24th ANNUAL REPORT
URBANA LANDFILL COMPLEX

GROUNDWATER MONITORING ACTIVITIES
MONITORING YEAR 2015

Prepared for

CHAMPAIGN-URBANA
SOLID WASTE DISPOSAL SYSTEM

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REFERENCE MATERIAL – IN POCKET

CD-ROM containing laboratory data, historical groundwater data, statistical files, and other relevant items.

EXECUTIVE SUMMARY

This report covers groundwater-monitoring activities at the Urbana Landfill Complex from January through December 2015. Glasford Formation monitoring wells were sampled and the groundwater samples analyzed for a suite of thirteen (15) parameters during the Second and Fourth Quarters (Q182 and Q184). Four (4) Wedron Formation monitoring wells were sampled and groundwater analyzed for the same parameters in the Second Quarter only (Q182). Field parameters were collected from all monitoring wells during each of the four quarters of 2015.

The hydraulic head in the upper Glasford Formation appears to have returned to 1999 levels as interpreted from the geomean of the data. Water level measurements for the 2015 monitoring period vary as did water level data over the previous years. Groundwater movement in the Glasford Formation is generally from east to west beneath the ULC area at a relatively low gradient of 0.002 ft/ft.

No significant changes in overall groundwater quality of Glasford Formation groundwater were observed. Concentrations of listed parameters are normal and below the Class I Groundwater Standard with the exception of manganese in groundwater collected from up gradient Monitoring Well 4G105. However, elevated manganese concentrations have been demonstrated to be naturally occurring in the formation thus impact from landfill material is unlikely absent any other indicators.

Groundwater quality in the Wedron Formation as reflected from samples collected from monitoring well 3G102 remains degraded from previous years although somewhat stabilized as of 2015. While the Wedron Formation is neither the target zone nor the formation of concern, the ten (10) acre site monitored by 3G102 requires maintenance to prevent leachate buildup and an increased hydraulic head that likely would create seepage and other problems. Leachate levels should be measured quarterly to determine if pumping is a viable activity to avoid future issues.

Data collected during Monitoring Year 2015 have been added to the ULC groundwater data files and are included on the CD-ROM provided with this report.

Surface water data show no apparent water quality change between upstream and downstream sampling locations for the reach of the Saline Ditch adjacent to the ULC. Monitored constituents generally appear to decrease downstream although the change is not statistically significant.

Based on the laboratory analyses of groundwater collected from the monitoring wells at the Urbana Landfill Complex during the year 2015, there is no indication of any impact to groundwater in the Glasford Formation or surface water quality in the Saline Ditch from the facility.

GROUNDWATER MONITORING ACTIVITIES JANUARY THROUGH DECEMBER 2015

1.0 BACKGROUND

This is the ***24th Annual Report*** on groundwater monitoring activities at the Urbana Landfill Complex (ULC). This report evaluates water level and water quality data collected January through December 2015. PDC Laboratories, Inc. performed data collection and sampling activities as well as analytical laboratory services for the first two quarters of the 2015-monitoring year while Environmental Monitoring and Technologies, Inc. (EMT), did the same for the final two quarters of the 2015-monitoring year. Both contractors were under the supervision of Midwest Engineering and Testing, Inc.

Selected Findings or Recommendations offered in the ***23rd Annual Report*** for 2014 included:

1. The potentiometric surface for groundwater in the Glasford Formation appears to continue the rebound from lower levels as has been observed over the recent years

2. Groundwater quality at the 10-acre site as observed in well 3-G102 continues to bear close observation.

3. Groundwater in up-gradient well 4G105 continues to exhibit dissolved manganese concentrations at or slightly above Class I Groundwater Standards. This is a naturally occurring element and not the result of any input from landfill waste.

4. The installation of a new monitoring well 8G101 has been completed and added to the monitoring system along the southern perimeter of the ULC. Initial laboratory analyses of groundwater collected from the well is consistent with that expected for Glasford Formation groundwater.

5. Based on laboratory analyses of groundwater collected from monitoring wells at the ULC and statistical evaluation of those data, there is no indication of a leachate release from the ULC into the monitored aquifer, the Glasford Formation Aquifer.

6. Based on laboratory analyses of surface water collected from the Saline Ditch reach adjacent to the ULC and statistical evaluation of those data, there is no indication of impact to surface water from activities at the ULC or from buried waste.

2.0 GROUNDWATER ELEVATION DATA

Groundwater elevation data along with three (3) field parameters (temperature, *pH*, and specific conductance) are collected on a quarterly schedule from the closed facility's groundwater monitoring network. This network consists of nine (9) monitoring wells screened in and open to the Glasford Formation and four (4) monitoring wells screened in and open to the Wedron Formation (Plate 1). Monitoring wells 1G103, 4G102, and 6G101 are open to an elevation interval of approximately 562 to 600 feet *National Geodetic Vertical Datum* (NGVD), while 4G104A, 4G105, 5G101, 5G102, 6G102, and 8G101 span an interval of approximately 606 to 641 feet (NGVD).

Monitoring well water level data are generally consistent and synchronous over the period of record. Excursions from the norm for water levels in specific monitoring wells have been discussed in previous annual reports. Figure 1 depicts water level data from 1999 (Q116) through 2015 (Q184) for all wells open to the Glasford Formation. The apparent drop in water levels given by certain 4th Quarter, 2014 and 1st Quarter 2015 monitoring wells is not clearly understood as it is asynchronous. It is not known if this reflects a measurement problem or actual drop in hydraulic head. Nonetheless, the hydraulic head appears to have recovered by 2nd Quarter 2015. Figure 2 shows the interpreted groundwater contours using 2015 water level data that approximate the hydraulic head within the upper Glasford Formation. The general direction of flow continues to appear to be west to west-northwest as in previous years with some variability across the ULC footprint.

Figure 1 also includes geomean data for each Quarter and the trend line for those data. The geometric mean, in mathematics, is a type of mean or average, which indicates the central tendency or typical value of a set of numbers. It is similar to the arithmetic mean, except that instead of adding the set of numbers and then dividing the sum by the count of numbers in the set, *n*, the numbers are multiplied and then the n^{th} root of the resulting product is taken.

The calculated groundwater gradient for 2015 using the drop in the geomean hydraulic head geomean between up-gradient monitoring well 4G105 and down gradient monitoring well 4G102 is essentially the same as previous years, about 0.002. This compares quite favorably with water level data reported for the region as a whole (ISGS, 2006). The geomean for all Upper Glasford Formation water level data appears to have stabilized and recovered through the most recent period of record. The maximum difference over the period noted in Figure 1 as given by the geomean for all well elevations is 5.1-ft. The apparent potentiometric surface of groundwater in the Glasford Formation has recovered to within a foot of that in 1999 (647.38) based on the geomean calculated for this year (647.07).

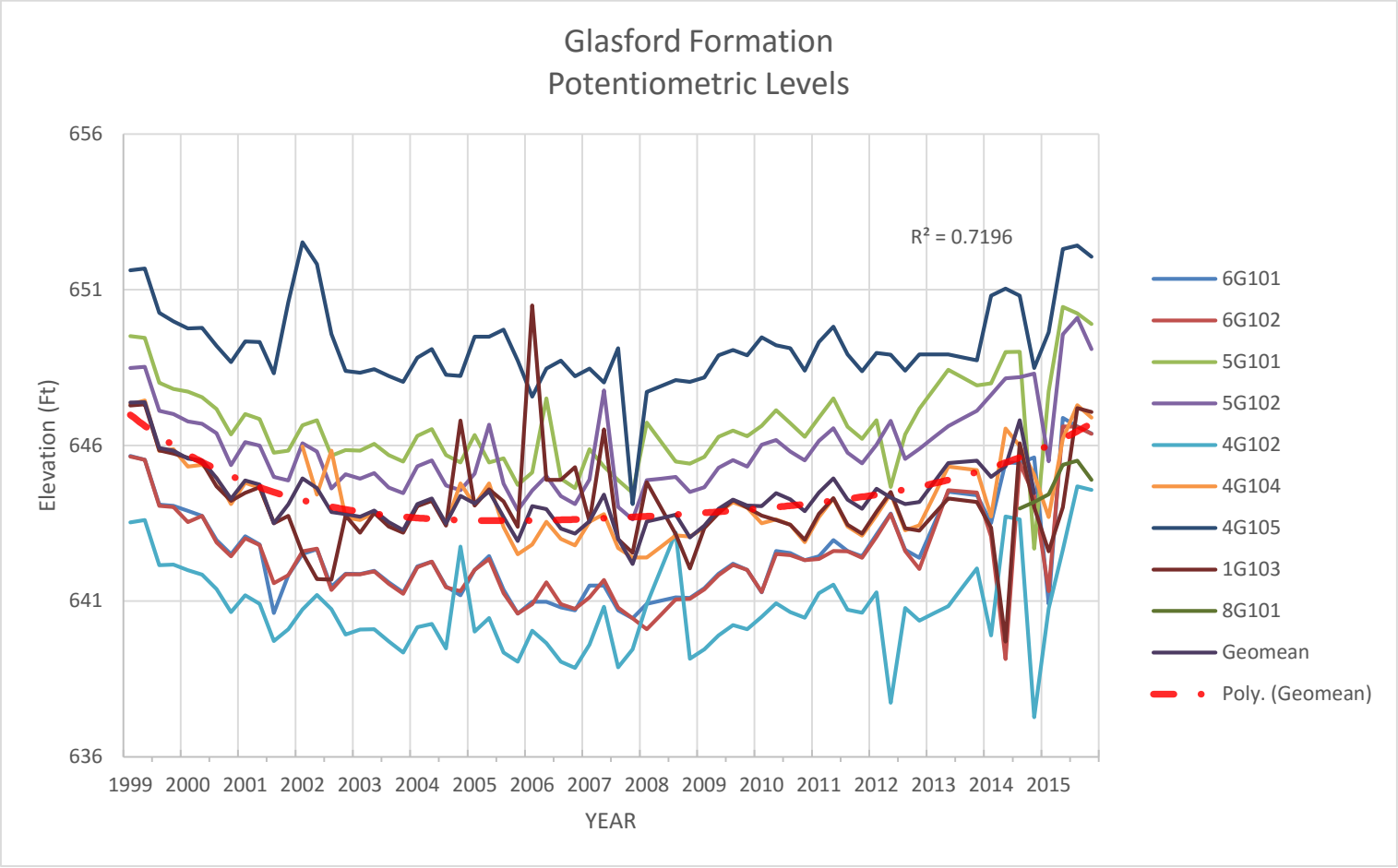

Figure 1 Upper Glasford Formation potentiometric data: 1999 through 2015.
Geomean plotted and 4th order polynomial regression line added.

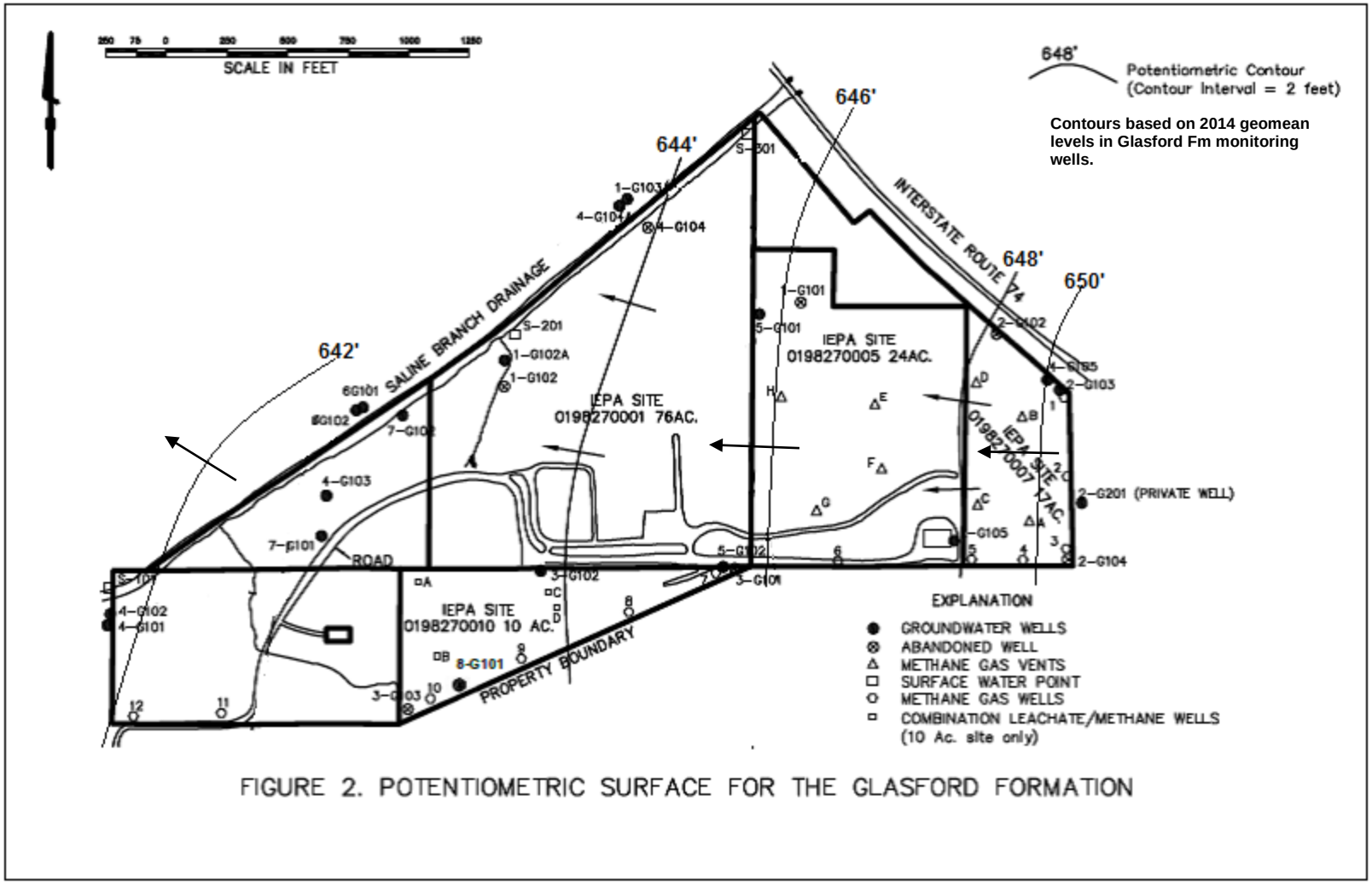

FIGURE 2. POTENTIOMETRIC SURFACE FOR THE GLASFORD FORMATION

Figure 2 Potentiometric contour map of the Upper Glasford Formation. Arrows indicate general direction of groundwater flow in the upper Glasford Formation monitored and is essentially the same as in previous years.

3.0 WATER QUALITY DATA

Groundwater samples are collected during the Second Quarter from both Glasford and Wedron Formation monitoring wells and analyzed for the basic Hoesman Agreement parameters as well as several additional inorganic parameters that were added subsequent to the Agreement. Fourth Quarter sampling for the Hoesman parameters is limited to Glasford Formation monitoring wells. The Hoesman Plus parameters consist of Alkalinity, Hardness, N-Ammonia, Nitrate/Nitrite, Boron, Chloride, Sulfate, Total Dissolved Solids, Total Organic Carbon, Total Organic Halides, and the dissolved concentrations of Iron, Magnesium, Calcium, Manganese, and Sodium.

The analytical results for these groundwater samples as listed in Tables 1 and 2 were supported by full quality control data. Detailed field measurement data and laboratory reports are included in on the accompanying compact data disc.

Table 1 Results of water quality analyses for Quarter 182 (June 2015)

Formation	Glasford (1)									Wedron (1)				Class I (2)
Well Number/ Analyte	1G 103	4G 102	4G 104A	4G 105	5G 101	5G 102	6G 101	6G 102	8G 101	2G 103	2G 105	3G 102	4G 101	
Alkalinity	450	350	400	330	360	380	360	230	NA	430	600	790	380	None
N-Ammonia	4.3	0.60	0.16	<0.10	0.78	1.1	2.4	4.6	2.0	0.19	0.031	<0.10	<0.10	None (3)
Boron	1.7	0.230	0.230	0.092	0.110	0.45	0.140	0.200		0.073	0.280	0.160	0.600	2
Calcium	78	95	81	82	79	66	75	47		110	150	140	78	None
Chloride	<10	6.4	22	14	4.6	3.0	5.3	3.5	4.1	71	89	160	16	200
Hardness	400	510	420	390	430	370	350	210		600	880	960	420	None
Iron	0.019	0.66	0.011	0.010	0.041	0.03	1.2	0.210	1.4	0.064	0.013	4.3	0.065	5
Magnesium	51	67	52	46	56	49	40	22		80	120	150	55	None
Manganese	***0.170***	0.042	0.012	0.0053	0.046	0.061	0.054	0.058	***0.180***	0.800	0.200	1.4	0.011	0.15
Nitrate/Nitrite-N	<0.020	<0.02	4.2	0.73	0.36	<0.020	0.030	0.65		0.031	<0.020	<0.02	0.69	10
Sodium	12	26	27	14	13	23	15	22		36	37	40	33	None
Sulfate	38	28	13	50	42	3.7	<1.0	<1.0	6.8	150	200	41	98	400
TDS	540	460	540	480	480	410	410	260	370	780	1100	1100	590	1200
TOC	5.8	2.2	2.9	1.1	0.92	1.5	1.8	3.2	1.9	2.3	5.2	8.7	8.1	None
TOX (Mean)	0.013	0.021	0.0079	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	0.026	0.051	0.200	0.47	None

(1) Concentrations in parts per million (mg/L). NA = not analyzed. (2) Concentrations for analytes that equal and/or exceed Class 1 Groundwater Standards are shown in ***italicized and bold font*** while concentrations exceeding an "action level" are **boldface type** only. Class I Groundwater Standards stipulate "except as due to natural causes or as provided in Section 620.450" ***but do not apply to the groundwater extracted from the Wedron Formation monitoring wells***. Groundwater Standards in parts per million (mg/L) if stated or None. (3) Action level established at 5 mg/L.

Table 2 Water quality analyses from Quarter 184 (November 2015)										
Formation Monitored	Glasford Monitoring Wells (1)									Class I (2)
Well Number/ Analyte	1G103	4G102	4G104A	4G105	5G101	5G102	6G101	6G102	8G1081	
Alkalinity	312	353	388	410	319	304	346	376	331	None
N-Ammonia	<0.475	<0.950	4.92	2.26	<0.950	<0.950	2.66	4.79	1.6	None
Boron	0.0779	0.137	0.206	1.51	0.09	0.348	0.120	0.253	0.543	2.0
Calcium	88.1	85.5	103	98.8	77.6	67.8	79.3	87.4	67.8	None
Chloride	13.2	5.40	20.0	7.55	3.92	<3.0	4.52	<3.0	4.07	200
Hardness	397	407	453	419	389	334	351	364	327	None
Iron	0.421	2.51	0.621	1.42	0.128	1.53	1.18	3.46	2.66	5.0
Magnesium	42.9	47	47.2	41.8	47.5	40.1	37.3	36.5	38.3	None
Manganese	0.0306	0.073	0.131	***0.254***	0.0424	0.0397	0.0491	0.143	***0.236***	0.15
Nitrate/Nitrite	0.690	<0.5	<0.50	<0.50	1.0	<0.50	<0.50	<0.50	<0.50	10
Sodium	13.1	14.5	23.4	54.1	12.3	21.6	13.5	21.7	39.9	None
Sulfate	46.2	27.6	11.8	33	39	<5.0	<5.0	<5.0	16.1	400
TDS	4.6	386	436	456	378	294	346	366	330	1200
TOC	<1.0	<0.1	2.81	5.61	<1.0	1.03	1.50	3.17	1.90	None
TOX	<0.1	0.124	<0.1	0.144	<0.1	<0.1	<0.1	<0.1	<0.1	None

(1) Concentrations in parts per million (mg/L). N/A = not analyzed. (2) Concentrations for analytes that equal and/or exceed Class 1 Groundwater Standards are shown in ***italicized and bold font*** while concentrations exceeding an "action level" are **boldface type** only. Class I Groundwater Standards stipulate "except as due to natural causes or as provided in Section 620.450." Groundwater Standards in parts per million (mg/L) if stated or None. (3) Action level established at 5 mg/L.

4.0 Saline Ditch

Surface water sampling from the reach of the Saline Ditch flowing adjacent to the ULC had been performed for several years prior to about 1999. It was discontinued for a brief period and then resumed in Fall 2004 when a release of a unknown tar-like substance from the adjacent landfill cell into the Saline Ditch was discovered. Based on chemical analysis, it was simply described as a petroleum based substance (PBS).

Surface water sampling upstream and downstream of landfill contents points are designated as ULC S101 and ULC S301 respectively had been performed on a quarterly schedule until July 2008 when the regional office of the Illinois EPA advised the City of Urbana that quarterly sampling was no longer required. Since that time, semi-annual samples of the surface water in the Ditch have been obtained to verify water quality and identify, if possible, any contaminants of concern.

No organic compounds have been detected in water collected from either sampling location. In fact no organic compounds related to the PBS have ever been detected. No other parameters analyzed exceeded General Water Quality Standards as set forth in 35 IL ADM. Code, Part 302. The chemistry of water sampled from the Saline Ditch at the downstream sampling point is not statistically different compared to the water sampled at the upstream point.

5.0 Leachate Removal

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Periodic seepage of leachate along the north slope of the 24-acre and 17-acre has occurred over the past decade or more. Leachate samples collected from these seeps were analyzed several years ago for inorganic and organic parameters. While the geochemical character of the leachate samples was demonstrably different for the two sites, the constituents measured and the concentration levels reported are typical for leachate from municipal solid waste and posed no significant threat to human health or the environment.

In 2009 a 4-inch diameter leachate recovery well was installed to check leachate levels and, based on the leachate level observed, will be used to reduce hydrostatic pressure within the buried waste by pumping and disposing of excess leachate as it accumulates. A solar-powered pump and associated piping have been fitted to the well and UPW Staff has reported that the system removed approximately 108,040 gallons of leachate in 2015 prior to being shut down for the winter months.

6.0 Discussion

Groundwater Elevations - Groundwater elevation data for 2015 were interpreted to suggest a continued increase of the potentiometric head according to the polynomial trend line of the geomean. That interpretation seems to be supported by the data collected since about 2001 (Figure 1) that appear to indicate recovery following the decline observed in the geomean from 1998 through 2001. In part, the magnitude of apparent recovery is somewhat veiled by the correction in water levels for the period of record noted in the 18th Annual Report (Rapps, 2010).

Water level elevations for 2015 as given by data from Q180 through Q184 mirror the variability noted in prior years. However, there are some apparent differences in hydraulic head at several monitoring locations relative to 4th Quarter 2014 and 1st Quarter 2015 as noted by the reported water level measurements. Water level elevation changes are generally synchronous with respect to observed changes at the various monitoring locations. It is not clear whether this is the result of measurement error or actual fluctuation in hydraulic head. The apparent asynchronous character of the hydraulic head over the monitoring well array does not continue beyond the 1st Quarter 2015.

Regardless, based on the geomean value alone, the hydraulic head in the monitored zone has recovered to within about 1-ft of that observed in 1999 following a depression of more than 5-ft reported previously (Rapps, 2008). Minor changes in groundwater gradient have been previously interpreted as connected to pumping rate variability and public water use associated with Illinois American Water groundwater withdrawals at their facility just west of Lincoln Avenue.

A polynomial trend line is a curved line that is used when data fluctuates such as that observed in water level data for the ULC. The order of the polynomial can be determined by the number of fluctuations in the data or by how many bends appear in the curve; the trend line in Figure 1 is a fourth order computation with an R2 value of 0.71, essentially the same as reported for 2014. The R2 value is a measure of the correlation for a set of data; in this case it is based on the square of the Pearson correlation coefficient between the observed and predicted values.

Water level variability in monitoring wells as measured quarterly is systemically consistent and the direction of groundwater flow in the upper Glasford Formation remains east to west as it has for the period of record. The general direction and gradient of groundwater flow, as interpreted from mean water level

data observed in all Glasford Formation monitoring wells, have not changed in any significant manner over the years these data have been collected. The generalized contours of the Upper Glasford potentiometric surface as interpreted from the geomean of 2015 water level data measured are shown on Figure 2 along with the projected flow path(s) of groundwater across the gradient of that surface. This is essentially the same interpretation given for the past several years and Figure 2 has not changed over the past few years.

Differences in the elevation span(s) to which well screens are placed in Glasford monitoring wells result in a general interpretation as to the position of the equipotential lines. The resultant "bowed" nature of these lines as depicted in Figure 2 is due, in part, to the variance in the lithological character of the Glasford Formation to which the individual well screens are open. However, the generally west direction of movement is an accurate depiction of groundwater flow and this has been the case for the period of record.

The groundwater elevation data from monitoring well 8G101 installed in 2014 on the south side of the landfill footprint (Plate 1, Figure 2) has not altered the map in any significant way.

Groundwater Quality - Groundwater quality data collected for monitoring year 2015 were evaluated using statistical methods including the Shapiro-Francia Test of Normality, Non-parametric Prediction Interval analyses, and Parametric Analyses of Variance (ANOVA). The data for most constituents exhibit a non-normal distribution as they have over the period of record. There were no significant deviations in the data from expected results that would indicate impacts to Glasford Formation groundwater from materials contained within the ULC. The chemical character of groundwater collected from the monitoring wells open to the Glasford Formation remains typical for the formation.

Groundwater quality is evaluated by assessing the concentrations of several constituents of concern as determined by the Hoesman Agreement and by recommendations over the past several years. More specifically, statistical comparisons are made by comparing groundwater quality in up-gradient monitoring wells to that collected from down-gradient wells using a statistical model based on inter-well comparisons. At the ULC the primary up-gradient well is 4G105 while all others are down-gradient wells (Figure 2).

Glasford Formation groundwater as determined from laboratory analyses for the selected suite of parameters has been consistent and predictable from the earliest measurements.

For 2015, all dissolved iron concentrations in groundwater samples from Glasford Formation monitoring wells were lower than the Class I Groundwater Standard, 5.0 mg/L. Dissolved manganese exceeded the Class I standard in up-gradient monitoring well 4G105 and the new down gradient monitoring well 8G101 by 10 ppb. As noted in prior reports, manganese is a natural occurring elemental source in Glasford Formation sediments through which the groundwater moves. Further, statistical evaluation of the data does not indicate impact from anthropogenic sources as no other exceedances of typical leachate constituents were observed. No organic compounds were detected at measurable levels in groundwater sampled from monitoring well 8G101.

Wedron Formation sediments are naturally high in iron and manganese and, therefore, groundwater within the formation also contains relatively high concentrations of these naturally occurring elements. There are no known nearby wells that access this formation for potable water. While the permeability of the Wedron Formation is very low, its overlying stratigraphic position allows for sediments to provide a potential source of iron or manganese as groundwater moves very slowly downward into the upper Glasford Formation.

Four (4) Wedron Formation monitoring wells are sampled and analyzed the 2nd Quarter of each year for groundwater quality parameters as set by the Hoesman Agreement. The results for groundwater collected from monitoring well 3G102 indicated exceedances in chloride, iron and manganese concentrations above the Class I Groundwater Standard and Total Dissolved Solids near the Standard.

However, as noted in previous reports, groundwater flowing into monitoring well 3G102 is not classified as Class I Groundwater and, further, monitoring well 3G102 is not monitoring the target zone. The allowable concentration for Class II groundwater for manganese is 10 mg/l; thus groundwater collected from monitoring well 3G102 does not exceed the appropriate groundwater standard. While groundwater collected from monitoring well 3G102 groundwater has been observed to be high in these four (4) parameters over the past years the 2015 data seem to indicate an apparent leveling off.

Nonetheless, it is likely that the elevated concentrations as compared to years past indicate movement of leachate within the waste. This may be the result of increased infiltration from the surface into the buried waste due to vegetation interruption of the cover and depression development in the cover from degradation of the buried waste. Figure 3 shows the variability of chloride concentrations since the year 2007. Similar but less dramatic increases can also be observed with TDS, iron, and manganese concentrations through the same period.

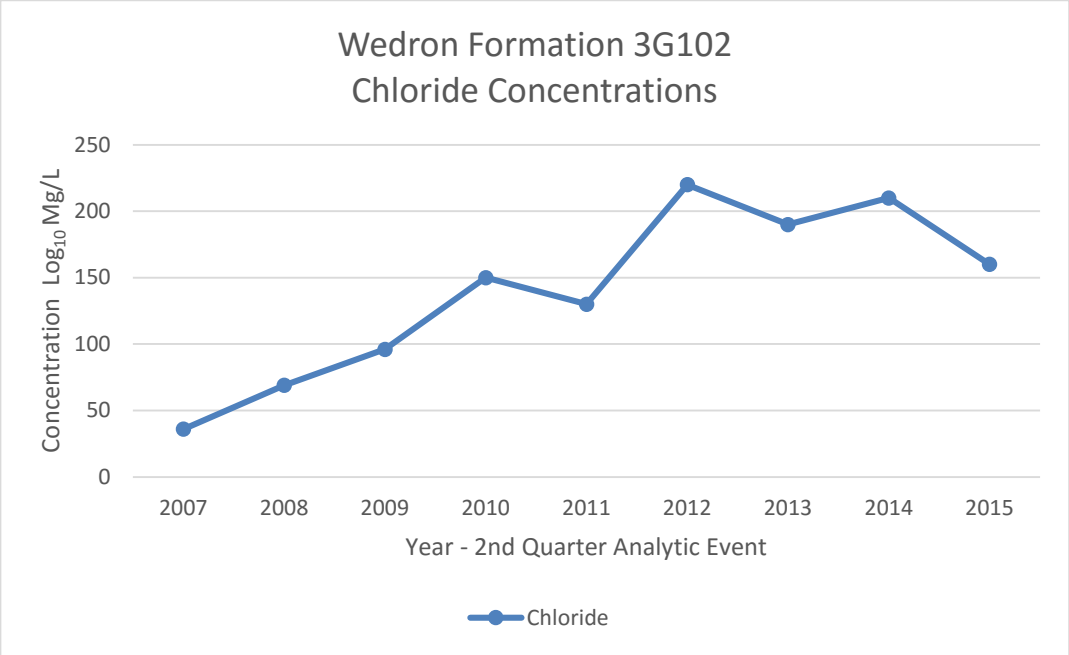

Figure 3 Graph of chloride concentrations measured in groundwater collected from Wedron Formation well 3G102.

More directly, since about 2008 the hydraulic head in monitoring well 3G102 has been slowly increasing. Between 1999 and 2008 the measured depth to water in the well was relatively static at about 20 feet below the measuring point. Since 2008 depth to water as decreased and is more variable ranging from a minimum of about 16 feet to 20 feet below the measuring point (Figure 4) and indication of local hydraulic input which is most likely from leachate hydrostatic pressure.

Collection of leachate levels through quarterly measurements taken at the 10-acre site gas vents as the observation locations will determine if additional action such as pumping is warranted. At least one sample of leachate should be obtained for laboratory analysis of the Hoesman parameters.

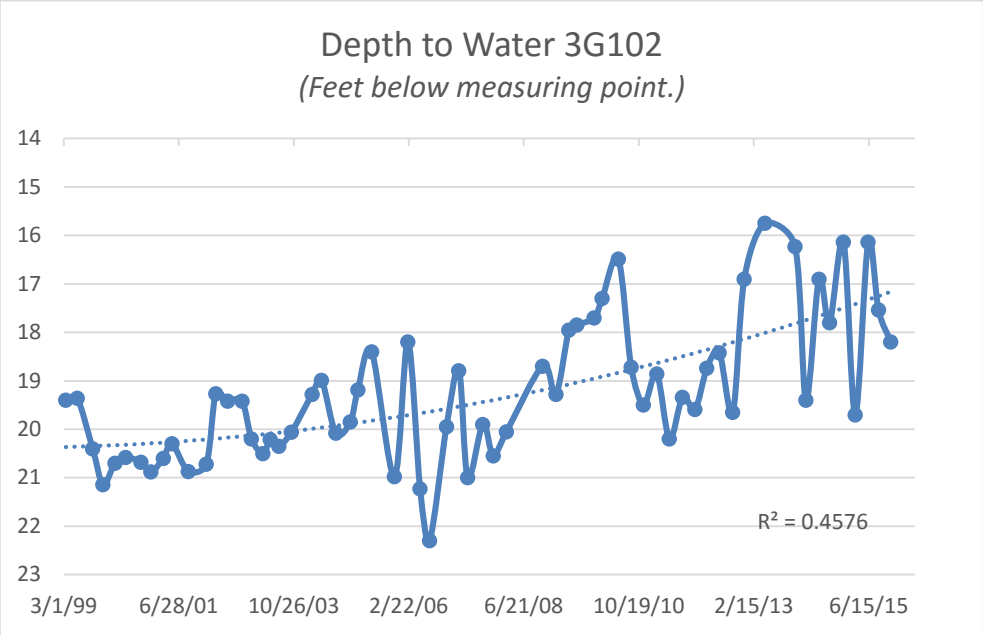

Figure 4 Monitoring Well 3G102 water levels 1999 -2015

Surface Water Quality - Water samples collected from surface water flowing in the Saline Ditch adjacent to the ULC did not contain any constituents in concentrations of concern. Saline Ditch water meets the General Use Water Quality Standard as evidenced by the parameters analyzed. Concentrations of measured constituents at the downstream sampling location were, in general, lower than the concentrations of the same constituents sampled at the upstream location although not statistically different. The quality of water flowing by the ULC has not been impacted or otherwise degraded and, therefore, is not being affected by present-day operations or previously buried waste at ULC.

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7.0 FINDINGS and RECOMMENDATIONS

Monitoring activities at the ULC through December 2015 have resulted in the following findings and recommendations:

1. The potentiometric surface for groundwater in the upper Glasford Formation appears to have returned to the 1999 level as interpreted from the geomean of the combined monitoring well water level data;

2. Groundwater quality at the 10-acre site as observed in well 3-G102 continues to require close monitoring and should be scheduled for 4th Quarter analysis as for the primary wells of the Glasford Formation.

3. Leachate levels at the 10-acre site should be measured each quarter to determine if leachate volume is increasing. In addition, at least one sample should be collected for analysis of the Hoesman parameters.

4. Groundwater in up-gradient well 4G105 continues to exhibit dissolved manganese concentrations at or slightly above Class I Groundwater Standards. This is a naturally occurring element and is not believed to be the result of a release from the landfill.

5. Based on laboratory analyses of groundwater collected from monitoring wells at the ULC and statistical evaluation of those data, there is no indication of a leachate release from the ULC into the monitored aquifer, the Glasford Formation Aquifer.

6. Based on laboratory analyses of surface water collected from the Saline Ditch reach adjacent to the ULC and statistical evaluation of those data, there is no indication of impact to surface water from activities at the ULC or from buried waste.

7. The ten (10) acre site is in need of cover repair cover and active removal of undesirable woody plant species that are likely creating opportunities for infiltration of precipitation.

8.0 REFERENCES & BIBLIOGRAPHY

Midwest Engineering and Testing, Inc., March 2015. *23rd Annual Report, Urbana Landfill Complex: Groundwater Monitoring Activities, Monitoring Year 2014.*

Rapps Engineering and Applied Science, Inc.,

February 2008. *16th Annual Report, Urbana Landfill Complex: Groundwater Monitoring Activities, Monitoring Year 2007*.

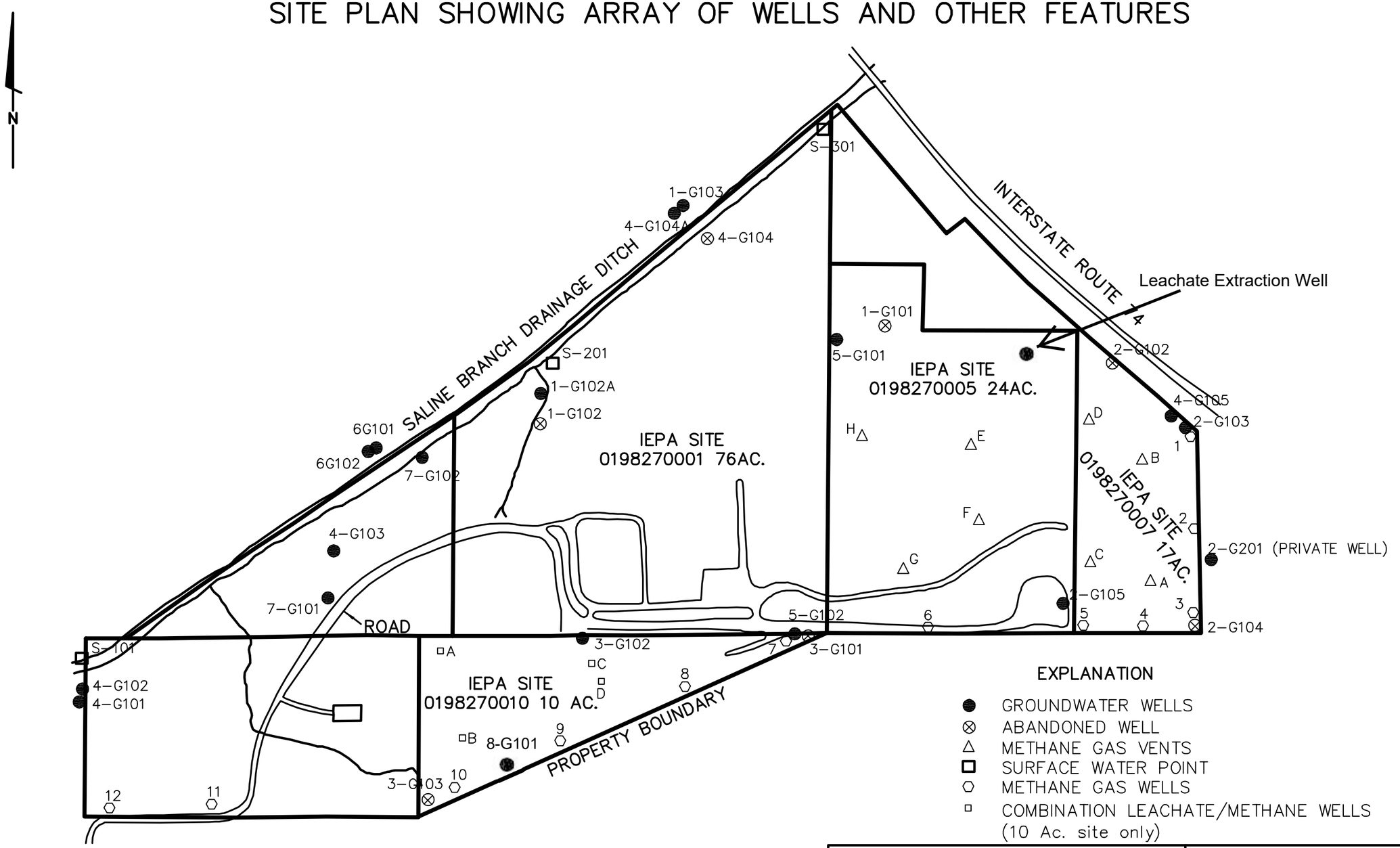
February 2010. *18th Annual Report, Urbana Landfill Complex: Groundwater Monitoring Activities, Monitoring Year 2009.*

APPENDIX A

Compact Data Disc

PLATE I - Site Map
Urbana Landfill Complex

SITE PLAN SHOWING ARRAY OF WELLS AND OTHER FEATURES



EXPLANATION

- GROUNDWATER WELLS
- ABANDONED WELL
- METHANE GAS VENTS
- SURFACE WATER POINT
- METHANE GAS WELLS
- COMBINATION LEACHATE/METHANE WELLS (10 Ac. site only)

MET

Midwest Engineering & Testing, Inc.
Champaign, IL

PLATE I

URBANA LANDFILL COMPLEX

24th Annual Report

March 2016