King County Department of Natural Resources and Parks

# Solid Waste Division

ENVIRONMENTAL INVESTIGATIONS, MONITORING, AND REMEDIATION SERVICES FOR CLOSED LANDFILLS

CONTRACT NO. E00102E08

TASK NO. 310.1.7.5

# PERIMETER PROBE INVESTIGATION AND MONITORING – VASHON LANDFILL

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King County
Department of
Natural Resources and Parks
**Solid Waste Division**

*Waste* **Prevention** | *Resource* **Recovery** | *Waste* **Disposal**

www.kingcounty.gov/solidwaste

**November 19, 2015**

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# PERIMETER PROBE INVESTIGATION AND MONITORING

## VASHON LANDFILL

Prepared for

King County

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# TABLE OF CONTENTS

List of Figures ..... i
List of Tables ..... i
1.0 Introduction ..... 1
2.0 Background ..... 1
3.0 Field Investigation Scope of Work ..... 1
4.0 Landfill Gas Monitoring Procedures ..... 2
5.0 Data Analysis ..... 3

# LIST OF FIGURES

Figure 1. Perimeter LFG Probe Location Map ..... 9
Figure 2. Gas Probe Monitoring Field Form. ..... 11

# LIST OF TABLES

Table 1. Gas Probe Purge Times ..... 4

# 1.0 INTRODUCTION

Herrera Environmental Consultants (Herrera) has prepared this Work Plan for King County Solid Waste District (KCSWD) under Contract Number: E00102E08 for Environmental Investigations Monitoring, and Remediation Services for Closed Landfills. The Work Plan addresses Perimeter Probe Investigation and Monitoring at Vashon Landfill under Task 310.1.7.5.

# 2.0 BACKGROUND

A review of recent LFG system monitoring results indicated:

- No methane detected in lateral EF-1 during nine of 12 monthly monitoring events (June 2014 to June 2015), with concentrations of 6.5, 10.1, and 1.2 percent methane detected last November, December, and January (Figure 1)
- Methane concentrations ranged from 0 to 3.1 percent and from 0 to 0.9 percent in laterals EF-2 and EF-3, respectively, in the same period (June 2014 through June 2015).
- The valve at lateral T-2 remained closed during this past year and no methane was detected, when monitored.
- Methane concentrations greater than 40 percent have been measured in south slope probe VTP2D.

In addition, no methane was detected in T-2 during March and April 2013, when Herrera and King County monitored the extraction system with the valves fully closed, partially opened, and fully opened.

Blockages within laterals EF-1, EF-2, EF-3, and T-2 were originally thought to have resulted in this low to no LFG found over the last couple of years of monitoring. A camera survey, conducted in June 2015, indicated no blockages in any of the laterals; however, some fine-grained material was identified both within a small portion of the EF-1 lateral pipe itself, as well as in bedding material exposed during pipe excavation. It appears that this fine-grain material may exist along the entire lateral lengths, limiting LFG flow into the pipes. It was also determined that laterals EF-1, EF-2, and EF-3 are all connected to each other.

Herrera's scope of work for Task 310-164 currently includes influence testing, to determine their effectiveness in drawing LFG from surrounding formations and to evaluate potential LFG migration/interconnection within the gravel blanket. Herrera does not recommend proceeding with influence testing until additional system characteristics are defined, focusing on understanding LFG migration and pathways that can impact the CC2 aquifer.

# 3.0 FIELD INVESTIGATION SCOPE OF WORK

Herrera will conduct a field investigation of existing perimeter probes. Figure 1 provides locations of 26 perimeter probes, including NP-1 through NP-8 (NP probes each include three nested probes), GP-1, GP-2, and three temporary probes, VTP1S, VTP2S, and VTP2D. LFG measurements also will be taken from monitoring wells MW-21 and MW-35, if the water level is below the top of the well screen.

To accomplish the field investigation, Herrera will:

- Coordinate with KCSWD for site access.
- Track barometric pressure and identify low pressure events to begin LFG monitoring, if possible (considering that the field effort could take 3 days, once monitoring begins, it will continue to completion, despite changing barometric pressure conditions).
- Measure water levels in 28 perimeter probes and three temporary probes to determine whether blockages exist and compare to conditions identified in probe construction logs.
- Measure water levels in monitoring wells MW-21 and MW-35, compare with well construction log to verify that there is an unsaturated screen section.
- Monitor LFG at all probe and monitoring well locations using purge times that will evacuate a minimum of one probe/well volume from each probe/well prior to recording gas measurements.

# 4.0 LANDFILL GAS MONITORING PROCEDURES

The Landtec Gem 2000 Plus will be calibrated daily with methane, according to procedures provided in the operations manual.

Gas probe monitoring will be conducted by attaching a Tygon tube with quick-connect fittings to the well cap or silicon tubing directly to the stopcock. A 2-inch diameter pressure cap modified for inclusion of tubing and a quick-connect fitting will be used to monitor the 2-inch diameter groundwater monitoring wells. The tubing will be attached to a water filter and to the intake of the GEM 2000 Plus multi-meter. Downhole pressure relative to atmospheric pressure will be measured after connecting the GEM 2000 Plus to the gas probe stopcock prior to purging.

Water levels in each of the probe/well locations will be measured with a water level indicator. Procedures for water level measurement are provided in Section 5.5.2, Table 5-7 of the King County Department of Natural Resources Draft Environmental Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan for Vashon Island Closed Landfill completed by KCSWD in December 2006:

- If probes contain water, they will be purged prior to monitoring, the water collected in a bucket (should be less than several gallons), and disposed of in the leachate collection pond.
- For probes with purge volumes greater than 3,000 milliliters, a vacuum pump may be used to facilitate purging
- Methane, carbon dioxide, oxygen, and hydrogen sulfide concentrations, probe pressure and barometric pressure will be measured using the GEM 2000 Plus.
- All parameters, except barometric pressure, will be measured and recorded at minimum 20second intervals during purging.
- An initial reading will be taken.
- The ambient barometric pressure near the well head at the time of sampling will be measured, once prior to connecting the GEM 2000 Plus to the wellhead.

- Purge a minimum of one pore volume. Continue purging and record parameters at minimum 20-second intervals, until parameters are stabilized. Stabilization is defined as three readings over a 1-minute period that are within 10% of one another.

Table 1 provides gas probe purge times, including the casing volume for each monitoring location. Monitoring and water level data will be recorded on the Gas Monitoring Log form (Figure 2).

# 5.0 DATA ANALYSIS

The LFG monitoring results will be used to evaluate site-wide LFG migration and determine pathways that may impact the CC2 aquifer. These data will be used to develop recommendations including:

- Additional LFG characterization in areas such as south of the landfill in the vicinity of temporary probe VTP-2D, where methane concentrations ranging from 35 to 55 percent by volume have been measured with the Gas Clam over the past few months.
- Influence testing in areas where LFG is not being captured by the LFG extraction system.
- Repair and maintenance needs for LFG probes that do not function correctly.

## Table 1. Gas Probe Purge Times

| Probe ID | Diameter (inches) | Approx. Depth to mid-Screen (ft) | Casing Volume (mL) | GEM5000 500 mL/min | | GEM2000 300 mL/min | | Supplemental Pump 3000 mL/min | | Construction Info Source |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time to Purge at 500 mL/min (h:mm:ss) | Percent Casing Volume Purged | Time to Purge at 300 mL/min (h:mm:ss) | Percent Casing Volume Purged | Time to Purge at 3000 mL/min (h:mm:ss) | Percent Casing Volume Purged | |
| | | | | 1 CV | 1 min | 1 CV | 1 min | 1 CV | 1 min | |
| VaNP001D | 0.75 | 95 | 8,300 | 0:16:36 | 6% | 0:27:40 | 4% | 0:02:46 | 36% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP001I | 0.75 | 40 | 3,500 | 0:07:00 | 14% | 0:11:40 | 9% | 0:01:10 | 86% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP001S | 0.75 | 15 | 1,300 | 0:02:36 | 38% | 0:04:20 | 23% | 0:00:26 | 231% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP002D | 0.75 | 85 | 7,400 | 0:14:48 | 7% | 0:24:40 | 4% | 0:02:28 | 41% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP002I | 0.75 | 50 | 4,300 | 0:08:36 | 12% | 0:14:20 | 7% | 0:01:26 | 70% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP002S | 0.75 | 20 | 1,700 | 0:03:24 | 29% | 0:05:40 | 18% | 0:00:34 | 176% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP003D | 0.75 | 85 | 7,400 | 0:14:48 | 7% | 0:24:40 | 4% | 0:02:28 | 41% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP003I | 0.75 | 40 | 3,500 | 0:07:00 | 14% | 0:11:40 | 9% | 0:01:10 | 86% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP003S | 0.75 | 15 | 1,300 | 0:02:36 | 38% | 0:04:20 | 23% | 0:00:26 | 231% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP004D | 0.75 | 85 | 7,400 | 0:14:48 | 7% | 0:24:40 | 4% | 0:02:28 | 41% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP004I | 0.75 | 35 | 3,000 | 0:06:00 | 17% | 0:10:00 | 10% | 0:01:00 | 100% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP004S | 0.75 | 15 | 1,300 | 0:02:36 | 38% | 0:04:20 | 23% | 0:00:26 | 231% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP005D | 0.75 | 70 | 6,100 | 0:12:12 | 8% | 0:20:20 | 5% | 0:02:02 | 49% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP005I | 0.75 | 35 | 3,000 | 0:06:00 | 17% | 0:10:00 | 10% | 0:01:00 | 100% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP005S | 0.75 | 15 | 1,300 | 0:02:36 | 38% | 0:04:20 | 23% | 0:00:26 | 231% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP006D | 0.75 | 95 | 8,300 | 0:16:36 | 6% | 0:27:40 | 4% | 0:02:46 | 36% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP006I | 0.75 | 40 | 3,500 | 0:07:00 | 14% | 0:11:40 | 9% | 0:01:10 | 86% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP006S | 0.75 | 15 | 1,300 | 0:02:36 | 38% | 0:04:20 | 23% | 0:00:26 | 231% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP007D | 0.75 | 90 | 7,800 | 0:15:36 | 6% | 0:26:00 | 4% | 0:02:36 | 38% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP007I | 0.75 | 45 | 3,900 | 0:07:48 | 13% | 0:13:00 | 8% | 0:01:18 | 77% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP007S | 0.75 | 15 | 1,300 | 0:02:36 | 38% | 0:04:20 | 23% | 0:00:26 | 231% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP008D | 0.75 | 100 | 8,700 | 0:17:24 | 6% | 0:29:00 | 3% | 0:02:54 | 34% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP008I | 0.75 | 50 | 4,300 | 0:08:36 | 12% | 0:14:20 | 7% | 0:01:26 | 70% | CH2M Hill, 1996, VILF MW Const Report |
| VaNP008S | 0.75 | 15 | 1,300 | 0:02:36 | 38% | 0:04:20 | 23% | 0:00:26 | 231% | CH2M Hill, 1996, VILF MW Const Report |

| Table 1 (continued). Gas Probe Purge Times | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | GEM5000 | | GEM2000 | | Supplemental Pump | | |
| | | | | 500 | mL/min | 300 | mL/min | 3000 | mL/min | |
| Probe ID | Diameter (inches) | Approx. Depth to mid-Screen (ft) | Casing Volume (mL) | Time to Purge at 500 mL/min (h:mm:ss) | Percent Casing Volume Purged | Time to Purge at 300 mL/min (h:mm:ss) | Percent Casing Volume Purged | Time to Purge at 3000 mL/min (h:mm:ss) | Percent Casing Volume Purged | Construction Info Source |
| | | | | 1 CV | 1 min | 1 CV | 1 min | 1 CV | 1 min | |
| VTP1s | 0.75 | 14 | 1,200 | 0:02:24 | 42% | 0:04:00 | 25% | 0:00:24 | 250% | well log |
| VTP2s | 0.75 | 6 | 500 | 0:01:00 | 100% | 0:01:40 | 60% | 0:00:10 | 600% | well log |
| VTP2d | 0.75 | 23 | 2,000 | 0:04:00 | 25% | 0:06:40 | 15% | 0:00:40 | 150% | well log |
| Vagp0001 | 2 | 25 | 15,400 | 0:30:48 | 3% | 0:51:20 | 2% | 0:00:00 | 924000% | Terra Assoc, 1992, MW and GP Installation |
| Vagp0002 | 2 | 25 | 15,400 | 0:30:48 | 3% | 0:51:20 | 2% | 0:00:00 | 924000% | Terra Assoc, 1992, MW and GP Installation |
| VagpMW21 | 2 | 105 | 64,900 | 2:09:48 | 1% | 3:36:20 | 0% | 0:00:00 | 3894000% | well log |
| VagpMW35 | 2 | 119 | 73,500 | 2:27:00 | 1% | 4:05:00 | 0% | 0:00:00 | 4410000% | well log |

# Figures

NORTH

0 100

Scale in Feet

DISCHARGE STACK

LFG TREATMENT FACILITIES

EXHAUSTER

APPROXIMATE LIMIT OF LINED REFUSE AREA

East Perimeter Road

ACTIVATED CARBON CANISTERS (2)

T2 RISER

EAST POND

TRANSFER STATION ENTRANCE

2001 FINAL COVER LIMIT

LFG RISER FT-6

LFG RISER FT-6A

LFG RISER FT-5

South Perimeter Road

VTP2S VTP2D

SOUTH SILTATION POND

LEACHATE LAGOON

West Perimeter Road

EF3 RISER

VTP1S

EF2 RISER

EF1 RISER

PUBLIC ENTRANCE

Westside Highway SW

MW - 35

MW - 21

## LEGEND

- PERIMETER GAS PROBE
- TEMPORARY GAS PROBE
- MW-# GROUNDWATER MONITORING WELL
- LFG RISER
- LFG LANDFILL GAS

HERRERA

King County
Department of Natural Resources & Parks
Solid Waste Division

# PERIMETER LFG PROBE LOCATION MAP

Vashon Island Landfill
King County, Washington

Sheet 1

Date November 2015

REFERENCE: PHOTOGRAMMETRY BY: (3D)I TECHNOLOGIES, INC. 04-26-04

Path: C:\proj\Y2009\09-04304-000\CAD\Dwgs\Vashon\LFG M Filename: Figure 1 Plot date: Nov 04, 2015-02:39:48pm CAD User: emarshall.
Xref Filename: [ X21104004bm0404 ] [ X21104004ml ] [ X21104004mt ]

# Gas Probe Monitoring Field Form

Gas Probe ID: _____ - _____ Date and Time: _____

| Casing Volume Purged | Volume Purged (cc) | Purge Rate (ml/min) | PURGE TIME | | | | $CH_4$ (% Volume) | $CO_2$ (% Volume) | $O_2$ (% Volume) | H2S (% Volume) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | min | | sec | | | | | |
| 1/4 | | | | min | | sec | | | | | |
| 1/2 | | | | min | | sec | | | | | |
| 3/4 | | | | min | | sec | | | | | |
| 1 | | | | min | | sec | | | | | |
| 1-1/4 | | | | min | | sec | | | | | |
| 1-1/2 | | | | min | | sec | | | | | |
| 1-3/4 | | | | min | | sec | | | | | |
| 2 | | | | min | | sec | | | | | |
| 2-1/4 | | | | min | | sec | | | | | |
| 2-1/2 | | | | min | | sec | | | | | |
| 2-3/4 | | | | min | | sec | | | | | |
| 3 | | | | min | | sec | | | | | |

Barometric Pressure: _____

Well head Pressure: _____

Well Diameter: _____

Water Level/Well Bottom: _____ Screen: _____

Water Volume Removed: _____

Equipment Used: Gem 2000 (Plus), Water Level Meter, SKC Pump

Figure 2. Gas Probe Monitoring Field Form.