JMO Consulting

May 20, 2021 *SENT VIA EMAIL*

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Subject: Revised Technical Memorandum: Statistical Derivation of Background Metal Concentrations – Olympic View Sanitary Landfill, Kitsap County, Washington

On behalf of Waste Management of Washington, Inc. (WMW), JMO Consulting is pleased to provide this revised Technical Memorandum (Memo) describing the statistical analysis used to develop background concentrations for total arsenic, total iron and total manganese in groundwater at the Olympic View Sanitary Landfill (OVSL) in Kitsap County Washington. This project has been a collaborative effort working closely with Washington Department of Ecology (Ecology) and Kitsap Public Health District (KPHD). Based on agency comments received on the initial Technical Memorandum submitted on 22 April 2021, this document has been revised to include additional information on how background concentrations will be applied at the facility and further clarification that background values apply to total metal concentrations. Additional information concerning the data utilized in the development of background values is contained in a prior Technical Memorandum dated 25 March 2021 and included herein (Appendix 1).

BACKGROUND

Background values for arsenic, iron and manganese are currently established using water quality data from upgradient monitoring wells at the facility. This approach presents an inherent dilemma given the shift in redox conditions that exist across the site and the occurrence of wetlands along the downgradient margins of the facilities. Groundwater upgradient of the landfill to the east is subject to a geochemically-oxidizing (i.e., aerobic) conditions due to the percolation of rainwater with high dissolved oxygen.

As groundwater flows downgradient, recharge is restricted by the landfill cover system and oxygen may be consumed by aerobic microbial conditions. At the downgradient margins of the site, expansive wetland conditions exist along the margins of the Union River valley and further reduced (i.e., anaerobic) conditions prevail. Under the reducing conditions observed downgradient of the landfill, the concentrations of arsenic, iron and manganese may be naturally elevated compared to upgradient conditions.

Based on this knowledge, a goal was established to develop updated background metal concentrations in groundwater that would be more reflective of natural conditions monitored by the compliance, performance and downgradient wells at the facility. This effort included re-evaluation of previous data

collected from a background study performed as part of the 2007 Remedial Investigation Report (RI; Parametrix, 2007). The prior work included the sampling of nine domestic wells for total arsenic, total iron and total manganese. The wells are located approximately 0.5 to 0.75 miles to the west, northwest and north of the landfill in relatively close proximity to Union River valley (Figure 1). The analytical results from the domestic well sampling program (Table 1) indicate that arsenic was detected above the reporting limit (RL) in all samples analyzed. Iron and manganese were also detected in all samples analyzed with two results for each consistent being reported at estimated concentrations below the RL.

STATISTICAL METHODOLOGY AND RESULTS

Upon acceptance of the background dataset by Ecology and KPHD, the focus of the project shifted to statistical analysis of the data. In email correspondence dated 20 April 2021, Ecology provided direction on the statistical approach to be utilized. Ecology indicated that the methodology relies upon the Implementation Guidance for the Groundwater Quality Standards (Chapter 173-200 WAC) and the ProUCL Technical Guide, and that empirical groundwater quality data for the region should also be considered in the evaluation. Based on their assessment of background dataset, Ecology requested the following statistical analysis:

- Total Arsenic: 95% UTL with 95% Coverage assuming normal distribution;
- Total Iron: 95% Percentile Bootstrap UTL with 95% Coverage assuming nonparametric distribution; and
- Total Manganese: 95% Percentile Bootstrap UTL with 95% Coverage assuming nonparametric distribution.

Following Ecology's guidance, the data were analyzed by GeoChem Applications using the statistical software package ProUCL. The results of the analysis provide the following statistical background limits for the site's compliance, performance and downgradient wells:

- Total Arsenic: 0.00427 milligrams-per-liter (mg/L);
- Total Iron: 1.9 mg/L; and
- Total Manganese: 0.73 mg/L.

Attachment 1 provides the ProUCL statistical output documenting the above limits.

DISCUSSION

As discussed with Ecology, although the updated background values listed above provide a far better prediction of the natural metal concentrations in groundwater relative to current limits, it is unlikely that they bracket localized natural conditions (i.e., wetland areas) which exist at the site. This

conclusion is based on long-term groundwater monitoring well data that show a significantly greater concentration range than that observed for the domestic wells included in the statistical calculation. This difference can likely be attributed to the presence of more reducing localized conditions at the site whereby certain trace metals can reach significantly higher natural equilibrium concentrations in groundwater.

It appears that this effect is reflected currently in certain site monitoring wells that exhibit apparent steady-state concentrations that are higher than the updated limits. Attachment 2 contains a few such examples.[1] Based on these and other long-term historical concentration data, it is unlikely that the updated limits fully bracket the natural conditions at the site. As such, it is anticipated that the groundwater quality at several monitoring wells affected by localized processes is unlikely to achieve the updated background limits (particularly for iron and manganese) and that additional well-specific analysis may be required in the future to move the facility through MTCA and the post-closure-care process.

CONCLUSIONS AND RECOMMENDATIONS

The change in natural redox conditions that occurs across the site necessitated a closer examination of background metal concentrations in groundwater. Utilizing data collected from a prior study and working closely with Ecology and KPHD, updated background concentrations for arsenic, iron and manganese have been developed for the site's compliance, performance and downgradient wells. Following the data evaluation procedures specified by Ecology, the following background concentrations were developed: total arsenic – 0.00427 mg/L; total iron – 1.9 mg/L; and total manganese – 0.73 mg/L. The updated limits provide a better prediction of the natural conditions present at the facility and it is recommended that they replace the current background values.

JMO Consulting appreciates the assistance provided by Ecology and KPHD on this important project. Please let me know if you have any questions regarding the information presented.

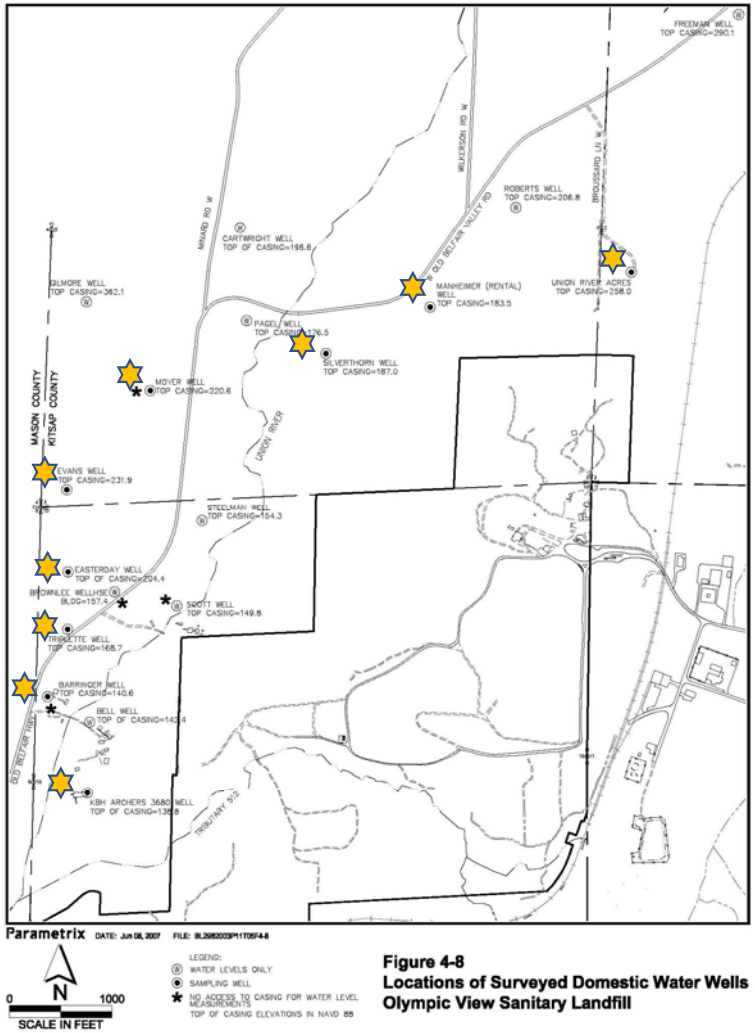
Sincerely,
JMO Consulting

James M. Obereiner, P.G.
Principal Hydrogeologist

Cc: Steven Williams, Ecology
Phil Perley, WM
Will Neal, GeoChem Application

[1] Figures included in Attachment 2 provide both total and dissolved metals concentrations to present a more extensive historical dataset.

Figure 1 – Domestic Well Sampling Locations



Source: Parametrix 2007 RI Report

Table 1: Domestic Well Analytical Data

Table 5-2. Summary of Domestic Well Sampling Results, Olympic View Sanitary Landfill

Sample No.	Well Owner/ Well Name	Date Sampled	1,1-DCE (µg/L)	Vinyl Chloride (µg/L)	VOCs (µg/L)	Arsenic (mg/L) [1]	Iron (mg/L)	Manganese (mg/L)	Total Coliform
Chapter 173-200 WAC:			--	0.02	--	0.00005	0.3	0.05	
MCL:			70	2	--	0.01	0.3	0.05	
10499JS	Silverthorn	1/3/2006	<0.7	<0.02	all Non-Detect	0.00245	0.42	0.020 J	absent
3650KBHA	KBH Archers	1/3/2006	<0.7	<0.02	all Non-Detect	0.00132	0.14	0.0039 J	absent
11132T	Triplette	1/3/2006	<0.7	<0.02	all Non-Detect	0.00284	0.50	0.320 J	present
911132TD	Triplette (duplicate)	1/3/2006	<0.7	<0.02	all Non-Detect	0.00287	0.39	0.220 J	present
11120VE	Easterday	1/3/2006	<0.7	<0.02	all Non-Detect	0.00038	1.9	0.730 J	absent
11101WE	Evans	1/3/2006	<0.7	<0.02	all Non-Detect	0.00021	0.088	0.0012 J	present
5981VRA	Union River Acres	1/11/2006	<0.7	<0.02	all Non-Detect	0.00042	0.024B	0.00052 BJ	absent
10195EM	Manheimer	1/11/2006	<0.7	<0.02	all Non-Detect	0.00191	0.590	0.042 J	not tested [2]
10771JPM	Moyer	1/11/2006	<0.7	<0.02	all Non-Detect	0.00046	0.060	0.0002 BJ	absent
11199LB	Barringer	1/11/2006	<0.7	<0.02	all Non-Detect	0.00160	0.031B	0.046 J	present

Highlighted values exceed Chapter 173-200 WAC and secondary MCL standards
1 MTCA A (WA state background) = 0.005 mg/L
2 well casing has no cap or sanitary seal; well currently not in use
J = Method blank contamination
B = Estimated value less than the reporting limit.

Source: Parametrix 2007 RI Report

ATTACHMENT 1

ARSENIC - TOTAL	Normal Background Statistics for Uncensored Full Data Sets
User Selected Options	
Date/Time of Computation	ProUCL 5.14/21/2021 6:03:22 AM
From File	Test for OVSL.xls
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
New or Future K Observations	1

C0: data in mg/L

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	1
Minimum	2.10E-04	First Quartile	4.20E-04
Second Largest	0.00245	Median	0.00132
Maximum	0.00286	Third Quartile	0.00191
Mean	0.00129	SD	9.82E-04
Coefficient of Variation	0.762	Skewness	0.412
Mean of logged Data	-7	SD of logged Data	0.953

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	3.031	d2max (for USL)	2.11

Normal GOF Test

Shapiro Wilk Test Statistic	0.897	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.245	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	0.00427	90% Percentile (z)	0.00255
95% UPL (t)	0.00321	95% Percentile (z)	0.0029
95% USL	0.00336	99% Percentile (z)	0.00357

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Prepared by GeoChem Applications

IRON -TOTAL

Nonparametric Background Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.14/21/2021 6:06:42 AM
From File	Test for OVSL.xls
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Number of Bootstrap Operations	2000

C1: data in mg/L

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	1
Minimum	0.024	First Quartile	0.06
Second Largest	0.59	Median	0.14
Maximum	1.9	Third Quartile	0.455
Mean	0.412	SD	0.596
Coefficient of Variation	1.448	Skewness	2.339
Mean of logged Data	-1.773	SD of logged Data	1.477

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	3.031	d2max (for USL)	2.11

Nonparametric Distribution Free Background Statistics

Data appear Approximate Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	9	95% UTL with 95% Coverage	1.9
Approx, f used to compute achieved CC	0.474	Approximate Actual Confidence Coefficient achieved by UTL	0.37
		Approximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	1.9	95% BCA Bootstrap UTL with 95% Coverage	1.9
95% UPL	1.9	90% Percentile	0.852
90% Chebyshev UPL	2.298	95% Percentile	1.376
95% Chebyshev UPL	3.153	99% Percentile	1.795
95% USL	1.9		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

MANGANESE -TOTAL

Nonparametric Background Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.14/21/2021 6:08:30 AM
From File	Test for OVSL.xls
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Number of Bootstrap Operations	2000

C2: data in mg/L

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	1
Minimum	2.00E-04	First Quartile	0.0012
Second Largest	0.27	Median	0.02
Maximum	0.73	Third Quartile	0.046
Mean	0.124	SD	0.243
Coefficient of Variation	1.963	Skewness	2.426
Mean of logged Data	-4.46	SD of logged Data	2.815

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	3.031	d2max (for USL)	2.11

Nonparametric Distribution Free Background Statistics

Data appear Gamma Distributed at 5% Significance Level

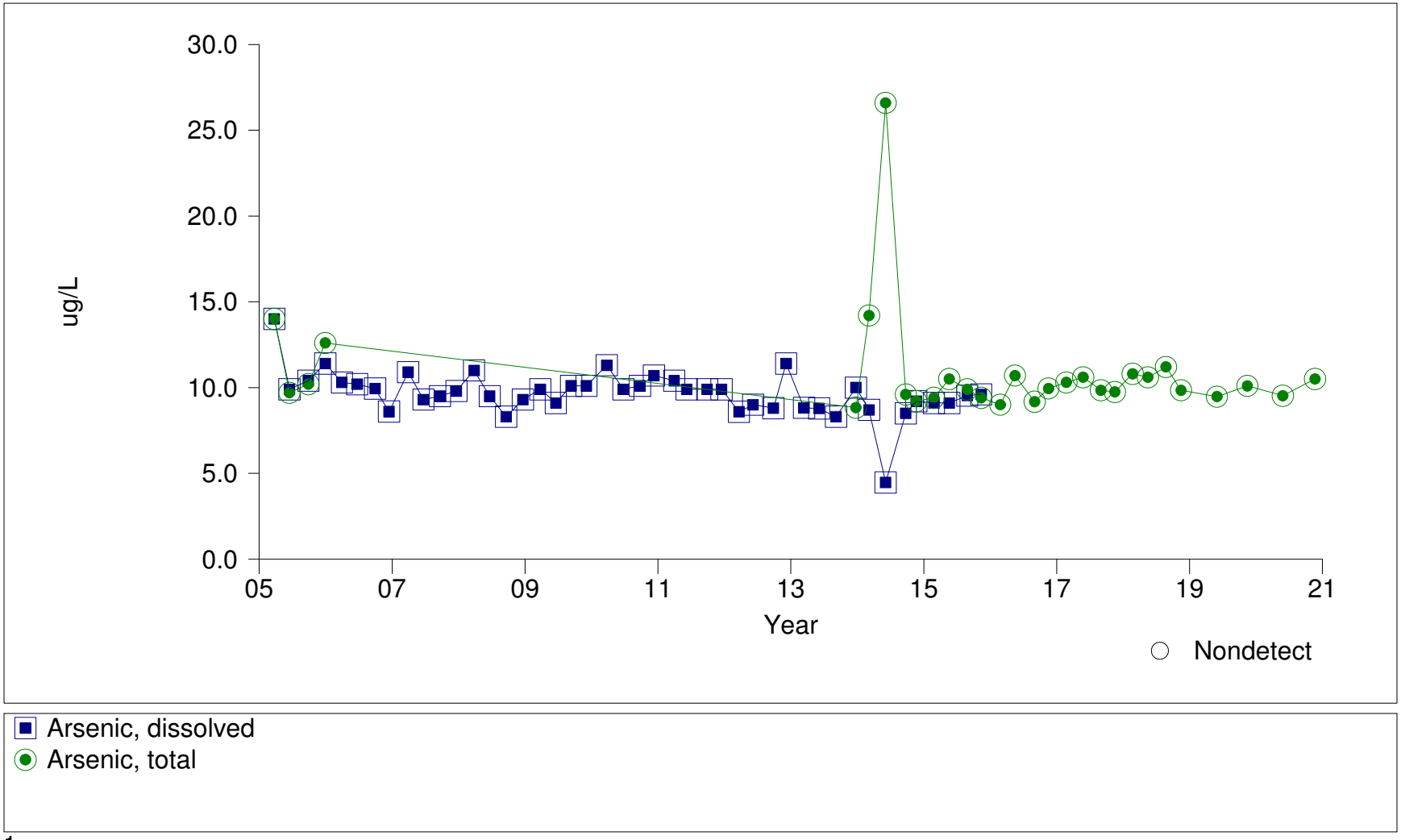
Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	9	95% UTL with 95% Coverage	0.73
Approx, f used to compute achieved CC	0.474	Approximate Actual Confidence Coefficient achieved by UTL	0.37
		Approximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	0.73	95% BCA Bootstrap UTL with 95% Coverage	0.73
95% UPL	0.73	90% Percentile	0.362
90% Chebyshev UPL	0.892	95% Percentile	0.546
95% Chebyshev UPL	1.24	99% Percentile	0.693
95% USL	0.73		

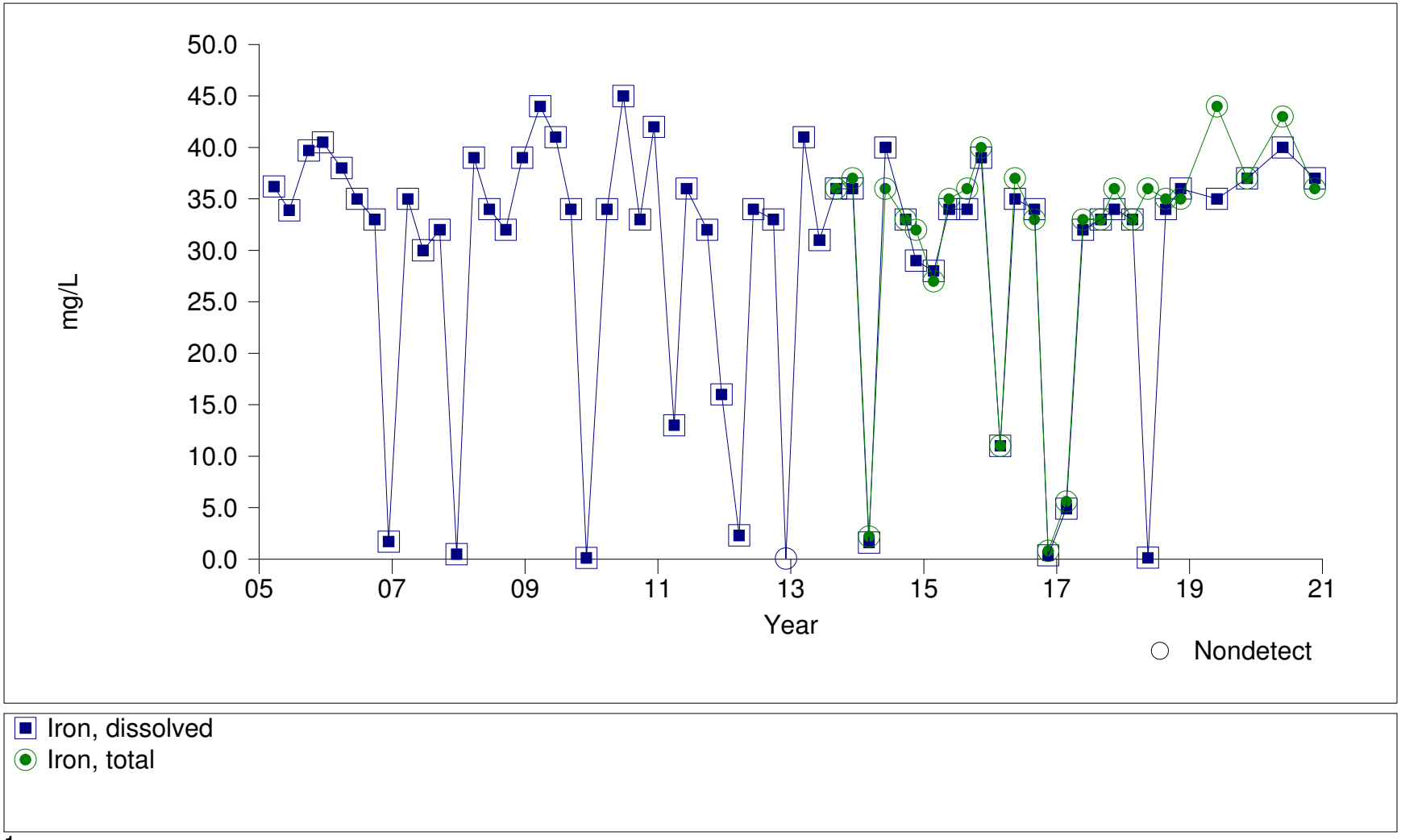
Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

ATTACHMENT 2

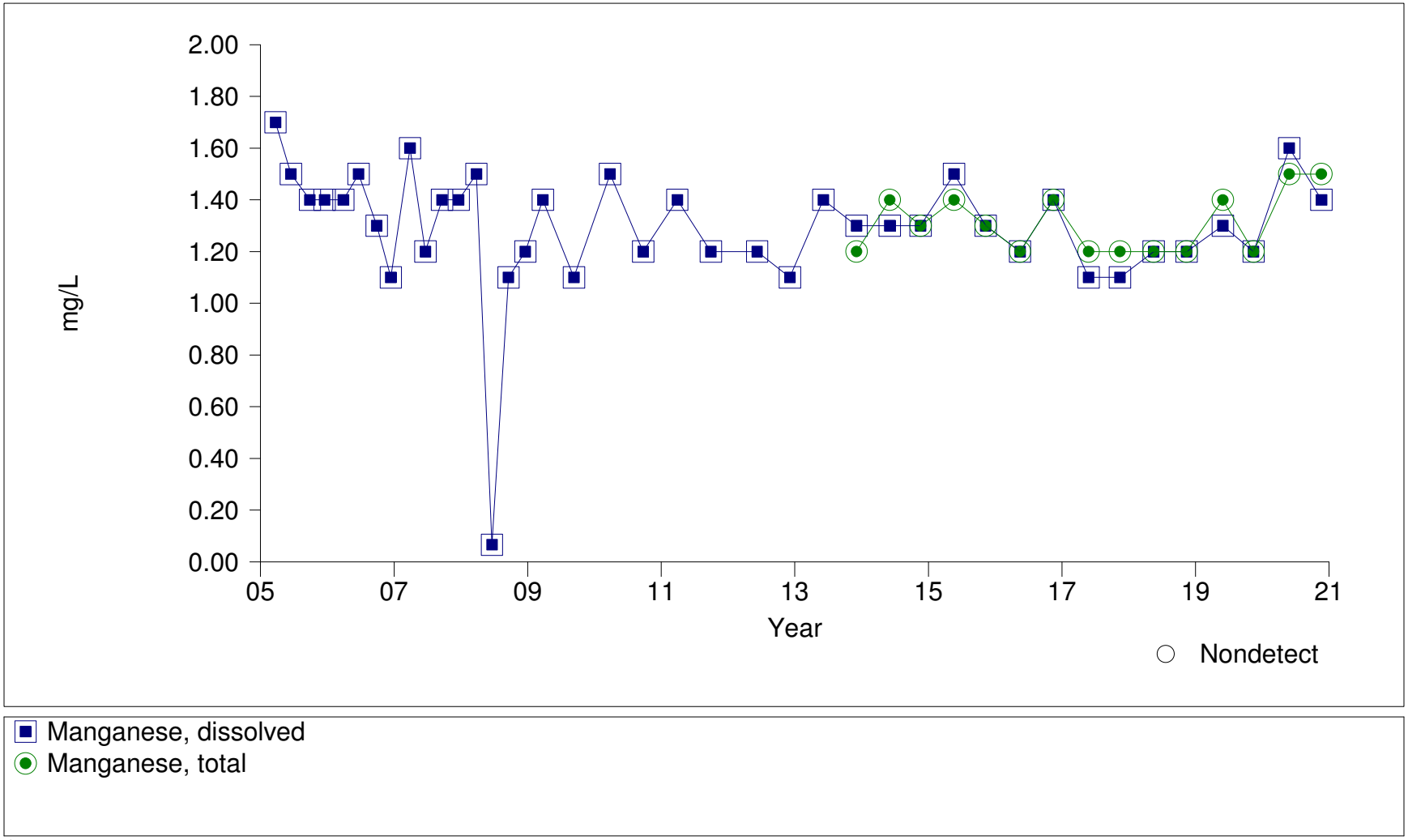
Time Series Plot for MW-32



Time Series Plot for MW-39



Time Series Plot for MW-29A



APPENDIX 1
Technical Memorandum: Revised Technical Memorandum: Development of Background Metal Concentrations – Olympic View Sanitary Landfill, Kitsap County, Washington
March 25, 2021

JMO Consulting

March 25, 2021 *SENT VIA EMAIL*

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Subject: Revised Technical Memorandum: Development of Background Metal Concentrations – Olympic View Sanitary Landfill, Kitsap County, Washington

On behalf of Waste Management of Washington, Inc. (WMW), JMO Consulting is pleased to provide this Revised Technical Memorandum (Memo) describing the process completed to date for developing background concentrations of arsenic, iron and manganese in groundwater at the Olympic View Sanitary Landfill (OVSL) in Kitsap County Washington. This has been a collaborative effort working closely with Washington Department of Ecology (Ecology) and Kitsap Public Health District (KPHD). Based on the agency comments received on the initial Technical Memorandum submitted on 11 March 2021, this Memo has been revised to include: additional information on the analytical methods (total vs. dissolved) utilized during the domestic well sampling program; further justification for the use of all domestic wells in background development; and a change in nomenclature when referring to KPHD.

BACKGROUND

As discussed with Ecology and KPHD, background values for arsenic, iron and manganese are currently established using water quality data from upgradient monitoring wells at the facility. This approach presents an inherent dilemma given the shift in redox conditions that exist across the site and the occurrence of wetlands along the downgradient margins of the facilities. Groundwater upgradient of the landfill to the east is subject to a geochemically-oxidizing (i.e., aerobic) conditions due to the percolation of rainwater with high dissolved oxygen.

As groundwater flows downgradient, recharge is restricted by the landfill cover system and oxygen may be consumed by aerobic microbial conditions. At the downgradient margins of the site, expansive wetland conditions exist along the margins of the Union River valley and further reduced (i.e., anaerobic) conditions prevail. Under the reducing conditions observed downgradient of the landfill, the concentrations of arsenic, iron and manganese (as well as ammonia) may be naturally elevated compared to upgradient conditions.

Based on this knowledge, a goal was established to develop more appropriate background metal concentrations in groundwater for the facility. As part of this effort, previous data collected from a background study performed as part of the 2007 Remedial Investigation Report (RI; Parametrix, 2007) was re-evaluated. The prior work included the sampling of nine domestic wells for total arsenic, total

iron and total manganese. The wells are located approximately 0.5 to 0.75 miles to the west, northwest and north of the landfill in relatively close proximity to Union River valley (Figure 1). In an effort to supplement the existing domestic well sampling results, State and County databases were queried for additional data.

DATABASE SEARCH

A thorough database search was completed for arsenic, iron, manganese, and ammonia sampling results for groundwater wells located in the vicinity of the landfill. Although ammonia was not included in the previous domestic well sampling program, it has been identified as a constituent of concern at OVSL and a background limit has been established using the upgradient monitoring well data.

Working closely with Ecology, the database search was performed initially by JMO Consulting. SCS joined the effort to provide additional ArcGIS and data mining support. The following databases were queried:

- Ecology's Cleanup Site (TCP) - https://apps.ecology.wa.gov/gsp/SiteSearchPage.aspx
- Ecology's statewide database used in conjunction with the *Draft Natural Background Arsenic in Groundwater Report* (Excel file)
- Washington State Department of Health Sentry site for community water supply systems - https://www.doh.wa.gov/DataandStatisticalReports/EnvironmentalHealth/DrinkingWaterSystemData/SentryInternet
- KPHD's scanned records portal - https://kitsappublichealth.org/weblink

Review of Ecology's TCP database indicated that several sites located within a 3-mile radius of the landfill may have tested for metals in groundwater based on site "profile" information. However, under the "view electronic documents" tab in the database, no analytical data appears to be posted for these facilities. The majority of these sites are also located to the east of the landfill, away from the Union River valley.

The focus shifted to Ecology's statewide arsenic database used in conjunction with the *Draft Natural Background Arsenic in Groundwater Report*. SCS utilized the coordinate information contained in Ecology's 2003-2010 database and ArcGIS to plot sampling locations within a 5-mile and 10-mile radius of OVSL. The SCS query was limited to true arsenic detections (i.e., non-U results) in wells less than 250-feet deep. The results of this query indicated no detections of arsenic above the reporting limit (RL) within a 5-mile radius of the site. In addition, no information on RLs is apparent in this database. As shown on Figure 2, arsenic detections were identified within a 10-mile radius of OVSL. These data are presented in a separate file prepared by SCS (Excel file #1) and they indicate that the detected arsenic concentrations range between 1.33 and 8 micrograms-per-liter (µg/L).

As discussed with Ecology, the next step in the process was to identify if more recent sampling results may be available from wells in the area. The search was also expanded to include iron, manganese and ammonia data. SCS queried the Washington Department of Health's (DOH) water system

database for arsenic, iron, manganese and nitrate at the eight closest sampling locations to OVSL as identified in the ArcGIS mapping. Ammonia data was not available in the DOH database and nitrate data was queried for informational purposes. Review of water systems sampling data from 2000 to current found all non-detect results for arsenic, iron and manganese. Again, information regarding RLs is not apparent in the DOH database. A list of the 8 wells reviewed is included in a separate file prepared by SCS (Excel file #2) under the tabs "Wells Within 5 Miles" and "DOH Water Quality."

Lastly, the KPHD's database for single or shared domestic water systems was queried by SCS for iron, manganese and nitrate. Neither arsenic or ammonia data were available in the KPHD database, and nitrate data was queried for informational purposes. The search included an area bounded by the Mason County line and City of Bremerton water service area. This included an area extending approximately 1.5 miles north and south of the landfill and approximately 0.5 miles east and west of the landfill. Eight of the roughly two hundred parcels located in the search area had sample results from domestic wells after the year 2000 that indicate a detection of either manganese, iron, or nitrogen. Only one of these wells had detections for all three. Archived lab reports appear to be included in the KPHD's database and information on RLs could be extracted. The 3rd tab of the attached file prepared by SCS (Excel file #2) has a link to the original documentation submitted to the county for each analysis.

SUMMARY OF PREVIOUS DATA COLLECTED

As part of the 2007 RI, a domestic well sampling program was implemented at the site. Based on information contained in the RI, a Sampling and Analysis Plan (SAP) was prepared by Parametrix (Parametrix 2005a) and subsequently approved by Ecology. Groundwater samples were collected from nine domestic wells in late December 2005 and early January 2006. The wells were sampled for total arsenic, total iron, total manganese, total coliform and volatile organic compounds (VOCs). The locations of the wells are shown on Figure 1. Well depth and water level information are provided on Table 4-3b of the RI Report and attached herein as Table 1. The sampling results are provided on Table 5-2 of the RI Report and attached herein as Table 2.

The RI report (Appendix C and D) also included boring logs for domestic wells in the vicinity of the site. Review of that information indicates that boring logs were available for five of the domestic wells sampled [Evans, Union River Acres, Easterday, Barringer and KBH Archers; Attachment 1 (note: well log names shown on Table 4-3B)] and that that the wells were completed in sands and gravels. The hydrogeologic cross-sections included in the RI report indicate that the sand and gravel deposits penetrated by the domestic wells shown in the profile are completed in Vashon Outwash Deposits, consistent with the monitoring wells installed at OVSL. A geologic map and cross-sections A-A', D-D' and E-E' (which include orientations extending to the domestic wells) are attached herein as Figures 3 through 6.

The analytical results from the domestic well sampling program (Table 5-2) indicate that arsenic was detected above the RL in all samples analyzed. Iron and manganese were also detected in all samples analyzed with two results for each consistent being reported at estimated concentrations below the RL. No VOCs were reported in any of the samples.

As part of the Draft Final Human Health Risk Assessment (HHRA), Revision 1.0 (AMEC Geomatrix, 2008), analytical data collected from the domestic wells was utilized to calculate background concentrations for arsenic in the vicinity of the site. That work was performed by Arcadis and was included as Appendix D of the HHRA report. Data from seven of the domestic wells sampled were used along with five additional sampling results from a dataset provided by KPHD. The two southern-most domestic wells (Barringer and KBH Archer) were not used in the calculation because they were considered cross-gradient or downgradient of the western end of the landfill.

The Arcadis report indicates that the data was analyzed following guidance provided by Ecology for estimating natural background conditions for indicator hazardous substance (WAC 173-340-709) and Ecology's statistical software (MSTAT 3.0) in the background calculation module (BGCKD971). The background concentration was defined as the true upper 90th percentile or four times the 50th percentile, whichever is lower. In this case, four times the 50th percentile was the lower concentration and a background arsenic value of 8.5 ug/L was recommended.

SUMMARY AND CONCLUSIONS

An extensive internet search was completed with intent to augment the dataset to be used for development of background metal concentrations at the facility. This search was performed initially by JMO Consulting, and additional ArcGIS and data mining assistance was provided by SCS. A brief summary of the important findings is provided below:

- The existing data set from the nine domestic wells sampled as part of the RI had true detections of total arsenic, total iron and total manganese. These wells are located in relatively close proximity to the Union River valley at distances ranging between approximately 0.5 to 0.75 miles from the landfill. The data were collected under an approved SAP and there is a relatively high degree of confidence in the results.

- Ecology's statewide arsenic database provides useful information on regional arsenic concentrations in groundwater. These data provide good context (or comparative reference) for any future background limits established for arsenic in the landfill vicinity. However, there were no detections of arsenic within a 5-mile radius of the landfill and no RL information is apparent in this database.

- Similarly, review of more recent data in DOH's database for arsenic, iron, and manganese did not reveal any detections above the reporting limit. Again, information regarding RLs is not apparent in the DOH database.

- Examination of the KPHD database identified a few detections of iron and manganese within the query area and RL information appears to be available.

In summary, the results of the database search have not uncovered additional sampling results that would appear to beneficially augment data previously collected from the domestic well sampling program. The additional data obtained for wells located within a 5-mile radius of the landfill are predominantly non-detect for arsenic, iron and manganese. Even if reporting limit information was

available, these data would likely not add value to the existing dataset which includes all true detections for wells located in close proximity of both the landfill and Union River valley.

RECOMMENDATIONS

It is recommended that background concentrations for total arsenic, total iron and total manganese be developed utilizing data from the nine domestic wells sampled as part of the RI. This includes use of the two southerly-most wells (Barringer and KBH Archer) which may be located downgradient of the landfill. Review of the analytical data for these wells (Table 5-2) indicates that the concentrations of arsenic, iron and manganese are generally in the mid-range to low-end of all data collected from the domestic well sampling program (i.e., they are not elevated compared to the other wells). In addition, no VOCs were detected in these wells. The Barringer well is also located on the opposite side of the Union River from the landfill.

Further justification for including the two southerly-most domestic wells in background development is provided by examining the historical indicators of landfill-related groundwater effects at the facility and assessing the downgradient extent of such water quality changes. Utilizing chloride as a conservative tracer, Figure 7 was developed showing historical concentrations of chloride in a monitoring well with known landfill-related effects (MW-32) and two monitoring wells located further downgradient near the property boundary (MW-30A and MW-37). As shown on Figure 7, the chloride concentrations in MW-32 clearly show historical landfill-related effects, with more recent data approaching an asymptotic level more consistent with background. In contrast to the early chloride data for MW-32, the two downgradient wells do not show any appreciable landfill effect.

The two southerly-most domestic wells (Barringer and KBH Archer) are located approximately 3,000 feet from the landfill and it is very unlikely that the arsenic, iron and manganese data collected from these wells during the domestic well sampling program could have been influenced by the facility. Initial analysis of all nine domestic well sampling results indicates that the data is lognormally distributed with no outliers, and it is recommended that all nine wells be included in the background development for arsenic, iron and manganese.

Although the previous arsenic background calculation performed by Arcadis included five additional sampling results provided by KPHD, it is recommended that these data not be utilized to develop background concentrations. Based on available information, the locations of these sampling points are not certain. The data also appears to be from the 1992-1994 timeframe and the RLs look to be much higher than those used in the domestic well sampling program. The limited information available suggests that three of the samples had no arsenic detected above an RL of 20 ug/L. This reporting limit is two orders-of-magnitude higher than the RL achieved in the RI domestic well sampling program.

It is also not recommended that the background dataset be augmented with the KPHD data for iron and manganese identified during the SCS database query. The results of the RI sampling program measured true detections of arsenic, iron and manganese in all nine domestic wells sampled and there is a relatively high degree of confidence in these data. Use of the KPHD data would include mixing and matching of select parameters, potentially variable RLs, and inclusion of ½ RL or other assumption

into the calculation. Incorporating these data would add a degree of uncertainty into background development.

The above recommendations are supported by examination of the character and distribution of the data collected from the nine domestic wells sampled as part of the RI. Attachment 2 presents frequency distributions, quantile-quantile normal probability plots, and Shapiro-Wilk normality tests for arsenic, iron, and manganese prepared by GeoChem Applications. The statistical information presented in these attachments indicates the data for each metal appear uniformly structured with a log-normal distribution and no outliers. This suggests that an adequate number of representative background data points has likely been captured in the nine-well data sets, and upper background concentration limits can be calculated via various statistical methods based on log-normal distributions. These limits will likely be conservative given the extensive wetland conditions that exist downgradient of the landfill and the increased potential for more reduced groundwater conditions in site wells compared to the domestic wells sampled.

JMO Consulting appreciates the assistance provided by Ecology and KPHD on this important project. Please let me know if you have any questions regarding the information presented. I look forward to further discussion of the statistical approach once the background data set has been agreed upon.

Sincerely,
JMO Consulting

James M. Obereiner, P.G.
Principal Hydrogeologist

Cc: Steven Williams, Ecology
Phil Perley, WM
Chris Perra, SCS Engineers
Will Neal, GeoChem Application

Separate Files:
Excel File #1
Excel File #2

Figure 1 – Domestic Well Sampling Locations

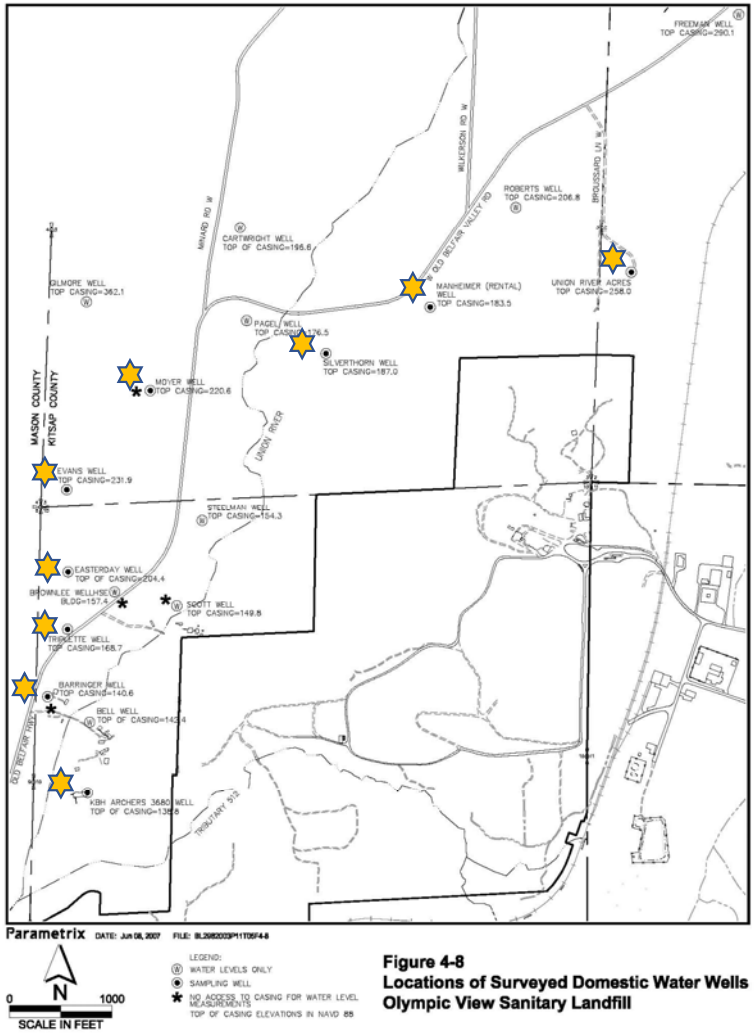


Figure 4-8
Locations of Surveyed Domestic Water Wells
Olympic View Sanitary Landfill

Figure 2: Radius Search of Arsenic Data from Ecology Statewide Database

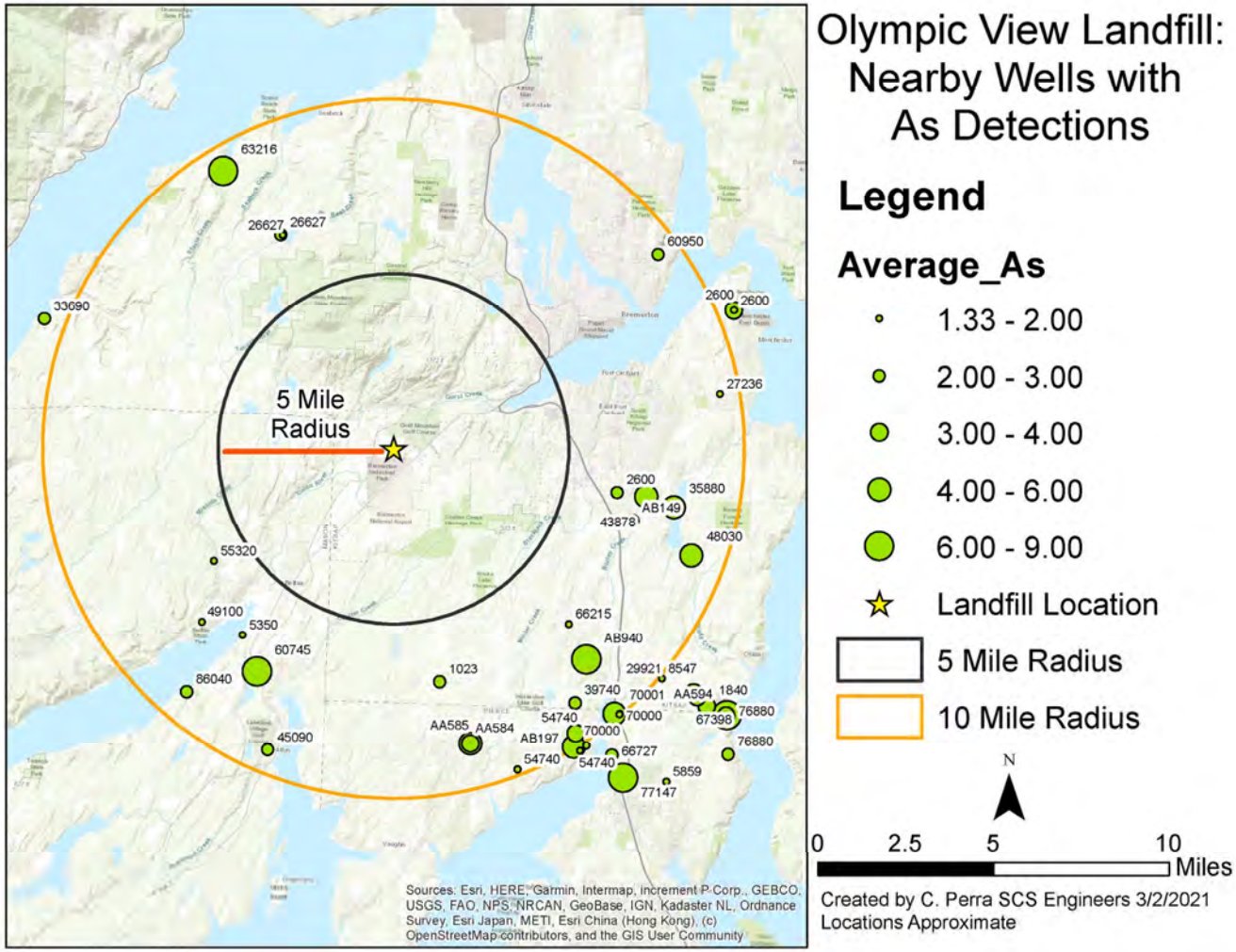
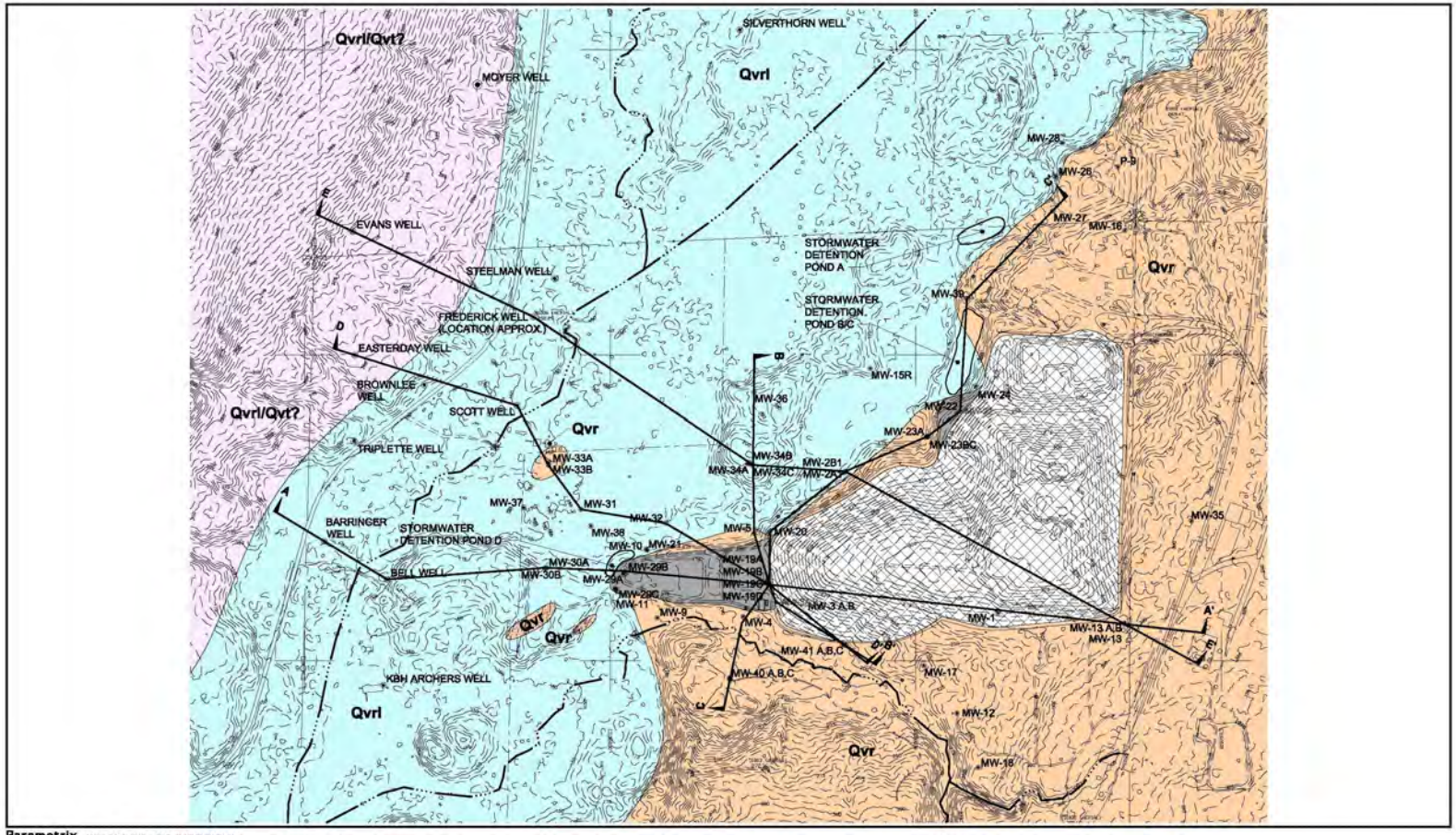


Figure 3: Geologic Map with Cross-Section Orientation



Parametrix DATE: Feb 21, 2007 FILE: SL2662003P08T04F4-1

N

0 600

SCALE IN FEET

Legend:

- Landfill
- Fill
- Qvr — Vashon Recessional Outwash Deposits
- Qvrl — Vashon Recessional Lacustrine Deposits
- Qvrl/Qvt? — Vashon Recessional Lacustrine Deposits or Vashon Till
- D — D' Location of Hydrogeologic Cross Section

Note:

Geologic contacts modified from Haussler and Clark (2000) based on site exploration data.

Figure 4-1
Geologic Map and Hydrogeologic Cross Section Locations
Olympic View Sanitary Landfill

Figure 4: Geologic Cross-Section A-A'

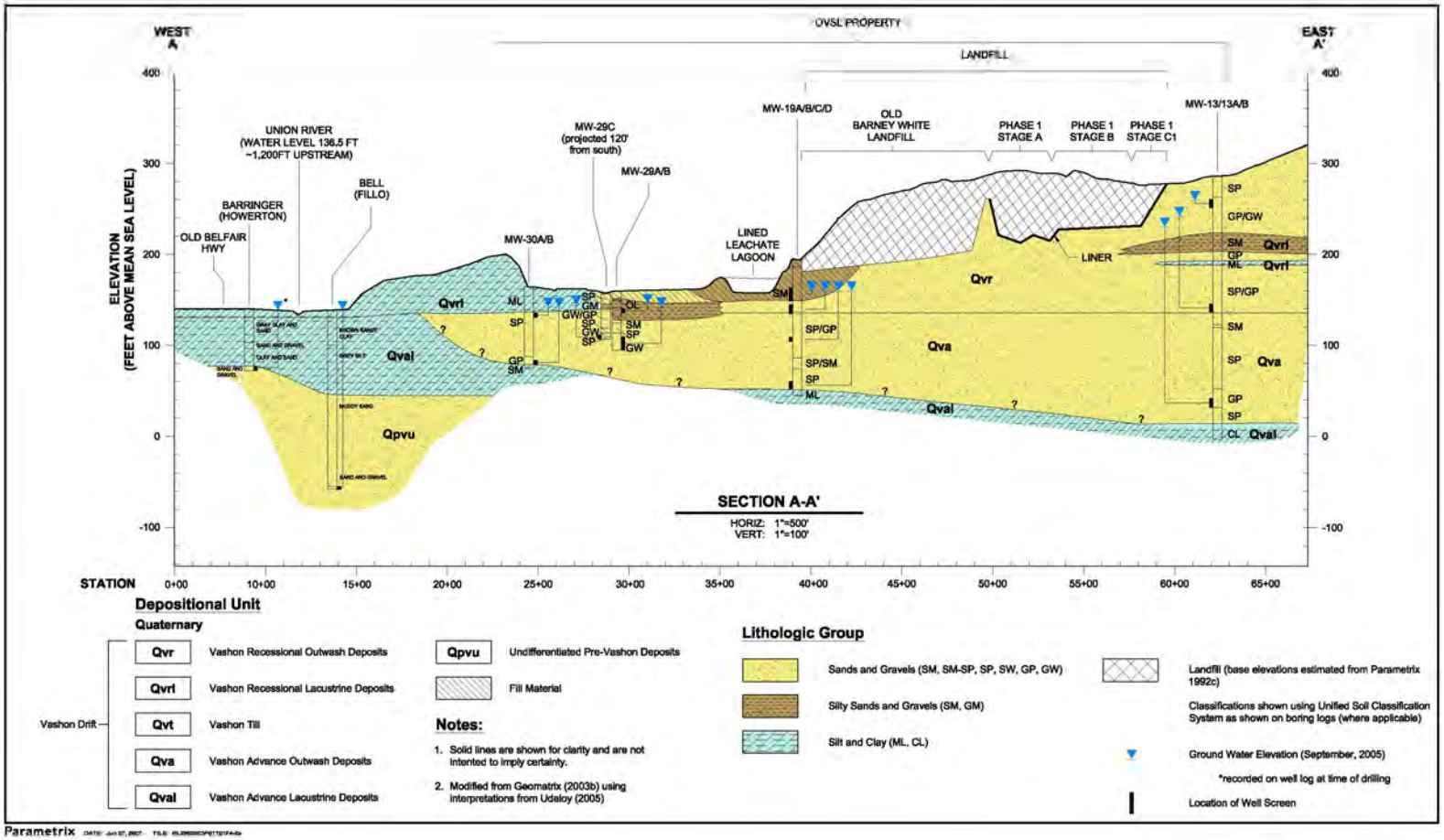


Figure 4-2a
Hydrogeologic Cross-Section A-A'
Olympic View Sanitary Landfill

Figure 5: Geologic Cross-Section D-D'

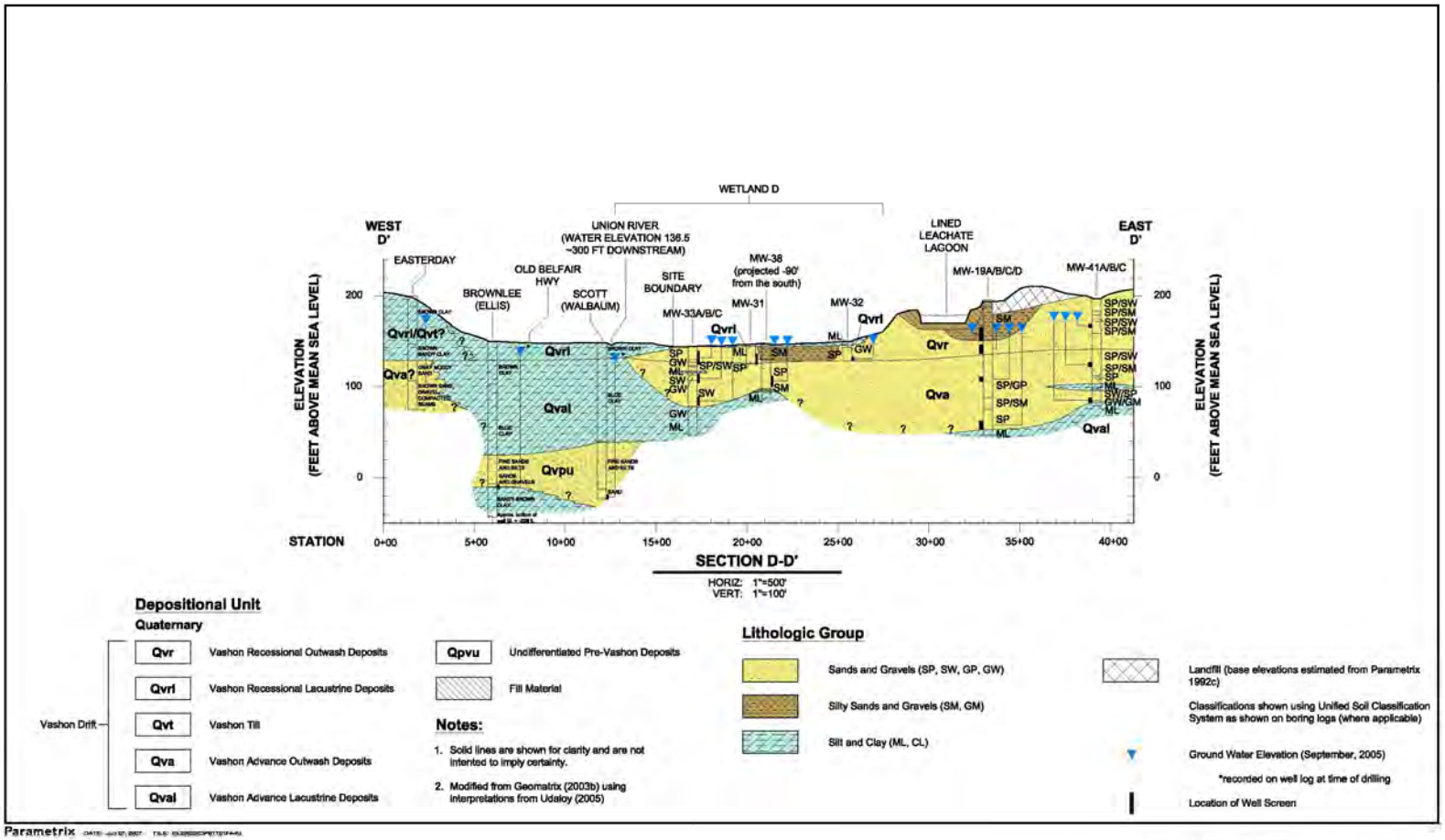


Figure 4-2d
Hydrogeologic Cross-Section D-D'
Olympic View Sanitary Landfill

Figure 6: Geologic Cross-Section E-E'

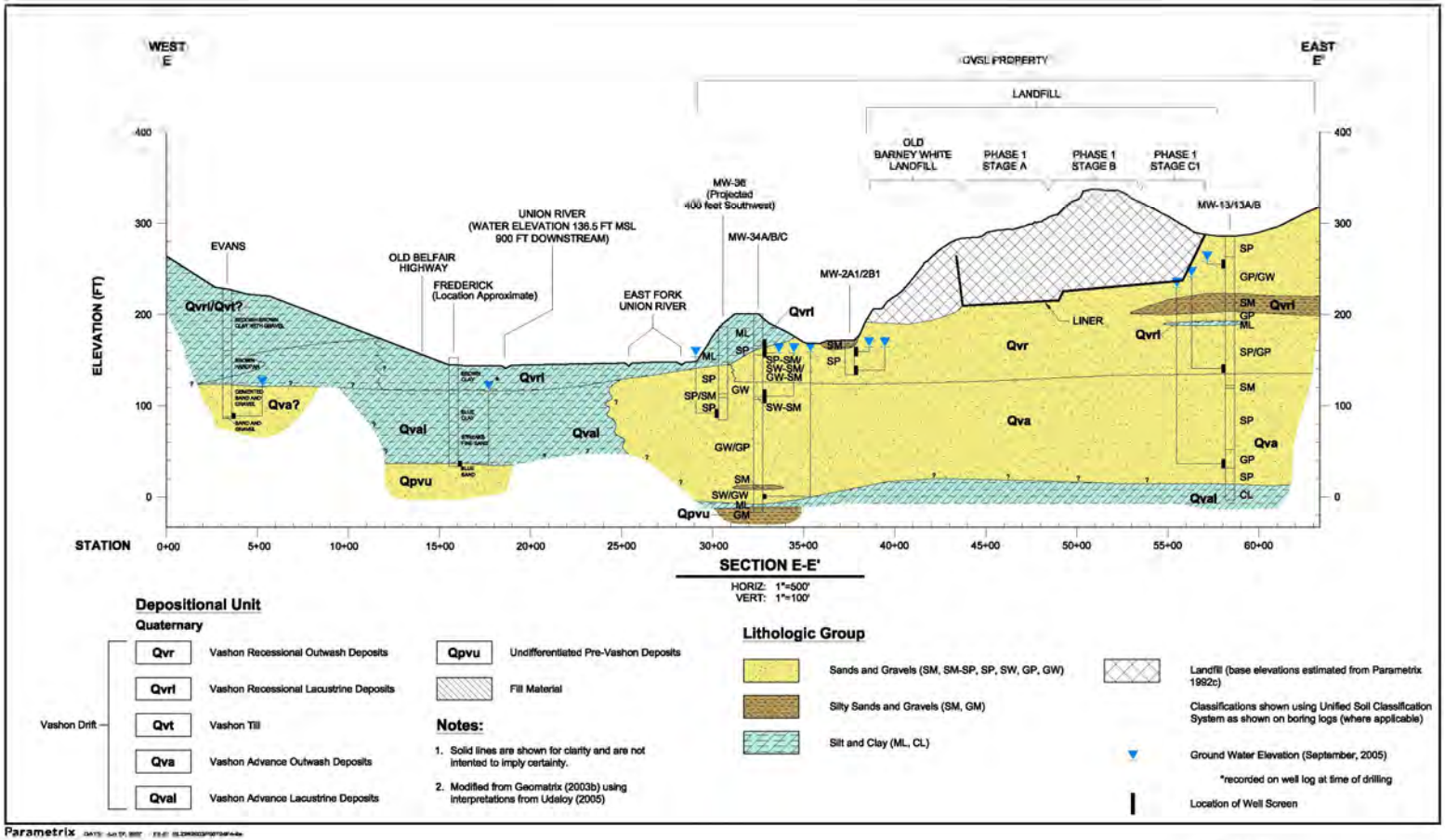


Figure 4-2e
Hydrogeologic Cross-Section E-E'
Olympic View Sanitary Landfill

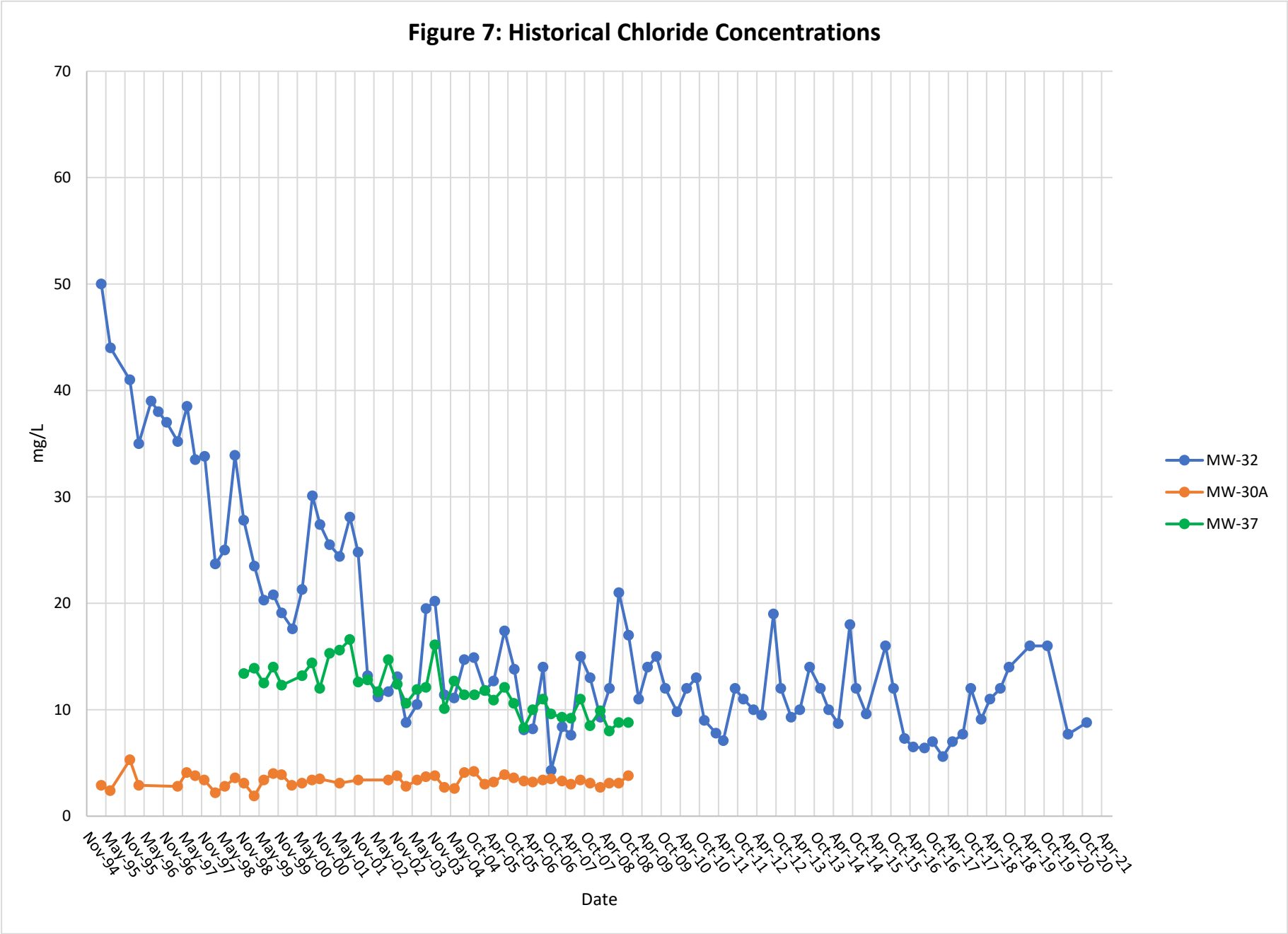


Figure 7: Historical Chloride Concentrations
mg/L
70
60
50
40
30
20
10
0
Date
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
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Apr-19
Oct-19
Apr-20
Oct-20
Apr-21
MW-32
MW-30A
MW-37

Table 1: Domestic Well Information

Table 4-3b. Water Level Measurements, Private Wells

Well Log Name/Date Completed	Road	Address	Owner	Northing	Easting	Height of TOC above ground surface (ft)	TOC Elevation, ft NAVD 88 (surveyed 2005)	Depth, ft Below TOC	Elevation of Well Bottom, ft NAVD 88	Depth to Water, ft Below TOC	Water Level Elevation, ft NAVD 88	Water Level Elevation, ft MSL[1]	Date of Water-Level Measurement	Comments
Evans 6-1-01	Bill Evans Rd	11101	Evans, William F. Jr. *	190809.8	1154314.6	1.0	231.9	130.3	101.6	110.3	121.6	118.1	7-26-2005	
Cartwright 3-25-69	Minard	5618	Cartwright, Jack E.	193360.7	1156008.6	0.9	196.6	35.9	160.7	14.5	182.1	178.6	8-2-2005	
Gilmore 8-11-99	Minard	5747	Gilmore, Roger S.	192635.1	1154506.5	1.2	362.1	230.7	131.4	182.0	180.1	176.6	8-2-2005	
Les Smith 1-20-87	Wild Eagle Ln	5981	Union River Acres Water System *	192922.5	1159830.4	1.0	258.0	159.0	99.0	63.2	194.8	191.3	7-29-2005	
No Log	W. Belfair Valley Rd.	9545	Freeman, James Jjr & Mary	195443.8	1160879.7	0.5	290.1	87.0	203.1	83.0	207.1	203.6	8-2-2005	
Roberts 3-31-99	W. Belfair Valley Rd.	10011	Roberts, Carl A.	193560.8	1158702.3	1.9	206.8	64.7	142.1	11.3	195.5	192.0	8-2-2005	
No Log	W. Belfair Valley Rd.	10195	Manheimer, Elaine *	192583.0	1157865.3	0.2	183.5	42.0	141.5	1.2	182.3	178.8	7-28-2005	
No Log	W. Belfair Valley Rd.	10499	Silverthorn, Joseph *	192132.4	1156847.5	0.5	187.0	104.5	82.5	12.1	174.9	171.4	7-25-2005	
Pagel 4-15-00	W. Belfair Valley Rd.	10613	Pagel, Robert	192453.0	1156072.3	1.0	176.5	572.0	-395.5	0.0	176.5	173.0	8-2-2005	flowing well; water level at top of casing
Seabolt 5-7-78	W. Belfair Valley Rd.	10771	Moyer, John and Pam *	191772.3	1155130.7	1.5	220.6	179	41.6	63	158	154.1	5-7-1978	total depth from well log (5-7-1978); access plug could not be removed to measure well
No Log	W. Belfair Valley Rd.	10885	Steelman, Violet S.	190501.2	1155636.6	0.1	154.3	300	-145.7	0.0	154.3	150.8	7-25-2005	well depth reported by owner; flowing well; water level at top of casing
Ellis 8-22-92	W. Belfair Valley Rd.	10955	Brownlee, Christa	189805.0	1154787.1	—	157.4	160	-3	20	137	133	8-22-92	No access for well measurements; information from well log (8-22-92)
Walbaum 11-20-91	W. Belfair Valley Rd.	10979	Scott, Allison	189668.9	1155390.3	—	149.8	170	-20	17	133	129	11-20-91	No access for well measurements: information from well log (11-20-91)
Easterday 8-18-81	W. Belfair Valley Rd.	11120	Easterday, Val E. *	189999.6	1154327.7	0.8	204.4	119.9	84.5	47.4	157.0	153.5	9-3-2005	
No Log	W. Belfair Valley Rd.	11132	Triplette *	189439.5	1154322.7	1.0	168.7	130.5	38.2	28.2	140.5	137	7-26-2005	
Howerton 2-9-78	W. Belfair Valley Rd.	11199	Barringer, Lisa *	188782.4	1154128.0	—	140.6	68	73	1	140	136	2-9-78)	No access for well measurements: information from well log (2-9-78)
Fillo 9-30-75	W. Belfair Valley Rd.	11239	Bell, Larry	188533.1	1154538.6	3.0	142.4	196.0	-53.6	5.4	137.0	133.5	8-3-2005	152 TD in field; log shows TD=196
KBH Archers 4-20-94	W. Belfair Valley Rd.	3650	KBH Archers *	187838.9	1154516.6	1.0	138.8	105.0	33.8	3.5	135.3	131.8	9-1-2005	

[1] NAVD88 (North American Vertical Datum of 1988) converted to MSL by subtracting 3.52 ft.
* Wells sampled in January 2006
TOC = top of casing
— = No data available

Table 2: Domestic Well Analytical Data

Table 5-2. Summary of Domestic Well Sampling Results, Olympic View Sanitary Landfill

Sample No.	Well Owner/ Well Name	Date Sampled	1,1-DCE (µg/L)	Vinyl Chloride (µg/L)	VOCs (µg/L)	Arsenic (mg/L) [1]	Iron (mg/L)	Manganese (mg/L)	Total Coliform
Chapter 173-200 WAC:			--	0.02	--	0.00005	0.3	0.05	
MCL:			70	2	--	0.01	0.3	0.05	
10499JS	Silverthorn	1/3/2006	<0.7	<0.02	all Non-Detect	0.00245	0.42	0.020 J	absent
3650KBHA	KBH Archers	1/3/2006	<0.7	<0.02	all Non-Detect	0.00132	0.14	0.0039 J	absent
11132T	Triplette	1/3/2006	<0.7	<0.02	all Non-Detect	0.00284	0.50	0.320 J	present
911132TD	Triplette (duplicate)	1/3/2006	<0.7	<0.02	all Non-Detect	0.00287	0.39	0.220 J	present
11120VE	Easterday	1/3/2006	<0.7	<0.02	all Non-Detect	0.00038	1.9	0.730 J	absent
11101WE	Evans	1/3/2006	<0.7	<0.02	all Non-Detect	0.00021	0.088	0.0012 J	present
5981VRA	Union River Acres	1/11/2006	<0.7	<0.02	all Non-Detect	0.00042	0.024B	0.00052 BJ	absent
10195EM	Manheimer	1/11/2006	<0.7	<0.02	all Non-Detect	0.00191	0.590	0.042 J	not tested [2]
10771JPM	Moyer	1/11/2006	<0.7	<0.02	all Non-Detect	0.00046	0.060	0.0002 BJ	absent
11199LB	Barringer	1/11/2006	<0.7	<0.02	all Non-Detect	0.00160	0.031B	0.046 J	present

Highlighted values exceed Chapter 173-200 WAC and secondary MCL standards
1 MTCA A (WA state background) = 0.005 mg/L
2 well casing has no cap or sanitary seal; well currently not in use
J = Method blank contamination
B = Estimated value less than the reporting limit.

ATTACHMENT 1

WATER WELL REPORT

Original & 1st copy - Ecology, 2nd copy - owner, 3rd copy - driller

Construction/Decommission ("x" in circle)
(X) Construction
( ) Decommission *ORIGINAL CONSTRUCTION Notice of Intent Number* _____

PROPOSED USE: [X] Domestic [ ] Industrial [ ] Municipal [ ] DeWater [ ] Irrigation [ ] Test Well [ ] Other _____

TYPE OF WORK: Owner's number of well (if more than one) _____
[X] New Well [ ] Reconditioned Method: [ ] Dug [ ] Bored [ ] Driven [ ] Deepened [X] Cable [ ] Rotary [ ] Jetted

DIMENSIONS: Diameter of well 6 inches, drilled 142 ft.
Depth of completed well 142 ft.

CONSTRUCTION DETAILS
Casing Installed: [X] Welded 6" Diam. from 0 ft. to 137 ft.
[ ] Liner installed ____" Diam. from ____ ft. to ____ ft.
[ ] Threaded ____" Diam. from ____ ft. to ____ ft.

Perforations: [ ] Yes [X] No
Type of perforator used _____
SIZE of perfs ____ in. by ____ in. and no. of perfs ____ from ____ ft. to ____ ft.

Screens: [X] Yes [ ] No [X] K-Pac Location 135
Manufacturer's Name Cook
Type stainless Model No. _____
Diam. 5 Slot Size 40 from 137 ft. to 142 ft.
Diam. ____ Slot Size ____ from ____ ft. to ____ ft.

Gravel/Filter packed: [ ] Yes [X] No [ ] Size of gravel/sand _____
Materials placed from ____ ft. to ____ ft.

Surface Seal: [X] Yes [ ] No To what depth? 19 ft
Materials used in seal Bentonite
Did any strata contain unusable water? [ ] Yes [X] No
Type of water? _____ Depth of strata _____
Method of sealing strata off _____

PUMP: Manufacturer's Name Jacuzzi
Type: sub. H.P. 3/4

WATER LEVELS: Land-surface elevation above mean sea level ____ ft.
Static level 113 ft. below top of well Date _____
Artesian pressure ____ lbs. per square inch Date _____
Artesian water is controlled by _____ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level.
Was a pump test made? [X] Yes [ ] No If yes, by whom? _____
Yield: 14 gal./min. with 5 ft. drawdown after 1 hrs.
Yield: 14 gal./min. with 5 ft. drawdown after 2 hrs.
Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
0	118				
1 min.	114				
2 min.	113				

Date of test _____
Bailer test ____ gal./min. with ____ ft. drawdown after ____ hrs.
Airtest ____ gal./min. with stem set at ____ ft. for ____ hrs.
Artesian flow ____ g.p.m. Date _____
Temperature of water ____ Was a chemical analysis made? [X] Yes [ ] No

CURRENT
Notice of Intent No. WE 00080
Unique Ecology Well ID Tag No. AFN 981
Water Right Permit No. _____
Property Owner Name Bill Evans
Well Street Address Old Bel Fair Hwy
City Bremerton County: Kitsap
Location SW 1/4 1/4 SW 1/4 Sec 3 Twn 23 R 1W EWM or WWM (circle one)
Lat/Long: (s,t,r still REQUIRED) Lat Deg ____ Lat Min/Sec ____ Long Deg ____ Long Min/Sec ____
Tax Parcel No. 032301-3-041-1002

CONSTRUCTION OR DECOMMISSION PROCEDURE
Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. Indicate all water encountered. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Top soil	0	2
Redish brown clay with gravel	2	70
Brown hardpan	70	115
Cemented sand & gravel with water	115	140
Sand & gravel with water	140	142

Start Date 5/24/01 Completed Date 6/1/01

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

[X] Driller [ ] Engineer [ ] Trainee Name (Print) Rylan Broughton
Driller/Engineer/Trainee Signature Rylan Broughton
Driller or Trainee License No. 2304
If trainee, licensed driller's Signature and License no. _____

Drilling Company Davis Drilling
Address 340 NE Davis Farm Rd.
City, State, Zip Belfair WA 98528
Contractor's Registration No. DAVISDI1100A Date June 01

Ecology is an Equal Opportunity Employer. ECY 050-1-20 (Rev 4/01)

ATTACHMENT 1

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

KPUD — UNION RIVER ACRES

WATER WELL REPORT

STATE OF WASHINGTON G1-25296C

23/01N/02W

Application No. .....

Permit No. AAC939

(1) OWNER: Name Les Smith Address 7550 E. Juneau Ct. Port Orchard

(2) LOCATION OF WELL: County Kitsap NW ¼ SW ¼ Sec 2 T 23 N., R 1W W.M.

Distance and direction from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) ....
New well ☒ Deepened ☐ Reconditioned ☐
Method: Dug ☐ Bored ☐ Cable ☐ Driven ☐ Rotary ☒ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 159 ft. Depth of completed well 159 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6" Diam. from 0 ft. to 148 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☐ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☒ No ☐
Manufacturer's Name Johnson
Type Stainless steel Model No.
Diam. 6 Slot size .015 from 149 ft. to 154 ft.
Diam. 6 Slot size .015 from 154 ft. to 159 ft.

Gravel packed: Yes ☐ No ☒ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level 220 TOPO ft.
Static level 65 ft. below top of well Date 1-20-87
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test 30 gal./min. with 11 ft. drawdown after 1 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
Brown sand	0	41
Brown sand layers brown clay	41	75
Brown sand water	75	120
Brown sand some gravels water	120	130
Brown sand water layers brown clay	130	150
Brown sand some gravels water	150	159

Well head 159 ft. 6½ in.
To top of packer 147 ft. 2 in.
Riser pipe 1 ft. 6 in.
.015 slot screen 5 ft. 3 in.
.015 slot screen 5 ft. 3½ in.
Tailpipe 4 in.
Screen overall 12 ft. 6½ in.
Six in casing 148 ft. 10 1/8 in.
Static head 65 ft.
30 G.P.M. 76 ft. 5 in.

SCREEN ≈ 220 to 220
-148
86

RECEIVED
JAN 26 1987
DEPARTMENT OF ECOLOGY
NORTHWEST REGION

Work started 1-19- 87 Completed 1-20- 87

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Nicholson Drilling, Inc. (Person, firm, or corporation) (Type or print)

Address P.O. box 123 Port Orchard, WA 98

[Signed] (Well Driller)

License No. 0520 Date 1-22- 87

USE ADDITIONAL SHEETS IF NECESSARY

ATTACHMENT 1

23/01W-10D

The Original and First Copy with Dept. upon receipt of Report. Second Copy — Owner's Copy Third Copy — Driller's Copy

18-81

WATER WELL REPORT 23/01W-10D

STATE OF WASHINGTON

Application No. .....

Permit No. .....

(1) OWNER: Name Val Easterday Address 11120 W. Old Belfair Hwy. Bremerton,

LOCATION OF WELL: County Kitsap NW ¼ NW ¼ Sec. 10 T. 23 N., R. 1 W.W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☒ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)....

New well ☒ Deepened ☐ Reconditioned ☐

Method: Dug ☐ Bored ☐ Cable ☒ Driven ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.

Drilled 112 ft. Depth of completed well 112 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6 " Diam. from 0 ft. to 112 ft.

Threaded ☐ " Diam. from ft. to ft.

Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒

Type of perforator used

SIZE of perforations in. by in.

perforations from ft. to ft.

perforations from ft. to ft.

perforations from ft. to ft.

Screens: Yes ☐ No ☒

Manufacturer's Name

Type Model No.

Diam. Slot size from ft. to ft.

Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel:

Gravel placed from ft. to ft.

Surface Seal: Yes ☒ No ☐ To what depth? 20 ft.

Material used in seal Bentonite & Cement

Did any strata contain unusable water? Yes ☐ No ☒

Type of water? Depth of strata

Method of sealing strata off

(7) PUMP: Manufacturer's Name Berkeley

Type: Jet 11 HP ½

(8) WATER LEVELS: Land-surface elevation above mean sea level....

Static level 75 ft. below top of well Date 3/26/81

Artesian pressure lbs. per square inch Date

Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? Yes ☐ No ☒ If yes, by whom?

Yield: gal./min. with ft. drawdown after hrs.

" " " "

" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test

Bailer test 12 gal./min. with 19 ft. drawdown after 1 hrs.

Artesian flow G.P.M. Date

Temperature of water Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
Brown clay	0	47
Blue sandy clay	47	63
Brown sand, gravle, clay	63	84
Brown sand, gravel, clay, streaks water	84	112

Well total 112 Ft. 1½ In.
No Screen
Total Six In. Casing = 112 Ft. 1½ In.

Static Head = 75 Ft.
10 GPM 89 Ft. 6 In.
15 GPM 94 Ft. 6 In.

Work started March 23, 19 81 Completed March 26, 19 81

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Nicholson Drilling Company (Person, firm, or corporation) (Type or print)

Address P.O. Box 123 Port Orchard, Wa. 98

[Signed] (Well Driller)

License No. 0419 Date March 27, 19 81

ATTACHMENT 1

23/01W-10L

Application No. .....

Permit No. .....

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

#48=81

WATER WELL REPORT
STATE OF WASHINGTON

23/1W-10D

(1) OWNER: Name Don Easterday Address ~~Bremerton~~, Wa. ~~98310~~ 98528

(2) LOCATION OF WELL: County Kitsap NW¼ NW¼ Sec. 10 T. 23 N., R. 1 W.W.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) ....
New well ☒ Deepened ☐ Reconditioned ☐
Method: Dug ☐ Bored ☐ Cable ☒ Driven ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 124 ft. Depth of completed well 124 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6 " Diam. from 0 ft. to 124 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☐ No ☒
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 22 ft.
Material used in seal Bentonite & Cement
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name None
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level .... ft.
Static level 31 ft. below top of well Date 8/18/81
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test 8 gal./min. with 77 ft. drawdown after 1 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:
Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
Brown clay	0	45
Brown sandy clay	45	68
Gray muddy sand	68	108
Brown sand, gravel, compacted seams, water bearing	108	124

Well Total 124 Ft. 10 In.
No screen
Total Six In. Casing = 124 Ft. 10 In.

Static Head = 31 Ft.
8 GPM 108 Ft.

Work started Aug. 13, 19 81 Completed Aug. 9, 19 81

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Nicholson Drilling Co. (Person, firm, or corporation) (Type or print)

Address P.O. Box 123 Port Orchard, Wa.

[Signed] [signature] (Well Driller)

License No. 0520 Date Aug. 20, 19 81

ATTACHMENT 1

23/01W-10 E/F

Application No. .....

Permit No. .....

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

(1) OWNER: Name Harold T. Howerton Address St.Rt.2, Box 652, Bremerton, Wash.

(2) LOCATION OF WELL: County Kitsap S½ ¼ NW ¼ Sec. 10 T. 23 N., R. 1W W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)....

New well ☒ Deepened ☐ Reconditioned ☐

Method: Dug ☐ Bored ☐ Cable ☒ Driven ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.

Drilled 68 ft. Depth of completed well 68 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6 " Diam. from 0 ft. to 65 ft.

Threaded ☐ " Diam. from ft. to ft.

Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒

Type of perforator used

SIZE of perforations in. by in.

perforations from ft. to ft.

perforations from ft. to ft.

perforations from ft. to ft.

Screens: Yes ☒ No ☐

Manufacturer's Name UPO Johnson

Type stainless steel Model No.

Diam. 6 Slot size 018 from 63 ft. to 68 ft.

Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel:

Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.

Material used in seal Bentonite

Did any strata contain unusable water? Yes ☐ No ☐

Type of water? Depth of strata

Method of sealing strata off

(7) PUMP: Manufacturer's Name owner installing

Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level....

Static level 1 ft. below top of well Date 2/9/78

Artesian pressure lbs. per square inch Date

Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? Yes ☐ No ☒ If yes, by whom?

Yield: gal./min. with ft. drawdown after hrs.

" " " "

" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test

Bailer test 13 gal./min. with 40 ft. drawdown after 4 hrs.

Artesian flow g.p.m. Date

Temperature of water Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Brown topsoil	0	6
gray clay & sand	6	28
gray clay, sand- some gravel to ½", hard packed - weeps water	28	38
water bearing gray sand & gravel	38	45
gray clay & sand	45	61
water bearing gray sand - gravel to ½"	61	68
gray sand, clay, gravel - hard packed	68	

Work started Feb. 5, 19 78 Completed Feb. 9, 19 78

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Frank's Well Drilling (Person, firm, or corporation) (Type or print)

Address Star Route 2, Box 779, Bremerton, Wash. 98310

[Signed] Frank Kuhn Sr. (Well Driller)

License No. 250 Date Feb. 11, 19 78

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 7356—OS—(Rev. 4-71).

ATTACHMENT 1

RECEIVED
APR 26 1994
DEPT. OF ECOLOGY

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. W 044070
UNIQUE WELL I.D. # ABG 095
Water Right Permit No. 23 | 1W | 10 M

(1) OWNER: Name KBH Archers Address 3680 Old Belfair Hwy Belfair, WA 98528

(2) LOCATION OF WELL: County Kitsap NW 1/4 SW 1/4 Sec 10 T. 23 N. R. 1W W.M.

(2a) STREET ADDRESS OF WELL (or nearest address) 3680 Old Belfair Hwy, Belfair WA 98528

(3) PROPOSED USE: [X] Domestic [ ] Industrial [ ] Municipal [ ] Irrigation [ ] Test Well [ ] Other [ ] DeWater

(4) TYPE OF WORK: Owner's number of well (if more than one)
Abandoned [ ] New well [X] Deepened [ ] Reconditioned [ ]
Method: Dug [ ] Cable [X] Rotary [ ] Bored [ ] Driven [ ] Jetted [ ]

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 105 feet. Depth of completed well 105 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6" Diam. from 0 ft. to 105 ft.
Welded [X] Liner installed [ ] Threaded [ ]
Perforations: Yes [ ] No [X]
Type of perforator used ____ SIZE of perforations ____ in. by ____ in.
____ perforations from ____ ft. to ____ ft.
____ perforations from ____ ft. to ____ ft.
____ perforations from ____ ft. to ____ ft.

Screens: Yes [X] No [ ]
Manufacturer's Name Cook Model No. ____
Type Stainless wire wrap
Diam. 5" Slot size 16 from 100 ft. to 105 ft.
Diam. ____ Slot size ____ from ____ ft. to ____ ft.

Gravel packed: Yes [ ] No [X] Size of gravel ____
Gravel placed from ____ ft. to ____ ft.

Surface seal: Yes [X] No [ ] To what depth? ____ ft.
Material used in seal Betonite
Did any strata contain unusable water? Yes [ ] No [X]
Type of water? ____ Depth of strata ____
Method of sealing strata off ____

(7) PUMP: Manufacturer's Name Jacuzzi H.P. 1
Type: sub.

(8) WATER LEVELS: Land-surface elevation above mean sea level ____ ft.
Static level 1 ft. below top of well Date ____
Artesian pressure ____ lbs. per square inch Date ____
Artesian water is controlled by ____ (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes [X] No [ ] If yes, by whom? 1706
Yield: 21 gal./min. with 81 ft. drawdown after 1 hrs.
" 21 " 81 " 2 "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
0	82	3	46	10	13
1	68	4	38	15	5
2	55	5	32	1HR	1

Date of test ____
Bailer test ____ gal./min. with ____ ft. drawdown after ____ hrs.
Airtest ____ gal./min. with stem set at ____ ft. for ____ hrs.
Artesian flow ____ g.p.m. Date ____
Temperature of water ____ Was a chemical analysis made? Yes [X] No [ ]

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Top Soil	0	3
Sandy Clay	3	18
Sandy Gravel Clay & Peat with Water	18	40
Sand & Gravel with Water	40	62
Blue Clay	62	70
Silty Blue Sand	70	75
Brown Sand with Water	75	105

Work Started 4/17/94 19. Completed 4/20/94 19.

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Davis Drilling (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address Belfair, WA 98528
(Signed) [signature] (WELL DRILLER) License No. 1706
Contractor's Registration No. DAVISSI1100A Date April 19

(USE ADDITIONAL SHEETS IF NECESSARY)