REGION 5 RAC2

REMEDIAL ACTION CONTRACT FOR

Remedial, Enforcement Oversight, and
Non-Time Critical Removal Activities at Sites of Release
or Threatened Release of Hazardous Substances in Region 5

EVALUATION FOR IN SITU TREATMENT OF GROUNDWATER REPORT

Oconomowoc Electroplating Company, Inc.
Oconomowoc, Wisconsin

WA No. 003-LRLR-05M8/Contract No. EP-S5-06-01

July 2008

PREPARED FOR

U.S. Environmental Protection Agency

PREPARED BY

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347192.MS.01

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Subject: Evaluation for In Situ Treatment of Groundwater
Oconomowoc Electroplating Company, Inc. Site, Ashippun, Wisconsin
WA No. 003-LRLR-05M8, Contract No. EP-S5-06-01

Dear Mr. Ryan:

Enclosed please find for your review one CD containing the above-referenced report for the Oconomowoc Electroplating Company, Inc. Site for your review. If required, we can also send hard copy versions. Please contact me if you have any questions or concerns at 414-847-0437.

Sincerely,

CH2M HILL

Matt Boekenhauer

Matt Boekenhauer
Site Manager

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EVALUATION FOR
IN SITU TREATMENT OF GROUNDWATER

OCONOMOWOC ELECTROPLATING COMPANY, INC.
Oconomowoc, Wisconsin

WA No. 003-LRLR-05M8/Contract No. EP-S5-06-01

July 2008

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Acronyms and Abbreviations

μg/L	micrograms per liter
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, xylene
cis-1,2-DCE	cis-1,2-dichloroethene
cm/sec	centimeters per second
CVOC	chlorinated volatile organic compound
DNAPL	dense nonaqueous phase liquid
EISB	enhanced in situ bioremediation
EOS™	emulsified oil substrate
ES	enforcement standard
EVO	emulsified vegetable oil
FSP	Field Sampling Plan
HRC	hydrogen release compound
NA	natural attenuation
O&M	operation and maintenance
PAL	preventive action limit
PCE	tetrachloroethene
QAPP	Quality Assurance Project Plan
ROI	radius of influence
TCA	1,1,1-trichloroethane
TCE	trichloroethene
TOC	total organic carbon
USEPA	United States Environmental Protection Agency
VC	Vinyl Chloride
VFA	volatile fatty acids
VOC	volatile organic compound
WDNR	Wisconsin Department of Natural Resources

SECTION 1

Introduction and Background

This report presents a brief evaluation of the feasibility and cost effectiveness of enhancing the biodegradation of chlorinated volatile organic compounds (CVOCs) at the former Oconomowoc Electroplating Company, Inc. (OECI) Site (the Site) in Oconomowoc, Wisconsin. The goal of the enhanced bioremediation is to increase the rate of contaminant reduction already occurring through natural processes, thereby decreasing the overall duration for monitored natural attenuation (NA) to achieve target groundwater concentrations. This evaluation was performed for the U.S. Environmental Protection Agency (USEPA) in accordance with Revision 3 of the statement of work for Work Assignment No. 003-LRLR-05M8/Contract No. EP-S5-06-01.

1.1 Background and Objectives

This section provides a brief summary of the project background. Detailed discussions of the site history and physical and chemical characteristics are presented in the Annual Groundwater Monitoring Reports (CH2M HILL, 2007b and 2008a).

The OECI site is currently undergoing groundwater monitoring in accordance with the *Quality Assurance Project Plan* (QAPP) (CH2M HILL, 2004), *QAPP Changes Letter* (CH2M HILL, 2007a), and *Field Sampling Plan* (CH2M HILL, 2006). A site map is provided as Figure 1. A groundwater extraction system was operated at the Site for 8 years at the five locations shown on Figure 1, substantially lowering the concentrations of metals and CVOCs in groundwater. In the summer of 2002, metal concentrations had decreased to levels that allowed for cessation of groundwater treatment operations per the Wisconsin Department of Natural Resources (WDNR) and United States Environmental Protection Agency (USEPA), Region 5. The extraction system ceased operation in July 2004.

Long-term groundwater monitoring began in October 2004. Data sets from 2003 (pre-shut-down), and 2004 and 2005 (both post-shut-down) showed similar groundwater concentrations, suggesting a relatively stable post-extraction plume. Data from 2006 through 2008 also show continued evidence that NA is occurring. Evidence for NA continues to be strongest at shallow well locations downgradient of former OECI facility operations. However, it appears that NA rates may be declining due to several reasons, primarily the decreased concentrations of total organic carbon (TOC) and benzene, toluene, ethylbenzene, xylene (BTEX) compounds available in groundwater for reductive dechlorination.

In May 2009, the Site will be transitioned to the WDNR. The objective of this memorandum is to evaluate a cost-effective method to enhance biological degradation activities ongoing at the Site for possible implementation prior to its transition to the WDNR. Therefore, the evaluation has incorporated technical, practical, and time-constraint factors.

1.1.1 Site History

The 10-acre Site comprises the former 4-acre OECI facility (bounded by Elm, Oak, and Eva Streets, and the Town of Ashippun municipal garage) located at 2573 Oak Street in Ashippun, Wisconsin, and 6 acres of a wet, low-lying area located adjacent to the southwest portion of the former site (Figure 1). This low-lying area is referred to in historical and recent project plans as a wetland area. Davy Creek flows through this wetland area south of the Site.

Various onsite metal cleaning and electroplating processes were performed at OECI since operations began in 1957. Operation materials included chlorinated solvents, cyanide, chromium, cadmium, copper, nickel, tin, and zinc. Degreasing operations were performed at the Site using unknown compounds. OECI ceased operation in 1990 due to financial hardship. Buildings at the Site were demolished in May 1992.

Initial source reduction activities previously performed at the Site include the removal of the former lagoon sediment and sludge, contaminated soil, and contaminated sediment in the wetlands around Davy Creek.

1.1.2 Hydrogeologic Units

Hydrogeologic features are conceptually depicted in Figure 2. Two bedrock aquifers (units capable of yielding water to supply wells) are present beneath the Site at depth: the Ordovician Galena-Platteville dolomite and St. Peter Sandstone. The Maquoketa shale (also Ordovician in age), which sits above these bedrock aquifers and is the uppermost bedrock unit encountered at the Site, is considered to be an aquitard unit on a regional basis. However, it does contain some dolomite interlayers and fractures that are capable of yielding sufficient quantities of water for residential use. The unconsolidated materials, sitting above the Maquoketa shale at the site, are silty sand and clay with intermittent clay lenses and an estimated horizontal hydraulic conductivity of 1×10^{-3} to 1×10^{-4} centimeters per second (cm/sec) from pump testing data (RMT, 2004).

Groundwater monitoring wells are installed at the Site in the shallow and deep portions of the unconsolidated deposits and in the upper bedrock. Nested wells are installed in the unconsolidated deposits, with the shallow wells monitoring the upper portion, "water table" depths of this unit and the deep wells monitoring the lower portion of this unit (Figure 2).

Groundwater flow directions are to the south-southwest toward Davy Creek in the unconsolidated zone (Figures 3 and 4) and to the southeast, south, and southwest in the bedrock zone (Figure 5). Vertical gradients within the unconsolidated material are strongly upward in well nests situated downgradient of the former facility and upgradient of Davy Creek.

1.1.3 CVOC Distribution

CVOCs, including "parent" products, such as tetrachloroethene (PCE), trichloroethene (TCE), and 1,1,1-trichloroethane (1,1,1-TCA) are present at the site as are the "daughter" (biodegradation) products such as cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride (VC). Distribution as of January 2008 is summarized by hydrogeologic unit, below.

Unconsolidated Shallow Unit

In general, the distribution of PCE, TCE, and 1,1,1-TCA parent products in the shallow unconsolidated aquifer currently extends from the southern portion of the Site toward the wetland area, consistent with the groundwater flow direction in the shallow unconsolidated unit (Figure 6) and consistent with historical observations. During recent sampling, including January 2008, TCE was detected at the highest concentrations in the shallow unconsolidated unit from groundwater samples collected at points immediately beneath or directly downgradient of the former OECI facility (MW-103S, MW-12S, and MW-105S), exceeding the State of Wisconsin's Enforcement Standard (ES) at each of three locations (Figure 1). TCE was also detected further downgradient at MW-16S.

Degradation products cis-1,2-DCE and VC were detected as indicated on Figure 7 immediately beneath and directly downgradient of the facility in the shallow unconsolidated unit, consistent with where parent compounds are detected and consistent with previous sampling results (CH2M HILL, 2007a). The highest concentration of VC was detected at MW-16S, downgradient of the former facility and just upgradient of Davy Creek (33 micrograms per liter [μg/L] in September 2007).

CVOCs have not been detected in groundwater collected at sentinel wells MW-106S and MW-107S since monitoring began at these locations (Figure 1).

Unconsolidated Deep

Similar to the shallow unconsolidated zone, there have been no confirmed volatile organic compound (VOC) detections (two consecutive detections recorded) in groundwater collected from sentinel wells MW-106D and MW-107D in the deep unconsolidated zone since monitoring began at these locations (Figure 8). Based on January 2008 groundwater results (Figure 8), TCE concentrations in the deep unconsolidated unit are highest in groundwater collected at MW-103D (940 μg/L), immediately beneath the former facility area. TCE concentrations are almost an order of magnitude lower at MW-5D (210 μg/L), located to the southeast and slightly downgradient. TCE was also detected in groundwater collected at the cross-gradient monitoring wells in the deep unconsolidated unit to the west of the site (MW-102D and MW-15D). These concentrations decreased significantly with distance from the site and at MW-105D, immediately downgradient of the site (Figure 8). TCE is also detected at deep well locations west-southwest of the Site. Because of the groundwater flow directions in the deep unconsolidated unit (Figure 4) versus the concentrations detected there, it is not clear that the TCE detected west-northwest of the site is from the site.

Degradation products VC and cis-1,2-DCE were detected in deep monitoring wells onsite and downgradient of the facility, in a similar pattern as TCE (Figure 9). The highest concentration of cis-1,2-DCE in the deep unconsolidated unit occurred in MW-5D (120 μg/L) and the highest concentration of VC in groundwater from MW-105D (1.80 μg/L). Groundwater from cross-gradient wells MW-102D and MW-15D also contained cis-1,2-DCE. Overall, there were more degradation products that exceed the State of Wisconsin's NR 140 ES or preventive action limit (PAL) in the deep unit in January 2008 than reported for January 2007 (CH2M HILL, 2008a).

Bedrock Wells—Monitoring and Private

The distribution of parent compounds (Figure 10—TCE; 1,1,1-TCA) and degradation compounds (Figure 11—cis-1,2-DCE; VC) present in the groundwater beneath and downgradient of the facility in the bedrock unit support that natural attenuation is occurring. The private bedrock wells with CVOC detections are situated to the west and apparently downgradient (Figure 5) of the former OECI facility. In January 2008, three additional wells exceeded the VC PAL in January 2008 versus January 2007: PW-11, PW-04, and PW-07, indicating an overall increase in concentrations at these wells (CH2M HILL, 2008a). Similar to the situation in the deep unconsolidated unit, it is not clear that the TCE and VC concentrations in bedrock private wells west of the site are from an onsite, shallower source.

1.1.4 Summary of CVOC Distribution

Figures 6, 8, and 10 depict the primary areas of TCE in groundwater within the shallow and deep unconsolidated, and bedrock units, respectively. The highest TCE concentrations in the shallow unconsolidated zone appear to be downgradient from the facility. Possible reasons for this condition include the following:

1. Dissolved TCE concentrations were hydraulically contained by active groundwater extraction and have migrated farther downgradient since the cessation of pumping in 2004.
2. There is an area of higher TCE concentrations beneath the facility that is not evident given the current monitoring network.

The highest concentrations of TCE in the deep part of the unconsolidated unit occur beneath the southeastern portion of the former operations area, possibly indicating:

1. A source of TCE was located in the vicinity of the southeast operations area in the past, forming a small area that continues to contribute to dissolved constituents at MW-103D.
2. Based on groundwater flow directions in the three hydrogeologic units (shallow and deep unconsolidated units, bedrock units), TCE west of the site in the deep unconsolidated zone and TCE and VC west of the site in private (bedrock) wells may not be directly linked to the VOC source in the former operations area but may be due to an alternate source.

1.1.5 Natural Attenuation Analysis

Site groundwater data has been evaluated regarding ongoing natural attenuation using the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water* (Wiedemeier, et. al., 1998). A scoring system is described in the protocol and used for this Site as summarized for each of the recommended parameters on Table 1. The scores are assigned to each hydrogeologic unit based on the average of the quarterly geochemical and biochemical parameter values for that unit for a 1-year time period.

Four quarters of data for each of two, 1-year time periods ("2006" = April 2006 through January 2007; "2007" = April 2007 through January 2008) were compared to the preferred concentrations of NA indicator parameters for an overall screening of Site conditions

(Table 2). This scoring exercise shows that evidence for anaerobic biodegradation is present in each of the three units during the reporting periods (Table 1). Of the three units, the shallow unconsolidated unit wells scored slightly higher compared to the deep unconsolidated unit wells, and bedrock wells scored lowest for both reporting periods. In addition, the scores presented for the more recent data period (2007) are lower than indicated for the previous data period (2006).

Therefore, NA appears to be ongoing, especially in the shallow and deep unconsolidated units, but at a relatively slow rate that could possibly benefit from biological enhancement. Enhancement in the bedrock unit is not considered appropriate or necessary at this time due to the very low concentrations present.

SECTION 2

Applicability of Enhanced In-Situ Treatment to Site Conditions

2.1 In Situ Treatment of Groundwater

In situ treatment of groundwater entails treating the groundwater while it is in the aquifer, which can be achieved by applying physical/chemical, biological, or thermal techniques. Examples of possible approaches to in situ treatment of CVOCs in groundwater include chemical oxidation, NA, chemical reduction, permeable treatment beds, resistive heating, thermal desorption, and/or biological treatment technologies. In situ treatment can be directed at the high concentration source areas or throughout the plume.

Because of its relative low to moderate cost compared to other in situ technologies, and because natural attenuation processes have been shown to be ongoing at the site, enhanced in situ bioremediation (EISB) is being considered for the unconsolidated unit at OECI. The unconsolidated unit is chosen since it has the highest CVOC concentrations and the best indicator conditions for ongoing, natural attenuation.

There are two types of EISB that can be considered: biostimulation and bioaugmentation. Biostimulation involves addition of a food grade or similar carbon substrate (lactate, alcohol, acetic acid, emulsified oil, or hydrogen release compound [HRC]) via injection wells or geoprobe points to stimulate natural anaerobic organisms already present so they can produce an anaerobic-reducing environment to reduce CVOCs. The substrate addition stimulates the native micro-organisms, which in turn "consume" the contaminants generating methane/ethane/ethene and other byproducts. Injections can be performed periodically to sustain the biological community. The substrates are relatively inexpensive and available, and passive injection points (less expensive than active injection or circulation points) can be used.

Bioaugmentation involves the injection of a known consortium of CVOC-degrading bacteria. At some sites, the activity of the naturally occurring microorganisms is significantly reduced or possibly inhibited because of site geochemical conditions. Bioaugmentation may be applicable if incomplete dechlorination of CVOCs occurs regardless of the electron donors that are used. At some sites, conversion of TCE to cis-1,2-DCE occurs, but further degradation does not occur, even after addition of electron donors and nutrients. Implementation of bioaugmentation with a known chlorinated solvent-degrading microbial consortium has been shown capable of complete dechlorination to ethene.

Because complete dechlorination is occurring at OECI (CH2M HILL, 2008a), biostimulation has been chosen for further evaluation instead of bioaugmentation. In addition, results of an EISB pilot study (CH2M HILL, 2008b) performed in 2007 at a site with similar unconsolidated zone hydrogeology indicate that biostimulation is an effective groundwater treatment technology in this type of hydrogeologic environment. Based on current

information, implementation of biostimulation should decrease CVOC concentrations at the injection site and downgradient at the OECI site.

Several different types of food-grade substrate can potentially be used at the OECI site for biostimulation. These types include soluble substrate (such as sodium lactate or high fructose corn syrup) or a low solubility/slow-release substrate (such as emulsified vegetable oil [EVO], for example emulsified oil substrate [EOS™] or similar products). Soluble substrates degrade quickly and have relatively short half lives. Therefore, they typically must be injected more frequently to obtain results similar to one injection of a slow-release substrate (CH2M HILL, 2008b). At the OECI site, a slow-release substrate is recommended for longer-term supplementation effects. Injection of a product such as EOS™ is considered during this evaluation for the OECI site due to the shortened time period available for enhancement prior to transition of the site to the WDNR. Costs for implementation of another brand of oil supplement are estimated to be similar to the cost estimate provided below for implementation of EOS™. If implementation is pursued, optimization of the substrate used and its cost would be established during design.

SECTION 3

Site Preparation and Treatment Activities

3.1 Options for Treatment and/or Delineation

This memorandum describes and documents costs for several options:

1. Perform a pilot-scale injection without further delineation of CVOC concentrations in groundwater (limitations discussed, below), or
2. Complete a delineation exercise first, followed by an injection in an "optimized" location—for cost purposes the injection area(s) are assumed to be identical to those used for No. 1, above.

The remainder of this section describes the activities required and order-of-magnitude costs for either option.

3.1.1 Pilot-Scale Treatment

A pilot-scale injection of substrate could be completed in the areas of known, higher concentration CVOCs without any further delineation. The limitations to a pilot-scale operation include the following:

- The higher concentration areas of TCE in the vicinity of MW-105S and MW-103D would be amended with the substrate, but non-delineated area(s) of higher concentration upgradient or cross gradient (based on known groundwater flow directions) of these positions would not be treated.
- If areas of higher concentrations are situated upgradient of MW-105S andMW-103D, they may migrate into the vicinity of these wells after the substrate has been depleted, thereby causing a "rebound" of TCE to higher concentrations at these wells.
- If areas of higher concentrations are situated beneath the western portion of the former operations area, the areas may continue to contribute dissolved TCE concentration to both deep unconsolidated and bedrock wells (including private wells) west of the site.
- An adequate monitoring network is not available to determine the success/adequacy of the supplementation.

Based on the selected pilot treatment areas (MW-105S and MW-103D) and EISB remedial technology identified, the objective for the EISB pilot test is as follows:

> Supplement available organic carbon to biostimulate existing microorganisms that are upgradient of MW-105S and MW-103D to enhance ongoing biodegradation processes.

The following activities would be required for pilot test planning and implementation:

1. Prepare an aqueous solution with water (estimated 4,700 gallons per injection site) and substrate onsite. The substrate would be mixed with water at an approximate 2 percent substrate volume versus water volume. After preparation, the solution will be injected using direct-push temporary probes.

2. Install temporary well probes (direct-push method) along two lines situated within the area of known higher concentrations in the vicinity of MW-105S and MW-103D to inject the substrate (Figure 12). The proposed pilot injection lines are situated upgradient of these two wells, and the treated groundwater should travel downgradient toward each well based on groundwater flow direction at the site.

3. Inject the substrate. Injection probe spacing is estimated to occur on 15 foot spacing (estimating a 7.5-foot radius of influence [ROI]) based on previous studies in similar geology (CH2M HILL, 2008b). The injection rods will be installed to a depth of 20 feet, with the treated zone ranging from approximately 20 feet to 10 feet below ground surface (bgs).

Note that there is no additional permanent monitoring well or injection well installation for this pilot scale effort or follow-up monitoring specific to the injection. Quarterly monitoring at the existing monitoring well network will continue through May 2009. VOC and NA analysis is already part of that program.

3.1.2 Optimizing EISB Implementation: Delineation and Monitoring

To perform optimal biological supplementation, the following additional steps are recommended for implementation prior to pilot test planning and implementation:

1. Prepare a Field Sampling Plan (FSP) Addendum and QAPP Addendum for USEPA review and approval.

2. Further delineate the areas of higher VOC concentrations—In the shallow unconsolidated zone, this appears to be centered around MW-105S, but it may extend northward into the vicinity where former operations occurred. In addition, there may be an area of higher concentrations farther west beneath the former operations area that contributes to the dissolved TCE concentrations detected west of the site in deep unconsolidated wells and in private bedrock wells. In the deep unconsolidated zone, the highest TCE concentration is beneath the southeast corner of former operations near MW-103D, but the extent of this high concentration zone is unknown. Delineation is important to the overall success of supplementation because the dimensions of the high concentration zone will dictate injection volumes and frequency. Also, if a higher concentration zone is left untreated, rebound of VOC concentrations may occur after the injected substrate has been consumed.

Based on the results of the delineation, additional steps could be completed as follows:

3. Optimize locations for the shallow and/or deep zones for injection and monitoring based on the delineation and the known subsurface properties. (Currently, there is only one monitoring well each for shallow and deep zones.) Install additional monitoring points.

4. Execute Steps 1 to 3 of the pilot-scale injection procedure above.
5. Determine the overall effectiveness of in situ treatment for achieving complete reduction of TCE to nontoxic degradation products (such as ethene or ethane) by performing initial and periodic post-injection monitoring. (If additional monitoring points are not installed, this step will not be performed.)
6. Establish the duration that the injected substrates can maintain enhanced reducing conditions, relative to background, for in situ treatment based on the monitoring data. (If the substrate duration is not measured, this step will not be completed).
7. Determine the radius of influence (ROI) of the selected injection method (this may occur subsequent to Nos. 2 and 3, above). (If additional monitoring points are not installed, this step will not be performed.)
8. Re-inject based on an appropriate schedule and ROI as established in Steps 5 through 7 above.

3.1.3 Summary: Pilot Treatment and/or Delineation

The limitations to performing an EISB without optimizing the pilot injection location are described above. However, the pilot-scale treatment can be performed without optimizing the injection location. The order-of-magnitude cost estimate for the pilot-scale injection includes costs for pilot-scale treatment and delineation (only Steps 1 and 2 of the delineation and monitoring), but the delineation part can be removed from the total cost if only pilot-scale treatment is selected for implementation. Steps 3 and 5 through 8 of the delineation and monitoring may be completed using information from the delineation exercise, but are not included in the cost because there is not enough information to estimate these costs until completion of the delineation. Quarterly groundwater monitoring is not included in the cost estimate because this work is included under the previously approved work assignment for the OECI site.

3.2 Estimated Capital Cost

An order of magnitude cost estimate (plus 50 percent to minus 30 percent) for the pilot-scale injection activity, including Steps 1 and 2 of delineation and monitoring, is outlined on Table 2. The cost range applies only to the alternatives as they are described in this document and does not account for changes in the scope of the alternatives. Selection of specific technologies or processes to configure remedial alternatives is intended not to limit flexibility during remedial planning and implementation, but to provide a basis for preparing cost estimates. The specific details of remedial actions and cost estimates would be refined during final planning. Potential variations in the cost estimate include actual labor and material costs, competitive market conditions, actual site conditions, final project scope, the implementation schedule, subcontractor costs, and other variables.

The estimated cost for implementation of the one time EISB injection, including a further delineation exercise, is $300,000. The estimated cost for implementation of the one time EISB injection, not including further delineation, is $250,000. The estimated cost does not include

Steps 3 and 5 through 8 of the delineation and monitoring. Additional details regarding major components of the cost estimate are described below.

3.2.1 State Agency Coordination—Injection

It is anticipated that the State of Wisconsin has specific requirements regarding injection of material into the groundwater. If biostimulation is selected for implementation as described, CH2M HILL, on behalf of USEPA, will coordinate with the WDNR to incorporate those requirements. The estimated cost for this effort is included in the cost estimate.

3.2.2 Delineation

Further delineation of the areas of higher concentration, if selected, would entail mobilization of a direct-push, track-mounted rig and equipment crew. It is estimated that 15 separate probe locations, emanating outward from the locations of MW-105S and/or MW-103D, would be necessary. Probes would be pushed to a total depth of 25 feet with 3 groundwater grab samples collected at each location (water table, 10 feet bgs, 20 feet bgs). Groundwater samples would be shipped offsite for laboratory analysis of VOCs. CH2M HILL would subcontract for disposal of soil cuttings and groundwater purge material. The duration of field work associated with the delineation is five working days. The estimated cost for the delineation includes the subcontractor's time and materials, expendable and rented equipment, and oversight by CH2M HILL.

3.2.3 One Time EISB Injection

The estimate of pilot-scale injection of substrate, if selected for implementation, includes installation of direct-push probes with a 15-foot spacing along two lines, as shown on Figure 12. The probe locations are placed to impact the areas immediately upgradient of MW-105S and MW-103D. These lines are situated within the estimated zones of highest TCE concentration at the OECI site. The injection sites are based on an assumed ROI of 7.5 feet. The estimated cost for the injection includes the subcontractor's time and materials, expendable and rented equipment, and oversight by CH2M HILL. As previously stated, costs for implementation of another brand of oil supplement are estimated to be similar to the cost estimate provided below for implementation of EOS™.

3.2.4 Costs Not Included

Costs not included in the estimate are for the installation of any permanent injection wells or additional monitoring wells, additional monitoring costs beyond those already incurred during ongoing quarterly sampling, or costs for injection beyond those locations shown in Figure 12 if delineation indicates there are extended or additional high concentration zones.

SECTION 4

Summary

The goal of the enhanced bioremediation is to reduce contaminant concentrations to levels that will decrease the overall duration for monitored NA to achieve target groundwater concentrations. A brief evaluation of the feasibility and cost effectiveness of enhancing the biodegradation of CVOCs at the former OECI site indicates the following:

- EISB, specifically injection of a supplemental oil product, appears feasible for the OECI site based on current information.
- EISB is expected to reduce CVOC concentrations at the injection sites and downgradient from the injection sites.
- The potential injection sites would be optimized by further delineation of dissolved concentrations of CVOCs in groundwater.
- If further delineation is not selected as part of implementation, the injection will be implemented in the areas upgradient of MW-105S and MW-103D because these are the areas of the site with the highest TCE concentrations based on current conditions. Implementation of the injection program without further delineation could result in a rebound of TCE concentrations from locations upgradient of these two wells or from another potential area of higher concentrations.

SECTION 5

References

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Wiedemeier, T. H., et al. 1998. *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater.* EPA/600/R-98/128.

TABLE 1

Screening for Anaerobic Biodegradation[a,b] Processes and Interpretation of Screening Results: 2006 versus 2007 Data

OECI Site

				"2006"			"2007"		
				April 2006 - January 2007			April 2007 - January 2008		
Analysis	Preferred Concentration Indicating Anaerobic Biodegradation[a]	Interpretation[a]	Potential Score[c]	Shallow	Deep	Bedrock	Shallow	Deep	Bedrock
Oxygen (mg/L)	< 0.5 mg/L	Tolerated, suppresses the reductive pathway at higher concentrations.	3	0	0	0	0	0	0
Oxygen (mg/L)	> 5 mg/L	Not tolerated, however, VC may be oxidized aerobically.	-3	0	0	0	0	0	0
Nitrate (mg/L)	< 1 mg/L	At higher concentrations, may compete with reductive pathway.	2	2	2	2	2	2	2
Iron II[d]	> 1 mg/L	Reductive pathway possible; VC may be oxidized under Fe (III)-reducing conditions.	3	3	3	3	0	0	0
Sulfate (mg/L)	< 20 mg/L	At higher concentrations, may compete with reductive pathway.	2	0	0	0	0	0	0
Sulfide (mg/L)	> 1 mg/L	Reductive pathway possible.	3	0	0	0	0	0	0
Methane (mg/L)	< 0.5 mg/L	VC oxidizes.	0	0	0	0	0	0	0
Methane (mg/L)	> 0.5 mg/L	Ultimate reductive daughter product, VC accumulates.	3	0	0	0	0	0	0
Oxidation Reduction Potential (mV)	< 50 mV	Reductive pathway possible.	1	1	1	1	1	1	1
Oxidation Reduction Potential (mV)	< -100 mV	Reductive pathway likely.	2	0	0	0	0	0	0
pH	5 < pH < 9	Optimal range for reductive pathway.	0	0	0	0	0	0	0
pH	5 > pH > 9	Outside optimal range for reductive pathway.	-2	0	0	0	0	0	0
TOC (mg/L)	> 20 mg/L	Carbon and energy source; drives dechlorination; can be natural or anthropogenic.	2	0	0	0	0	0	0
Temperature (degrees Celsius)	> 20C	At T .20C, biochemical process is accelerated.	1	0	0	0	0	0	0
Alkalinity (mg/L)	> 2x background	Results from interaction between CO2 and aquifer materials.	1	0	0	0	0	0	0
Chloride (mg/L)	> 2x background	Daughter product of organic chlorine.	2	2	0	2	2	2	2
BTEX (mg/L)	> 0.1 mg/L	Carbon and energy source; drives dechlorination.	2	2	2	0	0	0	0
Trichloroethene (mg/L)	Not applicable	Material released.	0	0	0	0	0	0	0
Dichloroethene (mg/L)	Not applicable	Daughter product of TCE; If cis is > 80% of total DCE it is likely a daughter product, 1,1DCE can be chemical reaction product of TCA.	2	2	2	2	2	2	2
Vinyl chloride (mg/L)	Not applicable	Daughter product of DCE.	2	2	2	2	2	2	0
1,1,1-trichloroethane (mg/L)	Not applicable	Material released.	0	0	0	0	0	0	0
1,1-dichloroethane (mg/L)	Not applicable	Daughter product of TCA under reducing conditions.	2	2	2	0	2	2	0
Chloroethane (mg/L)	Not applicable	Daughter product of DCA or VC under reducing conditions.	2	0	0	0	0	0	0
Ethene/Ethane (mg/L)	> 0.01 mg/L	Daughter product of VC/ethene.	2	2	2	2	0	0	0
Ethene/Ethane (mg/L)	> 0.1 mg/L	Daughter product of VC/ethene.	3	3	3	3	0	0	0
			SCORE[e,e]	21	19	17	11	11	7

Background levels for alkalinity and chloride for shallow and deep aquifers is average of quarterly values for upgradient wells MW-1S and MW-4S

Background levels for alkalinity and chloride for bedrock aquifer is average of quarterly values for upgradient well MW-1D

[a] See Table 2.3 in Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water, EPA/600/R-98/128.

[b] See CH2M HILL, 2008a for study area constituent values.

[c] Points awarded only when 50 percent or more of results for a particular parameter for the wells sampled were at the preferred concentration. The total number of wells did NOT include upgradient wells for a given hydrogeologic unit.

[d] Sampled for dissolved iron. Compared values to background concentrations (>2x background).

[e] Scores of 15 to 20 = Adequate evidence for anaerobic biodegradation of CVOCs.

Table 2
Cost Estimate Summary for Source Delineation and/or Enhanced In Situ Bioremediation Pilot Scale Injection

TABLE 2
Cost Estimate Summary for Delineation and/or One-Time EISB Injection

Site: Oconomowoc Electroplating Company, Inc., Ashippun, WI
Media: Groundwater
Phase: Long Term Remedial Action
Base Year: 2008
Date: 6/12/2008 0:00

Description: Optional Further Delineation of Potential Source Zone
One Time EISB Injection to Enhance Bioremediation of CVOCs in Groundwater
(Area of High Concentration)

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	SUBTOTAL	TOTAL	NOTES
Coordination with State Agency regarding Injection	1	LS	$5,000	$5,000	$5,000	CH2M HILL Estimate: Assumes 40 hours of $125 per hour person
Further Delineation of Potential Source Zone Using Geoprobe (Optional)					$21,210	
Mobilization	1	LS	$1,000	$1,000		Contractor Quote
Geoprobe daily rate (Track rig)	5	DY	$1,750.00	$8,750		Contractor Quote
Expendable items	5	DY	$220.00	$1,100		Contractor Quote
Per diem, 1 man 6 nights	6	DY	$135.00	$810		Contractor Quote
Laboratory Analysis for VOCs	45	EA	$60	$2,700		CH2M HILL Estimate; Project Experience
Sample Shipping	5	EA	$100	$500		CH2M HILL Estimate; Project Experience
Investigation Derived Waste Transportation and Disposal	2	DRUM	$350	$700		1 Drum Each-Soil & Water; Contractor Quote
Oversight Labor	60	HR	$90	$5,400		CH2M HILL Estimate; 1 person, 5 days
Oversight Per Diem	5	DY	$50	$250		CH2M HILL Estimate; 1 person, 5 days
One Time EISB Injection					$105,170	
EISB Material	1	LS	$ 47,100	$47,100		Emulsified Oil cost of $4/lb soil in a cylinder 10 feet high, 20 feet diameter
Water Cost	76,500	GAL	$0.0400	$3,060		Contractor Quote: "Waterman" Milwaukee WI
Frac Tank Rental	5	UN	$1,500	$7,500		Five, 18,000 gallon tanks for 1 month for estimated 76,500 gallons of wtr
Mob of probe & inject trailer	1	LS	$1,875	$1,875		Contractor Quote
Geoprobe daily rate (Track rig)	9	DY	$1,750	$15,750		Contractor Quote
Pump at 5 gpm @ 1850 psi	9	DY	$480	$4,320		Contractor Quote
Inoculant mixing unit	9	DY	$300	$2,700		Contractor Quote
100 feet of HP injection line	1	LS	$350	$350		Contractor Quote
Skid steer/fork lift	9	DY	$55	$495		Contractor Quote
Drum pump	9	DY	$10	$90		Contractor Quote
Second Tech	9	DY	$450	$4,050		Contractor Quote
Expendable items	9	DY	$100	$900		Contractor Quote
Subcontractor Per diem, 2 men 9 nights	18	DY	$135	$2,430		Contractor Quote
Oversight Labor	90	HR	$90	$8,100		CH2M HILL Estimate; 1 person for 18 days
Oversight Per Diem	9	DY	$50	$450		CH2M HILL Estimate; 1 person for 18 days
Summary Report of EISB Injection	60	HR	$100	$6,000		CH2M HILL Estimate; Brief Report
SUBCONTRACT SUBTOTAL					$131,380	
Payment/Performance Bonds and Insurance (4%)	4%				$5,255	
Contractor Fee (5%)	5%				$6,832	
Contractor Professional/Technical Services					$24,962	
Project Management	5%			$6,569		
Remedial Design	8%			$10,510		
Construction Management	6%			$7,883		
Contractor Program Management						
Program Management Oversight	2.5%			$4,211		
Contingency	25%			$35,867		10% Scope + 15% Bid
TOTAL CAPITAL COST					$ 299,809	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY.	UNIT	UNIT COST	TOTAL	NOTES
Groundwater Sampling					
Groundwater Sampling Labor Included in Current SOW Through May 2009					
TOTAL ANNUAL O&M COST				$0	

PERIODIC COSTS

DESCRIPTION		QTY	UNIT	UNIT COST	TOTAL	NOTES
Reporting						
5 year Review	5	0	LS	$15,000	$0	
5 year Review	10	0	LS	$15,000	$0	
5 year Review	15	0	LS	$15,000	$0	
5 year Review	20	0	LS	$15,000	$0	
5 year Review	25	0	LS	$15,000	$0	
5 year Review	30	0	LS	$15,000	$0	
5 year Review	35	0	LS	$15,000	$0	
5 year Review	40	0	LS	$15,000	$0	
5 year Review	45	0	LS	$15,000	$0	
5 year Review	50	0	LS	$15,000	$0	
				TOTAL	$0	
TOTAL PERIODIC COST					$0	

PRESENT VALUE ANALYSIS

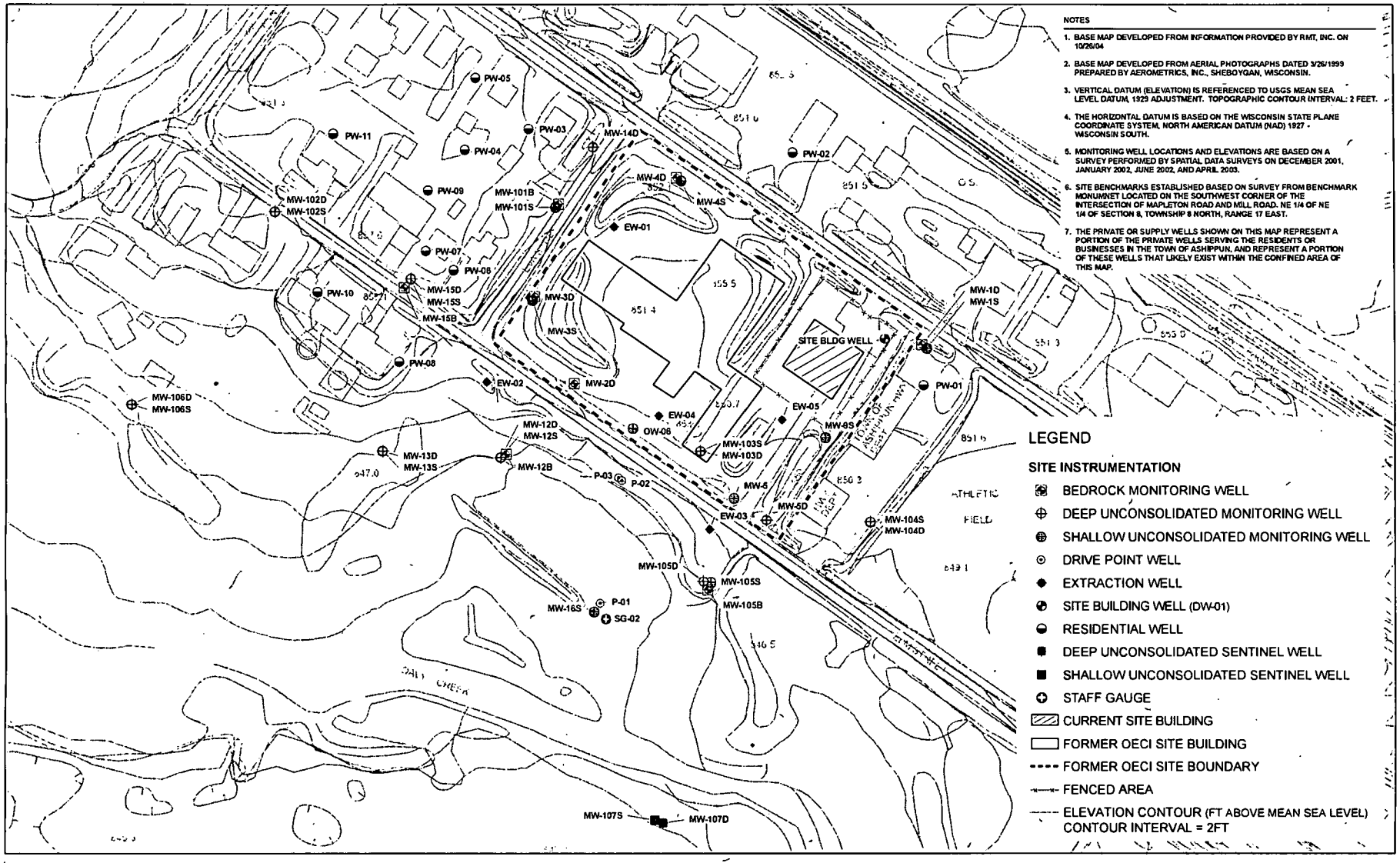
Discount Rate = 7%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR	PRESENT VALUE	NOTES
CAPITAL COST	0	$299,809	$299,809	1	$299,809	
ANNUAL O&M COST	1	$0	$0	0.93	$0	
PERIODIC COST	5	$0	$0	0.71	$0	
PERIODIC COST	10	$0	$0	0.51	$0	
PERIODIC COST	15	$0	$0	0.36	$0	
PERIODIC COST	20	$0	$0	0.26	$0	
PERIODIC COST	25	$0	$0	0.18	$0	
PERIODIC COST	30	$0	$0	0.13	$0	
PERIODIC COST	35	$0	$0	0.09	$0	
PERIODIC COST	40	$0	$0	0.07	$0	
PERIODIC COST	45	$0	$0	0.05	$0	
PERIODIC COST	50	$0	$0	0.03	$0	
		$299,809			$299,809	
TOTAL PRESENT VALUE OF ALTERNATIVE					$300,000	Value rounded to nearest $10,000.

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Figures



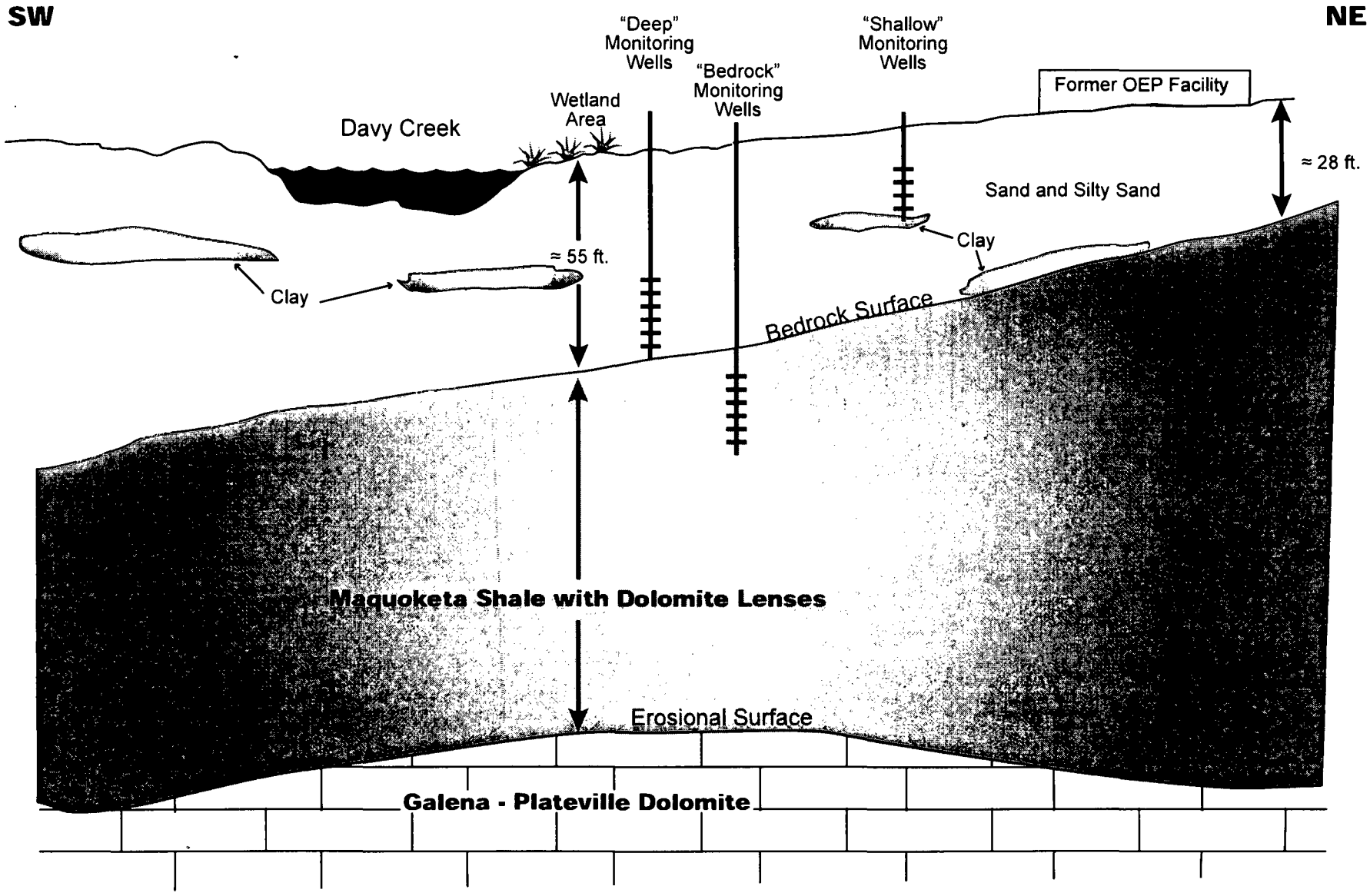
NOTES

1. BASE MAP DEVELOPED FROM INFORMATION PROVIDED BY RMT, INC. ON 10/26/04
2. BASE MAP DEVELOPED FROM AERIAL PHOTOGRAPHS DATED 3/26/1999 PREPARED BY AEROMETRICS, INC., SHEBOYGAN, WISCONSIN.
3. VERTICAL DATUM (ELEVATION) IS REFERENCED TO USGS MEAN SEA LEVEL DATUM, 1929 ADJUSTMENT. TOPOGRAPHIC CONTOUR INTERVAL: 2 FEET.
4. THE HORIZONTAL DATUM IS BASED ON THE WISCONSIN STATE PLANE COORDINATE SYSTEM, NORTH AMERICAN DATUM (NAD) 1927 - WISCONSIN SOUTH.
5. MONITORING WELL LOCATIONS AND ELEVATIONS ARE BASED ON A SURVEY PERFORMED BY SPATIAL DATA SURVEYS ON DECEMBER 2001, JANUARY 2002, JUNE 2002, AND APRIL 2003.
6. SITE BENCHMARKS ESTABLISHED BASED ON SURVEY FROM BENCHMARK MONUMNET LOCATED ON THE SOUTHWEST CORNER OF THE INTERSECTION OF MAPLETON ROAD AND MILL ROAD. NE 1/4 OF NE 1/4 OF SECTION 8, TOWNSHIP 8 NORTH, RANGE 17 EAST.
7. THE PRIVATE OR SUPPLY WELLS SHOWN ON THIS MAP REPRESENT A PORTION OF THE PRIVATE WELLS SERVING THE RESIDENTS OR BUSINESSES IN THE TOWN OF ASHIPPUN, AND REPRESENT A PORTION OF THESE WELLS THAT LIKELY EXIST WITHIN THE CONFINED AREA OF THIS MAP.

FIGURE 1
Site Monitoring Well Locations
OECI Site

CH2MHILL

ES052007001CVO-OECI_Site_MonitoringWellLocations_Fig01_EISB-062008_v02



- NOT TO SCALE -

FIGURE 2
Conceptual Depiction of Site Hydrogeologic Units and Well Placement
OECI Site

CH2MHILL

ES052007001CVO-OECI_Site_ConceptualAquifer_Fig02_EISB-062008_v04

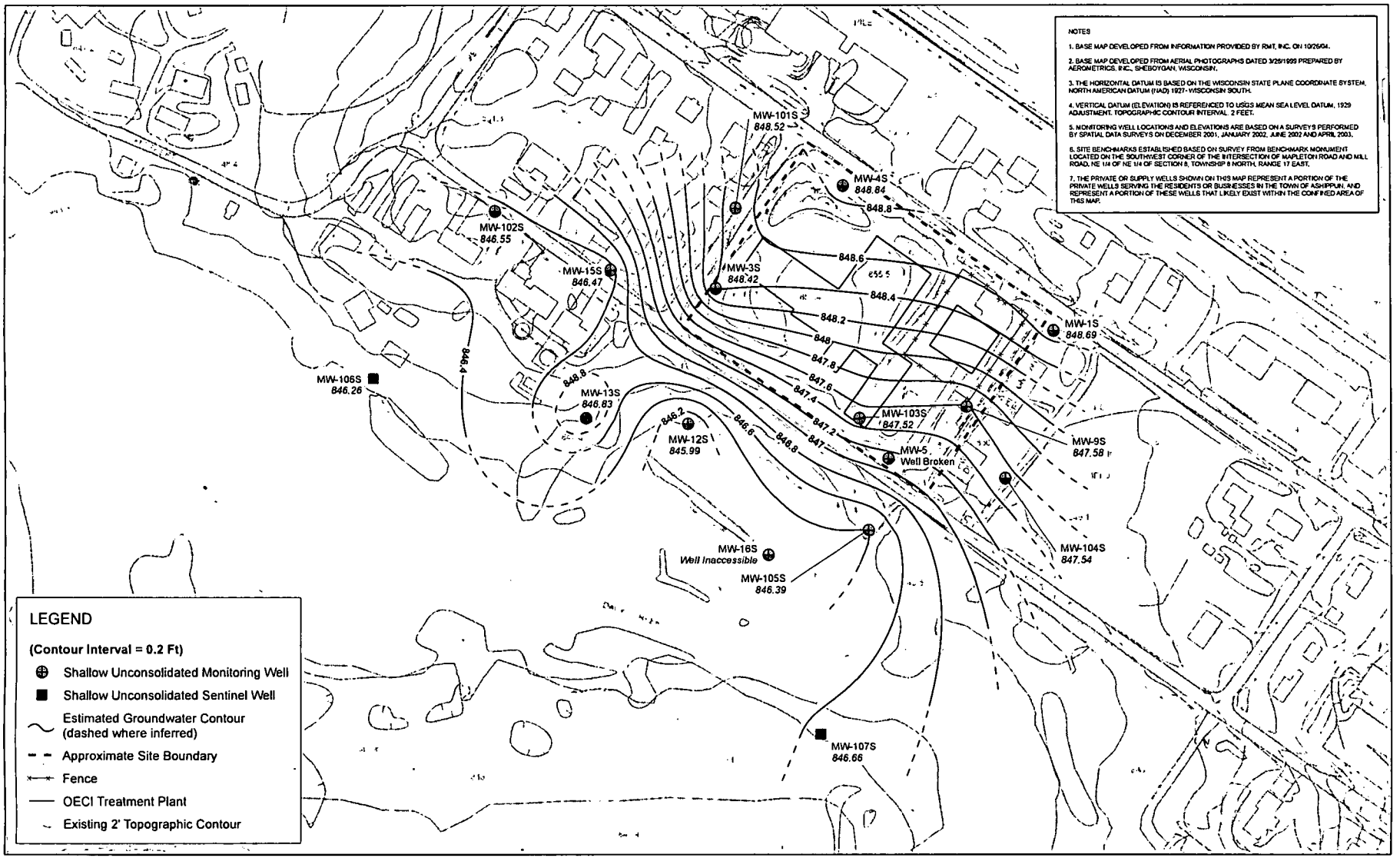


FIGURE 3
Shallow Unconsolidated Groundwater Elevations - January 2008
OECI Site

CH2MHILL

MKE \\WAVE\PROJ\GIS\OECI\MAPFILES\GROUNDWATER_ELEVATION_MAPS_JAN_2008\FIGURE04_SHALLOW_UNCONSOLIDATED_AQUIFER_JAN2008_GW_ELEV.MXD 6/8/2008 12:16:19

ES052007001CVO-OECI_ShallowUnconsolidated_GWelev_Fig03_EISB-062008_v03

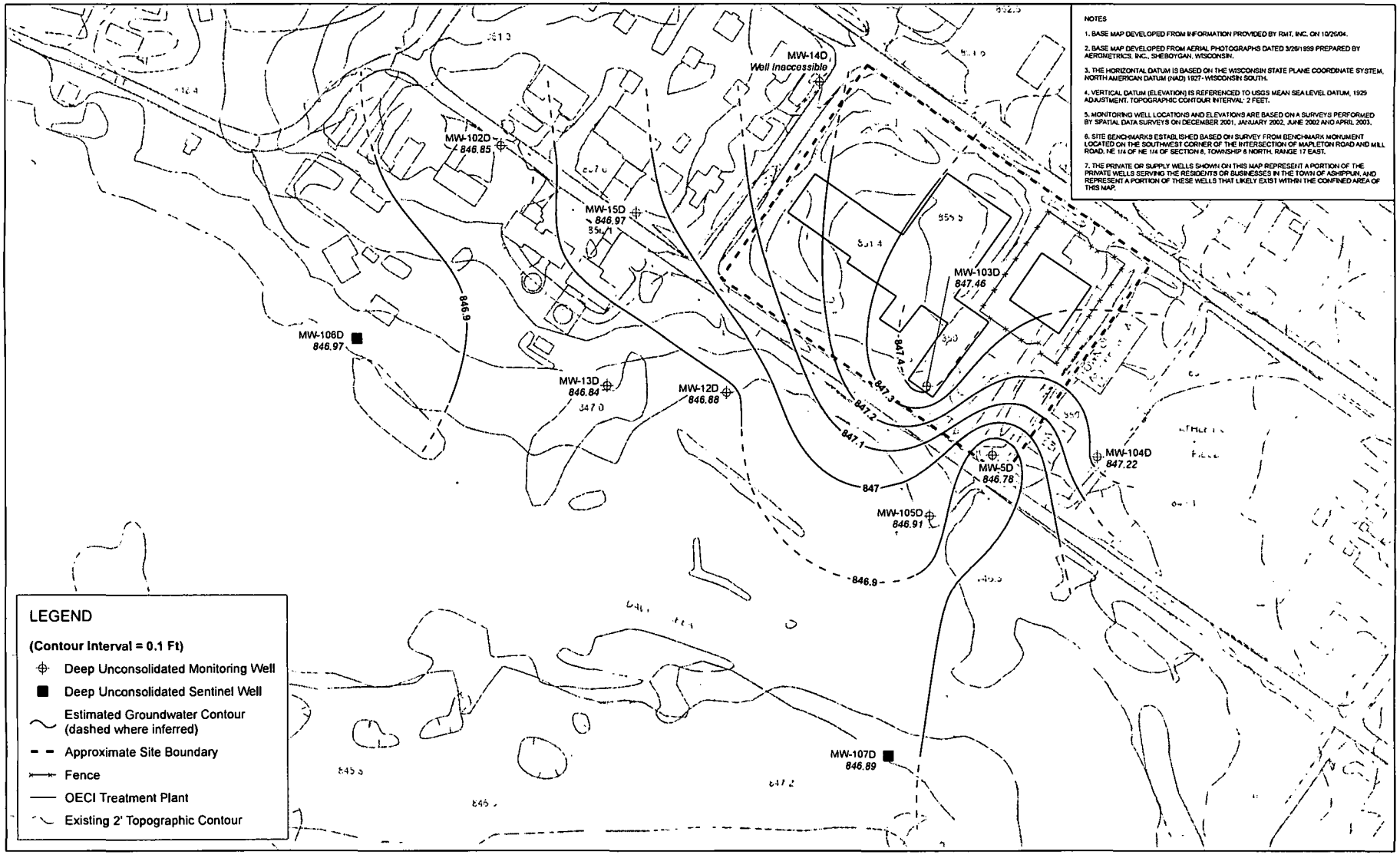


FIGURE 4
Deep Unconsolidated Groundwater Elevations - January 2008
OECI Site

CH2MHILL

MKE \\WAVE\PROJGIS\OECI\MAPFILES\GROUNDWATER_ELEVATION_MAPS_JAN_2008\FIGURE05_DEEP_UNCONSOLIDATED_AQUIFER_JAN2008_GW_ELEV.MXD 6/4/2008 16:29:48
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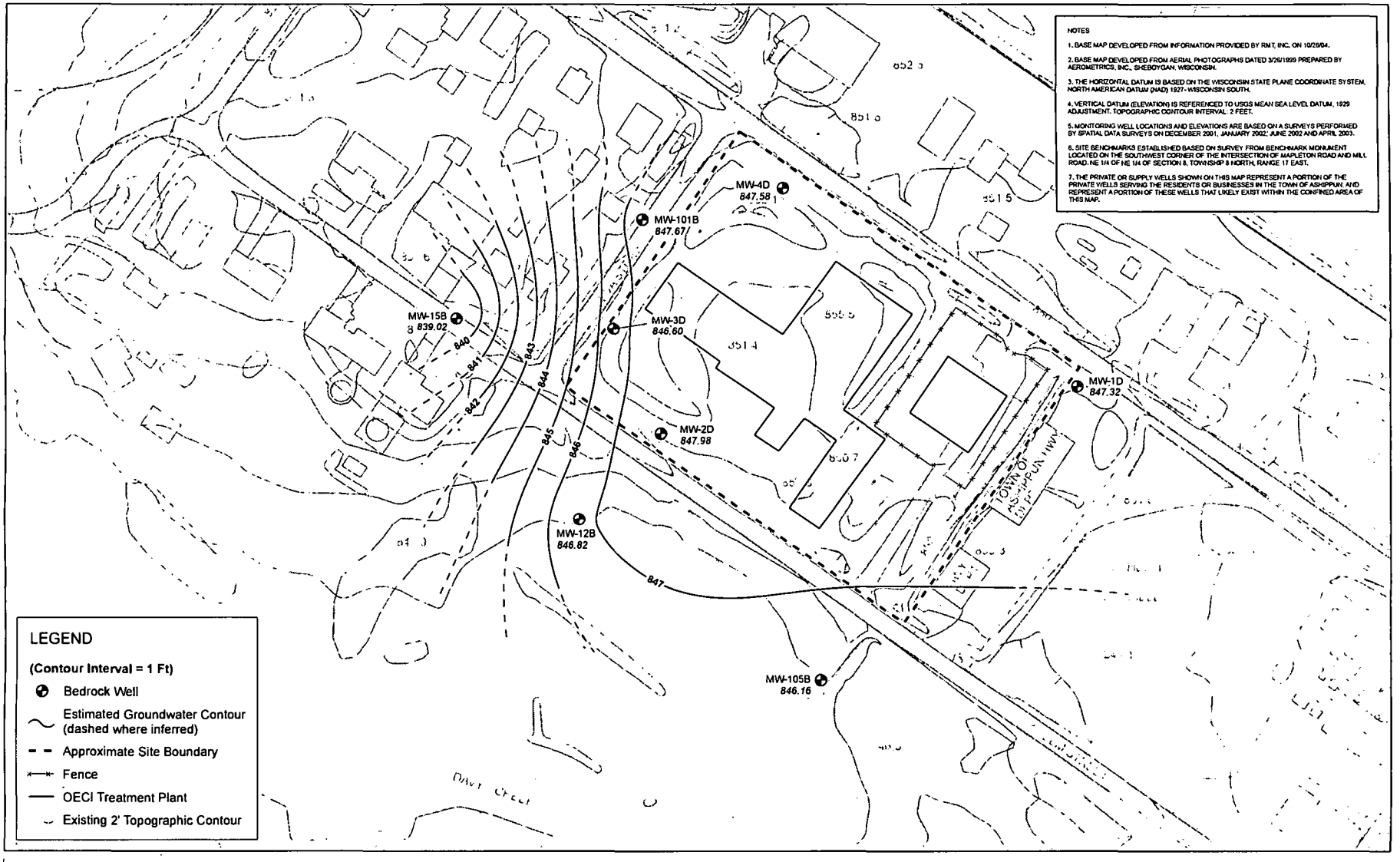

FIGURE 5
Bedrock Groundwater Elevations - January 2008
OECI Site

CH2MHILL

MKE \\WAVE\PROJGIS\OECI\MAPFILES\GROUNDWATER_ELEVATION_MAPS_JAN_2008\FIGURE06_BEDROCK_CONTOUR_JAN2008_GW_ELEV.MXD 6/4/2008 16:38:21
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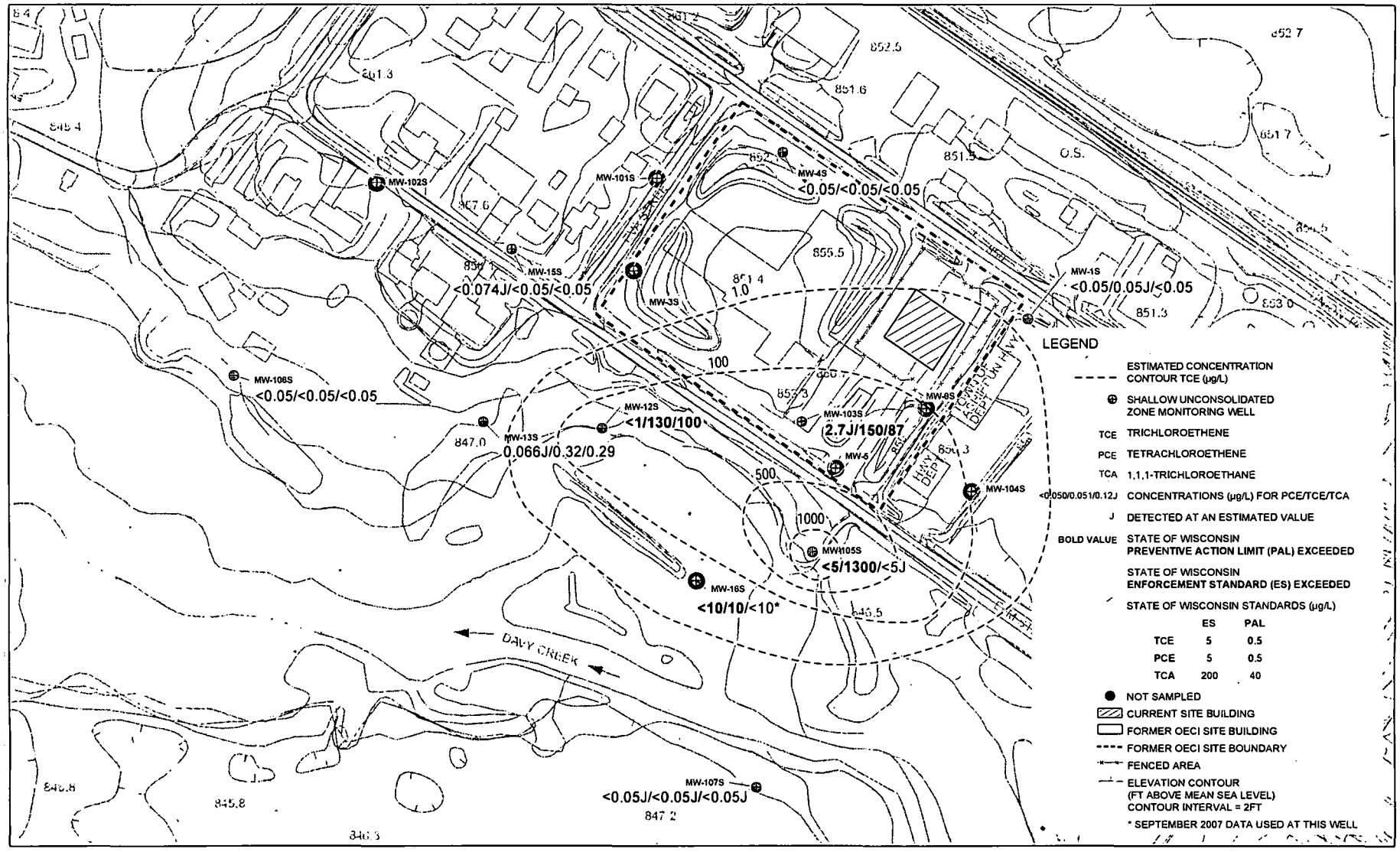


FIGURE 6
Groundwater PCE, TCE and TCA Concentrations in Shallow Unconsolidated Wells – January 2008
OECI Site

ES052007001CVO-OECI_TCE_PCE_TCA_Shallow_Fig06_EISB-062006_v04

CH2MHILL

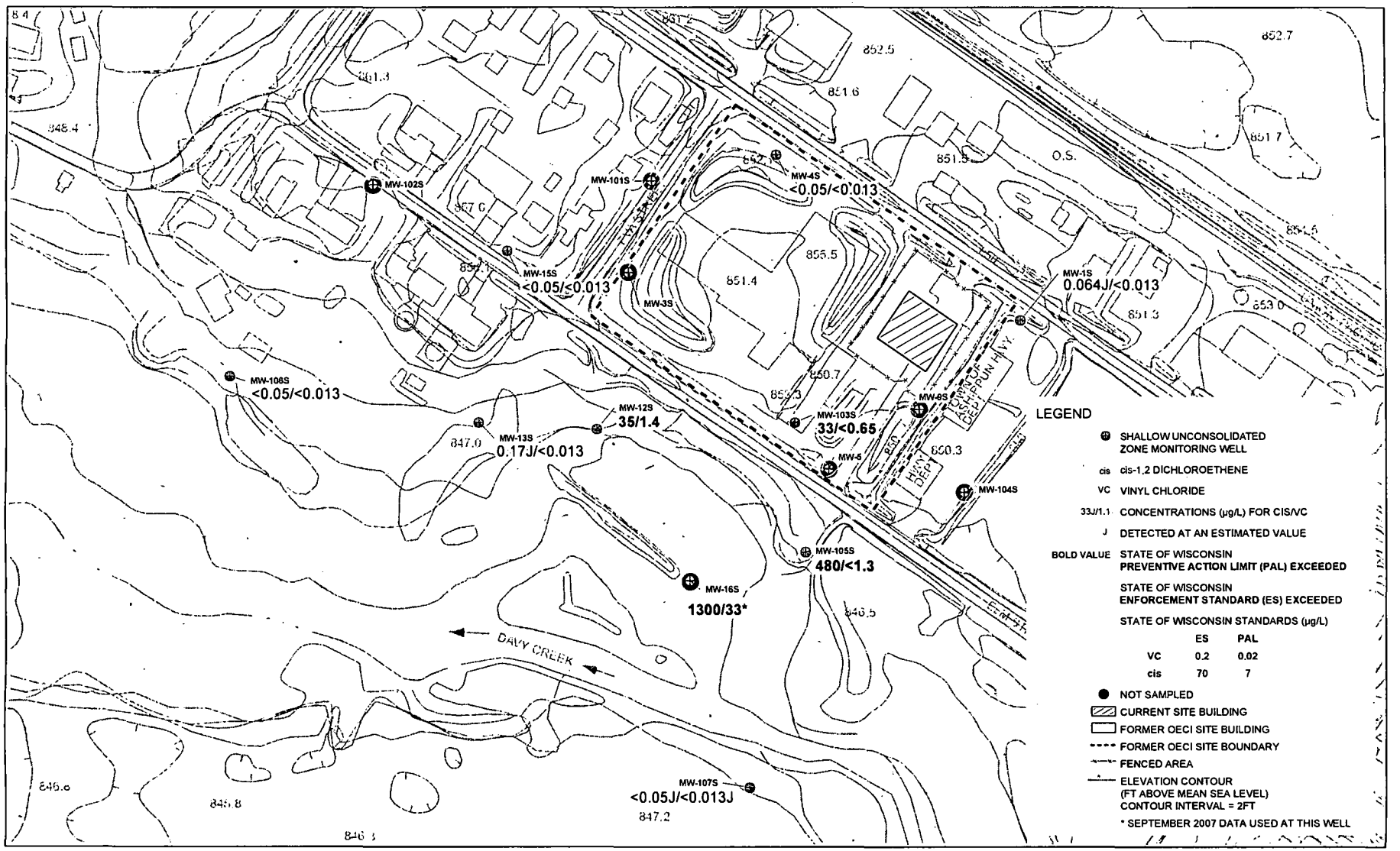


FIGURE 7
Groundwater CIS and VC Concentrations in Shallow Unconsolidated Wells - January 2008
OECI Site

CH2MHILL

ES052007001CVO-OECI_VEcis_Shallow_Fig07_EISB-062008_v04

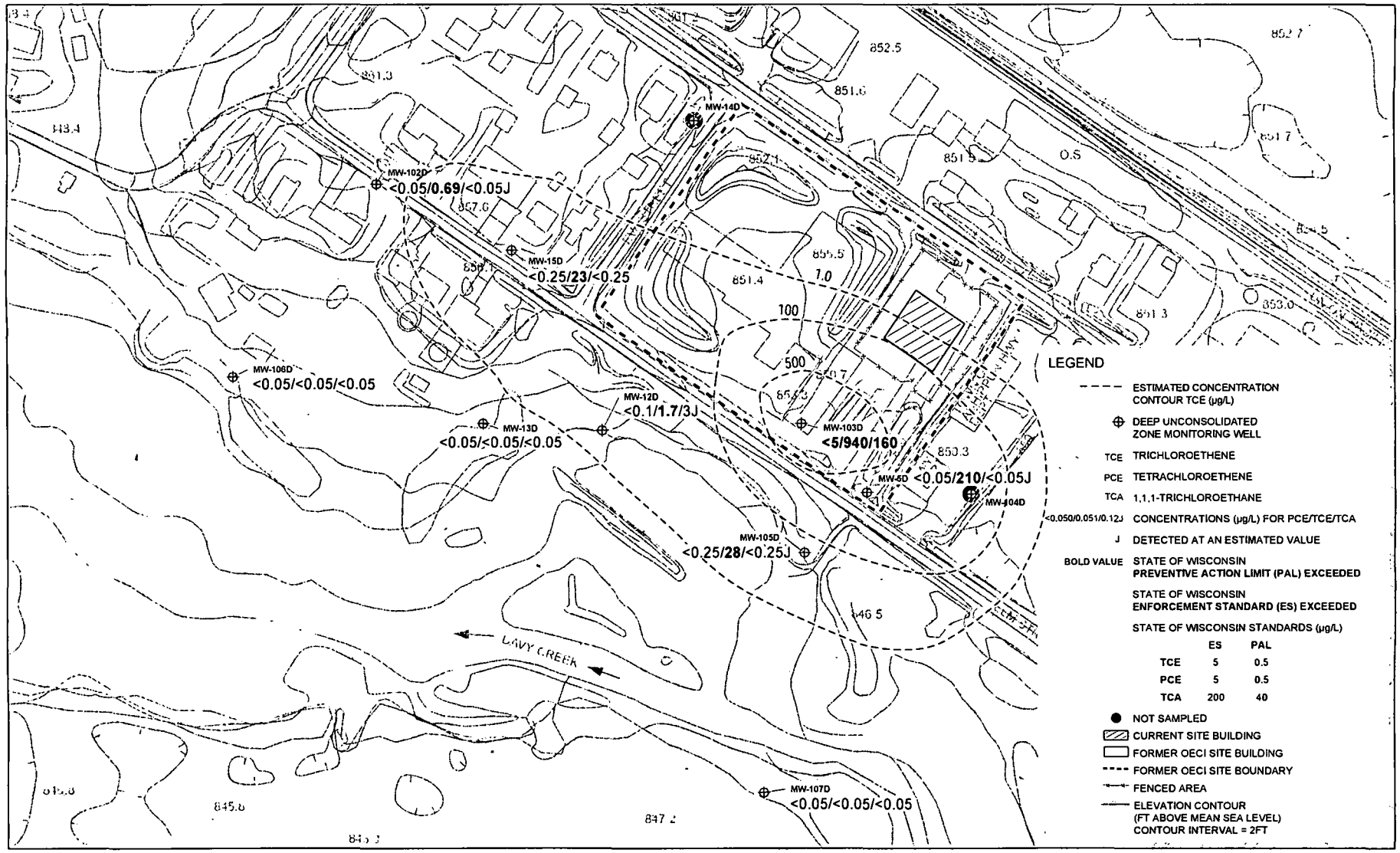


FIGURE 8
Groundwater PCE, TCE and TCA Concentrations in Deep Unconsolidated Wells – January 2008
OECI Site

CH2MHILL

ES052007001CVO-OECI_TCE_PCE_TCA_Deep_Fig08_EISB-062008_v05

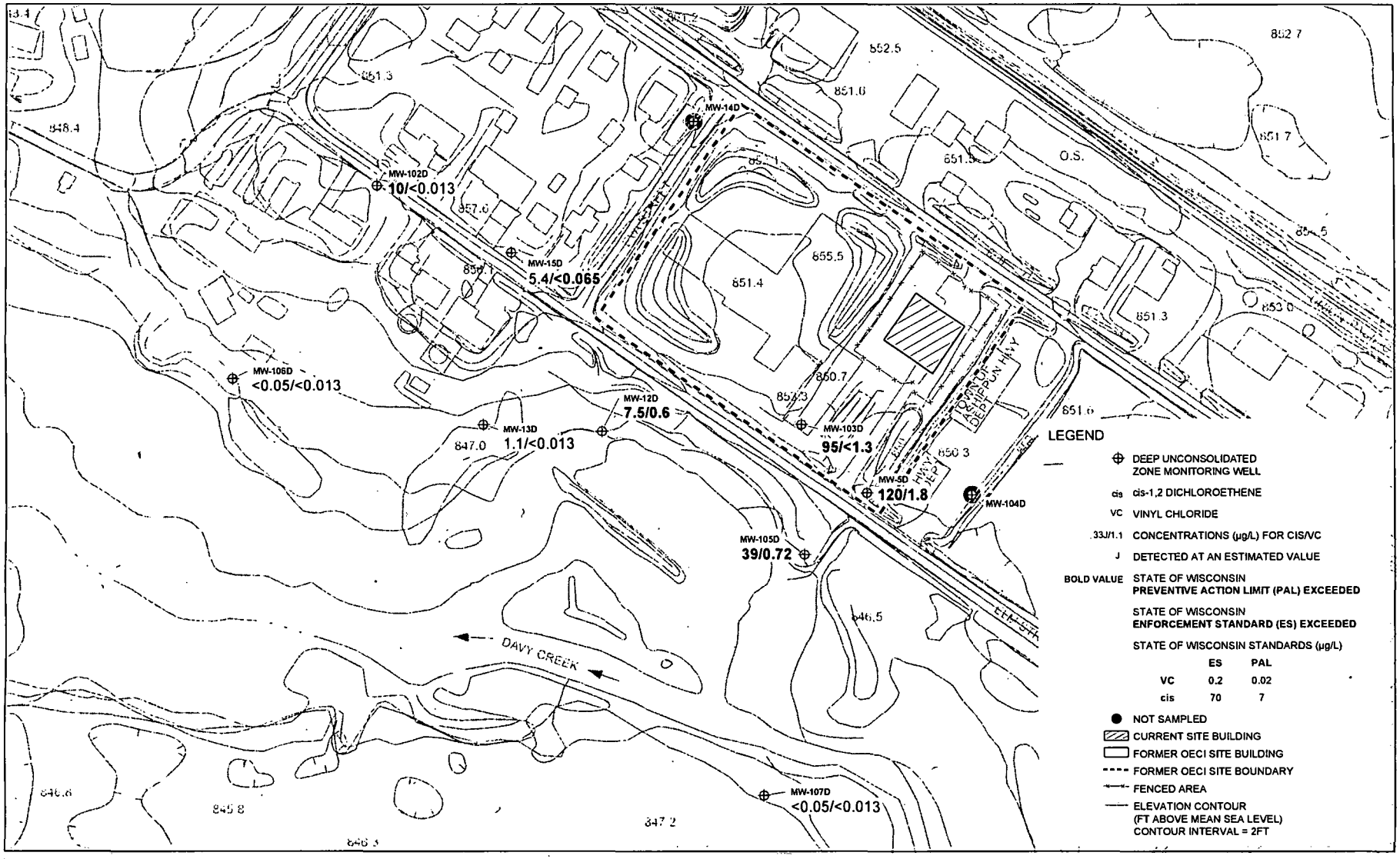


FIGURE 9
Groundwater CIS and VC Concentrations in Deep Unconsolidated Wells – January 2008
OECI Site

CH2MHILL

ES052007001CVO-OECI_VEcis_Deep_Fig09_EISB-062008_v03

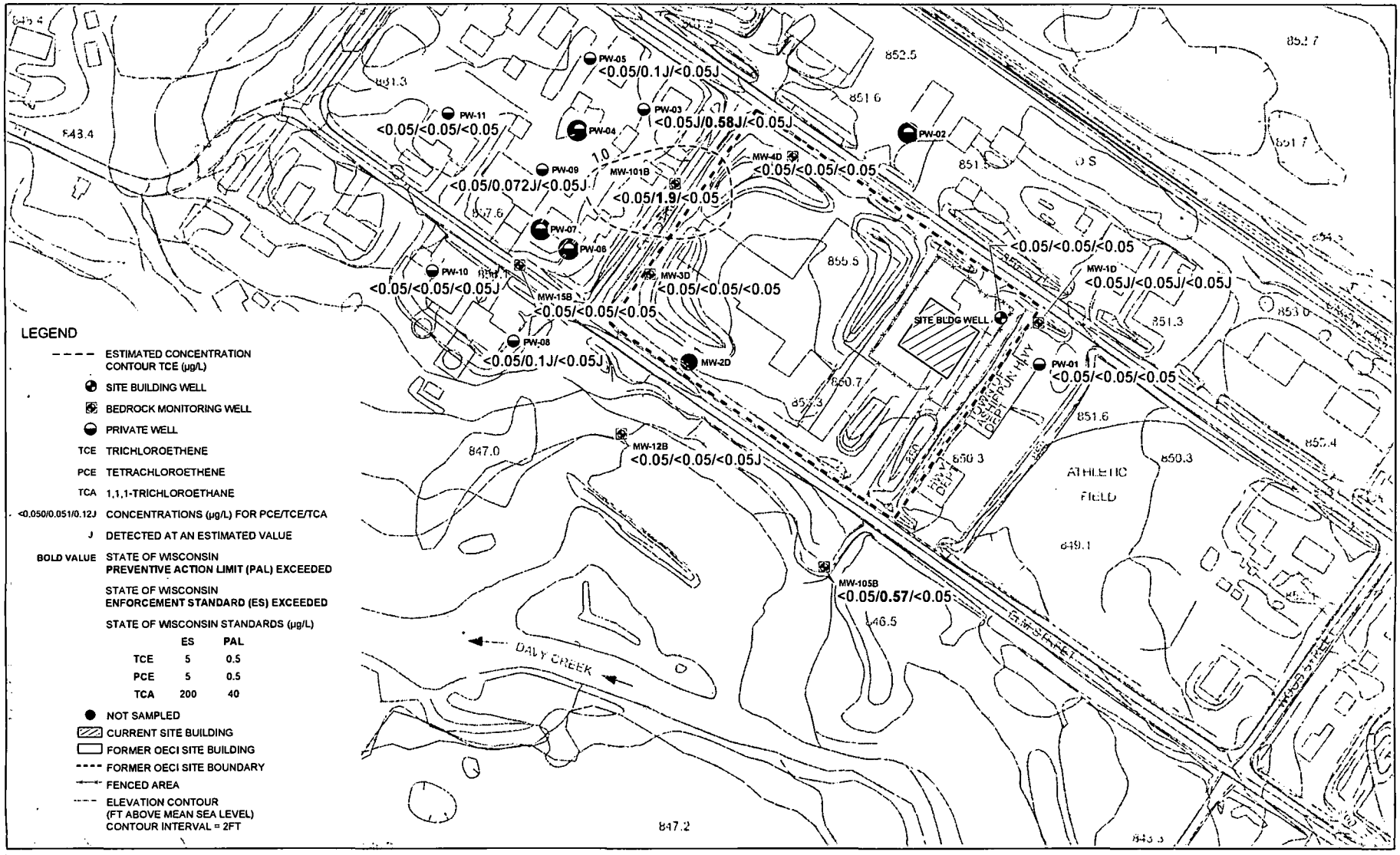


FIGURE 10
Groundwater PCE, TCE and TCA Concentrations in Bedrock Wells – January 2008
OECI Site

CH2MHILL

ES052007001CVO-OECI_TCA_PCE_TCE_Bedrock_Fig10_EISB-062008_v02

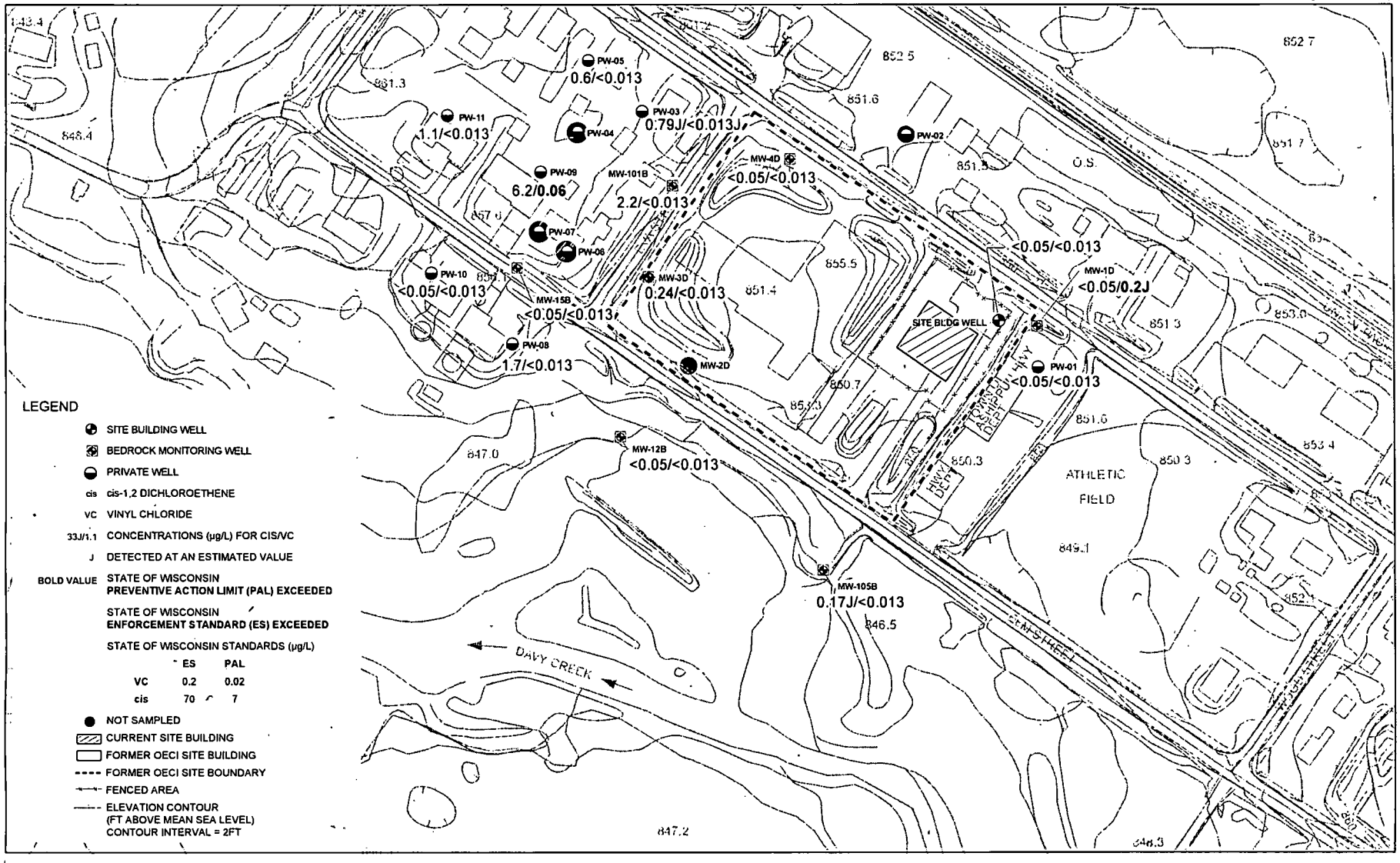


FIGURE 11
Groundwater CIS and VC Concentrations in Bedrock Wells – January 2008
OECI Site

CH2MHILL

ES052007001CVO-OECI_VCcis_Bedrock_Fig11_EISB-062008_v03

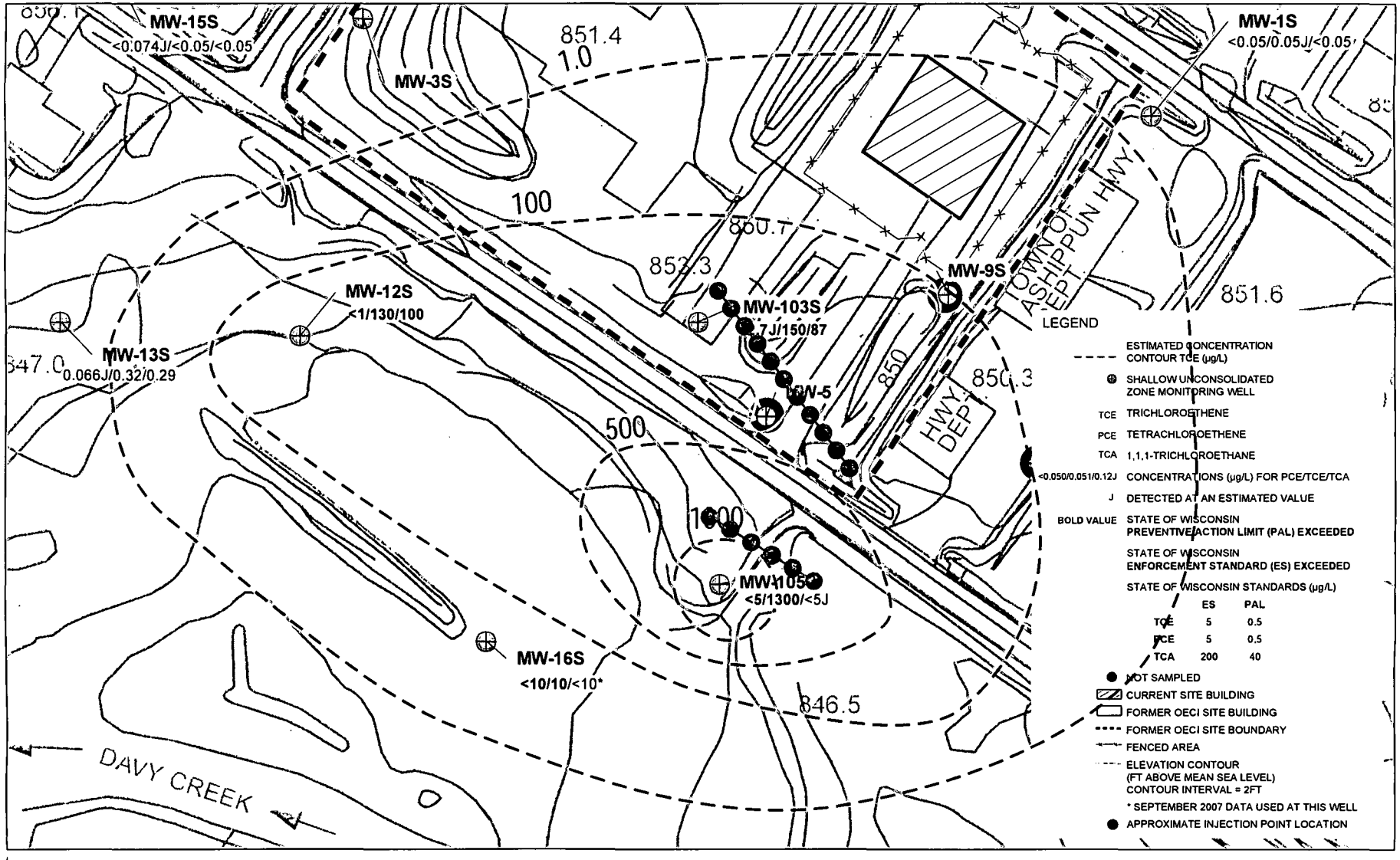
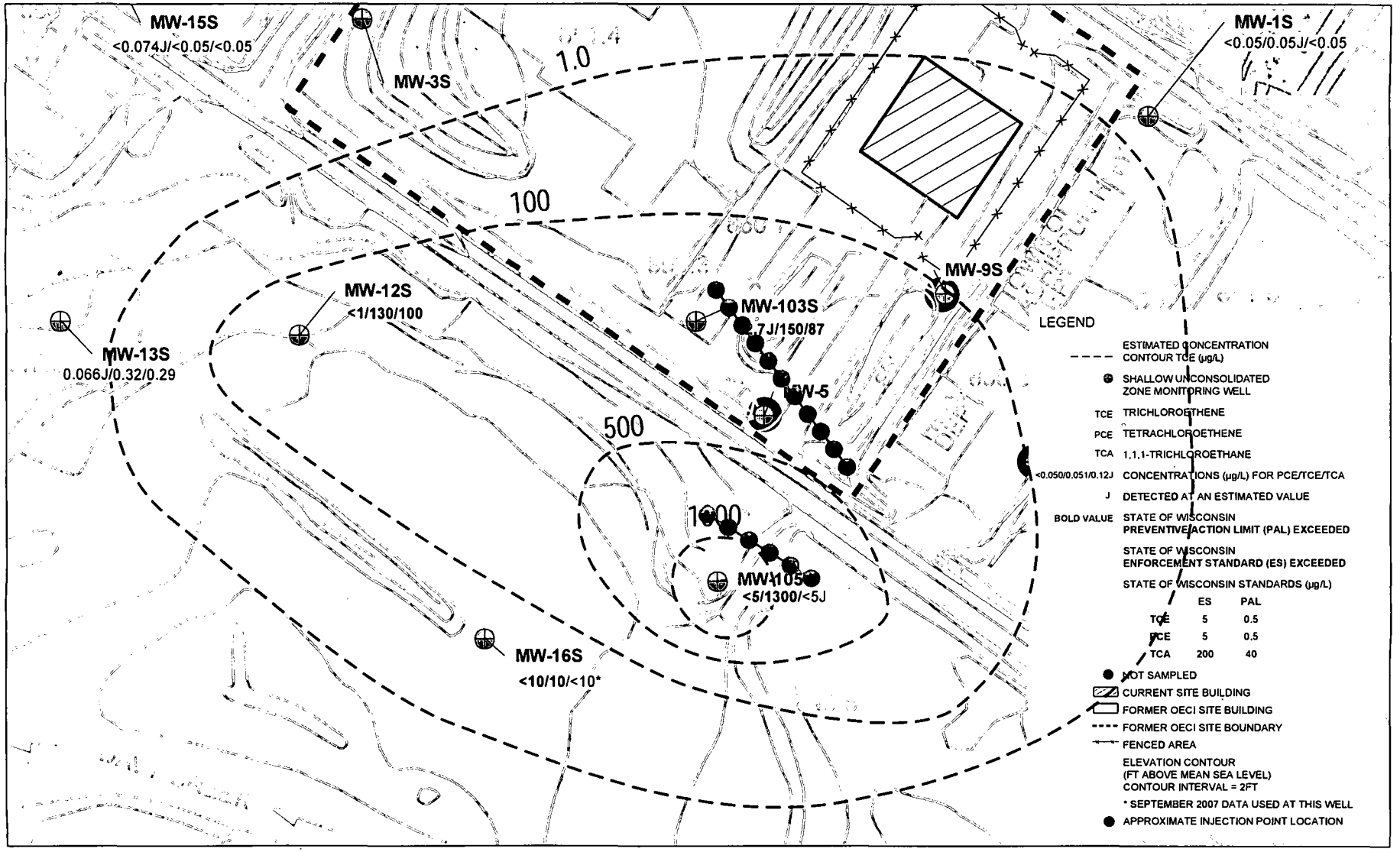


FIGURE 12
Proposed GW Injection Points to Target Known Higher TCE Concentration
OECI Site

CH2MHILL

ES052007001CVO-OECI_ProposedGWInjection_Fig12_EISB-062008_v05



0 30 60
Feet

FIGURE 12
Proposed GW Injection Points to Target Known Higher TCE Concentration
OECI Site

CH2MHILL

ES052007001CVO-OECI_ProposedGWInjection_Fig12_EISB-062008_v05

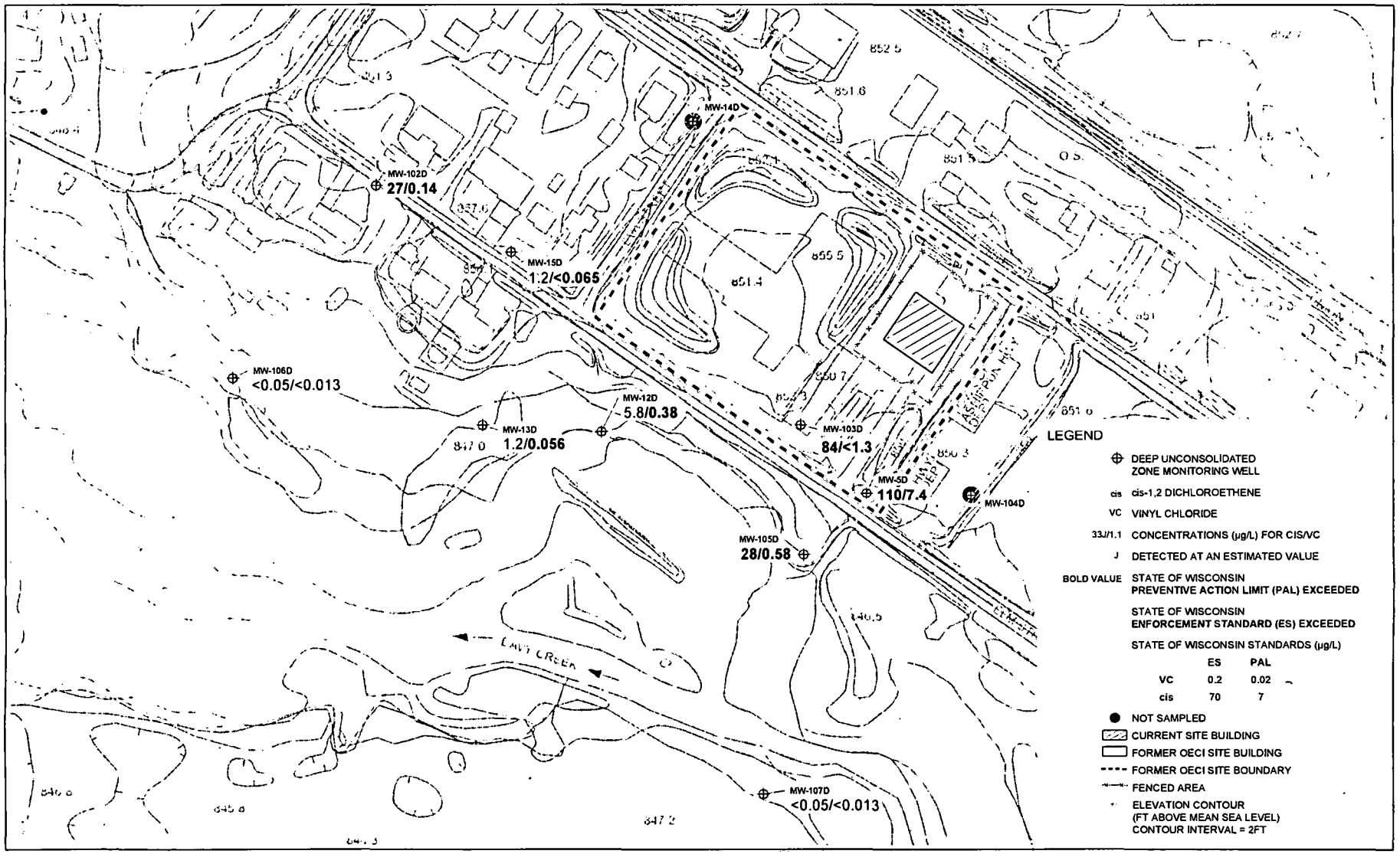


FIGURE 10
Groundwater CIS and VC Concentrations in Deep Unconsolidated Wells - April 2008
2008 2nd Quarter Groundwater Report
OECI Site

CH2MHILL

ES052007001CVO-OECI_VEcis_Deep_Fig10_2ndQR-2008_v05