

## INDIVIDUAL WELLS

MW-27A -- MW-27A is located approximately 250 feet inside the western property boundary and is screened between 59.5 ft and 69.5 ft bgs.

### Indicator and Non-metal Parameters

MW-27A is fairly neutral with a pH range of 6.42 to 7.95 (median 7.04). A single pH value falls slightly below the secondary criterion range of 6.5 - 8.5. Specific conductance is stable (146 - 192  $\mu$ S/cm) and overlaps with the range of MW-55 in the same aquifer. COD is undetectable, except for one anomalous outlier at 12,000 mg/L. Chloride levels (0.5 - 3.9 mg/L) are relatively low compared to other wells in the Stratified Drift unit. In contrast, fluoride levels fluctuate from approximately 0.1 to 0.3 mg/L and are higher than in other wells. The maximum value for total inorganic nitrogen is less than 0.3 mg/L and is primarily due to the contribution from ammonia. MW-27A has sulfate levels ranging from 5.4 to 11 mg/L (median 6.9 mg/L).

### Metal Parameters

Dissolved iron ranges from ND to 0.1 mg/L with a median of 0.02 mg/L. The majority of values for dissolved manganese exceed the secondary criterion level of 0.05 mg/L (range 0.04 - 0.08 mg/L, median 0.07 mg/L). Stable dissolved arsenic levels (0.014 - 0.018) also exceed the state criterion of 0.05  $\mu$ g/L, but are below the federal standard of 0.05 mg/L for total arsenic. Dissolved barium and copper are not detectable in

this well. Only four samples show the presence of dissolved zinc (maximum 0.073 mg/L).

### Organic Parameters

The organic analysis reveals only acetone and methylene chloride detections in MW-27A. Acetone is detected at 20, 21, 24, and 36  $\mu\text{g/L}$  (only three of these points are shown on Fig. \* due to averaging). The duplicate values of 21 and 24  $\mu\text{g/L}$  are associated with a method blank reading of 21  $\mu\text{g/L}$  and a field blank reading of 17  $\mu\text{g/L}$ . Methylene chloride is found in 10 out of 14 samples (maximum 10  $\mu\text{g/L}$ ). All methylene chloride samples are accompanied by contaminated blanks.

### Trends

No seasonal or other temporal trends are obvious in this well. However, the results are suggestive of a possible increase in dissolved zinc, as this parameter shows up sporadically after being near or below detection in the previous reporting period. No leachate impacts are evident.

**MW-28** -- MW-28 is located approximately 750 feet inside the northern property boundary and is screened between 29 ft and 39 ft bgs.

### Indicator and Non-metal Parameters

Only four data points exist for pH and specific conductance and six points exist for each of the remaining parameters, thus knowledge of the

behavior at this well is limited. The pH is fairly acidic (5.98 - 6.83) with two points falling outside the secondary criterion range of 6.5 - 8.5. Specific conductance ranges from 200 to 300  $\mu\text{S}/\text{cm}$ . There is no detection of COD except for a high outlier of 8,000 mg/L which occurs within the same sample batch as the COD outlier in MW-27A. Chloride and total inorganic nitrogen appear to be relatively stable in the ranges of 4.3 - 6.4 mg/L and 0.08 - 0.56 mg/L, respectively. Fluoride concentrations are close to the limit of detection (maximum 0.06 mg/L). Sulfate, in contrast, tends to be higher in MW-28 than in the other wells within the Stratified Drift unit, and shows a large outlier at 350 mg/L (range 14 - 359 mg/L, median 32.5 mg/L).

#### Metal Parameters

All dissolved iron and manganese values except for one in each case exceed the secondary state and federal criteria levels for total metals. Dissolved iron ranges from ND - 3.5 mg/L (median 1.3 mg/L), and dissolved manganese ranges from ND - 6.4 mg/L. It is evident that these parameters follow the same patterns (see Figures \* and \*). Note that the ND results occur in the same sample (2/14/91), as do the highest values (8/9/90). Dissolved arsenic ranges from ND to 0.007 mg/L--all detections are above the state standard of 0.05  $\mu\text{g}/\text{L}$  for total arsenic, but below the federal standard of 0.05 mg/L. No dissolved barium or copper are detected in this well. Dissolved zinc ranges from ND to 0.03 mg/L.

#### Organic Parameters

Methylene chloride (ND - 7.5  $\mu\text{g/L}$ , median 1.8  $\mu\text{g/L}$ ) is the only detectable organic compound in MW-28. All samples and all blanks except one display the presence of methylene chloride.

### Trends

Like MW-48 in the Glacial Till unit, a pattern of decline followed by increase is apparent in the sulfate levels when previous and current data are viewed together. No other trends are apparent. Elevated levels of pH, dissolved iron, and dissolved manganese are present in this well.

**MW-29** -- MW-29 is located in the northeast region of the site. This well is screened between 18 ft and 28 ft bgs.

### Indicator and Non-metal Parameters

Similar to MW-28, MW-29 has mostly acidic pH values ranging from 5.93 to 7.32 (median 6.32). Six of eleven sample results fall below the secondary standard range of 6.5 - 8.5. Specific conductance in MW-29 has the lowest magnitude in the aquifer (range 8.4 - 112  $\mu\text{S/cm}$ , median 87  $\mu\text{S/cm}$ ). Only one sample shows a detectable level of COD (22 mg/L). Chloride levels range from 2.3 to 5.7 mg/L. Fluoride levels are close to the limits of detection (maximum 0.06 mg/L). Compared to other wells in the Stratified Drift unit, MW-29 has the highest and most variable level of total inorganic nitrogen (range 1.6 - 3.2 mg/L, median 2.2 mg/L) which stems almost entirely from concentrations of nitrate. Conversely, this well has the lowest range of sulfate values (0.5 - 15 mg/L).

### Metal Parameters

In general, metal concentrations are fairly low. Dissolved iron (ND - 1.8 mg/L), dissolved barium (ND - 0.06 mg/L) and dissolved copper (ND - 0.005 mg/L) are all close to the limits of detection except for a couple of outliers. Dissolved manganese and dissolved arsenic, also have many values at or below detection, however, for the former, one value, 0.11 mg/L is above the secondary standard for total manganese, and for the latter, five of eleven values fall between the state (0.05  $\mu$ g/L) and federal (0.05 mg/L) primary standards for total arsenic. Dissolved zinc ranges from ND to about 0.05 mg/L. The highest zinc value is associated with a method blank contaminated with 0.02 mg/L dissolved zinc.

### Organic Parameters

Three volatile organic compounds are detectable in MW-29. The first, acetone, shows one value of 14  $\mu$ g/L. The second, 2-butanone, shows one value of 15  $\mu$ g/L. Lastly, out of eleven samples seven show detections of methylene chloride, all of which are accompanied by contaminated blanks.

### Trends

No trends are apparent in this well. pH, total inorganic nitrogen, and 2-butanone levels may indicate leachate infiltration.

**MW-30A** -- MW-30A is located in the northeast region of the site approximately 950-1000 feet from the eastern property boundary. It is screened between 25 ft

and 35 ft bgs.

#### Indicator and Non-metal Parameters

The pH range is narrow and acidic at MW-30A (5.92 - 6.4, median 6.23). Specific conductance (510 - 720  $\mu\text{S}/\text{cm}$ , median 620  $\mu\text{S}/\text{cm}$ ), and chloride (0.5 - 39 mg/L, median 13 mg/L) are relatively high compared to other wells in this aquifer. Only four out of 34 samples show detectable COD levels (maximum 32 mg/L, not shown on Figure \* due to averaging). In general, fluoride concentrations are close to the limit of detection with the exception of one value of 0.4 mg/L. Total inorganic nitrogen varies from 0.025 to 0.93 mg/L. Sulfate concentrations vary from 10 to 30.5 mg/L (median 19 mg/L).

#### Metal Parameters

Both dissolved iron (ND - 6.9 mg/L) and manganese (0.11 - 3.2 mg/L) are present in MW-30A. The majority of readings for both of these metals exceed secondary state and federal standards for total iron and manganese. The maximum dissolved arsenic concentration, 0.002 mg/L, falls between state and federal limits for total arsenic, with the remaining values close to or below the limit of detection. Only one sample shows detectable dissolved barium (0.11 mg/L), and two samples show detectable dissolved copper (0.004 and 0.006 mg/L--averaged on Figure \*). The concentration of dissolved zinc is variable in the range of ND - 0.06 mg/L, with an outlier at 0.27 mg/L.

## Organic Parameters

Seven volatile organic compounds are present in MW-30A: acetone, benzene, 1,2-DCA, 1,2-DCE, methylene chloride, TCE, and vinyl chloride. For acetone there are a total of six detections (some averaged on Figure \*), three of which are accompanied by contaminated method blanks. In one case, the blank concentration is three times as high as the sample concentration. Of 34 samples, 18 show benzene concentrations ranging up to 3.9  $\mu\text{g/L}$  all of which exceed state (1.0  $\mu\text{g/L}$ ) but not federal (5  $\mu\text{g/L}$ ) standards. 27 of 34 samples show 1,2-DCA concentrations (1.5 - 4.6  $\mu\text{g/L}$ ) above state (0.5  $\mu\text{g/L}$ ) but below federal (5  $\mu\text{g/L}$ ) criteria levels. By far the most highly concentrated organic compound in MW-30A is 1,2-DCE (cis and trans) which ranges up to 180  $\mu\text{g/L}$ . There is no applicable standard for this compound. Methylene chloride concentrations range from 7 to 52  $\mu\text{g/L}$ , all of which exceed the state criterion of 5  $\mu\text{g/L}$ . It should be noted that 28 of 34 methylene chloride readings are accompanied by contaminated method blanks. For TCE, concentrations range from ND to 4  $\mu\text{g/L}$  with an outlier at 23  $\mu\text{g/L}$ . Six of these concentrations are at or above the state criterion of 3  $\mu\text{g/L}$ , and three are above the federal criterion of 5  $\mu\text{g/L}$ . Finally, vinyl chloride ranges from ND to 26  $\mu\text{g/L}$ , with 29 of 34 readings above the state standard of 0.02  $\mu\text{g/L}$ , and the federal standard of 2  $\mu\text{g/L}$ .

## Trends

Installed in November, 1989, MW-30A has no historical data available. From the current data, it is evident that chloride concentrations have

increased, and metals (Fe, Mn, and Zn), benzene, methylene, and vinyl chloride have declined after reaching short-term peaks. 1,2-DCA and 1,2-DCE have increased over the duration of the study period, with the former now possibly experiencing a decline. The presence of organic compounds indicates contamination in this well.

**MW-42D** -- MW-42D is located in very close proximity to both MW-39 and MW-42S approximately 500 feet inside the southern property boundary. It is screened between 48 ft and 68 ft bgs.

#### Indicator and Non-metal Parameters

This well has a neutral pH (6.6 - 7.19, median 6.91). The specific conductance (1338 - 1800  $\mu$ S/cm, median 1618.5) and chloride (ND - 77 mg/L, median 63 mg/L) levels are atypically high for the Stratified Drift unit. COD ranges from ND to 48 mg/L with a median of 29 mg/L. Fluoride varies over the span ND - 1.7 mg/L (median 0.05 mg/L). The concentration of total inorganic nitrogen is low at 0.035 to 0.52 mg/L. Sulfate levels are moderate at ND to 16 mg/L (median 4.2 mg/L).

#### Metal Parameters

Dissolved arsenic, barium, and iron are elevated at MW-42D compared to other wells in the Stratified Drift unit. In addition to being elevated, dissolved arsenic is also more variable at this well. Dissolved arsenic concentrations range from 0.021 to 0.12 mg/L, with three of ten values exceeding the federal criterion of 0.05 mg/L (for total arsenic) and all

values exceeding the state criterion of 0.05  $\mu\text{g/L}$ . Dissolved barium ranges from 0.07 to 0.2 mg/L with a median of 0.071 mg/L. All dissolved iron values (3.8 to 10 mg/L, median 8.7 mg/L) are above the state and federal secondary standard of 0.3 mg/L for total iron. The box plots for dissolved copper (Figure \*) are misleading; no dissolved copper is detectable in this well, thus the plot simply reflects a change in detection limits. Dissolved manganese (2.6 - 4.6 mg/L) at MW-42D retains the second highest values in the aquifer; all values exceed the secondary state and federal criterion of 0.05 mg/L for total manganese. The maximum concentration of dissolved zinc is 0.04 mg/L.

### Organic Parameters

Acetone, 2-butanone, methylene chloride, and toluene are present in MW-42D. Three out of ten samples display acetone values of 10, 14, and 19  $\mu\text{g/L}$ . The lowest reading for acetone is associated with a method blank value of 2  $\mu\text{g/L}$ . One sample exhibits 2-butanone (9  $\mu\text{g/L}$ ), and two samples exhibit toluene (2  $\mu\text{g/L}$ ). The toluene detections are similar to levels found in MW-29, ~~and which are far below the federal standard of 1,000  $\mu\text{g/L}$  for this compound.~~ Seven of ten samples show the presence of methylene chloride (maximum 8  $\mu\text{g/L}$ ), with one exceedance of the 5  $\mu\text{g/L}$  state standard. However, six of these methylene chloride samples also have contaminated method blanks.

### Trends

A comparison of previously reported laboratory conductance measurements

with the current field conductance data reveals a continuing decline in conductivity. To a lesser extent, and interrupted by a low outlier, chloride concentrations also appear to be declining over time. Fluoride levels appear to drop more abruptly to values near the detection limit. It is of interest to note that the decline in fluoride coincides with changes in both the laboratory and method used for the analysis. Acetone, 2-butanone, and toluene have apparently peaked in the middle of the previous reporting period and have subsequently made substantial declines. Other than these general trends, no other patterns are evident. One might interpret the decreases in specific conductance, chloride, and organics as indicating a declining impact from leachate at this site.

**MW-55** -- MW-55 is found in the northwest section of the site approximately 850-875 feet from the western property boundary and is screened between 37.5 ft and 47.5 ft bgs.

#### Indicator and Non-metal Parameters

All but two samples have pH values above 7 (range 6.57 - 7.75, median 7.355), making MW-55 more basic than most other wells within the aquifer. Specific conductance is stable in the range of 120 to 152  $\mu\text{S}/\text{cm}$  ( median 134.6  $\mu\text{S}/\text{cm}$ ). Only two detections of COD occur (11, 20 mg/L). Chloride (ND - 3.4 mg/L) and fluoride (ND - 0.16 mg/L) concentrations are fairly low, as is the concentration of total inorganic nitrogen (0.035 - 0.92 mg/L) compared to other wells in the aquifer. More intermediate are the sulfate readings (3.7 - 17 mg/L, median 9 mg/L).

### Metal Parameters

In contrast to other wells in the Stratified Drift unit, MW-55 has relatively low dissolved iron content ranging from ND to 0.39 mg/L, with only one point above the secondary criterion level of 0.3 mg/L for total iron. However, this high value is associated with a method blank containing 0.11 mg/L dissolved iron. There is also a method blank reading of 0.02 mg/L for one iron sample reading of 0.02 mg/L. Dissolved manganese is consistently high (0.094 - 0.13 mg/L) and all values exceed the secondary drinking water standard of 0.05 mg/L for total manganese. Dissolved arsenic is detected in half of the twelve samples at levels falling between the state and federal criteria levels, with a maximum of 0.014 mg/L. No dissolved barium is detected, and only one sample displays a low concentration of dissolved copper (0.003 mg/L). Dissolved zinc is detectable in three samples (0.02, 0.027, and 0.03 mg/L) at levels far below the 5 mg/L standard.

### Organic Parameters

No volatile organics are present at levels above detection limits except for acetone (15, 20  $\mu\text{g/L}$ --averaged on Figure \*), and methylene chloride (maximum 19  $\mu\text{g/L}$ ). The method blank accompanying the duplicate acetone readings has an acetone concentration of 30  $\mu\text{g/L}$ . The majority of method blanks for methylene chloride are contaminated.

### Trends

After what may have been a slight increase in the previous reporting period, sulfate levels appear to be stable in the 10 mg/L range. No other trends are apparent, and no impacts from leachate are evident at MW-55.

### Aquifer 2, Stratigraphic Unit F

Two wells, MW-56 and MW-57, were installed and monitored as part of the South Cedar Hills Remedial Investigation. A third well, MW-60, was installed as part of a related project, the Queen City Farms Remedial Investigation. These three wells have only recently been placed on the quarterly monitoring schedule. Data for the wells is only included in tabular form since insufficient data exists to perform statistical evaluations.

As discussed in Chapter 2, the general flow direction of Aquifer 2 below Cedar Hills is north to northeast. MW-56, MW-57 and MW-60 can therefore be considered upgradient to the Cedar Hills site.

\*Are we including these wells in this document even though they are part of the RI?

### Aquifer 3, Stratigraphic Unit H

A total of ten wells are completed in the upper portion of Aquifer 3. However, two wells, MW-58 and MW-59, are treated as part of the remedial investigation of Queen City Farms and will not be included here. The eight wells to be

discussed are: MW-21, MW-22, MW-24, MW-43, MW-44, MW-53, MW-58 (MW-58A), MW-59, MW-PW1, and MW-OS1 (see Figure \_\_\_). MW-PW1 is the on-site production well, and MW-OS1 is one of the off-site wells, (Figure \_\_\_ and \_\_\_). The plotted data for selected parameters are provided in Appendix \_\_\_. For each well, the following parameters will be covered: pH, specific conductance, COD, Cl, total inorganic nitrogen, sulfate, dissolved iron, and dissolved manganese. Data from the upper portion of Aquifer 3 are described below.

\*Are we including MW-58 and MW-59 even though they are part of RI?

### Indicator and Non-metal Parameters

#### pH

In Aquifer 3, pH ranges from a low of 6.1 in MW-OS1 to a high of 8.45 in MW-22. The box plots, Figure \*, show a wide band of overlap across the neutral pH region in most wells. Wells that tend to have slightly more acidic water include MW-24 and MW-OS1, whereas those with more alkaline values include MW-22, MW-43 and MW-53. The narrowest pH ranges are found in MW-24, MW-44, and MW-PW1. The largest gap between readings comes in MW-53 and has a magnitude of about 1.5 pH units. The remainder of the wells have fairly slight to moderate fluctuations. Six wells have readings at or below the secondary standard range of 6.5-8.5. They are: MW-21 (min 6.4), MW-22 (min 6.5), MW-24 (min 6.29), MW-43 (min 6.44), MW-PW1 (min 6.44), and MW-OS1 (min 6.1).

#### Specific Conductance

There is a broad range of specific conductance values from 96  $\mu\text{S}/\text{cm}$  in MW-21 to 307  $\mu\text{S}/\text{cm}$  in MW-24 within Aquifer 3. It becomes apparent when viewing the

box plots, Figure \*, that most values fall between 100-200  $\mu\text{S}/\text{cm}$  except in MW-24. In this well, values (range 245 - 307  $\mu\text{S}/\text{cm}$ ) are significantly higher than those of the other wells. MW-24 perhaps also has slightly greater fluctuations (up to 50  $\mu\text{S}/\text{cm}$ ) than the other wells (up to 25  $\mu\text{S}/\text{cm}$ ). In general, however, specific conductance appears to be fairly stable in this aquifer. A comparison of previous laboratory data shows less variability in the current field data. There are no state or federal standards for this parameter.

#### COD

COD is undetectable in MW-21, MW-22, MW-24, and MW-PW1. The only detections in the remaining wells are as follows: MW-43 (19, 20 mg/L), MW-44 (15, 15, 22 mg/L), MW-53 (19 mg/L), and MW-OS1 (32 mg/L). There are no state or federal standards for COD in ground water.

#### Chloride

Chloride concentrations range from below detection to 81 mg/L. It is evident that MW-24 has higher chloride concentrations (median 7.35 mg/L) than the other wells (median 1.2 - 4 mg/L). In addition, this well has slightly larger fluctuations than the other wells which are characterized by fairly stable concentrations except for sporadic spikes (see time plots, Figures \* through \*). Previous data suggest that chloride levels in MW-24 declined to a low of around 4 mg/L at the end of 1989 and have since increased slightly. No other trends are evident and no values in this aquifer exceed the state and federal secondary standards of 250 mg/L.

#### Total Inorganic Nitrogen

The level of total inorganic nitrogen in this aquifer ranges from 0.035

to 2.42 mg/L. However, it is clear from the box plots, Figure \*, that MW-44 (range 0.035 - 2.23 mg/L) and MW-OS1 (range 0.91 - 2.42 mg/L) are responsible for the high-end values. The typical range in the remaining wells is below 0.2 mg/L where little variability is seen. In contrast, as exhibited by time plots, Figures \* through \*, both MW-44 and MW-OS1 have higher variability with fluctuations of up to 2 mg/L between readings. The elevated levels at these two wells are due to higher concentrations of nitrate. No patterns of increase or decrease are evident in any of the wells, and no values exceed the 10 mg/L state and federal primary standard for nitrate alone.

### Sulfate

Sulfate levels range from below detection to 25 mg/L. It is apparent from the box plots, Figure \*, that three wells, MW-24, MW-43, and MW-PW1 have higher sulfate concentrations in the range 10 - 20 mg/L for the majority of data, and the remaining wells have values below 10 mg/L. The highest value, 25 mg/L, is an outlier in MW-43. In general, the three high-end wells also have broader ranges, though there are outliers in low-end wells, MW-44 (15 mg/L) and MW-OS1 (11, 13 mg/L) which increase their variability. For MW-24, a comparison of the previous data indicates a continuing decline in sulfate. In contrast, evidence in the current data suggests a slight increase in sulfate in MW-PW1 (see time plots, Figures \* through \*). None of these values are close to the state and federal secondary standard of 250 mg/L.

### Metal Parameters

#### Dissolved Iron

Neither MW-PW1 nor MW-OS1 is included for dissolved iron or manganese.

The range of dissolved iron in this aquifer is from below detection to 10 mg/L. The box plots, Figure \*, illustrates the dissimilarity between MW-24 and the other wells. Not only does MW-24 have the highest values in the aquifer--all above 3.6 mg/L--but it also has the broadest range. The other wells have values below 4 mg/L and their ranges tend to be relatively narrow. As exhibited by time plots, Figures \* through \*, dissolved iron is moderately stable in most wells except for occasional fluctuations of up to 2 mg/L with no temporal trends evident. MW-24, however, shows an apparent increasing trend beginning in February, 1990, after a period of decline (see previous data). There are exceedances of the state and federal secondary standard of 0.3 mg/L for total iron in all of the wells except MW-53 (max 0.06 mg/L), as follows: MW-21 (11 of 12, max 3 mg/L), MW-22 (7 of 11, max 1.2 mg/L), MW-24 (14 of 14, max 10 mg/L), MW-43 (9 of 10, max 1.4 mg/L), and MW-44 (3 of 17, max 1 mg/L).

#### Dissolved Manganese

Concentrations of dissolved manganese range from 0.014 to 1.1 mg/L. Similar to dissolved iron, MW-24 has the highest values ranging from 0.4 to 1.1 mg/L, as displayed in the box plots, Figure \*. Intermediate values are found in MW-22 (08 - 0.36 mg/L), and MW-43 (0.16 - 0.23 mg/L). Comparatively lower values are present in MW-21 (0.028 - 0.18 mg/L), MW-44 (0.014 - 0.05 mg/L), and MW-53 (0.07 - 0.1 mg/L). The ranges of MW-21, MW-22, and MW-24 appear to be broader than the other wells and there are some fluctuations of 0.2 to 0.4 mg/L between readings in these wells, as shown by the time plots, Figures \* through \*. Additionally, the behavior of dissolved manganese in MW-24 may mirror the slight increase in dissolved iron in this well, though the pattern is not as clear.

## Total Iron

Only MW-OS1 and MW-PW1 are included for total iron, manganese, and zinc. It should be noted that MW-PW1 has only four sampling dates compared to 10 for MW-OS1. Levels of total iron are significantly lower in MW-OS1 (0.035 - 0.01 mg/L) than in MW-PW1 (0.04 - 1.7 mg/L). MW-OS1 also has a narrower range of values, as displayed by the box plots, Figure \*. No trends are apparent, and there are no exceedances of the state and federal standard (0.3 mg/L) in MW-OS1. In MW-PW1, five out of six readings (includes one set of duplicates) exceed this limit.

## Total Manganese

Total manganese ranges from 0.01 to 0.07 mg/L in MW-PW1, and there are detections in MW-OS1 of 0.004 and 0.01 mg/L. The distribution between these two wells is similar to that of total iron, as illustrated by the box plots, Figure \*. No trends are apparent (see time plots, Figures \* and \*). In MW-PW1, five out of six readings exceed the state and federal standard of 0.05 mg/L.

## Total Zinc

The level of total zinc is from below detection to 0.041 mg/L in MW-OS1, with fluctuations of more than 0.02 mg/L between some readings. In contrast, there are only two detections, 0.02 and 0.14 mg/L, in MW-PW1. None of the concentrations in either well exceeds the state and federal standard of 5 mg/L, and no temporal trends are seen.

## INDIVIDUAL WELLS

MW-21 -- MW-21 is an on-site well located 600-625 feet within the western

property boundary in the northwest corner of the site. This well is screened between 155 ft and 163 ft bgs.

The water in this well has a pH range of 6.4 to 7.85, median 6.75. The two lowest pH values, 6.4 and 6.42, lie outside the secondary criterion range of 6.5 - 8.5. Specific conductance at MW-21 is stable in the range of 96 to 117  $\mu\text{S}/\text{cm}$  (mean 107  $\mu\text{S}/\text{cm}$ ), and has the lowest values in the aquifer. No COD is detectable. Chloride levels, varying from ND to 4 mg/L (median 2 mg/L), are similar to many other wells in the aquifer. Sulfate concentrations span a moderate range from 2.5 to 10 mg/L (median 7 mg/L). Low levels of total inorganic nitrogen are similar to the majority of wells in Aquifer 3 and fall within the range, 0.035 - 0.34 mg/L. Dissolved iron (0.2 - 3 mg/L, median 1.9 mg/L) is slightly higher than other wells except for MW-24, and eleven out of twelve readings exceed the secondary water quality standard of 0.3 mg/L for total iron. Dissolved manganese ranges from 0.028 to 0.1 mg/L with an outlier at 0.18 mg/L. Three out of twelve of these values surpass the secondary criterion of 0.05 mg/L for total manganese.

### Trends

No trends are evident in the time graphs for MW-21, and there is no apparent impact from leachate.

**MW-22** -- MW-22 is located within the site property boundary in the northeast corner of the site and is screened between 265 ft and 275 ft bgs.

MW-22 has a slightly alkaline pH which ranges from 6.5 to 8.45 (median 7.3). Specific conductance is relatively stable in the range of 130 to 162  $\mu$ S/cm. Chloride concentrations are around 2 mg/L with one outlier at 59 mg/L. Sulfate levels fluctuate around a mean of 5.4 mg/L. Low levels of total inorganic nitrogen are present in the range of 0.035 to 0.13 mg/L. One out of eleven samples has an undetectable dissolved iron concentration, with the remaining samples having values above the secondary standard (range 0.3 - 1.2 mg/L) for total iron. It should be noted that the method blank associated with the highest sample value displays a level of 0.02 mg/L dissolved iron. All readings of dissolved manganese, ranging from 0.08 to 0.36 mg/L, are above the secondary water quality standard for total manganese.

### Trends

There may be a slight increase in dissolved manganese levels in MW-22 continuing from the previous sampling period. Otherwise, no trends are seen and no impacts from leachate are evident.

MW-24 -- MW-24 is an on-site well adjacent to MW-25. Located approximately 500 feet inside the southern property boundary, this well is screened between 188 ft and 193 ft bgs.

The pH ranges from 6.29 to 7.57 with a median of 6.74. With

values ranging from 245 to 307  $\mu\text{S}/\text{cm}$  (median 275  $\mu\text{S}/\text{cm}$ ), MW-24 has the highest specific conductance in the aquifer. No COD is detectable. Chloride concentrations are elevated slightly above those of the other wells (median 7.35 mg/L) with an atypically high outlier at 81 mg/L. Total inorganic nitrogen levels are low (0.035 to 0.16 mg/L), but sulfate levels are moderately high and variable with a range of 2.4 to 20 mg/L (median 14 mg/L). The concentration range of dissolved iron, 3.7 - 10 mg/L, is the highest in the aquifer and is entirely above the secondary standard for total iron. The same is true for dissolved manganese which ranges from 0.4 to 1.1 mg/L.

### Trends

After a decline in chloride shown in historical data for this well, there appears to be an increase in this parameter during the current sampling period. A similar pattern is evident in the readings for dissolved iron. No trends are readily apparent in this well.

**MW-43** -- MW-43 is located in the uppermost northeast region of the site. It is within 100 feet of the eastern property boundary and is screened between 298 ft and 310 ft bgs.

One sample shows a pH value (6.44) slightly below the secondary standard range of 6.5 - 8.5. The remaining pH readings range up to 8.22 with a neutral median of 7.1. The specific conductance

spans a narrow range from 150 to 180  $\mu\text{S}/\text{cm}$  (median 165  $\mu\text{S}/\text{cm}$ ). Only two samples have detectable levels of COD (19, 20 mg/L). The chloride concentrations are relatively low and range from ND to 6.2 mg/L. In contrast, sulfate levels are moderately high and variable much like those found in MW-PW1. Sulfate ranges from 9 to 20 mg/L with an outlier of 25 mg/L. The field blank associated with the top sample value contains 4.5 mg/L sulfate, and the trip blank taken on the same date has a sulfate level of 6 mg/L. Like the majority of wells in this aquifer, the total inorganic nitrogen concentrations in MW-43 are low (0.035 - 0.17 mg/L). Dissolved iron ranges from 0.12 to 1.4 mg/L with all values lying above the secondary water quality standard for total iron of 0.3 mg/L. The field and trip blanks associated with the lowest iron reading show levels of 0.06 and 0.03 mg/L dissolved iron, respectively. The levels of dissolved manganese are also above the secondary criterion for total manganese, but are more stable at a mean value of 0.218 mg/L.

### Trends

There are no apparent patterns in the ground water readings for this well. No evidence points to leachate impacts.

**MW-44** -- MW-44 is found along the eastern edge of the site within the site boundary. It is screened between 267 ft and 277 ft bgs.

This well is characterized by a pH range of 6.66 to 7.73

averaging 6.93. Specific conductance is within the range typical for this aquifer with stable values from 110 to 136  $\mu\text{S}/\text{cm}$ . Like MW-43, only two detections of COD are seen (15 and 22 mg/L). Chloride levels are similar to those found in MW-21 and span the range of ND to 4.4 mg/L (median 2 mg/L). Levels of total inorganic nitrogen are noticeably different in this well; the range is relatively broader (0.035 to 2.23 mg/L) and the magnitude higher than in the other wells. The primary cause of the elevated inorganic nitrogen is the level of nitrate. Sulfate concentrations center around a median of 4.5 mg/L with several low outliers and one high outlier (15 mg/L). Dissolved iron (ND - 1 mg/L) and dissolved manganese (0.014 - 0.05 mg/L) are relatively low, however, two out of fifteen iron results and one manganese reading fall at or above the secondary water quality criteria for total iron and manganese. A field blank containing 0.06 mg/L dissolved iron is associated with duplicate iron readings of 0.43 and 0.45 mg/L. In addition, it is important to note that the method blank associated with one manganese reading of 0.02 mg/L contains a level of 0.01 mg/L dissolved manganese.

### Trends

No trends emerge when the data for this well are plotted over time. There is a relatively large fluctuation in total inorganic nitrogen (nitrate), but there are no reasons to conclude that this well is being impacted by the landfill.

MW-53 -- MW-53 is an on-site well located in the southwest corner of the site along the western edge of the property. Screening occurs between 278 ft and 298 ft bgs.

Levels of pH (6.74 - 8.4), specific conductance ( 100 - 121  $\mu$ S/cm), and COD (one detection at 19 mg/L) are relatively stable and unremarkable. Chloride (2 - 4.7 mg/L, median 3.75 mg/L) and sulfate (ND - 5.6 mg/L, median 2.85 mg/L) concentrations are within the typical range for this aquifer. Total inorganic nitrogen ranges from 0.035 to 0.21 mg/L, with ammonia and nitrate contributing to the top values. Dissolved iron concentrations at MW-53 are the lowest in the aquifer and lie at or below 0.06 mg/L. In contrast, dissolved manganese levels are moderate and range from 0.07 to 0.1 mg/L, with all points above the secondary criterion of 0.05 mg/L for total manganese.

#### Trends

No trends or impacts are apparent at this well.

MW-PW1 -- MW-PW1 is an on-site production well located far within the property boundaries in the southeast region of the site. It is screened between 337 ft and 347 ft bgs.

The pH in MW-PW1 has both acidic and alkaline values, ranging from 6.44 to 7.31 (median 6.8) with the lowest one falling below the secondary criterion range for drinking water of 6.5 - 8.5.

Specific conductance ranges from 140 to 210  $\mu\text{S}/\text{cm}$  (median 170  $\mu\text{S}/\text{cm}$ ). No COD is detectable in this well. Ranging from 2.4 to 5.2 mg/L, levels of chloride in MW-PW1 are similar to those in MW-53. Sulfate concentrations (11 - 19 mg/L) are among the highest in the aquifer at levels similar to those found in MW-43. In contrast, total inorganic nitrogen concentrations (0.035 - 1.14 mg/L) are on par with the majority of wells in the aquifer except for a high outlier at 1.14 mg/L (not shown on graph due to averaging). There are only four values shown on the graphs for each of the total metals. The patterns for iron and manganese are the same, namely; one sample taken on 7/22/91 has a value below the secondary water standard, whereas the remaining readings are above this limit. The readings for total zinc are the reverse. The reading on 7/22/91 is the highest at 0.14 mg/L (though below the secondary standard of 5 mg/L for total zinc), and the remainder of readings are at or below the limit of detection.

### Trends

It is possible that slight increases in specific conductance, chloride and sulfate concentrations are occurring in the ground water in MW-PW1. \*? Although such increases are minor in magnitude and involve a small number of data points, they may suggest possible impacts from leachate at this well. ?

MW-OS1 -- MW-OS1 is the only off-site well located in this aquifer. It lies

500-600 feet outside the eastern property boundary and is screened between 156 ft and 158 ft bgs.

The average pH (median 7.1, range 6.1 - 7.67) at MW-OS1 is typical of the other wells in the aquifer. However, MW-OS1 contains the lowest pH value (6.1) within the aquifer. In addition to the low point, one other point at 6.46 is below the secondary standard range for pH. Specific conductance ranges from 120 to 150  $\mu\text{S}/\text{cm}$  with a median of 130  $\mu\text{S}/\text{cm}$ . COD and chloride each have one high outlier. For COD, the point at 32 mg/L is the only detectable value. Values for chloride range from 1 to 6.6 mg/L with a median of 2 mg/L. Chiefly due to nitrate levels, the variable total inorganic nitrogen concentrations in this well are the highest in the aquifer (0.91 to 2.42 mg/L) and overlap with values found in MW-44. Sulfate concentrations center around 6.85 mg/L with two outliers (11 and 13 mg/L). There are no exceedances of secondary standards by total iron (ND - 0.09 mg/L), manganese (ND - 0.01 mg/L), or zinc (ND - 0.041 mg/L).

### Trends

No temporal trends are evident in MW-OS1. Aside from total inorganic nitrogen, no parameters are elevated at this well, thus no leachate impacts are thought to be occurring.

### Aquifer 3, Stratigraphic Unit J and Lower

One on-site monitoring well (MW-54, Figure \*) is completed in Aquifer 3, below unit H. The three remaining off-site wells (MW-OS2, MW-OS3, MW-OS4: see Figure \_\_\_) are also completed below unit H, and may or may not be located within Aquifer 3. In MW-54, only the following leachate indicator parameters will be discussed: pH, specific conductance, COD, chloride, sulfate, total inorganic nitrogen, dissolved iron, and dissolved manganese. In the three off-site wells, the same parameters will be discussed except that total iron, manganese, and zinc will be included instead of the two dissolved metals listed above. Plotted data for these selected parameters are provided in Appendix \_\_\_.

#### Indicator and Non-metal Parameters

##### pH

MW-54 and MW-OS3 tend to have more alkaline pH levels in the range 7.19 to 8.56, than MW-OS2 and MW-OS4 which have values from 7.011 to 7.77 (see box plots, Figure \*). The breadth of ranges is similar in all four wells. There are no exceedances of secondary standards in MW-54. However, MW-OS2 has a low value outside the secondary standard range, whereas MW-OS3 has one high value outside the range, and MW-OS4 has two values below the range.

##### Specific Conductance

In this aquifer, specific conductance ranges from 120 to 248  $\mu\text{S}/\text{cm}$ . Similar to pH, MW-OS2 and MW-OS4 have lower levels (120 - 182  $\mu\text{S}/\text{cm}$ ) than are found in the other two wells, as shown in the box plots, Figure \*. The

highest values are present in MW-OS3 (215 - 248  $\mu\text{S}/\text{cm}$ ) and intermediate values are found in MW-54 (175 - 200  $\mu\text{S}/\text{cm}$ ). MW-OS2 has the highest variability between readings, displayed by the time plots, Figures \* through \*. There are no applicable state or federal criteria for specific conductance.

#### COD

COD is not detectable in these wells except for rare spikes, as follows: MW-54 (1800 mg/L); MW-OS2 (26 and 44 mg/L); MW-OS3 (29 mg/L); and, MW-OS4 (29 mg/L) (refer to box plots, Figure \*, and time plots, Figures \* through \*). There are no state or federal standards for COD.

#### Chloride

Chloride concentrations vary from below detection to 22 mg/L. The high-end value of 22 mg/L appears as an outlier in MW-OS2. The median values in MW-54, MW-OS2 and MW-OS3 are between 1.5 - 3 mg/L, as seen on the box plots (Figure \*), whereas for MW-OS4 it is 6 mg/L. Fluctuations of up to 2 mg/L between readings can be seen in some wells (time plots, Figures \* through \*). None of the concentrations is near the secondary standard of 250 mg/L.

#### Total Inorganic Nitrogen

The level of total inorganic nitrogen ranges from 0.035 - 2.72 mg/L, however, MW-54 and MW-OS3 have low ranges with medians of 0.035 mg/L. In contrast, the medians of MW-OS2 and MW-OS4 are around 0.4 mg/L. Aside from one high outlier of 2.72 mg/L in MW-OS2, values appear to be stable and far below the 10.0 mg/L standard for nitrate alone.

## Sulfate

As indicated by the box plots (Figure \*), the lowest sulfate values appear in MW-54 with only three detections (1.5, 4.1, and 4.5 mg/L). Intermediate values are found in MW-OS3 (2.4 - 6.4 mg/L), and MW-OS4 (ND - 9 mg/L), and fluctuate up to 4 mg/L between readings. MW-OS2 has the highest sulfate concentrations (6.8 - 28 mg/L, median 8.5 mg/L) with two high outliers (15 and 28 mg/L). There are no exceedances of the secondary standard of 250 mg/L for sulfate.

## Metal Parameters

### Dissolved Iron

Only MW-54 is included here. This well has variable dissolved iron concentrations ranging from below detection to 0.11 mg/L. The median is 0.06 mg/L and there are no exceedances of the secondary standard of 0.3 mg/L for total iron. (Refer to box plots, Figure \*, and time plots, Figure \*).

### Dissolved Manganese

Only MW-54 is included here. Levels range from below detection to 0.06 mg/L. The high-end reading is an outlier, as indicated by the time plot (Figure \*). Otherwise, the values are relatively stable with a median of 0.019 mg/L. One out of eleven samples exceeds the state and federal secondary standard of 0.05 mg/L for total manganese.

### Total Iron

MW-54 is not included here. Total iron ranges from below detection to 35 mg/L. However, as displayed by the box plots, Figure \*, values in MW-OS2

(ND - 35 mg/L) are significantly higher than those in both MW-OS3 (ND - 0.18 mg/L) and MW-OS4 (ND - 0.12 mg/L). There are no exceedances of the state and federal secondary standard in the latter two wells. In MW-OS2, values fluctuate widely (see time plot, Figure \*), and 9 out of 19 readings exceed the 0.3 mg/L secondary standard.

#### Total Manganese

MW-54 is not included here. As with total iron, lower values are present in MW-OS3 (0.27 - 0.04 mg/L) and MW-OS4 (ND - 0.06 mg/L) than in MW-OS2 (ND - 0.52 mg/L). Values in MW-OS2 have high variability with greater than 0.4 mg/L gaps between readings, and 9 out of 19 results exceed the state and federal secondary standard of 0.05 mg/L. One exceedance of the secondary standard also occurs in MW-OS4.

#### Total Zinc

MW-54 is not included here. The box plots, Figure \*, illustrate the discrepancy in total zinc levels among the three wells; MW-OS4 has the highest (0.34 - 0.81 mg/L); MW-OS2 has intermediate (ND - 0.51 mg/L); and, MW-OS3 has the lowest values (ND - 0.72 mg/L). Outliers contribute to the broad ranges in MW-OS2 and MW-OS4, and the variability can be seen in the time plots, Figure \* through \*. There are no exceedances of the state and federal secondary standard of 5 mg/L.

#### INDIVIDUAL WELLS

MW-54 -- MW-54 is found on-site in the southeast corner of the property 250-300 feet from the eastern property line in close proximity to MW-48. This

well is screened between 328 ft and 350.5 ft bgs.

Entirely within the basic range, MW-54 has pH values from 7.4 to 8.4 (median 7.8). This well has specific conductance values ranging from 128 to 200  $\mu\text{S}/\text{cm}$ . COD is undetectable except for one anomalous reading at 1800 mg/L. Chloride concentrations which range from 0.5 to 2.3 mg/L are the lowest in the aquifer. Sulfate is detectable in three of eleven samples with a maximum of 4.5 mg/L. The level of total inorganic nitrogen (0.035 - 0.24 mg/L) overlaps with the range found in MW-OS3. For dissolved iron, values range from ND to 0.11 mg/L (median 0.06 mg/L), and for dissolved manganese, values range from ND to 0.06 mg/L (median 0.019 mg/L), with only the highest manganese reading exceeding the secondary water quality standard of 0.05 mg/L for total manganese.

### Trends

Concentrations in MW-54 appear to be relatively stable with no trends and no apparent impacts from leachate.

**MW-OS2** -- MW-OS2 is an off-site well located on privately owned land adjacent to the landfill property approximately 500 feet from the eastern property boundary. It is screened at approximately 400 ft bgs. .

### Indicator Parameters

Levels of both pH and specific conductance are similar to those at MW-OS4. The pH at this well ranges from 6.36 to 7.68 with a median of 7.22. Specific conductance has a range of 120 to 170  $\mu\text{S}/\text{cm}$  (median 143  $\mu\text{S}/\text{cm}$ ). COD is undetectable at MW-OS2 except for two samples (26 and 44 mg/L). The concentration of chloride is fairly stable at around 2 mg/L, except for one reading at 22 mg/L. Sulfate concentrations range from 6.8 to 28 mg/L with a median of 8.5 mg/L. Total inorganic nitrogen values are below 0.7 mg/L (median 0.43 mg/L) except for an outlier at 2.7 mg/L caused by a peak in nitrate concentration. The concentrations of total iron and total manganese are higher and more variable at MW-OS2 than at other wells in the lower Aquifer 3. Iron ranges from ND to 35 mg/L (median 0.775 mg/L), and manganese ranges from ND to 0.52 mg/L (median 0.053 mg/L). In both cases, nine out of 22 sample results for these metals exceed the respective secondary state and federal criteria levels. Total zinc levels at MW-OS2 lie intermediate between those at MW-OS3 and MW-OS4, and range from ND to 0.51 mg/L.

### Trends

Aside from possible slight increases in specific conductance and total zinc, there are no apparent trends in this well and no apparent impacts from leachate.

**MW-OS3** -- MW-OS3 is another off-site well located on privately owned land. This well is found 700-800 feet from the southeast corner of the property and

is screened at approximately 200 ft bgs.

### Indicator Parameters

Similar to MW-54, the ground water in this well is alkaline and has a pH range of 7.56 - 8.56 with a median of 7.8. Specific conductance (215 - 248  $\mu\text{S}/\text{cm}$ , median 220  $\mu\text{S}/\text{cm}$ ) is higher than in the other wells within the aquifer. No COD is detectable except for one value of 29 mg/L which occurs in the same sampling batch as one of the outliers in MW-OS2. Chloride ranges from 1.5 to 4 mg/L with a median of 2.95 mg/L. The concentration of sulfate is moderate and ranges from 2.4 to 6.4 mg/L. Total inorganic nitrogen is uniformly low at values below 0.12 mg/L. Six out of nine samples have no detectable total iron, and the values for the remaining three samples (0.04, 0.05, and 0.18 mg/L) are below the secondary standard of 0.3 mg/L. For total manganese, the concentrations are stable at about 0.03 mg/L (range 0.027 - 0.04 mg/L). The maximum concentration of total zinc at MW-OS3 is 0.072 mg/L, with other values often falling below the limit of detection.

### Trends

No trends are observed in this well.

**MW-OS4** -- MW-OS4, like MW-OS2 and MW-OS3, is located outside the landfill boundary, near the northeast corner of the property. This well is screened at

approximately 258 ft bgs.

### Indicator Parameters

The ground water in MW-OS4 has a pH range of 6.45 to 7.77, similar to that of MW-OS2. Specific conductance is slightly higher than at MW-OS2, and has values spanning a narrow range of 140 to 180  $\mu\text{S}/\text{cm}$ . Like the other three wells in this aquifer, COD is undetectable at MW-OS4 except for an outlier of 29 mg/L, again occurring in the same analytical batch as the outliers in wells MW-OS2 and MW-OS3. Fairly stable chloride concentrations, elevated compared to other wells, reach the range of 5 to 7 mg/L. More variable sulfate concentrations range from ND to 9 mg/L. The level of total inorganic nitrogen is stable at about 0.4 mg/L. Total iron concentrations are low ranging from ND to 0.05 mg/L with an outlier of 0.12 mg/L. Total manganese is detectable in three out of thirteen samples at levels of 0.002, 0.004, and 0.06 mg/L, the highest of which exceeds secondary drinking water standards. MW-OS4 has the highest total zinc concentrations in the aquifer (range 0.334 - 0.81 mg/L). However, the highest zinc reading is associated with a method blank containing 0.02 mg/L total zinc.

### Trends

There is possibly a slight increase in the concentration of total zinc in this well. Otherwise, no trends are apparent, and no impacts from

leachate are evident.

### Summary

Generally, and as might be expected, wells close to the surface, particularly water in wells perched in till or the Stratified Drift layers, show some evidence of impact from the landfill. This is true in wells MW-30/30A, MW-42D, and MW-42S where elevated concentrations of some constituents have been detected.

Other wells in the shallow zones may show elevated concentrations of indicator parameters and detections of volatile organic compounds. As expected from the highly variable nature of the geology in the shallow zones, the levels of indicator parameters are highly variable. In addition, trends of indicators appear to be variable; no consistent pattern is obvious by stratigraphic grouping. This may be due to the fact that, as noted in the geology description, the shallow aquifer zones may not be in hydraulic connection over extended distances.

Most occurrences of "elevated" parameters show decreasing trends for the period of record (MW-39, MW-25\*, MW-50, MW-42D, \*insert another well here that may have been accidentally erased, and MW-28) and may imply that current management practices and corrective actions being implemented at the site are resulting in reductions in existing and potential impacts. \*Add re increasing trends.

Wells sampled in Aquifers 2 and 3 and in the deeper zone show no evidence of impact from surface activities. \*What about MW-PWI? Generally, indicator parameter levels in these zones are more consistent among wells than for the drift and till units; levels appear to be characteristic of general aquifer conditions.