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NSPS LANDFILL GAS COLLECTION AND CONTROL SYSTEM DESIGN PLAN AND MONITORING PLAN

OTTAWA COUNTY FARMS LANDFILL

COOPERSVILLE, MICHIGAN

Prepared in Accordance with 40 CFR 60 Subpart WWW

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PREPARED BY

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INTRODUCTION AND GENERAL SITE CHARACTERISTICS

1 INTRODUCTION AND GENERAL SITE CHARACTERISTICS

1.1 APPLICABILITY

This document serves as a Landfill Gas Collection and Control System (GCCS) design plan for the Ottawa County Farms Landfill in accordance with requirements of 40 Code of Federal Regulations (CFR) New Source Performance Standards Part 60, Subpart WWW, for Municipal Solid Waste Landfills (NSPS). The purpose of this document is to provide a design plan that meets the requirements of the NSPS and to provide the Administrator the design standards and calculations used to prepare this GCCS Design Plan. The current GCCS Design Plan for the site was previously submitted to the Michigan Department of Environmental Quality (MDEQ) on December 17, 2007. As a result of proposed landfill expansion to increase the capacity of the site, the attached GCCS Design Plan is being submitted to completely replace the current GCCS Design Plan.

The submittal of this document fulfills the requirement for the facility to prepare a collection and control system design plan in accordance with 40 CFR 60.752(b)(2). The design plan outlines the methodology employed to design a landfill gas management system that will collect and dispose of the landfill gas generated in the entire permitted landfill at final grades.

A site plan depicting the current layout of the GCCS is included in Appendix A. A conceptual layout drawing depicting the proposed final build-out of the existing GCCS and standard details are in Appendix B. In addition, the facility's proposed methods for complying with the monitoring record keeping and reporting requirements of the NSPS are discussed. A surface monitoring plan is also presented in Appendix E.

The proposed GCCS build-out plan in Appendix B depicts the GCCS following closure of the landfill and may not be representative of interim GCCS construction details during the site's active landfill operations. However, the GCCS will at all times be constructed or expanded to maintain compliance with NSPS requirements. Due to possible future landfill operational changes, the GCCS design may also be altered to maintain compliance with the provisions of the NSPS and to accommodate actual field conditions at the time of construction.

As the site develops, additional LFG extraction wells will be installed as needed to control migration and surface emissions of methane. The locations and details of the anticipated proposed LFG extraction wells for the currently permitted landfill area at landfill completion are shown in Appendix C. Where needed, interim horizontal collection trenches may also be installed in areas of the landfill that are not yet at final grade. Once the landfill achieves its final elevation, vertical wells will be installed to replace the interim horizontal collection trenches.

The NSPS requires that several additional items be addressed in the design plan, such as depths of refuse, cover properties, compatibility with filling operations, integration with closure end use, and minimization of off-site migration. These items are discussed in this section, since they are not referenced in other areas of the design plan.

1.2 SITE BACKGROUND

The Ottawa County Farms Landfill is located in Coopersville, Michigan. The total landfill footprint with expansion is approximately 242.32 acres. Final closure of the entire facility is projected in the year 2082. However, the actual closure date will depend on refuse acceptance rates and the degree of landfill settlement. The landfill consists of several closed areas, and areas that have not yet been constructed.

1.3 CURRENT CONTROL STATUS

The Ottawa County Farms Landfill has a gas collection system in place over much of the waste in-place area. Gas is currently collected from vertical gas extraction wells and connections to leachate cleanout risers. The system is expanded as required by the NSPS. The type of gas collector selected in a particular area may vary depending on waste age, whether the area is at interim or final grades, etc. The site may select a variety of options to achieve the required control.

Collected gas from the landfill area is sent to a landfill gas to electricity plant which utilizes Caterpillar 3516 and 3520 engines to combust the landfill gas. A backup enclosed flare is also available for control. A small industrial burner utilizes a small quantity of landfill gas to dry and process foundry sands. The final type of control may change at any time depending on future landfill gas demand. Air permits for new gas control devices will be obtained as required.

The proposed design for the facility at final grades is provided in Appendix B. However, the final configuration may change from the design based on the site's operational needs and/or other considerations. An up-to-date copy of the gas-system as-builts will be kept in the site's files as required by the NSPS.

1.4 GAS WELL DECOMMISSIONING

A gas well may be decommissioned if it is experiencing declining gas flows. Pursuant to guidance provided by USEPA, the following steps will be initiated to decommission a well experiencing declining gas flow rates:

- Change to standard operating procedure: described in detail in Section III of this design plan.
- Permanent decommissioning (cut off wellhead below ground, cap and backfill). Physical abandonment may not be performed immediately following well disconnection. Timing of the physical abandonment of the well will depend on weather conditions or the potential for the well to recover sufficient gas flows.

MDEQ will be contacted for approval prior to the permanent decommissioning of any well.

1.5 GCCS DESIGN CHANGES

Installation of gas collection and control system (GCCS) components is anticipated to coincide with stages of fill development and NSPS regulations regarding installation of GCCS components stipulated in §60.752(b)(2)(ii)(A)(2). Due to operational changes, the GCCS design presented in this Design Plan may be altered to maintain compliance with the provisions of the NSPS and to accommodate actual field conditions at the time of construction. However, the GCCS will at all times be constructed or expanded to maintain compliance with NSPS requirements.

1.6 INSTALLATION AND STARTUP OF NEW GAS WELLS

New gas extraction wells will be installed as required by §60.753(a) to ensure that landfill gas is being collected from each area, cell or group of cells in the landfill in which solid waste has been in place for 5 years or more if active or 2 years or more if closed or at final grades. Once these new gas extraction wells are constructed and set in operation, they will be in a Startup mode as defined in the MACT standards (§63 Subpart AAAA). A Startup Form will be completed to document the time and date of Startup of operation for the well as required by the facility's Startup/Shutdown and Malfunction Plan. The gas collection well field will need to be "tuned" once new gas extraction wells are installed to return the system to a state of equilibrium. Adjustments will be made to the vacuum being applied to the new gas extraction well and other nearby wells.

Once the gas collection well field returns to a state of equilibrium and the new gas extraction wells meets the operational standards outlined in the NSPS, the Startup phase of operation for the new well will be complete. The Startup end date and time will be documented on the Startup Form. The new gas extraction well will then be added to the monthly operational standard monitoring schedule.

1.7 LANDFILL UNIT/AREA EXCLUSIONS

No areas of the landfill have been excluded from coverage of the GCCS in accordance with 60.759(a)(3)(i) as a result of asbestos placement, or the placement of non-degradable material. In addition, no areas of the landfill were determined to be non-productive (i.e., contribute <1 percent of the total amount of NMOC emissions from the landfill) in accordance with 60.759(a)(3)(ii); therefore, no areas of the landfill have been excluded from coverage of the GCCS.

1.8 DEPTHS OF REFUSE

The boring depth for the LFG extraction components installed in areas of the landfill that contain a geomembrane liner system is generally kept a minimum distance of 10 feet above the bottom of the landfill in order to avoid penetration of the liner during well installation. Depth of refuse is calculated by subtracting the bottom of the landfill elevation from the ground surface elevation.

1.9 COVER PROPERTIES

There are two separate final cover systems for the Ottawa County Landfill. The final cover system installed prior to Subititle D from ground surface to top of refuse is:

- 12 inch vegetated topsoil layer
- 24 inch layer of clay with a permeability of k = 1 x 10^{-5} cm/sec.

The final cover system for the remainder of the landfill from ground surface to top of refuse is:

- 6 inch layer of vegetated topsoil
- 12 inch layer of soil
- 12 inch layer of sand or Geocomposite plus 12 inch layer of soil
- 40 mil LLDPE
- 18 inch layer of clay with a permeability of k = 1 x 10^{-5} cm/sec.

However, the future final cover profile may change based on permit modifications or other approved alterations.

The final cover system design also provides a significant barrier to LFG emission and air infiltration when combined with an active LFG extraction system. The GCCS will provide components for collecting LFG or relieving pressures from LFG from beneath this layer.

Where applicable, the installation of GCCS components in closed areas will be completed by restoring the landfill cover to its pre-construction condition. Cover restoration will be performed under supervision of a construction quality assurance program implemented by Ottawa County Farms Landfill and verified for proper restoration.

During final cover construction the existing GCCS may need to be taken off-line; as such, monthly wellhead monitoring and quarterly surface emission monitoring (SEM) will not be performed for safety purposes during this time. Refer to Appendix F for alternatives to monitoring during final cover construction.

1.10 LANDFILL GAS CONTROL SYSTEM EXPANDABILITY

Expandability of the GCCS is achieved by installing items such as in-line valves, flange adapters with blind flanges or HDPE butt caps along the transmission piping, which allows the LFG transmission piping to be easily modified and expanded in the future. In the event that actual LFG flow rates do exceed the capacity of the system, additional GCCS components will be designed and installed in accordance with NSPS requirements.

1.11 LEACHATE/CONDENSATE MANAGEMENT

Transmission header and lateral piping is sloped to promote gravity flow of the condensate to engineered low points in the GCCS piping. Collected condensate is pumped from engineered low points or drained into the leachate collection system for disposal with the leachate generated by the landfill.

Leachate and condensate are stored in tanks prior to being pumped and hauled by truck to a local POTW. Future condensate management options may change depending on operational or regulatory considerations.

1.12 ACCESSIBILITY

Accessibility to the GCCS components is achieved by installing commonly accessed components (such as wellheads, monitoring ports, etc.) on relatively flat surfaces of the landfill or near the landfill's road network. Since the GCCS will be predominately installed below grade, valves and monitoring ports will be installed above grade, or within vaults, to increase their accessibility.

1.13 COMPATIBILITY WITH FILLING OPERATIONS

With the exception of areas that have been excluded from control, gas will be collected from areas of the landfill that have been active for 5 years or more; or are at final grade, with waste in place for at least 2 years. Methods for gas collection may include vertical gas extraction wells, extraction from the leachate collection system, horizontal trenches, etc. The methods selected for each area will take into account the stage of filling operations occurring in the area, in order to minimize damage to the collection system from landfill traffic.

As refuse filling operations proceed and portions of the site reach final or near-final grades, additional GCCS components will be installed. Using this method allows GCCS components to be installed in accordance with §60.752(b)(2)(ii)(A)(2)(i) and (ii) while minimizing interference of the GCCS with ongoing filling operations.

1.14 INTEGRATION WITH CLOSURE END USE

Future land use for the Ottawa County Farms Landfill will be determined upon closure of the facility. The end use plan shall comply with MDEQ regulations and shall not disturb the integrity of the gas control system, final cover system, or any other components of the containment or monitoring system.

1.15 AIR INTRUSION CONTROL

Air intrusion control is accomplished via the placement of daily, intermediate, and final cover. To accommodate the penetration of the geosynthetic component of the final cover system, the geosynthetic component will be snugly fitted to the pipe penetrations utilizing a “pipe boot”. Air intrusion is also minimized by completing the upper portion of each vertical LFG extraction well using solid pipe from the top of the well perforations to the landfill surface. The placement of a bentonite seal and soil backfill above the aggregate material minimizes air intrusion through the top cover of the landfill as shown on Drawing B-2 in Appendix B.

Air intrusion and LFG emissions will also be controlled through periodic monitoring and adjustment of the GCCS in coordination with appropriate maintenance of the landfill cover system. Monitoring the wellfield and in accordance with the operational monitoring standards for the LFG collection elements in accordance with NSPS requirements will also serve to reduce air intrusion. If the GCCS does not meet the operational monitoring standards, it will be adjusted or modified in accordance with NSPS requirements.

1.16 CORROSION RESISTANCE

Corrosion resistance of the GCCS is achieved through the use of corrosion resistant materials or materials that have a corrosion resistant coating, in accordance with 40 CFR §60.759(b)(1). The primary components used in the construction of the GCCS are HDPE and PVC piping or other non-porous corrosion resistant material.

1.17 FILL SETTLEMENT

Settlement will occur due to decomposition of the refuse. To accommodate refuse settlement, the GCCS components have been and continue to be designed and installed with several features to account for this settlement including:

- LFG extraction wellheads connected to the LFG transmission piping via a flexible pipe or hose connection. This allows the LFG piping to accommodate changes in the orientation of the LFG transmission piping or LFG extraction well.
- LFG transmission piping is sloped so that reasonable amounts of differential settlement may occur without causing pipe breakage, or disrupting the overall flow gradient of the LFG transmission piping.
- HDPE piping will be used for the construction of the header piping and transmission system. HDPE piping is flexible and absorbs differential settlement without breaking or cracking.

1.18 RESISTANCE TO DECOMPOSITION HEAT

Resistance of the GCCS to the heat generated as a result of refuse decomposition is achieved through the use of materials tested and proven to withstand temperatures well above those typically found in landfills. Landfill gas temperature will be monitored periodically in accordance with operational monitoring standards for the LFG collection elements as required by NSPS. The GCCS will be adjusted or modified to mitigate potential effects of elevated temperatures when warranted.

1.19 MINIMIZATION OF OFF-SITE MIGRATION

The installation and operation of an active gas recovery system causes an inward pressure gradient at the landfill, which will serve to minimize off-site migration of landfill gas. The facility performs perimeter gas monitoring in accordance with MDEQ regulations. This monitoring will help to measure the effectiveness of the gas collection system at minimizing off-site migration.

1.20 ALTERNATIVES TO THE NSPS

The alternatives to the operational standards, test methods, procedures, compliance measures, monitoring, record keeping or reporting provisions of 60.753 through 60.758 of the NSPS have been previously approved by MDEQ and are included in Appendix F.

ENGINEERING CALCULATIONS

2 CALCULATION OF MAXIMUM GAS FLOW RATE

The NSPS states that "gas mover equipment... be sized to handle the maximum gas generation flow rate expected over the intended use period of the gas moving equipment" (40 CFR 60.759[c]). In compliance with NSPS, the maximum expected LFG flow rate for the Ottawa County Farms Landfill was used for sizing the GCCS for peak flow conditions. The LFG generation and recovery rates for Ottawa County Farms Landfill were estimated using the U.S. Environmental Protection Agency (EPA) Landfill Gas Emissions Model (LandGEM). The modeling results reflect the estimated waste quantities accepted over the operating life of the site. Copies of the EPA LandGEM model print-outs are included in Appendix C.

The gas generation parameters established by the EPA in AP-42, Compilation of Air Pollutant Emission Factors, recommends a methane generation potential (L_o) of 100 cubic meters per megagram of solid waste, and a methane generation constant (k) of 0.04 year^{-1}. For converting methane to LFG, a methane content of 50 percent was assumed.

For historical waste acceptance rates for the years 1982-2015, where the detailed information on the waste types was available, only the putrescible waste portions were included and non-putrescible waste portions were taken out in the gas generation model. The future non-putrescible waste portion is assumed based on the average non-putrescible waste composition for the last 5-year (2011-2015) and is taken out for future waste acceptance rates from 2016 through closure in the model.

Based on the model outputs provided in Appendix C, the peak maximum landfill gas generation flow rate for Ottawa County Farms Landfill is estimated to occur at the end of year 2082 at 5,127 standard cubic feet per minute (scfm). Using a GCCS collection efficiency of 100 percent (for conservative design purposes), the peak estimated LFG extraction rate will be approximately 5,127 scfm. This maximum landfill gas extraction rate was used as the design basis value for sizing the LFG system components.

The site currently sends landfill gas to a landfill gas to energy (LFGTE) facility which utilizes Caterpillar 3516 and 3520 engines with a design capacity of approximately 2,100 scfm and 1,005 scfm, respectively, to combust the landfill gas for the generation of electrical power for onsite usage and export to the electrical grid. Additionally, the site also has a backup enclosed flare with a design capacity of approximately 3,700 scfm. At this estimated peak extraction rate, the existing control equipment will have enough capacity for the future peak LFG extraction rates.

The sizing of the future GCCS is based on the maximum LFG extraction rate of 5,127 scfm as estimated using the LandGEM and AP-42 emission factors. The final GCCS piping system has been sized to handle this maximum estimated LFG extraction rate while maintaining vacuum throughout the header pipe. Design computations for sizing the LFG transmission piping and determining system vacuum requirements were performed using the computerized KYGas® model. A copy of the model printout and its description are included in Appendix D.

3 GAS EXTRACTION SYSTEM DESIGN CRITERIA

3.1 INTRODUCTION

The first step in performing a gas system design is to lay out the location of the vertical gas extraction wells. One of the requirements of the NSPS for designing a gas collection system is to ensure sufficient density of the LFG extraction points, as stated below:

> **§60.759(a)(2)** The sufficient density of gas collection devices determined in paragraph (a)(1) of this section shall address landfill gas migration issues and augmentation of the collection system through the use of active or passive systems at the landfill perimeter or exterior.

Per the definition stated in §60.751, "sufficient density" means "any number, spacing, and combination of collection system components necessary to maintain emission and migration control as determined by measures of performance set forth in this part."

The well spacing required to achieve comprehensive control of LFG is a function of many parameters including liner type, cover type, surrounding geology/hydrogeology, landfill geometry, well depth, waste composition and age, and the presence of liquids within the landfill. Mathematical models can be derived to estimate the zone of influence of a well. However, due to the below conditions and the inherent variability of waste properties within a landfill, many parameters such as permeability, channelized flow, saturated zones, and the effect of daily and intermediate cover soil layers are extremely difficult or impossible to define adequately. The error introduced as a result of the required simplifying assumptions and estimated properties produces results that are often less reliable than the application of extensive industry experience.

The factors and site-specific conditions that are typically used to establish adequate well spacing, which may change as the landfill is built out and ages, may include the following:

- SEM results
- Site specific conditions at the time of installation
- Permeability of waste materials or final cover capping systems
- Permeability of daily cover soils
- LFG generation rate
- Moisture
- LFG viscosity
- Past experience/engineering judgment
- LFG temperature
- Waste age
- Waste composition

Please note that the foregoing list is not intended to be comprehensive.

This approach is consistent with spacing criteria used at other landfills and should effectively control surface emissions and subsurface migration of LFG in accordance with NSPS requirements.

The average spacing of the existing extraction wells varies from 200 to 300 feet apart, with an average of 200 to 300 feet for future wells. In addition, if needed, horizontal collection trenches will be used to control LFG. Based on extensive industry experience, the LFG collector spacing shown should be adequate to provide comprehensive control of the LFG as required. In the event that this spacing is not adequate to meet the required operating standards, additional collectors will be installed as necessary.

Additionally, properly designed, installed, and operated, gas collection element density can be demonstrated in the field by use of the Surface Emission Monitoring (SEM) requirements contained in 40 CFR 60.753 of the NSPS.

Many of the variables mentioned above can vary based on the location of waste within the waste footprint. Please note that the EPA Background Information Document included in Appendix G on page 1-38, indicates that the SEM events were implemented by the EPA to verify that the GCCS is adequately operated and maintained.

3.2 FINAL GCCS DESIGN METHODOLOGY

The Ottawa County Farms Landfill will continue to be developed in accordance with its current MDEQ Solid Waste Permit. The installation of future GCCS components will continue to be coordinated with the facility's development, and as otherwise required by NSPS regulations regarding installation of GCCS components. Due to the potential for unforeseen landfill operation changes, some changes to the GCCS design may need to be made in order to maintain compliance with NSPS provisions and to accommodate actual field conditions at the time of GCCS construction.

This section identifies components proposed for future expansion of the Ottawa County Farms Landfill GCCS. A phased GCCS design will be implemented in order to comply with the NSPS requirements for GCCS expansions stipulated in §60.752(b)(2)(ii)(A)(2). A conceptual layout drawing depicting the proposed final build out of the existing GCCS and standard details are included in Appendix B.

As the site develops, additional LFG extraction wells will be installed as needed to control migration and surface emissions of methane. The locations and details of the anticipated final proposed LFG extraction wells for the currently permitted landfill area are shown in Appendix B. Where needed, interim horizontal collection trenches may also be installed in areas of the landfill that are not yet at final grade. Once the landfill achieves its final elevation, vertical wells will be installed to replace the interim horizontal collection trenches.

In addition, an active overliner LFG system is proposed to collect the gas underneath the overliner as well as to prevent the subsurface gas migration. This system will be installed prior to and underneath the overliner. As part of the overliner LFG system, the existing gas extraction system within the overliner area will be cut below grade and then connected to a series of perforated pipes and rock filled trenches. The piping then will be connected to the active LFG collection piping, which will induce a vacuum on this system.

If the LFG extraction components (i.e., LFG extraction wells and horizontal LFG collectors) are no longer functional and the SEM and gas probe monitoring results shows no exceedance in the immediate vicinity of the LFG extraction components, then the LFG extraction components will be decommissioned and the information will be included in the Semi-Annual NSPS report.

The future LFG extraction well layout was developed with both perimeter and internal extraction wells with the average spacing of approximately 200 to 300 feet. Each LFG extraction well will be equipped with a control valve and monitoring ports similar to the Drawing B-2 in Appendix B. These control valves and monitoring ports, used in conjunction with controls on the blower, will allow the site operator to regulate vacuum and LFG levels at each individual LFG extraction well. This will allow the operator to make adjustments in order to effectively reduce the potential for air intrusion, subsurface migration and odors, as well as to protect the integrity of the final cover system. The LFG extraction wells will be installed as the landfill develops in accordance with the NSPS requirements.

The proposed GCCS components will serve to expand the existing system. The proposed components will be installed in phases as needed.

Future LFG transmission piping will be sized to accommodate the maximum expected LFG flow rate as estimated by LFG generation rate modeling. The results of the KY Gas Model that was used to determine the future pipe sizing are included in Appendix D of this plan.

This GCCS Design Plan has been prepared for NSPS compliance for the entire Ottawa County Farms Landfill. Technical information and drawings depicting the future GCCS expansion(s) are included in this GCCS Design Plan and in Appendix B, respectively. Completion details for future GCCS expansions will be similar to those shown in Appendix B. Drawing B-1 in Appendix B depicts the GCCS following closure of the landfill and may not be representative of interim GCCS construction details during the site's active landfill operations. However, the GCCS will at all times be constructed or expanded to maintain compliance with NSPS requirements. Due to possible future landfill operational changes, the GCCS design may also be altered to maintain compliance with the provisions of the NSPS and to accommodate actual field conditions at the time of construction.

3.3 WELL CONSTRUCTION

3.3.1. Description of Vertical Gas Wells:

A typical gas well proposed for installation at the facility is included in Appendix B. The conceptual layout drawing depicting the proposed final build out of the existing GCCS and standard details are included in Appendix B. As indicated previously, the facility may employ a variety of collection methods in order to extract landfill gas. As-built drawings of the collection system will be kept on site in the NSPS files, as required by the regulations.

3.3.2. NSPS Compliance:

The proposed gas collection wells will meet the following requirements listed in 40 CFR 60.759:

- minimization of air intrusion
- waste depths and proper connector assembly (closing valves, sampling ports, etc.).
- required materials of construction and gravel dimensions
- corrosion resistance
- sufficient density of extraction devices
- avoidance of damage to underlying liners
- occurrence of water within the landfill

4 HEADER PIPE SIZING

4.1. INTRODUCTION

The next step in designing a gas collection system is to lay out the header line and laterals to connect each of the gas wells into the system, and convey the collected gas to a central location for destruction. After the design engineer has routed the most efficient header system for collecting gas from the extraction wells, the header pipe must be sized appropriately to convey the maximum expected gas flow [40 CFR §60.752(b)(2)(ii)(A)(1)]. Typical design criteria and header construction methods are generally discussed in the following subsections.

The Ottawa County Farms Landfill has an existing gas collection system over a portion of the waste. The following provides a narrative describing the results of a KYGas® analysis of the landfill gas collection and control system (GCCS) installed at Ottawa County Farms Landfill. The purpose of conducting this analysis was to evaluate the following:

- Pressure distribution profile for the existing piping system;
- Verify that the existing and future piping system is adequately sized and that the sizing is consistent with current industry practices; and
- Confirm the existing landfill gas blower inlet vacuum is adequate for GCCS operation.

The KYGas® model was development by the University of Kentucky for performing water and gas distribution flow analyses. The program uses a 2-dimensional model depicting the geometry of the piping system. Once the 2-dimension layout of the system has been entered into the model, the user enters the physical properties of the gas, plus other site-specific parameters for the size and type of pipe, gas flow requirements, and operating pressure conditions to calculate the system gas velocities and pressure distribution.

KYGas® utilizes the Ideal Gas Law for pressure-temperature-density relationships and the Darcy-Weisbach equation for head losses related to uncompressible flow. The program operates under the assumption that all flow in the piping system is steady, one-dimensional, isothermal flow for an ideal gas.

4.2. MODEL INPUT DATA

For the Ottawa County Farms Landfill, the GCCS layout and pipe sizes used in the model were based on as-built information provided for the existing system, and the proposed future expansions of the system through site closure. High density polyethylene (HDPE) piping having a standard diameter ratio (SDR) rating of 17 was assumed for the inside pipe diameters. Other parameters required for the model include:

- Pipe length
- Roughness within the pipe
- Minor loss coefficient
- LFG operating temperature
- LFG flow rate into the system at each well or node
- Ratio of specific heats
- Specific gravity of the landfill gas
- Absolute viscosity of the landfill gas

The peak landfill gas (LFG) flow rate condition used in the model was derived from LFG generation rate modeling prepared using the EPA LandGEM model. The facility's peak LFG generation rate was calculated to be approximately 5,127 standard cubic feet per minute (scfm) in 2082. Using a GCCS collection efficiency of 100 percent (for conservative design purposes), the peak estimated LFG extraction rate will be approximately 5,127 scfm. The final GCCS piping system has been sized to handle this maximum estimated LFG extraction rate while maintaining vacuum throughout the header pipe. Design computations for sizing the LFG transmission piping and determining system vacuum requirements were performed using the computerized KYGas® model. A copy of the model printout and its description are included in Appendix D.

The KYGas® model requires the user to specify an operating pressure for each vacuum source used in the analysis. Based on information provided by the facility, a target vacuum of 60 inches water column gauge ("w.c.) was used during the KYGas® analysis for the co-generation plant, although more vacuum is potentially available.

The user can start the evaluation of the system once all of the required information is input into the program. This evaluation is an iterative process. Multiple model runs are conducted by adjusting the pipe diameter, until the velocities in the system piping and the vacuum pressure remaining at the furthest node meet design requirements.

The design criteria utilized for the header system is:

- Maximum Concurrent velocity: 40 feet/second
- Maximum Countercurrent velocity: 20 feet/second
- Maintain minimum vacuum throughout the header pipe

4.3. DESCRIPTION OF KYGAS® MODEL RESULTS

The following narrative describes the information and data included on the KYGas model printouts included in Appendix D.

Page 1 of each print out provides a summary of the simulation, including gas parameters and units of measure. The Summary of Pipe Network Geometric and Operating Data section of each print out depicts the geometry and operating criteria used in the model. Column 1 identifies the pipe name ("P-"), with columns 2 and 3 identifying the pipe nodes ("J-") that connect to each pipe segment. Column 4 is the length of the pipe segment, with the actual inside diameter of the pipe shown in column 5. Column 6 is the interior roughness coefficient used in the model for HDPE pipe, while column 7 is a multiplier used in the calculations to take into account the additional friction losses incurred from pipe fittings, pipe size reductions, and valves installed along the HDPE piping system. The last two columns are not used for gas flow calculations.

The next table in this section summarizes the junction "nodes" and their "demands", or the quantity of LFG entering the system at each node location. Column 1 identifies each junction node, or point in the piping where there is flow added to the header or there is a change in pipe size. Column 2 identifies the LFG extraction well(s) or other system component that connects to the piping system at that junction location. Column 3 identifies the flow that is added to the header at each junction node in scfm. Column 4 represents the negative pressure that is added to the system in order to extract LFG. R-1 represents the blower and the vacuum (in inches water column) it is applying to the system. Because the GCCS operates under a negative pressure, the operating flow rates and pressures are entered as negative numbers.

The next section, which includes the results of the simulation, consists of two tables. The first presents the modeling results for each pipe segment. Columns 1 through 3 have already been described. Column 4 indicates the total LFG flow rate [in standard cubic feet per minute (scfm)] for each pipe. A negative number simply indicates the direction of LFG flow is reversed from the orientation indicated by the pipe nodes. On the print-out table, the direction of flow from Node #1 (Column 2) towards Node #2 (Column 3) is represented as a positive value. If the direction of flow is calculated to be from Node #2 (Column 3) towards Node #1 (Column 2), the flow rate in Column 4 is represented as a negative value. Column 5 is the calculated friction loss along the pipe segment expressed in inches of water column. Column 6 is the calculated velocity of the LFG flowing through the pipe segment. Column 7 is the density of LFG calculated while running the program. Column 8 is a variable calculated by the model for each pipe segment based on flow rate.

The second table presents the modeling results for each pipe node. The first three columns have already been described. Column 4 indicates the calculated static pressure within the piping in inches of water column at each node location when using the selected system vacuum. Column 5 is the absolute pressure in pounds per square inch, while Column 6 is the static pressure from Column 4 expressed in pounds per square inch. The last column is again the calculated density of LFG.

Figure 1 for each KYGas model identifies the pipe segment and junction node names used by the model. These names can be used to reference the information on the model print-out. Figure 2 for each KYGas model identifies the gas velocity for each pipe segment and amount of vacuum at each junction node calculated by the model.

4.4. SUMMARY OF KYGAS® RESULTS

Interpreting the data involves evaluating the data for the following parameters:

- Gas velocity in the pipe segments.
- The static pressure in inches of water column at the pipe nodes.

The calculated pipe velocities based on the proposed pipe layout and size are generally less than 20 ft/sec for counter-current flow and 40 ft/sec for concurrent flows. The LFG collection piping system as modeled is adequately sized to provide for a minimum of 10-inches of vacuum at the furthest pipe node from the flare facility. Given that this modeling represents ideal conditions, although smaller pipe size would meet the vacuum and velocity parameters, larger pipes in some cases are proposed to allow for some factor of safety.

4.5. HEADER CONSTRUCTION

4.5.1. Description of Header Collection Pipe Network

The header pipe proposed for installation is high density polyethylene (HDPE) pipe. HDPE pipe is ideal due to its compatibility with landfill gas and waste, its flexibility (if settlement occurs), its long term stability and its excellent chemical resistance. The pipe is set in a trench, and is surrounded by compatible bedding media.

Control valves are located throughout the collection header network. The valves can manually shut off the applied vacuum to a particular section of header pipe. This allows portions of the well field to be isolated for monitoring and maintenance purposes.

4.5.2. NSPS Compliance

Blind flanges have been incorporated into the design in order to allow for future gas system expansions. The header system as described in this section will meet the following requirements listed in 40 CFR §60.759:

- gas system expandability & accessibility
- corrosion resistance
- fill settlement
- required materials of construction
- ability to withstand planned overburden or traffic loads

5 GAS MOVER EQUIPMENT SIZING

5.1. INTRODUCTION

Per 40 CFR §60.752(b)(2)(ii)(A)(1), the active gas extraction system must be designed to handle the maximum expected gas flow rate from the entire area of the landfill that warrants control, over the intended use period of the gas control system equipment. 40 CFR §60.752(b)(2)(ii)(A)(3) requires that gas be collected at a sufficient extraction rate.

General design criteria and the method for determining the required gas mover equipment size are discussed in the following section. The Ottawa County Farms Landfill currently has two (2) rotary vane compressors at one of the gas-to-energy plants. The other plant (Plant 2) has a compressor as well. The open flare does not have an independent blower; it is supplied by the compressor in Plant 2.

5.2. GENERAL DESIGN CRITERIA

5.2.1. Flow Volumes:

The compressors at the gas plants provides a uniform source of vacuum over a wide range of flow rates, since gas flow volumes will vary over the life of the gas extraction system. Minimum system flows are those expected when only the initial phases of the system have been installed. Maximum flows will occur after the entire gas system is in place.

5.2.2. Pressure Requirements:

The compressors at the gas plant are capable of supplying sufficient negative pressure to overcome pressure drops and resistance through piping and equipment at the calculated maximum gas flow rate, as well as supplying sufficient positive pressure for delivery of the collected gas off site to the end user, or to the flare for combustion.

5.2.3. Design Methodologies:

Flow Volumes: The Ottawa County Farms Landfill's existing gas mover equipment are capable of handling 5,127 scfm landfill gas. Currently, the site is using the existing compressors at the gas to energy plant. As gas production volumes increase, the site will select gas mover equipment that is adequate to handle the collected volumes of gas from the gas system.

Pressure Losses in Gas System: A total system pressure drop of approximately 35 inches w.c. was estimated for the Ottawa County Farms Landfill.

Applied Well Vacuums: For design purposes, it is assumed that a minimum of 10” water column vacuum, PW, should be available at the gas wells in order to provide sufficient vacuum for gas extraction. This is consistent with measured vacuums observed by field personnel during routine gas system monitoring.

Pressure Loss Through Future Flare: A pressure loss, PF, on the positive side of the gas mover equipments is created by the discharge piping, the flame arrester, orifice plate and the flare itself. The designer typically assumes a maximum drop of 12” w.c. through these components, based on information supplied by flare manufacturers.

Required Vacuum: Based on these pressure losses for the gas management system, the gas mover equipment must ultimately be capable of providing the following vacuum:

$P_{total} = P_H + P_W + P_F$
= 35”+ 10” + 12”
= 57” w.c. total static pressure.

Gas mover equipment is required that can accommodate the total maximum flow of 5,127 scfm while providing static pressures of 57” w.c. The two existing rotary vane compressors at the six engine gas plant (Plant 1) can each accommodate flow rates of 1,325 scfm (2,650 scfm total) and are able to apply a vacuum of 135 inches w.c. to the collection system. The compressor in Plant 2 can move 1,900 scfm of landfill gas, and can apply a vacuum of 60 inches w.c. to the field.

This is currently sufficient to meet the needs of the site. A larger blower or compressor will be installed at the facility at the point in time when collected gas volumes warrant additional vacuum.

6 CONTROL DEVICE SIZING

6.1. INTRODUCTION

The last requirement in designing a gas collection system is to size and select a control device meeting the requirements of 40 CFR §60.752(b)(2)(iii). The control device must be capable of combusting a wide range of flow volumes.

The Ottawa County Farms Landfill currently compresses, dewaters and filters the landfill gas prior to combustion in the gas plant engines. An open flare is available for additional control.

6.2. GENERAL DESIGN CRITERIA

The treatment process consists of compression, dewatering and filtration of the landfill gas. Treatment is one of the three allowable control methods of the NSPS.

40 CFR 60.752(b)(2)(iii)(A) requires that open flares used for control be designed and operated in accordance with 40 CFR 60.18. This includes no visible emissions, and criteria for minimum heating value of the fuel being burned, and exit velocity restrictions.

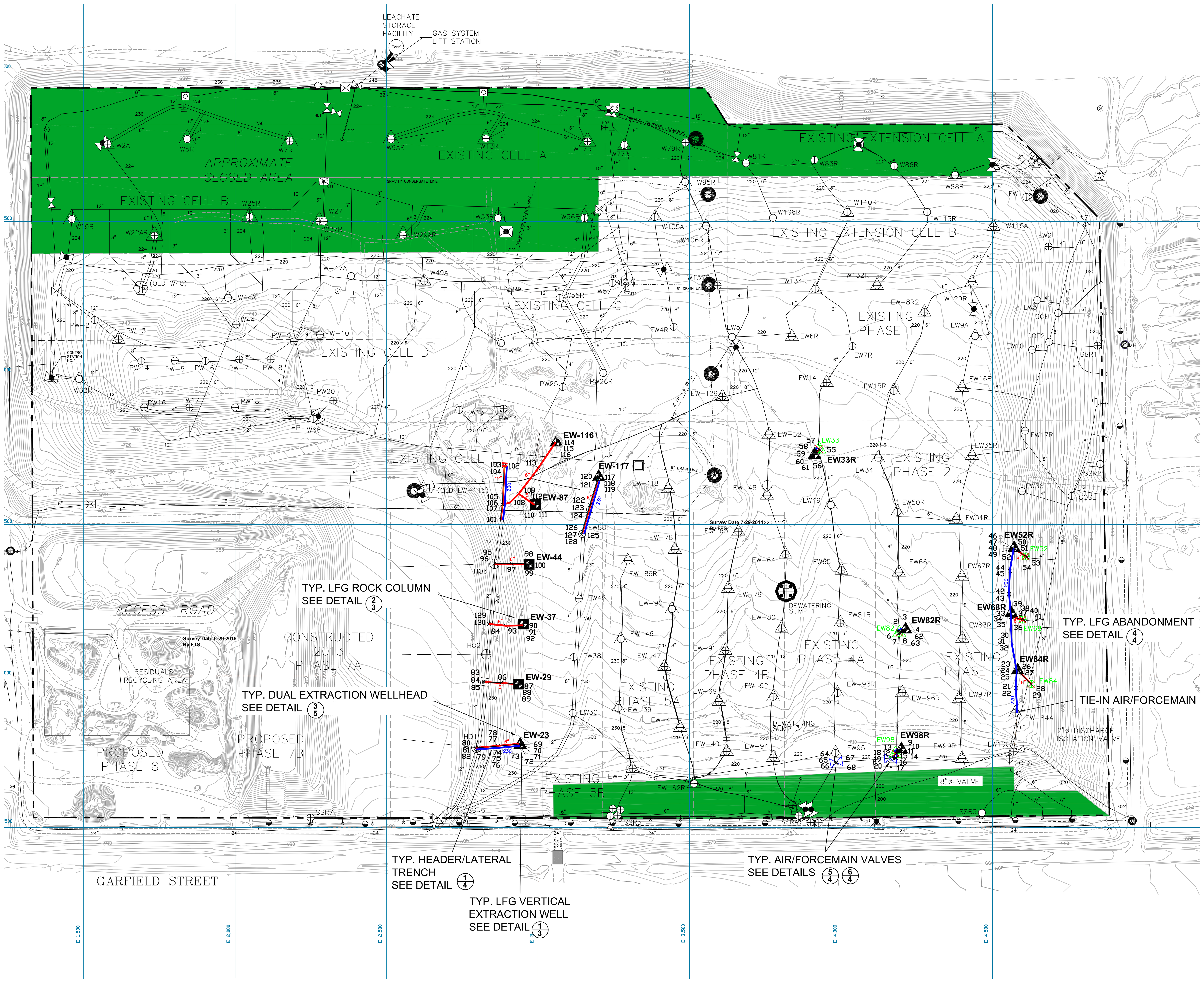
6.3. CONTROL DEVICE SIZING

The expected maximum system gas flow rate at the Ottawa County Farms Landfill was calculated to be 5,127 scfm. The existing gas plant engines can combust a total of 3,105 scfm of flow. The enclosed flare can combust 3,700 scfm of flow, for a total current site control capacity of 6,805 scfm.

The facility will periodically evaluate the existing gas control capabilities, prior to each expansion of the gas collection system, to insure that adequate combustion capacity exists for the expected increase in collected gas volumes. Additional control equipment will be added as needed when collected gas volumes warrant the increase.

APPENDIX A

EXISTING GCCS LAYOUT



Number	Northing	Easting	Elevation	Desc
2	5151.17	4209.56	725.22	PIPE-6-90
3	5151.36	4209.12	725.27	PIPE-2-A-90
4	5150.28	4209.52	725.39	PIPE-2-90
5	5141.71	4189.07	724.31	PIPE-4-90
6	5141.97	4189.95	724.33	PIPE-6X4-R
7	5143.52	4193.00	723.75	PIPE-AIR-T
8	5141.25	4193.08	723.73	PIPE-DIS-T
9	4759.34	4198.26	709.90	EW-98R-GRD
10	4758.42	4198.25	712.82	EW-98R-TOC
11	4743.56	4182.20	705.52	PIPE-4-90
12	4743.97	4182.14	705.07	PIPE-AIR-T
13	4742.96	4183.78	705.41	PIPE-DIS-T
14	4758.16	4196.29	711.86	PIPE-6-FLANGE
15	4729.75	4180.81	703.44	VALVE 2-DIS
16	4729.77	4180.46	703.39	PIPE-2-FLAN
17	4729.72	4181.39	703.41	PIPE-2-FLAN
18	4729.25	4179.97	703.30	PIPE-2-A-90
19	4729.43	4182.42	703.33	PIPE-2-A-90
20	4729.51	4185.98	703.08	2-EXIST-T-A
21	4961.05	4577.72	719.52	PIPE-2-DIS
22	4961.18	4577.16	719.58	PIPE-2-AIR
23	5017.83	4579.67	721.99	PIPE-AIR-T
24	5017.31	4578.56	722.04	PIPE-DIS-T
25	5016.20	4582.78	722.15	PIPE-6-90
26	5020.06	4583.54	724.45	EW-84R-GRD
27	5019.92	4583.88	727.37	EW-84R-TOC
28	4974.58	4626.51	713.04	PIPE-6-45
29	4972.44	4626.80	712.08	PIPE-4-90
30	5108.59	4562.61	725.53	VALVE 2-DIS
31	5108.53	4562.18	725.54	PIPE-2-DIS
32	5109.07	4562.95	725.44	PIPE-2-AIR
33	5194.55	4560.77	727.09	PIPE-2-AIR
34	5194.83	4560.44	727.17	PIPE-2-DIS
35	5195.02	4560.54	727.16	PIPE-DIS-T
36	5194.85	4560.67	727.15	PIPE-AIR-T
37	5195.75	4563.14	725.72	PIPE-6-90
38	5198.89	4563.21	730.18	EW-68R-GRD
39	5199.08	4563.10	733.25	EW-68R-TOC
40	5184.16	4604.65	717.16	PIPE-4-90
41	5184.12	4604.26	717.15	PIPE-6X4-R
42	5270.53	4553.67	729.47	PIPE-2-DIS
43	5270.74	4554.51	729.51	PIPE-2-AIR
44	5346.93	4557.07	730.04	PIPE-2-AIR
45	5346.83	4556.48	730.13	PIPE-2-DIS
46	5421.03	4569.44	729.99	PIPE-2-DIS
47	5420.88	4569.73	729.89	PIPE-2-AIR
48	5421.01	4569.71	729.88	PIPE-2-A-90
49	5421.14	4569.29	729.97	PIPE-2-90
50	5419.22	4572.41	727.57	PIPE-6-90
51	5422.42	4573.12	731.09	EW-52R-GRD
52	5422.27	4572.33	734.11	EW-52R-TOC
53	5391.94	4614.35	716.63	PIPE-4-90
54	5392.21	4613.80	716.67	PIPE-6X4-R
55	5745.82	3929.94	735.95	PIPE-4-90
56	5745.68	3929.37	736.01	PIPE-6X4-R
57	5743.08	3915.59	739.12	PIPE-6-90
58	5744.16	3913.84	739.24	PIPE-2-A-90
59	5743.76	3914.28	739.17	PIPE-2-90
60	5742.73	3911.84	743.15	EW-33R-GRD
61	5742.57	3911.86	745.59	EW-33R-TOC
62	5153.56	4212.90	731.15	EW-82R-TOC
63	5153.77	4212.98	728.83	EW-82R-GRD
64	4713.77	3985.28	701.46	PIPE-2-A-90
65	4714.02	3982.64	701.50	PIPE-2-A-90
66	4714.30	3983.91	701.60	VALVE 2-DIS
67	4714.19	3984.38	701.53	PIPE-2-FLAN
68	4714.32	3983.47	701.53	PIPE-2-FLAN
69	4774.00	2941.05	717.45	EW-23-GRD
70	4774.42	2940.97	719.99	EW-23-TOC
71	4776.16	2937.32	714.42	PIPE-6-90
72	4775.08	2937.62	714.10	PIPE-2-A-90
73	4774.71	2937.05	714.03	PIPE-3-90
74	4768.06	2868.90	701.30	PIPE-3-T
75	4768.47	2868.73	701.31	PIPE-AIR-T
76	4769.61	2868.72	701.77	PIPE-6
77	4767.89	2868.85	701.46	PIPE-3
78	4768.69	2868.53	701.34	PIPE-2-AIR
79	4762.58	2793.86	686.31	PIPE-AIR-T
80	4762.48	2793.23	686.36	PIPE-3-T
81	4763.05	2795.89	687.36	PIPE-6-T
82	4762.99	2796.36	688.40	PIPE-6-T
83	4979.33	2820.32	693.32	PIPE-3-T
84	4981.65	2820.18	693.38	PIPE-AIR-T
85	4979.86	2823.50	695.89	12X6-TEE
86	4977.82	2878.73	707.75	PIPE-6
87	4973.01	2933.46	720.00	PIPE-6-90
88	4972.12	2937.44	723.62	EW-29-GRD
89	4972.09	2937.60	726.68	EW-29-TOC
90	5167.16	2949.69	726.73	PIPE-6-90
91	5170.20	2952.42	730.29	EW-37-GRD
92	5169.84	2952.57	733.87	EW-37-TOC
93	5165.84	2893.38	715.01	PIPE-6
94	5171.62	2837.27	702.18	12X6-TEE
95	5370.30	2855.78	713.58	PIPE-6-T
96	5370.35	2855.67	713.58	PIPE-6-T
97	5370.87	2912.93	726.10	PIPE-6
98	5372.28	2970.87	738.42	PIPE-6-90
99	5369.71	2972.44	740.73	EW-44-GRD
100	5369.66	2972.43	743.11	EW-44-TOC
101	5515.11	2876.07	725.40	PIPE-FLANGE
102	5693.60	2889.39	733.98	PIPE-FLANGE
103	5693.85	2888.44	733.18	AIR-CAP
104	5693.75	2887.64	733.00	3-DIS-CAP
105	5565.94	2881.49	727.39	PIPE-3
106	5565.43	2882.00	727.26	PIPE-2-AIR
107	5565.43	2883.02	727.78	12X6-TEE
108	5572.47	2907.47	729.17	PIPE-6
109	5601.04	2936.10	731.05	PIPE-6-T
110	5564.18	2988.95	737.45	PIPE-6-90
111	5566.68	2989.82	740.12	EW-87-GRD
112	5566.42	2989.88	742.60	EW-87-TOC
113	5685.57	3000.61	735.86	PIPE-6
114	5771.10	3057.58	741.45	PIPE-6-90
115	5769.68	3059.95	747.85	EW-116-TOC
116	5769.93	3059.79	743.16	EW-116-GRD
117	5657.21	3200.10	749.19	EW-117-GRD
118	5657.67	3199.97	751.01	EW-117-TOC
119	5655.40	3197.37	748.26	PIPE-6-90
120	5654.68	3199.57	748.14	PIPE-2-A-90
121	5655.14	3198.87	748.13	PIPE-3-90
122	5564.63	3170.34	744.60	PIPE-3
123	5564.33	3169.74	744.86	PIPE-6
124	5563.73	3171.04	744.52	PIPE-2-AIR
125	5466.62	3142.21	738.30	PIPE-6-T
126	5467.41	3142.85	741.13	PIPE-3-T
127	5466.71	3142.18	741.25	PIPE-6-T
128	5465.72	3143.57	741.16	PIPE-AIR-T
129	5171.96	2837.26	702.15	ELECTRA-CUP
130	5170.27	2837.29	702.08	ELECTRA-CUP

LEGEND

- LIMITS OF WASTE
- EXISTING 10' CONTOUR (800)
- EXISTING 2' CONTOUR
- EXISTING BURIED ELECTRIC LINE
- EXISTING LANDFILL GAS HEADER (12")
- EXISTING GRAVITY CONDENSATE LINE
- EXISTING COMBINATION WELLHEAD
- EXISTING EXTRACTION WELLHEAD
- EXISTING HEADER ACCESS RISER
- EXISTING REMOTE WELLHEAD
- EXISTING LEACHATE MANHOLE
- EXISTING BLIND FLANGE
- EXISTING FLANGE CONNECTION
- LANDFILL DEWATERING PUMP (DP)
- EXISTING ROAD CROSSING
- EXISTING FINAL COVER AREA
- EXISTING VALVE
- EXISTING BLOWOFF AND BALL VALVE
- EXISTING STORMWATER CATCH BASIN
- 236 — AIR & FORCEMAIN 236=2" AIR, 3" FORCEMAIN, 6" CONTAINMENT
- 220 — AIR & FORCEMAIN 220=2" AIR, 3" FORCEMAIN, NO CONTAINMENT
- 6" — LFG HEADER / LATERAL
- LFG VERTICAL EXTRACTION WELL
- LFG WELL ABANDONMENT
- LFG DUAL EXTRACTION WELLHEAD
- LFG ROCK COLUMN
- AIRLINE & CONDENSATE VALVES

NOTES:

1. EXISTING AERIAL MAPPING CONTOURS DEVELOPED BY COOPER AERIAL SURVEYS CO. DATED MARCH 27, 2015.
2. MINIMUM SLOPE FOR GAS HEADER/LATERAL PIPES WITHIN WASTE LIMITS IS 5%, 3% WITH APPROVAL OF EM.
3. ALL HDPE PIPE CONNECTIONS WERE BUTT FUSION OR FLANGES UNLESS. THERE WAS THREE ELECTRO FUSION COUPLERS PRE-APPROVED BY DESIGN ENGINEER AND OWNER AT THE PRECONSTRUCTION MEETING. TEST PORTS WERE NOT REQUIRED ON BOTH SIDES.
4. PRESSURE TEST:
   A. PRESSURE DROP OVER ONE HOUR PERIOD DOES NOT EXCEED 10%.
   B. FINAL TEST WAS CONDUCTED AFTER PIPE IS PLACED IN TRENCH.
   C. PRESSURES:
      GAS HEADER/LATERAL: 10 PSI
      FORCEMAIN: 100 PSI
      AIR LINE: 100 PSI
5. CONTRACTOR WAS RESPONSIBLE TO OBTAIN ALL MATERIALS INCLUDING PIPE, MATERIAL FOR FINAL COVER REPAIRS AND OTHERS.
6. CONTRACTOR WAS RESPONSIBLE FOR IMMEDIATE PROPER DISPOSAL OF WELL CUTTINGS AND OTHER MATERIALS.
7. CONTRACTOR WAS RESPONSIBLE FOR ALL GEOSYNTHETIC SYSTEM REPAIRS, IF APPLICABLE.
8. BORING & EXCAVATIONS WERE BACKFILLED IMMEDIATELY FOLLOWING COMPLETION.
9. NO WELL ABANDONMENTS SHALL BE COMPLETED UNTIL THE CORRESPONDING REDRILL IS UNDER VACUUM. VACUUM TO NEW WELLS REQUIRED WITHIN 24 HOURS.
10. ALL EXISTING WELLS TO BE REDILLED WERE ABANDONED PER NOTE 9 AND THE EXISTING WELL CASINGS WERE REMOVED.
11. DRILLING ACTIVITIES BEGIN AFTER RECEIVING THE REQUIRED SIGNATURES ON THE WELL SCHEDULE. ANY CHANGES TO WELL LOCATIONS OR DEPTHS REQUIRED THE SIGNATURES TO BE OBTAINED AGAIN AND THE NEW LOCATION WAS SURVEYED TO VERIFY EXISTING GROUND ELEVATION.

Ottawa County Farms Landfill - 2015 Gas Expansion

Gas Extraction Well Location — Toc = Top of casing

Well ID	Latitude	Longitude	Description
23	43 2 46.357411 N	85 56 58.082446 W	EW-23-TOC
29	43 2 48.309751 N	85 56 58.134341 W	EW-29-TOC
33R	43 2 55.943072 N	85 56 45.038982 W	EW-33R-TOC
37	43 2 50.263238 N	85 56 57.939183 W	EW-37-TOC
44	43 2 52.237386 N	85 56 57.678357 W	EW-44-TOC
52R	43 2 52.795104 N	85 56 36.133891 W	EW-52R-TOC
68R	43 2 50.590426 N	85 56 36.251093 W	EW-68R-TOC
82R	43 2 50.132521 N	85 56 40.965724 W	EW-82R-TOC
84R	43 2 48.821369 N	85 56 35.965520 W	EW-84R-TOC
87	43 2 54.181203 N	85 56 57.449807 W	EW-87-TOC
98R	43 2 46.229368 N	85 56 41.150306 W	EW-98R-TOC
116	43 2 56.190478 N	85 56 56.512903 W	EW-116-TOC
117	43 2 55.087491 N	85 56 54.623517 W	EW-117-TOC

REPUBLIC SERVICES

Rev.	Date	Description	By	Chk

DRAWN BY PEW — CADD Review PEW — CHECKED BY

Field Technology Services

OTTAWA COUNTY FARMS LANDFILL 2015 LANDFILL GAS EXPANSION

15550 68TH
COOPERSVILLE, MICHIGAN

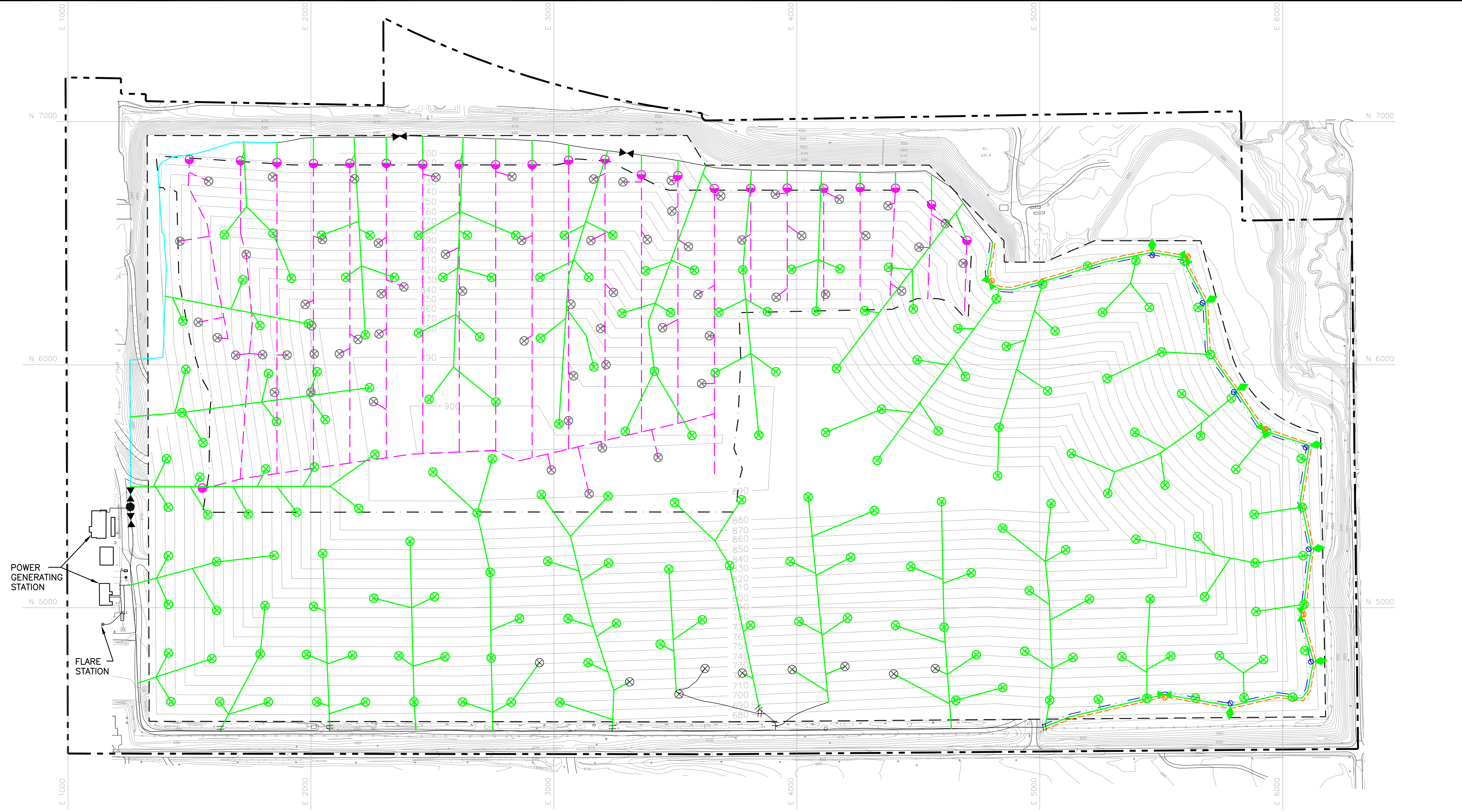
SITE MAP & SURVEY RECORD PLAN

SCALE	PROJECT NUMBER	SHEET	REV.
1" = 175'	OCFL-15-006-09	2	0

DATE 9/22/15

APPENDIX B

FUTURE GCCS COMPLETION PLAN AND DETAILS



0 200 400
SCALE IN FEET

LEGEND

(line symbol)	PERMIT BOUNDARY
(line symbol)	LIMIT OF WASTE
(line symbol)	OVERLINER BOUNDARY
(line symbol, 680)	EXISTING CONTOUR
(line symbol, 900)	FINAL COVER CONTOUR
(N 5000)	SITE GRID
⊗	EXISTING LFG EXTRACTION WELL
⊗	EXISTING LFG EXTRACTION WELL (TO BE CONVERTED TO HORIZONTAL CHIMNEY WELL)
(line symbol)	EXISTING LFG COLLECTION PIPING
⋈	EXISTING LFG ISOLATION VALVE
●	EXISTING LIFT STATION
⊩	EXISTING BLIND FLANGE
⊗	FUTURE LFG EXTRACTION WELL
(line symbol)	FUTURE LFG COLLECTION PIPING
◆	FUTURE CONDENSATE SUMP
⋈	FUTURE LFG ISOLATION VALVE
(symbol)	FUTURE HORIZONTAL COLLECTOR
(line symbol)	FUTURE AIR SUPPLY PIPING
(line symbol)	FUTURE CONDENSATE FORCEMAIN
⊘ ⊘	FUTURE AIR/FORCEMAIN VALVE
(line symbol)	EXISTING LFG COLLECTION PIPING (TO BE REPLACED, SEE NOTE 4)

NOTES:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY COOPER AERIAL SURVEYS, CO. FROM AERIAL PHOTOGRAPHY FLOWN MARCH 30, 2016.
2. THE FUTURE LFG SYSTEM COMPONENTS ARE APPROXIMATE. ACTUAL NUMBER, LOCATION, AND PIPING CONFIGURATION TO BE DETERMINED BASED ON FIELD CONDITIONS AT THE TIME OF INSTALLATION, SYSTEM PERFORMANCE DATA, AND AS DETERMINED NECESSARY BY A PROFESSIONAL ENGINEER.
3. FUTURE LFG SYSTEM COMPONENTS WILL BE INSTALLED IN PHASES AS NEEDED.
4. EXISTING LFG HEADER TO BE REPLACED WITH A LARGER HEADER AND/OR A PARALLEL HEADER TO BE INSTALLED ALONG WITH THE EXISTING HEADER IN THE FUTURE TO HANDLE THE ADDITIONAL GAS EXTRACTED BY THE GCCS THROUGH FACILITY CLOSURE.

☐ DRAFT
■ FOR PERMITTING PURPOSES ONLY
☐ APPROVED FOR CONSTRUCTION
☐ CLIENT APPROVAL BY: ______

PREPARED FOR:
OTTAWA COUNTY LANDFILL, INC

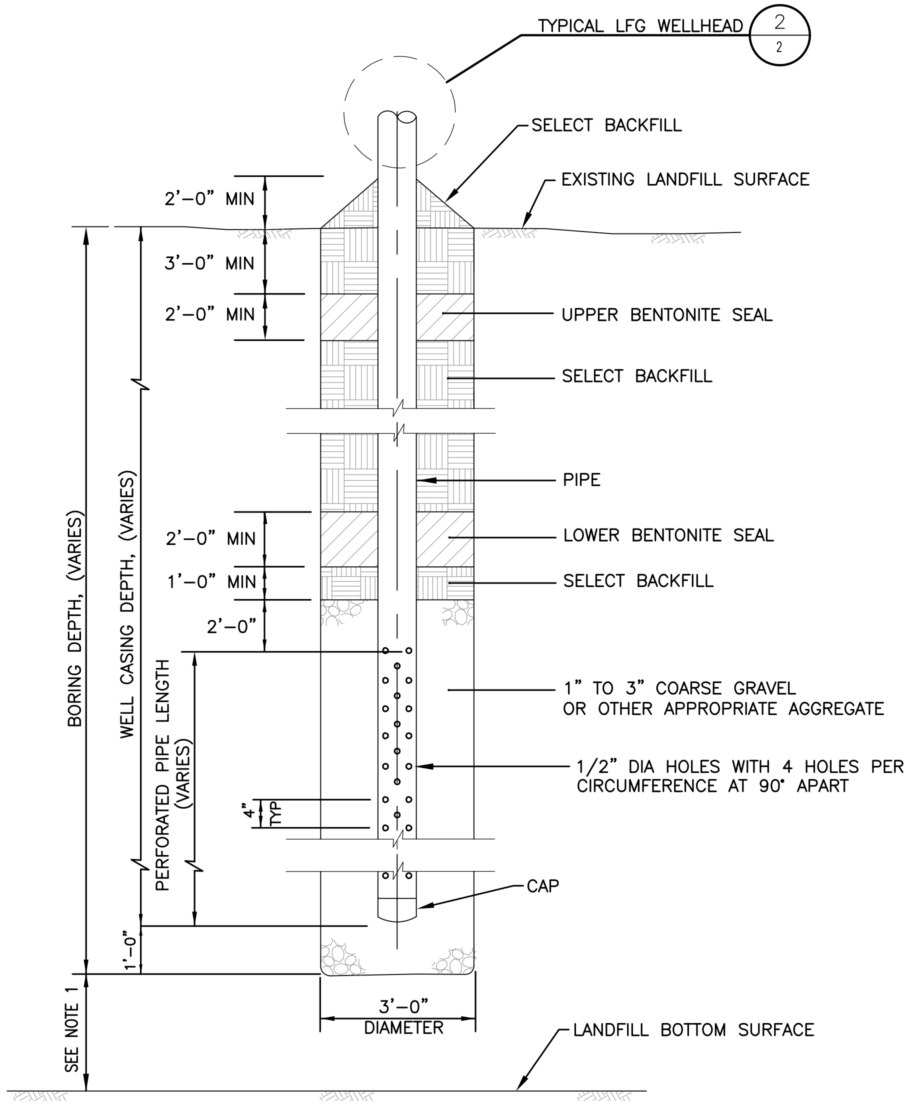
NSPS GCCS DESIGN PLAN
FUTURE GCCS COMPLETION PLAN
OTTAWA COUNTY FARMS LANDFILL
OTTAWA COUNTY, MICHIGAN

No.	DATE	REVISION DESCRIPTION

Weaver Consultants Group
WEAVER CONSULTANTS GROUP
400 ANN STREET N.W., SUITE 201A
GRAND RAPIDS, MICHIGAN 49504
(616) 458-8052
www.wcgrp.com

DRAWN BY:	VRS
REVIEWED BY:	MKS
DATE:	04/2016
FILE:	0120-685-11
CAD:	B-1 GCCS COMPLETION PLAN

DRAWING
B-1

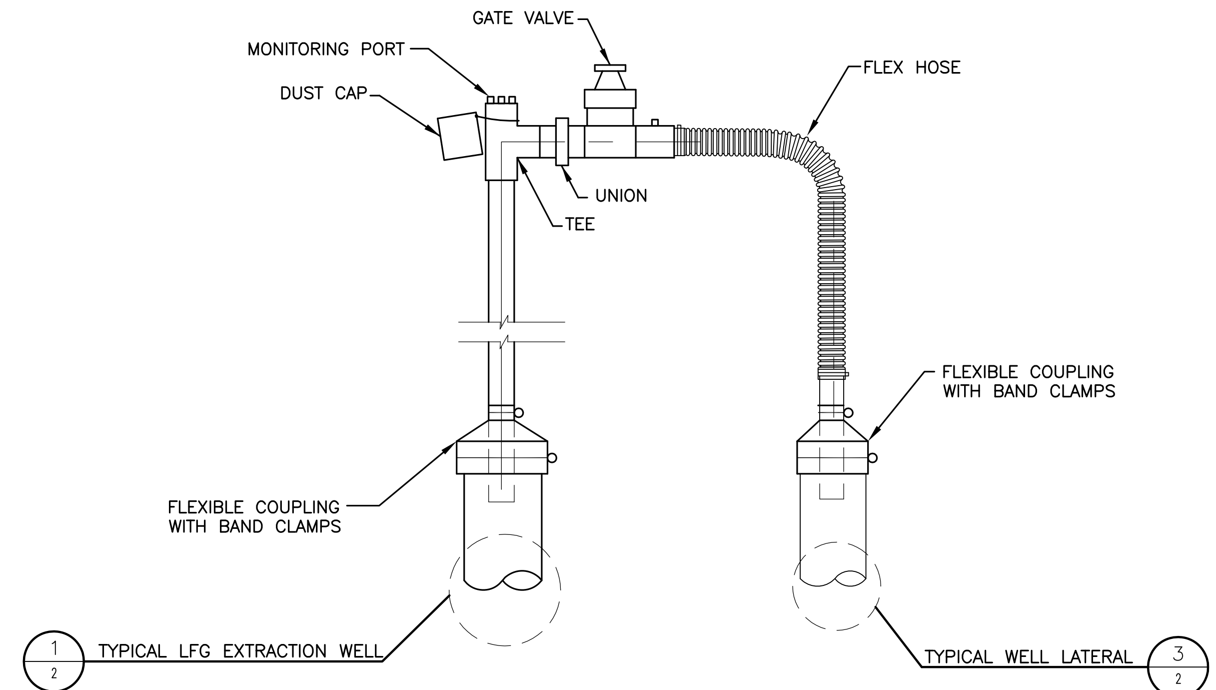


TYPICAL LFG EXTRACTION WELL (1/2)

NTS

NOTES:

1. BOTTOM OF BORE HOLE TO BE A MINIMUM OF 10 FT FROM LANDFILL REPORTED BOTTOM SURFACE. ALL DEPTHS WILL BE CONFIRMED PRIOR TO DRILLING.
2. ALL SIZES AND DIMENSIONS ARE APPROXIMATE.
3. THE DETAIL SHOWN ABOVE REPRESENTS THE PROPOSED TYPICAL DESIGN. HOWEVER, ANY MODIFICATIONS THAT ARE MADE WILL BE APPROVED BY A LICENSED ENGINEER AT THE TIME OF CONSTRUCTION.

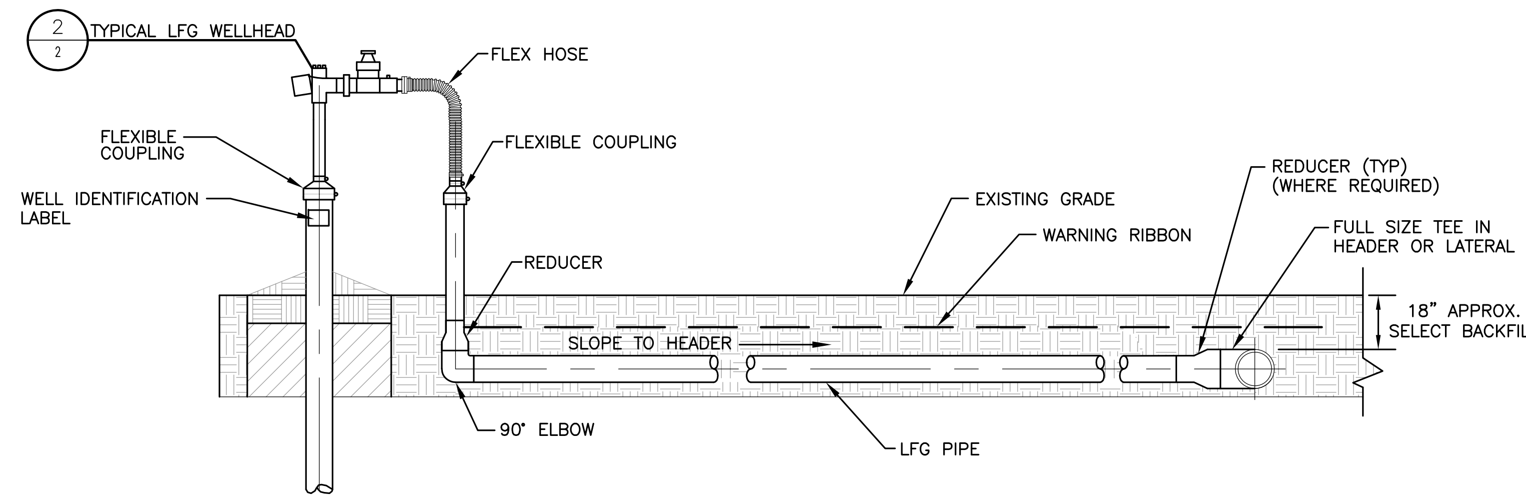


TYPICAL LFG WELLHEAD (2/2)

NTS

NOTES:

1. ALL SIZES AND DIMENSIONS ARE APPROXIMATE.
2. THE DETAIL SHOWN ABOVE REPRESENTS THE PROPOSED TYPICAL DESIGN. HOWEVER, ANY MODIFICATIONS THAT ARE MADE WILL BE APPROVED BY A LICENSED ENGINEER AT THE TIME OF CONSTRUCTION.



TYPICAL WELL LATERAL (3/2)

NTS

NOTES:

1. ALL SIZES AND DIMENSIONS ARE APPROXIMATE.
2. THE DETAIL SHOWN ABOVE REPRESENTS THE PROPOSED TYPICAL DESIGN. HOWEVER, ANY MODIFICATIONS THAT ARE MADE WILL BE APPROVED BY A LICENSED ENGINEER AT THE TIME OF CONSTRUCTION.

☐ DRAFT
■ FOR PERMITTING PURPOSES ONLY
☐ APPROVED FOR CONSTRUCTION
☐ CLIENT APPROVAL BY:

PREPARED FOR:
OTTAWA COUNTY LANDFILL, INC

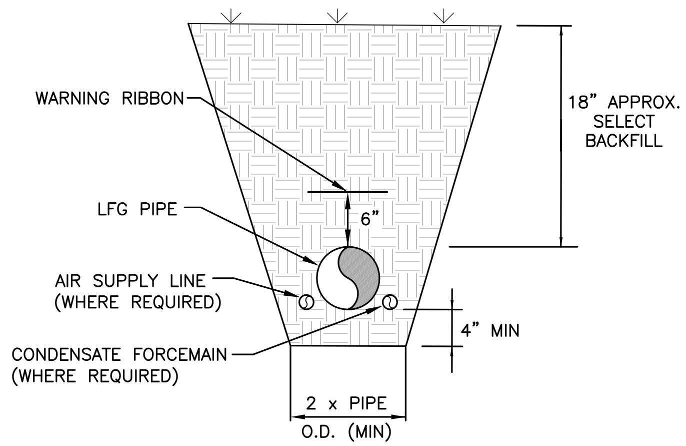
NSPS GCCS DESIGN PLAN
EXTRACTION WELL DETAILS
OTTAWA COUNTY FARMS LANDFILL
OTTAWA COUNTY, MICHIGAN

No.	DATE	REVISION DESCRIPTION

Weaver Consultants Group
WEAVER CONSULTANTS GROUP
400 ANN STREET N.W., SUITE 201A
GRAND RAPIDS, MICHIGAN 49504
(616) 458-8052
www.wcgrp.com

DRAWN BY:	VRS
REVIEWED BY:	MKS
DATE:	04/2016
FILE:	0120-685-11
CAD: B-2 DETAILS	

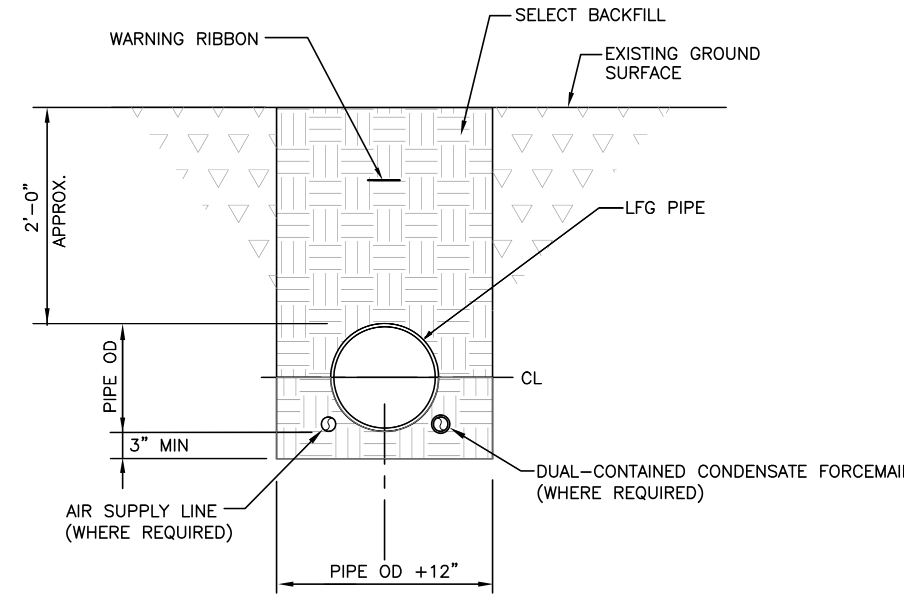
DRAWING
B-2



TYPICAL PIPE TRENCH (4/3)
(INSIDE LIMITS OF WASTE)
NTS

NOTES:

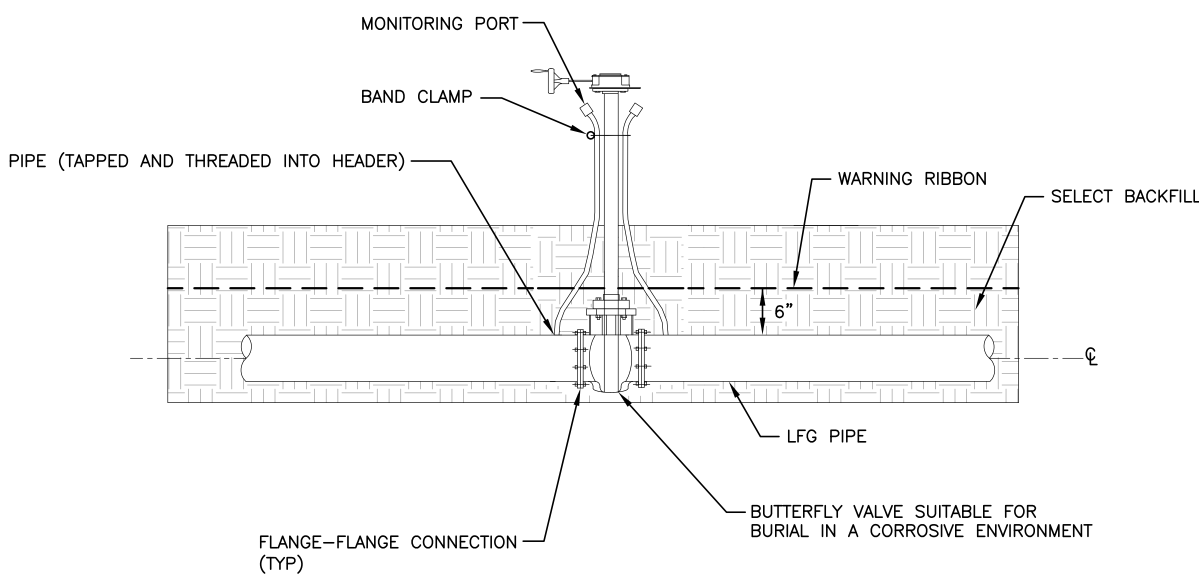
1. ALL SIZES AND DIMENSIONS ARE APPROXIMATE.
2. THE DETAIL SHOWN ABOVE REPRESENTS THE PROPOSED TYPICAL DESIGN. HOWEVER, ANY MODIFICATIONS THAT ARE MADE WILL BE APPROVED BY A LICENSED ENGINEER AT THE TIME OF CONSTRUCTION.



TYPICAL PIPE TRENCH (5/3)
(OUTSIDE LIMITS OF WASTE)
NTS

NOTES:

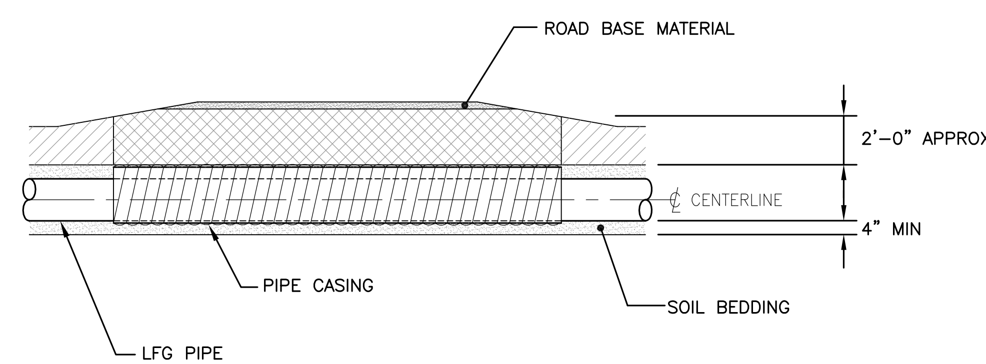
1. ALL SIZES AND DIMENSIONS ARE APPROXIMATE.
2. THE DETAIL SHOWN ABOVE REPRESENTS THE PROPOSED TYPICAL DESIGN. HOWEVER, ANY MODIFICATIONS THAT ARE MADE WILL BE APPROVED BY A LICENSED ENGINEER AT THE TIME OF CONSTRUCTION.



TYPICAL LFG ISOLATION VALVE (6/3)
NTS

NOTES:

1. ALL SIZES AND DIMENSIONS ARE APPROXIMATE.
2. THE DETAIL SHOWN ABOVE REPRESENTS THE PROPOSED TYPICAL DESIGN. HOWEVER, ANY MODIFICATIONS THAT ARE MADE WILL BE APPROVED BY A LICENSED ENGINEER AT THE TIME OF CONSTRUCTION.



TYPICAL ROAD CROSSING (7/3)
NTS

NOTE:

1. THE DETAIL SHOWN ABOVE REPRESENTS THE PROPOSED TYPICAL DESIGN. HOWEVER, ANY MODIFICATIONS THAT ARE MADE WILL BE APPROVED BY A LICENSED ENGINEER AT THE TIME OF CONSTRUCTION.

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PREPARED FOR:
OTTAWA COUNTY LANDFILL, INC

NSPS GCCS DESIGN PLAN
PIPING DETAILS
OTTAWA COUNTY FARMS LANDFILL
OTTAWA COUNTY, MICHIGAN

No.	DATE	REVISION DESCRIPTION

Weaver Consultants Group
WEAVER CONSULTANTS GROUP
400 ANN STREET N.W., SUITE 201A
GRAND RAPIDS, MICHIGAN 49504
(616) 458-8052
www.wcgrp.com

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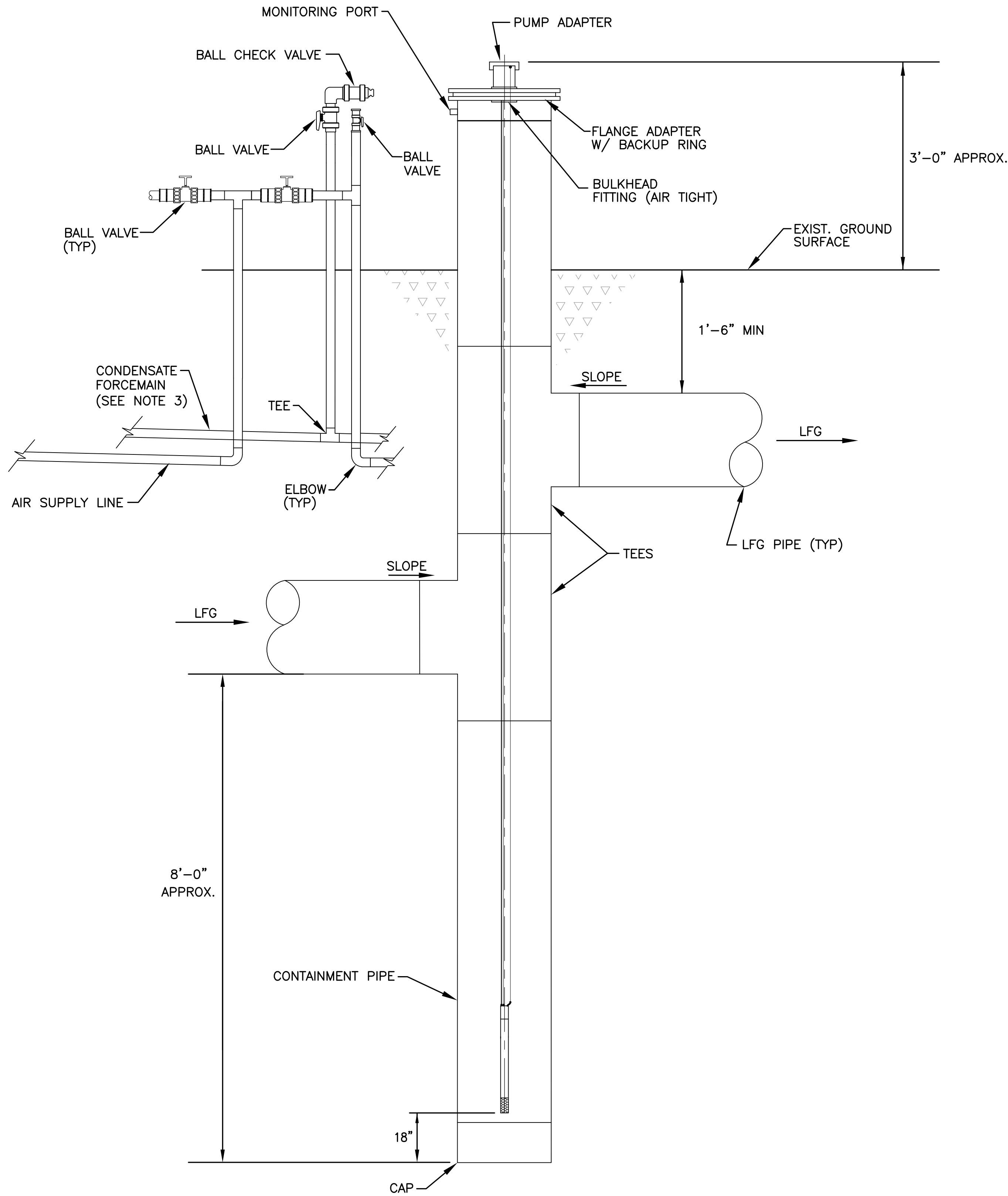
REVIEWED BY:	MKS
DATE:	04/2016
FILE:	0120-685-11
CAD: B-3 DETAILS	

DRAWING
B-3

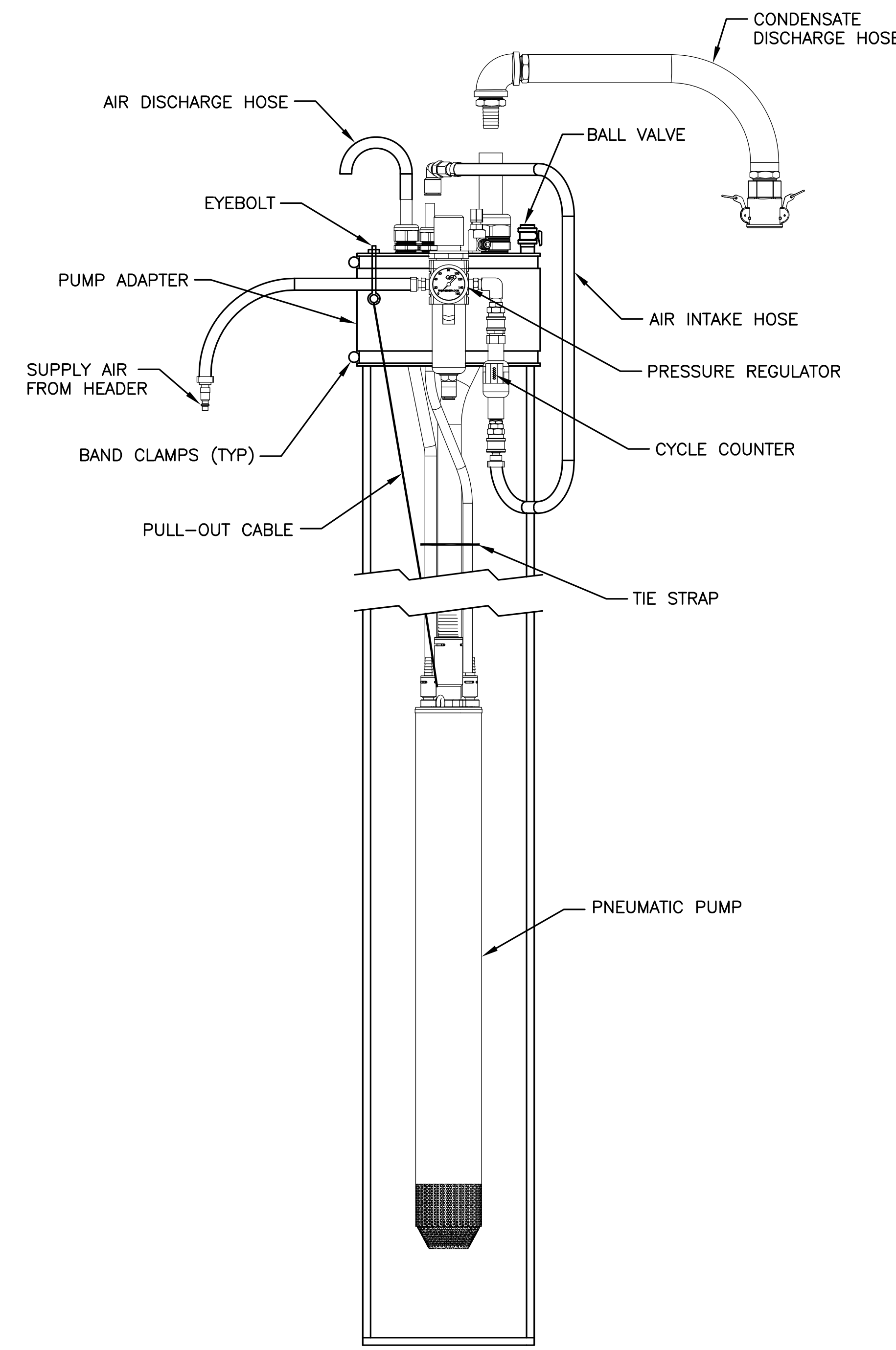


TYPICAL CONDENSATE SUMP (8/4)

NTS

NOTES:

1. PUMP HOSES ARE NOT SHOWN IN THIS VIEW.
2. ALL SIZES AND DIMENSIONS ARE APPROXIMATE.
3. DUAL–CONTAINED CONDENSATE FORCEMAIN TO BE INSTALLED OUTSIDE LIMITS OF WASTE.
4. THE DETAIL SHOWN ABOVE REPRESENTS THE PROPOSED TYPICAL DESIGN. HOWEVER, ANY MODIFICATIONS THAT ARE MADE WILL BE APPROVED BY A LICENSED ENGINEER AT THE TIME OF CONSTRUCTION.



TYPICAL PUMP DETAIL (9/4)

NTS

NOTE:

1. THE DETAIL SHOWN ABOVE REPRESENTS THE PROPOSED TYPICAL DESIGN. HOWEVER, ANY MODIFICATIONS THAT ARE MADE WILL BE APPROVED BY A LICENSED ENGINEER AT THE TIME OF CONSTRUCTION.

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NSPS GCCS DESIGN PLAN
CONDENSATE SUMP DETAILS
OTTAWA COUNTY FARMS LANDFILL
OTTAWA COUNTY, MICHIGAN

No.	DATE	REVISION DESCRIPTION

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REVIEWED BY:	MKS
DATE:	04/2016
FILE:	0120-685-11
CAD: B-4 DETAILS	

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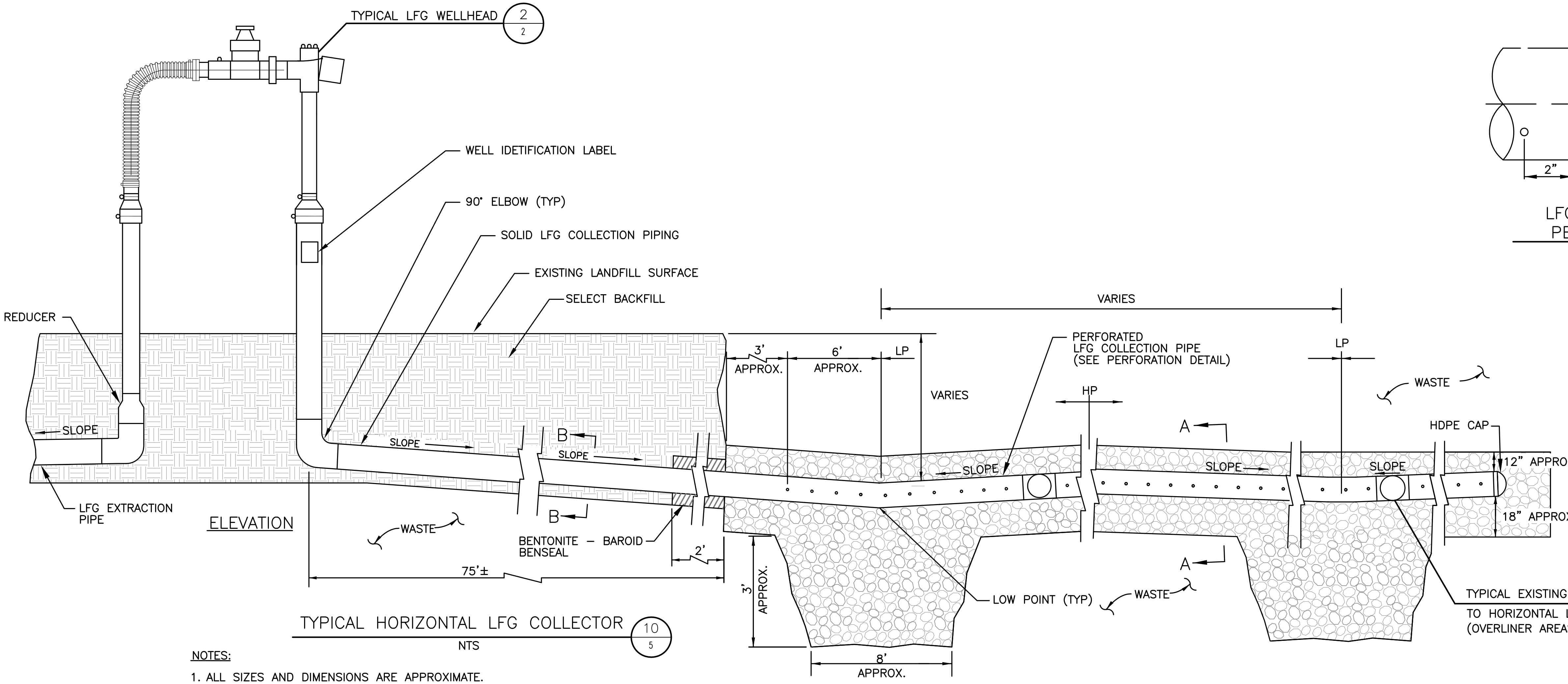
B-4

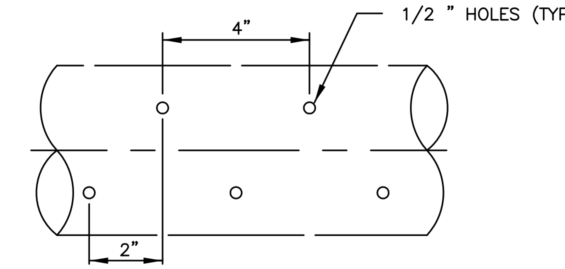


TYPICAL HORIZONTAL LFG COLLECTOR (10/5)

NTS

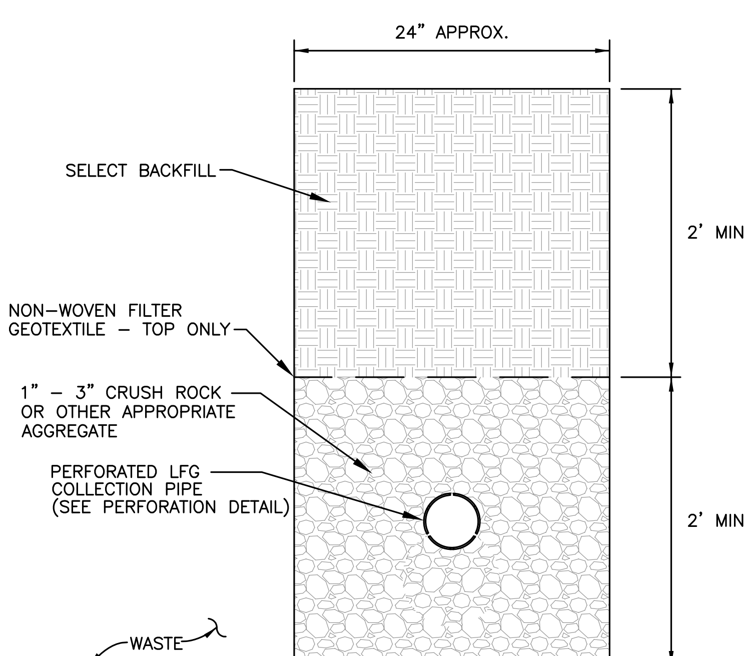
NOTES:

1. ALL SIZES AND DIMENSIONS ARE APPROXIMATE.
2. HORIZONTAL COLLECTORS MAY BE USED FOR INTERIM GAS CONTROL.
3. EXISTING GAS WELL TIE-IN TO HORIZONTAL LFG COLLECTOR ONLY APPLICABLE IN THE OVERLINER AREAS.
4. THE DETAIL SHOWN ABOVE REPRESENTS THE PROPOSED TYPICAL DESIGN. HOWEVER, ANY MODIFICATIONS THAT ARE MADE WILL BE APPROVED BY A LICENSED ENGINEER AT THE TIME OF CONSTRUCTION.



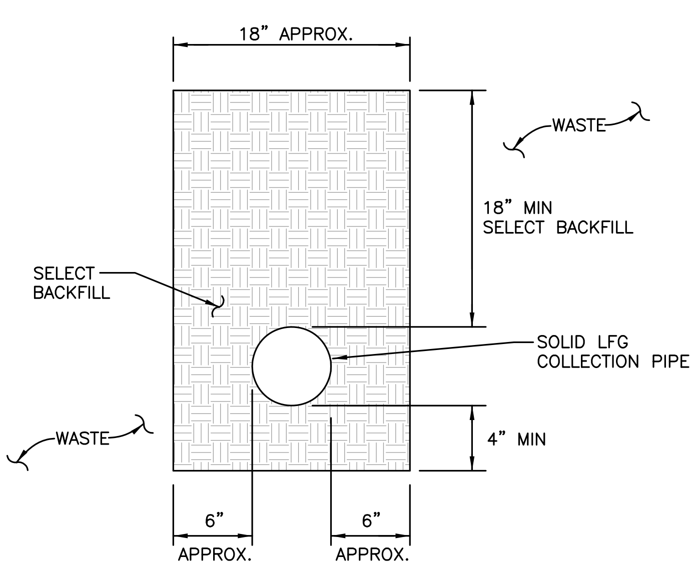
LFG COLLECTION PIPE PERFORATION DETAIL

NTS



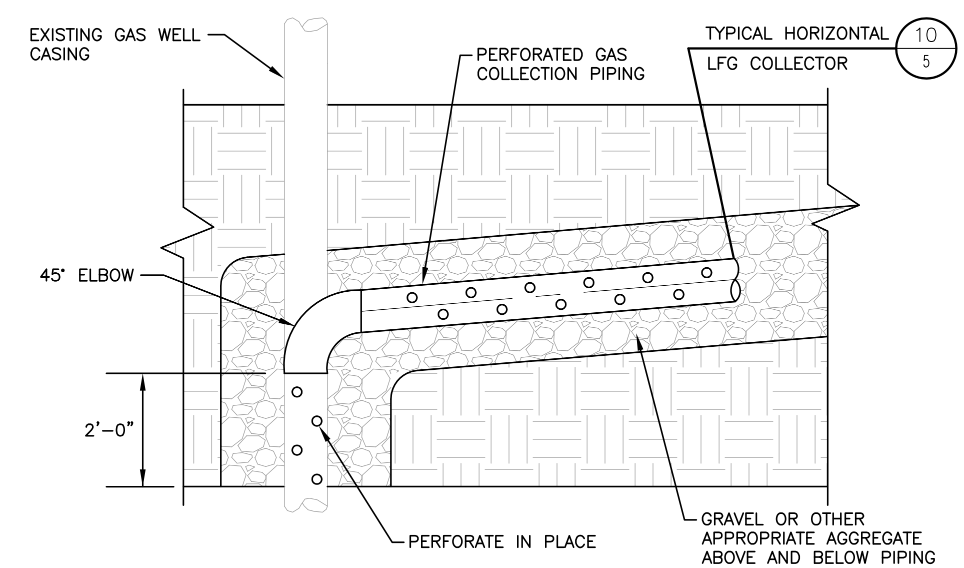
SECTION A–A

NTS



SECTION B–B

NTS



TYPICAL EXISTING WELL TIE-IN TO HORIZONTAL LFG COLLECTOR (11/5)

(OVERLINER AREAS)

NTS

NOTES:

1. ALL SIZES AND DIMENSIONS ARE APPROXIMATE.
2. THE DETAIL SHOWN ABOVE REPRESENTS THE PROPOSED TYPICAL DESIGN. HOWEVER, ANY MODIFICATIONS THAT ARE MADE WILL BE APPROVED BY A LICENSED ENGINEER AT THE TIME OF CONSTRUCTION.

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PREPARED FOR:
OTTAWA COUNTY LANDFILL, INC

NSPS GCCS DESIGN PLAN
HORIZONTAL LFG COLLECTOR DETAILS
OTTAWA COUNTY FARMS LANDFILL
OTTAWA COUNTY, MICHIGAN

No.	DATE	REVISION DESCRIPTION

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REVIEWED BY:	MKS
DATE:	04/2016
FILE:	0120-685-11
CAD: B-5 DETAILS	

DRAWING B-5

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APPENDIX C

LANDFILL GAS GENERATION RATE MODELING RESULTS

Estimated Landfill Gas Generation Rate
Ottawa County Farms Landfill

Year	Putrescible Waste Accepted (Mg/yr)	Putrescible Waste In-Place (Mg)	Landfill Gas Generation (scfm)		
			Run 1 (scfm)	Run 2 (scfm)	Combined (scfm)
1982	144,700	0	0	--	0
1983	179,000	144,700	76	--	76
1984	207,100	323,700	168	--	168
1985	224,100	530,800	271	--	271
1986	284,100	754,900	378	--	378
1987	281,000	1,039,000	514	--	514
1988	407,000	1,320,000	642	--	642
1989	457,000	1,727,000	831	--	831
1990	462,000	2,184,000	1,040	--	1,040
1991	439,000	2,646,000	1,243	--	1,243
1992	297,000	3,085,000	1,426	--	1,426
1993	281,000	3,382,000	1,527	--	1,527
1994	281,000	3,663,000	1,616	--	1,616
1995	328,000	3,944,000	1,701	--	1,701
1996	439,000	4,272,000	1,807	--	1,807
1997	530,000	4,711,000	1,968	--	1,968
1998	619,000	5,241,000	2,171	--	2,171
1999	576,000	5,860,000	2,412	--	2,412
2000	769,000	6,436,000	2,622	--	2,622
2001	893,000	7,205,000	2,925	--	2,925
2002	752,000	8,098,000	3,282	--	3,282
2003	834,000	8,850,000	3,550	--	3,550
2004	426,000	9,684,000	3,851	--	3,851
2005	500,665	10,110,000	3,925	--	3,925
2006	498,281	10,610,665	4,036	--	4,036
2007	290,221	11,108,946	4,141	--	4,141
2008	320,845	11,399,167	4,131	--	4,131
2009	228,969	11,720,012	4,139	--	4,139
2010	228,807	11,948,981	4,097	--	4,097
2011	250,764	12,177,788	4,058	--	4,058
2012	272,359	12,428,552	4,031	--	4,031
2013	228,386	12,700,911	4,017	--	4,017
2014	273,224	12,929,297	3,980	--	3,980
2015	238,109	13,202,521	3,968	--	3,968
2016	387,522	13,440,630	3,938	--	3,938
2017	387,522	13,828,152	3,988	--	3,988
2018	387,522	14,215,674	4,036	--	4,036
2019	387,522	14,603,196	4,083	--	4,083
2020	387,522	14,990,718	4,127	--	4,127
2021	387,522	15,378,240	4,170	--	4,170
2022	387,522	15,765,762	4,211	--	4,211
2023	387,522	16,153,284	4,251	--	4,251
2024	387,522	16,540,806	4,289	--	4,289
2025	387,522	16,928,328	4,325	--	4,325
2026	387,522	17,315,850	4,360	--	4,360
2027	387,522	17,703,372	4,394	--	4,394
2028	387,522	18,090,895	4,426	--	4,426

Estimated Landfill Gas Generation Rate
Ottawa County Farms Landfill

Year	Putrescible Waste Accepted (Mg/yr)	Putrescible Waste In-Place (Mg)	Landfill Gas Generation (scfm)		
			Run 1 (scfm)	Run 2 (scfm)	Combined (scfm)
2029	387,522	18,478,417	4,457	--	4,457
2030	387,522	18,865,939	4,487	--	4,487
2031	387,522	19,253,461	4,515	--	4,515
2032	387,522	19,640,983	4,543	--	4,543
2033	387,522	20,028,505	4,570	--	4,570
2034	387,522	20,416,027	4,595	--	4,595
2035	387,522	20,803,549	4,619	--	4,619
2036	387,522	21,191,071	4,643	--	4,643
2037	387,522	21,578,593	4,665	--	4,665
2038	387,522	21,966,115	4,687	--	4,687
2039	387,522	22,353,637	4,708	--	4,708
2040	387,522	22,741,159	4,728	--	4,728
2041	387,522	23,128,681	4,747	--	4,747
2042	387,522	23,516,203	4,766	--	4,766
2043	387,522	23,903,725	4,783	--	4,783
2044	387,522	24,291,247	4,800	--	4,800
2045	387,522	24,678,769	4,817	--	4,817
2046	387,522	25,066,291	4,832	--	4,832
2047	387,522	25,453,813	4,848	--	4,848
2048	387,522	25,841,335	4,862	--	4,862
2049	387,522	26,228,857	4,876	--	4,876
2050	387,522	26,616,380	4,889	--	4,889
2051	387,522	27,003,902	4,902	--	4,902
2052	387,522	27,391,424	4,915	--	4,915
2053	387,522	27,778,946	4,927	--	4,927
2054	387,522	28,166,468	4,938	--	4,938
2055	387,522	28,553,990	4,949	--	4,949
2056	387,522	28,941,512	4,960	--	4,960
2057	387,522	29,329,034	4,970	--	4,970
2058	387,522	29,716,556	4,979	--	4,979
2059	387,522	30,104,078	4,989	--	4,989
2060	387,522	30,491,600	4,998	--	4,998
2061	387,522	30,879,122	5,006	--	5,006
2062	387,522	31,266,644	5,015	0	5,015
2063	387,522	31,654,166	4,818	205	5,023
2064	387,522	32,041,688	4,629	401	5,030
2065	387,522	32,429,210	4,448	590	5,038
2066	387,522	32,816,732	4,273	772	5,045
2067	387,522	33,204,254	4,106	946	5,052
2068	387,522	33,591,776	3,945	1,113	5,058
2069	387,522	33,979,298	3,790	1,274	5,064
2070	387,522	34,366,820	3,641	1,429	5,070
2071	387,522	34,754,342	3,499	1,578	5,076
2072	387,522	35,141,864	3,361	1,720	5,082
2073	387,522	35,529,387	3,230	1,857	5,087
2074	387,522	35,916,909	3,103	1,989	5,092
2075	387,522	36,304,431	2,981	2,116	5,097

Estimated Landfill Gas Generation Rate
Ottawa County Farms Landfill

Year	Putrescible Waste Accepted (Mg/yr)	Putrescible Waste In-Place (Mg)	Landfill Gas Generation (scfm)		
			Run 1 (scfm)	Run 2 (scfm)	Combined (scfm)
2076	387,522	36,691,953	2,864	2,237	5,102
2077	387,522	37,079,475	2,752	2,354	5,106
2078	387,522	37,466,997	2,644	2,467	5,111
2079	387,522	37,854,519	2,541	2,574	5,115
2080	387,522	38,242,041	2,441	2,678	5,119
2081	387,522	38,629,563	2,345	2,778	5,123
2082	**172,501**	**39,017,085**	**2,253**	**2,873**	**5,127**
2083	--	39,189,586	2,165	2,852	5,017
2084	--	39,189,586	2,080	2,740	4,820
2085	--	39,189,586	1,998	2,633	4,631

Summary Report

Landfill Name or Identifier: Ottawa County Farms Landfill - Run 1

Date: Friday, April 15, 2016

Description/Comments:

Waste design capacity and this model only accounts for putrescible portion of waste.

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

The 80-year waste acceptance limit of the model has been exceeded before the Waste Design Capacity was reached. The model will assume the 80th year of waste acceptance as the final year to estimate emissions. See Section 2.6 of the User's Manual.

LANDFILL CHARACTERISTICS

Landfill Open Year	**1982**	
Landfill Closure Year (with 80-year limit)	**2061**	
Actual Closure Year (without limit)	***2062***	
Have Model Calculate Closure Year?	**Yes**	
Waste Design Capacity	**31,266,644**	*megagrams*

MODEL PARAMETERS

Methane Generation Rate, k	**0.040**	*$year^{-1}$*
Potential Methane Generation Capacity, L_o	**100**	*m^3/Mg*
NMOC Concentration	**407**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	
Gas / Pollutant #4:	

WASTE ACCEPTANCE RATES

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
1982	144,700	159,170	0	0
1983	179,000	196,900	144,700	159,170
1984	207,100	227,810	323,700	356,070
1985	224,100	246,510	530,800	583,880
1986	284,100	312,510	754,900	830,390
1987	281,000	309,100	1,039,000	1,142,900
1988	407,000	447,700	1,320,000	1,452,000
1989	457,000	502,700	1,727,000	1,899,700
1990	462,000	508,200	2,184,000	2,402,400
1991	439,000	482,900	2,646,000	2,910,600
1992	297,000	326,700	3,085,000	3,393,500
1993	281,000	309,100	3,382,000	3,720,200
1994	281,000	309,100	3,663,000	4,029,300
1995	328,000	360,800	3,944,000	4,338,400
1996	439,000	482,900	4,272,000	4,699,200
1997	530,000	583,000	4,711,000	5,182,100
1998	619,000	680,900	5,241,000	5,765,100
1999	576,000	633,600	5,860,000	6,446,000
2000	769,000	845,900	6,436,000	7,079,600
2001	893,000	982,300	7,205,000	7,925,500
2002	752,000	827,200	8,098,000	8,907,800
2003	834,000	917,400	8,850,000	9,735,000
2004	426,000	468,600	9,684,000	10,652,400
2005	500,665	550,732	10,110,000	11,121,000
2006	498,281	548,109	10,610,665	11,671,732
2007	290,221	319,243	11,108,946	12,219,841
2008	320,845	352,930	11,399,167	12,539,084
2009	228,969	251,866	11,720,012	12,892,013
2010	228,807	251,688	11,948,981	13,143,879
2011	250,764	275,840	12,177,788	13,395,567
2012	272,359	299,595	12,428,552	13,671,407
2013	228,386	251,225	12,700,911	13,971,002
2014	273,224	300,546	12,929,297	14,222,227
2015	238,109	261,920	13,202,521	14,522,773
2016	387,522	426,274	13,440,630	14,784,693
2017	387,522	426,274	13,828,152	15,210,967
2018	387,522	426,274	14,215,674	15,637,241
2019	387,522	426,274	14,603,196	16,063,516
2020	387,522	426,274	14,990,718	16,489,790
2021	387,522	426,274	15,378,240	16,916,064

WASTE ACCEPTANCE RATES (Continued)

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	***(short tons/year)***	***(Mg)***	***(short tons)***
2022	387,522	426,274	15,765,762	17,342,338
2023	387,522	426,274	16,153,284	17,768,613
2024	387,522	426,274	16,540,806	18,194,887
2025	387,522	426,274	16,928,328	18,621,161
2026	387,522	426,274	17,315,850	19,047,435
2027	387,522	426,274	17,703,372	19,473,710
2028	387,522	426,274	18,090,895	19,899,984
2029	387,522	426,274	18,478,417	20,326,258
2030	387,522	426,274	18,865,939	20,752,532
2031	387,522	426,274	19,253,461	21,178,807
2032	387,522	426,274	19,640,983	21,605,081
2033	387,522	426,274	20,028,505	22,031,355
2034	387,522	426,274	20,416,027	22,457,629
2035	387,522	426,274	20,803,549	22,883,904
2036	387,522	426,274	21,191,071	23,310,178
2037	387,522	426,274	21,578,593	23,736,452
2038	387,522	426,274	21,966,115	24,162,726
2039	387,522	426,274	22,353,637	24,589,001
2040	387,522	426,274	22,741,159	25,015,275
2041	387,522	426,274	23,128,681	25,441,549
2042	387,522	426,274	23,516,203	25,867,823
2043	387,522	426,274	23,903,725	26,294,098
2044	387,522	426,274	24,291,247	26,720,372
2045	387,522	426,274	24,678,769	27,146,646
2046	387,522	426,274	25,066,291	27,572,920
2047	387,522	426,274	25,453,813	27,999,195
2048	387,522	426,274	25,841,335	28,425,469
2049	387,522	426,274	26,228,857	28,851,743
2050	387,522	426,274	26,616,380	29,278,017
2051	387,522	426,274	27,003,902	29,704,292
2052	387,522	426,274	27,391,424	30,130,566
2053	387,522	426,274	27,778,946	30,556,840
2054	387,522	426,274	28,166,468	30,983,114
2055	387,522	426,274	28,553,990	31,409,389
2056	387,522	426,274	28,941,512	31,835,663
2057	387,522	426,274	29,329,034	32,261,937
2058	387,522	426,274	29,716,556	32,688,211
2059	387,522	426,274	30,104,078	33,114,486
2060	387,522	426,274	30,491,600	33,540,760
2061	387,522	426,274	30,879,122	33,967,034

Results

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1982	0	0	0	0	0	0
1983	1.420E+03	1.137E+06	7.640E+01	3.793E+02	5.685E+05	3.820E+01
1984	3.121E+03	2.499E+06	1.679E+02	8.336E+02	1.249E+06	8.395E+01
1985	5.031E+03	4.028E+06	2.707E+02	1.344E+03	2.014E+06	1.353E+02
1986	7.033E+03	5.631E+06	3.784E+02	1.878E+03	2.816E+06	1.892E+02
1987	9.545E+03	7.643E+06	5.135E+02	2.549E+03	3.821E+06	2.568E+02
1988	1.193E+04	9.551E+06	6.417E+02	3.186E+03	4.776E+06	3.209E+02
1989	1.545E+04	1.237E+07	8.315E+02	4.128E+03	6.187E+06	4.157E+02
1990	1.933E+04	1.548E+07	1.040E+03	5.164E+03	7.740E+06	5.201E+02
1991	2.311E+04	1.850E+07	1.243E+03	6.172E+03	9.252E+06	6.216E+02
1992	2.651E+04	2.123E+07	1.426E+03	7.081E+03	1.061E+07	7.132E+02
1993	2.839E+04	2.273E+07	1.527E+03	7.582E+03	1.136E+07	7.636E+02
1994	3.003E+04	2.405E+07	1.616E+03	8.021E+03	1.202E+07	8.078E+02
1995	3.161E+04	2.531E+07	1.701E+03	8.443E+03	1.266E+07	8.503E+02
1996	3.359E+04	2.690E+07	1.807E+03	8.972E+03	1.345E+07	9.036E+02
1997	3.658E+04	2.929E+07	1.968E+03	9.771E+03	1.465E+07	9.840E+02
1998	4.035E+04	3.231E+07	2.171E+03	1.078E+04	1.615E+07	1.085E+03
1999	4.484E+04	3.590E+07	2.412E+03	1.198E+04	1.795E+07	1.206E+03
2000	4.873E+04	3.902E+07	2.622E+03	1.302E+04	1.951E+07	1.311E+03
2001	5.437E+04	4.354E+07	2.925E+03	1.452E+04	2.177E+07	1.463E+03
2002	6.100E+04	4.885E+07	3.282E+03	1.629E+04	2.442E+07	1.641E+03
2003	6.599E+04	5.284E+07	3.550E+03	1.763E+04	2.642E+07	1.775E+03
2004	7.158E+04	5.732E+07	3.851E+03	1.912E+04	2.866E+07	1.926E+03
2005	7.296E+04	5.842E+07	3.925E+03	1.949E+04	2.921E+07	1.963E+03
2006	7.501E+04	6.006E+07	4.036E+03	2.004E+04	3.003E+07	2.018E+03
2007	7.696E+04	6.162E+07	4.141E+03	2.056E+04	3.081E+07	2.070E+03
2008	7.679E+04	6.149E+07	4.131E+03	2.051E+04	3.074E+07	2.066E+03
2009	7.693E+04	6.160E+07	4.139E+03	2.055E+04	3.080E+07	2.069E+03
2010	7.616E+04	6.098E+07	4.097E+03	2.034E+04	3.049E+07	2.049E+03
2011	7.542E+04	6.039E+07	4.058E+03	2.014E+04	3.019E+07	2.029E+03
2012	7.492E+04	5.999E+07	4.031E+03	2.001E+04	3.000E+07	2.015E+03
2013	7.465E+04	5.978E+07	4.017E+03	1.994E+04	2.989E+07	2.008E+03
2014	7.397E+04	5.923E+07	3.980E+03	1.976E+04	2.962E+07	1.990E+03
2015	7.375E+04	5.905E+07	3.968E+03	1.970E+04	2.953E+07	1.984E+03
2016	7.319E+04	5.861E+07	3.938E+03	1.955E+04	2.931E+07	1.969E+03
2017	7.413E+04	5.936E+07	3.988E+03	1.980E+04	2.968E+07	1.994E+03
2018	7.502E+04	6.007E+07	4.036E+03	2.004E+04	3.004E+07	2.018E+03
2019	7.588E+04	6.076E+07	4.083E+03	2.027E+04	3.038E+07	2.041E+03
2020	7.671E+04	6.143E+07	4.127E+03	2.049E+04	3.071E+07	2.064E+03
2021	7.751E+04	6.206E+07	4.170E+03	2.070E+04	3.103E+07	2.085E+03
2022	7.827E+04	6.267E+07	4.211E+03	2.091E+04	3.134E+07	2.106E+03
2023	7.900E+04	6.326E+07	4.251E+03	2.110E+04	3.163E+07	2.125E+03
2024	7.971E+04	6.383E+07	4.289E+03	2.129E+04	3.191E+07	2.144E+03
2025	8.039E+04	6.437E+07	4.325E+03	2.147E+04	3.218E+07	2.162E+03
2026	8.104E+04	6.489E+07	4.360E+03	2.165E+04	3.245E+07	2.180E+03
2027	8.166E+04	6.539E+07	4.394E+03	2.181E+04	3.270E+07	2.197E+03
2028	8.226E+04	6.587E+07	4.426E+03	2.197E+04	3.294E+07	2.213E+03
2029	8.284E+04	6.633E+07	4.457E+03	2.213E+04	3.317E+07	2.228E+03
2030	8.339E+04	6.678E+07	4.487E+03	2.228E+04	3.339E+07	2.243E+03
2031	8.393E+04	6.721E+07	4.515E+03	2.242E+04	3.360E+07	2.258E+03

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)*
2032	8.444E+04	6.761E+07	4.543E+03	2.255E+04	3.381E+07	2.272E+03
2033	8.493E+04	6.801E+07	4.570E+03	2.269E+04	3.400E+07	2.285E+03
2034	8.540E+04	6.839E+07	4.595E+03	2.281E+04	3.419E+07	2.297E+03
2035	8.586E+04	6.875E+07	4.619E+03	2.293E+04	3.438E+07	2.310E+03
2036	8.629E+04	6.910E+07	4.643E+03	2.305E+04	3.455E+07	2.321E+03
2037	8.671E+04	6.944E+07	4.665E+03	2.316E+04	3.472E+07	2.333E+03
2038	8.712E+04	6.976E+07	4.687E+03	2.327E+04	3.488E+07	2.344E+03
2039	8.750E+04	7.007E+07	4.708E+03	2.337E+04	3.503E+07	2.354E+03
2040	8.787E+04	7.037E+07	4.728E+03	2.347E+04	3.518E+07	2.364E+03
2041	8.823E+04	7.065E+07	4.747E+03	2.357E+04	3.533E+07	2.374E+03
2042	8.857E+04	7.093E+07	4.766E+03	2.366E+04	3.546E+07	2.383E+03
2043	8.890E+04	7.119E+07	4.783E+03	2.375E+04	3.560E+07	2.392E+03
2044	8.922E+04	7.144E+07	4.800E+03	2.383E+04	3.572E+07	2.400E+03
2045	8.953E+04	7.169E+07	4.817E+03	2.391E+04	3.584E+07	2.408E+03
2046	8.982E+04	7.192E+07	4.832E+03	2.399E+04	3.596E+07	2.416E+03
2047	9.010E+04	7.215E+07	4.848E+03	2.407E+04	3.607E+07	2.424E+03
2048	9.037E+04	7.236E+07	4.862E+03	2.414E+04	3.618E+07	2.431E+03
2049	9.063E+04	7.257E+07	4.876E+03	2.421E+04	3.629E+07	2.438E+03
2050	9.088E+04	7.277E+07	4.889E+03	2.427E+04	3.639E+07	2.445E+03
2051	9.112E+04	7.296E+07	4.902E+03	2.434E+04	3.648E+07	2.451E+03
2052	9.135E+04	7.315E+07	4.915E+03	2.440E+04	3.657E+07	2.457E+03
2053	9.157E+04	7.332E+07	4.927E+03	2.446E+04	3.666E+07	2.463E+03
2054	9.178E+04	7.349E+07	4.938E+03	2.452E+04	3.675E+07	2.469E+03
2055	9.198E+04	7.366E+07	4.949E+03	2.457E+04	3.683E+07	2.474E+03
2056	9.218E+04	7.381E+07	4.960E+03	2.462E+04	3.691E+07	2.480E+03
2057	9.237E+04	7.396E+07	4.970E+03	2.467E+04	3.698E+07	2.485E+03
2058	9.255E+04	7.411E+07	4.979E+03	2.472E+04	3.705E+07	2.490E+03
2059	9.272E+04	7.425E+07	4.989E+03	2.477E+04	3.712E+07	2.494E+03
2060	9.289E+04	7.438E+07	4.998E+03	2.481E+04	3.719E+07	2.499E+03
2061	9.305E+04	7.451E+07	5.006E+03	2.485E+04	3.726E+07	2.503E+03
2062	9.320E+04	7.463E+07	5.015E+03	2.490E+04	3.732E+07	2.507E+03
2063	8.955E+04	7.171E+07	4.818E+03	2.392E+04	3.585E+07	2.409E+03
2064	8.604E+04	6.890E+07	4.629E+03	2.298E+04	3.445E+07	2.315E+03
2065	8.267E+04	6.619E+07	4.448E+03	2.208E+04	3.310E+07	2.224E+03
2066	7.942E+04	6.360E+07	4.273E+03	2.121E+04	3.180E+07	2.137E+03
2067	7.631E+04	6.111E+07	4.106E+03	2.038E+04	3.055E+07	2.053E+03
2068	7.332E+04	5.871E+07	3.945E+03	1.958E+04	2.935E+07	1.972E+03
2069	7.044E+04	5.641E+07	3.790E+03	1.882E+04	2.820E+07	1.895E+03
2070	6.768E+04	5.420E+07	3.641E+03	1.808E+04	2.710E+07	1.821E+03
2071	6.503E+04	5.207E+07	3.499E+03	1.737E+04	2.604E+07	1.749E+03
2072	6.248E+04	5.003E+07	3.361E+03	1.669E+04	2.501E+07	1.681E+03
2073	6.003E+04	4.807E+07	3.230E+03	1.603E+04	2.403E+07	1.615E+03
2074	5.767E+04	4.618E+07	3.103E+03	1.541E+04	2.309E+07	1.551E+03
2075	5.541E+04	4.437E+07	2.981E+03	1.480E+04	2.219E+07	1.491E+03
2076	5.324E+04	4.263E+07	2.864E+03	1.422E+04	2.132E+07	1.432E+03
2077	5.115E+04	4.096E+07	2.752E+03	1.366E+04	2.048E+07	1.376E+03
2078	4.915E+04	3.935E+07	2.644E+03	1.313E+04	1.968E+07	1.322E+03
2079	4.722E+04	3.781E+07	2.541E+03	1.261E+04	1.891E+07	1.270E+03
2080	4.537E+04	3.633E+07	2.441E+03	1.212E+04	1.816E+07	1.220E+03
2081	4.359E+04	3.490E+07	2.345E+03	1.164E+04	1.745E+07	1.173E+03
2082	4.188E+04	3.354E+07	2.253E+03	1.119E+04	1.677E+07	1.127E+03

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)
2083	4.024E+04	3.222E+07	2.165E+03	1.075E+04	1.611E+07	1.082E+03
2084	3.866E+04	3.096E+07	2.080E+03	1.033E+04	1.548E+07	1.040E+03
2085	3.714E+04	2.974E+07	1.998E+03	9.922E+03	1.487E+07	9.992E+02
2086	3.569E+04	2.858E+07	1.920E+03	9.533E+03	1.429E+07	9.600E+02
2087	3.429E+04	2.746E+07	1.845E+03	9.159E+03	1.373E+07	9.224E+02
2088	3.294E+04	2.638E+07	1.772E+03	8.800E+03	1.319E+07	8.862E+02
2089	3.165E+04	2.535E+07	1.703E+03	8.455E+03	1.267E+07	8.515E+02
2090	3.041E+04	2.435E+07	1.636E+03	8.123E+03	1.218E+07	8.181E+02
2091	2.922E+04	2.340E+07	1.572E+03	7.805E+03	1.170E+07	7.860E+02
2092	2.807E+04	2.248E+07	1.510E+03	7.499E+03	1.124E+07	7.552E+02
2093	2.697E+04	2.160E+07	1.451E+03	7.205E+03	1.080E+07	7.256E+02
2094	2.591E+04	2.075E+07	1.394E+03	6.922E+03	1.038E+07	6.971E+02
2095	2.490E+04	1.994E+07	1.340E+03	6.651E+03	9.969E+06	6.698E+02
2096	2.392E+04	1.916E+07	1.287E+03	6.390E+03	9.578E+06	6.435E+02
2097	2.298E+04	1.840E+07	1.237E+03	6.139E+03	9.202E+06	6.183E+02
2098	2.208E+04	1.768E+07	1.188E+03	5.899E+03	8.841E+06	5.941E+02
2099	2.122E+04	1.699E+07	1.142E+03	5.667E+03	8.495E+06	5.708E+02
2100	2.039E+04	1.632E+07	1.097E+03	5.445E+03	8.162E+06	5.484E+02
2101	1.959E+04	1.568E+07	1.054E+03	5.232E+03	7.842E+06	5.269E+02
2102	1.882E+04	1.507E+07	1.012E+03	5.026E+03	7.534E+06	5.062E+02
2103	1.808E+04	1.448E+07	9.727E+02	4.829E+03	7.239E+06	4.864E+02
2104	1.737E+04	1.391E+07	9.346E+02	4.640E+03	6.955E+06	4.673E+02
2105	1.669E+04	1.336E+07	8.980E+02	4.458E+03	6.682E+06	4.490E+02
2106	1.604E+04	1.284E+07	8.627E+02	4.283E+03	6.420E+06	4.314E+02
2107	1.541E+04	1.234E+07	8.289E+02	4.115E+03	6.168E+06	4.145E+02
2108	1.480E+04	1.185E+07	7.964E+02	3.954E+03	5.927E+06	3.982E+02
2109	1.422E+04	1.139E+07	7.652E+02	3.799E+03	5.694E+06	3.826E+02
2110	1.366E+04	1.094E+07	7.352E+02	3.650E+03	5.471E+06	3.676E+02
2111	1.313E+04	1.051E+07	7.064E+02	3.507E+03	5.256E+06	3.532E+02
2112	1.261E+04	1.010E+07	6.787E+02	3.369E+03	5.050E+06	3.393E+02
2113	1.212E+04	9.705E+06	6.520E+02	3.237E+03	4.852E+06	3.260E+02
2114	1.164E+04	9.324E+06	6.265E+02	3.110E+03	4.662E+06	3.132E+02
2115	1.119E+04	8.958E+06	6.019E+02	2.988E+03	4.479E+06	3.010E+02
2116	1.075E+04	8.607E+06	5.783E+02	2.871E+03	4.304E+06	2.892E+02
2117	1.033E+04	8.270E+06	5.556E+02	2.759E+03	4.135E+06	2.778E+02
2118	9.922E+03	7.945E+06	5.339E+02	2.650E+03	3.973E+06	2.669E+02
2119	9.533E+03	7.634E+06	5.129E+02	2.546E+03	3.817E+06	2.565E+02
2120	9.160E+03	7.335E+06	4.928E+02	2.447E+03	3.667E+06	2.464E+02
2121	8.800E+03	7.047E+06	4.735E+02	2.351E+03	3.523E+06	2.367E+02
2122	8.455E+03	6.771E+06	4.549E+02	2.259E+03	3.385E+06	2.275E+02

Summary Report

Landfill Name or Identifier: Ottawa County Farms Landfill - Run 1

Date: Friday, April 15, 2016

Description/Comments:

Waste design capacity and this model only accounts for putrescible portion of waste.

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

The 80-year waste acceptance limit of the model has been exceeded before the Waste Design Capacity was reached. The model will assume the 80th year of waste acceptance as the final year to estimate emissions. See Section 2.6 of the User's Manual.

LANDFILL CHARACTERISTICS

Landfill Open Year	**1982**	
Landfill Closure Year (with 80-year limit)	**2061**	
Actual Closure Year (without limit)	***2062***	
Have Model Calculate Closure Year?	**Yes**	
Waste Design Capacity	**31,266,644**	*megagrams*

MODEL PARAMETERS

Methane Generation Rate, k	**0.040**	*year $^{-1}$*
Potential Methane Generation Capacity, L_o	**100**	*m^3/Mg*
NMOC Concentration	**407**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

Gas / Pollutant #1:	**Total landfill gas**
Gas / Pollutant #2:	**Methane**
Gas / Pollutant #3:	
Gas / Pollutant #4:	

WASTE ACCEPTANCE RATES

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
1982	144,700	159,170	0	0
1983	179,000	196,900	144,700	159,170
1984	207,100	227,810	323,700	356,070
1985	224,100	246,510	530,800	583,880
1986	284,100	312,510	754,900	830,390
1987	281,000	309,100	1,039,000	1,142,900
1988	407,000	447,700	1,320,000	1,452,000
1989	457,000	502,700	1,727,000	1,899,700
1990	462,000	508,200	2,184,000	2,402,400
1991	439,000	482,900	2,646,000	2,910,600
1992	297,000	326,700	3,085,000	3,393,500
1993	281,000	309,100	3,382,000	3,720,200
1994	281,000	309,100	3,663,000	4,029,300
1995	328,000	360,800	3,944,000	4,338,400
1996	439,000	482,900	4,272,000	4,699,200
1997	530,000	583,000	4,711,000	5,182,100
1998	619,000	680,900	5,241,000	5,765,100
1999	576,000	633,600	5,860,000	6,446,000
2000	769,000	845,900	6,436,000	7,079,600
2001	893,000	982,300	7,205,000	7,925,500
2002	752,000	827,200	8,098,000	8,907,800
2003	834,000	917,400	8,850,000	9,735,000
2004	426,000	468,600	9,684,000	10,652,400
2005	500,665	550,732	10,110,000	11,121,000
2006	498,281	548,109	10,610,665	11,671,732
2007	290,221	319,243	11,108,946	12,219,841
2008	320,845	352,930	11,399,167	12,539,084
2009	228,969	251,866	11,720,012	12,892,013
2010	228,807	251,688	11,948,981	13,143,879
2011	250,764	275,840	12,177,788	13,395,567
2012	272,359	299,595	12,428,552	13,671,407
2013	228,386	251,225	12,700,911	13,971,002
2014	273,224	300,546	12,929,297	14,222,227
2015	238,109	261,920	13,202,521	14,522,773
2016	387,522	426,274	13,440,630	14,784,693
2017	387,522	426,274	13,828,152	15,210,967
2018	387,522	426,274	14,215,674	15,637,241
2019	387,522	426,274	14,603,196	16,063,516
2020	387,522	426,274	14,990,718	16,489,790
2021	387,522	426,274	15,378,240	16,916,064

WASTE ACCEPTANCE RATES (Continued)

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
2022	387,522	426,274	15,765,762	17,342,338
2023	387,522	426,274	16,153,284	17,768,613
2024	387,522	426,274	16,540,806	18,194,887
2025	387,522	426,274	16,928,328	18,621,161
2026	387,522	426,274	17,315,850	19,047,435
2027	387,522	426,274	17,703,372	19,473,710
2028	387,522	426,274	18,090,895	19,899,984
2029	387,522	426,274	18,478,417	20,326,258
2030	387,522	426,274	18,865,939	20,752,532
2031	387,522	426,274	19,253,461	21,178,807
2032	387,522	426,274	19,640,983	21,605,081
2033	387,522	426,274	20,028,505	22,031,355
2034	387,522	426,274	20,416,027	22,457,629
2035	387,522	426,274	20,803,549	22,883,904
2036	387,522	426,274	21,191,071	23,310,178
2037	387,522	426,274	21,578,593	23,736,452
2038	387,522	426,274	21,966,115	24,162,726
2039	387,522	426,274	22,353,637	24,589,001
2040	387,522	426,274	22,741,159	25,015,275
2041	387,522	426,274	23,128,681	25,441,549
2042	387,522	426,274	23,516,203	25,867,823
2043	387,522	426,274	23,903,725	26,294,098
2044	387,522	426,274	24,291,247	26,720,372
2045	387,522	426,274	24,678,769	27,146,646
2046	387,522	426,274	25,066,291	27,572,920
2047	387,522	426,274	25,453,813	27,999,195
2048	387,522	426,274	25,841,335	28,425,469
2049	387,522	426,274	26,228,857	28,851,743
2050	387,522	426,274	26,616,380	29,278,017
2051	387,522	426,274	27,003,902	29,704,292
2052	387,522	426,274	27,391,424	30,130,566
2053	387,522	426,274	27,778,946	30,556,840
2054	387,522	426,274	28,166,468	30,983,114
2055	387,522	426,274	28,553,990	31,409,389
2056	387,522	426,274	28,941,512	31,835,663
2057	387,522	426,274	29,329,034	32,261,937
2058	387,522	426,274	29,716,556	32,688,211
2059	387,522	426,274	30,104,078	33,114,486
2060	387,522	426,274	30,491,600	33,540,760
2061	387,522	426,274	30,879,122	33,967,034

Results

Year	Total landfill gas			Methane		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1982	0	0	0	0	0	0
1983	1.420E+03	1.137E+06	7.640E+01	3.793E+02	5.685E+05	3.820E+01
1984	3.121E+03	2.499E+06	1.679E+02	8.336E+02	1.249E+06	8.395E+01
1985	5.031E+03	4.028E+06	2.707E+02	1.344E+03	2.014E+06	1.353E+02
1986	7.033E+03	5.631E+06	3.784E+02	1.878E+03	2.816E+06	1.892E+02
1987	9.545E+03	7.643E+06	5.135E+02	2.549E+03	3.821E+06	2.568E+02
1988	1.193E+04	9.551E+06	6.417E+02	3.186E+03	4.776E+06	3.209E+02
1989	1.545E+04	1.237E+07	8.315E+02	4.128E+03	6.187E+06	4.157E+02
1990	1.933E+04	1.548E+07	1.040E+03	5.164E+03	7.740E+06	5.201E+02
1991	2.311E+04	1.850E+07	1.243E+03	6.172E+03	9.252E+06	6.216E+02
1992	2.651E+04	2.123E+07	1.426E+03	7.081E+03	1.061E+07	7.132E+02
1993	2.839E+04	2.273E+07	1.527E+03	7.582E+03	1.136E+07	7.636E+02
1994	3.003E+04	2.405E+07	1.616E+03	8.021E+03	1.202E+07	8.078E+02
1995	3.161E+04	2.531E+07	1.701E+03	8.443E+03	1.266E+07	8.503E+02
1996	3.359E+04	2.690E+07	1.807E+03	8.972E+03	1.345E+07	9.036E+02
1997	3.658E+04	2.929E+07	1.968E+03	9.771E+03	1.465E+07	9.840E+02
1998	4.035E+04	3.231E+07	2.171E+03	1.078E+04	1.615E+07	1.085E+03
1999	4.484E+04	3.590E+07	2.412E+03	1.198E+04	1.795E+07	1.206E+03
2000	4.873E+04	3.902E+07	2.622E+03	1.302E+04	1.951E+07	1.311E+03
2001	5.437E+04	4.354E+07	2.925E+03	1.452E+04	2.177E+07	1.463E+03
2002	6.100E+04	4.885E+07	3.282E+03	1.629E+04	2.442E+07	1.641E+03
2003	6.599E+04	5.284E+07	3.550E+03	1.763E+04	2.642E+07	1.775E+03
2004	7.158E+04	5.732E+07	3.851E+03	1.912E+04	2.866E+07	1.926E+03
2005	7.296E+04	5.842E+07	3.925E+03	1.949E+04	2.921E+07	1.963E+03
2006	7.501E+04	6.006E+07	4.036E+03	2.004E+04	3.003E+07	2.018E+03
2007	7.696E+04	6.162E+07	4.141E+03	2.056E+04	3.081E+07	2.070E+03
2008	7.679E+04	6.149E+07	4.131E+03	2.051E+04	3.074E+07	2.066E+03
2009	7.693E+04	6.160E+07	4.139E+03	2.055E+04	3.080E+07	2.069E+03
2010	7.616E+04	6.098E+07	4.097E+03	2.034E+04	3.049E+07	2.049E+03
2011	7.542E+04	6.039E+07	4.058E+03	2.014E+04	3.019E+07	2.029E+03
2012	7.492E+04	5.999E+07	4.031E+03	2.001E+04	3.000E+07	2.015E+03
2013	7.465E+04	5.978E+07	4.017E+03	1.994E+04	2.989E+07	2.008E+03
2014	7.397E+04	5.923E+07	3.980E+03	1.976E+04	2.962E+07	1.990E+03
2015	7.375E+04	5.905E+07	3.968E+03	1.970E+04	2.953E+07	1.984E+03
2016	7.319E+04	5.861E+07	3.938E+03	1.955E+04	2.931E+07	1.969E+03
2017	7.413E+04	5.936E+07	3.988E+03	1.980E+04	2.968E+07	1.994E+03
2018	7.502E+04	6.007E+07	4.036E+03	2.004E+04	3.004E+07	2.018E+03
2019	7.588E+04	6.076E+07	4.083E+03	2.027E+04	3.038E+07	2.041E+03
2020	7.671E+04	6.143E+07	4.127E+03	2.049E+04	3.071E+07	2.064E+03
2021	7.751E+04	6.206E+07	4.170E+03	2.070E+04	3.103E+07	2.085E+03
2022	7.827E+04	6.267E+07	4.211E+03	2.091E+04	3.134E+07	2.106E+03
2023	7.900E+04	6.326E+07	4.251E+03	2.110E+04	3.163E+07	2.125E+03
2024	7.971E+04	6.383E+07	4.289E+03	2.129E+04	3.191E+07	2.144E+03
2025	8.039E+04	6.437E+07	4.325E+03	2.147E+04	3.218E+07	2.162E+03
2026	8.104E+04	6.489E+07	4.360E+03	2.165E+04	3.245E+07	2.180E+03
2027	8.166E+04	6.539E+07	4.394E+03	2.181E+04	3.270E+07	2.197E+03
2028	8.226E+04	6.587E+07	4.426E+03	2.197E+04	3.294E+07	2.213E+03
2029	8.284E+04	6.633E+07	4.457E+03	2.213E+04	3.317E+07	2.228E+03
2030	8.339E+04	6.678E+07	4.487E+03	2.228E+04	3.339E+07	2.243E+03
2031	8.393E+04	6.721E+07	4.515E+03	2.242E+04	3.360E+07	2.258E+03

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)
2032	8.444E+04	6.761E+07	4.543E+03	2.255E+04	3.381E+07	2.272E+03
2033	8.493E+04	6.801E+07	4.570E+03	2.269E+04	3.400E+07	2.285E+03
2034	8.540E+04	6.839E+07	4.595E+03	2.281E+04	3.419E+07	2.297E+03
2035	8.586E+04	6.875E+07	4.619E+03	2.293E+04	3.438E+07	2.310E+03
2036	8.629E+04	6.910E+07	4.643E+03	2.305E+04	3.455E+07	2.321E+03
2037	8.671E+04	6.944E+07	4.665E+03	2.316E+04	3.472E+07	2.333E+03
2038	8.712E+04	6.976E+07	4.687E+03	2.327E+04	3.488E+07	2.344E+03
2039	8.750E+04	7.007E+07	4.708E+03	2.337E+04	3.503E+07	2.354E+03
2040	8.787E+04	7.037E+07	4.728E+03	2.347E+04	3.518E+07	2.364E+03
2041	8.823E+04	7.065E+07	4.747E+03	2.357E+04	3.533E+07	2.374E+03
2042	8.857E+04	7.093E+07	4.766E+03	2.366E+04	3.546E+07	2.383E+03
2043	8.890E+04	7.119E+07	4.783E+03	2.375E+04	3.560E+07	2.392E+03
2044	8.922E+04	7.144E+07	4.800E+03	2.383E+04	3.572E+07	2.400E+03
2045	8.953E+04	7.169E+07	4.817E+03	2.391E+04	3.584E+07	2.408E+03
2046	8.982E+04	7.192E+07	4.832E+03	2.399E+04	3.596E+07	2.416E+03
2047	9.010E+04	7.215E+07	4.848E+03	2.407E+04	3.607E+07	2.424E+03
2048	9.037E+04	7.236E+07	4.862E+03	2.414E+04	3.618E+07	2.431E+03
2049	9.063E+04	7.257E+07	4.876E+03	2.421E+04	3.629E+07	2.438E+03
2050	9.088E+04	7.277E+07	4.889E+03	2.427E+04	3.639E+07	2.445E+03
2051	9.112E+04	7.296E+07	4.902E+03	2.434E+04	3.648E+07	2.451E+03
2052	9.135E+04	7.315E+07	4.915E+03	2.440E+04	3.657E+07	2.457E+03
2053	9.157E+04	7.332E+07	4.927E+03	2.446E+04	3.666E+07	2.463E+03
2054	9.178E+04	7.349E+07	4.938E+03	2.452E+04	3.675E+07	2.469E+03
2055	9.198E+04	7.366E+07	4.949E+03	2.457E+04	3.683E+07	2.474E+03
2056	9.218E+04	7.381E+07	4.960E+03	2.462E+04	3.691E+07	2.480E+03
2057	9.237E+04	7.396E+07	4.970E+03	2.467E+04	3.698E+07	2.485E+03
2058	9.255E+04	7.411E+07	4.979E+03	2.472E+04	3.705E+07	2.490E+03
2059	9.272E+04	7.425E+07	4.989E+03	2.477E+04	3.712E+07	2.494E+03
2060	9.289E+04	7.438E+07	4.998E+03	2.481E+04	3.719E+07	2.499E+03
2061	9.305E+04	7.451E+07	5.006E+03	2.485E+04	3.726E+07	2.503E+03
2062	9.320E+04	7.463E+07	5.015E+03	2.490E+04	3.732E+07	2.507E+03
2063	8.955E+04	7.171E+07	4.818E+03	2.392E+04	3.585E+07	2.409E+03
2064	8.604E+04	6.890E+07	4.629E+03	2.298E+04	3.445E+07	2.315E+03
2065	8.267E+04	6.619E+07	4.448E+03	2.208E+04	3.310E+07	2.224E+03
2066	7.942E+04	6.360E+07	4.273E+03	2.121E+04	3.180E+07	2.137E+03
2067	7.631E+04	6.111E+07	4.106E+03	2.038E+04	3.055E+07	2.053E+03
2068	7.332E+04	5.871E+07	3.945E+03	1.958E+04	2.935E+07	1.972E+03
2069	7.044E+04	5.641E+07	3.790E+03	1.882E+04	2.820E+07	1.895E+03
2070	6.768E+04	5.420E+07	3.641E+03	1.808E+04	2.710E+07	1.821E+03
2071	6.503E+04	5.207E+07	3.499E+03	1.737E+04	2.604E+07	1.749E+03
2072	6.248E+04	5.003E+07	3.361E+03	1.669E+04	2.501E+07	1.681E+03
2073	6.003E+04	4.807E+07	3.230E+03	1.603E+04	2.403E+07	1.615E+03
2074	5.767E+04	4.618E+07	3.103E+03	1.541E+04	2.309E+07	1.551E+03
2075	5.541E+04	4.437E+07	2.981E+03	1.480E+04	2.219E+07	1.491E+03
2076	5.324E+04	4.263E+07	2.864E+03	1.422E+04	2.132E+07	1.432E+03
2077	5.115E+04	4.096E+07	2.752E+03	1.366E+04	2.048E+07	1.376E+03
2078	4.915E+04	3.935E+07	2.644E+03	1.313E+04	1.968E+07	1.322E+03
2079	4.722E+04	3.781E+07	2.541E+03	1.261E+04	1.891E+07	1.270E+03
2080	4.537E+04	3.633E+07	2.441E+03	1.212E+04	1.816E+07	1.220E+03
2081	4.359E+04	3.490E+07	2.345E+03	1.164E+04	1.745E+07	1.173E+03
2082	4.188E+04	3.354E+07	2.253E+03	1.119E+04	1.677E+07	1.127E+03

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)
2083	4.024E+04	3.222E+07	2.165E+03	1.075E+04	1.611E+07	1.082E+03
2084	3.866E+04	3.096E+07	2.080E+03	1.033E+04	1.548E+07	1.040E+03
2085	3.714E+04	2.974E+07	1.998E+03	9.922E+03	1.487E+07	9.992E+02
2086	3.569E+04	2.858E+07	1.920E+03	9.533E+03	1.429E+07	9.600E+02
2087	3.429E+04	2.746E+07	1.845E+03	9.159E+03	1.373E+07	9.224E+02
2088	3.294E+04	2.638E+07	1.772E+03	8.800E+03	1.319E+07	8.862E+02
2089	3.165E+04	2.535E+07	1.703E+03	8.455E+03	1.267E+07	8.515E+02
2090	3.041E+04	2.435E+07	1.636E+03	8.123E+03	1.218E+07	8.181E+02
2091	2.922E+04	2.340E+07	1.572E+03	7.805E+03	1.170E+07	7.860E+02
2092	2.807E+04	2.248E+07	1.510E+03	7.499E+03	1.124E+07	7.552E+02
2093	2.697E+04	2.160E+07	1.451E+03	7.205E+03	1.080E+07	7.256E+02
2094	2.591E+04	2.075E+07	1.394E+03	6.922E+03	1.038E+07	6.971E+02
2095	2.490E+04	1.994E+07	1.340E+03	6.651E+03	9.969E+06	6.698E+02
2096	2.392E+04	1.916E+07	1.287E+03	6.390E+03	9.578E+06	6.435E+02
2097	2.298E+04	1.840E+07	1.237E+03	6.139E+03	9.202E+06	6.183E+02
2098	2.208E+04	1.768E+07	1.188E+03	5.899E+03	8.841E+06	5.941E+02
2099	2.122E+04	1.699E+07	1.142E+03	5.667E+03	8.495E+06	5.708E+02
2100	2.039E+04	1.632E+07	1.097E+03	5.445E+03	8.162E+06	5.484E+02
2101	1.959E+04	1.568E+07	1.054E+03	5.232E+03	7.842E+06	5.269E+02
2102	1.882E+04	1.507E+07	1.012E+03	5.026E+03	7.534E+06	5.062E+02
2103	1.808E+04	1.448E+07	9.727E+02	4.829E+03	7.239E+06	4.864E+02
2104	1.737E+04	1.391E+07	9.346E+02	4.640E+03	6.955E+06	4.673E+02
2105	1.669E+04	1.336E+07	8.980E+02	4.458E+03	6.682E+06	4.490E+02
2106	1.604E+04	1.284E+07	8.627E+02	4.283E+03	6.420E+06	4.314E+02
2107	1.541E+04	1.234E+07	8.289E+02	4.115E+03	6.168E+06	4.145E+02
2108	1.480E+04	1.185E+07	7.964E+02	3.954E+03	5.927E+06	3.982E+02
2109	1.422E+04	1.139E+07	7.652E+02	3.799E+03	5.694E+06	3.826E+02
2110	1.366E+04	1.094E+07	7.352E+02	3.650E+03	5.471E+06	3.676E+02
2111	1.313E+04	1.051E+07	7.064E+02	3.507E+03	5.256E+06	3.532E+02
2112	1.261E+04	1.010E+07	6.787E+02	3.369E+03	5.050E+06	3.393E+02
2113	1.212E+04	9.705E+06	6.520E+02	3.237E+03	4.852E+06	3.260E+02
2114	1.164E+04	9.324E+06	6.265E+02	3.110E+03	4.662E+06	3.132E+02
2115	1.119E+04	8.958E+06	6.019E+02	2.988E+03	4.479E+06	3.010E+02
2116	1.075E+04	8.607E+06	5.783E+02	2.871E+03	4.304E+06	2.892E+02
2117	1.033E+04	8.270E+06	5.556E+02	2.759E+03	4.135E+06	2.778E+02
2118	9.922E+03	7.945E+06	5.339E+02	2.650E+03	3.973E+06	2.669E+02
2119	9.533E+03	7.634E+06	5.129E+02	2.546E+03	3.817E+06	2.565E+02
2120	9.160E+03	7.335E+06	4.928E+02	2.447E+03	3.667E+06	2.464E+02
2121	8.800E+03	7.047E+06	4.735E+02	2.351E+03	3.523E+06	2.367E+02
2122	8.455E+03	6.771E+06	4.549E+02	2.259E+03	3.385E+06	2.275E+02

APPENDIX D

KYGas® MODEL RESULTS

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* * * * * * * * * * * * * K Y G A S * * * * * * * * * * * * *
*                                                           *
*  Gas Network Analysis Software                            *
*                                                           *
*  CopyRighted by KYPIPE LLC (www.kypipe.com)               *
*  Version: 8.014  01/11/2016                               *
*  Serial #:  8-5537241                                     *
*  Interface:  Classic                                      *
*  Licensed for Pipe2012                                    *
*                                                           *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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INPUT DATA FILE NAME FOR THIS SIMULATION = p:\lfg\projects\ALLIED~1\OTTAWA~1\2016GC~1\kygas\RUN2~1\OTTAWA~1.KYP\ottawa_c.DAT
OUTPUT DATA FILE NAME FOR THIS SIMULATION = p:\lfg\projects\ALLIED~1\OTTAWA~1\2016GC~1\kygas\RUN2~1\OTTAWA~1.KYP\ottawa_c.OT2

DATE FOR THIS COMPUTER RUN : 4-25-2016
START TIME FOR THIS COMPUTER RUN : 10: 6: 7:11

SUMMARY OF DISTRIBUTION SYSTEM CHARACTERISTICS:

NUMBER OF PIPES = 76
NUMBER OF JUNCTION NODES = 75

UNITS SPECIFIED = ENGLISH

PROPERTIES OF THE GAS FOR THIS ANALYSIS ARE:

OPERATING TEMPERATURE = 100.000 DEGREES FAHRENHEIT
REFERENCE DENSITY (@ STD. PRESSURE) = .73E-01 POUNDS/CUBIC FOOT
GAS MOLECULAR WEIGHT = 30.010
GAS SPECIFIC GRAVITY = 1.036
RATIO OF SPECIFIC HEATS = 1.303
GAS CONSTANT = 51.494
ABSOLUTE VISCOSITY = .282E-06 POUND SECONDS/SQUARE FOOT

USER SPEC. FLOW UNITS (USFU) = SCF / MIN.
USER SPEC. PRESSURE UNITS(USPU) = INCHES OF WATER (GAUGE)

------- SUMMARY OF PIPE NETWORK GEOMETRIC AND OPERATING DATA -------

PIPE NAME	NODE #1	NODE #2	LENGTH (FT.)	DIAM. (IN.)	ROUGHNESS (MILLIFEET)	SUM-M FACT.	PUMP ID	ELEVATION CHANGE
P-1	R-1	J-2	158.3	26.3	.100	1.8	0	.0

P-10	J-10	J-11	150.0	21.0	.100	1.8	0	.0
P-11	J-11	J-12	152.0	15.8	.100	1.8	0	.0
P-12	J-12	J-13	150.0	15.8	.100	1.8	0	.0
P-13	J-13	J-14	150.0	15.8	.100	1.8	0	.0
P-14	J-14	J-15	53.0	15.8	.100	1.8	0	.0
P-15	J-15	J-16	97.0	15.8	.100	1.8	0	.0
P-16	J-16	J-17	150.0	15.8	.100	1.8	0	.0
P-17	J-18	J-19	90.0	15.8	.100	1.8	0	.0
P-18	J-19	J-20	151.0	15.8	.100	1.8	0	.0
P-19	J-20	J-21	152.0	15.8	.100	1.8	0	.0
P-2	J-2	J-3	88.0	21.0	.100	1.8	0	.0
P-20	J-21	J-22	42.0	15.8	.100	1.8	0	.0
P-21	J-22	J-23	110.0	15.8	.100	1.8	0	.0
P-22	J-23	J-24	152.0	15.8	.100	1.8	0	.0
P-23	J-24	J-25	117.0	15.8	.100	1.8	0	.0
P-24	J-25	J-26	44.0	15.8	.100	1.8	0	.0
P-25	J-26	J-27	142.0	15.8	.100	1.8	0	.0
P-26	J-27	J-28	150.0	15.8	.100	1.8	0	.0
P-27	J-28	J-29	150.0	15.8	.100	1.8	0	.0
P-28	J-29	J-30	150.0	15.8	.100	1.8	0	.0
P-29	J-30	J-31	146.0	15.8	.100	1.8	0	.0
P-3	J-3	J-4	288.0	21.0	.100	1.8	0	.0
P-30	J-31	J-32	153.0	15.8	.100	1.8	0	.0
P-31	J-32	J-33	124.0	15.8	.100	1.8	0	.0
P-32	J-33	J-34	81.0	15.8	.100	1.8	0	.0
P-33	J-34	J-1	180.0	15.8	.100	1.8	0	.0
P-34	J-35	J-36	184.0	11.2	.100	1.8	0	.0
P-35	J-36	J-37	196.0	11.2	.100	1.8	0	.0
P-36	J-37	J-38	206.0	11.2	.100	1.8	0	.0
P-37	J-38	J-39	65.0	11.2	.100	1.8	0	.0
P-38	J-39	J-40	176.0	11.2	.100	1.8	0	.0
P-39	J-40	J-41	164.0	11.2	.100	1.8	0	.0
P-4	J-4	J-5	234.0	21.0	.100	1.8	0	.0
P-40	J-41	J-42	200.0	11.2	.100	1.8	0	.0
P-41	J-42	J-43	200.0	11.2	.100	1.8	0	.0
P-42	J-43	J-44	200.0	11.2	.100	1.8	0	.0
P-43	J-44	J-45	200.0	11.2	.100	1.8	0	.0
P-44	J-45	J-46	58.0	11.2	.100	1.8	0	.0
P-45	J-46	J-47	176.0	11.2	.100	1.8	0	.0
P-46	J-47	J-48	200.0	11.2	.100	1.8	0	.0
P-47	J-48	J-49	274.0	11.2	.100	1.8	0	.0
P-48	J-49	J-50	144.0	11.2	.100	1.8	0	.0
P-49	J-50	J-51	58.0	11.2	.100	1.8	0	.0
P-5	J-5	J-6	136.0	21.0	.100	1.8	0	.0
P-50	J-51	J-52	199.0	15.8	.100	1.8	0	.0
P-51	J-52	J-53	61.0	15.8	.100	1.8	0	.0
P-52	J-53	J-54	135.0	15.8	.100	1.8	0	.0
P-53	J-54	J-55	65.0	15.8	.100	1.8	0	.0
P-54	J-55	J-56	148.0	15.8	.100	1.8	0	.0
P-55	J-56	J-57	128.0	15.8	.100	1.8	0	.0
P-56	J-57	J-58	75.0	15.8	.100	1.8	0	.0
P-57	J-58	J-59	195.0	15.8	.100	1.8	0	.0
P-58	J-59	J-60	130.0	15.8	.100	1.8	0	.0
P-59	J-60	J-61	110.0	15.8	.100	1.8	0	.0
P-6	J-6	J-7	252.0	21.0	.100	1.8	0	.0

P-60	J-61	J-62	387.0	21.0	.100	1.8	0	.0
P-61	J-62	J-63	94.0	21.0	.100	1.8	0	.0
P-62	J-63	J-64	630.0	21.0	.100	1.8	0	.0
P-63	J-64	J-65	673.0	21.0	.100	1.8	0	.0
P-64	J-65	J-66	490.0	21.0	.100	1.8	0	.0
P-65	J-66	J-67	317.0	21.0	.100	1.8	0	.0
P-66	J-67	J-68	357.0	21.0	.100	1.8	0	.0
P-67	J-68	J-69	447.0	21.0	.100	1.8	0	.0
P-68	J-69	J-70	317.0	21.0	.100	1.8	0	.0
P-69	J-70	J-71	193.0	21.0	.100	1.8	0	.0
P-7	J-7	J-8	118.0	21.0	.100	1.8	0	.0
P-70	J-71	J-72	405.0	21.0	.100	1.8	0	.0
P-71	J-72	J-73	32.0	21.0	.100	1.8	0	.0
P-72	J-72	J-2	317.0	21.0	.100	1.8	0	.0
P-73	J-17	J-74	150.0	15.8	.100	1.8	0	.0
P-74	J-74	J-18	60.0	15.8	.100	1.8	0	.0
P-75	J-1	J-35	215.0	11.2	.100	1.8	0	.0
P-8	J-8	J-9	563.0	21.0	.100	1.8	0	.0
P-9	J-9	J-10	218.0	21.0	.100	1.8	0	.0

JUNCTION NAME	NODE TITLE	ELEV	DEMAND (USFU)	FPN PRESSURE
J-1		.00	.00	
J-10		.00	-53.00	
J-11		.00	-20.00	
J-12		.00	-20.00	
J-13		.00	-95.00	
J-14		.00	-20.00	
J-15		.00	.00	
J-16		.00	-20.00	
J-17		.00	-178.00	
J-18		.00	.00	
J-19		.00	-20.00	
J-2		.00	.00	
J-20		.00	-20.00	
J-21		.00	-20.00	
J-22		.00	-117.00	
J-23		.00	-20.00	
J-24		.00	-20.00	
J-25		.00	-117.00	
J-26		.00	-20.00	
J-27		.00	-189.00	
J-28		.00	-20.00	
J-29		.00	-53.00	
J-3		.00	-193.00	
J-30		.00	-20.00	
J-31		.00	-20.00	
J-32		.00	-20.00	
J-33		.00	.00	
J-34		.00	-130.00	
J-35		.00	-305.00	
J-36		.00	-177.00	
J-37		.00	-8.00	

J-38	.00	-50.00	
J-39	.00	.00	
J-4	.00	-109.00	
J-40	.00	-8.00	
J-41	.00	-8.00	
J-42	.00	-59.00	
J-43	.00	-212.00	
J-44	.00	-33.00	
J-45	.00	.00	
J-46	.00	-8.00	
J-47	.00	-33.00	
J-48	.00	-152.00	
J-49	.00	-33.00	
J-5	.00	.00	
J-50	.00	-8.00	
J-51	.00	.00	
J-52	.00	-8.00	
J-53	.00	.00	
J-54	.00	-58.00	
J-55	.00	.00	
J-56	.00	-8.00	
J-57	.00	.00	
J-58	.00	-92.00	
J-59	.00	-8.00	
J-6	.00	.00	
J-60	.00	.00	
J-61	.00	-271.00	
J-62	.00	-262.00	
J-63	.00	.00	
J-64	.00	-637.00	
J-65	.00	-288.00	
J-66	.00	-253.00	
J-67	.00	-177.00	
J-68	.00	-151.00	
J-69	.00	-75.00	
J-7	.00	-50.00	
J-70	.00	.00	
J-71	.00	-41.00	
J-72	.00	-100.00	
J-73	.00	.00	
J-74	.00	-20.00	
J-8	.00	.00	
J-9	.00	-20.00	
R-1	.00	.00	-60.00

==

Set = 0

================== RESULTS FOR THIS SIMULATION FOLLOW ================

Solution was obtained in 7 trials
Flow Accuracy = .4612E-05[< .500E-02]
RV Accuracy = .0000E+00[< .100E-02]

PIPE NO.	NODE #1	NODE #2	FLOW (USFU)	LOSS (USPU)	VELOCITY (FT/S)	DENSITY (#/CF)	FRICTION FACTOR	AREA RATIO
P-1	R-1	J-2	-5127.000	.44	28.74	.063	.0141	.045
P-10	J-10	J-11	-1685.351	.13	14.68	.063	.0164	.023
P-11	J-11	J-12	-1665.350	.45	25.78	.063	.0158	.040
P-12	J-12	J-13	-1645.350	.44	25.43	.063	.0158	.039
P-13	J-13	J-14	-1550.350	.39	23.94	.063	.0160	.037
P-14	J-14	J-15	-1530.350	.26	23.61	.063	.0160	.037
P-15	J-15	J-16	-1530.350	.31	23.59	.063	.0160	.037
P-16	J-16	J-17	-1510.350	.37	23.26	.063	.0160	.036
P-17	J-18	J-19	-1312.350	.23	20.16	.063	.0164	.031
P-18	J-19	J-20	-1292.350	.28	19.84	.064	.0164	.031
P-19	J-20	J-21	-1272.350	.27	19.52	.064	.0165	.030
P-2	J-2	J-3	-2110.351	.17	18.47	.063	.0157	.029
P-20	J-21	J-22	-1252.350	.16	19.20	.064	.0165	.030
P-21	J-22	J-23	-1135.350	.18	17.39	.064	.0168	.027
P-22	J-23	J-24	-1115.351	.21	17.08	.064	.0169	.026
P-23	J-24	J-25	-1095.351	.18	16.76	.064	.0169	.026
P-24	J-25	J-26	-978.351	.10	14.97	.064	.0173	.023
P-25	J-26	J-27	-958.351	.15	14.66	.064	.0173	.023
P-26	J-27	J-28	-769.351	.10	11.76	.064	.0180	.018
P-27	J-28	J-29	-749.351	.10	11.45	.064	.0181	.018
P-28	J-29	J-30	-696.351	.08	10.64	.064	.0184	.017
P-29	J-30	J-31	-676.351	.08	10.33	.064	.0185	.016
P-3	J-3	J-4	-1917.351	.23	16.77	.063	.0160	.026
P-30	J-31	J-32	-656.351	.08	10.02	.064	.0186	.016
P-31	J-32	J-33	-636.351	.06	9.72	.064	.0187	.015
P-32	J-33	J-34	-636.351	.05	9.71	.064	.0187	.015
P-33	J-34	J-1	-506.351	.05	7.73	.064	.0196	.012
P-34	J-35	J-36	-201.351	.04	6.12	.064	.0222	.009
P-35	J-36	J-37	-24.351	.00	.74	.064	.0383	.001
P-36	J-37	J-38	-16.351	.00	.50	.064	.0434	.001
P-37	J-38	J-39	33.649	.00	1.02	.064	.0348	.002
P-38	J-39	J-40	33.649	.00	1.02	.064	.0348	.002
P-39	J-40	J-41	41.649	.00	1.27	.064	.0328	.002
P-4	J-4	J-5	-1808.350	.19	15.80	.063	.0162	.025
P-40	J-41	J-42	49.649	.00	1.51	.064	.0313	.002
P-41	J-42	J-43	108.649	.02	3.30	.064	.0256	.005
P-42	J-43	J-44	320.649	.11	9.75	.064	.0202	.015
P-43	J-44	J-45	353.649	.13	10.75	.064	.0198	.017
P-44	J-45	J-46	353.649	.07	10.76	.064	.0198	.017
P-45	J-46	J-47	361.649	.13	11.00	.064	.0197	.017
P-46	J-47	J-48	394.649	.16	12.01	.064	.0193	.019
P-47	J-48	J-49	546.649	.38	16.65	.064	.0182	.026
P-48	J-49	J-50	579.649	.27	17.67	.064	.0180	.027
P-49	J-50	J-51	587.649	.18	17.93	.064	.0180	.028
P-5	J-5	J-6	-1808.350	.14	15.80	.063	.0162	.025

P-50	J-51	J-52	587.649	.07	9.00	.064	.0190	.014
P-51	J-52	J-53	595.649	.04	9.12	.064	.0189	.014
P-52	J-53	J-54	595.649	.06	9.12	.064	.0189	.014
P-53	J-54	J-55	653.649	.05	10.01	.064	.0186	.016
P-54	J-55	J-56	653.649	.07	10.02	.064	.0186	.016
P-55	J-56	J-57	661.649	.07	10.14	.064	.0186	.016
P-56	J-57	J-58	661.649	.06	10.14	.064	.0186	.016
P-57	J-58	J-59	753.649	.11	11.56	.064	.0181	.018
P-58	J-59	J-60	761.649	.09	11.68	.064	.0181	.018
P-59	J-60	J-61	761.649	.09	11.68	.064	.0181	.018
P-6	J-6	J-7	-1808.350	.19	15.79	.063	.0162	.024
P-60	J-61	J-62	1032.649	.09	8.91	.064	.0179	.014
P-61	J-62	J-63	1294.649	.06	11.18	.064	.0172	.017
P-62	J-63	J-64	1294.649	.19	11.18	.064	.0172	.017
P-63	J-64	J-65	1931.650	.42	16.70	.063	.0160	.026
P-64	J-65	J-66	2219.649	.43	19.21	.063	.0156	.030
P-65	J-66	J-67	2472.649	.40	21.43	.063	.0153	.033
P-66	J-67	J-68	2649.649	.49	22.99	.063	.0152	.036
P-67	J-68	J-69	2800.649	.63	24.34	.063	.0150	.038
P-68	J-69	J-70	2875.649	.53	25.03	.063	.0150	.039
P-69	J-70	J-71	2875.649	.41	25.07	.063	.0150	.039
P-7	J-7	J-8	-1758.351	.13	15.34	.063	.0162	.024
P-70	J-71	J-72	2916.649	.64	25.46	.063	.0149	.039
P-71	J-72	J-73	.000	.00	.00	.063	.0000	.000
P-72	J-72	J-2	3016.649	.59	26.38	.063	.0149	.041
P-73	J-17	J-74	-1332.350	.29	20.49	.063	.0164	.032
P-74	J-74	J-18	-1312.350	.20	20.17	.063	.0164	.031
P-75	J-1	J-35	-506.351	.27	15.40	.064	.0185	.024
P-8	J-8	J-9	-1758.351	.31	15.34	.063	.0162	.024
P-9	J-9	J-10	-1738.350	.17	15.15	.063	.0163	.023
R-1	R-1	R-1	-5127.000	.00	.02	.063	.0299	.000

JUNCTION NAME	NODE TITLE	DEMAND (USFU)	PRESSURE (USPU)	PRESSURE (PSIA)	PRESSURE (PSIG)	DENSITY #/CF
J-1		.00	-52.83	12.79	-1.91	.064
J-10		-53.00	-58.04	12.60	-2.09	.063
J-11		-20.00	-57.91	12.61	-2.09	.063
J-12		-20.00	-57.46	12.62	-2.07	.063
J-13		-95.00	-57.01	12.64	-2.06	.063
J-14		-20.00	-56.62	12.65	-2.04	.063
J-15		.00	-56.37	12.66	-2.03	.063
J-16		-20.00	-56.05	12.67	-2.02	.063
J-17		-178.00	-55.68	12.69	-2.01	.063
J-18		.00	-55.19	12.70	-1.99	.063
J-19		-20.00	-54.96	12.71	-1.98	.064
J-2		.00	-59.56	12.55	-2.15	.063
J-20		-20.00	-54.69	12.72	-1.97	.064
J-21		-20.00	-54.42	12.73	-1.96	.064
J-22		-117.00	-54.26	12.74	-1.96	.064
J-23		-20.00	-54.07	12.74	-1.95	.064
J-24		-20.00	-53.86	12.75	-1.94	.064

J-25	-117.00	-53.69	12.76	-1.94	.064
J-26	-20.00	-53.59	12.76	-1.93	.064
J-27	-189.00	-53.43	12.77	-1.93	.064
J-28	-20.00	-53.33	12.77	-1.92	.064
J-29	-53.00	-53.24	12.77	-1.92	.064
J-3	-193.00	-59.40	12.55	-2.14	.063
J-30	-20.00	-53.15	12.78	-1.92	.064
J-31	-20.00	-53.07	12.78	-1.92	.064
J-32	-20.00	-53.00	12.78	-1.91	.064
J-33	.00	-52.93	12.79	-1.91	.064
J-34	-130.00	-52.88	12.79	-1.91	.064
J-35	-305.00	-52.55	12.80	-1.90	.064
J-36	-177.00	-52.51	12.80	-1.89	.064
J-37	-8.00	-52.51	12.80	-1.89	.064
J-38	-50.00	-52.51	12.80	-1.89	.064
J-39	.00	-52.51	12.80	-1.89	.064
J-4	-109.00	-59.16	12.56	-2.14	.063
J-40	-8.00	-52.51	12.80	-1.89	.064
J-41	-8.00	-52.51	12.80	-1.90	.064
J-42	-59.00	-52.52	12.80	-1.90	.064
J-43	-212.00	-52.53	12.80	-1.90	.064
J-44	-33.00	-52.64	12.80	-1.90	.064
J-45	.00	-52.78	12.79	-1.90	.064
J-46	-8.00	-52.84	12.79	-1.91	.064
J-47	-33.00	-52.97	12.78	-1.91	.064
J-48	-152.00	-53.14	12.78	-1.92	.064
J-49	-33.00	-53.51	12.76	-1.93	.064
J-5	.00	-58.98	12.57	-2.13	.063
J-50	-8.00	-53.79	12.75	-1.94	.064
J-51	.00	-53.97	12.75	-1.95	.064
J-52	-8.00	-54.04	12.75	-1.95	.064
J-53	.00	-54.08	12.74	-1.95	.064
J-54	-58.00	-54.14	12.74	-1.95	.064
J-55	.00	-54.19	12.74	-1.96	.064
J-56	-8.00	-54.27	12.74	-1.96	.064
J-57	.00	-54.34	12.74	-1.96	.064
J-58	-92.00	-54.39	12.73	-1.96	.064
J-59	-8.00	-54.51	12.73	-1.97	.064
J-6	.00	-58.84	12.57	-2.12	.063
J-60	.00	-54.60	12.73	-1.97	.064
J-61	-271.00	-54.69	12.72	-1.97	.064
J-62	-262.00	-54.77	12.72	-1.98	.064
J-63	.00	-54.84	12.72	-1.98	.064
J-64	-637.00	-55.03	12.71	-1.99	.064
J-65	-288.00	-55.45	12.69	-2.00	.063
J-66	-253.00	-55.88	12.68	-2.02	.063
J-67	-177.00	-56.28	12.67	-2.03	.063
J-68	-151.00	-56.77	12.65	-2.05	.063
J-69	-75.00	-57.40	12.62	-2.07	.063
J-7	-50.00	-58.64	12.58	-2.12	.063
J-70	.00	-57.93	12.61	-2.09	.063
J-71	-41.00	-58.34	12.59	-2.11	.063
J-72	-100.00	-58.98	12.57	-2.13	.063
J-73	.00	-58.98	12.57	-2.13	.063
J-74	-20.00	-55.39	12.70	-2.00	.063

J-8	.00	-58.51	12.58	-2.11	.063
J-9	-20.00	-58.20	12.60	-2.10	.063
R-1	.00	-60.00	12.53	-2.17	.063

* This designates the use of default density in a low pressure region

THE NET SYSTEM DEMAND (USFU) = -5127.000

SUMMARY OF INFLOWS(+).AND.OUTFLOWS(-) :

NAME	FLOW (USFU)	FPN TITLE
R-1	-5127.0	R-1

MAXIMUM MACH NUMBER = .03 IN LINE NO. P-1

SUMMARY OF MINIMUM.AND.MAXIMUM VELOCITIES (FT/S)

MINIMUM		MAXIMUM	
R-1	.02	P-1	28.74
P-36	.50	P-72	26.38
P-35	.74	P-11	25.78
P-37	1.02	P-70	25.46
P-38	1.02	P-12	25.43

SUMMARY OF MINIMUM.AND.MAXIMUM LOSS/1000. (PSI)

MINIMUM		MAXIMUM	
R-1	.00	P-11	.05
P-36	.00	P-12	.05
P-35	.00	P-13	.05
P-37	.00	P-14	.05
P-38	.00	P-15	.05

SUMMARY OF MINIMUM.AND.MAXIMUM PRESSURES (USPU)

MINIMUM		MAXIMUM	
R-1	-60.00	J-38	-52.51
J-2	-59.56	J-37	-52.51
J-3	-59.40	J-39	-52.51
J-4	-59.16	J-36	-52.51
J-5	-58.98	J-40	-52.51

************************* END OF KYGAS SIMULATION ************************

DATE FOR THIS COMPUTER RUN : 4-25-2016
START TIME FOR THIS COMPUTER RUN : 10: 6: 7:13

KYGas Node/Pipe Designations

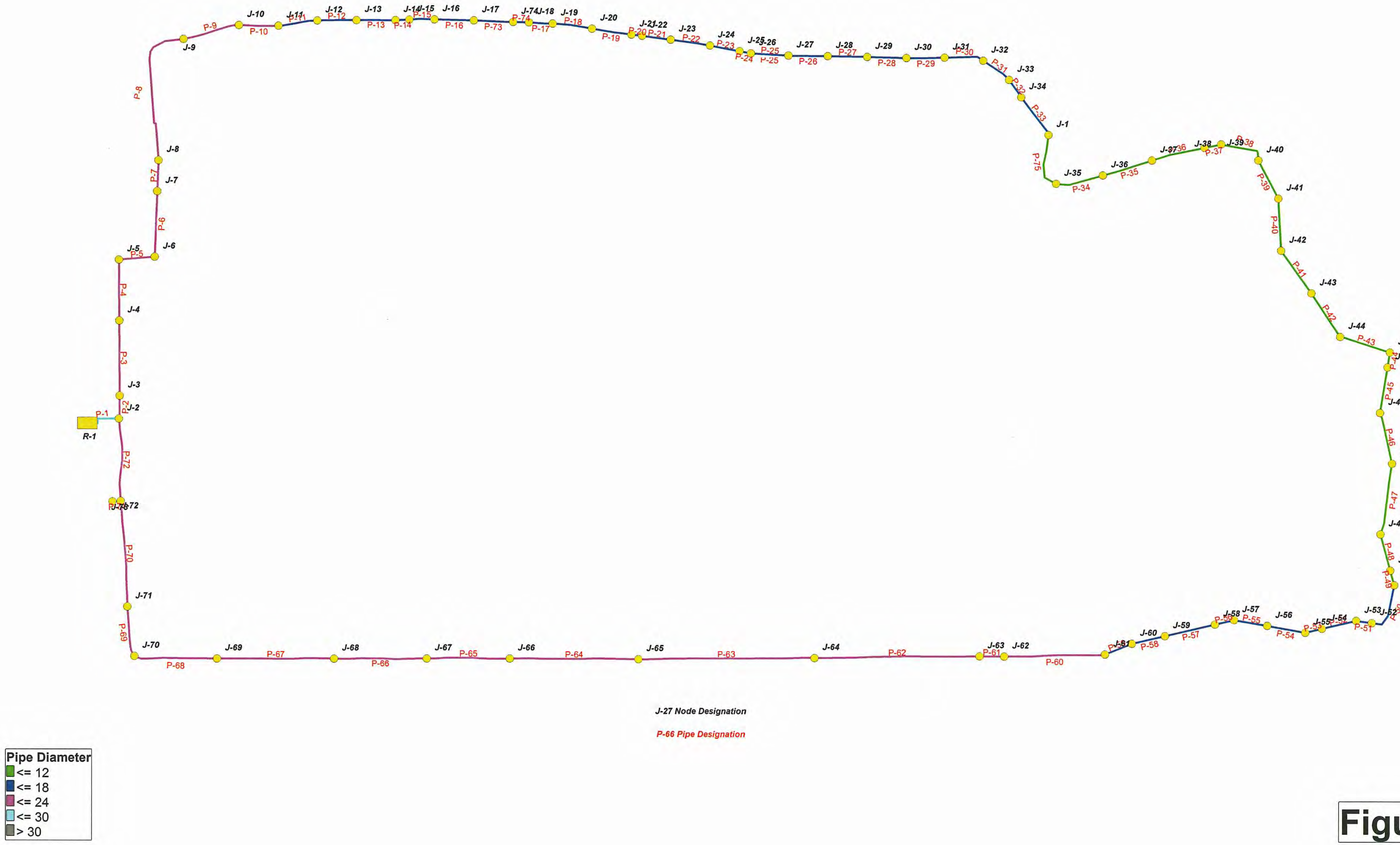


Figure 1

KYGas Vacuum/Velocity Results

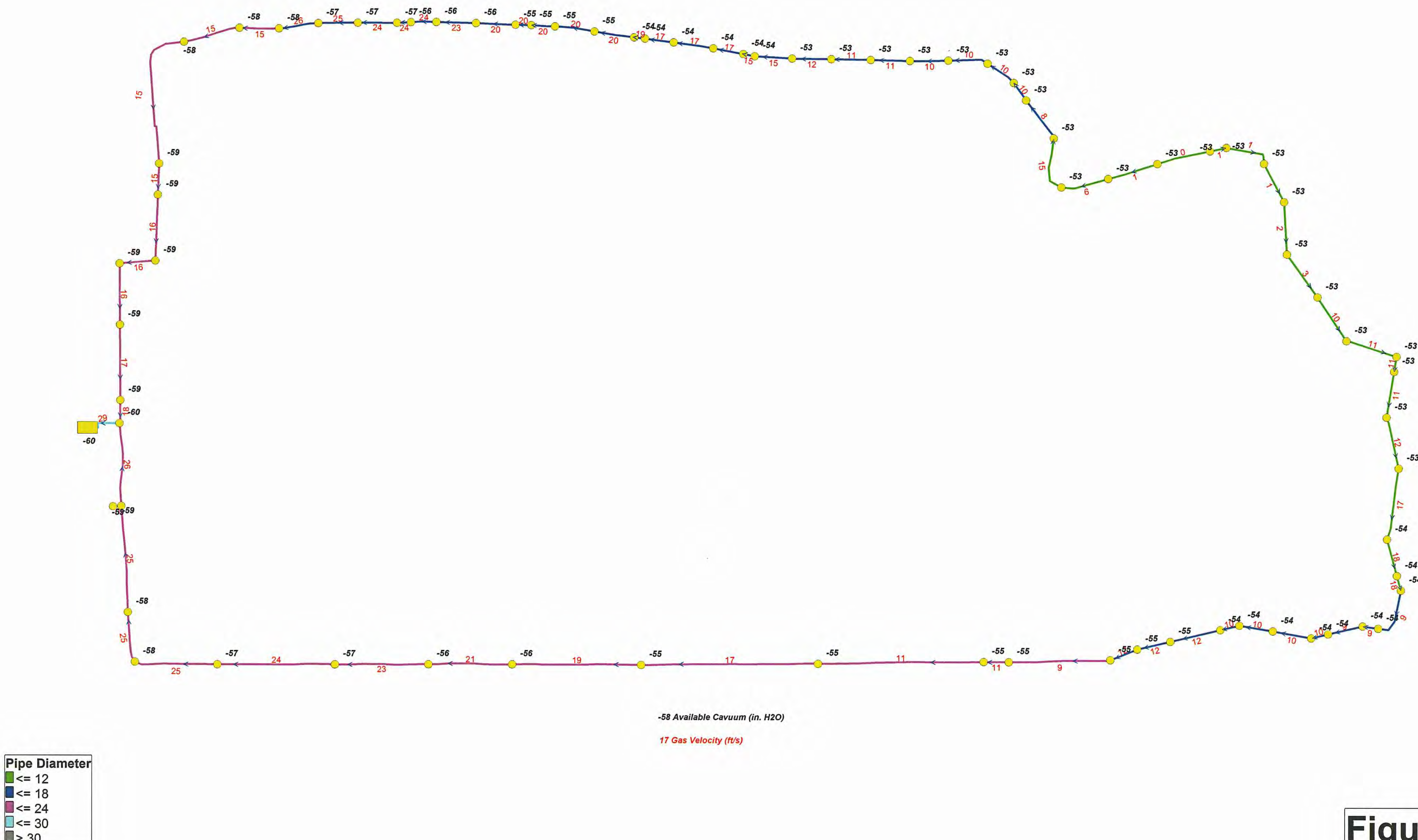


Figure 2

APPENDIX E

SURFACE EMISSIONS MONITORING PLAN

INTRODUCTION

40 CFR 60.755(c) requires the landfill gas collection system be operated so that the methane concentration is less than 500 ppm above background at the surface of the landfill. In addition, those areas that indicate elevated concentrations of LFG by visual observation (i.e., cracks or seeps in the landfill's cover and distressed vegetation) must also be monitored. This Surface Monitoring Design Plan specifies the monitoring procedures that will be used to meet the NSPS requirement. This plan includes topographical maps with the monitoring routes and specifies the monitoring procedures that will be followed. Any deviations from the surface monitoring requirements as stated in the NSPS are contained in this plan.

AREAS MONITORED

The NSPS requires monitoring along the entire perimeter of the collection area and along a serpentine pattern spaced 30 meters apart (or a site-specific established spacing) for each collection area on a quarterly basis.

The attached map in Appendix E shows the surface monitoring route proposed for the facility and utilizes a pattern of parallel lines approximately 100 feet (30 meters) apart to be followed over the surface area of the landfill that contains buried refuse. The monitoring plan shown in Drawing E-1 depicts the monitoring pattern following closure. During interim surface emission monitoring, the pattern may differ based on landfill development patterns and surface topography at the time of the monitoring events. Areas which are proposed to have alternative spacing include:

- Areas of the site with synthetic cover. The synthetic cover is expected to provide an excellent barrier to emissions; therefore, a greater spacing (60 meters vs. 30) between the passes is requested. Should an exceedance of 500 ppm or more be noted in this area, the interval will be reduced back to 30 meters until three consecutive monitoring events without an exceedance can be demonstrated. At that time, the site will return to a 60 meter interval.

Areas which are requested for exclusion include:

- Active areas of the site. Active areas are those areas which only have daily cover, and are being filled with waste. Active areas of the landfill have a larger volume of equipment traffic which poses an unacceptable health and safety risk to an individual in the area.

- Areas of the landfill with steep slopes. Steep slopes present a safety hazard to the monitoring technician traversing them.
- Areas of the site with snow or ice cover. Snow has the potential to cover uneven surfaces in the landfill cover (such as ruts) which could cause the technician to twist or break a leg. Icy slopes are difficult and dangerous to traverse.
- Areas of the site that are undergoing construction or final cover activities. These areas also have a large volume of equipment traffic, which poses a health and safety risk to the technician performing the scan.

MONITORING FREQUENCY

Surface monitoring will normally occur on a quarterly basis. Monitoring will be rescheduled if it cannot be conducted because temperature conditions are outside the operating range of the instrument and/or other conditions (snow cover, rain storms, etc.) prevent monitoring. The monitoring event will be rescheduled as soon as practical after the original scheduled date.

SURFACE MONITORING INSTRUMENT

The monitoring will be conducted with an organic vapor analyzer, flame ionization detector, or other portable monitor meeting the specifications in 40 CFR 60.755(d):

> "The portable analyzer shall meet the instrument specifications provided in Method 21 of Appendix A of 40 CFR Part 60 (Method 21), except that "methane" shall replace all references to VOC."

To meet the performance evaluation requirements in Method 21, the instrument evaluation procedures of Method 21 shall be used. The performance evaluation results will be documented in an instrument logbook or on a form similar to the one attached.

SURFACE MONITORING SURVEY

Immediately before commencing a surface monitoring survey, the instrument shall be calibrated per Method 21. The calibration gas shall be methane, diluted to a nominal concentration of 500 parts per million in air. Calibrations will be documented in an instrument logbook or on a form similar to the one attached.

The background concentration at the facility will be determined immediately prior to conducting the survey. The background concentration shall be determined by moving the probe inlet upwind outside the boundary of the landfill at least 30 meters from the perimeter wells. The background concentration, measurement location, and basic meteorological conditions will be recorded on a form similar to the one attached. Other factors that can affect "background" should be noted and accounted for (such as a nearby landfill, highway, refinery, chemical plant, etc.).

Surface emission monitoring shall be performed in accordance with Method 21, except that the probe inlet shall be placed within 5 to 10 centimeters of the ground and the probe will be moved continuously along the ground. Monitoring will not be performed during extreme meteorological conditions.

Surface monitoring will be conducted around the perimeter of the collection area and the route shown on the topographic map. Areas where visual observations indicate elevated concentrations of landfill gas, such as distressed vegetation and cracks or seeps in the cover, will be monitored.

Any reading of 500 parts per million or more above background at any location shall be recorded as a monitored exceedance and the following actions shall be taken:

i. The location of each monitored exceedance shall be marked and the location recorded.

ii. Cover maintenance or adjustments to the vacuum of the adjacent wells to increase the gas collection in the vicinity of each exceedance shall be made and the location shall be re-monitored within 10 calendar days of detecting the exceedance.

iii. If the re-monitoring of the location shows a second exceedance, additional corrective action shall be taken and the location shall be monitored again within 10 days of the second exceedance. If the re-monitoring shows a third exceedance for the same location, the action specified in paragraph (v) below shall be taken, and no further monitoring of that location is required until the action specified in paragraph (v) has been taken.

iv. Any location that initially showed an exceedance but has a methane concentration less than 500 ppm methane above background at the 10-day re-monitoring specified in paragraph (c)(4) (ii) or (iii) of this section shall be re-monitored 1 month from the initial exceedance. If the 1-month remonitoring shows a concentration less than 500 parts per million above background, no further monitoring of that location is required until the next quarterly monitoring period. If the 1-month remonitoring shows an exceedance, the actions specified in paragraph (iii) or (v) shall be taken.

v. For any location where monitored methane concentration equals or exceeds 500 parts per million above background three consecutive times within a quarterly period, a new well or other collection device shall be installed within 120 calendar days of the initial exceedance. An alternative remedy to the exceedance, such as upgrading the blower, header pipes or control device, and a corresponding timeline for installation may be submitted to the Administrator for approval.

REDUCED MONITORING FREQUENCY FOR CLOSED LANDFILLS

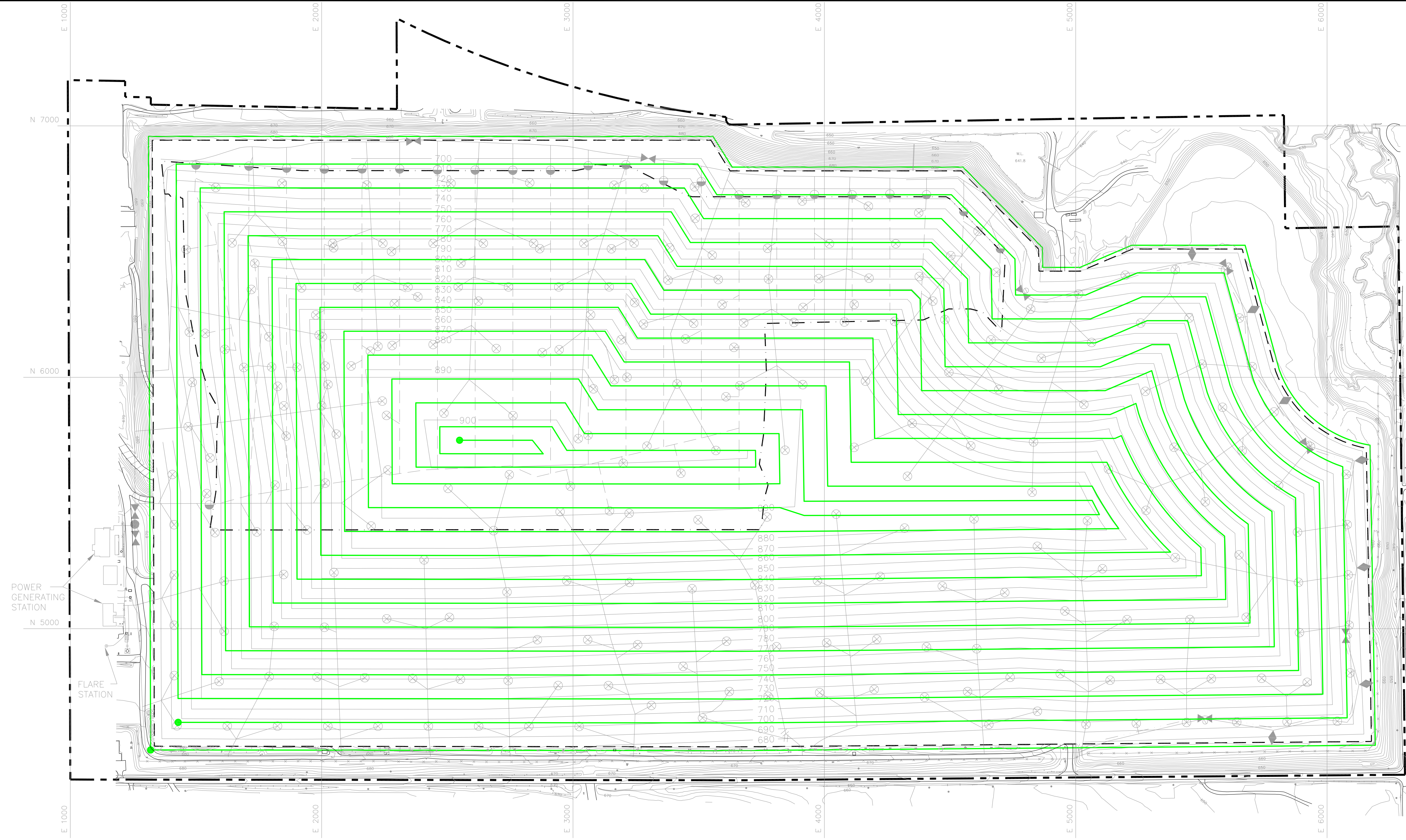
Any closed landfill that has no monitored exceedances of the 500 ppm limit above background in three consecutive quarterly monitoring periods may skip to annual monitoring. Any methane reading of 500 ppm or more above background detected during the annual monitoring returns the frequency to quarterly monitoring.

The facility is proposing to go to an annual schedule for areas of the site that are at final grade, and certified as closed, once three consecutive quarters with no surface monitoring exceedances have been performed. This alternative monitoring schedule was approved by Region 4 USEPA on July 12, 2004 for an NSPS landfill in Georgia (Applicability Determination Index Control No. 0500087).

COVER INTEGRITY MONITORING

40 CFR 60.755(b)(5) requires a program to monitor for cover integrity and implement cover repairs as necessary on a monthly basis. During the inspection, facility personnel will conduct a site walk of the landfill to inspect the cover. The inspector will look for signs of compromised cover integrity such as stressed vegetation, cracks, and erosion. The inspections will be documented. Areas of compromised integrity will be noted. The appropriate facility personnel will be notified of the compromised areas so that corrective actions can be taken.

In Section 7 of this GCCS plan, the facility has proposed an annual cover integrity inspection frequency for areas of the site that have been certified as closed.



LEGEND

PERMIT BOUNDARY	LIFT STATION
LIMIT OF WASTE	BLIND FLANGE
OVERLINER BOUNDARY	HORIZONTAL COLLECTOR
EXISTING CONTOUR	AIR SUPPLY PIPING
FINAL COVER CONTOUR	CONDENSATE FORCEMAIN
SITE GRID	AIR/FORCEMAIN VALVE
LFG EXTRACTION WELL	LOCATION OF WALKING PATH (SEE NOTE 2)
LFG COLLECTION PIPING	PATH START/FINISH (SEE NOTE 2)
CONDENSATE SUMP	
LFG ISOLATION VALVE	

0 200 400
SCALE IN FEET

NOTES:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY COOPER AERIAL SURVEYS, CO. FROM AERIAL PHOTOGRAPHY FLOWN MARCH 30, 2016.
2. THE PATH SHOWN REPRESENTS THE SURFACE EMISSIONS MONITORING PATH AT COMPLETION. HOWEVER, THE PATH WILL BE ADJUSTED AS NEEDED TO MATCH LANDFILL FILL OPERATIONS, GCCS INSTALLATIONS, AND TO AVOID DANGEROUS AREAS. A CURRENT SEM PATH WILL BE SUBMITTED IN EACH SEMI-ANNUAL NSPS REPORT. START AND FINISH LOCATIONS WILL VARY WITH FIELD CONDITIONS AT THE TIME OF MONITORING AND TO ACCOUNT FOR MULTIPLE DAYS AS NEEDED.

G:\0120\685\2016 LFG\GCCS DESIGN PLANS (04-16)\E-1_SEM PLAN.DWG, 5/11/2016 9:49:42 AM

☐ DRAFT
■ FOR PERMITTING PURPOSES ONLY
☐ APPROVED FOR CONSTRUCTION
☐ CLIENT APPROVAL BY: ______

PREPARED FOR:
OTTAWA COUNTY LANDFILL, INC

NSPS GCCS DESIGN PLAN
SURFACE EMISSIONS MONITORING PLAN

OTTAWA COUNTY FARMS LANDFILL
OTTAWA COUNTY, MICHIGAN

No.	DATE	REVISION DESCRIPTION

Weaver Consultants Group
WEAVER CONSULTANTS GROUP
400 ANN STREET N.W., SUITE 201A
GRAND RAPIDS, MICHIGAN 49504
(616) 458-8052
www.wcgrp.com

DRAWN BY:	VRS
REVIEWED BY:	MKS
DATE:	04/2016
FILE:	0120-685-11
CAD:	E-1 SEM PLAN

DRAWING
E-1

APPENDIX F

APPROVED ALTERNATIVES TO THE NSPS

REQUEST FOR VARIANCES & ALTERNATIVE PROCEDURES

Per 40 CFR §60.752(b)(2)(i)(B), the design plan shall include proposed alternative procedures to the prescriptive monitoring, record keeping and reporting requirements outlined in the NSPS.

1. Alternatives to the NSPS

60.752 (b) (2) (i) (B): The collection and control system design plan shall include any alternatives to the operational standards, test methods, procedures, compliance measures, monitoring, recordkeeping or reporting provisions of 60.753 through 60.758 proposed by the owner or operator. The following alternatives to the operational standards, test methods, procedures, compliance measures, monitoring, record keeping or reporting provisions of 60.753 through 60.758 of the NSPS are proposed at this time:

2. Migration Control Wells

Perimeter Migration Control Wells may be installed during the life of the facility. These wells shall be installed outside the limits of waste placement, and are intended to mitigate LFG movement beyond the limits of waste placement. As such, these extraction points are operated both intermittently (as monitoring of perimeter probes dictates the need for local operation) and aggressively (to provide immediate response to any occurrences of off-site LFG movement). These wells will be specifically designated as such at the time of installation and will not be monitored or reported under the provisions of the NSPS. The location of these wells (outside the limits of waste placement) and aggressive nature of operation dictate that these wells be generally operated under conditions of low methane quality and higher oxygen content than would be expected from an extraction point installed within the refuse mass.

3. Surface Emissions Monitoring Pattern

60.753(d): "...A surface monitoring design plan shall be developed that includes a topographical map and the rationale for any site specific deviations from the 30 meter intervals. Areas with steep slopes or other dangerous areas may be excluded from surface testing.

Ottawa County Farms Landfill proposes to widen the spacing between intervals from 30 meters to 60 meters in areas that have had or will have synthetic geomembrane–final cover installed after 3 consecutive quarters of surface emissions monitoring compliance has been met. The geomembrane cover is expected to pride an excellent barrier to surface emissions. Upon demonstration that the geomembrane-covered areas experience no exceedances for three consecutive quarters, the facility will submit notification that the spacing will be widened to 60 meters in these areas. This has been approved by USEPA Region 5 for a landfill in Michigan.

Ottawa County Farms Landfill also proposes to exclude dangerous areas such as roads, the active area, truck traffic areas, construction areas, areas with snow or ice cover, and steep slopes from surface testing, if the monitoring technician believes that the conditions may cause physical harm. The actual monitoring route followed for each quarter, including areas excluded and reasons for exclusion, shall be included with each surface scan report.

4. Surface Emissions Monitoring Correction Variance
Section 60.755 (c) (4): "Any reading of 500 ppm or more…shall be recorded as a monitored exceedance…cover maintenance or adjustments to the vacuum…shall be made and the locations shall be remonitored within 10 calendar days after detecting the exceedance…"

Ottawa County Farms Landfill is requesting a variance to the 10-day window allotted for adjustments to the cover and/or collection system. Industry experience with NSPS facilities in the Midwest suggests that the 10 day time frame is not reasonable to effect comprehensive repairs during all quarters of a typical year. For example, if the facility experiences a precipitation event following a surface scan, it may take several days or even weeks for the side slopes of the landfill to dry out enough to support construction equipment for cover repairs. This is due to the nature of the final cover required at many facilities; usually, it is several feet of clay overlain by six inches of topsoil. Clay can hold water for long periods of time. If the side slopes are not completely dry, the repair equipment can cause even greater damage to the cover (and subsequently higher emissions) than the original erosion or crack.

Poor weather conditions can prevent cover maintenance, leading the follow-up rescans 10 days later to automatically fail. This can ultimately force a facility to install an unneeded extraction well, when all that was really required was enough time to effect a cover repair.

The facility therefore requesting, through approval of this plan, that the 10 day rescan time frame be extended by an additional two weeks, in the event of bad weather conditions after a quarterly surface scan (should it be determined that the cover was the cause of the failing reading). The facility is proposing to receive this two-week extension automatically, upon providing written notification to the Agency that the extra time is needed due to poor weather conditions. The facility will place the notification letter in the NSPS files, along with a summary of the poor weather conditions.

This variance has been approved by Illinois EPA and the Minnesota Pollution Control Agency for NSPS landfills.

5. Final Cover Integrity Monitoring
60.755 (c) (5): "The owner or operator shall implement a program to monitor for cover integrity and implement cover repairs as necessary on a monthly basis."

In areas where final cover has been installed, damage to the cover from erosion is expected to be minimal, as opposed to the unvegetated interim slopes at the active portions of the facility. Ottawa County Farms Landfill is therefore proposing an annual inspection schedule for monitoring the areas under final cover. The remaining areas will be monitored monthly while they are active, but after closure, it is requested that the cover monitoring frequency be reduced to annual as well.

6. Oxygen Metering Methods
60.753 (c) (2) Operational Standards for Collection and Control Systems: "…oxygen shall be determined by an oxygen meter using Method 3A…"

When applicable, the Ottawa County Farms Landfill is proposing to use an on-site multi-gas analyzer, in lieu of a laboratory method, for determining the oxygen content of the landfill gas at each well and monitoring point. The site will be using a portable meter, such as a GEM-500, GEM-2000 or equivalent, calibrated to the manufacturer's specifications, to determine the oxygen content of the gas. This is acceptable to, and has previously been approved by, the U.S. EPA.

7. Monitoring at New/Extended Vertical Extraction Wells
60.756: "Except as provided in 60.752 (b) (2) (i) (B),
(a) Each owner or operator seeking to comply with 60.752 (b) (2) (ii) (A) for an active gas collection system shall install a sampling port and a thermometer or other temperature measuring device at each wellhead and:

(1) Measure the gauge pressure in the gas collection header on a monthly basis as provided in 60.755 (a) (3); and
(2) Monitor nitrogen or oxygen concentration in the landfill gas on a monthly basis as provided in 60.755 (a) (5); and
(3) Monitor temperature of the landfill gas on a monthly basis as provided in 60.755 (a) (5)."

New vertical gas extraction wells are often placed in the active area of the landfill several years before the waste has reached final grades. This is compliance with the NSPS. However, since the wells are placed in active areas, they periodically need to be "raised" (i.e. the well casing extended 15 to 25 vertically) in order to not be buried under lifts of trash. When they are raised, the HDPE lateral line, which provides the applied vacuum, is temporarily disconnected until the surrounding lift of trash is brought high enough to reconnect the well. The time frame between when a well is disconnected and raised, and when the waste height is high enough to reconnect the lateral, can often range from a few weeks to a few months. This can result in missed monthly readings at the well, since the well casing is too high for the technician to safely reach. Since the NSPS allows for exclusion of surface monitoring in "dangerous areas" of the site, the Ottawa County Farms Landfill believes it is reasonable to request exclusion to monitoring the wells raised in active areas. The facility proposes that readings will be missed at a particular well as long as the well cannot be safely accessed. If the facility cannot bring the waste height up to the new grade and re-attach the well within a reasonable amount of time (i.e. 60 days), then modifications to the lateral/wellhead such as the well will be cut back down and re-attached will be made for monitoring. This request is in accordance with 60.752(b) (2) (i) (B), which allows the facility to propose alternatives to the monitoring procedures in the NSPS.

8. Start-Up of New Wells and Collection System
40 CFR 60.755(a)(4) does not require the landfill to expand the wellfield due to positive pressure within the first 180 days of system operation. During the first 180 days of collection and control system operations, where either nitrogen or oxygen and/or temperature exceedences are monitored, the Ottawa County Farms Landfill proposes to apply corrective measures to achieve the operating standards; however no expansion of the collection system to address the exceedences will occur within 120 days. In addition, for new individual wells installed at the Ottawa County Farms Landfill, the facility proposes to not expand the wellfield during the first 180 days of operation for any individual well which pressure, temperature and/or either oxygen or nitrogen exceedences are

monitored. This will give the facility adequate time to properly redistribute available vacuum and re-balance the wellfield after the addition of the new wells.

9. Determination of Net Heating Value
The NSPS was revised on September 21, 2006 (Federal Register Vol. 71, No. 183, pg. 55121) to allow the use of USEPA Method 3C or ASTM D3588 in place of Method 18 and ASTM D1946 to determine landfill gas components for calculating net heating value under 60.18 (c) (3). Ottawa County Farms Landfill will utilize this method for performance testing should a new open flare be installed at the facility.

10. Monitoring for Air Intrusion
60.753 (c) requires nitrogen or oxygen to be monitored at each wellhead, but not both. SWANA requested USEPA clarify that if both parameters are monitored using a Gas Chromatograph (GC) and one shows an exceedance while the other is not, then this is not an exceedance requiring corrective action and follow-up monitoring. Monitoring of both parameters is common at sites that use an on-site GC to conduct this monitoring.

USEPA Response: If either oxygen OR nitrogen was selected as the parameter to be monitored in the Design Plan or the permit, then the site must monitor for and comply with that parameter. If the site did not specify whether oxygen or nitrogen would be monitored, then the site must comply with both parameters where a GC is being used as measurement. Pursuant to this response from the USEPA, Ottawa County Farms Landfill will utilize oxygen as the selected parameter for determining air intrusion.

11. Monitoring of New or Replacement Extraction Wells
Landfill gas systems are typically built in phases to accommodate for additional waste placement as well as to replace various wells from time to time due to settlement, etc. Installation of only a few additional wells can cause challenges with balancing the entire system and therefore additional time may be needed to not only achieve negative pressure in all wells but to also maintain the operating standard for oxygen, nitrogen and/or temperature.

Per 60.755 (a) (4), the landfill is not required to expand the system during the first 180 days after gas collection system start-up where pressure exceedences were recorded at one or more wells. SWANA recommends that, given the wellfield balancing challenges, USEPA should clarify that the exemption from system expansion applies to any individual well or series of wells associated with the new well (s) upon start-up.

USPEPA Response: Request approval for alternative timeline procedure as part of the Design plan or amendment to the Design Plan. Pursuant to this response from the USEPA, the Ottawa County Farms Landfill proposes to bring new and replacement wells into compliance within 180 days of installation. During this time period, the extraction wells will be monitored, however they will not be subject to the operational and monitoring constraints under 60.753.

12. Monitoring of Interim LFG Collectors
SWANA has requested clarification from the USEPA as to whether additional wells or collectors,

voluntarily established by the landfill operator, but not specified by the Gas Collection and Control System (GCCS) Design Plan, are subject to NSPS Operational Requirements.

This issue frequently arises when "extra" collectors are added (such as temporary horizontal trenches) or the leachate collection system is connected to the GCCS to control odors, to increase the quantity of LFG available for beneficial use, or to meet other landfill operating needs beyond regulatory compliance with the rule. Since a professional engineer certified that the GCCS Design Plan would meet the required level of LFG control without the use of the "extra" collectors and the Administrator approved the Design Plan, SWANA does not believe that the operating requirements should be beyond that required by the NSPS rule. Further, because these devices are installed for purposes other than to meet the requirements of the NSPS rule (i.e, odor control, energy recovery projects, etc.), their design may preclude their ability to meet the stipulated operation requirements. An example of this situation is when the leachate collection system is connected to the GCCS for odor mitigation purposes. Because the leachate collection layer extends close to the landfill surface and during initial cell development portions may even be exposed directly to air, a large amount of air can be drawn directly through the leachate system causing elevated oxygen concentrations at the wellhead. In this situation it is often impossible to limit the oxygen concentration to less than the regulatory standard of 5 percent. This, however, does not cause an operational problem as the air never moves through the waste and therefore does not increase the risk of subsurface fire.

A second example is when LFG is collected from the leachate collection system and the leachate level rises above the perforated portion of the leachate collection riser pipe. In this situation, LFG does not move through the riser and an unrepresentative but elevated oxygen concentration can be measured if a small quantity of air accidentally enters the top of the riser.

A third example is where the landfill owner or operator decides to install and operate wells or horizontal collectors in areas not yet required to have collection (i.e., initial waste placed is less than 5 years old in active fill area). There should be no obligation to collect the LFG and therefore no monitoring requirements for these wells until the age of the initial waste requires such operation.

A fourth example is a horizontal trench. Horizontal trenches tend to collect liquids and "water out" more quickly than vertical extraction wells. When this occurs, the trenches may occasionally be under positive pressure, and may experience a decline in gas quality. For this reason, it is proposed that horizontal trenches be exempt from the NSPS temperature, oxygen/nitrogen and pressure monitoring and operational requirements. Although these parameters will be measured monthly at trench monitoring locations, they will not be tracked as deviations if exceedances from the prescriptive NSPS values occur.

Although the NSPS rules may allow for regulatory approval of alternative oxygen standards to resolve some of these issues, regulatory agencies have proven extremely reluctant to grant such alternatives due to unfamiliarity with LFG control technology. A simpler solution would be to clarify in guidance that additional voluntary wells on collectors may be excluded from the performance standards used for wells to establish NSPS compliance.

USEPA Response: If the collectors are located in an area of the landfill not yet required to have control (i.e., initial waste in place is not yet 2 years in closed or final grade area or 5 years old in active areas) then the monitoring and operational requirements would not apply. If however, the collectors are located in areas of the landfill which require gas control, then the collectors must be monitored and achieve operating limits for pressure, oxygen and temperature. Alternative monitoring procedures and/or operating parameters for these collectors may be requested as part of the Design Plan or addendum to the Design Plan.

Pursuant to this response from the USEPA, the Ottawa County Farms Landfill proposes that all GCCS connections to leachate management structures or to interim LFG collectors located in an area of the landfill not yet required to have control (i.e., initial waste in place is not yet 2 years in closed or final grade area or 5 years old in active areas) be excluded from the NSPS operating and monitoring requirements. Since these GCCS connections are not part of the NSPS monitoring plan, if the site chooses to disconnect/decommission them in the future (prior to waste age reaching NSPS applicability) no approvals will be requested of the Agency prior to decommissioning.

13. Section 60.756(c) Monitoring of Operations:
"Each owner or operator seeking to comply with Section 60.752 (b) (2) (iii) using an open flare shall install, calibrate, maintain, and operate according to the manufacturer's specifications the following equipment:
(1) A heat sensing device, such as an ultraviolet beam sensor or thermocouple, at the pilot light or the flame itself to indicate the continuous presence of a flame.
(2) A device that records flow to or bypass of the flare. The owner or operator shall either:
(i) Install, calibrate, and maintain a gas flow rate measuring device that shall record the flow to the control device at least every 15 minutes; or
(ii) Secure the bypass line valve in the closed position with a car seal or a lock-and-key type configuration. A visual inspection of the seal or closure mechanism shall be performed at least once every month to ensure that the valve is maintained through the bypass line.

A close examination of the above "actual" NSPS language indicates that flow monitoring at an open flare may be unnecessary for NSPS compliance purposes if the control device does not contain a bypass valve. The apparent intent of the regulation was to show that flow was going to the flare, and not down a bypass line. If there is no bypass line present at a site, and all flow goes to the flare, then flow monitoring should not be required.

The most recent "Questions and Answers" Guidance Document (revised 5/02) posted by the USEPA on their Air Toxics Website for the Landfill NSPS (http://www.epa.gov/ttn/atw/landfill/landflpg.html) had the following guidance on this issue:

Gas Flow Monitoring

9. Question: The rule requires a gas flow rate measuring device that records the flow to the control device every 15 minutes or a lock and key to prevent bypass. The commenter stated that their systems are designed to shut everything off (e.g. the blower) if there is a problem, for example, with the flare. Can they disregard the gas flow/lock & key requirements as long as their system is designed with no means to bypass the control device?

Answer: The gas flow measurement or lock and key requirements would not apply to a system that is designed such that there is no physical means to bypass the gas flow before it reaches the control device.

The Ottawa County Farms Landfill gas collection and control system does not contain a bypass line. The system was designed and operated such that the blower shuts down and main valve closes to prevent the escape of landfill gas if the control device is not operating. The MDEQ has concurred with this request for other facilities, and has begun to remove the requirement for flare flow monitoring from several Renewable Operating Permits (ROP's).

14. Section 60.753 (b)(3) Operational Standards:

"Operate the collection system with negative pressure at each wellhead except under the following conditions:

(1) a fire or increased well temperature. The owner or operator shall record instances when positive pressure occurs in efforts to avoid a fire. These records shall be submitted with the annual reports as provided in 60.757(f) (1);

(2) use of a geomembrane or synthetic cover. The owner or operator shall develop acceptable pressure limits in the design plan;

(3) a decommissioned well. A well may experience a static positive pressure after shut down to accommodate for declining flows. All design changes shall be approved by the Administrator;

Several of the wells at the Ottawa County Farms Landfill are located in waste that is over 25 years of age, with declining gas flow rates. A few wells in the existing system periodically have oxygen exceedances of greater than 5% when vacuum is applied. However, the facility does not yet want to operationally decommission these wells, since they may be needed for surface emissions or gas migration control.

The site is therefore proposing a change to the standard operating procedure for these wells, as an alternative to decommissioning them. Ottawa County Farms Landfill proposes to make the following changes to its standard operating procedure for wells where oxygen cannot be brought to below 5% even at reduced vacuums:

a. When the oxygen concentration at these wells do not decline to acceptable levels after more than one hour of reduced vacuum, the wells will be shut off until the gas quality recovers.
b. The monthly monitoring required by §60.755 will be conducted for wells that have been shut down, but positive pressure or elevated oxygen concentrations will not be considered nor reported as exceedances of the operating limits of §60.753.
c. If monthly monitoring indicates that pressure has built up in the wells and the oxygen concentration still exceeds five percent, the wells will be briefly opened to relieve the pressure and will then be shut down until they are monitored the following month.
d. If the monthly monitoring indicates that gas quality has improved (i.e. the oxygen concentration has dropped below five percent), the wells will be brought back on line until the gas quality declines again.

e. The surface monitoring required under §60.755 will be conducted for wells that have been shut down. Standard remediation steps, including evaluating the need to return wells to full-time service, will be followed if exceedances of the 500-ppm methane surface concentration limits are detected.

Please note that this alternative standard operating procedure was approved by US EPA Region 4, at an NSPS landfill in Florida, on February 9, 2005. A similar procedure was approved by USEPA Region 5 at an NSPS Landfill in Illinois, on March 28, 2007.

15. 40 CFR 60.755(e) Compliance Provisions:
The provisions of this subpart apply at all times, except during periods of start-up, shutdown, or malfunction, provided that the duration of start-up, shutdown, or malfunction shall not exceed 5 days for collection systems and shall not exceed 1 hour for treatment or control devices.

It is impossible to respond to and fix most types of control device malfunctions in one hour or less. It is also impossible to do some types of control device maintenance in one hour or less. Similarly, repairs to the main header of the gas system may take more than 5 days depending on the scope of repairs and the weather.

The Landfill NESHAP (40 CFR 63 Subpart AAAA) requires the preparation of a Start-up, Shutdown and Malfunction (SSM) Plan. The plan must detail the actions to be taken by the site in the event of an SSM event. The duration of each event must be recorded, and all such SSM events reported on a semiannual basis.

The facility is requesting that the one hour/five day shutdown limitations of the NSPS not apply to the facility now that the Landfill NESHAP has been promulgated. These events will now be governed by the more stringent SSM plan recordkeeping and reporting requirements of the Landfill NESHAP.

This change to the one hour/five day provisions of the NSPS has been proposed by USEPA in the most recent draft revisions to the NSPS, issued on September 8, 2006 (Federal Register Vol. 171, No. 174, pg. 53272).

16. 40 CFR 60.757(f) Reporting:
Each owner or operator of a landfill seeking to comply with 60.752 (b) (2) using an active collection system designed in accordance with 60.752 (b) (2) (ii) shall submit to the Administrator annual reports of the recorded information in (f) (1) through (f) (6) of this paragraph.

The newly promulgated Landfill NESHAP requires that the annual NSPS report be submitted on a semiannual basis. However, the NSPS regulations still stipulate an annual frequency. The facility is proposing to submit semiannual reports on the same schedule as other report required by the facility's Renewable Operating Permit (i.e. semiannual reports due March 15 and September 15, as required at other Michigan NSPS sites) vs. submitting one annual report.

17. 40 CFR 60.752: Standards

60.752(b)(2)(i)(B) states "The collection and control system design plan shall include any alternatives to the operational standards, test methods, procedures, compliance measures, monitoring, recordkeeping or reporting provisions of 60.753 through 60.758 proposed by the owner or operator."

Ottawa County Farms Landfill may use passive gas flares as an option for gas collection and control, especially in areas where header installation would not be feasible due to active filling at interim landfill grades. The passive flares will be installed for odor control in non-NSPS areas (i.e. areas that do not meet the age criteria for NSPS control), and the site will not conduct any monitoring or recording activities for these flares.

The site may place these passive flares in NSPS areas on a temporary basis (i.e. for less than 180 days) in an effort to control odors and NMOC emissions until the active gas system can be expanded or repaired in the NSPS area. The passive flares will be used to supplement the existing gas system and in areas where construction of the gas header pipeline is not feasible at the time. The facility is requesting a variance from the monitoring and recordkeeping activities for the passive flares for the 180 day period the passive flares would be in operation.

18. Section 60.756(c) Monitoring of Operations:

"Each owner or operator seeking to comply with 60.752(b)(2)(iii) using an open flare shall install, calibrate, maintain, and operate according to the manufacturer's specifications the following equipment:

(1) A heat sensing device, such as an ultraviolet beam sensor or thermocouple, at the pilot light or the flame itself to indicate the continuous presence of a flame.

(2) A device that records flow to or bypass of the flare…"

The facility is requesting a variance from the monitoring requirements for open flares for the future passive flares used on a temporary basis in NSPS areas (i.e. less than 180 days). The use of passive flares will be in isolated areas and be in addition to (and not replace) the main control devices at the site.

19. Section 60.758 Recordkeeping:

60.758(b)(4): "Flow rate or bypass flow rate measurements...continuous records of the flare pilot flame or flare flame monitoring and records of all periods of operation during which the pilot flame and the flare flame is absent."

AND

60.758(c)(2) & (4): "(2) Each owner or operator subject to the provisions of this subpart shall keep up-to-date, readily accessible continuous records of the indication of flow to the control device…(4) Each owner or operator seeking to comply with provisions of this subpart by use of an open flare shall keep up-to-date, readily accessible records of all periods of operation in which the flame or flare pilot flame is absent."

As stated previously, if Ottawa County Farms Landfill elects to use passive flares in NSPS areas on a temporary (less than 180 days basis), the facility is requesting a variance to not monitor or record flame presence or gas flow for the temporary passive flares. The use of passive flares will be in isolated areas and be in addition to (and not replace) the landfill gas to energy plants and backup open flare used for control.

20. Section 60.758 Recordkeeping:
60.758(b)(4): "Where an owner or operator subject to the provisions of this subpart seeks to demonstrate compliance with 60.752(b)(2)(iii)(A) through use of an open flare, the flare type (i.e., steam-assisted, air-assisted, or nonassisted), all visible emission readings, heat content determination, flow rate or bypass flow rate measurements, and exit velocity determinations made during the performance test as specified in §60.18."

The facility is requesting a variance from testing for the temporary passive flares used in NSPS areas for less than 180. The use of passive flares will be in isolated areas and be in addition to (and not replace) the landfill gas to energy plants or backup open flare used for control.

21. Section 60.8 Initial Performance Test:
If the Ottawa County Farms Landfill receives an open flare from another landfill facility, and that open flare has undergone a successful NSPS Initial Performance Test at the original facility, the Ottawa County Farms Landfill is proposing to waive the performance test requirements for the open flare at the new location. The basis for the waiver is that the properties which affect the operation of the open flare (BTU value of the landfill gas combusted) should not vary significantly from site to site.

This variance request was approved by USEPA on September 15, 2004 for an NSPS landfill in Michigan.

22. Surface Emissions Monitoring for Closed Areas of Facility:
60.756(f) states "Any closed landfill that has no monitored exceedances of the operational standard in three consecutive quarterly monitoring periods may skip to annual monitoring."

The Ottawa County Farms Landfill is proposing to reduce the surface monitoring frequency in the certified closed areas of the landfill to an annual basis, once three clean consecutive quarters have been demonstrated in this closed area. The frequency will return to quarterly if a surface emissions exceedance of 500 ppm or more is detected in the certified closed area, until such time as the site can demonstrate three consecutive quarters with no exceedances.

This alternative monitoring schedule was approved by Region 4 USEPA on July 12, 2004 for an NSPS landfill in Georgia (Applicability Determination Index Control No. 0500087).

23. Compliance Provisions for Measured Wellfield Exceedances:

Sections 60.755(a)(3) and 40 CFR §60.755(a)(5) requires the landfill owner or operator to take corrective action to remedy GCCS operating and compliance monitoring exceedences within 5 calendar days. If the condition cannot be corrected within 15 days of the initial exceedence, the GCCS must be expanded within 120 days of the initial reported exceedence, or an alternate remedy to correct the exceedence(s) and a corresponding timeline for implementation may be submitted for agency approval.

The Ottawa County Farms Landfill is seeking State approval for an alternative to this corrective measure protocol. If the condition cannot be corrected within 15 days of the initial exceedence, Ottawa County Farms Landfill is proposing to continue monitoring the exceedence and make system adjustments for a period of 120 days from the date of the initial exceedence. A request for alternative time to achieve the operating criteria will not be submitted if the well begins operating within the specified operating criteria within 120 days. If the well(s) can be operated within the specified operating criteria during the 120-day period, no further action will be taken until the next monthly well monitoring event. Otherwise, Ottawa County Farms Landfill will take one of the follow actions:

- An assessment will be made during the 120-day period to determine whether the well may have become nonproductive. If it is determined the well(s) are non-producing, C&C Landfill will follow the action described under non-producing wells of this GCCS Design Plan, or
- If the well(s) cannot be corrected, nor do they meet the criterion described in non-producing wells then the site will either expand or modify the GCCS, or abandon the wells(s) in accordance with 40 CFR §60.759 (a)(3)(ii) of the NSPS. The proposed action will be submitted by Ottawa County Farms Landfill to the State for approval within the 120 days of the initial exceedence along with a corresponding timeline for implementation.

24. Recordkeeping for Enclosed Combustors

Section 60.758 (c)(1)(i) discusses exceedances for enclosed combustors if the average combustion temperature recorded is less than 28 ºC below the average combustion temperature during the most recent performance test at which compliance with 60.752(b)(2)(iii) was determined. In the event that the facility chooses to install an enclosed flare in the future, it may be used as a standby for the energy recovery plant located on site. During the standby period, a continuous LFG fueled pilot may be utilized and a flame scanner or thermocouple is used to confirm the presence of a flame on the pilot. In this standby mode there is no way for the enclosed flare stack to maintain the minimum stack temperature established during the performance test. In any case, the emissions are certainly de minimis, and this practice avoids the need to buy auxiliary fuels off site to maintain the pilot. Therefore, the facility proposes that standby pilot systems do not need to meet the temperature requirements of an NSPS flare.

25. Section 60.753(c): Operational Standards
60.753(c) states "Operate each interior wellhead in the collection system with a gas temperature less than 55°C (131°F)…."

Experience with other landfills has shown that internal landfill temperatures can achieve near thermophilic conditions where the interior of the landfill achieves temperatures of 140 to 150ºF without any evidence of subsurface composting. The anaerobic, methogenic generation process in a landfill is exothermic. The heterogeneous conditions within most landfills result in large variations in the biological conditions throughout the waste mass. If conditions within the landfill are near optimum, the decomposition process can generate higher exothermic temperatures. This can be especially true for deep landfills. Unlike shallow landfills where the waste materials can be influenced by ambient conditions (i.e., cold temperatures, ice or snow accumulations on the landfill surface, or infiltration of cold precipitation which can typically keep internal landfill temperatures below the 131ºF NSPS operating threshold), deep landfills such as the Ottawa County Farms Landfill are not as susceptible to this ambient influence.

40 CFR §60.755(a)(5) of the NSPS requires that if an exceedance of the 131ºF operating threshold is found at an extraction well, the landfill owner or operator must take action to correct the exceedance within 5 days. If the condition cannot be corrected within 15 days of the initial exceedance, the GCCS must be expanded within 120 days of the initial reported exceedance. It is believed that expanding the GCCS will not affect the biological conditions within a landfill to the point that the internal temperatures can be significantly affected.

Therefore, Ottawa County Farms Landfill is proposing the following alternative operating and monitoring plan for those LFG extraction well(s) that are unable to meet the 131ºF NSPS operating temperature threshold:

- A well or wells exhibiting operating temperatures above 131ºF, but below 150ºF, but where a fire is not suspected will be operated, monitored, and reported at their operating temperature. A bag sample to test for CO will be taken within 30 day to confirm no fire exists. If CO exists in less than 100 ppm no further action required. However, if a fire is suspected or the bag sample indicates greater than 100 ppm of CO, the well(s) the well will be turned off and the situation will be further investigated. If it is confirmed that fire is present, the well(s) will be shutoff as provided for under 40 CFR §60.753(b)(1) and corrective measures implemented to extinguish the problem. Once it is determined that any fire has been extinguished, the well(s) will then be placed back into service.
- A well or wells exhibiting operating temperatures above 150ºF will be shutoff as provided by the NSPS under 40 CFR §60.753(b)(1). An investigation will then be performed at the well(s) to determine if a fire is occurring at the well(s). If it is confirmed that fire is present, the well(s) will be shutoff as provided for under 40 CFR §60.753(b)(1) and corrective measures implemented to extinguish the problem. Once it is determined that any fire has been extinguished and the wellhead temperature is below 150ºF, the well(s) will then be placed back into service. If the initial investigation determines that no fire is present, the well(s) will be placed back

into service and the operating parameters at the wellhead(s) closely monitored. If conditions remain stable with no indication of the possibility of fire, the well(s) will then be operated, monitored, and reported at their operating temperature, with no further action required.

26. Section 60.753 & 60.755: Operational Standards & Compliance Provisions
In the event of excess precipitation, excessively cold weather, acts of God, terrorism, or if otherwise unsafe conditions exist, Ottawa County Farms Landfill may postpone monthly wellhead or quarterly surface methane emissions monitoring (and any re-checks) until safe conditions exist for field activities. These conditions and any monitoring delays will be logged in records kept at the landfill and reported to the State in routine reporting.

27. Section 60.756(b)(2)(i) Flow Monitoring Requirements
60.756(b)(2)(i) requires a facility to "Install, calibrate, and maintain a gas flow rate measuring device that shall record the flow to the control device at least every 15 minutes..."

Ottawa County Farms Landfill will eliminate the NSPS flow monitoring requirements for the engines, since the MDEQ has concurred that they run off of "treated" landfill gas, and thus are not subject to the testing, monitoring, recordkeeping or reporting requirements of the Landfill NSPS. See Attachment 4 for a copy of the Treatment Applicability correspondence.

28. Section 60.756(b)(1) Enclosed Combustor Temperature Monitoring Requirements
Per 60.756(b)(1), " Each owner or operator...using an enclosed combustor shall calibrate, maintain and operate...the following equipment: A temperature monitoring device equipped with a continuous recorder..."

Ottawa County Farms Landfill will eliminate the NSPS temperature monitoring requirements for the engines, since they operate on "treated" landfill gas, and thus are not subject to the testing, monitoring, recordkeeping or reporting requirements of the Landfill NSPS.

29. Section 60.756(b)(1) Recordkeeping for Enclosed Combustors
60.758(b)(2) states "Where an owner or operator subject to the provisions of this subpart seeks to demonstrate compliance with § 60.752(b)(2)(iii) through use of an enclosed combustion device

(I)...The average combustion temperature measured at least every 15 minutes and averaged over the same time period of the performance test."

As stated earlier, Ottawa County Farms Landfill will eliminate the NSPS temperature monitoring requirements for the engines, since they run off of "treated" landfill gas, and thus are not subject to the testing, monitoring, recordkeeping or reporting requirements of the Landfill NSPS.

30. Section 60.756(b)(1) Reporting Requirements for Enclosed Combustors
Per 60.758(c)(1)(i), " The following constitute exceedances that shall be recorded and reported...For enclosed combustors, all 3-hour periods of operation during which the average combustion temperature was more than 28 ^{o}C below the average combustion temperature during the most recent performance test at which compliance with 60.752(b)(2)(iii) was determined."

This is also not applicable to the engines since they run off of treated landfill gas.

31. Section 60.756(b)(1) Enclosed Combustor Temperature Monitoring Requirements
60.752(b)(2)(iii)(B) states " ...or, when an enclosed combustion device is used for control, to either reduce NMOC by 98 weight percent or reduce the outlet NMOC concentration to less than 20 parts per million by volume, dry basis as hexane at 3 percent oxygen. The reduction efficiency or parts per million by volume shall be established by an initial performance test, required under §60.8 using the test methods specified in §60.754(d)."

The existing (and any future) control devices that operate on "treated" landfill gas are no longer subject to the performance testing requirement of the NSPS.

APPENDIX G
NSPS BACKGROUND INFORMATION DOCUMENT

TREATMENT APPLICABILITY CORRESSPONDANCE

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
GRAND RAPIDS DISTRICT OFFICE

JENNIFER M. GRANHOLM
GOVERNOR

STEVEN E. CHESTER
DIRECTOR

May 18, 2004

Ms. Debbie Nurmi
Sunset Waste Services
250 64th Street
Coopersville, MI 49404

SRN: N3294
Ottawa County

Mr. Todd Davlin
Granger Electricity Generating Station
16980 Wood Road
P.O. Box 27185
Lansing, MI 48909

Dear Ms. Nurmi and Mr. Davlin:

SUBJECT: NSPS Applicability Determination – Treatment System
Ottawa County Farms Landfill and Ottawa Generating Station
Renewable Operating Permit (ROP) Number: 199600290

This is in response to letters dated December 17, 2003, from Todd Davlin of Granger Electric and March 26, 2004 from staff of EMCON/OWT, Inc. to the Department of Environmental, Air Quality Division (AQD), in which, a site specific New Source Performance Standard (NSPS) applicability determination was requested for a "treatment system" under the requirements of 40 CFR 60.752(b)(2)(iii)(C), for the Ottawa Generating Station.

The United States Environmental Protection Agency (USEPA) has indicated to the AQD that treatment systems meeting the proposed definition contained in the May 23, 2002, Federal Register Notice of proposed rulemaking can be approved on a case by case basis. Specifically, the USEPA has proposed the following definition for treatment systems under 40 CFR Part 60, Subpart WWW:

> "Treatment system means a system that filters, de-waters, and compresses the landfill gas."

Furthermore, the preamble to the proposed regulations says:

> "At a minimum, the system must filter landfill gas using a dry filter or similar device (e.g. impaction, interception, or diffusion device). The filter should reduce particulate matter in the gas stream. This will prolong the life of the combustion device and decrease the buildup of material on combustion device internals, which will support good combustion. Good combustion is essential to ensuring the proper destruction of NMOC. In addition, the system must de-water landfill gas using chillers or other dehydration equipment. The dewatering equipment should reduce moisture content of the gas, which will maintain low water content in the gas and will prevent degradation of combustion efficiencies. Finally, the system must compress landfill gas using blowers or similar devices. Compression should further reduce the moisture content of the gas and raise gas pressure to the level required by the end combustion device."

According to information attached to the above letters, landfill gas generated by the Ottawa County Farms Landfill is sent to a treatment system at the Ottawa Generating Station, where the landfill gas is compressed, dewatered and filtered prior to combustion in the internal combustion engines and the open flare at the generating station. More specifically, the landfill gas first enters a 36-inch diameter condensate/liquids knockout tank for gas dewatering, a 42-inch diameter carbon steel scrubber tank with scrubber pad for gas dewatering, one of two AC Compressor 150 horsepower model 19S rotary vane compressors for compressing the gas to 12-15 pounds per square inch gauge, one of two radiator style after-coolers which cool the compressed gas from 200 °F to approximately 125 °F, a Ruiter coalescing filter with 0.3-micron coalescing filters for filtering the gas, and a refrigerant fuel gas dryer for dewatering the gas and temperature control for optimum combustion.

Based on the information provided above and consistent with previous determinations made by the USEPA for similar processes, the AQD agrees that the steps the Ottawa Generating Station is taking to treat landfill gas prior to combustion meets the intent of a "treatment system" as stated in 40 CFR Part 60.752(b)(2)(iii)(C).

Be advised that any landfill gas that is emitted from any atmospheric vent from the gas treatment system shall be subject to the requirements of paragraphs 40 CFR Part 60.752(b)(2)(iii)(A) and (B). Additionally, any moisture that is removed from the landfill gas treatment system shall be treated as leachate in accordance with Part 115, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (Act 451).

Lastly, this designation of having a treatment system does not absolve your obligations under ROP No. 1996000290. However, it is recognized that a significant modification application was submitted to the AQD on March 26, 2004 requesting changes to ROP No. 1996000290 to incorporate the use of the "treatment system" option per 40 CFR Part 60.752(b)(2)(iii)(C) and to remove initial performance test requirements required by the NSPS for internal combustion engines and an open flare located at the Ottawa Generating Station.

If you have questions regarding this letter, please contact me at the telephone number below.

Sincerely,

David L. Morgan
Environmental Quality Analyst
Air Quality Division
616-356-0009

DLM:KO

cc: Mr. Jeff Gahris, EPA, Region V
Mr. Qaiser Baig, EMCON/OWT Inc.
Mr. Khaled Mahmood, EMCON/OWT Inc.

NSPS BACKGROUND INFORMATION DOCUMENT

The requirement to collect gas from areas containing solid waste was changed from 2 years at proposal for all areas, to 5 years for active areas and 2 years for closed or final grade areas. A summary of comments on this requirement and rationale for the change is contained in section 1.2.2.7 on "System Expansion."

The proposed requirement to maintain negative pressure at wellheads was not changed. The EPA has, however, provided for three exceptions when it may not be possible for sources to maintain negative pressure at wellheads. These exceptions are also discussed in section 1.2.2.7.

The proposed requirement for operation of the collection system with nitrogen levels less than or equal to 1 percent was revised to 20 percent based on new information received since proposal. An alternative provision for maintaining an oxygen level less than or equal to 5 percent, and an additional provision maintaining a temperature of less than 55 ^{o}C (or a higher established temperature) were added. The rationale for these changes is provided in section 1.2.2.6 on "Monitoring of Operations."

A significant new requirement to operate the gas collection system with a surface methane concentration less than 500 ppm (along with monitoring provisions to ensure maintenance of this concentration) was added after proposal. This surface emission limit was included under the operational standards, because the EPA is using it to verify that the system is adequately operated and maintained and not to ensure an emission limit, surface or otherwise, as normally constructed under Section 111. The rationale for this requirement is also provided in section 1.2.2.6.

The requirements to vent all emissions to a treatment or control device and to operate the device at all times when the emissions are being routed to the device have not changed

APPENDIX H

CERTIFICATION STATEMENT

CERTIFICATION STATEMENT

I certify that the Updated Landfill Gas Collection and Control System Design Plan for the Ottawa County Farms Landfill was prepared in general accordance with the requirements of 40 CFR 60 Subpart WWW.

Signed,

Tamara A Perkins 5/20/16

Tamara A Perkins, P.E.