative	Order of Magnitude Capital Cost	Estimated Annual O&M Costs	Equivalent Annual Cost
Option 1 - Do Nothing - Maintaining Existing Haul Practices	$0	$0	$1,418,700
Option 4A - Aerated Lagoon (Secondary Treatment)	$15,992,200	$440,000	$1,371,500
Option 4B - SBR (Secondary Treatment)	$17,056,500	$500,000	$1,493,500
Option 4C - SBR/Filtration/Disinfection (Tertiary Treatment)	$20,367,000	$650,000	$1,836,300

The costs in this memorandum do not include the purchasing of land or potential funding opportunities (grants and/or loans). It is important to reiterate that this memorandum is based on the 2030 population projections used in the 2007 Study. These projections may be high as the recent growth trends in the Borough have slowed. However, the costs of each facility in this memorandum are based on the quantity of septage treated which is also based on the projected population. Any changes in projected population will result in a scalable construction cost difference within reason.

Dependent upon on the final location of the regional septage treatment facility, treatment plant effluent water quality requirements could range from secondary to tertiary treatment and will be designated in an Alaska Pollutant Discharge Elimination System (APDES) permit from ADEC. The determination of the best available technology for a regional septage treatment facility would be impacted by the final site selected, discharge limits, etc. and should be evaluated in a more detailed engineering study.

Attachment A

Sequencing Batch Reactor – Manufacturer's Information

PROCESS DESIGN REPORT

AQUA-AEROBIC SYSTEMS, INC.

MATSU BOROUGH AK

Design#: 132885

Option: AquaSBR Preliminary Design

Designed By: Eric Roundy on Friday, December 14, 2012

Design Notes

Pre-SBR

- Pre-SBR treatment includes a Dissolved Air Floatation System or other system to remove the influent COD and TSS to the design influent parameters shown on the design summary.

- Neutralization is recommended/required ahead of the SBR if the pH is expected to fall outside of 6.5-8.5 for significant durations.

- Coarse solids removal/reduction is recommended prior to the SBR.

SBR

- The flow pattern is assumed to occur 24 hours/day over 7 days/week.

- The Maximum flow, as shown on the design, has been assumed as a hydraulic maximum and does not represent an additional organic load.

- The decanter performance is based upon a free-air discharge following the valve and immediately adjacent to the basin. Actual decanter performance depends upon the complete installation including specific liquid and piping elevations and any associated field piping losses to the final point of discharge. Modification of the high water level, low water level, centerline of discharge, and / or cycle structure may be required to achieve discharge of full batch volume based on actual site installation specifics.

Aeration

- The aeration system has been designed to provide 1.0 lbs O2/lb COD applied and 4.6 lbs O2/lb NH3-N applied at the design average loading conditions.

Process/Site

- An elevation of 20 ft. has been assumed as displayed on the design.

- The anticipated effluent NH3-N requirement is predicated upon an influent waste temperature of 8°C or greater. While lower temperatures may be acceptable for a short-term duration, nitrification below 10°C can be unpredictable, requiring special operator attention.

- Based on the information provided, the waste may be nutrient deficient. Nutrient addition is recommended to achieve a ratio of 100:5:1 (BOD:N:P).

- Sufficient alkalinity is required for nitrification, as approximately 7.1 mg alkalinity (as CaCO3) is required for every mg of NH3-N nitrified. If the raw water alkalinity cannot support this consumption, while maintaining a residual concentration of 50 mg/l, supplemental alkalinity shall be provided (by others).

- It is assumed that there are no substances in the influent stream that would be inhibitory for a biological system.

Anticipated

- It is assumed the influent COD is either directly, or biologically oxidizeable to the required discharge limits.

- Treatability study recommended to assure required effluent quality is achievable.

- Maximum fats, oils, and grease to the AquaSBR is 100 mg/l. Depending upon the nature of the FOG, reduction in activated sludge treatment is unpredictable. If an effluent FOG requirement exists, FOG should be reduced to the effluent limit required prior to biological treatment. High FOG levels may also cause poor settling and excessive foaming which can damage equipment and lead to effluent quality degradation.

Equipment

- The basin dimensions reported on the design have been assumed based upon the required volumes and assumed basin geometry. Actual basin geometry may be circular, square, rectangular or sloped with construction materials including concrete, steel or earthen.

- Rectangular or sloped basin construction with length to width ratios greater than 1.5:1 may require alterations in the equipment recommendation.

- Tanks are not included in the pricing and shall be provided by others.

- Influent is assumed to enter the reactor above the waterline, located appropriately to avoid proximity to the decanter, splashing or direct discharge in the immediate vicinity of other equipment.

- If the influent is to be located submerged below the waterline, adequate hydraulic capacity shall be made in the headworks to prevent backflow from one reactor to the other during transition of influent.

- A minimum freeboard of 2.0 ft. is recommended for diffused aeration.

- Aqua-Aerobic Systems, Inc. (AASI) is familiar with the Buy American provision of the American Recovery and Reinvestment Act of 2009 as well as other Buy American provisions (i.e. FAR 52.225, EXIM Bank, USAid, etc.). AASI can provide a system that is in full compliance with Buy American provisions. As the project develops AASI can work with you to ensure full compliance with a Buy American provision, if required. Please contact the factory should compliance with a Buy American provision be required.

Pricing

- Scope of supply includes installation supervision and start-up services; however, freight is not included.

- If the equipment is installed indoors, please ensure that the minimum number of air exchanges are provided otherwise explosion proof materials of construction will be required.

AquaSBR - Sequencing Batch Reactor - Design Summary

DESIGN INFLUENT CONDITIONS

Avg. Design Flow = 0.238165 MGD = 900 m3/day
Max Design Flow = 0.238165 MGD = 900 m3/day

			Effluent			
DESIGN PARAMETERS	**Influent**	**mg/l**	**Required**	**<= mg/l**	**Anticipated**	**<= mg/l**
Bio/Chem Oxygen Demand:	COD	1,250	BOD5	30	BOD5	30
Total Suspended Solids:	TSS	500	TSS	30	TSS	30
Inf. Ammonia Nitrogen:	NH3-N	50	--	--	--	--
Ammonia Nitrogen:	--	--	NH3-N	8.70	NH3-N	8.70

SITE CONDITIONS	**Maximum**		**Minimum**		**Design**		**Elevation (MSL)**
Ambient Air Temperatures:	70 F	21.1 C	20 F	-6.7 C	70 F	21.1 C	20 ft
Influent Waste Temperatures:	59 F	15.0 C	46 F	8.0 C	59 F	15.0 C	6.1 m

SBR BASIN DESIGN VALUES			**Water Depth**			**Basin Vol./Basin**		
No./Basin Geometry:	= 2 Square Basin(s)		**Min**	= 15.5 ft	= (4.7 m)	**Min**	= 0.167 MG	= (633.3 m^3)
Freeboard:	= 2.0 ft	= (0.6 m)	**Avg**	= 21.0 ft	= (6.4 m)	**Avg**	= 0.227 MG	= (858.7 m^3)
Length of Basin:	= 38.0 ft	= (11.6 m)	**Max**	= 21.0 ft	= (6.4 m)	**Max**	= 0.227 MG	= (858.7 m^3)
Width of Basin:	= 38.0 ft	= (11.6 m)						

Number of Cycles: = 2 per Day/Basin (advances cycles beyond MDF)
Cycle Duration: = 12.0 Hours/Cycle
Food/Mass (F/M) ratio: = 0.198 lbs. COD/lb. MLSS-Day
MLSS Concentration: = 4500 mg/l @ Min. Water Depth
Hydraulic Retention Time: = 1.905 Days @ Avg. Water Depth
Solids Retention Time: = 8.4 Days
Est. Net Sludge Yield: = 0.581 lbs. WAS/lb. COD
Est. Dry Solids Produced: = 1443.7 lbs. WAS/Day = (654.9 kg/Day)
Est. Solids Flow Rate: = 300 GPM (17311 GAL/Day) = (65.5 m^3/Day)
Decant Flow Rate @ MDF: = 992.0 GPM (as avg. from high to low water level) = (62.6 l/sec)
LWL to CenterLine Discharge: = 2.0 ft = (0.6 m)
Lbs. O2/lb. COD = 1.00
Lbs. O2/lb. NH3-N = 4.60
Actual Oxygen Required: = 2940 lbs./Day = (1333.4 kg/Day)
Air Flowrate/Basin: = 472 SCFM = (13.4 Sm3/min)
Max. Discharge Pressure: = 10.7 PSIG = (74 KPA)
Avg. Power Required: = 885.2 KW-Hrs/Day

Equipment Summary

AquaSBR

Influent Valves

2 Influent Valve(s) will be provided as follows:

- 4 inch electrically operated plug valve(s).

Mixers

2 AquaDDM Direct Drive Mixer(s) will be provided as follows:

- 7.5 HP Aqua-Aerobic Systems Endura Series Model FSS DDM Mixer(s).

Mixer Mooring

2 Mixer pivotal mooring assembly(ies) consisting of:

- 304 stainless steel pivotal mooring arm(s).
- #12 AWG-four conductor electrical service cable(s).
- Electrical cable strain relief grip(s), 2 eye, wire mesh.

2 Mixer De-Watering Support(s) will be provided as follows:

- Galvanized steel dewatering support post(s).
- Galvanized steel support angle(s).
- 304 stainless steel anchors.

Decanters

2 Decanter assembly(ies) consisting of:

- 6x4 Aqua-Aerobics decanter(s) with fiberglass float, 304 stainless steel weir, galvanized restrained mooring frame, and painted steel power section with #14-10 conductor power cable wired into a NEMA 4X stainless steel junction box with terminal strips for the single phase, 60 hertz actuator and limit switches.
- 8 inch diameter decant hose assembly.
- 4" schedule 40 galvanized steel mooring post.
- 8 inch electrically operated butterfly valve(s) with actuator.

Transfer Pumps/Valves

2 Submersible Pump Assembly(ies) consisting of the following items:

- 3 HP Submersible Pump(s) with painted cast iron pump housing, discharge elbow, and multi-conductor electrical cable.
- Manual plug valve(s).
- 3 inch Nibco check valve(s).
- Galvanized steel slide rail assembly(ies).
- 304 stainless steel intermediate support(s).

Retrievable Fine Bubble Diffusers

4 Retrievable Fine Bubble Diffuser Assembly(ies) consisting of:

- 20 diffuser tubes consisting of two flexible EPDM porous membrane sheaths mounted on a rigid support pipe with 304 stainless steel band clamps.
- 304 stainless steel manifold weldment.
- 304 stainless steel leveling angles.
- 304 stainless steel leveling studs.
- Galvanized vertical support beam.
- Galvanized vertical air column assembly.
- Galvanized upper vertical beam and pulley assembly.
- Galvanized top support bracket.
- 3" EPDM flexible air line with ny-glass quick disconnect end fittings.
- Galvanized threaded flange.

- 3" manual isolation butterfly valve with cast iron body, EPDM seat, aluminum bronze disk and one-piece steel shaft.
- Ny-glass quick disconnect cam lock adapter.
- 304 stainless steel adhesive anchors.
- Brace angles.

1 Diffuser Electric Winch(es) will be provided as follows:

- Portable electric winch.

Positive Displacement Blowers

3 Positive Displacement Blower Package(s), with each package consisting of:

- Sutorbilt 6M Positive Displacement Blower Package with common base, V-belt drive, enclosed drive guard, pressure gauge, pressure relief valve, and vibration pads.
- 304 stainless steel anchors.
- 40 HP motor with slide base.
- Inlet filter and inlet silencer.
- Discharge silencer, check valve, manual butterfly isolation valve, and flexible discharge connector.

Level Sensor Assemblies

2 Pressure Transducer Assembly(ies) each consisting of:

- Submersible pressure transducer(s).
- Mounting bracket weldment(s).
- Transducer mounting weldment(s).
- 304 stainless steel anchors.

2 Level Sensor Assembly(ies) will be provided as follows:

- Float switch(es).
- Float switch mounting bracket(s).
- 304 stainless steel anchors.

Instrumentation

2 Dissolved Oxygen Assembly(ies) consisting of:

- Hach LDO dissolved oxygen probe with replaceable sensor cap and electric cable. Probe includes stainless steel stationary bracket and retrievable pole probe mounting assembly. One (1) probe per basin.
- Hach SC200 controller and display module(s).

Controls

Controls wo/Starters

1 Controls Package(s) will be provided as follows:

- NEMA 12 panel enclosure suitable for indoor installation and constructed of painted steel.
- Fuse(s) and fuse block(s).
- Allen Bradley SLC5/05 central processing unit with 32K memory and Ethernet connection.
- Operator interface(s).
- Remote Access Ethernet Modem.

PROCESS DESIGN REPORT

AQUA-AEROBIC SYSTEMS, INC.

MATSU BOROUGH AK

Design#: 132905

Option: AquaSBR and AquaDisk Preliminary Design

Designed By: Eric Roundy on Friday, December 14, 2012

The enclosed information is based on preliminary data which we have received from you. There may be factors unknown to us which would alter the enclosed recommendation. These recommendations are based on models and assumptions widely used in the industry. While we attempt to keep these current, Aqua-Aerobic Systems, Inc. assumes no responsibility for their validity or any risks associated with their use. Also, because of the various factors stated above, Aqua-Aerobic Systems, Inc. assumes no responsibility for any liability resulting from any use made by you of the enclosed recommendations.

Pre-SBR

- Pre-SBR treatment includes a Dissolved Air Floatation System or other system to remove the influent COD and TSS to the design influent parameters shown on the design summary.

- Neutralization is recommended/required ahead of the SBR if the pH is expected to fall outside of 6.5-8.5 for significant durations.

- Coarse solids removal/reduction is recommended prior to the SBR.

SBR

- The flow pattern is assumed to occur 24 hours/day over 7 days/week.

- The Maximum flow, as shown on the design, has been assumed as a hydraulic maximum and does not represent an additional organic load.

- The decanter performance is based upon a free-air discharge following the valve and immediately adjacent to the basin. Actual decanter performance depends upon the complete installation including specific liquid and piping elevations and any associated field piping losses to the final point of discharge. Modification of the high water level, low water level, centerline of discharge, and / or cycle structure may be required to achieve discharge of full batch volume based on actual site installation specifics.

Aeration

- The aeration system has been designed to provide 1.0 lbs O2/lb COD applied and 4.6 lbs O2/lb NH3-N applied at the design average loading conditions.

Process/Site

- An elevation of 20 ft. has been assumed as displayed on the design.

- The anticipated effluent NH3-N requirement is predicated upon an influent waste temperature of 8°C or greater. While lower temperatures may be acceptable for a short-term duration, nitrification below 10°C can be unpredictable, requiring special operator attention.

- Based on the information provided, the waste may be nutrient deficient. Nutrient addition is recommended to achieve a ratio of 100:5:1 (BOD:N:P).

- Sufficient alkalinity is required for nitrification, as approximately 7.1 mg alkalinity (as CaCO3) is required for every mg of NH3-N nitrified. If the raw water alkalinity cannot support this consumption, while maintaining a residual concentration of 50 mg/l, supplemental alkalinity shall be provided (by others).

- It is assumed that there are no substances in the influent stream that would be inhibitory for a biological system.

Anticipated

- It is assumed the influent COD is either directly, or biologically oxidizeable to the required discharge limits.

- Treatability study recommended to assure required effluent quality is achievable.

- Maximum fats, oils, and grease to the AquaSBR is 100 mg/l. Depending upon the nature of the FOG, reduction in activated sludge treatment is unpredictable. If an effluent FOG requirement exists, FOG should be reduced to the effluent limit required prior to biological treatment. High FOG levels may also cause poor settling and excessive foaming which can damage equipment and lead to effluent quality degradation.

Filtration

- Effluent flow equalization follows the AquaSBR process. The anticipated filtered effluent quality is based on the filter influent conditions as shown under "Design Parameters" of this Process Design Report. In addition, the filter influent should be free of algae and other colloidal solids that are not filterable through a nominal 10 micron pore size media. Provisions to treat algae and condition the solids to be filterable are the responsibility of others.

- The anticipated effluent quality is based upon filterable influent solids.

- For this application, pile filter cloth is recommended.

Equipment

- The basin dimensions reported on the design have been assumed based upon the required volumes and assumed basin geometry. Actual basin geometry may be circular, square, rectangular or sloped with construction materials including concrete, steel or earthen.

- Rectangular or sloped basin construction with length to width ratios greater than 1.5:1 may require alterations in the equipment recommendation.

- Tanks (except the package filter tank) are not included in the pricing and shall be provided by others.

- Influent is assumed to enter the reactor above the waterline, located appropriately to avoid proximity to the decanter, splashing or direct discharge in the immediate vicinity of other equipment.

- If the influent is to be located submerged below the waterline, adequate hydraulic capacity shall be made in the headworks to prevent backflow from one reactor to the other during transition of influent.

- A minimum freeboard of 2.0 ft. is recommended for diffused aeration.

- Aqua-Aerobic Systems, Inc. (AASI) is familiar with the Buy American provision of the American Recovery and Reinvestment Act of 2009 as well as other Buy American provisions (i.e. FAR 52.225, EXIM Bank, USAid, etc.). AASI can provide a system that is in full compliance with Buy American provisions. As the project develops AASI can work with you to ensure full compliance with a Buy American provision, if required. Please contact the factory should compliance with a Buy American provision be required.

Pricing

- Scope of supply includes installation supervision and start-up services; however, freight is not included.

- If the equipment is installed indoors, please ensure that the minimum number of air exchanges are provided otherwise explosion proof materials of construction will be required.

AquaSBR - Sequencing Batch Reactor - Design Summary

DESIGN INFLUENT CONDITIONS

Avg. Design Flow = 0.238165 MGD = 900 m3/day

Max Design Flow = 0.238165 MGD = 900 m3/day

DESIGN PARAMETERS	Influent	mg/l	Effluent (After Filtration) Required	<= mg/l	Anticipated	<= mg/l
Bio/Chem Oxygen Demand:	COD	1,250	BOD5	15	BOD5	15
Total Suspended Solids:	TSS	500	TSS	15	TSS	15
Inf. Ammonia Nitrogen:	NH3-N	50	--	--	--	--
Ammonia Nitrogen:	--	--	NH3-N	1.70	NH3-N	1.70

SITE CONDITIONS	Maximum		Minimum		Design		Elevation (MSL)
Ambient Air Temperatures:	70 F	21.1 C	20 F	-6.7 C	70 F	21.1 C	20 ft
Influent Waste Temperatures:	59 F	15.0 C	46 F	8.0 C	59 F	15.0 C	6.1 m

SBR BASIN DESIGN VALUES			Water Depth			Basin Vol./Basin		
No./Basin Geometry:	= 2 Square Basin(s)		**Min**	= 15.5 ft	= (4.7 m)	**Min**	= 0.167 MG	= (633.3 m^3)
Freeboard:	= 2.0 ft	= (0.6 m)	**Avg**	= 21.0 ft	= (6.4 m)	**Avg**	= 0.227 MG	= (858.7 m^3)
Length of Basin:	= 38.0 ft	= (11.6 m)	**Max**	= 21.0 ft	= (6.4 m)	**Max**	= 0.227 MG	= (858.7 m^3)
Width of Basin:	= 38.0 ft	= (11.6 m)						

Number of Cycles: = 2 per Day/Basin (advances cycles beyond MDF)

Cycle Duration: = 12.0 Hours/Cycle

Food/Mass (F/M) ratio: = 0.198 lbs. COD/lb. MLSS-Day

MLSS Concentration: = 4500 mg/l @ Min. Water Depth

Hydraulic Retention Time: = 1.905 Days @ Avg. Water Depth

Solids Retention Time: = 8.4 Days

Est. Net Sludge Yield: = 0.581 lbs. WAS/lb. COD

Est. Dry Solids Produced: = 1443.7 lbs. WAS/Day = (654.9 kg/Day)

Est. Solids Flow Rate: = 300 GPM (17311 GAL/Day) = (65.5 m^3/Day)

Decant Flow Rate @ MDF: = 992.0 GPM (as avg. from high to low water level) = (62.6 l/sec)

LWL to CenterLine Discharge: = 2.0 ft = (0.6 m)

Lbs. O2/lb. COD = 1.00

Lbs. O2/lb. NH3-N = 4.60

Actual Oxygen Required: = 2940 lbs./Day = (1333.4 kg/Day)

Air Flowrate/Basin: = 472 SCFM = (13.4 Sm3/min)

Max. Discharge Pressure: = 10.7 PSIG = (74 KPA)

Avg. Power Required: = 885.2 KW-Hrs/Day

Post-Equalization - Design Summary

POST-SBR EQUALIZATION DESIGN PARAMETERS

Avg. Daily Flow (ADF):	= 0.238165 MGD	= (900 m³/day)
Max. Daily Flow (MDF):	= 0.238165 MGD	= (900 m³/day)
Decant Flow Rate from (Qd):	= 992 gpm	= (3.8 m³M)
Decant Duration (Td):	= 60 min	
Number Decants/Day:	= 4	
Time Between Start of Decants:	= 360 min	

POST-SBR EQUALIZATION VOLUME DETERMINATION

The volume required for equalization/storage shall be provided between the high and the low water levels of the basin(s). This Storage Volume (Vs) has been determined by the following:

Vs = [(Qd -(MDF x 694.4)] x Td = 49,597 gal = (6,630.5 ft³) = (187.8 m³)

The volumes determined in this summary reflect the minimum volumes necessary to achieve the desired results based upon the input provided to Aqua. If other hydraulic conditions exist that are not mentioned in this design summary or associated design notes, additional volume may be warranted.

Based upon liquid level inputs from each SBR reactor prior to decant, the rate of discharge from the Post-SBR Equalization basin shall be pre-determined to establish the proper number of pumps to be operated (or the correct valve position in the case of gravity flow). Level indication in the Post-SBR Equalization basin(s) shall override equipment operation.

POST-SBR EQUALIZATION BASIN DESIGN VALUES

No./Basin Geometry:	= 1 Rectangular Basin(s)				
Length of Basin:	= 38.0 ft	= (11.6 m)			
Width of Basin:	= 15.0 ft	= (4.6 m)			
Min. Water Depth:	= 1.5 ft	= (0.5 m)	**Min. Basin Vol. Basin:**	= 6,395.4 gal	= (24.2 m³)
Max. Water Depth:	= 13.1 ft	= (4.0 m)	**Max. Basin Vol. Basin:**	= 55,991.9 gal	= (212.0 m³)

POST-SBR EQUALIZATION EQUIPMENT CRITERIA

Mixing Energy with Diffusers:	= 15 SCFM/1000 ft³	
SCFM Required to Mix:	= 112 SCFM/basin	= (191 Nm³/hr/basin)
Max. Discharge Pressure:	= 6.3 PSIG	= (43.17 KPA)
Max. Flow Rate Required Basin:	= 165 gpm	= (0.626 m³/min)
Avg. Power Required:	= 62.8 kW-hr/day	

AquaDISK Tertiary Filtration - Design Summary

DESIGN INFLUENT CONDITIONS

Pre-Filter Treatment: SBR

Avg. Design Flow	= 0.238165 MGD	= 165.4 gpm	= 900 m³/day
Max Design Flow	= 0.238165 MGD	= 165.4 gpm	= 900 m³/day

AquaDISK FILTER RECOMMENDATION

Qty Of Filter Units Recommended = 1

Number Of Disks Per Unit = 4

Total Number Of Disks Recommended = 4

Total Filter Area Provided = 43.2 ft² = (4.01 m²)

Filter Model Recommended = AquaDisk Package: Model ADFSP-11-4E-PC

Filter Media Cloth Type = OptiFiber PA2-13

AquaDISK FILTER CALCULATIONS

Filter Type:

Vertically Mounted Cloth Media Disks featuring automatically operated vacuum backwash . Tank shall include a rounded bottom and solids removal system.

Average Flow Conditions:

Average Hydraulic Loading = Avg. Design Flow (gpm) / Recommended Filter Area (ft²)
= 165.4 / 43.2 ft²
= 3.83 gpm/ft² (2.60 l/s/m²) at Avg. Flow

Maximum Flow Conditions:

Maximum Hydraulic Loading = Max. Design Flow (gpm) / Recommended Filter Area (ft²)
= 165.4 / 43.2 ft²
= 3.83 gpm/ft² (2.60 l/s/m²) at Max. Flow

AquaSBR

Influent Valves

2 Influent Valve(s) will be provided as follows:

- 4 inch electrically operated plug valve(s).

Mixers

2 AquaDDM Direct Drive Mixer(s) will be provided as follows:

- 7.5 HP Aqua-Aerobic Systems Endura Series Model FSS DDM Mixer(s).

Mixer Mooring

2 Mixer pivotal mooring assembly(ies) consisting of:

- 304 stainless steel pivotal mooring arm(s).
- #12 AWG-four conductor electrical service cable(s).
- Electrical cable strain relief grip(s), 2 eye, wire mesh.

2 Mixer De-Watering Support(s) will be provided as follows:

- Galvanized steel dewatering support post(s).
- Galvanized steel support angle(s).
- 304 stainless steel anchors.

Decanters

2 Decanter assembly(ies) consisting of:

- 6x4 Aqua-Aerobics decanter(s) with fiberglass float, 304 stainless steel weir, galvanized restrained mooring frame, and painted steel power section with #14-10 conductor power cable wired into a NEMA 4X stainless steel junction box with terminal strips for the single phase, 60 hertz actuator and limit switches.
- 8 inch diameter decant hose assembly.
- 4" schedule 40 galvanized steel mooring post.
- 8 inch electrically operated butterfly valve(s) with actuator.

Transfer Pumps/Valves

2 Submersible Pump Assembly(ies) consisting of the following items:

- 3 HP Submersible Pump(s) with painted cast iron pump housing, discharge elbow, and multi-conductor electrical cable.
- Manual plug valve(s).
- 3 inch Nibco check valve(s).
- Galvanized steel slide rail assembly(ies).
- 304 stainless steel intermediate support(s).

Retrievable Fine Bubble Diffusers

4 Retrievable Fine Bubble Diffuser Assembly(ies) consisting of:

- 20 diffuser tubes consisting of two flexible EPDM porous membrane sheaths mounted on a rigid support pipe with 304 stainless steel band clamps.
- 304 stainless steel manifold weldment.
- 304 stainless steel leveling angles.
- 304 stainless steel leveling studs.
- Galvanized vertical support beam.
- Galvanized vertical air column assembly.
- Galvanized upper vertical beam and pulley assembly.
- Galvanized top support bracket.
- 3" EPDM flexible air line with ny-glass quick disconnect end fittings.
- Galvanized threaded flange.

- 3" manual isolation butterfly valve with cast iron body, EPDM seat, aluminum bronze disk and one-piece steel shaft.
- Ny-glass quick disconnect cam lock adapter.
- 304 stainless steel adhesive anchors.
- Brace angles.

1 Diffuser Electric Winch(es) will be provided as follows:

- Portable electric winch.

Positive Displacement Blowers

3 Positive Displacement Blower Package(s), with each package consisting of:

- Sutorbilt 6M Positive Displacement Blower Package with common base, V-belt drive, enclosed drive guard, pressure gauge, pressure relief valve, and vibration pads.
- 304 stainless steel anchors.
- 40 HP motor with slide base.
- Inlet filter and inlet silencer.
- Discharge silencer, check valve, manual butterfly isolation valve, and flexible discharge connector.

Level Sensor Assemblies

2 Pressure Transducer Assembly(ies) each consisting of:

- Submersible pressure transducer(s).
- Mounting bracket weldment(s).
- Transducer mounting weldment(s).
- 304 stainless steel anchors.

2 Level Sensor Assembly(ies) will be provided as follows:

- Float switch(es).
- Float switch mounting bracket(s).
- 304 stainless steel anchors.

Instrumentation

2 Dissolved Oxygen Assembly(ies) consisting of:

- Hach LDO dissolved oxygen probe with replaceable sensor cap and electric cable. Probe includes stainless steel stationary bracket and retrievable pole probe mounting assembly. One (1) probe per basin.
- Hach SC200 controller and display module(s).

AquaSBR: Post-Equalization

Transfer Pumps/Valves

2 Submersible Pump Assembly(ies) consisting of the following items:

- 3 HP Submersible Pump(s) with painted cast iron pump housing, discharge elbow, and multi-conductor electrical cable.
- Manual plug valve(s).
- 3 inch Nibco check valve(s).
- Galvanized steel slide rail assembly(ies).

Fixed Coarse Bubble Diffusers

1 Aqua-Aerobic's Fixed Coarse Bubble Diffuser System(s) consisting of the following components:

- PVC diffuser(s).
- Schedule 40 galvanized steel riser pipe(s).
- Schedule 40 PVC manifold piping.
- 304 stainless steel anchors.

Positive Displacement Blowers

1 Positive Displacement Blower Package(s), with each package consisting of:

- Sutorbilt 3M Positive Displacement Blower Package with common base, V-belt drive, enclosed drive guard, pressure gauge, pressure relief valve, and vibration pads.

- 304 stainless steel anchors.
- 7.5 HP motor with slide base.
- Inlet filter and inlet silencer.
- Discharge silencer, check valve, manual butterfly isolation valve, and flexible discharge connector.

Level Sensor Assemblies

1 Pressure Transducer Assembly(ies) each consisting of:

- Submersible pressure transducer(s).
- Mounting bracket weldment(s).
- Transducer mounting weldment(s).
- 304 stainless steel anchors.

1 Level Sensor Assembly(ies) will be provided as follows:

- Float switch(es).
- Float switch mounting bracket(s).
- 304 stainless steel anchors.

Controls

Controls wo/Starters

1 Controls Package(s) will be provided as follows:

- NEMA 12 panel enclosure suitable for indoor installation and constructed of painted steel.
- Fuse(s) and fuse block(s).
- Allen Bradley SLC5/05 central processing unit with 32K memory and Ethernet connection.
- Operator interface(s).
- Remote Access Ethernet Modem.

Cloth Media Filters

AquaDisk Tanks/Basins

1 AquaDisk Model # ADFSP-11x4E-PC Package Filter Painted Steel Tank(s) consisting of:

- 4 disk tank(s) will be painted steel, estimated dry weight is 3,825 lbs., and estimated operating weight is 9,500 lbs.
Each tank will include an integral solids waste collection manifold.
The tank finish will be:
Interior: near white sandblast (SSPC-SP10), painted with Tnemec N69 polyamide epoxy (color "safety blue") 2 coats 4-6 mils each for 8-12 mils DFT.
Exterior: commercial sandblast (SSPC-SP6), painted with Tnemec N69 polyamide epoxy (color "safety blue") 2 coats 3-4 mils each, 1 coat Tnemec 175 endurashield 2-3 mils for 8-11 mils DFT.
- 2" ball valve(s).

AquaDisk Centertube Assemblies

1 Centertube(s) consisting of:

- 304 stainless steel centertube weldment(s).
- Centertube driven sprocket(s).
- Dual wheel assembly(ies).
- Rider wheel bracket assembly(ies).
- Centertube bearing kit(s).
- Effluent centertube lip seal.
- Pile cloth media and non-corrosive support frame assemblies.
- 304 Stainless steel frame top plate(s),
- Media sealing gaskets.
- Disk segment 304 stainless steel support rods.

AquaDisk Drive Assemblies

1 Drive System(s) consisting of:

- Gearbox with motor.
- Drive sprocket(s).

- Drive chain(s) with pins.
- Stationary drive bracket weldment(s).
- Adjustable drive bracket weldment(s).
- Chain guard weldment(s).
- Warning label(s).

AquaDisk Backwash/Sludge Assemblies

1 Backwash System(s) consisting of:

- Backwash shoe assemblies.
- Backwash shoe support weldment(s).
- 1 1/2" flexible hose.
- Stainless steel backwash shoe springs.
- Hose clamps.

1 Backwash/Solids Waste Pump(s) consisting of:

- Backwash/waste pump(s).
- 0 to 15 psi pressure gauge(s).
- 0 to 30 inches mercury vacuum gauge(s).
- Throttling gate valve(s).
- 2" bronze 3 way ball valve(s).

AquaDisk Instrumentation

1 Pressure Transmitter(s) consisting of:

- Level transmitter(s).

1 Vacuum Transmitter(s) consisting of:

- Vacuum transmitter(s).

1 Float Switch(es) consisting of:

- Float switch(es).
- Float switch support bracket(s).

AquaDisk Valves

1 Solids Waste Valve(s) consisting of:

- 2" full port, three piece, stainless steel body ball valve(s), grooved end connections with single phase electric actuator(s). Valve / actuator combination shall be TCI / RCI (RCI, a division of Rotork), Nibco, or equal.
- 2" flexible hose.
- Victaulic coupler(s).

1 Set(s) of Backwash Valves consisting of:

- 2" full port, three piece, stainless steel body ball valve(s), grooved end connections with single phase electric actuator(s). Valve / actuator combination shall be TCI / RCI (RCI, a division of Rotork), Nibco, or equal.
- 2" flexible hose.
- Victaulic coupler(s).

AquaDisk Controls w/Starters

1 Control Panel(s) consisting of:

- NEMA 4X fiberglass enclosure(s).
- Circuit breaker with handle.
- Transformer(s).
- Fuses and fuse blocks.
- Line filter(s).
- GFI convenience outlet(s).
- Control relay(s).
- Selector switch(es).
- Indicating pilot light(s).
- MicroLogix 1400 PLC(s).
- Ethernet switch(es).

- Operator interface(s).
- Power supply(ies).
- Motor starter(s).
- Terminal blocks.
- UL label(s).

1 Conduit Installation(s) consisting of:

- PVC conduit and fittings.

Appendix I
Leachate Treatment Cost Estimates

07/31/2014 8:09
2014-071 PALMER LF LEACHATE EVAP-ENCON-ROM
***

BID TOTALS

Biditem	Description	Status - Rnd	Quantity	Units	Unit Price	Bid Total
10	MOBILIZATION		1.000	LS	200,000.00	200,000.00
20	BONDS & INSURANCE		1.000	LS	75,577.00	75,577.00
30	SUBMITTALS		1.000	LS	23,996.65	23,996.65
40	PERMITS		1.000	LS	47,500.00	47,500.00
50	SURVEY		1.000	LS	6,600.00	6,600.00
80	FENCING		1.000	LS	153,800.00	153,800.00
90	BUILDING FOUNDATION		1.000	LS	45,000.00	45,000.00
100	BUILDING STRUCTURE		1.000	LS	232,500.00	232,500.00
110	UTILITIES-OUTSIDE BUILDING		1.000	LS	30,000.00	30,000.00
120	UTILITIES - INSIDE BUILDING		1.000	LS	60,000.00	60,000.00
130	PURCHASE PLANT EQUIPMENT		1.000	LS	778,225.00	778,225.00
140	INSTALL PLANT EQUIPMENT		1.000	LS	155,645.00	155,645.00
150	INSIDE PIPING		1.000	LS	77,800.00	77,800.00
160	ELECTRICAL & NEW SUB STATION		1.000	LS	125,000.00	125,000.00
165	NATURAL GAS LINE		2,500.000	LF	30.00	75,000.00
170	INSTRUMENTS & CONTRLS		1.000	LS	10,000.00	10,000.00
180	LEACHATE EQUALIZATION LAGOON		750,000.000	GL	0.11	82,500.00
600	DEMOBILIZATION		1.000	LS	180,000.00	180,000.00
910	CONTRACTOR OVERHEAD(GENERAL CONDITIONS)		1.000	LS	105,374.00	105,374.00
920	CH OVERHEAD (GENERAL CONDITIONS)		1.000	LS	90,321.00	90,321.00
930	MANAGEMENT RESERVE (CONTINGENCY)		1.000	LS	225,802.00	225,802.00
970	TAXES		1.000	LS	88,052.00	88,052.00
980	MARK UP (PROFIT)		1.000	LS	228,350.00	228,350.00
			Bid Total	========>		$3,097,042.65

```
Activity        Desc                   Quantity            Unit           Perm    Constr    Equip   Sub-
   Resource                         Pcs          Unit      Cost    Labor  Materi  Matl/Ex    MentContrac     Total
-------------------------------------------------------------------------------------------------------------------

BID ITEM =      10                                 Land Item    SCHEDULE:   1          100
Description = MOBILIZATION                             Unit =    LS    Takeoff Quan:     1.000     Engr Quan:    1.000

19001005      MOBILIZATION                         Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WCNONE

4MOB          MOBILIZATION      1.00       1.00 LS       200,000.000                              200,000 200,000
-------------------------------------------------------------------------------------------------------------------

BID ITEM =      20                                 Land Item    SCHEDULE:   1          100
Description = BONDS & INSURANCE                        Unit =    LS    Takeoff Quan:     1.000     Engr Quan:    1.000

11002005      BONDS                                Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WCNONE

BONDS 1.7% X $3,023,109 = $
3BOND         BOND COST         1.00       1.00 LS        51,393.000                 51,393                   51,393

11002010      INSURANCE                            Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WCNONE

INSURANCE 0.8% X $3,023,109 = $24,184
3INSURANC     INSURANCE COST    1.00       1.00 LS        24,184.000                 24,184                   24,184
                                                                 ----------------------------------------------------
=====> Item Totals:      20       - BONDS & INSURANCE
$75,577.00                                                    [ ]                    75,577                   75,577
75,577.000                   1 LS                                                 75,577.00                75,577.00
-------------------------------------------------------------------------------------------------------------------

BID ITEM =      30                                 Land Item    SCHEDULE:   1          100
Description = SUBMITTALS                               Unit =    LS    Takeoff Quan:     1.000     Engr Quan:    1.000

11003005      WORK PLAN                            Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WCNONE
                                                                                                     **Unreviewed
 11030        SUBMITTALS                      16.00  CH         Prod:   0.0625 UH   Lab Pcs:  3.10     Eqp Pcs:  0.00
3DOCMTRL      DOCUMENT MATE     1.00       1.00 LS           200.000                    200                      200
X414          Project Eng    E6 1.00      16.00 MH            72.700   1,605                                   1,605
X430          Project Controls E 4 0.20    3.20 MH            52.900     234                                     234
X434          Cost/Schedule  E3 0.20       3.20 MH            43.800     193                                     193
X442          Document  Tech T2 0.10       1.60 MH            24.900      55                                      55
X450          Field Engineer  T4 0.20      3.20 MH            39.800     176                                     176
X462          Quality  Mngr  E4 0.20       3.20 MH            52.900     234                                     234
X866          Admin Assist.  T1 1.00      16.00 MH            22.900     506                                     506
X918          Safety Engineer E3 0.20      3.20 MH            43.900     194                                     194
$3,396.09              49.6000 MH/LS      49.60 MH          [ 2316 ]   3,196                200                3,396
  0.0625  Units/Hr *    0.6250 Un/Shift   0.0202 Unit/M             3,196.09             200.00             3,396.09
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Activity        Desc                    Quantity              Unit           Perm   Constr   Equip    Sub-
   Resource                          Pcs          Unit        Cost    Labor  Materi MatI/Ex    MentContrac      Total

BID ITEM =     30                                   Land Item    SCHEDULE:   1         100
Description = SUBMITTALS                               Unit =    LS   Takeoff Quan:    1.000     Engr Quan:    1.000

11003010     PROJECT SCHEDULE                          Quan:   1.00 LS   Hrs/Shft: 10.00  Cal 10   WCNONE
                                                                                                    **Unreviewed
 11030       SUBMITTALS                     24.00   CH        Prod:   0.0417 UH   Lab Pcs:  1.85    Eqp Pcs:  0.00
3DOCMTRL     DOCUMENT MATE 1.00      1.00 LS          350.000                       350                       350
X414         Project Eng     E6  0.15     3.60 MH           72.700     361                                    361
X430         Project Controls E 4  0.10   2.40 MH           52.900     175                                    175
X434         Cost/Schedule  E3  1.00     24.00 MH           43.800   1,451                                  1,451
X442         Document  Tech T2  0.10      2.40 MH           24.900      82                                     82
X866         Admin Assist.  T1  0.50     12.00 MH           22.900     379                                    379
$2,798.72           44.4000 MH/LS        44.40 MH      [ 1774.44 ]   2,449                      350          2,799
  0.0417  Units/Hr *   0.4167 Un/Shift   0.0225 Unit/M             2,448.72                  350.00       2,798.72

11003015     SWPPP                                     Quan:   1.00 LS   Hrs/Shft: 10.00  Cal 10   WCNONE
                                                                                                    **Unreviewed
FOR ALL SUBMITTALS ASSUME A DRAFT A DRAFT FINAL AND A FINAL FOR MOST SUBMITTALS
 11020       PLAN/DOC CREW                   1.00   CH        Prod:   1.0000 UH   Lab Pcs: 68.00    Eqp Pcs:  0.00
3DOCMTRL     DOCUMENT MATE 1.00      1.00 LS          750.000                       750                       750
AAA          *********LABOR**        0.00 MH            0.000
X274         Adminst Asst.    T2  18.00  18.00 MH           24.900     619                                    619
X414         Project Eng     E6  32.00   32.00 MH           72.700   3,210                                  3,210
X426         Jr Staff Eng    E3   18.00  18.00 MH           43.800   1,088                                  1,088
$5,666.94           68.0000 MH/LS        68.00 MH        [ 3563 ]    4,917                      750          5,667
  1.0000  Units/Hr *  10.0000 Un/Shift   0.0147 Unit/M             4,916.94                  750.00       5,666.94

11003020     HASP                                      Quan:   1.00 LS   Hrs/Shft: 10.00  Cal 10   WCNONE
                                                                                                    **Unreviewed
 11020       PLAN/DOC CREW                   1.00   CH        Prod:   1.0000 UH   Lab Pcs: 58.00    Eqp Pcs:  0.00
3DOCMTRL     DOCUMENT MATE 1.00      1.00 LS          950.000                       950                       950
AAA          *********LABOR**        0.00 MH            0.000
X274         Adminst Asst.    T2  20.00  20.00 MH           24.900     687                                    687
X414         Project Eng     E6  10.00   10.00 MH           72.700   1,003                                  1,003
X426         Jr Staff Eng    E3    8.00   8.00 MH           43.800     484                                    484
X918         Safety Engineer  E3  20.00  20.00 MH           43.900   1,212                                  1,212
$4,335.69           58.0000 MH/LS        58.00 MH       [ 2453.4 ]   3,386                      950          4,336
  1.0000  Units/Hr *  10.0000 Un/Shift   0.0172 Unit/M             3,385.69                  950.00       4,335.69

11003025     QA/QC PLAN                                Quan:   1.00 LS   Hrs/Shft: 10.00  Cal 10   WCNONE
                                                                                                    **Unreviewed
 11020       PLAN/DOC CREW                   1.00   CH        Prod:   1.0000 UH   Lab Pcs: 56.00    Eqp Pcs:  0.00
3DOCMTRL     DOCUMENT MATE 1.00      1.00 LS          700.000                       700                       700
AAA          *********LABOR**        0.00 MH            0.000
X274         Adminst Asst.    T2  20.00  20.00 MH           24.900     687                                    687
X414         Project Eng     E6  12.00   12.00 MH           72.700   1,204                                  1,204
X462         Quality  Mngr  E4  24.00    24.00 MH           52.900   1,752                                  1,752
$4,343.20           56.0000 MH/LS        56.00 MH        [ 2640 ]    3,643                      700          4,343
```

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Activity         Desc                     Quantity               Unit            Perm   Constr    Equip    Sub-
   Resource                           Pcs           Unit         Cost    Labor  Materi  Matl/Ex    Ment Contrac      Total

BID ITEM =      30                                     Land Item    SCHEDULE:   1          100
Description = SUBMITTALS                                   Unit =   LS   Takeoff Quan:    1.000    Engr Quan:    1.000

  1.0000  Units/Hr *   10.0000 Un/Shift     0.0179 Unit/M             3,643.20           700.00                 4,343.20

11003030      TRAFFIC PLAN                                 Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE
                                                                                                        **Unreviewed
 11020        PLAN/DOC CREW                      1.00   CH        Prod:    1.0000 UH   Lab Pcs: 52.00   Eqp Pcs:  0.00
3DOCMTRL      DOCUMENT MATE  1.00       1.00 LS             250.000                       250                      250
AAA           *********LABOR**          0.00 MH               0.000
X274          Adminst Asst.   T2  16.00    16.00 MH          24.900      550                                      550
X414          Project Eng     E6  12.00    12.00 MH          72.700    1,204                                    1,204
X426          Jr Staff Eng    E3  12.00    12.00 MH          43.800      725                                      725
X918          Safety Engineer E3  12.00    12.00 MH          43.900      727                                      727
$3,456.01          52.0000 MH/LS        52.00 MH          [ 2323.2 ]   3,206           250                      3,456
  1.0000  Units/Hr *   10.0000 Un/Shift     0.0192 Unit/M             3,206.01           250.00                 3,456.01

=====> Item Totals:      30       - SUBMITTALS
$23,996.65      328.0000 MH/LS        328.00 MH        [ 15070.04 ]  20,797         3,200                     23,997
23,996.650                  1 LS                                     20,796.65      3,200.00                  23,996.65

BID ITEM =      40                                     Land Item    SCHEDULE:   1          100
Description = PERMITS                                      Unit =   LS   Takeoff Quan:    1.000    Engr Quan:    1.000

11004005      404 PERMIT                                   Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE
                                                                                                        **Unreviewed
3404PERM      404 PERMIT         1.00       1.00 LS      40,000.000                    40,000                   40,000

11004010      DUST PERMIT                                  Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE
                                                                                                        **Unreviewed
3DUSTPRM      DUST PERMIT        1.00       1.00 LS       7,500.000                     7,500                    7,500

=====> Item Totals:      40       - PERMITS
$47,500.00                                                  [  ]                       47,500                   47,500
47,500.000                  1 LS                                                    47,500.00                47,500.00

BID ITEM =      50                                     Land Item    SCHEDULE:   1          100
Description = SURVEY                                       Unit =   LS   Takeoff Quan:    1.000    Engr Quan:    1.000

11005005      SURVEY                                       Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

THIS WOULD INCLUDE LAYOUT OF BUILDING , EQUALIZATION POND , ACCESS ROAD AND
UTILITIES . ALSO EARTHWORK QUANTITIES AND FINAL AS BUILT DRAWAINGS
4SURVEY       SURVEY SUB         1.00      60.00 HR         110.000                                        6,600    6,600
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Activity        Desc                  Quantity             Unit            Perm   Constr   Equip    Sub-
   Resource                   Pcs            Unit           Cost   Labor  Materi  Matl/Ex   Ment Contrac     Total
--------------------------------------------------------------------------------------------------------------------

BID ITEM =     80                                   Land Item    SCHEDULE:   1          100
Description = FENCING                                  Unit =    LS    Takeoff Quan:    1.000    Engr Quan:    1.000

19008005      CL FENCE                              Quan: 5,200.00 LF   Hrs/Shft: 10.00   Cal 10   WCNONE

4FENCE        Fencing - Sub       1.00  5,200.00 LF         29.000                                150,800  150,800

19008010      GATES - MAN                           Quan:     4.00 EA   Hrs/Shft: 10.00   Cal 10   WCNONE

4FENCE        Fencing - Sub       1.00      4.00 EA        300.000                                  1,200    1,200

19008015      GATES VEHICLE                         Quan:     2.00 EA   Hrs/Shft: 10.00   Cal 10   WCNONE

4FENCE        Fencing - Sub       1.00      2.00 EA        900.000                                  1,800    1,800
                                                                  ------------------------------------------------
=====> Item Totals:     80      - FENCING
$153,800.00                                                 [ ]                                   153,800  153,800
153,800.000                 1 LS                                                               153,800.00 153,800.00
--------------------------------------------------------------------------------------------------------------------

BID ITEM =     90                                   Land Item    SCHEDULE:   1          100
Description = BUILDING FOUNDATION                      Unit =    LS    Takeoff Quan:    1.000    Engr Quan:    1.000

51009005      BUILDING FOUNDATION & SLAB            Quan: 1,500.00 SF   Hrs/Shft: 10.00   Cal 10   WCNONE

4CONC         Concrete - Sub      1.00  1,500.00 SF         30.000                                 45,000   45,000
--------------------------------------------------------------------------------------------------------------------

BID ITEM =    100                                   Land Item    SCHEDULE:   1          100
Description = BUILDING STRUCTURE                       Unit =    LS    Takeoff Quan:    1.000    Engr Quan:    1.000

60010005      BUILDING STRUCTURE                    Quan: 1,500.00 SF   Hrs/Shft: 10.00   Cal 10   WCNONE

4BLDG         Building - Sub      1.00  1,500.00 SF        155.000                                232,500  232,500
--------------------------------------------------------------------------------------------------------------------

BID ITEM =    110                                   Land Item    SCHEDULE:   1          100
Description = UTILITIES-OUTSIDE BUILDING               Unit =    LS    Takeoff Quan:    1.000    Engr Quan:    1.000

60011005      UTILITIES-OUTSIDE BUILDING            Quan:     1.00 LS   Hrs/Shft: 10.00   Cal 10   WCNONE

4UTIL         UTILLITY SUB        1.00      1.00 LS     30,000.000                                 30,000   30,000
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Activity       Desc                 Quantity            Unit              Perm   Constr   Equip    Sub-
   Resource                      Pcs        Unit        Cost     Labor  Materi  Matl/Ex   Ment Contrac      Total
__________________________________________________________________________________________________________________

BID ITEM =     120                               Land Item   SCHEDULE:   1          100
Description = UTILITIES - INSIDE BUILDING           Unit =   LS   Takeoff Quan:    1.000     Engr Quan:    1.000

60012005     UTILITIES - INSIDE BUILDING         Quan:    1.00 LS  Hrs/Shft: 10.00  Cal 10   WC NONE

4UTIL        UTILLITY SUB      1.00      1.00 LS       60,000.000                                   60,000   60,000
__________________________________________________________________________________________________________________

BID ITEM =     130                               Land Item   SCHEDULE:   1          100
Description = PURCHASE PLANT EQUIPMENT              Unit =   LS   Takeoff Quan:    1.000     Engr Quan:    1.000

30013005     PURCHASE PLANT EQUIPMENT            Quan:    1.00 LS  Hrs/Shft: 10.00  Cal 10   WC NONE

THIS IS VENDOR QUOTE FOR ENCON EVAPORATORS AND SUPPORT EQUIPMENT
2EVAPEQ      EVAPORATOR EQU 1.00      1.00 LS      778,225.000          778,225                              778,225

=====> Item Totals:    130      - PURCHASE PLANT EQUIPMENT   ______________________________________________________
$778,225.00                                           [ ]          778,225                              778,225
778,225.000                    1 LS                              778,225.00                           778,225.00
__________________________________________________________________________________________________________________

BID ITEM =     140                               Land Item   SCHEDULE:   1          100
Description = INSTALL PLANT EQUIPMENT               Unit =   LS   Takeoff Quan:    1.000     Engr Quan:    1.000

30014005     INSTALL EQUIPMENT                   Quan:    1.00 LS  Hrs/Shft: 10.00  Cal 10   WC NONE

ASSUMES COST OF INSTALLATION 20% OF EQUIPMENT COST
4MECH        INSTALLATION SU 1.00     1.00 LS      155,645.000                                 155,645  155,645
__________________________________________________________________________________________________________________

BID ITEM =     150                               Land Item   SCHEDULE:   1          100
Description = INSIDE PIPING                         Unit =   LS   Takeoff Quan:    1.000     Engr Quan:    1.000

30015005     INSIDE PIPING                       Quan:    1.00 LS  Hrs/Shft: 10.00  Cal 10   WC NONE

ASSUME COST OF 1% OF EQUIPMENT COST
4MECH        INSTALLATION SU 1.00     1.00 LS       77,800.000                                  77,800   77,800
__________________________________________________________________________________________________________________

BID ITEM =     160                               Land Item   SCHEDULE:   1          100
Description = ELECTRICAL & NEW SUB STATION          Unit =   LS   Takeoff Quan:    1.000     Engr Quan:    1.000
```

```
Activity      Desc                  Quantity                 Unit          Perm    Constr    Equip   Sub-
   Resource                      Pcs        Unit             Cost    Labor Materi  Matl/Ex    Ment Contrac     Total
______________________________________________________________________________________________________________________

BID ITEM =    160                                  Land Item   SCHEDULE:   1          100
Description = ELECTRICAL & NEW SUB STATION            Unit =   LS    Takeoff Quan:     1.000    Engr Quan:     1.000

30016005      SUB STATION                          Quan:     1.00 LS  Hrs/Shft: 10.00  Cal 10  WC NONE

4ELECT        ELECTRICAL SUB   1.00      1.00 LS         50,000.000                               50,000    50,000

30016010      OH POWER LINE                        Quan: 2,500.00 LF  Hrs/Shft: 10.00  Cal 10  WC NONE

4ELEC         Electric - Sub   1.00  2,500.00 LF             30.000                               75,000    75,000
                                                              ____________________________________________________
=====> Item Totals:    160      - ELECTRICAL & NEW SUB STATION
$125,000.00                                                     [ ]                                125,000 125,000
125,000.000                  1 LS                                                               125,000.00 125,000.00
______________________________________________________________________________________________________________________

BID ITEM =    165                                  Land Item   SCHEDULE:   1          100
Description = NATURAL GAS LINE                        Unit =   LF    Takeoff Quan: 2,500.000    Engr Quan: 2,500.000

30016505      NATURAL GAS LINE                     Quan: 2,500.00 LF  Hrs/Shft: 10.00  Cal 10  WC NONE

4GAS          NATURAL GAS LIN  1.00  2,500.00 LF             30.000                               75,000    75,000
______________________________________________________________________________________________________________________

BID ITEM =    170                                  Land Item   SCHEDULE:   1          100
Description = INSTRUMENTS & CONTRLS                   Unit =   LS    Takeoff Quan:     1.000    Engr Quan:     1.000

30017005      INSTRUMENTS & CONTRLS                Quan:     1.00 LS  Hrs/Shft: 10.00  Cal 10  WC NONE

4ELEC         Electric - Sub   1.00      1.00 LS         10,000.000                               10,000    10,000
______________________________________________________________________________________________________________________

BID ITEM =    180                                  Land Item   SCHEDULE:   1          100
Description = LEACHATE EQUALIZATION LAGOON            Unit =   GL    Takeoff Quan: 750,000.000  Engr Quan: 750,000.000

19018005      EXCAVATE LAGOON                      Quan: 4,830.00 CY  Hrs/Shft: 10.00  Cal 10  WC NONE

 19015        SMALL EXCAV CREW             60.00  CH      Prod: 80.5000 UH  Lab Pcs:  6.00     Eqp Pcs:  4.00
3GRDST&S      GRADING ST&S     1.00    360.00 HM              2.000            720                         720
3PPE          PPE              1.00    360.00 HM              2.500            900                         900
8AAAA         *******EQUIPMEN            0.00 HR              0.000
8EXC330       Excavator Cat 330D L 1.00 60.00 HR            188.085                   11,285            11,285
8TRKHW10      Tandem Truck 12 CY 2.00  120.00 HR             73.856                    8,863             8,863
8TRKPU15      Pickup 4x4 3/4 Ton G 1.00 60.00 HR             15.264                      916               916
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Direct Cost Report

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Activity        Desc                    Quantity              Unit            Perm   Constr    Equip    Sub-
   Resource                        Pcs           Unit         Cost    Labor  Materi  Matl/Ex    Ment Contrac     Total
--------------------------------------------------------------------------------------------------------------------------

BID ITEM =    180                                Land Item    SCHEDULE:   1         100
Description = LEACHATE EQUALIZATION LAGOON       Unit =    GL   Takeoff Quan: 750,000.000    Engr Quan: 750,000.000

AAA          *********LABOR**         0.00 MH              0.000
LA30         Laborer General     1.00    60.00 MH             29.210    3,614                                       3,614
OP01F        Oper Foreman        1.00    60.00 MH             42.040    4,495                                       4,495
OPH14        Oper Hydr Backhoe 3 1.00    60.00 MH             39.280    4,280                                       4,280
OPSPT14      Oper Grade Checker  1.00    60.00 MH             37.790    4,164                                       4,164
TE22         Tmstr Dmp Trk 6-14c 2.00   120.00 MH             36.790    7,959                                       7,959
$47,195.84         0.0745  MH/CY        360.00 MH          [ 3.032 ]   24,512            1,620   21,064            47,196
 80.5000  Units/Hr *  805.0000 Un/Shift 13.4167 Unit/M                  5.07              0.34     4.36              9.77

19018010     INSTALL HDPE LINER                       Quan: 25,480.00 SF   Hrs/Shft: 10.00  Cal 10   WC NONE

4LINER       LINER SUB           1.00 25,480.00 SF             1.450                                   36,946    36,946
                                                                  ------------------------------------------------------
=====> Item Totals:    180      - LEACHATE EQUALIZATION LAGOON
$84,141.84        0.0004  MH/GL          360.00 MH           [ 0.02 ]  24,512            1,620   21,064  36,946    84,142
0.112                         750000 GL                                  0.03                      0.03    0.05      0.11
--------------------------------------------------------------------------------------------------------------------------

BID ITEM =    600                                Land Item    SCHEDULE:   1         100
Description = DEMOBILIZATION                     Unit =    LS   Takeoff Quan:      1.000    Engr Quan:       1.000

19060005     DEMOBILIZATION                           Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

4DEMOB       DEMOBILZATION       1.00     1.00 LS       180,000.000                                   180,000   180,000
--------------------------------------------------------------------------------------------------------------------------

BID ITEM =    910                                Land Item    SCHEDULE:   1         100
Description = CONTRACTOR OVERHEAD(GENERAL CO     Unit =    LS   Takeoff Quan:      1.000    Engr Quan:       1.000

11091005     CONTRACTOR OVERHEAD(GENERAL              Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

7% OF DIRECT COT EXCLUDING EQUIPMENT PURCHASE ,BONDS&INSURANCE,CH
OVERSIGHT,MANAGEMENT RESERVE
4CNTROH      CONTRACTOR OH       1.00     1.00 LS       105,374.000                                   105,374   105,374
--------------------------------------------------------------------------------------------------------------------------

BID ITEM =    920                                Land Item    SCHEDULE:   1         100
Description = CH OVERHEAD (GENERAL CONDITIONS)   Unit =    LS   Takeoff Quan:      1.000    Engr Quan:       1.000

11092005     CH OVERHEAD (GENERAL CONDITIO            Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE
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Activity        Desc                 Quantity              Unit           Perm   Constr   Equip    Sub-
   Resource                       Pcs          Unit         Cost    Labor Materi MatI/Ex    MentContrac      Total
____________________________________________________________________________________________________________________

BID ITEM =    920                               Land Item    SCHEDULE:   1         100
Description = CH OVERHEAD (GENERAL CONDITIONS)  Unit =       LS   Takeoff Quan:    1.000     Engr Quan:      1.000

CH OVERSIGHT 6% OF COSTS EXCLUDING,BONDS&INSURANCE,PERMITS,EQUIPMENT
PURCHASE,CONTRACTOR OH,MANAGEMENT RESERVE AND MARK UP
4CH          CH OVERHEAD & P 1.00       1.00  LS     90,321.000                                   90,321    90,321
____________________________________________________________________________________________________________________

BID ITEM =    930                               Land Item    SCHEDULE:   1         100
Description = MANAGEMENT RESERVE (CONTINGENC    Unit =       LS   Takeoff Quan:    1.000     Engr Quan:      1.000

11093005     MANAGEMENT RESERVE (CONTINGE   Quan:    1.00 LS  Hrs/Shft: 10.00  Cal 10   WCNONE

3MR15        MANAGEMNT RES   1.00       1.00  LS    225,802.000              225,802                       225,802
                                                               _____________________________________________________
=====> Item Totals:     930      - MANAGEMENT RESERVE (CONTINGENCY)
$225,802.00                                            [ ]                   225,802                       225,802
225,802.000                 1 LS                                          225,802.00                    225,802.00
____________________________________________________________________________________________________________________

BID ITEM =    970                               Land Item    SCHEDULE:   1         100
Description = TAXES                             Unit =       LS   Takeoff Quan:    1.000     Engr Quan:      1.000

11097005     TAXES (3% DIRECT COSTS)        Quan:    1.00 LS  Hrs/Shft: 10.00  Cal 10   WCNONE

3TAXES       TAXES PALMER A  1.00       1.00  LS     88,052.000               88,052                        88,052
                                                               _____________________________________________________
=====> Item Totals:     970      - TAXES
$88,052.00                                             [ ]                    88,052                        88,052
88,052.000                  1 LS                                           88,052.00                     88,052.00
____________________________________________________________________________________________________________________

BID ITEM =    980                               Land Item    SCHEDULE:   1         100
Description = MARK UP (PROFIT)                  Unit =       LS   Takeoff Quan:    1.000     Engr Quan:      1.000

11098005     MARK UP (PROFIT)               Quan:    1.00 LS  Hrs/Shft: 10.00  Cal 10   WCNONE

CONTRACTOR MARK UP OF 10% OF CONTRACTOR COSTS
3PROFIT      CONTRACTOR PRO  1.00       1.00  LS    228,350.000              228,350                       228,350
                                                               _____________________________________________________
=====> Item Totals:     980      - MARK UP (PROFIT)
$228,350.00                                            [ ]                   228,350                       228,350
228,350.000                 1 LS                                          228,350.00                    228,350.00
____________________________________________________________________________________________________________________
```

Direct Cost Report

BID ITEM = 980 Land Item SCHEDULE: 1 100
Description = MARK UP (PROFIT) Unit = LS Takeoff Quan: 1.000 Engr Quan: 1.000

Activity Resource	Desc	Quantity Pcs	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub- Contrac	Total
$3,098,684.49	*** Report Totals ***	688.00	MH		45,309	778,225	670,101	21,064	1,583,986	3,098,684

>>> indicates Non Additive Activity
------Report Notes:------
The estimate was prepared with TAKEOFF Quantities.
This report shows TAKEOFF Quantities with the resources.

"Unreviewed" Activities are marked.

Bid Date: Owner: Engineering Firm:
Estimator-In-Charge:

JOB NOTES

```
Estimate created on: 07/23/2014 by User#: 0 -
Source estimate used: C:\HEAVYBID\EST\ESTMAST
Labor Setup copied from: C:\HEAVYBID\EST\2014-710
Equipment Setup copied from: C:\HEAVYBID\EST\2014-710
Crew Setup copied from: C:\HEAVYBID\EST\2014-710
Material/Other Resources Setup copied from: C:\HEAVYBID\EST\2013-107
Overtime Rules Setup copied from: C:\HEAVYBID\EST\2014-710
Burden Tables Setup copied from: C:\HEAVYBID\EST\2014-710

************Estimate created on: 07/30/2014 by User#: 0 -
Source estimate used: C:\HEAVYBID\EST\2014-070
```

* on units of MH indicate average labor unit cost was used rather than base rate.
[ ] in the Unit Cost Column = Labor Unit Cost Without Labor Burdens

In equipment resources, rent % and EOE % not = 100% are represented as XXX%YYY where XXX=Rent% and YYY=EOE%

------Calendar Codes------

10	10 HOUR SHIFT (Default Calendar)
8	8 HOUR SHIFT
9	9 HOUR SHIFT

07/31/2014 16:06
2014-072 PALMER LF OPTION#2 SEPTAGE LEACHATE-ROM
***

BID TOTALS

Biditem	Description	Status - Rnd	Quantity	Units	Unit Price	Bid Total
10	MOBILIZATION		1.000	LS	800,000.00	800,000.00
20	BONDS & INSURANCE		1.000	LS	2.00	2.00
25	ENGINEERING DESIGN		1.000	LS	157,262.80	157,262.80
30	SUBMITTALS		1.000	LS	23,996.65	23,996.65
40	PERMITS		1.000	LS	67,500.00	67,500.00
50	SURVEY		1.000	LS	9,900.00	9,900.00
80	FENCING		1.000	LS	153,800.00	153,800.00
85	LEACHATE EQUALIZATION LAGOON		1.000	LS	84,141.84	84,141.84
87	PUMP STA LAGOON TO PLANT		1.000	LS	35,000.00	35,000.00
90	SBR BUILDING FOUNDATION		1.000	LS	960,000.00	960,000.00
100	SBR BUILDING		1.000	LS	5,250,000.00	5,250,000.00
110	UTILITIES-OUTSIDE BUILDING		1.000	LS	60,000.00	60,000.00
120	UTILITIES - INSIDE BUILDING		1.000	LS	100,000.00	100,000.00
130	PURCHASE SBR PLANT EQUIPMENT		1.000	LS	825,000.00	825,000.00
135	INSTALL SBR EQUIPMENT		1.000	LS	165,000.00	165,000.00
137	PRETREATMENT BUILDING		1.000	LS	273,400.00	273,400.00
138	PURCHASE PRETREATMENT EQUIPMENT		1.000	LS	3,505,500.00	3,505,500.00
140	INSTALL PRETREATMENT PLANT EQUIPMENT		1.000	LS	701,100.00	701,100.00
142	CENTRIFUGES		2.000	EA	162,000.00	324,000.00
150	INSIDE PIPING		1.000	LS	155,000.00	155,000.00
160	ELECTRICAL & NEW SUB STATION		1.000	LS	237,500.00	237,500.00
165	NATURAL GAS LINE		2,500.000	LF	30.00	75,000.00
170	INSTRUMENTS & CONTRLS		1.000	LS	50,000.00	50,000.00
180	LEACHATE EQUALIZATION LAGOON		750,000.000	GL	0.11	82,500.00
190	LEACH FIELD		10,000.000	SF	6.08	60,800.00
195	2" GW MONITOR WELL		4.000	EA	2,500.00	10,000.00
600	DEMOBILIZATION		1.000	LS	700,000.00	700,000.00
910	CONTRACTOR OVERHEAD(GENERAL CONDITIONS)		1.000	LS	622,428.00	622,428.00
920	CH OVERHEAD (GENERAL CONDITIONS)		1.000	LS	518,690.00	518,690.00
930	MANAGEMENT RESERVE (CONTINGENCY)		1.000	LS	1,556,070.00	1,556,070.00
970	TAXES		1.000	LS	526,958.00	526,958.00
980	MARK UP (PROFIT)		1.000	LS	1,037,380.00	1,037,380.00
			Bid Total	========>		$19,127,929.29

```
Activity        Desc                   Quantity              Unit          Perm    Constr    Equip    Sub-
   Resource                        Pcs          Unit         Cost   Labor  Materi  Matl/Ex    MentContrac      Total
______________________________________________________________________________________________________________________

BID ITEM =     10                                 Land Item    SCHEDULE:   1          100
Description = MOBILIZATION                            Unit =    LS    Takeoff Quan:    1.000     Engr Quan:    1.000

19001005      MOBILIZATION                           Quan:    1.00  LS   Hrs/Shft: 10.00  Cal 10   WCNONE

4MOB          MOBILIZATION       1.00       1.00  LS           800,000.000                        800,000  800,000
______________________________________________________________________________________________________________________

BID ITEM =     20                                 Land Item    SCHEDULE:   1          100
Description = BONDS & INSURANCE                       Unit =    LS    Takeoff Quan:    1.000     Engr Quan:    1.000

11002005      BONDS                                  Quan:    1.00  LS   Hrs/Shft: 10.00  Cal 10   WCNONE

BONDS 1.7% X $17,562,652 = $298,565
3BOND         BOND COST          1.00       1.00  LS              1.000                    1                     1

11002010      INSURANCE                              Quan:    1.00  LS   Hrs/Shft: 10.00  Cal 10   WCNONE

INSURANCE 0.8% X $17,562,652 = $140,501
3INSURANC     INSURANCE COST     1.00       1.00  LS              1.000                    1                     1
                                                                  _____________________________________________
=====> Item Totals:     20      - BONDS & INSURANCE
$2.00                                                               [ ]                    2                     2
2.000                          1 LS                                                     2.00                  2.00
______________________________________________________________________________________________________________________

BID ITEM =     25                                 Land Item    SCHEDULE:   1          100
Description = ENGINEERING DESIGN                      Unit =    LS    Takeoff Quan:    1.000     Engr Quan:    1.000

11002505      CH ENGINEERING DESIGN                  Quan:    1.00  LS   Hrs/Shft: 10.00  Cal 10   WCNONE

3DOCCOSTS     DOCUMENT COST      1.00       1.00  LS          4,000.000                4,000                 4,000
X414          ==> Project Eng    1.00     800.00  MH             72.700   80,261                            80,261
X418          ==> Engineering Mgr 1.00    400.00  MH             52.900   29,201                            29,201
X422          ==> Staff Enginer  1.00     600.00  MH             52.900   43,801                            43,801
$157,262.80      1,800.0000  MH/LS    1,800.00  MH          [ 111060 ] 153,263             4,000               157,263
                                      0.0006  Unit/M                  153,262.80          4,000.00           157,262.80
                                                                  _____________________________________________
=====> Item Totals:     25      - ENGINEERING DESIGN
$157,262.80  1,800.0000  MH/LS        1,800.00  MH          [ 111060 ] 153,263             4,000               157,263
157,262.800                    1 LS                                   153,262.80          4,000.00           157,262.80
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Activity        Desc                Quantity          Unit          Perm   Constr    Equip    Sub-
   Resource                      Pcs         Unit     Cost   Labor  Materi  Matl/Ex    Ment Contrac     Total

BID ITEM =     30                          Land Item    SCHEDULE:   1          100
Description = SUBMITTALS                      Unit =    LS   Takeoff Quan:     1.000    Engr Quan:     1.000

11003005     WORK PLAN                                 Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

 11030       SUBMITTALS                   16.00  CH       Prod:  0.0625 UH  Lab Pcs:  3.10    Eqp Pcs:  0.00
3DOCMTRL     DOCUMENT MATE 1.00     1.00 LS      200.000                    200                        200
X414         Project Eng      E6  1.00    16.00 MH       72.700  1,605                                     1,605
X430         Project Controls E 4 0.20     3.20 MH       52.900    234                                       234
X434         Cost/Schedule  E3    0.20     3.20 MH       43.800    193                                       193
X442         Document  Tech T2    0.10     1.60 MH       24.900     55                                        55
X450         Field Engineer   T4  0.20     3.20 MH       39.800    176                                       176
X462         Quality  Mngr   E4   0.20     3.20 MH       52.900    234                                       234
X866         Admin Assist.  T1    1.00    16.00 MH       22.900    506                                       506
X918         Safety Engineer  E3  0.20     3.20 MH       43.900    194                                       194
$3,396.09          49.6000 MH/LS          49.60 MH      [ 2316 ]   3,196                200                3,396
  0.0625  Units/Hr *   0.6250 Un/Shift   0.0202 Unit/M           3,196.09             200.00           3,396.09

11003010     PROJECT SCHEDULE                          Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

 11030       SUBMITTALS                   24.00  CH       Prod:  0.0417 UH  Lab Pcs:  1.85    Eqp Pcs:  0.00
3DOCMTRL     DOCUMENT MATE 1.00     1.00 LS      350.000                    350                        350
X414         Project Eng      E6  0.15     3.60 MH       72.700    361                                       361
X430         Project Controls E 4 0.10     2.40 MH       52.900    175                                       175
X434         Cost/Schedule  E3    1.00    24.00 MH       43.800  1,451                                     1,451
X442         Document  Tech T2    0.10     2.40 MH       24.900     82                                        82
X866         Admin Assist.  T1    0.50    12.00 MH       22.900    379                                       379
$2,798.72          44.4000 MH/LS          44.40 MH   [ 1774.44 ]   2,449                350                2,799
  0.0417  Units/Hr *   0.4167 Un/Shift   0.0225 Unit/M           2,448.72             350.00           2,798.72

11003015     SWPPP                                     Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

FOR ALL SUBMITTALS ASSUME A DRAFT A DRAFT FINAL AND A FINAL FOR MOST SUBMITTALS
 11020       PLAN/DOC CREW                 1.00  CH       Prod:  1.0000 UH  Lab Pcs: 68.00    Eqp Pcs:  0.00
3DOCMTRL     DOCUMENT MATE 1.00     1.00 LS      750.000                    750                        750
AAA          *********LABOR**       0.00 MH        0.000
X274         Adminst Asst.    T2 18.00    18.00 MH       24.900    619                                       619
X414         Project Eng      E6 32.00    32.00 MH       72.700  3,210                                     3,210
X426         Jr Staff Eng    E3  18.00    18.00 MH       43.800  1,088                                     1,088
$5,666.94          68.0000 MH/LS          68.00 MH      [ 3563 ]   4,917                750                5,667
  1.0000  Units/Hr *  10.0000 Un/Shift   0.0147 Unit/M           4,916.94             750.00           5,666.94

11003020     HASP                                      Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

 11020       PLAN/DOC CREW                 1.00  CH       Prod:  1.0000 UH  Lab Pcs: 58.00    Eqp Pcs:  0.00
3DOCMTRL     DOCUMENT MATE 1.00     1.00 LS      950.000                    950                        950
AAA          *********LABOR**       0.00 MH        0.000
X274         Adminst Asst.    T2 20.00    20.00 MH       24.900    687                                       687
```

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Activity        Desc                  Quantity              Unit          Perm   Constr    Equip   Sub-
   Resource                      Pcs          Unit          Cost   Labor  Materi MatI/Ex    MentContrac      Total

BID ITEM =      30                                 Land Item     SCHEDULE:    1          100
Description = SUBMITTALS                              Unit =       LS    Takeoff Quan:     1.000      Engr Quan:    1.000

X414          Project Eng      E6   10.00     10.00  MH            72.700    1,003                                   1,003
X426          Jr Staff Eng     E3    8.00      8.00  MH            43.800      484                                     484
X918          Safety Engineer  E3   20.00     20.00  MH            43.900    1,212                                   1,212
$4,335.69              58.0000  MH/LS        58.00  MH        [ 2453.4 ]    3,386                950                  4,336
  1.0000   Units/Hr *  10.0000  Un/Shift    0.0172  Unit/M                3,385.69             950.00               4,335.69

11003025      QA/QC PLAN                              Quan:    1.00  LS   Hrs/Shft: 10.00  Cal 10   WCNONE

 11020        PLAN/DOC CREW                     1.00   CH        Prod:   1.0000  UH   Lab Pcs: 56.00   Eqp Pcs:  0.00
3DOCMTRL      DOCUMENT MATE  1.00      1.00  LS           700.000                        700                    700
AAA           *********LABOR**         0.00  MH             0.000
X274          Adminst Asst.    T2   20.00     20.00  MH            24.900      687                                     687
X414          Project Eng      E6   12.00     12.00  MH            72.700    1,204                                   1,204
X462          Quality  Mngr    E4   24.00     24.00  MH            52.900    1,752                                   1,752
$4,343.20              56.0000  MH/LS        56.00  MH          [ 2640 ]    3,643                700                  4,343
  1.0000   Units/Hr *  10.0000  Un/Shift    0.0179  Unit/M                3,643.20             700.00               4,343.20

11003030      TRAFFIC PLAN                            Quan:    1.00  LS   Hrs/Shft: 10.00  Cal 10   WCNONE

 11020        PLAN/DOC CREW                     1.00   CH        Prod:   1.0000  UH   Lab Pcs: 52.00   Eqp Pcs:  0.00
3DOCMTRL      DOCUMENT MATE  1.00      1.00  LS           250.000                        250                    250
AAA           *********LABOR**         0.00  MH             0.000
X274          Adminst Asst.    T2   16.00     16.00  MH            24.900      550                                     550
X414          Project Eng      E6   12.00     12.00  MH            72.700    1,204                                   1,204
X426          Jr Staff Eng     E3   12.00     12.00  MH            43.800      725                                     725
X918          Safety Engineer  E3   12.00     12.00  MH            43.900      727                                     727
$3,456.01              52.0000  MH/LS        52.00  MH        [ 2323.2 ]    3,206                250                  3,456
  1.0000   Units/Hr *  10.0000  Un/Shift    0.0192  Unit/M                3,206.01             250.00               3,456.01

=====> Item Totals:      30       - SUBMITTALS
$23,996.65      328.0000  MH/LS          328.00  MH     [ 15070.04 ]   20,797              3,200                 23,997
23,996.650                   1 LS                                     20,796.65           3,200.00              23,996.65

BID ITEM =      40                                 Land Item     SCHEDULE:    1          100
Description = PERMITS                                 Unit =       LS    Takeoff Quan:     1.000      Engr Quan:    1.000

11004005      MSB BUILDING PERMIT                     Quan:    1.00  LS   Hrs/Shft: 10.00  Cal 10   WCNONE
                                                                                                       **Unreviewed
3MSBBLDPR MSB BUILDING PE  1.00      1.00  LS        60,000.000                    60,000                 60,000

11004010      DUST PERMIT                             Quan:    1.00  LS   Hrs/Shft: 10.00  Cal 10   WCNONE

3DUSTPRM      DUST PERMIT      1.00      1.00  LS         7,500.000                     7,500                  7,500
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Activity      Desc                   Quantity             Unit          Perm    Constr   Equip    Sub-
   Resource                       Pcs          Unit          Cost   Labor  Materi  Matl/Ex   Ment Contrac      Total
=====================================================================================================================

BID ITEM =     40                                  Land Item   SCHEDULE:   1          100
Description = PERMITS                                 Unit =   LS   Takeoff Quan:    1.000    Engr Quan:    1.000

=====> Item Totals:    40      - PERMITS
$67,500.00                                                     [ ]                  67,500                 67,500
67,500.000                  1 LS                                                 67,500.00              67,500.00
---------------------------------------------------------------------------------------------------------------------

BID ITEM =     50                                  Land Item   SCHEDULE:   1          100
Description = SURVEY                                  Unit =   LS   Takeoff Quan:    1.000    Engr Quan:    1.000

11005005     SURVEY                                Quan:    1.00 LS  Hrs/Shft: 10.00  Cal 10  WCNONE

THIS WOULD INCLUDE LAYOUT OF BUILDING , EQUALIZATION POND , ACCESS ROAD AND
UTILITIES . ALSO EARTHWORK QUANTITIES AND FINAL AS BUILT DRAWAINGS
4SURVEY      SURVEY SUB        1.00      90.00 HR         110.000                                     9,900     9,900
---------------------------------------------------------------------------------------------------------------------

BID ITEM =     80                                  Land Item   SCHEDULE:   1          100
Description = FENCING                                 Unit =   LS   Takeoff Quan:    1.000    Engr Quan:    1.000

19008005     CL FENCE                              Quan: 5,200.00 LF  Hrs/Shft: 10.00  Cal 10  WCNONE

4FENCE       Fencing - Sub     1.00  5,200.00 LF           29.000                                   150,800   150,800

19008010     GATES - MAN                           Quan:    4.00 EA  Hrs/Shft: 10.00  Cal 10  WCNONE

4FENCE       Fencing - Sub     1.00      4.00 EA          300.000                                     1,200     1,200

19008015     GATES VEHICLE                         Quan:    2.00 EA  Hrs/Shft: 10.00  Cal 10  WCNONE

4FENCE       Fencing - Sub     1.00      2.00 EA          900.000                                     1,800     1,800
                                                                 ------------------------------------------------
=====> Item Totals:    80      - FENCING
$153,800.00                                                    [ ]                                  153,800   153,800
153,800.000                 1 LS                                                                 153,800.00 153,800.00
---------------------------------------------------------------------------------------------------------------------

BID ITEM =     85                                  Land Item   SCHEDULE:   1          100
Description = LEACHATE EQUALIZATION LAGOON            Unit =   LS   Takeoff Quan:    1.000    Engr Quan:    1.000

19085005     EXCAVATE LAGOON                       Quan: 4,830.00 CY  Hrs/Shft: 10.00  Cal 10  WCNONE
                                                                                                    **Unreviewed
 19015       SMALL EXCAV CREW               60.00  CH      Prod:  80.5000 UH  Lab Pcs:  6.00   Eqp Pcs:  4.00
3GRDST&S     GRADING ST&S      1.00    360.00 HM            2.000                  720                       720
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Activity        Desc                  Quantity            Unit           Perm   Constr   Equip    Sub-
   Resource                       Pcs          Unit        Cost   Labor  Materi  Matl/Ex   Ment Contrac     Total

BID ITEM =     85                                  Land Item    SCHEDULE:   1          100
Description = LEACHATE EQUALIZATION LAGOON           Unit =     LS   Takeoff Quan:    1.000     Engr Quan:    1.000

3PPE          PPE                  1.00   360.00 HM         2.500                     900                       900
8AAAA         *******EQUIPMEN               0.00 HR         0.000
8EXC330       Excavator Cat 330D L 1.00    60.00 HR       188.085                            11,285          11,285
8TRKHW10      Tandem Truck 12 CY   2.00   120.00 HR        73.856                             8,863           8,863
8TRKPU15      Pickup 4x4 3/4 Ton G 1.00    60.00 HR        15.264                               916             916
AAA           *********LABOR**              0.00 MH         0.000
LA30          Laborer General      1.00    60.00 MH        29.210   3,614                                     3,614
OP01F         Oper Foreman         1.00    60.00 MH        42.040   4,495                                     4,495
OPH14         Oper Hydr Backhoe 3  1.00    60.00 MH        39.280   4,280                                     4,280
OPSPT14       Oper Grade Checker   1.00    60.00 MH        37.790   4,164                                     4,164
TE22          Tmstr Dmp Trk 6-14c  2.00   120.00 MH        36.790   7,959                                     7,959
$47,195.84           0.0745  MH/CY        360.00 MH      [ 3.032 ] 24,512                   1,620  21,064          47,196
 80.5000  Units/Hr *  805.0000  Un/Shift  13.4167 Unit/M              5.07                    0.34    4.36            9.77

19085010      INSTALL HDPE LINER                        Quan: 25,480.00 SF   Hrs/Shft: 10.00   Cal 10   WC NONE
                                                                                                        **Unreviewed
4LINER        LINER SUB            1.00 25,480.00 SF        1.450                                      36,946  36,946
                                                          ____________________________________________________________
=====> Item Totals:      85       -  LEACHATE EQUALIZATION LAGOON
$84,141.84        360.0000  MH/LS        360.00 MH     [ 14645.4 ] 24,512                   1,620  21,064  36,946  84,142
84,141.840                    1 LS                               24,512.18              1,620.00 21,063.66 36,946.00 84,141.84
______________________________________________________________________________________________________________

BID ITEM =     87                                  Land Item    SCHEDULE:   1          100
Description = PUMP STA LAGOON TO PLANT               Unit =     LS   Takeoff Quan:    1.000     Engr Quan:    1.000

19008705      PUMP STA LAGOON TO PLANT                  Quan:      1.00 LS   Hrs/Shft: 10.00   Cal 10   WC NONE
                                                                                                        **Unreviewed
THIS INCLUDES PUMP,PAD,INTAKE PIPE POWER TO PUMP AND DISCHARGE LINE TO PLANT
4MECH         INSTALLATION SU      1.00     1.00 LS    35,000.000                                      35,000  35,000
______________________________________________________________________________________________________________

BID ITEM =     90                                  Land Item    SCHEDULE:   1          100
Description = SBR BUILDING FOUNDATION                Unit =     LS   Takeoff Quan:    1.000     Engr Quan:    1.000

51009005      SBR BUILDING FOUNDATION & SLAB            Quan: 30,000.00 SF   Hrs/Shft: 10.00   Cal 10   WC NONE

BUILDING FOUNDATION WILL BE 200LF X 150LF = 30,000 SF
4CONC         Concrete - Sub       1.00 30,000.00 SF       32.000                                     960,000 960,000
______________________________________________________________________________________________________________
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Activity      Desc                    Quantity           Unit            Perm   Constr   Equip    Sub-
   Resource                     Pcs            Unit       Cost    Labor  Materi Matl/Ex   Ment Contrac      Total
--------------------------------------------------------------------------------------------------------------------

BID ITEM =     100                                Land Item    SCHEDULE:   1          100
Description = SBR BUILDING                            Unit =     LS   Takeoff Quan:    1.000     Engr Quan:    1.000

60010005      SBR BUILDING STRUCTURE              Quan: 30,000.00 SF   Hrs/Shft: 10.00  Cal 10   WC NONE

4BLDG         Building - Sub          1.00 30,000.00 SF        175.000                            5,250,000 5,250,000
--------------------------------------------------------------------------------------------------------------------

BID ITEM =     110                                Land Item    SCHEDULE:   1          100
Description = UTILITIES-OUTSIDE BUILDING              Unit =     LS   Takeoff Quan:    1.000     Engr Quan:    1.000

60011005      UTILITIES-OUTSIDE BUILDING          Quan:     1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

4UTIL         UTILLITY SUB            1.00      1.00 LS      60,000.000                              60,000    60,000
--------------------------------------------------------------------------------------------------------------------

BID ITEM =     120                                Land Item    SCHEDULE:   1          100
Description = UTILITIES - INSIDE BUILDING             Unit =     LS   Takeoff Quan:    1.000     Engr Quan:    1.000

60012005      UTILITIES - INSIDE BUILDING         Quan:     1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

4UTIL         UTILLITY SUB            1.00      1.00 LS     100,000.000                             100,000   100,000
--------------------------------------------------------------------------------------------------------------------

BID ITEM =     130                                Land Item    SCHEDULE:   1          100
Description = PURCHASE SBR PLANT EQUIPMENT            Unit =     LS   Takeoff Quan:    1.000     Engr Quan:    1.000

30013005      PURCHASE  SBR SYSTEM                Quan:     1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

THIS IS VENDOR QUOTE FOR SBR  AND SUPPORT EQUIPMENT
2EVOQUASB EVOQUA SBR SYS      1.00      1.00 LS     825,000.000        825,000                                825,000
                                                              ----------------------------------------------------
=====> Item Totals:     130      - PURCHASE SBR PLANT EQUIPMENT
$825,000.00                                                  [ ]       825,000                                825,000
825,000.000                    1 LS                                 825,000.00                             825,000.00
--------------------------------------------------------------------------------------------------------------------

BID ITEM =     135                                Land Item    SCHEDULE:   1          100
Description = INSTALL SBR EQUIPMENT                   Unit =     LS   Takeoff Quan:    1.000     Engr Quan:    1.000

13013505      INSTALL SBR EQUIPMENT               Quan:     1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE
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Activity        Desc                 Quantity              Unit          Perm   Constr    Equip    Sub-
   Resource                      Pcs          Unit          Cost   Labor Materi  Matl/Ex   Ment Contrac     Total
-------------------------------------------------------------------------------------------------------------------

BID ITEM =    135                          Land Item   SCHEDULE:   1        100
Description = INSTALL SBR EQUIPMENT            Unit =    LS   Takeoff Quan:    1.000      Engr Quan:    1.000

ASSUME COST OF INSTALLATION AT 20% OF EQUIPMENT COST ($825,000) = $165,000
4MECH        INSTALLATION SU 1.00     1.00 LS     165,000.000                                    165,000 165,000
-------------------------------------------------------------------------------------------------------------------

BID ITEM =    137                          Land Item   SCHEDULE:   1        100
Description = PRETREATMENT BUILDING            Unit =    LS   Takeoff Quan:    1.000      Engr Quan:    1.000

13013705     PRETREATMENT BUILDING CIP       Quan:    1.00 LS  Hrs/Shft: 10.00  Cal 10  WC NONE

4BLDG        Building - Sub  1.00     1.00 LS     273,400.000                                    273,400 273,400
-------------------------------------------------------------------------------------------------------------------

BID ITEM =    138                          Land Item   SCHEDULE:   1        100
Description = PURCHASE PRETREATMENT EQUIPMENT Unit =    LS   Takeoff Quan:    1.000      Engr Quan:    1.000

13013805     PURCHASE PRETREATMENT EQUIPM    Quan:    1.00 LS  Hrs/Shft: 10.00  Cal 10  WC NONE

2PRTEQP      PRETREATMENT E  1.00     1.00 LS   3,505,500.000      3,505,500                           3,505,500
                                                               -------------------------------------------------
=====> Item Totals:    138     - PURCHASE PRETREATMENT EQUIPMENT
$3,505,500.00                                            [ ]       3,505,500                           3,505,500
3,505,500.000               1 LS                               3,505,500.00                         3,505,500.00
-------------------------------------------------------------------------------------------------------------------

BID ITEM =    140                          Land Item   SCHEDULE:   1        100
Description = INSTALL PRETREATMENT PLANT EQUIP Unit =    LS   Takeoff Quan:    1.000      Engr Quan:    1.000

30014005     INSTALL EQUIPMENT               Quan:    1.00 LS  Hrs/Shft: 10.00  Cal 10  WC NONE

ASSUMES COST OF INSTALLATION 20% OF EQUIPMENT COST  ($3,505500)=$701,100
4MECH        INSTALLATION SU 1.00     1.00 LS     701,100.000                                    701,100 701,100
-------------------------------------------------------------------------------------------------------------------

BID ITEM =    142                          Land Item   SCHEDULE:   1        100
Description =  CENTRIFUGES                     Unit =    EA   Takeoff Quan:    2.000      Engr Quan:    2.000

11014205     FURNISH & INSTALL CENTRIFUGES   Quan:    2.00 EA  Hrs/Shft: 10.00  Cal 10  WC NONE

2CNTRAFG     CENTRIFUGE      1.00     2.00 EA     162,000.000        324,000                             324,000
                                                               -------------------------------------------------
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Activity        Desc                   Quantity              Unit              Perm   Constr    Equip    Sub-
   Resource                         Pcs         Unit          Cost    Labor  Materi  Matl/Ex    Ment  Contrac      Total
------------------------------------------------------------------------------------------------------------------------

BID ITEM =     142                                   Land Item    SCHEDULE:   1         100
Description =  CENTRIFUGES                              Unit =    EA   Takeoff Quan:    2.000     Engr Quan:      2.000

=====> Item Totals:     142      -   CENTRIFUGES
$324,000.00                                                    [ ]           324,000                          324,000
162,000.000                   2 EA                                        162,000.00                       162,000.00
------------------------------------------------------------------------------------------------------------------------

BID ITEM =     150                                   Land Item    SCHEDULE:   1         100
Description = INSIDE PIPING                             Unit =    LS   Takeoff Quan:    1.000     Engr Quan:      1.000

30015005       INSIDE PIPING                          Quan:    1.00 LS   Hrs/Shft: 10.00   Cal 10   WC NONE

ASSUME COST OF 1% OF EQUIPMENT COST
4MECH          INSTALLATION SU 1.00      1.00 LS       155,000.000                             155,000 155,000
------------------------------------------------------------------------------------------------------------------------

BID ITEM =     160                                   Land Item    SCHEDULE:   1         100
Description = ELECTRICAL & NEW SUB STATION              Unit =    LS   Takeoff Quan:    1.000     Engr Quan:      1.000

30016005       SUB STATION                            Quan:    1.00 LS   Hrs/Shft: 10.00   Cal 10   WC NONE

4ELECT         ELECTRICAL SUB  1.00      1.00 LS       150,000.000                             150,000 150,000

30016010       OH POWER LINE                          Quan: 2,500.00 LF  Hrs/Shft: 10.00   Cal 10   WC NONE

4ELEC          Electric - Sub     1.00  2,500.00 LF         35.000                              87,500  87,500
                                                               ---------------------------------------------------------
=====> Item Totals:     160      - ELECTRICAL & NEW SUB STATION
$237,500.00                                                    [ ]                             237,500 237,500
237,500.000                   1 LS                                                          237,500.00 237,500.00
------------------------------------------------------------------------------------------------------------------------

BID ITEM =     165                                   Land Item    SCHEDULE:   1         100
Description = NATURAL GAS LINE                          Unit =    LF   Takeoff Quan: 2,500.000    Engr Quan:  2,500.000

30016505       NATURAL GAS LINE                       Quan: 2,500.00 LF  Hrs/Shft: 10.00   Cal 10   WC NONE

4GAS           NATURAL GAS LIN 1.00  2,500.00 LF            30.000                              75,000  75,000
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BID ITEM =     170                                   Land Item    SCHEDULE:   1         100
Description = INSTRUMENTS & CONTRLS                     Unit =    LS   Takeoff Quan:    1.000     Engr Quan:      1.000
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Activity       Desc                 Quantity              Unit          Perm   Constr   Equip    Sub-
   Resource                       Pcs        Unit         Cost   Labor Materi  Matl/Ex   Ment Contrac    Total
_____________________________________________________________________________________________________________

BID ITEM =     170                              Land Item    SCHEDULE:   1          100
Description = INSTRUMENTS & CONTRLS               Unit =     LS  Takeoff Quan:    1.000   Engr Quan:     1.000

30017005       INSTRUMENTS & CONTRLS              Quan:    1.00 LS  Hrs/Shft: 10.00  Cal 10  WCNONE

4ELEC          Electric - Sub      1.00      1.00 LS    50,000.000                              50,000   50,000
_____________________________________________________________________________________________________________


BID ITEM =     180                              Land Item    SCHEDULE:   1          100
Description = LEACHATE EQUALIZATION LAGOON        Unit =     GL  Takeoff Quan: 750,000.000  Engr Quan: 750,000.000

19018005       EXCAVATE LAGOON                    Quan: 4,830.00 CY  Hrs/Shft: 10.00  Cal 10  WCNONE

 19015         SMALL EXCAV CREW              60.00  CH       Prod:  80.5000 UH  Lab Pcs:  6.00    Eqp Pcs:  4.00
3GRDST&S       GRADING ST&S        1.00    360.00 HM         2.000                    720                   720
3PPE           PPE                 1.00    360.00 HM         2.500                    900                   900
8AAAA          *******EQUIPMEN               0.00 HR         0.000
8EXC330        Excavator Cat 330D L 1.00    60.00 HR       188.085                          11,285       11,285
8TRKHW10       Tandem Truck 12 CY  2.00    120.00 HR        73.856                           8,863        8,863
8TRKPU15       Pickup 4x4 3/4 Ton G 1.00    60.00 HR        15.264                             916          916
AAA            *********LABOR**              0.00 MH         0.000
LA30           Laborer General     1.00     60.00 MH        29.210   3,614                                3,614
OP01F          Oper Foreman        1.00     60.00 MH        42.040   4,495                                4,495
OPH14          Oper Hydr Backhoe 3 1.00     60.00 MH        39.280   4,280                                4,280
OPSPT14        Oper Grade Checker  1.00     60.00 MH        37.790   4,164                                4,164
TE22           Tmstr Dmp Trk 6-14c 2.00    120.00 MH        36.790   7,959                                7,959
$47,195.84           0.0745  MH/CY         360.00 MH      [ 3.032 ] 24,512          1,620   21,064       47,196
 80.5000  Units/Hr *  805.0000 Un/Shift  13.4167 Unit/M              5.07           0.34     4.36         9.77

19018010       INSTALL HDPE LINER                 Quan: 25,480.00 SF  Hrs/Shft: 10.00  Cal 10  WCNONE

4LINER         LINER SUB           1.00 25,480.00 SF         1.450                              36,946   36,946
                                                                   ___________________________________________
=====> Item Totals:      180      - LEACHATE EQUALIZATION LAGOON
$84,141.84           0.0004  MH/GL         360.00 MH       [ 0.02 ] 24,512          1,620   21,064  36,946   84,142
0.112                            750000 GL                           0.03                     0.03    0.05     0.11
_____________________________________________________________________________________________________________


BID ITEM =     190                              Land Item    SCHEDULE:   1          100
Description = LEACH FIELD                         Unit =     SF  Takeoff Quan: 10,000.000  Engr Quan: 10,000.000

19019005       EXCAVATE LEACH FIELD               Quan: 750.00 CY  Hrs/Shft: 10.00  Cal 10  WCNONE

 19015         SMALL EXCAV CREW              12.00  CH       Prod:  62.5000 UH  Lab Pcs:  6.00    Eqp Pcs:  4.00
3GRDST&S       GRADING ST&S        1.00     72.00 HM         2.000                    144                   144
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Activity        Desc                  Quantity            Unit          Perm    Constr    Equip     Sub-
   Resource                        Pcs          Unit      Cost   Labor  Materi  Matl/Ex    Ment  Contrac      Total
--------------------------------------------------------------------------------------------------------------------

BID ITEM =     190                                Land Item    SCHEDULE:    1           100
Description = LEACH FIELD                            Unit =      SF   Takeoff Quan: 10,000.000    Engr Quan: 10,000.000

3PPE          PPE                    1.00     72.00 HM         2.500                     180                     180
8AAAA         *******EQUIPMEN                  0.00 HR         0.000
8EXC330       Excavator Cat 330D L   1.00     12.00 HR       188.085                           2,257           2,257
8TRKHW10      Tandem Truck 12 CY     2.00     24.00 HR        73.856                           1,773           1,773
8TRKPU15      Pickup 4x4 3/4 Ton G   1.00     12.00 HR        15.264                             183             183
AAA           *********LABOR**                 0.00 MH         0.000
LA30          Laborer General        1.00     12.00 MH        29.210     723                                     723
OP01F         Oper Foreman           1.00     12.00 MH        42.040     899                                     899
OPH14         Oper Hydr Backhoe 3    1.00     12.00 MH        39.280     856                                     856
OPSPT14       Oper Grade Checker     1.00     12.00 MH        37.790     833                                     833
TE22          Tmstr Dmp Trk 6-14c    2.00     24.00 MH        36.790   1,592                                   1,592
$9,439.14              0.0960 MH/CY           72.00 MH      [ 3.905 ]  4,902             324   4,213           9,439
 62.5000  Units/Hr *  625.0000 Un/Shift     10.4167 Unit/M              6.54            0.43    5.62           12.59

19019010      SET TANK AND LINES & GRAVEL & C  Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

 13010        SMALL SWPP CREW                   16.00  CH       Prod:   0.0625 UH  Lab Pcs:  5.00    Eqp Pcs:  3.00
2DRNGRVLD     GRAVEL DRAIN FO        1.00    555.00 TN        18.200          10,101                          10,101
2PVCPP4       PVC PERF PIPE 4"       1.00  2,700.00 LF         8.200          22,140                          22,140
2SEPBOX5M     TANK 5000 GAL          1.00      1.00 LS    12,400.000          12,400                          12,400
3GRDST&S      GRADING ST&S           1.00     80.00 HM         2.000                     160                     160
3PPE          PPE                    1.00     80.00 HM         2.500                     200                     200
8AAAA         *******EQUIPMEN                  0.00 HR         0.000
8BHLD416      BHL Cat 416E 1CY       1.00     16.00 HR        39.398                             630             630
8TRKGS10      Flatbed Truck 15K 20   1.00     16.00 HR        25.297                             405             405
8TRKPU10      Pickup 4x2 3/4 Ton G   1.00     16.00 HR        13.322                             213             213
AAA           *********LABOR**                 0.00 MH         0.000
LA01F         Laborer Foreman        1.00     16.00 MH        36.260   1,110                                   1,110
LA30          Laborer General        3.00     48.00 MH        29.210   2,891                                   2,891
OPH14         Oper Hydr Backhoe 3    1.00     16.00 MH        39.280   1,141                                   1,141
$51,392.03            80.0000 MH/LS           80.00 MH     [ 2871.8 ]  5,143  44,641     360   1,248          51,392
   0.0625  Units/Hr *   0.6250 Un/Shift      0.0125 Unit/M          5,142.80 44,641.00 360.00 1,248.23       51,392.03

=====> Item Totals:      190      - LEACH FIELD
$60,831.17          0.0152 MH/SF             152.00 MH       [ 0.58 ] 10,045  44,641     684   5,461          60,831
6.083                          10000 SF                                 1.00    4.46    0.07    0.55            6.08
--------------------------------------------------------------------------------------------------------------------

BID ITEM =     195                                Land Item    SCHEDULE:    1           100
Description = 2" GW MONITOR WELL                     Unit =      EA   Takeoff Quan:    4.000    Engr Quan:    4.000

20019505      2" GW MONITOR WELL               Quan:    4.00 EA   Hrs/Shft: 10.00  Cal 10   WC NONE

4DRILL        WELL DRILLER           1.00      4.00 EA     2,500.000                                  10,000  10,000
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Activity         Desc                     Quantity              Unit          Perm   Constr   Equip   Sub-
   Resource                           Pcs          Unit         Cost   Labor  Materi Matl/Ex   Ment Contrac    Total

BID ITEM =    600                                  Land Item   SCHEDULE:   1        100
Description = DEMOBILIZATION                          Unit =   LS   Takeoff Quan:   1.000   Engr Quan:   1.000

19060005     DEMOBILIZATION                     Quan:   1.00 LS  Hrs/Shft: 10.00 Cal 10  WC NONE

4DEMOB       DEMOBILZATION  1.00     1.00 LS        700,000.000                                 700,000  700,000

BID ITEM =    910                                  Land Item   SCHEDULE:   1        100
Description = CONTRACTOR OVERHEAD(GENERAL CO Unit =    LS   Takeoff Quan:   1.000   Engr Quan:   1.000

11091005     CONTRACTOR OVERHEAD(GENERAL        Quan:   1.00 LS  Hrs/Shft: 10.00 Cal 10  WC NONE

6% OF DIRECT COT EXCLUDING EQUIPMENT PURCHASE ,BONDS&INSURANCE,CH
OVERSIGHT,MANAGEMENT RESERVE
4CNTROH      CONTRACTOR OH  1.00     1.00 LS        622,428.000                                 622,428  622,428

BID ITEM =    920                                  Land Item   SCHEDULE:   1        100
Description = CH OVERHEAD (GENERAL CONDITIONS) Unit =  LS   Takeoff Quan:   1.000   Engr Quan:   1.000

11092005     CH OVERHEAD (GENERAL CONDITIO      Quan:   1.00 LS  Hrs/Shft: 10.00 Cal 10  WC NONE

CH OVERSIGHT 5% OF COSTS EXCLUDING,BONDS&INSURANCE,PERMITS,EQUIPMENT
PURCHASE,CONTRACTOR OH,MANAGEMENT RESERVE AND MARK UP
4CH          CH OVERHEAD & P 1.00    1.00 LS        518,690.000                                 518,690  518,690

BID ITEM =    930                                  Land Item   SCHEDULE:   1        100
Description = MANAGEMENT RESERVE (CONTINGENC Unit =    LS   Takeoff Quan:   1.000   Engr Quan:   1.000

11093005     MANAGEMENT RESERVE (CONTINGE       Quan:   1.00 LS  Hrs/Shft: 10.00 Cal 10  WC NONE

MANAGEMENT RESERVE (CONTINGENCY) 15% OF DIRECT COSTS
4MR15        MANAGE MENT RE 1.00     1.00 LS      1,556,070.000                               1,556,070 1,556,070

BID ITEM =    970                                  Land Item   SCHEDULE:   1        100
Description = TAXES                                   Unit =   LS   Takeoff Quan:   1.000   Engr Quan:   1.000

11097005     TAXES (3% DIRECT COSTS)            Quan:   1.00 LS  Hrs/Shft: 10.00 Cal 10  WC NONE
```

Activity Resource	Desc	Quantity Pcs	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub- Contrac	Total

BID ITEM = 970 Land Item SCHEDULE: 1 100
Description = TAXES Unit = LS Takeoff Quan: 1.000 Engr Quan: 1.000

3TAXES	TAXES PALMER A	1.00	1.00 LS	526,958.000			526,958			526,958

=====> Item Totals: 970 - TAXES

$526,958.00				[ ]			526,958			526,958
526,958.000		1 LS					526,958.00			526,958.00

BID ITEM = 980 Land Item SCHEDULE: 1 100
Description = MARK UP (PROFIT) Unit = LS Takeoff Quan: 1.000 Engr Quan: 1.000

11098005 MARK UP (PROFIT) Quan: 1.00 LS Hrs/Shft: 10.00 Cal 10 WC NONE

CONTRACTOR MARK UP OF 10% OF CONTRACTOR COSTS

4PROFIT	CONTRACTOR PRO	1.00	1.00 LS	1,037,380.000					1,037,380	1,037,380

$19,129,602.30	*** Report Totals ***	3,000.00 MH			233,129	4,699,141	605,584	47,588	13,544,160	19,129,602

>>> indicates Non Additive Activity
------Report Notes:------
The estimate was prepared with TAKEOFF Quantities.
This report shows TAKEOFF Quantities with the resources.

"Unreviewed" Activities are marked.

Bid Date: Owner: Engineering Firm:
Estimator-In-Charge:

JOB NOTES

```
Estimate created on: 07/23/2014 by User#: 0 -
Source estimate used: C:\HEAVYBID\EST\ESTMAST
Labor Setup copied from: C:\HEAVYBID\EST\2014-710
Equipment Setup copied from: C:\HEAVYBID\EST\2014-710
Crew Setup copied from: C:\HEAVYBID\EST\2014-710
Material/Other Resources Setup copied from: C:\HEAVYBID\EST\2013-107
Overtime Rules Setup copied from: C:\HEAVYBID\EST\2014-710
Burden Tables Setup copied from: C:\HEAVYBID\EST\2014-710

************Estimate created on: 07/30/2014 by User#: 0 -
Source estimate used: C:\HEAVYBID\EST\2014-070
```

* on units of MH indicate average labor unit cost was used rather than base rate.

Activity Resource	Desc	Quantity Pcs	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub- Contrac	Total

BID ITEM = 980 Land Item SCHEDULE: 1 100
Description = MARK UP (PROFIT) Unit = LS Takeoff Quan: 1.000 Engr Quan: 1.000

[ ] in the Unit Cost Column = Labor Unit Cost Without Labor Burdens

In equipment resources, rent % and EOE % not = 100% are represented as XXX%YYY where XXX=Rent% and YYY=EOE%

------Calendar Codes------

10	10 HOUR SHIFT (Default Calendar)
8	8 HOUR SHIFT
9	9 HOUR SHIFT

07/31/2014 14:39
2014-074 PALMER LF OPTN#3 EVOQUA MBR CL-5 ROM
***

BID TOTALS

Biditem	Description	Status - Rnd	Quantity	Units	Unit Price	Bid Total
10	MOBILIZATION		1.000	LS	800,000.00	800,000.00
20	BONDS & INSURANCE		1.000	LS	371,416.00	371,416.00
25	ENGINEERING DESIGN		1.000	LS	157,262.80	157,262.80
30	SUBMITTALS		1.000	LS	23,996.65	23,996.65
40	PERMITS		1.000	LS	67,500.00	67,500.00
50	SURVEY		1.000	LS	9,900.00	9,900.00
80	FENCING		1.000	LS	153,800.00	153,800.00
85	LEACHATE EQUALIZATION LAGOON		1.000	LS	84,141.84	84,141.84
87	PUMP STA LAGOON TO PLANT		1.000	LS	35,000.00	35,000.00
90	MBR BUILDING FOUNDATION		1.000	LS	960,000.00	960,000.00
100	MBR BUILDING STRUCTURE		1.000	LS	5,250,000.00	5,250,000.00
110	UTILITIES-OUTSIDE BUILDING		1.000	LS	60,000.00	60,000.00
120	UTILITIES - INSIDE BUILDING		1.000	LS	100,000.00	100,000.00
130	PURCHASE PLANT EQUIPMENT		1.000	LS	1,500,000.00	1,500,000.00
140	INSTALL EVOCA PLANT EQUIPMENT		1.000	LS	300,000.00	300,000.00
142	CENTRIFUGES		2.000	EA	194,400.00	388,800.00
150	INSIDE PIPING		1.000	LS	155,000.00	155,000.00
160	ELECTRICAL & NEW SUB STATION		1.000	LS	237,500.00	237,500.00
165	NATURAL GAS LINE		2,500.000	LF	30.00	75,000.00
170	INSTRUMENTS & CONTRLS		1.000	LS	50,000.00	50,000.00
190	LEACH FIELD		10,000.000	SF	6.08	60,800.00
195	2" GW MONITOR WELL		4.000	EA	2,500.00	10,000.00
600	DEMOBILIZATION		1.000	LS	700,000.00	700,000.00
910	CONTRACTOR OVERHEAD(GENERAL CONDITIONS)		1.000	LS	677,510.00	677,510.00
920	CH OVERHEAD (GENERAL CONDITIONS)		1.000	LS	580,722.00	580,722.00
930	MANAGEMENT RESERVE (CONTINGENCY)		1.000	LS	1,451,806.00	1,451,806.00
970	TAXES		1.000	LS	456,842.00	456,842.00
980	MARK UP (PROFIT)		1.000	LS	967,870.00	967,870.00
			Bid Total	========>		$15,684,867.29

Direct Cost Report

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Activity      Desc                 Quantity            Unit              Perm   Constr   Equip   Sub-
  Resource                      Pcs         Unit        Cost     Labor  Materi  Matl/Ex   Ment Contrac     Total
__________________________________________________________________________________________________________________

BID ITEM =     10                           Land Item   SCHEDULE:   1        100
Description = MOBILIZATION                     Unit =   LS   Takeoff Quan:   1.000    Engr Quan:    1.000

19001005      MOBILIZATION                     Quan:    1.00 LS  Hrs/Shft: 10.00  Cal 10  WCNONE

4MOB          MOBILIZATION     1.00      1.00 LS      800,000.000                              800,000 800,000
__________________________________________________________________________________________________________________

BID ITEM =     20                           Land Item   SCHEDULE:   1        100
Description = BONDS & INSURANCE                Unit =   LS   Takeoff Quan:   1.000    Engr Quan:    1.000

11002005      BONDS                            Quan:    1.00 LS  Hrs/Shft: 10.00  Cal 10  WCNONE

BONDS 1.7% X $14,856,644 = $252,563
3BOND         BOND COST        1.00      1.00 LS      252,563.000                  252,563               252,563

11002010      INSURANCE                        Quan:    1.00 LS  Hrs/Shft: 10.00  Cal 10  WCNONE

INSURANCE 0.8% X $14,856,644 = $118,853
3INSURANC     INSURANCE COST   1.00      1.00 LS      118,853.000                  118,853               118,853
                                                     ______________________________________________________________
=====> Item Totals:     20      - BONDS & INSURANCE
$371,416.00                                                [ ]                     371,416               371,416
371,416.000                    1 LS                                             371,416.00            371,416.00
__________________________________________________________________________________________________________________

BID ITEM =     25                           Land Item   SCHEDULE:   1        100
Description = ENGINEERING DESIGN               Unit =   LS   Takeoff Quan:   1.000    Engr Quan:    1.000

11002505      CH ENGINEERING DESIGN            Quan:    1.00 LS  Hrs/Shft: 10.00  Cal 10  WCNONE

3DOCCOSTS     DOCUMENT COST    1.00      1.00 LS        4,000.000                    4,000                 4,000
X414          ==> Project Eng  1.00    800.00 MH           72.700   80,261                                80,261
X418          ==> Engineering Mgr 1.00 400.00 MH           52.900   29,201                                29,201
X422          ==> Staff Enginer 1.00   600.00 MH           52.900   43,801                                43,801
$157,262.80       1,800.0000 MH/LS   1,800.00 MH       [ 111060 ] 153,263            4,000               157,263
                                       0.0006 Unit/M              153,262.80         4,000.00            157,262.80
                                                     ______________________________________________________________
=====> Item Totals:     25      - ENGINEERING DESIGN
$157,262.80  1,800.0000 MH/LS        1,800.00 MH       [ 111060 ] 153,263            4,000               157,263
157,262.800                    1 LS                               153,262.80         4,000.00            157,262.80
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Activity        Desc                Quantity            Unit          Perm   Constr    Equip   Sub-
  Resource                       Pcs         Unit       Cost   Labor Materi  Matl/Ex    Ment Contrac     Total
--------------------------------------------------------------------------------------------------------------

BID ITEM =     30                               Land Item    SCHEDULE:    1         100
Description = SUBMITTALS                           Unit =    LS   Takeoff Quan:    1.000    Engr Quan:    1.000

11003005    WORK PLAN                           Quan:   1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

 11030      SUBMITTALS                    16.00  CH       Prod:   0.0625 UH  Lab Pcs:  3.10    Eqp Pcs:  0.00
3DOCMTRL    DOCUMENT MATE 1.00     1.00 LS        200.000                    200                      200
X414        Project Eng     E6  1.00    16.00 MH         72.700   1,605                                1,605
X430        Project Controls E 4  0.20   3.20 MH         52.900     234                                  234
X434        Cost/Schedule   E3  0.20     3.20 MH         43.800     193                                  193
X442        Document  Tech T2  0.10      1.60 MH         24.900      55                                   55
X450        Field Engineer   T4  0.20    3.20 MH         39.800     176                                  176
X462        Quality  Mngr   E4  0.20     3.20 MH         52.900     234                                  234
X866        Admin Assist.  T1  1.00     16.00 MH         22.900     506                                  506
X918        Safety Engineer  E3  0.20    3.20 MH         43.900     194                                  194
$3,396.09          49.6000  MH/LS       49.60 MH       [ 2316 ]   3,196              200                3,396
  0.0625  Units/Hr *   0.6250  Un/Shift   0.0202  Unit/M         3,196.09           200.00             3,396.09

11003010    PROJECT SCHEDULE                    Quan:   1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

 11030      SUBMITTALS                    24.00  CH       Prod:   0.0417 UH  Lab Pcs:  1.85    Eqp Pcs:  0.00
3DOCMTRL    DOCUMENT MATE 1.00     1.00 LS        350.000                    350                      350
X414        Project Eng     E6  0.15     3.60 MH         72.700     361                                  361
X430        Project Controls E 4  0.10   2.40 MH         52.900     175                                  175
X434        Cost/Schedule   E3  1.00    24.00 MH         43.800   1,451                                1,451
X442        Document  Tech T2  0.10      2.40 MH         24.900      82                                   82
X866        Admin Assist.  T1  0.50     12.00 MH         22.900     379                                  379
$2,798.72          44.4000  MH/LS       44.40 MH     [ 1774.44 ]  2,449              350                2,799
  0.0417  Units/Hr *   0.4167  Un/Shift   0.0225  Unit/M         2,448.72           350.00             2,798.72

11003015    SWPPP                               Quan:   1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

FOR ALL SUBMITTALS ASSUME A DRAFT A DRAFT FINAL AND A FINAL FOR MOST SUBMITTALS
 11020      PLAN/DOC CREW                  1.00  CH       Prod:   1.0000 UH  Lab Pcs: 68.00    Eqp Pcs:  0.00
3DOCMTRL    DOCUMENT MATE 1.00     1.00 LS        750.000                    750                      750
AAA         *********LABOR**        0.00 MH          0.000
X274        Adminst Asst.    T2  18.00  18.00 MH         24.900     619                                  619
X414        Project Eng     E6  32.00   32.00 MH         72.700   3,210                                3,210
X426        Jr Staff Eng     E3   18.00  18.00 MH         43.800   1,088                                1,088
$5,666.94          68.0000  MH/LS       68.00 MH       [ 3563 ]   4,917              750                5,667
  1.0000  Units/Hr *  10.0000  Un/Shift   0.0147  Unit/M         4,916.94           750.00             5,666.94

11003020    HASP                                Quan:   1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

 11020      PLAN/DOC CREW                  1.00  CH       Prod:   1.0000 UH  Lab Pcs: 58.00    Eqp Pcs:  0.00
3DOCMTRL    DOCUMENT MATE 1.00     1.00 LS        950.000                    950                      950
AAA         *********LABOR**        0.00 MH          0.000
X274        Adminst Asst.    T2  20.00  20.00 MH         24.900     687                                  687
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Activity        Desc                  Quantity              Unit              Perm   Constr    Equip    Sub-
   Resource                        Pcs          Unit        Cost     Labor  Materi  Matl/Ex    Ment Contrac     Total

BID ITEM =     30                                    Land Item    SCHEDULE:   1          100
Description = SUBMITTALS                                Unit =    LS    Takeoff Quan:     1.000     Engr Quan:    1.000

X414         Project Eng      E6  10.00    10.00 MH        72.700    1,003                                     1,003
X426         Jr Staff Eng    E3    8.00     8.00 MH        43.800      484                                       484
X918         Safety Engineer E3  20.00    20.00 MH        43.900    1,212                                     1,212
$4,335.69           58.0000 MH/LS         58.00 MH     [ 2453.4 ]   3,386               950                   4,336
  1.0000  Units/Hr *  10.0000 Un/Shift   0.0172 Unit/M             3,385.69            950.00                4,335.69

11003025     QA/QC PLAN                              Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

 11020       PLAN/DOC CREW                      1.00  CH      Prod:   1.0000 UH  Lab Pcs: 56.00    Eqp Pcs:  0.00
3DOCMTRL     DOCUMENT MATE  1.00     1.00 LS       700.000                         700                       700
AAA          *********LABOR**        0.00 MH         0.000
X274         Adminst Asst.    T2  20.00    20.00 MH        24.900      687                                       687
X414         Project Eng      E6  12.00    12.00 MH        72.700    1,204                                     1,204
X462         Quality  Mngr   E4  24.00    24.00 MH        52.900    1,752                                     1,752
$4,343.20           56.0000 MH/LS         56.00 MH      [ 2640 ]    3,643               700                   4,343
  1.0000  Units/Hr *  10.0000 Un/Shift   0.0179 Unit/M             3,643.20            700.00                4,343.20

11003030     TRAFFIC PLAN                            Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

 11020       PLAN/DOC CREW                      1.00  CH      Prod:   1.0000 UH  Lab Pcs: 52.00    Eqp Pcs:  0.00
3DOCMTRL     DOCUMENT MATE  1.00     1.00 LS       250.000                         250                       250
AAA          *********LABOR**        0.00 MH         0.000
X274         Adminst Asst.    T2  16.00    16.00 MH        24.900      550                                       550
X414         Project Eng      E6  12.00    12.00 MH        72.700    1,204                                     1,204
X426         Jr Staff Eng    E3  12.00    12.00 MH        43.800      725                                       725
X918         Safety Engineer E3  12.00    12.00 MH        43.900      727                                       727
$3,456.01           52.0000 MH/LS         52.00 MH     [ 2323.2 ]   3,206               250                   3,456
  1.0000  Units/Hr *  10.0000 Un/Shift   0.0192 Unit/M             3,206.01            250.00                3,456.01

=====> Item Totals:       30        - SUBMITTALS
$23,996.65      328.0000  MH/LS          328.00 MH   [ 15070.04 ]  20,797             3,200                  23,997
23,996.650                    1 LS                                20,796.65          3,200.00              23,996.65

BID ITEM =     40                                    Land Item    SCHEDULE:   1          100
Description = PERMITS                                   Unit =    LS    Takeoff Quan:     1.000     Engr Quan:    1.000

11004005     MSB BUILDING PERMIT                     Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

3MSBBLDPR MSB BUILDING PE  1.00      1.00 LS     60,000.000                      60,000                    60,000

11004010     DUST PERMIT                             Quan:    1.00 LS   Hrs/Shft: 10.00  Cal 10   WC NONE

3DUSTPRM     DUST PERMIT      1.00      1.00 LS      7,500.000                       7,500                     7,500
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Activity       Desc                  Quantity             Unit           Perm   Constr    Equip    Sub-
   Resource                       Pcs          Unit        Cost   Labor  Materi  Matl/Ex    Ment Contrac     Total
___________________________________________________________________________________________________________________

BID ITEM =     40                               Land Item   SCHEDULE:   1          100
Description = PERMITS                              Unit =   LS   Takeoff Quan:    1.000     Engr Quan:     1.000

=====> Item Totals:      40       - PERMITS
$67,500.00                                                  [ ]                     67,500                    67,500
67,500.000                     1 LS                                              67,500.00                 67,500.00
___________________________________________________________________________________________________________________

BID ITEM =     50                               Land Item   SCHEDULE:   1          100
Description = SURVEY                               Unit =   LS   Takeoff Quan:    1.000     Engr Quan:     1.000

11005005     SURVEY                             Quan:    1.00 LS  Hrs/Shft: 10.00  Cal 10  WCNONE

THIS WOULD INCLUDE LAYOUT OF BUILDING , EQUALIZATION POND , ACCESS ROAD AND
UTILITIES . ALSO EARTHWORK QUANTITIES AND FINAL AS BUILT DRAWAINGS
4SURVEY      SURVEY SUB       1.00    90.00 HR          110.000                                       9,900     9,900
___________________________________________________________________________________________________________________

BID ITEM =     80                               Land Item   SCHEDULE:   1          100
Description = FENCING                              Unit =   LS   Takeoff Quan:    1.000     Engr Quan:     1.000

19008005     CL FENCE                           Quan: 5,200.00 LF  Hrs/Shft: 10.00  Cal 10  WCNONE

4FENCE       Fencing - Sub    1.00 5,200.00 LF           29.000                                     150,800   150,800

19008010     GATES - MAN                        Quan:    4.00 EA  Hrs/Shft: 10.00  Cal 10  WCNONE

4FENCE       Fencing - Sub    1.00     4.00 EA          300.000                                       1,200     1,200

19008015     GATES VEHICLE                      Quan:    2.00 EA  Hrs/Shft: 10.00  Cal 10  WCNONE

4FENCE       Fencing - Sub    1.00     2.00 EA          900.000                                       1,800     1,800
                                                               ____________________________________________________
=====> Item Totals:      80       - FENCING
$153,800.00                                                 [ ]                                     153,800   153,800
153,800.000                    1 LS                                                              153,800.00 153,800.00
___________________________________________________________________________________________________________________

BID ITEM =     85                               Land Item   SCHEDULE:   1          100
Description = LEACHATE EQUALIZATION LAGOON         Unit =   LS   Takeoff Quan:    1.000     Engr Quan:     1.000

19085005     EXCAVATE LAGOON                    Quan: 4,830.00 CY  Hrs/Shft: 10.00  Cal 10  WCNONE

 19015       SMALL EXCAV CREW               60.00   CH      Prod:  80.5000 UH  Lab Pcs:  6.00    Eqp Pcs:  4.00
3GRDST&S     GRADING ST&S     1.00   360.00 HM            2.000                     720                         720
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Activity          Desc                  Quantity              Unit          Perm   Constr    Equip    Sub-
   Resource                        Pcs            Unit        Cost   Labor  Materi  Matl/Ex    Ment Contrac     Total
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BID ITEM =      85                                   Land Item    SCHEDULE:   1        100
Description = LEACHATE EQUALIZATION LAGOON             Unit =      LS   Takeoff Quan:    1.000     Engr Quan:     1.000

3PPE          PPE                  1.00   360.00 HM          2.500                       900                        900
8AAAA         *******EQUIPMEN               0.00 HR          0.000
8EXC330       Excavator Cat 330D L 1.00    60.00 HR        188.085                              11,285           11,285
8TRKHW10      Tandem Truck 12 CY   2.00   120.00 HR         73.856                               8,863            8,863
8TRKPU15      Pickup 4x4 3/4 Ton G 1.00    60.00 HR         15.264                                 916              916
AAA           *********LABOR**              0.00 MH          0.000
LA30          Laborer General      1.00    60.00 MH         29.210   3,614                                        3,614
OP01F         Oper Foreman         1.00    60.00 MH         42.040   4,495                                        4,495
OPH14         Oper Hydr Backhoe 3  1.00    60.00 MH         39.280   4,280                                        4,280
OPSPT14       Oper Grade Checker   1.00    60.00 MH         37.790   4,164                                        4,164
TE22          Tmstr Dmp Trk 6-14c  2.00   120.00 MH         36.790   7,959                                        7,959
$47,195.84            0.0745  MH/CY       360.00 MH      [ 3.032 ]  24,512               1,620  21,064           47,196
 80.5000  Units/Hr *  805.0000  Un/Shift 13.4167 Unit/M               5.07                0.34    4.36             9.77

19085010      INSTALL HDPE LINER                      Quan: 25,480.00 SF   Hrs/Shft: 10.00   Cal 10   WC NONE

4LINER        LINER SUB            1.00 25,480.00 SF         1.450                                       36,946  36,946
                                                                  _________________________________________________
=====> Item Totals:      85       - LEACHATE EQUALIZATION LAGOON
$84,141.84       360.0000  MH/LS          360.00 MH     [ 14645.4 ]  24,512               1,620  21,064  36,946  84,142
84,141.840                   1 LS                                24,512.18             1,620.00 21,063.66 36,946.00 84,141.84
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BID ITEM =      87                                   Land Item    SCHEDULE:   1        100
Description = PUMP STA LAGOON TO PLANT                 Unit =      LS   Takeoff Quan:    1.000     Engr Quan:     1.000

19008705      PUMP STA LAGOON TO PLANT                Quan:     1.00 LS    Hrs/Shft: 10.00   Cal 10   WC NONE

THIS INCLUDES PUMP,PAD,INTAKE PIPE POWER TO PUMP AND DISCHARGE LINE TO PLANT
4MECH         INSTALLATION SU      1.00     1.00 LS      35,000.000                                      35,000  35,000
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BID ITEM =      90                                   Land Item    SCHEDULE:   1        100
Description = MBR  BUILDING FOUNDATION                 Unit =      LS   Takeoff Quan:    1.000     Engr Quan:     1.000

51009005      BUILDING FOUNDATION & SLAB              Quan: 30,000.00 SF   Hrs/Shft: 10.00   Cal 10   WC NONE

BUILDING FOUNDATION WILL BE 200LF X 150LF = 30,000 SF
4CONC         Concrete - Sub       1.00 30,000.00 SF        32.000                                      960,000 960,000
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Activity      Desc                 Quantity             Unit           Perm   Constr   Equip   Sub-
   Resource                     Pcs         Unit         Cost   Labor  Materi  Matl/Ex   Ment Contrac      Total
_________________________________________________________________________________________________________________

BID ITEM =     100                                Land Item   SCHEDULE:   1          100
Description = MBR BUILDING STRUCTURE                 Unit =   LS  Takeoff Quan:    1.000    Engr Quan:    1.000

60010005      BUILDING STRUCTURE                 Quan: 30,000.00 SF  Hrs/Shft: 10.00  Cal 10  WC NONE

4BLDG         Building - Sub     1.00 30,000.00 SF         175.000                          5,250,000 5,250,000
_________________________________________________________________________________________________________________

BID ITEM =     110                                Land Item   SCHEDULE:   1          100
Description = UTILITIES-OUTSIDE BUILDING             Unit =   LS  Takeoff Quan:    1.000    Engr Quan:    1.000

60011005      UTILITIES-OUTSIDE BUILDING         Quan:     1.00 LS  Hrs/Shft: 10.00  Cal 10  WC NONE

4UTIL         UTILLITY SUB       1.00      1.00 LS      60,000.000                             60,000    60,000
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BID ITEM =     120                                Land Item   SCHEDULE:   1          100
Description = UTILITIES - INSIDE BUILDING            Unit =   LS  Takeoff Quan:    1.000    Engr Quan:    1.000

60012005      UTILITIES - INSIDE BUILDING        Quan:     1.00 LS  Hrs/Shft: 10.00  Cal 10  WC NONE

4UTIL         UTILLITY SUB       1.00      1.00 LS     100,000.000                            100,000   100,000
_________________________________________________________________________________________________________________

BID ITEM =     130                                Land Item   SCHEDULE:   1          100
Description = PURCHASE PLANT EQUIPMENT               Unit =   LS  Takeoff Quan:    1.000    Engr Quan:    1.000

30013005      PURCHASE EVOQUA MBR SYSTEM         Quan:     1.00 LS  Hrs/Shft: 10.00  Cal 10  WC NONE

THIS IS VENDOR QUOTE FOR SBR ACTIVATED SLUDGE AND SUPPORT EQUIPMENT
2EVOQUAM  EVOQUA MBR SYS   1.00      1.00 LS   1,500,000.000         1,500,000                          1,500,000
                                                        _________________________________________________________
=====> Item Totals:     130      - PURCHASE PLANT EQUIPMENT
$1,500,000.00                                          [ ]           1,500,000                          1,500,000
1,500,000.000                  1 LS                               1,500,000.00                       1,500,000.00
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BID ITEM =     140                                Land Item   SCHEDULE:   1          100
Description = INSTALL EVOCA PLANT EQUIPMENT          Unit =   LS  Takeoff Quan:    1.000    Engr Quan:    1.000

30014005      INSTALL EQUIPMENT                  Quan:     1.00 LS  Hrs/Shft: 10.00  Cal 10  WC NONE
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Activity Resource	Desc	Quantity Pcs	Unit		Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total

BID ITEM = 140 Land Item SCHEDULE: 1 100
Description = INSTALL EVOCA PLANT EQUIPMENT Unit = LS Takeoff Quan: 1.000 Engr Quan: 1.000

ASSUMES COST OF MBR EQUIPMENT
INSTALLATION 20% OF EQUIPMENT COST FOR EVOQUA ($1,500,000)=$300,000

4MECH	INSTALLATION SU	1.00	1.00	LS	300,000.000					300,000	300,000

BID ITEM = 142 Land Item SCHEDULE: 1 100
Description = CENTRIFUGES Unit = EA Takeoff Quan: 2.000 Engr Quan: 2.000

11014205 FURNISH & INSTALL CENTRIFUGES Quan: 2.00 EA Hrs/Shft: 10.00 Cal 10 WC NONE

INCLUDES INSTALLATION

2CNTRAFG	CENTRIFUGE	1.00	2.00	EA	194,400.000		388,800				388,800

=====> Item Totals: 142 - CENTRIFUGES

$388,800.00					[ ]		388,800				388,800
194,400.000		2 EA					194,400.00				194,400.00

BID ITEM = 150 Land Item SCHEDULE: 1 100
Description = INSIDE PIPING Unit = LS Takeoff Quan: 1.000 Engr Quan: 1.000

30015005 INSIDE PIPING Quan: 1.00 LS Hrs/Shft: 10.00 Cal 10 WC NONE

ASSUME COST OF 1% OF EQUIPMENT COST

4MECH	INSTALLATION SU	1.00	1.00	LS	155,000.000					155,000	155,000

BID ITEM = 160 Land Item SCHEDULE: 1 100
Description = ELECTRICAL & NEW SUB STATION Unit = LS Takeoff Quan: 1.000 Engr Quan: 1.000

30016005 SUB STATION Quan: 1.00 LS Hrs/Shft: 10.00 Cal 10 WC NONE

4ELECT	ELECTRICAL SUB	1.00	1.00	LS	150,000.000					150,000	150,000

30016010 OH POWER LINE Quan: 2,500.00 LF Hrs/Shft: 10.00 Cal 10 WC NONE

4ELEC	Electric - Sub	1.00	2,500.00	LF	35.000					87,500	87,500

=====> Item Totals: 160 - ELECTRICAL & NEW SUB STATION

$237,500.00					[ ]					237,500	237,500
237,500.000		1 LS								237,500.00	237,500.00

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Activity        Desc                      Quantity               Unit          Perm   Constr    Equip    Sub-
   Resource                          Pcs            Unit         Cost   Labor Materi  Matl/Ex    MentContrac       Total
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BID ITEM =      165                                   Land Item    SCHEDULE:   1           100
Description = NATURAL GAS LINE                           Unit =    LF   Takeoff Quan: 2,500.000     Engr Quan:  2,500.000

30016505     NATURAL GAS LINE                        Quan: 2,500.00 LF  Hrs/Shft: 10.00  Cal 10  WCNONE

4GAS         NATURAL GAS LIN 1.00  2,500.00 LF            30.000                                   75,000   75,000
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BID ITEM =      170                                   Land Item    SCHEDULE:   1           100
Description = INSTRUMENTS & CONTRLS                      Unit =    LS   Takeoff Quan:     1.000     Engr Quan:      1.000

30017005     INSTRUMENTS & CONTRLS                   Quan:     1.00 LS  Hrs/Shft: 10.00  Cal 10  WCNONE

4ELEC        Electric - Sub     1.00      1.00 LS     50,000.000                                   50,000   50,000
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BID ITEM =      190                                   Land Item    SCHEDULE:   1           100
Description = LEACH FIELD                                Unit =    SF   Takeoff Quan: 10,000.000    Engr Quan: 10,000.000

19019005     EXCAVATE LEACH FIELD                    Quan: 750.00 CY  Hrs/Shft: 10.00  Cal 10  WCNONE

 19015       SMALL EXCAV CREW              12.00   CH        Prod: 62.5000  UH  Lab Pcs:  6.00    Eqp Pcs:  4.00
3GRDST&S     GRADING ST&S       1.00     72.00 HM          2.000                   144                      144
3PPE         PPE                1.00     72.00 HM          2.500                   180                      180
8AAAA        *******EQUIPMEN              0.00 HR          0.000
8EXC330      Excavator Cat 330D L 1.00   12.00 HR        188.085                           2,257          2,257
8TRKHW10     Tandem Truck 12 CY 2.00     24.00 HR         73.856                           1,773          1,773
8TRKPU15     Pickup 4x4 3/4 Ton G 1.00   12.00 HR         15.264                             183            183
AAA          *********LABOR**             0.00 MH          0.000
LA30         Laborer General    1.00     12.00 MH         29.210     723                                    723
OP01F        Oper Foreman       1.00     12.00 MH         42.040     899                                    899
OPH14        Oper Hydr Backhoe 3 1.00    12.00 MH         39.280     856                                    856
OPSPT14      Oper Grade Checker 1.00     12.00 MH         37.790     833                                    833
TE22         Tmstr Dmp Trk 6-14c 2.00    24.00 MH         36.790   1,592                                  1,592
$9,439.14           0.0960 MH/CY         72.00 MH       [ 3.905 ]  4,902               324   4,213          9,439
 62.5000  Units/Hr * 625.0000 Un/Shift  10.4167 Unit/M               6.54              0.43    5.62          12.59

19019010     SET TANK AND LINES & GRAVEL & C         Quan:     1.00 LS  Hrs/Shft: 10.00  Cal 10  WCNONE

 13010       SMALL SWPP CREW               16.00   CH        Prod:  0.0625  UH  Lab Pcs:  5.00    Eqp Pcs:  3.00
2DRNGRVLDGRAVEL DRAIN FO 1.00   555.00 TN         18.200           10,101                            10,101
2PVCPP4      PVC PERF PIPE 4"   1.00  2,700.00 LF          8.200           22,140                            22,140
2SEPBOX5M    TANK 5000 GAL      1.00      1.00 LS     12,400.000           12,400                            12,400
3GRDST&S     GRADING ST&S       1.00     80.00 HM          2.000                   160                      160
3PPE         PPE                1.00     80.00 HM          2.500                   200                      200
```

BID ITEM = 190 Land Item SCHEDULE: 1 100
Description = LEACH FIELD Unit = SF Takeoff Quan: 10,000.000 Engr Quan: 10,000.000

Activity Resource	Desc	Pcs	Quantity	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
8AAAA	*******EQUIPMEN		0.00	HR	0.000						
8BHLD416	BHL Cat 416E 1CY	1.00	16.00	HR	39.398				630		630
8TRKGS10	Flatbed Truck 15K 20	1.00	16.00	HR	25.297				405		405
8TRKPU10	Pickup 4x2 3/4 Ton G	1.00	16.00	HR	13.322				213		213
AAA	*********LABOR**		0.00	MH	0.000						
LA01F	Laborer Foreman	1.00	16.00	MH	36.260	1,110					1,110
LA30	Laborer General	3.00	48.00	MH	29.210	2,891					2,891
OPH14	Oper Hydr Backhoe 3	1.00	16.00	MH	39.280	1,141					1,141
$51,392.03	80.0000 MH/LS		80.00	MH	[2871.8]	5,143	44,641	360	1,248		51,392
0.0625 Units/Hr *	0.6250 Un/Shift		0.0125	Unit/M		5,142.80	44,641.00	360.00	1,248.23		51,392.03

=====> Item Totals: 190 - LEACH FIELD

$60,831.17	0.0152 MH/SF		152.00	MH	[0.58]	10,045	44,641	684	5,461		60,831
6.083	10000 SF					1.00	4.46	0.07	0.55		6.08

BID ITEM = 195 Land Item SCHEDULE: 1 100
Description = 2" GW MONITOR WELL Unit = EA Takeoff Quan: 4.000 Engr Quan: 4.000

20019505 2" GW MONITOR WELL Quan: 4.00 EA Hrs/Shft: 10.00 Cal 10 WC NONE

4DRILL	WELL DRILLER	1.00	4.00	EA	2,500.000					10,000	10,000

BID ITEM = 600 Land Item SCHEDULE: 1 100
Description = DEMOBILIZATION Unit = LS Takeoff Quan: 1.000 Engr Quan: 1.000

19060005 DEMOBILIZATION Quan: 1.00 LS Hrs/Shft: 10.00 Cal 10 WC NONE

4DEMOB	DEMOBILZATION	1.00	1.00	LS	700,000.000					700,000	700,000

BID ITEM = 910 Land Item SCHEDULE: 1 100
Description = CONTRACTOR OVERHEAD(GENERAL CO Unit = LS Takeoff Quan: 1.000 Engr Quan: 1.000

11091005 CONTRACTOR OVERHEAD(GENERAL Quan: 1.00 LS Hrs/Shft: 10.00 Cal 10 WC NONE

7% OF DIRECT COT EXCLUDING EQUIPMENT PURCHASE ,BONDS&INSURANCE,CH
OVERSIGHT,MANAGEMENT RESERVE

4CNTROH	CONTRACTOR OH	1.00	1.00	LS	677,510.000					677,510	677,510

```
Activity      Desc                 Quantity          Unit         Perm   Constr   Equip   Sub-
  Resource                      Pcs        Unit      Cost  Labor  Materi MatI/Ex   MentContrac     Total

BID ITEM =    920                          Land Item   SCHEDULE:  1        100
Description = CH OVERHEAD (GENERAL CONDITIONS)  Unit =  LS  Takeoff Quan:  1.000   Engr Quan:   1.000

11092005    CH OVERHEAD (GENERAL CONDITIO  Quan:   1.00 LS  Hrs/Shft: 10.00 Cal 10  WCNONE

CH OVERSIGHT 6% OF COSTS EXCLUDING,BONDS&INSURANCE,PERMITS,EQUIPMENT
PURCHASE,CONTRACTOR OH,MANAGEMENT RESERVE AND MARK UP
4CH         CH OVERHEAD & P 1.00    1.00 LS    580,722.000                           580,722 580,722


BID ITEM =    930                          Land Item   SCHEDULE:  1        100
Description = MANAGEMENT RESERVE (CONTINGENC  Unit =  LS  Takeoff Quan:  1.000   Engr Quan:   1.000

11093005    MANAGEMENT RESERVE (CONTINGE   Quan:   1.00 LS  Hrs/Shft: 10.00 Cal 10  WCNONE

MANAGEMENT RESERVE (CONTINGENCY) 15% DIRECT COST
4MR15       MANAGE MENT RE 1.00     1.00 LS    1,451,806.000                       1,451,806 1,451,806


BID ITEM =    970                          Land Item   SCHEDULE:  1        100
Description = TAXES                           Unit =  LS  Takeoff Quan:  1.000   Engr Quan:   1.000

11097005    TAXES (3% DIRECT COSTS)        Quan:   1.00 LS  Hrs/Shft: 10.00 Cal 10  WCNONE

3TAXES      TAXES PALMER A 1.00     1.00 LS    456,842.000          456,842                  456,842

=====> Item Totals:    970     - TAXES
$456,842.00                                       [ ]                 456,842                  456,842
456,842.000               1 LS                                    456,842.00               456,842.00


BID ITEM =    980                          Land Item   SCHEDULE:  1        100
Description = MARK UP (PROFIT)                Unit =  LS  Takeoff Quan:  1.000   Engr Quan:   1.000

11098005    MARK UP (PROFIT)               Quan:   1.00 LS  Hrs/Shft: 10.00 Cal 10  WCNONE

CONTRACTOR MARK UP OF 10% OF CONTRACTOR COSTS
4PROFIT     CONTRACTOR PRO 1.00     1.00 LS    967,870.000                           967,870 967,870


$15,684,898.46  ***  Report Totals  *** 2,640.00 MH     208,617 1,933,441 905,262  26,525 12,611,054 15,684,898
```

BID ITEM = 980 Land Item SCHEDULE: 1 100
Description = MARK UP (PROFIT) Unit = LS Takeoff Quan: 1.000 Engr Quan: 1.000

>>> indicates Non Additive Activity
------Report Notes:------
The estimate was prepared with TAKEOFF Quantities.
This report shows TAKEOFF Quantities with the resources.

Bid Date: Owner: Engineering Firm:
Estimator-In-Charge:

JOB NOTES

```
Estimate created on: 07/23/2014 by User#: 0 -
Source estimate used: C:\HEAVYBID\EST\ESTMAST
Labor Setup copied from: C:\HEAVYBID\EST\2014-710
Equipment Setup copied from: C:\HEAVYBID\EST\2014-710
Crew Setup copied from: C:\HEAVYBID\EST\2014-710
Material/Other Resources Setup copied from: C:\HEAVYBID\EST\2013-107
Overtime Rules Setup copied from: C:\HEAVYBID\EST\2014-710
Burden Tables Setup copied from: C:\HEAVYBID\EST\2014-710

************Estimate created on: 07/30/2014 by User#: 0 -
Source estimate used: C:\HEAVYBID\EST\2014-070

************Estimate created on: 07/31/2014 by User#: 0 -
Source estimate used: C:\HEAVYBID\EST\2014-072
```

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* on units of MH indicate average labor unit cost was used rather than base rate.
[ ] in the Unit Cost Column = Labor Unit Cost Without Labor Burdens
In equipment resources, rent % and EOE % not = 100% are represented as XXX%YYY where XXX=Rent% and YYY=EOE%
------Calendar Codes------

10	10 HOUR SHIFT (Default Calendar)
8	8 HOUR SHIFT
9	9 HOUR SHIFT

```
2014-070          PALMER LF OPTION #1 O&M ANNUAL COSTS                                 08/01/2014   13:32
                                             Direct Cost Report

Activity          Desc                     Quantity                  Unit          Perm   Constr   Equip   Sub-
   Resource                           Pcs            Unit            Cost    Labor Materi Matl/Ex   MentContrac      Total
________________________________________________________________________________________________________________________

BID ITEM =      10                                        Land Item    SCHEDULE:   1          100
Description = SBR PLANT  LABOR OPERATION                     Unit =    YR   Takeoff Quan:    1.000    Engr Quan:    1.000

11001005     EVAP PLANT  LABOR OPERATION          Quan:    1.00 YR  Hrs/Shft: 8.00              WCNONE

 11005       STANDARD CREW SBR          2,080.00  CH         Prod:   0.0005 UH  Lab Pcs:  3.25     Eqp Pcs:  1.20
8AAAA        *******EQUIPMEN               0.00 HR            0.000
8FORK02      Forklift Cat TH220B  0.10   208.00 HR           34.270                        7,128            7,128
8TRKGS10     Flatbed Truck 15K 20 0.10   208.00 HR           25.297                        5,262            5,262
8TRKPU15     Pickup 4x4 3/4 Ton G 1.00 2,080.00 HR           15.264                       31,749           31,749
AAA          *********LABOR**              0.00 MH            0.000
PO01S        Supervisor           0.25   520.00 MH           55.000  44,590                                44,590
PO0F         Foreman              1.00 2,080.00 MH           40.020 141,593                               141,593
PO20         Plant Journyman      2.00 4,160.00 MH           38.000 273,270                               273,270
$503,592.53      6,760.0000 MH/YR  6,760.00 MH      [ 269921.6 ] 459,453                      44,139          503,593
  0.0005  Units/Hr *   0.0038 Un/Shift   0.0001 Unit/M           459,453.49                   44,139.04       503,592.53
                                                                  ______________________________________________________
=====> Item Totals:      10       - SBR PLANT  LABOR OPERATION
$503,592.53  6,760.0000  MH/YR      6,760.00 MH      [ 269921.6 ] 459,453                      44,139          503,593
503,592.530                 1 YR                                 459,453.49                   44,139.04       503,592.53
________________________________________________________________________________________________________________________

BID ITEM =      20                                        Land Item    SCHEDULE:   1          100
Description = POWER FOR PLANT                                Unit =    YR   Takeoff Quan:    1.000    Engr Quan:    1.000

11002005     POWER FOR PLANT                      Quan:    1.00 YR  Hrs/Shft: 8.00              WCNONE

3KW/H        KW/HR                1.00 4,000,000.00 KW/H      0.190               760,000                     760,000
                                                                  ______________________________________________________
=====> Item Totals:      20       - POWER FOR PLANT
$760,000.00                                                   [ ]                 760,000                     760,000
760,000.000                 1 YR                                                760,000.00                  760,000.00
________________________________________________________________________________________________________________________

BID ITEM =      30                                        Land Item    SCHEDULE:   1          100
Description = REPLACEMENT/REPAIR PARTS                       Unit =    YR   Takeoff Quan:    1.000    Engr Quan:    1.000

11003005     REPLACEMENT/REPAIR PARTS             Quan:    1.00 YR  Hrs/Shft: 8.00              WCNONE

3RRP         REPAIR&REPLC PA 1.00      1.00 LS        8,000.000                 8,000                       8,000
                                                                  ______________________________________________________
=====> Item Totals:      30       - REPLACEMENT/REPAIR PARTS
$8,000.00                                                     [ ]                   8,000                       8,000
8,000.000                   1 YR                                                  8,000.00                    8,000.00
________________________________________________________________________________________________________________________
```

```
Activity        Desc                  Quantity              Unit          Perm    Constr    Equip    Sub-
   Resource                       Pcs          Unit         Cost   Labor  Materi  Matl/Ex    Ment Contrac     Total

BID ITEM =      40                                Land Item    SCHEDULE:   1          100
Description = CHEMICALS                              Unit =     YR   Takeoff Quan:    1.000    Engr Quan:    1.000

11004005    CHEMICALS                              Quan:    1.00 YR  Hrs/Shft: 8.00            WCNONE

3MICCHEM    MISCELLANEOUS   1.00 4,000,000.00 GL          0.020                  80,000                  80,000

=====> Item Totals:      40       - CHEMICALS
$80,000.00                                                [ ]                    80,000                  80,000
80,000.000                 1 YR                                               80,000.00               80,000.00

$1,351,592.53    *** Report Totals *** 6,760.00 MH             459,453          848,000   44,139        1,351,593
```

>>> indicates Non Additive Activity
------Report Notes:------
The estimate was prepared with TAKEOFF Quantities.
This report shows TAKEOFF Quantities with the resources.

Bid Date: Owner: Engineering Firm:
Estimator-In-Charge:

JOB NOTES

```
Estimate created on: 08/01/2014 by User#: 0 -
Source estimate used: C:\HEAVYBID\EST\ESTMAST
Labor Setup copied from: C:\HEAVYBID\EST\2014-072
Equipment Setup copied from: C:\HEAVYBID\EST\2014-072
Material/Other Resources Setup copied from: C:\HEAVYBID\EST\2014-072
Overtime Rules Setup copied from: C:\HEAVYBID\EST\2014-072
Burden Tables Setup copied from: C:\HEAVYBID\EST\2014-072

************Estimate created on: 08/01/2014 by User#: 0 -
Source estimate used: C:\HEAVYBID\EST\2014-073
```

* on units of MH indicate average labor unit cost was used rather than base rate.
[ ] in the Unit Cost Column = Labor Unit Cost Without Labor Burdens

```
 In equipment resources, rent % and EOE % not = 100% are represented as XXX%YYY where
XXX=Rent% and YYY=EOE%
```

------Calendar Codes------

Direct Cost Report

```
Activity      Desc                  Quantity              Unit          Perm   Constr   Equip    Sub-
   Resource                      Pcs          Unit        Cost   Labor  Materi MatI/Ex   MentContrac      Total
________________________________________________________________________________________________________

BID ITEM =    10                                Land Item   SCHEDULE:  1        100
Description = MBR PLANT  LABOR OPERATION           Unit =   YR   Takeoff Quan:   1.000    Engr Quan:   1.000

11001005      SBR PLANT  LABOR OPERATION        Quan:   1.00 YR  Hrs/Shft: 8.00           WCNONE

 11005        STANDARD CREW SBR        2,080.00 CH        Prod:  0.0005 UH  Lab Pcs:  4.50   Eqp Pcs:  1.20
8AAAA         *******EQUIPMEN              0.00 HR           0.000
8FORK02       Forklift Cat TH220B 0.10   208.00 HR          34.270                        7,128          7,128
8TRKGS10      Flatbed Truck 15K 20 0.10  208.00 HR          25.297                        5,262          5,262
8TRKPU15      Pickup 4x4 3/4 Ton G 1.00 2,080.00 HR         15.264                       31,749         31,749
AAA           *********LABOR**             0.00 MH           0.000
PO01S         Supervisor          0.50 1,040.00 MH          55.000  89,180                               89,180
PO0F          Foreman             1.00 2,080.00 MH          40.020 141,593                              141,593
PO20          Plant Journyman     3.00 6,240.00 MH          38.000 409,906                              409,906
$684,817.73      9,360.0000 MH/YR  9,360.00 MH       [ 377561.6 ] 640,679                        44,139        684,818
  0.0005  Units/Hr *  0.0038 Un/Shift   0.0001 Unit/M       640,678.69                    44,139.04     684,817.73
                                                     ___________________________________________________
=====> Item Totals:     10      -  MBR PLANT  LABOR OPERATION
$684,817.73  9,360.0000 MH/YR      9,360.00 MH       [ 377561.6 ] 640,679                        44,139        684,818
684,817.730                1 YR                             640,678.69                    44,139.04     684,817.73
________________________________________________________________________________________________________

BID ITEM =    20                                Land Item   SCHEDULE:  1        100
Description = POWER FOR PLANT                      Unit =   YR   Takeoff Quan:   1.000    Engr Quan:   1.000

11002005      POWER FOR PLANT                   Quan:   1.00 YR  Hrs/Shft: 8.00           WCNONE

3KW/H         KW/HR               1.00 1,314,000.00 KW/H      0.190               249,660                   249,660
                                                     ___________________________________________________
=====> Item Totals:     20      -  POWER FOR PLANT
$249,660.00                                                  [  ]               249,660                   249,660
249,660.000                1 YR                                               249,660.00                249,660.00
________________________________________________________________________________________________________

BID ITEM =    30                                Land Item   SCHEDULE:  1        100
Description = REPLACEMENT/REPAIR PARTS             Unit =   YR   Takeoff Quan:   1.000    Engr Quan:   1.000

11003005      REPLACEMENT/REPAIR PARTS          Quan:   1.00 YR  Hrs/Shft: 8.00           WCNONE

3RRP          REPAIR&REPLC PA 1.00     1.00 LS         15,000.000                15,000                    15,000
                                                     ___________________________________________________
=====> Item Totals:     30      -  REPLACEMENT/REPAIR PARTS
$15,000.00                                                   [  ]                15,000                    15,000
15,000.000                 1 YR                                                15,000.00                 15,000.00
________________________________________________________________________________________________________
```

```
Activity        Desc               Quantity          Unit        Perm  Constr   Equip  Sub-
   Resource                     Pcs        Unit      Cost  Labor Materi Matl/Ex  Ment Contrac    Total
------------------------------------------------------------------------------------------------------

BID ITEM =    40                            Land Item   SCHEDULE:   1        100
Description = CHEMICALS                        Unit =   YR   Takeoff Quan:   1.000   Engr Quan:   1.000

11004005  CHEMICALS                         Quan:   1.00 YR  Hrs/Shft: 8.00         WCNONE

3MICCHEM  MISCELLANEOUS  1.00 1,314,000.00 GL      0.030               39,420                  39,420

=====> Item Totals:    40     - CHEMICALS
$39,420.00                                          [ ]               39,420                  39,420
39,420.000                1 YR                                     39,420.00               39,420.00
------------------------------------------------------------------------------------------------------

$988,897.73    ***  Report Totals  *** 9,360.00 MH        640,679      304,080  44,139        988,898
```

>>> indicates Non Additive Activity

------Report Notes:------

The estimate was prepared with TAKEOFF Quantities.

This report shows TAKEOFF Quantities with the resources.

Bid Date: Owner: Engineering Firm:
Estimator-In-Charge:

JOB NOTES

```
Estimate created on: 08/01/2014 by User#: 0 -
Source estimate used: C:\HEAVYBID\EST\ESTMAST
Labor Setup copied from: C:\HEAVYBID\EST\2014-072
Equipment Setup copied from: C:\HEAVYBID\EST\2014-072
Material/Other Resources Setup copied from: C:\HEAVYBID\EST\2014-072
Overtime Rules Setup copied from: C:\HEAVYBID\EST\2014-072
Burden Tables Setup copied from: C:\HEAVYBID\EST\2014-072

************Estimate created on: 08/01/2014 by User#: 0 -
Source estimate used: C:\HEAVYBID\EST\2014-073
```

* on units of MH indicate average labor unit cost was used rather than base rate.

[ ] in the Unit Cost Column = Labor Unit Cost Without Labor Burdens

In equipment resources, rent % and EOE % not = 100% are represented as XXX%YYY where XXX=Rent% and YYY=EOE%

------Calendar Codes------

```
                                        Direct Cost Report

Activity       Desc                    Quantity              Unit              Perm   Constr   Equip    Sub-
   Resource                          Pcs        Unit         Cost     Labor  Materi  Matl/Ex    MentContrac      Total
_____________________________________________________________________________________________________________________

BID ITEM =      10                                  Land Item     SCHEDULE:   1          100
Description = SBR PLANT  LABOR OPERATION                Unit =    YR    Takeoff Quan:     1.000     Engr Quan:     1.000

11001005     SBR PLANT  LABOR OPERATION          Quan:     1.00 YR  Hrs/Shft: 8.00            WCNONE

 11005       STANDARD CREW SBR            2,080.00  CH          Prod:   0.0005 UH  Lab Pcs:  6.50      Eqp Pcs:  1.20
8AAAAA       *******EQUIPMEN                  0.00  HR             0.000
8FORK02      Forklift Cat TH220B  0.10     208.00  HR            34.270                              7,128          7,128
8TRKGS10     Flatbed Truck 15K 20 0.10     208.00  HR            25.297                              5,262          5,262
8TRKPU15     Pickup 4x4 3/4 Ton G 1.00   2,080.00  HR            15.264                             31,749         31,749
AAA          *********LABOR**                 0.00  MH             0.000
PO01S        Supervisor           0.50   1,040.00  MH            55.000   89,180                                   89,180
PO0F         Foreman              1.00   2,080.00  MH            40.020  141,593                                  141,593
PO20         Plant Journyman      5.00  10,400.00  MH            38.000  683,176                                  683,176
$958,088.13      13,520.0000  MH/YR  13,520.00  MH       [ 535641.6 ]  913,949                             44,139        958,088
  0.0005  Units/Hr *    0.0038  Un/Shift    0.0001  Unit/M            913,949.09                          44,139.04     958,088.13
                                                                     ____________________________________________________
=====> Item Totals:      10       - SBR PLANT  LABOR OPERATION
$958,088.13  13,520.0000  MH/YR        13,520.00  MH       [ 535641.6 ]  913,949                             44,139        958,088
958,088.130                     1 YR                                   913,949.09                          44,139.04     958,088.13
_____________________________________________________________________________________________________________________

BID ITEM =      20                                  Land Item     SCHEDULE:   1          100
Description = POWER FOR PLANT                           Unit =    YR    Takeoff Quan:     1.000     Engr Quan:     1.000

11002005     POWER FOR PLANT                     Quan:     1.00 YR  Hrs/Shft: 8.00            WCNONE

3KW/H        KW/HR                1.00 1,412,550.00 KW/H            0.190                 268,385                  268,385
                                                                     ____________________________________________________
=====> Item Totals:      20       - POWER FOR PLANT
$268,384.50                                                        [ ]                   268,385                  268,385
268,384.500                     1 YR                                                   268,384.50               268,384.50
_____________________________________________________________________________________________________________________

BID ITEM =      30                                  Land Item     SCHEDULE:   1          100
Description = REPLACEMENT/REPAIR PARTS                  Unit =    YR    Takeoff Quan:     1.000     Engr Quan:     1.000

11003005     REPLACEMENT/REPAIR PARTS            Quan:     1.00 YR  Hrs/Shft: 8.00            WCNONE

3RRP         REPAIR&REPLC PA 1.00         1.00  LS        7,500.000                     7,500                    7,500
                                                                     ____________________________________________________
=====> Item Totals:      30       - REPLACEMENT/REPAIR PARTS
$7,500.00                                                          [ ]                     7,500                    7,500
7,500.000                       1 YR                                                     7,500.00                 7,500.00
_____________________________________________________________________________________________________________________
```

BID ITEM = 40 Land Item SCHEDULE: 1 100
Description = CHEMICALS Unit = YR Takeoff Quan: 1.000 Engr Quan: 1.000

11004005 CHEMICALS Quan: 1.00 YR Hrs/Shft: 8.00 WCNONE

Activity Resource	Desc	Quantity Pcs	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub- Contrac	Total
3MICCHEM	MISCELLANEOUS	1.00	1,412,500.00 GL	0.030			42,375			42,375
=====> Item Totals: 40	- CHEMICALS									
$42,375.00				[ ]			42,375			42,375
42,375.000			1 YR				42,375.00			42,375.00
$1,276,347.63	*** Report Totals ***	13,520.00	MH		913,949		318,260	44,139		1,276,348

>>> indicates Non Additive Activity
------Report Notes:------
The estimate was prepared with TAKEOFF Quantities.
This report shows TAKEOFF Quantities with the resources.

Bid Date: Owner: Engineering Firm:
Estimator-In-Charge:

JOB NOTES

```
Estimate created on: 08/01/2014 by User#: 0 -
Source estimate used: C:\HEAVYBID\EST\ESTMAST
Labor Setup copied from: C:\HEAVYBID\EST\2014-072
Equipment Setup copied from: C:\HEAVYBID\EST\2014-072
Material/Other Resources Setup copied from: C:\HEAVYBID\EST\2014-072
Overtime Rules Setup copied from: C:\HEAVYBID\EST\2014-072
Burden Tables Setup copied from: C:\HEAVYBID\EST\2014-072
```

* on units of MH indicate average labor unit cost was used rather than base rate.
[ ] in the Unit Cost Column = Labor Unit Cost Without Labor Burdens

```
 In equipment resources, rent % and EOE % not = 100% are represented as XXX%YYY where
XXX=Rent% and YYY=EOE%
```

------Calendar Codes------

Appendix J
Closure and Post-Closure Cost Estimate

APPENDIX J

Closure and Post-Closure Cost Estimate

TABLE J-1

Scope for Matanuska-Susitna Borough Central Landfill Post Closure Cost Estimate

Matanuska-Susitna Borough Central landfill Development Plan

No.	Item	Area (ft²)	Depth (ft)	Quantity	Units	Comments
Location: Central Landfill in Palmer:						
Add contractor overhead, fee, bonding, and mob/demob						
Closure Construction: Apply Final Cover to the Final Cell, Cell 15, in Year 2071						
1	Final Cover Soil	1,904,000	1.0	70,519	yd^3	Supply (from onsite stockpile) and grade
2	Geosynthetic Clay Liner	1,904,000	—	1,904,000	ft^2	Use \$0.42/ ft^2or your Alaska cost
3	Flexible Membrane Liner	1,904,000	—	1,904,000	ft^2	Use \$0.35/ ft^2or your Alaska cost
4	Granular Drainage Material	1,904,000	1.5	105,778	yd^3	Assume screened from onsite materials to remove fines
5	Silt-Loam Topsoil	1,904,000	0.7	47,012	yd^3	Assume available onsite
6	Hydroseeding	1,904,000	—	1,904,000	ft^2	
7	Stormwater-Construct Terraces	—	—	1,000	LF	Use $8.00/LF (2006)
8	Landfill Gas Collection System	—	—	3,300,000	2006 dollars	EPA Guide for Methane Mitigation Projects, 1996
9	Flare System	—	—	300,000	2006 dollars	EPA Guide for Methane Mitigation Projects, 1996
Monitoring Equipment - Year 2071						
1	Abandon gas probes	—	150.0	2	300	
2	Install new gas probes	—	150.0	2	300	
3	Abandon monitoring wells	—	50.0	2	100	
4	Install new monitoring wells	—	50.0	2	100	
Annual Post-Closure Maintenance for 30 Years (2071 – 2101)						
1	Repair cover side slopes	13,425,000	—	24,861	yd^3	Assume 5% per year, 1-foot cover
2	Hydroseeding	13,425,000		671,250	ft^2	Assume 5% per year

TABLE J-1

Scope for Matanuska-Susitna Borough Central Landfill Post Closure Cost Estimate

Matanuska-Susitna Borough Central landfill Development Plan

No.	Item	Area (ft^2)	Depth (ft)	Quantity	Units	Comments
3	Maintain leachate collection equip.	—	5,000	dollars	—	
4	Collect, treat, dispose leachate	—	—	819,000	gal	Use $0.10 per gallon
5	Clean perimeter drainage ditches	—	—	3,000	LF	Use $5.00 per LF
Annual Post-Closure Monitoring for 30 Years (2071 - 2101)						
1	Groundwater sampling & analysis	—	—	—	$25,000	Estimated average over 30 years
2	Methane sampling & analysis	—	—	—	$15,000	Estimated average over 30 years
3	Surface water sampling & analysis	—	—	—	$10,000	Estimated average over 30 years
4	Leachate sampling & analysis	—	—	—	$10,000	Estimated average over 30 years
Post-Closure Certification - Year 2101						
1	Post-Closure Certification Report	—	—	—	$25,000	2006 costs, to be incurred in 2100
	Administrative Services	10% of subtotal				
	Technical and Professional Services	12% of subtotal				
	Closure Contingency	5% of subtotal				

Notes:

EPA = U.S. Environmental Protection Agency
ft^2 = square foot
LF = linear feet
yd^3 = cubic yard

09/12/2014 15:49
2014-080 MSB LANDFILL CLOSURE
***

BID TOTALS

Biditem	Description	Status - Rnd	Quantity	Units	Unit Price	Bid Total
10	MOBILIZATION		1.000	LS	496,000.00	496,000.00
20	BONDS & INSURANCE		1.000	LS	431,154.00	431,154.00
30	SUBMITTALS		1.000	LS	34,533.88	34,533.88
40	PERMITS		1.000	LS	7,500.00	7,500.00
50	SURVEY		1.000	LS	38,500.00	38,500.00
60	LEVELING COURSE (6")		32,569.000	CY	5.59	182,060.71
70	GEOSYNTHETIC CLAY LINER		195,412.000	SY	7.50	1,465,590.00
80	FLEXIBLE MEMBRANE LINER		195,412.000	SY	9.59	1,874,001.08
90	GRANULAR DRAINAGE MATERIAL(18")		97,706.000	CY	26.92	2,630,245.52
100	EARTHEN MATERIAL/TOPSOIL(6")		32,569.000	CY	14.92	485,929.48
110	HYDROSEEDING		1,759.000	MSF	150.00	263,850.00
120	MONITORING WELLS		4.000	EA	3,750.00	15,000.00
130	STORMWATER CONTROL TERRACES		1,000.000	LF	14.27	14,270.00
140	LANDFILL GAS COLLECTION SYSTEM		1.000	LS	3,750,000.00	3,750,000.00
150	GAS FLARE SYSTEM		1.000	LS	350,000.00	350,000.00
200	DEMOBILIZATION		1.000	LS	345,000.00	345,000.00
910	CONTRACTOR OVERHEAD		1.000	LS	1,235,440.00	1,235,440.00
920	CH OVERHEAD		1.000	LS	1,482,530.00	1,482,530.00
930	CONTINGENCY		1.000	LS	617,720.00	617,720.00
970	TAXES		1.000	LS	370,632.00	370,632.00
980	MARK UP(PROFIT)		1.000	LS	1,235,424.00	1,235,424.00
			Bid Total	========>		$17,325,380.67

Direct Cost Report

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Activity       Desc                   Quantity              Unit           Perm    Constr   Equip     Sub-
   Resource                        Pcs          Unit        Cost    Labor  Materi  Matl/Ex   Ment Contrac      Total
--------------------------------------------------------------------------------------------------------------------

BID ITEM =     10                                   Land Item   SCHEDULE:   1         100
Description = MOBILIZATION                             Unit =   LS   Takeoff Quan:   1.000    Engr Quan:     1.000

19001005     MOBILIZATION                           Quan:    1.00 LS   Hrs/Shft: 8.00            WCNONE

assume 4% of direct cost
4MOB         MOBILIZATION       1.00       1.00 LS         496,000.000                          496,000 496,000
--------------------------------------------------------------------------------------------------------------------

BID ITEM =     20                                   Land Item   SCHEDULE:   1         100
Description = BONDS & INSURANCE                        Unit =   LS   Takeoff Quan:   1.000    Engr Quan:     1.000

11002005     BONDS                                  Quan:    1.00 LS   Hrs/Shft: 8.00            WCNONE

BONDS 1.7% X $17,246,165 = $293,185
3BOND        BOND COST          1.00       1.00 LS         293,185.000           293,185                 293,185

11002010     INSURANCE                              Quan:    1.00 LS   Hrs/Shft: 8.00            WCNONE

INSURANCE 0.8% X $17,246,165 = $137,969
3INSURANC    INSURANCE COST     1.00       1.00 LS         137,969.000           137,969                 137,969
                                                                  ----------------------------------------------
=====> Item Totals:     20      - BONDS & INSURANCE
$431,154.00                                             [ ]                      431,154                 431,154
431,154.000                 1 LS                                               431,154.00              431,154.00
--------------------------------------------------------------------------------------------------------------------

BID ITEM =     30                                   Land Item   SCHEDULE:   1         100
Description = SUBMITTALS                               Unit =   LS   Takeoff Quan:   1.000    Engr Quan:     1.000

11003005     WORK PLAN                              Quan:    1.00 LS   Hrs/Shft: 8.00            WCNONE

 11030       SUBMITTALS                    24.00  CH       Prod:   0.0417 UH   Lab Pcs:  3.10   Eqp Pcs:  0.00
3DOCMTRL     DOCUMENT MATE      1.00       1.00 LS         200.000                  200                      200
X414         Project Eng    E6  1.00      24.00 MH          72.700    2,408                                2,408
X430         Project Controls E 4  0.20    4.80 MH          52.900      350                                  350
X434         Cost/Schedule  E3  0.20       4.80 MH          43.800      290                                  290
X442         Document  Tech T2  0.10       2.40 MH          24.900       82                                   82
X450         Field Engineer  T4  0.20      4.80 MH          39.800      264                                  264
X462         Quality  Mngr  E4  0.20       4.80 MH          52.900      350                                  350
X866         Admin Assist.  T1  1.00      24.00 MH          22.900      758                                  758
X918         Safety Engineer E3  0.20      4.80 MH          43.900      291                                  291
$4,994.12          74.4000 MH/LS          74.40 MH         [ 3474 ]   4,794            200                 4,994
  0.0417  Units/Hr *  0.3333 Un/Shift   0.0134 Unit/M              4,794.12         200.00              4,994.12
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Activity        Desc                   Quantity                Unit            Perm   Constr    Equip   Sub-
   Resource                        Pcs          Unit           Cost    Labor  Materi  Matl/Ex    Ment Contrac      Total
------------------------------------------------------------------------------------------------------------------------

BID ITEM =      30                                    Land Item    SCHEDULE:   1            100
Description = SUBMITTALS                                 Unit =    LS   Takeoff Quan:    1.000     Engr Quan:     1.000

11003010      PROJECT SCHEDULE                          Quan:    1.00 LS   Hrs/Shft: 8.00          WC NONE

 11030        SUBMITTALS                      32.00  CH       Prod:   0.0313 UH  Lab Pcs:  1.85     Eqp Pcs:  0.00
3DOCMTRL      DOCUMENT MATE 1.00      1.00 LS          350.000                    350                        350
X414          Project Eng     E6  0.15     4.80 MH           72.700      482                                    482
X430          Project Controls E 4 0.10    3.20 MH           52.900      234                                    234
X434          Cost/Schedule  E3  1.00     32.00 MH           43.800    1,934                                  1,934
X442          Document  Tech T2  0.10      3.20 MH           24.900      110                                    110
X866          Admin Assist.  T1  0.50     16.00 MH           22.900      506                                    506
$3,614.97            59.2000 MH/LS        59.20 MH       [ 2365.92 ]   3,265             350                  3,615
  0.0313  Units/Hr *    0.2500 Un/Shift   0.0169 Unit/M               3,264.97          350.00               3,614.97

11003015      SWPPP                                     Quan:    1.00 LS   Hrs/Shft: 8.00          WC NONE

FOR ALL SUBMITTALS ASSUME A DRAFT A DRAFT FINAL AND A FINAL FOR MOST SUBMITTALS
 11020        PLAN/DOC CREW                    2.00  CH       Prod:   0.5000 UH  Lab Pcs: 68.00     Eqp Pcs:  0.00
3DOCMTRL      DOCUMENT MATE 1.00      1.00 LS          750.000                    750                        750
AAA           *********LABOR**        0.00 MH            0.000
X274          Adminst Asst.    T2  18.00  36.00 MH           24.900    1,237                                  1,237
X414          Project Eng     E6  32.00   64.00 MH           72.700    6,421                                  6,421
X426          Jr Staff Eng    E3  18.00   36.00 MH           43.800    2,176                                  2,176
$10,583.87          136.0000 MH/LS       136.00 MH          [ 7126 ]   9,834             750                 10,584
  0.5000  Units/Hr *    4.0000 Un/Shift   0.0074 Unit/M               9,833.87          750.00              10,583.87

11003020      HASP                                      Quan:    1.00 LS   Hrs/Shft: 8.00          WC NONE

 11020        PLAN/DOC CREW                    1.00  CH       Prod:   1.0000 UH  Lab Pcs: 58.00     Eqp Pcs:  0.00
3DOCMTRL      DOCUMENT MATE 1.00      1.00 LS          950.000                    950                        950
AAA           *********LABOR**        0.00 MH            0.000
X274          Adminst Asst.    T2  20.00  20.00 MH           24.900      687                                    687
X414          Project Eng     E6  10.00   10.00 MH           72.700    1,003                                  1,003
X426          Jr Staff Eng    E3   8.00    8.00 MH           43.800      484                                    484
X918          Safety Engineer  E3  20.00  20.00 MH           43.900    1,212                                  1,212
$4,335.69            58.0000 MH/LS        58.00 MH         [ 2453.4 ]   3,386             950                  4,336
  1.0000  Units/Hr *    8.0000 Un/Shift   0.0172 Unit/M               3,385.69          950.00               4,335.69

11003025      QA/QC PLAN                                Quan:    1.00 LS   Hrs/Shft: 8.00          WC NONE

 11020        PLAN/DOC CREW                    1.00  CH       Prod:   1.0000 UH  Lab Pcs: 56.00     Eqp Pcs:  0.00
3DOCMTRL      DOCUMENT MATE 1.00      1.00 LS          700.000                    700                        700
AAA           *********LABOR**        0.00 MH            0.000
X274          Adminst Asst.    T2  20.00  20.00 MH           24.900      687                                    687
X414          Project Eng     E6  12.00   12.00 MH           72.700    1,204                                  1,204
X462          Quality  Mngr  E4  24.00    24.00 MH           52.900    1,752                                  1,752
$4,343.20            56.0000 MH/LS        56.00 MH          [ 2640 ]   3,643             700                  4,343
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Activity        Desc                       Quantity              Unit              Perm    Constr    Equip     Sub-
   Resource                          Pcs           Unit          Cost     Labor   Materi  Matl/Ex   Ment Contrac      Total
------------------------------------------------------------------------------------------------------------------------

BID ITEM =      30                                   Land Item     SCHEDULE:    1          100
Description = SUBMITTALS                                Unit =     LS   Takeoff Quan:     1.000      Engr Quan:     1.000

  1.0000  Units/Hr *    8.0000  Un/Shift     0.0179  Unit/M                3,643.20           700.00             4,343.20

11003030      TRAFFIC PLAN                              Quan:     1.00  LS   Hrs/Shft: 8.00            WC NONE

 11020        PLAN/DOC CREW                     2.00   CH        Prod:   0.5000 UH   Lab Pcs: 52.00    Eqp Pcs:  0.00
3DOCMTRL      DOCUMENT MATE  1.00        1.00  LS          250.000                        250                    250
AAA           *********LABOR**           0.00  MH            0.000
X274          Adminst Asst.   T2  16.00  32.00  MH           24.900    1,100                                    1,100
X414          Project Eng     E6  12.00  24.00  MH           72.700    2,408                                    2,408
X426          Jr Staff Eng    E3  12.00  24.00  MH           43.800    1,451                                    1,451
X918          Safety Engineer E3  12.00  24.00  MH           43.900    1,454                                    1,454
$6,662.03          104.0000  MH/LS      104.00  MH         [ 4646.4 ]  6,412              250                    6,662
  0.5000  Units/Hr *    4.0000  Un/Shift     0.0096  Unit/M                6,412.03           250.00             6,662.03
                                                                    ---------------------------------------------------
=====> Item Totals:       30       - SUBMITTALS
$34,533.88       487.6000  MH/LS        487.60  MH      [ 22705.72 ]  31,334            3,200                   34,534
34,533.880                   1 LS                                  31,333.88          3,200.00               34,533.88
------------------------------------------------------------------------------------------------------------------------

BID ITEM =      40                                   Land Item     SCHEDULE:    1          100
Description = PERMITS                                   Unit =     LS   Takeoff Quan:     1.000      Engr Quan:     1.000

11004010      DUST PERMIT                               Quan:     1.00  LS   Hrs/Shft: 8.00            WC NONE

NO INFORMATION ON ANY PERMITS ASSUME WE MAY NEED A DUST PERMIT AS A MINNIMUM
3DUSTPRM      DUST PERMIT       1.00      1.00  LS        7,500.000                     7,500                    7,500
                                                                    ---------------------------------------------------
=====> Item Totals:       40       - PERMITS
$7,500.00                                                      [ ]                      7,500                    7,500
7,500.000                    1 LS                                                    7,500.00                 7,500.00
------------------------------------------------------------------------------------------------------------------------

BID ITEM =      50                                   Land Item     SCHEDULE:    1          100
Description = SURVEY                                    Unit =     LS   Takeoff Quan:     1.000      Engr Quan:     1.000

11005005      SURVEY                                    Quan:     1.00  LS   Hrs/Shft: 8.00            WC NONE

THIS WOULD INCLUDE LAYOUT OF VARIOUS LIFTS . ALSO EARTHWORK QUANTITIES AND FINAL AS
BUILT DRAWAINGS
4SURVEY       SURVEY SUB        1.00    350.00  HR          110.000                                     38,500   38,500
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Activity Resource	Desc	Pcs	Quantity	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total

BID ITEM = 60 Land Item SCHEDULE: 1 100
Description = LEVELING COURSE (6") Unit = CY Takeoff Quan: 32,569.000 Engr Quan: 32,569.000

19006005 LEVELING COURSE (6") Quan: 32,569.00 CY Hrs/Shft: 8.00 WC NONE

THIS IS ON SITE MATERIAL THAT IS CLOSE THE QUANTITY OF MATERIAL SHOWN IS AVERAGE 6" OVER THE SITE

19200 SCRAPER EXCAV 70.00 CH Prod: 465.2714 UH Lab Pcs: 12.00 Eqp Pcs: 10.00

8AAAA	*******EQUIPMEN		0.00	HR	0.000						
8BDZR09T	Bulldozer Cat D9T	1.00	70.00	HR	292.721				20,490		20,490
8COMPACB8	Compactor Cat 825H	1.00	70.00	HR	214.573				15,020		15,020
8GRDR16	Grader Cat 16M 297	1.00	70.00	HR	216.325				15,143		15,143
8SCRPRTE62	Scraper Cat 627G TE	4.00	280.00	HR	266.878				74,726		74,726
8TRKPU25	Pickup 4x4 3/4 Ton D	1.00	70.00	HR	14.854				1,040		1,040
8TRKWTR04	Water Truck 4,000 ga	1.00	70.00	HR	60.834				4,258		4,258
8WATERTK1	Klein Tank 12K Gallo	1.00	70.00	HR	18.585				1,301		1,301
AAA	*********LABOR**	1.00	70.00	MH	0.000						
LA30	Laborer General	1.00	70.00	MH	29.210	3,975					3,975
OP01F	Oper Foreman	1.00	70.00	MH	42.040	4,897					4,897
OPB14	Oper Blade (Rough)	1.00	70.00	MH	38.510	4,605					4,605
OPC10	Oper Compactor Larg	1.00	70.00	MH	37.790	4,546					4,546
OPD10	Oper Dozer Large	1.00	70.00	MH	39.280	4,669					4,669
OPSC10	Oper Scraper < 40 Cy	4.00	280.00	MH	38.510	18,422					18,422
OPSPT14	Oper Grade Checker	1.00	70.00	MH	37.790	4,546					4,546
TE22	Tmstr Dmp Trk 6-14c	1.00	70.00	MH	36.790	4,339					4,339
$181,977.24	0.0257 MH/CY		840.00	MH	[0.893]	49,999			131,978		181,977
465.2714 Units/Hr *	3,722.1714 Un/Shift		38.7726	Unit/M		1.54			4.05		5.59

=====> Item Totals: 60 - LEVELING COURSE (6")

$181,977.24	0.0257 MH/CY		840.00	MH	[0.893]	49,999			131,978		181,977
5.587	32569 CY					1.54			4.05		5.59

BID ITEM = 70 Land Item SCHEDULE: 1 100
Description = GEOSYNTHETIC CLAY LINER Unit = SY Takeoff Quan: 195,412.000 Engr Quan: 195,412.000

19007005 GEOSYNTHETIC CLAY LINER Quan: 195,412.00 SY Hrs/Shft: 8.00 WC NONE

13010 SMALL SWPP CREW 600.00 CH Prod: 325.6867 UH Lab Pcs: 11.00 Eqp Pcs: 4.00

2GCL	GEOSYNTHETIC C	1.05	195,412.00	SY	4.900		957,519				957,519
3GRDST&S	GRADING ST&S	1.00	6,600.00	HM	2.000			13,200			13,200
3PPE	PPE	1.00	6,600.00	HM	2.500			16,500			16,500
8AAAA	*******EQUIPMEN		0.00	HR	0.000						
8LDRW950	Loader Cat 950H 4C	1.00	600.00	HR	84.857				50,914		50,914
8TRKGS10	Flatbed Truck 15K 20	2.00	1,200.00	HR	25.297				30,356		30,356
8TRKPU10	Pickup 4x2 3/4 Ton G	1.00	600.00	HR	13.322				7,993		7,993

```
Activity          Desc                    Quantity              Unit            Perm    Constr    Equip     Sub-
   Resource                          Pcs           Unit         Cost    Labor  Materi  Matl/Ex    Ment  Contrac        Total

BID ITEM =      70                                    Land Item    SCHEDULE:   1          100
Description = GEOSYNTHETIC CLAY LINER                  Unit =      SY   Takeoff Quan: 195,412.000    Engr Quan:   195,412.000

AAA           *********LABOR**               0.00  MH           0.000
LA01F         Laborer Foreman       1.00   600.00  MH          36.260   39,064                                        39,064
LA30          Laborer General       7.00 4,200.00  MH          29.210  238,509                                       238,509
OPL10         Oper Loader Wheel <   1.00   600.00  MH          37.790   38,965                                        38,965
TE18          Teamster Flatrack 1 A 2.00 1,200.00  MH          35.790   72,963                                        72,963
$1,465,983.40           0.0337  MH/SY    6,600.00  MH       [ 1.075 ] 389,501 957,519   29,700   89,264            1,465,983
 325.6867   Units/Hr * 2,605.4933 Un/Shift  29.6079 Unit/M                1.99    4.90     0.15     0.46                 7.50

=====> Item Totals:       70        - GEOSYNTHETIC CLAY LINER
$1,465,983.40      0.0337  MH/SY         6,600.00  MH       [ 1.075 ] 389,501 957,519   29,700   89,264            1,465,983
7.502                         195412 SY                                1.99    4.90     0.15     0.46                 7.50


BID ITEM =      80                                    Land Item    SCHEDULE:   1          100
Description = FLEXIBLE MEMBRANE LINER                  Unit =      SY   Takeoff Quan: 195,412.000    Engr Quan:   195,412.000

19008005      FLEXIBLE MEMBRANE LINER                 Quan: 195,412.00 SY   Hrs/Shft: 8.00           WCNONE

4LINER        LINER SUB             1.00 195,412.00 SY          9.500                                  1,856,414 1,856,414

19008010      LINER TESTING SUPPORT                   Quan: 195,412.00 SY   Hrs/Shft: 8.00           WCNONE

 13010        SMALL SWPP CREW                 48.00  CH       Prod: 4,071.0833 UH  Lab Pcs:  4.00   Eqp Pcs:  4.00
3GRDST&S      GRADING ST&S          1.00   192.00  HM           2.000                     384                            384
3PPE          PPE                   1.00   192.00  HM           2.500                     480                            480
8AAAA         *******EQUIPMEN                0.00  HR           0.000
8COMPR04      Compressor 185 CFM    1.00    48.00  HR          16.134                                774                   774
8TRKGS10      Flatbed Truck 15K 20  1.00    48.00  HR          25.297                              1,214                 1,214
8TRKPU10      Pickup 4x2 3/4 Ton G  1.00    48.00  HR          13.322                                639                   639
8TRKWTR04     Water Truck 4,000 ga  1.00    48.00  HR          60.834                              2,920                 2,920
AAA           *********LABOR**               0.00  MH           0.000
LA01F         Laborer Foreman       1.00    48.00  MH          36.260    3,125                                         3,125
LA30          Laborer General       2.00    96.00  MH          29.210    5,452                                         5,452
TE22          Tmstr Dmp Trk 6-14c   1.00    48.00  MH          36.790    2,975                                         2,975
$17,964.04              0.0009  MH/SY      192.00  MH       [ 0.032 ]   11,552             864    5,548                17,964
 4,071.0833 Units/Hr * 32,568.6667 Un/Shift 1,017.7806 Unit/M             0.06                      0.03                  0.09

=====> Item Totals:       80        - FLEXIBLE MEMBRANE LINER
$1,874,378.04      0.0009  MH/SY           192.00  MH       [ 0.032 ]   11,552             864    5,548 1,856,414 1,874,378
9.592                         195412 SY                                0.06                       0.03     9.50      9.59
```

BID ITEM = 90 Land Item SCHEDULE: 1 100
Description = GRANULAR DRAINAGE MATERIAL(18") Unit = CY Takeoff Quan: 97,706.000 Engr Quan: 97,706.000

19009005 LOAD & HAUL (2 MI) TO SCREEN PLA Quan: 107,477.00 CY Hrs/Shft: 8.00 WC NONE

ASSUMES 10% WASTE WATER TRUCK AND BLADE FULL TIME ON HAUL ROAD ASSUMES THE HAUL ROAD (2 MILES) IS ROUGHED IN PLACE . D-7 DOZER PUSH TO 980 FEL AND D-7 DOZER AT PLANT STOCK PILE

19120 LOAD & HAUL 400.00 CH Prod: 268.6925 UH Lab Pcs: 12.00 Eqp Pcs: 11.00

Activity Resource	Desc	Pcs	Quantity	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
3GRDST&S	GRADING ST&S	1.00	4,800.00	HM	2.000			9,600			9,600
3PPE	PPE	1.00	4,800.00	HM	2.500			12,000			12,000
8AAAA	*******EQUIPMEN		0.00	HR	0.000						
8BDZR07R	Bulldozer Cat D7R X	2.00	800.00	HR	146.537				117,230		117,230
8GRDR12	Grader Cat 12H 145	1.00	400.00	HR	77.429				30,972		30,972
8LDRW980	Loader Cat 980H 7.5	1.00	400.00	HR	156.432				62,573		62,573
8TRKOR730	Off Road Cat 730 Arti	5.00	2,000.00	HR	131.807				263,614		263,614
8TRKPU15	Pickup 4x4 3/4 Ton G	1.00	400.00	HR	15.264				6,106		6,106
8TRKWTR04	Water Truck 4,000 ga	1.00	400.00	HR	60.834				24,334		24,334
AAA	*********LABOR**		0.00	MH	0.000						
LA30	Laborer General	1.00	400.00	MH	29.210	22,715					22,715
OP01F	Oper Foreman	1.00	400.00	MH	42.040	27,983					27,983
OPB14	Oper Blade (Rough)	1.00	400.00	MH	38.510	26,317					26,317
OPD10	Oper Dozer Large	2.00	800.00	MH	39.280	53,360					53,360
OPL14	Oper Loader Wheel >	1.00	400.00	MH	39.280	26,680					26,680
TE22	Tmstr Dmp Trk 6-14c	1.00	400.00	MH	36.790	24,793					24,793
TR26	Teamster Dump 29-3	5.00	2,000.00	MH	38.890	128,920					128,920
$837,195.68	0.0446 MH/CY		4,800.00	MH	[1.708]	310,768		21,600	504,827		837,196
268.6925 Units/Hr *	2,149.5400 Un/Shift		22.3910	Unit/M		2.89		0.20	4.70		7.79

19009010 MOB & SET UP SCREEN PLANT Quan: 1.00 LS Hrs/Shft: 8.00 WC NONE

19100 MOB & SET SCREEN 20.00 CH Prod: 0.0500 UH Lab Pcs: 11.00 Eqp Pcs: 14.00

Activity Resource	Desc	Pcs	Quantity	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
3GRDST&S	GRADING ST&S	1.00	220.00	HM	2.000			440			440
3MISCLMTR	MISCL MATERIAL	1.00	1.00	LS	750.000			750			750
3PPE	PPE	1.00	220.00	HM	2.500			550			550
8AAAA	*******EQUIPMEN		0.00	HR	0.000						
8AGGPL22	Conveyor 300 TPH, 2	1.00	20.00	HR	23.199				464		464
8AGGPL42	Vib Griz Feeder 42"x	1.00	20.00	HR	40.566				811		811
8AGGPL50	Screen Double Deck 5	1.00	20.00	HR	39.084				782		782
8BDZR08T	Bulldozer Cat D8T	1.00	20.00	HR	223.120				4,462		4,462
8CRANERT5	Crane Grove RT525E	1.00	20.00	HR	93.141				1,863		1,863
8GEN100	Generator 100 KW	1.00	20.00	HR	42.046				841		841
8LDRW980	Loader Cat 980H 7.5	1.00	20.00	HR	156.432				3,129		3,129
8TRKGS10	Flatbed Truck 15K 20	1.00	20.00	HR	25.297				506		506
8TRKGS60	Mechanics Truck 35K	1.00	20.00	HR	83.419				1,668		1,668
8TRKHW15	Tractor 400 HP 75K	2.00	40.00	HR	74.417				2,977		2,977
8TRKHW30	Lowbed Trailer 60 T	2.00	40.00	HR	29.470				1,179		1,179

```
Activity        Desc                    Quantity              Unit           Perm    Constr    Equip     Sub-
   Resource                        Pcs          Unit          Cost    Labor  Materi  Matl/Ex    Ment  Contrac      Total
-------------------------------------------------------------------------------------------------------------------------

BID ITEM =      90                                    Land Item    SCHEDULE:   1           100
Description = GRANULAR DRAINAGE MATERIAL(18")   Unit =    CY    Takeoff Quan: 97,706.000     Engr Quan:  97,706.000

8TRKPU15    Pickup 4x4 3/4 Ton G  1.00     20.00 HR         15.264                              305                  305
AAA         *********LABOR**                0.00 MH          0.000
LA30        Laborer General       2.00     40.00 MH         29.210    2,272                                        2,272
OP01F       Oper Foreman          1.00     20.00 MH         42.040    1,399                                        1,399
OPCR10      Opr Crane 15-50 Ton   1.00     20.00 MH         38.510    1,316                                        1,316
OPD10       Oper Dozer Large      1.00     20.00 MH         39.280    1,334                                        1,334
OPL14       Oper Loader Wheel >   1.00     20.00 MH         39.280    1,334                                        1,334
OPSPT22     Oper Mech (Heavy)     1.00     20.00 MH         41.040    1,376                                        1,376
OPSPT38     Oper Screen Belt Or   1.00     20.00 MH         37.790    1,299                                        1,299
TE18        Teamster Flatrack 1 A 1.00     20.00 MH         35.790    1,216                                        1,216
TE34        Teamster High-Low B   2.00     40.00 MH         38.890    2,578                                        2,578
$34,850.18         220.0000  MH/LS    220.00 MH       [ 8198.6 ]   14,123             1,740   18,987              34,850
  0.0500  Units/Hr *   0.4000 Un/Shift  0.0045 Unit/M          14,123.34          1,740.00 18,986.84           34,850.18

19009015    SCREEN MATERIAL                         Quan: 145,095.00 TN  Hrs/Shft: 8.00          WC NONE

 19100      MOB & SET SCREEN                820.00  CH        Prod: 176.9451 UH   Lab Pcs:  7.00     Eqp Pcs:  8.00
3GRDST&S    GRADING ST&S          1.00  5,740.00 HM          2.000                      11,480                    11,480
3MSCLMTRL   MISCELLANEOUS         1.00 145,095.00 TN         0.100                      14,510                    14,510
3PPE        PPE                   1.00  5,740.00 HM          2.500                      14,350                    14,350
8AAAA       *******EQUIPMEN                 0.00 HR          0.000
8AGGPL22    Conveyor 300 TPH, 2   1.00    820.00 HR         23.199                              19,023            19,023
8AGGPL42    Vib Griz Feeder 42"x  1.00    820.00 HR         40.566                              33,264            33,264
8AGGPL50    Screen Double Deck 5  1.00    820.00 HR         39.084                              32,049            32,049
8BDZR08T    Bulldozer Cat D8T     1.00    820.00 HR        223.120                             182,958           182,958
8GEN100     Generator 100 KW      1.00    820.00 HR         42.046                              34,478            34,478
8LDRW980    Loader Cat 980H 7.5   1.00    820.00 HR        156.432                             128,274           128,274
8TRKGS60    Mechanics Truck 35K   1.00    820.00 HR         83.419                              68,404            68,404
8TRKPU15    Pickup 4x4 3/4 Ton G  1.00    820.00 HR         15.264                              12,516            12,516
AAA         *********LABOR**                0.00 MH          0.000
LA30        Laborer General       2.00  1,640.00 MH         29.210   93,132                                       93,132
OP01F       Oper Foreman          1.00    820.00 MH         42.040   57,365                                       57,365
OPD10       Oper Dozer Large      1.00    820.00 MH         39.280   54,694                                       54,694
OPL14       Oper Loader Wheel >   1.00    820.00 MH         39.280   54,694                                       54,694
OPSPT22     Oper Mech (Heavy)     1.00    820.00 MH         41.040   56,397                                       56,397
OPSPT38     Oper Screen Belt Or   1.00    820.00 MH         37.790   53,253                                       53,253
$920,841.55          0.0395  MH/TN  5,740.00 MH        [ 1.457 ]  369,535            40,340  510,967             920,842
 176.9451  Units/Hr * 1,415.5610 Un/Shift 25.2779 Unit/M               2.55               0.28     3.52                6.35

19009020    LOAD,HAUL&PLACE GRANULAR MA             Quan: 97,706.00 CY  Hrs/Shft: 8.00           WC NONE

 19017      LOAD,HAUL,PLACE TS              500.00  CH        Prod: 195.4120 UH   Lab Pcs: 13.00     Eqp Pcs: 15.00
3GRDST&S    GRADING ST&S          1.00  6,500.00 HM          2.000                      13,000                    13,000
3PPE        PPE                   1.00  6,500.00 HM          2.500                      16,250                    16,250
8AAAA       *******EQUIPMEN                 0.00 HR          0.000
```

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Activity          Desc                  Quantity            Unit           Perm   Constr    Equip     Sub-
    Resource                        Pcs          Unit       Cost    Labor  Materi MatI/Ex    MentContrac        Total

BID ITEM =      90                                      Land Item    SCHEDULE:   1            100
Description = GRANULAR DRAINAGE MATERIAL(18")  Unit =   CY  Takeoff Quan: 97,706.000    Engr Quan:  97,706.000

8BDZR04LGPBulldozer Cat D 4G L  1.00    500.00 HR         58.006                          29,003            29,003
8GRDR12   Grader Cat 12H 145    1.00    500.00 HR         77.429                          38,715            38,715
8LDRW980  Loader Cat 980H 7.5   1.00    500.00 HR        156.432                          78,216            78,216
8TRKHW10  Tandem Truck 12 CY    5.00  2,500.00 HR         73.856                         184,640           184,640
8TRKHW25  Bottom Dump Trailer   5.00  2,500.00 HR         12.270                          30,675            30,675
8TRKPU25  Pickup 4x4 3/4 Ton D  1.00    500.00 HR         14.854                           7,427             7,427
8TRKWTR04 Water Truck 4,000 ga  1.00    500.00 HR         60.834                          30,417            30,417
AAA       *********LABOR**                0.00 MH          0.000
LA30      Laborer General       2.00  1,000.00 MH         29.210  56,788                                    56,788
OP01F     Oper Foreman          1.00    500.00 MH         42.040  34,979                                    34,979
OPB10     Oper Blade Finish     1.00    500.00 MH         39.280  33,350                                    33,350
OPD10     Oper Dozer Large      1.00    500.00 MH         39.280  33,350                                    33,350
OPL10     Oper Loader Wheel <   1.00    500.00 MH         37.790  32,471                                    32,471
OPSPT14   Oper Grade Checker    1.00    500.00 MH         37.790  32,471                                    32,471
TE22      Tmstr Dmp Trk 6-14c   1.00    500.00 MH         36.790  30,991                                    30,991
TE26      Tmstr Dmp Trk 14-29   5.00  2,500.00 MH         36.790 154,956                                   154,956
$837,698.10         0.0665  MH/CY     6,500.00 MH      [ 2.433 ] 409,356          29,250 399,093           837,698
 195.4120  Units/Hr *  1,563.2960 Un/Shift   15.0317 Unit/M         4.19            0.30    4.08              8.57

=====> Item Totals:      90      - GRANULAR DRAINAGE MATERIAL(18")
$2,630,585.51     0.1766  MH/CY      17,260.00 MH      [ 6.559 ] 1,103,783        92,930 1,433,873        2,630,586
26.923                      97706 CY                               11.30            0.95   14.68             26.92

BID ITEM =     100                                      Land Item    SCHEDULE:   1            100
Description = EARTHEN MATERIAL/TOPSOIL(6")      Unit =   CY  Takeoff Quan: 32,569.000    Engr Quan:  32,569.000

19010005      EARTHEN MATERIAL/TOPSOIL(6")    Quan: 32,569.00 CY  Hrs/Shft: 8.00           WCNONE

ASSUME CLOSE BY SOURCE WITH A $3.50 ROYALTY LOADED
 19017    LOAD,HAUL,PLACE TS                232.00 CH       Prod: 140.3836 UH  Lab Pcs: 13.00     Eqp Pcs: 15.00
2TOPSOIL  TOP SOIL              1.00 32,569.00 CY          3.500          113,992                          113,992
3GRDST&S  GRADING ST&S          1.00  3,016.00 HM          2.000                   6,032                     6,032
3PPE      PPE                   1.00  3,016.00 HM          2.500                   7,540                     7,540
8AAAA     *******EQUIPMEN                 0.00 HR          0.000
8BDZR04LGPBulldozer Cat D 4G L  1.00    232.00 HR         58.006                          13,457            13,457
8GRDR12   Grader Cat 12H 145    1.00    232.00 HR         77.429                          17,964            17,964
8LDRW950  Loader Cat 950H 4C    1.00    232.00 HR         84.857                          19,687            19,687
8TRKHW10  Tandem Truck 12 CY    5.00  1,160.00 HR         73.856                          85,673            85,673
8TRKHW25  Bottom Dump Trailer   5.00  1,160.00 HR         12.270                          14,233            14,233
8TRKPU25  Pickup 4x4 3/4 Ton D  1.00    232.00 HR         14.854                           3,446             3,446
8TRKWTR04 Water Truck 4,000 ga  1.00    232.00 HR         60.834                          14,113            14,113
AAA       *********LABOR**                0.00 MH          0.000
LA30      Laborer General       2.00    464.00 MH         29.210  26,350                                    26,350
```

Direct Cost Report

Activity Resource	Desc	Quantity Pcs	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total

BID ITEM = 100 Land Item SCHEDULE: 1 100
Description = EARTHEN MATERIAL/TOPSOIL(6") Unit = CY Takeoff Quan: 32,569.000 Engr Quan: 32,569.000

Activity / Resource	Desc	Pcs	Quantity	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
OP01F	Oper Foreman	1.00	232.00	MH	42.040	16,230					16,230
OPB10	Oper Blade Finish	1.00	232.00	MH	39.280	15,474					15,474
OPD10	Oper Dozer Large	1.00	232.00	MH	39.280	15,474					15,474
OPL10	Oper Loader Wheel <	1.00	232.00	MH	37.790	15,067					15,067
OPSPT14	Oper Grade Checker	1.00	232.00	MH	37.790	15,067					15,067
TE22	Tmstr Dmp Trk 6-14c	1.00	232.00	MH	36.790	14,380					14,380
TE26	Tmstr Dmp Trk 14-29	5.00	1,160.00	MH	36.790	71,899					71,899
$486,077.95	0.0926 MH/CY		3,016.00	MH	[3.386]	189,941	113,992	13,572	168,573		486,078
140.3836 Units/Hr *	1,123.0690 Un/Shift		10.7987	Unit/M		5.83	3.50	0.42	5.18		14.92

=====> Item Totals: 100 - EARTHEN MATERIAL/TOPSOIL(6")

		Quantity	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
$486,077.95	0.0926 MH/CY	3,016.00	MH	[3.386]	189,941	113,992	13,572	168,573		486,078
14.925		32569	CY		5.83	3.50	0.42	5.18		14.92

BID ITEM = 110 Land Item SCHEDULE: 1 100
Description = HYDROSEEDING Unit = MSF Takeoff Quan: 1,759.000 Engr Quan: 1,759.000

19011005 HYDROSEEDING Quan: 1,759.00 MS Hrs/Shft: 8.00 WCNONE

NO SEEDING SPECIFICATIONS USED ADJUSTED PRICE FROM 2006 ESTIMATE

Resource	Desc	Pcs	Quantity	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
4HYDRO	HYDRO SEEDER	1.00	1,759.00	MSF	150.000					263,850	263,850

BID ITEM = 120 Land Item SCHEDULE: 1 100
Description = MONITORING WELLS Unit = EA Takeoff Quan: 4.000 Engr Quan: 4.000

19012005 MONITORING WELLS (50VLF) Quan: 4.00 EA Hrs/Shft: 8.00 WCNONE

ASSUME $75/VLF @ 50 VLF = $3750 EA ASSUMED A 50' DEPTH

Resource	Desc	Pcs	Quantity	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
4DRILL	WELL DRILLER	1.00	4.00	EA	3,750.000					15,000	15,000

BID ITEM = 130 Land Item SCHEDULE: 1 100
Description = STORMWATER CONTROL TERRACES Unit = LF Takeoff Quan: 1,000.000 Engr Quan: 1,000.000

19013005 STORMWATER CONTROL TERRACES Quan: 1,000.00 LF Hrs/Shft: 8.00 WCNONE

THIS ITEM COPIED FROM 2006 ESTIMATE AS WE HAVE NO DRAWINGS OR SPECIFICATIONS FOR THESE DITCHES

19015 SMALL EXCAV CREW 20.00 CH Prod: 50.0000 UH Lab Pcs: 7.00 Eqp Pcs: 4.00

Resource	Desc	Pcs	Quantity	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
3GRDST&S	GRADING ST&S	1.00	140.00	HM	2.000			280			280

```
Activity        Desc                  Quantity                 Unit          Perm    Constr    Equip     Sub-
   Resource                      Pcs            Unit           Cost   Labor  Materi  Matl/Ex    Ment  Contrac      Total
-----------------------------------------------------------------------------------------------------------------------

BID ITEM =      130                              Land Item    SCHEDULE:    1          100
Description = STORMWATER CONTROL TERRACES         Unit =      LF   Takeoff Quan: 1,000.000    Engr Quan:  1,000.000

3PPE          PPE                  1.00   140.00 HM           2.500                    350                         350
8AAAA         *******EQUIPMEN               0.00 HR           0.000
8EXC315       Excavator Cat 315D L 1.00    20.00 HR          79.812                           1,596              1,596
8TRKHW10      Tandem Truck 12 CY   2.00    40.00 HR          73.856                           2,954              2,954
8TRKPU15      Pickup 4x4 3/4 Ton G 1.00    20.00 HR          15.264                             305                305
AAA           *********LABOR**              0.00 MH           0.000
LA30          Laborer General      2.00    40.00 MH          29.210   2,272                                      2,272
OP01F         Oper Foreman         1.00    20.00 MH          42.040   1,399                                      1,399
OPH14         Oper Hydr Backhoe 3  1.00    20.00 MH          39.280   1,334                                      1,334
OPSPT14       Oper Grade Checker   1.00    20.00 MH          37.790   1,299                                      1,299
TE22          Tmstr Dmp Trk 6-14c  2.00    40.00 MH          36.790   2,479                                      2,479
$14,268.55            0.1400 MH/LF        140.00 MH       [ 5.022 ]   8,783            630    4,856             14,269
 50.0000  Units/Hr *  400.0000 Un/Shift    7.1429 Unit/M                8.78           0.63     4.86              14.27
                                                          _____________________________________________________________
=====> Item Totals:      130      - STORMWATER CONTROL TERRACES
$14,268.55         0.1400 MH/LF           140.00 MH       [ 5.022 ]   8,783            630    4,856             14,269
14.269                      1000 LF                                     8.78           0.63     4.86              14.27
-----------------------------------------------------------------------------------------------------------------------

BID ITEM =      140                              Land Item    SCHEDULE:    1          100
Description = LANDFILL GAS COLLECTION SYSTEM      Unit =      LS   Takeoff Quan:     1.000    Engr Quan:      1.000

19014005      LANDFILL GAS COLLECTION SYSTE    Quan:    1.00 LS  Hrs/Shft: 8.00          WC NONE

ADJUSTED COST FROM 2006 ESTIMATE AS WE HAVE NO DRAWINGS OR SPECIFICATIONS FOR THIS
WORK
4MECH         INSTALLATION SU      1.00     1.00 LS     3,750,000.000                               3,750,000  3,750,000
-----------------------------------------------------------------------------------------------------------------------

BID ITEM =      150                              Land Item    SCHEDULE:    1          100
Description = GAS FLARE SYSTEM                    Unit =      LS   Takeoff Quan:     1.000    Engr Quan:      1.000

19015005      GAS FLARE SYSTEM                 Quan:    1.00 LS  Hrs/Shft: 8.00          WC NONE

ADJUSTED PRICE FROM 2006 ESTIMATE AS WE HAVE NO DRAWINGS OR SPECIFICATIONS
4MECH         INSTALLATION SU      1.00     1.00 LS       350,000.000                                 350,000    350,000
-----------------------------------------------------------------------------------------------------------------------

BID ITEM =      200                              Land Item    SCHEDULE:    1          100
Description = DEMOBILIZATION                      Unit =      LS   Takeoff Quan:     1.000    Engr Quan:      1.000
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Activity         Desc                 Quantity              Unit             Perm   Constr    Equip   Sub-
   Resource                       Pcs           Unit        Cost    Labor  Materi  Matl/Ex    Ment Contrac      Total
_____________________________________________________________________________________________________________________

BID ITEM =    200                                 Land Item    SCHEDULE:   1          100
Description = DEMOBILIZATION                         Unit =    LS    Takeoff Quan:    1.000     Engr Quan:     1.000

19020005     DEMOBILIZATION                       Quan:     1.00  LS   Hrs/Shft: 8.00            WCNONE

assume 3% of direct costs
4DEMOB       DEMOBILZATION  1.00       1.00  LS       345,000.000                                  345,000  345,000
_____________________________________________________________________________________________________________________

BID ITEM =    910                                 Land Item    SCHEDULE:   1          100
Description = CONTRACTOR OVERHEAD                    Unit =    LS    Takeoff Quan:    1.000     Engr Quan:     1.000

11091005     CONTRACTOR OVERHEAD(GENERAL          Quan:     1.00  LS   Hrs/Shft: 8.00            WCNONE

10% OF DIRECT COT EXCLUDING BONDS&INSURANCE,CH OVERSIGHT,MANAGEMENT RESERVE
AS PER 2006 ESTIMATE
4CNTROH      CONTRACTOR OH  1.00       1.00  LS     1,235,440.000                                1,235,440 1,235,440
_____________________________________________________________________________________________________________________

BID ITEM =    920                                 Land Item    SCHEDULE:   1          100
Description = CH OVERHEAD                            Unit =    LS    Takeoff Quan:    1.000     Engr Quan:     1.000

11092005     CH OVERHEAD (TECHNICAL&PROFE         Quan:     1.00  LS   Hrs/Shft: 8.00            WCNONE

CH OVERSIGHT 12% OF COSTS EXCLUDING,BONDS&INSURANCE,PERMITS,EQUIPMENT
PURCHASE,CONTRACTOR OH,MANAGEMENT RESERVE AND MARK UP
AS PER 2006 ESTIMATE
4CH          CH OVERHEAD & P 1.00      1.00  LS     1,482,530.000                                1,482,530 1,482,530
_____________________________________________________________________________________________________________________

BID ITEM =    930                                 Land Item    SCHEDULE:   1          100
Description = CONTINGENCY                            Unit =    LS    Takeoff Quan:    1.000     Engr Quan:     1.000

11093005     MANAGEMENT RESERVE (CONTINGE         Quan:     1.00  LS   Hrs/Shft: 8.00            WCNONE

ASSUME A MANAGEMENT RESERVE OF 5% OF DIRECT COSTS
AS PER 2006 ESTIMATE
4MR15        MANAGE MENT RE 1.00       1.00  LS       617,720.000                                  617,720  617,720
_____________________________________________________________________________________________________________________

BID ITEM =    970                                 Land Item    SCHEDULE:   1          100
Description = TAXES                                  Unit =    LS    Takeoff Quan:    1.000     Engr Quan:     1.000
```

Activity Resource	Desc	Quantity Pcs	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub- Contrac	Total

BID ITEM = 970 Land Item SCHEDULE: 1 100
Description = TAXES Unit = LS Takeoff Quan: 1.000 Engr Quan: 1.000

11097005 TAXES (3% DIRECT COSTS) Quan: 1.00 LS Hrs/Shft: 8.00 WC NONE

TAXES 3% DIRECT COSTS
THIS TAX RATE HAS NOT BEEN CONFIRMED

Activity Resource	Desc	Quantity Pcs	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub- Contrac	Total
3TAXES	TAXES PALMER A	1.00	1.00 LS	370,632.000			370,632			370,632

=====> Item Totals: 970 - TAXES

$370,632.00		[ ]			370,632			370,632
370,632.000	1 LS				370,632.00			370,632.00

BID ITEM = 980 Land Item SCHEDULE: 1 100
Description = MARK UP(PROFIT) Unit = LS Takeoff Quan: 1.000 Engr Quan: 1.000

11098005 MARK UP (PROFIT) Quan: 1.00 LS Hrs/Shft: 8.00 WC NONE

CONTRACTOR MARK UP OF 10% OF CONTRACTOR COSTS
AS PER 2006 ESTIMATE

Activity Resource	Desc	Quantity Pcs	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub- Contrac	Total
4PROFIT	CONTRACTOR PRO	1.00	1.00 LS	1,235,424.000					1,235,424	1,235,424

			Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
$17,326,554.57	*** Report Totals ***	28,535.60 MH	1,784,892	1,071,510	950,182	1,834,093	11,685,878	17,326,555

>>> indicates Non Additive Activity
------Report Notes:------
The estimate was prepared with TAKEOFF Quantities.
This report shows TAKEOFF Quantities with the resources.

Bid Date: Owner: Engineering Firm:
Estimator-In-Charge:

JOB NOTES

```
Estimate created on: 07/30/2014 by User#: 0 -
Source estimate used: C:\HEAVYBID\EST\ESTMAST
Labor Setup copied from: C:\HEAVYBID\EST\2014-072
Equipment Setup copied from: C:\HEAVYBID\EST\2014-072
Crew Setup copied from: C:\HEAVYBID\EST\2014-072
Material/Other Resources Setup copied from: C:\HEAVYBID\EST\2014-072
Overtime Rules Setup copied from: C:\HEAVYBID\EST\2014-072
Burden Tables Setup copied from: C:\HEAVYBID\EST\2014-072

************Estimate created on: 09/10/2014 by User#: 0 -
```

Activity Resource	Desc	Quantity Pcs	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub- Contrac	Total

BID ITEM = 980 Land Item SCHEDULE: 1 100
Description = MARK UP(PROFIT) Unit = LS Takeoff Quan: 1.000 Engr Quan: 1.000

```
Source estimate used: C:\HEAVYBID\EST\2014-068
```

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* on units of MH indicate average labor unit cost was used rather than base rate.
[ ] in the Unit Cost Column = Labor Unit Cost Without Labor Burdens

```
 In equipment resources, rent % and EOE % not = 100% are represented as XXX%YYY where
XXX=Rent% and YYY=EOE%
```

------Calendar Codes------

Appendix K
Annual Contribution to Closure Fund Model

APPENDIX K

Annual Contribution to Closure Fund Model

TABLE K-1

Matanuska-Susitna Borough Central Landfill, Inputs to Closure Fund Contributions

Matanuska-Susitna Borough Central landfill Development Plan

Inflation	2.4%
Interest	3.0%
Model Start Year	2014
Year of Closure	2170
Post Closure Start	2171
Costs:	
Current Fund Balance	$3,876,843 [c]
Closure Costs ($2014)	$17,327,000
Closure Costs ($2170)	$700,675,000
Post Closure Costs (2014$) [a]	$175,000
Post Closure Costs (2014$) [b]	$37,000

[a] Post closure costs of annual maintenance and monitoring.

[b] Post closure cost of certification (2200 only)

[c] This is as of June 30, 2014

TABLE K-2

Matanuska-Susitna Borough Central Landfill, Closure and Post-Closure Costs (2014$)

Matanuska-Susitna Borough Central landfill Development Plan

Description	Quantity	Units	Unit Price	Total
Mobilization	1	LS	$496,000.00	$496,000.00
Bonds & insurance	1	LS	$431,154.00	$431,154.00
Submittals	1	LS	$34,533.88	$34,533.88
Permits	1	LS	$7,500.00	$7,500.00
Survey	1	LS	$38,500.00	$38,500.00
Leveling course (6")	32569	CY	$5.59	$181,977.24
Geosynthetic clay liner	195412	SY	$7.50	$1,465,983.40
Flexible membrane liner	195412	SY	$9.59	$1,874,378.09
Granular drainage material (18")	97706	CY	$26.92	$2,630,585.51
Earthen material/topsoil (6")	32569	CY	$14.92	$486,078.01
Hydroseeding	1759	MSF	$150.00	$263,850.00
Monitoring wells	4	EA	$3,750.00	$15,000.00
Stormwater control terraces	1000	LF	$14.27	$14,268.55
Landfill gas collection system	1	LS	$3,750,000.00	$3,750,000.00
Gas flare system	1	LS	$350,000.00	$350,000.00
Demobilization	1	LS	$345,000.00	$345,000.00
Contractor overhead	1	LS	$1,235,440.00	$1,235,440.00
CH overhead	1	LS	$1,482,530.00	$1,482,530.00
Contingency	1	LS	$617,720.00	$617,720.00
Taxes	1	LS	$370,632.00	$370,632.00
Mark-up (profit)	1	LS	$1,235,424.00	$1,235,424.00
				$17,326,554.68
Annual Post-Closure Maintenance 30Yrs				
Repair cover side slopes	3257	CY	$6.50	$21,170.00
Hydroseeding	87935	SF	$0.15	$13,190.00
Maintain leachate equipment	1	LS	$5,000.00	$5,000.00
Collect,treat,dispose leachate	75000	GL	$0.15	$11,250.00
Clean perimeter drainage ditches	3000	LF	$5.80	$17,400.00
				$68,010.00

TABLE K-2

Matanuska-Susitna Borough Central Landfill, Closure and Post-Closure Costs (2014$)

Matanuska-Susitna Borough Central landfill Development Plan

Description	Quantity	Units	Unit Price	Total
Annual Post-Closure Monitoring 30Yrs				
Groundwater sampling & analysis	1	LS	$29,000.00	$29,000.00
Methane sampling & analysis	1	LS	$17,400.00	$17,400.00
Surface water sampling & analysis	1	LS	$11,600.00	$11,600.00
Leachate sampling & analysis	1	LS	$11,600.00	$11,600.00
				$69,600.00
Post-Closure Certification				
Post-Closure Certification Report	1	LS	$29,000.00	$29,000.00
				$29,000.00
			SUBTOTAL	**$166,610.00**
			Administrative services (10%)	**$16,661.00**
			Technical and Professional Services (12%)	**$19,993.00**
			Closure Contingency (5%)	**$8,305.00**
			TOTAL	**$44,959.00**

Notes:

CY = cubic yard
GL = gallon
LF = linear foot
LS = lump sum
MSF = thousand square feet
SY = square yard

TABLE K-3

Matanuska-Susitna Borough Central Landfill, Calculation of Closure Fund Contributions

Matanuska-Susitna Borough Central landfill Development Plan

Year	Closure Cost	Post-Closure Cost	Closure Fund Contribution	End-Year Closure Fund Balance	Per-ton Contribution	Per-ton Contribution (2014$)
2014	$0	$0	$9,562	$3,934,996	$0.16	$0.16
2015	$0	$0	$10,034	$4,063,230	$0.16	$0.16
2016	$0	$0	$10,529	$4,195,814	$0.17	$0.16
2017	$0	$0	$11,049	$4,332,903	$0.17	$0.16
2018	$0	$0	$11,584	$4,474,647	$0.17	$0.16
2019	$0	$0	$12,144	$4,621,213	$0.18	$0.16
2020	$0	$0	$12,732	$4,772,772	$0.18	$0.16
2021	$0	$0	$13,348	$4,929,503	$0.19	$0.16
2022	$0	$0	$13,994	$5,091,591	$0.19	$0.16
2023	$0	$0	$14,666	$5,259,224	$0.20	$0.16
2024	$0	$0	$15,370	$5,432,601	$0.20	$0.16
2025	$0	$0	$16,108	$5,611,929	$0.21	$0.16
2026	$0	$0	$16,881	$5,797,421	$0.21	$0.16
2027	$0	$0	$17,692	$5,989,300	$0.22	$0.16
2028	$0	$0	$18,498	$6,187,755	$0.22	$0.16
2029	$0	$0	$19,342	$6,393,020	$0.23	$0.16
2030	$0	$0	$20,224	$6,605,338	$0.23	$0.16
2031	$0	$0	$21,146	$6,824,961	$0.24	$0.16
2032	$0	$0	$22,111	$7,052,152	$0.24	$0.16
2033	$0	$0	$23,012	$7,287,075	$0.25	$0.16
2034	$0	$0	$23,951	$7,529,997	$0.26	$0.16
2035	$0	$0	$24,928	$7,781,198	$0.26	$0.16
2036	$0	$0	$25,944	$8,040,968	$0.27	$0.16
2037	$0	$0	$27,002	$8,309,604	$0.27	$0.16
2038	$0	$0	$28,055	$8,587,368	$0.28	$0.16
2039	$0	$0	$29,148	$8,874,574	$0.29	$0.16
2040	$0	$0	$30,284	$9,171,550	$0.29	$0.16
2041	$0	$0	$31,464	$9,478,633	$0.30	$0.16
2042	$0	$0	$32,691	$9,796,173	$0.31	$0.16
2043	$0	$0	$33,965	$10,124,532	$0.32	$0.16
2044	$0	$0	$35,289	$10,464,086	$0.32	$0.16
2045	$0	$0	$36,664	$10,815,223	$0.33	$0.16
2046	$0	$0	$38,093	$11,178,344	$0.34	$0.16
2047	$0	$0	$39,578	$11,553,865	$0.35	$0.16
2048	$0	$0	$41,120	$11,942,218	$0.36	$0.16
2049	$0	$0	$42,723	$12,343,848	$0.36	$0.16
2050	$0	$0	$44,388	$12,759,217	$0.37	$0.16

TABLE K-3

Matanuska-Susitna Borough Central Landfill, Calculation of Closure Fund Contributions

Matanuska-Susitna Borough Central landfill Development Plan

Year	Closure Cost	Post-Closure Cost	Closure Fund Contribution	End-Year Closure Fund Balance	Per-ton Contribution	Per-ton Contribution (2014$)
2051	$0	$0	$46,118	$13,188,803	$0.38	$0.16
2052	$0	$0	$47,915	$13,633,101	$0.39	$0.16
2053	$0	$0	$49,782	$14,092,623	$0.40	$0.16
2054	$0	$0	$51,723	$14,567,900	$0.41	$0.16
2055	$0	$0	$53,739	$15,059,482	$0.42	$0.16
2056	$0	$0	$55,833	$15,567,937	$0.43	$0.16
2057	$0	$0	$58,009	$16,093,854	$0.44	$0.16
2058	$0	$0	$60,270	$16,637,843	$0.45	$0.16
2059	$0	$0	$62,619	$17,200,537	$0.46	$0.16
2060	$0	$0	$65,059	$17,782,588	$0.47	$0.16
2061	$0	$0	$67,595	$18,384,675	$0.48	$0.16
2062	$0	$0	$70,229	$19,007,498	$0.50	$0.16
2063	$0	$0	$72,966	$19,651,783	$0.51	$0.16
2064	$0	$0	$75,810	$20,318,284	$0.52	$0.16
2065	$0	$0	$78,765	$21,007,779	$0.53	$0.16
2066	$0	$0	$81,835	$21,721,075	$0.54	$0.16
2067	$0	$0	$85,024	$22,459,007	$0.56	$0.16
2068	$0	$0	$88,338	$23,222,440	$0.57	$0.16
2069	$0	$0	$91,781	$24,012,270	$0.58	$0.16
2070	$0	$0	$95,358	$24,829,427	$0.60	$0.16
2071	$0	$0	$99,074	$25,674,870	$0.61	$0.16
2072	$0	$0	$102,936	$26,549,595	$0.63	$0.16
2073	$0	$0	$106,947	$27,454,635	$0.64	$0.16
2074	$0	$0	$111,116	$28,391,056	$0.66	$0.16
2075	$0	$0	$115,446	$29,359,966	$0.67	$0.16
2076	$0	$0	$119,946	$30,362,509	$0.69	$0.16
2077	$0	$0	$124,620	$31,399,874	$0.71	$0.16
2078	$0	$0	$129,477	$32,473,290	$0.72	$0.16
2079	$0	$0	$134,524	$33,584,030	$0.74	$0.16
2080	$0	$0	$139,766	$34,733,414	$0.76	$0.16
2081	$0	$0	$145,214	$35,922,808	$0.78	$0.16
2082	$0	$0	$150,873	$37,153,629	$0.80	$0.16
2083	$0	$0	$156,753	$38,427,343	$0.82	$0.16
2084	$0	$0	$162,863	$39,745,468	$0.83	$0.16
2085	$0	$0	$169,210	$41,109,581	$0.85	$0.16
2086	$0	$0	$175,805	$42,521,310	$0.88	$0.16
2087	$0	$0	$182,657	$43,982,346	$0.90	$0.16

TABLE K-3

Matanuska-Susitna Borough Central Landfill, Calculation of Closure Fund Contributions

Matanuska-Susitna Borough Central landfill Development Plan

Year	Closure Cost	Post-Closure Cost	Closure Fund Contribution	End-Year Closure Fund Balance	Per-ton Contribution	Per-ton Contribution (2014$)
2088	$0	$0	$189,776	$45,494,439	$0.92	$0.16
2089	$0	$0	$197,172	$47,059,401	$0.94	$0.16
2090	$0	$0	$204,857	$48,679,113	$0.96	$0.16
2091	$0	$0	$212,841	$50,355,519	$0.99	$0.16
2092	$0	$0	$221,136	$52,090,638	$1.01	$0.16
2093	$0	$0	$229,754	$53,886,558	$1.03	$0.16
2094	$0	$0	$238,709	$55,745,444	$1.06	$0.16
2095	$0	$0	$248,012	$57,669,540	$1.08	$0.16
2096	$0	$0	$257,678	$59,661,169	$1.11	$0.16
2097	$0	$0	$267,721	$61,722,741	$1.14	$0.16
2098	$0	$0	$278,155	$63,856,751	$1.16	$0.16
2099	$0	$0	$288,996	$66,065,784	$1.19	$0.16
2100	$0	$0	$300,259	$68,352,521	$1.22	$0.16
2101	$0	$0	$311,962	$70,719,738	$1.25	$0.16
2102	$0	$0	$324,120	$73,170,312	$1.28	$0.16
2103	$0	$0	$336,752	$75,707,225	$1.31	$0.16
2104	$0	$0	$349,877	$78,333,567	$1.34	$0.16
2105	$0	$0	$363,513	$81,052,539	$1.37	$0.16
2106	$0	$0	$377,681	$83,867,461	$1.41	$0.16
2107	$0	$0	$392,400	$86,781,772	$1.44	$0.16
2108	$0	$0	$407,694	$89,799,034	$1.47	$0.16
2109	$0	$0	$423,583	$92,922,942	$1.51	$0.16
2110	$0	$0	$440,092	$96,157,323	$1.55	$0.16
2111	$0	$0	$457,244	$99,506,146	$1.58	$0.16
2112	$0	$0	$475,065	$102,973,521	$1.62	$0.16
2113	$0	$0	$493,580	$106,563,710	$1.66	$0.16
2114	$0	$0	$512,817	$110,281,130	$1.70	$0.16
2115	$0	$0	$532,803	$114,130,359	$1.74	$0.16
2116	$0	$0	$553,569	$118,116,142	$1.78	$0.16
2117	$0	$0	$575,143	$122,243,397	$1.83	$0.16
2118	$0	$0	$597,559	$126,517,221	$1.87	$0.16
2119	$0	$0	$620,848	$130,942,899	$1.91	$0.16
2120	$0	$0	$645,045	$135,525,907	$1.96	$0.16
2121	$0	$0	$670,185	$140,271,922	$2.01	$0.16
2122	$0	$0	$696,305	$145,186,829	$2.06	$0.16
2123	$0	$0	$723,443	$150,276,728	$2.10	$0.16
2124	$0	$0	$751,638	$155,547,943	$2.16	$0.16

TABLE K-3

Matanuska-Susitna Borough Central Landfill, Calculation of Closure Fund Contributions

Matanuska-Susitna Borough Central landfill Development Plan

Year	Closure Cost	Post-Closure Cost	Closure Fund Contribution	End-Year Closure Fund Balance	Per-ton Contribution	Per-ton Contribution (2014$)
2125	$0	$0	$780,933	$161,007,028	$2.21	$0.16
2126	$0	$0	$811,369	$166,660,778	$2.26	$0.16
2127	$0	$0	$842,991	$172,516,237	$2.31	$0.16
2128	$0	$0	$875,846	$178,580,708	$2.37	$0.16
2129	$0	$0	$909,981	$184,861,760	$2.43	$0.16
2130	$0	$0	$945,447	$191,367,241	$2.49	$0.16
2131	$0	$0	$982,294	$198,105,287	$2.54	$0.16
2132	$0	$0	$1,020,578	$205,084,333	$2.61	$0.16
2133	$0	$0	$1,060,354	$212,313,122	$2.67	$0.16
2134	$0	$0	$1,101,681	$219,800,722	$2.73	$0.16
2135	$0	$0	$1,144,618	$227,556,530	$2.80	$0.16
2136	$0	$0	$1,189,228	$235,590,292	$2.87	$0.16
2137	$0	$0	$1,235,577	$243,912,111	$2.93	$0.16
2138	$0	$0	$1,283,732	$252,532,463	$3.00	$0.16
2139	$0	$0	$1,333,764	$261,462,208	$3.08	$0.16
2140	$0	$0	$1,385,747	$270,712,607	$3.15	$0.16
2141	$0	$0	$1,439,755	$280,295,336	$3.23	$0.16
2142	$0	$0	$1,495,868	$290,222,501	$3.30	$0.16
2143	$0	$0	$1,554,168	$300,506,656	$3.38	$0.16
2144	$0	$0	$1,614,740	$311,160,817	$3.46	$0.16
2145	$0	$0	$1,677,673	$322,198,479	$3.55	$0.16
2146	$0	$0	$1,743,058	$333,633,637	$3.63	$0.16
2147	$0	$0	$1,810,992	$345,480,804	$3.72	$0.16
2148	$0	$0	$1,881,574	$357,755,025	$3.81	$0.16
2149	$0	$0	$1,954,906	$370,471,905	$3.90	$0.16
2150	$0	$0	$2,031,097	$383,647,626	$3.99	$0.16
2151	$0	$0	$2,110,257	$397,298,965	$4.09	$0.16
2152	$0	$0	$2,192,502	$411,443,323	$4.19	$0.16
2153	$0	$0	$2,277,952	$426,098,745	$4.29	$0.16
2154	$0	$0	$2,366,733	$441,283,941	$4.39	$0.16
2155	$0	$0	$2,458,974	$457,018,319	$4.50	$0.16
2156	$0	$0	$2,554,810	$473,322,001	$4.60	$0.16
2157	$0	$0	$2,654,382	$490,215,858	$4.71	$0.16
2158	$0	$0	$2,757,834	$507,721,535	$4.83	$0.16
2159	$0	$0	$2,865,317	$525,861,478	$4.94	$0.16
2160	$0	$0	$2,976,990	$544,658,967	$5.06	$0.16
2161	$0	$0	$3,093,015	$564,138,147	$5.18	$0.16

TABLE K-3

Matanuska-Susitna Borough Central Landfill, Calculation of Closure Fund Contributions

Matanuska-Susitna Borough Central landfill Development Plan

Year	Closure Cost	Post-Closure Cost	Closure Fund Contribution	End-Year Closure Fund Balance	Per-ton Contribution	Per-ton Contribution (2014$)
2162	$0	$0	$3,213,563	$584,324,058	$5.31	$0.16
2163	$0	$0	$3,338,808	$605,242,670	$5.44	$0.16
2164	$0	$0	$3,468,935	$626,920,918	$5.57	$0.16
2165	$0	$0	$3,604,133	$649,386,741	$5.70	$0.16
2166	$0	$0	$3,744,601	$672,669,113	$5.84	$0.16
2167	$0	$0	$3,890,543	$696,798,087	$5.98	$0.16
2168	$0	$0	$4,042,173	$721,804,835	$6.12	$0.16
2169	$0	$0	$4,199,712	$747,721,688	$6.27	$0.16
2170	$700,675,000	$0	$4,363,392	$73,907,181	$6.42	$0.16
2171	$0	$7,246,549	$4,468,113	$73,412,982	$6.57	$0.16
2172	$0	$7,420,466	$4,575,348	$72,838,883	$6.73	$0.16
2173	$0	$7,598,558	$4,685,156	$72,180,926	$6.89	$0.16
2174	$0	$7,780,923	$4,797,600	$71,434,995	$7.06	$0.16
2175	$0	$7,967,665	$4,912,742	$70,596,813	$7.23	$0.16
2176	$0	$8,158,889	$5,030,648	$69,661,937	$7.40	$0.16
2177	$0	$8,354,702	$5,151,384	$68,625,747	$7.58	$0.16
2178	$0	$8,555,215	$5,275,017	$67,483,447	$7.76	$0.16
2179	$0	$8,760,540	$5,401,617	$66,230,052	$7.94	$0.16
2180	$0	$8,970,793	$5,531,256	$64,860,385	$8.13	$0.16
2181	$0	$9,186,092	$5,664,006	$63,369,071	$8.33	$0.16
2182	$0	$9,406,559	$5,799,943	$61,750,526	$8.53	$0.16
2183	$0	$9,632,316	$5,939,141	$59,998,954	$8.73	$0.16
2184	$0	$9,863,492	$6,081,681	$58,108,337	$8.94	$0.16
2185	$0	$10,100,215	$6,227,641	$56,072,427	$9.16	$0.16
2186	$0	$10,342,621	$6,377,104	$53,884,740	$9.38	$0.16
2187	$0	$10,590,843	$6,530,155	$51,538,546	$9.60	$0.16
2188	$0	$10,845,024	$6,686,879	$49,026,861	$9.83	$0.16
2189	$0	$11,105,304	$6,847,364	$46,342,436	$10.07	$0.16
2190	$0	$11,371,832	$7,011,700	$43,477,754	$10.31	$0.16
2191	$0	$11,644,755	$7,179,981	$40,425,012	$10.56	$0.16
2192	$0	$11,924,230	$7,352,301	$37,176,118	$10.81	$0.16
2193	$0	$12,210,411	$7,528,756	$33,722,677	$11.07	$0.16
2194	$0	$12,503,461	$7,709,446	$30,055,985	$11.34	$0.16
2195	$0	$12,803,544	$7,894,473	$26,167,010	$11.61	$0.16
2196	$0	$13,110,829	$8,083,940	$22,046,390	$11.89	$0.16
2197	$0	$13,425,489	$8,277,955	$17,684,417	$12.17	$0.16
2198	$0	$13,747,701	$8,476,626	$13,071,024	$12.47	$0.16

TABLE K-3

Matanuska-Susitna Borough Central Landfill, Calculation of Closure Fund Contributions

Matanuska-Susitna Borough Central landfill Development Plan

Year	Closure Cost	Post-Closure Cost	Closure Fund Contribution	End-Year Closure Fund Balance	Per-ton Contribution	Per-ton Contribution (2014$)
2199	$0	$14,077,646	$8,680,065	$8,195,774	$12.77	$0.16
2200	$0	$17,463,360	$8,888,386	$0	$13.07	$0.16

Appendix L
Historical Waste Disposal

TABLE 1
ESTIMATED HISTORICAL WASTE DISPOSAL FOR YEARS 1980-1999

Year	MSB Population[1]	Waste Per Capita[2] (short ton/capita)	Estimated Waste Disposal[3] (short tons)	(metric tons)
1980	17,816	0.75	13,362	12,122
1981	19,574	0.76	14,876	13,495
1982	22,352	0.77	17,211	15,614
1983	26,856	0.77	20,679	18,760
1984	32,653	0.78	25,469	23,105
1985	38,078	0.79	30,082	27,290
1986	40,583	0.79	32,061	29,086
1987	40,189	0.80	32,151	29,167
1988	38,768	0.80	31,014	28,136
1989	38,002	0.83	31,542	28,615
1990	39,683	0.82	32,540	29,520
1991	41,819	0.76	31,782	28,832
1992	44,370	0.74	32,834	29,787
1993	46,659	0.76	35,461	32,170
1994	47,636	0.75	35,727	32,411
1995	48,906	0.70	34,234	31,057
1996	50,367	0.68	34,250	31,071
1997	52,125	0.69	35,966	32,628
1998	54,153	0.75	40,615	36,846
1999	55,694	0.75	41,771	37,894
		Total:	**603,627**	**547,606**

Notes:

1. Population and growth rate estimates are from the Alaska Department of Labor and Work Force Development's *Population by Alaska Economic Region, Borough and Census Area, 1980-1990* (Vintage 2013), and *Population by Alaska Economic Region, Borough and Census Area, 1990-2000 (Vintage 2012).* http://labor.state.ak.us/research/pop/popest.htm
2. Waste per Capita waste disposal rates are from Table HH-2 to Subpart HH of 40 CFR 98 - U.S. Per Capita Waste Disposal Rates.
3. Estimated waste disposal quantity at the Central Landfill for Years 1980 to 1999 are based on the estimated population served by the landfill in each year, the values for national average per capita waste disposal rates found in Table HH-2 to Subpart HH of 40 CFR 98, and Equation HH-2 to Subpart HH of 40 CFR 98.

TABLE 2
ESTIMATED HISTORICAL WASTE DISPOSAL FOR YEARS 2000-2013

Historical Waste Disposal By Landfill Disposal Area[1]

		Total Waste Disposal	
Years	Active Disposal Area(s)	(short tons)	(metric tons)
2000 - 2003	Unlined Landfill (Cells 1/2A)	207,601	188,334
2004 - 2014/07	Lined Landfill (Cells 2B/3)	744,275	675,202
	Total:	**951,876**	**863,536**

Historical Waste Disposal by Year[1]

	Waste Disposal Records	
Year	(short tons)	(metric tons)
2000	45,758	41,511
Subtotal, 2000:	**45,758**	**41,511**
2007	59,099	53,614
2008	54,834	49,745
2009	57,067	51,771
2010	57,727	52,370
2011	58,934	53,465
2012	58,602	53,163
2013	58,796	53,339
up to 2014/06	57,141	51,838
Subtotal, 2007 - 2014/06:	**462,200**	**419,305**
Total:	**507,958**	**460,816**

Estimated Waste Disposal for Missing Years of Data

	Total Waste Disposal Remaining[2]	Constant Average Waste Disposal Rate[3]
Years	(short tons)	(short tons/year)
2001-2003	161,843	53,948
2004-2006, and 2014/07	282,075	91,484

	Estimated Waste Disposal[4]	
Year	(short tons)	(metric tons)
2001	53,948	48,941
2002	53,948	48,941
2003	53,948	48,941
2004	91,484	82,994
2005	91,484	82,994
2006	91,484	82,994
2014/07 only	7,624	6,916
Total:	**443,920**	**402,721**

Notes:

1. Historical waste disposal data by landfill disposal area, and operating years 2000, and 2007-2014/06 is from the MSB's Waste Works database. Summaries were emailed to C. Hinds/CH2M HILL by M. Shapiro/MSB in July 2014.
2. Total waste disposal remaining for years 2001- 2003, and years 2004 - 2006 and 2014/07, are based on the total disposal by landfill disposal area minus the subtotal of waste disposal by year, for the respective operating period.
3. Constant average waste disposal rates are calculated per Equation HH-3 to Subpart HH of 40 CFR 98.
4. Estimated waste disposal for missing years of data are based on the constant average waste disposal rates calucated using Eq. HH-3 for the respective time period.

Appendix M
Gas Generation Estimates

LandGEM - Version 3.02

US EPA Office of Research and Development

CLEAN
AIR
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CENTER

EPA

LandGEM
Landfill Gas Emissions Model
Version 3.02

U.S. Environmental Protection Agency
Office of Research and Development
National Risk Management Research Laboratory (NRMRL)
and
Clean Air Technology Center (CATC)
Research Triangle Park, North Carolina

May 2005

Summary Report

Landfill Name or Identifier: MSB Central Landfill

Date: Tuesday, July 29, 2014

Description/Comments:

Waste acceptance rates for Years 1980-1999 are estimated per Eq. HH-2 to Subpart HH of 40 CFR 98. Waste acceptance rates for Years 2000 and 2007-2013 are based on MSB data records. Waste acceptance rates for Years 2001-2006 are estimated per Eq. HH-3 to Subpart HH of 40 CFR 98. Waste acceptance rates for 2014-2059 are estimates based on population growth projections, and waste data for 2013.

About LandGEM:

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} k L_o \left(\frac{M_i}{10} \right) e^{-k t_{ij}}$$

Where,

Q_{CH4} = annual methane generation in the year of the calculation (*m^3/year*)
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate (*$year^{-1}$*)
L_o = potential methane generation capacity (*m^3/Mg*)
M_i = mass of waste accepted in the i^{th} year (*Mg*)
t_{ij} = age of the j^{th} section of waste mass M_i accepted in the i^{th} year (*decimal years*, e.g., 3.2 years)

LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on EPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate. Defaults for estimating emissions for this type of operation are being developed to include in LandGEM along with defaults for convential landfills (no leachate or liquid additions) for developing emission inventories and determining CAA applicability. Refer to the Web site identified above for future updates.

Input Review

LANDFILL CHARACTERISTICS

Landfill Open Year	**1980**	
Landfill Closure Year (with 80-year limit)	**2059**	
Actual Closure Year (without limit)	***2059***	
Have Model Calculate Closure Year?	**No**	
Waste Design Capacity		*short tons*

MODEL PARAMETERS

Methane Generation Rate, k	**0.020**	*year* $^{-1}$
Potential Methane Generation Capacity, L_o	**170**	*m* ^{3} */Mg*
NMOC Concentration	**4,000**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	**Carbon dioxide**
Gas / Pollutant #4:	**NMOC**

WASTE ACCEPTANCE RATES

Year	**Waste Accepted**		**Waste-In-Place**	
	(Mg/year)	***(short tons/year)***	***(Mg)***	***(short tons)***
1980	12,147	13,362	0	0
1981	13,524	14,876	12,147	13,362
1982	15,646	17,211	25,671	28,238
1983	18,799	20,679	41,317	45,449
1984	23,154	25,469	60,116	66,128
1985	27,347	30,082	83,270	91,597
1986	29,146	32,061	110,617	121,679
1987	29,228	32,151	139,764	153,740
1988	28,195	31,014	168,992	185,891
1989	28,675	31,542	197,186	216,905
1990	29,582	32,540	225,861	248,447
1991	28,893	31,782	255,443	280,987
1992	29,849	32,834	284,335	312,769
1993	32,237	35,461	314,185	345,603
1994	32,479	35,727	346,422	381,064
1995	31,122	34,234	378,901	416,791
1996	31,136	34,250	410,023	451,025
1997	32,696	35,966	441,159	485,275
1998	36,923	40,615	473,855	521,241
1999	37,974	41,771	510,778	561,856
2000	41,598	45,758	548,752	603,627
2001	49,044	53,948	590,350	649,385
2002	49,044	53,948	639,394	703,333
2003	49,044	53,948	688,437	757,281
2004	83,167	91,484	737,481	811,229
2005	83,167	91,484	820,648	902,713
2006	83,167	91,484	903,815	994,197
2007	53,726	59,099	986,983	1,085,681
2008	49,849	54,834	1,040,709	1,144,780
2009	51,879	57,067	1,090,558	1,199,614
2010	52,479	57,727	1,142,437	1,256,681
2011	53,576	58,934	1,194,916	1,314,408
2012	53,275	58,602	1,248,493	1,373,342
2013	53,451	58,796	1,301,767	1,431,944
2014	54,776	60,253	1,355,218	1,490,740
2015	56,133	61,746	1,409,994	1,550,993
2016	57,524	63,276	1,466,127	1,612,739
2017	58,949	64,844	1,523,650	1,676,015
2018	60,353	66,388	1,582,600	1,740,860
2019	61,791	67,970	1,642,953	1,807,248

WASTE ACCEPTANCE RATES (Continued)

Year	**Waste Accepted**		**Waste-In-Place**	
	(Mg/year)	***(short tons/year)***	***(Mg)***	***(short tons)***
2020	63,262	69,588	1,704,743	1,875,218
2021	64,769	71,246	1,768,006	1,944,806
2022	66,312	72,943	1,832,775	2,016,052
2023	67,867	74,653	1,899,086	2,088,995
2024	69,458	76,404	1,966,953	2,163,648
2025	71,087	78,196	2,036,411	2,240,052
2026	72,754	80,030	2,107,498	2,318,248
2027	74,461	81,907	2,180,253	2,398,278
2028	76,031	83,634	2,254,713	2,480,184
2029	77,635	85,399	2,330,745	2,563,819
2030	79,273	87,200	2,408,380	2,649,218
2031	80,945	89,040	2,487,653	2,736,418
2032	82,653	90,918	2,568,598	2,825,458
2033	84,008	92,409	2,651,251	2,916,377
2034	85,385	93,923	2,735,259	3,008,785
2035	86,784	95,463	2,820,644	3,102,708
2036	88,207	97,027	2,907,428	3,198,171
2037	89,652	98,618	2,995,635	3,295,198
2038	90,963	100,060	3,085,287	3,393,816
2039	92,293	101,523	3,176,250	3,493,875
2040	93,643	103,007	3,268,544	3,595,398
2041	95,012	104,514	3,362,187	3,698,406
2042	96,402	106,042	3,457,199	3,802,919
2043	97,812	107,593	3,553,601	3,908,961
2044	99,242	109,166	3,651,413	4,016,554
2045	100,693	110,762	3,750,654	4,125,720
2046	102,165	112,382	3,851,348	4,236,482
2047	103,659	114,025	3,953,513	4,348,864
2048	105,175	115,693	4,057,172	4,462,890
2049	106,713	117,385	4,162,348	4,578,582
2050	108,274	119,101	4,269,061	4,695,967
2051	109,857	120,843	4,377,335	4,815,068
2052	111,463	122,610	4,487,192	4,935,911
2053	113,093	124,403	4,598,655	5,058,521
2054	114,747	126,222	4,711,748	5,182,923
2055	116,425	128,068	4,826,496	5,309,145
2056	118,128	129,940	4,942,921	5,437,213
2057	119,855	131,840	5,061,048	5,567,153
2058	121,608	133,768	5,180,903	5,698,994
2059	123,386	135,724	5,302,511	5,832,762

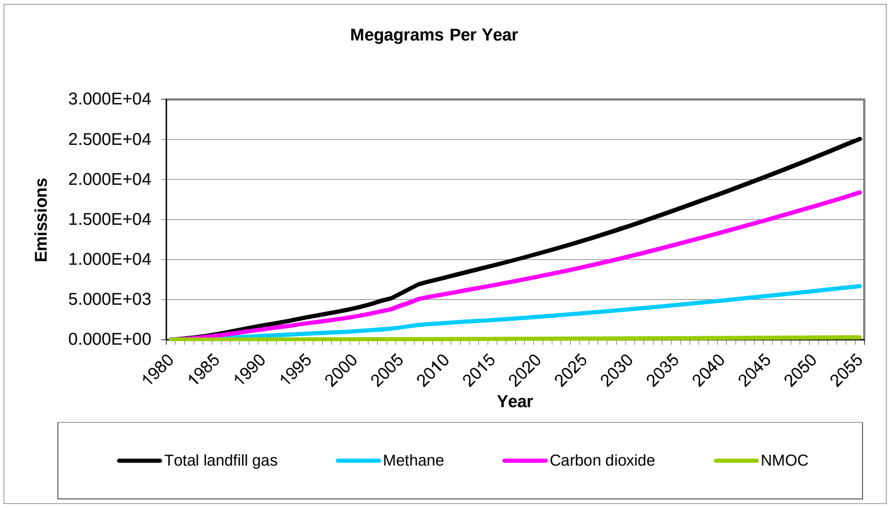
Pollutant Parameters

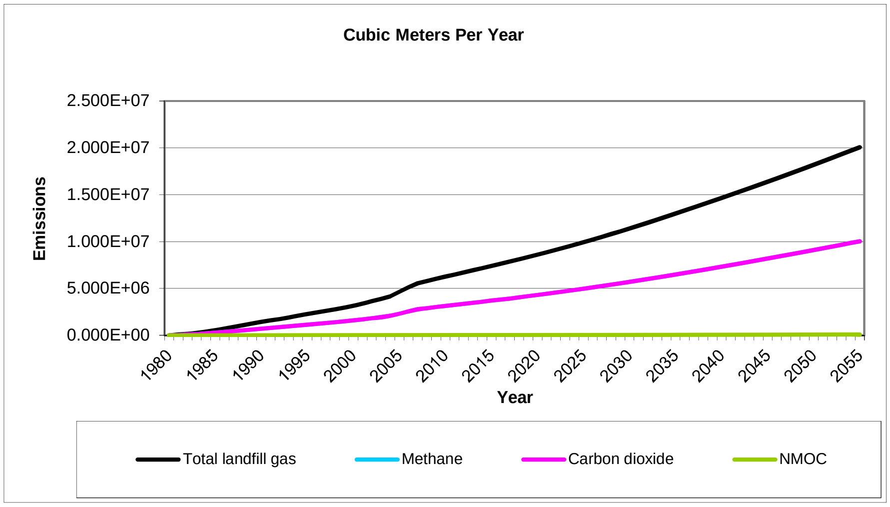
		Gas / Pollutant Default Parameters:		User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Gases	Total landfill gas		0.00		
	Methane		16.04		
	Carbon dioxide		44.01		
	NMOC	4,000	86.18		
Pollutants	1,1,1-Trichloroethane (methyl chloroform) - HAP	0.48	133.41		
	1,1,2,2-Tetrachloroethane - HAP/VOC	1.1	167.85		
	1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	2.4	98.97		
	1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.20	96.94		
	1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.41	98.96		
	1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.18	112.99		
	2-Propanol (isopropyl alcohol) - VOC	50	60.11		
	Acetone	7.0	58.08		
	Acrylonitrile - HAP/VOC	6.3	53.06		
	Benzene - No or Unknown Co-disposal - HAP/VOC	1.9	78.11		
	Benzene - Co-disposal - HAP/VOC	11	78.11		
	Bromodichloromethane - VOC	3.1	163.83		
	Butane - VOC	5.0	58.12		
	Carbon disulfide - HAP/VOC	0.58	76.13		
	Carbon monoxide	140	28.01		
	Carbon tetrachloride - HAP/VOC	4.0E-03	153.84		
	Carbonyl sulfide - HAP/VOC	0.49	60.07		
	Chlorobenzene - HAP/VOC	0.25	112.56		
	Chlorodifluoromethane	1.3	86.47		
	Chloroethane (ethyl chloride) - HAP/VOC	1.3	64.52		
	Chloroform - HAP/VOC	0.03	119.39		
	Chloromethane - VOC	1.2	50.49		
	Dichlorobenzene - (HAP for para isomer/VOC)	0.21	147		
	Dichlorodifluoromethane	16	120.91		
	Dichlorofluoromethane - VOC	2.6	102.92		
	Dichloromethane (methylene chloride) - HAP	14	84.94		
	Dimethyl sulfide (methyl sulfide) - VOC	7.8	62.13		
	Ethane	890	30.07		
	Ethanol - VOC	27	46.08		

Pollutant Parameters (Continued)

		Gas / Pollutant Default Parameters:		*User-specified Pollutant Parameters:*	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Pollutants	Ethyl mercaptan (ethanethiol) - VOC	2.3	62.13		
	Ethylbenzene - HAP/VOC	4.6	106.16		
	Ethylene dibromide - HAP/VOC	1.0E-03	187.88		
	Fluorotrichloromethane - VOC	0.76	137.38		
	Hexane - HAP/VOC	6.6	86.18		
	Hydrogen sulfide	36	34.08		
	Mercury (total) - HAP	2.9E-04	200.61		
	Methyl ethyl ketone - HAP/VOC	7.1	72.11		
	Methyl isobutyl ketone - HAP/VOC	1.9	100.16		
	Methyl mercaptan - VOC	2.5	48.11		
	Pentane - VOC	3.3	72.15		
	Perchloroethylene (tetrachloroethylene) - HAP	3.7	165.83		
	Propane - VOC	11	44.09		
	t-1,2-Dichloroethene - VOC	2.8	96.94		
	Toluene - No or Unknown Co-disposal - HAP/VOC	39	92.13		
	Toluene - Co-disposal - HAP/VOC	170	92.13		
	Trichloroethylene (trichloroethene) - HAP/VOC	2.8	131.40		
	Vinyl chloride - HAP/VOC	7.3	62.50		
	Xylenes - HAP/VOC	12	106.16		

Graphs


Megagrams Per Year
3.000E+04
2.500E+04
2.000E+04
1.500E+04
1.000E+04
5.000E+03
0.000E+00
Emissions
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
2055
Year
Total landfill gas
Methane
Carbon dioxide
NMOC


Cubic Meters Per Year
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2.000E+07
1.500E+07
1.000E+07
5.000E+06
0.000E+00
Emissions
1980
1985
1990
1995
2000
2005
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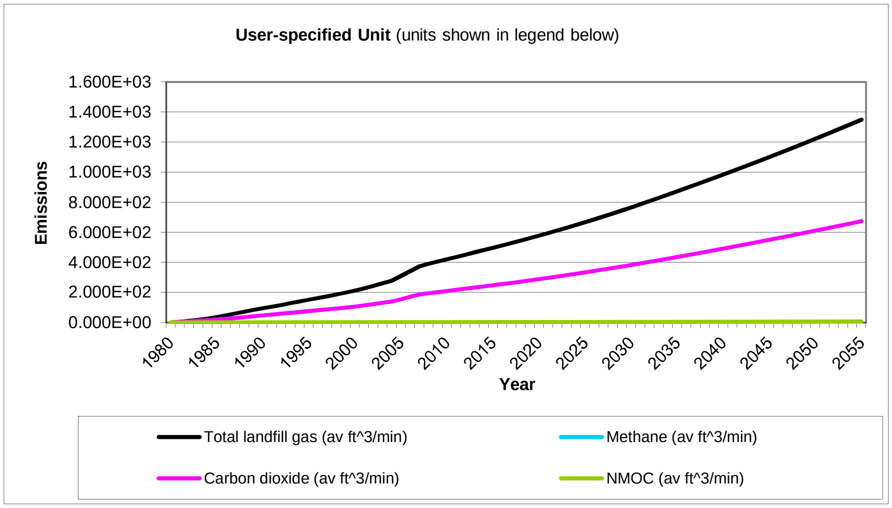
Year
Total landfill gas
Methane
Carbon dioxide
NMOC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1.400E+03
1.200E+03
1.000E+03
8.000E+02
6.000E+02
4.000E+02
2.000E+02
0.000E+00
Emissions
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
2055
Year
Total landfill gas (av ft^3/min)
Methane (av ft^3/min)
Carbon dioxide (av ft^3/min)
NMOC (av ft^3/min)

Results

Year	Total landfill gas			Methane		
	(Mg/year)	***(m^3/year)***	***(av ft^3/min)***	***(Mg/year)***	***(m^3/year)***	***(av ft^3/min)***
1980	0	0	0	0	0	0
1981	1.022E+02	8.186E+04	5.500E+00	2.731E+01	4.093E+04	2.750E+00
1982	2.140E+02	1.714E+05	1.152E+01	5.717E+01	8.569E+04	5.758E+00
1983	3.415E+02	2.734E+05	1.837E+01	9.121E+01	1.367E+05	9.186E+00
1984	4.929E+02	3.947E+05	2.652E+01	1.317E+02	1.974E+05	1.326E+01
1985	6.780E+02	5.429E+05	3.648E+01	1.811E+02	2.715E+05	1.824E+01
1986	8.948E+02	7.165E+05	4.814E+01	2.390E+02	3.582E+05	2.407E+01
1987	1.122E+03	8.987E+05	6.038E+01	2.998E+02	4.494E+05	3.019E+01
1988	1.346E+03	1.078E+06	7.242E+01	3.596E+02	5.389E+05	3.621E+01
1989	1.557E+03	1.247E+06	8.376E+01	4.158E+02	6.233E+05	4.188E+01
1990	1.767E+03	1.415E+06	9.508E+01	4.720E+02	7.076E+05	4.754E+01
1991	1.981E+03	1.586E+06	1.066E+02	5.292E+02	7.932E+05	5.330E+01
1992	2.185E+03	1.750E+06	1.176E+02	5.837E+02	8.749E+05	5.878E+01
1993	2.393E+03	1.916E+06	1.288E+02	6.392E+02	9.581E+05	6.438E+01
1994	2.617E+03	2.096E+06	1.408E+02	6.990E+02	1.048E+06	7.040E+01
1995	2.839E+03	2.273E+06	1.527E+02	7.582E+02	1.136E+06	7.636E+01
1996	3.044E+03	2.438E+06	1.638E+02	8.131E+02	1.219E+06	8.189E+01
1997	3.246E+03	2.599E+06	1.746E+02	8.670E+02	1.300E+06	8.732E+01
1998	3.457E+03	2.768E+06	1.860E+02	9.234E+02	1.384E+06	9.300E+01
1999	3.699E+03	2.962E+06	1.990E+02	9.881E+02	1.481E+06	9.951E+01
2000	3.946E+03	3.159E+06	2.123E+02	1.054E+03	1.580E+06	1.061E+02
2001	4.218E+03	3.377E+06	2.269E+02	1.127E+03	1.689E+06	1.135E+02
2002	4.547E+03	3.641E+06	2.446E+02	1.214E+03	1.820E+06	1.223E+02
2003	4.869E+03	3.899E+06	2.620E+02	1.301E+03	1.950E+06	1.310E+02
2004	5.186E+03	4.153E+06	2.790E+02	1.385E+03	2.076E+06	1.395E+02
2005	5.783E+03	4.631E+06	3.111E+02	1.545E+03	2.315E+06	1.556E+02
2006	6.368E+03	5.100E+06	3.426E+02	1.701E+03	2.550E+06	1.713E+02
2007	6.942E+03	5.559E+06	3.735E+02	1.854E+03	2.780E+06	1.868E+02
2008	7.257E+03	5.811E+06	3.904E+02	1.938E+03	2.906E+06	1.952E+02
2009	7.533E+03	6.032E+06	4.053E+02	2.012E+03	3.016E+06	2.026E+02
2010	7.820E+03	6.262E+06	4.208E+02	2.089E+03	3.131E+06	2.104E+02
2011	8.107E+03	6.492E+06	4.362E+02	2.165E+03	3.246E+06	2.181E+02
2012	8.397E+03	6.724E+06	4.518E+02	2.243E+03	3.362E+06	2.259E+02
2013	8.680E+03	6.950E+06	4.670E+02	2.318E+03	3.475E+06	2.335E+02
2014	8.958E+03	7.173E+06	4.819E+02	2.393E+03	3.586E+06	2.410E+02
2015	9.241E+03	7.400E+06	4.972E+02	2.468E+03	3.700E+06	2.486E+02
2016	9.531E+03	7.632E+06	5.128E+02	2.546E+03	3.816E+06	2.564E+02
2017	9.826E+03	7.868E+06	5.287E+02	2.625E+03	3.934E+06	2.643E+02
2018	1.013E+04	8.110E+06	5.449E+02	2.705E+03	4.055E+06	2.724E+02
2019	1.043E+04	8.356E+06	5.614E+02	2.787E+03	4.178E+06	2.807E+02
2020	1.075E+04	8.607E+06	5.783E+02	2.871E+03	4.303E+06	2.891E+02
2021	1.107E+04	8.863E+06	5.955E+02	2.956E+03	4.431E+06	2.977E+02
2022	1.139E+04	9.124E+06	6.130E+02	3.043E+03	4.562E+06	3.065E+02
2023	1.173E+04	9.390E+06	6.309E+02	3.132E+03	4.695E+06	3.155E+02
2024	1.207E+04	9.661E+06	6.491E+02	3.223E+03	4.831E+06	3.246E+02
2025	1.241E+04	9.938E+06	6.677E+02	3.315E+03	4.969E+06	3.339E+02
2026	1.276E+04	1.022E+07	6.867E+02	3.409E+03	5.110E+06	3.434E+02
2027	1.312E+04	1.051E+07	7.061E+02	3.505E+03	5.254E+06	3.530E+02
2028	1.349E+04	1.080E+07	7.258E+02	3.603E+03	5.401E+06	3.629E+02
2029	1.386E+04	1.110E+07	7.458E+02	3.703E+03	5.550E+06	3.729E+02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2030	1.424E+04	1.140E+07	7.662E+02	3.804E+03	5.702E+06	3.831E+02
2031	1.463E+04	1.171E+07	7.870E+02	3.907E+03	5.856E+06	3.935E+02
2032	1.502E+04	1.203E+07	8.080E+02	4.012E+03	6.013E+06	4.040E+02
2033	1.542E+04	1.234E+07	8.294E+02	4.118E+03	6.172E+06	4.147E+02
2034	1.582E+04	1.267E+07	8.511E+02	4.225E+03	6.333E+06	4.255E+02
2035	1.622E+04	1.299E+07	8.729E+02	4.334E+03	6.496E+06	4.364E+02
2036	1.663E+04	1.332E+07	8.949E+02	4.443E+03	6.659E+06	4.474E+02
2037	1.705E+04	1.365E+07	9.171E+02	4.553E+03	6.825E+06	4.586E+02
2038	1.746E+04	1.398E+07	9.395E+02	4.664E+03	6.992E+06	4.698E+02
2039	1.788E+04	1.432E+07	9.621E+02	4.777E+03	7.160E+06	4.811E+02
2040	1.831E+04	1.466E+07	9.849E+02	4.890E+03	7.329E+06	4.924E+02
2041	1.873E+04	1.500E+07	1.008E+03	5.003E+03	7.499E+06	5.039E+02
2042	1.916E+04	1.534E+07	1.031E+03	5.118E+03	7.671E+06	5.154E+02
2043	1.959E+04	1.569E+07	1.054E+03	5.233E+03	7.844E+06	5.270E+02
2044	2.003E+04	1.604E+07	1.077E+03	5.349E+03	8.018E+06	5.387E+02
2045	2.047E+04	1.639E+07	1.101E+03	5.467E+03	8.194E+06	5.505E+02
2046	2.091E+04	1.674E+07	1.125E+03	5.585E+03	8.371E+06	5.624E+02
2047	2.135E+04	1.710E+07	1.149E+03	5.704E+03	8.549E+06	5.744E+02
2048	2.180E+04	1.746E+07	1.173E+03	5.824E+03	8.729E+06	5.865E+02
2049	2.226E+04	1.782E+07	1.197E+03	5.945E+03	8.911E+06	5.987E+02
2050	2.271E+04	1.819E+07	1.222E+03	6.067E+03	9.094E+06	6.110E+02
2051	2.318E+04	1.856E+07	1.247E+03	6.190E+03	9.279E+06	6.234E+02
2052	2.364E+04	1.893E+07	1.272E+03	6.315E+03	9.465E+06	6.360E+02
2053	2.411E+04	1.931E+07	1.297E+03	6.440E+03	9.653E+06	6.486E+02
2054	2.459E+04	1.969E+07	1.323E+03	6.567E+03	9.843E+06	6.614E+02
2055	2.506E+04	2.007E+07	1.349E+03	6.695E+03	1.004E+07	6.743E+02
2056	2.555E+04	2.046E+07	1.375E+03	6.824E+03	1.023E+07	6.873E+02
2057	2.604E+04	2.085E+07	1.401E+03	6.955E+03	1.042E+07	7.004E+02
2058	2.653E+04	2.124E+07	1.427E+03	7.086E+03	1.062E+07	7.137E+02
2059	2.703E+04	2.164E+07	1.454E+03	7.219E+03	1.082E+07	7.271E+02
2060	2.753E+04	2.205E+07	1.481E+03	7.354E+03	1.102E+07	7.406E+02
2061	2.699E+04	2.161E+07	1.452E+03	7.208E+03	1.080E+07	7.259E+02
2062	2.645E+04	2.118E+07	1.423E+03	7.065E+03	1.059E+07	7.116E+02
2063	2.593E+04	2.076E+07	1.395E+03	6.925E+03	1.038E+07	6.975E+02
2064	2.541E+04	2.035E+07	1.367E+03	6.788E+03	1.018E+07	6.837E+02
2065	2.491E+04	1.995E+07	1.340E+03	6.654E+03	9.974E+06	6.701E+02
2066	2.442E+04	1.955E+07	1.314E+03	6.522E+03	9.776E+06	6.569E+02
2067	2.393E+04	1.917E+07	1.288E+03	6.393E+03	9.583E+06	6.439E+02
2068	2.346E+04	1.879E+07	1.262E+03	6.266E+03	9.393E+06	6.311E+02
2069	2.300E+04	1.841E+07	1.237E+03	6.142E+03	9.207E+06	6.186E+02
2070	2.254E+04	1.805E+07	1.213E+03	6.021E+03	9.025E+06	6.064E+02
2071	2.209E+04	1.769E+07	1.189E+03	5.901E+03	8.846E+06	5.944E+02
2072	2.166E+04	1.734E+07	1.165E+03	5.785E+03	8.671E+06	5.826E+02
2073	2.123E+04	1.700E+07	1.142E+03	5.670E+03	8.499E+06	5.710E+02
2074	2.081E+04	1.666E+07	1.119E+03	5.558E+03	8.331E+06	5.597E+02
2075	2.040E+04	1.633E+07	1.097E+03	5.448E+03	8.166E+06	5.487E+02
2076	1.999E+04	1.601E+07	1.076E+03	5.340E+03	8.004E+06	5.378E+02
2077	1.960E+04	1.569E+07	1.054E+03	5.234E+03	7.846E+06	5.271E+02
2078	1.921E+04	1.538E+07	1.033E+03	5.131E+03	7.690E+06	5.167E+02
2079	1.883E+04	1.508E+07	1.013E+03	5.029E+03	7.538E+06	5.065E+02
2080	1.845E+04	1.478E+07	9.929E+02	4.929E+03	7.389E+06	4.964E+02

Results (Continued)

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2081	1.809E+04	1.448E+07	9.732E+02	4.832E+03	7.242E+06	4.866E+02
2082	1.773E+04	1.420E+07	9.540E+02	4.736E+03	7.099E+06	4.770E+02
2083	1.738E+04	1.392E+07	9.351E+02	4.642E+03	6.958E+06	4.675E+02
2084	1.704E+04	1.364E+07	9.166E+02	4.550E+03	6.821E+06	4.583E+02
2085	1.670E+04	1.337E+07	8.984E+02	4.460E+03	6.686E+06	4.492E+02
2086	1.637E+04	1.311E+07	8.806E+02	4.372E+03	6.553E+06	4.403E+02
2087	1.604E+04	1.285E+07	8.632E+02	4.285E+03	6.423E+06	4.316E+02
2088	1.573E+04	1.259E+07	8.461E+02	4.201E+03	6.296E+06	4.230E+02
2089	1.541E+04	1.234E+07	8.293E+02	4.117E+03	6.172E+06	4.147E+02
2090	1.511E+04	1.210E+07	8.129E+02	4.036E+03	6.049E+06	4.065E+02
2091	1.481E+04	1.186E+07	7.968E+02	3.956E+03	5.930E+06	3.984E+02
2092	1.452E+04	1.162E+07	7.810E+02	3.878E+03	5.812E+06	3.905E+02
2093	1.423E+04	1.139E+07	7.656E+02	3.801E+03	5.697E+06	3.828E+02
2094	1.395E+04	1.117E+07	7.504E+02	3.726E+03	5.584E+06	3.752E+02
2095	1.367E+04	1.095E+07	7.355E+02	3.652E+03	5.474E+06	3.678E+02
2096	1.340E+04	1.073E+07	7.210E+02	3.579E+03	5.365E+06	3.605E+02
2097	1.314E+04	1.052E+07	7.067E+02	3.509E+03	5.259E+06	3.534E+02
2098	1.288E+04	1.031E+07	6.927E+02	3.439E+03	5.155E+06	3.464E+02
2099	1.262E+04	1.011E+07	6.790E+02	3.371E+03	5.053E+06	3.395E+02
2100	1.237E+04	9.906E+06	6.656E+02	3.304E+03	4.953E+06	3.328E+02
2101	1.213E+04	9.709E+06	6.524E+02	3.239E+03	4.855E+06	3.262E+02
2102	1.189E+04	9.517E+06	6.395E+02	3.175E+03	4.759E+06	3.197E+02
2103	1.165E+04	9.329E+06	6.268E+02	3.112E+03	4.664E+06	3.134E+02
2104	1.142E+04	9.144E+06	6.144E+02	3.050E+03	4.572E+06	3.072E+02
2105	1.119E+04	8.963E+06	6.022E+02	2.990E+03	4.481E+06	3.011E+02
2106	1.097E+04	8.785E+06	5.903E+02	2.931E+03	4.393E+06	2.951E+02
2107	1.075E+04	8.611E+06	5.786E+02	2.873E+03	4.306E+06	2.893E+02
2108	1.054E+04	8.441E+06	5.671E+02	2.816E+03	4.220E+06	2.836E+02
2109	1.033E+04	8.274E+06	5.559E+02	2.760E+03	4.137E+06	2.780E+02
2110	1.013E+04	8.110E+06	5.449E+02	2.705E+03	4.055E+06	2.725E+02
2111	9.927E+03	7.949E+06	5.341E+02	2.652E+03	3.975E+06	2.671E+02
2112	9.731E+03	7.792E+06	5.235E+02	2.599E+03	3.896E+06	2.618E+02
2113	9.538E+03	7.638E+06	5.132E+02	2.548E+03	3.819E+06	2.566E+02
2114	9.349E+03	7.486E+06	5.030E+02	2.497E+03	3.743E+06	2.515E+02
2115	9.164E+03	7.338E+06	4.931E+02	2.448E+03	3.669E+06	2.465E+02
2116	8.983E+03	7.193E+06	4.833E+02	2.399E+03	3.596E+06	2.416E+02
2117	8.805E+03	7.050E+06	4.737E+02	2.352E+03	3.525E+06	2.369E+02
2118	8.630E+03	6.911E+06	4.643E+02	2.305E+03	3.455E+06	2.322E+02
2119	8.460E+03	6.774E+06	4.551E+02	2.260E+03	3.387E+06	2.276E+02
2120	8.292E+03	6.640E+06	4.461E+02	2.215E+03	3.320E+06	2.231E+02

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1980	0	0	0	0	0	0
1981	7.492E+01	4.093E+04	2.750E+00	1.174E+00	3.275E+02	2.200E-02
1982	1.569E+02	8.569E+04	5.758E+00	2.457E+00	6.855E+02	4.606E-02
1983	2.503E+02	1.367E+05	9.186E+00	3.920E+00	1.094E+03	7.349E-02
1984	3.613E+02	1.974E+05	1.326E+01	5.659E+00	1.579E+03	1.061E-01
1985	4.969E+02	2.715E+05	1.824E+01	7.784E+00	2.172E+03	1.459E-01
1986	6.558E+02	3.582E+05	2.407E+01	1.027E+01	2.866E+03	1.926E-01
1987	8.225E+02	4.494E+05	3.019E+01	1.289E+01	3.595E+03	2.415E-01
1988	9.865E+02	5.389E+05	3.621E+01	1.545E+01	4.312E+03	2.897E-01
1989	1.141E+03	6.233E+05	4.188E+01	1.787E+01	4.986E+03	3.350E-01
1990	1.295E+03	7.076E+05	4.754E+01	2.029E+01	5.660E+03	3.803E-01
1991	1.452E+03	7.932E+05	5.330E+01	2.275E+01	6.346E+03	4.264E-01
1992	1.601E+03	8.749E+05	5.878E+01	2.509E+01	6.999E+03	4.703E-01
1993	1.754E+03	9.581E+05	6.438E+01	2.748E+01	7.665E+03	5.150E-01
1994	1.918E+03	1.048E+06	7.040E+01	3.005E+01	8.382E+03	5.632E-01
1995	2.080E+03	1.136E+06	7.636E+01	3.259E+01	9.092E+03	6.109E-01
1996	2.231E+03	1.219E+06	8.189E+01	3.495E+01	9.751E+03	6.552E-01
1997	2.379E+03	1.300E+06	8.732E+01	3.727E+01	1.040E+04	6.986E-01
1998	2.534E+03	1.384E+06	9.300E+01	3.969E+01	1.107E+04	7.440E-01
1999	2.711E+03	1.481E+06	9.951E+01	4.247E+01	1.185E+04	7.961E-01
2000	2.892E+03	1.580E+06	1.061E+02	4.530E+01	1.264E+04	8.491E-01
2001	3.091E+03	1.689E+06	1.135E+02	4.842E+01	1.351E+04	9.076E-01
2002	3.332E+03	1.820E+06	1.223E+02	5.220E+01	1.456E+04	9.785E-01
2003	3.569E+03	1.950E+06	1.310E+02	5.591E+01	1.560E+04	1.048E+00
2004	3.801E+03	2.076E+06	1.395E+02	5.954E+01	1.661E+04	1.116E+00
2005	4.238E+03	2.315E+06	1.556E+02	6.640E+01	1.852E+04	1.245E+00
2006	4.667E+03	2.550E+06	1.713E+02	7.312E+01	2.040E+04	1.371E+00
2007	5.088E+03	2.780E+06	1.868E+02	7.971E+01	2.224E+04	1.494E+00
2008	5.319E+03	2.906E+06	1.952E+02	8.332E+01	2.324E+04	1.562E+00
2009	5.521E+03	3.016E+06	2.026E+02	8.649E+01	2.413E+04	1.621E+00
2010	5.731E+03	3.131E+06	2.104E+02	8.979E+01	2.505E+04	1.683E+00
2011	5.942E+03	3.246E+06	2.181E+02	9.308E+01	2.597E+04	1.745E+00
2012	6.154E+03	3.362E+06	2.259E+02	9.641E+01	2.690E+04	1.807E+00
2013	6.361E+03	3.475E+06	2.335E+02	9.965E+01	2.780E+04	1.868E+00
2014	6.565E+03	3.586E+06	2.410E+02	1.028E+02	2.869E+04	1.928E+00
2015	6.773E+03	3.700E+06	2.486E+02	1.061E+02	2.960E+04	1.989E+00
2016	6.985E+03	3.816E+06	2.564E+02	1.094E+02	3.053E+04	2.051E+00
2017	7.201E+03	3.934E+06	2.643E+02	1.128E+02	3.147E+04	2.115E+00
2018	7.422E+03	4.055E+06	2.724E+02	1.163E+02	3.244E+04	2.180E+00
2019	7.648E+03	4.178E+06	2.807E+02	1.198E+02	3.342E+04	2.246E+00
2020	7.877E+03	4.303E+06	2.891E+02	1.234E+02	3.443E+04	2.313E+00
2021	8.112E+03	4.431E+06	2.977E+02	1.271E+02	3.545E+04	2.382E+00
2022	8.350E+03	4.562E+06	3.065E+02	1.308E+02	3.649E+04	2.452E+00
2023	8.594E+03	4.695E+06	3.155E+02	1.346E+02	3.756E+04	2.524E+00
2024	8.843E+03	4.831E+06	3.246E+02	1.385E+02	3.865E+04	2.597E+00
2025	9.096E+03	4.969E+06	3.339E+02	1.425E+02	3.975E+04	2.671E+00
2026	9.354E+03	5.110E+06	3.434E+02	1.465E+02	4.088E+04	2.747E+00
2027	9.618E+03	5.254E+06	3.530E+02	1.507E+02	4.203E+04	2.824E+00
2028	9.887E+03	5.401E+06	3.629E+02	1.549E+02	4.321E+04	2.903E+00
2029	1.016E+04	5.550E+06	3.729E+02	1.592E+02	4.440E+04	2.983E+00

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2030	1.044E+04	5.702E+06	3.831E+02	1.635E+02	4.562E+04	3.065E+00
2031	1.072E+04	5.856E+06	3.935E+02	1.679E+02	4.685E+04	3.148E+00
2032	1.101E+04	6.013E+06	4.040E+02	1.724E+02	4.810E+04	3.232E+00
2033	1.130E+04	6.172E+06	4.147E+02	1.770E+02	4.938E+04	3.318E+00
2034	1.159E+04	6.333E+06	4.255E+02	1.816E+02	5.067E+04	3.404E+00
2035	1.189E+04	6.496E+06	4.364E+02	1.863E+02	5.196E+04	3.491E+00
2036	1.219E+04	6.659E+06	4.474E+02	1.910E+02	5.328E+04	3.580E+00
2037	1.249E+04	6.825E+06	4.586E+02	1.957E+02	5.460E+04	3.668E+00
2038	1.280E+04	6.992E+06	4.698E+02	2.005E+02	5.593E+04	3.758E+00
2039	1.311E+04	7.160E+06	4.811E+02	2.053E+02	5.728E+04	3.849E+00
2040	1.342E+04	7.329E+06	4.924E+02	2.102E+02	5.863E+04	3.939E+00
2041	1.373E+04	7.499E+06	5.039E+02	2.151E+02	6.000E+04	4.031E+00
2042	1.404E+04	7.671E+06	5.154E+02	2.200E+02	6.137E+04	4.123E+00
2043	1.436E+04	7.844E+06	5.270E+02	2.249E+02	6.275E+04	4.216E+00
2044	1.468E+04	8.018E+06	5.387E+02	2.299E+02	6.415E+04	4.310E+00
2045	1.500E+04	8.194E+06	5.505E+02	2.350E+02	6.555E+04	4.404E+00
2046	1.532E+04	8.371E+06	5.624E+02	2.400E+02	6.697E+04	4.500E+00
2047	1.565E+04	8.549E+06	5.744E+02	2.452E+02	6.840E+04	4.595E+00
2048	1.598E+04	8.729E+06	5.865E+02	2.503E+02	6.984E+04	4.692E+00
2049	1.631E+04	8.911E+06	5.987E+02	2.555E+02	7.129E+04	4.790E+00
2050	1.665E+04	9.094E+06	6.110E+02	2.608E+02	7.275E+04	4.888E+00
2051	1.698E+04	9.279E+06	6.234E+02	2.661E+02	7.423E+04	4.988E+00
2052	1.733E+04	9.465E+06	6.360E+02	2.714E+02	7.572E+04	5.088E+00
2053	1.767E+04	9.653E+06	6.486E+02	2.768E+02	7.723E+04	5.189E+00
2054	1.802E+04	9.843E+06	6.614E+02	2.823E+02	7.875E+04	5.291E+00
2055	1.837E+04	1.004E+07	6.743E+02	2.878E+02	8.028E+04	5.394E+00
2056	1.872E+04	1.023E+07	6.873E+02	2.933E+02	8.183E+04	5.498E+00
2057	1.908E+04	1.042E+07	7.004E+02	2.989E+02	8.339E+04	5.603E+00
2058	1.944E+04	1.062E+07	7.137E+02	3.046E+02	8.497E+04	5.709E+00
2059	1.981E+04	1.082E+07	7.271E+02	3.103E+02	8.657E+04	5.817E+00
2060	2.018E+04	1.102E+07	7.406E+02	3.161E+02	8.818E+04	5.925E+00
2061	1.978E+04	1.080E+07	7.259E+02	3.098E+02	8.643E+04	5.808E+00
2062	1.939E+04	1.059E+07	7.116E+02	3.037E+02	8.472E+04	5.693E+00
2063	1.900E+04	1.038E+07	6.975E+02	2.977E+02	8.305E+04	5.580E+00
2064	1.863E+04	1.018E+07	6.837E+02	2.918E+02	8.140E+04	5.469E+00
2065	1.826E+04	9.974E+06	6.701E+02	2.860E+02	7.979E+04	5.361E+00
2066	1.790E+04	9.776E+06	6.569E+02	2.803E+02	7.821E+04	5.255E+00
2067	1.754E+04	9.583E+06	6.439E+02	2.748E+02	7.666E+04	5.151E+00
2068	1.719E+04	9.393E+06	6.311E+02	2.693E+02	7.514E+04	5.049E+00
2069	1.685E+04	9.207E+06	6.186E+02	2.640E+02	7.365E+04	4.949E+00
2070	1.652E+04	9.025E+06	6.064E+02	2.588E+02	7.220E+04	4.851E+00
2071	1.619E+04	8.846E+06	5.944E+02	2.537E+02	7.077E+04	4.755E+00
2072	1.587E+04	8.671E+06	5.826E+02	2.486E+02	6.937E+04	4.661E+00
2073	1.556E+04	8.499E+06	5.710E+02	2.437E+02	6.799E+04	4.568E+00
2074	1.525E+04	8.331E+06	5.597E+02	2.389E+02	6.665E+04	4.478E+00
2075	1.495E+04	8.166E+06	5.487E+02	2.342E+02	6.533E+04	4.389E+00
2076	1.465E+04	8.004E+06	5.378E+02	2.295E+02	6.403E+04	4.302E+00
2077	1.436E+04	7.846E+06	5.271E+02	2.250E+02	6.276E+04	4.217E+00
2078	1.408E+04	7.690E+06	5.167E+02	2.205E+02	6.152E+04	4.134E+00
2079	1.380E+04	7.538E+06	5.065E+02	2.162E+02	6.030E+04	4.052E+00
2080	1.352E+04	7.389E+06	4.964E+02	2.119E+02	5.911E+04	3.972E+00

Results (Continued)

Year	Carbon dioxide			NMOC		
	(Mg/year)	***(m^3/year)***	***(av ft^3/min)***	***(Mg/year)***	***(m^3/year)***	***(av ft^3/min)***
2081	1.326E+04	7.242E+06	4.866E+02	2.077E+02	5.794E+04	3.893E+00
2082	1.299E+04	7.099E+06	4.770E+02	2.036E+02	5.679E+04	3.816E+00
2083	1.274E+04	6.958E+06	4.675E+02	1.995E+02	5.567E+04	3.740E+00
2084	1.249E+04	6.821E+06	4.583E+02	1.956E+02	5.456E+04	3.666E+00
2085	1.224E+04	6.686E+06	4.492E+02	1.917E+02	5.348E+04	3.594E+00
2086	1.200E+04	6.553E+06	4.403E+02	1.879E+02	5.243E+04	3.522E+00
2087	1.176E+04	6.423E+06	4.316E+02	1.842E+02	5.139E+04	3.453E+00
2088	1.153E+04	6.296E+06	4.230E+02	1.805E+02	5.037E+04	3.384E+00
2089	1.130E+04	6.172E+06	4.147E+02	1.770E+02	4.937E+04	3.317E+00
2090	1.107E+04	6.049E+06	4.065E+02	1.735E+02	4.839E+04	3.252E+00
2091	1.085E+04	5.930E+06	3.984E+02	1.700E+02	4.744E+04	3.187E+00
2092	1.064E+04	5.812E+06	3.905E+02	1.667E+02	4.650E+04	3.124E+00
2093	1.043E+04	5.697E+06	3.828E+02	1.634E+02	4.558E+04	3.062E+00
2094	1.022E+04	5.584E+06	3.752E+02	1.601E+02	4.467E+04	3.002E+00
2095	1.002E+04	5.474E+06	3.678E+02	1.570E+02	4.379E+04	2.942E+00
2096	9.821E+03	5.365E+06	3.605E+02	1.539E+02	4.292E+04	2.884E+00
2097	9.627E+03	5.259E+06	3.534E+02	1.508E+02	4.207E+04	2.827E+00
2098	9.436E+03	5.155E+06	3.464E+02	1.478E+02	4.124E+04	2.771E+00
2099	9.249E+03	5.053E+06	3.395E+02	1.449E+02	4.042E+04	2.716E+00
2100	9.066E+03	4.953E+06	3.328E+02	1.420E+02	3.962E+04	2.662E+00
2101	8.887E+03	4.855E+06	3.262E+02	1.392E+02	3.884E+04	2.609E+00
2102	8.711E+03	4.759E+06	3.197E+02	1.365E+02	3.807E+04	2.558E+00
2103	8.538E+03	4.664E+06	3.134E+02	1.338E+02	3.731E+04	2.507E+00
2104	8.369E+03	4.572E+06	3.072E+02	1.311E+02	3.658E+04	2.458E+00
2105	8.203E+03	4.481E+06	3.011E+02	1.285E+02	3.585E+04	2.409E+00
2106	8.041E+03	4.393E+06	2.951E+02	1.260E+02	3.514E+04	2.361E+00
2107	7.882E+03	4.306E+06	2.893E+02	1.235E+02	3.445E+04	2.314E+00
2108	7.726E+03	4.220E+06	2.836E+02	1.210E+02	3.376E+04	2.269E+00
2109	7.573E+03	4.137E+06	2.780E+02	1.186E+02	3.310E+04	2.224E+00
2110	7.423E+03	4.055E+06	2.725E+02	1.163E+02	3.244E+04	2.180E+00
2111	7.276E+03	3.975E+06	2.671E+02	1.140E+02	3.180E+04	2.136E+00
2112	7.132E+03	3.896E+06	2.618E+02	1.117E+02	3.117E+04	2.094E+00
2113	6.990E+03	3.819E+06	2.566E+02	1.095E+02	3.055E+04	2.053E+00
2114	6.852E+03	3.743E+06	2.515E+02	1.073E+02	2.995E+04	2.012E+00
2115	6.716E+03	3.669E+06	2.465E+02	1.052E+02	2.935E+04	1.972E+00
2116	6.583E+03	3.596E+06	2.416E+02	1.031E+02	2.877E+04	1.933E+00
2117	6.453E+03	3.525E+06	2.369E+02	1.011E+02	2.820E+04	1.895E+00
2118	6.325E+03	3.455E+06	2.322E+02	9.909E+01	2.764E+04	1.857E+00
2119	6.200E+03	3.387E+06	2.276E+02	9.713E+01	2.710E+04	1.821E+00
2120	6.077E+03	3.320E+06	2.231E+02	9.520E+01	2.656E+04	1.785E+00

Results of GHG Reporting Rule Applicability

Yes, the facility is subject to the reporting rule, based on the information you have provided.

You will need Adobe Reader to view some of the files linked from this page. See EPA's PDF page to learn more.

Facility

Class 1 MSW Landfill
Not provided
Not provided

Date of This Assessment

Tuesday, July 29, 2014

Year of Emissions

2014

Preliminary Estimate of MSW Landfill's CO_2e Emissions

Calculation Variables	Value	Unit of Measure
Quantity of waste in place through 2013	1352388	Metric tons
Year landfill opened	1980	Calendar year
Adjusted CH_4 Generation for Reporting Year 2014	77859	**Metric tons CO_2e**

Calculation Variables	Value	Unit of Measure
Landfill Capacity	1352388	Metric Tons
Year landfill opened	1980	Calendar year
Year landfill closed	active	Calendar year
Adjusted CH_4 Generation for Reporting Year 2014	77859	**Metric tons CO_2e**

Note: This is a preliminary estimate of MSW landfill CO_2e emissions intended for screening purposes only.

Relevant Subparts

If subject to the rule, you must collect data; calculate GHGs; and follow the procedures for quality assurance, missing data, recordkeeping, and reporting that are specified in the 40 CFR part 98 subparts listed below based on your selections:

- Subpart A. - General Provisions
  - Section 98.1-98.8.
  - Information Sheet (PDF). (6 pp., 146 K)
  - Plain English Guide to the GHG Reporting Rule.
- Subpart HH. - Municipal Solid Waste Landfills
  - Section 98.340-98.348.
  - Information Sheet.
  - Monitoring Checklist (PDF). (1 p., 47 K)

Applicability Tool Disclaimer

The content provided in the applicability tool is intended solely as compliance assistance for potential reporters to aid in assessing whether they are required to report under the Greenhouse Gas Mandatory Reporting Rule. Any variation between the rule and the information provided in this tool is unintentional, and, in the case of such variations, the requirements of the rule govern.

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Last updated on Thursday, January 09, 2014

Appendix N
Method Sampling Instructions

Method 2E - Determination of Landfill Gas Production Flow Rate

Note: This method does not include all of the specifications (*e.g.*, equipment and supplies) and procedures (*e.g.*, sampling and analytical) essential to its performance. Some material is incorporated by reference from other methods in this part. Therefore, to obtain reliable results, persons using this method should also have a thorough knowledge of at least the following additional test methods: Methods 2 and 3C.

1.0 Scope and Application

1.1 Applicability. This method applies to the measurement of landfill gas (LFG) production flow rate from municipal solid waste landfills and is used to calculate the flow rate of nonmethane organic compounds (NMOC) from landfills.

1.2 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 Extraction wells are installed either in a cluster of three or at five dispersed locations in the landfill. A blower is used to extract LFG from the landfill. LFG composition, landfill pressures, and orifice pressure differentials from the wells are measured and the landfill gas production flow rate is calculated.

3.0 Definitions [Reserved]

4.0 Interferences [Reserved]

5.0 Safety

5.1 Since this method is complex, only experienced personnel should perform the test. Landfill gas contains methane, therefore explosive mixtures may exist at or near the landfill. It is advisable to take appropriate safety precautions when testing landfills, such as refraining from smoking and installing explosion-proof equipment.

6.0 Equipment and Supplies

6.1 Well Drilling Rig. Capable of boring a 0.61 m (24 in.) diameter hole into the landfill to a minimum of 75 percent of the landfill depth. The depth of the well shall not extend to the bottom of the landfill or the liquid level.

6.2 Gravel. No fines. Gravel diameter should be appreciably larger than perforations stated in Sections 6.10 and 8.2.

6.3 Bentonite.

6.4 Backfill Material. Clay, soil, and sandy loam have been found to be acceptable.

6.5 Extraction Well Pipe. Minimum diameter of 3 in., constructed of polyvinyl chloride (PVC), high density polyethylene (HDPE), fiberglass, stainless steel, or other suitable nonporous material capable of transporting landfill gas.

6.6 Above Ground Well Assembly. Valve capable of adjusting gas flow, such as a gate, ball, or butterfly valve; sampling ports at the well head and outlet; and a flow measuring device, such as an in-line orifice meter or pitot tube. A schematic of the aboveground well head assembly is shown in Figure 2E–1.

6.7 Cap. Constructed of PVC or HDPE.

6.8 Header Piping. Constructed of PVC or HDPE.

6.9 Auger. Capable of boring a 0.15-to 0.23-m (6-to 9-in.) diameter hole to a depth equal to the top of the perforated section of the extraction well, for pressure probe installation.

6.10 Pressure Probe. Constructed of PVC or stainless steel (316), 0.025-m (1-in.). Schedule 40 pipe. Perforate the bottom two-thirds. A minimum requirement for perforations is slots or holes with an open area equivalent to four 0.006-m (1/4-in.) diameter holes spaced 90° apart every 0.15 m (6 in.).

6.11 Blower and Flare Assembly. Explosion-proof blower, capable of extracting LFG at a flow rate of 8.5 m^3/min (300 ft^3/min), a water knockout, and flare or incinerator.

6.12 Standard Pitot Tube and Differential Pressure Gauge for Flow Rate Calibration with Standard Pitot. Same as Method 2, Sections 6.7 and 6.8.

6.13 Orifice Meter. Orifice plate, pressure tabs, and pressure measuring device to measure the LFG flow rate.

6.14 Barometer. Same as Method 4, Section 6.1.5.

6.15 Differential Pressure Gauge. Water-filled U-tube manometer or equivalent, capable of measuring within 0.02 mm Hg (0.01 in. H_2O), for measuring the pressure of the pressure probes.

7.0 Reagents and Standards. Not Applicable

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Placement of Extraction Wells. The landfill owner or operator may install a single cluster of three extraction wells in a test area or space five equal-volume wells over the landfill. The cluster wells are recommended but may be used only if the composition, age of the refuse, and the landfill depth of the test area can be determined.

8.1.1 Cluster Wells. Consult landfill site records for the age of the refuse, depth, and composition of various sections of the landfill. Select an area near the perimeter of the landfill with a depth equal to or greater than the average depth of the landfill and with the average age of the refuse between 2 and 10 years old. Avoid areas known to contain non-decomposable materials, such as concrete and asbestos. Locate the cluster wells as shown in Figure 2E–2.

8.1.1.1 The age of the refuse in a test area will not be uniform, so calculate a weighted average age of the refuse as shown in Section 12.2.

8.1.2 Equal Volume Wells. Divide the sections of the landfill that are at least 2 years old into five areas representing equal volumes. Locate an extraction well near the center of each area.

8.2 Installation of Extraction Wells. Use a well drilling rig to dig a 0.6 m (24 in.) diameter hole in the landfill to a minimum of 75 percent of the landfill depth, not to extend to the bottom of the landfill or the liquid level. Perforate the bottom two thirds of the extraction well pipe. A minimum requirement for perforations is holes or slots with an open area equivalent to 0.01-m (0.5-in.) diameter holes spaced 90° apart every 0.1 to 0.2 m (4 to 8 in.). Place the extraction well in the center of the hole and backfill with gravel to a level 0.30 m (1 ft) above the perforated section. Add a layer of backfill material 1.2 m (4 ft) thick. Add a layer of bentonite 0.9 m (3 ft) thick, and backfill the remainder of the hole with cover material or material equal in permeability to the existing cover material. The specifications for extraction well installation are shown in Figure 2E–3.

8.3 Pressure Probes. Shallow pressure probes are used in the check for infiltration of air into the landfill, and deep pressure probes are used to determine the radius of influence. Locate pressure probes along three radial arms approximately 120° apart at distances of 3, 15, 30, and 45 m (10, 50, 100, and 150 ft) from the extraction well. The tester has the option of locating additional pressure probes at distances every 15 m (50 feet) beyond 45 m (150 ft). Example placements of probes are shown in Figure 2E–4. The 15-, 30-, and 45-m, (50-, 100-, and 150-ft) probes from each well, and any additional probes located along the three radial arms (deep probes), shall extend to a depth equal to the top of the perforated section of the extraction wells. All other probes (shallow probes) shall extend to a depth equal to half the depth of the deep probes.

8.3.1 Use an auger to dig a hole, 0.15- to 0.23-m (6-to 9-in.) in diameter, for each pressure probe. Perforate the bottom two thirds of the pressure probe. A minimum requirement for perforations is holes or slots with an open area equivalent to four 0.006-m (0.25-in.) diameter holes spaced 90° apart every 0.15 m (6 in.). Place the pressure probe in the center of the hole and backfill with gravel to a level 0.30 m (1 ft) above the perforated section. Add a layer of backfill material at least 1.2 m (4 ft) thick. Add a layer of bentonite at least 0.3 m (1 ft) thick, and backfill the remainder of the hole with cover material or material equal in permeability to the existing cover material. The specifications for pressure probe installation are shown in Figure 2E–5.

8.4 LFG Flow Rate Measurement. Place the flow measurement device, such as an orifice meter, as shown in Figure 2E–1. Attach the wells to the blower and flare assembly. The individual wells may be ducted to a common header so that a single blower, flare assembly, and flow meter may be used. Use the procedures in Section 10.1 to calibrate the flow meter.

8.5 Leak-Check. A leak-check of the above ground system is required for accurate flow rate measurements and for safety. Sample LFG at the well head sample port and at the outlet sample port. Use Method 3C to determine nitrogen (N_2) concentrations. Determine the difference between the well head and outlet N_2 concentrations using the formula in Section 12.3. The system passes the leak-check if the difference is less than 10,000 ppmv.

8.6 Static Testing. Close the control valves on the well heads during static testing. Measure the gauge pressure (P_g) at each deep pressure probe and the barometric pressure (P_{bar}) every 8 hours (hr) for 3 days. Convert the gauge pressure of each deep pressure probe to absolute pressure using the equation in Section 12.4. Record as P_i (initial absolute pressure).

8.6.1 For each probe, average all of the 8-hr deep pressure probe readings (P_i) and record as P_{ia} (average absolute pressure). P_{ia} is used in Section 8.7.5 to determine the maximum radius of influence.

8.6.2 Measure the static flow rate of each well once during static testing.

8.7 Short-Term Testing. The purpose of short-term testing is to determine the maximum vacuum that can be applied to the wells without infiltration of ambient air into the landfill. The short-term testing is performed on one well at a time. Burn all LFG with a flare or incinerator.

8.7.1 Use the blower to extract LFG from a single well at a rate at least twice the static flow rate of the respective well measured in Section 8.6.2. If using a single blower and flare assembly and a common header system, close the control valve on the wells not being measured. Allow 24 hr for the system to stabilize at this flow rate.

8.7.2 Test for infiltration of air into the landfill by measuring the gauge pressures of the shallow pressure probes and using Method 3C to determine the LFG N_2 concentration. If the LFG N_2 concentration is less than 5 percent and all of the shallow probes have a positive gauge pressure, increase the blower vacuum by 3.7 mm Hg (2 in. H_2O), wait 24 hr, and repeat the tests for infiltration. Continue the above steps of increasing blower vacuum by 3.7 mm Hg (2 in. H_2O), waiting 24 hr, and testing for infiltration until the concentration of N_2 exceeds 5 percent or any of the shallow probes have a negative gauge pressure. When this occurs, reduce the blower vacuum to the maximum setting at which the N_2 concentration was less than 5 percent and the gauge pressures of the shallow probes are positive.

8.7.3 At this blower vacuum, measure atmospheric pressure (P_{bar}) every 8 hr for 24 hr, and record the LFG flow rate (Q_s) and the probe gauge pressures (P_f) for all of the probes. Convert the gauge pressures of the deep probes to absolute pressures for each 8-hr reading at Q_s as shown in Section 12.4.

8.7.4 For each probe, average the 8-hr deep pressure probe absolute pressure readings and record as P_{fa} (the final average absolute pressure).

8.7.5 For each probe, compare the initial average pressure (P_{ia}) from Section 8.6.1 to the final average pressure (P_{fa}). Determine the furthermost point from the well head along each radial arm where $P_{fa} \leq P_{ia}$. This distance is the maximum radius of influence (R_m), which is the distance from the well affected by the vacuum. Average these values to determine the average maximum radius of influence (R_{ma}).

8.7.6 Calculate the depth (D_{st}) affected by the extraction well during the short term test as shown in Section 12.6. If the computed value of D_{st} exceeds the depth of the landfill, set D_{st} equal to the landfill depth.

8.7.7 Calculate the void volume (V) for the extraction well as shown in Section 12.7.

8.7.8 Repeat the procedures in Section 8.7 for each well.

8.8 Calculate the total void volume of the test wells (V_v) by summing the void volumes (V) of each well.

8.9 Long-Term Testing. The purpose of long-term testing is to extract two void volumes of LFG from the extraction wells. Use the blower to extract LFG from the wells. If a single Blower and flare assembly and common header system are used, open all control valves and set the blower vacuum equal to the highest stabilized blower vacuum demonstrated by any individual well in Section 8.7. Every 8 hr, sample the LFG from the well head sample port, measure the gauge pressures of the shallow pressure probes, the blower vacuum, the LFG flow rate, and use the criteria for infiltration in Section 8.7.2 and Method 3C to test for infiltration. If infiltration is detected, do not reduce the blower vacuum, instead reduce the LFG flow rate from the well by adjusting the control valve on the well head. Adjust each affected well individually. Continue until the equivalent of two total void volumes (V_v) have been extracted, or until $V_t = 2V_v$.

8.9.1 Calculate V_t, the total volume of LFG extracted from the wells, as shown in Section 12.8.

8.9.2 Record the final stabilized flow rate as Q_f and the gauge pressure for each deep probe. If, during the long term testing, the flow rate does not stabilize, calculate Q_f by averaging the last 10 recorded flow rates.

8.9.3 For each deep probe, convert each gauge pressure to absolute pressure as in Section 12.4. Average these values and record as P_{sa}. For each probe, compare P_{ia} to P_{sa}. Determine the furthermost point from the well head along each radial arm where $P_{sa} \leq P_{ia}$. This distance is the stabilized radius of influence. Average these values to determine the average stabilized radius of influence (R_{sa}).

8.10 Determine the NMOC mass emission rate using the procedures in Section 12.9 through 12.15.

9.0 Quality Control

9.1 Miscellaneous Quality Control Measures.

Section	Quality control measure	Effect
10.1	LFG flow rate meter calibration	Ensures accurate measurement of LFG flow rate and sample volume

10.0 Calibration and Standardization

10.1 LFG Flow Rate Meter (Orifice) Calibration Procedure. Locate a standard pitot tube in line with an orifice meter. Use the procedures in Section 8, 12.5, 12.6, and 12.7 of Method 2 to determine the average dry gas volumetric flow rate for at least five flow rates that bracket the expected LFG flow rates, except in Section 8.1, use a standard pitot tube rather than a Type S pitot tube. Method 3C may be used to determine the dry molecular weight. It may be necessary to calibrate more than one orifice meter in order to bracket the LFG flow rates. Construct a calibration curve by plotting the pressure drops across the orifice meter for each flow rate versus the average dry gas volumetric flow rate in m^3/min of the gas.

11.0 Procedures [Reserved]

12.0 Data Analysis and Calculations

12.1 Nomenclature.

A=Age of landfill, yr.

A_{avg} = Average age of the refuse tested, yr.

A_i = Age of refuse in the ^{ith} fraction, yr.

A_r = Acceptance rate, Mg/yr.

C_{NMOC} = NMOC concentration, ppmv as hexane (C_{NMOC}=C_t/6).

C_o = Concentration of N_2 at the outlet, ppmv.

C_t = NMOC concentration, ppmv (carbon equivalent) from Method 25C.

C_w = Concentration of N_2 at the wellhead, ppmv.

D = Depth affected by the test wells, m.

D_{st} = Depth affected by the test wells in the short-term test, m.

e = Base number for natural logarithms (2.718).

f = Fraction of decomposable refuse in the landfill.

f_i = Fraction of the refuse in the ^{ith} section.

k = Landfill gas generation constant, yr^{-1}.

L_o = Methane generation potential, m^3/Mg.

L_o' = Revised methane generation potential to account for the amount of non-decomposable material in the landfill, m^3/Mg.

M_i = Mass of refuse in the ^{ith} section, Mg.

M_r = Mass of decomposable refuse affected by the test well, Mg.

P_{bar} = Atmospheric pressure, mm Hg.

P_f = Final absolute pressure of the deep pressure probes during short-term testing, mm Hg.

P_{fa} = Average final absolute pressure of the deep pressure probes during short-term testing, mm Hg.

P_{gf} = final gauge pressure of the deep pressure probes, mm Hg.

P_{gi} = Initial gauge pressure of the deep pressure probes, mm Hg.

P_i = Initial absolute pressure of the deep pressure probes during static testing, mm Hg.

P_{ia} = Average initial absolute pressure of the deep pressure probes during static testing, mm Hg.

P_s = Final absolute pressure of the deep pressure probes during long-term testing, mm Hg.

P_{sa} = Average final absolute pressure of the deep pressure probes during long-term testing, mm Hg.

Q_f = Final stabilized flow rate, m^3/min.

Q_i = LFG flow rate measured at orifice meter during the ith interval, m^3/min.

Q_s = Maximum LFG flow rate at each well determined by short-term test, m^3/min.

Q_t = NMOC mass emission rate, m^3/min.

R_m = Maximum radius of influence, m.

R_{ma} = Average maximum radius of influence, m.

R_s = Stabilized radius of influence for an individual well, m.

R_{sa} = Average stabilized radius of influence, m.

t_i = Age of section i, yr.

t_t = Total time of long-term testing, yr.

t_{vi} = Time of the ^{ith} interval (usually 8), hr.

V=Void volume of test well, m^3.

V_r = Volume of refuse affected by the test well, m^3.

V_t = Total volume of refuse affected by the long-term testing, m^3.

V_v = Total void volume affected by test wells, m^3.

WD = Well depth, m.

ρ = Refuse density, Mg/m^3 (Assume 0.64 Mg/m^3 if data are unavailable).

12.2 Use the following equation to calculate a weighted average age of landfill refuse.

$$A_{avg} = \sum_{i=1}^{n} f_i A_i \qquad Eq.\ 2E\text{-}1$$

12.3 Use the following equation to determine the difference in N_2 concentrations (ppmv) at the well head and outlet location.

$$Difference = C_o - C_w \qquad Eq.\ 2E\text{-}2$$

12.4 Use the following equation to convert the gauge pressure (P_g) of each initial deep pressure probe to absolute pressure (P_i).

$$P_i = P_{bar} + P_{gi} \qquad Eq.\ 2E\text{-}3$$

12.5 Use the following equation to convert the gauge pressures of the deep probes to absolute pressures for each 8-hr reading at Q_s.

$$P_f = P_{bar} + P_{gf} \qquad Eq.\ 2E\text{-}4$$

12.6 Use the following equation to calculate the depth (D_{st}) affected by the extraction well during the short-term test.

$$D_{st} = WD + R_{ma} \qquad Eq.\ 2E\text{-}5$$

12.7 Use the following equation to calculate the void volume for the extraction well (V).

$$V = 0.40\,\Pi\,R_{ma}^{2}\,D_{st} \qquad Eq.\ 2E\text{-}6$$

12.8 Use the following equation to calculate V_t, the total volume of LFG extracted from the wells.

$$V_t = \sum_{i=1}^{n} 60\,Q_i t_{vi} \qquad Eq.\ 2E\text{-}7$$

12.9 Use the following equation to calculate the depth affected by the test well. If using cluster wells, use the average depth of the wells for WD. If the value of D is greater than the depth of the landfill, set D equal to the landfill depth.

$$D = WD + R_{sa} \qquad Eq.\ 2E\text{-}8$$

12.10 Use the following equation to calculate the volume of refuse affected by the test well.

$$V_r = R_{sa}^{2}\,\Pi\,D \qquad Eq.\ 2E\text{-}9$$

12.11 Use the following equation to calculate the mass affected by the test well.

$$M_r = V_r\,\rho \qquad Eq.\ 2E\text{-}10$$

12.12 Modify L_o to account for the non-decomposable refuse in the landfill.

$$L_o' = f\,L_o \qquad Eq.\ 2E\text{-}11$$

12.13 In the following equation, solve for k (landfill gas generation constant) by iteration. A suggested procedure is to select a value for k, calculate the left side of the equation, and if not equal to zero, select another value for k. Continue this process until the left hand side of the equation equals zero, ±0.001.

$$k_e^{-k} A_{avg} - \frac{Q_f}{2\,L_o' M_r} = 0 \qquad Eq.\ 2E\text{-}12$$

12.14 Use the following equation to determine landfill NMOC mass emission rate if the yearly acceptance rate of refuse has been consistent (10 percent) over the life of the landfill.

$$Q_t = 2 L'_o A_r \left(1 - e^{-kA}\right) C_{NMOC} \left(3.595 \times 10^{-9}\right) \qquad Eq.\ 2E\text{-}13$$

12.15 Use the following equation to determine landfill NMOC mass emission rate if the acceptance rate has not been consistent over the life of the landfill.

$$Q_t = 2 k L'_o C_{NMOC} \left(3.595 \times 10^{-9}\right) \sum_{i=1}^{n} M_i e^{-kt_i} \qquad Eq.\ 2E\text{-}14$$

13.0 Method Performance [Reserved]

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 References

1. Same as Method 2, Appendix A, 40 CFR Part 60.

2. Emcon Associates, Methane Generation and Recovery from Landfills. Ann Arbor Science, 1982.

3. The Johns Hopkins University, Brown Station Road Landfill Gas Resource Assessment, Volume 1: Field Testing and Gas Recovery Projections. Laurel, Maryland: October 1982.

4. Mandeville and Associates, Procedure Manual for Landfill Gases Emission Testing.

5. Letter and attachments from Briggum, S., Waste Management of North America, to Thorneloe, S., EPA. Response to July 28, 1988 request for additional information. August 18, 1988.

6. Letter and attachments from Briggum, S., Waste Management of North America, to Wyatt, S., EPA. Response to December 7, 1988 request for additional information. January 16, 1989.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

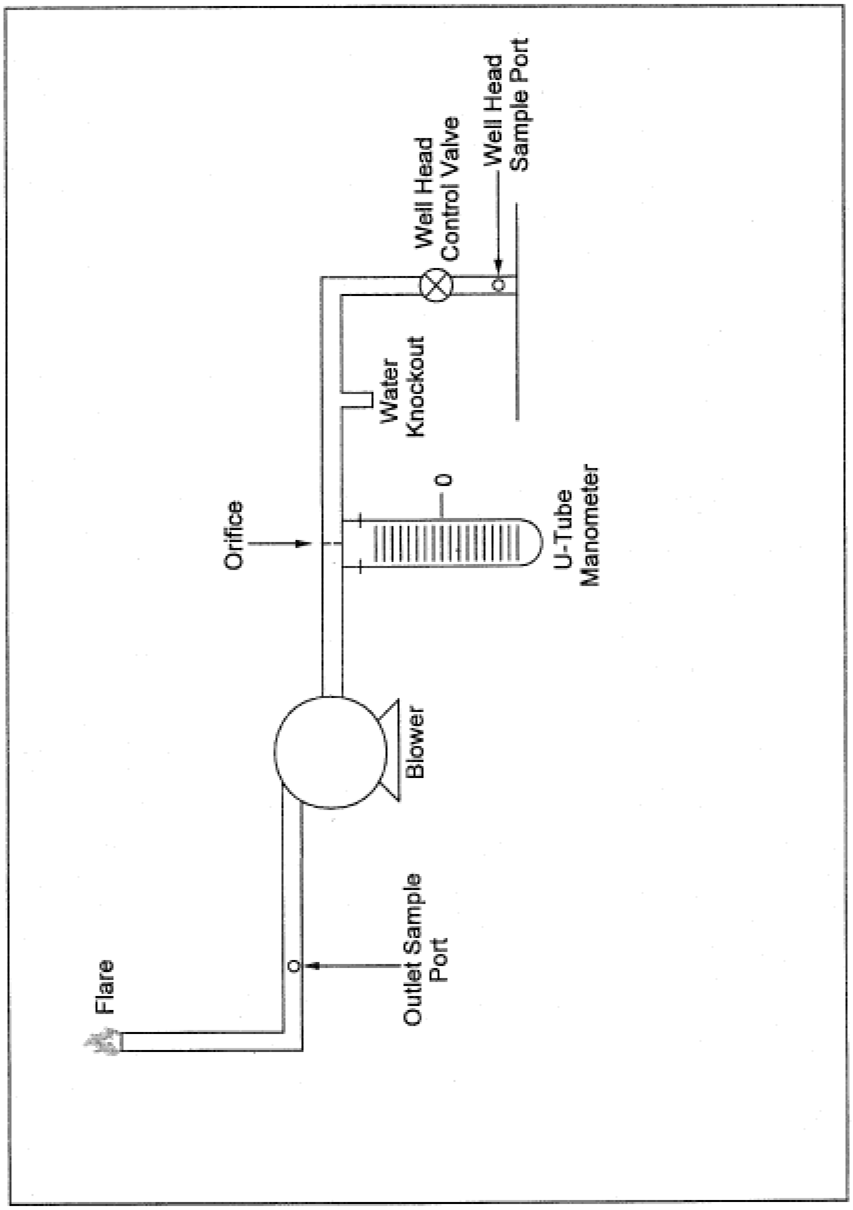


Figure 2E-1. Schematic of Aboveground Well Head Assembly.

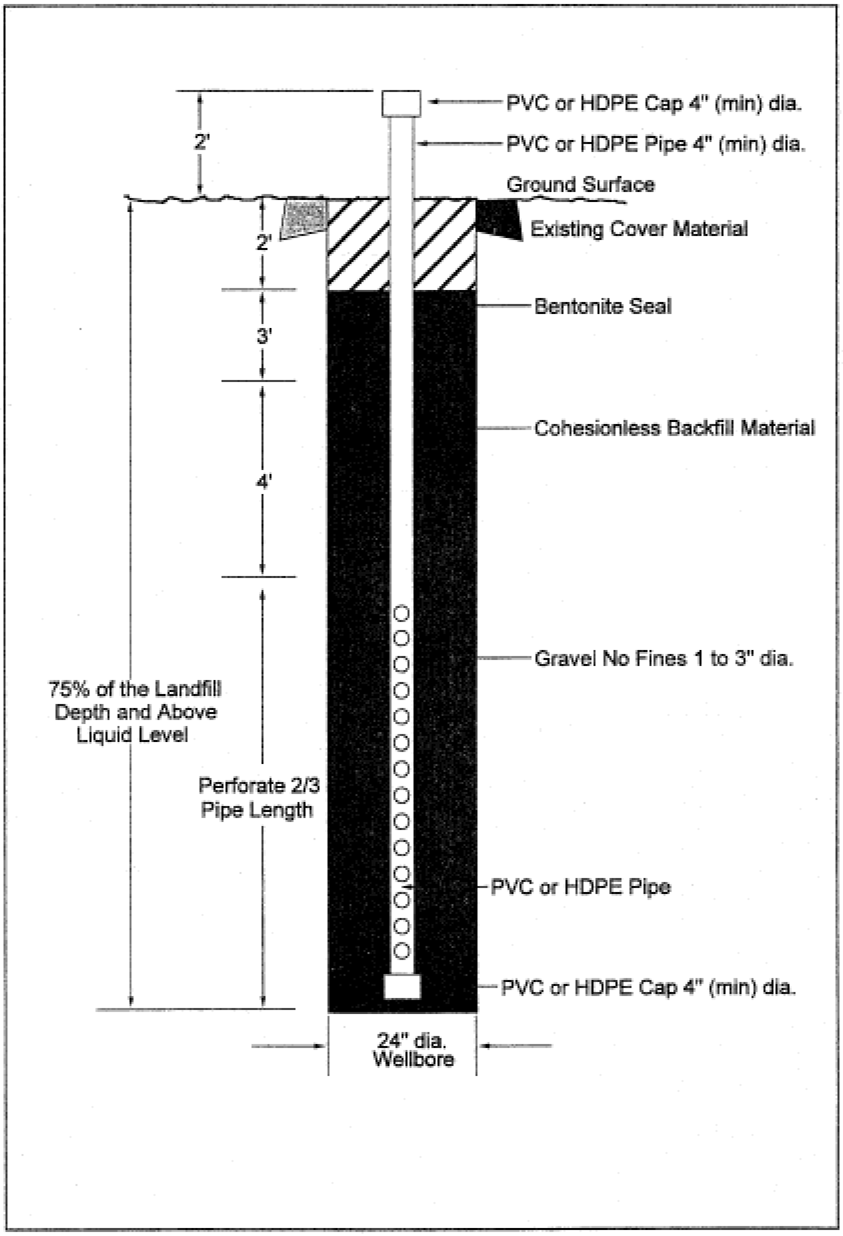


Figure 2E-3. Gas Extraction Well.

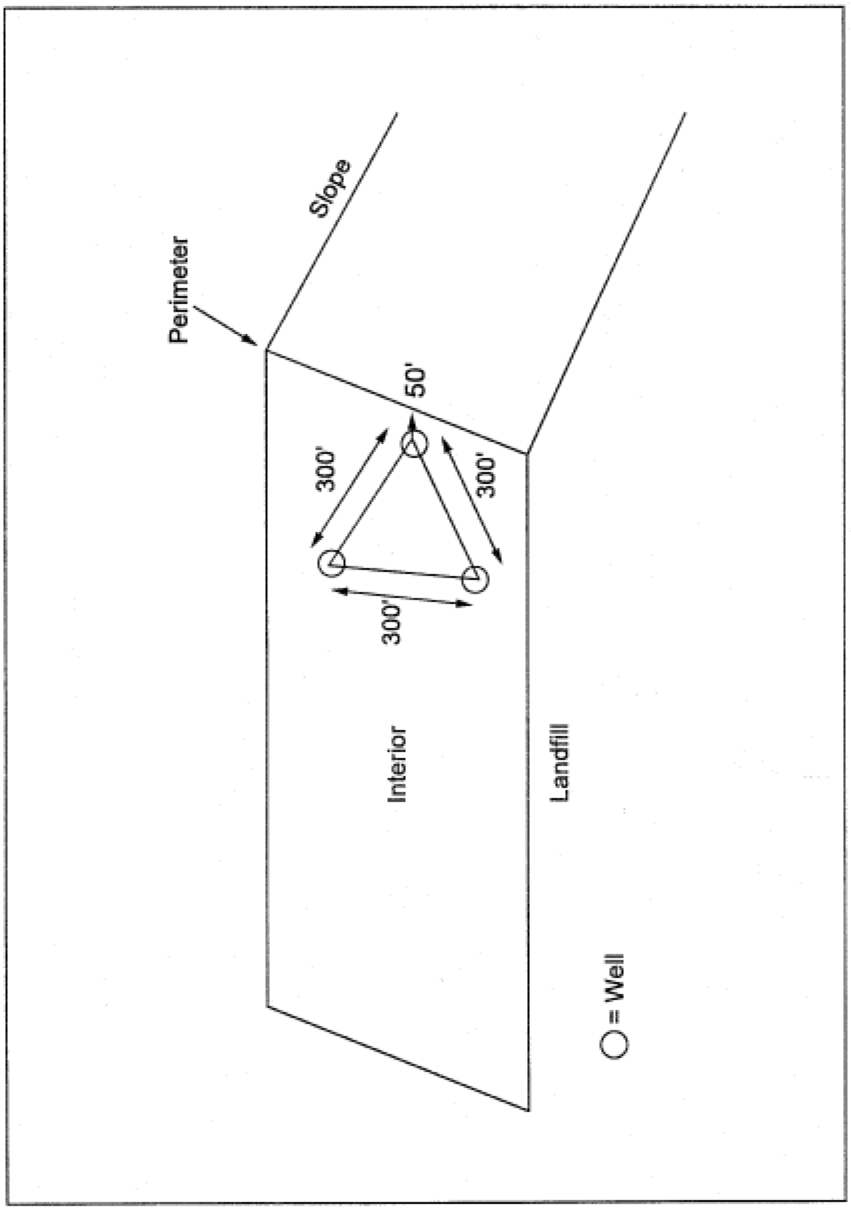


Figure 2E-2. Cluster Well Placement.

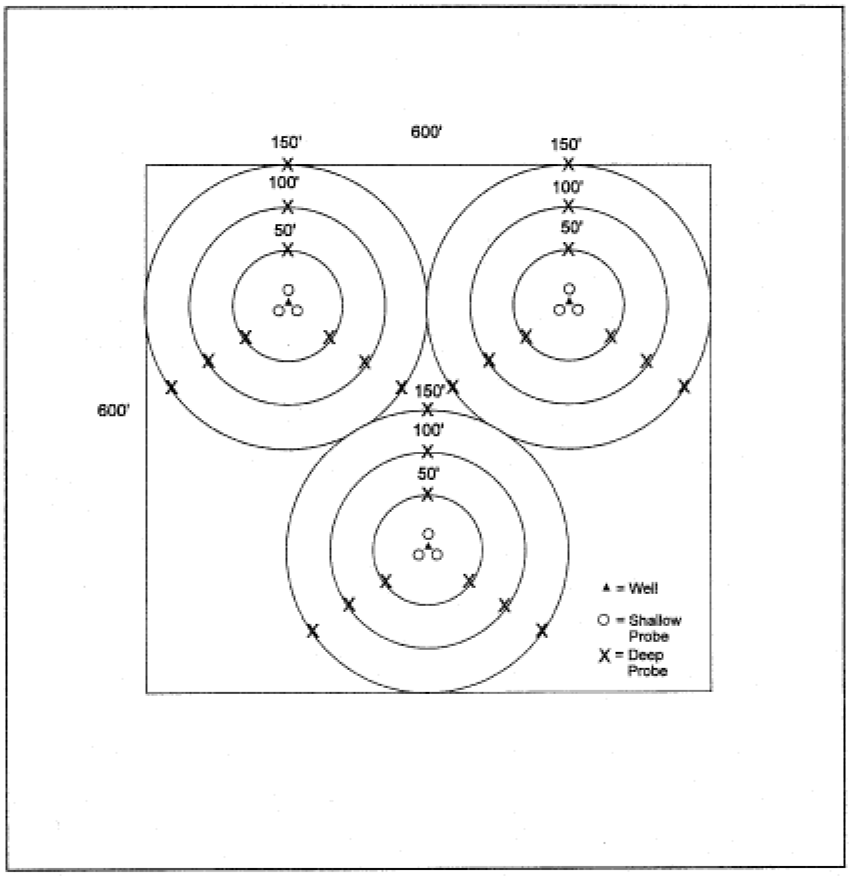


Figure 2E-4. Cluster Well Configuration.

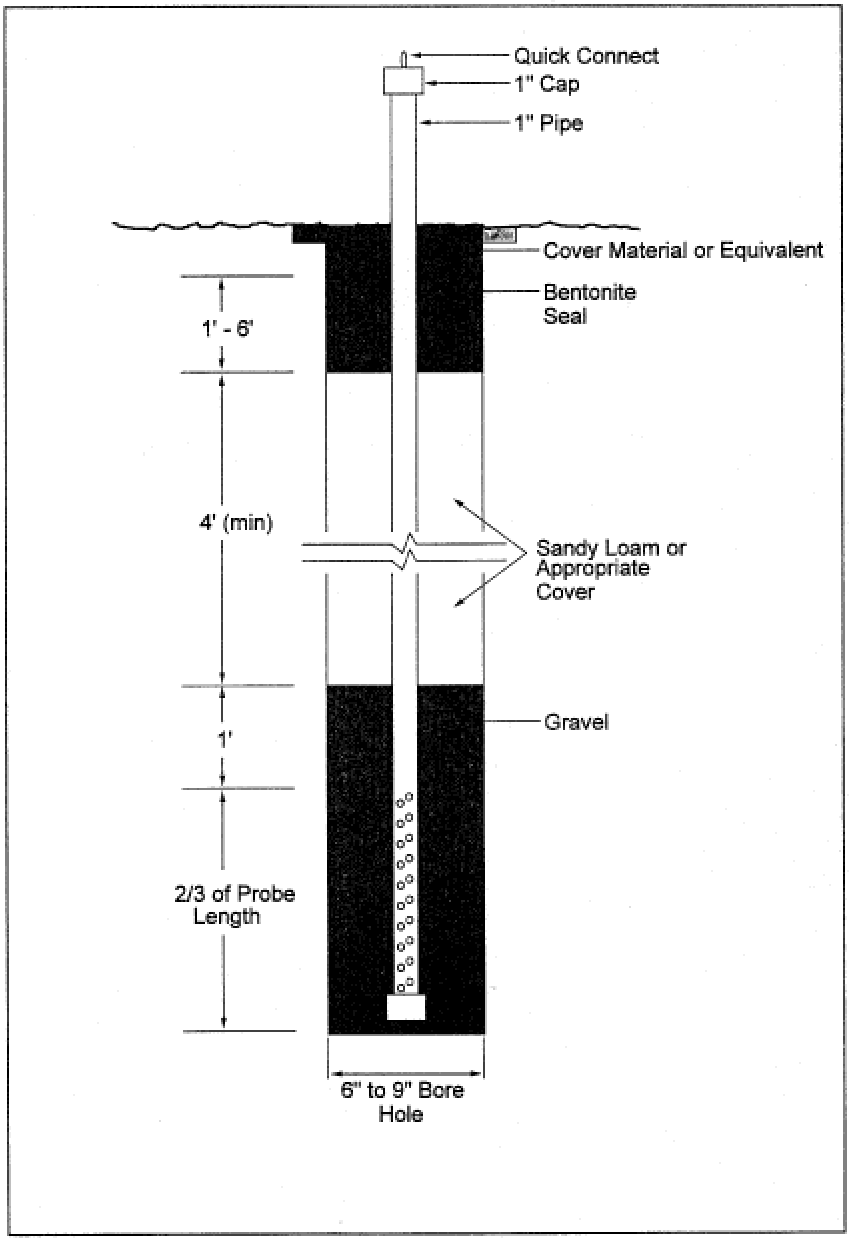


Figure 2E-5. Pressure Probe.

3.1 Method Specific Sampling Instructions

Air Toxics Method @ 71 Siloxanes

Siloxanes are a family of organic compounds containing chains of silicon, oxygen, and methyl groups. These organosilicon compounds, commonly called silicones, differ from naturally occurring inorganic forms of silicon (i.e., silicates). Siloxanes are manufactured in a wide variety of forms including low to high viscosity fluids, gums, elastomers, and resins.

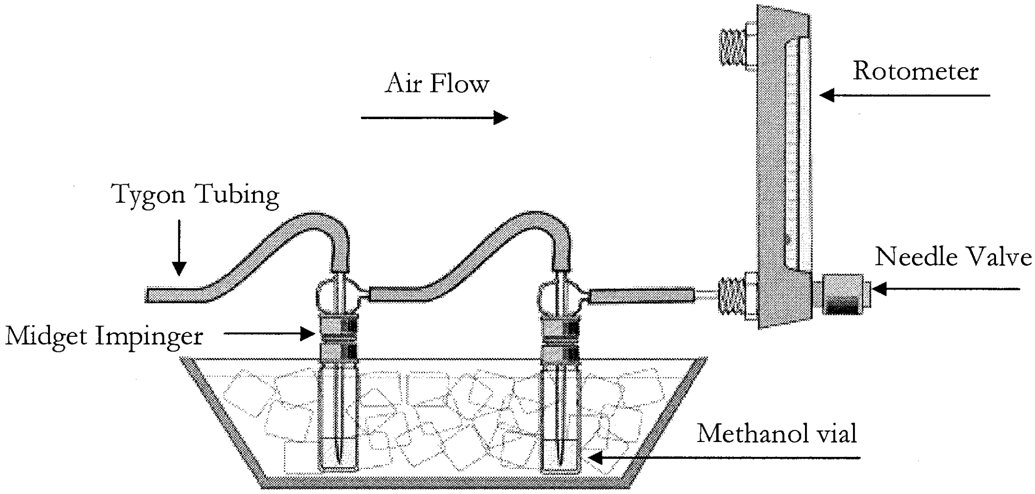
Building on results of the 1997 Dow Corning landfill consortium investigation, the ATL method is based on drawing air-phase samples through a series of two midget impingers containing methanol (see Table 1). Siloxanes present in the air-phase dissolve in the chilled methanol solution and are subsequently capped and kept chilled until analysis. The suggested media hold time is 30 days and the suggested sample hold time until analysis is 21 days.

Air Toxics @ 71 Siloxanes

Media	One pair of 24 mL borosilicate glass vials with Teflon screw caps and midget impingers in ice bath
Impinger Solution	Up to 15 mL methanol (6 mL suggested)
Sampling Volume	Determined by user (20 L suggested)
Sampling Rate	Determined by user (112 mL/min for 3 hours suggested)
Sample Handling	Cap vials and keep chilled at 4 ± 2°C
Media Hold Time	30 days from date of certification
Sample Hold Time	21 days from collection

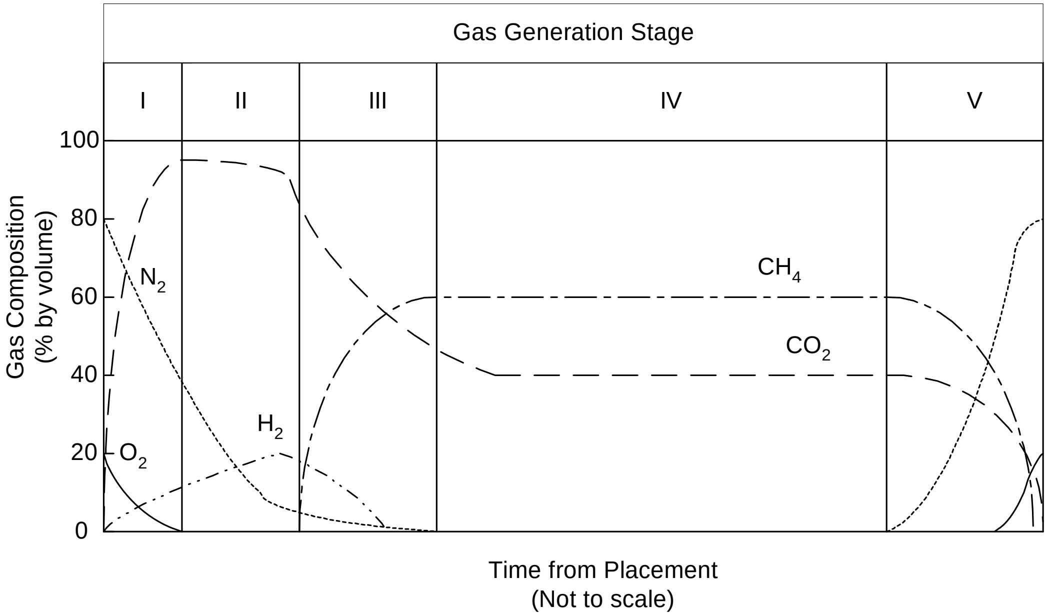
3.1 Method Specific Sampling Instructions

Collect the sample by attaching inert, flexible tubing from the source air stream to the inlet of the first impinger (see Figure 4). Additional tubing connects the outlet of the first impinger to the inlet of the second impinger and both impingers are chilled in an ice bath. If the source is not under pressure, a low-volume pump can supply the vacuum required to draw the sample though the impingers.



A needle valve and rotameter can be used to adjust and measure the flow rate of sample through the impingers. The user must determine optimum sampling rate and volume to achieve the data quality objectives of the sampling program. Sampling rates from 100 to 1,000 mL/min are appropriate as long as there is not significant loss of impinger solution. The amount of sample air drawn through the impingers and the amount of methanol in the impinger determine the final reporting limit concentration. The more sample air drawn through the impingers equates to more target constituent concentrated in the solution and thus lower reporting limits. Be careful not to over sample and saturate the solution. Less impinger solution equates to lower reporting limits, but has less capacity to dissolve the target constituents. For applications involving siloxanes removal from methane gas sources, Applied Filter Technology suggests filling each impinger with 6 mL of methanol and sampling at a flow rate of 112 mL/min for 180 minutes [4]. This arrangement results in a sampling volume of approximately 20 L.

Appendix O
Stages of Biodegradation



Stage I	- Aerobic phase
Stage II	- Acidogenic phase
Stage III	- Exponential growth phase
Stage IV	- Stationary phase
Stage V	- Endogenic decay phase

Fig. 2-1 Stages of biodegradation of solid waste (Augenstein and Pacey, 1991)

Appendix P
Gas Testing Cost Estimates

CH2M HILL

MSB Central Landfill
Costs for a Landfill Gas Testing Program and Well Installations at Cells 2A and 2B

Engineer's Order-of-Magnitude Cost Estimate[a]

Item No.	Description	Estimated Quantity	Unit	Unit Price	Extended Unit Price
Step 1 - Prepare Design Documents for Active Landfill Gas Collection System (LFGCS)					
1	Design Drawings and Specifications	1	LS	$ 20,000.00	$ 20,000
	Step 1 Subtotal				**$ 20,000**
Step 2 - Construct Active LFGCS					
2	Cell 2A Vertical Gas Extraction Wells, 45' Depth	3	EA	$ 40,000.00	$ 120,000
3	Cell 2B Vertical Gas Extraction Wells, 75' Depth	3	EA	$ 62,500.00	$ 187,500
4	Cell 2A Shallow Probes, 15' Depth	9	EA	$ 250.00	$ 2,250
5	Cell 2A Deep Probes, 30' Depth	27	EA	$ 500.00	$ 13,500
6	Cell 2B Shallow Probes, 25' Depth	9	EA	$ 400.00	$ 3,600
7	Cell 2B Deep Probes, 50' Depth	27	EA	$ 800.00	$ 21,600
8	Above Ground Temporary Gas Collection Network	1	LS	$ 15,000.00	$ 15,000
	Construction Subtotal				$ 363,450
9	Bonds, Insurance Premiums, Mob/Demob, and Contract Closeout	6%			$ 21,807
10	Construction Facilities, Temporary Controls, and HSE	4%			$ 14,538
11	Engineering Construction Management	6%			$ 21,807
	Step 2 Subtotal				**$ 421,602**
Step 3 - Prepare Sampling and Testing Plan					
12	Prepare Sampling and Testing Plan	1	LS	$ 14,000.00	$ 14,000
	Step 3 Subtotal				**$ 14,000**
Step 4 - Conduct Landfill Gas Testing Program					
13	Blower System Rental	1	LS	$ 15,000.00	$ 15,000
14	Light Tower Rental, Fuel, and O&M	1	LS	$ 15,000.00	$ 15,000
15	Gas Meter Rental, and Calibration Gases	1	LS	$ 4,500.00	$ 4,500
16	Siloxanes Sampling Equipment and Blower Rental	1	LS	$ 1,000.00	$ 1,000
17	Siloxanes Laboratory Testing, including S/H	1	LS	$ 2,000.00	$ 2,000
18	Engineering for Landfill Gas Testing Program Implementation	1	LS	$ 100,000.00	$ 100,000
19	Miscellaneous Field Expenses and Per Diem	1	LS	$ 10,000.00	$ 10,000
	Step 4 Subtotal				**$ 147,500**
Step 5 - Prepare Test Report					
20	Prepare Test report	1	LS	$ 14,000.00	$ 14,000
	Step 5 Subtotal				**$ 14,000**
	Project Subtotal				**$ 617,102**
	Contingency[b]	30%			$ 185,131
	PROJECT TOTAL (rounded)				**$ 802,000**

Notes:

(a) This cost opinion is a rough order of magnitude (ROM) estimate in 2014$ and has been prepared for project guidance based on the landfill gas testing program for Cells 2A and 2B described in the 2014 MSB Central Landfill Development Plan. The actual cost of the project will depend on competitive market conditions, actual labor and material costs, actual site conditions, productivity, project scope, final design and schedule, and other factors. As a result, the actual project costs will vary from those presented above. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

(b) Contingency is for scope changes that are presently unforeseen

LS = lump sum

TECHNICAL MEMORANDUM

C&D Cell Development Plan

PREPARED FOR:	Matanuska-Susitna Borough
COPY TO:	Project File
PREPARED BY:	Jeremiah Knuth/CH2M
DATE:	May 31, 2017
PROJECT NUMBER:	690743
APPROVED BY:	Cory Hinds/CH2M

This Construction and Demolition (C&D) cell development plan provides a summary of the data, assumptions, and approaches that were used during the development of the conceptual layout for the new C&D cell at the Matanuska-Susitna Borough (MSB) Central Landfill. This includes a summary of baseline data used to: estimate future airspace requirements; utilize existing site conditions; and assemble landfill elements to provide the MSB Solid Waste Division (SWD) with a development plan that optimizes available airspace and gravel resources at the MSB Central Landfill. This development plan is to be used by the MSB as guidance for development of the new C&D cell.

1.0 Population and Waste Growth

Historical Growth

As the population in the MSB continues to increases, so will the quantity of C&D waste entering the MSB Central Landfill. Historical population data of the MSB was gathered from the U.S. Census Bureau (USCB, 2011; 2017). Since 2001, the population of the MSB has grown an average of 3.55% annually as summarized in Table 1. Individual annual growths rates have ranged from 2.18% (2012) to 5.36% (2004).

In order to forecast future airspace requirements and related material needs, a relationship trend between incoming C&D waste quantities entering the MSB Central Landfill and MSB population was determined over the period from 2001 to 2016. Annual incoming C&D waste tonnages were provided by the MSB. As expected, historical data indicates that incoming C&D waste quantities increased as the population of the MSB grew. Table 2 summarize this relationship trend from 2001 to 2016.

TABLE 1
Historical MSB Population Growth (2001 to 2016)

Year	MSB Population[1]	Annual Growth Rate
2001	61,807	--
2002	64,353	4.12%
2003	67,162	4.36%
2004	70,761	5.36%
2005	74,409	5.16%
2006	78,633	5.68%
2007	81,402	3.52%
2008	84,079	3.29%
2009	86,885	3.34%

2014	98,196	2.37%
2015	101,120	2.98%
2016	104,365	3.21%
Average	84,033	3.55%

Notes:

[1] The 2016 US Census Bureau population estimates for the MSB (USCB, 2001; 2017)

In order to forecast future airspace requirements and related material needs, a relationship trend between incoming C&D waste quantities entering the MSB Central Landfill and MSB population was determined over the period from 2001 to 2016. Annual incoming C&D waste tonnages were provided by the MSB. As expected, historical data indicates that incoming C&D waste quantities increased as the population of the MSB grew. Table 2 summarize this relationship trend from 2001 to 2016.

TABLE 2

Historical Annual MSB Population and Incoming C&D Waste Quantities (2001 to 2016)

Year	**MSB Population**[1]	**Incoming C&D Waste Weight** (Tons)	**Incoming C&D Waste Volume**[2,3] (CY)	**Average Daily C&D Waste Volume**[2,3] (CY)
2001	61,807	2,841	5,682	16
2002	64,353	4,461	8,923	25
2003	67,162	5,390	10,781	30
2004	70,761	5,834	11,667	32
2005	74,409	8,052	16,104	45
2006	78,633	7,752	15,503	43
2007	81,402	10,143	20,285	57
2008	84,079	9,439	18,878	53
2009	86,885	10,357	20,715	58
2010	89,766	10,926	21,852	61
2011	91,831	11,356	22,711	63
2012	93,831	9,812	19,623	55
2013	95,923	11,631	23,262	65
2014	98,196	13,220	26,440	74
2015	101,120	15,087	30,174	84
2016	104,365	13,562	27,124	76
5-year Average (2011 - 2016)	98,687	12,662	25,325	71
10-year Average (2006 - 2016)	92,740	11,553	23,106	64
Timeframe Average (2001 - 2016)	84,033	9,366	18,733	52

Notes:

[1] Annual population values based on U.S Census Bureau data (USCB, 2011; 2017)

[2] Assumes an in-place, compacted C&D waste density of 1,000 lb/cy (soil cover not included); as provided by the MSB and verified with standard industry values (FEMA, 2010).

[3] Assumes that similar compaction equipment and methods that are currently used by the MSB will continue to be used in the future resulting in a compacted C&D waste density of 1,000 lb/cy.

[4] This incoming C&D waste (Y) to population (X) relationship is best modeled logarithmically using the equation: $Y = 20129*\ln(X) – 218628$.

Future Growth

The population of the MSB is expected to continue to increase at a similar rate as historically observed. Based on the population growth observed from 2001 to 2016, the MSB population is projected to increase linearly over the next 10-years. Table 3 summarizes the projected population and future growth rates of the MSB.

TABLE 3

MSB Population Growth Forecast (2017 to 2027)

Year	MSB Population[1]	Annual Growth Rate
2017	107,958	3.44%
2018	110,773	2.61%
2019	113,587	2.54%
2020	116,402	2.48%
2021	119,217	2.42%
2022	122,032	2.36%
2023	124,846	2.31%
2024	127,661	2.25%
2025	130,476	2.20%
2026	133,290	2.16%
2027	136,105	2.11%
Average	122,032	2.44%

Notes:

[1] Future population was estimated based on the linear relationship between the MSB population (Y) and Year (X) represented by the equation: Y = 2814.728 (X) - 5569348.382.

Future C&D waste quantities have been estimated based on the projected annual population of the MSB. The quantity of C&D waste entering the MSB Central Landfill is expected to logarithmically increase with population growth based on the waste relationship trend summarized in Table 1. The equation presented in Graph 1 below (and Table 1) was used to estimate the annual incoming quantities of C&D waste from 2017 to 2027 based on MSB population forecasts (Table 3). Graph 1 shows this waste relationship trend projected to the forecasted MSB population (136,105 citizens) in 2027. Based on this trend, future incoming C&D waste quantities were estimated and summarized in Table 4.

GRAPH 1 - Incoming C&D Waste Growth with MSB Population (2001 to 2027)

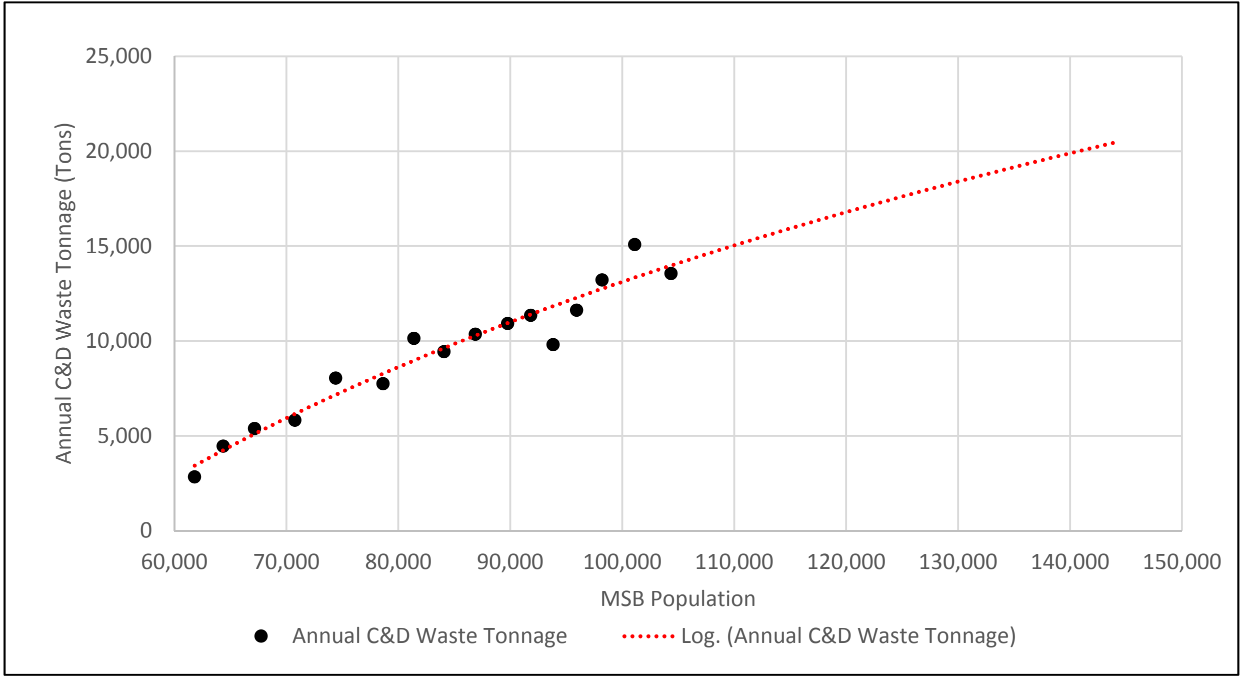


TABLE 4

Estimated Annual MSB Population and Incoming C&D Waste Quantities (2017 to 2027)

Year	MSB Population[1]	Incoming C&D Waste Weight[2] (Tons)	Incoming C&D Waste Volume[3] (CY)	Average Daily C&D Waste Volume[3] (CY)
2017	107,958	14,657	29,314	82
2018	110,773	15,175	30,350	85
2019	113,587	15,680	31,360	87
2020	116,402	16,173	32,346	90
2021	119,217	16,654	33,308	93
2022	122,032	17,124	34,247	95
2023	124,846	17,583	35,165	98
2024	127,661	18,031	36,063	100
2025	130,476	18,470	36,941	103
2026	133,290	18,900	37,800	105
2027	136,105	19,321	38,641	108

Notes:

[1] Annual population values were forecast as summarized in Table 3.

[2] Incoming C&D waste tonnages are estimated based on the logarithmical trend presented in Table 1. The relationship between the annual incoming C&D waste quantities (Y) and population (X) are represented by the equation: Y = 120129*ln (X) – 218628.

[3] Assumes an in-place, compacted C&D waste density of 1,000 lb/cy (soil cover not included); as provided by the MSB and verified with standard industry values (FEMA, 2010).

2.0 Airspace Requirements

The MSB does not currently track actual daily cover soil use, so cover soil estimates were calculated based on the estimated annual volumes of incoming C&D waste (Table 4) and design assumptions for the new C&D landfill cell. The MSB indicated that C&D waste will be accepted and placed within the landfill cell in 10-foot-thick lifts and that operations will be conducted a total of 359 days a year.

The working deck and face of the C&D landfill cell was assumed to be covered daily based on the regulatory required 6-inches of daily soil cover and 12-inches of interim cover. Based on the geometry of the working face, the daily soil cover usage was estimated. All daily soil cover was estimated to be compacted to an average density of 120 lbs per cubic foot. Calculations of exposed C&D waste for each daily cell indicate that the annual estimated daily cover quantities presented in Table 5 are sufficient to cover the entire top and sloped faces of the working landfill.

Once the incoming C&D waste and daily soil cover quantities were determined, the total combined weights and volumes (airspace volume) of the C&D waste and daily soil cover were calculated annually as summarized in Table 5.

TABLE 5

Estimated Annual Incoming C&D Waste, Daily Soil Cover, Total Quantities, and Soil-to-Waste Ratio (2017 to 2027)

Year	MSB Population[1]	Incoming C&D Waste Weight[2] (Tons)	Incoming C&D Waste Volume[3] (CY)	Daily Soil Cover Weight[2] (Tons)	Daily Soil Cover Volume[4] (CY)	Total Weight[5] (Tons)	Airspace Volume[6] (CY)	Average Daily Airspace Volume (CY/Day)	Soil-to-Waste Ratio
2017	107,958	14,657	29,314	12,547	7,745	27,204	37,059	103	0.26
2018	110,773	15,175	30,350	12,700	7,839	27,875	38,190	106	0.26
2019	113,587	15,680	31,360	12,847	7,930	28,527	39,291	109	0.25
2020	116,402	16,173	32,346	12,989	8,018	29,162	40,364	112	0.25

2021	119,217	16,654	33,308	13,127	8,103	29,781	41,411	115	0.24
2022	122,032	17,124	34,247	13,260	8,185	30,383	42,432	118	0.24
2023	124,846	17,583	35,165	13,389	8,265	30,971	43,430	121	0.24
2024	127,661	18,031	36,063	13,514	8,342	31,545	44,404	124	0.23
2025	130,476	18,470	36,941	13,635	8,417	32,105	45,357	126	0.23
2026	133,290	18,900	37,800	13,753	8,489	32,653	46,289	129	0.22
2027	136,105	19,321	38,641	13,867	8,560	33,188	47,201	131	0.22
10-year Average	123,439	17,311	34,622	13,308	8,215	30,619	42,837	119	0.24

Notes:

[1] Annual population values were forecast as summarized in Table 3.

[2] Incoming C&D waste tonnages are estimated based on the logarithmical trend presented in Section 1.1.

[3] Assumes an in-place, compacted C&D waste density of 1,000 lb/cy (soil cover not included); as provided by the MSB and verified with standard industry values (FEMA, 2010).[2] Calculated assuming: a) 10 foot lifts, b) a side slope ratio of 3:1, c) a working face with two exposed sides, d) compacted daily soil cover thickness of 0.5 feet (6 inches), and e) 359 working days a year.

[4] Assumes an in-place, compacted daily soil cover density of 120 lbs/cft.

[5] Total combined weight of C&D waste and daily soil cover.

[6] Total combined in-place, compacted volume of C&D waste and daily soil cover.

Cumulative incoming C&D waste, daily soil cover, and airspace quantities are summarized in Table 6. It is estimated that 187,767 tons (375,534 CY) of C&D waste will be accepted at the MSB Central Landfill over the next 10 years (2017 to 2027). It is expected that all of this C&D waste will placed within the new C&D waste cell which will required an estimated 89,894 CY of soil to cover the working face of the C&D waste cell daily. An estimated total airspace volume of 465,428 CY will be required to accept the volume of C&D waste and soil cover anticipated for the next 10 years. Graph 2 shows the required total cumulative airspace volume required with time.

TABLE 6

Estimated Cumulative Incoming C&D Waste, Daily Soil Cover, and Airspace Quantities (2017 to 2027)

Year[1]	**Incoming C&D Waste Weight[2]** (Tons)	**Cumulative Incoming C&D Waste Weight[2]** (Tons)	**Incoming C&D Waste Volume[3]** (CY)	**Cumulative Incoming C&D Waste Volume[3]**	**Daily Soil Cover Volume[4]** (CY)	**Cumulative Daily Soil Cover Volume[4]** (CY)	**Landfill Airspace Volume[5]** (CY)	**Cumulative Landfill Airspace Volume[5]** (CY)
2017	14,657	14,657	29,314	29,314	7,745	7,745	37,059	37,059
2018	15,175	29,832	30,350	59,664	7,839	15,585	38,190	75,249
2019	15,680	45,512	31,360	91,024	7,930	23,515	39,291	114,539
2020	16,173	61,685	32,346	123,370	8,018	31,533	40,364	154,903
2021	16,654	78,339	33,308	156,678	8,103	39,636	41,411	196,314
2022	17,124	95,462	34,247	190,925	8,185	47,821	42,432	238,746
2023	17,583	113,045	35,165	226,090	8,265	56,086	43,430	282,176
2024	18,031	131,076	36,063	262,153	8,342	64,428	44,404	326,580
2025	18,470	149,547	36,941	299,093	8,417	72,844	45,357	371,938
2026	18,900	168,447	37,800	336,893	8,489	81,334	46,289	418,227
2027	**19,321**	**187,767**	**38,641**	**375,534**	**8,560**	**89,894**	**47,201**	**465,428**

Notes:

[1] End of the year date (i.e. 2017 = December 31, 2017)

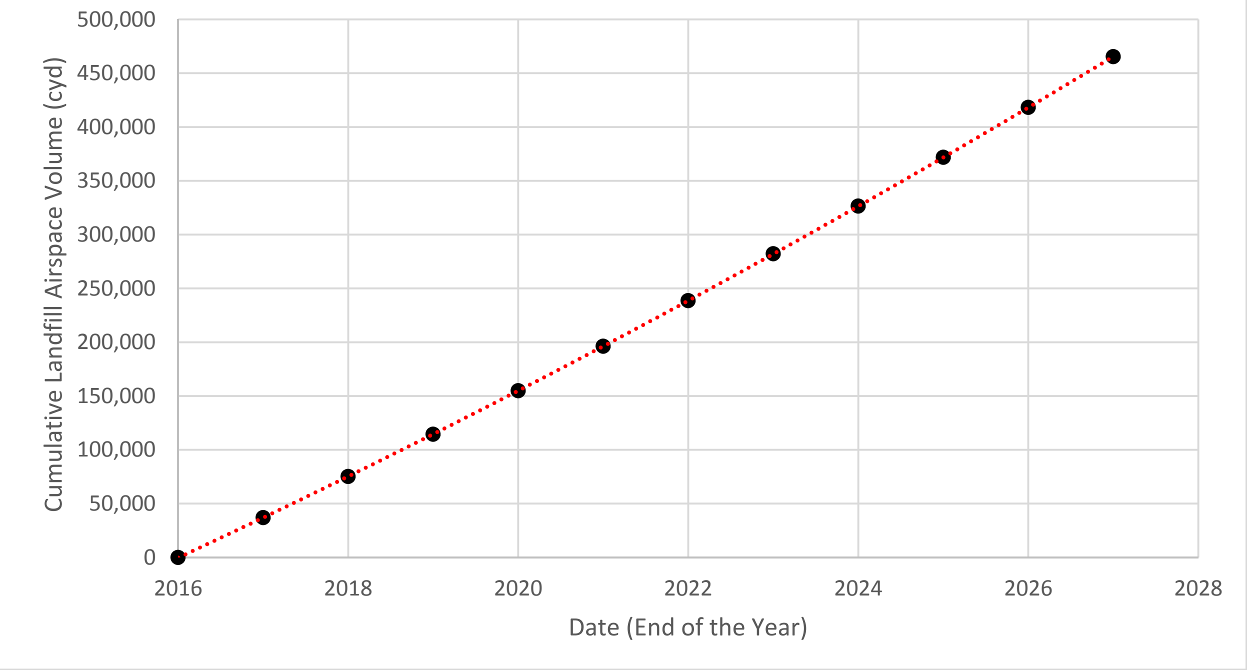
[2] Incoming C&D waste tonnages are estimated based on the logarithmical trend presented in Section 1.1.

[3] Assumes an in-place, compacted C&D waste density of 1,000 lb/cy (soil cover not included); as provided by the MSB and verified with standard industry values (FEMA, 2010).

[4] Calculated assuming: a) 10 foot lifts, b) a side slope ratio of 3:1, c) a working face with two exposed sides, d) compacted daily soil cover thickness of 0.5 feet (6 inches), e) 359 working days a year, and f) an in-place, compacted daily soil cover density of 120 lbs/cy.

[5] Total combined in-place, compacted volume of C&D waste and daily soil cover.

GRAPH 2 – Cumulative Landfill Airspace Required (2001 to 2027)



3.0 C&D Cell Capacity

The proposed site plan and the existing conditions of the new MSB C&D landfill cell is shown in Drawings 1 and 2. Drawing 3 shows the proposed final C&D cell grading plan once construction is complete. Drawing 1, 2, and 3 are located at the end of this report. For the purposes of gravel excavation the new C&D cell has been subdivided into two phase areas: Phase 1 and Phase 2 areas. Once both phases are constructed the bottom grade of the C&D cell is estimated to encompass an area of approximately 238,500 square feet (5.47 acres). Based on a cell design side slope ratio of 1.8:1 (horizontal to vertical), the airspace volume up to the top of the side slopes of the Phase 1 and Phase 2 areas (crest elevations ranging from 252 feet to 328 feet) are estimated in Table 7. Based on a beginning fill date of August 1, 2017, it is estimated that the lifespan of Phase 1 area will be approximately 13.5 years. The Phase 2 area will be filled in another 13.1 years. Without mounding (i.e., filling to the approximate elevation of surrounding ridge crest elevations only), the proposed C&D cell is estimated to be full in September 2043 with a total lifespan of approximately 26.6 years.

TABLE 7
Phase 1 and 2 Airspace Volume, Fill Duration, and Estimated Fill Date

			Fill Date[3]		Fill Duration[3]		Cumulative Landfill Airspace Volume[3,4]	
Phase	Phase Airspace Volume[1] (CY)	Cumulative Cell Airspace Volume[1] (CY)	Start[2]	Finish	(Days)	(Years)[5]	Start[6] (CY)	Finish (CY)
1	593,000	593,000	8/1/2017	11/16/2030	4856	13.5	21,431	614,431
2	1,421,000	2,014,000	11/16/2030	9/20/2043	4691	13.1	614,431	2,035,431

Notes:
[1] Airspace volume up to the top of the side slopes (cell crest) for each phase area. Estimated from the proposed final C&D cell grading plan using AutoCAD software.
[2] Estimated start of filling operations within the new C&D cell.
[3] Calculated based on the values and trend documented in Table 6 and Graph 2.
[4] The cumulative landfill C&D airspace volume since Dec. 31, 2016 for the MSB landfill.
[5] Assumes 359 filling (working) days a year.
[6] Value on the fill start date within the new C&D cell.

For the short-term, the airspace volume and fill duration for the first two 10-foot waste lifts over the Phase 1 area are estimated in Table 8.

TABLE 8
Phase 1 10 foot Lift Airspace Volume, Fill Duration, and Fill Date

Lift[1]	Phase Airspace Volume[2]	Cumulative Cell Airspace Volume[2]	Fill Date[4]		Fill Duration[4]		Cumulative Landfill Airspace Volume[4,5]	
			Start[3]	Finish			Start[7]	Finish
	(CY)	(CY)			(Days)	(Years)[6]	(CY)	(CY)
1	44,000	44,000	8/1/2017	9/26/2018	421	1.2	21,431	65,431
2	44,000	88,000	9/26/2018	11/10/2019	410	1.1	65,431	109,431

Notes:
[1] Assumes each waste lift is 10 feet thick.
[2] Airspace volume up to the top of the side slopes (cell crest) for each phase area. Estimated from the proposed final C&D cell grading plan using AutoCAD software.
[3] Estimated start of filling operations within the new C&D cell.
[4] Calculated based on the values and trend documented in Table 6 and Graph 2.
[5] The cumulative landfill C&D airspace volume since Dec. 31, 2016 for the MSB landfill.
[6] Assumes 359 filling (working) days a year.
[7] Value on the fill start date within the new C&D cell.

5.0 C&D Cell Development Basis

Methodology for Developing Cell Bottom Grading Plan

The general methodology below was used to develop the landfill development grading plans for the C&D Landfill Cell:

- Define the cell boundary limits based on the MSB Central Landfill property boundary property, existing landfill cells, and residential area and power line buffer zones.
- Develop overall bottom grades for the landfill that are a minimum of approximately 10 feet above the regional groundwater elevation.
- Develop access roads to the C&D cell to provide for two-way traffic.
- Calculate the amount of soil excavation and embankment fill between the existing ground topography and the bottom grading plan for total landfill development.
- Estimate the amount of surplus soil available for offsite use by deducting the total soil required daily cover from the net amount of soil excavated for total landfill development (that is, surplus soil from excavation).
- Develop cell sequencing plan for excavation construction and waste filling.

Cell Boundary Limits

The MSB Central Landfill property boundary was obtained from the MSB. Per direction from the MSB, future development is limited to the area east of the existing Matanuska Electric Association (MEA) 100-foot power line easement. The proposed new C&D cell will be constructed along the western edge of the MSB Central Landfill property immediately south of the existing C&D landfill cell (Drawing 1). Buffer zones between the C&D cell and existing residential property and utility easements measured from the cell boundary to the facility boundary. The north boundary will have at least a 1,500-foot buffer from existing residential property. The buffer on the west side will be a minimum of 50 feet from any MEA power pole guy wires.

Bottom Grading Plan

The bottom grading plan (Drawings 3 and 4) was developed so that bottom grades for the C&D cell meet the minimum regulatory 10-foot separation from bottom grade to the assumed regional high groundwater elevation. There are no hydrogeologic investigation or associated hydrographs available that identify the high groundwater elevation throughout the year; therefore, the high groundwater elevations are a compilation of the highest groundwater elevations between the available June 22, 2005, and March 11, 2014, groundwater data (Shannon & Wilson, Inc. 2005; 2014). This data indicates that groundwater generally slopes from north to south, with approximate elevations ranging from 190 feet at the north to 160 feet at the southern extent of the C&D cell. Minimum landfill bottom grades were developed by projecting the assumed regional groundwater surface up 10 feet to meet the minimum 10-foot separation requirement. Bottom grading plan side slopes from perimeter and interior berm roads are 1.8H:1V down to each landfill phase bottom. The depth of the landfill bottom ranges from approximately 44 to 138 feet below the elevation of the perimeter, with the shallowest depth at the northern edge of the Phase 2 area and the deepest depth at the southern edge of Phase 1 area. The landfill floor of each phase was developed to optimize the separation between high groundwater and the bottom of the landfill.

Access Roads

The C&D access road alignments can be seen in Drawing 1. An approximate minimum 400-foot turning radius was used for access road alignments to allow for two-way haul truck traffic based on a selected AASHTO 74-foot-long semitrailer turning geometry. Access roads are expected to consist of 30-foot-wide roadways (2x 12-foot lane and 3-foot shoulder with 1.5 percent centerline crown). Maximum access road grades are not to exceed current grades of 10 percent along straight portions and 5 percent on curves. Similarly, any service roads within the C&D cell should be 20 feet wide and should not exceed the greater of current grades or a maximum grade of 12 percent.

Excavation Cut, Embankment Fill, and Gravel Surplus

The existing area of the proposed C&D cell is located in an area of naturally occurring glacial moraines and consists of a rolling, hilly topography (Drawings 2 and 3). A significant volume of soil will be excavated (cut) in two phases (Phase 1 and Phase 2) to construct the designed bottom grade (Drawings 3 and 4). Natural soils consist predominately of silty gravel. The estimated volumes of soil to be excavated between the existing ground topography and the bottom grade is summarized in Table 8 and Drawing 4. No embankment or other soil fill is required for construction of the proposed C&D cell.

The MSB can use an unlimited supply of soil (gravel) throughout the borough. The MSB would like to maximize any surplus gravel for sale or use elsewhere within the MSB. Initially, the MSB proposed to use a fraction of the surplus gravel from the C&D Cell excavation for daily cover and other purposes within the MSB Landfill, such as at municipal solid waste (MSW) Cells 3 and 4. However, the MSB subsequently decided that all surplus gravel from the C&D Cell excavation will be sold or used outside the MSB Landfill, rather than at MSW Cells 3 and 4. Instead MSW Cells 3 and 4 will use nearer gravel sources closer as recommended in Attachment A.

Calculations used to determine soil balance currently assumes that no gravel stockpiling is required at the MSB Landfill except for the soils needed for use as C&D cell daily cover. The rate of sale or use is expected to equal the rate of excavation. A surplus of gravel is anticipated as summarized in Table 9.

TABLE 9

Estimated Phase 1 and 2 Excavation Cut, Embankment Fill, Soil Cover, and Soil Surplus Volumes

Phase	Excavation Cut Soil Volume	Embankment Fill Volume	Required C&D Cell Soil Cover	Net Soil Surplus
	CY	CY	CY	CY
1	450,000	0	115,086	334,914
2	335,000	0	235,392	99,608
Total	**785,000**	**0**	**350,478**	**434,522**

Gravel Mining and Waste Placement Plan

The gravel mining and waste placement plan is shown in Drawing 3. In general, the cell will be constructed and filled according to the work sequence in Table 10.

TABLE 10

Cell Gravel Mining and Waste Placement Sequence

Gravel Mining (Excavation)	Waste Placement (Filling)
• **Step 1 - Phase 1 Gravel Mining:** Mine gravel to expand the existing depression on the eastern portion of the Phase 1 area.	
• **Step 2 – Phase 1 Gravel Mining:** Continue mining gravel in the southern and western portion of the Phase 1 area, including the side slopes. Finish excavation of the Phase 1 area down to the design bottom grade.	• **Step 1 - Phase 1 Waste Placement:** Begin filling the expanded depression in the eastern portion of the Phase 1 area.
• **Step 3 - Phase 2 Gravel Mining:** Begin mining gravel in the northern portion of the Phase 2 area moving north to south. Continue mining gravel southward into the 100-foot high ridge within the southern portion of Phase 1 area. Finish excavation of the Phase 2 area down to the design bottom grade.	• **Step 2 - Phase 1 Waste Placement:** Continue filling the remaining portions of the Phase 1 area to the final elevation with 3:1 fill slope as shown in Section A-A' in Drawing 4.
	• **Step 3 - Phase 2 Waste Placement:** Construct bottom liner[1] and fill the Phase 2 area.

Notes:

[1] Discussions with ADEC Solid Waste Division (Lori Aldrich, April 2015) indicate that future solid waste regulations will require a liner for new C&D cell expansions. These future regulations are likely to take effect in 2018 or 2019, after Phase 1 development is complete. Therefore, it is likely that Phase 2 development will require a bottom liner and leachate collection.

6.0 Works Sited

Federal Emergency Management Agency (FEMA). 2010. FEMA DEBRIS ESTIMATING FIELD GUIDE. Department of Homeland Security. Document No. FEMA-329. https://www.fema.gov/pdf/government/grant/pa/fema_329_debris_estimating.pdf. Accessed March 27, 2017

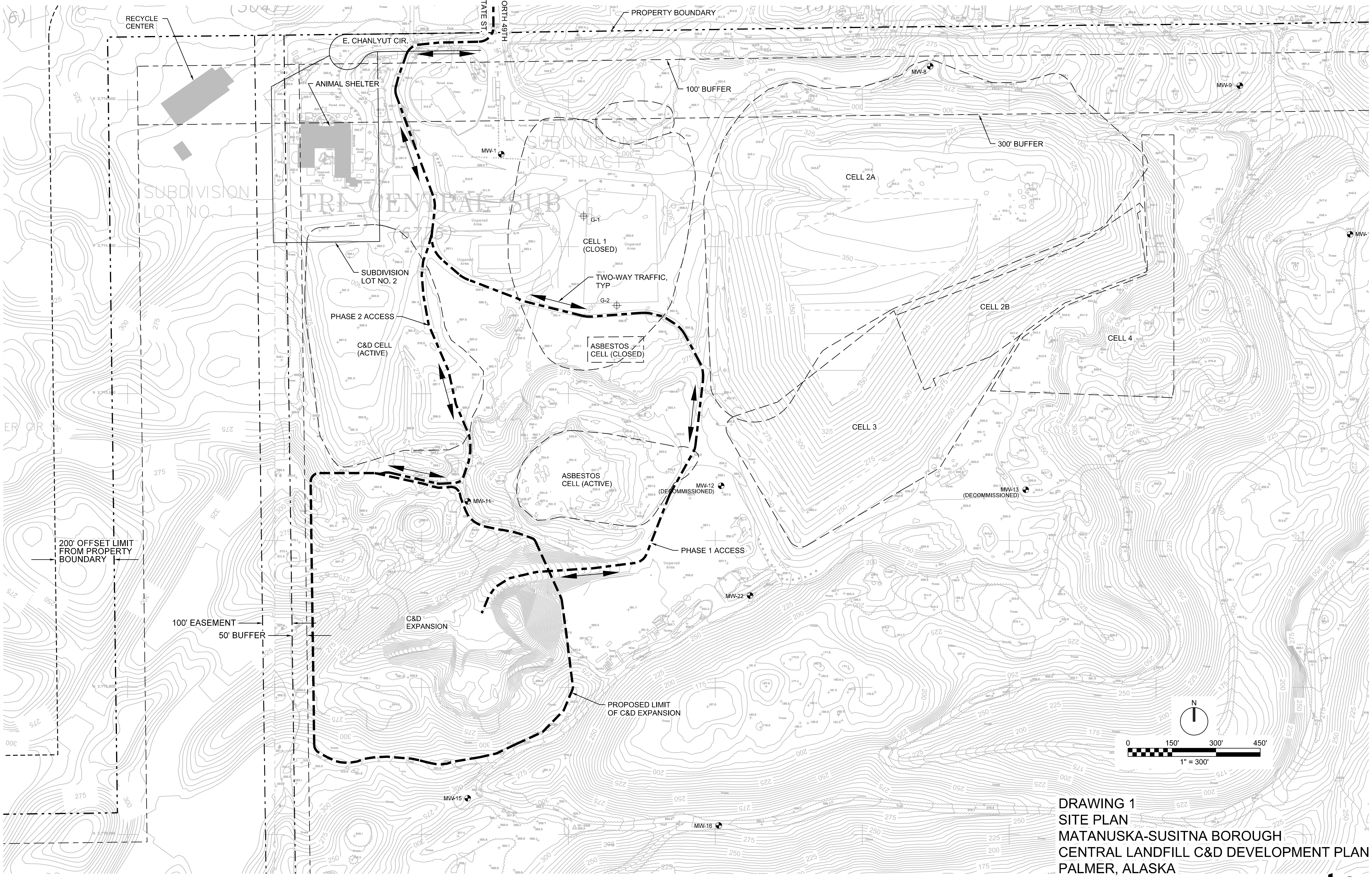
US Census Bureau (USCB). 2011. *Intercensal Estimates of the Resident Population for Counties: April 1, 2000 to July 1, 2010.* https://www.census.gov/data/tables/time-series/demo/popest/intercensal-2000-2010-counties.html. September. Accessed March 27, 2017

US Census Bureau (USCB). 2017. *Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2016.* https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=PEP_2011_PEPANNRES&prodType=table. March. Accessed March 27, 2017

Shannon & Wilson, Inc. 2014. March 11, 2014 Groundwater Map.

Shannon & Wilson, Inc. 2005. June 22, 2005 Groundwater Map.

Drawings



DRAWING 1
SITE PLAN
MATANUSKA-SUSITNA BOROUGH
CENTRAL LANDFILL C&D DEVELOPMENT PLAN
PALMER, ALASKA

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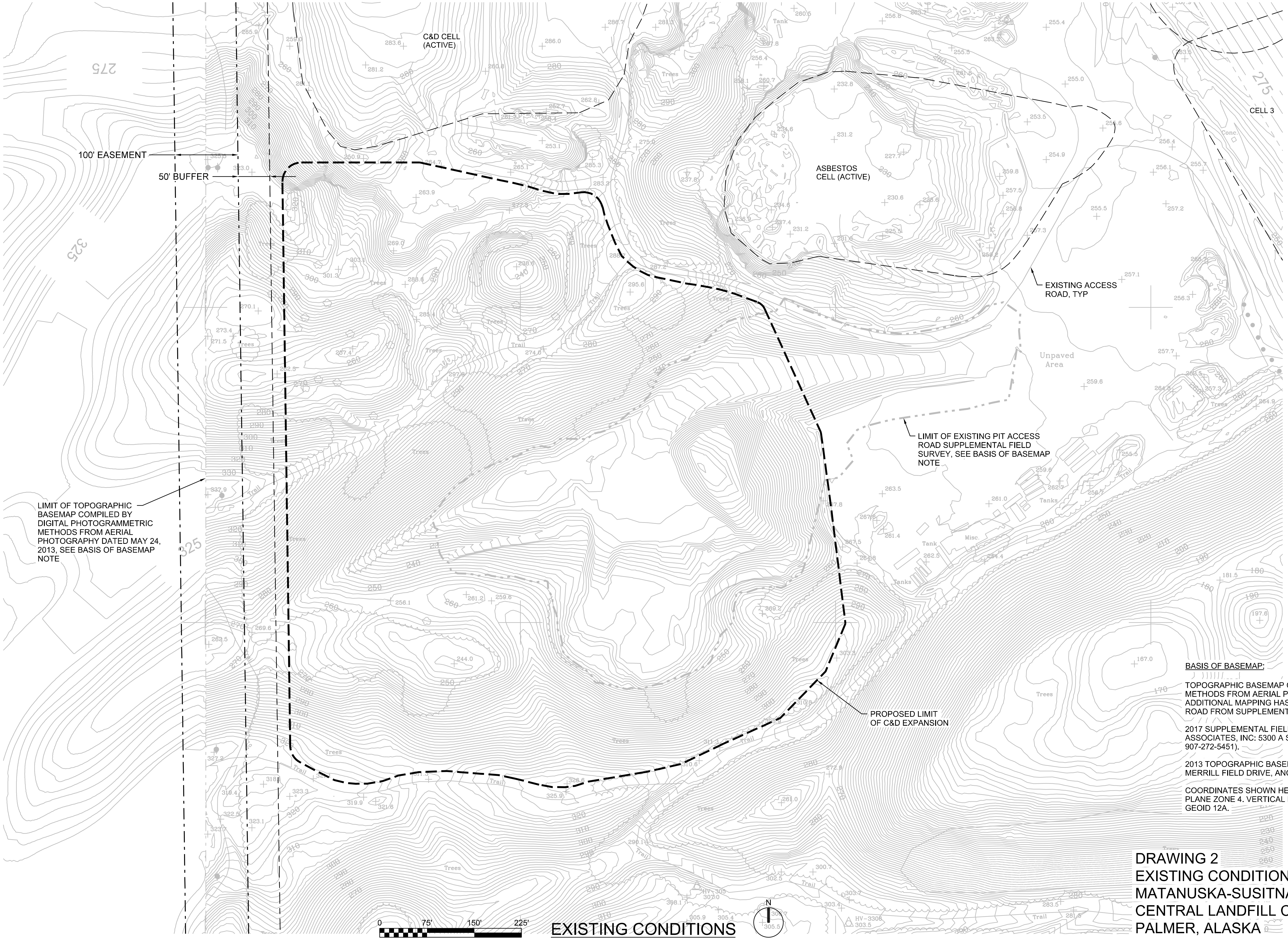

EXISTING CONDITIONS

BASIS OF BASEMAP:

TOPOGRAPHIC BASEMAP COMPILED BY DIGITAL PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED MAY 24, 2013. ADDITIONAL MAPPING HAS BEEN ADDED FOR EXISTING PIT ACCESS ROAD FROM SUPPLEMENTAL FIELD SURVEY DATED MARCH 17, 2017.

2017 SUPPLEMENTAL FIELD SURVEY PREPARED BY LOUNSBURY & ASSOCIATES, INC: 5300 A STREET, ANCHORAGE, AK 99518 (PH: 907-272-5451).

2013 TOPOGRAPHIC BASEMAP PREPARED BY QUANTUM SPATIAL: 2014 MERRILL FIELD DRIVE, ANCHORAGE, AK 99501 (PH: 907-272-4495).

COORDINATES SHOWN HEREON ARE BASED ON NAD83 ALASKA STATE PLANE ZONE 4. VERTICAL ELEVATIONS ARE BASED ON NAVD88 USING GEOID 12A.

DRAWING 2
EXISTING CONDITIONS
MATANUSKA-SUSITNA BOROUGH
CENTRAL LANDFILL C&D DEVELOPMENT PLAN
PALMER, ALASKA

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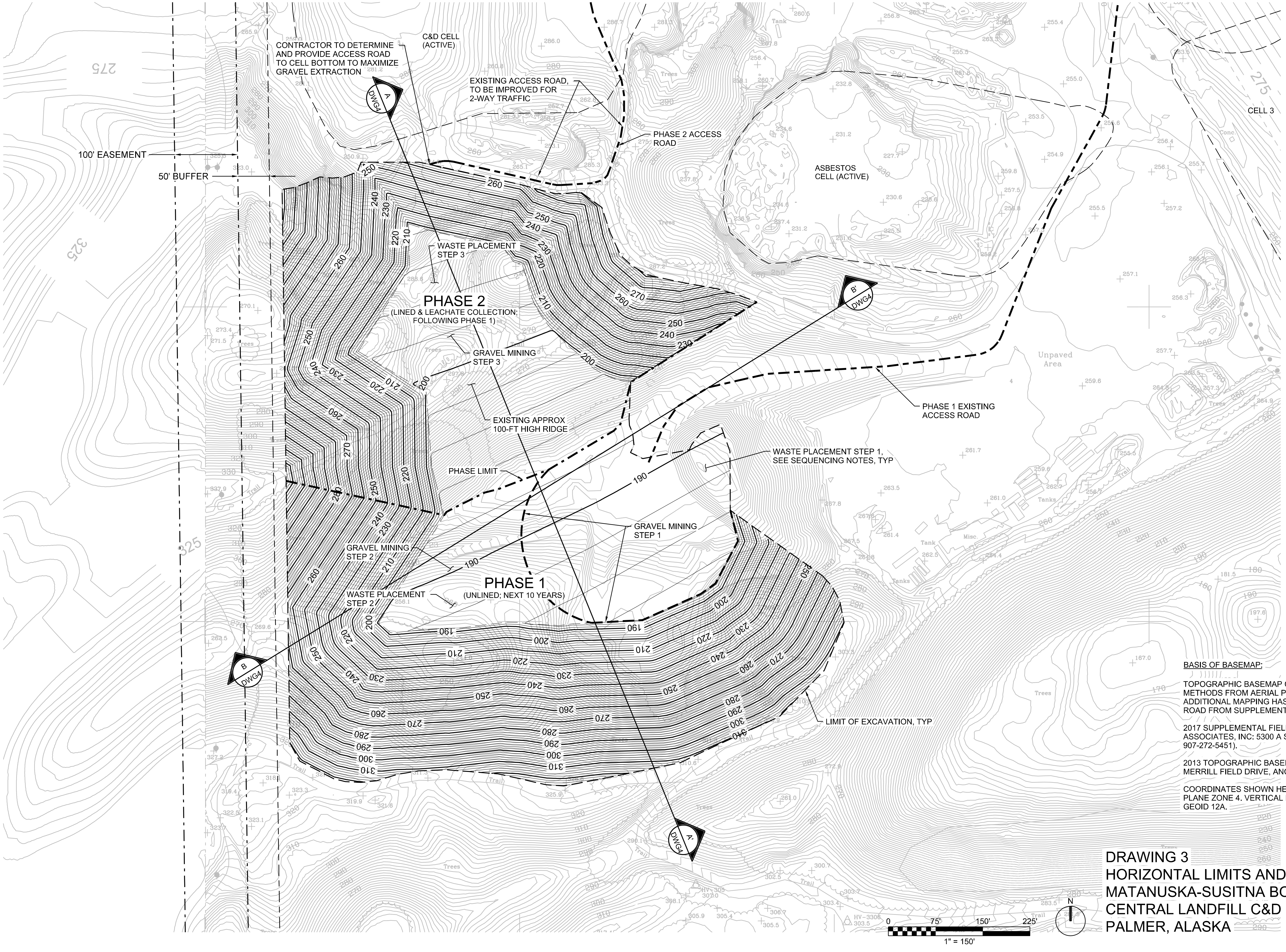

EXCAVATION SUMMARY

	VOLUME (CY)	YEARS
PHASE 1	450,000	
PHASE 2	335,000	

NOTES:

1. QUANTITIES PROVIDED ARE FOR ESTIMATING PURPOSES ONLY.
2. CONTOURS SHOWN ARE EXCAVATION GRADES.
3. EXCAVATION VOLUME IS IN-PLACE VOLUME AND DOES NOT ACCOUNT FOR SOIL SHRINK OR SWELL.
4. YEARS IN TABLE REPRESENT AN ACCEPTABLE RANGE FOR BEGINNING AND ENDING CELL EXCAVATION.
5. EXCAVATION VOLUME ACCOUNTS FOR MINOR FILL AREAS SHOWN.

GRAVEL MINING SEQUENCING:

STEP 1: MINE GRAVEL TO EXPAND EXISTING PHASE 1 LOW AREA.

STEP 2: MINE GRAVEL FROM REMAINDER OF PHASE 1 AREA AND SIDE SLOPES TO LIMITS SHOWN.

STEP 3: MINE GRAVEL OUT OF PHASE 2 AREA.

WASTE PLACEMENT SEQUENCING:

STEP 1: FILL PHASE 1 BOTTOM AREA AS EXISTING GRAVEL IS REMOVED.

STEP 2: FILL REMAINDER OF PHASE 1 AREA FOLLOWING COMPLETION OF PHASE 1 MINING.

STEP 3: FILL PHASE 2 AREAS FOLLOWING COMPLETION OF MINING.

BASIS OF BASEMAP:

TOPOGRAPHIC BASEMAP COMPILED BY DIGITAL PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED MAY 24, 2013. ADDITIONAL MAPPING HAS BEEN ADDED FOR EXISTING PIT ACCESS ROAD FROM SUPPLEMENTAL FIELD SURVEY DATED MARCH 17, 2017.

2017 SUPPLEMENTAL FIELD SURVEY PREPARED BY LOUNSBURY & ASSOCIATES, INC: 5300 A STREET, ANCHORAGE, AK 99518 (PH: 907-272-5451).

2013 TOPOGRAPHIC BASEMAP PREPARED BY QUANTUM SPATIAL: 2014 MERRILL FIELD DRIVE, ANCHORAGE, AK 99501 (PH: 907-272-4495).

COORDINATES SHOWN HEREON ARE BASED ON NAD83 ALASKA STATE PLANE ZONE 4. VERTICAL ELEVATIONS ARE BASED ON NAVD88 USING GEOID 12A.

DRAWING 3
HORIZONTAL LIMITS AND BOTTOM GRADING PLAN
MATANUSKA-SUSITNA BOROUGH
CENTRAL LANDFILL C&D DEVELOPMENT PLAN
PALMER, ALASKA

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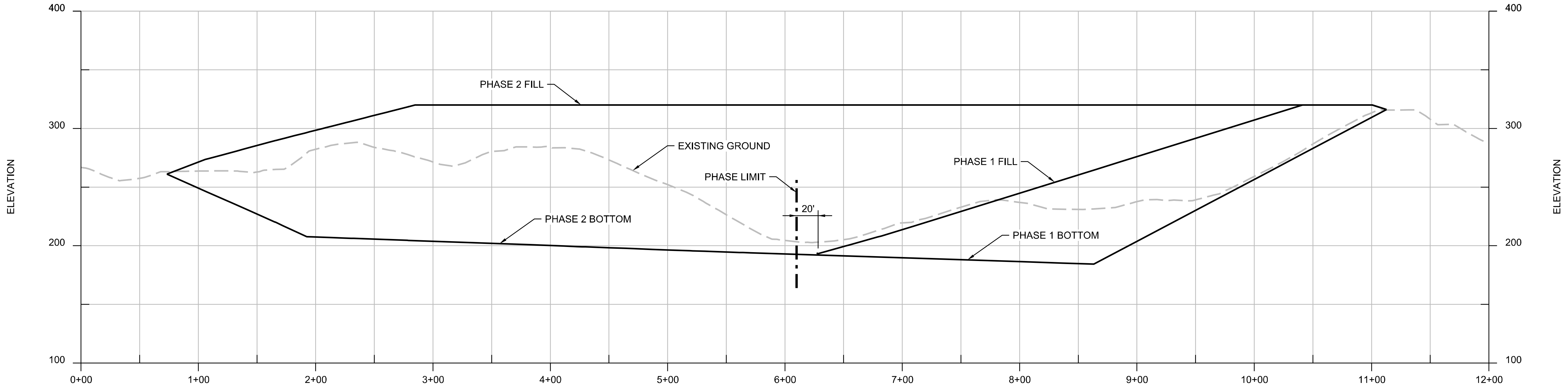
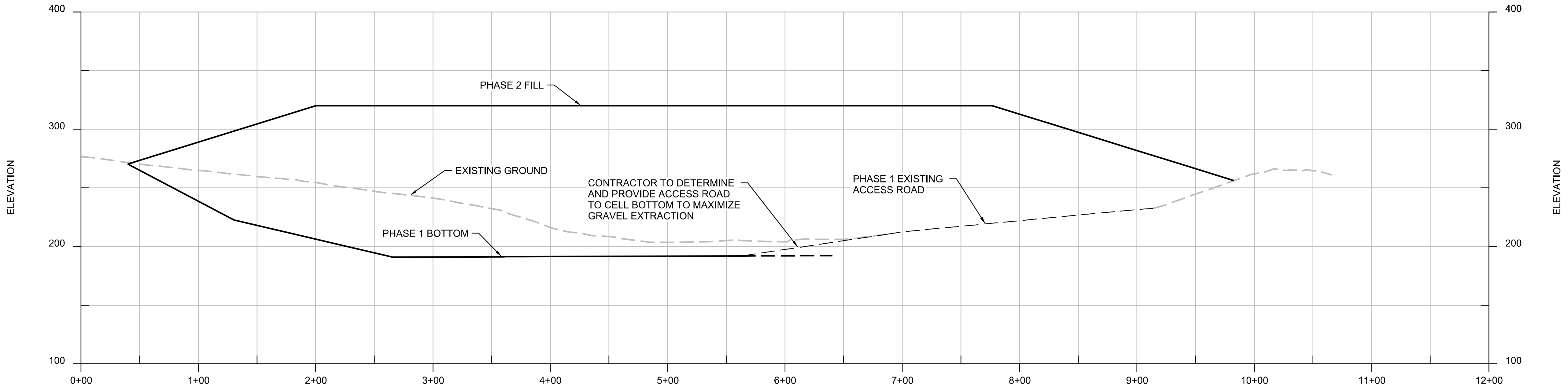


C&D CELL SECTION A-A'



C&D CELL SECTION B-B'

DRAWING 4
SECTIONS
MATANUSKA-SUSITNA BOROUGH
CENTRAL LANDFILL C&D DEVELOPMENT PLAN
PALMER, ALASKA

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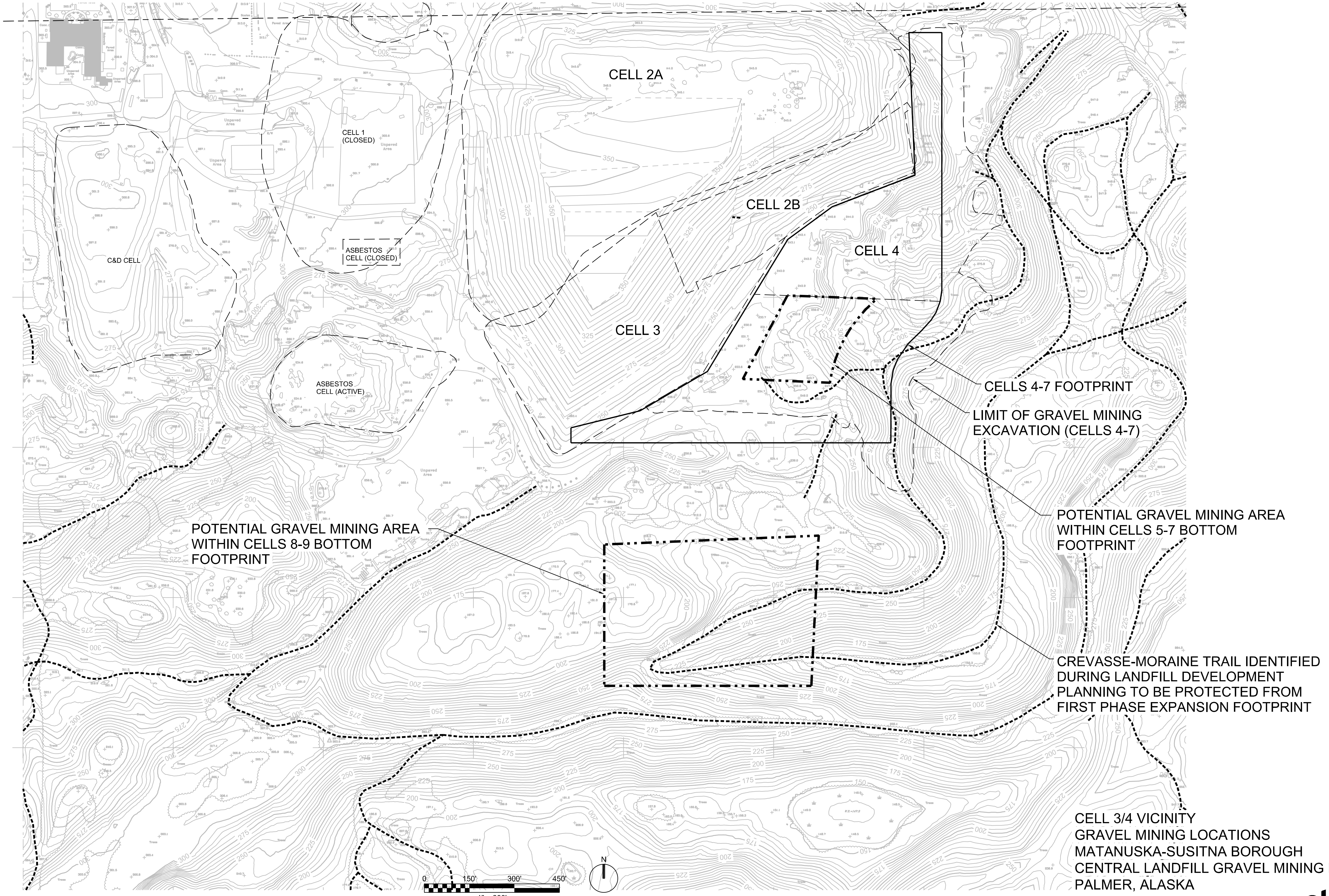
Attachment A



CELL 3/4 VICINITY
GRAVEL MINING LOCATIONS
MATANUSKA-SUSITNA BOROUGH
CENTRAL LANDFILL GRAVEL MINING PLAN
PALMER, ALASKA

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APPENDIX L – FINANCIAL ASSURANCE AND COST ESTIMATES

Matanuska-Susitna Borough Central Landfill Development Plan
Burns & McDonnell, June 2020
Phase 1 GCCS Costs

Item	Unit	Unit Cost	Quantity	Total Cost	Remarks
GC Mobilization/Demobilization	ls	15%	831,000	$ 124,650	Based on percent of GC cost; AK mobilization
As-built Surveys	ls	$ 30,000	2	$ 60,000	
Driller Mobilization	ls	$ 11,500	2	$ 23,000	Driller quote plus 15% markup
Driller Daily Travel	day	$ 403	14	$ 5,635	Driller quote plus 15% markup
Standby	hr	$ 489	16	$ 7,820	Driller quote plus 15% markup
LFG Wells					
Revegetation	ac	$ 3,000	6	$ 18,000	Seed, fertilizer, amendments, and mulch
New Wellheads	ea	$ 1,500	39	$ 58,500	Inc. surface completion
LFG well Installation	vf	$ 288	2,340	$ 672,750	Driller quote plus 15% markup, average depth 60'
Well Rock	ton	$ 25	330	$ 8,250	
Haul/Place Excavated MSW onsite	cy	$ 4	750	$ 3,000	Waste from well boring placed in Cell 3
Wellhead Frost Protection	ea	$ 1,500	39	$ 58,500	
GSE Fabrinet Double-sided Geocomposite on Cell 2A	SY	$ 15.42	300	$ 4,626	~100 SY/roll
GSE Geosynthetic Clay Liner on Cell 2A	SY	$ 14.92	300	$ 4,476	~100 SY/roll
Compacted Soil on Cell 2A	CY	$ 5.00	300	$ 1,500	
LFG Piping					
Install 6" Gas Lateral HDPE pipe with Integral Insulation	lf	$ 60	5,650	$ 339,000	6" HDPE above ground Lateral, w/field joint kits
Install 8" Gas Header HDPE pipe with Integral Insulation	lf	$ 100	3,870	$ 387,000	8" HDPE above ground Header, w/field joint kits
Install 8" Ball Valve	ea	$ 3,500	5	$ 17,500	
Install 6" Ball Valve	ea	$ 3,000	5	$ 15,000	
GCCS Construction Subtotal				**$ 1,809,207**	
15% Davis Bacon Allowance	ls		1	**$ 271,381**	
Construction Total				**$ 2,080,588**	
Engineering/Project Mgmt. Cost					
GCCS Design		$ 90,000	2	$ 180,000	
GCCS Field Eng/Oversight		10%	2	$ 362,000	% of GCCS Construction Cost
Commissioning & Training & GCCS Balancing		$ 100,000	2	$ 200,000	
Engineering/Project Mgmt. Total				**$ 742,000**	
Global Project Contingency		10%	**2**	**$ 564,000**	
Implementation Cost				**$ 3,390,000**	

Abreviations

ac: acre
cy: cubic yard
ea: each
lf: linear foot
ls: lump sum
sf: square foot

vf: vertical foot
yr: year
CQA: Construction Quality Assurance
GC: General Contractor
GCCS: Gas Containment and Control System
HDPE: High Density Polyethylene

LFG: Landfill Gas
MSW: Municipal Solid Waste
PVC: Polyvinyl Chloride

Matanuska-Susitna Borough Central Landfill Development Plan
Burns & McDonnell, June 2020
C&D Cell 1 Closure Cost Estimate

Year of Closure = 2020
Year of Estimate = 2020
Area of Closure (C&D Cell 1) = 5.8

No.	Item	Depth (ft)	Quantity	Units	Unit Cost (2020)	Total Cost (2020)
1	Project Admin, Temp Facilities, Mob/Demob, Contract Closeout		7.00%	total	$ 445,515	$ 31,186
2	Survey		5.82	Acres	$ 4,719	$ 27,481
3	Subgrade Preparation		5.82	Acres	$ 1,890	$ 11,003
4	Cover/Drain Material	1.5	14,092	CY	$ 15.18	$ 213,932
5	Silt-Loam Topsoil	0.5	4,697	CY	$ 26.69	$ 125,391
6	Seeding		5.82	Acres	$ 6,132	$ 35,707
7	Stormwater Control		5.82	Acres	$ 5,496	$ 32,000
					Subtotal =	**$ 476,701**
	Contingency Final Cover		5%	subtotal		$ 23,835
	Engineering and Oversight		10%	subtotal		$ 47,670
					Total =	**$ 549,000**
					Closure Cost per Acre =	**$ 94,282**

C&D Cell 2 Closure Cost Estimate

Year of Closure = 2078
Year of Estimate = 2020
Area of Closure (C&D Cell 2) = 20.7

No.	Item	Depth (ft)	Quantity	Units	Unit Cost (2020)	Total Cost (2020)
1	Project Admin, Temp Facilities, Mob/Demob, Contract Closeout		7.00%	total	$ 1,583,043	$ 110,813
2	Survey		20.69	Acres	$ 4,719	$ 97,647
3	Subgrade Preparation		20.69	Acres	$ 1,890	$ 39,098
4	Cover/Drain Material	1.5	50,071	CY	$ 15.18	$ 760,163
5	Silt-Loam Topsoil	0.5	16,690	CY	$ 26.69	$ 445,550
6	Seeding		20.69	Acres	$ 6,132	$ 126,878
7	Stormwater Control		20.69	Acres	$ 5,496	$ 113,707
					Subtotal =	**$ 1,693,856**
	Contingency Final Cover		5%	subtotal		$ 84,693
	Engineering and Oversight		10%	subtotal		$ 169,386
					Total =	**$ 1,950,000**
					Closure Cost per Acre =	**$ 94,246**

Matanuska-Susitna Borough Central Landfill Development Plan
Burns & McDonnell, June 2020
Asbestos Closure Cost Estimate

Year of Closure = 2077
Year of Estimate = 2020
Area of Closure (Asbestos) = 7.3

No.	Item	Depth (ft)	Quantity	Units	Unit Cost (2020)	Total Cost (2020)
1	Project Admin, Temp Facilities, Mob/Demob, Contract Closeout		7.00%	total	$ 555,049	$ 38,853
2	Survey		7.25	Acres	$ 4,719	$ 34,237
3	Subgrade Preparation		7.25	Acres	$ 1,890	$ 13,708
4	Cover/Drain Material	1.5	17,556	CY	$ 15.18	$ 266,530
5	Silt-Loam Topsoil	0.5	5,852	CY	$ 26.69	$ 156,220
6	Seeding		7.25	Acres	$ 6,132	$ 44,486
7	Stormwater Control		7.25	Acres	$ 5,496	$ 39,868
					Subtotal =	**$ 593,903**
	Contingency Final Cover		5%	subtotal		$ 29,695
	Engineering and Oversight		10%	subtotal		$ 59,390
					Total =	**$ 683,000**
					Closure Cost per Acre =	**$ 94,147**

Matanuska-Susitna Borough Central Landfill Development Plan
Burns & McDonnell, June 2020
Cell 5 Construction Cost Estimate

Cell 5 Acreage = **9.47**
Inflation = **2.5%**
Year of Calculation = **2020**

Item		**Description**	**Est. Quantity**	**Units**	**Unit Price**		**Total Price (OOPC)**	
1		Mobilization/Demobilization/Insurance/Permits	7%	LS	$	6,070,656	$	424,946
2		Surveying & Staking (including QA/QC Survey and As-Recorded Documentation)	9.47	Acre	$	4,719	$	44,694
3		Site Health and Safety Plan	1	LS	$	5,000	$	5,000
4		Misc. Storm Water and Erosion Control	1	LS	$	75,000	$	75,000
5		Earthwork						
	a	General Excavation for Cell 5	516,241	CY	$	5.40	$	2,787,704
	b	Subgrade Preparation	9.47	Acre	$	8,900	$	84,286
	c	6" Cushion Layer	7,639	CY	$	30.00	$	229,182
	d	Granular Drainage Layer	22,918	CY	$	41.00	$	939,644
6		Geosynthetics						
	a	GCL Liner	495,032	SF	$	1.14	$	564,337
	b	60-mil Textured (Both Sides) HDPE Geomembrane Liner	495,032	SF	$	1.30	$	643,542
	c	Geotextile Cushion	495,032	SF	$	0.55	$	272,268
	d	Electrical Conductance Testing	1	LS	$	20,000	$	20,000
7		Leachate Collection and Conveyance System	1	LS	$	120,000	$	120,000
8		Leachate SSR Pipe, Manhole, Pump, and Appurtenances	1	LS	$	200,000	$	200,000
9		Electrical	1	LS	$	85,000	$	85,000
						Total	***$***	***6,495,601.75***
						Contingency (10%)	*$*	*649,560.17*
						Total with Contingency	**$**	**6,495,601.75**

Matanuska-Susitna Borough Central Landfill Development Plan

Burns & McDonnell, June 2020

Table 1.1.9. Implicit Price Deflators for Gross Domestic Product

[Index numbers, 2012=100] Seasonally adjusted

Bureau of Economic Analysis

Last Revised on: May 28, 2020 - Next Release Date June 25, 2020

		2017				2018				2019				2020
Line		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
1	**Gross domestic product**	107.058	107.411	107.973	108.713	109.355	110.281	110.767	111.256	111.473	112.188	112.664	113.043	113.493
2	**Personal consumption expenditures**	105.35	105.591	106.029	106.729	107.396	107.984	108.408	108.768	108.875	109.518	109.923	110.297	110.646
3	Goods	94.898	94.264	94.425	94.759	95.229	95.401	95.32	94.983	94.591	94.956	94.773	94.679	94.46
4	Durable goods	90.041	89.258	88.668	88.257	88.019	87.633	87.375	87.122	87.05	86.661	86.39	85.689	85.334
5	Nondurable goods	97.357	96.807	97.387	98.142	99.015	99.507	99.528	99.144	98.568	99.37	99.24	99.508	99.369
6	Services	110.741	111.448	112.034	112.93	113.702	114.513	115.213	115.951	116.332	117.126	117.857	118.49	119.158
7	**Gross private domestic investment**	104.711	105.273	105.475	105.997	106.963	108.039	108.218	108.624	108.683	109.485	109.614	109.956	110.854
8	Fixed investment	105.263	105.846	106.389	106.708	107.59	108.381	108.947	109.092	109.573	110.106	110.422	110.654	111.011
9	Nonresidential	101.63	101.985	102.328	102.504	102.945	103.423	103.837	103.835	104.237	104.765	104.907	105.017	105.304
10	Structures	111.331	112.46	113.711	114.325	115.138	116.55	117.482	119.087	119.9	121.075	121.543	121.878	122.247
11	Equipment	97.32	97.34	97.299	97.194	97.116	97.32	97.708	97.434	97.667	97.762	97.485	97.543	97.7
12	Intellectual property products	101.241	101.588	101.911	102.214	103.154	103.434	103.56	102.986	103.38	104.125	104.64	104.702	105.107
13	Residential	121.447	122.963	124.343	125.27	128.04	130.22	131.472	132.292	133.132	133.679	134.805	135.593	136.258
14	Change in private inventories	---	---	---	---	---	---	---	---	---	---	---	---	---
15	**Net exports of goods and services**	---	---	---	---	---	---	---	---	---	---	---	---	---
16	Exports	95.041	95.078	95.959	97.266	98.123	99.363	99.642	99.287	98.666	99.466	98.879	98.476	97.67
17	Goods	89.215	89.059	90.152	91.367	92.233	93.579	93.795	93.125	92.185	92.723	91.778	91.412	90.069
18	Services	108.137	108.612	109.004	110.516	111.348	112.327	112.753	113.146	113.287	114.703	114.973	114.489	114.994
19	Imports	88.302	88.241	88.385	89.522	91.121	91.25	91.38	90.975	90.161	90.524	89.6	89.483	89.451
20	Goods	85.61	85.34	85.288	86.499	88.205	88.251	88.341	87.82	86.862	87.231	86.143	85.932	85.903
21	Services	102.392	103.42	104.581	105.335	106.355	106.932	107.287	107.511	107.461	107.796	107.732	108.096	108.049
22	**Government consumption expenditures and gross investment**	106.695	107.1	107.84	108.943	110.004	111.043	111.878	112.67	113.042	113.521	113.968	114.489	115.36
23	Federal	105.227	105.663	106.195	107.057	108.213	108.986	109.679	110.444	111.685	111.09	111.511	111.951	112.221
24	National defense	103.892	104.162	104.596	105.404	106.568	107.307	108.016	108.506	108.793	109.195	109.584	110.058	110.309
25	Nondefense	107.342	108.026	108.705	109.647	110.795	111.618	112.287	113.468	116.191	114.046	114.517	114.904	115.204
26	State and local	107.693	108.08	108.948	110.198	111.202	112.406	113.33	114.139	113.97	115.122	115.586	116.159	117.413
	Addendum:													
27	Gross national product	106.999	107.351	107.91	108.641	109.259	110.182	110.668	111.154	111.386	112.1	112.574	112.953	113.403
			3.79%											5.34%
			2.73%											

Matanuska-Susitna Borough Central Landfill Development Plan
Burns & McDonnell, June 2020
Closure Cost Estimate

Year of Closure = 2043
Year of Estimate = 2020
Area of Closure (Cells 2B-5) = 40.3
Inflation Rate = 2.14% *10-yr CPI long term forecast as published by Fed Reserve Bank*
Discount Rate = 0.67% *10-yr Treasury yield, May 2020*

No.	**Item**	**Depth (ft)**	**Quantity**	**Units**	**Unit Cost (2020)**	**Total Cost (2020)**
1	Project Admin, Temp Facilities, Mob/Demob, Contract Closeout		7.00%	total	$ 5,698,719	$ 398,910
2	Survey		40.30	Acres	$ 4,719	$ 190,184
3	Subgrade Preparation		40.30	Acres	$ 1,890	$ 76,149
4	Leveling Course/Cushion Layer	0.5	32,507	CY	$ 16.20	$ 526,577
5	40 mil LLDPE Geomembrane Liner		1,755,391	SF	$ 1.19	$ 2,088,915
6	Cover/Drain Material	1.5	97,522	CY	$ 15.18	$ 1,480,537
7	Silt-Loam Topsoil	0.5	32,507	CY	$ 26.69	$ 867,780
8	Seeding		40.30	Acres	$ 6,132	$ 247,115
9	Stormwater Control		40.30	Acres	$ 5,496	$ 221,462
10	Active LFG System Expansion (Wells and Piping)		1	LS	$ 1,588,102	$ 1,588,102
					Subtotal =	**$ 7,685,732**
	Contingency Final Cover		5%	subtotal		$ 304,881
	Contingency Gas System		15%	subtotal		$ 238,215
	Engineering and Oversight		10%	subtotal		$ 768,573
					Total =	**$ 8,997,402**
					Closure Cost per Acre =	**$ 223,270**

NSPS Check:

Cells 1-5

Historic 1980-2019:	1,664,460		
Projected 2020-2042:	1,690,588		
Projected 2043	50,514		
	3,405,562	Total Tons	
	3,088,844	Mg	>2.5 M Mg

Therefore; active LFG system is needed for Cells 1-5 (to be installed in 2020)

Matanuska-Susitna Borough Central Landfill Development Plan
Burns & McDonnell, June 2020
Post-Closure Cost Estimate

Year of Closure = 2043
Year of Estimate = 2020
Post-Closure Period = 30 years
Inflation Factor = 2.14%
Area of Final Cover (Cells 1-5) = 64.0

POST CLOSURE COST ITEM			ANNUAL COST 2020
Item	**Quantity**	**Units**	
Annual Inspection and Reporting			
Site Visits & Reports	4	per year	
Inspection Time	10	hours/visit	
Labor Rate	$79.00	per hour	
ANNUAL INSPECTION AND REPORTING COST			$3,160
Cover Maintenance			
Repair Cover Side Slopes	0.50%		
Repair Area	0.32	Acres	
Soil Cover Cost (from closure cost estimate)	$ 64,406	per acre	
ANNUAL COVER MAINTENANCE COST			$20,620
Vegetation and Stormwater Control			
Frequency	2	times/year	
Duration/visit (assume 0.5 hr per acre)	40	hours	
Equipment/Operator Cost	$79.00	hour	
Clean Perimeter Drainage Ditches	623	LF	
Cost for Cleaning Ditches	$5.47	per LF	
ANNUAL VEGETATION AND STORMWATER CONTROL COST			$9,727
Gas System Monitoring, Operation and Maintenance			
Methane Sampling and Analysis	$10,534	per year	
Piping Repair, Well Replacement	$3,160	per year	
Condensate Disposal	$1,975	per year	
System Operator	$30,548	per year	
Power and Pilot Gas	$10,534	per year	
ANNUAL GAS SYSTEM COST			$56,750
Environmental Monitoring			
Groundwater Sampling and Analysis	$36,868	per year	
Surface Water Sampling and Analysis	$13,167	per year	
Groundwater Well Maintenance	$2,107	per year	
ANNUAL ENVIRONMENTAL MONITORING COST			$52,142
Leachate Control Costs			
System Operator	$20,014	per year	
Equipment Maintenance & Replacement	$2,800	per year	
Leachate System Cleanout	$21,067	per year	
Leachate Sampling and Analysis	$13,167	per year	
Leachate Quantity per Year	250,000	gal	
Hauling/Disposal Rate	$0.16	per gal	
Leachate Disposal	$39,501	per year	

ANNUAL LEACHATE CONTROL COSTS			$96,550
Miscellaneous Civil Maintenance			
Road Repair	$2,200	per year	
Surface Water Drainage Repair & Cleaning	$2,200	per year	
ANNUAL CIVIL MAINTENANCE			$4,400
Post-Closure Certification (only last year)	$32,000	LS	$32,000
SUBTOTAL			$243,349
Technical and Professional Services	5%	of total	$12,167
Contingency	10%	of total	$24,335
TOTAL			**$279,851**

30-YEARS OF POST-CLOSURE COSTS	**$8,395,528**

Matanuska-Susitna Borough Central Landfill Development Plan
Burns & McDonnell, June 2020
Annual Expense Recognition

FY*	Percent of Capacity Used	Landfill Closure and Post-Closure Costs	Total Liability	Accounting Expense to Recognize [1]
2018-19			$5,463,707	
2019-20	29%	$17,392,929	$5,072,271	($391,436)
2020-21	32%	$17,765,138	$5,603,336	$531,065
2021-22	34%	$18,145,312	$6,163,438	$560,103
2022-23	36%	$18,533,622	$6,753,939	$590,501
2023-24	39%	$18,930,241	$7,376,260	$622,320
2024-25	42%	$19,335,348	$8,031,883	$655,623
2025-26	44%	$19,749,125	$8,722,356	$690,474
2026-27	47%	$20,171,756	$9,449,298	$726,942
2027-28	50%	$20,603,432	$10,214,395	$765,097
2028-29	52%	$21,044,345	$11,019,410	$805,015
2029-30	55%	$21,494,694	$11,866,181	$846,771
2030-31	58%	$21,954,681	$12,756,628	$890,447
2031-32	61%	$22,424,511	$13,692,754	$936,126
2032-33	64%	$22,904,395	$14,676,651	$983,897
2033-34	67%	$23,394,549	$15,710,501	$1,033,850
2034-35	70%	$23,895,193	$16,796,582	$1,086,081
2035-36	73%	$24,406,550	$17,937,272	$1,140,689
2036-37	77%	$24,928,850	$19,135,049	$1,197,778
2037-38	80%	$25,462,327	$20,392,504	$1,257,455
2038-39	83%	$26,007,221	$21,712,337	$1,319,833
2039-40	87%	$26,563,776	$23,097,367	$1,385,030
2040-41	90%	$27,132,241	$24,550,534	$1,453,167
2041-42	94%	$27,712,871	$26,074,907	$1,524,373
2042-43	98%	$28,305,926	$27,673,688	$1,598,781
2043-44	100%	$28,911,673	$28,911,676	$1,237,988

**Fiscal Year runs from July 1 to June 30*

1. Represents the annual expense to be recognized per GASB 18

APPENDIX M – SOIL BALANCE

Matanuska-Susitna Borough Central Landfill Development Plan
Burns & McDonnell, June 2020
Inputs Used in Calculations

				Base-Existing V(straight wall analysis)1		
Cell / Phase	**Waste/Daily/FI Volume (top of Drainage to top of FI) - net V (cy)**	**Cell/Corridor Boundary Area (acres)**	**Incremental Closure Area (acres)**	**Cut**	**Fill**	**Net**
Cell 1 (Closed)		9.79				
Cell 2A (Closed)		13.94				
Cell 2B		4.59				
Cell 3 Remaining	228,465.6	17.65	13.21			
Cell 4	983,563.9	8.59	4.12			
Cell 5	1,410,506.7	9.47	7.21	516,241	518	(515,724)
Ph2C1	1,584,589.3	11.58	6.60	446,190	79,890	(366,300)
PH2C2	2,192,400.4	14.67	7.81	484,300	179,213	(305,087)
PH2C3	2,890,114.8	17.15	9.57	1,410,787	103,855	(1,306,933)
PH2C4	3,433,973.6	17.26	11.00	587,065	282,225	(304,840)
PH2C5	3,660,197.3	17.26	13.28	1,990,336	196,117	(1,794,220)
PH2C6	4,227,811.6	19.33	15.41	2,526,302	101,605	(2,424,697)
PH2C7	5,148,773.0	15.18	39.67	955,272	1,722,208	766,936
PH3	24,065,327.8	122.87	147.19	9,244,585	695,447	(8,549,138)
	49,825,724.0	**275.60**	**275.06**	**18,161,077.8**		(14,800,001)
C&D LF Exist		8.54	5.82			
C&D LF Expansion	2,775,989.0	17.97	20.69	569,390	14,719	(554,671)
Asbestos	520,816.7	7.25	7.25	-	-	-

1. Actual excavation and fill may differ at the time of construction; volumes are based on a "straight line cut" of the cells based on the boundaries.

(from Mat-Su Airspace Spreadsheet)

Year	**Annual Tonnage into Cell 3**	**Survey (CY)**	**% Change**	**% Change (5-yr)**
2009 (3/1-12/31)	49,584.80	85,066		
2010	57,726.79	95,341		
2011	57,602.36	97,999	-0.2%	
2012	57,437.85	105,200	-0.3%	
2013	58,798.80	102,459	2.4%	
2014	58,658.58	76,251	-0.2%	
2015	57,504.72	78,754	-2.0%	-0.1%
2016	59,568.72	80,878	3.6%	0.7%
2017	58,192.74	77,804	-2.3%	0.3%
2018	54,146.53	76,292	-7.0%	-1.6%
2019	57,311.21	73,993	5.8%	-0.5%
	626,533.1	**950,037**	**0.0%**	**-0.2%**
	Total Cell 3 Capacity:	**1,178,503**	**CY**	

Average Cell 3 AUF (2009-2019): **1,327.8** (from Mat-Su Airspace Spreadsheet)

Total Cell 1 and 2A/B Capacity **800,000** **cy (estimated)**

Cell	**Percent of Area**	**Estimated Capacity (cy)**
Cell 1 (Closed)	34.6%	276,537
Cell 2A (closed)	49.2%	393,832
Cell 2B	16.2%	129,630
Total	100.0%	800,000

C&D Area

year	C&D Tonnage	5-yr avg	10-yr avg	% growth
2000	-			
2001	2,841			
2002	4,461			
2003	5,390			
2004	5,854	3,709		
2005	8,052	5,320		
2006	7,752	6,302		
2007	10,143	7,438		
2008	9,439	8,248		
2009	10,357	9,148	6,429	
2010	10,926	9,723	7,521	17%
2011	11,356	10,444	8,373	11%
2012	9,812	10,378	8,908	6%
2013	11,631	10,816	9,532	7%
2014	12,504	11,246	10,197	7%
2015	14,950	12,050	10,887	7%
2016	8,738	11,527	10,986	1%
2017	12,879	12,140	11,259	2%
2018	13,564	12,527	11,672	4%
2019	11,732	12,373	11,809	1%

Asbestos Airspace Usage	Pounds disposed annually	Net Airspace Utilized between survey dates (CY)	Approx. AUF (lbs/CY)
2017	436220	5578	78.2
2018	346820	4326	80.2
2019	458000	6653	68.8
			75.7

Matanuska-Susitna Borough Central Landfill Development Plan
Burns & McDonnell, June 2020
Total Tonnage Report - Solid Waste Division

Year	**Total MSW (tons)**	**Asbestos (tons from 2019 ADEC Memo)**	
1980	12,122		
1981	13,495		
1982	15,614		
1983	18,760		
1984	23,105		
1985	27,290		
1986	29,086		
1987	29,167		
1988	28,136		
1989	28,615		
1990	29,520		
1991	28,832		
1992	29,787		
1993	32,170		
1994	32,411		
1995	31,057		
1996	31,071		
1997	32,628		
1998	36,846		
1999	37,894		
2000	45,259		
2001	43,289		Began using wasteworks system and recording c&d waste.
2002	49,415		
2003	50,497		
2004	54,121		
2005	60,622	17	Began using wasteworks system to record asbestos.
2006	65,703	235	Began using wasteworks system and recording residential MSW.
2007	59,099	2,933	
2008	54,834	132	
2009	57,067	78	3.1.2009 Cell 3 Starts
2010	*57,727*	46	*<-- MSW Data from Cell 3 tonnage*
2011	*57,602*	315	*<-- MSW Data from Cell 3 tonnage*
2012	*57,438*	297	*<-- MSW Data from Cell 3 tonnage*
2013	*58,799*	197	*<-- MSW Data from Cell 3 tonnage*
2014	*58,659*	458	*<-- MSW Data from Cell 3 tonnage*
2015	*57,505*	89	*<-- MSW Data from Cell 3 tonnage*
2016	*59,569*	202	*<-- MSW Data from Cell 3 tonnage*
2017	*58,193*	218	*<-- MSW Data from Cell 3 tonnage*
2018	*54,147*	173	*<-- MSW Data from Cell 3 tonnage*
2019	*57,311*	229	*<-- MSW Data from Cell 3 tonnage; Asbestos from airspace tracking*
Total *	1,664,460	5,618	***182***

** Total known waste buried on the property

Matanuska-Susitna Borough Central Landfill Development Plan
Burns & McDonnell, June 2020
Soil Balance

Asbestos Percent Daily/Intermediate Cover:	50%	
C&D Percent Daily/Intermediate Cover:	20%	
MSW Percent Daily/Intermediate Cover:	20%	
Base Drain Soil Depth:	1.5	ft
Base Cushion Depth:	0.5	ft
Final Cover Drain Soil/General Soil Depth:	1.5	ft
Final Cover Cushion Depth:	0.5	ft
Percent Gravel Content:	40%	
Assumed Existing Topsoil Depth:	1	ft
Final Topsoil Depth:	0.5	ft
Starting Soil Balance:	100,000	CY

<-- estimate, confirm

Cell / Phase	Liner Area (acre)	Final Cover Area (acres)	Disposal Airspace (CY)	Cut Soil (CY) - includes Topsoil	Topsoil Available (CY)	Topsoil Need (CY)	Cut Soil (CY) - Less Topsoil	Gravel Avail (CY)	Liner Gravel Needed (CY)	Gravel Remaining (CY)	Sand/Fines Available (CY)	Basegrade Fill Volume (CY)	Base Cushion Material (CY)	Daily & Intermediate Cover (CY)	Final Cover Cushion Material (CY)	Final Cover Soil (sand/fines) (CY)	Net Sand/Fines per Cell (CY)	Cumulative Gravel Available for Sale (CY)
C&D LF Exist	8.54	5.82	-			4,697.2								-		14,091.5	**(14,091.55)**	(14,091.55)
C&D LF Expansion	17.97	20.69	2,775,989.0	569,389.7		16,690.4	569,389.7	227,755.9		227,755.86	341,633.80	14,719.0		555,197.80		50,071.3	**(278,354.27)**	(64,689.95)
Cell 2B/3 Remaining		17.80	228,465.6			14,360.3								45,693.12		43,081.0	**(88,774.09)**	(153,464.05)
Cell 4		4.12	983,563.9			3,321.3								196,712.78		9,964.0	**(206,676.82)**	(360,140.87)
Cell 5	9.47	7.21	1,410,506.7	516,241.4	0.00	5,816.0	516,241.4	206,496.6	22,918.16	183,578.40	309,744.84	517.9	7,639.39	282,101.34	7,639.39	17,447.9	**(5,601.02)**	(182,163.49)
Ph2C1	11.58	6.60	1,584,589.3	446,190.0	18,676.9	5,326.8	427,513.1	171,005.3	28,015.31	142,989.94	256,507.88	79,890.3	9,338.44	316,917.87	9,338.44	15,980.4	**(174,957.53)**	(214,131.07)
PH2C2	14.67	7.81	2,192,400.4	484,300.0	23,673.0	6,297.7	460,627.0	184,250.8	35,509.45	148,741.36	276,376.22	179,213.0	11,836.48	438,480.08	11,836.48	18,893.2	**(383,883.01)**	(449,272.72)
PH2C3	17.15	9.57	2,890,114.8	1,410,787.4	27,665.9	7,719.9	1,383,121.5	553,248.6	41,498.88	511,749.71	829,872.89	103,854.6	13,832.96	578,022.96	13,832.96	23,159.6	**97,169.76**	159,646.76
PH2C4	17.26	11.00	3,433,973.6	587,064.8	27,847.1	8,870.8	559,217.7	223,687.1	41,770.58	181,916.52	335,530.65	282,224.5	13,923.53	686,794.72	13,923.53	26,612.3	**(687,947.97)**	(346,384.70)
PH2C5	17.26	13.28	3,660,197.3	1,990,336.1	27,847.1	10,710.2	1,962,489.0	784,995.6	41,770.58	743,225.03	1,177,493.42	196,116.5	13,923.53	732,039.46	13,923.53	32,130.6	**189,359.83**	586,200.16
PH2C6	19.33	15.41	4,227,811.6	2,526,301.5	31,178.1	12,428.6	2,495,123.4	998,049.4	46,767.20	951,282.16	1,497,074.03	101,605.0	15,589.07	845,562.32	15,589.07	37,285.8	**481,442.82**	2,018,925.14
PH2C7	15.18	39.67	5,148,773.0	955,271.8	24,497.4	31,998.1	930,774.4	372,309.7	36,746.15	335,563.60	558,464.62	1,722,207.7	12,248.72	1,029,754.60	12,248.72	95,994.4	**(2,313,989.47)**	40,499.27
PH3	122.87	147.19	24,065,327.8	9,244,584.8	198,227.8	118,733.8	9,046,357.0	3,618,542.8	297,341.77	3,321,201.02	5,427,814.17	695,447.1	99,113.92	4,813,065.56	99,113.92	356,201.4	**(635,127.72)**	2,726,572.56
Asbestos	7.25	7.25	520,816.7	-	-	5,852.0	-	-		-	-	-		260,408.35		17,556.1	**(277,964.42)**	2,448,608.14
		Total		**18,730,467.5**	**379,613.3**	**252,823.1**	**18,350,854.2**	**7,340,341.7**	**592,338.1**	**6,748,003.6**	**11,010,512.5**	**3,375,795.6**	**197,446.0**	**10,780,751.0**	**197,446.0**	**758,469.4**	**(4,299,395.5)**	
		MSW Total	**49,825,724.0**	**18,161,077.8**	**379,613.3**	**225,583.5**	**17,781,464.5**	**7,112,585.8**	**592,338.1**	**6,520,247.7**	**10,668,878.7**	**3,361,076.6**	**197,446.0**	**9,965,144.8**	**197,446.0**	**676,750.5**	**(3,728,985.2)**	
		C&D Total	**2,775,989.0**	**569,389.7**	**-**	**21,387.6**	**569,389.7**	**227,755.9**	**-**	**227,755.9**	**341,633.8**	**14,719.0**	**-**	**555,197.8**	**-**	**64,162.8**	**(292,445.8)**	
		Asbestos Total	**520,816.7**	**-**	**-**	**5,852.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**260,408.4**	**-**	**17,556.1**	**(277,964.4)**	

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