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March 25, 2010

Cliff Walkey
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Subject: Module 1 DNAPL Recovery System Shut Down and
Remaining DNAPL Recovery Systems Alternate End Point
Union Pacific Railroad Tie Treating Plant, The Dalles, Oregon

Dear Mr. Walkey:

On behalf of Union Pacific Railroad (UPRR), CH2M HILL is submitting the attached technical memorandum (TM) for the Tie Treating Plant in The Dalles, Oregon. The TM presents an evaluation of the dense non-aqueous phase liquid (DNAPL) recovery in Module 1 based on decline curve evaluation as described in the *Groundwater Remedial Action Plan* (GWRAP) (CH2M HILL, 1997), and presents an alternate approach for DNAPL recovery system shut down based on the reductions in DNAPL transmissivity that have been observed in Module 1.

In addition, UPRR and CH2M HILL are pleased to inform DEQ that the Module 1 DNAPL recovery system has reached its operational endpoint! As discussed in the TM and documented in Appendix A, Module 1 achieved the 95 percent maximum potential recoverable volume, which is the recovery end point established in the GWRAP. The DNAPL Recovery Design Basis Report (CH2M HILL, 1998) states that Module 1 system shut down will occur 100 days after the 95 percent MPR volume has been reached. Based on the evaluation presented in this TM, CH2M HILL will be shutting down Module 1 on April 1, 2010.

In addition, UPRR requests DEQ concurrence that reduction in DNAPL transmissivity, as discussed in the attached TM, can be used as an alternate system endpoint for DNAPL recovery as it applies to the unconfined water bearing zone hydraulic containment system, the Module 2/3 system, and the DNAPL recovery from the Sand Hollow II Well 13-230.

Please contact me at (503) 872-4441 or Gary Honeyman at (402) 233-1007 with any questions or comments.

Sincerely,

CH2M HILL, Inc.

Cynthia R. Donnerberg

Cynthia R. Donnerberg. P.E.
Project Manager

c: Gary Honeyman/UPRR
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Alternate End Point for DNAPL Recovery Systems Union Pacific Railroad Former Tie Treating Plant, The Dalles, Oregon

Introduction

This technical memorandum (TM) presents an evaluation of dense non-aqueous phase liquid (DNAPL) recovery at the Union Pacific Railroad (UPRR) Former Tie Treating Plant (site) located in The Dalles, Oregon using observations from over 12 years of oil recovery. From the information gained from system operation, an alternate approach to the system operational end point evaluation from that originally presented in the *Groundwater Remedial Action Plan* (GWRAP) (CH2M HILL, 1997) is presented.

This TM is organized into the following sections:

- Objectives of the Technical Memorandum
- Site Setting
- Remedial Action Objectives (RAOs)
- Groundwater Remedial Action Plan Summary
- Current Status of Module 1 DNAPL Recovery
- Module 1 DNAPL Transmissivity Evaluation
- Compliance with RAOs
- Alternate DNAPL Recovery System Operational End Point
- References

Objectives of the Technical Memorandum

The objectives of this TM include the following:

- Evaluate DNAPL recovery in Module 1
- Evaluate DNAPL transmissivity in Module 1
- Evaluate compliance with RAOs in Module 1
- Present alternate DNAPL recovery system operational end point criteria for Module 2/3 and the hydraulic containment system (HCS)

Site Setting

The stratigraphy beneath the site consist of a thick (2,000 feet or more) sequence of basalt flows of the Columbia River Basalt Group, overlain by a thin (approximately 30 feet) layer of unconsolidated alluvial terrace deposits consisting of sand, silt, and gravel. The basalt flows sequentially underlying alluvium at the site include the Sentinel Gap flow, the Sand

Hollow I and II flows, and the Ginkgo II flow. The Ginkgo I flow occurs only in the eastern portion of the site.

The multiple water-bearing zones are encountered in the underlying alluvium and basalt flows. An unconfined water-bearing zone (approximately 10 to 40 feet below ground surface) occurs in the alluvial deposits and fractured Sentinel Gap flow top, while confined water bearing zones occur in the Sand Hollow I (90 to 170 feet), Sand Hollow II (170 to 330 feet), and the Ginkgo II (340 to 500 feet). The principal confined water-bearing zones occur in the flow tops of the respective basalt flows. As is typical for basalt flows of the Columbia River Basalt Group, the Sentinel Gap Basalt and Sand Hollow flow interiors generally are not water-bearing and act as confining layers.

Historically, creosote and wood treating chemicals were released to subsurface soil during treating operations, primarily from former ponds, located south of the retort buildings. The immiscible creosote, which was only slightly heavier than water, sank through the alluvium and the fractured Sentinel Gap flow top to the top of the denser, less fractured Sentinal Gap flow interior. The creosote subsequently moved laterally along the sloped surface of the Sentinal Gap flow interior confining layer and pooled into a low area of the formation just south of Interstate 84. Although dissolved-phase constituents related to plant operations have migrated through the dense flow interior of the Basalt of Sentinel Gap to the Sand Hollow I aquifer, DNAPL has not been identified beneath the Sentinel Gap despite extensive site characterization work, except near an old water well that had been improperly abandoned in the late 1950s. Until it was grouted and sealed in 1989 by UPRR, the improperly-abandoned well acted as a conduit for DNAPL migration to the Sand Hollow I interflow zone and Sand Hollow II intraflow zone, where it subsequently has been recovered by periodically pumping DNAPL out of MW13(230). Figure 1 illustrates the conceptual model of DNAPL migration through various hydraulic and stratigraphic zones.

Remedial Action Objectives

Remedial action objectives for the site were developed following Oregon criteria set forth in OAR 340-122-090 and established in the Record of Decision (ROD) which Oregon Department of Environmental Quality (DEQ) issued March 1996. The site-specific RAOs related to DNAPL at the site are presented here.

- Prevent further migration of DNAPL in the unconfined water-bearing zone and Sand Hollow II flow interior
- Remove DNAPL to the extent practicable to prevent continued vertical or horizontal migration to the uncontaminated portions of the aquifer
- Restore the water quality of the water-bearing zones currently contaminated with DNAPL to the extent feasible at the site

Although the unconfined water bearing zone is not currently used as drinking water source, the ROD established Maximum Contaminant Levels as the cleanup goal for the this zone. However, the ROD also qualified this cleanup standard with the following:

> *"…based on the information obtained during the remedial investigation, DEQ believes that the selected remedy may not be able to achieve the concentration levels presented above* (MCL

concentration levels), *in the unconfined water-bearing zone nor in a portion of the Sand Hollow I aquifer*."

Groundwater Remedial Action Plan Summary

The GWRAP set forth an approach to DNAPL recovery monitoring and performance analysis based on UPRR's experience at the former tie treating plant in Laramie, Wyoming. The cumulative DNAPL recovery curve was identified as a means to evaluate mobile DNAPL recovery. The endpoint for mobile DNAPL recovery at the Laramie site was recovery of 95 percent of the maximum potential recoverable (MPR) volume where the maximum was defined as the asymptote of the cumulative production curve. The GWRAP also established that performance data from Module 1 would be used to define an end point for mobile DNAPL recovery operations at the site.

Current Status of Module 1 DNAPL Recovery

Table 1 presents cumulative DNAPL recovery from the DNAPL recovery units and HCS through December 31, 2009. As indicated on Table 1, annual DNAPL recovery from Module 1 has been decreasing since 2000.

Figure 2 presents the cumulative DNAPL recovery over time for Module 1. The asymptote shape of the curve indicates that the MPR volume of DNAPL has been reached.

As described in the *DNAPL Recovery Design Basis Report (DBR)* (CH2M HILL, 1998), the MPR volume is determined by preparing a decline curve that plots the cumulative DNAPL recovery versus DNAPL recovery rate (Figure 3). The linear portions of Figure 4 are then extrapolated to zero on the DNAPL recovery curve axis to a recovery rate of zero.

Graphical extrapolation and linear regression were used to determine a range of values for the MPR volume. This analysis is presented in Attachment A. For Module 1, a linear regression of the last four data points provided the best curve fit. The total maximum recoverable volume is 12,500 gallons, and the 95 percent MPR volume is 11,960 gallons (Attachment A). As of December 31, 2009, 12,282 gallons have been recovered from Module 1. Based on the recovery end point established in the GWRAP, Module 1 has reached the operational end point.

In reviewing Module 1 DNAPL recovery data as a whole it was observed that the instantaneous recovery graph (Figure 4) presents a more real time depiction of DNAPL recovery. Figure 4 shows that a decrease in the instantaneous DNAPL recovery rate occurred in approximately August 2006 from about 2.5 gallons per day to less than 0.5 gallon per day in 2010.

This observation led CH2M HILL to revisit the site conceptual model. As DEQ may recall, the original conceptual model for DNAPL recovery was built upon the experience in DNAPL recovery developed by CH2M HILL and UPRR at UPRR's tie treating plant in Laramie, Wyoming. Although adaptations were required – such as the use of wells in fractured basalt at The Dalles rather than the dual drain lines that were used in the alluvium at Laramie – the underlying remedial concept between the two sites was similar. At Laramie, the depletion in recoverable DNAPL occurred relatively steadily, consistent with fluid flow through granular porous media. At The Dalles, however, the depletion in recoverable DNAPL can be described as a "punctuated" decline curve; wherein the gradual decline in recoverable DNAPL is punctuated by episodes of more rapid decline. This observed decrease in DNAPL recovery at The Dalles is likely due to DNAPL depletion within individual fractures, which allows water to invade the fracture, creating a barrier to further DNAPL flow paths to the recovery wells. In other words, as DNAPL recovery has progressed, the amount of DNAPL in a fracture is decreased over time until insufficient DNAPL remains to maintain a saturated DNAPL flow path in the fracture; effectively shutting down DNAPL movement within the fracture. This results in a more accelerated drop in DNAPL recovery than would be expected for an alluvial aquifer as at the Laramie Tie Plant where the decline curve approach first was used by UPRR.

With these observations, CH2M HILL evaluated if there were other analysis methods that may provide a better indication of when the remedial action objective of removing DNAPL to the extent practicable to prevent vertical or horizontal migration were more appropriate for the site. Because DNAPL transmissivity is a measure of how much DNAPL can be transmitted by the formation, a DNAPL transmissivity evaluation presented in the following section was performed to identify if there was a link between the decrease in the DNAPL recovery rate and a change in DNAPL transmissivity.

Module 1 DNAPL Horizontal Transmissivity Evaluation

Review of site data and operation logs for Module 1 uncovered instances of drawdown of DNAPL in extraction well EX-12. The DNAPL in EX-12 was completely pumped out of the well when a pump switch was accidentally left in the "ON" position during maintenance activities. The drawdown occurred in the years 2000, 2002, 2003, 2006, and 2007 with recovery periods ranging from 22 days (2000) to 686 days (2007).

By analyzing the recovery of the DNAPL over time, the associated hydrocarbon transmissivity of the DNAPL found at this location can be measured. The transmissivity helps describe the potential mobility and ultimately, the potential recoverability of the DNAPL found in the subsurface. The drawdown/recovery tests conducted at monitoring well EX-12, which consisted of documenting the recovery of the DNAPL over time, were analyzed using a modified version of the light non-aqueous phase liquid (LNAPL) method described by Huntley (2000). Attachment B provides a memorandum on how the equation was modified for use with DNAPL after consultation with Dr. Huntley.

Attachment C provides the calculations for the transmissivity evaluation, the results of which are summarized here. The DNAPL drawdown/recovery tests conducted at monitoring well EX-12 resulted in DNAPL transmissivity values ranging from 0.5305 ft^2/day (2000) to 0.0393 ft^2/day (2007) (Figure 5). The drawdown/recovery tests indicate that the conductivity and transmissivity of the DNAPL in monitoring well EX-12 have decreased over time by an order of magnitude. There is no indication as to the reason for the short-lived transient increase in these parameters in 2003, although the test data for that year do show a fairly inconsistent water table elevation which, as discussed in Attachment C, may influence the calculations. Regardless, the most recent measurements of DNAPL transmissivity (using test data through January 22, 2009) are approximately an order of magnitude lower than they were in 2000.

Figure 6 shows the Module 1 instantaneous recovery rate over time with the DNAPL transmissivity and associated reductions noted. The graph indicates that the significant decrease in instantaneous recovery rate in August 2006 discussed in the previous section correlates to an approximate 85 percent reduction in DNAPL transmissivity from the initial transmissivity data in 2000. By 2007, the DNAPL transmissivity in Module 1 had been reduced by 93 percent.

Based on the reduction of DNAPL transmissivity data and meeting DEQ criteria described in the ROD, the GWRAP and the DBR, Module 1 will be shutdown on April 1, 2010.

Vertical DNAPL Migration Potential

The hydrogeologic properties of the flood basalt flows underlying the tie plant, specifically, the very low vertical hydraulic conductivity of the basalt flow interiors, have prevented and continue to prevent vertical migration of DNAPL to the Sand Hollow I water bearing zone, except where an improperly abandoned water well (well 2F(1)) provided an artificial conduit for vertical DNAPL movement during the 31-year period from 1958 through 1989.

The ability for DNAPL to move vertically in fractured rock below the water table depends on the ability for the DNAPL to displace water from fractures, which in turn depends on a variety of factors, such as:

1. Fracture aperture width (larger aperture increases migration potential)
2. DNAPL viscosity (greater viscosity reduces migration potential)
3. DNAPL-water surface tension (greater surface tension reduces migration potential)
4. DNAPL density (greater density increases migration potential)
5. DNAPL pool height (greater pool height increases migration potential)
6. Vertical hydraulic gradient (greater downward vertical gradient increases migration potential)

Factors 1 though 4 are physical properties that have remained constant over time at the site. Factors 5 and 6, however, have changed over time; both in a direction that would further reduce the potential for vertical DNAPL migration.

Specifically, the recovery of DNAPL from the alluvium and Sentinel Gap flow top has reduced the height of DNAPL remaining at the site. For example, in IMW-6, the elevation of the DNAPL surface early in 1998 was about 63.5 feet, NGVD (Appendix A of the *Progress Report for Activities Conducted from July 1, 2008 Through June 30, 2009* (CH2M HILL, 2009). The log of IMW-6 (contained in the Remedial Investigation Report) indicates that the top of the dense, competent Sentinel Gap flow interior occurs at an elevation of 57.7 feet. Consequently, the height of DNAPL at this well above the top of the dense flow interior of the Basalt of Sentinel Gap was 63.5 - 57.7 = 5.8 feet. In 2009, the elevation of DNAPL in IMW-6 was about 58.5 feet, which translates to a height of 0.8 foot. In this example, the height of DNAPL above the confining layer has been decreased by remedial actions by 86 percent. This represents a substantial reduction in the potential for vertical DNAPL migration.

Similarly, the shut down and demolition of the Northwest Aluminum primary aluminum reduction plant has reversed the long-term decline in Sand Hollow I water levels. For example, the water elevation in the Sand Hollow I aquifer in well DMW-13 was 32.44 feet in

1988, as reported in the Phase III Hydrogeologic Study report. The water level in unconfined aquifer well SS-07, by comparison, was 86.34 feet. With a screen separation of 65 feet, this correlates to a downward vertical gradient of (32.44 – 86.34)/65 = -0.83 foot per foot. By 2009, however, the water elevations in the Sand Hollow I aquifer had recovered so substantially that the elevation in DMW-13 was 53.01 feet (CH2M HILL, 2009). The corresponding SS-07 elevation was 83.66 feet, correlating to a downward vertical gradient of -0.47 foot per foot. Consequently, the vertical hydraulic gradient has been reduced by 43 percent. This reduction in vertical hydraulic gradient concomitantly reduces the potential for vertical migration of DNAPL.

In summary, the hydrogeologic setting at the tie plant prevented vertical DNAPL migration to the Sand Hollow I aquifer over the life of the tie treating plant, except for where an improperly abandoned borehole provided an artificial conduit until it was identified and sealed in 1989. This protectiveness has been increased substantially by the effective DNAPL recovery program in the unconfined aquifer at the site, as well as by the recovery in Sand Hollow I water levels related to the shut down and demolition of the Northwest Aluminum reduction plant in The Dalles. Even though vertical DNAPL migration did not occur through the Sentinel Gap flow interior through natural processes prior to the beginning of DNAPL recovery, it is even less likely to occur now.

Compliance with RAOs

The volume of mobile DNAPL has been reduced since start up of the recovery systems, as indicated by the significant reduction in DNAPL transmissivity in Module 1 and the reduction in vertical migration potential at the site. These reductions achieve the site-specific RAOs by reducing the likelihood of DNAPL migration.

Horizontal and vertical migration of DNAPL has not occurred at the site, other than the temporal lateral redistribution of DNAPL within the unconfined aquifer that occurred for a period of time after DNAPL release to the subsurface ceased. This has been demonstrated by well measurements using an oil/water interface probe that have been collected from 44 wells across the site on a quarterly basis since 1997. DNAPL has not been detected in new wells that had not previously shown the presence of DNAPL.

Currently, DNAPL moves into the recovery wells under an artificially induced gradient. The horizontal and vertical hydraulic gradients imposed on the unconfined aquifer during remediation far exceed natural gradients, meaning the evaluation of DNAPL transmissivity under these artificial conditions is conservative. After groundwater circulation in Module 1 is shut down, the remaining DNAPL will be less mobile under natural conditions than what is currently observed under operational conditions.

Alternate DNAPL Recovery System Operational End Point

In 1997 when the GWRAP was developed the decline curve evaluation was the best available approach to analyze the recovery of mobile DNAPL. Since then, DNAPL evaluation techniques have evolved and CH2M HILL considers an evaluation of DNAPL transmissivity to be a more accurate measurement of potential mobility. The evaluation of Module 1 data presented in this memorandum indicates that sustained reductions in the instantaneous recovery rate correlate to significant reductions in DNAPL transmissivity.

The decline curve evaluation described in previous sections indicates the 95 percent MPR volume is 11,960 gallons. The cumulative volume recovered from Module 1 in August 2006, when an 85 percent reduction in transmissivity was observed, was 11,043 gallons.

Moving forward, UPRR proposes to baseline the transmissivity in Module 2/3 and the HCS wells by using historic instances of DNAPL drawdown or through planned drawdown tests at select wells. Once a baseline is set, the instantaneous recovery rates will be monitored periodically over time. Additional drawdown tests will be performed when sustained changes in the instantaneous recovery rates are observed to occur to reevaluate DNAPL transmissivity reduction in Module 2/3 and the HCS. Data will be compiled and presented to DEQ for each operational recovery unit in support of operational shut down when significant reduction in transmissivity is achieved.

References

CH2M HILL, 1988. *Phase III Hydrogeologic Study Report.*

CH2M HILL, 1997. *Groundwater Remedial Action Plan.* Prepared for Union Pacific Railroad Company. May.

CH2M HILL, 1998. *DNAPL Recovery Design Basis Report*. Prepared for Union Pacific Railroad Company, Tie Treating Plant, The Dalles, Oregon. June.

CH2M HILL, 2009. *Progress Report for Activities Conducted from July 1, 2008 Through June 30, 2009.* October.

Huntley, D. 2000. *Analytic Determination of Hydrocarbon Transmissivity from Baildown Tests.* Ground Water. V. 38, no. 1, pp. 46-52.

Tables

Table 1
Unconfined Water-Bearing Zone DNAPL Recovery Summary
UPRR-The Dalles Tie Treating Plant

	Module 1		Module 2/3		Hydraulic Containment System		Total[b]	
Period Ending	**Annual DNAPL Recovery (gal)**	**Cumulative DNAPL Recovery (gal)**	**Annual DNAPL Recovery (gal)**	**Cumulative DNAPL Recovery (gal)**	**Annual DNAPL Recovery (gal)**	**Cumulative DNAPL Recovery (gal)**	**Annual DNAPL Recovery (gal)**	**Cumulative DNAPL Recovery (gal)**
1998					1,341	1,341	1,341	1,341
1999	830	830			2,549	3,890	3,379	4,720
2000	2,762	3,591			3,491	7,381	6,253	10,972
2001	1,755	5,346			1,907	9,288	3,662	14,634
2002	1,594	6,939			4,728	13,601	6,322	20,541
2003	1,179	8,118			7,207	20,768	8,386	28,887
2004	1,291	9,409	7,529	7,529	11,990	32,758	20,810	49,697
2005	982	10,391	5,828	13,357	5,360	38,118	12,170	61,867
2006	908	11,299	4,996	18,353	4,860	42,993	10,764	72,646
2007	482	11,781	4,099	22,452	2,970	45,963	7,551	80,197
2008	328	12,109	3,891	26,343	2,530	48,493	6,749	86,946
January-09	*17*	*12,126*	*352*	*26,695*	*210*	*48,703*	*579*	*87,525*
February-09	*11*	*12,137*	*247*	*26,942*	*180*	*48,883*	*438*	*87,963*
March-09	*12*	*12,149*	*375*	*27,317*	*210*	*49,093*	*597*	*88,560*
April-09	*11*	*12,160*	*258*	*27,575*	*200*	*49,293*	*469*	*89,029*
May-09	*28*	*12,188*	*335*	*27,910*	*170*	*49,463*	*533*	*89,562*
June-09	*16*	*12,204*	*295*	*28,205*	*200*	*49,663*	*511*	*90,072*
July-09	*14*	*12,218*	*264*	*28,469*	*195*	*49,858*	*473*	*90,545*
August-09	*14*	*12,232*	*412*	*28,881*	*180*	*50,038*	*606*	*91,151*
September-09	*11*	*12,243*	*330*	*29,211*	*170*	*50,208*	*511*	*91,662*
October-09	*14*	*12,257*	*315*	*29,526*	*175*	*50,383*	*504*	*92,166*
November-09	*14*	*12,271*	*324*	*29,850*	*190*	*50,573*	*528*	*92,694*
December-09	*11*	*12,282*	*295*	*30,145*	*225*	*50,798*	*531*	*93,225*
2009[a]	173	*12,282*	3,802	*30,145*	2,305	*50,798*	6,280	*93,225*

[a] Recovery period January 1 through December 31, 2009.

[b] Total is for the unconfined water-bearing zone only. DNAPL recovered from MW-13(230) is not included in this total.

Figures

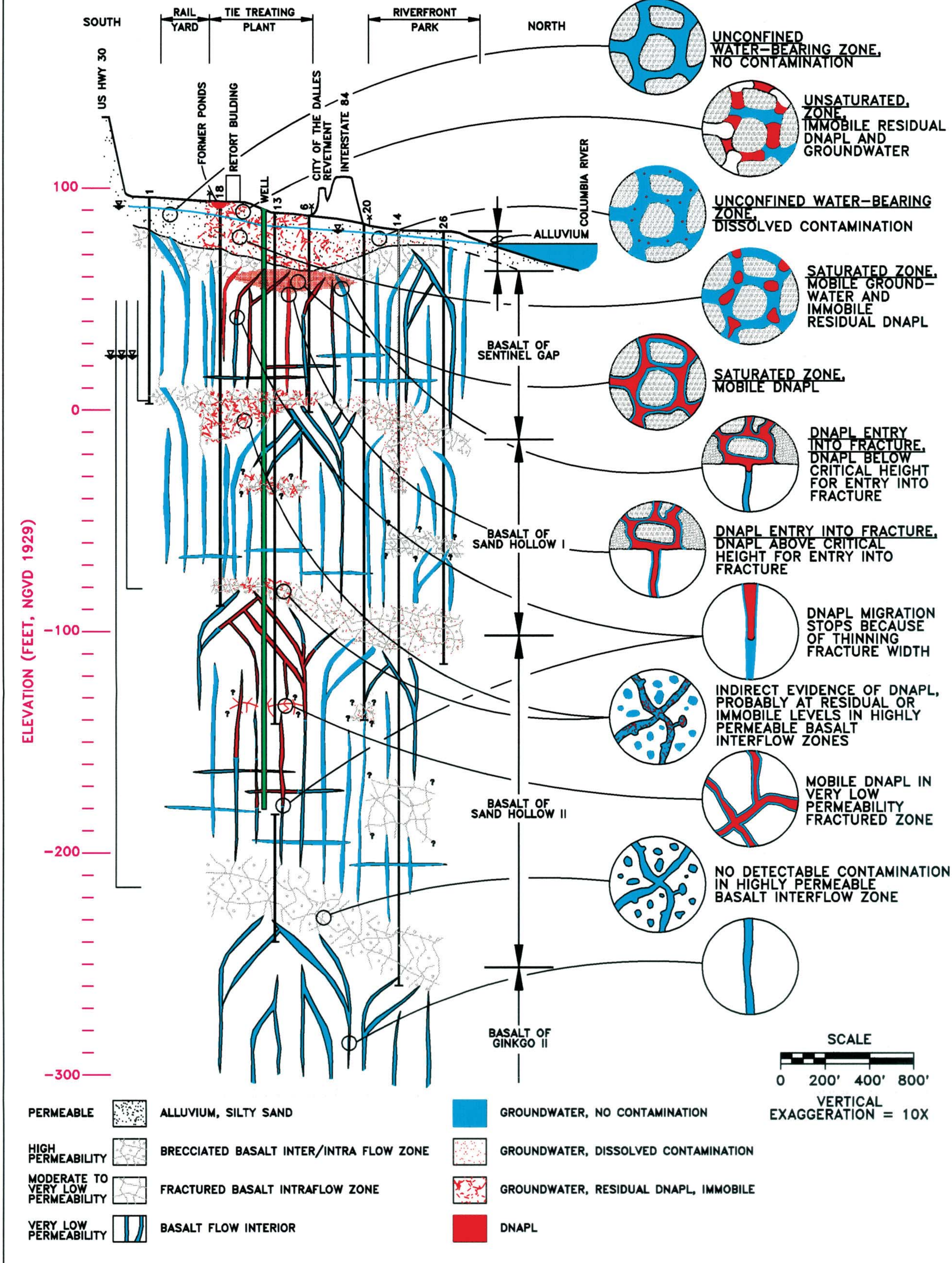

FIGURE 1
SCHEMATIC SITE HYDROSTRATIGRAPHY SHOWING CONCEPTUAL DNAPL TRANSPORT
UNION PACIFIC RAILROAD COMPANY
TIE TREATING PLANT–THE DALLES, OREGON

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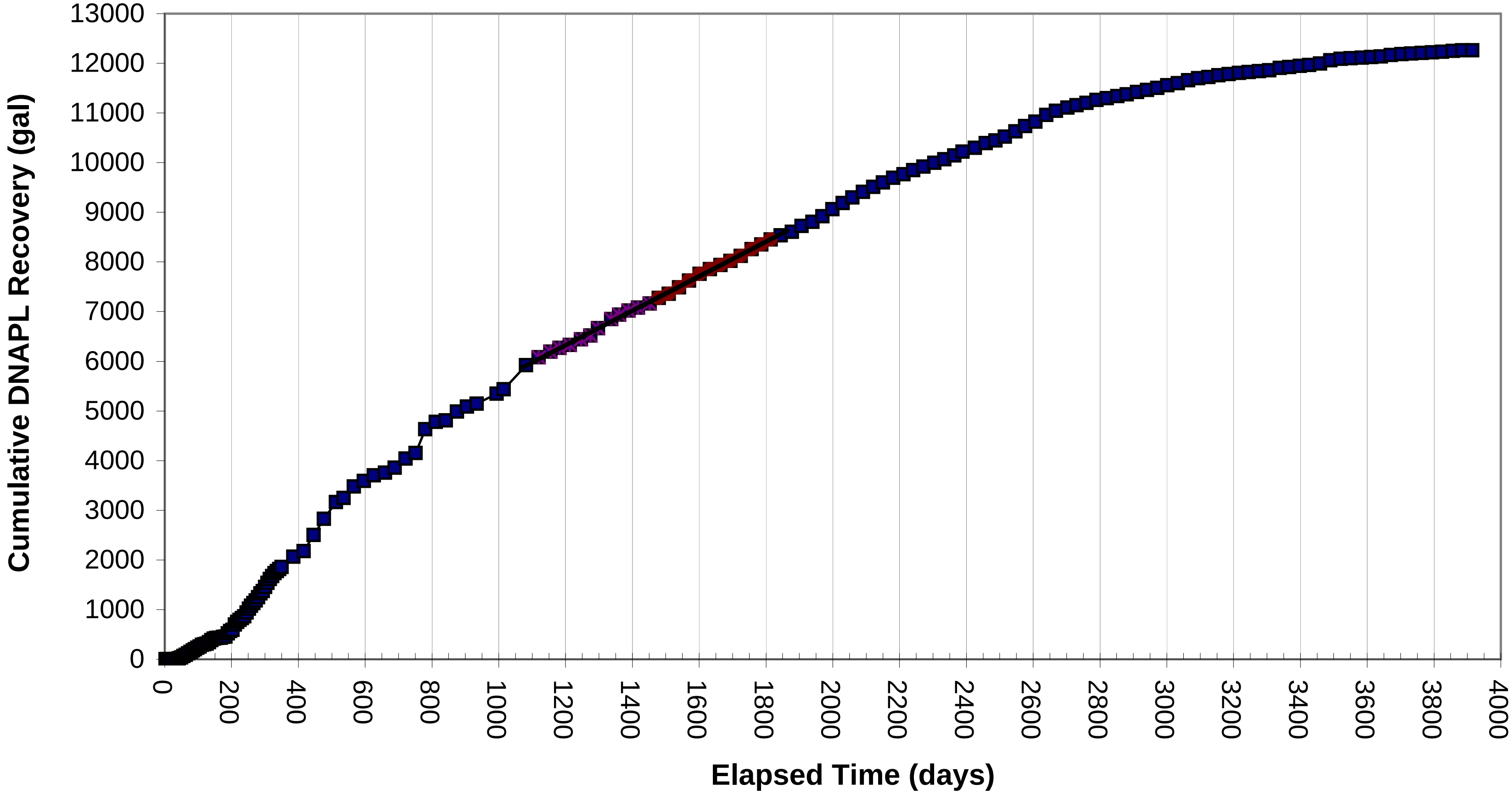


FIGURE 2
CUMULATIVE RECOVERY VERSUS TIME - MODULE 1
UNION PACIFIC RAILROAD COMPANY
TIE TREATING PLANT-THE DALLES, OREGON

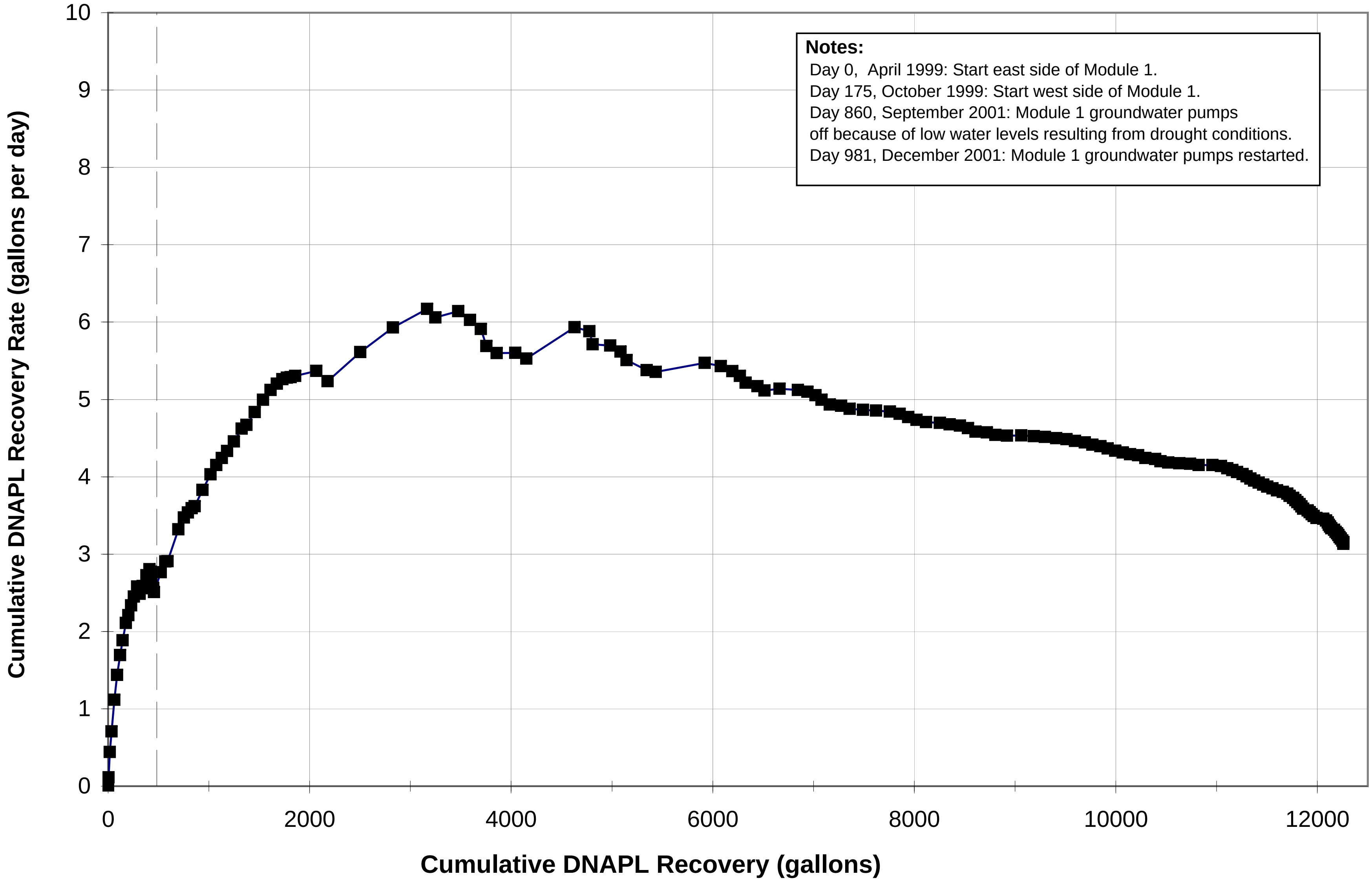


FIGURE 3
DECLINE CURVE - MODULE 1
UNION PACIFIC RAILROAD COMPANY
TIE TREATING PLANT-THE DALLES, OREGON

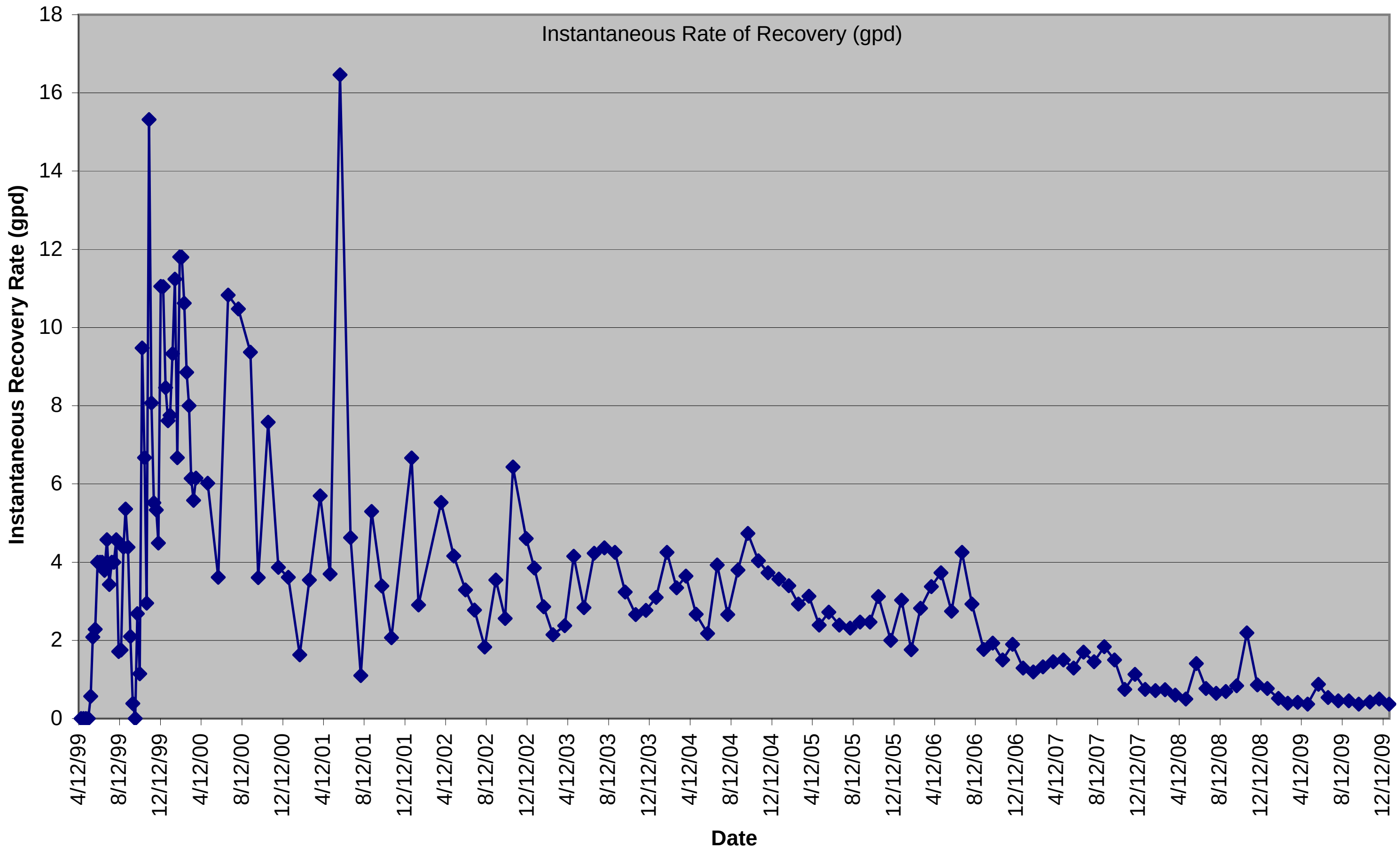


FIGURE 4
INSTANTANEOUS DNAPL RECOVERY - MODULE 1
UNION PACIFIC RAILROAD COMPANY
TIE TREATING PLANT-THE DALLES, OREGON

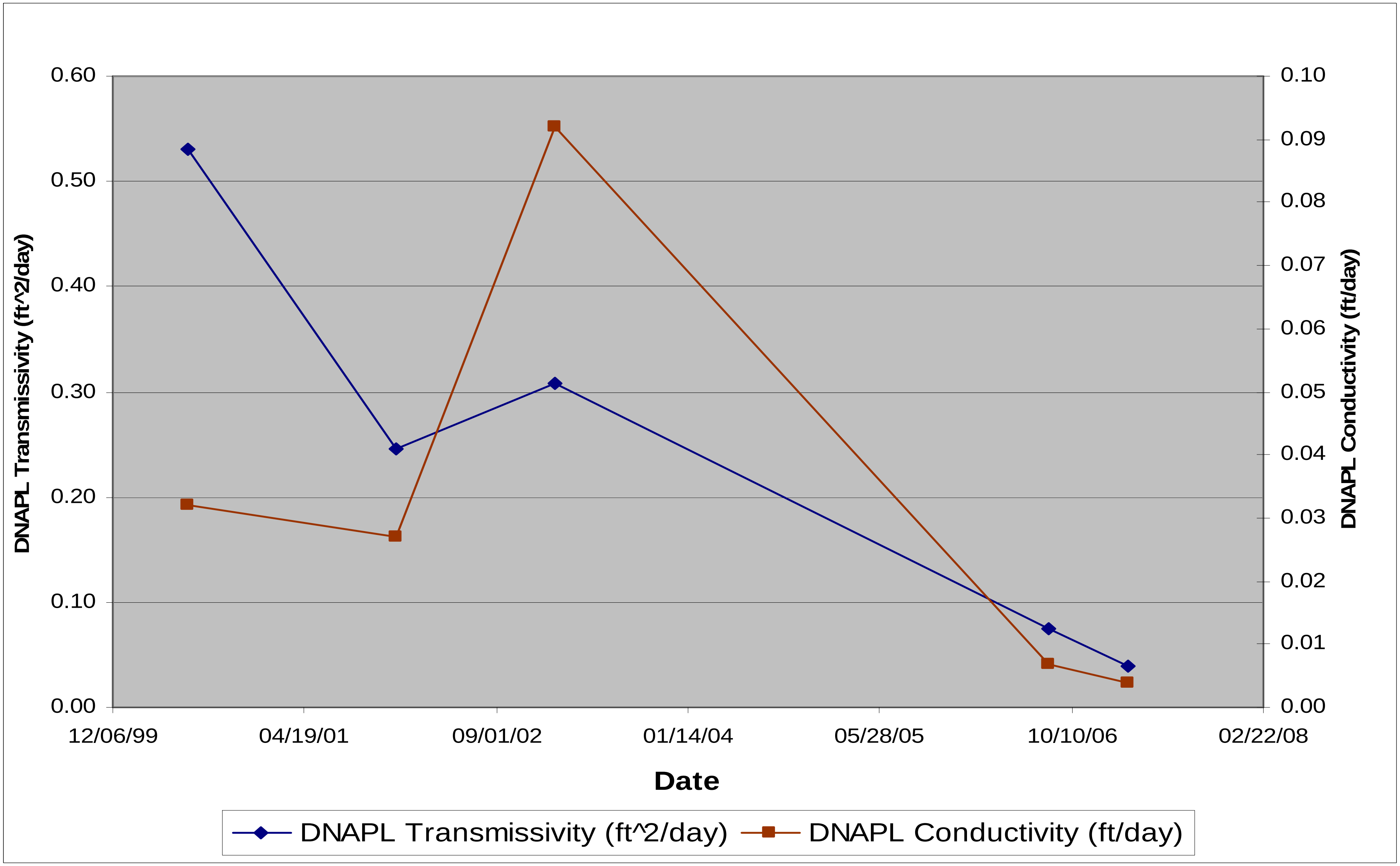


FIGURE 5
DNAPL TRANSMISSIVITY AND CONDUCTIVITY OVER TIME - MODULE 1
UNION PACIFIC RAILROAD COMPANY
TIE TREATING PLANT-THE DALLES, OREGON

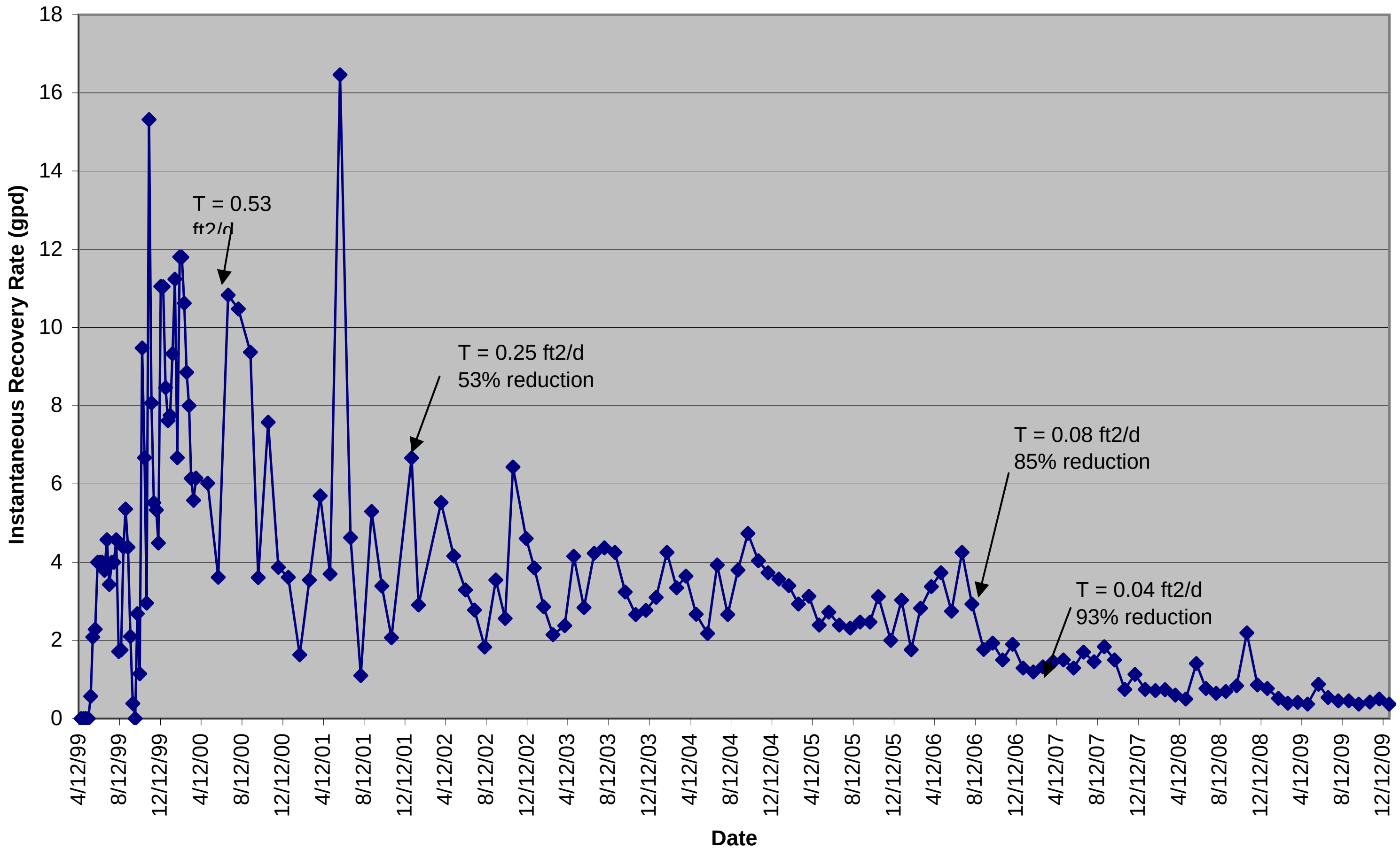


FIGURE 6
INSTANTANEOUS DNAPL RECOVERY - MODULE 1
UNION PACIFIC RAILROAD COMPANY
TIE TREATING PLANT-THE DALLES, OREGON

Attachment A

DNAPL Recovery Unit End Point Analysis Procedure

The following steps are used to calculate the 95 percent maximum potential recoverable (MPR) volume.

1. Begin with the Cumulative Oil Recovery vs. Time graph (x-axis is elapsed time in days, y-axis is cumulative oil recovered in gallons) (Figure A-1).
2. At each section with a different slope, draw a tangent line.
3. Calculate the slope of each tangent line (delta Y/delta X)
4. a. Plot the calculated slope values [which represents Oil Recovery Rate (gal/day) vs. the Cumulative Recovery (gal)], which is the point where the tangent line touches the graphed line.

   b. If graph is concave, use the midpoint of the segment (for Cumulative Recovery (gal) value)
5. Extrapolate the resulting graph to zero. This represents the theoretical MPR for that unit.

Both visual/graphical extrapolation and linear regression (Figures A-2 thru A-4) are used to provide a range of MPR. The end point for DNAPL recovery is 95 percent of the MPR.

Figure A-4 provides the best fit for the data and provides 95 percent MPR volume of 11,960 gallons.

Table A-1
Annual Rate of DNAPL Recovery - Module 1
UPRR-The Dalles Tie Treating Plant

Year	Cumulative Recovered (gallons)	Rate (gallons per day)
1999	427	3.0911
2000	1248	8.8002
2001	3248	6.6895
2002	5086	4.378
2003	6515	3.475
2004	7854	3.4863
2005	9062	3.6089
2006	10142	2.5149
2007	11157	1.9461
2008	11701	1.1532
2009	11992	0.8485
2010	12259	0.367

Table A-2
Estimated 95% Maximum Potential Recoverable Volume
UPRR-The Dalles Tie Treating Plant

Graph Extrapolation	
14,750	
14,013	95% of theoretical
14,020	95% of theoretical (rounded up to the nearest 10)
Theoretical using linear regression of all 12 points	
14,850	Endpoint
14,108	95% of theoretical
14,110	95% of theoretical (rounded up to the nearest 10)
Theoretical using linear regression of last 8 points	
13,989	Endpoint
13,289	95% of theoretical
13,290	95% of theoretical (rounded up to the nearest 10)
Theoretical using linear regression of last 4 points	
12,587	Endpoint
11,958	95% of theoretical
11,960	95% of theoretical (rounded up to the nearest 10)

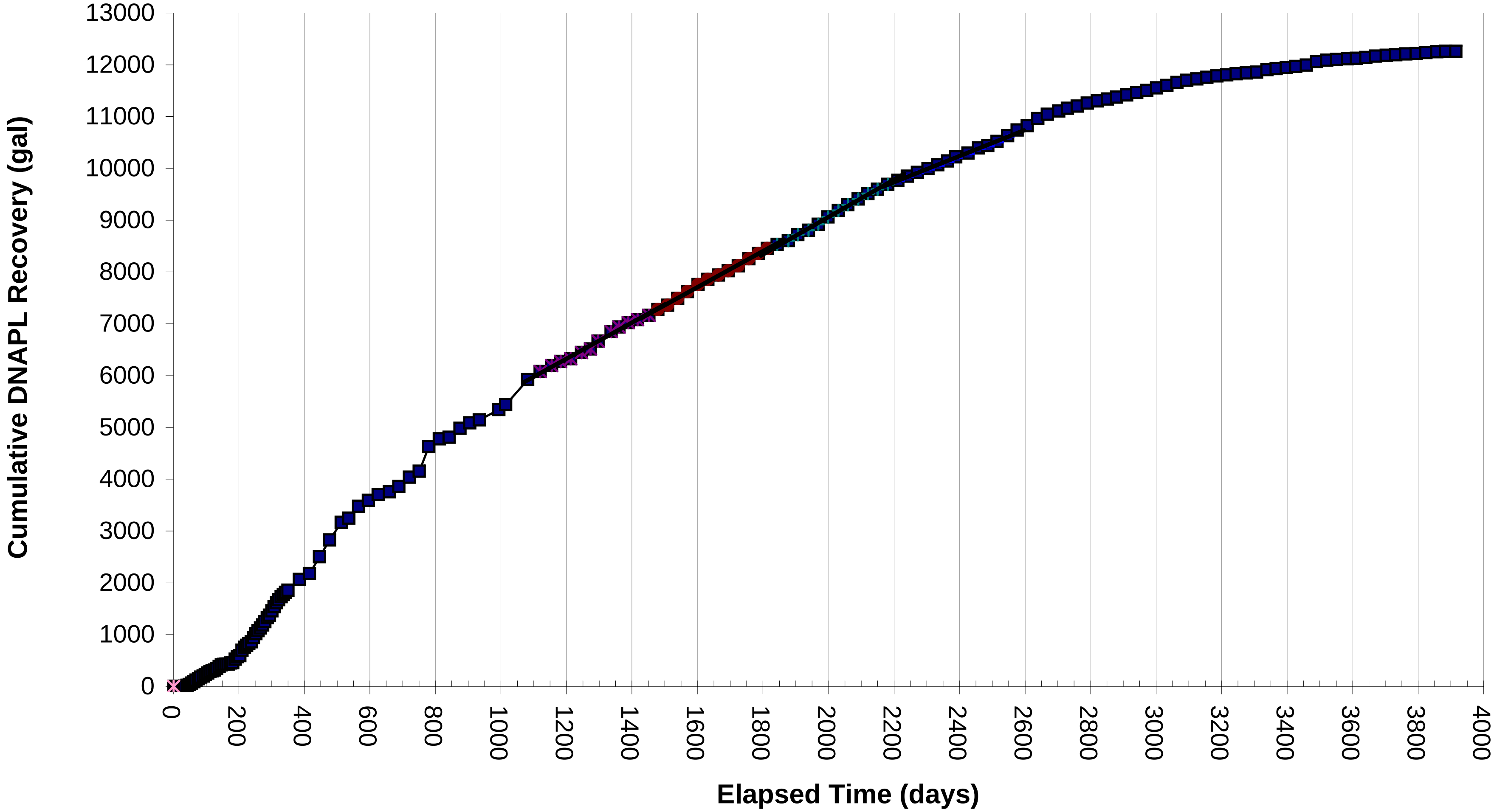


Figure A-1
CUMULATIVE DNAPL RECOVERY CURVE - MODULE 1
UNION PACIFIC RAILROAD COMPANY
TIE TREATING PLANT-THE DALLES, OREGON

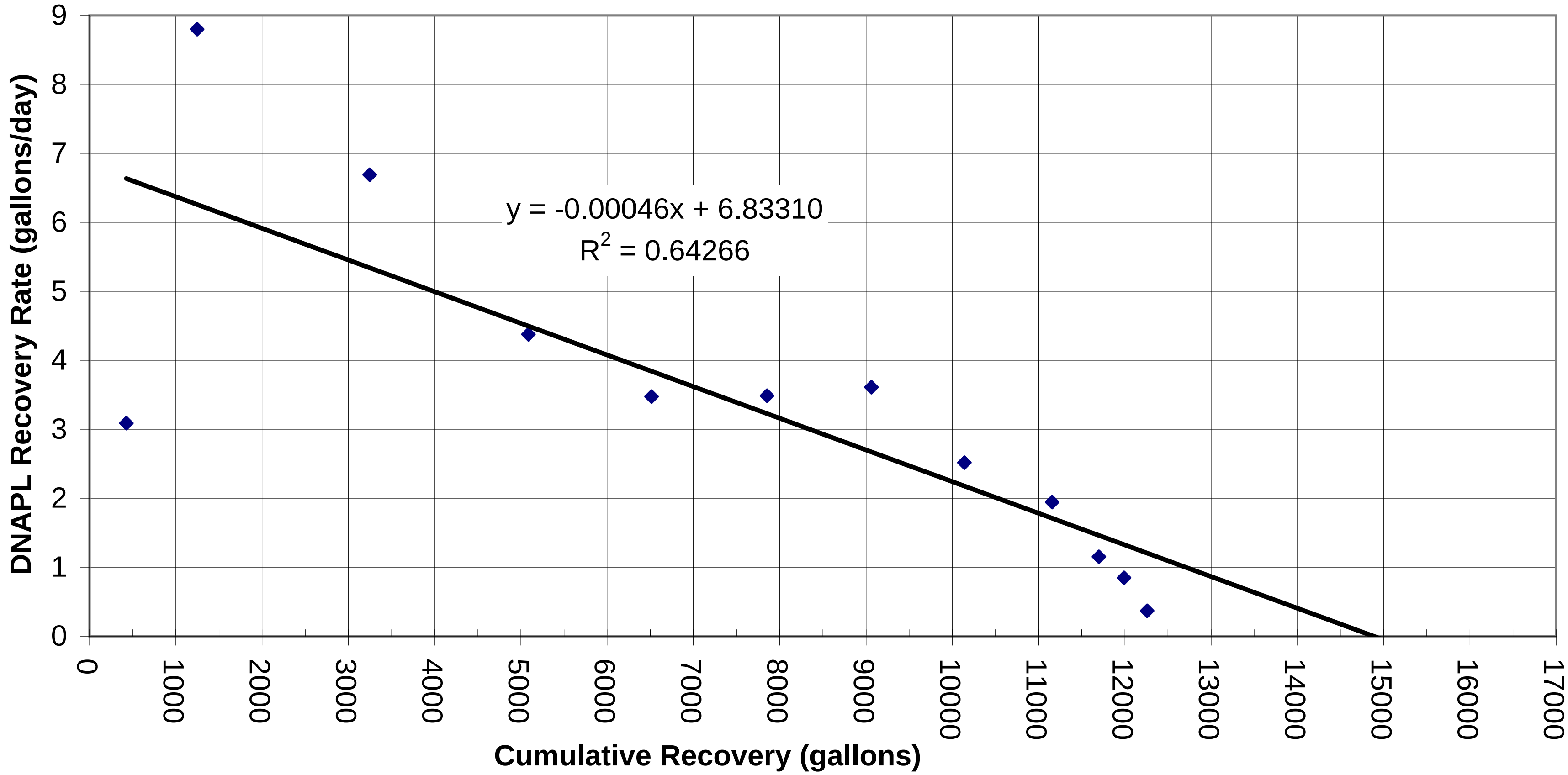


FIGURE A-2

DNAPL RECOVERY RATE VS. CUMULATIVE RECOVERY - MODULE 1

LINEAR REGRESSION - ALL POINTS

UNION PACIFIC RAILROAD COMPANY

TIE TREATING PLANT-THE DALLES, OREGON

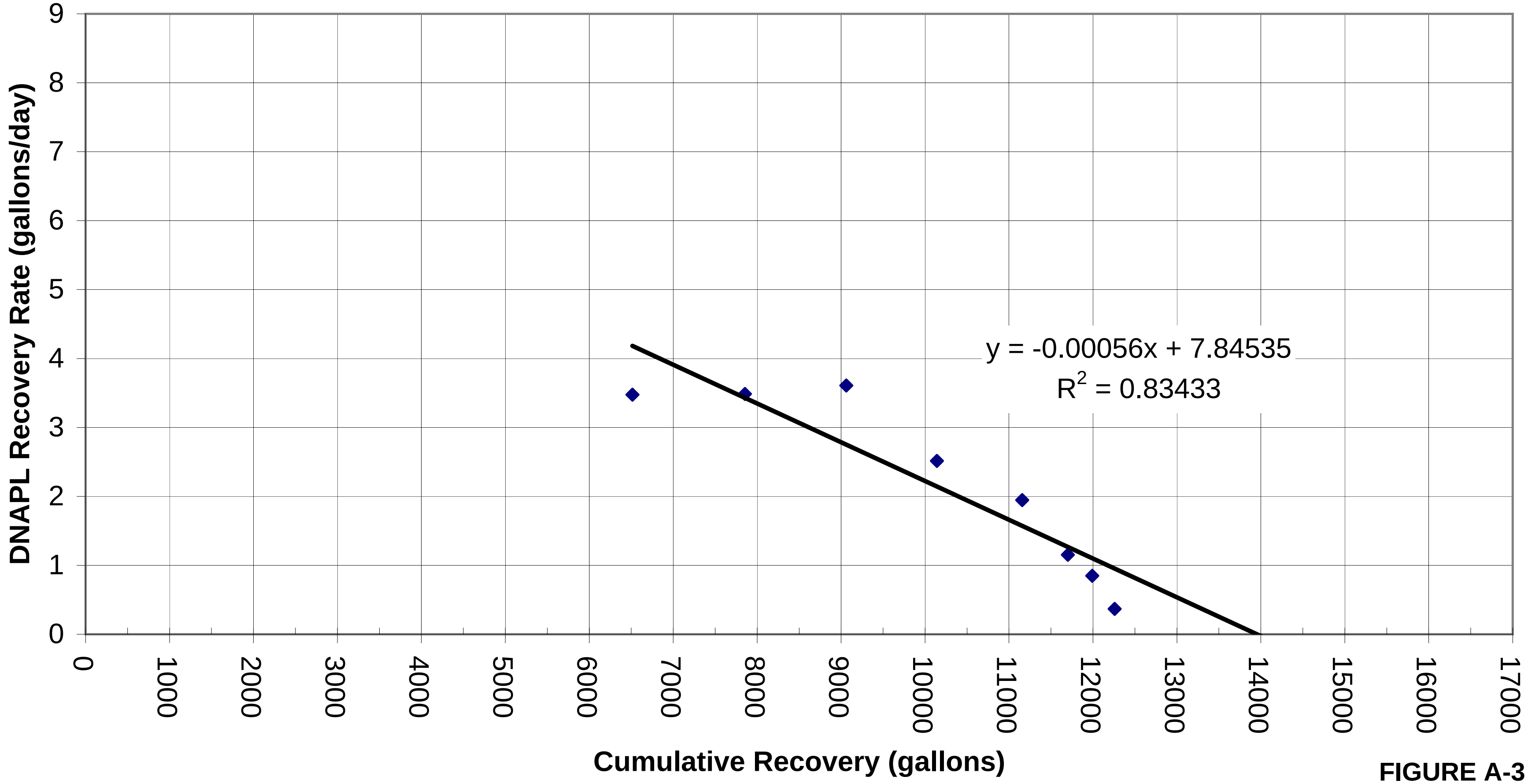


FIGURE A-3
DNAPL RECOVERY RATE VS. CUMULATIVE RECOVERY - MODULE 1
LINEAR REGRESSION - LAST 8 POINTS
UNION PACIFIC RAILROAD COMPANY
TIE TREATING PLANT-THE DALLES, OREGON

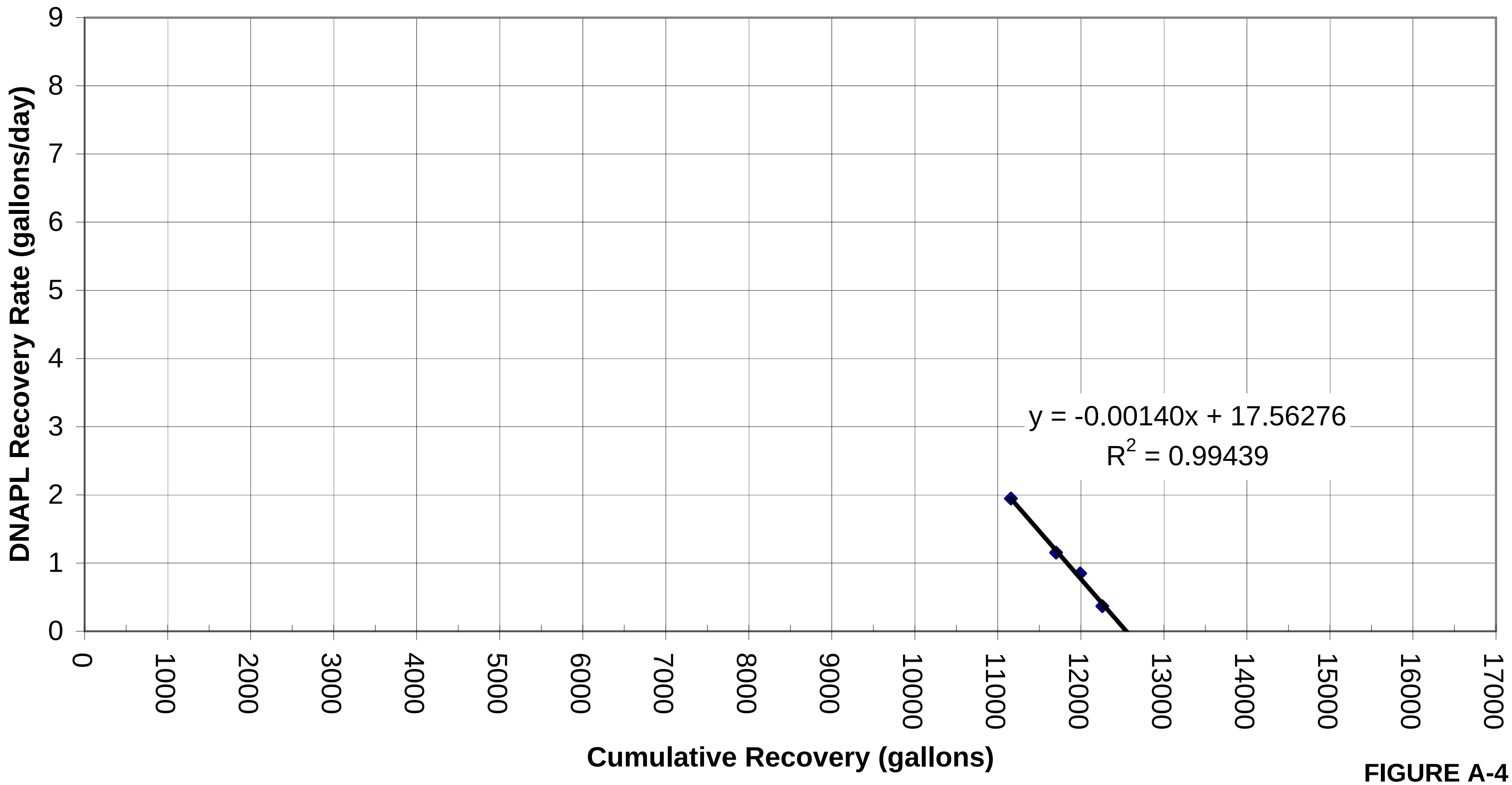


FIGURE A-4

DNAPL RECOVERY RATE VS. CUMULATIVE RECOVERY - MODULE 1

LINEAR REGRESSION - LAST 4 POINTS

UNION PACIFIC RAILROAD COMPANY

TIE TREATING PLANT-THE DALLES, OREGON

Attachment B

DNAPL Transmissivity Calculation Using Drawdown Test Data

The time/recovery data generated during the bail down tests can be analyzed using a modified form of the Bouwer and Rice slug test analysis as presented in Dr. David Huntley's paper (2000) to generate a DNAPL conductivity and DNAPL transmissivity. The modification of the Bouwer and Rice analysis comes from the fact that the equations for the original analysis were derived for a single phase (water). The inclusion of a second phase requires the results to be "corrected" to account for the second phase; specifically in the case of Huntley, which was derived for an LNAPL, the results are corrected by the reciprocal of the difference between the density of the two fluids (water and LNAPL). Because the Huntley method was developed for an LNAPL, additional modifications to the equations were necessary to account for fluid which is denser than water.

In the case of a DNAPL, the hydraulic head, and therefore the drawdown, is not simply the elevation of the DNAPL/water interface because of the pressure of the water above that interface. Recognizing that the hydraulic head is equal to $z + h/\rho(r)$, where z is the elevation of the DNAPL/water interface, h is the height of the water column above the DNAPL/water interface, and $\rho(r)$ is the relative density of the DNAPL, the equations in Huntley can be modified for drawdown/recovery of a DNAPL. The key to this "re-derivation" is the assumption that the water table elevation remains constant, and therefore, the resultant equation is the same as the original Bouwer and Rice equation, with a correction factor. As explained above, for an LNAPL (as presented in Huntley), the correction factor is the reciprocal of the difference between the density of the two fluids (water and LNAPL). For a DNAPL, the correction factor is the relative density of the DNAPL divided by the relative density of the DNAPL minus one, or $\rho(r)/(\rho(r) - 1)$.

Reference

Huntley, D. 2000. *Analytic Determination of Hydrocarbon Transmissivity from Baildown Tests*. Ground Water. V. 38, no. 1, pp. 46-52.

Attachment C

Module 1 DNAPL Transmissivity Calculations Using Drawdown/Recovery Test Data

Beginning in 2000, a series of recovery tests were conducted on the dense non-aqueous phase liquid (DNAPL) found at the Union Pacific Railroad Tie Treating Plant in The Dalles, Oregon. These tests of the DNAPL found in monitoring well EX-12 occurred in the years 2000, 2002, 2003, 2006, and 2007, over time periods ranging from 22 days (2000) to 686 days (2007). By analyzing the recovery of the DNAPL over time, the associated hydrocarbon conductivity and transmissivity of the DNAPL found at this location can be measured. The transmissivity and conductivity help describe the potential mobility and ultimately, the potential recoverability, of the DNAPL found in the subsurface.

Test Method and Procedure

The drawdown/recovery tests conducted at monitoring well EX-12, which consisted of documenting the recovery of the DNAPL over time, were analyzed using the light non-aqueous phase liquid (LNAPL) method described by Huntley (2000) and modified as described in Attachment B. The drawdown/recovery data provided, however, did not allow for the direct determination of the initial (static) measurement of the DNAPL/water interface (depth to DNAPL) and the water/air interface (depth to water). Therefore, an assumption was made that the static conditions prior to the removal and subsequent recovery of the DNAPL were equal to the final recovery measurement (final depths to DNAPL and water). In other words, the test was presumed to have accounted for complete recovery of the DNAPL into the well.

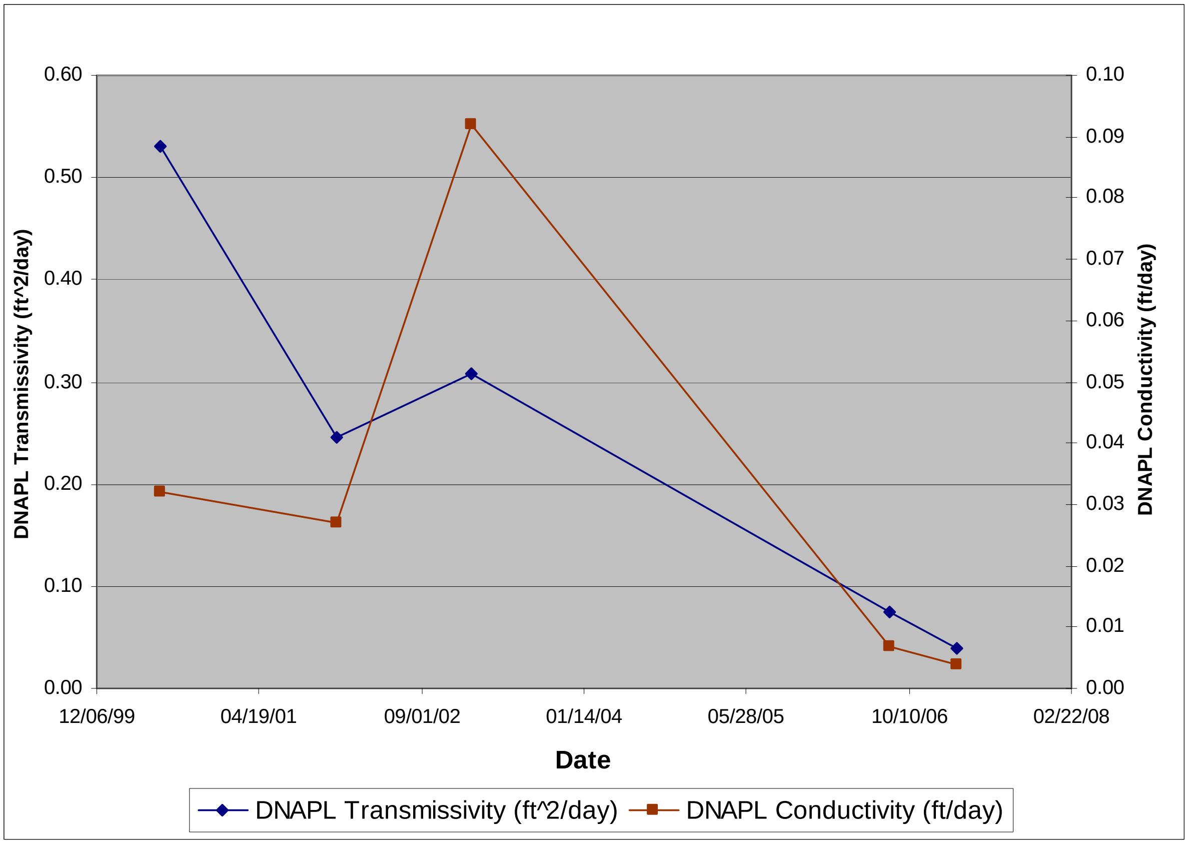
In addition to the time/recovery data, the analysis required other parameters to describe the fluid being recovered, and the monitoring well containing the fluid. Those data were obtained from the well construction diagrams (casing radius, radius of the well, and the total depth of the well screen) and laboratory analysis (DNAPL specific gravity).

As described in Attachment B, for a DNAPL, the correction factor is the relative density of the DNAPL divided by the relative density of the DNAPL minus one, or $\rho(r)/(\rho(r) - 1)$. Because the DNAPL found in monitoring well EX-12 has a relative density of 1.05, the correction term in the Bouwer and Rice equation is 21.

The DNAPL drawdown/recovery test analysis for the tests conducted at monitoring well EX-12 are presented in Exhibit C-1 through C-5.

Test Results

The DNAPL drawdown/recovery tests conducted at monitoring well EX-12 resulted in DNAPL conductivity values ranging from 0.092 ft/day (2003) to 0.0039 ft/day (2007), and DNAPL transmissivity values ranging from 0.5305 ft^2/day (2000) to 0.0393 ft^2/day (2007).



The drawdown/recovery tests indicate that the conductivity and transmissivity of the DNAPL in monitoring well EX-12 have decreased over time by an order of magnitude. There is no indication as to the reason for the increase in these parameters in 2003, although the test data for that year do show a fairly inconsistent water table elevation, which, as discussed above, underlies one of the primary assumptions of the analysis; that is, that the water table elevation remains constant. Regardless, the most recent measurements of DNAPL conductivity and transmissivity (using test data through January 22, 2009) are approximately an order of magnitude lower than they were in 2000.

Reference

Huntley, D. 2000. *Analytic Determination of Hydrocarbon Transmissivity from Baildown Tests*. Ground Water. V. 38, no. 1, pp. 46-52.

Exhibit C-1

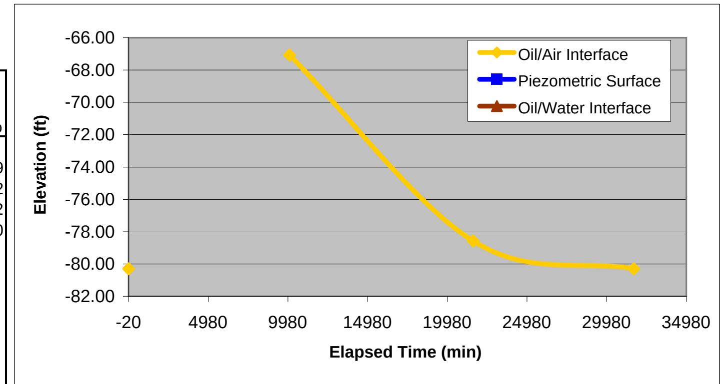
DNAPL Baildown Test at Dalles - 2000

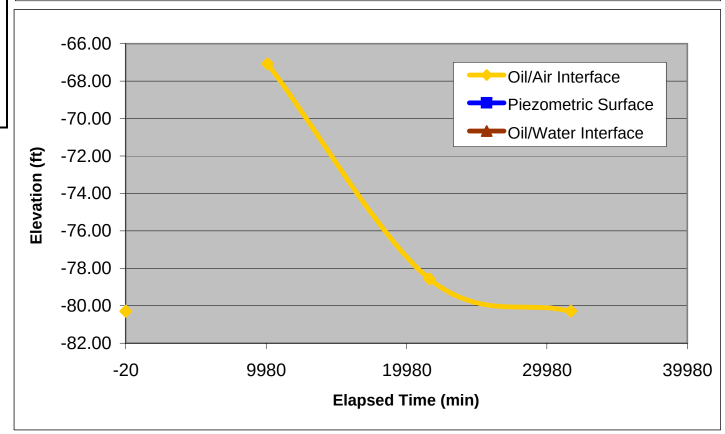
Bottom of Well Elevation = 59.17

Date	Time	Elapsed Time		Product Elevation	Water Elevation	Product Thickness	Z_w	Z_o	Z_p	S_o
6/20/2000	12:00:00	Static	**-20.00**	80.29		21.12		-80.29		
6/20/2000	12:00:00	0.00	0.00	63.70		4.53				16.59
6/27/2000	12:00:00	10080.00	10080.00	67.07		7.90		-67.07		13.22
7/5/2000	12:00:00	21600.00	21600.00	78.57		19.40		-78.57		1.72
7/12/2000	12:00:00	31680.00	31680.00	80.29		21.12		-80.29		0.00

T Calc - Part 1	7.62E-04	
Transmissivity =	**3.68E-04**	**ft^2/min**
K_{LNAPL} =	**2.22E-05**	**ft/min**
Transmissivity =	**5.70E-03**	**cm^2/sec**
K_{LNAPL} =	**1.13E-05**	**cm/sec**

Casing Radius =	0.833	feet
t (time) =	22000	minutes
Radius of Influence =	10	feet
Radius of Well =	1.1563	feet
S_0 (intercept) =	16.75	
s (drawdown) =	10	feet
Static Water Depth =	0	fbgs
Product SG =	1.05	---





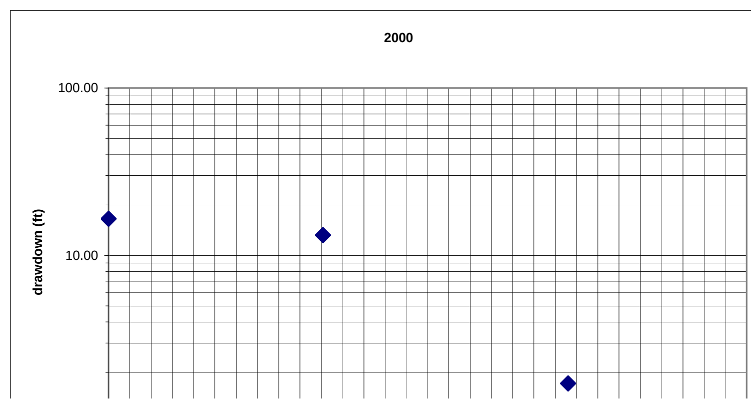


Exhibit C-2

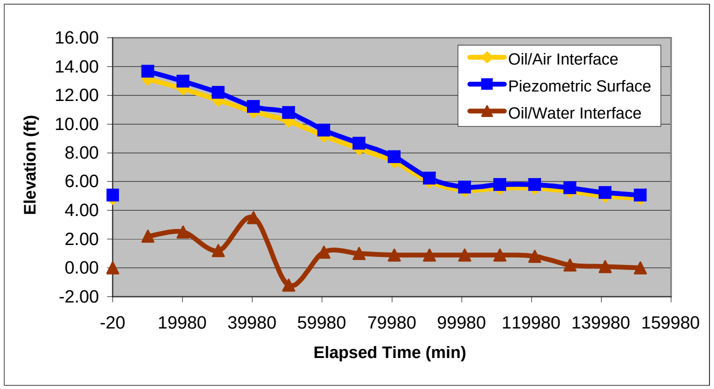
DNAPL Baildown Test at Dalles - 2002

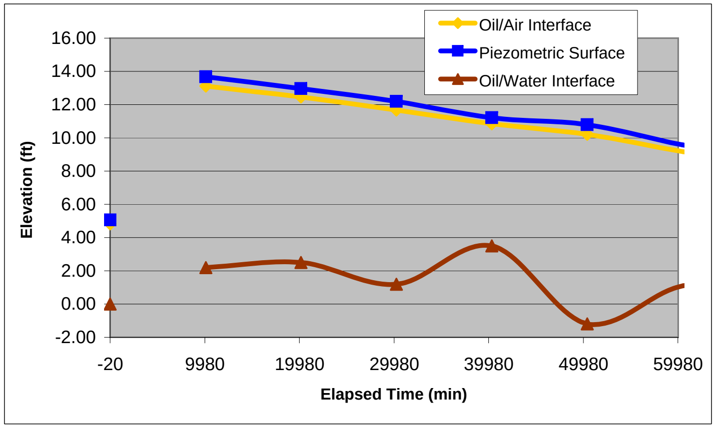
Bottom of Well Elevation = 59.17

Date	Time	Elapsed Time		Product Elevation	Water Elevation	Product Thickness	Z_w	Z_o	Z_p	S_o
12/13/2001	12:00:00	Static	**-20.00**	80.28	85.10	21.11	0.00	4.82	5.0610	
12/13/2001	12:00:00	0.00	0.00	71.16	84.90	11.99				9.12
12/20/2001	12:00:00	10080.00	10080.00	71.98	82.90	12.81	2.20	13.12	13.6660	8.30
12/27/2001	12:00:00	20160.00	20160.00	72.63	82.60	13.46	2.50	12.47	12.9685	7.65
1/3/2002	12:00:00	30240.00	30240.00	73.43	83.90	14.26	1.20	11.67	12.1935	6.85
1/10/2002	12:00:00	40320.00	40320.00	74.25	81.60	15.08	3.50	10.85	11.2175	6.03
1/17/2002	12:00:00	50400.00	50400.00	74.88	86.30	15.71	-1.20	10.22	10.7910	5.40
1/24/2002	12:00:00	60480.00	60480.00	75.93	84.00	16.76	1.10	9.17	9.5735	4.35
1/31/2002	12:00:00	70560.00	70560.00	76.81	84.10	17.64	1.00	8.29	8.6545	3.47
2/7/2002	12:00:00	80640.00	80640.00	77.71	84.20	18.54	0.90	7.39	7.7145	2.57
2/14/2002	12:00:00	90720.00	90720.00	79.12	84.20	19.95	0.90	5.98	6.2340	1.16
2/21/2002	12:00:00	100800.00	100800.00	79.71	84.20	20.54	0.90	5.39	5.6145	0.57
2/28/2002	12:00:00	110880.00	110880.00	79.55	84.20	20.38	0.90	5.55	5.7825	0.73
3/7/2002	12:00:00	120960.00	120960.00	79.55	84.30	20.38	0.80	5.55	5.7875	0.73
3/14/2002	12:00:00	131040.00	131040.00	79.78	84.90	20.61	0.20	5.32	5.5760	0.50
3/21/2002	12:00:00	141120.00	141120.00	80.12	85.00	20.95	0.10	4.98	5.2240	0.16
3/28/2002	12:00:00	151200.00	151200.00	80.28	85.10	21.11	0.00	4.82	5.0610	0.00

T Calc - Part 1	1.12E-03
Transmissivity =	**1.71E-04 ft^2/min**
K_{LNAPL} =	**1.88E-05 ft/min**
Transmissivity =	**2.65E-03 cm^2/sec**
K_{LNAPL} =	**9.53E-06 cm/sec**

Casing Radius =	0.833	feet
t (time) =	15000	minutes
Radius of Influence =	10	feet
Radius of Well =	1.1563	feet
S_0 (intercept) =	9.42	
s (drawdown) =	8	feet
Static Water Depth =	85.1	fbgs
Product SG =	1.05	---





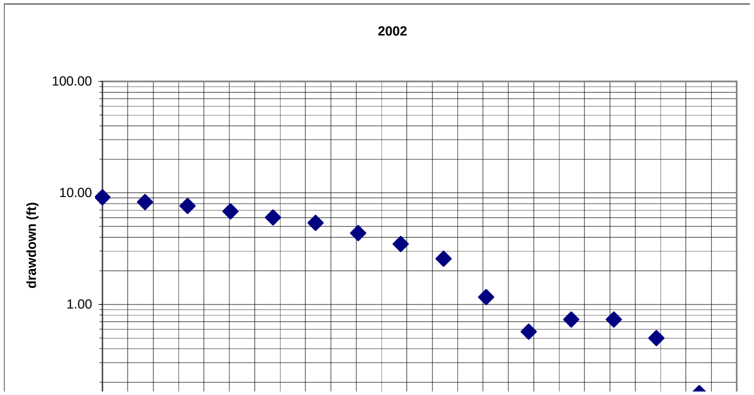


Exhibit C-3

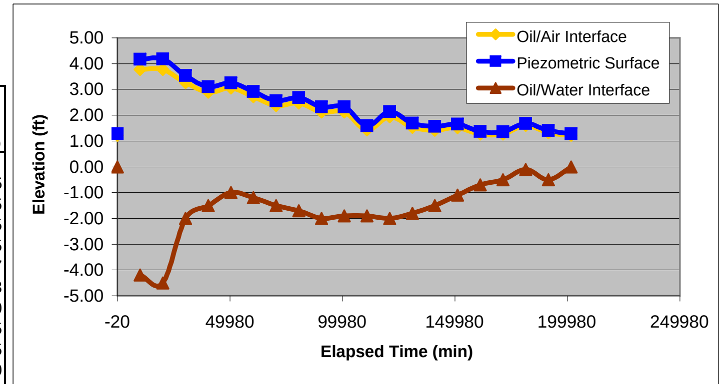
DNAPL Baildown Test at Dalles - 2003

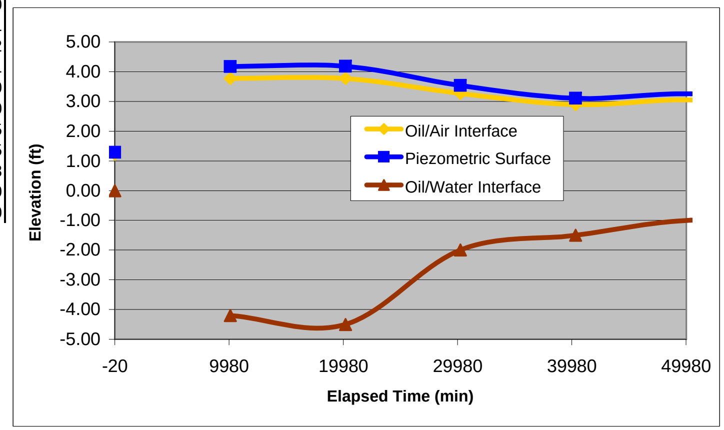
Bottom of Well Elevation = 59.17

Date	Time	Elapsed Time		Product Elevation	Water Elevation	Product Thickness	Z_w	Z_o	Z_p	S_o
1/30/2003	12:00:00	Static	**-20.00**	79.28	80.50	20.11	0.00	1.22	1.2810	
1/30/2003	12:00:00	0.00	0.00	75.93	84.10	16.76				3.35
2/6/2003	12:00:00	10080.00	10080.00	76.73	84.70	17.56	-4.20	3.77	4.1685	2.55
2/13/2003	12:00:00	20160.00	20160.00	76.73	85.00	17.56	-4.50	3.77	4.1835	2.55
2/20/2003	12:00:00	30240.00	30240.00	77.23	82.50	18.06	-2.00	3.27	3.5335	2.05
2/27/2003	12:00:00	40320.00	40320.00	77.61	82.00	18.44	-1.50	2.89	3.1095	1.67
3/6/2003	12:00:00	50400.00	50400.00	77.45	81.50	18.28	-1.00	3.05	3.2525	1.83
3/13/2003	12:00:00	60480.00	60480.00	77.78	81.70	18.61	-1.20	2.72	2.9160	1.50
3/20/2003	12:00:00	70560.00	70560.00	78.13	82.00	18.96	-1.50	2.37	2.5635	1.15
3/27/2003	12:00:00	80640.00	80640.00	78.03	82.20	18.86	-1.70	2.47	2.6785	1.25
4/3/2003	12:00:00	90720.00	90720.00	78.38	82.50	19.21	-2.00	2.12	2.3260	0.90
4/10/2003	12:00:00	100800.00	100800.00	78.38	82.40	19.21	-1.90	2.12	2.3210	0.90
4/17/2003	12:00:00	110880.00	110880.00	79.07	82.40	19.90	-1.90	1.43	1.5965	0.21
4/24/2003	12:00:00	120960.00	120960.00	78.56	82.50	19.39	-2.00	1.94	2.1370	0.72
5/1/2003	12:00:00	131040.00	131040.00	78.97	82.30	19.80	-1.80	1.53	1.6965	0.31
5/8/2003	12:00:00	141120.00	141120.00	79.08	82.00	19.91	-1.50	1.42	1.5660	0.20
5/15/2003	12:00:00	151200.00	151200.00	78.98	81.60	19.81	-1.10	1.52	1.6510	0.30
5/22/2003	12:00:00	161280.00	161280.00	79.23	81.20	20.06	-0.70	1.27	1.3685	0.05
5/29/2003	12:00:00	171360.00	171360.00	79.23	81.00	20.06	-0.50	1.27	1.3585	0.05
6/5/2003	12:00:00	181440.00	181440.00	78.90	80.60	19.73	-0.10	1.60	1.6850	0.38
6/12/2003	12:00:00	191520.00	191520.00	79.18	81.00	20.01	-0.50	1.32	1.4110	0.10
6/19/2003	13:00:00	201660.00	201660.00	79.28	80.50	20.11	0.00	1.22	1.2810	0.00

T Calc - Part 1	4.79E-04	
Transmissivity =	**2.14E-04**	**ft^2/min**
K_{LNAPL} =	**6.39E-05**	**ft/min**
Transmissivity =	**3.31E-03**	**cm^2/sec**
K_{LNAPL} =	**3.24E-05**	**cm/sec**

Casing Radius =	0.833	feet
t (time) =	35000	minutes
Radius of Influence =	10	feet
Radius of Well =	1.1563	feet
S_0 (intercept) =	3.221	
s (drawdown) =	2	feet
Static Water Depth =	80.5	fbgs
Product SG =	1.05	---





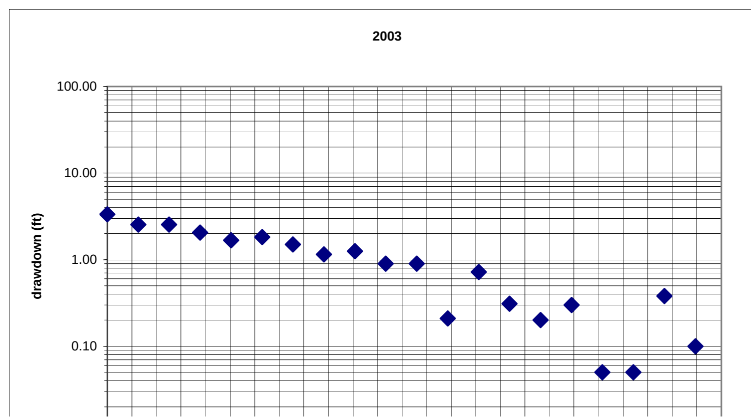


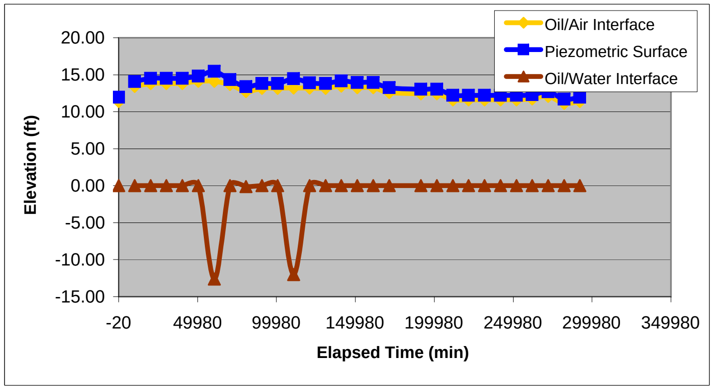
Exhibit C-4

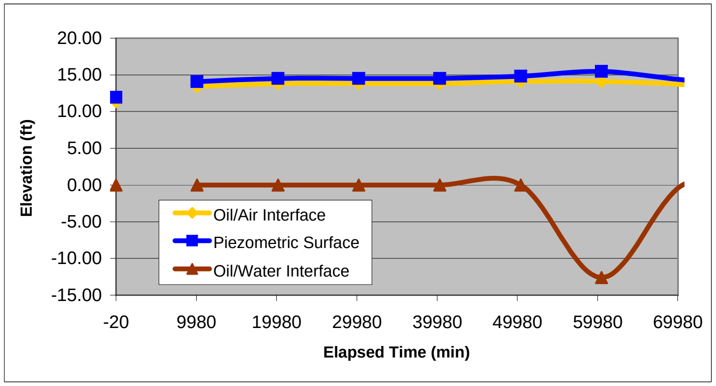
DNAPL Baildown Test at Dalles - 2006

Bottom of Well Elevation = 59.17

Date	Time	Elapsed Time		Product Elevation	Water Elevation	Product Thickness	Z_w	Z_o	Z_p	S_o
8/10/2006	12:00:00	Static	**-20.00**	70.33	81.70	11.16	0.00	11.37	11.9385	
8/10/2006	12:00:00	0.00	0.00	66.93	81.70	7.76				3.40
8/17/2006	12:00:00	10080.00	10080.00	68.28	81.70	9.11	0.00	13.42	14.0910	2.05
8/24/2006	12:00:00	20160.00	20160.00	67.88	81.70	8.71	0.00	13.82	14.5110	2.45
8/31/2006	12:00:00	30240.00	30240.00	67.88	81.70	8.71	0.00	13.82	14.5110	2.45
9/7/2006	12:00:00	40320.00	40320.00	67.88	81.70	8.71	0.00	13.82	14.5110	2.45
9/14/2006	12:00:00	50400.00	50400.00	67.58	81.70	8.41	0.00	14.12	14.8260	2.75
9/21/2006	12:00:00	60480.00	60480.00	67.58	94.30	8.41	-12.60	14.12	15.4560	2.75
9/28/2006	12:00:00	70560.00	70560.00	68.03	81.70	8.86	0.00	13.67	14.3535	2.30
10/5/2006	12:00:00	80640.00	80640.00	68.98	81.80	9.81	-0.10	12.72	13.3610	1.35
10/12/2006	12:00:00	90720.00	90720.00	68.53	81.70	9.36	0.00	13.17	13.8285	1.80
10/19/2006	12:00:00	100800.00	100800.00	68.53	81.70	9.36	0.00	13.17	13.8285	1.80
10/26/2006	12:00:00	110880.00	110880.00	68.48	93.70	9.31	-12.00	13.22	14.4810	1.85
11/2/2006	12:00:00	120960.00	120960.00	68.48	81.70	9.31	0.00	13.22	13.8810	1.85
11/9/2006	12:00:00	131040.00	131040.00	68.53	81.70	9.36	0.00	13.17	13.8285	1.80
11/16/2006	12:00:00	141120.00	141120.00	68.23	81.70	9.06	0.00	13.47	14.1435	2.10
11/23/2006	12:00:00	151200.00	151200.00	68.43	81.70	9.26	0.00	13.27	13.9335	1.90
11/30/2006	12:00:00	161280.00	161280.00	68.43	81.70	9.26	0.00	13.27	13.9335	1.90
12/7/2006	12:00:00	171360.00	171360.00	69.08	81.70	9.91	0.00	12.62	13.2510	1.25
12/21/2006	12:00:00	191520.00	191520.00	69.28	81.70	10.11	0.00	12.42	13.0410	1.05
12/28/2006	12:00:00	201600.00	201600.00	69.28	81.70	10.11	0.00	12.42	13.0410	1.05
1/4/2007	12:00:00	211680.00	211680.00	70.08	81.70	10.91	0.00	11.62	12.2010	0.25
1/11/2007	12:00:00	221760.00	221760.00	70.08	81.70	10.91	0.00	11.62	12.2010	0.25
1/18/2007	12:00:00	231840.00	231840.00	70.08	81.70	10.91	0.00	11.62	12.2010	0.25
1/25/2007	12:00:00	241920.00	241920.00	70.08	81.70	10.91	0.00	11.62	12.2010	0.25
2/1/2007	12:00:00	252000.00	252000.00	70.08	81.70	10.91	0.00	11.62	12.2010	0.25
2/8/2007	12:00:00	262080.00	262080.00	69.98	81.70	10.81	0.00	11.72	12.3060	0.35
2/15/2007	12:00:00	272160.00	272160.00	69.63	81.70	10.46	0.00	12.07	12.6735	0.70
2/22/2007	12:00:00	282240.00	282240.00	70.58	81.70	11.41	0.00	11.12	11.6760	-0.25
3/1/2007	12:00:00	292320.00	292320.00	70.33	81.70	11.16	0.00	11.37	11.9385	0.00

T Calc - Part 1	1.86E-04
Transmissivity =	**5.24E-05 ft^2/min**
K_{LNAPL} =	**4.69E-06 ft/min**
Transmissivity =	**8.11E-04 cm^2/sec**
K_{LNAPL} =	**2.38E-06 cm/sec**





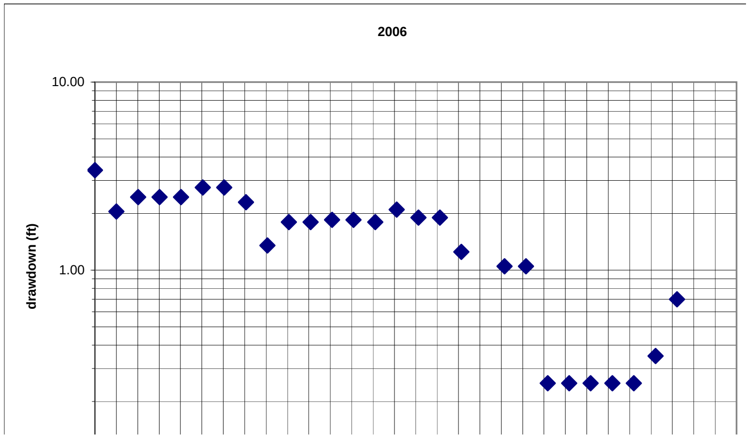
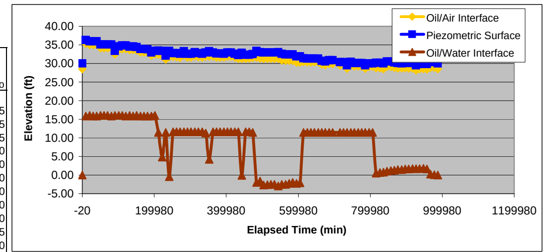


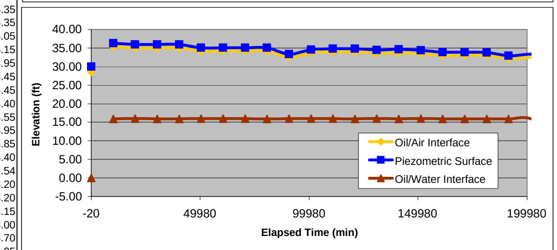
Exhibit C-5

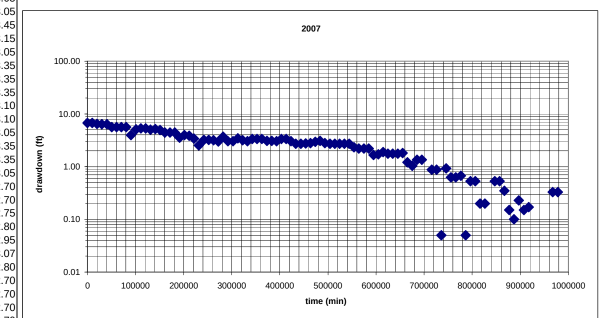
DNAPL Baildown Test at Dalles - 2007

Bottom of Well Elevation = 59.17

Date	Time	Elapsed Time		Product Elevation	Water Elevation	Product Thickness	Z_w	Z_o	Z_p	S_o
3/8/2007	12:00:00	Static	**-20.00**	69.13	97.70	9.96	0.00	28.57	29.9985	
3/8/2007	12:00:00	0.00	0.00	62.38	81.80	3.21				6.75
3/15/2007	12:00:00	10080.00	10080.00	62.38	81.80	3.21	15.90	35.32	36.2910	6.75
3/22/2007	12:00:00	20160.00	20160.00	62.68	81.70	3.51	16.00	35.02	35.9710	6.45
3/29/2007	12:00:00	30240.00	30240.00	62.73	81.80	3.56	15.90	34.97	35.9235	6.40
4/5/2007	12:00:00	40320.00	40320.00	62.73	81.80	3.56	15.90	34.97	35.9235	6.40
4/12/2007	12:00:00	50400.00	50400.00	63.53	81.70	4.36	16.00	34.17	35.0785	5.60
4/19/2007	12:00:00	60480.00	60480.00	63.53	81.70	4.36	16.00	34.17	35.0785	5.60
4/26/2007	12:00:00	70560.00	70560.00	63.53	81.70	4.36	16.00	34.17	35.0785	5.60
5/3/2007	12:00:00	80640.00	80640.00	63.53	81.80	4.36	15.90	34.17	35.0835	5.60
5/10/2007	12:00:00	90720.00	90720.00	65.18	81.70	6.01	16.00	32.52	33.3460	3.95
5/17/2007	12:00:00	100800.00	100800.00	64.03	81.70	4.86	16.00	33.67	34.5535	5.10
5/24/2007	12:00:00	110880.00	110880.00	63.78	81.70	4.61	16.00	33.92	34.8160	5.35
5/31/2007	12:00:00	120960.00	120960.00	63.78	81.80	4.61	15.90	33.92	34.8210	5.35
6/7/2007	12:00:00	131040.00	131040.00	64.08	81.70	4.91	16.00	33.62	34.5010	5.05
6/14/2007	12:00:00	141120.00	141120.00	63.98	81.80	4.81	15.90	33.72	34.6110	5.15
6/21/2007	12:00:00	151200.00	151200.00	64.18	81.70	5.01	16.00	33.52	34.3960	4.95
6/28/2007	12:00:00	161280.00	161280.00	64.68	81.80	5.51	15.90	33.02	33.8760	4.45
7/5/2007	12:00:00	171360.00	171360.00	64.68	81.80	5.51	15.90	33.02	33.8760	4.45
7/12/2007	12:00:00	181440.00	181440.00	64.73	81.80	5.56	15.90	32.97	33.8235	4.40
7/19/2007	12:00:00	191520.00	191520.00	65.58	81.80	6.41	15.90	32.12	32.9310	3.55
7/26/2007	12:00:00	201600.00	201600.00	65.18	81.70	6.01	16.00	32.52	33.3460	3.95
8/2/2007	12:00:00	211680.00	211680.00	65.28	86.20	6.11	11.50	32.42	33.4660	3.85
8/9/2007	12:00:00	221760.00	221760.00	65.73	92.90	6.56	4.80	31.97	33.3285	3.40
8/16/2007	12:00:00	231840.00	231840.00	66.59	86.20	7.42	11.50	31.11	32.0905	2.54
8/23/2007	12:00:00	241920.00	241920.00	65.93	98.10	6.76	-0.40	31.77	33.3785	3.20
8/30/2007	12:00:00	252000.00	252000.00	65.93	86.10	6.76	11.60	31.77	32.7785	3.20
9/6/2007	12:00:00	262080.00	262080.00	65.98	86.10	6.81	11.60	31.72	32.7260	3.15
9/13/2007	12:00:00	272160.00	272160.00	66.13	86.10	6.96	11.60	31.57	32.5685	3.00
9/20/2007	12:00:00	282240.00	282240.00	65.43	86.10	6.26	11.60	32.27	33.3035	3.70
9/27/2007	12:00:00	292320.00	292320.00	66.08	86.10	6.91	11.60	31.62	32.6210	3.05
10/4/2007	12:00:00	302400.00	302400.00	66.08	86.10	6.91	11.60	31.62	32.6210	3.05
10/11/2007	12:00:00	312480.00	312480.00	65.68	86.10	6.51	11.60	32.02	33.0410	3.45
10/18/2007	12:00:00	322560.00	322560.00	65.98	86.10	6.81	11.60	31.72	32.7260	3.15
10/25/2007	12:00:00	332640.00	332640.00	66.08	86.10	6.91	11.60	31.62	32.6210	3.05
11/1/2007	12:00:00	342720.00	342720.00	65.78	86.40	6.61	11.30	31.92	32.9510	3.35
11/8/2007	12:00:00	352800.00	352800.00	65.78	93.50	6.61	4.20	31.92	33.3060	3.35
11/15/2007	12:00:00	362880.00	362880.00	65.78	86.10	6.61	11.60	31.92	32.9360	3.35
11/22/2007	12:00:00	372960.00	372960.00	66.03	86.10	6.86	11.60	31.67	32.6735	3.10
11/29/2007	12:00:00	383040.00	383040.00	66.03	86.10	6.86	11.60	31.67	32.6735	3.10
12/6/2007	12:00:00	393120.00	393120.00	66.08	86.10	6.91	11.60	31.62	32.6210	3.05
12/13/2007	12:00:00	403200.00	403200.00	65.78	86.10	6.61	11.60	31.92	32.9360	3.35
12/20/2007	12:00:00	413280.00	413280.00	65.78	86.10	6.61	11.60	31.92	32.9360	3.35
12/27/2007	12:00:00	423360.00	423360.00	66.08	86.10	6.91	11.60	31.62	32.6210	3.05
1/3/2008	12:00:00	433440.00	433440.00	66.43	86.10	7.26	11.60	31.27	32.2535	2.70
1/10/2008	12:00:00	443520.00	443520.00	66.43	97.80	7.26	-0.10	31.27	32.8385	2.70
1/17/2008	12:00:00	453600.00	453600.00	66.38	86.10	7.21	11.60	31.32	32.3060	2.75
1/24/2008	12:00:00	463680.00	463680.00	66.33	86.10	7.16	11.60	31.37	32.3585	2.80
1/31/2008	12:00:00	473760.00	473760.00	66.18	86.20	7.01	11.50	31.52	32.5210	2.95
2/7/2008	12:00:00	483840.00	483840.00	66.06	99.70	6.89	-2.00	31.64	33.3220	3.07
2/14/2008	12:00:00	493920.00	493920.00	66.33	99.30	7.16	-1.60	31.37	33.0185	2.80
2/21/2008	12:00:00	504000.00	504000.00	66.43	100.40	7.26	-2.70	31.27	32.9685	2.70
2/28/2008	12:00:00	514080.00	514080.00	66.43	100.30	7.26	-2.60	31.27	32.9635	2.70
3/6/2008	12:00:00	524160.00	524160.00	66.43	100.20	7.26	-2.50	31.27	32.9585	2.70
3/13/2008	12:00:00	534240.00	534240.00	66.43	100.20	7.26	-2.50	31.27	32.9585	2.70
3/20/2008	12:00:00	544320.00	544320.00	66.43	100.60	7.26	-2.90	31.27	32.9785	2.70
3/27/2008	12:00:00	554400.00	554400.00	66.80	100.20	7.63	-2.50	30.90	32.5700	2.33
4/3/2008	12:00:00	564480.00	564480.00	66.93	100.20	7.76	-2.50	30.77	32.4335	2.20
4/10/2008	12:00:00	574560.00	574560.00	66.93	99.90	7.76	-2.20	30.77	32.4185	2.20
4/17/2008	12:00:00	584640.00	584640.00	66.93	99.70	7.76	-2.00	30.77	32.4085	2.20
4/24/2008	12:00:00	594720.00	594720.00	67.46	99.90	8.29	-2.20	30.24	31.8620	1.67
5/1/2008	12:00:00	604800.00	604800.00	67.41	99.80	8.24	-2.10	30.29	31.9095	1.72
5/8/2008	12:00:00	614880.00	614880.00	67.24	86.20	8.07	11.50	30.46	31.4080	1.89
5/15/2008	12:00:00	624960.00	624960.00	67.38	86.20	8.21	11.50	30.32	31.2610	1.75
5/22/2008	12:00:00	635040.00	635040.00	67.38	86.20	8.21	11.50	30.32	31.2610	1.75
5/29/2008	12:00:00	645120.00	645120.00	67.38	86.20	8.21	11.50	30.32	31.2610	1.75
6/5/2008	12:00:00	655200.00	655200.00	67.33	86.20	8.16	11.50	30.37	31.3135	1.80
6/12/2008	12:00:00	665280.00	665280.00	67.93	86.20	8.76	11.50	29.77	30.6835	1.20
6/19/2008	12:00:00	675360.00	675360.00	68.10	86.20	8.93	11.50	29.60	30.5050	1.03
6/26/2008	12:00:00	685440.00	685440.00	67.78	86.20	8.61	11.50	29.92	30.8410	1.35
7/3/2008	12:00:00	695520.00	695520.00	67.78	86.20	8.61	11.50	29.92	30.8410	1.35
7/17/2008	12:00:00	715680.00	715680.00	68.26	86.20	9.09	11.50	29.44	30.3370	0.87
7/24/2008	12:00:00	725760.00	725760.00	68.26	86.20	9.09	11.50	29.44	30.3370	0.87
7/31/2008	12:00:00	735840.00	735840.00	69.08	86.20	9.91	11.50	28.62	29.4760	0.05
8/7/2008	12:00:00	745920.00	745920.00	68.21	86.20	9.04	11.50	29.49	30.3895	0.92
8/14/2008	12:00:00	756000.00	756000.00	68.50	86.20	9.33	11.50	29.20	30.0850	0.63
8/21/2008	12:00:00	766080.00	766080.00	68.50	86.20	9.33	11.50	29.20	30.0850	0.63
8/28/2008	12:00:00	776160.00	776160.00	68.46	86.20	9.29	11.50	29.24	30.1270	0.67
9/4/2008	12:00:00	786240.00	786240.00	69.08	86.20	9.91	11.50	28.62	29.4760	0.05
9/11/2008	12:00:00	796320.00	796320.00	68.60	86.20	9.43	11.50	29.10	29.9800	0.53
9/18/2008	12:00:00	806400.00	806400.00	68.60	86.20	9.43	11.50	29.10	29.9800	0.53
9/25/2008	12:00:00	816480.00	816480.00	68.93	97.20	9.76	0.50	28.77	30.1835	0.20
10/2/2008	12:00:00	826560.00	826560.00	68.93	97.00	9.76	0.70	28.77	30.1735	0.20
10/9/2008	12:00:00	836640.00	836640.00	69.13	96.90	9.96	0.80	28.57	29.9585	0.00
10/16/2008	12:00:00	846720.00	846720.00	68.60	96.70	9.43	1.00	29.10	30.5050	0.53
10/23/2008	12:00:00	856800.00	856800.00	68.60	96.50	9.43	1.20	29.10	30.4950	0.53
10/30/2008	12:00:00	866880.00	866880.00	68.78	96.40	9.61	1.30	28.92	30.3010	0.35
11/6/2008	12:00:00	876960.00	876960.00	68.98	96.20	9.81	1.50	28.72	30.0810	0.15
11/13/2008	12:00:00	887040.00	887040.00	69.03	96.20	9.86	1.50	28.67	30.0285	0.10
11/20/2008	12:00:00	897120.00	897120.00	68.90	96.10	9.73	1.60	28.80	30.1600	0.23
11/27/2008	12:00:00	907200.00	907200.00	68.98	96.10	9.81	1.60	28.72	30.0760	0.15
12/4/2008	12:00:00	917280.00	917280.00	68.96	96.00	9.79	1.70	28.74	30.0920	0.17
12/11/2008	12:00:00	927360.00	927360.00	69.53	96.00	10.36	1.70	28.17	29.4935	-0.40
12/18/2008	12:00:00	937440.00	937440.00	69.18	96.00	10.01	1.70	28.52	29.8610	-0.05
12/25/2008	12:00:00	947520.00	947520.00	69.18	95.90	10.01	1.80	28.52	29.8560	-0.05
1/1/2009	12:00:00	957600.00	957600.00	69.23	96.10	10.06	1.60	28.47	29.8135	-0.10
1/8/2009	12:00:00	967680.00	967680.00	68.80	97.40	9.63	0.30	28.90	30.3300	0.33
1/15/2009	12:00:00	977760.00	977760.00	68.80	97.60	9.63	0.10	28.90	30.3400	0.33
1/22/2009	12:00:00	987840.00	987840.00	69.13	97.70	9.96	0.00	28.57	29.9985	0.00







T Calc - Part 1	7.62E-05	
Transmissivity =	**2.73E-05**	**ft^2/min**
K_{LNAPL} =	**2.74E-06**	**ft/min**
Transmissivity =	**4.22E-04**	**cm^2/sec**
K_{LNAPL} =	**1.39E-06**	**cm/sec**

Casing Radius =	0.833	feet
t (time) =	220000	minutes
Radius of Influence =	10	feet
Radius of Well =	1.1563	feet
S_0 (intercept) =	5.86	
s (drawdown) =	4	feet
Static Water Depth =	97.7	fbgs
Product SG =	1.05	---