Bethlehem Cemetery Well
Additional Information Supporting Exemption from the PZ Order
December 7, 2011

BACKGROUND

The Bethlehem Cemetery (2801 Jackson Avenue, Ann Arbor) has a well that is used for irrigation purposes. This well is within the Prohibition Zone (PZ). According to the Order Prohibiting Groundwater Use entered with the Washtenaw County Circuit Court (Order), the consumption or use by any person of groundwater from the PZ is prohibited.

There are some exemptions allowed for in the Order. Exemption 5(e) states: *any existing water supply well that has been demonstrated, on a case-by-case basis and with the written approval of the MDEQ, to draw water from a formation that is not likely to become contaminated with 1,4-dioxane emanating from the PLS facility. Such wells shall be monitored for 1,4-dioxane by PLS at a frequency determined by the MDEQ.*

In an email to the Michigan Department of Environmental Quality (MDEQ) dated September 23, 2011, PLS has provided support for its opinion that the Bethlehem Cemetery well meets this exemption. The MDEQ has asked for additional supporting information, which is the subject of this document.

Well Information

The well is located on property located in the City of Ann Arbor. The property parcel number is 09-08-25-104-001. According to the Washtenaw County GIS MapWashtenaw website, the property is owned by Bethlehem Church.

The location of the cemetery well is shown on Attachment 1. This location was mapped using hand-held GPS and available aerial photography. (**X Coordinate:** 13280491.07 **Y Coordinate:** 285154.10, NAD83 Michigan State Planes, South Zone, International Foot).

The well is located at an elevation of approximately 965 feet above mean sea level (amsl). The well is on a topographic high for the area. For reference, this location is approximately 50 feet higher than the area around First Sister Lake and Maple Village.

The Well Record for the well is provided as Attachment 2. According to the record, the well was installed in 1994, constructed of 5-inch PVC and has a 4 foot stainless steel screen completed between 108 and 112 feet. This puts the screen center at an elevation of approximately 855 feet amsl.

For reference, MW-43 located on the east side First Sister Lake has an elevation (center) of approximately 821 feet amsl, MW-108s has a screen elevation of 758 feet amsl, and MW-72s has a screen elevation of approximately 823 feet amsl. This places the well screen above most off-site PLS monitoring wells.

Well Use Information

The cemetery well is used for seasonal irrigation purposes. PLS representatives contacted Bethlehem Church regarding the use of the well. According to a church representative, the well supplies several "spigots" in the cemetery. Users of the cemetery can use the spigots to fill up watering cans to water flowers and plants at grave sites. The spigot lines are purged in the winter to prevent freezing.

The well is not connected to any centralized irrigation system. There is a bathroom at the site, but according to the church representative, it's for an office (not the public) and is no longer used.

According to the well log, the maximum pumping capacity of the pump in the well is slightly over 19 gallons per minute. This well is not considered a Large Quantity Withdraw as defined by the State.

Water Quality Sampling

Groundwater samples have been collected from this well by PLS and others since 2001. Sampling information is provided as Attachment 3. To date, five (5) samples have been collected and all of the samples have been non-detect for 1,4-dioxane.

Hydrogeological Setting

A south-north hydrogeological cross section showing the cemetery well/boring information in relationship to PLS wells to the north is provided as Attachment 4. In relationship to PLS MW-72s/d, the cemetery well is completed at a higher elevation, possibly in a shallower aquifer.

Water table contouring by the MDEQ (Groundwater Mapper) suggests the cemetery well is in an area of a groundwater divide, with flow radiating west to east from the well area (Attachment 5). This observation is generally consistent with contouring of the Unit D2 aquifer in this area which shows a divide west of the cemetery (October 2011 PLS D2 & E Potentiometric Surface map). In either case, there is no indication of flow from the Pall site toward the cemetery well in the shallower aquifers. Contouring of the deeper (E) aquifer shows flow from the Pall site in a direction slightly north of the cemetery (October 2011 PLS D2 & E Potentiometric Surface map). Flow in this aquifer is consistent with the well-established presence of the Unit E plume north of the cemetery well.

The hydraulic influence of the cemetery wells withdrawal is expected to be minimal considering the well is used only seasonally and is not used for purposes other than watering individual cemetery plots.

Relationship to Known Area of Contamination

Water quality data from the cemetery well have shown that for the past 10 years, 1,4-dioxane has not impacted this well. During this time, it has been well documented that 1,4-dioxane has migrated a considerable distance to the east. If this well was in the pathway of contamination, it is reasonable to say that it should have been contaminated by now, especially given the fact that this well is completed at a shallower elevation. (shallower aquifers were contaminated by 1,4-dioxane earliest).

Recent interpretations of the extent of 1,4-dioxane suggest the plume boundary (85 ug/L) is positioned approximately 400-500 feet to the north of the cemetery well. At a comparable depth interval at MW-72 boring, 1,4-dioxane was determined to be between ND (<1 ug/L) and 16 ug/L. 1,4-Dioxane concentrations at MW-72s have declined with time and were most recently 11 ug/L (10/11/11).

1,4-Dioxane is known to be present at well locations to the west (MW-108s/d and MW-71). These wells are considerably deeper than the cemetery well. Groundwater samples from shallower wells in this area (MW-43, and MW 16 to the south) have generally been not detect for 1,4-dioxane.

Water quality and water level data indicate that the 1,4-dioxane contamination at wells MW-108s/d and MW-71 flows to the northeast, or northeast rather than east. There is no indication that flow from this area is due east toward the cemetery well.

Summary

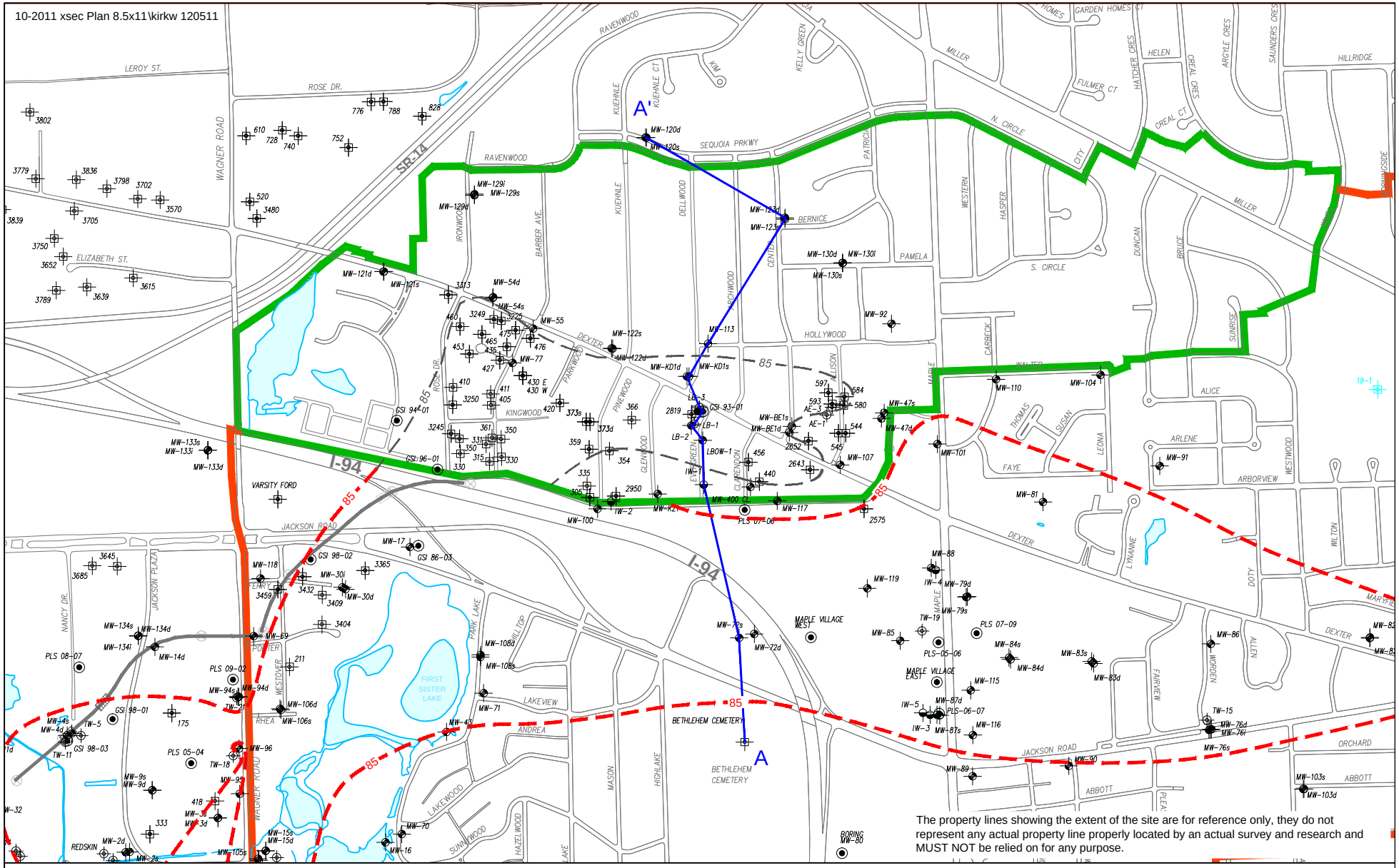
The cemetery well provides an important service to those using the cemetery. Water from the well is used sparingly. PLS believes the cemetery well should be exempt from the PZ Order. Water quality data support hydrogeological interpretations that this well is not vulnerable to 1,4-dioxane contamination from the PLS site. The fact 1,4-dioxane has not been detected at this location for over 10 years is an excellent indicator that this well is not likely to become contaminated in the future.

The absence of 1,4-dioxane in the cemetery is consistent with groundwater elevation contouring by MDEQ and PLS suggests the groundwater flow is not toward the cemetery well from the PLS site in the shallower aquifer(s) that this well appears to be completed within.

Pall believes these findings support our interpretation that the cemetery well meets the conditions of exemption 5(e) provided for in the Order.

PLS proposes that groundwater samples be collected from this well on an annual basis and analyzed for 1,4-dioxane. Pall proposes that the sampling be done in the spring/early summer, which will be early in the watering season.

Attachment 1 – Site Map with Well Location and other Features



NORTH

0 1000 2000

SCALE IN FEET

LEGEND

- UNIT E 1,4-DIOXANE ISOCONCENTRATION CONTOUR (µg/L)
- UNIT D_2 1,4-DIOXANE ISOCONCENTRATION CONTOUR (µg/L)
- PROHIBITION ZONE BOUNDARY
- EXTENDED PROHIBITION ZONE BOUNDARY
- CROSS SECTION

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Hard copy is intended to be 8.5"x11" when plotted.

A-A' CROSS SECTION

PLAN VIEW

DECEMBER 2011

806500

Attachment 2 – Well Record

Bethlehem Cemetery

Attention: Leon Moore

2801 JACKSON

GEOLOGICAL SURVEY NO.

MICHIGAN DEPARTMENT OF PUBLIC HEALTH
WATER WELL AND PUMP RECORD

PERMIT NUMBER 44 6669

1 LOCATION OF WELL

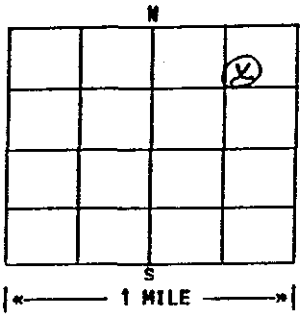
C	Township Name	Fraction	Section Number	Town Number	Range Number
WASHTENAW	SCIO	SW ¼ NE ¼ NE ¼	25	2 S	5 E

Distance And Direction From Road Intersection

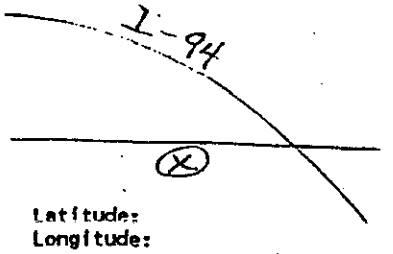
2801 JACKSON
ANN ARBOR, MI 48103

Street Address & City of Well Location

Locate with "X" in Section Below



Sketch Map



Latitude:
Longitude:

3 OWNER OF WELL

Address: BETHLEHEM UNITED CHURCH
423 SOUTH FOURTH STREET
ANN ARBOR, MI 48104

Address Same As Well Location? NO

4 WELL DEPTH: 112 FT. **Date Completed** 07/01/94 REPLACEMENT WELL

5 DRILLING METHOD: ROTARY

6 USE: Irrigation

7 CASING: PLASTIC

Diameter 5 " to 108 ft. depth
Diameter ____ " to ____ ft. depth

Grouted Drill Hole Diameter

9 " to 100 ft. depth
____ " to ____ ft. depth

Height: ABOVE
Surface 1'
Weight SDR 21
Drive Shoe: NO

2 FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
BROWN CLAY	40	40
GRAVEL	10	50
GRAY CLAY	30	80
GRAVEL	32	112

8 SCREEN: Type STAINLESS Diameter 5 " Nominal
SLOT 30 Length 4 ft.
Set Between 108 ft. and 112 ft.
FITTINGS: K-PACKER Blank above screen 1 ft.

9 STATIC WATER LEVEL
88 ft. below land surface Flow: YES

10 PUMPING LEVEL: below land surface
88 ft. after 2 hrs. pumping at 12 G.P.M.
___ ft. after ___ hrs. pumping at ___ G.P.M.

11 WELL HEAD COMPLETION: PITLESS ADAPTOR

12 WELL GROUTED? YES
BEN-SEAL from 0 to 100 ft.
5 bags of cement. Additives ____

13 Nearest source of contamination
Type SEPTIC Distance 100 ft Direction S
Well disinfected upon completion? YES
Was old well plugged? YES

14 PUMP:
Manufacturer's Name RED JACKET (OWNERS)
Model number 30SN1-98C HP 1 VOLTS 230V
Length of Drop Pipe 105 ft., Capacity ___ G.P.M.
Type SUBMERSIBLE
PRESSURE TANK:
Manufacturer's Name AMTROL
Model Number WX251 Capacity 19.2 Gallons

RECEIVED
JUL 28 1994
ENV. HEALTH

MS20391 8/20/91
PS30391
WELLS AWC 5-1 1" GALVANIZED

15. Remarks, elevation, source of data, etc.
Log amended 7/26/94 - Well to be used for irrigation. (City Permit)

16. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled UNDER MY jurisdiction and this report is true to the best of MY knowledge and belief.

Cribley Drilling Co., Inc. 81-0524
REGISTERED BUSINESS NAME REGISTRATION NO.

Address 8300 Dexter Chelsea Rd Dexter, MI 48130

17. Rig Operator's Name: PERRY KLEIN

Signed Jack D. Clark Date 7-13-94
AUTHORIZED REPRESENTATIVE

D 2/89 CDCW11253P12038 08/20/92

Authority: Act 368 PA 1978
Completion: Required
Penalty: Conviction of a violation of any provision is a misdemeanor.

IMPORTANT: File with deed.

07-29-94

Attachment 3 – Water Quality Data

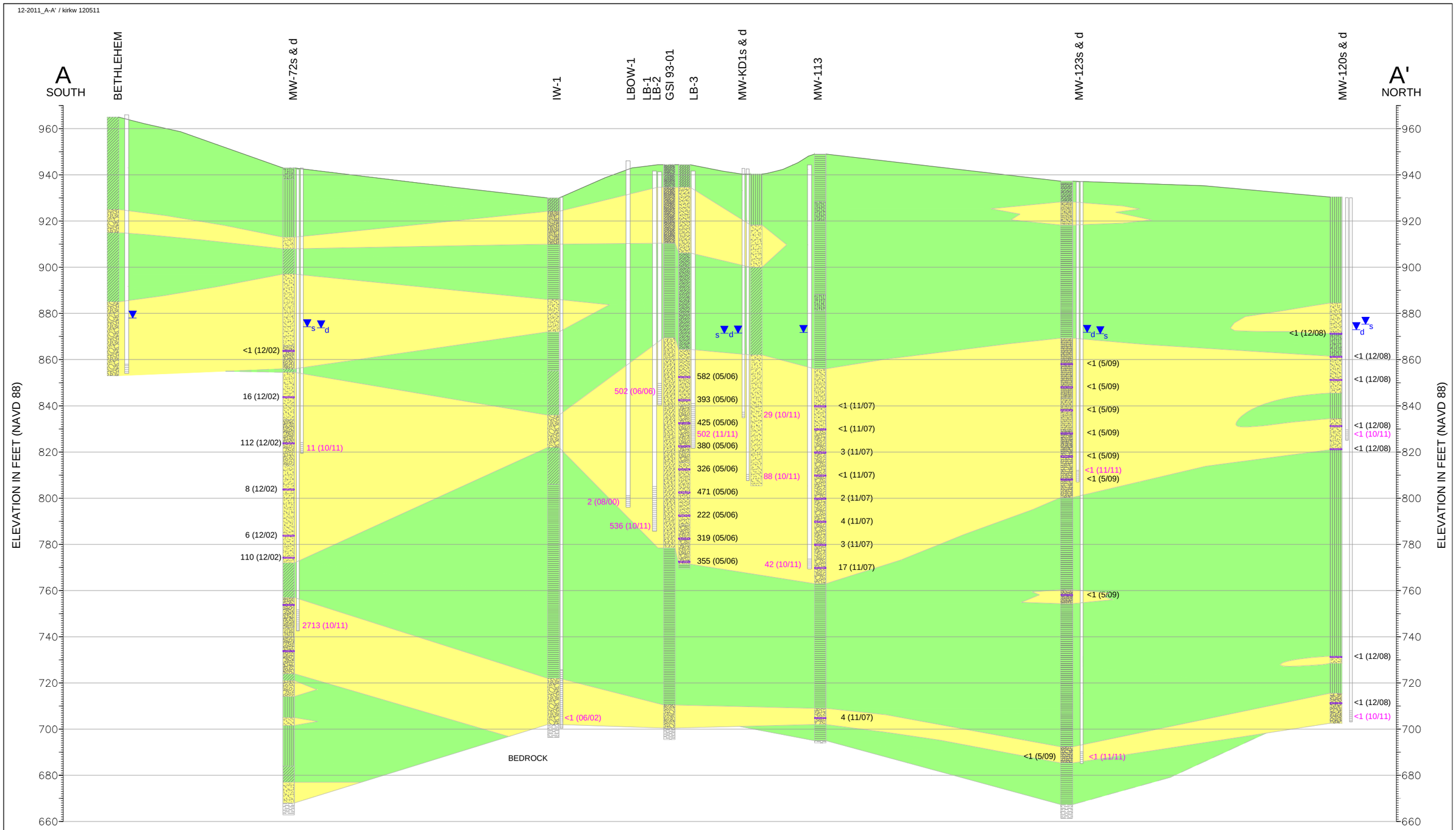
Analytical Data Report: Bethlehem Cemetery

Aquifer: Not Determined	**Date Installed:** 07/01/1994	**Boring Depth:** 112.00 Feet bgl	**Screen 1:** 112.00 to 108.00 Feet
Map Location: L-25	**Well Driller:** Cribley Drilling	**Ground Elevation:** Unknown Feet	**Screen 1 Length:** 4.00
X Coordinate: 13280491.07	**Well Type:** Miscellaneous Wells	**TOC Elevation:** Unknown Feet	**Screen 2:** NA to NA Feet
Y Coordinate: 285154.10	**Sampling Interval:** Annual	**TOC to screen bottom:** Unknown Feet	
	Static Interval: Not Set	**Notes:**	

Date Collected	Time Collected	1,4-Dioxane Results (ppb)	R.L.	Bromate Results	R.L.	Bromide Results	R.L.	Static Time	Static Reading	Comments
08/22/2011	10:50	nd	1.0							
07/14/2010	12:40	nd	1.0							
09/19/2006	11:50	nd	1.0							
06/02/2003	08:30	nd	1.0							
09/24/2001		nd	1.0							Sample collected by Sybil Kolon-MDEQ

Attachment 4 – Cross Section

12-2011_A-A' / kirkw 120511



0 200 400

SCALE IN FEET

VERTICAL EXAGGERATION = 10X

LEGEND

67 - SAMPLE INTERVAL AND 1,4-DIOXANE CONCENTRATION µ/L (Samples Collected By Similprobe During Installation Unless Noted)

130 - 1,4-DIOXANE CONCENTRATION (µ/L) AND COLLECTION DATE (Samples Collected From Well)

SAND GRAVEL SHALE CLAY SILT DIAMICTON

WELL

WATER LEVEL ELEVATION

SCREENED INTERVAL

NOTES:
-MOST RECENT WATER QUALITY DATA WAS USED.
-DISTANCES BETWEEN MW-KD1s THROUGH TO LB-1 ARE EXAGGERATED TO BETTER SHOW LITHOLOGY.

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Hard copy is intended to be 11"x17" when plotted.

A-A' CROSS SECTION

DECEMBER 2011

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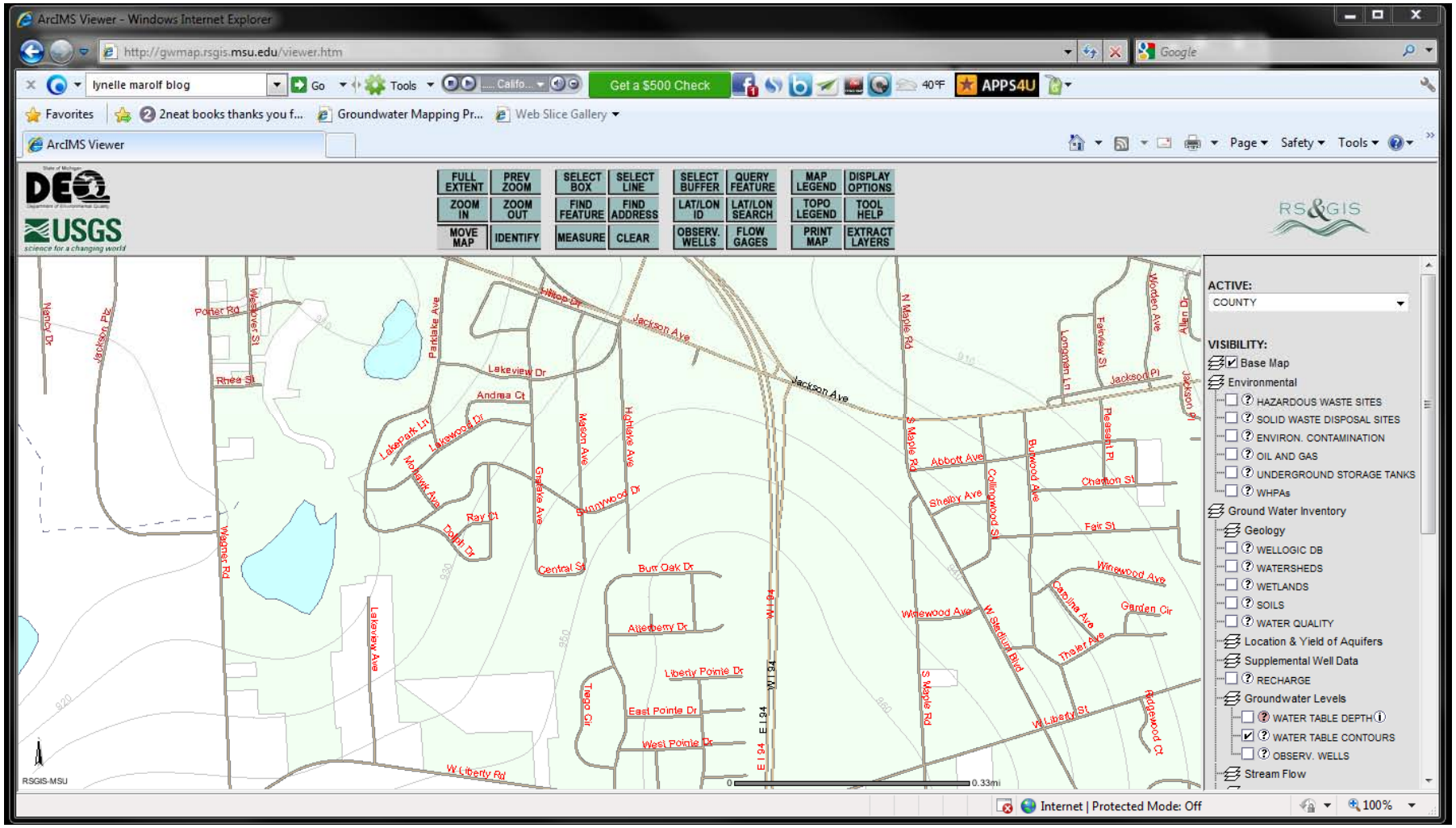
Attachment 5 – MDEQ Water Table Map


ArcIMS Viewer - Windows Internet Explorer
http://gwmap.rsgis.msu.edu/viewer.htm
ArcIMS Viewer
FULL EXTENT
PREV ZOOM
SELECT BOX
SELECT LINE
SELECT BUFFER
QUERY FEATURE
MAP LEGEND
DISPLAY OPTIONS
ZOOM IN
ZOOM OUT
FIND FEATURE
FIND ADDRESS
LAT/LON ID
LAT/LON SEARCH
TOPO LEGEND
TOOL HELP
MOVE MAP
IDENTIFY
MEASURE
CLEAR
OBSERV. WELLS
FLOW GAGES
PRINT MAP
EXTRACT LAYERS
RS&GIS
ACTIVE:
COUNTY
VISIBILITY:
Base Map
Environmental
HAZARDOUS WASTE SITES
SOLID WASTE DISPOSAL SITES
ENVIRON. CONTAMINATION
OIL AND GAS
UNDERGROUND STORAGE TANKS
WHPAs
Ground Water Inventory
Geology
WELLOGIC DB
WATERSHEDS
WETLANDS
SOILS
WATER QUALITY
Location & Yield of Aquifers
Supplemental Well Data
RECHARGE
Groundwater Levels
WATER TABLE DEPTH
WATER TABLE CONTOURS
OBSERV. WELLS
Stream Flow
Jackson Ave
Lakeview Dr
Andrea Ct
Parklake Ave
Mason Ave
Highlake Ave
Glenlake Ave
Sunnywood Dr
Central St
Burr Oak Dr
Allenberry Dr
Liberty Pointe Dr
East Pointe Dr
West Pointe Dr
Trego Cir
W Liberty Rd
Lakeview Ave
Porter Rd
Rhea St
Wagner Rd
Ray Ct
Dolph Dr
Lakepark Ln
Mohawk Ave
Lakewood Dr
N Maple Rd
S Maple Rd
Abbott Ave
Shelby Ave
Collingwood St
Burwood Ave
Chenon St
Fair St
Winewood Ave
Carolina Ave
Garden Cir
Thaler Ave
W Stadium Blvd
W Liberty St
Ridgewood Ct
Fairview St
Longcrest Ln
Worden Ave
Jackson Pl
Reesell Pl
I 94
RSGIS-MSU
0.33mi
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