Landfill Gas Collection Assessment

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Jacobs Engineering Group Inc.

1100 112th Avenue NE
Suite 500
Bellevue, WA 98004-5118
United States
T +1.425.453.5000

www.jacobs.com

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Contents

1. Overview

King County Solid Waste Division (KCSWD) owns and operates the Cedar Hills Regional Landfill (CHRLF) in King County, Washington. CHRLF has been in operation since 1965. The oldest area of the landfill is the unlined Main Hill and Area 8 is actively receiving waste (Figure 1).

As part of operations, KCSWD collects landfill gas (LFG) from a series of horizontal and vertical collectors located throughout the waste mass (Figure 2). There are 729 active LFG collectors at CHRLF. The horizontal and vertical collectors are connected to a header system which conveys the majority of the LFG to the North Flare Station (NFS) (Figure 3) for destruction or in a pipeline to BioEnergy of Washington (BEW) for processing. Since October 2010, KCSWD has contracted with BEW to deliver LFG to their gas-to-energy facility which processes the gas into pipeline quality biogas. Gas that does not go to NFS/BEW is sent to an onsite low-Btu flare.

Prior to November 2019, the gas quantity collected from the landfill and routed to BEW was averaging above 9,000 standard cubic feet per minute (scfm) at 50 percent methane by volume but beginning in November 2019 both the quantity and quality of LFG began to show a steady decline. There was an abrupt decline of approximately 500 scfm in May 2020, but this has since been attributed to the recalibration of the flow meter. The decline which began in November 2019 has continued, with December 2020 flows in the 6,700 scfm range at the NFS. Overall, the BEW collection system has lost approximately 1,800 scfm in just over a year.

KCSWD has performed several studies and pilots to increase gas collection efficiency and to determine the cause of the decline and determine whether it represents a change in LFG generation and/or collection, but has not come to any definitive conclusions. The changes that were made did not yield improvements to the quantity of gas being collected, although there was some improvement in quality with respect to lower concentrations of nitrogen in the gas being delivered to BEW. For this assessment, KCSWD contracted with Jacobs Engineering Group Inc. (Jacobs) and Herrera Environmental Consultants (Herrera), who subcontracted with SCS Engineers (SCS) (Consultant team), to collaborate in determining possible reasons for the LFG decline and to provide recommendations for potential improvements. The Consultant team has reviewed existing compliance and performance data previously collected and evaluated by KCSWD, as well as data relating to landfill operations and installation of LFG collection infrastructure. The Consultant team also performed LFG generation and recovery modeling. This report summarizes the information provided and analyses performed, identifies and discusses possible causes of reduced collection and/or generation, and presents recommendations for improvements that could potentially increase LFG collection efficiency.

The following subsections provide a brief overview of conditions that may affect LFG generation and collection. This information is general in nature and provides some basic background on LFG generation and challenges with LFG recovery. This background information also helps with the interpretation and understanding of operating/monitoring LFG data collected and the overall performance of the gas collection and control system (GCCS).

1.1 Rate and Total Volume of LFG Production

The rate of LFG production, total volume produced, and quality of gas (i.e., methane concentration) is dependent on many factors, including:

- Amount and rate of waste deposition
- Type of refuse deposited (type and quantity of organics)
- Moisture content of refuse deposited

- Surface water infiltrating deposited refuse (either as rain, snowmelt, direct surface water run-on, irrigation, or recycled leachate)
- Amount of air remaining in refuse (or amount of air allowed to enter refuse after deposition)
- Age of refuse

Moisture is a major factor in gas production. Waste that is deposited wet or that is exposed to rainfall, snowmelt, surface water infiltration, groundwater infiltration, leachate recirculation, or irrigation after burial tends to decompose more quickly and produce LFG at a greater rate over a shorter period of time than relatively dry refuse.

The rate at which gas is produced will vary significantly between landfills in wet and dry climates. For a landfill in a wet region, gas will be generated at a high rate, with a high peak rate, and decline faster than a landfill in a dry region. Conversely, a landfill in a dry region will generate gas at a slower rate, with a much lower peak rate and very slow decline rate.

Regardless of the rate of gas production, landfills of the same size (i.e. organic content) in dry or wet climates have the potential to produce nearly the same volume of gas over their lifetimes.

1.2 Presence of Liquid in LFG Wells and Collectors

Since CHRLF receives an average annual precipitation of 56 inches, it is considered a "wet region" landfill by the solid waste industry. Relative to "dry region" landfills, wet region landfills have waste with higher moisture, experience earlier peak LFG generation (within 9 to 18 months of waste placement) and have a greater peak LFG generation rate. After peak LFG production is achieved, production declines at a faster rate than dry region landfills.

Wet region landfills are characterized by zones of saturated waste that occur as either perched layers of saturation, pockets of liquid, or a combination of both. Saturated liquid zones do not easily drain through waste due, in part, to the amount of plastics in the waste and/or the occurrence of layers of consolidated material (e.g., low permeability cover soil).

Leachate collection systems do not efficiently remove perched layers or pockets of liquid because the zones of saturation do not necessarily extend to the bottom of the landfill where the leachate collection system is located. Perched layers (zones) of liquid are often encountered during the drilling of vertical extraction wells. When a perched layer is encountered during drilling, liquid will fill the bore hole as the well is being installed and can remain in the gas well for months or years. Liquid level measurements in wells do not distinguish whether liquid is from a perched zone or extends to the base of the landfill. This makes it difficult to thoroughly understand how much liquid is stored within the waste mass.

LFG produced in saturated waste will "bubble up" into an unsaturated zone where it can be captured by the nearest well/collector or escape to the atmosphere or surrounding soils. In unsaturated zones, LFG gas movement is generally in the horizontal direction, as the permeability in the horizontal direction can be up to 10 times greater than the vertical direction. While LFG production continues even when the waste is saturated, LFG recovery from saturated waste is inhibited by liquid that infiltrates into the wells/collectors. This makes it challenging to recover LFG from wet sites.

Methods of managing liquids in the waste mass for landfills in wet climates (thereby enhancing LFG recovery) include installation of temporary or interim cover systems that minimize/prevent infiltration of precipitation, reducing the surface area of active waste disposal, enhancing storm-water runoff features, installing more wells and collectors at a closer spacing/density, and designing/installing more robust gas wells and collectors that incorporate design features that allow for dewatering of liquids that may accumulate in the wells/collectors.

1.3 Site Conditions and GCCS Design

Other landfill conditions and GCCS design factors can cause a decline in LFG recovery, aside from the liquid in the extraction network, including the following:

- Aerobic conditions can develop because of air intrusion, subsurface thermal oxidation, or other factors that inhibit methane producing bacteria, thereby inhibiting or halting LFG generation.
- Damage to wells/collectors can occur due to a lack of a robust design and/or construction, differential settlement, limited maintenance, or inadvertent damage from maintenance and/or landfill operations.
- Blocked pipes from condensate gathering in low points of collection piping caused by differential settlement and/or insufficient pipe slope.
- Biological, chemical, or other types of fouling of wells, collectors, or conveyance pipes that block gas flows and cause frictional loss.
- Submerged portions of the perforated pipe segments of wells and/or collectors due to lack of dewatering features.
- Insufficient wellfield operations, such as infrequent monitoring and/or balancing can lead to sub-optimal performance and potentially the development of aerobic conditions.
- Insufficient vacuum distribution in the gas conveyance pipe that limits available system vacuum at the individual wells and collectors.
- Insufficient distribution and density of well and collectors.
- Unnecessarily large active and inactive areas that contribute to air intrusion.
- Wells and collectors with little or no means to remove any leachate that may accumulate in the perforated pipes.
- The installation of wells and collectors after gas generation has already reached peak generation and is in a state of decline. The longer the period between the last waste being placed and well/collector installation, the lower the gas recovery.
- Inconsistent and/or low frequency of GCCS expansions. Wells and/or collectors that are not installed on an appropriate schedule prevent the early recovery of LFG being generated in the year after the waste is placed.
- Decreased flow and inhibited methane generation can also occur at landfills with some of the following characteristics: deep and wet waste; primary gas ratio (i.e. methane/carbon dioxide) decreasing over time; elevated carbon dioxide and hydrogen in LFG; and leachate with high Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Suspended Solids (TSS) and/or low pH.

An example of the third to last bullet item above is when wells/collectors at a wet region landfill are installed in areas where final grades have been established, meaning the waste is likely older than 2 years. LFG recovered from wells/collectors under these conditions is gas being generated after the peak has been achieved.

An example of the second to last bullet item above is when the GCCS is expanded at five-year increments. The LFG recovery curve, when plotted, appears like a “saw tooth” trend line and illustrates how the projected recovery declines every year for four years before dramatically increasing in year five when additional gas wells/collectors are installed in newer areas of waste disposal. Installing wells and/or collectors on a more frequent and consistent interval (e.g., every year) can potentially enhance LFG recovery and avoid an uneven trend in gas recovery.

2. Compliance Data Review

2.1 Nasal Ranger Data

KCSWD provided data from regular (sometimes multiple times per day) odor analyses performed using a Nasal Ranger, a field olfactometer which can measure and quantify odor strength in ambient air. The Nasal Ranger does not identify the odor; the user of the device must classify the smell. KCSWD provided Nasal Ranger data for the period from December 2018 to August 2020, and flagged odors with a value greater than 2 as significant. During each monthly event, the Nasal Ranger is used to monitor in locations that are spread across the site from the administrative office to the individual areas of the landfill. Based on the data provided, odors of LFG were noted 11 times out of 4,767 measurements taken during the data period. In all 11 instances, the LFG odor value that the Nasal Ranger returned to the user was less than 2. The majority of values that exceeded 2 were identified as either compost or fresh refuse, most likely from the working face that is actively receiving refuse.

In summary, the Nasal Ranger data review does not support that LFG is escaping the site into the ambient air.

2.2 Serpentine Data

KCSWD provided data for quarterly serpentine methane monitoring (surface emission monitoring or SEM) performed during the period between January 2018 and October 2020. During this time, SEM was performed on all areas of the landfill which have been closed. Although the federally regulated methane threshold for SEM is 500 parts per million (ppm), KCSWD uses a lower value of 100 ppm at CHRLF as the action level for KCSWD to investigate possible LFG emissions. Methane concentrations below 100 ppm are not recorded during the initial monitoring events. At locations where methane in excess of 100 ppm was recorded, rechecks were performed at 10 days and 30 days after the initial measurement. For the rechecks, all concentrations of methane detected were recorded, even if lower than 100 ppm.

There were no measurements of methane over 100 ppm in the year 2018 or the 1st quarter of 2019, which indicates collection of the LFG was efficient and there were no compromises in the system. In the 2nd quarter of 2019 there were two locations during the SEM that recorded methane in concentrations greater than 100 ppm. These readings were attributed to closed wellheads and a compromised lateral. Both issues were remediated and 10- and 30-day rechecks resulted in concentrations less than 100 ppm. The 3rd quarter SEM event was free of methane above the site action level, but the 4th quarter of 2019 recorded two methane measurements above 100 ppm. These occurred in Area 7, where the liner was punctured during cover soil placement, and along the anchor trench of Area 6. The Area 7 liner was repaired, and balancing adjustments were made to nearby wells. The 10- and 30-day rechecks in this area did not record methane above 100 ppm. Wells near the Area 6 anchor trench were adjusted, and the 30-day recheck recorded methane above the action level but below the federal compliance limit of 500 ppm. The 1st quarter of 2020 had several measurements above 100 ppm, which were remediated to below the federal compliance limit by the 30-day recheck. The 2nd quarter had one measurement above 100 ppm which was remedied by the 10-day recheck. The 3rd and 4th quarters of 2020 measured no methane above the CHRLF action level.

The SEM data indicates that KCSWD has taken immediate action when methane is measured above the site action level of 100 ppm during surface emissions monitoring. All of the measurements were compliant with the federal limit within the 30-day rechecks. The data suggests that LFG is being effectively captured in the areas where SEM is performed.

2.3 Probe Data

KCSWD also provided LFG probe data from January 2018 to December 2020. CHRLF has 145 LFG probes, which are monitored monthly to assess the performance of the LFG collection system in controlling gas migration. Fifty-two of the probes are performance probes located within the limits of waste placement. The remaining 93 are compliance probes located around the perimeter of the landfill. Seven of the performance probes have shown fluctuating methane concentrations that often exceed 5 percent by volume. None of the compliance probes exhibited methane in excess of 5 percent during the reviewed timeframe. Based on the data reviewed, the Consultant team finds no evidence to suggest that unrecovered LFG is migrating off-site.

3. Performance Data Review

3.1 Flow Data

A review of the historical landfill gas recovery rates (flow data) was performed to examine the trends in LFG recovery and compare these trends to other site activities and the LFG recovery model results (discussed in Section 3.4). This review, in conjunction with LFG recovery modeling, helped provide a better understanding of the increases and decreases in historical LFG recovery rates at CHRLF.

A summary of historically measured landfill gas recovery rates for the total site, as measured at the NFS, is presented in Appendix A and Figure 4. The table and figure show the average monthly flow rate and average yearly flow rate in scfm (normalized to 50 percent methane by volume) from 1992 to 2020. This data was derived from daily methane and flow rate data provided by KCSWD.

The daily flow rate was measured at the flow meter at the NFS. The instrument is a thermal anemometer type flow meter manufactured by Fluid Components International (model GF-90). The daily methane content, used to determine the normalized flow and Btu rate, was measured manually once per day at the NFS prior to 2018 (using a portable gas analyzer, GEM 2000 and/or 5000). From 2018 to the present, the daily methane content was measured at the BEW plant with a continuous stationary gas chromatograph / mass spectrometer (GC/MS) that records measurements every 15 minutes.

It should be noted that the methane and flow measurement instruments and frequency of measurement have changed over the years, so the data over this time period is not consistent and will have variations that cannot be quantified. Regarding the accuracy of the flow meter, in May of 2020, the flow meter was calibrated and found to be off by more than 500 scfm (i.e., greater than 5 percent of the lower flow rate after calibration). There is no way of knowing when the inaccurate recording started or the range of drift in the data. Nevertheless, the data is still valuable for use in assessing site conditions relative to LFG recovery.

As can be seen by Figure 4, starting in 2006 with the filling of Area 6, there is a relatively steady increase in LFG recovery through 2019, based on average annual flow rates. The figure also shows monthly flow rates with periodic short decreasing trends in flow rates, for example:

- 8-month decrease of 1,062 scfm - February to September 2011 (10,449 to 9,387)
- 8-month decrease of 1,006 scfm - January to August 2012 (10,449 to 9,443)
- 10-month decrease of 1,310 scfm - October 2014 to July 2015 (10,941 to 9,631)
- 7-month decrease of 972 scfm - November 2015 to May 2016 (11,751 to 10,779)
- 10-month decrease of 2,594 scfm - September 2019 to June 2020 (11,649 to 9,055)

The latest decreasing trend is the most significant. These sharp declines in gas recovery may be partially attributed to the high amount of annual precipitation during this time period, which was 6.0 inches greater than the average annual precipitation. Note that within the last 9 years, 5 of those years have seen precipitation 9.3 inches or greater than the average annual precipitation. To better understand these trends, the cumulative active wells and operating wells and collectors were plotted on Figure 4. The total cumulative count of active, available wells and collectors for each month since the beginning of filling in Area 6 were consolidated to annual average values for use with the LFG recovery tables and graphs. As can be seen on Figure 4, the cumulative average annual number of active/available wells and collectors shows a relatively steady increase similar to the generally steady increase in LFG recovery. This trend shows the number of active/available wells and collectors and does not consider the wells and collectors that have no flow or no vacuum due to operational issues.

Figure 4 also shows the cumulative average number of open wells (wells with vacuum and/or flow). The open wells and collectors represent approximately one third of the number of active/available wells and collectors. The trend for the cumulative average annual number of open wells has a lower steady increase when compared to the historical LFG recovery and cumulative average annual number of active/available wells and collectors. This suggests a slight overall decreasing trend in LFG recovery over the time period. This decreasing trend may be due to several factors that are described in Section 1.

Another observation from reviewing the figure is the dramatic drop in LFG recovery when transitioning from one landfill area to the next. When one area is finished and another area begins filling, there is a dramatic drop in overall LFG recovery, followed by a slower rate of increase eventually regaining and surpassing the previous LFG recovery peak. For example, Figure 4 shows the following:

- From Area 4 to Area 5 a decrease of 2,112 scfm – March 1999 to April 2002 (10,612 to 8,500)
- From Area 5 to Area 6 a decrease of 2,204 scfm - May 2005 to April 2007 (10,917 to 8,713)
- From Area 6 to Area 7 a decrease of 1,062 scfm - February to September 2011 (10,449 to 9,387)
- From Area 7 to Area 8 a decrease of 2,379 scfm - November 2019 to November 2020 (11,207 to 8,828)

The above conditions of transition, from one landfill area to the next, reflect the lag response of both LFG generation from the new active area, and the lag response of LFG recovery from activating the newly installed horizontal gas collectors. The new waste takes longer to produce LFG in a new area and the horizontal gas collectors are not immediately activated. As the waste profile gets thicker, the horizontal collectors can be activated.

Also, the recently closed landfill area is now in a state of declining LFG generation so the combination of moving to a new area and closing the previous area compounds the effect of decreasing LFG recovery during these time periods. After several lifts of waste are deposited with activation of horizontal gas collectors, the LFG recovery begins to rebound and continues to increase until the area is closed.

3.2 Header Vacuum Data

KCSWD provided vacuum and flow data at the NFS for the period from June 2017 to mid-December 2020. The monitoring location at the NFS is labeled as GF-90. At this location, the flow and vacuum are totalized for the site. KCSWD also provided vacuum gauge readings from header locations across the site; however, this data only extends into early November 2020. There are a total of 14 header vacuum gauges that span the extraction system from the NFS to the south end of the site. As of November 6, 2020, which is the last date for which data was provided, 9 of the 14 gauges are either out for repair or have stopped recording. The 5 remaining header vacuum gauges, which were used in the analysis, are labeled as follows:

1. Meter 2 – Central Header Main Hill (gauge #4102017)
2. Meter 7 – 4 Interior East (gauge #4102025)
3. Meter 9 –4 Interior East Crossover Header (gauge #4102015)
4. Meter 11 – 4 Interior West Crossover Header (gauge #4102024)
5. Meter 14 – 4 Interior North Near NFS (gauge #4102016)

This section will focus in on the timeline that KCSWD has provided which identifies November 2019 as the beginning of the decline in flow quantity and quality. During the time period between November 2019 and October 2020, the NFS maintained a relatively consistent vacuum on the wellfield that averaged -30 inches water column (in-wc). On October 27, 2020, KCSWD adjusted two isolation valves within the collection and conveyance system looped network in attempts to improve the LFG quality (reduce nitrogen and oxygen). The isolation valve adjustments were successful in reducing the nitrogen and oxygen concentrations; however, the adjustments also had the unintended effect of isolating the piping network such that it was no longer functioning as a loop system. This resulted in an increased vacuum of -60 in-wc (inches of water column) at the NFS. The NFS blowers do not currently contain operating variable frequency drives (VFDs); therefore, blower speeds cannot be turned down to reduce the vacuum. By isolating or cutting off the loop system that allows gas to flow by the shortest and most efficient route, increased friction within the piping system further reduced the flow of LFG. While the quality of gas reached a more acceptable level, the quantity declined due to losses caused by the additional length that the gas must travel through the piping network to reach the NFS. Prior to the isolation valve adjustment, gas flow to BEW in the month of October 2020 was averaging just above 7,000 scfm. Since the valve adjustment flow has dropped to an average of 6,600 scfm.

Three of the five header vacuum gauges included in this analysis experienced an increase in vacuum that matched the increase observed at the NFS as a result of the valve closing exercise that took place on October 27, 2020. Meters 7 (4 Interior East), 9 (4 Interior East Crossover Header) and 14 (4 Interior North Near NFS) all displayed a vacuum increase of approximately -30 in-wc (from mid/upper -20s to mid/upper -50s) which matches the vacuum increase observed at GF-90. One of the remaining vacuum gauges, Meter 11 (4 Interior West Crossover Header), experienced an increase in vacuum from around -20 in-wc to the mid -30s in-wc, which is half of the increase observed at GF-90.

The only operational header vacuum gauge which did not experience an increase in vacuum corresponding to the valve adjustment is Meter 2 (Central Header Main Hill) which is located on the Central Header on the south side of the Main Hill. Before the valve adjustment in October 2020, vacuum readings at this meter were in the low -20s in-wc. After the valve exercise the vacuum dropped to -10 in-wc. The data suggests that there is substantial vacuum loss between Meters 2 and 7. Based on the information provided by KCSWD, one of the valves that was partially closed is located between these two gauges.

In summary, 4 of the 5 operational header vacuum gauges showed an increase when the vacuum at the NFS was increased. However, beginning at Meter 2 (Central Header Main Hill) and continuing south in a clockwise direction the vacuum loss appears to be inhibiting gas collection. Based on conversations with KCSWD, the Consultant team understands there may be a constriction or blockage in the header at the southwest corner of Area 7. Prior to the valve exercise, the gas that had a route down the Central Header past Meter 2 (Central Header Main Hill) is now taking a longer path clockwise around Area 7 and Area 8 going northbound to the NFS along the West Perimeter header. KCSWD is currently addressing this issue as part of the 2021 construction season with a relocation of the header to be placed on top of Area 7. That problem, however, does not explain the vacuum loss at Meter 11 (4 Interior West Crossover Header), which is relatively close to the NFS, and the loss at Meter 2 (Central Header Main Hill) prior to the valve adjustment. The Consultant team would expect all of the vacuum readings in the header to be closer to the readings at GF-90, as are Meters 14, 9, and 7. In accordance with standard design and operation practice, vacuum loss should not exceed 1 in-wc per 100 feet of pipe. Greater vacuum loss is often an indicator of compromises in the header pipe system.

3.3 Landfill Gas Collection Data

Currently, CHRLF has 729 active LFG collection structures installed in the landfill waste mass. The majority of the structures are horizontal collectors that are installed as filling progresses in the lifts of waste. The remaining structures are vertical wells that are located primarily in older areas of the landfill (Area 2/3, Area 6, and Central Pit). Each collection structure is outfitted with a wellhead which enables field technicians to take gas measurements at the well. Of the 729 LFG collection structures, 357 have modern precision valve wellheads installed. These wellheads enable small adjustments to be made to the valve which modulates the flow of gas through the wellhead. The remaining LFG collection structures have either gate or butterfly valves, which allow very little modulation of gas flow through the wellhead. Table 1, below, provides a breakdown of collector and wellhead valve types by collection system.

Table 1: Summary of LFG Collectors at CHRLF

LFG Destination	Total Number of Collectors	Collector Type		Valve Type	
		Horizontal	Vertical	Precision	Butterfly/Gate
NFS/BEW	608	504	104	349	259
Low-Btu Flare	121	92	29	8	113
Totals	729	596	133	357	372

3.3.1 Wellhead Data

KCSWD has provided data for each individual well across the landfill during the period from January 2018 to early December 2020. At first look, gas production appears to be the highest in Area 7; however, high methane percentages in individual wells are not necessarily an indicator of good gas collection. To demonstrate this, we have explained the data for two different wells in the following paragraphs.

The first well, A7L4NWC1, appears to be a good LFG producer. This well is a horizontal collector installed in the northwest part of lift 4 of Area 7. The gas quality (methane content) of this well has consistently been in the 60 percent range over the data period. As of December 2020, the methane content is 58.9 percent with 0.2 percent oxygen and no nitrogen. On the surface these numbers look very positive from an LFG generation perspective. However, comparison of the applied and system pressures indicates that the LFG is not being collected effectively, and this data likely represents gas buildup rather than gas collection. The applied pressure at this well averaged -19.25 in-wc in September 2020. The system pressure at Meter 5(southeast West Perimeter header), the nearest header vacuum gauge, was last recorded in September 2020 at -16.8 in-wc. The fact that the applied pressure at the well is so close to the system pressure is an indication that the well has no room to operate, meaning the valve cannot be opened any further to allow the 60 percent methane to equalize down to a more representative concentration. This is also called room to run or available pressure. Several conditions can cause a lack of room to run, including insufficient vacuum, inability to make small valve adjustments, or a watered-in or damaged collection pipe. Furthermore, the field technician who monitors this well has also noted “surging” at the wellhead starting in October 2018, which is an indicator of a watered-in collector. While the gas concentration data suggests this well is producing good quality (high methane and low oxygen/nitrogen) LFG, the pressure data indicates that collection is not optimal.

As a comparison to the horizontal collector data described above, the Consultant team also looked at the gas data for A600DPW2, which is an existing dual-phase vertical well in Area 6. Dual-phase indicates that the well collects gas but is also fitted with a pump that is submersed inside the vertical well casing to collect and remove liquid. The gas data for this well is consistent through the data timeline, averaging 53 percent methane and 0.8 percent oxygen for the year 2020. As of late November, the applied pressure of the well measured -0.7 in-wc and the system pressure at the nearest header vacuum gauge, Meter 7 (4 Interior East), measured -55.3 in-wc. These pressure readings indicate that this well has plenty of room to run. It has a substantial amount of system pressure available, and the pump in the well allows the perforations to stay mostly open, allowing for good gas collection.

The Consultant team also reviewed data that was provided by area for wells in Areas 2/3, Area 4, Area 5, Area 6, Area 7, and Central Pit. In evaluating the data, we mirrored KCSWD's analysis by including only the wells that are open (i.e., wells with both flow and vacuum). Table 2 lists the number of wells in each area that were identified by KCSWD as contributing reasonable quality and quantity of gas to the NFS/BEW.

Table 2: CHRLF LFG Wells by Area Currently Contributing to NFS/BEW

	Area 2/3	Area 4	Area 5	Area 6	Area 7	Central Pit
Wells that Contribute to NFS/BEW	2	5	18	16	29	20
Total Wells in Area	12	155	61	118	160	173
Percent of Total Wells in Area that are Open	16.7%	3.2%	29.5%	13.6%	18.1%	11.6%

Table 2 suggests that areas with waste closest to peak gas generation are not being fully utilized. Area 7, for example, has 29 out of 160 wells that are open and sending gas to NFS/BEW. The remaining 131 wells are closed. This contrasts with Area 5, where nearly 30 percent of the wells are being utilized. LFG quality and quantity from open wells in each of the areas over the two-year data period are presented graphically in Appendix B.

3.3.2 Header Collection Data

KCSWD has provided flow data for the three main headers that are routed the NFS/BEW (Central, 4 Interior, and West Perimeter). The data indicates that the valve adjustment conducted in late October 2020 impacted the flow in all three. The West Perimeter saw the largest change in flow, increasing from below 3,000 scfm to approximately 4,500 scfm in December 2020. This header also saw a positive change in gas quality as well. Methane percentages increased and oxygen/nitrogen concentrations decreased. Both the 4 Interior and Central Headers show a negative impact from the valve exercise. The quality of LFG in the Central Header remained the same; however, the flow dropped from around 3,000 scfm to approximately 1,800 scfm. The 4 Interior saw an approximate 1,500 scfm drop in flow, methane decreased, and nitrogen increased.

3.4 LFG Recovery Modeling

This section of the report summarizes the data, assumptions, and methods used to develop the LFG recovery projections for the CHRLF that are provided in Exhibits 1 through 11 in Appendix C. The Consultant team prepared the LFG recovery projections using SCS's proprietary LFG model, waste disposal and LFG collection data, and an assessment of the CHRLF collection system performance.

3.4.1 Introduction

The LFG model used by the Consultant team applies the same first-order decay equation as the U.S. Environmental Protection Agency's (EPA's) Landfill Gas Emissions Model (LandGEM). Unlike LandGEM, which estimates LFG generation, the LFG model developed by SCS estimates the LFG recovery potential, which is the maximum amount of LFG a fully comprehensive, efficiently operated GCCS can recover. The LFG recovery potential is estimated by applying model k (methane generation rate) and Lo (potential methane generation capacity) factors that are calibrated to LFG flow rates measured at the landfill being modeled, or developed by SCS using a database of over 1,200 years of LFG flow and methane data from 253 landfills with operational LFG collection systems.

Expected LFG recovery given the limitations of the actual or proposed collection system is calculated by multiplying the recovery potential by the estimated fraction of LFG that is effectively collected, a measure referred to in these projections as collection system coverage. Collection system coverage is analogous to collection efficiency, except that collection system coverage describes the fraction of potentially recoverable LFG which is collected, while collection efficiency describes the fraction of generated LFG which is collected. Realistic estimates of collection system coverage based on the existing system design and performance, and planned GCCS build-out schedules, can then be applied to the model projections of the LFG recovery potential to derive estimates of expected recovery.

3.4.2 Data Used to Develop LFG Recovery Projections

LFG recovery projections provided in this report are based on the following information, which was provided by KCSWD, was available in SCS data files from prior work evaluating LFG recovery at CHRLF, or is available on-line:

- Annual total waste disposed from 1965 through 1999 was provided in “2019 D-Tonnage History.xls”.
- Annual total waste disposed from 2000 through 2020, forecasted waste disposal rates for 2021 through 2040, and the total site capacity including Area 9 (69 million tons), were provided by KCSWD in an email on January 6, 2021.
- Acreage and waste depths with daily, intermediate, and final cover in 2016 through 2019, and annual LFG recovery data for 2016 from the Methane Reporting Rule (MRR) Greenhouse Gas (GHG) emissions reports for 2016 through 2019, which are available on a U.S. EPA website.[1]
- Waste characterization studies performed for KCSWD in 1996, 2009, 2011, and 2019 provided information on the characteristics and fractions of municipal solid waste (MSW), construction and demolition (C&D) waste, sludge, and inert wastes disposed.
- The historical allocation of annual waste tonnages into each disposal area was calculated based on estimated in-place waste densities and information provided in Figure 1 (“CHRLF Features”) from “Area 7 Gas Collection and Control System Evaluation Cedar Hills Regional Landfill (Draft), King County, WA” (“Area 7 Report”) (dated December 2020).
- Estimated future annual waste tonnages allocated to Area 8, Area 9, and on top of Areas 5 and 6 are derived from estimated in-place densities and information on waste volumes (in place and remaining capacities) in each disposal area provided in an MSW Permit for the CHRLF by King County Environmental Health Services Division (PR00115736), dated May 7, 2019.
- Annual average LFG recovery and methane concentrations of recovered LFG in 1992 through 2015 was calculated from data provided by KCSWD for a prior LFG modeling study prepared by SCS in 2015.
- Annual average LFG recovery and methane concentrations of recovered LFG in 2017 through 2020 were calculated from average daily flows to each device and methane concentrations measured at the BEW plant, provided by KCSWD (“SCADA daily data”), after excluding days with missing, bad, or anomalous data.
- Site drawings showing the current GCCS layout were provided in the December 2020 Area 7 Report.
- Wellfield monitoring data covering January through December 2020 was derived from measurements taken during this time period and reported in “Gas Operator Field Reports” provided by KCSWD.
- Annual average precipitation (56 inches) experienced at the site is based on historical climate data for Landsburg, WA.[2]

3.4.3 Landfill Background and Waste Disposal Estimates

The CHRLF began operation in 1965, has approximately 43 million tons of waste in place currently, and a total site capacity of 69 million tons. Based on projected waste disposal rates, the CHRLF is expected to reach capacity and close in 2046.

The CHRLF waste footprint currently covers approximately 283 acres. Historical and projected waste disposal in existing and future disposal areas are described as follows:

- The Main Hill, Southeast Pit, and Central Pit Areas, which combined received approximately 12.0 million tons (18.3 million yd^3) of waste from 1965-1988.
- Area 2/3, which received approximately 4.9 million tons (9.15 million yd^3) of waste from 1988-1991.
- Area 4, which received approximately 7.0 million tons (10.2 million yd^3) of waste from 1991-2000.
- Area 5, which received approximately 5.25 million tons (8.4 million yd^3) of waste from 2000-2005 and is projected to receive another 724,000 tons (1.1 million yd^3) of waste on the top deck in 2025-2026.
- Area 6, which received approximately 4.4 million tons (6.8 million yd^3) of waste from 2005-2010 and is projected to receive another 856,000 tons (1.4 million yd^3) of waste on the top deck in 2026-2027.
- Area 7, which received approximately 8.1 million tons (9.1 million yd^3) of waste from 2010-2019.
- Area 8, which started receiving wastes in 2019 and is expected to be full in 2028 after receiving approximately 6.5 million tons (7.8 million yd^3) of waste.
- Area 9, which is projected to receive approximately 19.3 million tons from 2028-2046.

Waste disposed prior to 2019 was estimated to consist of approximately 7-13% C&D waste, 1-5% inert materials, and the remainder MSW based on historical waste composition data for King County. Disposal in 2019 and later years is estimated to consist of 73% MSW, 16% C&D waste, and 11% inert materials based on 2019 waste composition data for King County.

3.4.4 LFG Collection System and Historical LFG Recovery Rates

CHRLF has a comprehensive GCCS with an extraction network of over 729 vertical gas wells and horizontal gas collectors. Vertical gas wells were used in the older areas of the landfill (Main Hill, Southeast Pit, Central Pit) while horizontal gas collectors have been used in the newer areas of the landfill (Area 2/3, Area 4, Area 5, Area 6, Area 7, and Area 8). The GCCS also includes a gas conveyance pipe system, condensate disposal system, blower flare station, and a booster blower station to send LFG to BEW. In addition, the GCCS includes a subsurface LFG migration monitoring network.

SCS used actual LFG recovery rates to calibrate the LFG recovery model by adjusting model input parameters to correlate projected recovery with collection system coverage and measured LFG flows. Annual average LFG flows, methane content, and LFG recovery adjusted to 50% methane in 2017 through 2020 are shown in Table 3.

Table 3: CHRLF 2017-2020 Annual Average LFG Recovery Rates

Year	LFG Recovery (scfm)	Average % CH_4	LFG Recovery (scfm at 50% CH_4)
2017	10,306	53.3%	10,993
2018	10,587	53.7%	11,331
2019	10,516	53.6%	11,276

2020	9,133	52.6%	9,611

Table 3 shows that average annual LFG recovery reached maximum levels of approximately 11,300 scfm at 50% methane in 2018 and 2019 but declined significantly in 2020. Monthly average LFG recovery rates in 2020 are shown in Table 4. The monthly data for 2020 show that LFG recovery adjusted to 50% methane declined below 10,000 scfm in May, reached a low of 8,572 scfm in December, and averaged 9,064 scfm between July and December. Based on the declining monthly flow rates during 2020, the July-December average recovery rate (9,064 scfm at 50% methane) was conservatively estimated to be more representative of recent collection system performance and was subsequently used in the LFG model.

Table 4: CHRLF 2020 Monthly Average LFG Recovery Rates

Month	LFG Recovery (scfm)	Average % CH_4	LFG Recovery (scfm at 50% CH_4)
Jan-20	10,006	52.9%	10,588
Feb-20	10,362	52.4%	10,865
Mar-20	9,874	52.4%	10,347
Apr-20	9,935	51.3%	10,195
May-20	9,272	53.3%	9,876
Jun-20	8,622	52.6%	9,078
Jul-20	8,632	52.0%	8,984
Aug-20	8,678	52.6%	9,127
Sep-20	9,207	52.6%	9,688
Oct-20	8,799	52.2%	9,183
Nov-20	8,257	53.5%	8,831
Dec-20	7,949	53.9%	8,572
Jan. – June Average	9,768	52.5%	10,158
July – Dec. Average	8,587	52.5%	9,064

Site drawings of the installed wellfield, wellfield monitoring data, and actual LFG recovery data were evaluated to estimate collection system coverage effectively achieved during 2018-2020 in each disposal area and the total landfill, as follows:

- The Main Hill, Southeast Pit, and Central Pit Areas are estimated to have 95% coverage in 2018-2020.

- Area 2/3 is estimated to have 95% coverage in 2018-2019 and 85% coverage in 2020.
- Area 4 is estimated to have 95% coverage in 2018-2019 and 80% coverage in 2020.
- Area 5 is estimated to have 95% coverage in 2018-2019 and 90% coverage in 2020.
- Area 6 is estimated to have 95% coverage in 2018-2019 and 85% coverage in 2020.
- Area 7 is estimated to have 91% coverage in 2018-2019 and 80% coverage in 2020.
- Total site collection system coverage is the calculated flow-weighted average value across all disposal areas, and is estimated to be 93% in 2018, 92% in 2019, and 76% in 2020 (0% coverage in Area 8).

Collection system coverage was back calculated for prior years with flow data (1992-2017) based on actual LFG recovery as a percentage of the projected LFG recovery potential. From 1998 through 2017, estimated collection system coverage has ranged between 70% and 90%.

Assuming that the installed wellfield is maintained, and current and future wells are installed, repaired and/or replaced as needed in all disposal areas, collection system coverage in future years is estimated to be as follows:

- The Main Hill, Southeast Pit, and Central Pit Areas are estimated to remain at 95% coverage in all future years.
- Area 2/3 is estimated to remain at 85% coverage in all future years.
- Area 4 is estimated to increase to 85% coverage in 2021 and 90% coverage in 2022 and future years.
- Area 5 is estimated to remain at 90% coverage in 2021, and then increase to 95% coverage in 2022 following system improvements, which is maintained except for years during and immediately following waste disposal on the top deck (starting in 2025). Collection system coverage in Area 5 decreases to 85% in 2025 and 2026, before increasing back to 95% by 2028.
- Area 6 is estimated to increase to 85% coverage in 2021, 90% coverage in 2022, and 95% coverage in 2023, which is maintained except for years during and immediately following waste disposal on the top deck. Collection system coverage in Area 6 decreases to 85% in 2026 and 2027, before increasing back to 95% by 2029.
- Area 7 is assumed to have annual collection system expansions and/or improvements over the next 3 years, and is estimated to achieve 85% coverage in 2021, 90% coverage in 2022, and 95% coverage in 2023 and later years after a final cover is completed over the disposal area.
- Area 8 is estimated to achieve 45% coverage with a partial system in 2021, and to steadily increase coverage with annual collection system expansions and/or improvements over the next 10 years, to reach 55% in 2022, 68% in 2024, 76% in 2026, 85% in 2029, and 95% in 2031 and later years after a final cover is completed over the disposal area.
- Area 9 is estimated to start LFG collection and achieve 45% coverage with a partial system in 2030, and to steadily increase coverage with annual collection system expansions and/or improvements over the following 18 years, to reach 55% in 2031, 68% in 2033, 75% in 2035, 80% in 2038, 85% in 2046, and 95% in 2048 and later years after a final cover is completed over the disposal area.
- Total site collection system coverage is estimated to increase to 78% in 2021, 80% in 2022, 82% in 2023, and be maintained between 83% and 86% from 2024 until the landfill closes in 2046. Projected collection system coverage will increase to 90% in 2047 and 95% in 2048 and later years after a final cover is completed over all disposal areas.

3.4.5 LFG Recovery Projections

The LFG recovery model for the CHRLF was developed by the Consultant team using the following input assumptions:

- Historical and projected waste disposal rates that are discussed in Section 3.4.3 and provided in Appendix C, Exhibit 1. The historic and projected future waste disposal rates for each disposal area are presented in Exhibits 4 through 11 in Appendix C.
- Collection system coverage discussed in Section 3.4.4. Total site collection system coverage is estimated to be 76% in 2020, and to increase incrementally over time to reach 83% to 86% coverage from 2024 until the site closes in 2046, after which system coverage is projected to reach a maximum of 95% in 2048.
- Methane Decay Rate Constant (k): The Consultant team assigned a k value of 0.140 per year to MSW, which is a default k value for MSW at sites in this region that receive an average of 56 inches of precipitation annually. Temporary increases were also made to model k values for MSW disposed in Area 7 and Area 8 using a "variable k model" to account for high precipitation in 2010, 2012, 2014, 2017, and December 2019 through February 2020. A model k value of 0.110 was assigned to C&D waste based on the estimated decay rate for the organic fraction (primarily wood) and the estimated ratio of C&D to MSW k values.
- Ultimate Methane Recovery Potential (Lo): SCS assigned an Lo value of 3,630 ft3/ton to MSW based on calibration of the model to actual LFG recovery in 2020, considering estimated collection system coverage. This Lo value is approximately 21% higher than the default Lo value for MSW in landfills in this climate. An Lo value of 2,950 ft3/ton was selected for C&D waste based on its estimated organic content, and the estimated ratio of C&D to MSW Lo values.

The LFG recovery projections for the CHRLF are provided in Appendix C, Exhibits 1 through 11. All LFG flows are shown adjusted to 50% methane content. Exhibits 1 and 2 show LFG recovery projections for the entire landfill. Exhibit 3 shows the LFG recovery potential and LFG recovery from the existing and planned collection system broken out by disposal area. Exhibits 4 through 11 show LFG recovery projections for each disposal area.

Exhibit 1 and Exhibits 4 through 11 provide the following information:

- Annual historical and projected future waste disposal rates.
- Annual tons of waste in place.
- Projected theoretical maximum LFG recovery potential, which is 100% of the maximum amount of LFG that is potentially recoverable with a comprehensive and efficiently operated collection system.
- Estimated collection system coverage.
- Projected LFG recovery from the existing and planned collection system.

Exhibit 2 (graph) provides the following information:

- Projected LFG recovery potential.
- Projected LFG recovery from the existing and planned system.
- Average actual LFG recovery rates in 1992 through 2020.

Model results support that the LFG recovery potential at the CHRLF has been declining since 2018 due primarily to declining disposal rates, and will continue to decline until 2025, and then increase incrementally due to projected increases in waste disposal rates. Projected annual average LFG recovery at 50% methane will decrease slightly over the next two years to 8,911 scfm in 2021 and 8,843 scfm in 2022, despite increases in collection system coverage. Continued system improvements and increases in LFG recovery potential allow projected LFG recovery to increase steadily starting in 2025 to reach 9,263 scfm in 2028. Projected LFG recovery declines from 2029 through 2032 due to limited system coverage during the early years of operation in Area 9, before increasing starting in 2033. Projected LFG recovery reaches 9,322 scfm in 2035, 10,077 scfm in 2040, and a maximum of 11,542 scfm in 2047. LFG recovery is projected to decline rapidly (12.7% annually) after site closure due to the high waste decay rate.

[1] www.ghgdata.epa.gov/ghgp/main.do.

[2] Historical climate summaries are available for Western U.S. states at www.wrcc.dri.edu/Climsum.html.

3.4.6 LFG Recovery Model Limitations and Disclaimer

The LFG recovery estimates provided in this section (3.4) have been prepared in accordance with the care and skill generally exercised by reputable LFG professionals, under similar circumstances, in this or similar localities. Because the input coefficients developed by the Consultant team for modeling LFG recovery at U.S. landfills do not provide information on LFG emissions, they should not be used for any regulatory purpose and are not consistent with U.S. EPA regulation and guidance for LFG modeling for Clean Air Act programs. The LFG recovery projections are based on our engineering judgment as of the date of this report. No warranty, expressed or implied, is made as to the professional opinions presented herein. Changes in the landfill property use and conditions (for example: variations in rainfall, water levels, waste composition, landfill operations, final cover systems, or other factors) may affect future gas recovery at the landfill. The Consultant team does not guarantee the quantity or the quality of the available landfill gas.

3.5 LandGEM Modeling

For comparison purposes, a LandGEM model run was prepared for the CHRLF using total annual waste disposal rates (from Exhibit 1 in Appendix D) and default model input parameters assigned in the model for emissions inventories, which are as follows:

- Methane generation rate (k) is 0.040/year,
- Potential methane generation capacity (Lo) is 100 cubic meters per year (3,204 ft^3/year).

The LandGEM summary report showing model results is provided in Appendix D along with a graph (Figure D-1) comparing the LandGEM LFG generation estimates to the LFG recovery projections and the actual LFG flows. As the graph shows, actual LFG recovery exceeded the LandGEM generation estimates except in 2020, when actual recovery averaged 9,064 scfm and modeled generation was 9,304 scfm. The low estimates of LFG generation for CHRLF produced by LandGEM are caused primarily by the model k value of 0.04/year, which is assigned to all landfills in the U.S. experiencing 25 or more inches of precipitation per year. Given that the CHRLF experiences an average of 56 inches of precipitation per year, a k value of 0.04/year does not represent waste decay rates that consider site-specific moisture conditions.

4. Possible Causes of Reduced Collection & Generation

4.1 Landfill Gas Wellheads

As mentioned in Section 3.3, there are 349 wells connected to the NFS/BEW collection system that are equipped with precision wellhead control assemblies. The remaining 259 wellheads have a gate or butterfly valve to control the vacuum applied to the wells.

The type of wellhead installed on an LFG collection structure can affect the generation and collection of LFG within the well's area of influence. Over half of the wells contributing gas to NFS/BEW are configured with gate or butterfly valves. Gate and butterfly valves typically operate most efficiently when either fully open or fully closed. Small valve adjustments to regulate the flow and vacuum are difficult to make. If too much vacuum is applied, the well may short-circuit (i.e, pull in atmospheric air from the ground surface), which can lead to oxygen intrusion and can create aerobic conditions that may impede the microbial activity in the waste mass and reduce or stop LFG generation. By contrast, a precision wellhead can extend the life of an LFG collection structure because incremental adjustments can be made to the applied vacuum that allows the microbial activity in the waste mass to flourish longer and continue to generate LFG.

The location and orientation of a wellhead can also impact gas collection efficiency. Some of the wellheads on the horizontal collectors at CHRLF are oriented in a horizontal position and are located at a low point in the collection piping. This can allow for the potential collection of condensate at the wellhead. In contrast, wellheads installed in a vertical position allow condensate to flow either back into the waste or into the header system where it can then flow to a condensate sump and be removed.

Additionally, low spots (i.e., bellies) were also observed by the Consultant team in the collection system piping between the waste mass and some of the wellheads. Bellies are a location where the designed slope of the pipe is reduced and/or reversed, allowing liquid buildup and serving as a source of surging. Surging makes it difficult to properly balance a well because movement of water in the pipe prevents the gas readings from stabilizing.

KCSWD has determined that some horizontal collectors at CHRLF are watered-in with leachate. This can cause LFG collection issues. If the wellheads on these collectors are installed at the low point, leachate will flow to the wellheads. This can cause the surging that has been noted by field technicians during wellfield monitoring and balancing. The unstable readings caused by the surging can make it difficult to accurately tune the well. In addition, leachate in the perforated section of the horizontal collector will reduce the radius of influence of the well and can also cause surging.

If too much leachate makes it past the wellhead and enters the header system, the capacity of the header system condensate traps could be overwhelmed, which would back up liquids into the header pipes themselves. The presence of undrained liquids in the header pipes can reduce LFG collection and conveyance efficiency.

4.2 Landfill Gas Collection Structures

CHRLF has a total of 729 active LFG collection structures that are comprised of various forms of horizontal collectors and vertical wells. The majority of the structures are horizontal collectors that are installed soon after individual waste lifts are completed. The horizontal collectors are constructed as either looped collectors with a connection to the manifold system at either end of the collector or as individual collectors with only one point of connection to the header system. Table 1 in Section 3.3 provides a breakdown of the collector types by collection system. The current NFS/BEW collection system consists of 504 horizontal collectors and 104 vertical wells. The remaining collection structures are connected to the low-Btu flare system.

Horizontal collectors are typically interim structures that are meant to capture gas that is produced early in the LFG generation curve and as waste is being placed in successively higher lifts. Horizontal collectors tend to have a shorter lifespan than vertical wells due to damage from waste settlement (i.e., crushing or collapse) and blockage due to liquid collecting in the perforated section of the collector. Once waste filling has reached an acceptable level (i.e., interim or final closure), horizontal collectors can be supplemented or replaced with vertical well infrastructure to maintain or improve LFG collection.

Other benefits of vertical LFG wells include easier maintenance and monitoring as well as larger zones of collection within the waste mass. Vertical wells are easier to maintain than horizontal collectors and are installed within 10-20 feet of the base liner system, providing gas collection of the full waste column. Vertical wells can be sounded to measure the depth to liquid and depth to bottom of the wells. The sounding data can be cross checked with as-built information to determine whether the structure has been compromised by high liquid levels or pinches/obstructions in the well casing. The data can also be cross checked against wellhead monitoring data to determine if a compromised well is contributing to poor gas quality.

It is difficult to repair a horizontal collector that is compromised due to crushing or being watered-in. Once the gas flow is impeded, the structure's usefulness in collecting LFG is limited. This type of well failure is common if the collector is located in the lower lifts of waste. When a horizontal collector is watered-in, site operations can vacuum out the liquid, but it is likely that the collector will experience a recharge of liquid in the perforated section of the pipe. In contrast, a pump can be installed in a vertical well that will dewater the well and help maintain efficient gas collection.

4.3 Water Levels in the Waste Mass

Liquid level data for CHRLF is limited, but KCSWD is currently investigating 70 horizontal collection structures that have exhibited a loss of flow and/or gas quality. KCSWD is conducting this investigation by using a camera in the horizontal collectors to determine if there are blockages due to pinches/obstructions or the presence of liquid. Of the 70 collectors, 50 of them have provided data that gives information on the cause of flow loss or a decline in gas quality. The camera investigation is focusing on Areas 4 through 7 and the Central Pit.

- In Area 4, there are 5 LFG collectors planned for investigation. The cause of the loss of flow has been determined to be liquid blockages but the camera work has not been performed.
- There are 16 collectors planned for investigation in Area 5. Two of the collectors are suspected to be flooded with liquid, but the camera work has not been performed. Two structures in Area 5 that have been evaluated with a camera were noted to have liquid in the collector. Twelve collectors are still being evaluated.
- Area 6 has a total of 9 collectors to be investigated. Four of the collectors are noted to have a possible gas flow loss due to liquid accumulation.
- A total of 20 collectors are scheduled to be investigated in Area 7. Ten collectors are suspected to be compromised to due liquid or blockages.
- There are 20 collectors in the Central Pit that will be investigated. Currently, 3 have been evaluated and liquid is suspected as the cause of the decline in LFG flow in one of the collectors.

At present, there is not sufficient data to determine whether liquid is an issue throughout the entire site or limited to specific areas or zones within each area. KCSWD has noted that there is liquid present in Area 7, but the extent of the liquid has not been determined.

4.4 Header Loops and System Vacuum Controls

More recent reductions in LFG flow were observed immediately following the isolation valve adjustment that was conducted on October 27, 2020. As discussed in Section 3.2, selected header valves were closed which effectively cut off the existing header loop system. While flow on the West Header increased, the 4 Interior and the Central Header experienced reduced gas flow and either no change or a decrease in gas quality. Prior to closing the valves, the gas collected on the south end of the CHRLF could be routed to the north via either the West Header or the Central Header. This loop was eliminated when the valve near Meter 2 (Central Header Main Hill) was partially closed, forcing the gas to travel a longer distance back to the NFS via the West Header. In summary, the overall flow of the site has declined since the valves near Meter 2 (Central Header Main Hill) were partially closed.

As described in Section 3.2, the NFS blowers do not currently have VFDs and cannot be adjusted to account for changes in vacuum. VFDs and other flare and blower system modifications are being implemented as part of the 2021 construction activities. When the VFD's are installed, the blowers will be better able to be adjusted to maintain flows and vacuum. They would also give KCSWD greater flexibility in troubleshooting the wellfield without being concerned that closing valves would increase the vacuum. With VFDs installed, the vacuum would remain stable regardless of adjustments made in the wellfield.

4.5 Gas Collection Gap Between Areas 7 & 8

CHRLF is currently filling in Area 8, which is south of Area 7. Although waste placement in Area 7 was completed in late 2019, the top deck does not have final cover and the horizontal collectors installed in the top lift of Area 7 were only recently brought into service. In addition, the first two lifts of waste in Area 8 have horizontal collectors installed; however, the collectors were not put into operation until recently once sufficient filling had occurred above them to prevent air intrusion. Timing the incorporation of new collectors into the active system to occur sooner could help with avoiding future declines in LFG collection. As previously discussed, peak LFG generation occurs earlier in wet region landfills and can be missed if incorporation of new collection infrastructure is delayed.

5. Recommendations

The recommendations presented here are divided into short-term items that can be implemented quickly and long-term items that will require additional planning and design before being implemented.

5.1 Short-Term Action Items

5.1.1 Wellhead Replacement and Accompanying Pipes

Currently, 57 percent of the wells (349 out of 608) that are connected to the NFS/BEW wellfield are fitted with precision wellhead control assemblies. The installation of these newer style wellheads allows increased tuning performance and improved flow monitoring when used with orifice plates. The Consultant team recommends that KCSWD consider installation of precision wellheads on a more widespread scale in a configuration that allows for obtaining flow measurements using orifice plates. In areas where this is not currently possible, KCSWD may consider using another type of wellhead that is available and allows measurement of flow rates in the horizontal pipe position (e.g., a venturi style flow device). We further recommend that sample ports be installed on the system pressure side of all existing wellheads. System pressure data can be utilized to give KCSWD the ability to determine how much the well can be tuned, the available system vacuum (room to run as described in Section 3.3.1), and the vacuum loss at the wellhead. In addition, we recommend this data be combined with the other wellfield monitoring data for more efficient evaluation and sorting.

The Consultant team also recommends that KCSWD continue current efforts to adjust existing pipe supports and install additional robust pipe supports, as well as re-slope the above ground pipes to remove bellies to provide consistent LFG flow and vacuum to the wells/collectors. Pipe supports should have sufficient strength and anchorage so the movement of pipes, due to thermal expansion and contraction, does not cause the supports to move. The pipe supports for HDPE pipe should be spaced approximately 6 feet on center to prevent sagging of pipe between the supports. The supports should also be wide enough to allow the HDPE pipe to move horizontally (back and forth across the support surface) to accommodate thermal expansion and contraction.

5.1.2 Conveyance System Modifications

To better assess LFG collection system performance and target potential improvements throughout the LFG collection piping infrastructure at CHRLF, the current sitewide KY Pipe model should be updated with current header vacuum readings. Of the 14 vacuum gauges across the site, only five were recording in November 2020. KCSWD is currently replacing vacuum gauges across the site to allow updated modeling calibration and system assessment. The KY Pipe model should take into consideration the vacuum set point, header pipe sizing, and the LFG collectors on-site. As mentioned in Section 3.2, pipe sizes should deliver a vacuum loss that does not exceed 1 in-wc per 100 feet of pipe. The KY Pipe model provides a tool to evaluate system performance and to identify potential system issues such as constrictions, undersized pipe, liquid blockages, or other anomalies to be investigated and repaired as necessary. The model can also be used as predictive tool for potential system modifications and alternative evaluations. The Consultant team recommends that the model be used to evaluate reconnecting the header loop system.

Long-term data collection will be improved if KCSWD installs sample ports on the system side of wellheads at CHLRF as recommended in Section 5.1.1. This would provide additional data regarding which collection structures are experiencing vacuum loss.

KCSWD is currently evaluating and developing design of modifications to the collection system and low-Btu flare system capacity. The Consultant team recommends that KCSWD consider conveyance system upgrades allowing segregation of lower quality gas producing collectors and wells. This would facilitate improved collection control and improve overall system control and performance. These modifications would likely result in a reduction of the quantity of gas conveyed to BEW, but the quality of gas should increase.

5.1.3 System Rebalancing

CHRLF may benefit from a system-wide LFG wellfield rebalancing effort that would include setting new monitoring and balancing procedures for the site and the operations team. These procedures would include changes in monitoring frequency and data collection. Wellfield balancing currently occurs twice a month. With precision valve installation and pipe support and sag improvements as well as additional anticipated improvements to flow control monitoring stations, the current balancing frequency is likely adequate to optimize collection control. However, KCSWD may consider more frequent monitoring events allowing technicians to perform a root cause analysis to understand why a collector is underperforming.

KCSWD may consider updating well tuning procedures for wells that are historically poor producers. Updating tuning procedures should be done in conjunction with the wellhead modifications discussed in Section 5.1.1 above. The site currently has an assortment of LFG collectors installed, including horizontal collectors, vertical wells, leachate cleanouts, edge collectors, and toe collectors. Structures like these likely have the control valve set at a minimum position. It should be opened enough to be on vacuum, but not open to the point that high oxygen (>1%) and nitrogen (>5%) will be introduced to the system at a higher concentration and rate. This tuning procedure should be done on a well by well basis. As part of rebalancing the wellfield, the operational data for each well should be evaluated. The wells that need immediate attention should be prioritized. High priority wells would include those wells that historically produce high quantity and quality LFG, wells with high methane concentration (>55%), and wells with high oxygen (>2%) or nitrogen (>5%) concentrations. Each well should be tuned to optimize its performance within the acceptable parameters to meet regulations. Where possible, methane concentrations should be maintained between 47% and 53%, nitrogen levels should be maintained below 5%, and oxygen levels should be maintained below 2%.

The available system vacuum (i.e. room to run) at the wellheads should be measured on a regular basis. This will provide the information needed to determine the ability of an LFG well to operate efficiently. Wells that are noted to have poor room to run should be flagged and an investigation should be undertaken to determine the problem with the well.

5.1.4 Continue Investigation of Blockages in Horizontal Gas Collectors

The Consultant team recommends that KCSWD continue to investigate pipe blockages in the horizontal gas collectors with video camera inspection to evaluate the cause of reduced LFG collection. This will help determine remedial action and provide input for future design considerations and help with locating new vertical gas wells.

5.1.5 Install VFDs with Pressure Transmitters

KCSWD is currently finalizing designs for blower system and control upgrades to the NFS. The Consultant team recommends that collection control operation includes the ability to provide constant vacuum to the wellfield and prevent large fluctuations in system vacuum applied to LFG collectors due to continual fluctuating barometric pressure. This would allow the existing blower flare station to provide better control on the wellfield and to optimize the gas extraction rates.

Providing a constant system vacuum requires utilizing VFD motors on the existing blower skid allowing the blowers to speed up and slow down based on a vacuum control set point. Since the set point is based on gauge pressure transmitter, the system vacuum is allowed to mimic the fluctuating barometric pressure and provide a constant available system vacuum to the wellfield (constant relative to barometric pressure).

5.2 Long-Term Recommendations

5.2.1 Geotechnical Field Investigation

Because elevated liquid levels in the landfill are considered a potential cause of reduced gas collection, the Consultant team recommends that KCSWD consider undertaking a field program to investigate the nature of the conditions in the waste mass currently impeding gas recovery prior to installing vertical gas wells and/or pumps. We recommend consideration of cone penetration testing (CPT) and/or piezometer installation as methods to identify the locations best suited for potential installation of vertical gas wells. The CPT utilizes real time direct push drilling technology to help define areas (zones) of saturated waste, high pressure and high temperature. CPT work has been used successfully at other landfills in wet climates and has been found to be a very cost-effective technique for defining conditions in the waste mass that may impede or promote recovery of LFG. Installed piezometers can be used to measure the level and extent of liquid in the waste mass over a period of time and could also be monitored for gas pressure and quality in a given location. Both CPT and piezometer installation are lower-cost investigation options and quick first steps that can provide useful information for the design of a more robust GCCS expansion.

5.2.2 Vertical Well Planning and Installation

Currently, only 17 percent of the NFS/BEW wellfield is comprised of vertical gas well infrastructure. For this reason, the Consultant team recommends that KCSWD consider adding vertical wells throughout Areas 4 through 7. As discussed in Section 4.2, it is easier to diagnose and correct problems with vertical wells than with horizontal collectors. Vertical wells are less prone to settlement. Vertical wells will also allow KCSWD to access gas that may still be present in lower lifts of waste placement, especially if the horizontal collectors in those lifts are no longer functioning due to pinches, collapse, obstruction, or watering-in. The addition of vertical wells will require the installation of additional gas conveyance infrastructure, specifically header and lateral piping. The wellheads on vertical wells must be installed at the well locations; therefore, new piping must be installed to connect the new wells to existing headers. If vertical wells are drilled in older sections of the landfill that have a final cover system installed, we recommend that KCSWD install cover penetration seals around the well casings.

5.2.3 Dual-Phase Extraction Planning and Installation

If KCSWD elects to install vertical wells as recommended in Section 5.2.2, the Consultant team recommends the installation of pumps in the wells that show high liquid levels during the regular liquid level measurement (sounding) events recommended in Section 5.2.4. If pumps are installed, we recommend that KCSWD institute a maintenance program for the dual-phase wells, including maintaining logs that track stroke counter readings, routine liquid level measurements, gas flow rates, pump placement depth in well, and pump maintenance activities (cleaning, replacements of parts, etc.). Implementation of a dual-phase extraction program will require the installation of additional infrastructure, specifically a compressor facility, air supply pipes, and leachate discharge (force main) pipes, so that the vertical wells can be outfitted with pneumatic pumps.

5.2.4 Well Liquid Level (Sounding) Monitoring

The Consultant team recommends that KCSWD conduct quarterly liquid level measurements using an electronic conductive style measuring tape (i.e., referred to as well sounding) in all future vertical wells that may be installed. Well sounding events will help evaluate if a vertical well is compromised due to damage or high liquid levels submerging the perforated segment of the well that interferes with the collection of LFG. The liquid levels will also indicate the saturation levels in specific areas of the landfill. This data may lead to the need to add more vertical infrastructure with dual-phase extraction via pneumatic pumps. Existing vertical wells or future vertical wells that have pumps should be considered for monthly maintenance. In these monthly maintenance events, the pump should be removed and examined to determine its operational capabilities.

5.2.5 Evaluate Future Designs for More Effective Horizontal Gas Collectors

As part of the Area 7 closure, KCSWD conducted a horizontal collector alternatives and pilot study to inform design criteria for future horizontal collector configuration and spacing. If the horizontal collector system is to be supplemented with vertical wells (including dual-phase wells), the Consultant team recommends that the horizontal collector layouts in Areas 8 and 9 should be reviewed and updated to work as an integrated system with vertical wells that will be installed in the future.

5.2.6 Data Recording and Presentation Improvements

The Consultant team recommends that KCSWD evaluate the data being collected for operating the GCCS and standardize the following:

- Identification labeling,
- Operating parameters, and
- Presentation of operating parameters.

Examples of standardized identification labels would include developing consistent labels for each type of gas collection structure. This would allow ease of sorting the data by type of LFG collector for review and assessment of each type of collector's performance.

Examples of standard operating parameters include identifying select parameters critical to understanding the LFG collector performance and omitting the extraneous data that does not provide significant value to understanding the operation of the individual wells/collectors.

An example of presentation of operating parameters includes organizing the column headings for each monitored parameter in order of importance: well temperature, system pressure, well pressure, differential pressure, orifice plate diameter (where applicable), flow, valve position, gas composition (methane, carbon dioxide, oxygen, and balance gas), and adjusted settings. This would also include listing rows by specific types of well and collectors for each area. In addition, the first rows in the table would identify the normal operating range for specific parameters. The listed values that are outside the normal operating range would be highlighted in yellow, indicating above normal range, or highlighted in green, indicating below normal range.

5.2.7 Prepare a GCCS 5-Year Sequencing Plan

KCSWD may consider developing a GCCS sequencing plan for future planning of the GCCS infrastructure. The GCCS sequencing plan would consist of drawings developed to illustrate the installation of GCCS infrastructure anticipated on an annual basis for the next 5 years, based on the filling plans for the CHRLF.

These drawings will assist KCSWD with coordination of landfilling operations and GCCS installation. This effort is critical for achieving functioning horizontal gas collectors, vertical gas wells, and conveyance piping; prolonging the life of the GCCS components; and reducing interferences/conflicts between landfill activities and GCCS operations. The drawings will also provide quantity estimates from which the cost of GCCS components can be forecasted. The drawings can also include an estimate of annual contingency components to provide more pro-active implementation of backup controls when system components fail unexpectedly.

The GCCS sequencing drawings would be based on the existing conditions for gas collection wells and waste in place, future area/cell/fill sequencing drawings, and input from site personnel. The GCCS sequencing drawings would take into account the following:

- Reducing odors.
- Minimizing air intrusion.
- Leachate drainage.
- Condensate drainage.
- Complying with NSPS 2/5 year rule.
- Minimizing the interruption to landfilling operations.

The following items would be incorporated into the GCCS sequencing drawings:

- Integration with filling activities.
- Location of new vertical wells.
- Locations, alignment, and grades for new horizontal collectors.
- Location, alignment, grades, and size of new gas conveyance pipe.

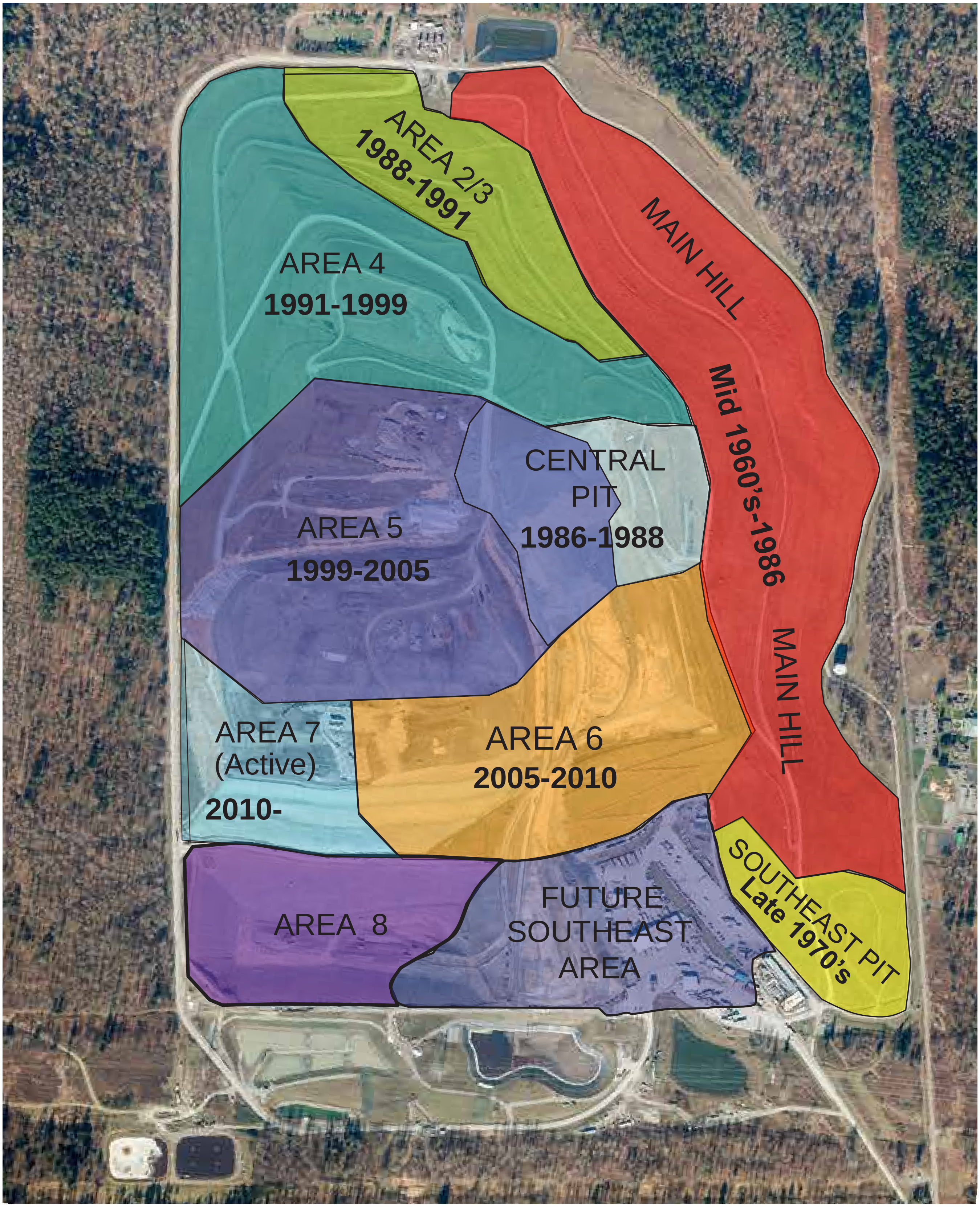
Each GCCS sequence drawing would include the new planned fill area for the specific year, the existing fill areas, and an overlay illustrating the planned locations of the vertical gas wells, horizontal gas collectors, gas conveyance pipe, and condensate pipes. The GCCS sequencing drawings would also provide estimated quantities for forecasting budgetary costs on an annual basis.

5.2.8 As-Built Drawings and Construction Quality Assurance

The Consultant Team recommends that KCSWD implement more detailed as-built/record survey and construction quality assurance (CQA, a.k.a construction inspection) for future GCCS expansion and upgrades. This work will help ensure the GCCS components are installed in a manner that meets the design intent and provides long term function of the components. The information from the as-built surveys and CQA documentation can also be used in the future to review and assess installation conditions and diagnose potential issues that may arise year(s) after construction is finished. Third-party construction inspection could be performed to provide an independent assessment and record of constructed elements. As-built information should be prepared and stamped by a Washington State Land Surveyor.

Figure 1. Cedar Hills Regional Landfill Area Layout

Figure 1. Cedar Hills Regional Landfil



Source; King County Solid Waste Management Plan, King County Solid Waste Division, 2019

Figure 2. Cedar Hills Regional Landfill LFG Well Site Plan

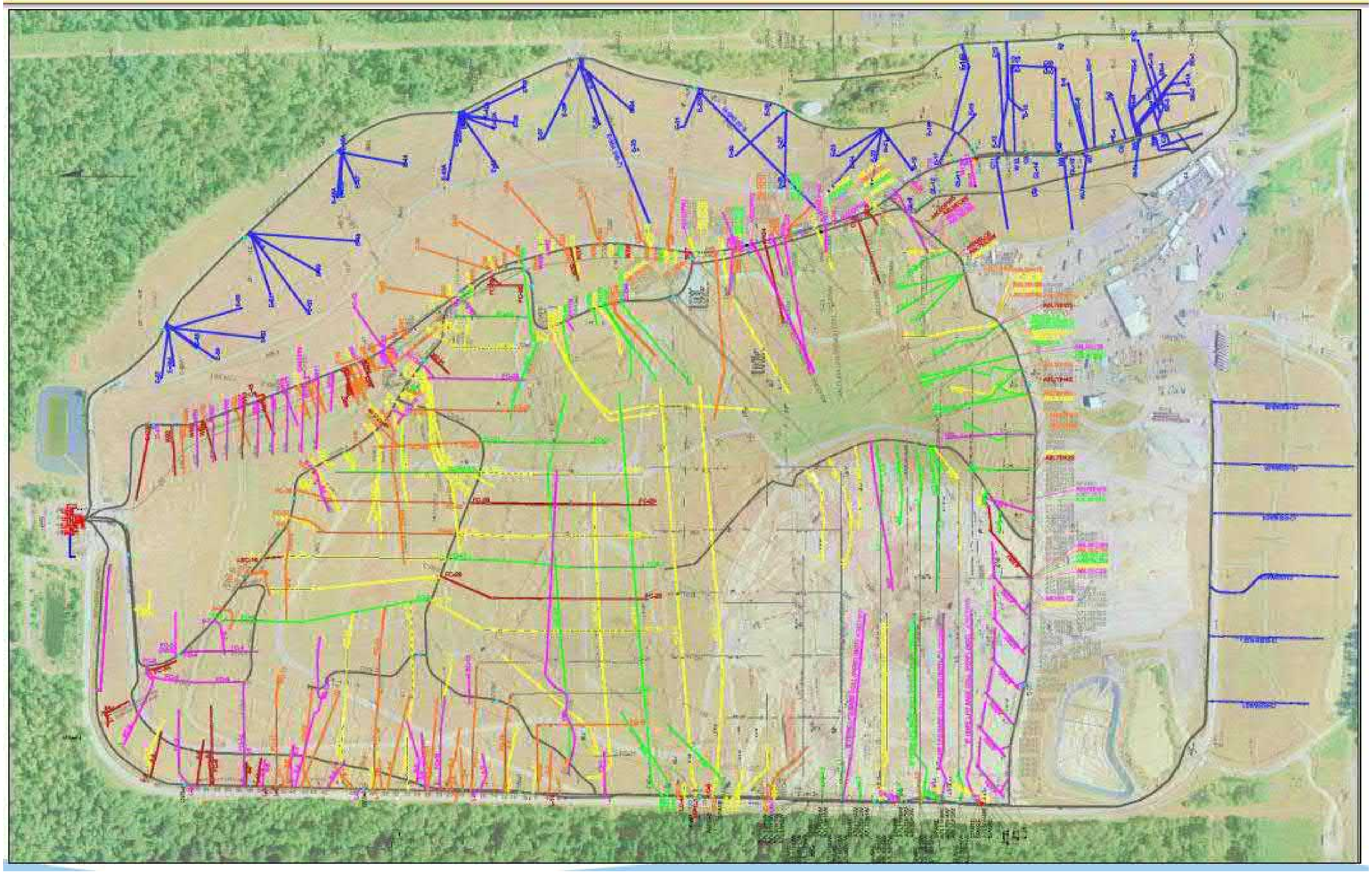


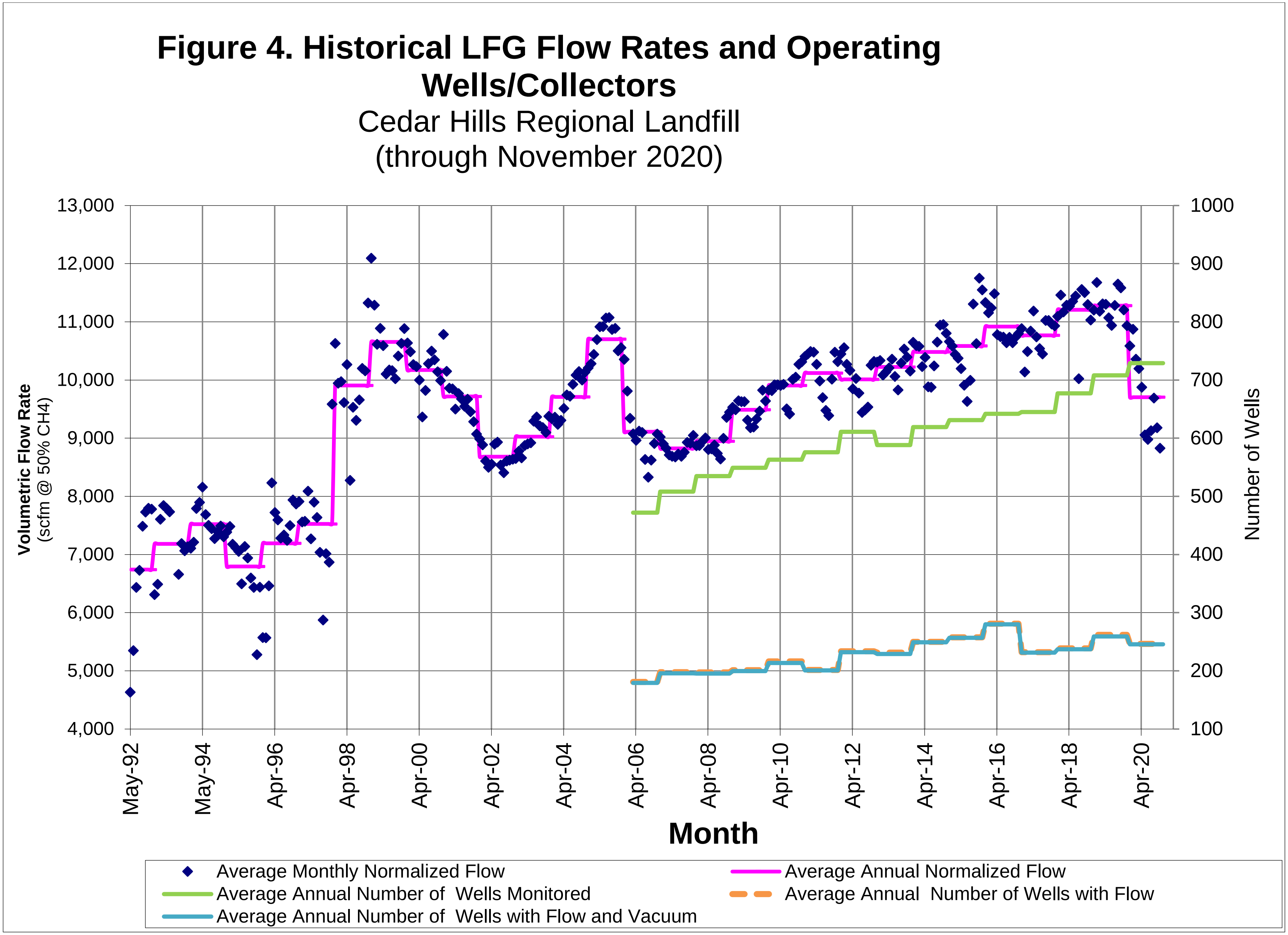
Figure 2. Layout of LFG Collection System at Cedar Hills Regional Landfill

Figure 3. Cedar Hills Regional Landfill Gas Conveyance System

Figure 3. CHRLF LFG Header System

Figure 4. Historical Flow Rates and Operating Wells Graph

Figure 4. Historical Flow Rates and Operating Wells Graph



Appendix A. Historical Flow Rates and Operating Wells Tables

Table 1 - Historical LFG Recovery Flow Rates and Operating Wells / Collectors

12-Jan-21

Cedar Hills Regional Landfill

Month	Average Monthly Flow (scfm)	Average Monthly Methane Content (% vol.)	Avg. Monthly Normalized Flow @ 50% Methane (scfm)	Average Annual Normalized Flow (scfm)	Count of Wells Monitored (#)	Annual Avg Number of Wells Monitored	Count of Wells with Flow (#)	Annual Avg Number of Wells with Flow	Count of Wells with Flow and Vacuum (#)	Annual Avg Number of Wells with Flow and Vacuum
May-92	4,705	49.2	4,633	6,742						
Jun-92	5,336	50.1	5,346	6,742						
Jul-92	6,184	52.0	6,434	6,742						
Aug-92	6,223	54.1	6,728	6,742						
Sep-92	6,935	54.0	7,487	6,742						
Oct-92	7,321	52.8	7,728	6,742						
Nov-92	7,413	52.6	7,795	6,742						
Dec-92	7,392	52.6	7,781	6,742						
Jan-93	6,927	45.6	6,312	7,183						
Feb-93	6,527	49.7	6,489	7,183						
Mar-93	7,068	53.8	7,606	7,183						
Apr-93	7,582	51.7	7,842	7,183						
May-93	7,421	52.5	7,797	7,183						
Jun-93	7,451	51.9	7,735	7,183						
Jul-93				7,183						
Aug-93				7,183						
Sep-93	6,827	48.8	6,660	7,183						
Oct-93	7,052	51.0	7,189	7,183						
Nov-93	6,854	51.5	7,065	7,183						
Dec-93	6,754	52.8	7,135	7,183						
Jan-94	6,727	52.8	7,106	7,522						
Feb-94	6,859	52.6	7,213	7,522						
Mar-94	7,241	53.8	7,793	7,522						
Apr-94	7,504	52.6	7,895	7,522						
May-94	8,072	50.5	8,159	7,522						
Jun-94	7,465	51.5	7,687	7,522						
Jul-94	7,391	50.8	7,502	7,522						
Aug-94	7,567	49.2	7,444	7,522						
Sep-94	7,411	49.1	7,274	7,522						
Oct-94	7,524	49.1	7,392	7,522						
Nov-94	7,504	49.9	7,488	7,522						
Dec-94	7,162	51.0	7,306	7,522						
Jan-95	7,453	49.5	7,385	6,795						
Feb-95	7,592	49.3	7,482	6,795						
Mar-95	7,658	46.8	7,175	6,795						
Apr-95	7,495	47.5	7,114	6,795						
May-95	7,876	44.8	7,052	6,795						
Jun-95	6,968	46.6	6,498	6,795						
Jul-95	8,037	44.4	7,137	6,795						
Aug-95	7,422	46.8	6,943	6,795						
Sep-95	7,035	46.9	6,598	6,795						
Oct-95	7,305	44.0	6,434	6,795						
Nov-95	6,586	40.1	5,279	6,795						
Dec-95	7,404	43.5	6,440	6,795						
Jan-96	5,465	51.0	5,571	7,193						
Feb-96	5,621	49.5	5,569	7,193						
Mar-96	7,012	46.1	6,460	7,193						
Apr-96	8,391	49.1	8,234	7,193						
May-96	7,847	49.2	7,720	7,193						
Jun-96	7,957	47.7	7,594	7,193						
Jul-96	7,757	46.9	7,283	7,193						
Aug-96	7,737	47.4	7,337	7,193						
Sep-96	7,761	46.7	7,243	7,193						
Oct-96	7,650	49.0	7,496	7,193						
Nov-96	7,978	49.7	7,937	7,193						
Dec-96	7,975	49.3	7,868	7,193						
Jan-97	8,235	48.0	7,912	7,526						
Feb-97	7,431	50.9	7,559	7,526						
Mar-97	7,242	52.3	7,570	7,526						

Appendix A. Historical Flow Rates and Operating Wells

Month	Average Monthly Flow (scfm)	Average Monthly Methane Content (% vol.)	Avg. Monthly Normalized Flow @ 50% Methane (scfm)	Average Annual Normalized Flow (scfm)	Count of Wells Monitored (#)	Annual Avg Number of Wells Monitored	Count of Wells with Flow (#)	Annual Avg Number of Wells with Flow	Count of Wells with Flow and Vacuum (#)	Annual Avg Number of Wells with Flow and Vacuum
Apr-97	7,881	51.3	8,089	7,526						
May-97	7,213	50.4	7,268	7,526						
Jun-97	7,658	51.6	7,899	7,526						
Jul-97	7,325	52.1	7,636	7,526						
Aug-97	6,979	50.4	7,040	7,526						
Sep-97	6,040	48.6	5,875	7,526						
Oct-97	6,912	50.7	7,014	7,526						
Nov-97	7,016	48.9	6,867	7,526						
Dec-97	9,574	50.1	9,587	7,526						
Jan-98	10,208	52.1	10,628	9,906						
Feb-98	10,108	49.2	9,945	9,906						
Mar-98	10,098	49.4	9,974	9,906						
Apr-98	9,684	49.6	9,612	9,906						
May-98	9,809	52.3	10,268	9,906						
Jun-98	8,785	47.1	8,274	9,906						
Jul-98	9,555	49.9	9,532	9,906						
Aug-98	9,443	49.3	9,307	9,906						
Sep-98	9,540	50.6	9,657	9,906						
Oct-98	9,804	52.0	10,199	9,906						
Nov-98	9,895	51.3	10,157	9,906						
Dec-98	10,695	52.9	11,324	9,906						
Jan-99	11,637	52.0	12,093	10,655						
Feb-99	10,847	52.0	11,285	10,655						
Mar-99	9,698	54.7	10,612	10,655						
Apr-99	10,019	54.3	10,888	10,655						
May-99	9,926	53.3	10,591	10,655						
Jun-99	9,530	53.0	10,105	10,655						
Jul-99	9,626	52.8	10,174	10,655						
Aug-99	9,483	53.6	10,161	10,655						
Sep-99	9,471	52.9	10,023	10,655						
Oct-99	9,634	54.0	10,413	10,655						
Nov-99	9,738	54.6	10,631	10,655						
Dec-99	10,265	53.0	10,884	10,655						
Jan-00	10,048	52.9	10,637	10,172						
Feb-00	9,933	52.8	10,485	10,172						
Mar-00	9,890	51.9	10,266	10,172						
Apr-00	9,955	51.4	10,231	10,172						
May-00	9,833	50.8	9,997	10,172						
Jun-00	9,392	49.8	9,363	10,172						
Jul-00	9,735	50.4	9,821	10,172						
Aug-00	10,045	51.2	10,281	10,172						
Sep-00	10,433	50.3	10,499	10,172						
Oct-00	10,058	51.4	10,346	10,172						
Nov-00	10,139	50.0	10,144	10,172						
Dec-00	9,771	51.1	9,993	10,172						
Jan-01	10,040	53.7	10,783	9,718						
Feb-01	10,006	50.7	10,150	9,718						
Mar-01	9,689	50.9	9,861	9,718						
Apr-01	9,553	51.5	9,848	9,718						
May-01	9,160	51.9	9,502	9,718						
Jun-01	9,537	51.2	9,769	9,718						
Jul-01	9,486	51.0	9,674	9,718						
Aug-01	9,312	51.3	9,547	9,718						
Sep-01	9,577	50.5	9,669	9,718						
Oct-01	9,293	50.9	9,454	9,718						
Nov-01	9,060	51.2	9,284	9,718						
Dec-01	9,010	50.3	9,071	9,718						
Jan-02	8,887	50.6	8,987	8,682						
Feb-02	8,720	50.9	8,884	8,682						
Mar-02	8,428	51.1	8,609	8,682						
Apr-02	8,132	52.3	8,500	8,682						
May-02	8,242	51.9	8,555	8,682						
Jun-02	8,580	51.9	8,899	8,682						

Appendix A. Historical Flow Rates and Operating Wells

Month	Average Monthly Flow (scfm)	Average Monthly Methane Content (% vol.)	Avg. Monthly Normalized Flow @ 50% Methane (scfm)	Average Annual Normalized Flow (scfm)	Count of Wells Monitored (#)	Annual Avg Number of Wells Monitored	Count of Wells with Flow (#)	Annual Avg Number of Wells with Flow	Count of Wells with Flow and Vacuum (#)	Annual Avg Number of Wells with Flow and Vacuum
Jul-02	8,610	51.9	8,933	8,682						
Aug-02	8,258	51.7	8,539	8,682						
Sep-02	8,011	52.5	8,407	8,682						
Oct-02	8,429	51.1	8,607	8,682						
Nov-02	8,645	49.9	8,623	8,682						
Dec-02	8,215	52.6	8,640	8,682						
Jan-03	8,271	52.3	8,651	9,026						
Feb-03	8,231	53.3	8,776	9,026						
Mar-03	8,264	52.4	8,660	9,026						
Apr-03	8,585	51.7	8,875	9,026						
May-03	8,814	50.5	8,902	9,026						
Jun-03	8,641	51.6	8,920	9,026						
Jul-03	8,866	52.4	9,292	9,026						
Aug-03	9,062	51.7	9,366	9,026						
Sep-03	8,857	52.0	9,212	9,026						
Oct-03	8,767	52.4	9,184	9,026						
Nov-03	8,634	52.7	9,100	9,026						
Dec-03	8,927	52.5	9,375	9,026						
Jan-04	8,834	52.8	9,335	9,709						
Feb-04	9,031	51.8	9,360	9,709						
Mar-04	9,065	50.9	9,237	9,709						
Apr-04	9,172	50.7	9,308	9,709						
May-04	9,111	52.2	9,513	9,709						
Jun-04	9,428	51.7	9,745	9,709						
Jul-04	9,405	51.7	9,722	9,709						
Aug-04	9,542	52.0	9,926	9,709						
Sep-04	9,764	51.6	10,084	9,709						
Oct-04	9,727	52.2	10,147	9,709						
Nov-04	9,548	52.4	10,001	9,709						
Dec-04	9,590	52.8	10,136	9,709						
Jan-05	9,872	51.7	10,209	10,701						
Feb-05	9,975	51.5	10,282	10,701						
Mar-05	10,050	51.9	10,438	10,701						
Apr-05	10,292	52.0	10,693	10,701						
May-05	10,455	52.2	10,917	10,701						
Jun-05	10,463	52.2	10,920	10,701						
Jul-05	10,701	51.7	11,066	10,701						
Aug-05	10,700	51.8	11,076	10,701						
Sep-05	10,535	51.6	10,868	10,701						
Oct-05	10,581	51.5	10,889	10,701						
Nov-05	10,191	51.5	10,503	10,701						
Dec-05	10,294	51.3	10,556	10,701						
Jan-06	9,998	51.8	10,354	9,111						
Feb-06	9,631	50.9	9,808	9,111						
Mar-06	9,250	50.5	9,342	9,111						
Apr-06	9,023	50.3	9,076	9,111	466	472	166	181	165	179
May-06	8,994	49.8	8,961	9,111	472	472	183	181	179	179
Jun-06	8,941	51.0	9,121	9,111	472	472	180	181	180	179
Jul-06	8,954	50.8	9,098	9,111	472	472	170	181	170	179
Aug-06	8,742	49.4	8,634	9,111	471	472	195	181	194	179
Sep-06	8,469	49.2	8,328	9,111	472	472	167	181	165	179
Oct-06	8,683	49.6	8,621	9,111	474	472	183	181	182	179
Nov-06	8,857	50.3	8,910	9,111	473	472	204	181	200	179
Dec-06	8,934	50.8	9,073	9,111	474	472	181	181	179	179
Jan-07	9,039	49.9	9,020	8,825	476	508	202	198	202	196
Feb-07	9,024	49.3	8,903	8,825	475	508	201	198	199	196
Mar-07	8,904	49.6	8,828	8,825	505	508	178	198	177	196
Apr-07	8,937	48.7	8,713	8,825	510	508	172	198	168	196
May-07	8,922	48.7	8,689	8,825	510	508	206	198	203	196
Jun-07	8,835	49.1	8,677	8,825	514	508	194	198	191	196
Jul-07	8,713	50.1	8,727	8,825	512	508	200	198	195	196
Aug-07	8,673	50.1	8,689	8,825	510	508	203	198	201	196
Sep-07	8,666	50.5	8,759	8,825	516	508	204	198	204	196

Appendix A. Historical Flow Rates and Operating Wells

Month	Average Monthly Flow (scfm)	Average Monthly Methane Content (% vol.)	Avg. Monthly Normalized Flow @ 50% Methane (scfm)	Average Annual Normalized Flow (scfm)	Count of Wells Monitored (#)	Annual Avg Number of Wells Monitored	Count of Wells with Flow (#)	Annual Avg Number of Wells with Flow	Count of Wells with Flow and Vacuum (#)	Annual Avg Number of Wells with Flow and Vacuum
Oct-07	9,016	49.5	8,929	8,825	522	508	218	198	217	196
Nov-07	8,985	49.6	8,912	8,825	522	508	211	198	211	196
Dec-07	9,106	49.7	9,050	8,825	522	508	182	198	181	196
Jan-08	8,942	49.6	8,871	8,949	522	535	194	197	187	195
Feb-08	8,784	50.5	8,875	8,949	527	535	162	197	158	195
Mar-08	8,667	51.6	8,944	8,949	527	535	185	197	184	195
Apr-08	8,729	51.6	9,005	8,949	527	535	203	197	201	195
May-08	8,702	50.6	8,805	8,949	533	535	210	197	210	195
Jun-08	8,609	51.2	8,816	8,949	533	535	208	197	206	195
Jul-08	8,611	51.6	8,883	8,949	538	535	192	197	192	195
Aug-08	8,548	51.1	8,740	8,949	539	535	179	197	178	195
Sep-08	8,468	51.0	8,643	8,949	539	535	199	197	199	195
Oct-08	8,776	51.3	8,997	8,949	542	535	203	197	201	195
Nov-08	9,008	51.9	9,358	8,949	549	535	226	197	222	195
Dec-08	9,192	51.4	9,447	8,949	549	535	206	197	205	195
Jan-09	9,303	51.2	9,532	9,488	549	549	215	201	215	200
Feb-09	9,212	51.5	9,488	9,488	549	549	217	201	216	200
Mar-09	9,263	52.0	9,642	9,488	549	549	209	201	206	200
Apr-09	9,334	51.6	9,629	9,488	549	549	206	201	205	200
May-09	9,265	52.0	9,629	9,488	549	549	187	201	186	200
Jun-09	9,064	51.4	9,311	9,488	549	549	207	201	205	200
Jul-09	8,881	51.7	9,180	9,488	549	549	199	201	197	200
Aug-09	9,016	51.0	9,193	9,488	548	549	185	201	185	200
Sep-09	9,053	51.5	9,330	9,488	549	549	188	201	181	200
Oct-09	9,096	52.0	9,466	9,488	549	549	193	201	191	200
Nov-09	9,346	52.6	9,823	9,488	549	549	220	201	219	200
Dec-09	9,488	50.8	9,639	9,488	549	549	189	201	189	200
Jan-10	9,364	52.5	9,826	9,906	555	563	200	216	200	214
Feb-10	9,358	52.5	9,819	9,906	555	563	238	216	233	214
Mar-10	9,410	52.7	9,918	9,906	555	563	199	216	195	214
Apr-10	9,418	52.7	9,918	9,906	555	563	201	216	196	214
May-10	9,343	53.0	9,906	9,906	555	563	205	216	204	214
Jun-10	9,408	52.8	9,926	9,906	555	563	207	216	206	214
Jul-10	9,054	52.5	9,504	9,906	555	563	210	216	209	214
Aug-10	9,132	51.6	9,416	9,906	582	563	259	216	259	214
Sep-10	9,427	53.1	10,009	9,906	572	563	234	216	233	214
Oct-10	9,642	52.1	10,049	9,906	572	563	214	216	206	214
Nov-10	9,801	52.4	10,270	9,906	572	563	220	216	218	214
Dec-10	9,722	53.0	10,312	9,906	572	563	208	216	205	214
Jan-11	9,771	53.2	10,404	10,120	572	576	184	202	183	201
Feb-11	9,822	53.2	10,449	10,120	570	576	205	202	203	201
Mar-11	9,777	53.7	10,492	10,120	572	576	206	202	205	201
Apr-11	9,735	53.8	10,478	10,120	571	576	193	202	193	201
May-11	9,528	53.9	10,269	10,120	571	576	206	202	206	201
Jun-11	9,387	53.2	9,983	10,120	571	576	191	202	191	201
Jul-11	9,196	52.7	9,696	10,120	572	576	178	202	176	201
Aug-11	9,089	52.1	9,479	10,120	571	576	171	202	171	201
Sep-11	9,121	51.5	9,387	10,120	571	576	195	202	195	201
Oct-11	9,610	52.1	10,015	10,120	575	576	201	202	199	201
Nov-11	10,708	48.9	10,477	10,120	601	576	254	202	251	201
Dec-11	11,357	45.4	10,316	10,120	589	576	237	202	237	201
Jan-12	10,510	49.7	10,449	10,011	606	611	256	234	256	232
Feb-12	10,713	49.3	10,556	10,011	608	611	225	234	225	232
Mar-12	10,418	49.3	10,271	10,011	610	611	237	234	237	232
Apr-12	10,704	47.5	10,166	10,011	610	611	231	234	230	232
May-12	10,537	46.7	9,850	10,011	610	611	249	234	249	232
Jun-12	10,413	48.2	10,028	10,011	610	611	243	234	243	232
Jul-12	10,085	48.5	9,775	10,011	610	611	195	234	193	232
Aug-12	9,349	50.5	9,443	10,011	610	611	248	234	248	232
Sep-12	9,319	50.9	9,483	10,011	610	611	238	234	232	232
Oct-12	9,410	50.7	9,536	10,011	610	611	214	234	211	232
Nov-12	10,042	51.1	10,256	10,011	618	611	233	234	232	232
Dec-12	10,253	50.3	10,320	10,011	618	611	233	234	229	232

Appendix A. Historical Flow Rates and Operating Wells

Month	Average Monthly Flow (scfm)	Average Monthly Methane Content (% vol.)	Avg. Monthly Normalized Flow @ 50% Methane (scfm)	Average Annual Normalized Flow (scfm)	Count of Wells Monitored (#)	Annual Avg Number of Wells Monitored	Count of Wells with Flow (#)	Annual Avg Number of Wells with Flow	Count of Wells with Flow and Vacuum (#)	Annual Avg Number of Wells with Flow and Vacuum
Jan-13	10,390	49.6	10,310	10,225	592	588	261	231	255	229
Feb-13	10,270	50.3	10,335	10,225	592	588	242	231	242	229
Mar-13	10,153	49.7	10,085	10,225	592	588	225	231	221	229
Apr-13	10,107	50.2	10,137	10,225	592	588	240	231	238	229
May-13	10,209	50.0	10,206	10,225	592	588	219	231	216	229
Jun-13	10,001	51.8	10,360	10,225	592	588	218	231	217	229
Jul-13	9,818	51.2	10,059	10,225	592	588	222	231	219	229
Aug-13	9,746	50.4	9,830	10,225	592	588	236	231	235	229
Sep-13	9,963	51.7	10,294	10,225	592	588	230	231	230	229
Oct-13	10,323	51.0	10,533	10,225	602	588	248	231	246	229
Nov-13	10,206	50.9	10,395	10,225	599	588	239	231	238	229
Dec-13	10,141	50.1	10,153	10,225	527	588	194	231	192	229
Jan-14	10,499	50.7	10,648	10,483	601	619	248	250	247	249
Feb-14	10,453	50.7	10,591	10,483	614	619	260	250	260	249
Mar-14	10,382	51.0	10,580	10,483	614	619	256	250	256	249
Apr-14	10,177	50.3	10,231	10,483	615	619	226	250	225	249
May-14	10,066	51.6	10,388	10,483	615	619	256	250	255	249
Jun-14	9,797	50.4	9,882	10,483	615	619	237	250	234	249
Jul-14	9,814	50.3	9,876	10,483	615	619	216	250	216	249
Aug-14	9,951	51.5	10,244	10,483	617	619	232	250	232	249
Sep-14	10,163	52.4	10,654	10,483	623	619	240	250	239	249
Oct-14	10,417	52.5	10,941	10,483	631	619	239	250	238	249
Nov-14	10,462	52.3	10,953	10,483	631	619	287	250	286	249
Dec-14	10,782	50.1	10,802	10,483	631	619	304	250	302	249
Jan-15	10,441	51.1	10,661	10,585	631	631	270	258	270	257
Feb-15	10,349	51.1	10,583	10,585	631	631	256	258	255	257
Mar-15	10,249	50.9	10,439	10,585	631	631	251	258	251	257
Apr-15	10,225	50.7	10,374	10,585	631	631	241	258	241	257
May-15	10,049	50.7	10,195	10,585	631	631	251	258	251	257
Jun-15	9,737	50.9	9,912	10,585	631	631	239	258	239	257
Jul-15	9,642	49.9	9,631	10,585	629	631	217	258	216	257
Aug-15	9,841	50.8	9,996	10,585	626	631	310	258	307	257
Sep-15	11,171	50.6	11,307	10,585	627	631	298	258	298	257
Oct-15	10,624	50.0	10,624	10,585	630	631	257	258	256	257
Nov-15	11,751	50.0	11,751	10,585	634	631	251	258	249	257
Dec-15	11,549	50.0	11,549	10,585	634	631	249	258	249	257
Jan-16	11,332	50.0	11,332	10,919	641	642	259	281	259	280
Feb-16	11,156	50.0	11,156	10,919	641	642	244	281	244	280
Mar-16	11,239	50.0	11,239	10,919	642	642	326	281	326	280
Apr-16	11,484	50.0	11,484	10,919	641	642	260	281	259	280
May-16	10,779	50.0	10,779	10,919	641	642	291	281	291	280
Jun-16	10,745	50.0	10,745	10,919	639	642	298	281	298	280
Jul-16	10,739	50.0	10,739	10,919	642	642	311	281	311	280
Aug-16	10,642	50.0	10,642	10,919	645	642	335	281	326	280
Sep-16	10,735	50.0	10,735	10,919	642	642	295	281	295	280
Oct-16	10,641	50.0	10,641	10,919	644	642	282	281	279	280
Nov-16	10,736	50.0	10,736	10,919	643	642	263	281	263	280
Dec-16	10,798	50.0	10,798	10,919	643	642	209	281	209	280
Jan-17	10,884	50.0	10,884	10,768	642	645	222	232	221	231
Feb-17	10,140	50.0	10,140	10,768	642	645	244	232	244	231
Mar-17	10,284	51.0	10,490	10,768	642	645	213	232	213	231
Apr-17	10,318	52.5	10,843	10,768	NA	645	NA	232	NA	231
May-17	10,567	52.9	11,188	10,768	NA	645	NA	232	NA	231
Jun-17	9,977	53.8	10,742	10,768	643	645	255	232	253	231
Jul-17	10,051	52.4	10,542	10,768	643	645	249	232	246	231
Aug-17	9,861	53.0	10,446	10,768	643	645	275	232	273	231
Sep-17	10,291	53.6	11,023	10,768	650	645	252	232	251	231
Oct-17	10,242	53.8	11,024	10,768	650	645	211	232	211	231
Nov-17	10,936	50.1	10,960	10,768	649	645	196	232	195	231
Dec-17	10,536	51.9	10,931	10,768	650	645	205	232	205	231
Jan-18	10,556	52.5	11,093	11,207	664	677	189	239	189	237
Feb-18	10,868	52.7	11,461	11,207	665	677	212	239	212	237
Mar-18	10,677	52.3	11,172	11,207	670	677	219	239	218	237

Appendix A. Historical Flow Rates and Operating Wells

Month	Average Monthly Flow (scfm)	Average Monthly Methane Content (% vol.)	Avg. Monthly Normalized Flow @ 50% Methane (scfm)	Average Annual Normalized Flow (scfm)	Count of Wells Monitored (#)	Annual Avg Number of Wells Monitored	Count of Wells with Flow (#)	Annual Avg Number of Wells with Flow	Count of Wells with Flow and Vacuum (#)	Annual Avg Number of Wells with Flow and Vacuum
Apr-18	10,730	52.6	11,288	11,207	669	677	224	239	224	237
May-18	10,558	53.4	11,269	11,207	676	677	247	239	246	237
Jun-18	10,534	53.9	11,353	11,207	678	677	268	239	266	237
Jul-18	10,423	54.9	11,446	11,207	681	677	283	239	279	237
Aug-18	9,829	51.0	10,022	11,207	684	677	270	239	266	237
Sep-18	10,683	54.1	11,556	11,207	684	677	246	239	244	237
Oct-18	10,681	53.8	11,502	11,207	685	677	261	239	261	237
Nov-18	10,465	54.0	11,297	11,207	685	677	227	239	226	237
Dec-18	10,342	53.3	11,029	11,207	685	677	220	239	217	237
Jan-19	10,496	53.4	11,202	11,278	685	708	213	262	211	259
Feb-19	10,759	54.3	11,677	11,278	685	708	192	262	191	259
Mar-19	10,432	53.6	11,181	11,278	697	708	238	262	238	259
Apr-19	10,511	53.8	11,311	11,278	703	708	274	262	269	259
May-19	10,548	53.6	11,303	11,278	704	708	278	262	277	259
Jun-19	10,360	53.4	11,072	11,278	704	708	301	262	297	259
Jul-19	10,150	53.9	10,937	11,278	705	708	289	262	289	259
Aug-19	10,511	53.7	11,282	11,278	712	708	295	262	292	259
Sep-19	10,859	53.6	11,649	11,278	715	708	285	262	281	259
Oct-19	10,882	53.2	11,586	11,278	723	708	246	262	244	259
Nov-19	10,499	53.4	11,207	11,278	729	708	279	262	275	259
Dec-19	10,234	53.4	10,936	11,278	729	708	251	262	247	259
Jan-20	10,000	52.9	10,588	9,704	729	729	254	246	254	246
Feb-20	10,351	52.5	10,871	9,704	729	729	276	246	276	246
Mar-20	9,890	52.4	10,357	9,704	729	729	209	246	209	246
Apr-20	9,935	51.3	10,196	9,704	729	729	243	246	243	246
May-20	9,272	53.2	9,874	9,704	729	729	195	246	195	246
Jun-20	8,622	52.5	9,055	9,704	729	729	211	246	211	246
Jul-20	8,632	52.0	8,977	9,704	731	729	247	246	247	246
Aug-20	8,678	52.6	9,131	9,704	729	729	282	246	281	246
Sep-20	9,207	52.6	9,689	9,704	729	729	302	246	301	246
Oct-20	8,799	52.2	9,178	9,704	729	729	295	246	293	246
Nov-20	8,257	53.5	8,828	9,704	729	729	206	246	204	246
Dec-20					729	729	237	246	235	246

Appendix A. Historical Flow Rates and Operating Wells (mmBtu)

Table 1 - Historical LFG Recovery Flow Rates and Operating Wells / Collectors

13-Jan-21

Cedar Hills Regional Landfill

Month	Average Monthly Flow (scfm)	Average Monthly Methane Content (% vol.)	Avg Monthly Normalized Flow @ 50 % CH4 (scfm)	Average Annual Normalized Flow (scfm)	Avg Monthly Normalized Flow @ 50 % CH4 (MMBtu/hr)	Average Annual Normalized Flow (MMBtu/hr)	Count of Wells Monitored (#)	Average Annual Number of Wells Monitored	Count of Wells with Flow (#)	Average Annual Number of Wells with Flow	Count of Wells with Flow and Vacuum (#)	Average Annual Number of Wells with Flow and Vacuum
May-92	4,705	49.2	4,633	6,742	132	193						
Jun-92	5,336	50.1	5,346	6,742	153	193						
Jul-92	6,184	52.0	6,434	6,742	184	193						
Aug-92	6,223	54.1	6,728	6,742	192	193						
Sep-92	6,935	54.0	7,487	6,742	214	193						
Oct-92	7,321	52.8	7,728	6,742	221	193						
Nov-92	7,413	52.6	7,795	6,742	223	193						
Dec-92	7,392	52.6	7,781	6,742	222	193						
Jan-93	6,927	45.6	6,312	7,183	180	205						
Feb-93	6,527	49.7	6,489	7,183	185	205						
Mar-93	7,068	53.8	7,606	7,183	217	205						
Apr-93	7,582	51.7	7,842	7,183	224	205						
May-93	7,421	52.5	7,797	7,183	223	205						
Jun-93	7,451	51.9	7,735	7,183	221	205						
Jul-93				7,183		205						
Aug-93				7,183		205						
Sep-93	6,827	48.8	6,660	7,183	190	205						
Oct-93	7,052	51.0	7,189	7,183	205	205						
Nov-93	6,854	51.5	7,065	7,183	202	205						
Dec-93	6,754	52.8	7,135	7,183	204	205						
Jan-94	6,727	52.8	7,106	7,522	203	215						
Feb-94	6,859	52.6	7,213	7,522	206	215						
Mar-94	7,241	53.8	7,793	7,522	223	215						
Apr-94	7,504	52.6	7,895	7,522	225	215						
May-94	8,072	50.5	8,159	7,522	233	215						
Jun-94	7,465	51.5	7,687	7,522	220	215						
Jul-94	7,391	50.8	7,502	7,522	214	215						
Aug-94	7,567	49.2	7,444	7,522	213	215						
Sep-94	7,411	49.1	7,274	7,522	208	215						
Oct-94	7,524	49.1	7,392	7,522	211	215						
Nov-94	7,504	49.9	7,488	7,522	214	215						
Dec-94	7,162	51.0	7,306	7,522	209	215						
Jan-95	7,453	49.5	7,385	6,795	211	194						
Feb-95	7,592	49.3	7,482	6,795	214	194						
Mar-95	7,658	46.8	7,175	6,795	205	194						
Apr-95	7,495	47.5	7,114	6,795	203	194						
May-95	7,876	44.8	7,052	6,795	201	194						
Jun-95	6,968	46.6	6,498	6,795	186	194						
Jul-95	8,037	44.4	7,137	6,795	204	194						
Aug-95	7,422	46.8	6,943	6,795	198	194						
Sep-95	7,035	46.9	6,598	6,795	188	194						
Oct-95	7,305	44.0	6,434	6,795	184	194						
Nov-95	6,586	40.1	5,279	6,795	151	194						
Dec-95	7,404	43.5	6,440	6,795	184	194						
Jan-96	5,465	51.0	5,571	7,193	159	205						
Feb-96	5,621	49.5	5,569	7,193	159	205						
Mar-96	7,012	46.1	6,460	7,193	185	205						
Apr-96	8,391	49.1	8,234	7,193	235	205						
May-96	7,847	49.2	7,720	7,193	220	205						
Jun-96	7,957	47.7	7,594	7,193	217	205						
Jul-96	7,757	46.9	7,283	7,193	208	205						
Aug-96	7,737	47.4	7,337	7,193	210	205						
Sep-96	7,761	46.7	7,243	7,193	207	205						
Oct-96	7,650	49.0	7,496	7,193	214	205						
Nov-96	7,978	49.7	7,937	7,193	227	205						
Dec-96	7,975	49.3	7,868	7,193	225	205						
Jan-97	8,235	48.0	7,912	7,526	226	215						
Feb-97	7,431	50.9	7,559	7,526	216	215						
Mar-97	7,242	52.3	7,570	7,526	216	215						
Apr-97	7,881	51.3	8,089	7,526	231	215						
May-97	7,213	50.4	7,268	7,526	208	215						
Jun-97	7,658	51.6	7,899	7,526	226	215						
Jul-97	7,325	52.1	7,636	7,526	218	215						
Aug-97	6,979	50.4	7,040	7,526	201	215						
Sep-97	6,040	48.6	5,875	7,526	168	215						
Oct-97	6,912	50.7	7,014	7,526	200	215						
Nov-97	7,016	48.9	6,867	7,526	196	215						
Dec-97	9,574	50.1	9,587	7,526	274	215						
Jan-98	10,208	52.1	10,628	9,906	304	283						
Feb-98	10,108	49.2	9,945	9,906	284	283						
Mar-98	10,098	49.4	9,974	9,906	285	283						
Apr-98	9,684	49.6	9,612	9,906	275	283						
May-98	9,809	52.3	10,268	9,906	293	283						
Jun-98	8,785	47.1	8,274	9,906	236	283						

Table 1 - Historical LFG Recovery Flow Rates and Operating Wells / Collectors

13-Jan-21

Cedar Hills Regional Landfill

Month	Average Monthly Flow (scfm)	Average Monthly Methane Content (% vol.)	Avg Monthly Normalized Flow @ 50 % CH4 (scfm)	Average Annual Normalized Flow (scfm)	Avg Monthly Normalized Flow @ 50 % CH4 (MMBtu/hr)	Average Annual Normalized Flow (MMBtu/hr)	Count of Wells Monitored (#)	Average Annual Number of Wells Monitored	Count of Wells with Flow (#)	Average Annual Number of Wells with Flow	Count of Wells with Flow and Vacuum (#)	Average Annual Number of Wells with Flow and Vacuum
Jul-98	9,555	49.9	9,532	9,906	272	283						
Aug-98	9,443	49.3	9,307	9,906	266	283						
Sep-98	9,540	50.6	9,657	9,906	276	283						
Oct-98	9,804	52.0	10,199	9,906	291	283						
Nov-98	9,895	51.3	10,157	9,906	290	283						
Dec-98	10,695	52.9	11,324	9,906	323	283						
Jan-99	11,637	52.0	12,093	10,655	345	304						
Feb-99	10,847	52.0	11,285	10,655	322	304						
Mar-99	9,698	54.7	10,612	10,655	303	304						
Apr-99	10,019	54.3	10,888	10,655	311	304						
May-99	9,926	53.3	10,591	10,655	302	304						
Jun-99	9,530	53.0	10,105	10,655	289	304						
Jul-99	9,626	52.8	10,174	10,655	291	304						
Aug-99	9,483	53.6	10,161	10,655	290	304						
Sep-99	9,471	52.9	10,023	10,655	286	304						
Oct-99	9,634	54.0	10,413	10,655	297	304						
Nov-99	9,738	54.6	10,631	10,655	304	304						
Dec-99	10,265	53.0	10,884	10,655	311	304						
Jan-00	10,048	52.9	10,637	10,172	304	291						
Feb-00	9,933	52.8	10,485	10,172	299	291						
Mar-00	9,890	51.9	10,266	10,172	293	291						
Apr-00	9,955	51.4	10,231	10,172	292	291						
May-00	9,833	50.8	9,997	10,172	286	291						
Jun-00	9,392	49.8	9,363	10,172	267	291						
Jul-00	9,735	50.4	9,821	10,172	280	291						
Aug-00	10,045	51.2	10,281	10,172	294	291						
Sep-00	10,433	50.3	10,499	10,172	300	291						
Oct-00	10,058	51.4	10,346	10,172	295	291						
Nov-00	10,139	50.0	10,144	10,172	290	291						
Dec-00	9,771	51.1	9,993	10,172	285	291						
Jan-01	10,040	53.7	10,783	9,718	308	278						
Feb-01	10,006	50.7	10,150	9,718	290	278						
Mar-01	9,689	50.9	9,861	9,718	282	278						
Apr-01	9,553	51.5	9,848	9,718	281	278						
May-01	9,160	51.9	9,502	9,718	271	278						
Jun-01	9,537	51.2	9,769	9,718	279	278						
Jul-01	9,486	51.0	9,674	9,718	276	278						
Aug-01	9,312	51.3	9,547	9,718	273	278						
Sep-01	9,577	50.5	9,669	9,718	276	278						
Oct-01	9,293	50.9	9,454	9,718	270	278						
Nov-01	9,060	51.2	9,284	9,718	265	278						
Dec-01	9,010	50.3	9,071	9,718	259	278						
Jan-02	8,887	50.6	8,987	8,682	257	248						
Feb-02	8,720	50.9	8,884	8,682	254	248						
Mar-02	8,428	51.1	8,609	8,682	246	248						
Apr-02	8,132	52.3	8,500	8,682	243	248						
May-02	8,242	51.9	8,555	8,682	244	248						
Jun-02	8,580	51.9	8,899	8,682	254	248						
Jul-02	8,610	51.9	8,933	8,682	255	248						
Aug-02	8,258	51.7	8,539	8,682	244	248						
Sep-02	8,011	52.5	8,407	8,682	240	248						
Oct-02	8,429	51.1	8,607	8,682	246	248						
Nov-02	8,645	49.9	8,623	8,682	246	248						
Dec-02	8,215	52.6	8,640	8,682	247	248						
Jan-03	8,271	52.3	8,651	9,026	247	258						
Feb-03	8,231	53.3	8,776	9,026	251	258						
Mar-03	8,264	52.4	8,660	9,026	247	258						
Apr-03	8,585	51.7	8,875	9,026	253	258						
May-03	8,814	50.5	8,902	9,026	254	258						
Jun-03	8,641	51.6	8,920	9,026	255	258						
Jul-03	8,866	52.4	9,292	9,026	265	258						
Aug-03	9,062	51.7	9,366	9,026	267	258						
Sep-03	8,857	52.0	9,212	9,026	263	258						
Oct-03	8,767	52.4	9,184	9,026	262	258						
Nov-03	8,634	52.7	9,100	9,026	260	258						
Dec-03	8,927	52.5	9,375	9,026	268	258						
Jan-04	8,834	52.8	9,335	9,709	267	277						
Feb-04	9,031	51.8	9,360	9,709	267	277						
Mar-04	9,065	50.9	9,237	9,709	264	277						
Apr-04	9,172	50.7	9,308	9,709	266	277						
May-04	9,111	52.2	9,513	9,709	272	277						
Jun-04	9,428	51.7	9,745	9,709	278	277						
Jul-04	9,405	51.7	9,722	9,709	278	277						
Aug-04	9,542	52.0	9,926	9,709	283	277						
Sep-04	9,764	51.6	10,084	9,709	288	277						

Appendix A. Historical Flow Rates and Operating Wells (mmBtu)

Table 1 - Historical LFG Recovery Flow Rates and Operating Wells / Collectors

13-Jan-21

Cedar Hills Regional Landfill

Month	Average Monthly Flow (scfm)	Average Monthly Methane Content (% vol.)	Avg Monthly Normalized Flow @ 50 % CH4 (scfm)	Average Annual Normalized Flow (scfm)	Avg Monthly Normalized Flow @ 50 % CH4 (MMBtu/hr)	Average Annual Normalized Flow (MMBtu/hr)	Count of Wells Monitored (#)	Average Annual Number of Wells Monitored	Count of Wells with Flow (#)	Average Annual Number of Wells with Flow	Count of Wells with Flow and Vacuum (#)	Average Annual Number of Wells with Flow and Vacuum
Oct-04	9,727	52.2	10,147	9,709	290	277						
Nov-04	9,548	52.4	10,001	9,709	286	277						
Dec-04	9,590	52.8	10,136	9,709	289	277						
Jan-05	9,872	51.7	10,209	10,701	292	306						
Feb-05	9,975	51.5	10,282	10,701	294	306						
Mar-05	10,050	51.9	10,438	10,701	298	306						
Apr-05	10,292	52.0	10,693	10,701	305	306						
May-05	10,455	52.2	10,917	10,701	312	306						
Jun-05	10,463	52.2	10,920	10,701	312	306						
Jul-05	10,701	51.7	11,066	10,701	316	306						
Aug-05	10,700	51.8	11,076	10,701	316	306						
Sep-05	10,535	51.6	10,868	10,701	310	306						
Oct-05	10,581	51.5	10,889	10,701	311	306						
Nov-05	10,191	51.5	10,503	10,701	300	306						
Dec-05	10,294	51.3	10,556	10,701	301	306						
Jan-06	9,998	51.8	10,354	9,111	296	260						
Feb-06	9,631	50.9	9,808	9,111	280	260						
Mar-06	9,250	50.5	9,342	9,111	267	260						
Apr-06	9,023	50.3	9,076	9,111	259	260	466	472	166	181	165	179
May-06	8,994	49.8	8,961	9,111	256	260	472	472	183	181	179	179
Jun-06	8,941	51.0	9,121	9,111	260	260	472	472	180	181	180	179
Jul-06	8,954	50.8	9,098	9,111	260	260	472	472	170	181	170	179
Aug-06	8,742	49.4	8,634	9,111	247	260	471	472	195	181	194	179
Sep-06	8,469	49.2	8,328	9,111	238	260	472	472	167	181	165	179
Oct-06	8,683	49.6	8,621	9,111	246	260	474	472	183	181	182	179
Nov-06	8,857	50.3	8,910	9,111	254	260	473	472	204	181	200	179
Dec-06	8,934	50.8	9,073	9,111	259	260	474	472	181	181	179	179
Jan-07	9,039	49.9	9,020	8,825	258	252	476	508	202	198	202	196
Feb-07	9,024	49.3	8,903	8,825	254	252	475	508	201	198	199	196
Mar-07	8,904	49.6	8,828	8,825	252	252	505	508	178	198	177	196
Apr-07	8,937	48.7	8,713	8,825	249	252	510	508	172	198	168	196
May-07	8,922	48.7	8,689	8,825	248	252	510	508	206	198	203	196
Jun-07	8,835	49.1	8,677	8,825	248	252	514	508	194	198	191	196
Jul-07	8,713	50.1	8,727	8,825	249	252	512	508	200	198	195	196
Aug-07	8,673	50.1	8,689	8,825	248	252	510	508	203	198	201	196
Sep-07	8,666	50.5	8,759	8,825	250	252	516	508	204	198	204	196
Oct-07	9,016	49.5	8,929	8,825	255	252	522	508	218	198	217	196
Nov-07	8,985	49.6	8,912	8,825	255	252	522	508	211	198	211	196
Dec-07	9,106	49.7	9,050	8,825	258	252	522	508	182	198	181	196
Jan-08	8,942	49.6	8,871	8,949	253	256	522	535	194	197	187	195
Feb-08	8,784	50.5	8,875	8,949	253	256	527	535	162	197	158	195
Mar-08	8,667	51.6	8,944	8,949	255	256	527	535	185	197	184	195
Apr-08	8,729	51.6	9,005	8,949	257	256	527	535	203	197	201	195
May-08	8,702	50.6	8,805	8,949	251	256	533	535	210	197	210	195
Jun-08	8,609	51.2	8,816	8,949	252	256	533	535	208	197	206	195
Jul-08	8,611	51.6	8,883	8,949	254	256	538	535	192	197	192	195
Aug-08	8,548	51.1	8,740	8,949	250	256	539	535	179	197	178	195
Sep-08	8,468	51.0	8,643	8,949	247	256	539	535	199	197	199	195
Oct-08	8,776	51.3	8,997	8,949	257	256	542	535	203	197	201	195
Nov-08	9,008	51.9	9,358	8,949	267	256	549	535	226	197	222	195
Dec-08	9,192	51.4	9,447	8,949	270	256	549	535	206	197	205	195
Jan-09	9,303	51.2	9,532	9,488	272	271	549	549	215	201	215	200
Feb-09	9,212	51.5	9,488	9,488	271	271	549	549	217	201	216	200
Mar-09	9,263	52.0	9,642	9,488	275	271	549	549	209	201	206	200
Apr-09	9,334	51.6	9,629	9,488	275	271	549	549	206	201	205	200
May-09	9,265	52.0	9,629	9,488	275	271	549	549	187	201	186	200
Jun-09	9,064	51.4	9,311	9,488	266	271	549	549	207	201	205	200
Jul-09	8,881	51.7	9,180	9,488	262	271	549	549	199	201	197	200
Aug-09	9,016	51.0	9,193	9,488	263	271	548	549	185	201	185	200
Sep-09	9,053	51.5	9,330	9,488	266	271	549	549	188	201	181	200
Oct-09	9,096	52.0	9,466	9,488	270	271	549	549	193	201	191	200
Nov-09	9,346	52.6	9,823	9,488	281	271	549	549	220	201	219	200
Dec-09	9,488	50.8	9,639	9,488	275	271	549	549	189	201	189	200
Jan-10	9,364	52.5	9,826	9,906	281	283	555	563	200	216	200	214
Feb-10	9,358	52.5	9,819	9,906	280	283	555	563	238	216	233	214
Mar-10	9,410	52.7	9,918	9,906	283	283	555	563	199	216	195	214
Apr-10	9,418	52.7	9,918	9,906	283	283	555	563	201	216	196	214
May-10	9,343	53.0	9,906	9,906	283	283	555	563	205	216	204	214
Jun-10	9,408	52.8	9,926	9,906	283	283	555	563	207	216	206	214
Jul-10	9,054	52.5	9,504	9,906	271	283	555	563	210	216	209	214
Aug-10	9,132	51.6	9,416	9,906	269	283	582	563	259	216	259	214
Sep-10	9,427	53.1	10,009	9,906	286	283	572	563	234	216	233	214
Oct-10	9,642	52.1	10,049	9,906	287	283	572	563	214	216	206	214
Nov-10	9,801	52.4	10,270	9,906	293	283	572	563	220	216	218	214
Dec-10	9,722	53.0	10,312	9,906	295	283	572	563	208	216	205	214

Appendix A. Historical Flow Rates and Operating Wells (mmBtu)

Table 1 - Historical LFG Recovery Flow Rates and Operating Wells / Collectors

Cedar Hills Regional Landfill

13-Jan-21

Month	Average Monthly Flow (scfm)	Average Monthly Methane Content (% vol.)	Avg Monthly Normalized Flow @ 50 % CH4 (scfm)	Average Annual Normalized Flow (scfm)	Avg Monthly Normalized Flow @ 50 % CH4 (MMBtu/hr)	Average Annual Normalized Flow (MMBtu/hr)	Count of Wells Monitored (#)	Average Annual Number of Wells Monitored	Count of Wells with Flow (#)	Average Annual Number of Wells with Flow	Count of Wells with Flow and Vacuum (#)	Average Annual Number of Wells with Flow and Vacuum
Jan-11	9,771	53.2	10,404	10,120	297	289	572	576	184	202	183	201
Feb-11	9,822	53.2	10,449	10,120	298	289	570	576	205	202	203	201
Mar-11	9,777	53.7	10,492	10,120	300	289	572	576	206	202	205	201
Apr-11	9,735	53.8	10,478	10,120	299	289	571	576	193	202	193	201
May-11	9,528	53.9	10,269	10,120	293	289	571	576	206	202	206	201
Jun-11	9,387	53.2	9,983	10,120	285	289	571	576	191	202	191	201
Jul-11	9,196	52.7	9,696	10,120	277	289	572	576	178	202	176	201
Aug-11	9,089	52.1	9,479	10,120	271	289	571	576	171	202	171	201
Sep-11	9,121	51.5	9,387	10,120	268	289	571	576	195	202	195	201
Oct-11	9,610	52.1	10,015	10,120	286	289	575	576	201	202	199	201
Nov-11	10,708	48.9	10,477	10,120	299	289	601	576	254	202	251	201
Dec-11	11,357	45.4	10,316	10,120	295	289	589	576	237	202	237	201
Jan-12	10,510	49.7	10,449	10,011	298	286	606	611	256	234	256	232
Feb-12	10,713	49.3	10,556	10,011	301	286	608	611	225	234	225	232
Mar-12	10,418	49.3	10,271	10,011	293	286	610	611	237	234	237	232
Apr-12	10,704	47.5	10,166	10,011	290	286	610	611	231	234	230	232
May-12	10,537	46.7	9,850	10,011	281	286	610	611	249	234	249	232
Jun-12	10,413	48.2	10,028	10,011	286	286	610	611	243	234	243	232
Jul-12	10,085	48.5	9,775	10,011	279	286	610	611	195	234	193	232
Aug-12	9,349	50.5	9,443	10,011	270	286	610	611	248	234	248	232
Sep-12	9,319	50.9	9,483	10,011	271	286	610	611	238	234	232	232
Oct-12	9,410	50.7	9,536	10,011	272	286	610	611	214	234	211	232
Nov-12	10,042	51.1	10,256	10,011	293	286	618	611	233	234	232	232
Dec-12	10,253	50.3	10,320	10,011	295	286	618	611	233	234	229	232
Jan-13	10,390	49.6	10,310	10,225	294	292	592	588	261	231	255	229
Feb-13	10,270	50.3	10,335	10,225	295	292	592	588	242	231	242	229
Mar-13	10,153	49.7	10,085	10,225	288	292	592	588	225	231	221	229
Apr-13	10,107	50.2	10,137	10,225	290	292	592	588	240	231	238	229
May-13	10,209	50.0	10,206	10,225	291	292	592	588	219	231	216	229
Jun-13	10,001	51.8	10,360	10,225	296	292	592	588	218	231	217	229
Jul-13	9,818	51.2	10,059	10,225	287	292	592	588	222	231	219	229
Aug-13	9,746	50.4	9,830	10,225	281	292	592	588	236	231	235	229
Sep-13	9,963	51.7	10,294	10,225	294	292	592	588	230	231	230	229
Oct-13	10,323	51.0	10,533	10,225	301	292	602	588	248	231	246	229
Nov-13	10,206	50.9	10,395	10,225	297	292	599	588	239	231	238	229
Dec-13	10,141	50.1	10,153	10,225	290	292	527	588	194	231	192	229
Jan-14	10,499	50.7	10,648	10,483	304	299	601	619	248	250	247	249
Feb-14	10,453	50.7	10,591	10,483	302	299	614	619	260	250	260	249
Mar-14	10,382	51.0	10,580	10,483	302	299	614	619	256	250	256	249
Apr-14	10,177	50.3	10,231	10,483	292	299	615	619	226	250	225	249
May-14	10,066	51.6	10,388	10,483	297	299	615	619	256	250	255	249
Jun-14	9,797	50.4	9,882	10,483	282	299	615	619	237	250	234	249
Jul-14	9,814	50.3	9,876	10,483	282	299	615	619	216	250	216	249
Aug-14	9,951	51.5	10,244	10,483	293	299	617	619	232	250	232	249
Sep-14	10,163	52.4	10,654	10,483	304	299	623	619	240	250	239	249
Oct-14	10,417	52.5	10,941	10,483	312	299	631	619	239	250	238	249
Nov-14	10,462	52.3	10,953	10,483	313	299	631	619	287	250	286	249
Dec-14	10,782	50.1	10,802	10,483	309	299	631	619	304	250	302	249
Jan-15	10,441	51.1	10,661	10,585	304	302	631	631	270	258	270	257
Feb-15	10,349	51.1	10,583	10,585	302	302	631	631	256	258	255	257
Mar-15	10,249	50.9	10,439	10,585	298	302	631	631	251	258	251	257
Apr-15	10,225	50.7	10,374	10,585	296	302	631	631	241	258	241	257
May-15	10,049	50.7	10,195	10,585	291	302	631	631	251	258	251	257
Jun-15	9,737	50.9	9,912	10,585	283	302	631	631	239	258	239	257
Jul-15	9,642	49.9	9,631	10,585	275	302	629	631	217	258	216	257
Aug-15	9,841	50.8	9,996	10,585	285	302	626	631	310	258	307	257
Sep-15	11,171	50.6	11,307	10,585	323	302	627	631	298	258	298	257
Oct-15	10,624	50.0	10,624	10,585	303	302	630	631	257	258	256	257
Nov-15	11,751	50.0	11,751	10,585	336	302	634	631	251	258	249	257
Dec-15	11,549	50.0	11,549	10,585	330	302	634	631	249	258	249	257
Jan-16	11,332	50.0	11,332	10,919	324	312	641	642	259	281	259	280
Feb-16	11,156	50.0	11,156	10,919	319	312	641	642	244	281	244	280
Mar-16	11,239	50.0	11,239	10,919	321	312	642	642	326	281	326	280
Apr-16	11,484	50.0	11,484	10,919	328	312	641	642	260	281	259	280
May-16	10,779	50.0	10,779	10,919	308	312	641	642	291	281	291	280
Jun-16	10,745	50.0	10,745	10,919	307	312	639	642	298	281	298	280
Jul-16	10,739	50.0	10,739	10,919	307	312	642	642	311	281	311	280
Aug-16	10,642	50.0	10,642	10,919	304	312	645	642	335	281	326	280
Sep-16	10,735	50.0	10,735	10,919	307	312	642	642	295	281	295	280
Oct-16	10,641	50.0	10,641	10,919	304	312	644	642	282	281	279	280
Nov-16	10,736	50.0	10,736	10,919	307	312	643	642	263	281	263	280
Dec-16	10,798	50.0	10,798	10,919	308	312	643	642	209	281	209	280
Jan-17	10,884	50.0	10,884	10,768	311	308	642	645	222	232	221	231
Feb-17	10,140	50.0	10,140	10,768	290	308	642	645	244	232	244	231
Mar-17	10,284	51.0	10,490	10,768	300	308	642	645	213	232	213	231

Table 1 - Historical LFG Recovery Flow Rates and Operating Wells / Collectors

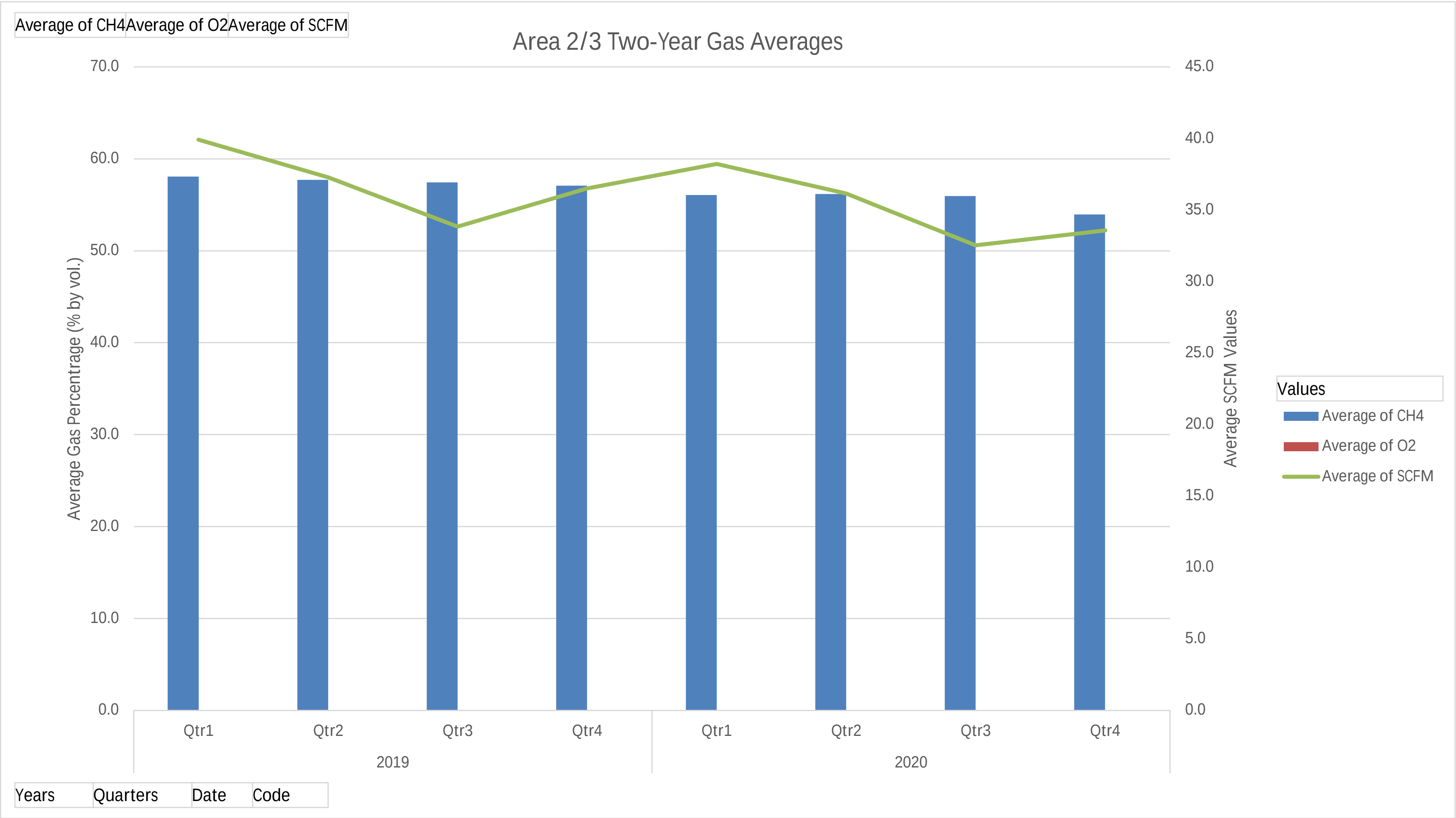
13-Jan-21

Cedar Hills Regional Landfill

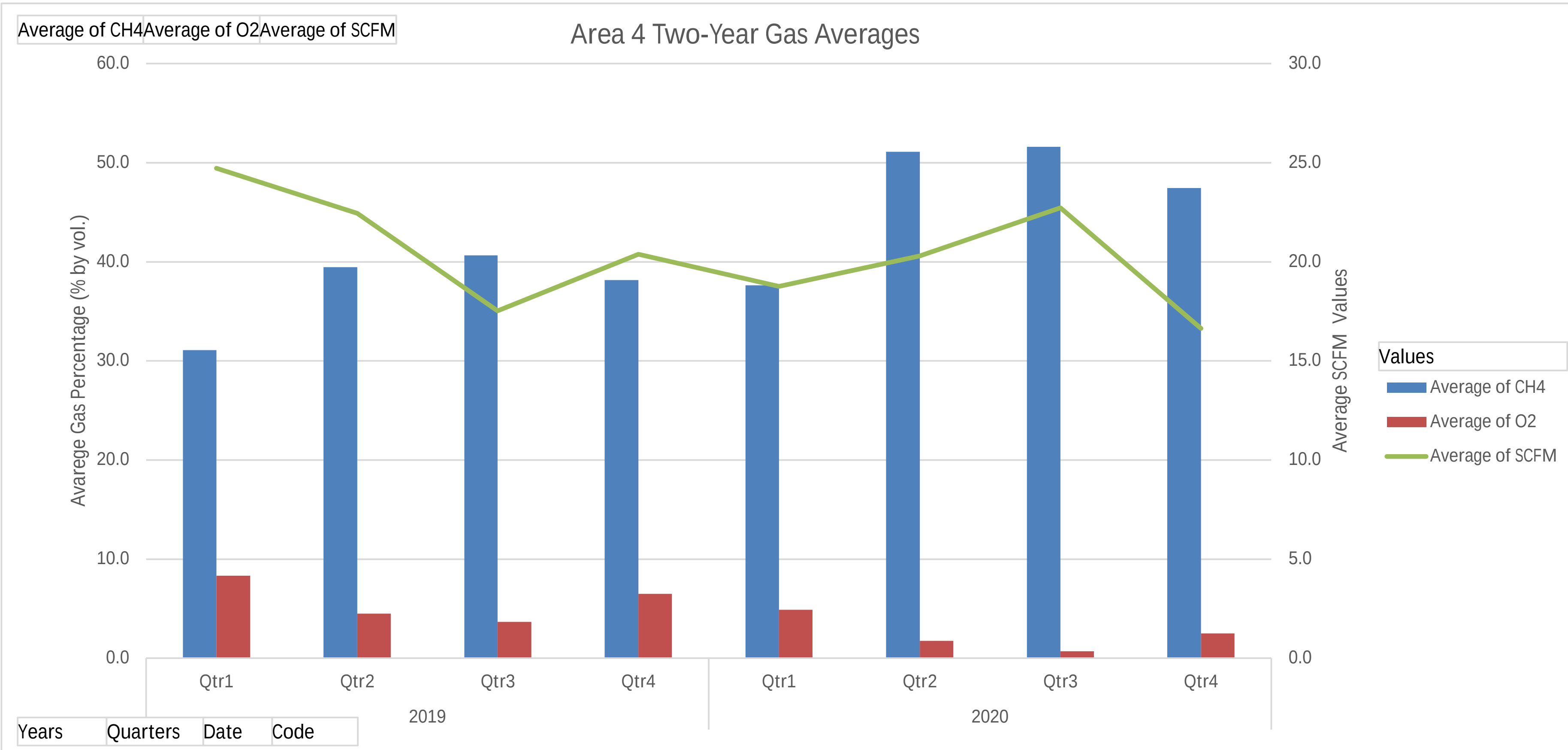
Month	Average Monthly Flow (scfm)	Average Monthly Methane Content (% vol.)	Avg Monthly Normalized Flow @ 50 % CH4 (scfm)	Average Annual Normalized Flow (scfm)	Avg Monthly Normalized Flow @ 50 % CH4 (MMBtu/hr)	Average Annual Normalized Flow (MMBtu/hr)	Count of Wells Monitored (#)	Average Annual Number of Wells Monitored	Count of Wells with Flow (#)	Average Annual Number of Wells with Flow	Count of Wells with Flow and Vacuum (#)	Average Annual Number of Wells with Flow and Vacuum
Apr-17	10,318	52.5	10,843	10,768	310	308	NA	645	NA	232	NA	231
May-17	10,567	52.9	11,188	10,768	320	308	NA	645	NA	232	NA	231
Jun-17	9,977	53.8	10,742	10,768	307	308	643	645	255	232	253	231
Jul-17	10,051	52.4	10,542	10,768	301	308	643	645	249	232	246	231
Aug-17	9,861	53.0	10,446	10,768	298	308	643	645	275	232	273	231
Sep-17	10,291	53.6	11,023	10,768	315	308	650	645	252	232	251	231
Oct-17	10,242	53.8	11,024	10,768	315	308	650	645	211	232	211	231
Nov-17	10,936	50.1	10,960	10,768	313	308	649	645	196	232	195	231
Dec-17	10,536	51.9	10,931	10,768	312	308	650	645	205	232	205	231
Jan-18	10,556	52.5	11,093	11,207	317	320	664	677	189	239	189	237
Feb-18	10,868	52.7	11,461	11,207	327	320	665	677	212	239	212	237
Mar-18	10,677	52.3	11,172	11,207	319	320	670	677	219	239	218	237
Apr-18	10,730	52.6	11,288	11,207	322	320	669	677	224	239	224	237
May-18	10,558	53.4	11,269	11,207	322	320	676	677	247	239	246	237
Jun-18	10,534	53.9	11,353	11,207	324	320	678	677	268	239	266	237
Jul-18	10,423	54.9	11,446	11,207	327	320	681	677	283	239	279	237
Aug-18	9,829	51.0	10,022	11,207	286	320	684	677	270	239	266	237
Sep-18	10,683	54.1	11,556	11,207	330	320	684	677	246	239	244	237
Oct-18	10,681	53.8	11,502	11,207	328	320	685	677	261	239	261	237
Nov-18	10,465	54.0	11,297	11,207	323	320	685	677	227	239	226	237
Dec-18	10,342	53.3	11,029	11,207	315	320	685	677	220	239	217	237
Jan-19	10,496	53.4	11,202	11,278	320	322	685	708	213	262	211	259
Feb-19	10,759	54.3	11,677	11,278	333	322	685	708	192	262	191	259
Mar-19	10,432	53.6	11,181	11,278	319	322	697	708	238	262	238	259
Apr-19	10,511	53.8	11,311	11,278	323	322	703	708	274	262	269	259
May-19	10,548	53.6	11,303	11,278	323	322	704	708	278	262	277	259
Jun-19	10,360	53.4	11,072	11,278	316	322	704	708	301	262	297	259
Jul-19	10,150	53.9	10,937	11,278	312	322	705	708	289	262	289	259
Aug-19	10,511	53.7	11,282	11,278	322	322	712	708	295	262	292	259
Sep-19	10,859	53.6	11,649	11,278	333	322	715	708	285	262	281	259
Oct-19	10,882	53.2	11,586	11,278	331	322	723	708	246	262	244	259
Nov-19	10,499	53.4	11,207	11,278	320	322	729	708	279	262	275	259
Dec-19	10,234	53.4	10,936	11,278	312	322	729	708	251	262	247	259
Jan-20	10,000	52.9	10,588	9,704	302	277	729	729	254	246	254	246
Feb-20	10,351	52.5	10,871	9,704	310	277	729	729	276	246	276	246
Mar-20	9,890	52.4	10,357	9,704	296	277	729	729	209	246	209	246
Apr-20	9,935	51.3	10,196	9,704	291	277	729	729	243	246	243	246
May-20	9,272	53.2	9,874	9,704	282	277	729	729	195	246	195	246
Jun-20	8,622	52.5	9,055	9,704	259	277	729	729	211	246	211	246
Jul-20	8,632	52.0	8,977	9,704	256	277	731	729	247	246	247	246
Aug-20	8,678	52.6	9,131	9,704	261	277	729	729	282	246	281	246
Sep-20	9,207	52.6	9,689	9,704	277	277	729	729	302	246	301	246
Oct-20	8,799	52.2	9,178	9,704	262	277	729	729	295	246	293	246
Nov-20	8,257	53.5	8,828	9,704	252	277	729	729	206	246	204	246
Dec-20												

Appendix B. Two Year Gas Averages of Wells Sent to NFS/BEW

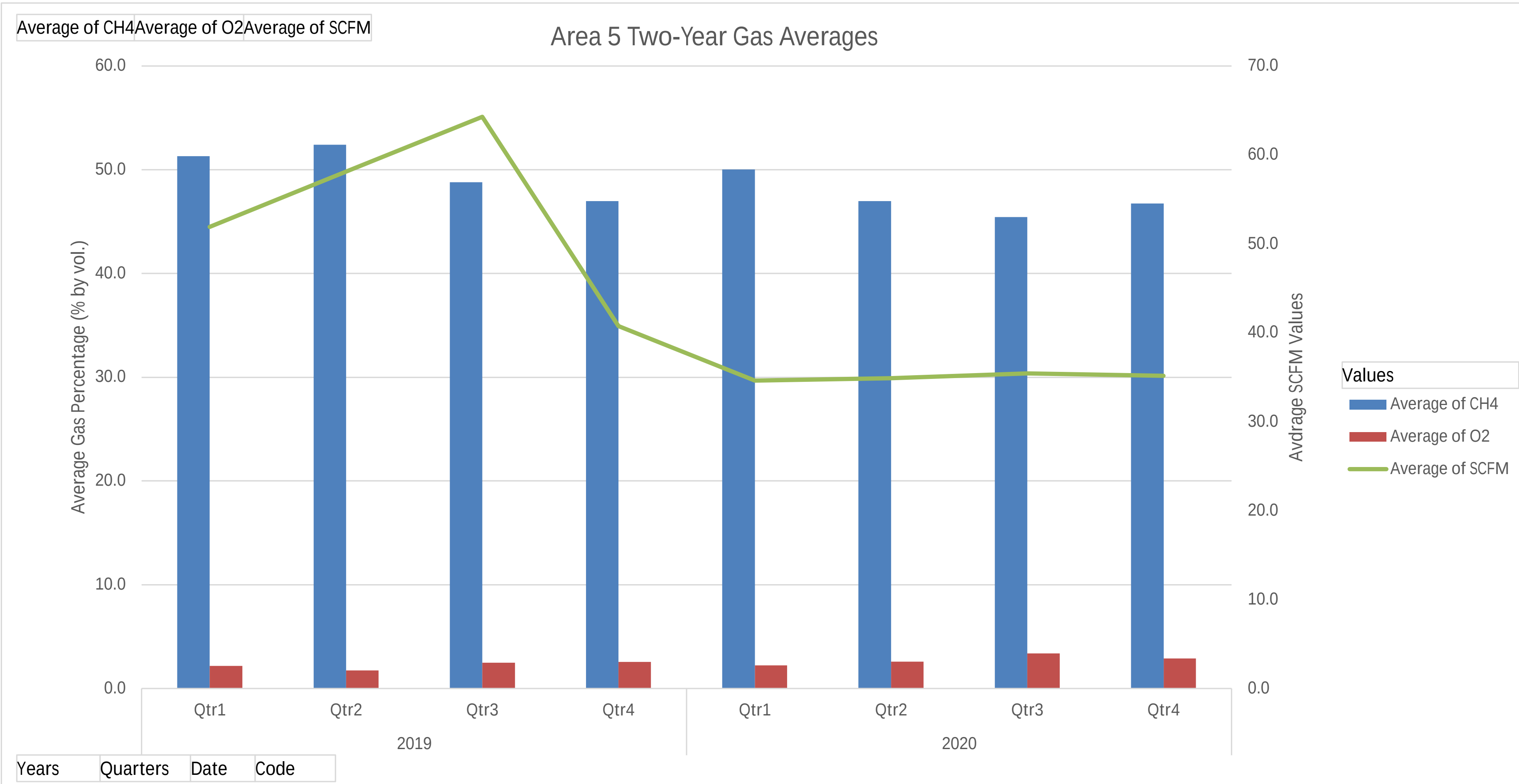
Appendix B. Two-Year Gas Averages by Area



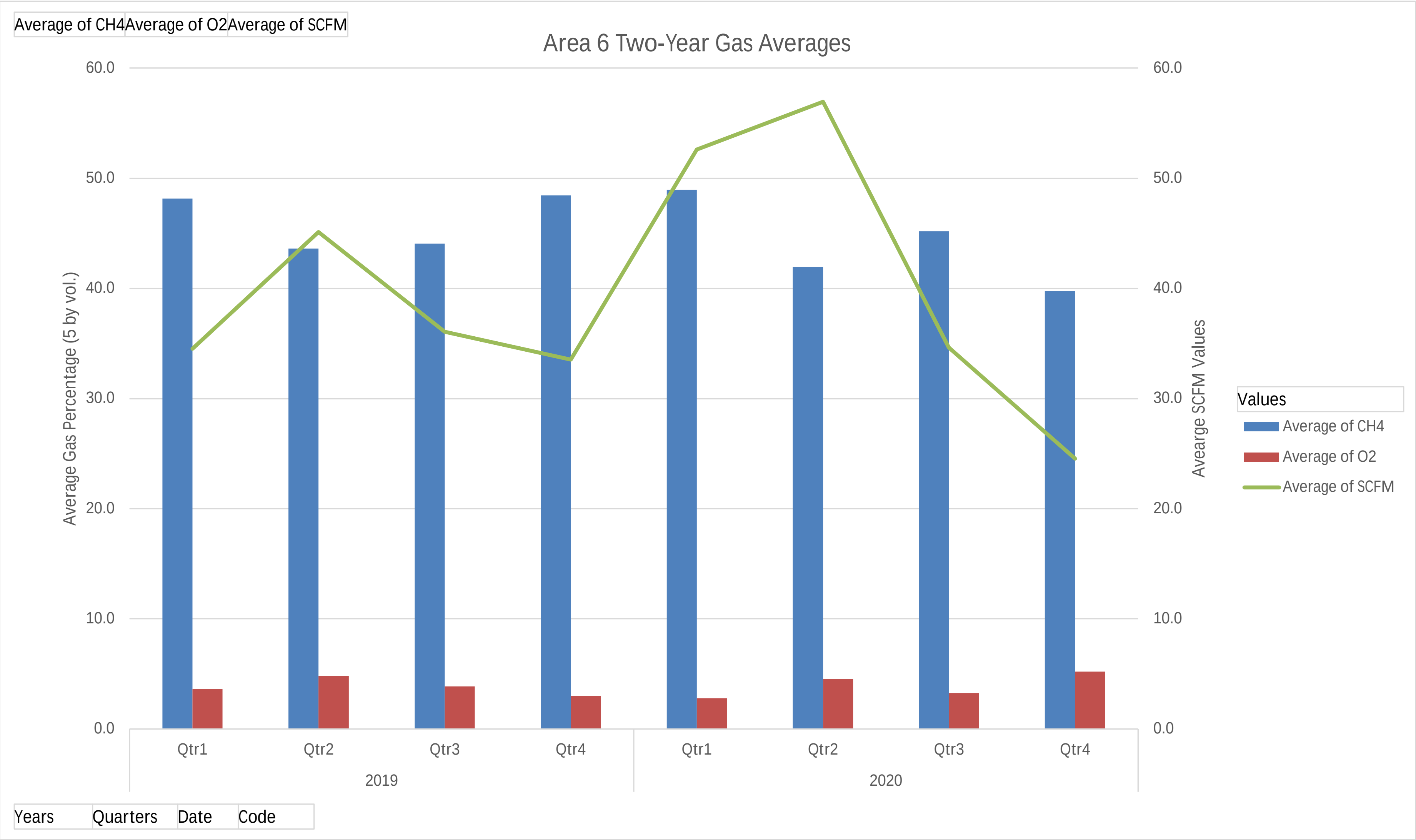
Appendix B. Two-Year Gas Averages by Area



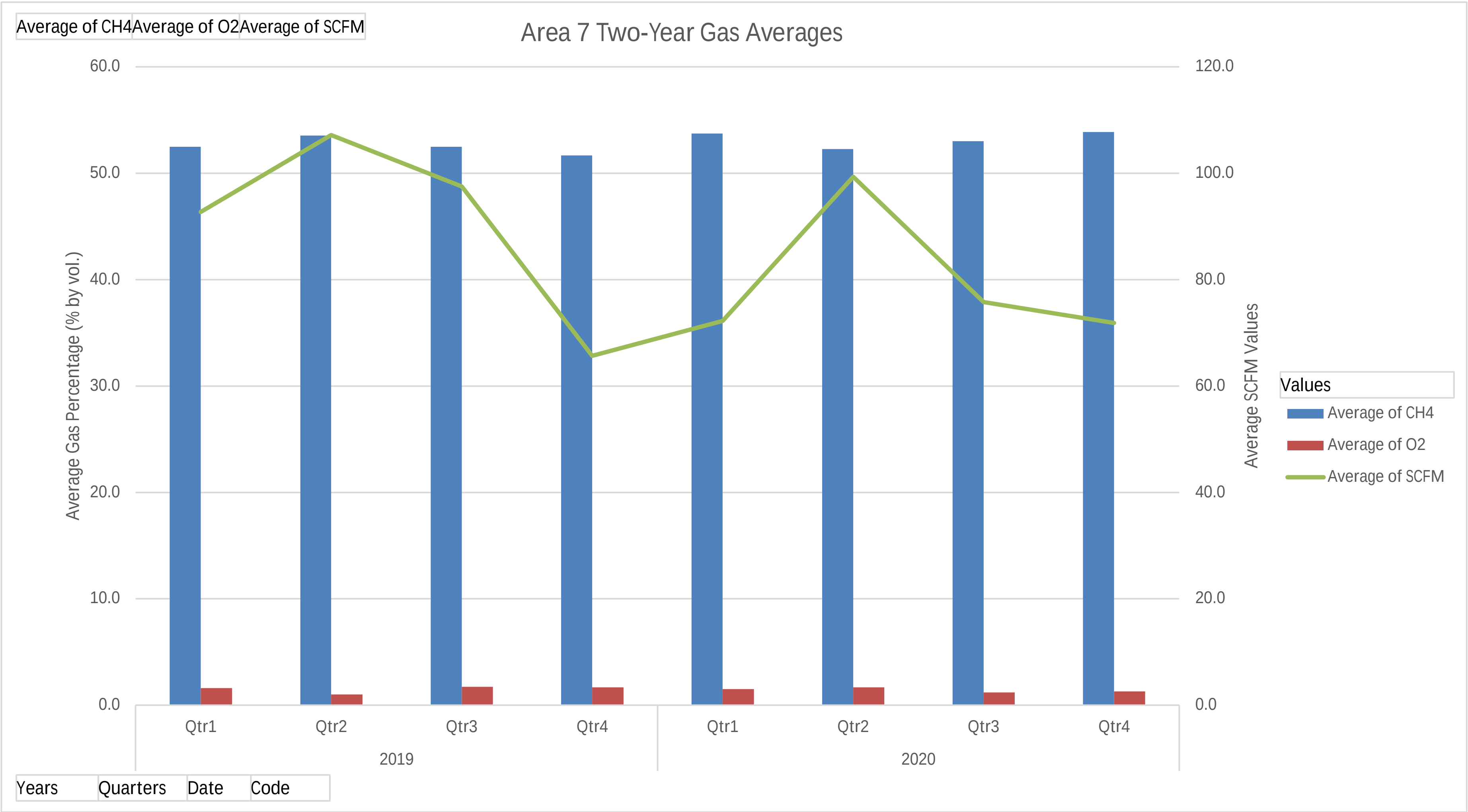
Appendix B. Two-Year Gas Averages by Area



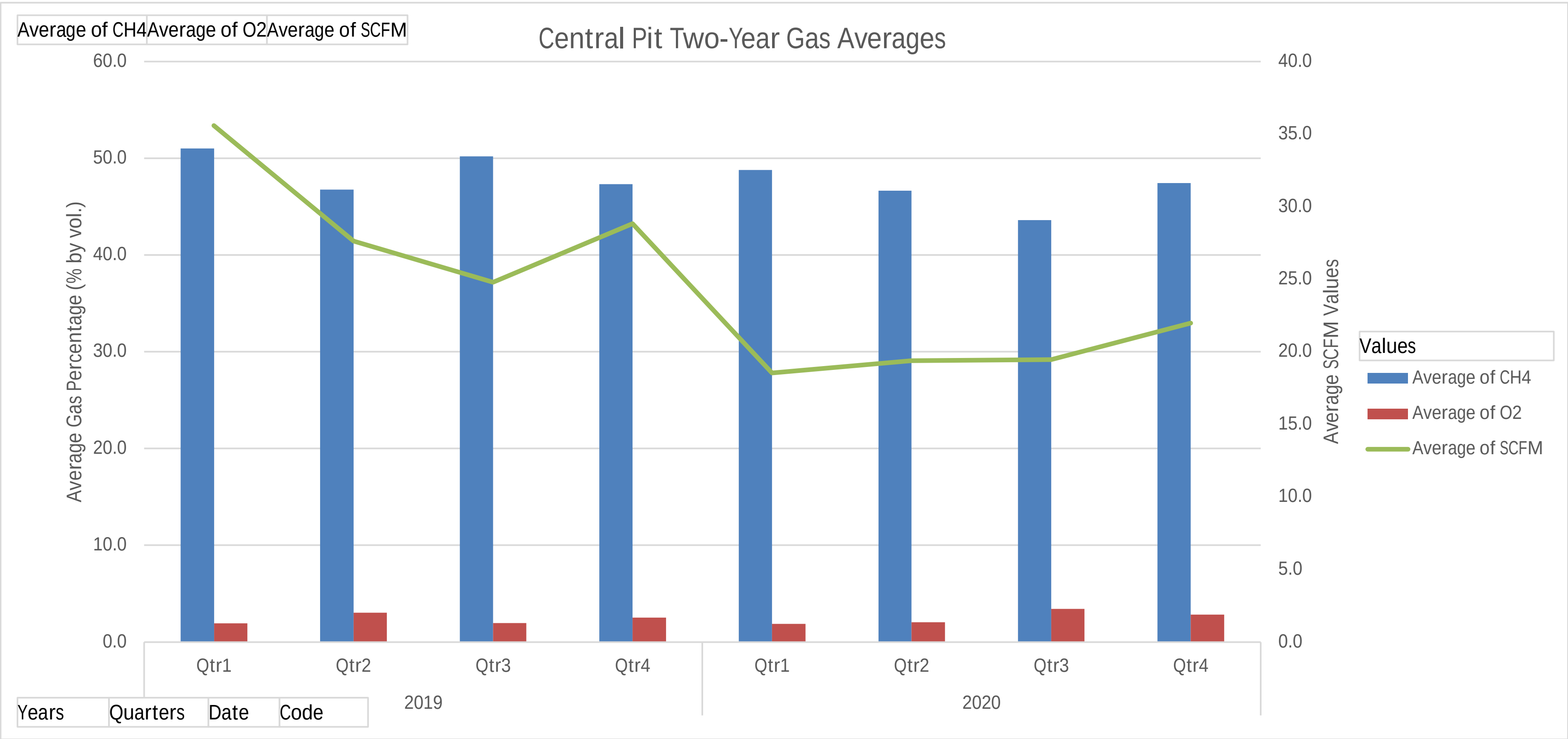
Appendix B. Two-Year Gas Averages by Area



Appendix B. Two-Year Gas Averages by Area



Appendix B. Two-Year Gas Averages by Area



Appendix C. LFG Recovery Modeling

EXHIBIT 1. LFG RECOVERY PROJECTION
CEDAR HILLS LANDFILL, MAPLE VALLEY, WA

Year	Annual Total Waste Disposal (tons/yr)	Total Waste In Place (tons)	LFG Recovery Potential (scfm)	LFG Recovery Potential (mmcf/day)	LFG Recovery Potential (mmBtu/hr)	LFG System Coverage (%)	LFG Recovery from Existing/Planned System (scfm)	LFG Recovery from Existing/Planned System (mmcf/day)	LFG Recovery from Existing/Planned System (mmBtu/hr)
1965	312,244	312,244	0	0.00	0	0%	0	0.00	0
1966	312,244	624,488	549	0.79	17	0%	0	0.00	0
1967	312,244	936,732	1,027	1.48	31	0%	0	0.00	0
1968	312,244	1,248,976	1,444	2.08	44	0%	0	0.00	0
1969	312,244	1,561,220	1,806	2.60	55	0%	0	0.00	0
1970	312,244	1,873,463	2,122	3.06	64	0%	0	0.00	0
1971	312,244	2,185,707	2,396	3.45	73	0%	0	0.00	0
1972	312,244	2,497,951	2,635	3.80	80	0%	0	0.00	0
1973	312,244	2,810,195	2,844	4.09	86	0%	0	0.00	0
1974	312,244	3,122,439	3,025	4.36	92	0%	0	0.00	0
1975	312,244	3,434,683	3,183	4.58	97	0%	0	0.00	0
1976	312,244	3,746,927	3,321	4.78	101	0%	0	0.00	0
1977	312,244	4,059,171	3,440	4.95	104	0%	0	0.00	0
1978	360,092	4,419,263	3,545	5.10	108	0%	0	0.00	0
1979	619,781	5,039,044	3,720	5.36	113	0%	0	0.00	0
1980	713,394	5,752,438	4,329	6.23	131	0%	0	0.00	0
1981	803,164	6,555,602	5,024	7.23	153	0%	0	0.00	0
1982	756,998	7,312,601	5,787	8.33	176	0%	0	0.00	0
1983	713,401	8,026,002	6,370	9.17	193	0%	0	0.00	0
1984	792,827	8,818,829	6,801	9.79	206	0%	0	0.00	0
1985	848,945	9,667,774	7,316	10.54	222	0%	0	0.00	0
1986	917,150	10,584,924	7,863	11.32	239	0%	0	0.00	0
1987	1,301,959	11,886,883	8,460	12.18	257	0%	0	0.00	0
1988	1,261,202	13,148,085	9,656	13.90	293	0%	0	0.00	0
1989	1,241,612	14,389,697	10,626	15.30	323	0%	0	0.00	0
1990	1,385,565	15,775,262	11,435	16.47	347	0%	0	0.00	0
1991	1,150,997	16,926,260	12,362	17.80	375	0%	0	0.00	0
1992	907,927	17,834,186	12,763	18.38	387	53%	6,742	9.71	205
1993	877,947	18,712,133	12,691	18.28	385	56%	7,169	10.32	218
1994	802,411	19,514,544	12,577	18.11	382	60%	7,522	10.83	228
1995	813,488	20,328,032	12,347	17.78	375	55%	6,795	9.78	206
1996	808,139	21,136,170	12,166	17.52	369	59%	7,193	10.36	218
1997	862,585	21,998,755	12,001	17.28	364	63%	7,526	10.84	228
1998	873,657	22,872,412	11,951	17.21	363	83%	9,906	14.26	301
1999	923,417	23,795,830	11,927	17.18	362	89%	10,655	15.34	323
2000	947,174	24,743,004	11,993	17.27	364	85%	10,172	14.65	309
2001	936,310	25,679,314	12,093	17.41	367	80%	9,718	13.99	295
2002	939,489	26,618,803	12,160	17.51	369	71%	8,682	12.50	264
2003	978,837	27,597,640	12,225	17.60	371	74%	9,026	13.00	274
2004	1,006,163	28,603,803	12,350	17.78	375	79%	9,709	13.98	295
2005	988,855	29,592,658	12,507	18.01	380	86%	10,701	15.41	325
2006	998,207	30,590,865	12,584	18.12	382	72%	9,111	13.12	277
2007	1,010,429	31,601,294	12,669	18.24	385	70%	8,825	12.71	268
2008	930,616	32,531,910	12,765	18.38	388	70%	8,949	12.89	272
2009	867,481	33,399,391	12,713	18.31	386	75%	9,488	13.66	288
2010	830,911	34,230,302	12,562	18.09	381	79%	9,906	14.26	301
2011	812,684	35,042,986	12,483	17.98	379	81%	10,120	14.57	307
2012	806,914	35,849,900	12,192	17.56	370	82%	10,011	14.42	304
2013	809,165	36,659,065	12,203	17.57	370	84%	10,225	14.72	310
2014	843,320	37,502,385	11,931	17.18	362	88%	10,483	15.10	318
2015	869,802	38,372,187	12,144	17.49	369	84%	10,224	14.72	310
2016	922,000	39,294,187	12,121	17.45	368	88%	10,633	15.31	323
2017	931,177	40,225,364	12,185	17.55	370	90%	10,993	15.83	334
2018	888,513	41,113,877	12,246	17.63	372	93%	11,331	16.32	344
2019	868,532	41,982,409	12,209	17.58	371	92%	11,276	16.24	342
2020	871,500	42,853,909	11,862	17.08	360	76%	9,064	13.05	275
2021	880,076	43,733,985	11,381	16.39	346	78%	8,911	12.83	271
2022	886,400	44,620,385	11,002	15.84	334	80%	8,843	12.73	268

EXHIBIT 1. LFG RECOVERY PROJECTION
CEDAR HILLS LANDFILL, MAPLE VALLEY, WA

Year	Annual Total Waste Disposal (tons/yr)	Total Waste In Place (tons)	LFG Recovery Potential (scfm)	LFG Recovery Potential (mmcf/day)	LFG Recovery Potential (mmBtu/hr)	LFG System Coverage (%)	LFG Recovery from Existing/Planned System (scfm)	LFG Recovery from Existing/Planned System (mmcf/day)	LFG Recovery from Existing/Planned System (mmBtu/hr)
2023	898,799	45,519,184	10,792	15.54	328	82%	8,901	12.82	270
2024	902,039	46,421,223	10,669	15.36	324	83%	8,827	12.71	268
2025	905,279	47,326,502	10,680	15.38	324	83%	8,863	12.76	269
2026	905,965	48,232,467	10,696	15.40	325	83%	8,907	12.83	270
2027	906,651	49,139,118	10,711	15.42	325	85%	9,086	13.08	276
2028	912,379	50,051,497	10,726	15.45	326	86%	9,263	13.34	281
2029	921,703	50,973,200	10,748	15.48	326	85%	9,135	13.15	277
2030	939,784	51,912,984	10,783	15.53	327	84%	9,055	13.04	275
2031	956,217	52,869,201	10,840	15.61	329	84%	9,058	13.04	275
2032	972,930	53,842,131	10,916	15.72	331	82%	8,996	12.95	273
2033	989,928	54,832,059	11,008	15.85	334	82%	9,075	13.07	276
2034	1,007,214	55,839,273	11,114	16.00	337	83%	9,243	13.31	281
2035	1,024,794	56,864,067	11,234	16.18	341	83%	9,322	13.42	283
2036	1,042,672	57,906,739	11,365	16.37	345	83%	9,455	13.62	287
2037	1,060,855	58,967,594	11,507	16.57	349	84%	9,637	13.88	293
2038	1,079,347	60,046,941	11,659	16.79	354	84%	9,774	14.07	297
2039	1,098,153	61,145,094	11,819	17.02	359	84%	9,938	14.31	302
2040	1,117,279	62,262,373	11,988	17.26	364	84%	10,077	14.51	306
2041	1,136,830	63,399,203	12,165	17.52	369	84%	10,233	14.74	311
2042	1,156,720	64,555,923	12,349	17.78	375	84%	10,405	14.98	316
2043	1,176,960	65,732,883	12,541	18.06	381	84%	10,590	15.25	322
2044	1,197,560	66,930,443	12,738	18.34	387	85%	10,788	15.54	328
2045	1,218,520	68,148,963	12,942	18.64	393	85%	10,999	15.84	334
2046	851,037	69,000,000	13,152	18.94	399	86%	11,280	16.24	342
2047	0	69,000,000	12,776	18.40	388	90%	11,542	16.62	350
2048	0	69,000,000	11,153	16.06	339	95%	10,595	15.26	322
2049	0	69,000,000	9,738	14.02	296	95%	9,250	13.32	281
2050	0	69,000,000	8,502	12.24	258	95%	8,077	11.63	245
2051	0	69,000,000	7,425	10.69	225	95%	7,053	10.16	214
2052	0	69,000,000	6,484	9.34	197	95%	6,159	8.87	187
2053	0	69,000,000	5,664	8.16	172	95%	5,380	7.75	163
2054	0	69,000,000	4,947	7.12	150	95%	4,699	6.77	143
2055	0	69,000,000	4,322	6.22	131	95%	4,106	5.91	125
2056	0	69,000,000	3,776	5.44	115	95%	3,587	5.17	109
2057	0	69,000,000	3,300	4.75	100	95%	3,134	4.51	95
2058	0	69,000,000	2,884	4.15	88	95%	2,739	3.94	83
2059	0	69,000,000	2,520	3.63	77	95%	2,394	3.45	73
2060	0	69,000,000	2,203	3.17	67	95%	2,093	3.01	64

EXHIBIT 2. LFG RECOVERY PROJECTION CEDAR HILLS LANDFILL, MAPLE VALLEY, WA

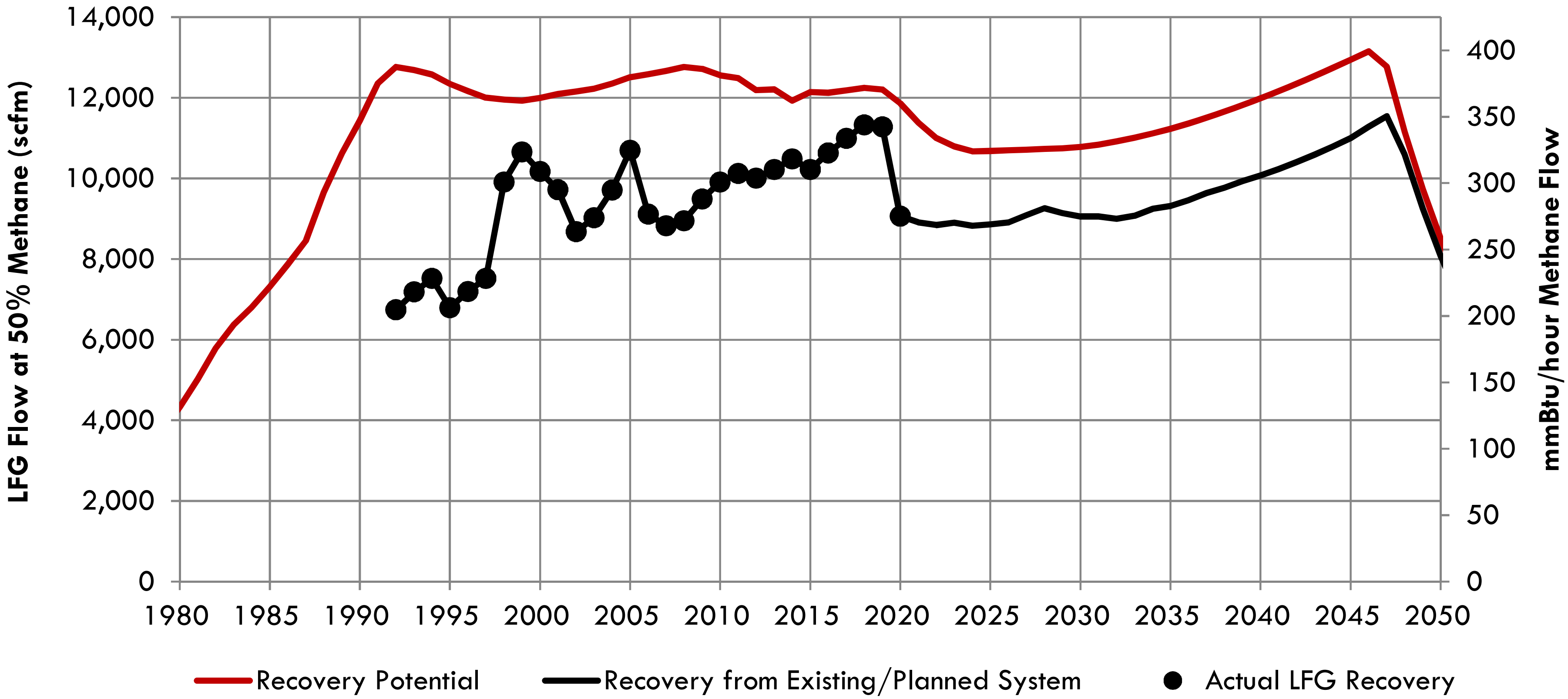


EXHIBIT 3. LFG RECOVERY PROJECTION BY DISPOSAL AREA
CEDAR HILLS LANDFILL, MAPLE VALLEY, WA

	LFG Recovery Potential (scfm)								LFG Recovery from Existing/Planned System (scfm)							
Year	1	2 & 3	4	5	6	7	8	9	1	2 & 3	4	5	6	7	8	9
1965	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	549	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	1,027	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1968	1,444	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	1,806	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970	2,122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	2,396	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	2,635	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	2,844	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1974	3,025	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	3,183	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	3,321	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	3,440	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	3,545	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	3,720	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	4,329	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	5,024	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	5,787	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	6,370	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	6,801	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	7,316	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	7,863	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	8,460	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	9,656	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	8,518	2,108	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	7,417	4,019	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	6,458	5,904	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	5,624	7,042	98	0	0	0	0	0	2,993	3,748	0	0	0	0	0	0
1993	4,897	6,133	1,662	0	0	0	0	0	3,183	3,986	0	0	0	0	0	0
1994	4,265	5,341	2,972	0	0	0	0	0	2,551	3,194	1,777	0	0	0	0	0
1995	3,714	4,651	3,982	0	0	0	0	0	2,044	2,560	2,191	0	0	0	0	0
1996	3,235	4,051	4,881	0	0	0	0	0	1,941	2,431	2,821	0	0	0	0	0
1997	2,817	3,529	5,655	0	0	0	0	0	1,831	2,294	3,401	0	0	0	0	0
1998	2,454	3,074	6,423	0	0	0	0	0	2,209	2,766	4,931	0	0	0	0	0
1999	2,137	2,677	7,112	0	0	0	0	0	1,924	2,410	6,322	0	0	0	0	0
2000	1,862	2,332	7,799	0	0	0	0	0	1,611	2,018	6,544	0	0	0	0	0
2001	1,622	2,032	6,865	1,573	0	0	0	0	1,394	1,747	5,902	675	0	0	0	0
2002	1,413	1,770	5,981	2,996	0	0	0	0	1,201	1,505	5,084	892	0	0	0	0
2003	1,231	1,543	5,211	4,241	0	0	0	0	1,047	1,311	4,429	2,239	0	0	0	0
2004	1,073	1,344	4,540	5,393	0	0	0	0	965	1,210	4,086	3,448	0	0	0	0
2005	935	1,171	3,956	6,445	0	0	0	0	888	1,113	3,758	4,942	0	0	0	0
2006	815	1,021	3,447	6,441	861	0	0	0	733	919	3,102	4,357	0	0	0	0
2007	710	890	3,004	5,612	2,454	0	0	0	639	801	2,703	4,682	0	0	0	0
2008	619	775	2,618	4,889	3,864	0	0	0	557	698	2,356	3,911	1,427	0	0	0
2009	539	676	2,281	4,260	4,957	0	0	0	485	608	2,053	3,834	2,507	0	0	0
2010	470	589	1,988	3,712	5,802	0	0	0	423	530	1,790	3,341	3,823	0	0	0
2011	410	513	1,733	3,234	5,200	1,392	0	0	369	462	1,560	2,911	3,900	918	0	0
2012	357	448	1,511	2,819	4,534	2,524	0	0	321	403	1,360	2,537	3,627	1,763	0	0

EXHIBIT 3. LFG RECOVERY PROJECTION BY DISPOSAL AREA
CEDAR HILLS LANDFILL, MAPLE VALLEY, WA

	LFG Recovery Potential (scfm)								LFG Recovery from Existing/Planned System (scfm)							
Year	1	2 & 3	4	5	6	7	8	9	1	2 & 3	4	5	6	7	8	9
2013	311	390	1,317	2,456	3,953	3,775	0	0	280	351	1,185	2,211	3,557	2,640	0	0
2014	271	340	1,148	2,141	3,447	4,584	0	0	258	323	1,091	2,034	3,274	3,503	0	0
2015	237	297	1,001	1,866	3,005	5,738	0	0	225	282	951	1,773	2,855	4,138	0	0
2016	206	259	873	1,627	2,621	6,535	0	0	196	246	829	1,545	2,490	5,327	0	0
2017	180	226	761	1,418	2,286	7,315	0	0	171	214	723	1,347	2,172	6,366	0	0
2018	157	197	664	1,236	1,994	7,999	0	0	149	187	631	1,174	1,894	7,296	0	0
2019	137	172	579	1,078	1,739	8,504	0	0	130	163	550	1,024	1,652	7,756	0	0
2020	119	150	505	940	1,517	7,960	670	0	113	127	404	846	1,214	6,360	0	0
2021	104	131	441	819	1,324	6,528	2,034	0	99	111	374	737	1,125	5,549	915	0
2022	91	114	384	715	1,155	5,421	3,122	0	86	97	346	679	1,039	4,879	1,717	0
2023	79	99	335	623	1,008	4,633	4,015	0	75	85	302	592	957	4,401	2,489	0
2024	69	87	293	544	879	4,040	4,757	0	66	74	263	516	835	3,838	3,235	0
2025	60	76	255	474	768	3,523	5,524	0	57	64	230	403	729	3,347	4,032	0
2026	53	66	223	965	670	3,073	5,647	0	50	56	201	820	569	2,919	4,292	0
2027	46	58	194	1,392	1,059	2,680	5,282	0	44	49	175	1,253	900	2,546	4,120	0
2028	40	50	170	1,214	1,752	2,338	5,161	0	38	43	153	1,154	1,577	2,221	4,077	0
2029	35	44	148	1,060	1,529	2,039	5,335	558	33	37	133	1,007	1,453	1,937	4,535	0
2030	31	38	129	925	1,335	1,779	4,656	1,890	29	33	116	878	1,268	1,690	4,191	850
2031	27	34	113	807	1,165	1,552	4,064	3,079	25	29	102	767	1,107	1,475	3,861	1,693
2032	23	29	99	704	1,017	1,354	3,548	4,141	22	25	89	669	966	1,287	3,371	2,568
2033	20	26	86	615	888	1,182	3,098	5,094	19	22	77	584	843	1,123	2,943	3,464
2034	18	22	75	537	775	1,031	2,705	5,951	17	19	68	510	736	980	2,569	4,345
2035	16	20	66	469	677	900	2,362	6,726	15	17	59	445	643	855	2,244	5,044
2036	14	17	57	409	591	786	2,062	7,429	13	14	52	389	561	747	1,959	5,720
2037	12	15	50	357	516	686	1,801	8,069	11	13	45	339	490	652	1,711	6,375
2038	10	13	44	312	451	599	1,573	8,656	10	11	39	296	428	569	1,495	6,925
2039	9	11	38	272	394	523	1,375	9,197	9	10	34	259	374	497	1,306	7,450
2040	8	10	33	238	344	457	1,201	9,697	8	8	30	226	327	434	1,141	7,903
2041	7	9	29	208	301	399	1,049	10,164	7	7	26	198	286	379	997	8,334
2042	6	8	26	182	263	348	917	10,600	6	6	23	173	250	331	871	8,745
2043	5	7	22	159	230	304	802	11,012	5	6	20	151	218	289	761	9,140
2044	5	6	20	139	201	266	701	11,402	4	5	18	132	191	253	666	9,521
2045	4	5	17	121	175	232	613	11,775	4	4	15	115	167	221	582	9,891
2046	4	4	15	106	153	203	536	12,131	3	4	13	101	146	193	509	10,312
2047	3	4	13	93	134	177	468	11,884	3	3	12	88	127	169	445	10,695
2048	3	3	11	81	117	155	410	10,373	3	3	10	77	111	147	389	9,854
2049	2	3	10	71	103	136	358	9,055	2	3	9	67	97	129	340	8,602
2050	2	3	9	62	90	118	313	7,905	2	2	8	59	85	113	298	7,510
2051	2	2	8	54	78	104	274	6,902	2	2	7	51	75	98	260	6,557
2052	2	2	7	47	69	91	240	6,027	2	2	6	45	65	86	228	5,726
2053	1	2	6	41	60	79	210	5,264	1	1	5	39	57	75	199	5,001
2054	1	2	5	36	53	69	184	4,597	1	1	5	34	50	66	175	4,367
2055	1	1	5	32	46	61	161	4,016	1	1	4	30	44	58	153	3,815
2056	1	1	4	28	40	53	141	3,508	1	1	4	26	38	50	134	3,333
2057	1	1	3	24	35	46	123	3,065	1	1	3	23	34	44	117	2,912
2058	1	1	3	21	31	41	108	2,678	1	1	3	20	29	39	103	2,544
2059	1	1	3	19	27	36	95	2,341	1	1	2	18	26	34	90	2,223
2060	1	1	2	16	24	31	83	2,046	1	1	2	16	23	30	79	1,943

EXHIBIT 4. LFG RECOVERY PROJECTION - MAIN HILL, SOUTHEAST PIT, AND CENTRAL PIT AREAS: CEDAR HILLS LANDFILL, MAPLE VALLEY, WA

	Annual Total Waste Disposal	Total Waste In Place	LFG Recovery Potential			LFG System Coverage	LFG Recovery from Existing/Planned System		
Year	(tons/yr)	(tons)	(scfm)	(mmcf/day)	(mmBtu/hr)	(%)	(scfm)	(mmcf/day)	(mmBtu/hr)
1965	312,244	312,244	0	0.00	0.0	0%	0	0.00	0.0
1966	312,244	624,488	549	0.79	16.7	0%	0	0.00	0.0
1967	312,244	936,732	1,027	1.48	31.2	0%	0	0.00	0.0
1968	312,244	1,248,976	1,444	2.08	43.8	0%	0	0.00	0.0
1969	312,244	1,561,220	1,806	2.60	54.8	0%	0	0.00	0.0
1970	312,244	1,873,463	2,122	3.06	64.4	0%	0	0.00	0.0
1971	312,244	2,185,707	2,396	3.45	72.8	0%	0	0.00	0.0
1972	312,244	2,497,951	2,635	3.80	80.0	0%	0	0.00	0.0
1973	312,244	2,810,195	2,844	4.09	86.3	0%	0	0.00	0.0
1974	312,244	3,122,439	3,025	4.36	91.8	0%	0	0.00	0.0
1975	312,244	3,434,683	3,183	4.58	96.6	0%	0	0.00	0.0
1976	312,244	3,746,927	3,321	4.78	100.8	0%	0	0.00	0.0
1977	312,244	4,059,171	3,440	4.95	104.4	0%	0	0.00	0.0
1978	360,092	4,419,263	3,545	5.10	107.6	0%	0	0.00	0.0
1979	619,781	5,039,044	3,720	5.36	112.9	0%	0	0.00	0.0
1980	713,394	5,752,438	4,329	6.23	131.4	0%	0	0.00	0.0
1981	803,164	6,555,602	5,024	7.23	152.5	0%	0	0.00	0.0
1982	756,998	7,312,601	5,787	8.33	175.7	0%	0	0.00	0.0
1983	713,401	8,026,002	6,370	9.17	193.4	0%	0	0.00	0.0
1984	792,827	8,818,829	6,801	9.79	206.5	0%	0	0.00	0.0
1985	848,945	9,667,774	7,316	10.54	222.1	0%	0	0.00	0.0
1986	917,150	10,584,924	7,863	11.32	238.7	0%	0	0.00	0.0
1987	1,301,959	11,886,883	8,460	12.18	256.8	0%	0	0.00	0.0
1988	63,117	11,950,000	9,656	13.90	293.2	0%	0	0.00	0.0
1989	0	11,950,000	8,518	12.27	258.6	0%	0	0.00	0.0
1990	0	11,950,000	7,417	10.68	225.2	0%	0	0.00	0.0
1991	0	11,950,000	6,458	9.30	196.1	0%	0	0.00	0.0
1992	0	11,950,000	5,624	8.10	170.7	53%	2,993	4.31	90.9
1993	0	11,950,000	4,897	7.05	148.7	65%	3,183	4.58	96.6
1994	0	11,950,000	4,265	6.14	129.5	60%	2,551	3.67	77.4
1995	0	11,950,000	3,714	5.35	112.8	55%	2,044	2.94	62.1
1996	0	11,950,000	3,235	4.66	98.2	60%	1,941	2.79	58.9
1997	0	11,950,000	2,817	4.06	85.5	65%	1,831	2.64	55.6
1998	0	11,950,000	2,454	3.53	74.5	90%	2,209	3.18	67.1
1999	0	11,950,000	2,137	3.08	64.9	90%	1,924	2.77	58.4
2000	0	11,950,000	1,862	2.68	56.5	87%	1,611	2.32	48.9
2001	0	11,950,000	1,622	2.34	49.2	86%	1,394	2.01	42.3
2002	0	11,950,000	1,413	2.03	42.9	85%	1,201	1.73	36.5
2003	0	11,950,000	1,231	1.77	37.4	85%	1,047	1.51	31.8
2004	0	11,950,000	1,073	1.54	32.6	90%	965	1.39	29.3
2005	0	11,950,000	935	1.35	28.4	95%	888	1.28	27.0
2006	0	11,950,000	815	1.17	24.7	90%	733	1.06	22.3
2007	0	11,950,000	710	1.02	21.6	90%	639	0.92	19.4
2008	0	11,950,000	619	0.89	18.8	90%	557	0.80	16.9
2009	0	11,950,000	539	0.78	16.4	90%	485	0.70	14.7
2010	0	11,950,000	470	0.68	14.3	90%	423	0.61	12.8
2011	0	11,950,000	410	0.59	12.4	90%	369	0.53	11.2
2012	0	11,950,000	357	0.51	10.8	90%	321	0.46	9.8
2013	0	11,950,000	311	0.45	9.5	90%	280	0.40	8.5
2014	0	11,950,000	271	0.39	8.2	95%	258	0.37	7.8
2015	0	11,950,000	237	0.34	7.2	95%	225	0.32	6.8
2016	0	11,950,000	206	0.30	6.3	95%	196	0.28	6.0
2017	0	11,950,000	180	0.26	5.5	95%	171	0.25	5.2
2018	0	11,950,000	157	0.23	4.8	95%	149	0.21	4.5
2019	0	11,950,000	137	0.20	4.2	95%	130	0.19	3.9
2020	0	11,950,000	119	0.17	3.6	95%	113	0.16	3.4

EXHIBIT 4. LFG RECOVERY PROJECTION - MAIN HILL, SOUTHEAST PIT, AND CENTRAL PIT AREAS: CEDAR HILLS LANDFILL, MAPLE VALLEY, WA

Year	Annual Total Waste Disposal (tons/yr)	Total Waste In Place (tons)	LFG Recovery Potential (scfm)	LFG Recovery Potential (mmcf/day)	LFG Recovery Potential (mmBtu/hr)	LFG System Coverage (%)	LFG Recovery from Existing/Planned System (scfm)	LFG Recovery from Existing/Planned System (mmcf/day)	LFG Recovery from Existing/Planned System (mmBtu/hr)
2021	0	11,950,000	104	0.15	3.2	95%	99	0.14	3.0
2022	0	11,950,000	91	0.13	2.8	95%	86	0.12	2.6
2023	0	11,950,000	79	0.11	2.4	95%	75	0.11	2.3
2024	0	11,950,000	69	0.10	2.1	95%	66	0.09	2.0
2025	0	11,950,000	60	0.09	1.8	95%	57	0.08	1.7
2026	0	11,950,000	53	0.08	1.6	95%	50	0.07	1.5
2027	0	11,950,000	46	0.07	1.4	95%	44	0.06	1.3
2028	0	11,950,000	40	0.06	1.2	95%	38	0.05	1.2
2029	0	11,950,000	35	0.05	1.1	95%	33	0.05	1.0
2030	0	11,950,000	31	0.04	0.9	95%	29	0.04	0.9
2031	0	11,950,000	27	0.04	0.8	95%	25	0.04	0.8
2032	0	11,950,000	23	0.03	0.7	95%	22	0.03	0.7
2033	0	11,950,000	20	0.03	0.6	95%	19	0.03	0.6
2034	0	11,950,000	18	0.03	0.5	95%	17	0.02	0.5
2035	0	11,950,000	16	0.02	0.5	95%	15	0.02	0.4
2036	0	11,950,000	14	0.02	0.4	95%	13	0.02	0.4
2037	0	11,950,000	12	0.02	0.4	95%	11	0.02	0.3
2038	0	11,950,000	10	0.01	0.3	95%	10	0.01	0.3
2039	0	11,950,000	9	0.01	0.3	95%	9	0.01	0.3
2040	0	11,950,000	8	0.01	0.2	95%	8	0.01	0.2

EXHIBIT 5. LFG RECOVERY PROJECTION - AREA 2/3: CEDAR HILLS LANDFILL, MAPLE VALLEY, WA

Year	Annual Total Waste Disposal (tons/yr)	Total Waste In Place (tons)	LFG Recovery Potential (scfm)	LFG Recovery Potential (mmcf/day)	LFG Recovery Potential (mmBtu/hr)	LFG System Coverage (%)	LFG Recovery from Existing/Planned System (scfm)	LFG Recovery from Existing/Planned System (mmcf/day)	LFG Recovery from Existing/Planned System (mmBtu/hr)
1988	1,198,085	1,198,085	0	0.00	0.0	0%	0	0.00	0.0
1989	1,241,612	2,439,697	2,108	3.03	64.0	0%	0	0.00	0.0
1990	1,385,565	3,825,262	4,019	5.79	122.0	0%	0	0.00	0.0
1991	1,094,738	4,920,000	5,904	8.50	179.3	0%	0	0.00	0.0
1992	0	4,920,000	7,042	10.14	213.8	53%	3,748	5.40	113.8
1993	0	4,920,000	6,133	8.83	186.2	65%	3,986	5.74	121.0
1994	0	4,920,000	5,341	7.69	162.1	60%	3,194	4.60	97.0
1995	0	4,920,000	4,651	6.70	141.2	55%	2,560	3.69	77.7
1996	0	4,920,000	4,051	5.83	123.0	60%	2,431	3.50	73.8
1997	0	4,920,000	3,529	5.08	107.1	65%	2,294	3.30	69.6
1998	0	4,920,000	3,074	4.43	93.3	90%	2,766	3.98	84.0
1999	0	4,920,000	2,677	3.86	81.3	90%	2,410	3.47	73.2
2000	0	4,920,000	2,332	3.36	70.8	87%	2,018	2.91	61.3
2001	0	4,920,000	2,032	2.93	61.7	86%	1,747	2.52	53.0
2002	0	4,920,000	1,770	2.55	53.7	85%	1,505	2.17	45.7
2003	0	4,920,000	1,543	2.22	46.8	85%	1,311	1.89	39.8
2004	0	4,920,000	1,344	1.94	40.8	90%	1,210	1.74	36.7
2005	0	4,920,000	1,171	1.69	35.6	95%	1,113	1.60	33.8
2006	0	4,920,000	1,021	1.47	31.0	90%	919	1.32	27.9
2007	0	4,920,000	890	1.28	27.0	90%	801	1.15	24.3
2008	0	4,920,000	775	1.12	23.5	90%	698	1.00	21.2
2009	0	4,920,000	676	0.97	20.5	90%	608	0.88	18.5
2010	0	4,920,000	589	0.85	17.9	90%	530	0.76	16.1
2011	0	4,920,000	513	0.74	15.6	90%	462	0.67	14.0
2012	0	4,920,000	448	0.64	13.6	90%	403	0.58	12.2
2013	0	4,920,000	390	0.56	11.8	90%	351	0.51	10.7
2014	0	4,920,000	340	0.49	10.3	95%	323	0.47	9.8
2015	0	4,920,000	297	0.43	9.0	95%	282	0.41	8.6
2016	0	4,920,000	259	0.37	7.9	95%	246	0.35	7.5
2017	0	4,920,000	226	0.32	6.9	95%	214	0.31	6.5
2018	0	4,920,000	197	0.28	6.0	95%	187	0.27	5.7
2019	0	4,920,000	172	0.25	5.2	95%	163	0.23	5.0
2020	0	4,920,000	150	0.22	4.5	85%	127	0.18	3.9
2021	0	4,920,000	131	0.19	4.0	85%	111	0.16	3.4
2022	0	4,920,000	114	0.16	3.5	85%	97	0.14	2.9
2023	0	4,920,000	99	0.14	3.0	85%	85	0.12	2.6
2024	0	4,920,000	87	0.12	2.6	85%	74	0.11	2.2
2025	0	4,920,000	76	0.11	2.3	85%	64	0.09	2.0
2026	0	4,920,000	66	0.10	2.0	85%	56	0.08	1.7
2027	0	4,920,000	58	0.08	1.8	85%	49	0.07	1.5
2028	0	4,920,000	50	0.07	1.5	85%	43	0.06	1.3
2029	0	4,920,000	44	0.06	1.3	85%	37	0.05	1.1
2030	0	4,920,000	38	0.06	1.2	85%	33	0.05	1.0
2031	0	4,920,000	34	0.05	1.0	85%	29	0.04	0.9
2032	0	4,920,000	29	0.04	0.9	85%	25	0.04	0.8
2033	0	4,920,000	26	0.04	0.8	85%	22	0.03	0.7
2034	0	4,920,000	22	0.03	0.7	85%	19	0.03	0.6
2035	0	4,920,000	20	0.03	0.6	85%	17	0.02	0.5
2036	0	4,920,000	17	0.02	0.5	85%	14	0.02	0.4
2037	0	4,920,000	15	0.02	0.5	85%	13	0.02	0.4
2038	0	4,920,000	13	0.02	0.4	85%	11	0.02	0.3
2039	0	4,920,000	11	0.02	0.3	85%	10	0.01	0.3
2040	0	4,920,000	10	0.01	0.3	85%	8	0.01	0.3

EXHIBIT 6. LFG RECOVERY PROJECTION - AREA 4
CEDAR HILLS LANDFILL, MAPLE VALLEY, WA

Year	Annual Total Waste Disposal (tons/yr)	Total Waste In Place (tons)	LFG Recovery Potential (scfm)	LFG Recovery Potential (mmcf/day)	LFG Recovery Potential (mmBtu/hr)	LFG System Coverage (%)	LFG Recovery from Existing/Planned System (scfm)	LFG Recovery from Existing/Planned System (mmcf/day)	LFG Recovery from Existing/Planned System (mmBtu/hr)
1991	56,260	56,260	0	0.00	0.0	0%	0	0.00	0.0
1992	907,927	964,186	98	0.14	3.0	0%	0	0.00	0.0
1993	877,947	1,842,133	1,662	2.39	50.4	0%	0	0.00	0.0
1994	802,411	2,644,544	2,972	4.28	90.2	60%	1,777	2.56	54.0
1995	813,488	3,458,031	3,982	5.73	120.9	55%	2,191	3.16	66.5
1996	808,139	4,266,170	4,881	7.03	148.2	58%	2,821	4.06	85.7
1997	862,585	5,128,755	5,655	8.14	171.7	60%	3,401	4.90	103.3
1998	873,657	6,002,412	6,423	9.25	195.0	77%	4,931	7.10	149.7
1999	923,417	6,925,830	7,112	10.24	215.9	89%	6,322	9.10	191.9
2000	41,171	6,967,000	7,799	11.23	236.8	84%	6,544	9.42	198.7
2001	0	6,967,000	6,865	9.89	208.4	86%	5,902	8.50	179.2
2002	0	6,967,000	5,981	8.61	181.6	85%	5,084	7.32	154.3
2003	0	6,967,000	5,211	7.50	158.2	85%	4,429	6.38	134.5
2004	0	6,967,000	4,540	6.54	137.8	90%	4,086	5.88	124.1
2005	0	6,967,000	3,956	5.70	120.1	95%	3,758	5.41	114.1
2006	0	6,967,000	3,447	4.96	104.6	90%	3,102	4.47	94.2
2007	0	6,967,000	3,004	4.33	91.2	90%	2,703	3.89	82.1
2008	0	6,967,000	2,618	3.77	79.5	90%	2,356	3.39	71.5
2009	0	6,967,000	2,281	3.29	69.3	90%	2,053	2.96	62.3
2010	0	6,967,000	1,988	2.86	60.4	90%	1,790	2.58	54.3
2011	0	6,967,000	1,733	2.50	52.6	90%	1,560	2.25	47.4
2012	0	6,967,000	1,511	2.18	45.9	90%	1,360	1.96	41.3
2013	0	6,967,000	1,317	1.90	40.0	90%	1,185	1.71	36.0
2014	0	6,967,000	1,148	1.65	34.9	95%	1,091	1.57	33.1
2015	0	6,967,000	1,001	1.44	30.4	95%	951	1.37	28.9
2016	0	6,967,000	873	1.26	26.5	95%	829	1.19	25.2
2017	0	6,967,000	761	1.10	23.1	95%	723	1.04	22.0
2018	0	6,967,000	664	0.96	20.2	95%	631	0.91	19.1
2019	0	6,967,000	579	0.83	17.6	95%	550	0.79	16.7
2020	0	6,967,000	505	0.73	15.3	80%	404	0.58	12.3
2021	0	6,967,000	441	0.63	13.4	85%	374	0.54	11.4
2022	0	6,967,000	384	0.55	11.7	90%	346	0.50	10.5
2023	0	6,967,000	335	0.48	10.2	90%	302	0.43	9.2
2024	0	6,967,000	293	0.42	8.9	90%	263	0.38	8.0
2025	0	6,967,000	255	0.37	7.8	90%	230	0.33	7.0
2026	0	6,967,000	223	0.32	6.8	90%	201	0.29	6.1
2027	0	6,967,000	194	0.28	5.9	90%	175	0.25	5.3
2028	0	6,967,000	170	0.24	5.2	90%	153	0.22	4.6
2029	0	6,967,000	148	0.21	4.5	90%	133	0.19	4.0
2030	0	6,967,000	129	0.19	3.9	90%	116	0.17	3.5
2031	0	6,967,000	113	0.16	3.4	90%	102	0.15	3.1
2032	0	6,967,000	99	0.14	3.0	90%	89	0.13	2.7
2033	0	6,967,000	86	0.12	2.6	90%	77	0.11	2.4
2034	0	6,967,000	75	0.11	2.3	90%	68	0.10	2.1
2035	0	6,967,000	66	0.09	2.0	90%	59	0.09	1.8
2036	0	6,967,000	57	0.08	1.7	90%	52	0.07	1.6
2037	0	6,967,000	50	0.07	1.5	90%	45	0.06	1.4
2038	0	6,967,000	44	0.06	1.3	90%	39	0.06	1.2
2039	0	6,967,000	38	0.06	1.2	90%	34	0.05	1.0
2040	0	6,967,000	33	0.05	1.0	90%	30	0.04	0.9

EXHIBIT 7. LFG RECOVERY PROJECTION - AREA 5
CEDAR HILLS LANDFILL, MAPLE VALLEY, WA

	Annual Total Waste Disposal	Total Waste In Place	LFG Recovery Potential			LFG System Coverage	LFG Recovery from Existing/Planned System		
Year	(tons/yr)	(tons)	(scfm)	(mmcf/day)	(mmBtu/hr)	(%)	(scfm)	(mmcf/day)	(mmBtu/hr)
2000	906,003	906,003	0	0.00	0.0	0%	0	0.00	0.0
2001	936,310	1,842,313	1,573	2.27	47.8	43%	675	0.97	20.5
2002	939,489	2,781,802	2,996	4.31	91.0	30%	892	1.28	27.1
2003	978,837	3,760,639	4,241	6.11	128.7	53%	2,239	3.22	68.0
2004	1,006,163	4,766,802	5,393	7.77	163.7	64%	3,448	4.96	104.7
2005	484,539	5,251,341	6,445	9.28	195.7	77%	4,942	7.12	150.0
2006	0	5,251,341	6,441	9.28	195.6	68%	4,357	6.27	132.3
2007	0	5,251,341	5,612	8.08	170.4	83%	4,682	6.74	142.2
2008	0	5,251,341	4,889	7.04	148.4	80%	3,911	5.63	118.7
2009	0	5,251,341	4,260	6.13	129.3	90%	3,834	5.52	116.4
2010	0	5,251,341	3,712	5.34	112.7	90%	3,341	4.81	101.4
2011	0	5,251,341	3,234	4.66	98.2	90%	2,911	4.19	88.4
2012	0	5,251,341	2,819	4.06	85.6	90%	2,537	3.65	77.0
2013	0	5,251,341	2,456	3.54	74.6	90%	2,211	3.18	67.1
2014	0	5,251,341	2,141	3.08	65.0	95%	2,034	2.93	61.7
2015	0	5,251,341	1,866	2.69	56.7	95%	1,773	2.55	53.8
2016	0	5,251,341	1,627	2.34	49.4	95%	1,545	2.23	46.9
2017	0	5,251,341	1,418	2.04	43.0	95%	1,347	1.94	40.9
2018	0	5,251,341	1,236	1.78	37.5	95%	1,174	1.69	35.7
2019	0	5,251,341	1,078	1.55	32.7	95%	1,024	1.47	31.1
2020	0	5,251,341	940	1.35	28.5	90%	846	1.22	25.7
2021	0	5,251,341	819	1.18	24.9	90%	737	1.06	22.4
2022	0	5,251,341	715	1.03	21.7	95%	679	0.98	20.6
2023	0	5,251,341	623	0.90	18.9	95%	592	0.85	18.0
2024	0	5,251,341	544	0.78	16.5	95%	516	0.74	15.7
2025	362,112	5,613,453	474	0.68	14.4	85%	403	0.58	12.2
2026	361,547	5,975,000	965	1.39	29.3	85%	820	1.18	24.9
2027	0	5,975,000	1,392	2.00	42.3	90%	1,253	1.80	38.0
2028	0	5,975,000	1,214	1.75	36.9	95%	1,154	1.66	35.0
2029	0	5,975,000	1,060	1.53	32.2	95%	1,007	1.45	30.6
2030	0	5,975,000	925	1.33	28.1	95%	878	1.26	26.7
2031	0	5,975,000	807	1.16	24.5	95%	767	1.10	23.3
2032	0	5,975,000	704	1.01	21.4	95%	669	0.96	20.3
2033	0	5,975,000	615	0.89	18.7	95%	584	0.84	17.7
2034	0	5,975,000	537	0.77	16.3	95%	510	0.73	15.5
2035	0	5,975,000	469	0.67	14.2	95%	445	0.64	13.5
2036	0	5,975,000	409	0.59	12.4	95%	389	0.56	11.8
2037	0	5,975,000	357	0.51	10.8	95%	339	0.49	10.3
2038	0	5,975,000	312	0.45	9.5	95%	296	0.43	9.0
2039	0	5,975,000	272	0.39	8.3	95%	259	0.37	7.9
2040	0	5,975,000	238	0.34	7.2	95%	226	0.33	6.9
2041	0	5,975,000	208	0.30	6.3	95%	198	0.28	6.0
2042	0	5,975,000	182	0.26	5.5	95%	173	0.25	5.2
2043	0	5,975,000	159	0.23	4.8	95%	151	0.22	4.6
2044	0	5,975,000	139	0.20	4.2	95%	132	0.19	4.0
2045	0	5,975,000	121	0.17	3.7	95%	115	0.17	3.5
2046	0	5,975,000	106	0.15	3.2	95%	101	0.14	3.1
2047	0	5,975,000	93	0.13	2.8	95%	88	0.13	2.7
2048	0	5,975,000	81	0.12	2.5	95%	77	0.11	2.3
2049	0	5,975,000	71	0.10	2.2	95%	67	0.10	2.0
2050	0	5,975,000	62	0.09	1.9	95%	59	0.08	1.8
2051	0	5,975,000	54	0.08	1.6	95%	51	0.07	1.6
2052	0	5,975,000	47	0.07	1.4	95%	45	0.06	1.4
2053	0	5,975,000	41	0.06	1.3	95%	39	0.06	1.2
2054	0	5,975,000	36	0.05	1.1	95%	34	0.05	1.0
2055	0	5,975,000	32	0.05	1.0	95%	30	0.04	0.9
2056	0	5,975,000	28	0.04	0.8	95%	26	0.04	0.8
2057	0	5,975,000	24	0.04	0.7	95%	23	0.03	0.7
2058	0	5,975,000	21	0.03	0.6	95%	20	0.03	0.6
2059	0	5,975,000	19	0.03	0.6	95%	18	0.03	0.5
2060	0	5,975,000	16	0.02	0.5	95%	16	0.02	0.5

EXHIBIT 8. LFG RECOVERY PROJECTION - AREA 6: CEDAR HILLS LANDFILL, MAPLE VALLEY, WA

	Annual Total Waste Disposal	Total Waste In Place	LFG Recovery Potential			LFG System Coverage	LFG Recovery from Existing/Planned System		
Year	(tons/yr)	(tons)	(scfm)	(mmcf/day)	(mmBtu/hr)	(%)	(scfm)	(mmcf/day)	(mmBtu/hr)
2005	504,316	504,316	0	0.00	0.0	0%	0	0.00	0.0
2006	998,207	1,502,523	861	1.24	26.1	0%	0	0.00	0.0
2007	1,010,429	2,512,952	2,454	3.53	74.5	0%	0	0.00	0.0
2008	930,616	3,443,568	3,864	5.56	117.3	37%	1,427	2.06	43.3
2009	867,481	4,311,049	4,957	7.14	150.5	51%	2,507	3.61	76.1
2010	83,091	4,394,140	5,802	8.36	176.2	66%	3,823	5.50	116.1
2011	0	4,394,140	5,200	7.49	157.9	75%	3,900	5.62	118.4
2012	0	4,394,140	4,534	6.53	137.6	80%	3,627	5.22	110.1
2013	0	4,394,140	3,953	5.69	120.0	90%	3,557	5.12	108.0
2014	0	4,394,140	3,447	4.96	104.6	95%	3,274	4.71	99.4
2015	0	4,394,140	3,005	4.33	91.2	95%	2,855	4.11	86.7
2016	0	4,394,140	2,621	3.77	79.6	95%	2,490	3.59	75.6
2017	0	4,394,140	2,286	3.29	69.4	95%	2,172	3.13	65.9
2018	0	4,394,140	1,994	2.87	60.5	95%	1,894	2.73	57.5
2019	0	4,394,140	1,739	2.50	52.8	95%	1,652	2.38	50.2
2020	0	4,394,140	1,517	2.18	46.1	80%	1,214	1.75	36.8
2021	0	4,394,140	1,324	1.91	40.2	85%	1,125	1.62	34.2
2022	0	4,394,140	1,155	1.66	35.1	90%	1,039	1.50	31.6
2023	0	4,394,140	1,008	1.45	30.6	95%	957	1.38	29.1
2024	0	4,394,140	879	1.27	26.7	95%	835	1.20	25.4
2025	0	4,394,140	768	1.11	23.3	95%	729	1.05	22.1
2026	311,869	4,706,010	670	0.96	20.3	85%	569	0.82	17.3
2027	543,991	5,250,000	1,059	1.53	32.2	85%	900	1.30	27.3
2028	0	5,250,000	1,752	2.52	53.2	90%	1,577	2.27	47.9
2029	0	5,250,000	1,529	2.20	46.4	95%	1,453	2.09	44.1
2030	0	5,250,000	1,335	1.92	40.5	95%	1,268	1.83	38.5
2031	0	5,250,000	1,165	1.68	35.4	95%	1,107	1.59	33.6
2032	0	5,250,000	1,017	1.46	30.9	95%	966	1.39	29.3
2033	0	5,250,000	888	1.28	26.9	95%	843	1.21	25.6
2034	0	5,250,000	775	1.12	23.5	95%	736	1.06	22.4
2035	0	5,250,000	677	0.97	20.5	95%	643	0.93	19.5
2036	0	5,250,000	591	0.85	17.9	95%	561	0.81	17.0
2037	0	5,250,000	516	0.74	15.7	95%	490	0.71	14.9
2038	0	5,250,000	451	0.65	13.7	95%	428	0.62	13.0
2039	0	5,250,000	394	0.57	12.0	95%	374	0.54	11.4
2040	0	5,250,000	344	0.50	10.4	95%	327	0.47	9.9
2041	0	5,250,000	301	0.43	9.1	95%	286	0.41	8.7
2042	0	5,250,000	263	0.38	8.0	95%	250	0.36	7.6
2043	0	5,250,000	230	0.33	7.0	95%	218	0.31	6.6
2044	0	5,250,000	201	0.29	6.1	95%	191	0.27	5.8
2045	0	5,250,000	175	0.25	5.3	95%	167	0.24	5.1
2046	0	5,250,000	153	0.22	4.7	95%	146	0.21	4.4
2047	0	5,250,000	134	0.19	4.1	95%	127	0.18	3.9
2048	0	5,250,000	117	0.17	3.6	95%	111	0.16	3.4
2049	0	5,250,000	103	0.15	3.1	95%	97	0.14	3.0
2050	0	5,250,000	90	0.13	2.7	95%	85	0.12	2.6
2051	0	5,250,000	78	0.11	2.4	95%	75	0.11	2.3
2052	0	5,250,000	69	0.10	2.1	95%	65	0.09	2.0
2053	0	5,250,000	60	0.09	1.8	95%	57	0.08	1.7
2054	0	5,250,000	53	0.08	1.6	95%	50	0.07	1.5
2055	0	5,250,000	46	0.07	1.4	95%	44	0.06	1.3
2056	0	5,250,000	40	0.06	1.2	95%	38	0.06	1.2
2057	0	5,250,000	35	0.05	1.1	95%	34	0.05	1.0
2058	0	5,250,000	31	0.04	0.9	95%	29	0.04	0.9
2059	0	5,250,000	27	0.04	0.8	95%	26	0.04	0.8
2060	0	5,250,000	24	0.03	0.7	95%	23	0.03	0.7

EXHIBIT 9. LFG RECOVERY PROJECTION - AREA 7
CEDAR HILLS LANDFILL, MAPLE VALLEY, WA

Year	Annual Total Waste Disposal (tons/yr)	Total Waste In Place (tons)	LFG Recovery Potential (scfm)	LFG Recovery Potential (mmcf/day)	LFG Recovery Potential (mmBtu/hr)	LFG System Coverage (%)	LFG Recovery from Existing/Planned System (scfm)	LFG Recovery from Existing/Planned System (mmcf/day)	LFG Recovery from Existing/Planned System (mmBtu/hr)
2010	747,820	747,820	0	0.00	0.0	0%	0	0.00	0.0
2011	812,684	1,560,504	1,392	2.00	42.3	66%	918	1.32	27.9
2012	806,914	2,367,418	2,524	3.64	76.6	70%	1,763	2.54	53.5
2013	809,165	3,176,583	3,775	5.44	114.6	70%	2,640	3.80	80.1
2014	843,320	4,019,903	4,584	6.60	139.2	76%	3,503	5.04	106.3
2015	869,802	4,889,705	5,738	8.26	174.2	72%	4,138	5.96	125.6
2016	922,000	5,811,705	6,535	9.41	198.4	82%	5,327	7.67	161.7
2017	931,177	6,742,882	7,315	10.53	222.1	87%	6,366	9.17	193.3
2018	888,513	7,631,395	7,999	11.52	242.8	91%	7,296	10.51	221.5
2019	453,605	8,085,000	8,504	12.25	258.2	91%	7,756	11.17	235.5
2020	0	8,085,000	7,960	11.46	241.7	80%	6,360	9.16	193.1
2021	0	8,085,000	6,528	9.40	198.2	85%	5,549	7.99	168.5
2022	0	8,085,000	5,421	7.81	164.6	90%	4,879	7.03	148.1
2023	0	8,085,000	4,633	6.67	140.7	95%	4,401	6.34	133.6
2024	0	8,085,000	4,040	5.82	122.6	95%	3,838	5.53	116.5
2025	0	8,085,000	3,523	5.07	107.0	95%	3,347	4.82	101.6
2026	0	8,085,000	3,073	4.42	93.3	95%	2,919	4.20	88.6
2027	0	8,085,000	2,680	3.86	81.4	95%	2,546	3.67	77.3
2028	0	8,085,000	2,338	3.37	71.0	95%	2,221	3.20	67.4
2029	0	8,085,000	2,039	2.94	61.9	95%	1,937	2.79	58.8
2030	0	8,085,000	1,779	2.56	54.0	95%	1,690	2.43	51.3
2031	0	8,085,000	1,552	2.24	47.1	95%	1,475	2.12	44.8
2032	0	8,085,000	1,354	1.95	41.1	95%	1,287	1.85	39.1
2033	0	8,085,000	1,182	1.70	35.9	95%	1,123	1.62	34.1
2034	0	8,085,000	1,031	1.49	31.3	95%	980	1.41	29.7
2035	0	8,085,000	900	1.30	27.3	95%	855	1.23	26.0
2036	0	8,085,000	786	1.13	23.9	95%	747	1.08	22.7
2037	0	8,085,000	686	0.99	20.8	95%	652	0.94	19.8
2038	0	8,085,000	599	0.86	18.2	95%	569	0.82	17.3
2039	0	8,085,000	523	0.75	15.9	95%	497	0.72	15.1
2040	0	8,085,000	457	0.66	13.9	95%	434	0.62	13.2
2041	0	8,085,000	399	0.57	12.1	95%	379	0.55	11.5
2042	0	8,085,000	348	0.50	10.6	95%	331	0.48	10.0
2043	0	8,085,000	304	0.44	9.2	95%	289	0.42	8.8
2044	0	8,085,000	266	0.38	8.1	95%	253	0.36	7.7
2045	0	8,085,000	232	0.33	7.1	95%	221	0.32	6.7
2046	0	8,085,000	203	0.29	6.2	95%	193	0.28	5.9
2047	0	8,085,000	177	0.26	5.4	95%	169	0.24	5.1
2048	0	8,085,000	155	0.22	4.7	95%	147	0.21	4.5
2049	0	8,085,000	136	0.20	4.1	95%	129	0.19	3.9
2050	0	8,085,000	118	0.17	3.6	95%	113	0.16	3.4
2051	0	8,085,000	104	0.15	3.1	95%	98	0.14	3.0
2052	0	8,085,000	91	0.13	2.8	95%	86	0.12	2.6
2053	0	8,085,000	79	0.11	2.4	95%	75	0.11	2.3
2054	0	8,085,000	69	0.10	2.1	95%	66	0.09	2.0
2055	0	8,085,000	61	0.09	1.8	95%	58	0.08	1.7
2056	0	8,085,000	53	0.08	1.6	95%	50	0.07	1.5
2057	0	8,085,000	46	0.07	1.4	95%	44	0.06	1.3
2058	0	8,085,000	41	0.06	1.2	95%	39	0.06	1.2
2059	0	8,085,000	36	0.05	1.1	95%	34	0.05	1.0
2060	0	8,085,000	31	0.04	0.9	95%	30	0.04	0.9

EXHIBIT 10. LFG RECOVERY PROJECTION - AREA 8
CEDAR HILLS LANDFILL, MAPLE VALLEY, WA

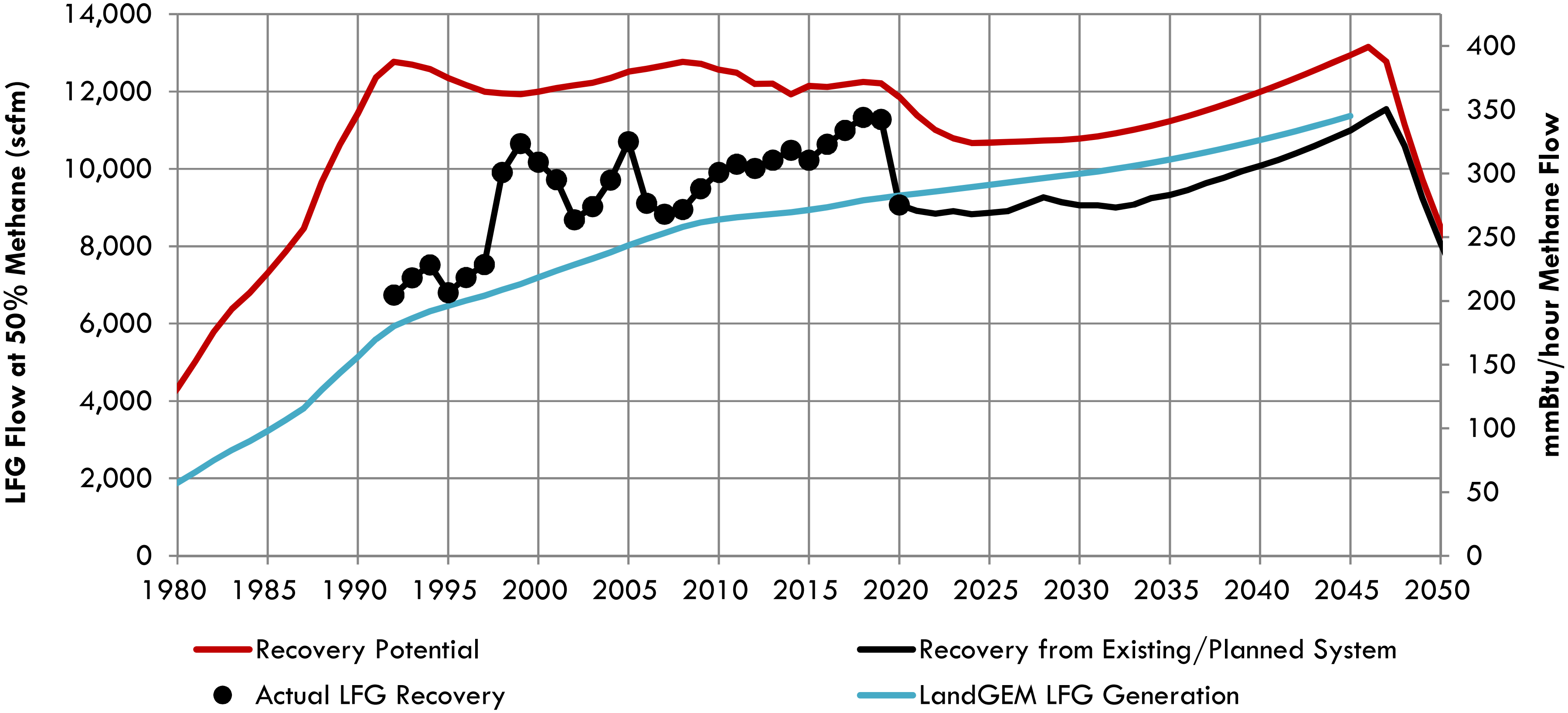
	Annual Total Waste Disposal	Total Waste In Place	LFG Recovery Potential			LFG System Coverage	LFG Recovery from Existing/Planned System		
Year	(tons/yr)	(tons)	(scfm)	(mmcf/day)	(mmBtu/hr)	(%)	(scfm)	(mmcf/day)	(mmBtu/hr)
2019	414,927	414,927	0	0.00	0.0	0%	0	0.00	0.0
2020	871,500	1,286,427	670	0.97	20.4	0%	0	0.00	0.0
2021	880,076	2,166,503	2,034	2.93	61.8	45%	915	1.32	27.8
2022	886,400	3,052,903	3,122	4.50	94.8	55%	1,717	2.47	52.1
2023	898,799	3,951,702	4,015	5.78	121.9	62%	2,489	3.58	75.6
2024	902,039	4,853,741	4,757	6.85	144.4	68%	3,235	4.66	98.2
2025	543,167	5,396,909	5,524	7.95	167.7	73%	4,032	5.81	122.4
2026	232,549	5,629,457	5,647	8.13	171.4	76%	4,292	6.18	130.3
2027	362,660	5,992,118	5,282	7.61	160.4	78%	4,120	5.93	125.1
2028	545,603	6,537,720	5,161	7.43	156.7	79%	4,077	5.87	123.8
2029	0	6,537,720	5,335	7.68	162.0	85%	4,535	6.53	137.7
2030	0	6,537,720	4,656	6.71	141.4	90%	4,191	6.03	127.2
2031	0	6,537,720	4,064	5.85	123.4	95%	3,861	5.56	117.2
2032	0	6,537,720	3,548	5.11	107.7	95%	3,371	4.85	102.3
2033	0	6,537,720	3,098	4.46	94.0	95%	2,943	4.24	89.3
2034	0	6,537,720	2,705	3.89	82.1	95%	2,569	3.70	78.0
2035	0	6,537,720	2,362	3.40	71.7	95%	2,244	3.23	68.1
2036	0	6,537,720	2,062	2.97	62.6	95%	1,959	2.82	59.5
2037	0	6,537,720	1,801	2.59	54.7	95%	1,711	2.46	52.0
2038	0	6,537,720	1,573	2.27	47.8	95%	1,495	2.15	45.4
2039	0	6,537,720	1,375	1.98	41.7	95%	1,306	1.88	39.6
2040	0	6,537,720	1,201	1.73	36.5	95%	1,141	1.64	34.6
2041	0	6,537,720	1,049	1.51	31.9	95%	997	1.44	30.3
2042	0	6,537,720	917	1.32	27.8	95%	871	1.25	26.5
2043	0	6,537,720	802	1.15	24.3	95%	761	1.10	23.1
2044	0	6,537,720	701	1.01	21.3	95%	666	0.96	20.2
2045	0	6,537,720	613	0.88	18.6	95%	582	0.84	17.7
2046	0	6,537,720	536	0.77	16.3	95%	509	0.73	15.4
2047	0	6,537,720	468	0.67	14.2	95%	445	0.64	13.5
2048	0	6,537,720	410	0.59	12.4	95%	389	0.56	11.8
2049	0	6,537,720	358	0.52	10.9	95%	340	0.49	10.3
2050	0	6,537,720	313	0.45	9.5	95%	298	0.43	9.0
2051	0	6,537,720	274	0.39	8.3	95%	260	0.38	7.9
2052	0	6,537,720	240	0.35	7.3	95%	228	0.33	6.9
2053	0	6,537,720	210	0.30	6.4	95%	199	0.29	6.1
2054	0	6,537,720	184	0.26	5.6	95%	175	0.25	5.3
2055	0	6,537,720	161	0.23	4.9	95%	153	0.22	4.6
2056	0	6,537,720	141	0.20	4.3	95%	134	0.19	4.1
2057	0	6,537,720	123	0.18	3.7	95%	117	0.17	3.6
2058	0	6,537,720	108	0.16	3.3	95%	103	0.15	3.1
2059	0	6,537,720	95	0.14	2.9	95%	90	0.13	2.7
2060	0	6,537,720	83	0.12	2.5	95%	79	0.11	2.4

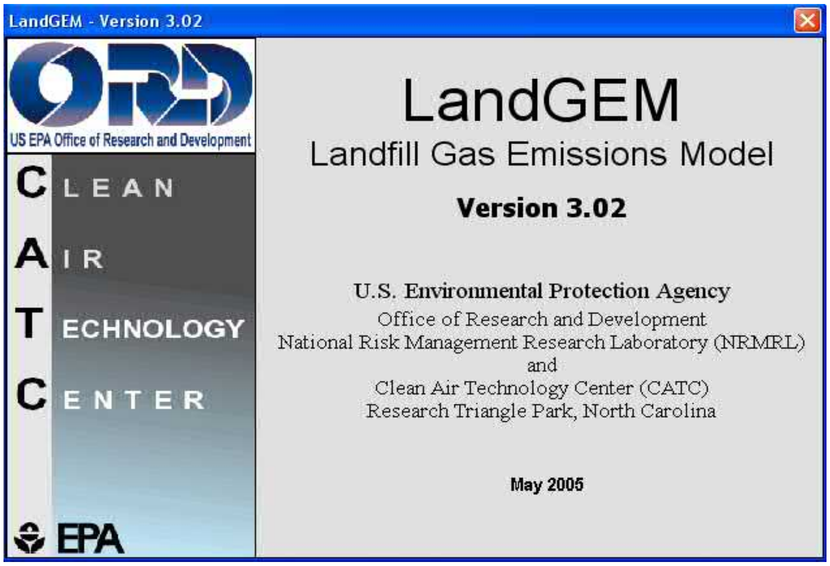
EXHIBIT 11. LFG RECOVERY PROJECTION - AREA 9
CEDAR HILLS LANDFILL, MAPLE VALLEY, WA

Year	Annual Total Waste Disposal (tons/yr)	Total Waste In Place (tons)	LFG Recovery Potential (scfm)	LFG Recovery Potential (mmcf/day)	LFG Recovery Potential (mmBtu/hr)	LFG System Coverage (%)	LFG Recovery from Existing/Planned System (scfm)	LFG Recovery from Existing/Planned System (mmcf/day)	LFG Recovery from Existing/Planned System (mmBtu/hr)
2028	366,776	366,776	0	0.00	0.0	0%	0	0.00	0.0
2029	921,703	1,288,479	558	0.80	16.9	0%	0	0.00	0.0
2030	939,784	2,228,263	1,890	2.72	57.4	45%	850	1.22	25.8
2031	956,217	3,184,480	3,079	4.43	93.5	55%	1,693	2.44	51.4
2032	972,930	4,157,410	4,141	5.96	125.7	62%	2,568	3.70	78.0
2033	989,928	5,147,338	5,094	7.34	154.7	68%	3,464	4.99	105.2
2034	1,007,214	6,154,552	5,951	8.57	180.7	73%	4,345	6.26	131.9
2035	1,024,794	7,179,346	6,726	9.69	204.2	75%	5,044	7.26	153.2
2036	1,042,672	8,222,018	7,429	10.70	225.5	77%	5,720	8.24	173.7
2037	1,060,855	9,282,873	8,069	11.62	245.0	79%	6,375	9.18	193.5
2038	1,079,347	10,362,220	8,656	12.47	262.8	80%	6,925	9.97	210.2
2039	1,098,153	11,460,373	9,197	13.24	279.2	81%	7,450	10.73	226.2
2040	1,117,279	12,577,652	9,697	13.96	294.4	82%	7,903	11.38	239.9
2041	1,136,830	13,714,482	10,164	14.64	308.6	82%	8,334	12.00	253.0
2042	1,156,720	14,871,202	10,600	15.26	321.8	83%	8,745	12.59	265.5
2043	1,176,960	16,048,162	11,012	15.86	334.3	83%	9,140	13.16	277.5
2044	1,197,560	17,245,722	11,402	16.42	346.2	84%	9,521	13.71	289.1
2045	1,218,520	18,464,242	11,775	16.96	357.5	84%	9,891	14.24	300.3
2046	851,037	19,315,280	12,131	17.47	368.3	85%	10,312	14.85	313.1
2047	0	19,315,280	11,884	17.11	360.8	90%	10,695	15.40	324.7
2048	0	19,315,280	10,373	14.94	314.9	95%	9,854	14.19	299.2
2049	0	19,315,280	9,055	13.04	274.9	95%	8,602	12.39	261.2
2050	0	19,315,280	7,905	11.38	240.0	95%	7,510	10.81	228.0
2051	0	19,315,280	6,902	9.94	209.6	95%	6,557	9.44	199.1
2052	0	19,315,280	6,027	8.68	183.0	95%	5,726	8.25	173.8
2053	0	19,315,280	5,264	7.58	159.8	95%	5,001	7.20	151.8
2054	0	19,315,280	4,597	6.62	139.6	95%	4,367	6.29	132.6
2055	0	19,315,280	4,016	5.78	121.9	95%	3,815	5.49	115.8
2056	0	19,315,280	3,508	5.05	106.5	95%	3,333	4.80	101.2
2057	0	19,315,280	3,065	4.41	93.1	95%	2,912	4.19	88.4
2058	0	19,315,280	2,678	3.86	81.3	95%	2,544	3.66	77.2
2059	0	19,315,280	2,341	3.37	71.1	95%	2,223	3.20	67.5
2060	0	19,315,280	2,046	2.95	62.1	95%	1,943	2.80	59.0

Appendix D. LandGEM Modeling

FIGURE D-1: COMPARISON OF LANDGEM RESULTS TO SCS LFG RECOVERY PROJECTION - CEDAR HILLS LANDFILL, MAPLE VALLEY, WA





Summary Report

Landfill Name or Identifier: Cedar Hills Regional Landfill

Date: Monday, January 11, 2021

Description/Comments:

About LandGEM:

First-Order Decomposition Rate Equation:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} kL_o \left(\frac{M_i}{10} \right) e^{-kt_{ij}}$$

Where,

Q_{CH4} = annual methane generation in the year of the calculation *(m^3/year)*
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate (*year^{-1}*)
L_o = potential methane generation capacity (*m^3/Mg*)

M_i = mass of waste accepted in the i^{th} year (*Mg*)
t_{ij} = age of the j^{th} section of waste mass M_i accepted in the i^{th} year (*decimal years*, e.g., 3.2 years)

LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in municipal solid waste (MSW) landfills. The software provides a relatively simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills. Field test data can also be used in place of model defaults when available. Further guidance on EPA test methods, Clean Air Act (CAA) regulations, and other guidance regarding landfill gas emissions and control technology requirements can be found at http://www.epa.gov/ttnatw01/landfill/landflpg.html.

LandGEM is considered a screening tool — the better the input data, the better the estimates. Often, there are limitations with the available data regarding waste quantity and composition, variation in design and operating practices over time, and changes occurring over time that impact the emissions potential. Changes to landfill operation, such as operating under wet conditions through leachate recirculation or other liquid additions, will result in generating more gas at a faster rate. Defaults for estimating emissions for this type of operation are being developed to include in LandGEM along with defaults for convential landfills (no leachate or liquid additions) for developing emission inventories and determining CAA applicability. Refer to the Web site identified above for future updates.

Input Review

LANDFILL CHARACTERISTICS

Landfill Open Year	**1965**	
Landfill Closure Year (with 80-year limit)	**2044**	**Landfill Closure Year entered exceeds the 80-year waste**
Actual Closure Year (without limit)	***2046***	**acceptance limit. See Section 2.6 of the User's Manual.**
Have Model Calculate Closure Year?	**No**	
Waste Design Capacity		*short tons*

MODEL PARAMETERS

Methane Generation Rate, k	**0.040**	*$year^{-1}$*
Potential Methane Generation Capacity, L_o	**100**	*m^3/Mg*
NMOC Concentration	**600**	*ppmv as hexane*
Methane Content	**50**	*% by volume*

GASES / POLLUTANTS SELECTED

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

WASTE ACCEPTANCE RATES

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
1965	283,858	312,244	0	0
1966	283,858	312,244	283,858	312,244
1967	283,858	312,244	567,716	624,488
1968	283,858	312,244	851,574	936,732
1969	283,858	312,244	1,135,432	1,248,976
1970	283,858	312,244	1,419,291	1,561,220
1971	283,858	312,244	1,703,149	1,873,463
1972	283,858	312,244	1,987,007	2,185,707
1973	283,858	312,244	2,270,865	2,497,951
1974	283,858	312,244	2,554,723	2,810,195
1975	283,858	312,244	2,838,581	3,122,439
1976	283,858	312,244	3,122,439	3,434,683
1977	283,858	312,244	3,406,297	3,746,927
1978	327,357	360,092	3,690,155	4,059,171
1979	563,437	619,781	4,017,512	4,419,263
1980	648,540	713,394	4,580,949	5,039,044
1981	730,149	803,164	5,229,489	5,752,438
1982	688,180	756,998	5,959,639	6,555,602
1983	648,546	713,401	6,647,819	7,312,601
1984	720,752	792,827	7,296,365	8,026,002
1985	771,768	848,945	8,017,117	8,818,829
1986	833,773	917,150	8,788,886	9,667,774
1987	1,183,599	1,301,959	9,622,658	10,584,924
1988	1,146,547	1,261,202	10,806,258	11,886,883
1989	1,128,738	1,241,612	11,952,805	13,148,085
1990	1,259,605	1,385,565	13,081,543	14,389,697
1991	1,046,361	1,150,997	14,341,148	15,775,262
1992	825,388	907,927	15,387,509	16,926,260
1993	798,133	877,947	16,212,897	17,834,186
1994	729,465	802,411	17,011,030	18,712,133
1995	739,534	813,488	17,740,494	19,514,544
1996	734,672	808,139	18,480,029	20,328,032
1997	784,168	862,585	19,214,700	21,136,170
1998	794,234	873,657	19,998,868	21,998,755
1999	839,470	923,417	20,793,102	22,872,412
2000	861,067	947,174	21,632,572	23,795,830
2001	851,191	936,310	22,493,640	24,743,004
2002	854,081	939,489	23,344,831	25,679,314
2003	889,852	978,837	24,198,911	26,618,803
2004	914,694	1,006,163	25,088,763	27,597,640

Appendix D. LandGEM Modeling

WASTE ACCEPTANCE RATES (Continued)

Year	Waste Accepted		Waste-In-Place	
	(Mg/year)	*(short tons/year)*	*(Mg)*	*(short tons)*
2005	898,959	988,855	26,003,457	28,603,803
2006	907,461	998,207	26,902,416	29,592,658
2007	918,572	1,010,429	27,809,877	30,590,865
2008	846,015	930,616	28,728,449	31,601,294
2009	788,619	867,481	29,574,463	32,531,910
2010	755,374	830,911	30,363,082	33,399,391
2011	738,804	812,684	31,118,456	34,230,302
2012	733,558	806,914	31,857,260	35,042,986
2013	735,605	809,165	32,590,818	35,849,900
2014	766,655	843,320	33,326,422	36,659,065
2015	790,729	869,802	34,093,077	37,502,385
2016	838,182	922,000	34,883,806	38,372,187
2017	846,525	931,177	35,721,988	39,294,187
2018	807,739	888,513	36,568,512	40,225,364
2019	789,575	868,532	37,376,251	41,113,877
2020	792,273	871,500	38,165,826	41,982,409
2021	800,069	880,076	38,958,099	42,853,909
2022	805,818	886,400	39,758,168	43,733,985
2023	817,090	898,799	40,563,986	44,620,385
2024	820,035	902,039	41,381,076	45,519,184
2025	822,981	905,279	42,201,111	46,421,223
2026	823,605	905,965	43,024,092	47,326,502
2027	824,228	906,651	43,847,697	48,232,467
2028	829,435	912,379	44,671,925	49,139,118
2029	837,912	921,703	45,501,361	50,051,497
2030	854,349	939,784	46,339,272	50,973,200
2031	869,288	956,217	47,193,621	51,912,984
2032	884,482	972,930	48,062,910	52,869,201
2033	899,935	989,928	48,947,391	53,842,131
2034	915,649	1,007,214	49,847,326	54,832,059
2035	931,631	1,024,794	50,762,975	55,839,273
2036	947,884	1,042,672	51,694,606	56,864,067
2037	964,414	1,060,855	52,642,490	57,906,739
2038	981,225	1,079,347	53,606,903	58,967,594
2039	998,321	1,098,153	54,588,128	60,046,941
2040	1,015,708	1,117,279	55,586,449	61,145,094
2041	1,033,482	1,136,830	56,602,157	62,262,373
2042	1,051,564	1,156,720	57,635,639	63,399,203
2043	1,069,964	1,176,960	58,687,202	64,555,923
2044	1,088,691	1,197,560	59,757,166	65,732,883

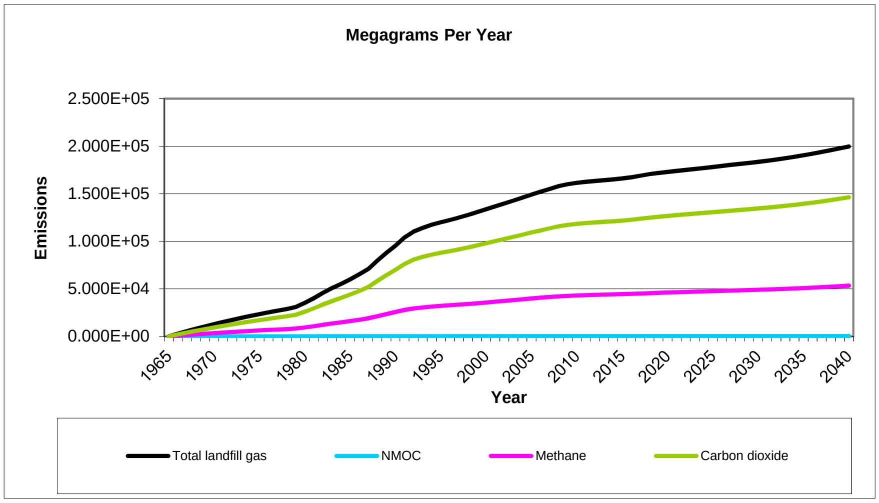
Pollutant Parameters

		Gas / Pollutant Default Parameters:		User-specified Pollutant Parameters:	
	Compound	Concentration (*ppmv*)	Molecular Weight	Concentration (*ppmv*)	Molecular Weight
Gases	Total landfill gas		0.00		
	Methane		16.04		
	Carbon dioxide		44.01		
	NMOC	4,000	86.18		
Pollutants	1,1,1-Trichloroethane (methyl chloroform) - HAP	0.48	133.41		
	1,1,2,2-Tetrachloroethane - HAP/VOC	1.1	167.85		
	1,1-Dichloroethane (ethylidene dichloride) - HAP/VOC	2.4	98.97		
	1,1-Dichloroethene (vinylidene chloride) - HAP/VOC	0.20	96.94		
	1,2-Dichloroethane (ethylene dichloride) - HAP/VOC	0.41	98.96		
	1,2-Dichloropropane (propylene dichloride) - HAP/VOC	0.18	112.99		
	2-Propanol (isopropyl alcohol) - VOC	50	60.11		
	Acetone	7.0	58.08		
	Acrylonitrile - HAP/VOC	6.3	53.06		
	Benzene - No or Unknown Co-disposal - HAP/VOC	1.9	78.11		
	Benzene - Co-disposal - HAP/VOC	11	78.11		
	Bromodichloromethane - VOC	3.1	163.83		
	Butane - VOC	5.0	58.12		
	Carbon disulfide - HAP/VOC	0.58	76.13		
	Carbon monoxide	140	28.01		
	Carbon tetrachloride - HAP/VOC	4.0E-03	153.84		
	Carbonyl sulfide - HAP/VOC	0.49	60.07		
	Chlorobenzene - HAP/VOC	0.25	112.56		
	Chlorodifluoromethane	1.3	86.47		
	Chloroethane (ethyl chloride) - HAP/VOC	1.3	64.52		
	Chloroform - HAP/VOC	0.03	119.39		
	Chloromethane - VOC	1.2	50.49		
	Dichlorobenzene - (HAP for para isomer/VOC)	0.21	147		
	Dichlorodifluoromethane	16	120.91		
	Dichlorofluoromethane - VOC	2.6	102.92		
	Dichloromethane (methylene chloride) - HAP	14	84.94		
	Dimethyl sulfide (methyl sulfide) - VOC	7.8	62.13		
	Ethane	890	30.07		
	Ethanol - VOC	27	46.08		

Pollutant Parameters (Continued)

	Compound	Gas / Pollutant Default Parameters: Concentration (*ppmv*)	Molecular Weight	User-specified Pollutant Parameters: Concentration (*ppmv*)	Molecular Weight
Pollutants	Ethyl mercaptan (ethanethiol) - VOC	2.3	62.13		
	Ethylbenzene - HAP/VOC	4.6	106.16		
	Ethylene dibromide - HAP/VOC	1.0E-03	187.88		
	Fluorotrichloromethane - VOC	0.76	137.38		
	Hexane - HAP/VOC	6.6	86.18		
	Hydrogen sulfide	36	34.08		
	Mercury (total) - HAP	2.9E-04	200.61		
	Methyl ethyl ketone - HAP/VOC	7.1	72.11		
	Methyl isobutyl ketone - HAP/VOC	1.9	100.16		
	Methyl mercaptan - VOC	2.5	48.11		
	Pentane - VOC	3.3	72.15		
	Perchloroethylene (tetrachloroethylene) - HAP	3.7	165.83		
	Propane - VOC	11	44.09		
	t-1,2-Dichloroethene - VOC	2.8	96.94		
	Toluene - No or Unknown Co-disposal - HAP/VOC	39	92.13		
	Toluene - Co-disposal - HAP/VOC	170	92.13		
	Trichloroethylene (trichloroethene) - HAP/VOC	2.8	131.40		
	Vinyl chloride - HAP/VOC	7.3	62.50		
	Xylenes - HAP/VOC	12	106.16		

Graphs


Megagrams Per Year
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2.000E+05
1.500E+05
1.000E+05
5.000E+04
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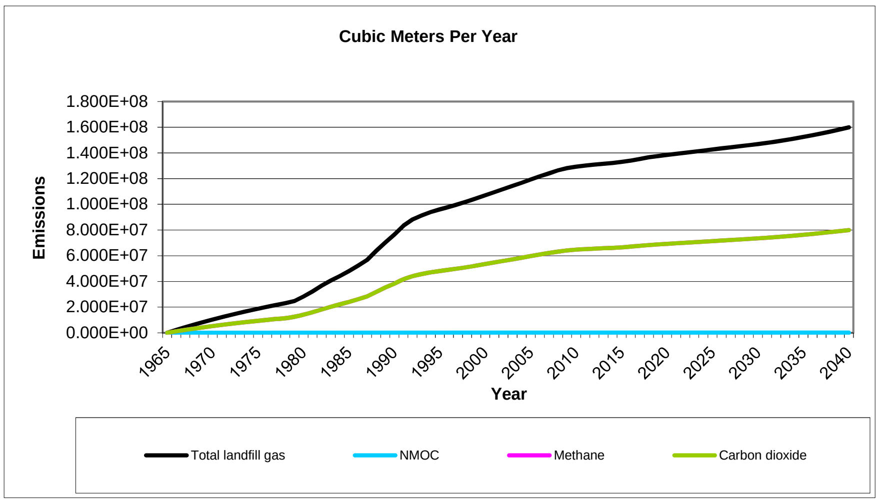
Emissions
1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040
Year
Total landfill gas
NMOC
Methane
Carbon dioxide


Cubic Meters Per Year
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1.000E+08
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6.000E+07
4.000E+07
2.000E+07
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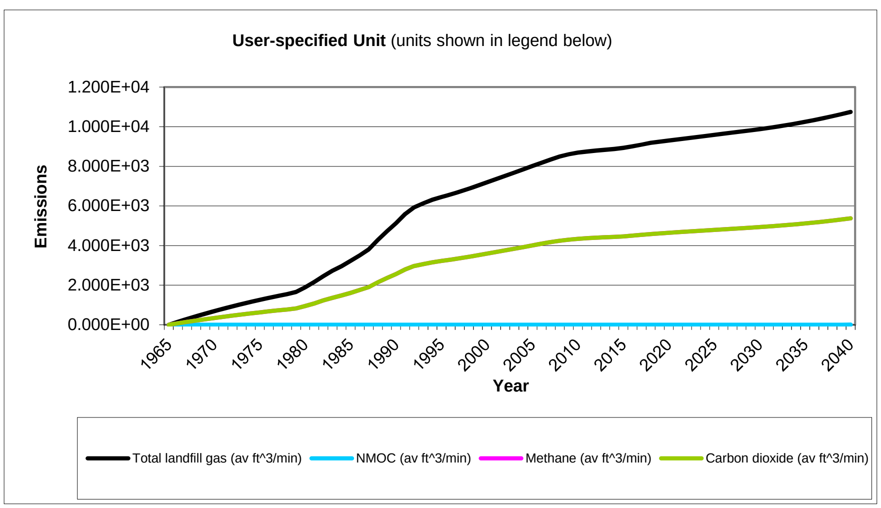
Emissions
1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040
Year
Total landfill gas
NMOC
Methane
Carbon dioxide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6.000E+03
4.000E+03
2.000E+03
0.000E+00
Emissions
1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040
Year
Total landfill gas (av ft^3/min)
NMOC (av ft^3/min)
Methane (av ft^3/min)
Carbon dioxide (av ft^3/min)

Appendix D. LandGEM Modeling

Results

Year	Total landfill gas			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1965	0	0	0	0	0	0
1966	2.786E+03	2.231E+06	1.499E+02	4.797E+00	1.338E+03	8.992E-02
1967	5.462E+03	4.374E+06	2.939E+02	9.406E+00	2.624E+03	1.763E-01
1968	8.033E+03	6.433E+06	4.322E+02	1.383E+01	3.860E+03	2.593E-01
1969	1.050E+04	8.411E+06	5.651E+02	1.809E+01	5.047E+03	3.391E-01
1970	1.288E+04	1.031E+07	6.928E+02	2.218E+01	6.187E+03	4.157E-01
1971	1.516E+04	1.214E+07	8.155E+02	2.610E+01	7.283E+03	4.893E-01
1972	1.735E+04	1.389E+07	9.334E+02	2.988E+01	8.335E+03	5.601E-01
1973	1.945E+04	1.558E+07	1.047E+03	3.350E+01	9.347E+03	6.280E-01
1974	2.148E+04	1.720E+07	1.156E+03	3.699E+01	1.032E+04	6.933E-01
1975	2.342E+04	1.875E+07	1.260E+03	4.033E+01	1.125E+04	7.560E-01
1976	2.529E+04	2.025E+07	1.361E+03	4.355E+01	1.215E+04	8.163E-01
1977	2.708E+04	2.169E+07	1.457E+03	4.664E+01	1.301E+04	8.742E-01
1978	2.881E+04	2.307E+07	1.550E+03	4.961E+01	1.384E+04	9.299E-01
1979	3.089E+04	2.473E+07	1.662E+03	5.319E+01	1.484E+04	9.971E-01
1980	3.521E+04	2.819E+07	1.894E+03	6.063E+01	1.691E+04	1.136E+00
1981	4.019E+04	3.218E+07	2.162E+03	6.921E+01	1.931E+04	1.297E+00
1982	4.578E+04	3.666E+07	2.463E+03	7.884E+01	2.199E+04	1.478E+00
1983	5.074E+04	4.063E+07	2.730E+03	8.738E+01	2.438E+04	1.638E+00
1984	5.511E+04	4.413E+07	2.965E+03	9.491E+01	2.648E+04	1.779E+00
1985	6.002E+04	4.806E+07	3.229E+03	1.034E+02	2.884E+04	1.938E+00
1986	6.524E+04	5.224E+07	3.510E+03	1.124E+02	3.135E+04	2.106E+00
1987	7.087E+04	5.675E+07	3.813E+03	1.220E+02	3.405E+04	2.288E+00
1988	7.970E+04	6.382E+07	4.288E+03	1.373E+02	3.829E+04	2.573E+00
1989	8.783E+04	7.033E+07	4.725E+03	1.513E+02	4.220E+04	2.835E+00
1990	9.546E+04	7.644E+07	5.136E+03	1.644E+02	4.586E+04	3.082E+00
1991	1.041E+05	8.334E+07	5.600E+03	1.792E+02	5.000E+04	3.360E+00
1992	1.103E+05	8.830E+07	5.933E+03	1.899E+02	5.298E+04	3.560E+00
1993	1.140E+05	9.132E+07	6.136E+03	1.964E+02	5.479E+04	3.681E+00
1994	1.174E+05	9.401E+07	6.317E+03	2.022E+02	5.641E+04	3.790E+00
1995	1.200E+05	9.606E+07	6.454E+03	2.066E+02	5.763E+04	3.872E+00
1996	1.225E+05	9.810E+07	6.591E+03	2.110E+02	5.886E+04	3.955E+00
1997	1.249E+05	1.000E+08	6.721E+03	2.151E+02	6.002E+04	4.032E+00
1998	1.277E+05	1.023E+08	6.871E+03	2.199E+02	6.136E+04	4.123E+00
1999	1.305E+05	1.045E+08	7.021E+03	2.247E+02	6.270E+04	4.213E+00
2000	1.336E+05	1.070E+08	7.189E+03	2.301E+02	6.420E+04	4.313E+00
2001	1.368E+05	1.096E+08	7.362E+03	2.356E+02	6.574E+04	4.417E+00
2002	1.398E+05	1.120E+08	7.523E+03	2.408E+02	6.718E+04	4.514E+00
2003	1.427E+05	1.143E+08	7.679E+03	2.458E+02	6.857E+04	4.607E+00
2004	1.459E+05	1.168E+08	7.847E+03	2.512E+02	7.008E+04	4.708E+00
2005	1.491E+05	1.194E+08	8.022E+03	2.568E+02	7.164E+04	4.813E+00
2006	1.521E+05	1.218E+08	8.183E+03	2.619E+02	7.307E+04	4.910E+00
2007	1.550E+05	1.241E+08	8.341E+03	2.670E+02	7.448E+04	5.004E+00
2008	1.580E+05	1.265E+08	8.499E+03	2.720E+02	7.589E+04	5.099E+00
2009	1.601E+05	1.282E+08	8.612E+03	2.757E+02	7.691E+04	5.167E+00
2010	1.615E+05	1.293E+08	8.691E+03	2.782E+02	7.761E+04	5.214E+00
2011	1.626E+05	1.302E+08	8.749E+03	2.800E+02	7.813E+04	5.249E+00
2012	1.635E+05	1.309E+08	8.796E+03	2.815E+02	7.855E+04	5.278E+00
2013	1.643E+05	1.315E+08	8.838E+03	2.829E+02	7.893E+04	5.303E+00
2014	1.650E+05	1.322E+08	8.880E+03	2.842E+02	7.930E+04	5.328E+00

Results (Continued)

Year	Total landfill gas			NMOC		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2015	1.661E+05	1.330E+08	8.937E+03	2.861E+02	7.980E+04	5.362E+00
2016	1.673E+05	1.340E+08	9.004E+03	2.882E+02	8.040E+04	5.402E+00
2017	1.690E+05	1.353E+08	9.093E+03	2.911E+02	8.120E+04	5.456E+00
2018	1.707E+05	1.367E+08	9.184E+03	2.940E+02	8.201E+04	5.510E+00
2019	1.719E+05	1.377E+08	9.250E+03	2.961E+02	8.260E+04	5.550E+00
2020	1.729E+05	1.385E+08	9.304E+03	2.978E+02	8.309E+04	5.582E+00
2021	1.739E+05	1.393E+08	9.358E+03	2.995E+02	8.356E+04	5.615E+00
2022	1.750E+05	1.401E+08	9.413E+03	3.013E+02	8.406E+04	5.648E+00
2023	1.760E+05	1.409E+08	9.469E+03	3.031E+02	8.456E+04	5.682E+00
2024	1.771E+05	1.418E+08	9.530E+03	3.050E+02	8.510E+04	5.718E+00
2025	1.782E+05	1.427E+08	9.589E+03	3.069E+02	8.563E+04	5.753E+00
2026	1.793E+05	1.436E+08	9.647E+03	3.088E+02	8.615E+04	5.788E+00
2027	1.804E+05	1.444E+08	9.704E+03	3.106E+02	8.666E+04	5.822E+00
2028	1.814E+05	1.452E+08	9.759E+03	3.124E+02	8.714E+04	5.855E+00
2029	1.824E+05	1.461E+08	9.814E+03	3.141E+02	8.764E+04	5.888E+00
2030	1.835E+05	1.469E+08	9.871E+03	3.160E+02	8.815E+04	5.923E+00
2031	1.847E+05	1.479E+08	9.935E+03	3.180E+02	8.872E+04	5.961E+00
2032	1.860E+05	1.489E+08	1.000E+04	3.202E+02	8.934E+04	6.003E+00
2033	1.873E+05	1.500E+08	1.008E+04	3.226E+02	9.001E+04	6.048E+00
2034	1.888E+05	1.512E+08	1.016E+04	3.252E+02	9.072E+04	6.096E+00
2035	1.904E+05	1.525E+08	1.024E+04	3.279E+02	9.148E+04	6.147E+00
2036	1.921E+05	1.538E+08	1.033E+04	3.308E+02	9.229E+04	6.201E+00
2037	1.939E+05	1.552E+08	1.043E+04	3.339E+02	9.314E+04	6.258E+00
2038	1.957E+05	1.567E+08	1.053E+04	3.371E+02	9.403E+04	6.318E+00
2039	1.977E+05	1.583E+08	1.064E+04	3.404E+02	9.497E+04	6.381E+00
2040	1.997E+05	1.599E+08	1.075E+04	3.439E+02	9.595E+04	6.447E+00
2041	2.019E+05	1.616E+08	1.086E+04	3.476E+02	9.698E+04	6.516E+00
2042	2.041E+05	1.634E+08	1.098E+04	3.515E+02	9.805E+04	6.588E+00
2043	2.064E+05	1.653E+08	1.110E+04	3.555E+02	9.916E+04	6.663E+00
2044	2.088E+05	1.672E+08	1.123E+04	3.596E+02	1.003E+05	6.741E+00
2045	2.113E+05	1.692E+08	1.137E+04	3.639E+02	1.015E+05	6.821E+00
2046	2.030E+05	1.626E+08	1.092E+04	3.496E+02	9.754E+04	6.554E+00
2047	1.951E+05	1.562E+08	1.049E+04	3.359E+02	9.371E+04	6.297E+00
2048	1.874E+05	1.501E+08	1.008E+04	3.227E+02	9.004E+04	6.050E+00
2049	1.801E+05	1.442E+08	9.688E+03	3.101E+02	8.651E+04	5.813E+00
2050	1.730E+05	1.385E+08	9.308E+03	2.979E+02	8.312E+04	5.585E+00
2051	1.662E+05	1.331E+08	8.943E+03	2.862E+02	7.986E+04	5.366E+00
2052	1.597E+05	1.279E+08	8.592E+03	2.750E+02	7.673E+04	5.155E+00
2053	1.534E+05	1.229E+08	8.255E+03	2.642E+02	7.372E+04	4.953E+00
2054	1.474E+05	1.180E+08	7.932E+03	2.539E+02	7.083E+04	4.759E+00
2055	1.416E+05	1.134E+08	7.621E+03	2.439E+02	6.805E+04	4.572E+00
2056	1.361E+05	1.090E+08	7.322E+03	2.344E+02	6.538E+04	4.393E+00
2057	1.307E+05	1.047E+08	7.035E+03	2.252E+02	6.282E+04	4.221E+00
2058	1.256E+05	1.006E+08	6.759E+03	2.163E+02	6.036E+04	4.055E+00
2059	1.207E+05	9.665E+07	6.494E+03	2.079E+02	5.799E+04	3.896E+00
2060	1.160E+05	9.286E+07	6.239E+03	1.997E+02	5.572E+04	3.743E+00
2061	1.114E+05	8.922E+07	5.995E+03	1.919E+02	5.353E+04	3.597E+00
2062	1.070E+05	8.572E+07	5.759E+03	1.844E+02	5.143E+04	3.456E+00
2063	1.029E+05	8.236E+07	5.534E+03	1.771E+02	4.941E+04	3.320E+00
2064	9.882E+04	7.913E+07	5.317E+03	1.702E+02	4.748E+04	3.190E+00
2065	9.494E+04	7.603E+07	5.108E+03	1.635E+02	4.562E+04	3.065E+00

Results (Continued)

Year	Total landfill gas			NMOC		
	(Mg/year)	(m^3/year)	(av ft^3/min)	(Mg/year)	(m^3/year)	(av ft^3/min)
2066	9.122E+04	7.305E+07	4.908E+03	1.571E+02	4.383E+04	2.945E+00
2067	8.764E+04	7.018E+07	4.715E+03	1.509E+02	4.211E+04	2.829E+00
2068	8.421E+04	6.743E+07	4.531E+03	1.450E+02	4.046E+04	2.718E+00
2069	8.091E+04	6.479E+07	4.353E+03	1.393E+02	3.887E+04	2.612E+00
2070	7.773E+04	6.224E+07	4.182E+03	1.339E+02	3.735E+04	2.509E+00
2071	7.469E+04	5.980E+07	4.018E+03	1.286E+02	3.588E+04	2.411E+00
2072	7.176E+04	5.746E+07	3.861E+03	1.236E+02	3.448E+04	2.316E+00
2073	6.894E+04	5.521E+07	3.709E+03	1.187E+02	3.312E+04	2.226E+00
2074	6.624E+04	5.304E+07	3.564E+03	1.141E+02	3.183E+04	2.138E+00
2075	6.364E+04	5.096E+07	3.424E+03	1.096E+02	3.058E+04	2.054E+00
2076	6.115E+04	4.896E+07	3.290E+03	1.053E+02	2.938E+04	1.974E+00
2077	5.875E+04	4.704E+07	3.161E+03	1.012E+02	2.823E+04	1.897E+00
2078	5.645E+04	4.520E+07	3.037E+03	9.721E+01	2.712E+04	1.822E+00
2079	5.423E+04	4.343E+07	2.918E+03	9.340E+01	2.606E+04	1.751E+00
2080	5.211E+04	4.172E+07	2.803E+03	8.974E+01	2.503E+04	1.682E+00
2081	5.006E+04	4.009E+07	2.694E+03	8.622E+01	2.405E+04	1.616E+00
2082	4.810E+04	3.852E+07	2.588E+03	8.284E+01	2.311E+04	1.553E+00
2083	4.621E+04	3.701E+07	2.486E+03	7.959E+01	2.220E+04	1.492E+00
2084	4.440E+04	3.555E+07	2.389E+03	7.647E+01	2.133E+04	1.433E+00
2085	4.266E+04	3.416E+07	2.295E+03	7.347E+01	2.050E+04	1.377E+00
2086	4.099E+04	3.282E+07	2.205E+03	7.059E+01	1.969E+04	1.323E+00
2087	3.938E+04	3.153E+07	2.119E+03	6.782E+01	1.892E+04	1.271E+00
2088	3.784E+04	3.030E+07	2.036E+03	6.516E+01	1.818E+04	1.221E+00
2089	3.635E+04	2.911E+07	1.956E+03	6.261E+01	1.747E+04	1.174E+00
2090	3.493E+04	2.797E+07	1.879E+03	6.015E+01	1.678E+04	1.128E+00
2091	3.356E+04	2.687E+07	1.806E+03	5.779E+01	1.612E+04	1.083E+00
2092	3.224E+04	2.582E+07	1.735E+03	5.553E+01	1.549E+04	1.041E+00
2093	3.098E+04	2.481E+07	1.667E+03	5.335E+01	1.488E+04	1.000E+00
2094	2.976E+04	2.383E+07	1.601E+03	5.126E+01	1.430E+04	9.608E-01
2095	2.860E+04	2.290E+07	1.539E+03	4.925E+01	1.374E+04	9.231E-01
2096	2.748E+04	2.200E+07	1.478E+03	4.732E+01	1.320E+04	8.869E-01
2097	2.640E+04	2.114E+07	1.420E+03	4.546E+01	1.268E+04	8.522E-01
2098	2.536E+04	2.031E+07	1.365E+03	4.368E+01	1.219E+04	8.187E-01
2099	2.437E+04	1.951E+07	1.311E+03	4.197E+01	1.171E+04	7.866E-01
2100	2.341E+04	1.875E+07	1.260E+03	4.032E+01	1.125E+04	7.558E-01
2101	2.249E+04	1.801E+07	1.210E+03	3.874E+01	1.081E+04	7.262E-01
2102	2.161E+04	1.731E+07	1.163E+03	3.722E+01	1.038E+04	6.977E-01
2103	2.077E+04	1.663E+07	1.117E+03	3.576E+01	9.977E+03	6.703E-01
2104	1.995E+04	1.598E+07	1.073E+03	3.436E+01	9.586E+03	6.440E-01
2105	1.917E+04	1.535E+07	1.031E+03	3.301E+01	9.210E+03	6.188E-01

Results (Continued)

Year	Methane			Carbon dioxide		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
1965	0	0	0	0	0	0
1966	7.440E+02	1.115E+06	7.493E+01	2.041E+03	1.115E+06	7.493E+01
1967	1.459E+03	2.187E+06	1.469E+02	4.003E+03	2.187E+06	1.469E+02
1968	2.146E+03	3.216E+06	2.161E+02	5.887E+03	3.216E+06	2.161E+02
1969	2.806E+03	4.205E+06	2.826E+02	7.698E+03	4.205E+06	2.826E+02
1970	3.440E+03	5.156E+06	3.464E+02	9.438E+03	5.156E+06	3.464E+02
1971	4.049E+03	6.069E+06	4.078E+02	1.111E+04	6.069E+06	4.078E+02
1972	4.634E+03	6.946E+06	4.667E+02	1.271E+04	6.946E+06	4.667E+02
1973	5.196E+03	7.789E+06	5.233E+02	1.426E+04	7.789E+06	5.233E+02
1974	5.737E+03	8.599E+06	5.778E+02	1.574E+04	8.599E+06	5.778E+02
1975	6.256E+03	9.377E+06	6.300E+02	1.716E+04	9.377E+06	6.300E+02
1976	6.755E+03	1.012E+07	6.803E+02	1.853E+04	1.012E+07	6.803E+02
1977	7.234E+03	1.084E+07	7.285E+02	1.985E+04	1.084E+07	7.285E+02
1978	7.694E+03	1.153E+07	7.749E+02	2.111E+04	1.153E+07	7.749E+02
1979	8.251E+03	1.237E+07	8.309E+02	2.264E+04	1.237E+07	8.309E+02
1980	9.404E+03	1.410E+07	9.471E+02	2.580E+04	1.410E+07	9.471E+02
1981	1.074E+04	1.609E+07	1.081E+03	2.945E+04	1.609E+07	1.081E+03
1982	1.223E+04	1.833E+07	1.232E+03	3.355E+04	1.833E+07	1.232E+03
1983	1.355E+04	2.031E+07	1.365E+03	3.718E+04	2.031E+07	1.365E+03
1984	1.472E+04	2.207E+07	1.483E+03	4.039E+04	2.207E+07	1.483E+03
1985	1.603E+04	2.403E+07	1.615E+03	4.399E+04	2.403E+07	1.615E+03
1986	1.743E+04	2.612E+07	1.755E+03	4.782E+04	2.612E+07	1.755E+03
1987	1.893E+04	2.837E+07	1.906E+03	5.194E+04	2.837E+07	1.906E+03
1988	2.129E+04	3.191E+07	2.144E+03	5.841E+04	3.191E+07	2.144E+03
1989	2.346E+04	3.516E+07	2.363E+03	6.437E+04	3.516E+07	2.363E+03
1990	2.550E+04	3.822E+07	2.568E+03	6.996E+04	3.822E+07	2.568E+03
1991	2.780E+04	4.167E+07	2.800E+03	7.628E+04	4.167E+07	2.800E+03
1992	2.945E+04	4.415E+07	2.966E+03	8.081E+04	4.415E+07	2.966E+03
1993	3.046E+04	4.566E+07	3.068E+03	8.358E+04	4.566E+07	3.068E+03
1994	3.136E+04	4.701E+07	3.158E+03	8.604E+04	4.701E+07	3.158E+03
1995	3.204E+04	4.803E+07	3.227E+03	8.792E+04	4.803E+07	3.227E+03
1996	3.272E+04	4.905E+07	3.296E+03	8.979E+04	4.905E+07	3.296E+03
1997	3.337E+04	5.001E+07	3.360E+03	9.155E+04	5.001E+07	3.360E+03
1998	3.411E+04	5.113E+07	3.436E+03	9.360E+04	5.113E+07	3.436E+03
1999	3.486E+04	5.225E+07	3.511E+03	9.564E+04	5.225E+07	3.511E+03
2000	3.569E+04	5.350E+07	3.595E+03	9.793E+04	5.350E+07	3.595E+03
2001	3.655E+04	5.478E+07	3.681E+03	1.003E+05	5.478E+07	3.681E+03
2002	3.735E+04	5.598E+07	3.761E+03	1.025E+05	5.598E+07	3.761E+03
2003	3.812E+04	5.714E+07	3.839E+03	1.046E+05	5.714E+07	3.839E+03
2004	3.896E+04	5.840E+07	3.924E+03	1.069E+05	5.840E+07	3.924E+03
2005	3.983E+04	5.970E+07	4.011E+03	1.093E+05	5.970E+07	4.011E+03
2006	4.062E+04	6.089E+07	4.091E+03	1.115E+05	6.089E+07	4.091E+03
2007	4.141E+04	6.207E+07	4.170E+03	1.136E+05	6.207E+07	4.170E+03
2008	4.219E+04	6.324E+07	4.249E+03	1.158E+05	6.324E+07	4.249E+03
2009	4.276E+04	6.409E+07	4.306E+03	1.173E+05	6.409E+07	4.306E+03
2010	4.315E+04	6.467E+07	4.345E+03	1.184E+05	6.467E+07	4.345E+03
2011	4.344E+04	6.511E+07	4.374E+03	1.192E+05	6.511E+07	4.374E+03
2012	4.367E+04	6.546E+07	4.398E+03	1.198E+05	6.546E+07	4.398E+03
2013	4.388E+04	6.577E+07	4.419E+03	1.204E+05	6.577E+07	4.419E+03
2014	4.409E+04	6.608E+07	4.440E+03	1.210E+05	6.608E+07	4.440E+03

Results (Continued)

Year	Methane			Carbon dioxide		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2015	4.437E+04	6.650E+07	4.468E+03	1.217E+05	6.650E+07	4.468E+03
2016	4.470E+04	6.700E+07	4.502E+03	1.226E+05	6.700E+07	4.502E+03
2017	4.514E+04	6.767E+07	4.547E+03	1.239E+05	6.767E+07	4.547E+03
2018	4.559E+04	6.834E+07	4.592E+03	1.251E+05	6.834E+07	4.592E+03
2019	4.592E+04	6.883E+07	4.625E+03	1.260E+05	6.883E+07	4.625E+03
2020	4.619E+04	6.924E+07	4.652E+03	1.267E+05	6.924E+07	4.652E+03
2021	4.646E+04	6.964E+07	4.679E+03	1.275E+05	6.964E+07	4.679E+03
2022	4.673E+04	7.005E+07	4.707E+03	1.282E+05	7.005E+07	4.707E+03
2023	4.701E+04	7.047E+07	4.735E+03	1.290E+05	7.047E+07	4.735E+03
2024	4.731E+04	7.092E+07	4.765E+03	1.298E+05	7.092E+07	4.765E+03
2025	4.761E+04	7.136E+07	4.794E+03	1.306E+05	7.136E+07	4.794E+03
2026	4.790E+04	7.179E+07	4.824E+03	1.314E+05	7.179E+07	4.824E+03
2027	4.818E+04	7.221E+07	4.852E+03	1.322E+05	7.221E+07	4.852E+03
2028	4.845E+04	7.262E+07	4.879E+03	1.329E+05	7.262E+07	4.879E+03
2029	4.872E+04	7.303E+07	4.907E+03	1.337E+05	7.303E+07	4.907E+03
2030	4.901E+04	7.346E+07	4.936E+03	1.345E+05	7.346E+07	4.936E+03
2031	4.933E+04	7.394E+07	4.968E+03	1.353E+05	7.394E+07	4.968E+03
2032	4.967E+04	7.445E+07	5.002E+03	1.363E+05	7.445E+07	5.002E+03
2033	5.004E+04	7.501E+07	5.040E+03	1.373E+05	7.501E+07	5.040E+03
2034	5.044E+04	7.560E+07	5.080E+03	1.384E+05	7.560E+07	5.080E+03
2035	5.086E+04	7.624E+07	5.122E+03	1.395E+05	7.624E+07	5.122E+03
2036	5.131E+04	7.691E+07	5.167E+03	1.408E+05	7.691E+07	5.167E+03
2037	5.178E+04	7.762E+07	5.215E+03	1.421E+05	7.762E+07	5.215E+03
2038	5.228E+04	7.836E+07	5.265E+03	1.434E+05	7.836E+07	5.265E+03
2039	5.280E+04	7.914E+07	5.318E+03	1.449E+05	7.914E+07	5.318E+03
2040	5.335E+04	7.996E+07	5.373E+03	1.464E+05	7.996E+07	5.373E+03
2041	5.392E+04	8.082E+07	5.430E+03	1.479E+05	8.082E+07	5.430E+03
2042	5.451E+04	8.171E+07	5.490E+03	1.496E+05	8.171E+07	5.490E+03
2043	5.513E+04	8.264E+07	5.552E+03	1.513E+05	8.264E+07	5.552E+03
2044	5.577E+04	8.360E+07	5.617E+03	1.530E+05	8.360E+07	5.617E+03
2045	5.644E+04	8.460E+07	5.684E+03	1.549E+05	8.460E+07	5.684E+03
2046	5.423E+04	8.128E+07	5.461E+03	1.488E+05	8.128E+07	5.461E+03
2047	5.210E+04	7.810E+07	5.247E+03	1.430E+05	7.810E+07	5.247E+03
2048	5.006E+04	7.503E+07	5.041E+03	1.373E+05	7.503E+07	5.041E+03
2049	4.810E+04	7.209E+07	4.844E+03	1.320E+05	7.209E+07	4.844E+03
2050	4.621E+04	6.926E+07	4.654E+03	1.268E+05	6.926E+07	4.654E+03
2051	4.440E+04	6.655E+07	4.471E+03	1.218E+05	6.655E+07	4.471E+03
2052	4.266E+04	6.394E+07	4.296E+03	1.170E+05	6.394E+07	4.296E+03
2053	4.098E+04	6.143E+07	4.128E+03	1.125E+05	6.143E+07	4.128E+03
2054	3.938E+04	5.902E+07	3.966E+03	1.080E+05	5.902E+07	3.966E+03
2055	3.783E+04	5.671E+07	3.810E+03	1.038E+05	5.671E+07	3.810E+03
2056	3.635E+04	5.449E+07	3.661E+03	9.974E+04	5.449E+07	3.661E+03
2057	3.492E+04	5.235E+07	3.517E+03	9.582E+04	5.235E+07	3.517E+03
2058	3.356E+04	5.030E+07	3.379E+03	9.207E+04	5.030E+07	3.379E+03
2059	3.224E+04	4.832E+07	3.247E+03	8.846E+04	4.832E+07	3.247E+03
2060	3.098E+04	4.643E+07	3.120E+03	8.499E+04	4.643E+07	3.120E+03
2061	2.976E+04	4.461E+07	2.997E+03	8.166E+04	4.461E+07	2.997E+03
2062	2.859E+04	4.286E+07	2.880E+03	7.845E+04	4.286E+07	2.880E+03
2063	2.747E+04	4.118E+07	2.767E+03	7.538E+04	4.118E+07	2.767E+03
2064	2.640E+04	3.956E+07	2.658E+03	7.242E+04	3.956E+07	2.658E+03
2065	2.536E+04	3.801E+07	2.554E+03	6.958E+04	3.801E+07	2.554E+03

Results (Continued)

Year	Methane			Carbon dioxide		
	(Mg/year)	*(m^3/year)*	*(av ft^3/min)*	*(Mg/year)*	*(m^3/year)*	*(av ft^3/min)*
2066	2.437E+04	3.652E+07	2.454E+03	6.685E+04	3.652E+07	2.454E+03
2067	2.341E+04	3.509E+07	2.358E+03	6.423E+04	3.509E+07	2.358E+03
2068	2.249E+04	3.371E+07	2.265E+03	6.171E+04	3.371E+07	2.265E+03
2069	2.161E+04	3.239E+07	2.176E+03	5.929E+04	3.239E+07	2.176E+03
2070	2.076E+04	3.112E+07	2.091E+03	5.697E+04	3.112E+07	2.091E+03
2071	1.995E+04	2.990E+07	2.009E+03	5.474E+04	2.990E+07	2.009E+03
2072	1.917E+04	2.873E+07	1.930E+03	5.259E+04	2.873E+07	1.930E+03
2073	1.842E+04	2.760E+07	1.855E+03	5.053E+04	2.760E+07	1.855E+03
2074	1.769E+04	2.652E+07	1.782E+03	4.855E+04	2.652E+07	1.782E+03
2075	1.700E+04	2.548E+07	1.712E+03	4.664E+04	2.548E+07	1.712E+03
2076	1.633E+04	2.448E+07	1.645E+03	4.481E+04	2.448E+07	1.645E+03
2077	1.569E+04	2.352E+07	1.580E+03	4.306E+04	2.352E+07	1.580E+03
2078	1.508E+04	2.260E+07	1.518E+03	4.137E+04	2.260E+07	1.518E+03
2079	1.449E+04	2.171E+07	1.459E+03	3.975E+04	2.171E+07	1.459E+03
2080	1.392E+04	2.086E+07	1.402E+03	3.819E+04	2.086E+07	1.402E+03
2081	1.337E+04	2.004E+07	1.347E+03	3.669E+04	2.004E+07	1.347E+03
2082	1.285E+04	1.926E+07	1.294E+03	3.525E+04	1.926E+07	1.294E+03
2083	1.234E+04	1.850E+07	1.243E+03	3.387E+04	1.850E+07	1.243E+03
2084	1.186E+04	1.778E+07	1.194E+03	3.254E+04	1.778E+07	1.194E+03
2085	1.140E+04	1.708E+07	1.148E+03	3.127E+04	1.708E+07	1.148E+03
2086	1.095E+04	1.641E+07	1.103E+03	3.004E+04	1.641E+07	1.103E+03
2087	1.052E+04	1.577E+07	1.059E+03	2.886E+04	1.577E+07	1.059E+03
2088	1.011E+04	1.515E+07	1.018E+03	2.773E+04	1.515E+07	1.018E+03
2089	9.710E+03	1.455E+07	9.779E+02	2.664E+04	1.455E+07	9.779E+02
2090	9.330E+03	1.398E+07	9.396E+02	2.560E+04	1.398E+07	9.396E+02
2091	8.964E+03	1.344E+07	9.028E+02	2.459E+04	1.344E+07	9.028E+02
2092	8.612E+03	1.291E+07	8.674E+02	2.363E+04	1.291E+07	8.674E+02
2093	8.275E+03	1.240E+07	8.333E+02	2.270E+04	1.240E+07	8.333E+02
2094	7.950E+03	1.192E+07	8.007E+02	2.181E+04	1.192E+07	8.007E+02
2095	7.638E+03	1.145E+07	7.693E+02	2.096E+04	1.145E+07	7.693E+02
2096	7.339E+03	1.100E+07	7.391E+02	2.014E+04	1.100E+07	7.391E+02
2097	7.051E+03	1.057E+07	7.101E+02	1.935E+04	1.057E+07	7.101E+02
2098	6.775E+03	1.015E+07	6.823E+02	1.859E+04	1.015E+07	6.823E+02
2099	6.509E+03	9.756E+06	6.555E+02	1.786E+04	9.756E+06	6.555E+02
2100	6.254E+03	9.374E+06	6.298E+02	1.716E+04	9.374E+06	6.298E+02
2101	6.009E+03	9.006E+06	6.051E+02	1.649E+04	9.006E+06	6.051E+02
2102	5.773E+03	8.653E+06	5.814E+02	1.584E+04	8.653E+06	5.814E+02
2103	5.547E+03	8.314E+06	5.586E+02	1.522E+04	8.314E+06	5.586E+02
2104	5.329E+03	7.988E+06	5.367E+02	1.462E+04	7.988E+06	5.367E+02
2105	5.120E+03	7.675E+06	5.157E+02	1.405E+04	7.675E+06	5.157E+02