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DEPARTMENT OF ECOLOGY

Lake Goodwin Landfill

2011 2nd Quarter Groundwater

Monitoring Report



Photo taken 8/1/08 J. Greninger

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TCP-NWRO

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1.0 INTRODUCTION

The following report presents the second quarter ground water monitoring results for 2011 at the Lake Goodwin Landfill (*Lake Goodwin Landfill, Site*). The site is located immediately west of Frank Waters Road in northwestern Snohomish County, about one and one half (1.5) miles northwest of Lake Goodwin and about five-(5) miles south of Stanwood (*T31N, R4E, sections 17, 20 Willamette Meridian*). The landfill is located at 18520 Frank Waters Road, Stanwood, Washington, 98292. The location of the site relative to existing municipal improvements is shown on the **Vicinity Map** (*figure 1*).

1.1 BACKGROUND

The Lake Goodwin Landfill is sited within a former County gravel pit. Waste disposed at the landfill reportedly consisted of municipal waste, including garbage and demolition debris, and some industrial waste. Waste was placed in the landfill starting in the early 1960's under the direction of **Snohomish County's Road Maintenance Division**. The landfill was closed in September 1982. Upon closure a cover system was installed. The landfill is not lined nor does it have leachate or gas collection systems. The Lake Goodwin Landfill is currently permitted for post-closure monitoring by the **Snohomish Health District (SHD)** with a Solid Waste Facility Permit (SW-085, 2010). Monitoring results are reviewed by both the **SHD** and the **Department of Ecology**.

1.2 PERMIT INFORMATION

Monitoring activities at the landfill are governed by the Solid Waste Facility Permit SW-085 (landfill permit, Snohomish Health District 2010). This permit requires post-closure ground water monitoring on a quarterly basis until the facility has been shown to be stable and/or not harmful to human health or the environment. The **SHD** permits and evaluates post-closure conditions at the Lake Goodwin Landfill using the Snohomish Health District Sanitary Codes, Chapter 3.1, Solid Waste Handling Regulations; Chapter 173-304 WAC Minimum Functional Standards for Solid Waste; Chapter 173-200 WAC Water Quality Standards for Ground Waters; and Chapter 246-290 WAC Drinking Water Regulations. There is no current Sampling & Analysis Plan (SAP) for this landfill.

1.3 SITE DESCRIPTION AND PHYSICAL CONDITIONS

The closed landfill is approximately 11.5 acres in size and is part of a larger County owned parcel of land. The Lake Goodwin Landfill is bounded by private residential property or commercial forest to the south, west and north. The Frank Waters Road is located along the eastern side of the site. Access into the site is from a partially paved and partially graveled driveway off of the Frank Waters Road. Existing site improvements are shown on the **Site Map** (*figure 2*).

The Lake Goodwin Landfill is located on a topographic feature known as the Tulalip Plateau, a rolling upland area bounded by the Stillaguamish River to the north, the Puget Sound to the west and south, and by a topographic low called the Marysville Trough to the east. The general topography in the immediate vicinity of the site is typical of glaciated areas within western Washington State – gently rolling landscapes bisected by seasonal and/or year round drainages, creeks and rivers. Several small to medium sized lakes are found in the immediate vicinity of the site. Lake Martha, Lake Howard and Lake Goodwin are all located within a few miles of the Landfill. There are no named drainages, creeks or rivers located in the immediate vicinity of the site. Elevations in the immediate vicinity of the landfill range from approximately el. 320 to el. 380 feet above mean sea level. Relative to existing surrounding topography the landfill itself is approximately 60 ft high. It has been graded and slopes gently in a north to northeast direction. Site Topography is shown on the **Topographic Map** (*figure 3*). In most places the landfill cover is well vegetated with grass, clover and weeds. A few Douglas fir have naturally reseeded in the fill cover near the edge of the site. There are no stormwater detention ponds or leachate collection ponds located on the site.

1.4 LOCAL HYDROGEOLOGY

Surficial geology of the site area is shown on the **Geologic Map** (*figure 4*). Based on the Geologic Map and the site explorations, surficial geology at the landfill site consists of Advance Outwash (*Qva*) sands and gravels locally overlain by sandy silts to silty sands and gravels – Glacial Till (*Qvt*).

The Lake Goodwin Landfill is located on an upland area known as the Tulalip Plateau. Below the Tulalip Plateau the most productive aquifer is the Advance Outwash (*Qva*) aquifer which is underlain by Transitional Bed (*Qtb*) silts and clays. Where overlain by Glacial Till (*Qvt*), the aquifer is confined. In the vicinity of the Lake Goodwin where Glacial Till (*Qvt*) is absent, ground

water is unconfined. With the exception of the surficial Glacial Till (Qvt) found overlying the Advance Outwash (Qva) sands and gravels along the southern edge of the landfill (LG-02), permeable soils were encountered from the surface down in all site explorations at the landfill. Ground water elevations below the landfill ranged from el. 148 to el. 153 with a north to northwest gradient in an unconfined condition within the Advance Outwash (Qva) aquifer.

1.5 EXISTING MONITORING NETWORK

As outlined in the Solid Waste Facility Permit SW-085, quarterly monitoring of ground water is required at the Lake Goodwin Landfill. There are currently five-(5) ground water monitoring wells (LG-01 thru LG-05) at the Lake Goodwin Landfill site that are read on a quarterly basis. Well locations are shown on the **Network Monitoring Map** (figure 5). Of these wells, one-(1) is considered to be an up-gradient well monitoring background ground water conditions in the immediate vicinity of the site (LG-02). The remaining four-(4) wells are located in and/or down gradient of the landfill (LG-01, and LG-03 thru LG-05) and monitor ground water conditions that may be impacted from the site. Second quarter monitoring results are discussed in section 2.0 below.

2.0 GROUND WATER MONITORING

Second quarter 2011 monitoring of the ground water wells at the Lake Goodwin Landfill was performed by **Snohomish County** personnel. Depth to water was measured and ground water samples were collected following approved sampling protocol. The following sections describe field procedures used and analytical results derived from the sampling event.

2.1 Ground Water Level Measurements

The depth to ground water within each well was measured prior to ground water sampling activities. The depth to ground water was measured using an electronic water level indicator in increments to the nearest 0.01 ft. as taken from a marked survey point on the top of each well casing.

Second Quarter Ground Water Measurements are shown in *Table 1* below. **Hydrographs** of the second quarter 2011 monitoring well readings are contained in *Appendix A* of this report. Based on the ground water readings for all wells except LG-01 and LG-03, small fluctuations in the ground water gradient below the site were observed. Down-gradient wells LG-01 and LG-03 showed a 3+ foot increase in ground water elevation over their previous readings. This fairly

rapid change in the ground water elevation has been observed in these wells in the past. It is not consistent with observed aquifer behavior and may possibly be due to reading error. Readings suggest that the aquifer is unconfined in the immediate vicinity of the site. The **Second Quarter Ground Water Contour Map** developed from the field data is shown in *Figure 6* of this report.

Measured precipitation at the Stanwood Weather Station (WA-SN-11 <http://www.cocorahs.org/state.aspx?state=wa>) during the second quarter monitoring period was 6.11 inches. For reference purposes, precipitation measured at station WA-SN-11 during the monitoring period has been included on the hydrographs.

Table 1 - Second Quarter Groundwater Measurements and Elevations

| Well Numbers | Casing Elevation | 1 st Quarter Delta/Elevation |
|--------------|------------------|---|
| LG-01 | 239.18 | +3.16 153.87 |
| LG-02 | 268.67 | +.49 152.53 |
| LG-03 | 241.20 | + 3.55 154.19 |
| LG-04 | 206.93 | +1.74 151.14 |
| LG-05 | 235.00 | +.65 151.93 |

2.2 Second Quarter Ground Water Sampling Event

Purging and sampling of each of the five-(5) monitoring wells was performed during the second quarter by Snohomish County personnel in accordance with the facilities closure permit. Approximately 1.7 to 3.1 gallons of water was purged from each well prior to sampling. Water samples were collected by slowly filling laboratory-supplied containers in such a manner as to reduce aeration. Sample containers were filled so that no headspace or air bubbles remained within the container. Samples were placed in coolers and packed in ice to keep samples at approximately 4C for delivery to the laboratory for testing. Samples were picked up by **Amtest** and taken to their Kirkland, WA laboratory for analysis of dissolved metals, volatile organic compounds (VOC's), and conventional chemistry parameters. Analytical Data is included in *Appendix B, Ground Water Analytical Data* of this report. The analytical data was compared to the maximum contaminant levels (MCL's). A complete statistical analysis of the data was also performed utilizing **DUMPStat**. Results are discussed below.

2.3 Evaluation of Second Quarter Ground Water Analytical Results

Second Quarter Ground Water Test Results for each well are summarized in *Table 2* below. A comparison of results to regulatory criteria (MCL's) shows:

Second Quarter: There were no measured exceedances of the MCL's for conventional chemistry parameters, dissolved metals or VOC's in up-gradient well LG-02 during this sampling event. An elevated conductivity levels above 700 micro ohms per centimeter (*umhos/cm*) was measured in well LG-03 during this sampling event. Out of compliance levels for pH were measured in wells LG-03, LG-04, and LG-05 during this sampling event. Elevated levels of sodium were measured in well LG-03 and LG-05 during this sampling event and elevated levels of TDS were found in well LG-03 during this sampling event. No VOC's above the MCL's were detected in any well during this sampling event.

Table 2 - Summary of Test Results - Second Quarter

| Well | Second Quarter 2011 Groundwater Standard Exceedances |
|-------|--|
| LG-01 | None |
| LG-02 | None |
| LG-03 | Conductivity, pH, sodium, total dissolved solids |
| LG-04 | pH |
| LG-05 | pH, sodium |

2.4 Statistical Evaluation

State health regulations under which the Lake Goodwin Landfill closure is permitted require that the landfill "...shall not cause exceedances of *Chapter 173-200 WAC, Water Quality Standards for Groundwater*, and *Chapter 246-290 WAC, Drinking Water Regulations*." The intent of these state regulations is to limit the impact that a landfill will have on the surrounding ground water resources. Collected ground water samples are tested for Primary and Secondary Drinking Water Standards, Dissolved Metals and Volatile Organic Compounds – and compared to the standards listed in the above referenced WAC's. Where an exceedance to the standards occurs, a statistical analysis is provided to determine the significance of the change or exceedance. Each of these exceedances has been statistically analyzed using **DUMPStat Software** (*version 2.1.9 by Robert D. Gibbons Lt., 2000*) per the *Subtitle D* regulations and as specifically referenced in the **U.S. EPA** guidance manual. Mean, standard deviation, prediction limits, and confidence values were calculated by **DUMPStat**.

Based on the statistical analysis, exceedances to the prediction limits were high for all of the conventional chemistry parameters, fairly minimal for the dissolved metals and there were no exceedances in the VOC's at any well. Calculated exceedances to the prediction limits in the second quarter are shown in *Table 3* below.

Table 3 - Statistical Summary - Second Quarter Limit Exceedances for 2011

| Well | Second Quarter 2011 Exceedances |
|-------|--|
| LG-01 | Alkalinity, bicarbonate, conductivity, magnesium, nitrate nitrogen, pH, potassium, TOC, barium |
| LG-02 | None |
| LG-03 | Alkalinity, bicarbonate, calcium, chloride, conductivity, magnesium, nitrate, pH, potassium, sodium, sulfate, TDS, TOC, barium, nickel (no change from Q-4 2010) |
| LG-04 | Alkalinity, bicarbonate, calcium, magnesium, pH, potassium, TOC, barium |
| LG-05 | Alkalinity, bicarbonate, calcium, conductivity, magnesium, nitrate, pH, potassium, sodium, barium |

Stiff Diagrams, Trilinear Diagrams and Statistically Significant Trends Analyses results are included in *Appendix C* of this report.

3.0 SUMMARY AND RECOMMENDATIONS

The ground water data collected during the 2011 Second quarter sampling events indicates the following:


- VOC's were not detected in any monitoring well during the sampling event.
- Measured conductivity was above background levels (*LG-02*) in all down gradient wells during this sampling event. Conductivity levels observed at wells *LG-03* and *LG-05* was significantly higher than the surrounding wells during this sampling event. Nitrate levels are increasing in *LG-03*.
- Statistical analysis did show significant impacts to wells *LG-03* and *LG-05*. Lesser impacts were indicated in wells *LG-01* and *LG-04*. Time series plots based on the **DUMPStat** analysis indicates that there were more significant decreasing trends than increasing trends during this sampling event.
- There were very minimal impacts to the ground water from dissolved metals. Small exceedances to the calculated prediction limits for Barium and Nickel (*LG-03*) were found in the down-gradient wells.

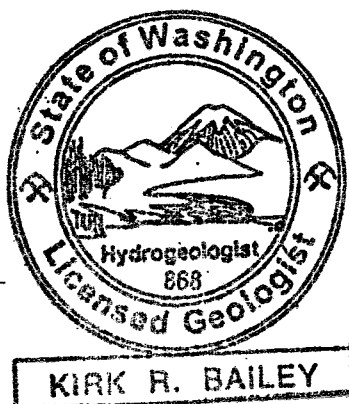
3.1 CONCLUSIONS/RECOMMENDATIONS

Second quarter 2011 data indicates that there is a leachate impact to the underlying Advance Outwash (*Qva*) aquifer below the Lake Goodwin Landfill. Statistical analysis indicates a large number of significantly decreasing trends which would suggest that the leachate impact to

the ground water below the landfill is decreasing at this time, however, several increasing trends have been monitored in down gradient well LG-01 and at least one increasing trend was found in LG-03. The data also suggests that the leachate plume impacting ground water extends beyond the landfill boundaries following the ground water gradient to the north-northeast through LG-03 and LG-05.

3.2 SIGNATURES and CERTIFICATIONS


Kirk R. Bailey, LEG, LHG
SCPW – Engineering Services

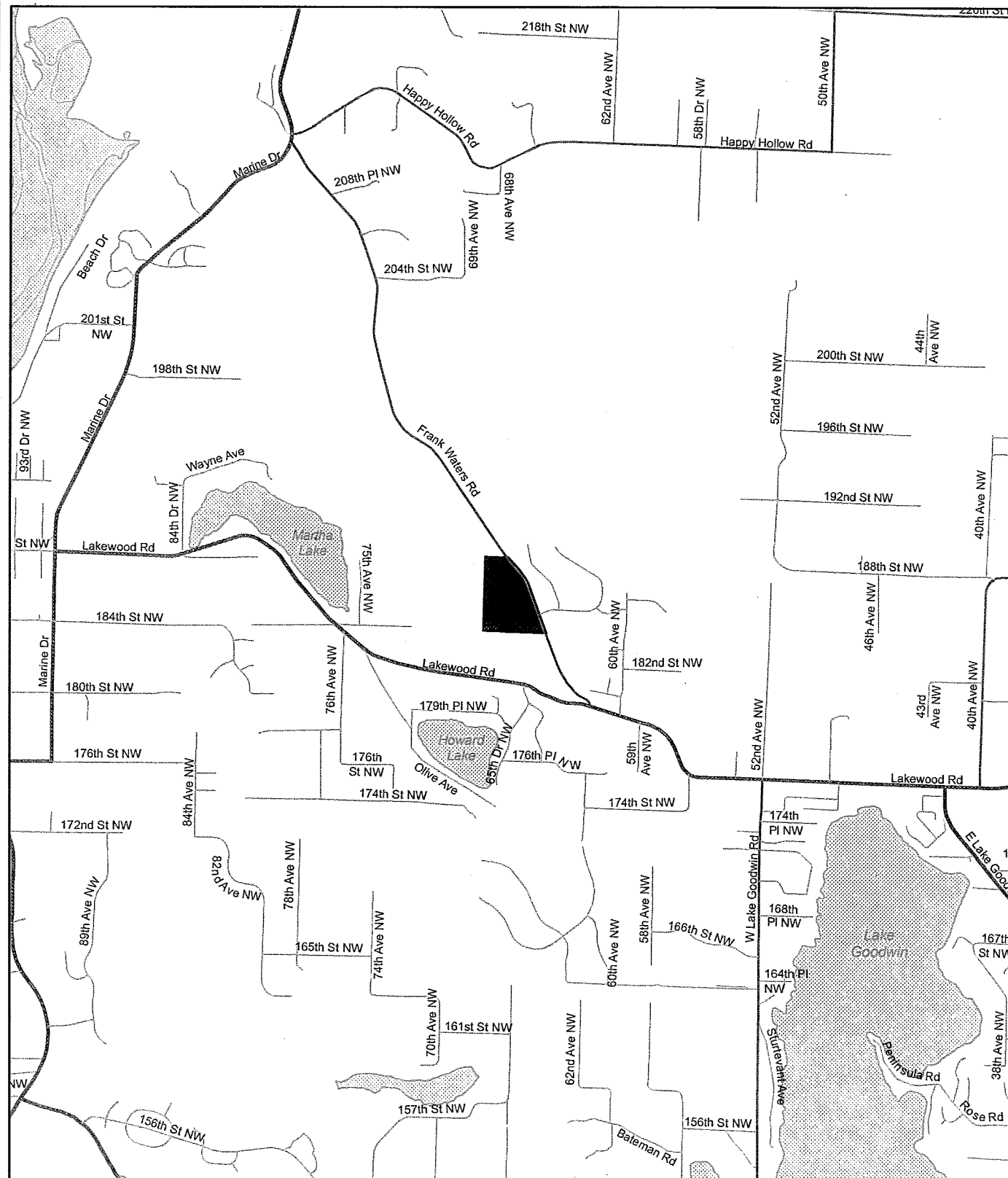



Deanna Carveth
SCPW – Solid Waste Division


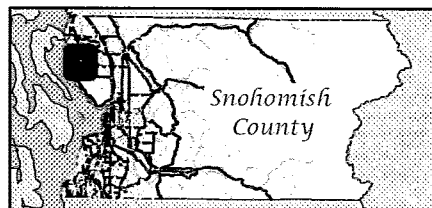
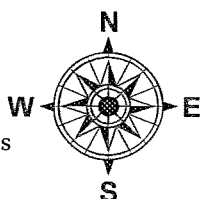
May 20, 2011

Figure 1

Lake Goodwin Landfill



1 inch = 0.5 miles

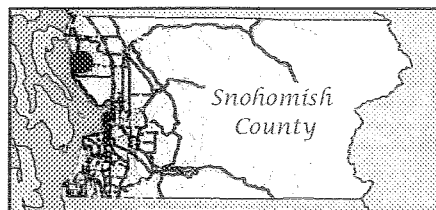
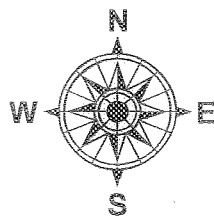
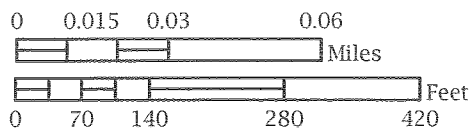
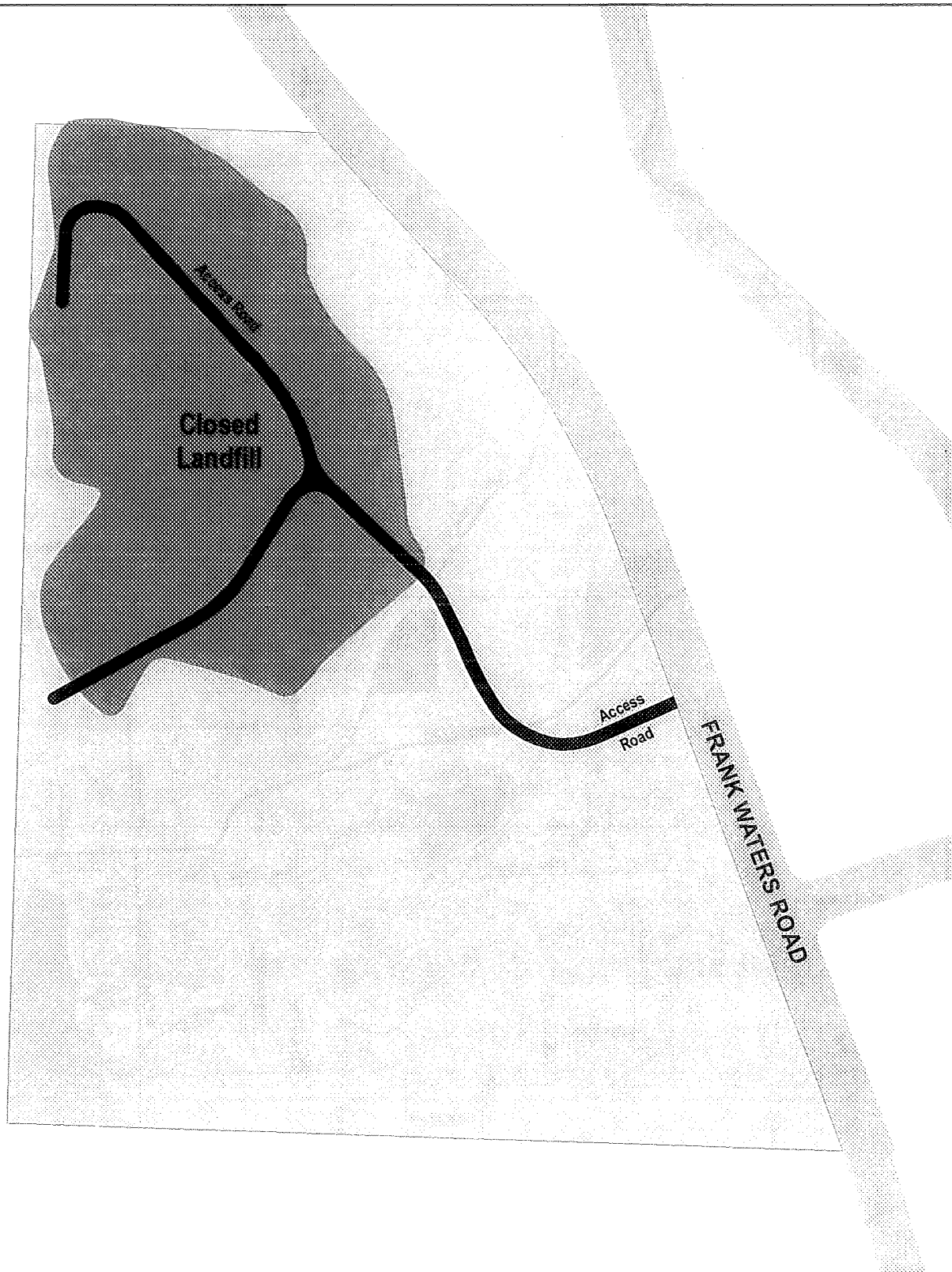


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Solid Waste Division
March 22, 2010

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Figure 2

Lake Goodwin Landfill Site Map




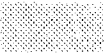

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March 25, 2010

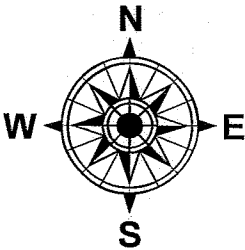
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Figure 3

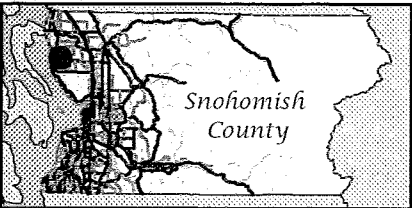
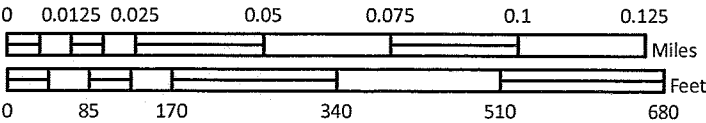
Lake Goodwin Landfill Topography

Map Features

-  Parcel Boundary
-  Subject Property Boundary
-  5 Foot Contours



1 inch = 200 feet



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Solid Waste Division
March 23, 2010

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Figure 4

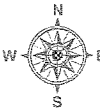
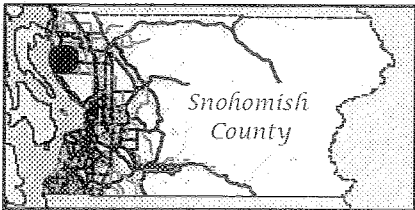
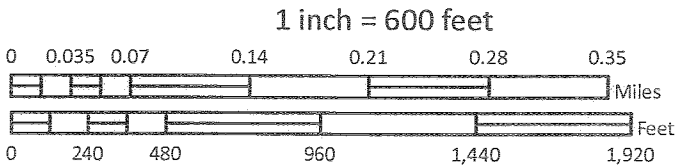
Lake Goodwin Landfill Geologic Map

Map Features

- Parcel Boundary
- Subject Property Boundary

Geologic Description

- Vashon advance outwash (Qva)
- Vashon recessional outwash
- Vashon till (Qvt)
- Water
- Modified Land



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Figure 5

Lake Goodwin Landfill

Groundwater Monitoring Network

Map Features

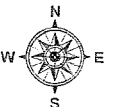
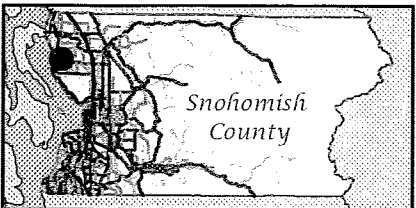
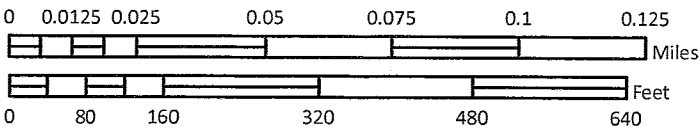
- Parcel Boundary
- Subject Property Boundary

Aquifer Unit (Active Wells)

- Deep Aquifer



1 inch = 200 feet



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April 15, 2010

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Figure 6

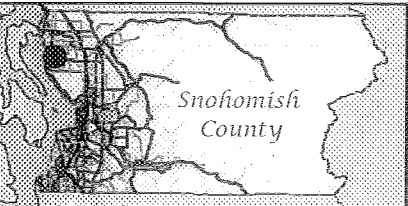
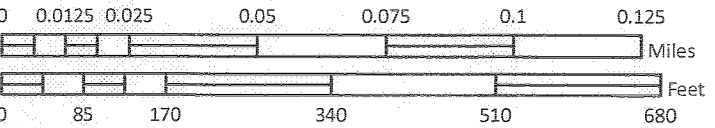
Lake Goodwin Landfill

Water Elevation Contours
2nd Quarter 2011



- DIRECTION OF GROUNDWATER FLOW
.661 ft/day
241 ft/year
68.75 degrees to the positive x-axis
- PARCEL BOUNDARY
- SUBJECT PROPERTY BOUNDARY
- 1 FT CONTOUR
- WELL LOCATION

| WELL_ID | SAMP_DATE | MEAS_HEAD |
|---------|-----------|-----------|
| LG-01 | 4/12/2011 | 153.87 |
| LG-02 | 4/12/2011 | 152.85 |
| LG-03 | 4/12/2011 | 154.19 |
| LG-04 | 4/12/2011 | 151.14 |
| LG-05 | 4/12/2011 | 151.93 |



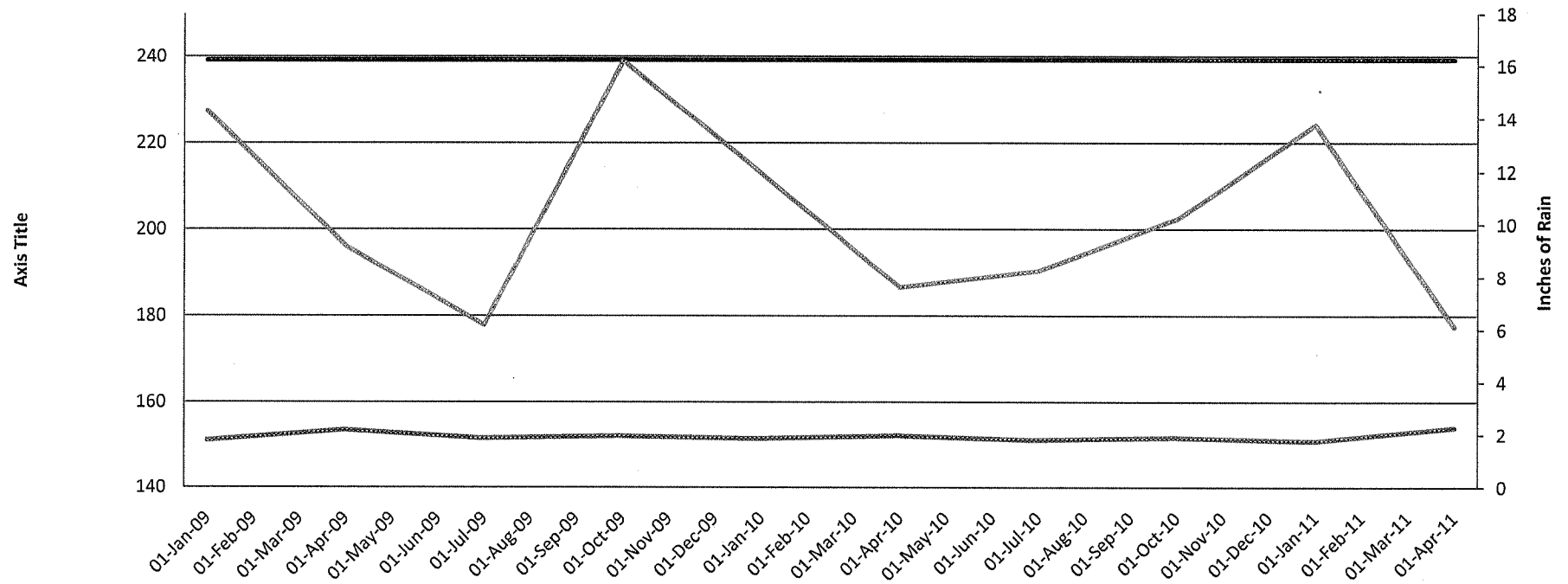
Snohomish County
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May 23, 2011

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Appendix A

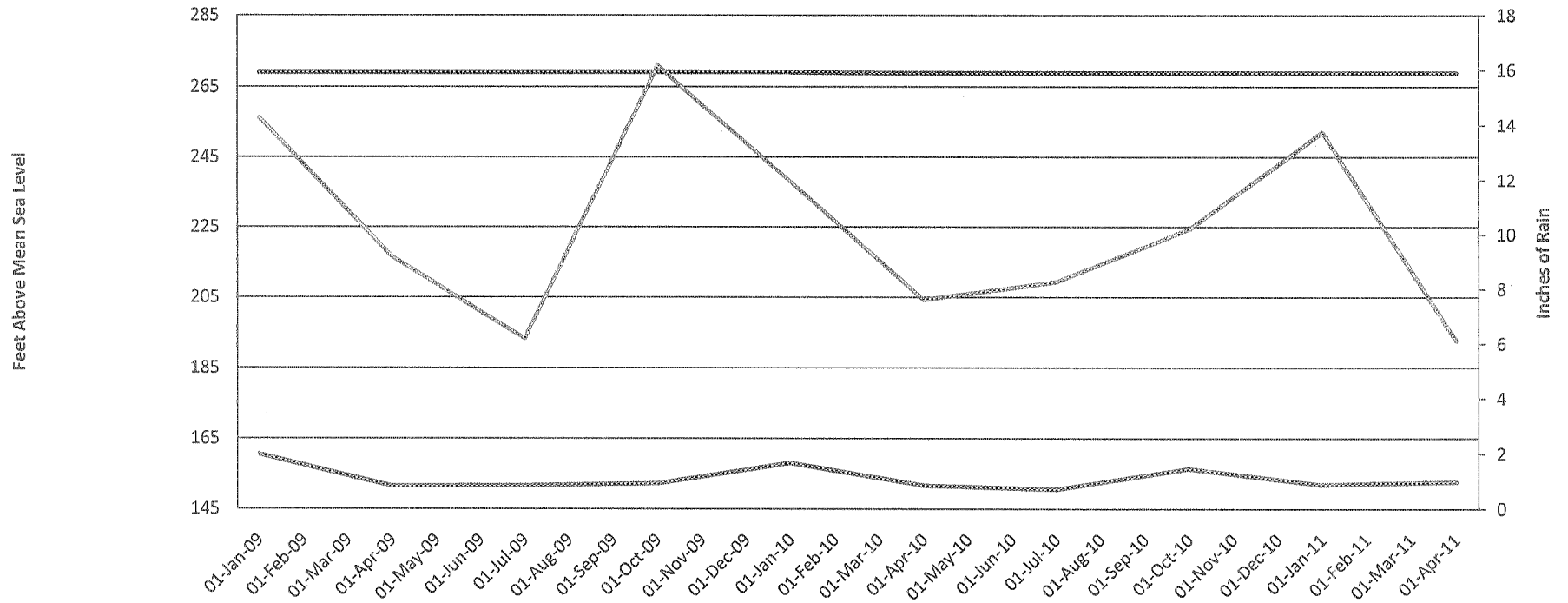
Hydrographs

Lake Goodwin Well LG-01



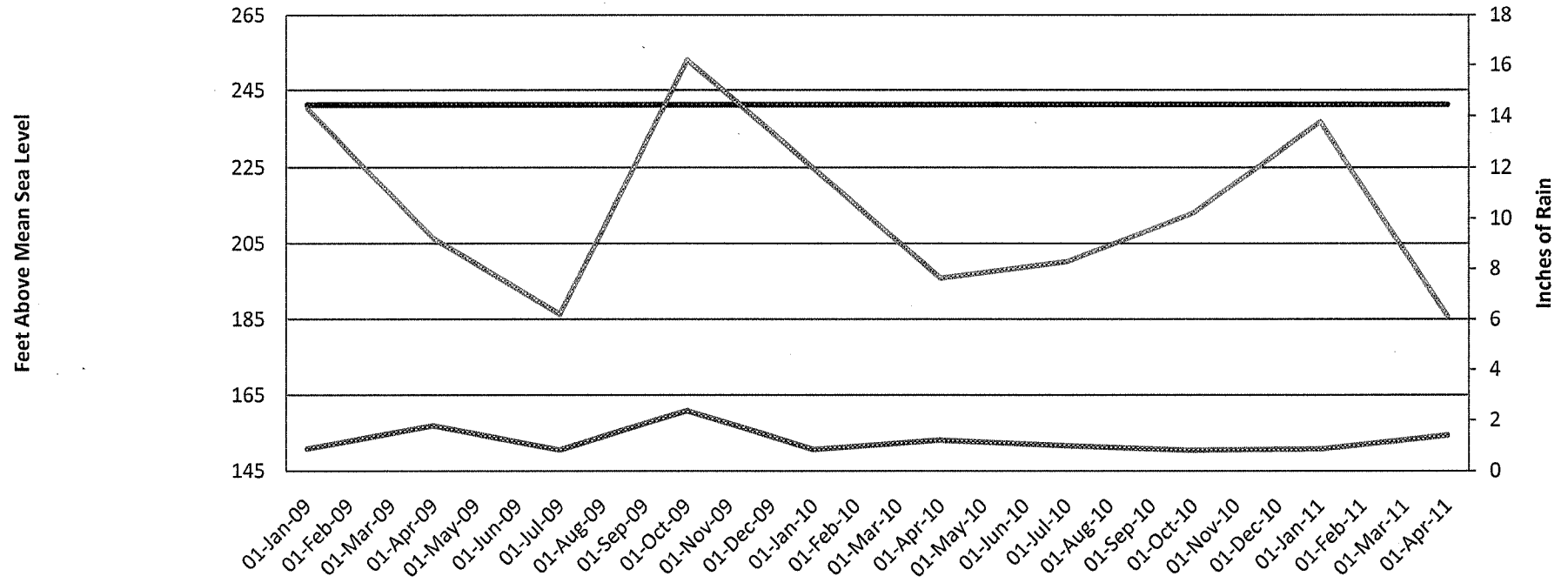
| | 27-Jan-09 | 21-Apr-09 | 29-Jul-09 | 08-Oct-09 | 20-Jan-10 | 20-Apr-10 | 7/13/2010 | 10/19/2010 | 1/8/2011 | 4/12/2011 |
|----------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|----------|-----------|
| Depth to Water | 151.06 | 153.43 | 151.48 | 152.04 | 151.46 | 152.09 | 151.05 | 151.56 | 150.71 | 153.87 |
| Well Casing | 239.18 | 239.18 | 239.18 | 239.18 | 239.18 | 239.18 | 239.18 | 239.18 | 239.18 | 239.18 |
| Precipitation | 14.3 | 9.2 | 6.2 | 16.2 | 11.96 | 7.62 | 8.26 | 10.2 | 13.75 | 6.11 |

Lake Goodwin Well LG-02



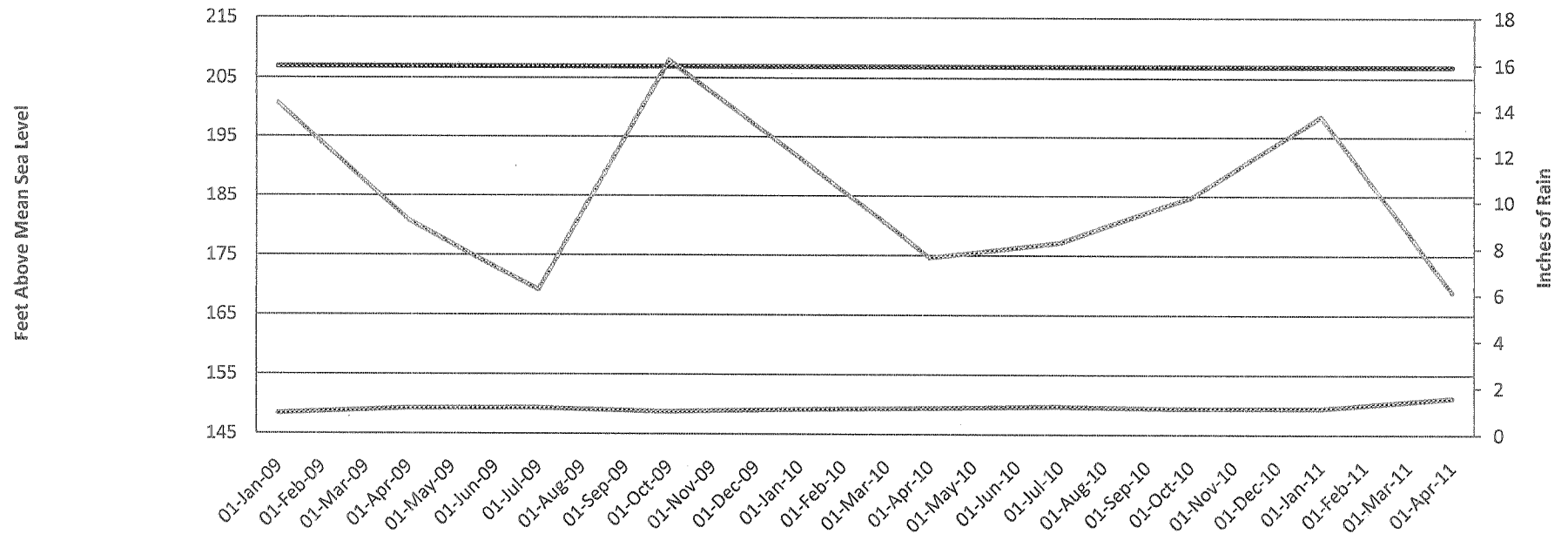
| | 27-Jan-09 | 21-Apr-09 | 29-Jul-09 | 08-Oct-09 | 20-Jan-10 | 4/20/2010 | 7/13/2010 | 10/19/2010 | 1/18/2011 | 4/12/2011 |
|-----------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|-----------|-----------|
| Groundwater Elevation | 160.57 | 151.56 | 151.59 | 152.25 | 158.1 | 151.67 | 150.54 | 156.37 | 151.74 | 152.53 |
| Well Casing | 268.99 | 268.99 | 268.99 | 268.99 | 268.99 | 268.67 | 268.67 | 268.67 | 268.67 | 268.67 |
| Precipitation | 14.3 | 9.2 | 6.2 | 16.2 | 11.96 | 7.62 | 8.26 | 10.2 | 13.75 | 6.11 |

Lake Goodwin Well LG-03



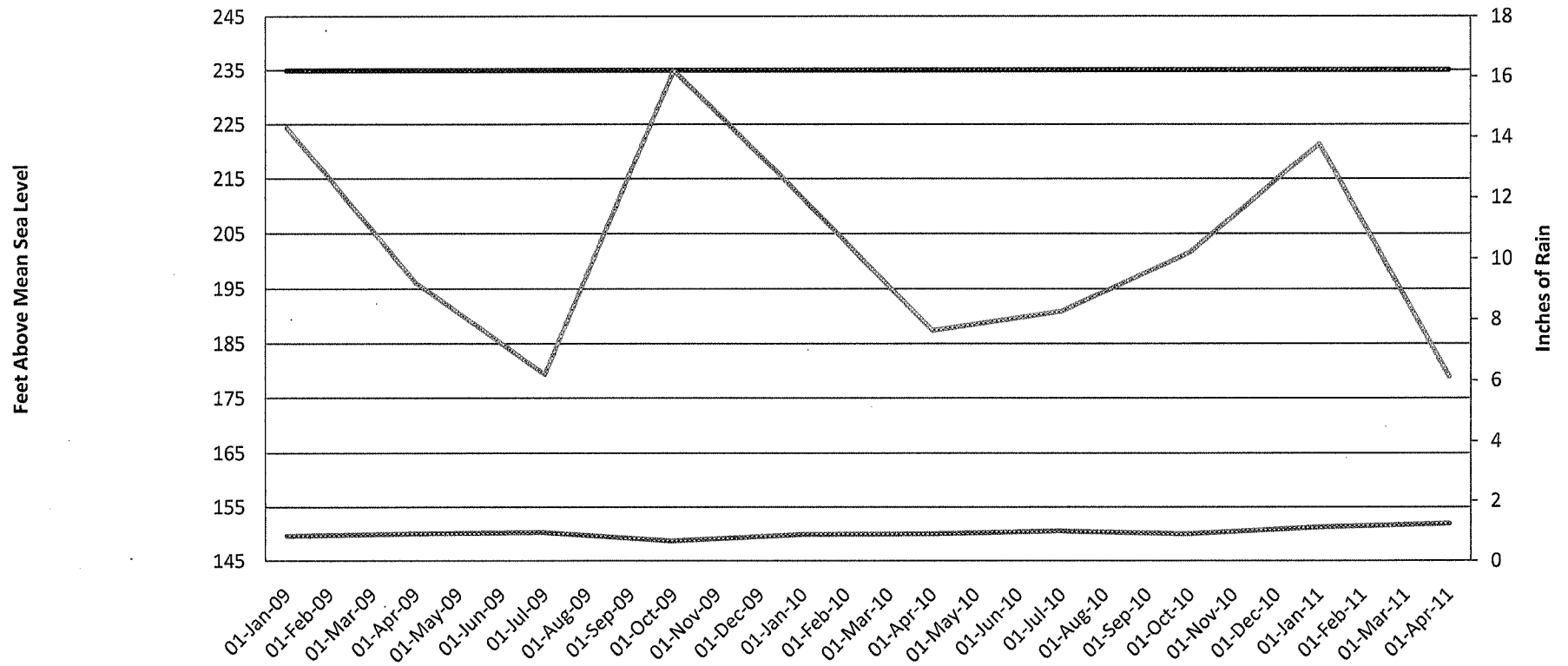
| | 27-Jan-09 | 21-Apr-09 | 29-Jul-09 | 08-Oct-09 | 20-Jan-10 | 4/20/2010 | 7/13/2010 | 10/19/2010 | 1/19/2011 | 4/12/2011 |
|------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|-----------|-----------|
| Groundwater Elevations | 150.86 | 156.82 | 150.51 | 160.84 | 150.59 | 153.1 | 151.59 | 150.35 | 150.64 | 154.19 |
| Well Casing | 241.2 | 241.2 | 241.2 | 241.2 | 241.2 | 241.2 | 241.2 | 241.2 | 241.2 | 241.2 |
| Precipitation | 14.3 | 9.2 | 6.2 | 16.2 | 11.96 | 7.62 | 8.26 | 10.2 | 13.75 | 6.11 |

Lake Goodwin Well LG-04



| | 27-Jan-09 | 21-Apr-09 | 31-Jul-09 | 08-Oct-09 | 20-Jan-10 | 4/20/2010 | 7/13/2010 | 10/19/2010 | 1/19/2011 | 4/12/2011 |
|-----------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|-----------|-----------|
| Groundwater Elevation | 148.5 | 149.34 | 149.46 | 148.84 | 149.22 | 149.42 | 149.72 | 149.39 | 149.4 | 151.14 |
| Well Casing | 206.93 | 206.93 | 206.93 | 206.93 | 206.93 | 206.93 | 206.93 | 206.93 | 206.93 | 206.93 |
| Precipitation | 14.3 | 9.2 | 6.2 | 16.2 | 11.96 | 7.62 | 8.26 | 10.2 | 13.75 | 6.11 |

Lake Goodwin Well LG-05



| | 27-Jan-09 | 21-Apr-09 | 29-Jul-09 | 08-Oct-09 | 20-Jan-10 | 4/20/2010 | 7/13/2010 | 10/19/2010 | 1/18/2011 | 4/12/2011 |
|-----------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|-----------|-----------|
| Groundwater Elevation | 149.71 | 150.11 | 150.39 | 148.79 | 149.98 | 150.09 | 150.62 | 150.05 | 151.28 | 151.93 |
| Well Casing | 235 | 235 | 235 | 235 | 235 | 235 | 235 | 235 | 235 | 235 |
| Precipitation | 14.3 | 9.2 | 6.2 | 16.2 | 11.96 | 7.62 | 8.26 | 10.2 | 13.75 | 6.11 |

Appendix B

Analytical Data

GROUNDWATER DATA SUMMARY: SECOND QUARTER 2011
LAKE GOODWIN LANDFILL
SNOHOMISH COUNTY, WASHINGTON

| Statistic Method | No. of Samples | No. of Detects | Prediction Limit (a) | MCL | Downgradient | | | | | | | | | | Upgradient | | |
|---------------------|-------------------|-------------------|-------------------------|-----|--------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|------------|---------|--|
| | | | | | LG-01 | | LG-03 | | LG-04 | | LG-05 | | LG-02 | | | | |
| | | | | | 4/12/11 | D V T C | 4/12/11 | D V T C | 4/12/11 | D V T C | 4/12/11 | D V T C | 4/12/11 | D V T C | 4/12/11 | D V T C | |

CONVENTIONAL CHEMISTRY PARAMETERS

(mg/L unless noted)

| | | | | | | | | | | |
|---------------------------|--------|----|----|-----------|---------|------------|-----------|------------|------------|---------|
| Alkalinity (as CaCO3) | normal | 23 | 23 | 139.6997 | -- | 150 V | 390 V | 140 E | 250 V Y | 86 |
| Ammonia Nitrogen | nonpar | 19 | 6 | 0.056 | -- | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U |
| Bicarbonate | normal | 23 | 23 | 129.5887 | -- | 150 V | 390 V | 140 V | 250 V | 86 |
| Calcium, Dissolved | normal | 23 | 23 | 20.7585 | -- | 18.8 P I N | 49.8 V | 22.2 V | 28.4 V | 16.6 |
| Chemical Oxygen Demand | nonpar | 19 | 2 | 26 | -- | 10 U | 15 | 10 U | 10 U | 10 U |
| Chloride | nonpar | 23 | 23 | 9.4 | 250 | 6 | 22 V | 4.4 | 4.2 P | 6.1 |
| Conductivity (umhos/cm) | normal | 23 | 23 | 323.1681 | 700 | 340 V | 970 V | 310 | 605 V | 240 |
| Magnesium, Dissolved | normal | 23 | 23 | 19.443 | -- | 26.2 V I N | 71.3 V | 20.4 V | 39.5 V | 14.5 |
| Nitrate Nitrogen (mg-N/L) | nonpar | 23 | 23 | 2.6 | 10 | 2.6 I N | 7.5 V I N | 1.3 | 5.7 V | 2.1 |
| Nitrite Nitrogen (mg-N/L) | nonpar | 19 | 6 | 0.003 | 1 | 0.001 | 0.001 | 0.001 | 0.001 D N | 0.001 |
| pH (std units) | normal | 23 | 23 | 6.67-7.75 | 6.5-8.5 | 6.64 V D N | 6.4 V | 6.21 V | 6.34 V D Y | 6.7 |
| Potassium, Dissolved | nonpar | 23 | 23 | 3.215 | -- | 3.65 V | 6.19 V | 3.27 V D Y | 5.78 V | 2.71 |
| Sodium, Dissolved | nonpar | 22 | 22 | 13.8 | 20 | 10 D N | 39.2 V | 11.5 D N | 40.3 V D N | 8.8 |
| Sulfate | normal | 23 | 23 | 16.2445 | 250 | 9.6 P | 84 V | 11 D Y | 14 P D N | 14 |
| Total Dissolved Solids | nonpar | 23 | 23 | 550 | 500 | 210 | 580 V | 210 | 365 | 170 |
| Total Organic Carbon | nonpar | 23 | 10 | 13 | -- | 21 E | 70 V | 24 E | 4 | 5.1 |

DISSOLVED METALS

EPA Methods 6010B/7131A (mg/L)

| | | | | | | | | | | |
|-----------|--------|----|----|--------|-------|------------|-------------|-------------|-------------|-----------|
| Antimony | nonpar | 23 | 3 | 0.01 | 0.006 | 0.00005 | 0.00009 | 0.00006 | 0.00008 | 0.00012 |
| Arsenic | nonpar | 18 | 18 | 0.0078 | 0.01 | 0.00058 | 0.00074 | 0.00037 | 0.00062 | 0.00344 |
| Barium | normal | 18 | 18 | 0.0136 | 2 | 0.0154 V Y | 0.0551 V | 0.0199 V | 0.037 V | 0.0096 |
| Beryllium | nonpar | 23 | 0 | 0.0005 | 0.004 | 0.0005 U | 0.0005 U | 0.0005 U | 0.0005 U | 0.0005 U |
| Cadmium | nonpar | 20 | 9 | 0.0002 | 0.005 | 0.00005 U | 0.00005 U P | 0.00005 U P | 0.00005 U P | 0.00005 U |
| Chromium | normal | 20 | 15 | 0.01 | 0.1 | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.0041 |
| Cobalt | nonpar | 23 | 4 | 0.008 | -- | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U |
| Copper | nonpar | 19 | 5 | 0.004 | 1.3 | 0.001 U | 0.001 U | 0.001 | 0.001 U | 0.001 U |
| Iron | nonpar | 23 | 4 | 0.031 | 0.3 | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U |
| Lead | nonpar | 22 | 3 | 0.001 | 0.015 | 0.00009 | 0.00005 U | 0.00007 | 0.00006 | 0.00005 U |
| Manganese | nonpar | 20 | 7 | 0.0061 | 0.05 | 0.0005 U | 0.0005 U | 0.0005 U | 0.0005 U | 0.0005 U |
| Nickel | nonpar | 23 | 0 | 0.005 | 0.1 | 0.005 U | 0.007 V | 0.005 U | 0.005 U | 0.005 U |
| Selenium | nonpar | 22 | 2 | 0.002 | 0.05 | 0.0005 U | 0.0005 U | 0.0005 U | 0.0005 U | 0.0005 U |
| Silver | nonpar | 22 | 2 | 4.2501 | 0.1 | 0.00005 U | 0.00005 U | 0.00005 U | 0.00005 U | 0.00005 U |
| Thallium | nonpar | 22 | 1 | 0.001 | 0.002 | 0.00005 U | 0.00005 U | 0.00005 U | 0.00005 U | 0.00005 U |
| Vanadium | nonpar | 21 | 5 | 0.01 | -- | 0.005 U | 0.005 U | 0.005 U | 0.005 U | 0.005 U |
| Zinc | nonpar | 22 | 9 | 0.007 | 5 | 0.001 U | 0.001 U | 0.001 U | 0.001 U | 0.001 U |

VOLATILE ORGANIC COMPOUNDS (VOCs)

EPA Method 8260 (µg/L)

| | | | | | | | | |
|---------------------------|----------------------|-----|-----|-----|-----|-----|-----|-----|
| 1,1,1-Trichloroethane | Too Many Non-Detects | N/A | 200 | 1 U | 1 U | 1 U | 1 U | 1 U |
| 1,1,2,2-Tetrachloroethane | Too Many Non-Detects | N/A | -- | 1 U | 1 U | 1 U | 1 U | 1 U |
| 1,1,2-Trichloroethane | Too Many Non-Detects | N/A | -- | 1 U | 1 U | 1 U | 1 U | 1 U |

GROUNDWATER DATA SUMMARY: SECOND QUARTER 2011
LAKE GOODWIN LANDFILL
SNOHOMISH COUNTY, WASHINGTON

| | Statistica Method | No. of Samples | No. of Detects | Prediction Limit (a) | MCL | Downgradient | | | | | | | | | | | | | | Upgradient | | | | | |
|--|----------------------|----------------------|----------------------|-------------------------|-------|--------------|---|---|---|-------|---------|---|---|-------|---|---------|---|-------|---|------------|---------|-------|---|---|---|
| | | | | | | LG-01 | | | | LG-03 | | | | LG-04 | | | | LG-05 | | | | LG-02 | | | |
| | | | | | | 4/12/11 | D | V | T | C | 4/12/11 | D | V | T | C | 4/12/11 | D | V | T | C | 4/12/11 | D | V | T | C |
| 1,1-Dichloroethane | Too Many Non-Detects | | | N/A | 1 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| 1,1-Dichloroethylene | Too Many Non-Detects | | | N/A | 7 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| 1,2,3-Trichloropropane | Too Many Non-Detects | | | N/A | --- | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| 1,2-Dibromo-3-chloropropane | Too Many Non-Detects | | | N/A | 5 | 5 | U | | | | 5 | U | | | | 5 | U | | | | 5 | U | | | |
| 1,2-Dibromoethane | Too Many Non-Detects | | | N/A | 1 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| 1,2-Dichlorobenzene | Too Many Non-Detects | | | N/A | 600 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| 1,2-Dichloroethane | Too Many Non-Detects | | | N/A | 5 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| 1,2-Dichloropropane | Too Many Non-Detects | | | N/A | 5 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| 1,4-Dichlorobenzene | Too Many Non-Detects | | | N/A | 75 | 4 | U | | | | 4 | U | | | | 4 | U | | | | 4 | U | | | |
| 2-Butanone | Too Many Non-Detects | | | N/A | --- | 5 | U | | | | 5 | U | | | | 5 | U | | | | 5 | U | | | |
| 2-Hexanone | Too Many Non-Detects | | | N/A | --- | 5 | U | | | | 5 | U | | | | 5 | U | | | | 5 | U | | | |
| 4-Methyl-2-Pentanone (MIBK) | Too Many Non-Detects | | | N/A | --- | 5 | U | | | | 5 | U | | | | 5 | U | | | | 5 | U | | | |
| Acetone | Too Many Non-Detects | | | N/A | --- | 5 | U | | | | 5 | U | | | | 5 | U | | | | 5 | U | | | |
| Acrylonitrile | Too Many Non-Detects | | | N/A | 5 | 5 | U | | | | 5 | U | | | | 5 | U | | | | 5 | U | | | |
| Benzene | Too Many Non-Detects | | | N/A | 5 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Bromodichloromethane | Too Many Non-Detects | | | N/A | 1 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Bromoform | Too Many Non-Detects | | | N/A | 5 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Bromomethane | Too Many Non-Detects | | | N/A | --- | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Carbon Disulfide | Too Many Non-Detects | | | N/A | --- | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Carbon Tetrachloride | Too Many Non-Detects | | | N/A | 5 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Chlorobenzene | Too Many Non-Detects | | | N/A | 100 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Chlorodibromomethane | Too Many Non-Detects | | | N/A | 1 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Chloroethane | Too Many Non-Detects | | | N/A | --- | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Chloroform | Too Many Non-Detects | | | N/A | 7 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Chloromethane | Too Many Non-Detects | | | N/A | --- | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| cis-1,2-Dichloroethene | Too Many Non-Detects | | | N/A | 70 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| cis-1,3-Dichloropropene | Too Many Non-Detects | | | N/A | --- | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Dibromomethane | Too Many Non-Detects | | | N/A | --- | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Ethyl Benzene | Too Many Non-Detects | | | N/A | 700 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| m,p-Xylene | Too Many Non-Detects | | | N/A | 10000 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Methyl Iodide | Too Many Non-Detects | | | N/A | --- | 5 | U | | | | 5 | U | | | | 5 | U | | | | 5 | U | | | |
| Methylene Chloride | Too Many Non-Detects | | | N/A | 5 | 1.5 | U | | | | 1.5 | U | | | | 1.5 | U | | | | 1.5 | U | | | |
| o-Xylene | Too Many Non-Detects | | | N/A | 10000 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Styrene | Too Many Non-Detects | | | N/A | 100 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Tetrachloroethylene | Too Many Non-Detects | | | N/A | 5 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Toluene | Too Many Non-Detects | | | N/A | 1000 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| trans-1,2-Dichloroethene | Too Many Non-Detects | | | N/A | 100 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| trans-1,3-Dichloropropene | Too Many Non-Detects | | | N/A | --- | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| trans-1,4-Dichloro-2-butene | Too Many Non-Detects | | | N/A | --- | 5 | U | | | | 5 | U | | | | 5 | U | | | | 5 | U | | | |
| Trichlorethene (1,1,2-Trichloroethylene) | Too Many Non-Detects | | | N/A | 5 | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Trichlorofluoromethane | Too Many Non-Detects | | | N/A | --- | 1 | U | | | | 1 | U | | | | 1 | U | | | | 1 | U | | | |
| Vinyl Acetate | Too Many Non-Detects | | | N/A | --- | 5 | U | | | | 5 | U | | | | 5 | U | | | | 5 | U | | | |
| Vinyl Chloride | Too Many Non-Detects | | | N/A | 2 | 0.2 | U | | | | 0.2 | U | | | | 0.2 | U | | | | 0.2 | U | | | |

mg/L = milligrams per liter (ppm), µg/L = micrograms per liter (ppb).

D Column: U = Compound not detected in any sample

V Column: V = verified hit, E = exceedance, waiting verification; P = Passed, exceedance not verified

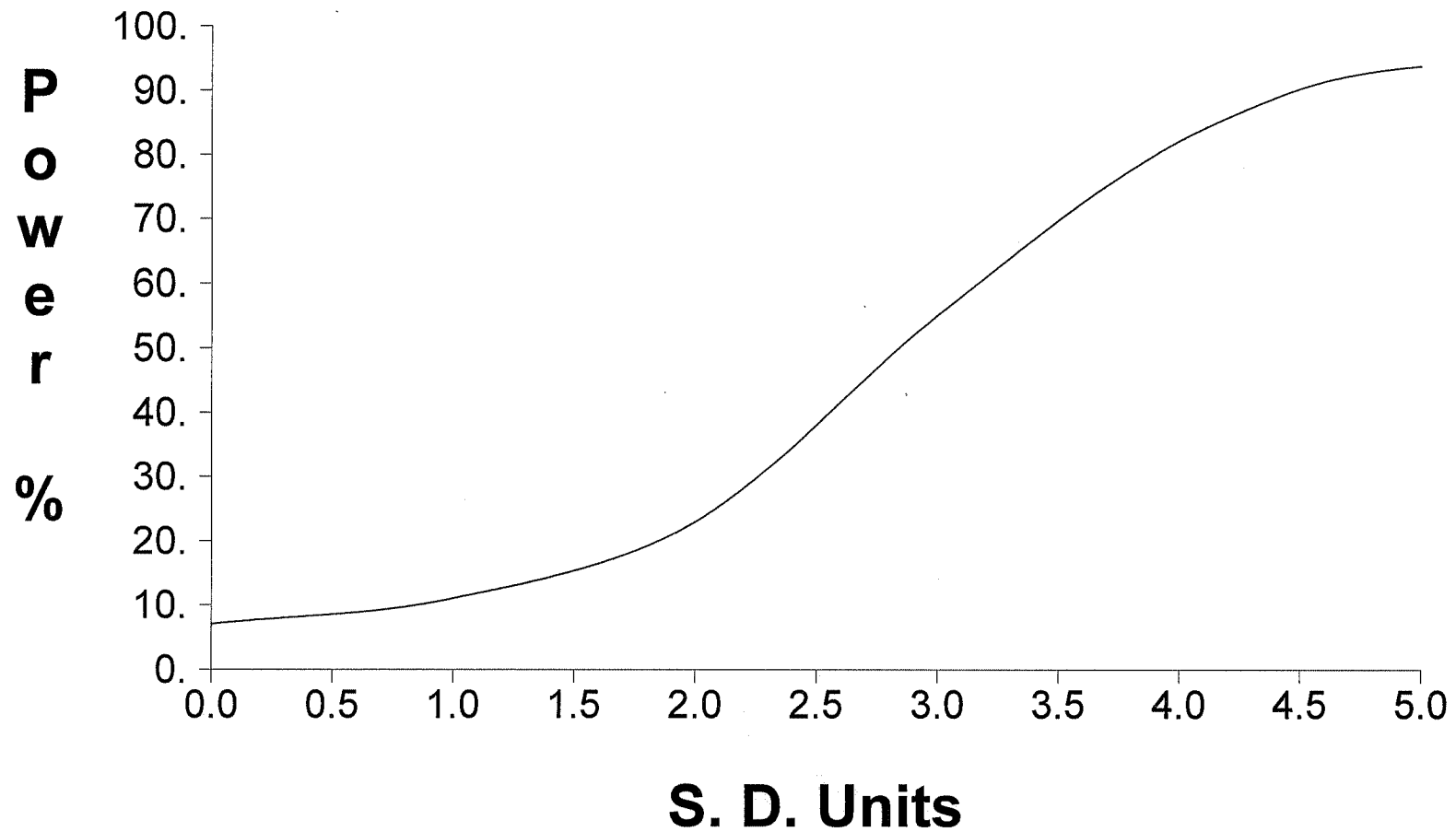
I means increasing trend, D means decreasing trend via Mann-Kendall Analysis

Ch? = a change in the trend analysis, N is no, Y is yes. Compared to previous quarter.

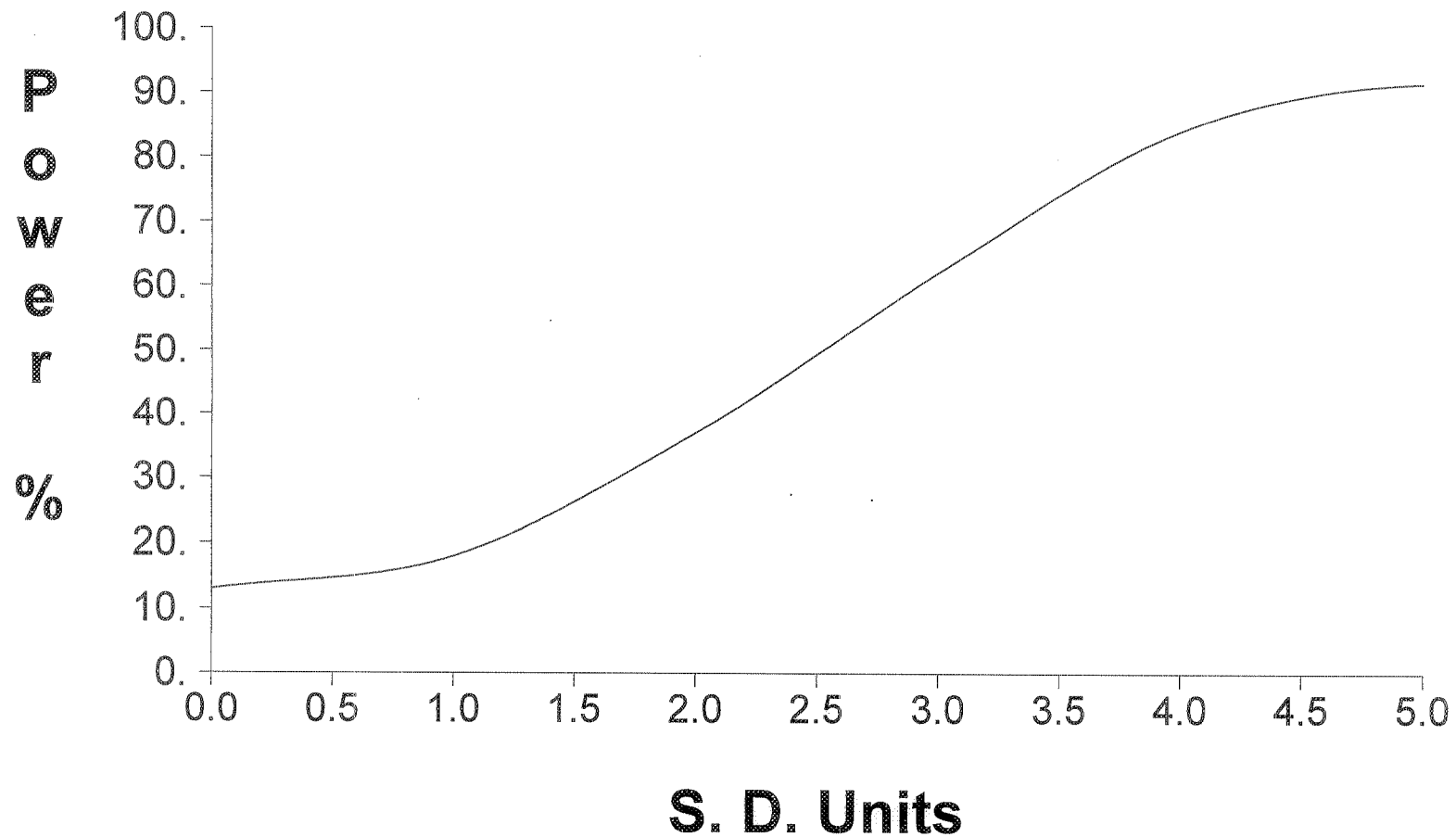
Appendix C

Stiff, Tri-linear and Trend Analysis

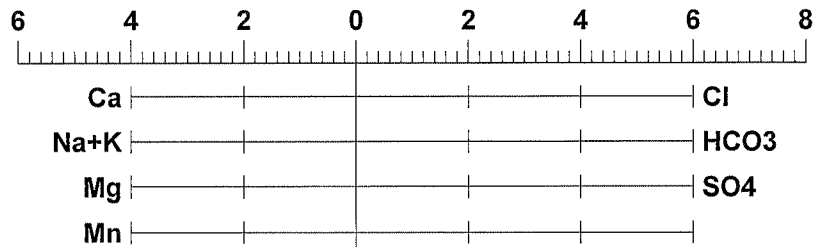
False Positive and False Negative Rates for Current Intra-Well Prediction Limits Monitoring Program



False Positive and False Negative Rates for Current Upgradient vs. Downgradient Monitoring Program



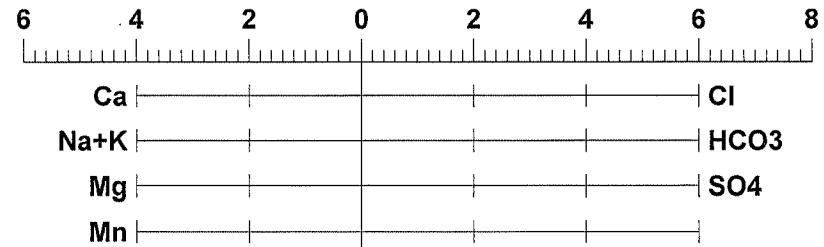
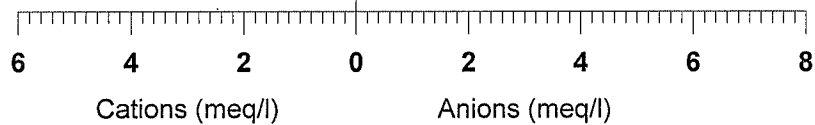
Goodwin Landfill



LG-01 4/12/2011 (12.3%,224.2503ppm)

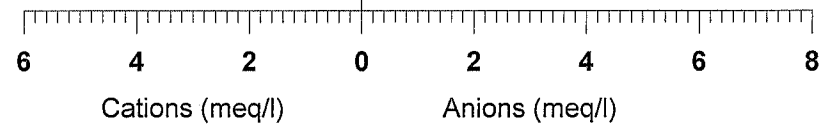
LG-02 4/12/2011 (13.8%,148.7103ppm)

LG-03 4/12/2011 (7.66%,662.4902ppm)



LG-04 4/12/2011 (12%,212.7703ppm)

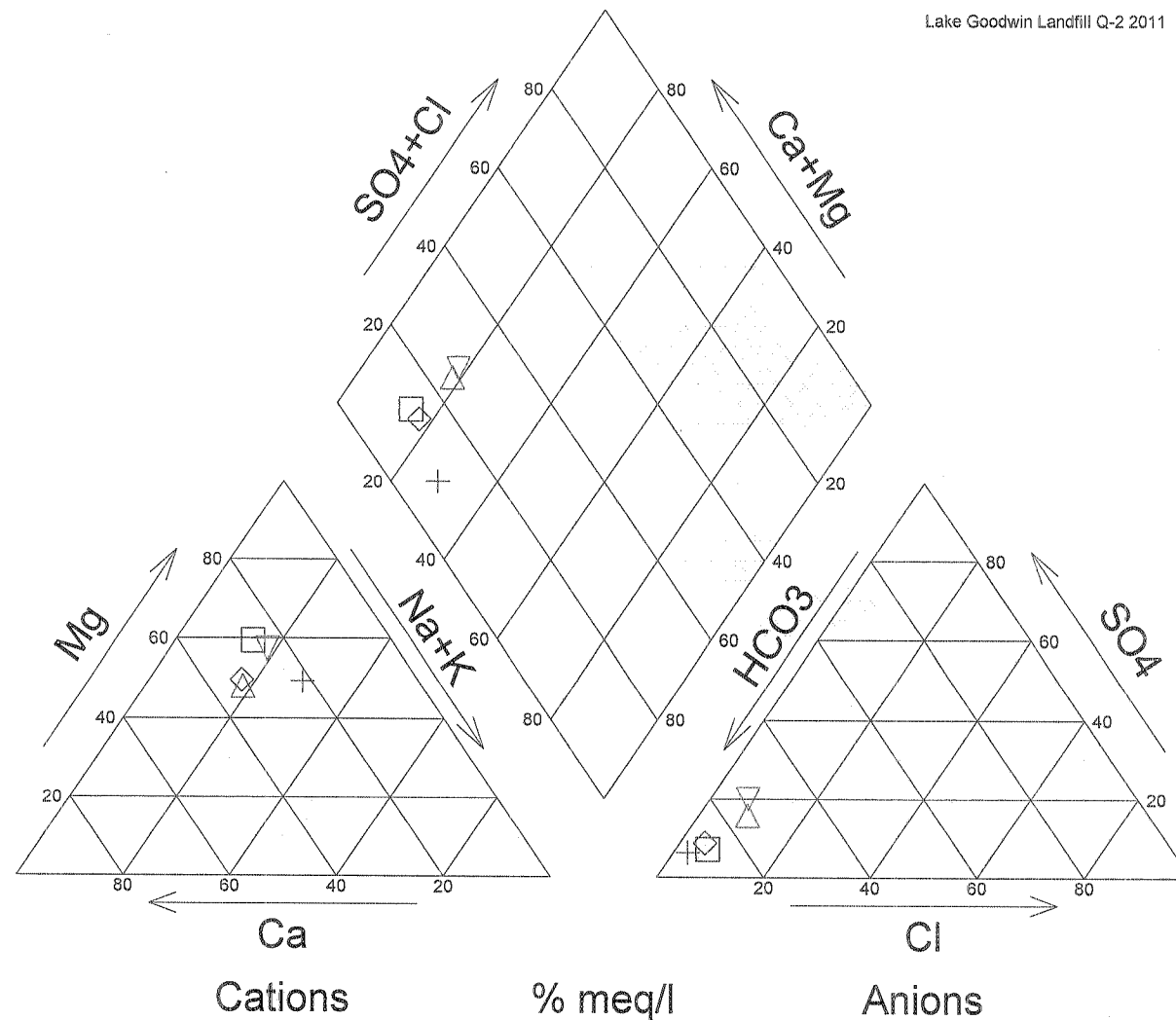
LG-05 4/12/2011 (18.6%,381.1852ppm)



Goodwin Landfill

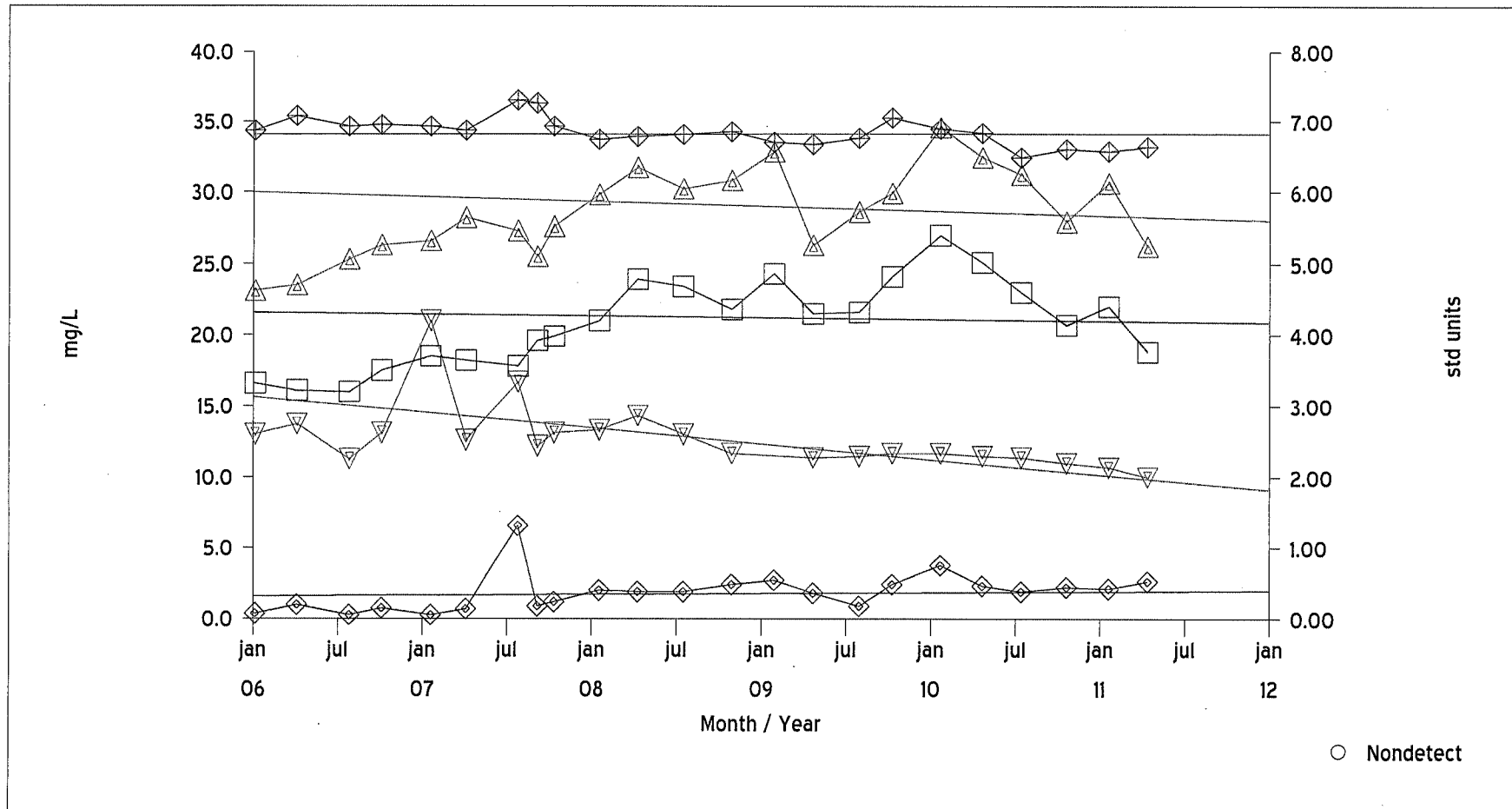
| | |
|---------|-------------------------------|
| □ LG-01 | 4/12/2011 (12.3%, 224.25ppm) |
| △ LG-02 | 4/12/2011 (13.8%, 148.71ppm) |
| ▽ LG-03 | 4/12/2011 (7.66%, 662.49ppm) |
| ◇ LG-04 | 4/12/2011 (12%, 212.77ppm) |
| + LG-05 | 4/12/2011 (18.6%, 381.185ppm) |

Lake Goodwin Landfill Q-2 2011



Goodwin Landfill

Time Series Plot for LG-01

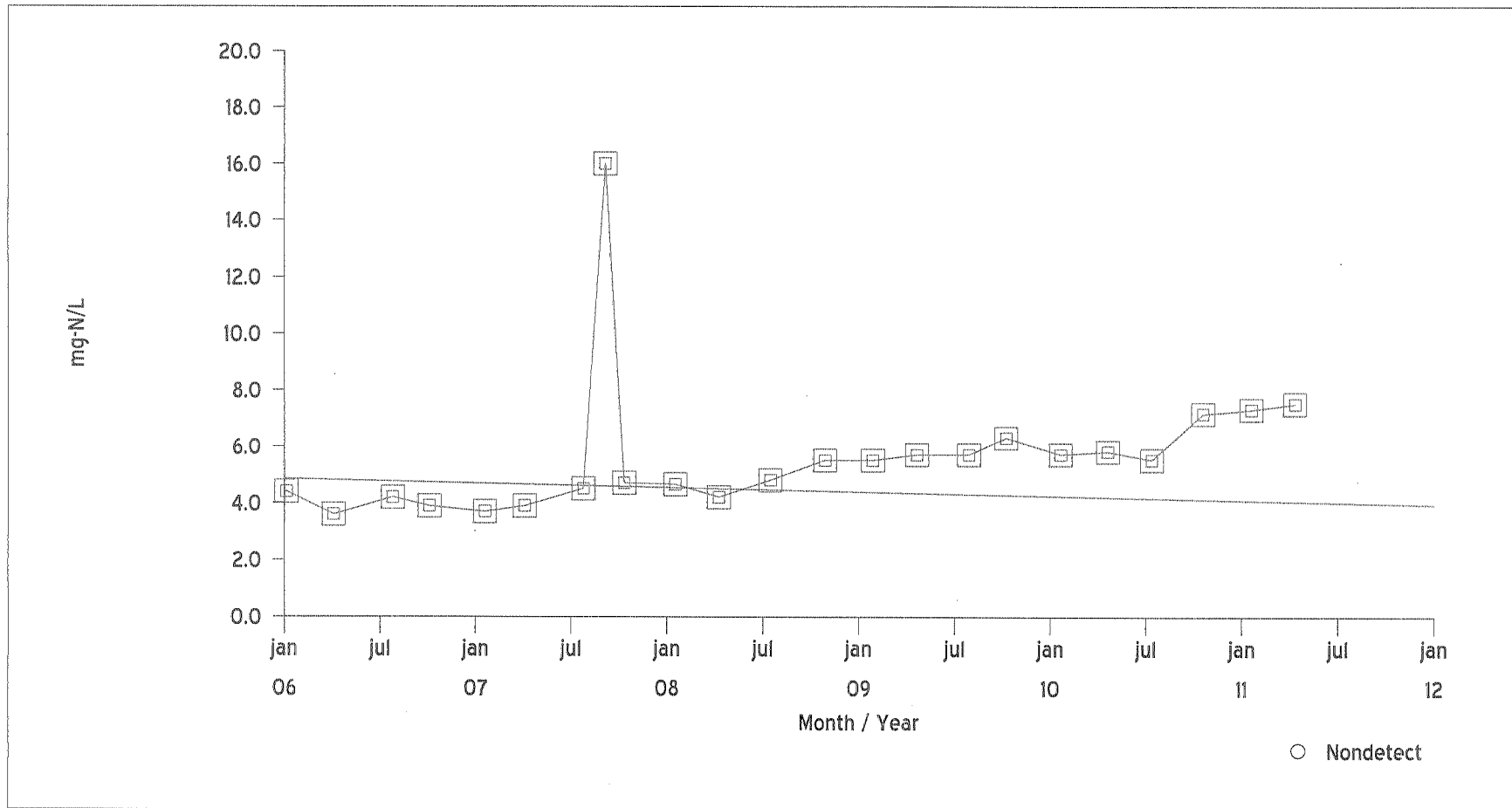


□ Dissolved calcium (cc: .056)
 ▲ Dissolved magnesium (cc: .181)
 ▼ Dissolved sodium (cc: .783)
 ◆ Nitrate nitrogen (cc: .415)

◆ pH (cc: .015)
 ○ Nondetect

Goodwin Landfill

Time Series Plot for LG-03

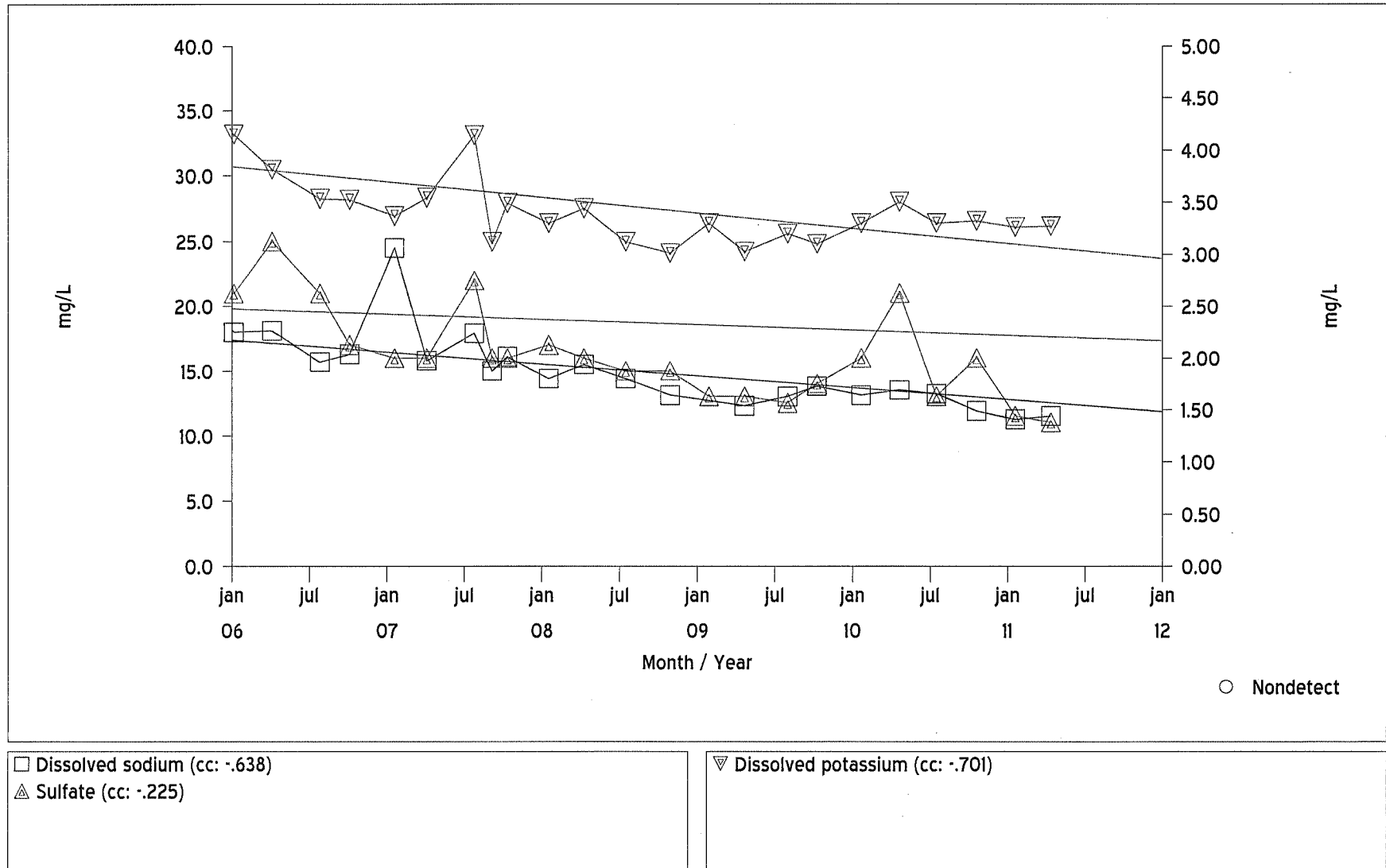


□ Nitrate nitrogen (cc: -.349)

○ Nondetect

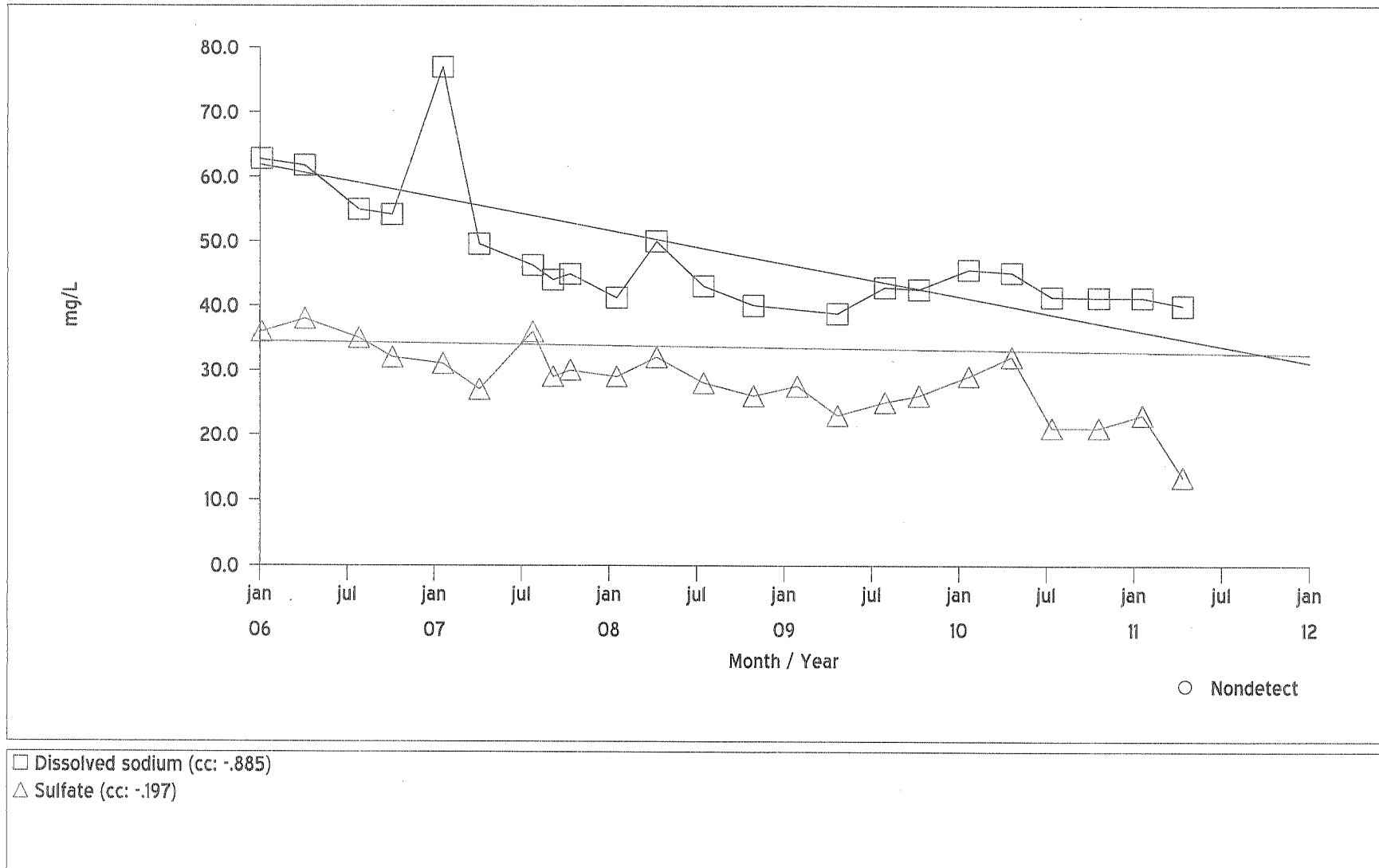
Goodwin Landfill

Time Series Plot for LG-04



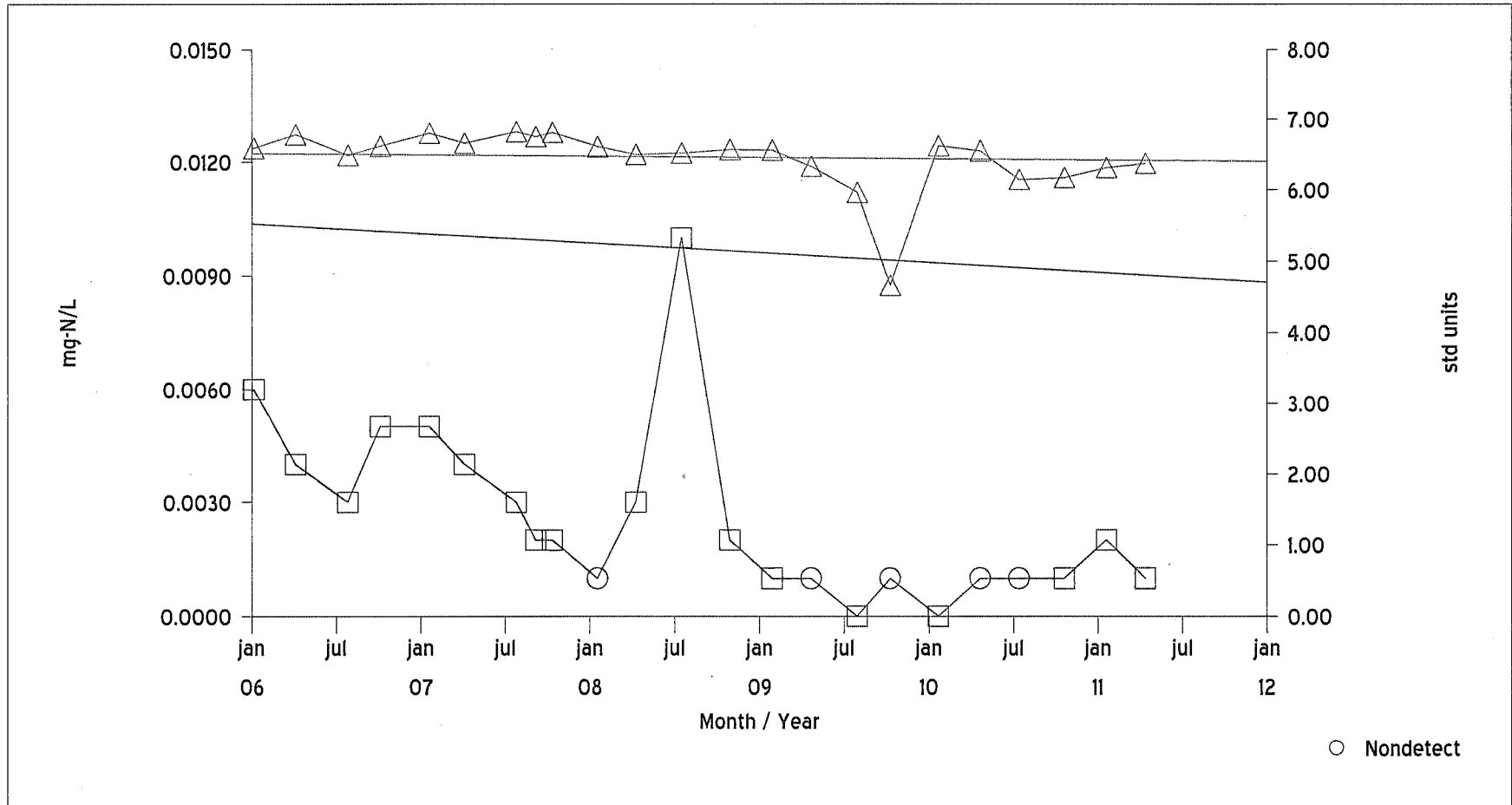
Goodwin Landfill

Time Series Plot for LG-05



Goodwin Landfill

Time Series Plot for LG-05



□ Nitrite nitrogen (cc: -.146)

△ pH (cc: -.347)

○ Nondetect