EVERGREEN SYSTEM

REVIEW

PLS LIFE SCIENCES
ANN ARBOR, MICHIGAN

MAY 2007

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

This plan outlines Pall Life Sciences' (PLS) strategy for the future of the Evergreen System. Specifically, this plan proposes modifications of established extraction rates and outlines a strategy for managing the leading edge of the Evergreen plume (that area between the LB-series wells and AE-3).

The Evergreen System is purged by three extraction wells (LB-1, LB-3, and AE-3) in order to meet the objectives of the Consent Judgment (CJ). The objectives of the CJ are as follows: (a) intercept and contain the leading edge of the plume of groundwater contamination detected in the vicinity of the Evergreen Subdivision area; (b) remove the contaminated groundwater from the affected aquifer; and (c) remove all groundwater contaminants from the affected aquifer or upgradient aquifers within the site that are not otherwise removed by the Core System as provided in Section V.B. or the GSI Property Remediation Systems provided in Section VI of the CJ. In addition to the requirements of the CJ, the Washtenaw County Court's July 17, 2000, Opinion and Remediation Enforcement Order (REO) has required the Evergreen System to maintain a flow rate of 200 gallons per minutes (gpm) at all times. So, PLS must meet both the CJ and the REO's requirements in regards to the Evergreen System.

For years, PLS was able to satisfy both the requirements of the CJ and REO. In other words, PLS was able to capture the leading edge of the plume in Allison Street, while operating the Evergreen System at 200 gpm (combined flow of LB and AE wells). However, for reasons outlined in this plan, PLS believes that modifications to the 200 gpm extraction rate and other requirements of the CJ are necessary.

PLS is seeking to change its obligations as set by the CJ and REO to develop a more effective and sustainable plan for the Evergreen System.

BACKGROUND INFORMATION

GEOLOGY AND HYDROGEOLOGY

The geology and hydrogeology of the Evergreen System area is discussed in detail in Appendix A of this plan.

1,4-DIOXANE EXTENT AND TRENDS

The Unit D_2 plume has been interpreted to be a distinct plume that migrated into the Evergreen Subdivision from the southwest. An isoconcentration map for the Evergreen Subdivision area is provided as Figure 1 and shows how the Unit D_2 plume has historically been interpreted. Recent efforts have focused on better understanding the relationships between what have been identified as the Unit D_2 and

Unit E plumes. These interpretations have been made possible by the continued collection of data by PLS in association with investigations of the Unit E plume.

The overall extent (boundary) of the Evergreen System plume has been fairly stable since active remediation began. Since spring 2002, concentrations of 1,4-dioxane at MW-KD1d have been rising, suggesting the northern boundary of the plume is slightly expanding. It is PLS' interpretation that this change relates to the rise in 1,4-dioxane concentrations observed in the Dupont area since fall 1998.

1,4-Dioxane concentration trends from groundwater samples from LB-1, LB-2, LB-3, 440 Clarendon, and 456 Clarendon have been fairly stable since peak concentrations were reached at these sites. 1,4-Dioxane trend graphs for these wells are provided in Appendix B. These observations are not consistent with the fact that 1,4-dioxane concentrations in the upgradient portion of the Unit D_2 plume have generally been declining. As will be further discussed in this report, PLS believes operation of the Evergreen System has resulted in a portion of the Unit E plume migrating toward (pulled into) the Evergreen system, thus sustaining 1,4-dioxane concentrations in the Evergreen System plume. This finding, along with updated interpretations of the geology in the Evergreen and Maple areas, demonstrates the difficulty in distinguishing between Unit D_2 and Unit E in the downgradient portions of the Evergreen Subdivision. For illustrative purposes, Figure 2 has been prepared to show an interpretation that combines the Unit D_2 and Unit E systems. PLS believes this may be a more representative interpretation of the relationship of the two plumes, rather than maps showing two distinct plumes.

CURRENT ISSUES

There are two primary issues associated with the Evergreen System that need to be addressed: (1) the extraction rates of LB-1 and LB-3 need to be modified, and (2) the Allison Street extraction wells cannot maintain a sufficient flow rate to capture the very leading edge of the plume. These issues and proposed solutions are discussed below.

ISSUE 1 – LB-1/LB-3 EXTRACTION RATES

PLS operates LB-1 and LB-3 at flow rates of approximately 90 and 80 gpm, respectively. These wells run 24 hours per day, 7 days per week, 365 days per year, unless they are shut down for maintenance or other unforeseen causes.

Routine monitoring data coupled with groundwater modeling suggest the extraction rates for these wells are excessive, and that flow rates can be reduced and still maintain capture of the Evergreen System plume width.

Concerns related to operating LB-1 and LB-3 at an excessively high flow rate include:

1. Pulling the Unit E Plume Northward - Available data suggest the capture zone created by LB-1 and LB-3 extends south to include what has been identified as the Unit E plume. As a result, a portion of the Unit E plume is “pulled” toward LB-1, LB-3, and AE-3 wells. Because of this process, 1,4-dioxane levels at LB-1, LB-3, and AE-3 are not declining at expected rates, and 1,4-dioxane levels in wells such as 456 Clarendon have continued to rise.

2. Altering Flow Directions - Another concern related to extracting too much water in the Evergreen System area is that the hydraulic depression caused by the pumping creates a deflection of the potentiometric surface contours, which creates a northeast component of flow in the area of Maple Road and Dexter. This results in the plume (combined Unit D_2 and Unit E) tracking along a pathway closer to the northern PZ boundary.

3. Excessive Energy Use – Although a lesser concern, pumping at excessive flow rates results in excessive energy use, which is an environmental concern in itself.

4. Excessive Wear on Pipelines – The Evergreen System transmission system operates at near capacity. Higher velocities and pressures associated with excessive pumping rates can lead to premature failure of pipelines.

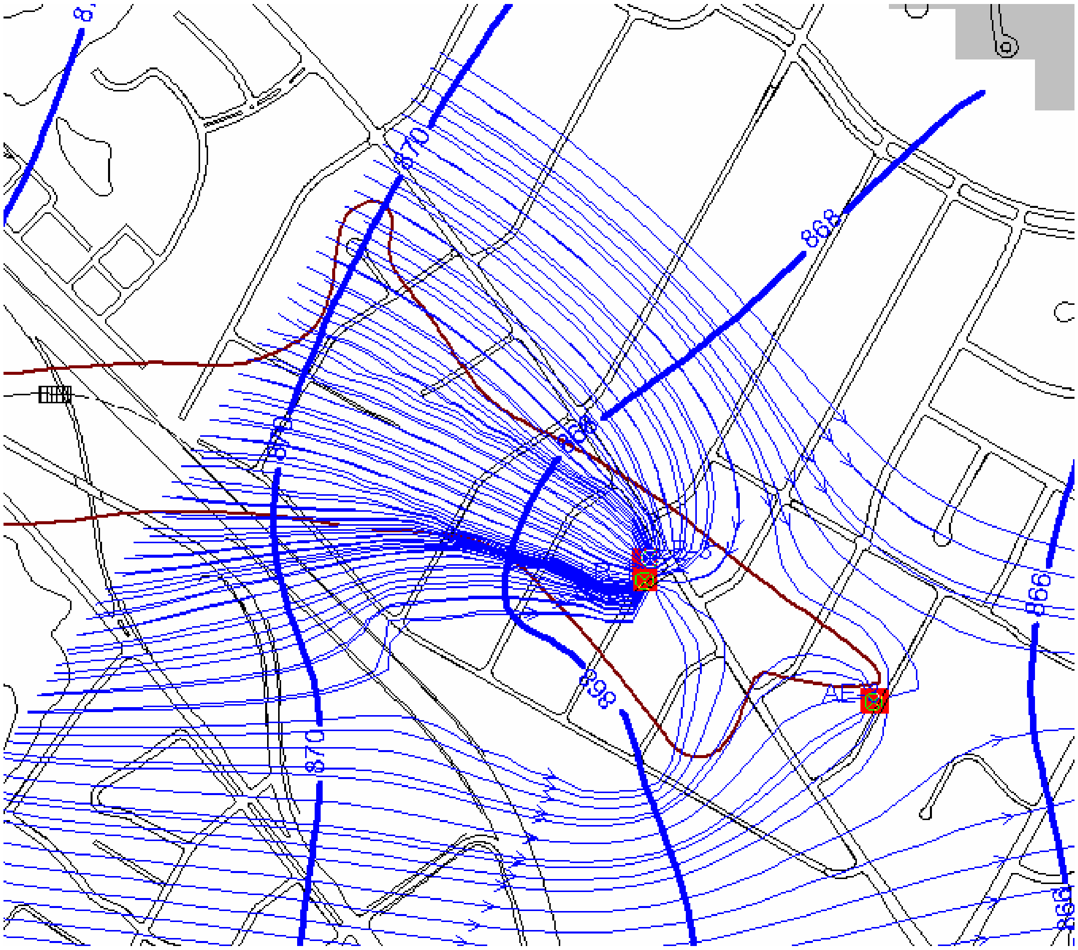
PROPOSED SOLUTION (ISSUE 1)

For the reasons noted above, it is proposed that the extraction rates for LB-1 and LB-3 be reduced.

In order to evaluate the changes resulting from a reduction in flow, an existing numerical groundwater flow model was used to simulate various operation conditions of the Evergreen System under. The model, which was constructed in 2002, was developed using the United States Geological Survey MODFLOW code. A report on the model was provided to the Michigan Department of Environmental Quality (MDEQ) in February 2002. It is recognized that this model is a simplification of the complex hydrogeological characteristics of the Evergreen System area and does not incorporate some of the recent interpretations outlined in this report. Nevertheless, this model can be used as a tool to reasonably simulate pumping conditions in the Evergreen System area. Some slight modifications to the model were made for this analysis and to further calibrate the existing MODFLOW model. Updated calibration information for the model is provided in Appendix C.

The following Figure 3 shows the simulated capture area of LB-1, LB-3, and AE-3 operating at 90 gpm, 80 gpm, and 32 gpm, respectively (September 2006 conditions).

Figure 3 – Steady State Simulation (LB-1 = 90 gpm, LB-3 = 80 gpm, and AE-3 = 32 gpm)



Note: Thin blue lines are particle traces, and the brown line is the extent of the 85 micrograms per liter (µg/L) 1,4-dioxane isoconcentration line (based on recent data).

The following key observations are noted from a review of Figure 3:

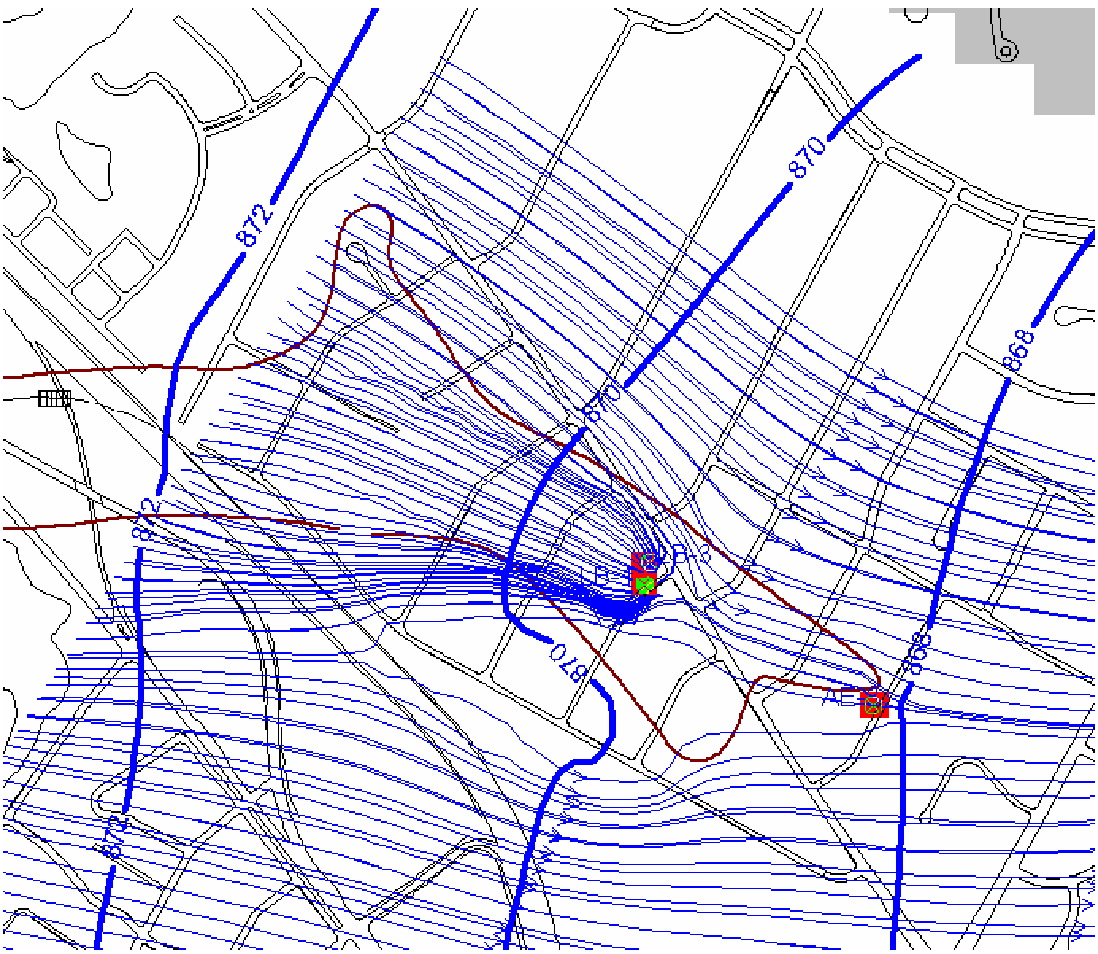
1. The entire plume, which is outlined in brown, is captured by the wells.

2. There is a significant portion of flow from the south that is also captured by the wells. With the area of low hydraulic conductivity to the south, groundwater is directed east of this area and migrates through the Clarendon area. This is consistent with water quality trends in this area (456 Clarendon), which have shown increasing trends over time.

3. AE-3 is receiving contribution from areas to the south. This may help explain why 1,4-dioxane levels in this well area have remained fairly steady, while the LB series wells have been consistently operated.

The calibrated MODFLOW model was used to examine the effect of reducing the flow rates of LB-1 and LB-3. The first simulation involved reducing the flow rates of these two wells by 50%, while AE-3 was operated at 10 gpm (its more recent extraction rate). This simulation is shown as Figure 4.

Figure 4 – Steady State Simulation (LB-1 = 45 gpm, LB-3 = 40 gpm, and AE-3 = 10 gpm)



Note: Thin blue lines are particle traces, and the brown line is the extent of the 85 µg/L 1,4-dioxane isoconcentration line (based on recent data).

Key observations made from comparing the Figure 4 with the Figure 3 simulations are:

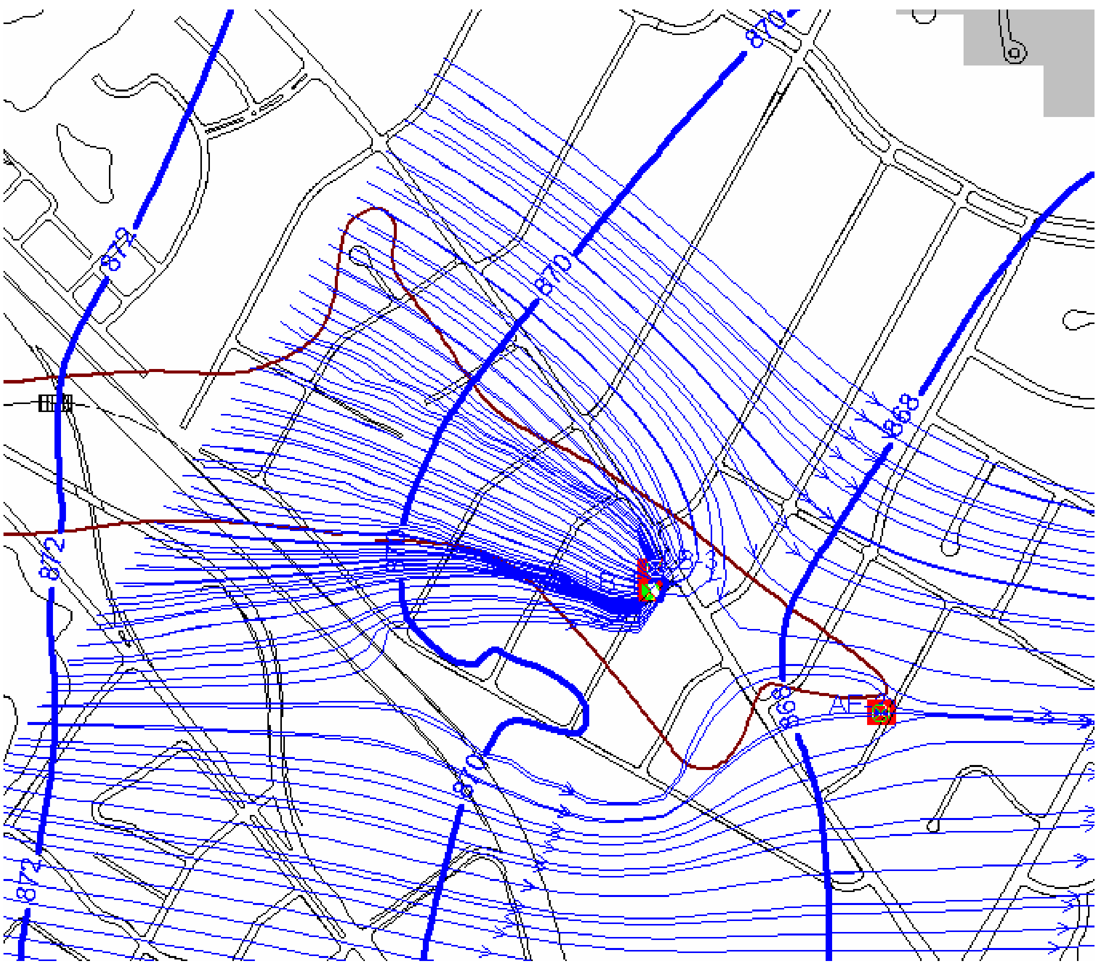
1. A majority of the Unit D_2 plume upgradient of LB-1 and LB-3 is captured at lower purge rates. Only a very limited area in the northern portion of Dupont and the portion of the plume in the Clarendon area is not in the capture zone.

2. AE-3 is not capable of capturing the portion of the plume downgradient of the LB-1 and LB-3 capture.

3. There is less contribution of flow from the south, although the pumping still causes some of the flow from the south to divert north.

The calibrated MODFLOW model was used to examine the effect of reducing the flow rates of LB-1 and LB-3 by 25% and operating AE-3 at 10 gpm. This simulation is shown as Figure 5.

Figure 5 – Steady State Simulation (LB-1 = 67 gpm, LB-3 = 60 gpm, and AE-3 = 10 gpm)



Note: Thin blue lines are particle traces, and the brown line is the extent of the 85 µg/L 1,4-dioxane isoconcentration line (based on recent data).

Key observations made from comparing the Figure 5 simulation with the Figure 3 simulation are:

1. All of the plume upgradient of LB-1 and LB-3 is captured.
2. AE-3 is not capable of capturing the portion of the plume downgradient of the LB-1 and LB-3 capture.
3. More of the Unit E plume is pulled into the capture area than with the 50% reduction scenario.

These two simulations suggest a flow rate reduction of LB-1 and LB-3 by 50% will still capture the majority of the width of the plume upgradient of these extraction wells, while minimizing the amount of the Unit E plume that is drawn north, toward the Evergreen System extraction wells. A very small portion of the Dupont plume is not shown to be captured under the 50% reduction scenario. It is important to note that this does not mean 1,4-dioxane at concentrations above 85 µg/L from this area will be out of the capture zone as it migrates eastward (downgradient) toward LB-1 and LB-3.

PROPOSAL FOR IMPLEMENTING THIS SOLUTION

It is proposed to initially reduce the flow rates in LB-1 and LB-3 by 25%. Data will be collected, and trends will be observed over a three-month period. Depending on the findings, PLS may propose to reduce the flow rates further, assuming this is supported by the monitoring data collected under the 25% reduction scenario. The advantage of further reducing the flow rate is to minimize contribution from the Unit E plume to the south. This will decrease the remediation time for the Unit D_2 plume.

To better monitor the effect of the proposed flow rate reduction, PLS is proposing the installation of a well north of the existing MW-KD cluster. This well will provide additional definition of the northern boundary of the plume.

PLS will make a motion to remove from the REO and the Five-Year Plan the current requirement to maintain a minimum purge rate of 200 gpm in the Evergreen System. Paragraph 5 of the Court's July 17, 2000, REO orders PLS to increase the pumping rate of LB-1, LB-2, and AE-3 to 200 gpm. The Five-Year Plan (p. 3) further states that the purged rates for these three wells will be maintained at a combined rate of 200 gpm until leave is granted from the MDEQ and the Court. This proposal will require changes in both documents. The Five-Year Plan can be amended to remove the minimum purge rates for LB-1, LB-2, and AE-3, and the REO can be similarly modified with the consent of the parties and the Court.

ISSUE 2 – ALLISON EXTRACTION WELLS CANNOT MAINTAIN A SUSTAINABLE FLOW

There are two main reasons the Allison extraction wells cannot maintain sufficient flow: (1) the hydrogeological setting of the wells (low transmissivity) and (2) declining water levels in the area.

Hydrogeological Setting: The Allison extraction wells are completed in a portion of the Unit D_2 aquifer that is considerably less transmissive than the area around the LB-series wells. This is supported by a review of drilling logs, geophysical logs, and well capacity information.

Wells completed in aquifers with a low transmissivity have a low specific capacity (volume of water produced per unit of drawdown). Additionally, wells completed in poorly producing aquifers can be prone to well fouling, since the screens used in these aquifers typically have higher entrance velocities (which promotes mineral precipitation), and there is less pore space in the material surrounding the well screen. PLS has had to put considerable effort and cost into maintaining the Allison Street wells.

Declining Water Levels: Further exacerbating capacity issues related to the AE wells has been a significant water level decline in the Evergreen System. As shown on hydrographs presented in Appendix A, water levels have declined approximately 8 feet in this area. This reduces the available drawdown (and capacity) of wells in the Allison area. The decline is likely attributable to PLS' remedial activities in hydraulically upgradient areas, although longer-term natural trends cannot be discounted as a contributing factor.

The problems experienced with AE-1 and AE-3 are chronic. PLS believes operation of wells in the area of Allison Street will be continually plagued with operational problems and is, therefore, not considered an effective long-term solution to capturing the remnant portion of the plume downgradient of the LB-series wells. Furthermore, maintaining and replacing wells in the Evergreen System area has become a disruption that is becoming less tolerable to the residents of this area. Continued attempts to operate wells in this area will only result in more unwanted disruptions.

PROPOSED SOLUTION (ISSUE 2)

A logical and practical step forward is to terminate the purging operation at Allison Street. PLS considered the alternative of moving the purge location either upgradient or downgradient. If the well were to be moved upgradient, the next logical location would be in the Center Street area. Modeling of this well configuration suggests such a well would not have a downgradient capture sufficient to reach out to the Allison Street area. Another alternative would be to install a well further downgradient, where geological conditions may change. However, one would have to question the value of such an effort, since this would be in an area where recent review shows there is no difference between the Unit D_2 and Unit E plumes/aquifers (see interpretations provided in Appendix A).

PLS has examined the fate of the plume remnant if extraction at AE-3 were to stop. The portion of the Unit D_2 plume that would migrate downgradient, if extraction downgradient of the LB-series wells were to cease, is shown on Figure 6. The mass of this remnant plume is estimated to be less than 250 pounds, with a maximum plume concentration estimated at approximately 500 µg/L. PLS' interpretations suggest the concentrations of this remnant plume will decrease as the flow rates of LB-1 and LB-3 are reduced and less of the Unit E plume is drawn in from the south. Interpretations of the geological setting and groundwater flow suggest the plume will migrate east, toward Maple Road, where it becomes indistinguishable from the Unit E plume in the Maple Village area. The approximate pathway of the plume is shown on Figure 6. There are numerous monitoring wells along this pathway, including: MW-47s, MW47d, MW-107, MW-101, MW-104, and MW-110. These wells can be used to monitor the fate of the plume as it moves downgradient.

The highest concentrations in the remnant plume are south of Dexter Road (456 Clarendon). Since the highest concentrations are in the southern portion of the remnant plume, the remnant plume is more likely to stay within the existing PZ as it moves downgradient.

PLS has conducted extensive investigations into the presence of drinking water wells in the Evergreen System area. There is one drinking water well outside the PZ (at 545 Allison Street) that may be in the pathway of the Unit D_2 plume. 1,4-Dioxane concentrations at this well are currently 7 µg/L, and there are no immediate plans to abandon this well. With the possible exception of 545 Allison Street, there would be no increased drinking water exposure risks resulting from letting the remnant Unit D_2 plume merge with Unit E. Because PLS and the MDEQ have been discussing possible modifications to the PZ in the area of the remnant plume, no significant change to the PZ would be necessary to include the remnant plume.

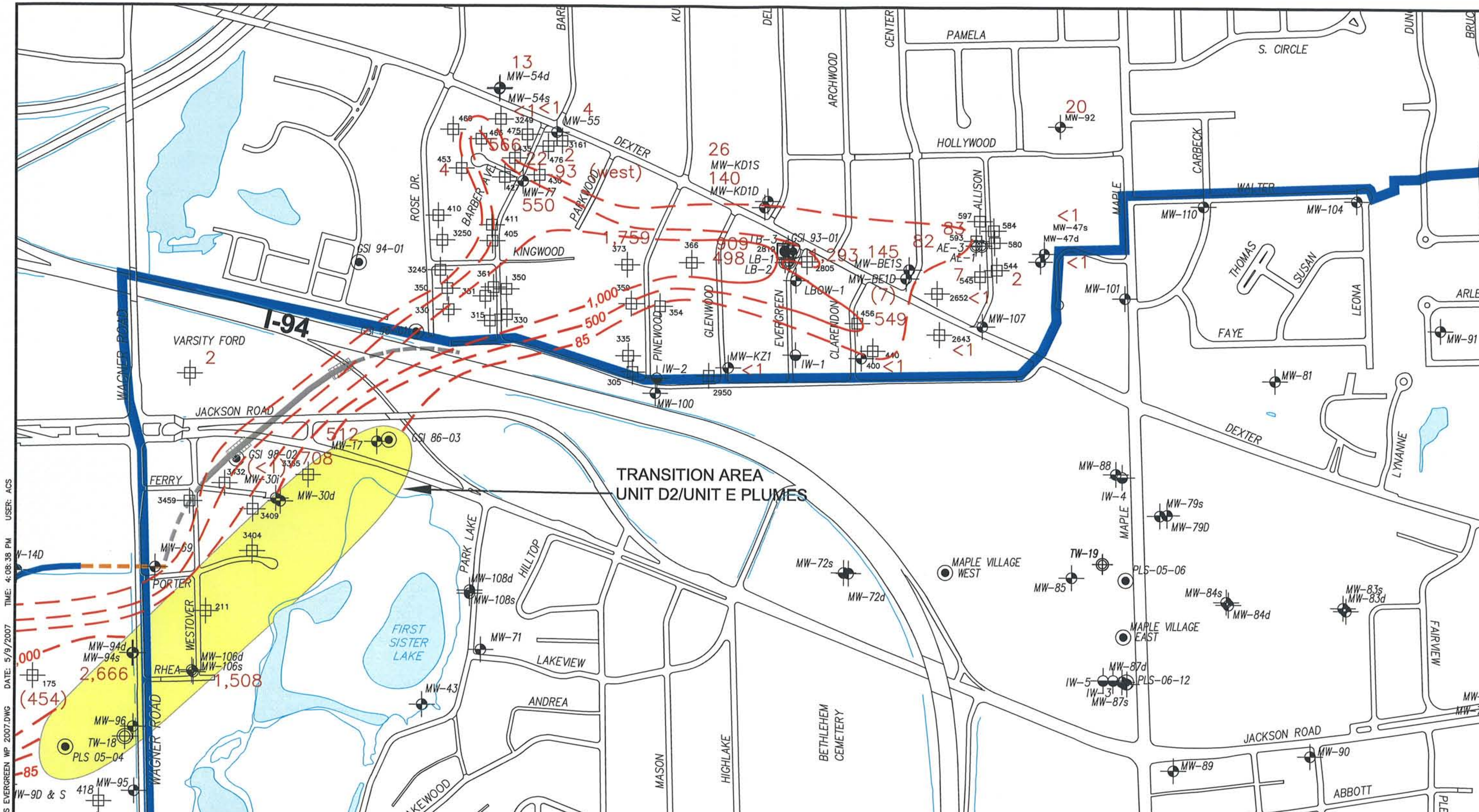
PROPOSAL FOR LEGAL AND REGULATORY IMPLEMENTATION OF THIS SOLUTION

This proposal would allow a portion of the groundwater contaminated above 85 parts per billion that is beneath the Evergreen Subdivision to migrate to the Unit E plume, where it would be handled under the Unit E Order and remedial system for that unit. This proposal addresses several changes in the understanding and condition of the aquifers in the Evergreen Subdivision, which will need to be reflected in the existing legal and regulatory documents. In order to implement the proposal, PLS is proposing several legal and regulatory actions.

1. **Expand the PZ for Unit E as necessary to cover the area of groundwater contamination currently in the vicinity of AE-3.** PLS already has a number of monitoring wells in place in this general vicinity that should allow for a quick adjustment to the current delineation, if needed.

2. **Make a motion to remove from the REO and the Five-Year Plan the current requirement to maintain a minimum purge rate of 200 gpm in the Evergreen System.** Paragraph 5 of the Court's July 17, 2000, REO requires PLS to increase the pumping rate of LB-1, LB-2, and AE-3 to 200 gpm. The Five-Year Plan (p. 3) further states that the purged rates for these three wells will be maintained at a combined rate of 200 gpm until leave is granted from the MDEQ and the Court. This proposal will require changes in both documents. The Five-Year Plan can be amended to remove the minimum purge rates for LB-1, LB-2, and AE-3; and the REO can be similarly modified with the consent of the parties and the Court.

3. **Make a minor amendment to the CJ consistent with this proposal.** The CJ is now over 16 years old, and the provisions regarding Evergreen Subdivision were drafted at a time when only one plume of contamination was known to exist in that area. In order to meet the objectives of Section V.1. of the CJ, the definition of the Evergreen Subdivision Area needs to be changed to exclude the portion of the plume that will be migrating to Unit E.



LEGEND

- MONITOR WELL
- RESIDENTIAL WELL
- PURGE WELL
- HYDROGEOLOGIC TEST BORING
- UV/OX. TREATMENT SYSTEM
- TEMPORARY PURGE WELL
- SURFACE WATER ELEVATION POINT
- 1,4-DIOXANE ISOCONCENTRATION CONTOUR (ug/L) – UNIT D_2
- 1,437 – 1,4-DIOXANE CONCENTRATION (ug/L)
- (184) – DATA NOT USED
- PROHIBITION ZONE BOUNDARY

NORTH

0 500 1000
Scale: 1" = 500'

UNIT D_2 AQUIFER
1,4-DIOXANE ISOCONCENTRATION CONTOUR MAP - October 2006-January 2007

ftc&h
engineers
scientists
architects
constructors
fishbeck, thompson, carr & huber, inc.

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

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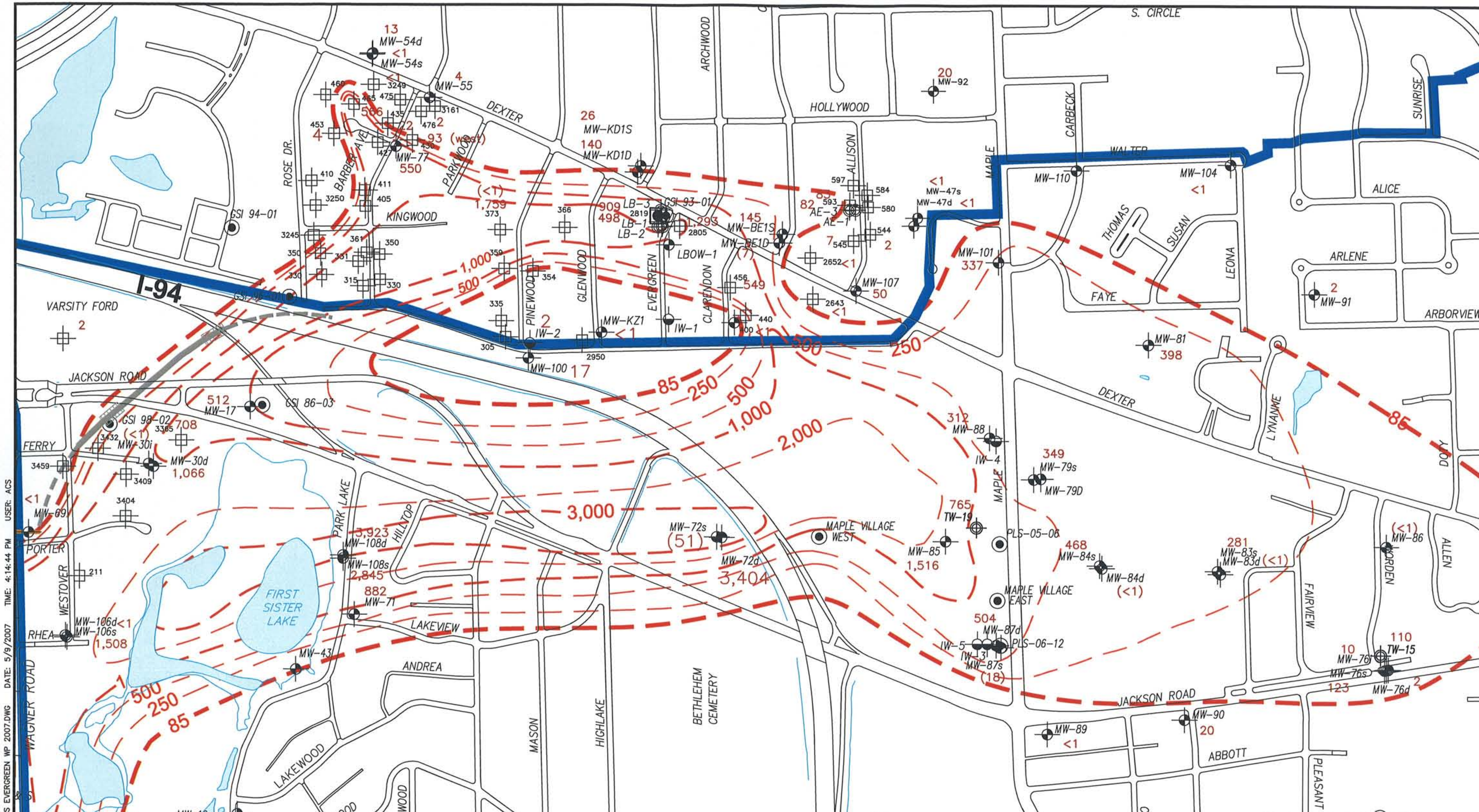
Scio Twp., Washtenaw County, Michigan
Evergreen Review

PROJECT NO.
F96502B

FIGURE NO.
1

PLOT INFO: F:\WORK\96502\DWG\CONTOUR MAPS EVERGREEN WP 2007.DWG DATE: 5/9/2007 TIME: 4:08:38 PM USER: ACS



LEGEND

- MONITOR WELL
- RESIDENTIAL WELL
- PURGE WELL
- HYDROGEOLOGIC TEST BORING
- UV/OX. TREATMENT SYSTEM
- TEMPORARY PURGE WELL
- SURFACE WATER ELEVATION POINT
- 1,4-DIOXANE ISOCONCENTRATION CONTOUR (ug/L) – UNITS D_2 & E (Combined) (October 2006 – January 2007)
- 1,437 – 1,4-DIOXANE CONCENTRATION (ug/L)
- (184) – DATA NOT USED
- PROHIBITION ZONE BOUNDARY

NORTH

0 500 1000

Scale: 1" = 500'

MAP SHOWING COMBINED UNIT D_2 & UNIT E PLUMES

ftc&h

engineers
scientists
architects
constructors

fishbeck, thompson, carr & huber, inc.

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

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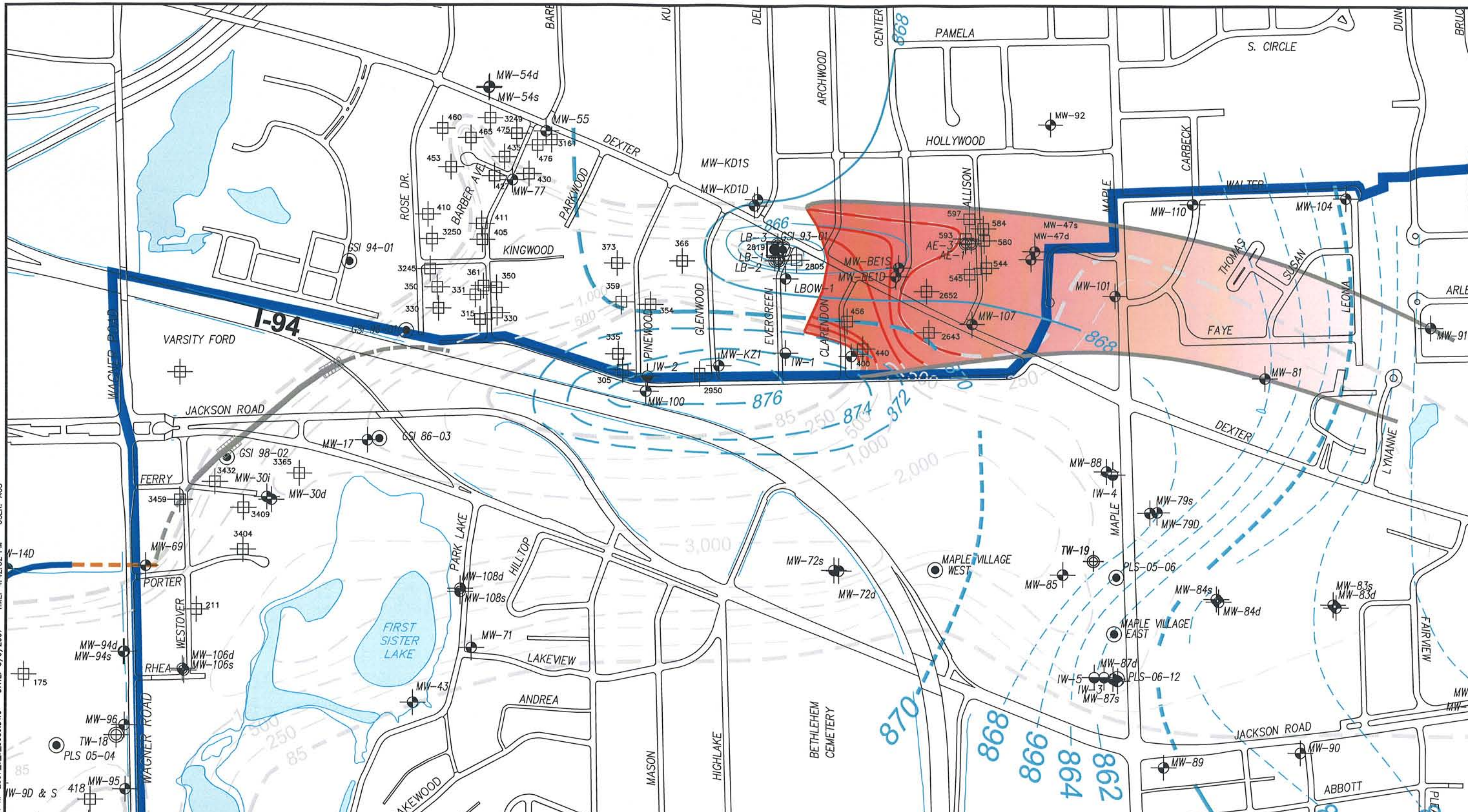
PROJECT NO.
F96502

FIGURE NO.
2



LEGEND

- MONITOR WELL
- RESIDENTIAL WELL
- PURGE WELL
- HYDROGEOLOGIC TEST BORING
- UV/OX. TREATMENT SYSTEM
- TEMPORARY PURGE WELL
- SURFACE WATER ELEVATION POINT
- UNITS D2 & E ISOCONCENTRATION CONTOUR (85 ppb) – October 2006–January 2007
- UNITS D2 & E POTENTIOMETRIC SURFACE CONTOUR (Feet amsl)
- 883.05 – POTENTIOMETRIC SURFACE ELEVATION (Feet amsl)
- (883.05) – DATA NOT CONTOURED
- PROHIBITION ZONE BOUNDARY
- MIGRATION PLUME PATHWAY

NORTH

0 500 1000

Scale: 1" = 500'

Contour Interval = 2.0'

PROBABLE DOWNGRADIENT MIGRATION PLUME PATHWAY OF REMNANT PORTION OF UNIT D_2 & E PLUME

ftc&h

engineers
scientists
architects
constructors

fishbeck, thompson, carr & huber, inc.

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PROJECT NO.
F96502B

FIGURE NO.
6

PLOT INFO: C:\WORK\CONTOUR MAPS EVERGREEN WP 2007_1_1_5389.DWG DATE: 5/9/2007 TIME: 4:42:52 PM USER: ACS

APPENDIX A

INTRODUCTION

This document describes the current status of Pall Life Sciences, Inc.'s (PLS) understanding of the Unit D_2 aquifer in the Evergreen area and its relationship to the Unit E aquifer.

The Evergreen plume is a long and relatively narrow plume that has migrated within an aquifer historically referred to as the Unit D_2 aquifer. The Evergreen plume and the Unit D_2 aquifer have been extensively studied by PLS since the plume entered the Evergreen Subdivision in the late 1980s. Recent investigations, including numerous deep boreholes drilled by PLS have provided further insight into the Unit D_2 aquifer and its relationship to other aquifers, including Unit E.

HYDROSTRATIGRAPHY

Cross sections have been prepared using log and analytical data from the PLS database for the Evergreen and Unit E plume areas. A map showing the locations of cross sections A-A' through D-D' is provided as Figure A-1. Many of these cross sections were incorporated with reports previously provided to the MDEQ. Some have been augmented with new well data (e.g., MW-110, etc.) and re-interpreted and re-presented here.

Each cross section was prepared by grouping similar lithologic units into hydrostratigraphic units. Strata composed predominantly of fine-grained materials (e.g., silts and clays) have been shaded in green on the cross sections. These strata generally represent material having a relatively low hydraulic conductivity and generally constitute confining units for the area. Strata composed predominantly of coarse-grained materials (e.g., sands and gravels) generally represent material having higher hydraulic conductivity and constitute aquifer units for the area. These units have been shaded in yellow. Significant features of each cross section are described below:

CROSS SECTION A-A'

Cross section A-A' (Figure A-2) extends from MW-69 at Wagner Road and Porter Street through the Evergreen Subdivision area, then eastward to MW-91. MW-91 is located east and downgradient of Maple Road. As shown, cross section A-A' traverses the Unit E and D_2 systems at Wagner Road, then follows the longitudinal axis of the Unit D_2 aquifer and plume through the Evergreen area, and rejoins with the Unit E system ending downgradient of Maple Road.

A review of cross section A-A' indicates at least three aquifers are present in the Evergreen Subdivision: Unit D_2, a shallower aquifer above Unit D_2, and a lower aquifer (Unit E) below Unit D_2. As shown, the aquifer thickness of Unit D_2 remains relatively uniform along its longitudinal axis from 373 Pinewood through LB-1, LB-2, and MW-BE1s&d, toward MW-47 and MW-101. For reference, monitoring wells MW-47 and MW-101 are located approximately 2,100 and 2,600 feet downgradient, respectively, of the 373 Pinewood wells.

The Unit E aquifer shown on cross section A-A' is the lower sand interval at the 373 Pinewood well (deep) and lower sand at MW-69. Historic interpretations have referred to this lower portion of Unit E as "E_2." On cross section A-A', the lower Unit E sand beneath Unit D_2 in the Evergreen area occurs intermittently and appears to be limited east of 373 Pinewood and downgradient to the area of roughly 400 Clarendon and MW-107.

Westward from 373 Pinewood, cross section A-A' shows the merger of the Unit D_2 and Unit E sand bodies in areas where the intervening confining layer is missing. The cause of the discontinuity of the confining unit can be the subject of debate (e.g., down-cutting by the Unit D_2 channel and breach of the confining unit versus localized non-deposition of the confining unit). However, the merger of the sand bodies offers potential hydraulic communication between the aquifers, regardless of the causal mechanism. A recent review of the Wagner Road area suggested the Unit E and D_2 aquifers may become locally indistinguishable in areas where the aquifers merge vertically and/or laterally.

In the area between 373 Pinewood and 400 Clarendon, the confining unit shown on cross section A-A' is well developed and laterally separates the D_2 and Unit E aquifers. This separation is borne out in the historic plume geometry depicted by the historic 1,4-dioxane isoconcentration maps for the Evergreen and Unit E plumes. A reasonable assumption is that the groundwater flow within an aquifer will follow the path of least resistance within preferential flow paths through the aquifer. The fact that the D_2 and Unit E plumes can be mapped as distinct in certain areas bear out these paths of preferential flow.

CROSS SECTION B-B'

A profile view of the Unit E and D_2 (Evergreen) aquifers is shown on cross section B-B' (Figure A-3). Cross section B-B' is constructed generally perpendicular to the Unit E and D_2 aquifers and extends northward from MW-72, through IW-1, to LB-1 and MW-KD1d. Historic interpretations of the aquifer geometry would characterize the sand intervals at MW-72s and MW-72d as the upper Unit E (E_1) and the lower Unit E (E_2) aquifers, respectively. Correlations indicate the deeper sand (historic Unit E_2) is present at IW-1, IW-2, and 373 Pinewood (deep). It is important to note that this lower Unit E sand interval has never been contaminated by 1,4-dioxane in the Evergreen area, except for trace levels in the IW wells.

Cross section B-B' shows lateral thinning of the upper Unit E (E_1) sand (screened in MW-72s) toward IW-1. As shown, this sand thickens north of IW-1 at LB-1 and MW-KD1d. At these later locations, the sand has historically been assigned to the Unit D_2 aquifer. The thickness of the sand at IW-1 is limited by the increased thickness of the intervening confining unit. Consequently, lateral separation of the upper Unit E and D_2 aquifer systems is largely affected by the increase in the confining unit thickness and the corresponding thinning and separation of the aquifers, as evidenced at IW-1. Further, this increased thickness of the confining unit and thinned aquifer (Unit D_2/upper Unit E) forms a hydraulic divide south of the LB-1 and LB-2 extraction wells. This has resulted in distinct Unit D_2 and Unit E plumes in this area.

CROSS SECTION C-C'

Comparison of cross section A-A' to similar cross sections for the Unit E aquifer show a merging of the D_2 and Unit E aquifers in the area downgradient of the 400 Clarendon well and northward from MW-88. Cross section C-C' (Figure A-4) depicts the aquifer geometry transverse to the Unit E plume at Maple Road, then extends northward to incorporate wells in the D_2 aquifer. Cross section C-C' shows the aquifer system along Maple Road (the Unit E aquifer) continues laterally northward and is correlative to the aquifers at MW-101, MW-47s&d, and MW-92. MW-101 is characterized as screened in the Unit E aquifer, while the later wells are depicted as being in the Unit D_2 (Evergreen) aquifer. Comparison of correlations shown on cross sections C-C' and A-A' show little or no distinction between the two aquifer units downgradient of 400 Clarendon. As such, the Unit E aquifer north of MW-88, at Maple Road, is shown to merge with the Unit D_2 aquifer.

CROSS SECTION D-D'

Cross section D-D' (Figure A-5) also shows a profile view of the Unit E aquifer along Maple Road, then extends north-northeastward to incorporate MW-81, MW-91, and MW-104. When compared to cross section A-A', the character of the confining unit and aquifer development suggests an aquifer geometry for Unit D_2 that develops a thicker sand body south of MW-104, with the longitudinal axis of the aquifer potentially trending toward the MW-91 area. This geometry would send groundwater flow within D_2 southeastward from the Allison Street area. With the merging of D_2 and Unit E, the two aquifer systems essentially become one in the area east of Maple Road.

GROUNDWATER FLOW (OVERVIEW)

A potentiometric surface map for Unit D_2 and a portion of the Unit E aquifers for data collected March 13, 2007, is provided as Figure A-6. Operation of the Evergreen extraction wells has resulted in a hydraulic depression. This depression results in a fairly extensive capture for the wells and the potential for groundwater from the south to be pulled into to this hydraulic sink. This groundwater is expected to move around the hydraulic high in the area of MW-KZ1 and 400 Clarendon.

Where the Unit E and D_2 aquifers merge, generally eastward of the well at 400 Clarendon and MW-107 and northward from MW-88, groundwater flow from the D_2 aquifer in the Evergreen area is expected to be controlled by the aquifer geometry and move toward MW-91.

The aquifer geometries reflected in the cross sections provide insight into the relationship between groundwater from the D_2 and Unit E aquifers and the distribution of 1,4-dioxane. Lateral and vertical confining of the aquifers appears to be the primary reason for steep hydraulic gradients observed downgradient (east) of Maple Road.

The hydraulic heads in the Evergreen area, measured in Unit D_2 and lower Unit E, suggest a slight downward gradient. The lack of data from nested well sets makes it difficult to interpret gradients between these aquifers. Water level data from nested well sets where the wells are completed in Unit D_2 or the upper Unit E show very minor vertical hydraulic gradients.

GROUNDWATER LEVELS

Groundwater levels have been measured routinely in many Evergreen area wells since the early to mid-1990s. Groundwater levels in the Evergreen Subdivision wells have been consistently dropping. A compiled hydrograph of water levels in selected Evergreen wells is provided as Figure A-6. The hydrograph shows that water levels have declined nearly 8 feet in many wells over the last 10 to 12 years. These water level drops are believed related, in part, to the operation of extraction wells in the Evergreen area and elsewhere. PLS has also come to believe that it is these water level declines that are a component source of the difficulties experienced with operations at the Evergreen extraction wells, particularly AE-3.

The magnitude of drawdown at the LB-1 and LB-2 extraction area may best be represented at the residential well at 2819 Dexter. The 2819 Dexter well is located west (upgradient) and in close proximity to the LB series extraction wells. Water levels at 2819 Dexter were similar to those encountered at

MW-BE1s&d as monitoring began. MW-BE1s&d are located approximately 700 feet east and generally downgradient of the 2819 Dexter well. With time, water levels at 2819 Dexter have dropped by roughly 11 feet.

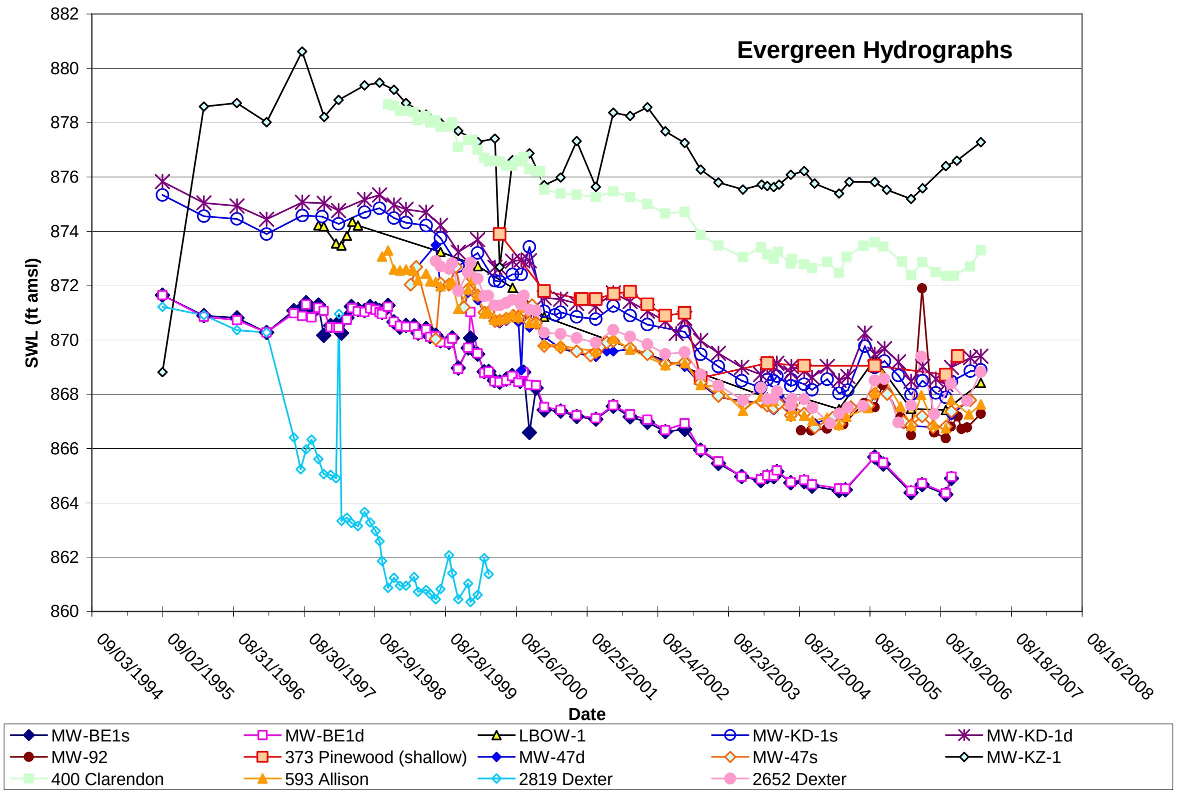


Figure A-6: Hydrographs of selected Evergreen wells showing water level declines.

AQUIFER HYDRAULIC CHARACTERISTICS

Aquifer tests have been conducted at the LB-1 and IW-1 wells in the Evergreen area. LB-1 aquifer testing was conducted between September 10 and 12, 1992. The tests utilized the 8-inch-diameter LB-1 well as the pumping well and two observation wells (the domestic well at 2819 Dexter and LBOW-1, a well drilled/installed specifically for the test). The test involved periodically measuring water levels in these wells during pumping and non-pumping conditions for a total period of approximately two days.

Analyses of aquifer performance test data indicate the aquifer responds as a confined aquifer with no storage in bounding confining layers. These analyses also indicate the aquifer has a transmissivity of approximately 18,063 square feet per day (ft^2/day) and a storativity ranging between 0.0092 and 0.00017.

Using an aquifer thickness of 75 feet, an average hydraulic conductivity for the aquifer material is calculated to be 241 ft/day.

IW-1 aquifer testing involved conducting a single-well aquifer performance test on October 11 and 12, 1993. This well is interpreted to be in Unit E (E_2). The test involved monitoring water levels in IW-1 while pumping it for a period of approximately 18.5 hours at a flow rate of approximately 101 gallons per minute (gpm), followed by monitoring water levels in the well during a 5.5-hour recovery period after the pump was shut off. The water levels were collected and recorded with a data logger equipped with a Keller 10-pound-per-square-inch transducer. Flow rates were measured using an electrical flow meter.

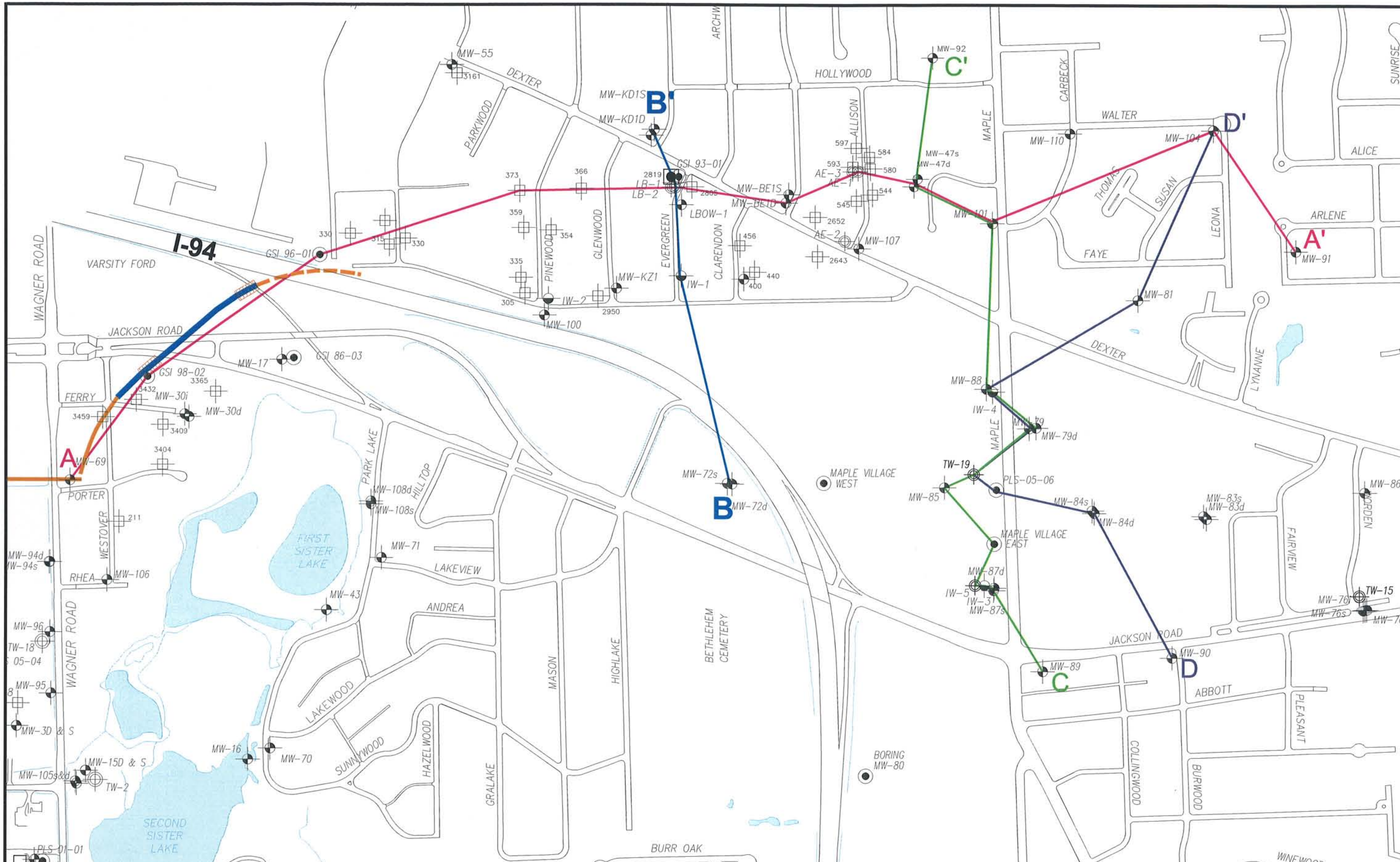
Drawdown and recovery graphs suggest the aquifer reacted as a semi-confined aquifer with storage in the confining layer. Due to some interferences during pumping, the t/t' versus residual drawdown data were used to calculate aquifer transmissivity. Using the recovery data, an aquifer transmissivity of 4,456 ft^2/day is calculated. Using an aquifer transmissivity of 4,456 gallons per day per foot and an aquifer thickness of 20 feet, the average hydraulic conductivity of the aquifer is calculated to be 223 ft/day.

For comparison, aquifer tests results for TW-16 are tabulated below, along with the results from TW-18 (along Wagner Road) and TW-19 (along Maple Road) and in Unit E. It can be seen that the aquifer transmissivities are similar at LB-1, TW-16, and TW-18, and are lower at TW-19.

Well ID	Aquifer	Test Length	Aquifer Thickness (ft)	Transmissivity (ft^2/day)	Storativity	Hydraulic Conductivity (ft/day)
TW-16 (aka IW-3)	E	24 hr + rec	78	17,604	1.36E-04	225.7
TW-18	E	24 hr + rec	100	20,013	4.7E-04	200
TW-19	E	24 hr + rec	97	6,819	1.36E-04	70

Note: rec = recovery

Thinning of the Unit D_2 aquifer, south of the LB series wells, is expected to considerably reduce transmissivity of the aquifer. Furthermore, drilling data for the AE series wells indicate the aquifer is comprised of finer-textured materials and is, therefore, also expected to have a lower transmissivity.



LEGEND

- MONITOR WELL
- RESIDENTIAL WELL
- PURGE WELL
- HYDROGEOLOGIC TEST BORING
- UV/OX. TREATMENT SYSTEM
- TEMPORARY PURGE WELL

NORTH

Scale: 1" = 500'

0 250 500

CROSS SECTION LOCATION MAP

ftc&h

engineers
scientists
architects
constructors

fishbeck, thompson, carr & huber, inc.

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

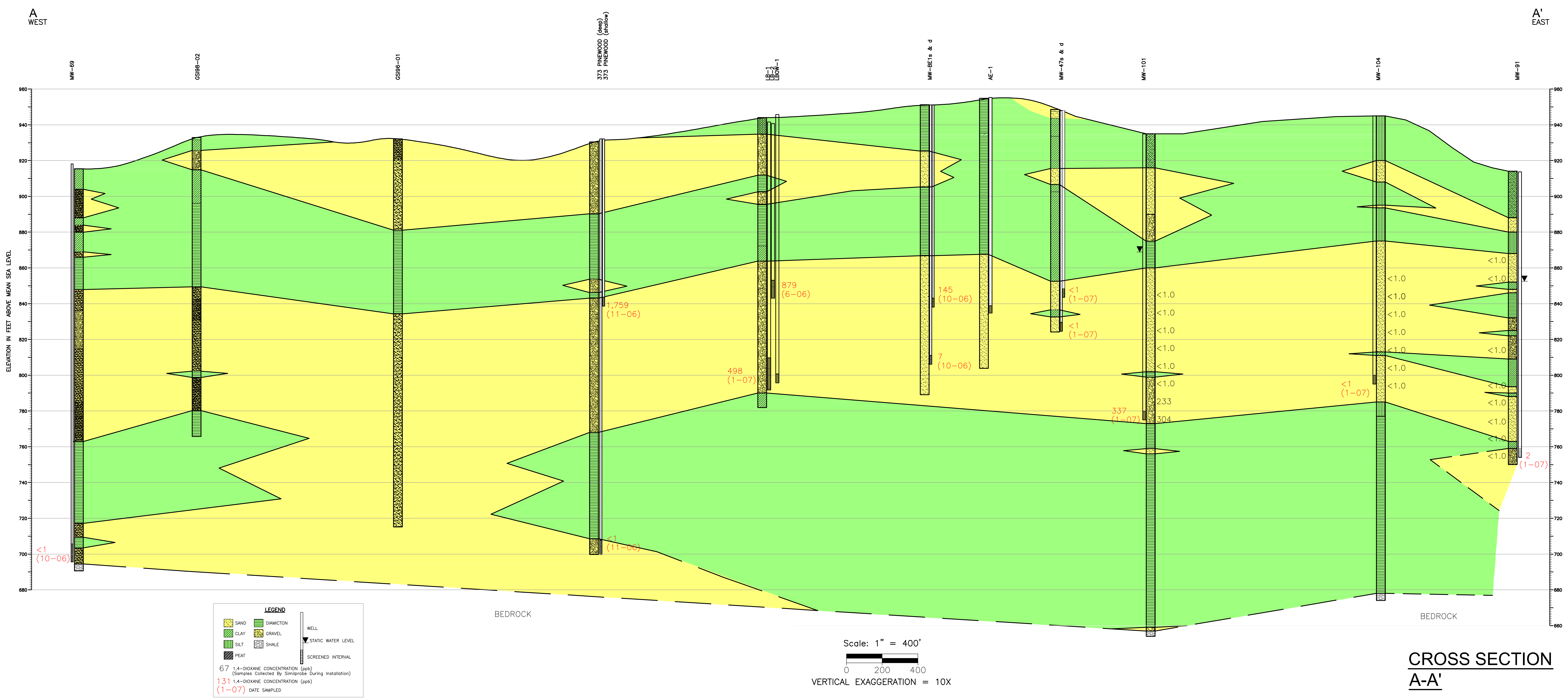
Pall Life Sciences

Scio Twp., Washtenaw County, Michigan

Evergreen Review

PROJECT NO.
F96502B

FIGURE NO.
A-1



CROSS SECTION A-A'

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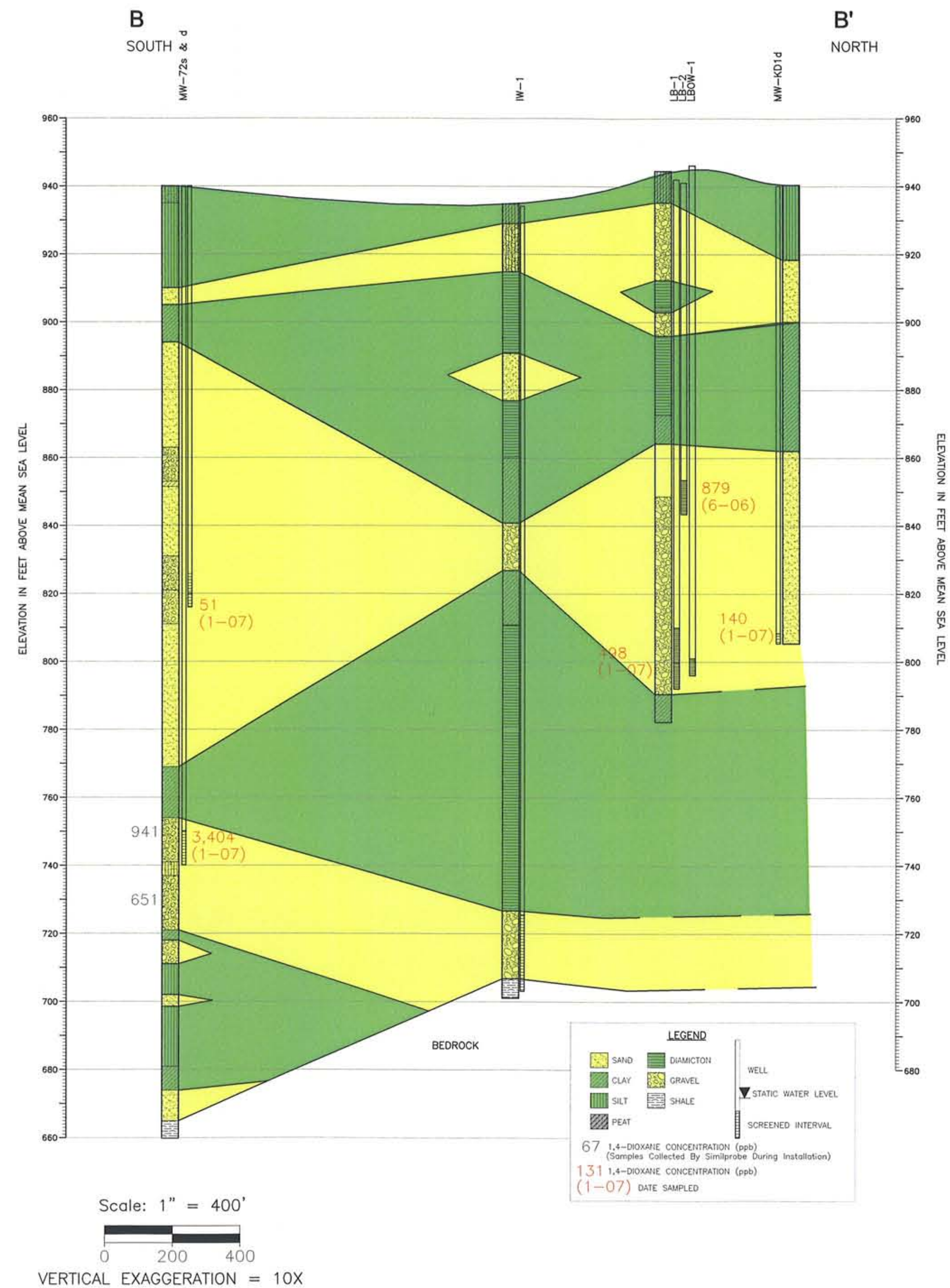
PROJECT NO.
F96502B

FIGURE NO.
A-2



CROSS SECTION B-B'

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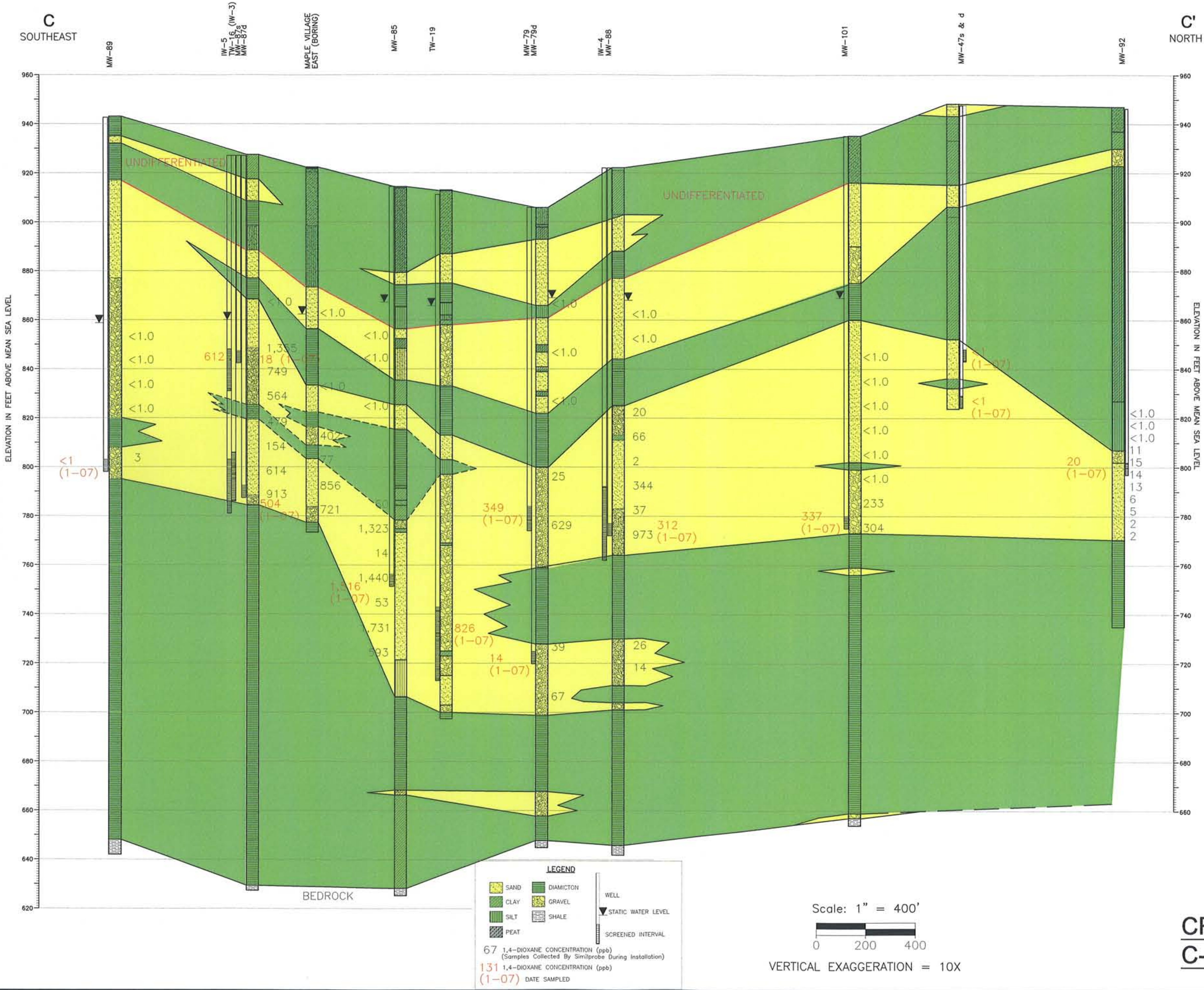
PROJECT NO.
F96502B

FIGURE NO.
A-3



CROSS SECTION C-C'

fTC&H

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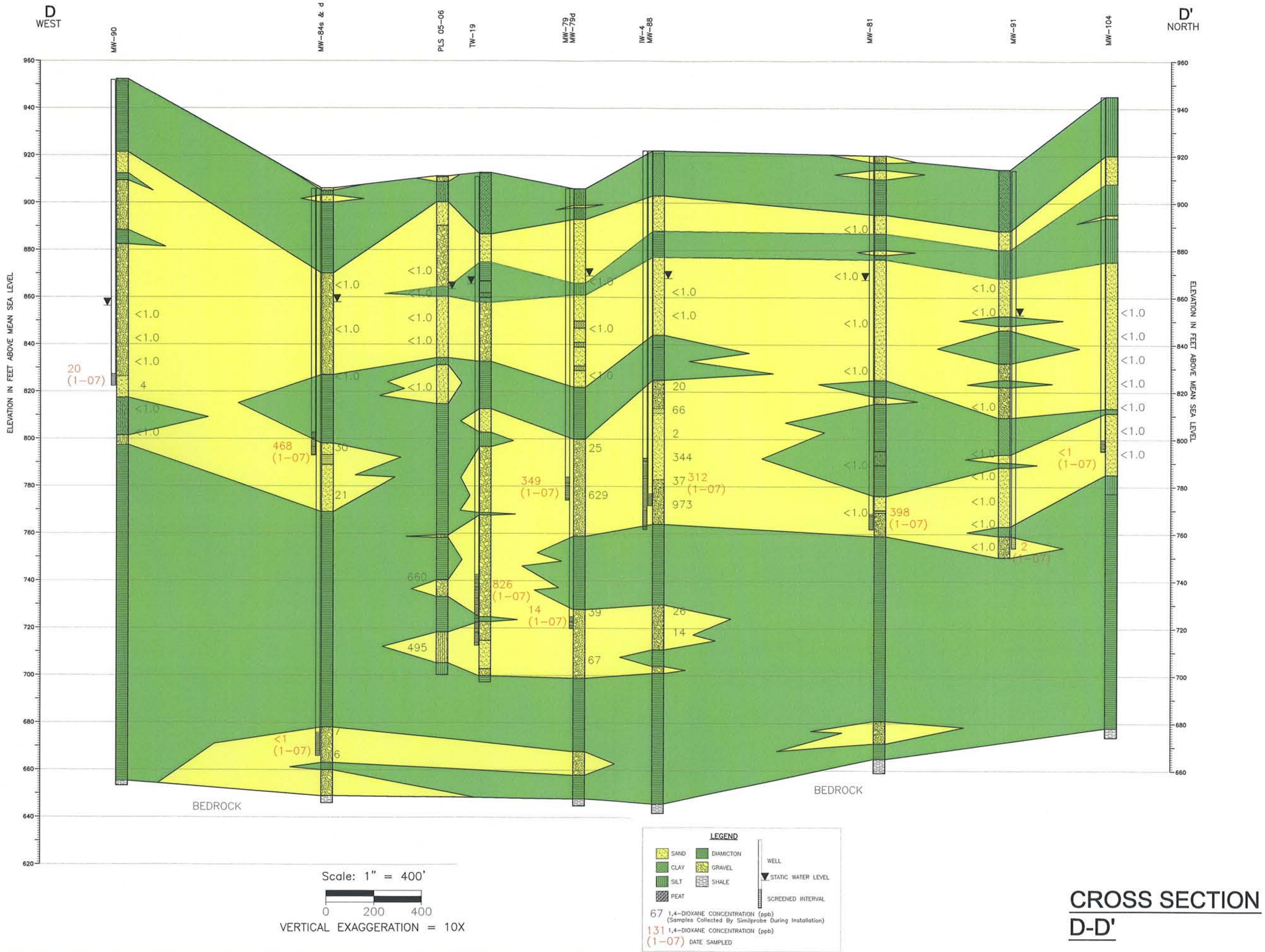
PROJECT NO.
F96502B

FIGURE NO.
A-4



CROSS SECTION D-D'

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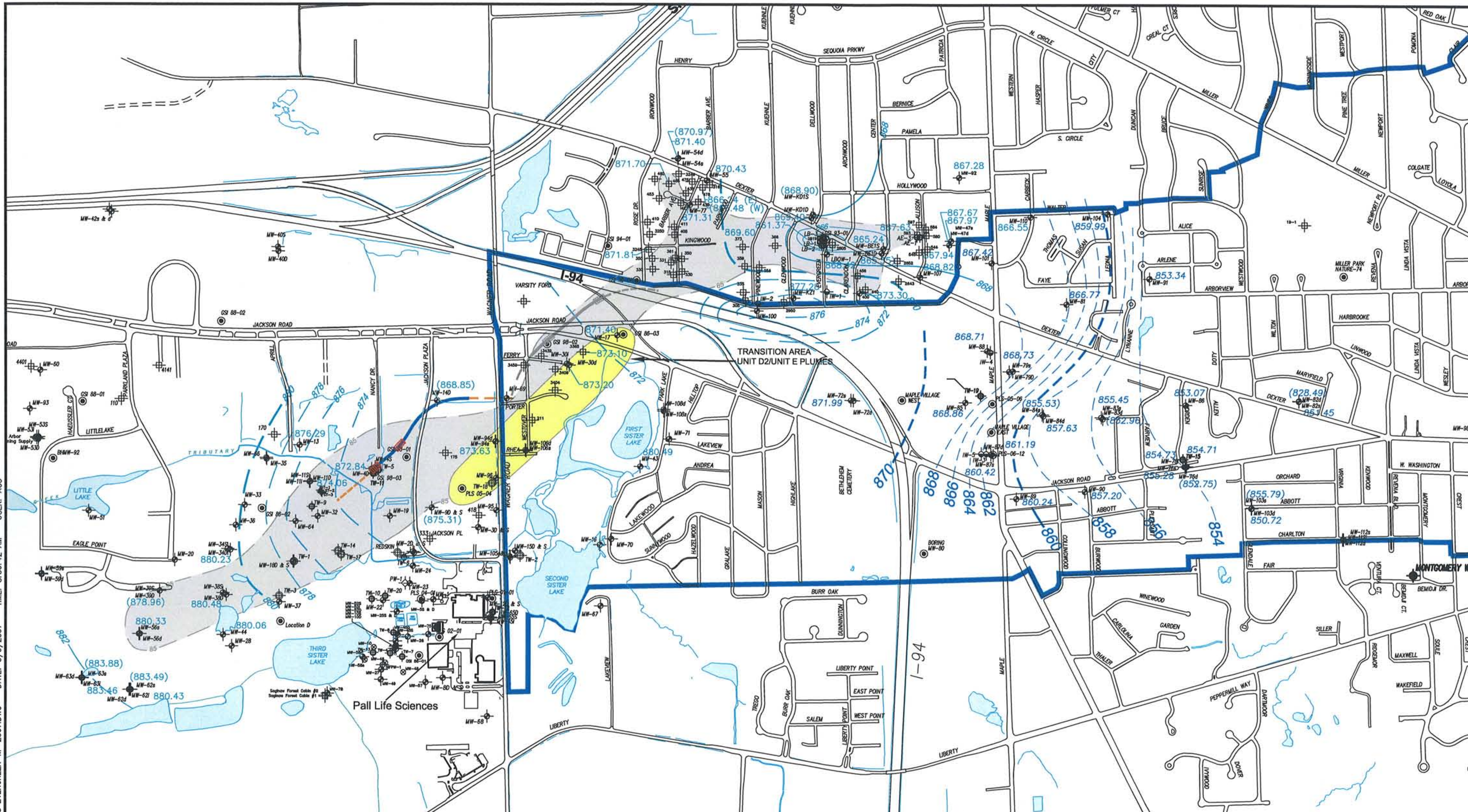
PROJECT NO.
F96502B

FIGURE NO.
A-5



LEGEND

- MONITOR WELL
- RESIDENTIAL WELL
- PURGE WELL
- HYDROGEOLOGIC TEST BORING
- UV/OX. TREATMENT SYSTEM
- TEMPORARY PURGE WELL
- SURFACE WATER ELEVATION POINT
- UNIT D2 1,4-DIOXANE CONCENTRATION CONTOUR (85 ppb)
- Unit E POTENTIOMETRIC SURFACE CONTOUR (Feet amsl)
- Unit D2 POTENTIOMETRIC SURFACE CONTOUR (Feet amsl)
- 883.05 – POTENTIOMETRIC SURFACE ELEVATION (Feet amsl)
- (883.05) – DATA NOT CONTOURED
- PROHIBITION ZONE BOUNDARY

NORTH

Scale: 1" = 1000' (0 – 1000 – 2000)

Contour Interval = 2.0'

UNIT D_2 & PORTIONS OF UNIT E AQUIFERS POTENTIOMETRIC SURFACE CONTOUR MAP - March 13, 2007

ftc&h

engineers
scientists
architects
constructors

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PROJECT NO.
F96502B

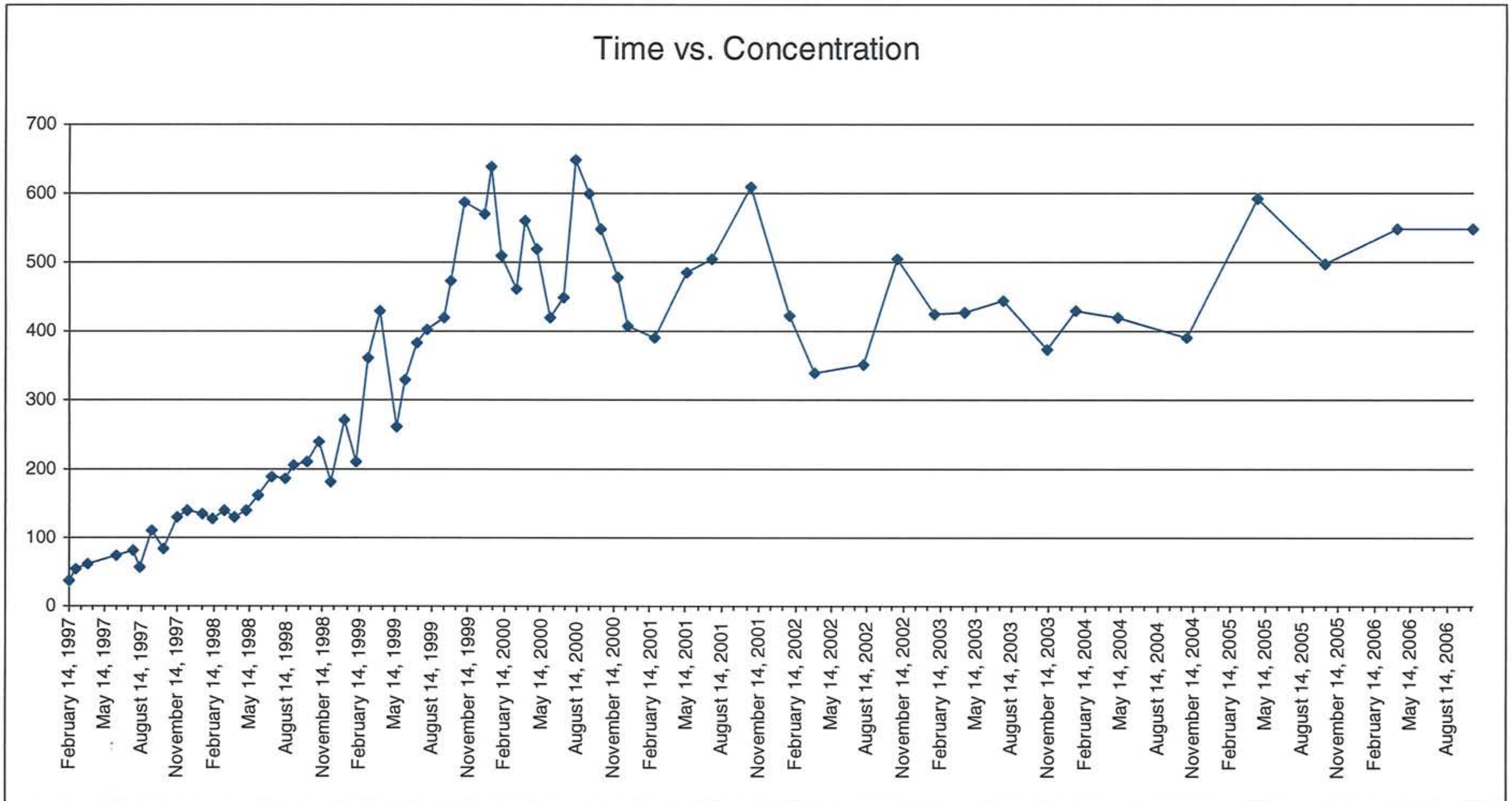
FIGURE NO.
A-6

PLOT INFO: F:\WORK\96502\DWG\CONTOUR MAPS EVERGREEN WP 2007.DWG DATE: 5/9/2007 TIME: 8:36:42 AM USER: ACS

APPENDIX B

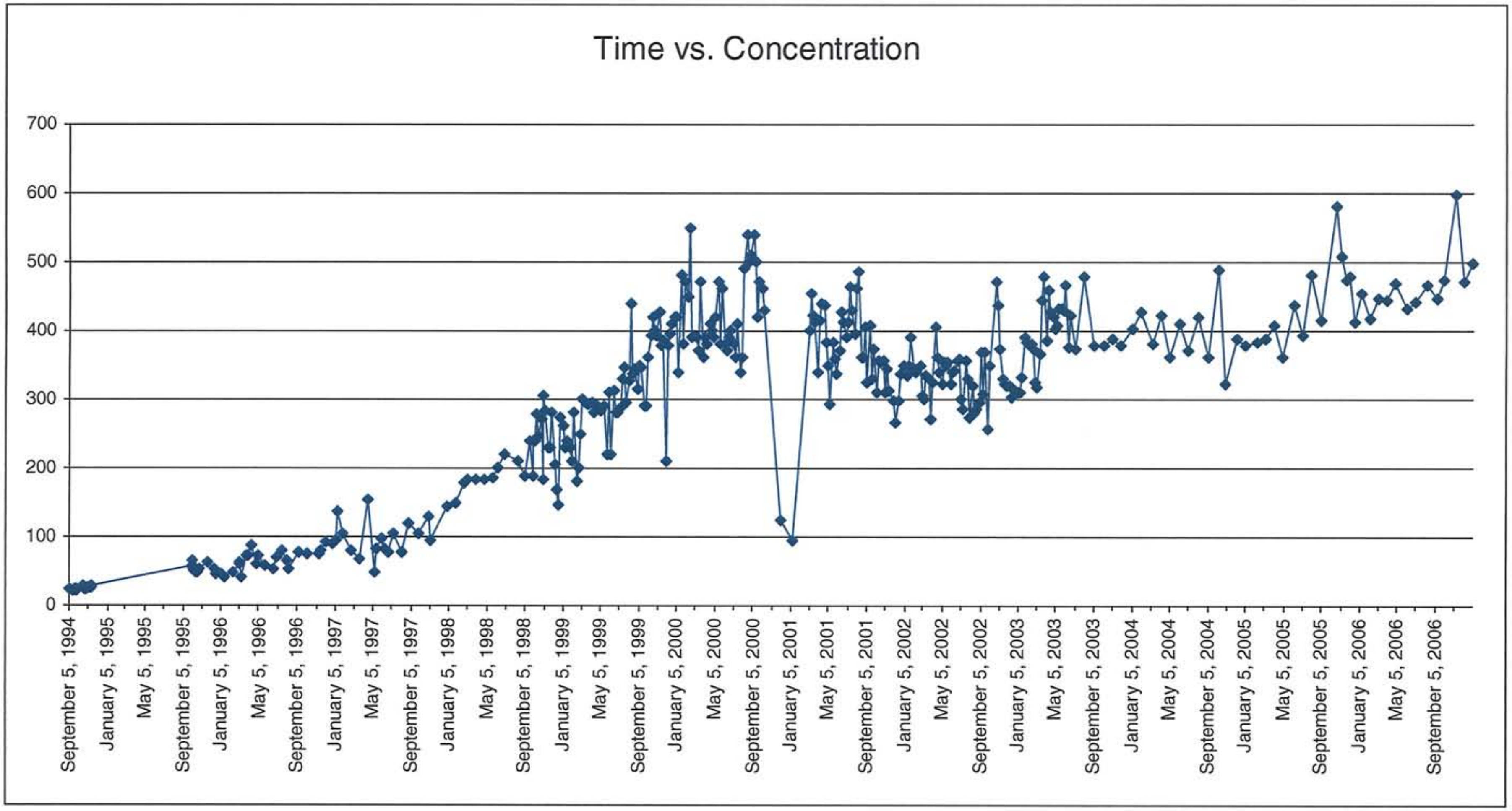
456 Clarendon

Aquifer: D2
Type of well: Residential Wells
Sampling Interval: Semi-Annual



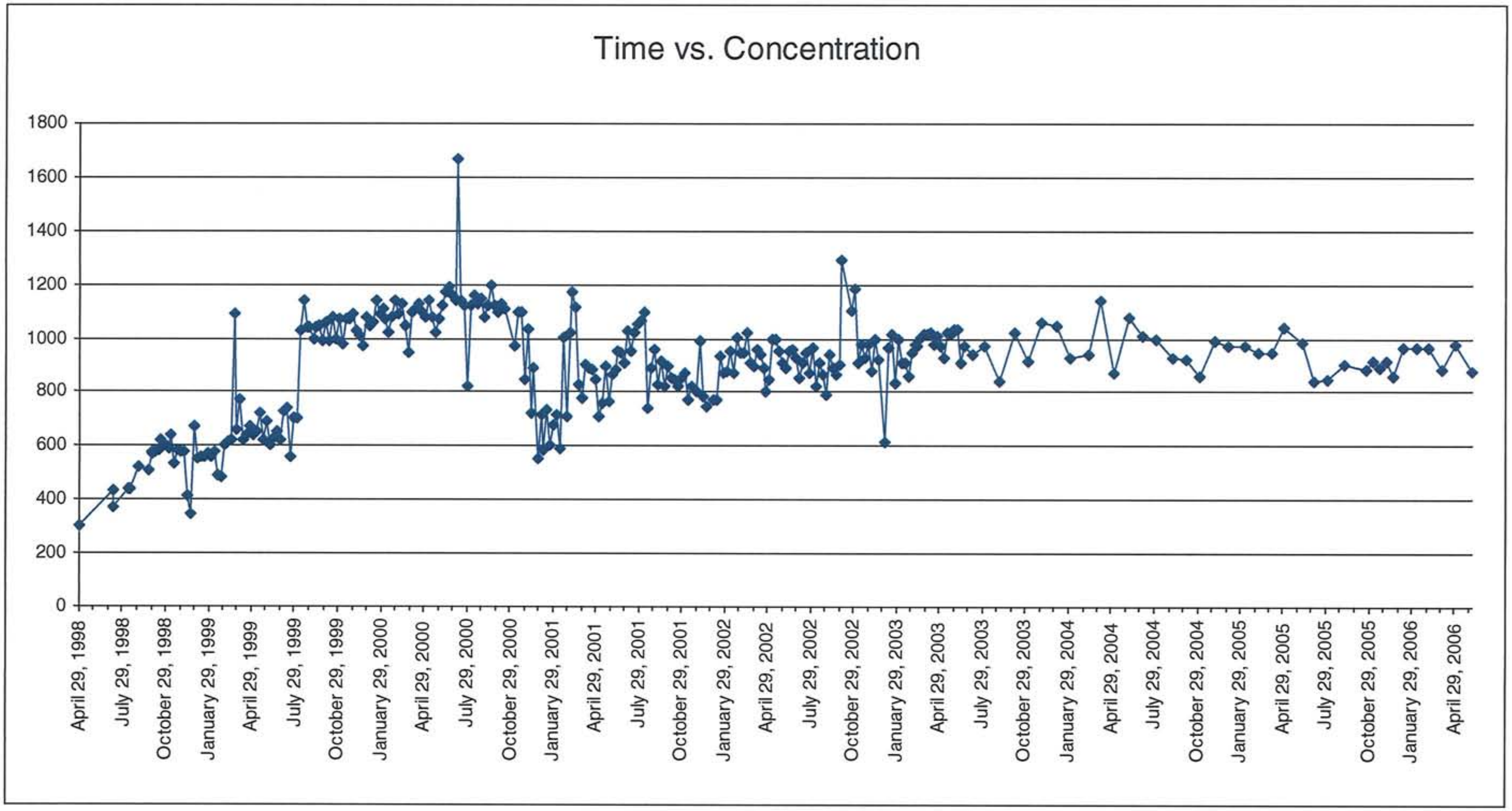
LB-1

Aquifer: D2
Type of well: Extraction Wells
Sampling Interval: Extraction Monthly



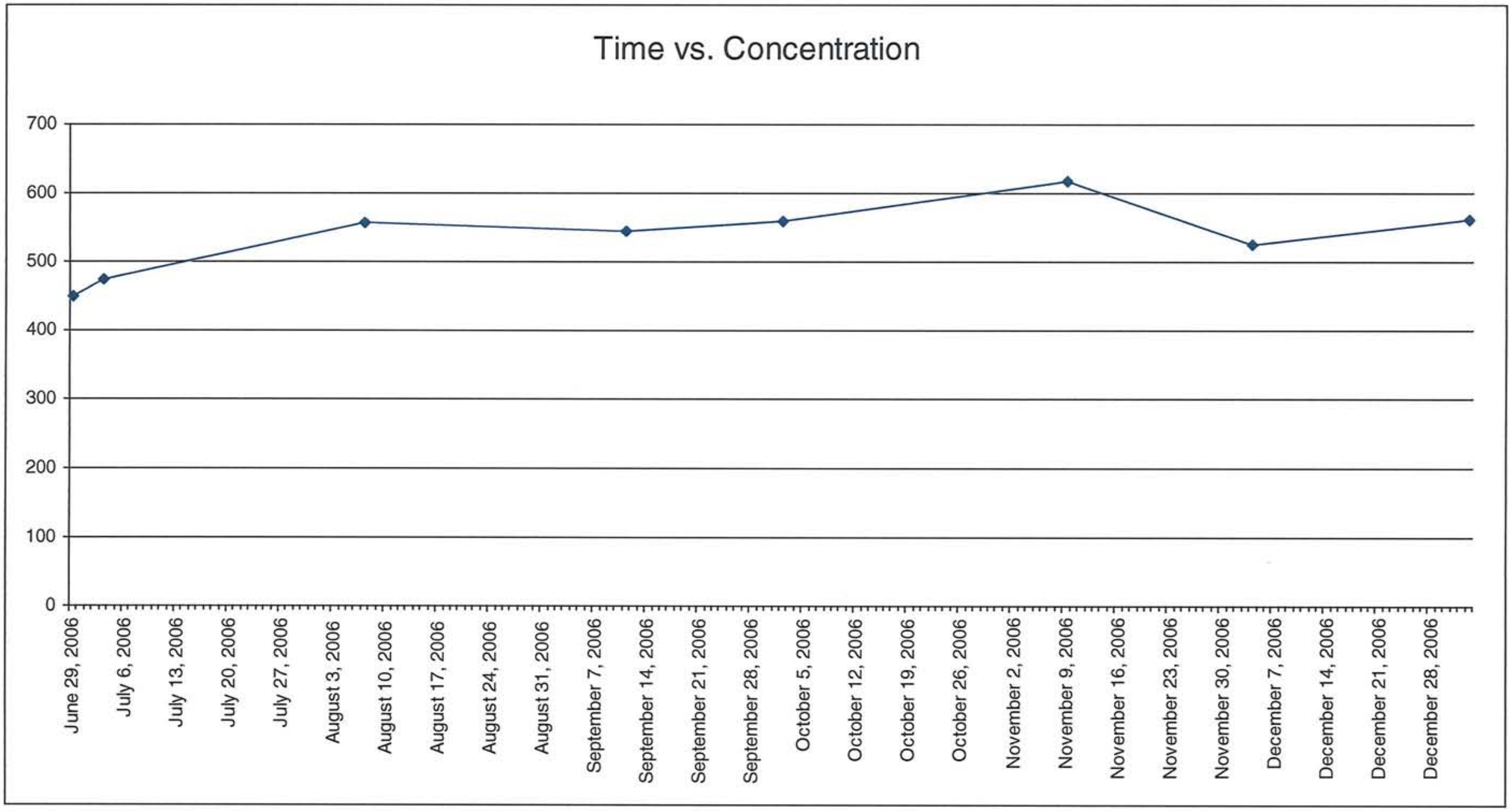
LB-2

Aquifer: D2
Type of well: Extraction Wells
Sampling Interval: Extraction Monthly



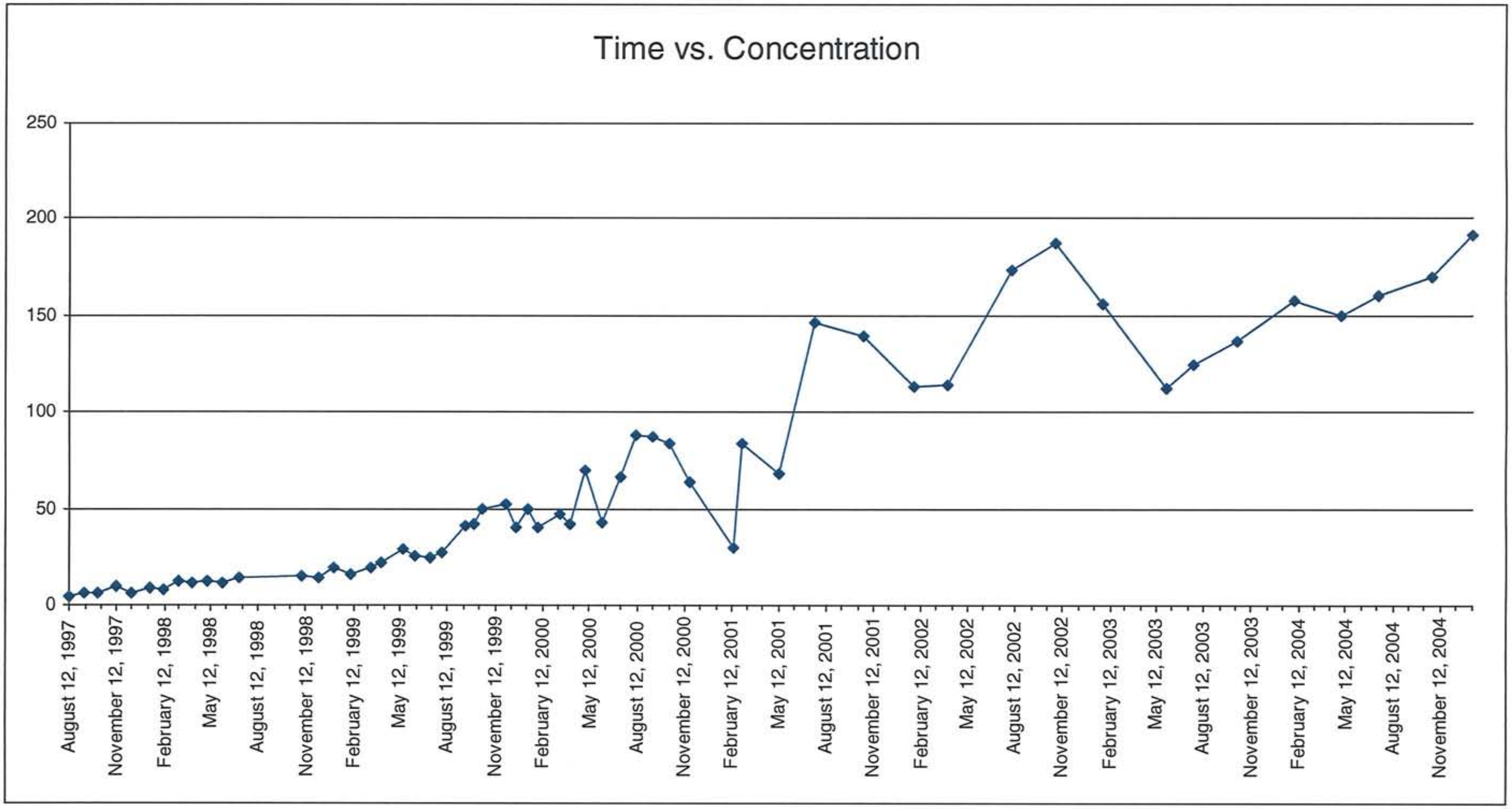
LB-3

Aquifer: Not Determined
Type of well: Extraction Wells
Sampling Interval: Extraction Monthly



440 Clarendon

Aquifer: D2
Type of well: Residential Wells
Sampling Interval: Not set



APPENDIX C

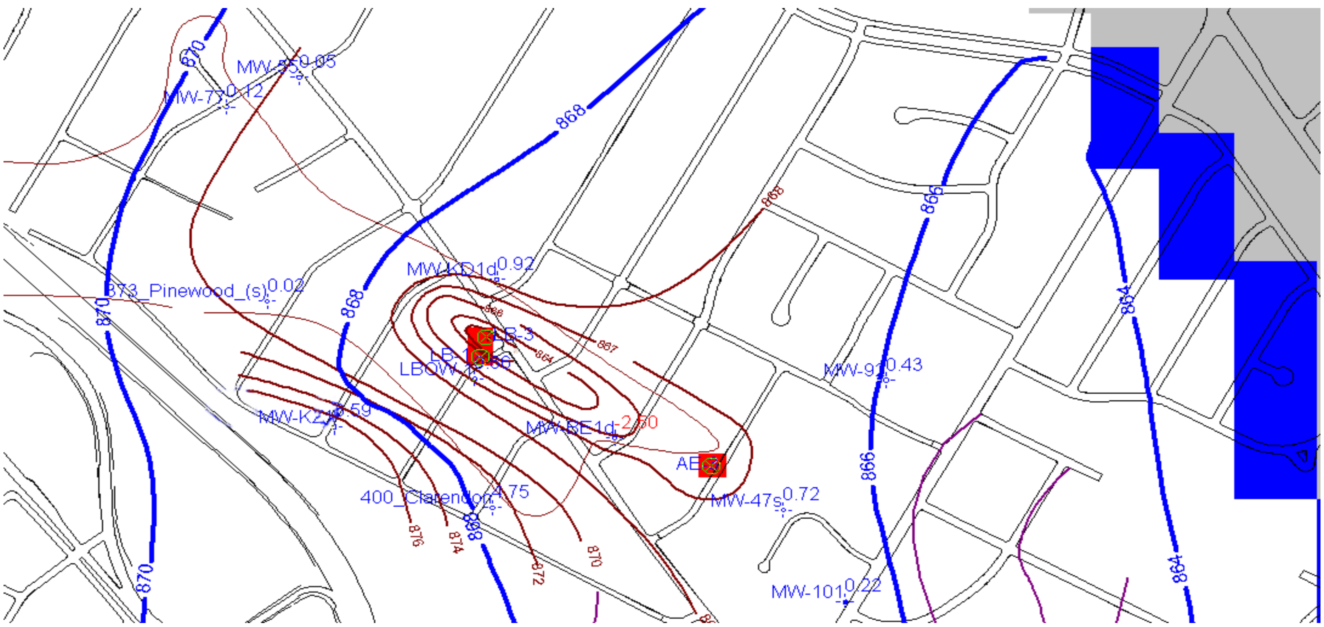
Appendix C – Groundwater Flow Model Calibration Information and Discussion
(May 10, 2007)

The groundwater flow model used for simulations provided in this report was previously described in a February 2002 report titled “Groundwater Flow and Contaminant Transport Modeling of 1,4-Dioxane, Pall Life Sciences, Ann Arbor, Michigan.” Minor modifications to this model were made for this analysis.

The slightly revised model was calibrated to data from a representative round of water level data collected in September 2006. The September 2006 data were calibrated to steady state flow conditions.

The simulated potentiometric surface for the calibrated model has been compared to the September 2006 measured potentiometric surface. This comparison is shown as Figure 1.

Figure 1 – Comparison of Measured (September 2006) and Simulated Heads (with residuals shown)



Notes: Blue = simulated surface; brown = measured surface, residuals are posted near wells (blue water levels are where the simulated water levels are too low, and red water levels are too high)

A review of Figure 1 suggests the simulated and measured surfaces compare well both in terms of magnitude and direction. The simulated surface in the area downgradient of AE-3 suggests a slightly more northeast component of flow as compared to the measured surface. This is due to the position of the constant head boundary used in the model. Because of this discrepancy, the model will not accurately predict the downgradient pathway of the plume past AE-3.

Appendix C – Groundwater Flow Model Calibration Information and Discussion
(May 10, 2007)

Calibrating with wells along Valley Drive required a considerable reduction of hydraulic conductivity in this area. Review of boring data from wells in this area suggest the Unit D_2 aquifer thins (see cross section B-B' in Appendix A) and appears to be less transmissive in this area. This is not uncommon, especially between what appear to be anastomosing outwash channels. Such features are commonly referred to as "braid bars." Water levels from MW-KZ1 and MW-400 have consistently shown higher hydraulic heads in this area, creating a local hydraulic divide. PLS has no reason to dispute these data. Additionally, data from recently installed MW-100 and the older MW-KZ1 show 1,4-dioxane is not present in the area at significant concentrations, thus supporting a divide between the two plumes in this area. In a February 18, 2004, MDEQ memorandum from Mr. Rick Mandle to Ms. Sybil Kolon, Mr. Mandle questioned PLS' assignment of a low hydraulic conductivity to this area in previous submittals. Although there are limited empirical data to support our interpretation, in the end, the manner in which this area is represented in the model makes little difference on the overall capture area for the extraction wells. If the area of low hydraulic conductivity is removed, the capture area merely extends further south.

It was difficult to calibrate to measured data from MW-BE1d. After calibration, the simulated head at this location remained higher than the measured head. It is likely that the pumping at LB-1 and LB-3 has lowered the head at this well more than the model predicts. There may be some preferential hydraulic communication between this area and LB-1 and LB-3 that is not identifiable by available field data. As such, the model might be underestimating the downgradient capture of LB-1 and LB-3.

Calibration Statistics

Name, X, Y, Layer, Observed, Computed, Weight, Group, Residual

MW-101,13281896.289044,287327.520908,2,866.520000,866.304863,1.000000,100,0.215137

MW-47s,13281495.216513,287540.119284,2,867.110000,866.390534,1.000000,100,0.719466

MW-BE1d,13280787.885364,287473.174974,2,864.360000,866.859858,1.000000,100,-2.499858

MW-77,13278798.224441,287919.107603,2,870.330000,870.205193,1.000000,100,0.124807

MW-55,13278971.023865,288169.908448,2,869.480000,869.426627,1.000000,100,0.053373

LBOW-1,13280202.369458,287414.723158,2,867.420000,866.759307,1.000000,100,0.660693

MW-KD1d,13280057.114065,287820.592516,2,868.120000,867.203912,1.000000,100,0.916088

MW-KZ1,13279849.140476,286964.885216,2,876.400000,869.808739,1.000000,100,6.591261

373_Pinewood_(s),13279356.184668,287290.503084,2,868.724000,868.704182,1.000000,100,0.019818

400_Clarendon,13280543.139619,286979.848436,2,872.350000,867.596707,1.000000,100,4.753293

MW-92,13281545.512518,288214.240143,2,866.380000,865.953011,1.000000,100,0.426989

Residual Mean,,,,,,1.089188
Res. Std. Dev.,,,,,,2.360257
Sum of Squares,,,,,,74.328592
Abs. Res. Mean,,,,,,1.543708
Min. Residual,,,,,,-2.499858
Max. Residual,,,,,,6.591261
Range in Target Values,,,,,,12.040000
Std. Dev./Range,,,,,,0.196035