1R - 277

REPORTS

DATE:

3/12/2007

1R0277

TRIDENT ENVIRONMENTAL

March 12, 2007

RECEIVED

MAR 15 2007

Oil Conservation Division
Environmental Bureau

Mr. Glenn Von Gonten
New Mexico Energy, Minerals and Natural Resources Department
Oil Conservation Division – Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

SUBJECT: 2006 ANNUAL GROUNDWATER MONITORING REPORT
FORMER UNOCAL SOUTH VACUUM UNIT
SECTION 35, TOWNSHIP 18 SOUTH, RANGE 35 EAST
LEA COUNTY, NEW MEXICO
NMOCD CASE NO.1R0277

Dear Mr. Von Gonten:

Enclosed is the 2006 Annual Groundwater Monitoring Report for the Former Unocal South Vacuum Unit site located in Lea County, New Mexico. With the recent acquisition of Unocal Corporation, Chevron Environmental Management Company is now managing the groundwater monitoring activities for the site.

Please contact me at 432-638-8740, Mr. John MacLeod (Chevron EMC) at 925-842 5200, or Allen Just (Arcadis) at 949-474-9052 with any questions or comments.

Sincerely,

Gilbert J. Van Deventer, REM, PG, NMCS
Trident Environmental – Midland, TX

Attachments

xc: Mr. John MacLeod, Chevron EMC, San Ramon, CA
Mr. Allen Just, Arcadis, Irvine, CA

IR0277

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MAR 15 2007

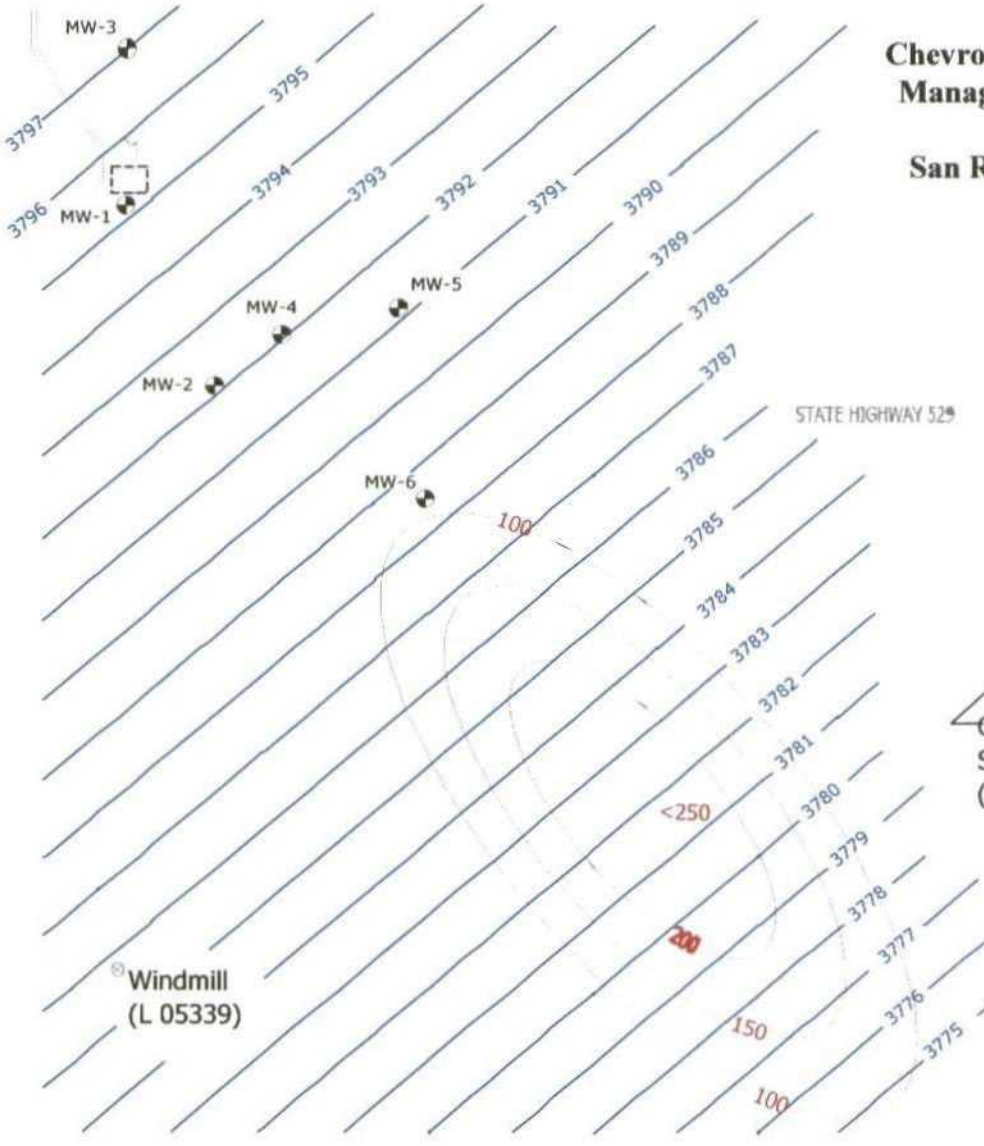
Oil Conservation Division
Environmental Bureau

2006 Annual Groundwater Monitoring Report
Former Unocal South Vacuum Unit
Section 35, Township 18 South, Range 35 East
Lea County, New Mexico

MARCH 12, 2007

Prepared For:

Chevron Environmental Management Company
P. O. Box 6012
San Ramon, CA 94583



Prepared By:

TRIDENT ENVIRONMENTAL

P. O. Box 7624
Midland, Texas 79708

2006 Annual Groundwater Monitoring Report

Former Unocal South Vacuum Unit

Lea County, New Mexico

Prepared for:

Chevron Environmental Management Company

6001 Bollinger Canyon Road

San Ramon, CA 94583

Prepared by:

Trident Environmental
P. O. Box 7624
Midland, Texas 79708
(432) 638-8740
FAX (413) 403-9968

SUBMITTED BY:

Gilbert J. Van Deventer, PG, NMCS, REM
Project Manager

DATE:

March 12, 2007

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1.0 Executive Summary

Trident Environmental (Trident) was retained by Blasland, Bouck, and Lee, Inc. (BBL), on behalf of Chevron Environmental Management Company (Chevron EMC), to perform the 2006 annual groundwater sampling and monitoring operations at the Former Unocal South Vacuum Unit (Site), which is located at township 18 south, range 35 east, section 35 in Lea County, New Mexico. Chevron EMC has assumed Unocal's environmental liability at the Site. This report documents the 2006 annual sampling event performed by Trident at the site on July 31, 2006. This report contains the historical groundwater elevation and analytical data from monitoring wells MW-1 through MW-6. The sampling event was conducted in accordance with the November 2, 2000 Groundwater Remediation Plan submitted by Unocal and the requirements specified in the New Mexico Oil and Conservation Division (OCD) letter dated February 8, 2001.

Based on the sampling and monitoring data to date, the following conclusions relevant to groundwater conditions at the Former Unocal South Vacuum Unit are evident:

- Chloride and total dissolved solids (TDS) concentrations in MW-1, near the source area, have generally decreased since 1996 with the exception of slight fluctuations since the 2003 sampling event. Similarly, chloride and TDS levels have decreased in the closest downgradient well, MW-4, since 1999 when that well was installed. Chloride and TDS concentrations in the remaining wells (MW-2, MW-3, MW-5, and MW-6) have remained relatively consistent with previous levels.

- The fate and transport modeling results continue to support the contention that the chloride and TDS plume is not likely to impact existing sources of water supply, the closest of which, a livestock well (Windmill L 05339) lies approximately 3,200 feet south of the source.

- According to conservative model simulations, the chloride plume will travel a maximum of 3,200 feet southeast of the source in approximately 152 years before concentrations return to levels below the New Mexico Water Quality Control Commission (WQCC) standard of 250 mg/L. The same analysis indicates that the TDS plume will travel only 2,300 feet in

approximately 89 years before concentrations return to levels below the WQCC standard of 1,000 mg/L.

- Based on the modeling results and predicted natural attenuation processes (advection and dispersion), there will be no adverse impact to human health and the environment nor will the livestock well exceed WQCC standards for chlorides or TDS due to the plume originating and traveling southeast, versus south, from the former emergency overflow pit.

- Groundwater elevations have steadily decreased at a rate of approximately 0.3 feet per year since the initial sampling event of monitoring well MW-1 in January 1995; with the exception of the 2005 sampling event due to higher than normal rainfall during 2004 and 2005. The decreasing groundwater elevation trend has continued during the 2006 sampling event.

Exemplary remedial actions were performed to the source area by Unocal, including plugging of the SWD well in 1971 and encapsulating the former surface impoundment area with solidification material in 1995, thus eliminating the threat of any continued release from the source. Based on the identified potential receptor and fate and transport modeling results, the chloride/TDS plume at the site presents low risk to human health and the environment; therefore Trident recommends the following actions for site closure:

- Continue the natural attenuation annual monitoring program with groundwater sampling and analysis of chloride and TDS concentrations for each of the six monitoring wells.

- Update flow and transport model to confirm the plume is naturally attenuating as described.

- Submit the 2007 annual groundwater monitoring report to OCD in January 2008 to document natural attenuation conditions.

2.0 Groundwater Sampling Procedures

On July 31, 2006, each of the six monitoring wells, MW-1 through MW-6, was gauged for depth to groundwater using a Solinst Model 101 electronic water indicator immediately prior to purging operations. A total of 35 gallons of groundwater was purged from each site monitoring well (3 to 12 gallons per well) using a decontaminated 2-inch diameter PVC bailer. After purging, groundwater samples were collected and parameters were measured using a Hanna Model 98130 pH-Conductivity-Temperature meter. Water samples for each monitoring well were transferred into 500 milliliter (ml) plastic containers for laboratory analysis of total dissolved solids (TDS) (EPA Method 160.1) and chloride (EPA Method 325.3). For each set of samples, chain of custody forms documenting sample identification numbers, collection times, and delivery times to the laboratory were completed. All water samples were placed in an ice-filled cooler immediately after collection and transported to Lancaster Laboratories. in Lancaster, PA for analysis.

3.0 Groundwater Elevations, Hydraulic Gradient and Flow Direction

Depth to groundwater varies from approximately 49.83 to 70.64 feet below top of well casing at the site. Groundwater elevations are summarized in Table 1. A groundwater gradient map indicating the direction of groundwater flow is illustrated in Figure 1. A historical groundwater elevation graph is shown in Figure 2. The groundwater gradient direction is to the southeast with a hydraulic gradient of approximately 0.004 ft/ft. According to published reports (*Ground-Water Conditions in Northern Lea County, New Mexico*, Ash, 1963 and *Geology and Ground-Water Conditions in Southern Lea County, New Mexico*, Nicholson and Clebsch, 1961) the groundwater encountered at the site is that of the Tertiary Ogallala Formation. The Ogallala Formation unconformably overlies the impermeable red-beds of the Triassic Chinle Formation at an elevation of approximately 3700 feet above mean sea level (AMSL). Based on the current groundwater elevations measured on site and published data referenced, the saturated thickness of the Ogallala Formation at the site ranges from approximately 87 to 97 feet.

4.0 Groundwater Quality Conditions

Groundwater sample analytical results are presented in Table 1. The WQCC standards are presented for comparison. Those constituents that recorded concentrations above the WQCC standards are highlighted in boldface type. The WQCC standard of 250 mg/L for chloride was exceeded in MW-1 (860 mg/L), MW-2 (401 mg/L), and MW-4 (926 mg/L). The WQCC standard of 1,000 mg/L for TDS was exceeded only in MW-1 (2,010 mg/L) and MW-4 (2,030 mg/L). The groundwater samples obtained from upgradient monitoring well MW-3 and downgradient wells MW-5 and MW-6 had chloride and TDS concentrations below WQCC standards.

The chloride and TDS concentrations are depicted graphically in Figure 3 and 4, respectively. The concentration isocons were drawn utilizing the Surfer® (version 6.0) contour modeling program (Kriging method). Since this contouring program does not take into account the known groundwater gradient, some of the isocons were manually converged into a more southeasterly orientation. Graphs depicting historical TDS and chloride concentrations in monitoring wells MW-1 through MW-6 are shown in Figures 5 and 6.

Chloride and TDS concentrations in MW-1, near the source area, have consistently decreased since 1996, with the exception of slight fluctuations since the 2003 sampling event. Similarly, chloride and TDS levels have decreased in the closest downgradient well, MW-4, since 1999 when that well was installed. Chloride and TDS concentrations in monitoring well MW-3 have slightly increased since 2000, which suggests a possible offsite source of chlorides and TDS located upgradient (northwest) from the site. Chloride and TDS levels in MW-2, MW-5, and MW-6 have remained relatively consistent with previous years.

In general, chloride and TDS concentrations in the areas above WQCC standards (MW-1, MW-2, and MW-4) appear to have decreased concurrently with decreases in the water table elevation. Similarly, chloride and TDS concentrations have exhibited relative increases after periodic increases in the water table elevation. There appears to be a six-month to one-year lag time between the observed relationship between water table fluctuation and chloride/TDS levels.

5.0 Fate and Transport Modeling Results

Fate and transport modeling was performed by Trident to simulate the movement of the chloride and TDS groundwater plume over time. Simulations were conducted using the two-dimensional groundwater flow and contaminant transport model WinTran, version 1.03 (1995) designed and distributed by Environmental Simulations, Inc. (ESI) of Herndon, Virginia. WinTran is built around a steady-state analytical element flow model, linked to a finite element contaminant transport model. A more detailed discussion of the flow and transport parameters used, assumptions, model calibrations, and simulation results are described in Appendix D.

Figures displaying modeled simulations of the chloride and TDS plumes over various time increments are included in Appendix C. Advective flow moves the center of plume mass downgradient as depicted in the simulations. The simulations also demonstrate how hydrodynamic dispersion serves to broaden the dimensions of the plume while reducing the concentrations in the middle of the plume.

Continued attenuation by dilution and dispersion of the plume, after the maximum chloride and TDS concentrations decrease to levels below WQCC standards, are shown in the final simulation for each constituent of concern (year 2158 for chloride and year 2095 for TDS, respectively). The center of the chloride plume is approximately 3,200 ft away from the pit and well source in the year 2158. The center of the TDS plume is approximately 2,300 ft away from the pit and well source in the year 2095.

The portions of the chloride and TDS plumes that are above WQCC standards do not reach any of the identified potential receptors at any time during their attenuation. The updated fate and transport model is consistent with that determined in the previous annual reports, however the plumes attenuate sooner and at a reduced terminal distance as a result of inputting the most recent chloride and TDS concentrations.

6.0 Conclusions

Conclusions relevant to groundwater conditions and the remediation performance at the Former Unocal South Vacuum Unit are presented below.

- Chloride and TDS concentrations in MW-1, near the source area, have generally decreased since 1996. Similarly, chloride and TDS levels have decreased in the closest downgradient well, MW-4, since 1999 when that well was installed. Chloride and TDS concentrations in the remaining wells (MW-2, MW-3, MW-5, and MW-6) have remained relatively consistent with previous levels.
- The fate and transport modeling results continue to support the contention that the chloride and total dissolved solids (TDS) plume is not likely to impact existing sources of water supply, the closest of which, a livestock well (Windmill L 05339), lies approximately 3,200 feet south of the source.
- According to conservative model simulations, the chloride plume will travel a maximum of 3,200 feet southeast of the source in approximately 152 years before concentrations return to levels below the New Mexico Water Quality Control Commission (WQCC) standard of 250 mg/L. The same analysis indicates that the TDS plume will travel only 2,300 feet in approximately 89 years before concentrations return to levels below the WQCC standard of 1,000 mg/L.
- Based on the modeling results and predicted natural attenuation processes (dispersion and dilution), there will be no adverse impact to human health and the environment nor will the livestock well (Windmill L 05339) exceed WQCC standards for chlorides or TDS due to the plume originating and traveling southeast, versus south, from the former emergency overflow pit.
- Groundwater elevations had steadily decreased at a rate of approximately 0.3 feet per year since the initial sampling event of monitoring well MW-1 in January 1995; however during 2005 the groundwater table has increased to an elevation similar to the 1999 level. The recent rise may be attributed to higher than normal rainfall during 2004 and 2005.

7.0 Recommendations

Chevron EMC has performed exemplary remedial actions to the source area, including plugging of the SWD well in 1971 and encapsulating the former surface impoundment area with solidification material in 1995, thus eliminating the threat of any continued release from the source. Based on the identified potential receptor and fate and transport modeling results, the chloride/TDS plume at the site presents low risk to human health and the environment; therefore Trident recommends the following actions for site closure:

- Continue the natural attenuation annual monitoring program with groundwater sampling and analysis of chloride and TDS concentrations for each of the six monitoring wells.
- Update flow and transport model to confirm the plume is naturally attenuating as described.
- Submit the 2007 annual groundwater monitoring report to OCD in January 2008 to document natural attenuation conditions.

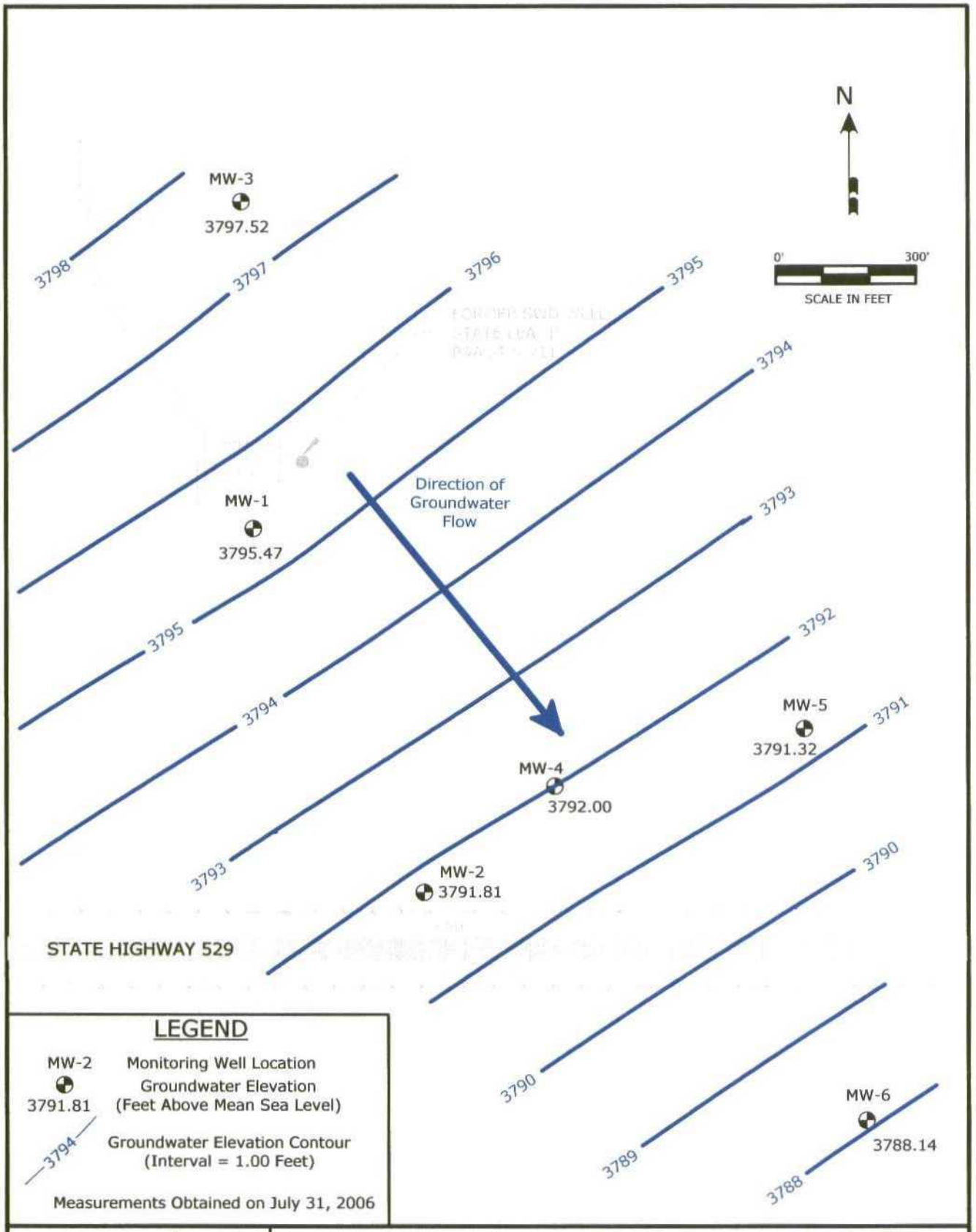
TABLE

Table 1
Summary of Groundwater Sampling Results

Monitoring Well	Sampling Date	Chloride (mg/L)	TDS (mg/L)	Depth to Groundwater (feet BTOC)	Top of Casing Elevation (feet AMSL)	Groundwater Elevation (feet AMSL)
MW-1	01/27/95	**1174**	**2250**	59.57	3858.37	3798.80
	05/18/95	**983**	**2251**	61.30	3858.37	3797.07
	08/28/96	**1420**	**2730**	61.57	3858.37	3796.80
	08/13/97	**1400**	**2800**	61.75	3858.37	3796.62
	09/30/99	**1094**	**2318**	62.51	3858.37	3795.86
	06/14/00	**927**	**2040**	62.85	3858.37	3795.52
	06/18/01	**813**	**1790**	63.07	3858.37	3795.30
	07/11/02	**784**	**1680**	63.28	3858.37	3795.09
	07/02/03	**715**	**2090**	63.66	3858.37	3794.71
	08/12/04	**628**	**2050**	63.83	3858.37	3794.54
	08/10/05	**774**	**1830**	62.62	3858.37	3795.75
	07/31/06	**860**	**2010**	62.90	3858.37	3795.47
MW-2	09/30/99	**298**	922	49.51	3841.64	3792.13
	06/14/00	**317**	852	49.81	3841.64	3791.83
	06/18/01	**288**	878	50.06	3841.64	3791.58
	07/11/02	**284**	808	50.29	3841.64	3791.35
	07/02/03	**268**	859	50.63	3841.64	3791.01
	08/12/04	**451**	931	50.81	3841.64	3790.83
	08/10/05	**355**	844	49.58	3841.64	3792.06
	07/31/06	**401**	922	49.83	3841.64	3791.81
MW-3	09/30/99	73.6	427	66.74	3864.73	3797.99
	06/14/00	75.5	433	67.01	3864.73	3797.72
	06/18/01	86.4	495	67.29	3864.73	3797.44
	07/11/02	103	509	67.59	3864.73	3797.14
	07/02/03	98.3	588	67.94	3864.73	3796.79
	08/12/04	111	605	68.07	3864.73	3796.66
	08/10/05	122	533	66.81	3864.73	3797.92
	07/31/06	141	619	67.21	3864.73	3797.52
MW-4	09/30/99	**1576**	**2981**	60.18	3852.51	3792.33
	06/14/00	**1500**	**2910**	60.55	3852.51	3791.96
	06/18/01	**1530**	**3180**	60.78	3852.51	3791.73
	07/11/02	**1290**	**2660**	60.98	3852.51	3791.53
	07/02/03	**1250**	**2610**	61.34	3852.51	3791.17
	08/12/04	**1130**	**2480**	61.50	3852.51	3791.01
	08/10/05	**1050**	**2230**	60.25	3852.51	3792.26
	07/31/06	**926**	**2030**	60.51	3852.51	3792.00
MW-5	06/14/00	13.7	274	68.57	3859.84	3791.27
	06/18/01	13.6	322	68.80	3859.84	3791.04
	07/11/02	15.5	308	68.98	3859.84	3790.86
	07/02/03	12.5	359	69.32	3859.84	3790.52
	08/12/04	15.3	375	69.46	3859.84	3790.38
	08/10/05	14.9	309	68.15	3859.84	3791.69
	07/31/06	13.3	290	68.52	3859.84	3791.32
MW-6	06/14/00	48	382	70.79	3858.78	3787.99
	06/18/01	50.8	431	70.98	3858.78	3787.80
	07/11/02	50	422	71.26	3858.78	3787.52
	07/02/03	46.5	471	71.52	3858.78	3787.26
	08/12/04	55.1	410	71.62	3858.78	3787.16
	08/10/05	55	391	70.33	3858.78	3788.45
	07/31/06	52.4	412	70.64	3858.78	3788.14
Windmill	07/31/06	38.2	400	---	---	---
WQCC Standards		250	1000			

Total Dissolved Soilds (TDS) and chloride concentrations listed in milligrams per liter (mg/L)
Analyses performed by Trace Analysis Inc., Lubbock, TX (1995-1998) and SPL, Inc., Houston, TX (1999-2000).
Values in boldface type indicate concentrations exceed New Mexico Water Quality Commission (WQCC) standards.
AMSL - Above Mean Sea Level; BTOC - Below Top of Casing
Groundwater flow direction is to the southeast with a gradient of approx. 0.004 ft/ft.
Elevations and state plane coordinates surveyed by Basin Surveys, Hobbs, NM.

FIGURES



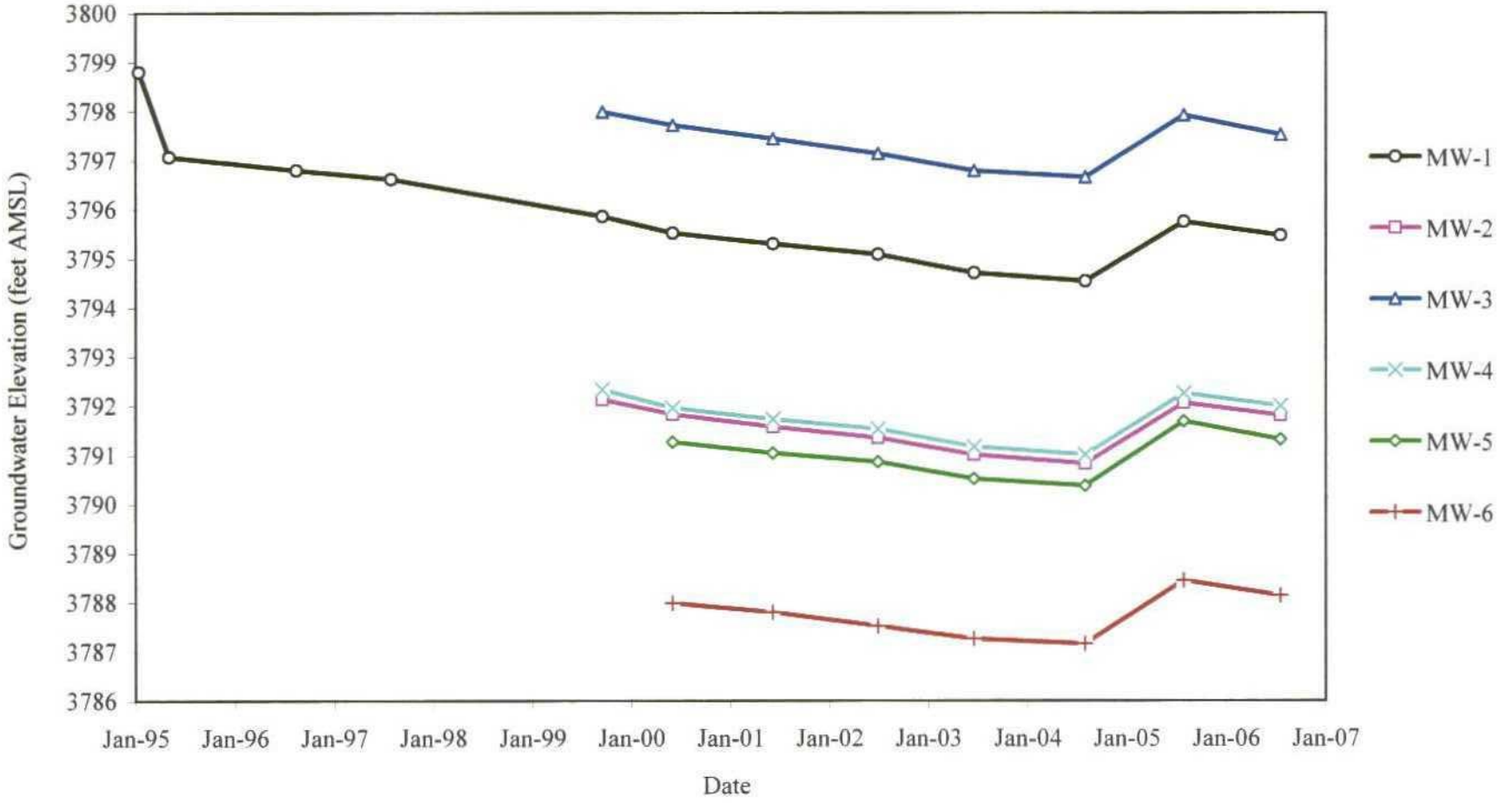
TRIDENT ENVIRONMENTAL

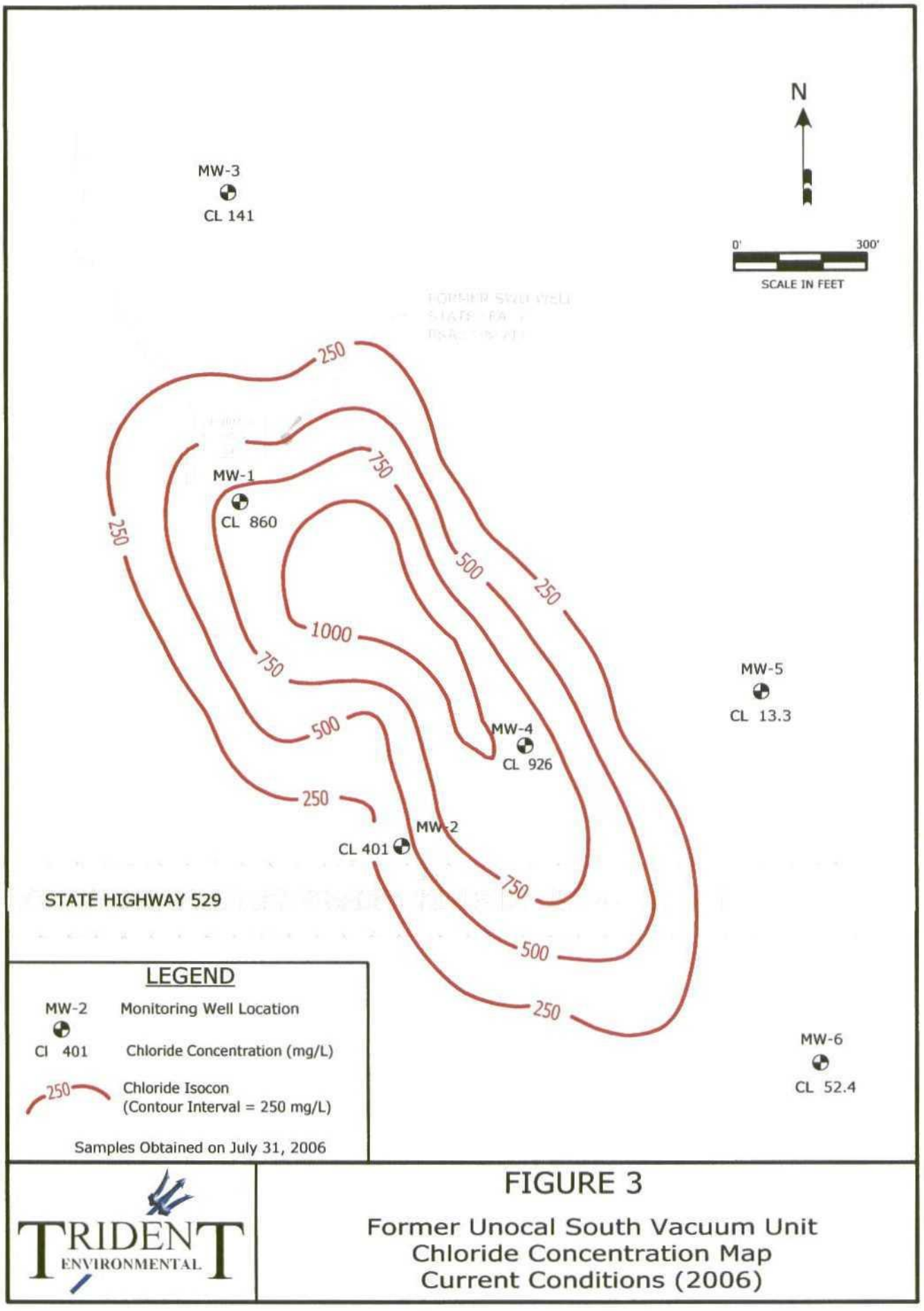
FIGURE 1

Former Unocal South Vacuum Unit

Groundwater Gradient Map

Figure 2
Historical Groundwater Elevations





TRIDENT ENVIRONMENTAL

FIGURE 3

Former Unocal South Vacuum Unit
Chloride Concentration Map
Current Conditions (2006)

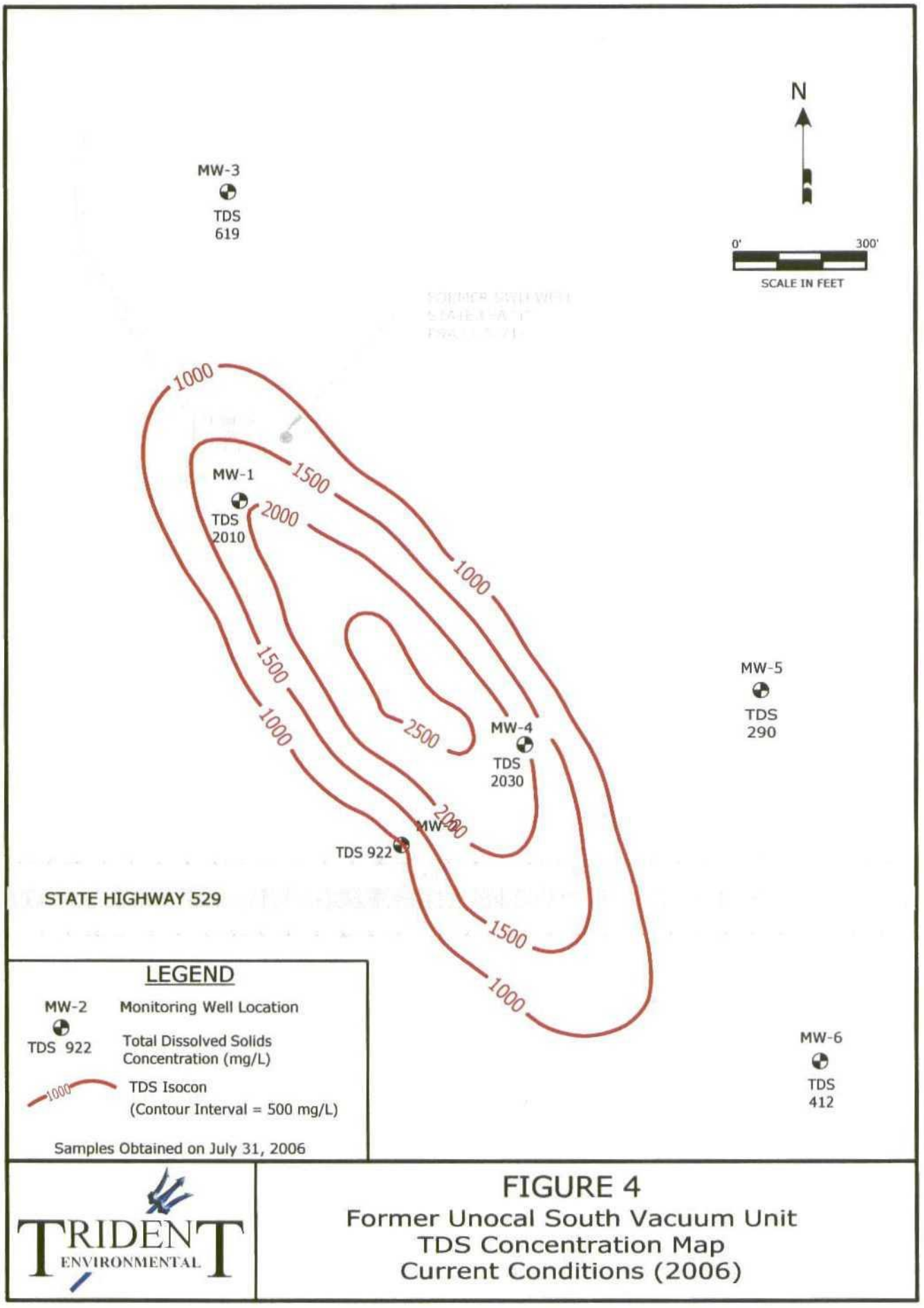


FIGURE 4

Former Unocal South Vacuum Unit
TDS Concentration Map
Current Conditions (2006)

Figure 5
Chloride Concentrations Versus Time Graph

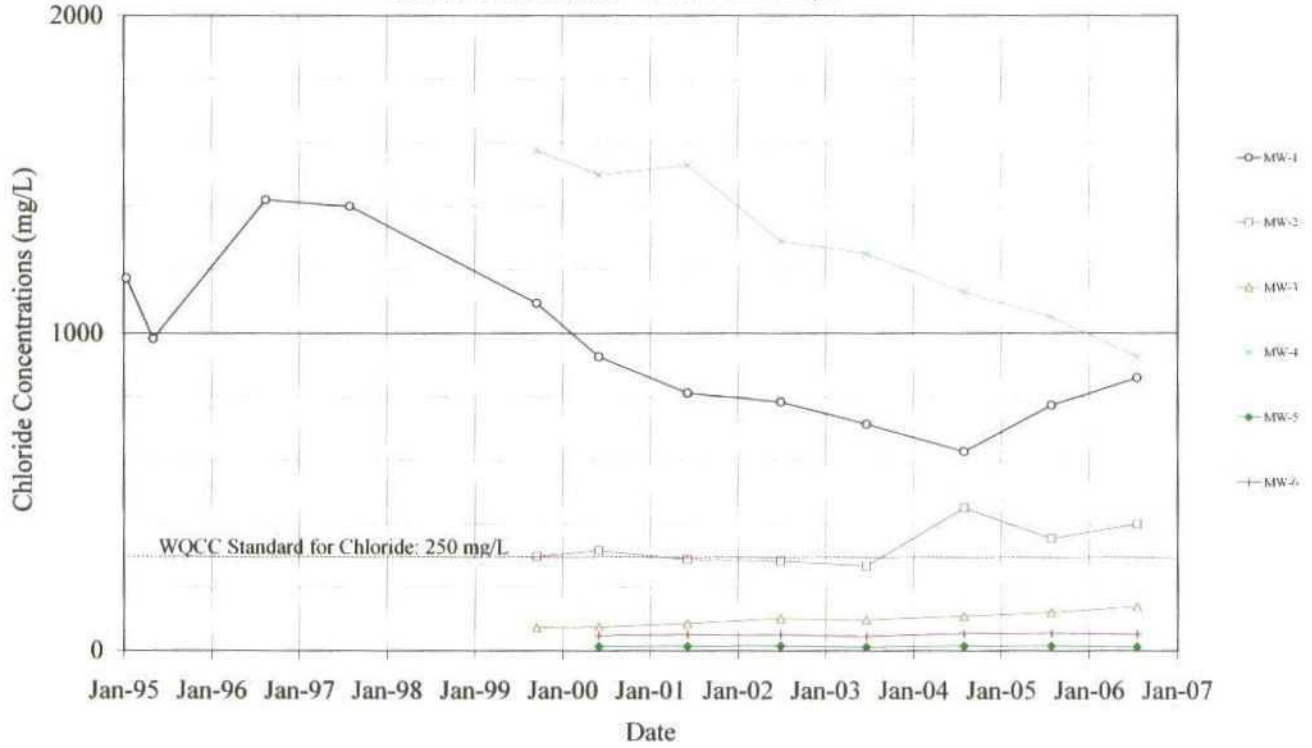
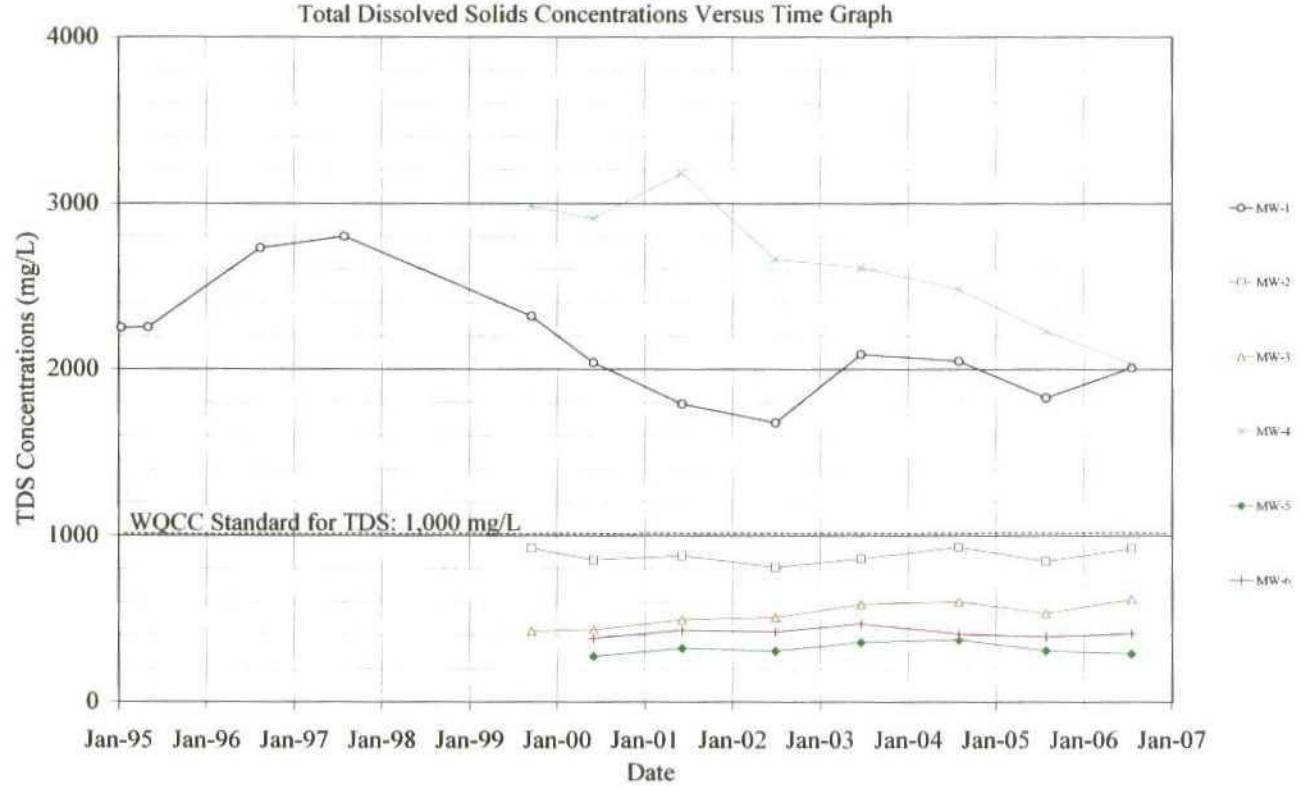


Figure 6
Total Dissolved Solids Concentrations Versus Time Graph



APPENDIX A

Laboratory Analytical Reports

And

Chain-of-Custody Documentation

Lancaster Laboratories

2425 New Holland Pike, PO Box 12425, Lancaster, PA 17605-2425 • 717-656-2300 Fax: 717-656-2681 • www.lancasterlabs.com

Analysis Report

ANALYTICAL RESULTS

Prepared for:

Union Oil of California
c/o Chevron Env Mgmt Co
PO Box 6012
San Ramon CA 94583

925-842-2477

Prepared by:

Lancaster Laboratories
2425 New Holland Pike
Lancaster, PA 17605-2425

SAMPLE GROUP

The sample group for this submittal is 999607. Samples arrived at the laboratory on Tuesday, August 01, 2006. The PO# for this group is 0015006947 and the release number is MACLEOD

.

Client Description	Lancaster Labs Number
MW-1 Grab Water Sample	4828875
MW-2 Grab Water Sample	4828876
MW-3 Grab Water Sample	4828877
MW-4 Grab Water Sample	4828878
MW-5 Grab Water Sample	4828879
MW-6 Grab Water Sample	4828880

1 COPY TO	Blasland Bouck & Lee	Attn: Allen Just
ELECTRONIC COPY TO	Trident Environmental	Attn: Gilbert Van Deventer

Lancaster Laboratories

2425 New Holland Pike, PO Box 12425, Lancaster, PA 17605-2425 • 717-656-2300 Fax: 717-656-2681 • www.lancasterlabs.com

Analysis Report

Questions? Contact your Client Services Representative
Katherine A Klinefelter at (717) 656-2300

Respectfully Submitted,

Kenneth A Bell

Kenneth A. Bell
Group Leader

Lancaster Laboratories

2425 New Holland Pike, PO Box 12425, Lancaster, PA 17605-2425 • 717-656-2300 Fax: 717-656-2681 • www.lancasterlabs.com

Analysis Report

Lancaster Laboratories Sample No. WW 4828875

MW-1 Grab Water Sample
Former Unocal South Vacuum Unit
Lea County, NM

Collected:07/31/2006 13:38 by GVD

Account Number: 11969

Submitted: 08/01/2006 09:20
Reported: 09/26/2006 at 15:25
Discard: 10/27/2006

Union Oil of California
c/o Chevron Env Mgmt Co
PO Box 6012
San Ramon CA 94583

MW1LE

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Units	Dilution Factor
00212	Total Dissolved Solids	n.a.	2,010.	77.6	240.	mg/l	1
01124	Chloride (titrimetric)	16887-00-6	860.	20.0	100.	mg/l	50

All QC is compliant unless otherwise noted. Please refer to the Quality Control Summary for overall QC performance data and associated samples.

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	EPA 160.1	1	08/03/2006 11:02	Susan E Hibner	1
01124	Chloride (titrimetric)	EPA 325.3	1	08/04/2006 14:07	Susan A Engle	50

*=This limit was used in the evaluation of the final result

Lancaster Laboratories

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Analysis Report

Lancaster Laboratories Sample No. WW 4828876

MW-2 Grab Water Sample
Former Unocal South Vacuum Unit
Lea County, NM

Collected:07/31/2006 11:31 by GVD

Submitted: 08/01/2006 09:20
Reported: 09/26/2006 at 15:25
Discard: 10/27/2006

MW2LE

Account Number: 11969

Union Oil of California
c/o Chevron Env Mgmt Co
PO Box 6012
San Ramon CA 94583

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Units	Dilution Factor
00212	Total Dissolved Solids	n.a.	922.	38.8	120.	mg/l	1
01124	Chloride (titrimetric)	16887-00-6	401.	8.0	40.0	mg/l	20

All QC is compliant unless otherwise noted. Please refer to the Quality Control Summary for overall QC performance data and associated samples.

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	EPA 160.1	1	08/03/2006 11:02	Susan E Hibner	1
01124	Chloride (titrimetric)	EPA 325.3	1	08/04/2006 14:07	Susan A Engle	20

*=This limit was used in the evaluation of the final result

Lancaster Laboratories

2425 New Holland Pike, PO Box 12425, Lancaster, PA 17605-2425 • 717-656-2300 Fax: 717-656-2681 • www.lancasterlabs.com

Analysis Report

Lancaster Laboratories Sample No. WW 4828877

MW-3 Grab Water Sample
Former Unocal South Vacuum Unit
Lea County, NM

Collected:07/31/2006 14:14 by GVD

Account Number: 11969

Submitted: 08/01/2006 09:20
Reported: 09/26/2006 at 15:25
Discard: 10/27/2006

Union Oil of California
c/o Chevron Env Mgmt Co
PO Box 6012
San Ramon CA 94583

MW3LE

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Units	Dilution Factor
00212	Total Dissolved Solids	n.a.	619.	9.7	30.0	mg/l	1
01124	Chloride (titrimetric)	16887-00-6	141.	2.0	10.0	mg/l	5

All QC is compliant unless otherwise noted. Please refer to the Quality Control Summary for overall QC performance data and associated samples.

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	EPA 160.1	1	08/03/2006 11:02	Susan E Hibner	1
01124	Chloride (titrimetric)	EPA 325.3	1	08/04/2006 14:07	Susan A Engle	5

*=This limit was used in the evaluation of the final result

Lancaster Laboratories

2425 New Holland Pike, PO Box 12425, Lancaster, PA 17605-2425 • 717-656-2300 Fax: 717-656-2681 • www.lancasterlabs.com

Analysis Report

Lancaster Laboratories Sample No. WW 4828878

MW-4 Grab Water Sample
Former Unocal South Vacuum Unit
Lea County, NM

Collected:07/31/2006 13:00 by GVD

Account Number: 11969

Submitted: 08/01/2006 09:20
Reported: 09/26/2006 at 15:25
Discard: 10/27/2006

Union Oil of California
c/o Chevron Env Mgmt Co
PO Box 6012
San Ramon CA 94583

MW4LE

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Units	Dilution Factor
00212	Total Dissolved Solids	n.a.	2,030.	77.6	240.	mg/l	1
01124	Chloride (titrimetric)	16887-00-6	926.	20.0	100.	mg/l	50

All QC is compliant unless otherwise noted. Please refer to the Quality Control Summary for overall QC performance data and associated samples.

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	EPA 160.1	1	08/03/2006 11:02	Susan E Hibner	1
01124	Chloride (titrimetric)	EPA 325.3	1	08/04/2006 14:07	Susan A Engle	50

*=This limit was used in the evaluation of the final result

Lancaster Laboratories

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Analysis Report

Lancaster Laboratories Sample No. WW 4828879

MW-5 Grab Water Sample
Former Unocal South Vacuum Unit
Lea County, NM

Collected:07/31/2006 12:04 by GVD

Submitted: 08/01/2006 09:20
Reported: 09/26/2006 at 15:25
Discard: 10/27/2006

MW5LE

Account Number: 11969

Union Oil of California
c/o Chevron Env Mgmt Co
PO Box 6012
San Ramon CA 94583

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Units	Dilution Factor
00212	Total Dissolved Solids	n.a.	290.	9.7	30.0	mg/l	1
01124	Chloride (titrimetric)	16887-00-6	13.3	2.0	10.0	mg/l	5

All QC is compliant unless otherwise noted. Please refer to the Quality Control Summary for overall QC performance data and associated samples.

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	EPA 160.1	1	08/03/2006 11:02	Susan E Hibner	1
01124	Chloride (titrimetric)	EPA 325.3	1	08/04/2006 14:07	Susan A Engle	5

*=This limit was used in the evaluation of the final result

Lancaster Laboratories

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Analysis Report

Lancaster Laboratories Sample No. WW 4828880

MW-6 Grab Water Sample
Former Unocal South Vacuum Unit
Lea County, NM

Collected:07/31/2006 14:56 by GVD

Submitted: 08/01/2006 09:20
Reported: 09/26/2006 at 15:25
Discard: 10/27/2006

MW6LE

Account Number: 11969

Union Oil of California
c/o Chevron Env Mgmt Co
PO Box 6012
San Ramon CA 94583

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Units	Dilution Factor
00212	Total Dissolved Solids	n.a.	412.	9.7	30.0	mg/l	1
01124	Chloride (titrimetric)	16887-00-6	52.4	1.6	8.0	mg/l	4

All QC is compliant unless otherwise noted. Please refer to the Quality Control Summary for overall QC performance data and associated samples.

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	EPA 160.1	1	08/03/2006 11:02	Susan E Hibner	1
01124	Chloride (titrimetric)	EPA 325.3	1	08/04/2006 14:07	Susan A Engle	4

*=This limit was used in the evaluation of the final result

Lancaster Laboratories

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Analysis Report

Quality Control Summary

Client Name: Union Oil of California
Reported: 09/26/06 at 03:25 PM

Group Number: 999607

Matrix QC may not be reported if site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD was performed, unless otherwise specified in the method.

Laboratory Compliance Quality Control

Analysis Name	Blank Result	Blank MDL**	Blank LOQ	Report Units	LCS %REC	LCSD %REC	LCS/LCSD Limits	RPD	RPD Max
Batch number: 06215021201A	Sample number(s): 4828875-4828880								
Total Dissolved Solids	N.D.	9.7	30.0	mg/l	96		80-120		
Batch number: 06216112402A	Sample number(s): 4828875-4828880								
Chloride (titrimetric)					99		96-102		

Sample Matrix Quality Control

Unspiked (UNSPK) = the sample used in conjunction with the matrix spike
Background (BKG) = the sample used in conjunction with the duplicate

Analysis Name	MS %REC	MSD %REC	MS/MSD Limits	RPD	RPD MAX	BKG Conc	DUP Conc	DUP RPD	Dup RPD Max
Batch number: 06215021201A	Sample number(s): 4828875-4828880 UNSPK: P830266 BKG: P830266								
Total Dissolved Solids	95	84	60-140	4	5	1,590.	1,630.	2	5
Batch number: 06216112402A	Sample number(s): 4828875-4828880 UNSPK: P831913 BKG: P831913								
Chloride (titrimetric)	100	98	92-103	2	2	31.2	29.1	7* (1)	4

*- Outside of specification
**-This limit was used in the evaluation of the final result for the blank
(1) The result for one or both determinations was less than five times the LOQ.
(2) The background result was more than four times the spike added.

Analysis Request/Environmental Services Chain of Custody

Lancaster Laboratories

For Lancaster Laboratories use only

Acct. # 11969 Group# 999607 Sample # 4828875-90

COC # 0118761

Please print. Instructions on reverse side correspond with circled numbers.

(1)

Client: Chevron / BBL — Acct. #: 209014516

Project Name/#: Former Unocal S. Vacuum Unit — PWSID #:

Project Manager: Allen Just — P.O.#:

Sampler: Gil VanDeventer — Quote #:

Name of state where samples were collected: New Mexico

For Lab Use Only
FSC:
SCR #: 31377

(6)

(2)			(3)			(4)			(5)									Remarks
									Chloride	TDS								
MW-1	7-31-06	1338	✓			✓		1	✓	✓								
MW-2	7-31-06	1131	✓			✓		1	✓	✓								
MW-3	7-31-06	1414	✓			✓		1	✓	✓								
MW-4	7-31-06	1306	✓			✓		1	✓	✓								
MW-5	7-31-06	1204	✓			✓		1	✓	✓								
MW-6	7-31-06	1456	✓			✓		1	✓	✓								
																		FedEx Air bill #
																		8576 8770 0292

(7) **Turnaround Time Requested** (TAT) (please circle): (Normal) Rush

(Rush TAT is subject to Lancaster Laboratories approval and surcharge.)

Date results are needed: _____

Rush results requested by (please circle): Phone Fax E-mail

Phone #: _____ Fax #: _____

E-mail address: acb@bbl-inc.com & gil@trident-environmental.com

(8) **Data Package Options** (please circle if required)

QC Summary — Type VI (Raw Data) — SDG Complete? Yes No

Type I (Tier I) — GLP

Type II (Tier II) — Other

Type III (NJ Red. Del.)

Type IV (CLP)

Site-specific QC required? Yes (No)

(If yes, indicate QC sample and submit triplicate volume.)

Internal Chain of Custody required? Yes No

(9)

Relinquished by:	Date	Time	Received by:	Date	Time
[signature]	7/25/06	11:08	[signature]	7/26/06	12:00
[signature]	7/31/06	1630			
			[signature]	8/1/06	0920

Lancaster Laboratories
Explanation of Symbols and Abbreviations

The following defines common symbols and abbreviations used in reporting technical data:

N.D.	none detected	**BMQL**	Below Minimum Quantitation Level
TNTC	Too Numerous To Count	**MPN**	Most Probable Number
IU	International Units	**CP Units**	cobalt-chloroplatinate units
umhos/cm	micromhos/cm	**NTU**	nephelometric turbidity units
C	degrees Celsius	**F**	degrees Fahrenheit
Cal	(diet) calories	**lb.**	pound(s)
meq	milliequivalents	**kg**	kilogram(s)
g	gram(s)	**mg**	milligram(s)
ug	microgram(s)	**l**	liter(s)
ml	milliliter(s)	**ul**	microliter(s)
m3	cubic meter(s)	**fib >5 um/ml**	fibers greater than 5 microns in length per ml

< less than – The number following the sign is the limit of quantitation, the smallest amount of analyte which can be reliably determined using this specific test.

> greater than

ppm parts per million – One ppm is equivalent to one milligram per kilogram (mg/kg), or one gram per million grams. For aqueous liquids, ppm is usually taken to be equivalent to milligrams per liter (mg/l), because one liter of water has a weight very close to a kilogram. For gases or vapors, one ppm is equivalent to one microliter of gas per liter of gas.

ppb parts per billion

Dry weight basis Results printed under this heading have been adjusted for moisture content. This increases the analyte weight concentration to approximate the value present in a similar sample without moisture.

U.S. EPA data qualifiers:

Organic Qualifiers		Inorganic Qualifiers	
A	TIC is a possible aldol-condensation product	**B**	Value is <CRDL, but ≥IDL
B	Analyte was also detected in the blank	**E**	Estimated due to interference
C	Pesticide result confirmed by GC/MS	**M**	Duplicate injection precision not met
D	Compound quatitated on a diluted sample	**N**	Spike amount not within control limits
E	Concentration exceeds the calibration range of the instrument	**S**	Method of standard additions (MSA) used for calculation
J	Estimated value	**U**	Compound was not detected
N	Presumptive evidence of a compound (TICs only)	**W**	Post digestion spike out of control limits
P	Concentration difference between primary and confirmation columns >25%	*	Duplicate analysis not within control limits
U	Compound was not detected	+	Correlation coefficient for MSA <0.995
X,Y,Z	Defined in case narrative		

Analytical test results for methods listed on the laboratories' accreditation scope meet all requirements of NELAC unless otherwise noted under the individual analysis.

Tests results relate only to the sample tested. Clients should be aware that a critical step in a chemical or microbiological analysis is the collection of the sample. Unless the sample analyzed is truly representative of the bulk of material involved, the test results will be meaningless. If you have questions regarding the proper techniques of collecting samples, please contact us. We cannot be held responsible for sample integrity, however, unless sampling has been performed by a member of our staff. This report shall not be reproduced except in full, without the written approval of the laboratory.

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Analysis Report

ANALYTICAL RESULTS

Prepared for:

Union Oil of California
c/o Chevron Env Mgmt Co
PO Box 6012
San Ramon CA 94583

925-842-2477

Prepared by:

Lancaster Laboratories
2425 New Holland Pike
Lancaster, PA 17605-2425

SAMPLE GROUP

The sample group for this submittal is 1000438. Samples arrived at the laboratory on Saturday, August 05, 2006. The PO# for this group is 0015006947 and the release number is MACLEOD.

Client Description	Lancaster Labs Number
Windmill(L-05339) Grab Water Sample	4833651

1 COPY TO	Blasland Bouck & Lee	Attn: Allen Just
ELECTRONIC COPY TO	Trident Environmental	Attn: Gilbert Van Deventer

Lancaster Laboratories

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Analysis Report

Questions? Contact your Client Services Representative
Katherine A Klinefelter at (717) 656-2300

Respectfully Submitted,

Kenneth A Bell

Kenneth A. Bell
Group Leader

Lancaster Laboratories

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Analysis Report

Lancaster Laboratories Sample No. WW 4833651

Windmill(L-05339) Grab Water Sample
Former Unocal South Vacuum Unit
Lea County, NM

Collected:07/31/2006 15:30 by GVD

Account Number: 11969

Submitted: 08/05/2006 10:15
Reported: 09/26/2006 at 15:25
Discard: 10/27/2006

Union Oil of California
c/o Chevron Env Mgmt Co
PO Box 6012
San Ramon CA 94583

05339

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Units	Dilution Factor
00212	Total Dissolved Solids	n.a.	400.	9.7	30.0	mg/l	1
01124	Chloride (titrimetric)	16887-00-6	38.2	0.40	2.0	mg/l	1

All QC is compliant unless otherwise noted. Please refer to the Quality Control Summary for overall QC performance data and associated samples.

Laboratory Chronicle

CAT No.	Analysis Name	Method	Trial#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	EPA 160.1	1	08/07/2006 09:03	Yolunder Y Bunch	1
01124	Chloride (titrimetric)	EPA 325.3	1	08/11/2006 08:05	Susan A Engle	1

*=This limit was used in the evaluation of the final result

Lancaster Laboratories

2425 New Holland Pike, PO Box 12425, Lancaster, PA 17605-2425 • 717-656-2300 Fax: 717-656-2681 • www.lancasterlabs.com

Analysis Report

Quality Control Summary

Client Name: Union Oil of California
Reported: 09/26/06 at 03:25 PM

Group Number: 1000438

Matrix QC may not be reported if site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD was performed, unless otherwise specified in the method.

Laboratory Compliance Quality Control

Analysis Name	Blank Result	Blank MDL**	Blank LOQ	Report Units	LCS %REC	LCSD %REC	LCS/LCSD Limits	RPD	RPD Max
Batch number: 06219021201A	Sample number(s): 4833651								
Total Dissolved Solids	N.D.	9.7	30.0	mg/l	96		80-120		
Batch number: 06223112401A	Sample number(s): 4833651								
Chloride (titrimetric)					99		96-102		

Sample Matrix Quality Control

Unspiked (UNSPK) = the sample used in conjunction with the matrix spike
Background (BKG) = the sample used in conjunction with the duplicate

Analysis Name	MS %REC	MSD %REC	MS/MSD Limits	RPD	RPD MAX	BKG Conc	DUP Conc	DUP RPD	Dup RPD Max
Batch number: 06219021201A	Sample number(s): 4833651 UNSPK: P832915 BKG: P832912								
Total Dissolved Solids	101	103	60-140	1	5	5,540.	5,290.	5	5
Batch number: 06223112401A	Sample number(s): 4833651 UNSPK: P832738 BKG: P832738								
Chloride (titrimetric)	97	97	92-103	0	2	17.4	17.2	1 (1)	4

*- Outside of specification
**-This limit was used in the evaluation of the final result for the blank
(1) The result for one or both determinations was less than five times the LOQ.
(2) The background result was more than four times the spike added.

Analysis Request / Environmental Services Chain of Custody

Lancaster Laboratories

For Lancaster Laboratories use only

Acct. # 11969 Group# 1000438 Sample # 4833651

COC # 0118762

Please print. Instructions on reverse side correspond with circled numbers.

(1) Client: Chevron / BBL — Project #: 009901456

Project Name/#: Former Unocal S. Vacuum Unit — PWSID #:

Project Manager: Allen Just — P.O.#:

Sampler: G.I Van Deventer — Quote #:

Name of state where samples were collected: New Mexico

(2) Sample Identification	Date Collected	Time Collected	(3) Soil	Water	Other	Total # of Containers	(4) Matrix	(5) Analyses Requested: Chloride	TDS	For Lab Use Only FSC: SCR #: (6) Remarks
Windmill (L-05339)	7-31-06	1530	✓	✓		1		✓	✓	

(7) **Turnaround Time Requested** (TAT) (please circle): (Normal) Rush

(Rush TAT is subject to Lancaster Laboratories approval and surcharge.)

Date results are needed:

~~Rush~~ results requested by (please circle): Phone Fax (E-mail)

Phone #: 949-474-9052 Fax #: 413-403-9

E-mail address: acb@bbl-inc.com & gil@trident-environmental.com

(8) **Data Package Options** (please circle if required)

QC Summary — Type VI (Raw Data) — SDG Complete? Yes No

Type I (Tier I) — GLP

Type II (Tier II) — Other — Site-specific QC required? Yes (No)

(If yes, indicate QC sample and submit triplicate volume.)

Type III (NJ Red. Del.)

Type IV (CLP) — Internal Chain of Custody required? Yes No

Relinquished by:	Date	Time	Received by:	Date	Time (9)
Gil Van Deventer	8/4/06	4:00			
Relinquished by:	Date	Time	Received by:	Date	Time
Relinquished by:	Date	Time	Received by:	Date	Time
Relinquished by:	Date	Time	Received by:	Date	Time
Relinquished by:	Date	Time	Received by:	8/4/06	1015

Lancaster Laboratories, Inc., 2425 New Holland Pike, PO Box 12425, Lancaster, PA 17605-2425 (717) 656-2300

Copies: White and yellow should accompany samples to Lancaster Laboratories. The pink copy should be retained by the client.

2102.02

Lancaster Laboratories
Explanation of Symbols and Abbreviations

The following defines common symbols and abbreviations used in reporting technical data:

N.D.	none detected	**BMQL**	Below Minimum Quantitation Level
TNTC	Too Numerous To Count	**MPN**	Most Probable Number
IU	International Units	**CP Units**	cobalt-chloroplatinate units
umhos/cm	micromhos/cm	**NTU**	nephelometric turbidity units
C	degrees Celsius	**F**	degrees Fahrenheit
Cal	(diet) calories	**lb.**	pound(s)
meq	milliequivalents	**kg**	kilogram(s)
g	gram(s)	**mg**	milligram(s)
ug	microgram(s)	**l**	liter(s)
ml	milliliter(s)	**ul**	microliter(s)
m3	cubic meter(s)	**fib >5 um/ml**	fibers greater than 5 microns in length per ml

< less than – The number following the sign is the limit of quantitation, the smallest amount of analyte which can be reliably determined using this specific test.

> greater than

ppm parts per million – One ppm is equivalent to one milligram per kilogram (mg/kg), or one gram per million grams. For aqueous liquids, ppm is usually taken to be equivalent to milligrams per liter (mg/l), because one liter of water has a weight very close to a kilogram. For gases or vapors, one ppm is equivalent to one microliter of gas per liter of gas.

ppb parts per billion

Dry weight basis Results printed under this heading have been adjusted for moisture content. This increases the analyte weight concentration to approximate the value present in a similar sample without moisture.

U.S. EPA data qualifiers:

Organic Qualifiers		Inorganic Qualifiers	
A	TIC is a possible aldol-condensation product	**B**	Value is <CRDL, but ≥IDL
B	Analyte was also detected in the blank	**E**	Estimated due to interference
C	Pesticide result confirmed by GC/MS	**M**	Duplicate injection precision not met
D	Compound quatitated on a diluted sample	**N**	Spike amount not within control limits
E	Concentration exceeds the calibration range of the instrument	**S**	Method of standard additions (MSA) used for calculation
J	Estimated value	**U**	Compound was not detected
N	Presumptive evidence of a compound (TICs only)	**W**	Post digestion spike out of control limits
P	Concentration difference between primary and confirmation columns >25%	*	Duplicate analysis not within control limits
U	Compound was not detected	+	Correlation coefficient for MSA <0.995
X,Y,Z	Defined in case narrative		

Analytical test results for methods listed on the laboratories' accreditation scope meet all requirements of NELAC unless otherwise noted under the individual analysis.

Tests results relate only to the sample tested. Clients should be aware that a critical step in a chemical or microbiological analysis is the collection of the sample. Unless the sample analyzed is truly representative of the bulk of material involved, the test results will be meaningless. If you have questions regarding the proper techniques of collecting samples, please contact us. We cannot be held responsible for sample integrity, however, unless sampling has been performed by a member of our staff. This report shall not be reproduced except in full, without the written approval of the laboratory.

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APPENDIX B

Monitoring Well Sampling Data Forms

WELL SAMPLING DATA FORM

CLIENT: Chevron Environmental Management Co. WELL ID: MW-1

SITE NAME: Former Unocal S. Vacuum Unit DATE: 07/31/06

PROJECT NO. V-107 SAMPLER: Van Deventer

PURGING METHOD: ☑ Hand Bailed ☐ump If Pump, Type: _____

SAMPLING METHOD: ☑ Disposable Bailer ☐rect from Discharge Hose Othe☐ _____

DESCRIBE EQUIPMENT DECONTAMINATION METHOD BEFORE SAMPLING THE WELL:

☑ Gloves ☑Alconox ☑stilled Water Rinse Othe☐ _____

DISPOSAL METHOD OF PURGE WATER: ☐ Surface Discharge ☐ums Di☑bsal Facility

TOTAL DEPTH OF WELL: 70.00 Feet

DEPTH TO WATER: 62.90 Feet

HEIGHT OF WATER COLUMN: 7.10 Feet 3.5 Minimum Gallons to purge 3 well volumes

WELL DIAMETER: 2.0 Inch

TIME	VOLUME PURGED	TEMP. °F	COND. mS/cm	pH	DO mg/L	Turb	PHYSICAL APPEARANCE AND REMARKS
13:22	0						Staring hand bailing
13:27	1	21.4	3.07	6.74			
13:30	2	20.4	3.10	6.86			
13:33	3	20.0	3.08	6.89			
13:38	4	20.5	3.16	6.67			Collected sample
0:16	:Total Time (hr:min)		4	:Total Vol (gal)		0.25	:Average Flow Rate (gal/min)

COMMENTS: Parameters obtained using a calibrated Hanna Model 98130 pH-Temperature-Conductivity meter.

Sample placed into 500 ml plastic container, and put on ice in cooler.

Delivered sample to SPL (Houston TX) for Chloride and TDS analyses.

WELL SAMPLING DATA FORM

CLIENT: Chevron Environmental Management Co. WELL ID: MW-2

SITE NAME: Former Unocal S. Vacuum Unit DATE: 07/31/06

PROJECT NO. V-107 SAMPLER: Van Deventer

PURGING METHOD: ☑ Hand Bailed ☐ump If Pump, Type: _____

SAMPLING METHOD: ☑ Disposable Bailer ☐irect from Discharge Hose Othe☐ _____

DESCRIBE EQUIPMENT DECONTAMINATION METHOD BEFORE SAMPLING THE WELL:

☑ Gloves ☑Alconox ☑stilled Water Rinse Othe☐ _____

DISPOSAL METHOD OF PURGE WATER: ☐ Surface Discharge ☐ums Dis☑bsal Facility

TOTAL DEPTH OF WELL: 71.00 Feet

DEPTH TO WATER: 49.83 Feet

HEIGHT OF WATER COLUMN: 21.17 Feet 10.4 Minimum Gallons to purge 3 well volumes

WELL DIAMETER: 2.0 Inch

TIME	VOLUME PURGED	TEMP. °F	COND. mS/cm	pH	DO mg/L	Turb	PHYSICAL APPEARANCE AND REMARKS
10:00	0						Staring hand bailing
10:07	2	70.6	1.10	8.36			
10:17	4	69.8	1.14	9.29			
10:24	6	68.2	1.46	9.36			
10:30	8	68.1	1.49	9.30			
10:35	10	68.1	1.56	9.33			
						10:50	Collected sample
0:35	:Total Time (hr:min)		10	:Total Vol (gal)		0.29	:Average Flow Rate (gal/min)

COMMENTS: Parameters obtained using a calibrated Hanna Model 98130 pH-Temperature-Conductivity meter.

Sample placed into 500 ml plastic container, and put on ice in cooler.

Delivered sample to SPL (Houston TX) for Chloride and TDS analyses.

WELL SAMPLING DATA FORM

CLIENT: Chevron Environmental Management Co. WELL ID: MW-3

SITE NAME: Former Unocal S. Vacuum Unit DATE: 07/31/06

PROJECT NO. V-107 SAMPLER: Van Deventer

PURGING METHOD: ☑ Hand Bailed ☐ump If Pump, Type: _____

SAMPLING METHOD: ☑ Disposable Bailer ☐rect from Discharge Hose Othe☐ _____

DESCRIBE EQUIPMENT DECONTAMINATION METHOD BEFORE SAMPLING THE WELL:

☑ Gloves ☑Alconox ☑stilled Water Rinse Othe☐ _____

DISPOSAL METHOD OF PURGE WATER: ☐ Surface Discharge ☐ums Dis☑bsal Facility

TOTAL DEPTH OF WELL: 77.00 Feet
DEPTH TO WATER: 67.21 Feet
HEIGHT OF WATER COLUMN: 9.79 Feet 4.8 Minimum Gallons to purge 3 well volumes
WELL DIAMETER: 2.0 Inch

TIME	VOLUME PURGED	TEMP. °F	COND. mS/cm	pH	DO mg/L	Turb	PHYSICAL APPEARANCE AND REMARKS
12:15	0						Staring hand bailing
12:18	1	71.9	0.69	7.22			
12:21	2	68.9	0.74	7.19			
12:23	3	68.3	0.74	7.03			
12:30	4	67.7	0.74	7.09			
12:34	5	67.5	0.75	7.03			
						12:35	Collected sample
0:19	:Total Time (hr:min)		5	:Total Vol (gal)		0.26	:Average Flow Rate (gal/min)

COMMENTS: Parameters obtained using a calibrated Hanna Model 98130 pH-Temperature-Conductivity meter.

Sample placed into 500 ml plastic container, and put on ice in cooler.

Delivered sample to SPL (Houston TX) for Chloride and TDS analyses.

WELL SAMPLING DATA FORM

CLIENT: Chevron Environmental Management Co. WELL ID: MW-4

SITE NAME: Former Unocal S. Vacuum Unit DATE: 07/31/06

PROJECT NO. V-107 SAMPLER: Van Deventer

PURGING METHOD: ☑ Hand Bailed ☐ump If Pump, Type: _____

SAMPLING METHOD: ☑ Disposable Bailer ☐rect from Discharge Hose Othe☐ _____

DESCRIBE EQUIPMENT DECONTAMINATION METHOD BEFORE SAMPLING THE WELL:

☑ Gloves ☑Alconox ☑stilled Water Rinse Othe☐ _____

DISPOSAL METHOD OF PURGE WATER: ☐ Surface Discharge ☐ums Dis☑bsal Facility

TOTAL DEPTH OF WELL: 71.00 Feet

DEPTH TO WATER: 60.51 Feet

HEIGHT OF WATER COLUMN: 10.49 Feet 5.1 Minimum Gallons to purge 3 well volumes

WELL DIAMETER: 2.0 Inch

TIME	VOLUME PURGED	TEMP. °F	COND. mS/cm	pH	DO mg/L	Turb	PHYSICAL APPEARANCE AND REMARKS
11:00	0						*Staring hand bailing*
11:07	2	71.2	4.37	7.49			
11:18	4	69.0	4.19	7.56			
11:37	6	69.1	4.03	7.28			
						11:21	Sample collected
0:37	:Total Time (hr:min)		6	:Total Vol (gal)		0.16	:Average Flow Rate (gal/min)

COMMENTS: Parameters obtained using a calibrated Hanna Model 98130 pH-Temperature-Conductivity meter.

Sample placed into 500 ml plastic container, and put on ice in cooler.

Delivered sample to SPL (Houston TX) for Chloride and TDS analyses.

WELL SAMPLING DATA FORM

CLIENT: Chevron Environmental Management Co. WELL ID: MW-5

SITE NAME: Former Unocal S. Vacuum Unit DATE: 07/31/06

PROJECT NO. V-107 SAMPLER: Van Deventer

PURGING METHOD: ☑ Hand Bailed ☐ump If Pump, Type: _____

SAMPLING METHOD: ☑ Disposable Bailer ☐rect from Discharge Hose Othe☐ _____

DESCRIBE EQUIPMENT DECONTAMINATION METHOD BEFORE SAMPLING THE WELL:

☑ Gloves ☑Alconox ☑stilled Water Rinse Othe☐ _____

DISPOSAL METHOD OF PURGE WATER: ☐ Surface Discharge ☐ums Dis☑bsal Facility

TOTAL DEPTH OF WELL: 75.00 Feet

DEPTH TO WATER: 68.52 Feet

HEIGHT OF WATER COLUMN: 6.48 Feet 3.2 Minimum Gallons to purge 3 well volumes

WELL DIAMETER: 2.0 Inch

TIME	VOLUME PURGED	TEMP. °F	COND. mS/cm	pH	DO mg/L	Turb	PHYSICAL APPEARANCE AND REMARKS
12:52	0						Staring hand bailing
12:54	1	70.7	0.45	7.35			
12:56	2	68.8	0.44	7.26			
12:59	3	68.3	0.44	7.26			
13:01	4	68.3	0.45	7.25			
13:04	5	68.5	0.43	7.29			
						13:07	Sample collected
0:12	:Total Time (hr:min)	5	:Total Vol (gal)			0.42	:Average Flow Rate (gal/min)

COMMENTS: Parameters obtained using a calibrated Hanna Model 98130 pH-Temperature-Conductivity meter.

Sample placed into 500 ml plastic container, and put on ice in cooler.

Delivered sample to SPL (Houston TX) for Chloride and TDS analyses.

WELL SAMPLING DATA FORM

CLIENT: Chevron Environmental Management Co. WELL ID: MW-6

SITE NAME: Former Unocal S. Vacuum Unit DATE: 07/31/06

PROJECT NO. V-107 SAMPLER: Van Deventer

PURGING METHOD: ☑ Hand Bailed ☐ump If Pump, Type: _____

SAMPLING METHOD: ☑ Disposable Bailer ☐rect from Discharge Hose Othe☐ _____

DESCRIBE EQUIPMENT DECONTAMINATION METHOD BEFORE SAMPLING THE WELL:

☑ Gloves ☑Alconox ☑stilled Water Rinse Othe☐ _____

DISPOSAL METHOD OF PURGE WATER: ☐ Surface Discharge ☐ums Dis☑bsal Facility

TOTAL DEPTH OF WELL: 76.00 Feet

DEPTH TO WATER: 70.64 Feet

HEIGHT OF WATER COLUMN: 5.36 Feet 2.6 Minimum Gallons to purge 3 well volumes

WELL DIAMETER: 2.0 Inch

TIME	VOLUME PURGED	TEMP. °F	COND. mS/cm	pH	DO mg/L	Turb	PHYSICAL APPEARANCE AND REMARKS
16:45	0						Staring hand bailing
16:49	1	68.1	0.59	8.25			
16:52	2	68.3	0.59	8.29			
16:56	3	68.0	0.59	8.23			Sample collected
0:11	:Total Time (hr:min)		3	:Total Vol (gal)		0.27	:Average Flow Rate (gal/min)

COMMENTS: Parameters obtained using a calibrated Hanna Model 98130 pH-Temperature-Conductivity meter.

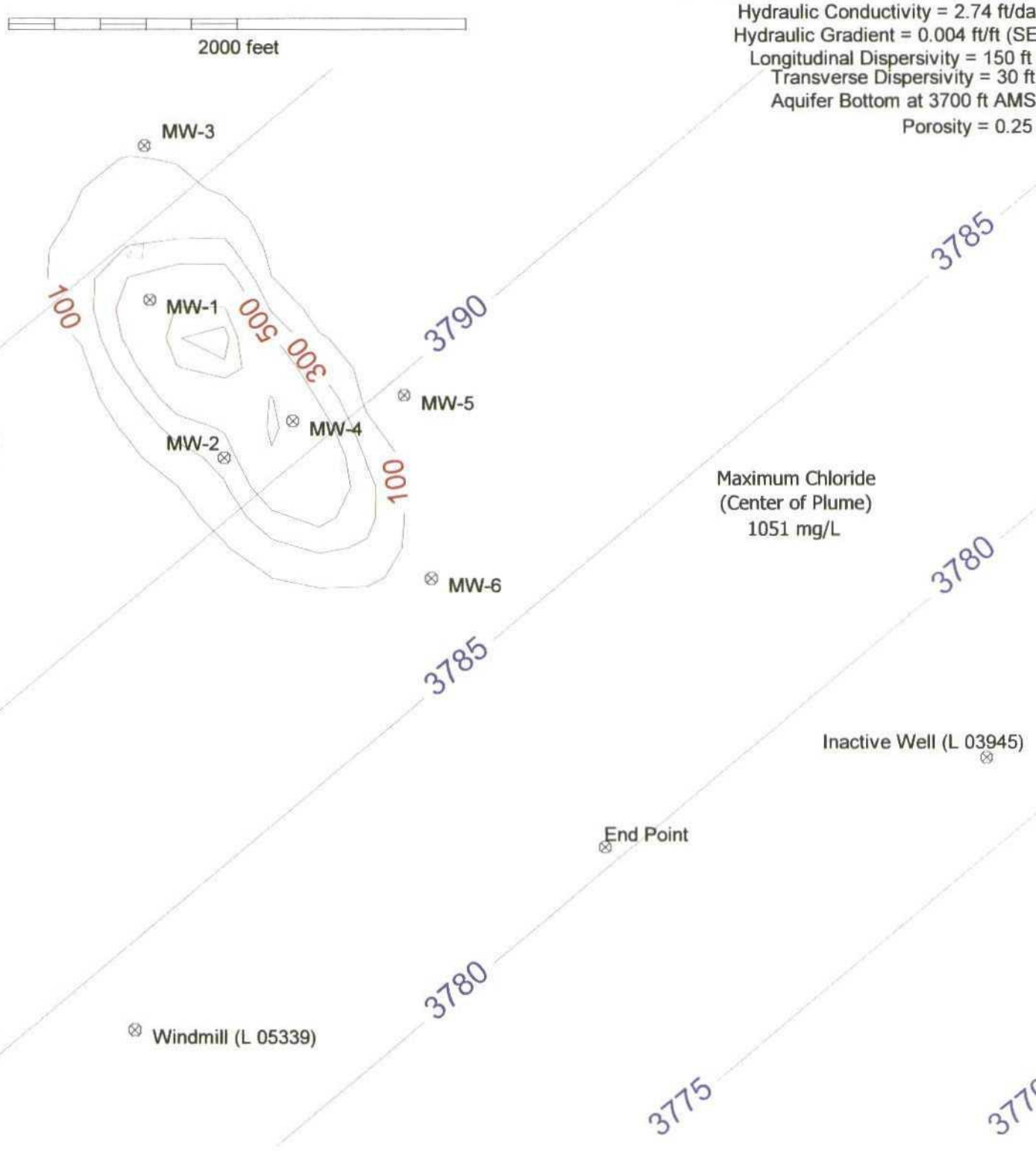
Sample placed into 500 ml plastic container, and put on ice in cooler.

Delivered sample to SPL (Houston TX) for Chloride and TDS analyses.

APPENDIX C

Chloride and TDS Plume Simulations

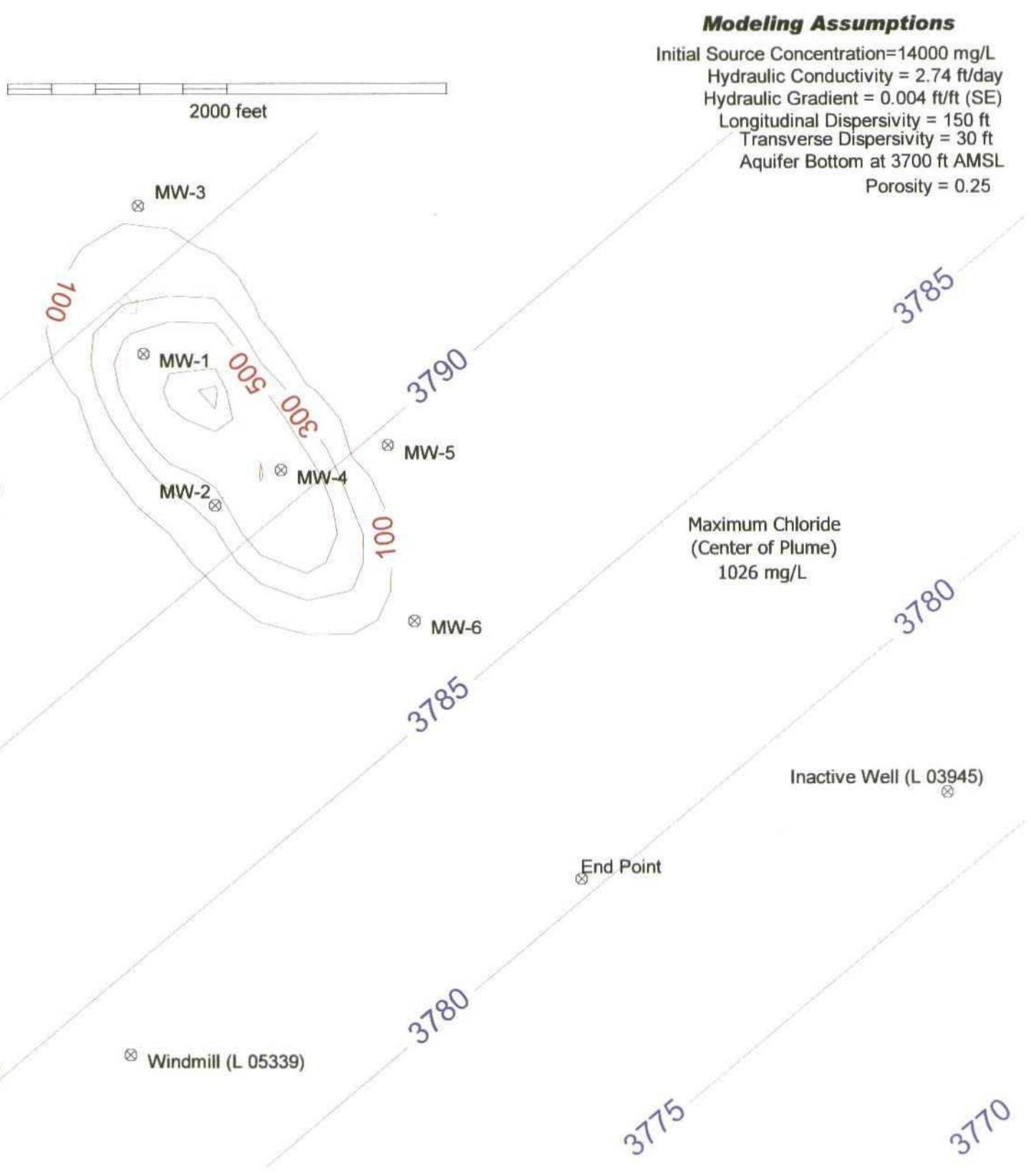
WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit Site
Chloride Plume (Year 2007)



Modeling Assumptions

Initial Source Concentration=14000 mg/L
Hydraulic Conductivity = 2.74 ft/day
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

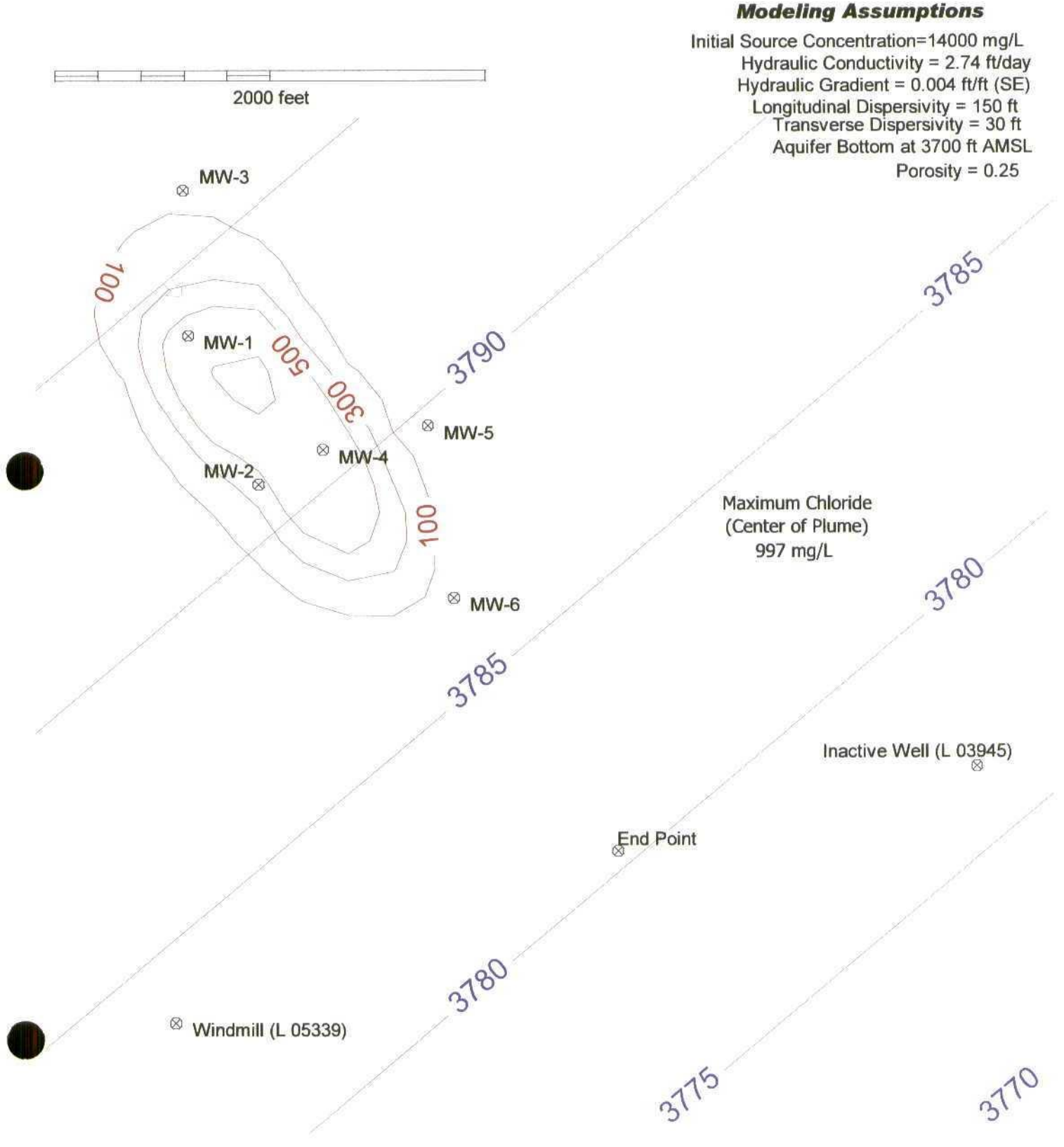
WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit Site
Chloride Plume (Year 2008)



Modeling Assumptions

Initial Source Concentration=14000 mg/L
Hydraulic Conductivity = 2.74 ft/day
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

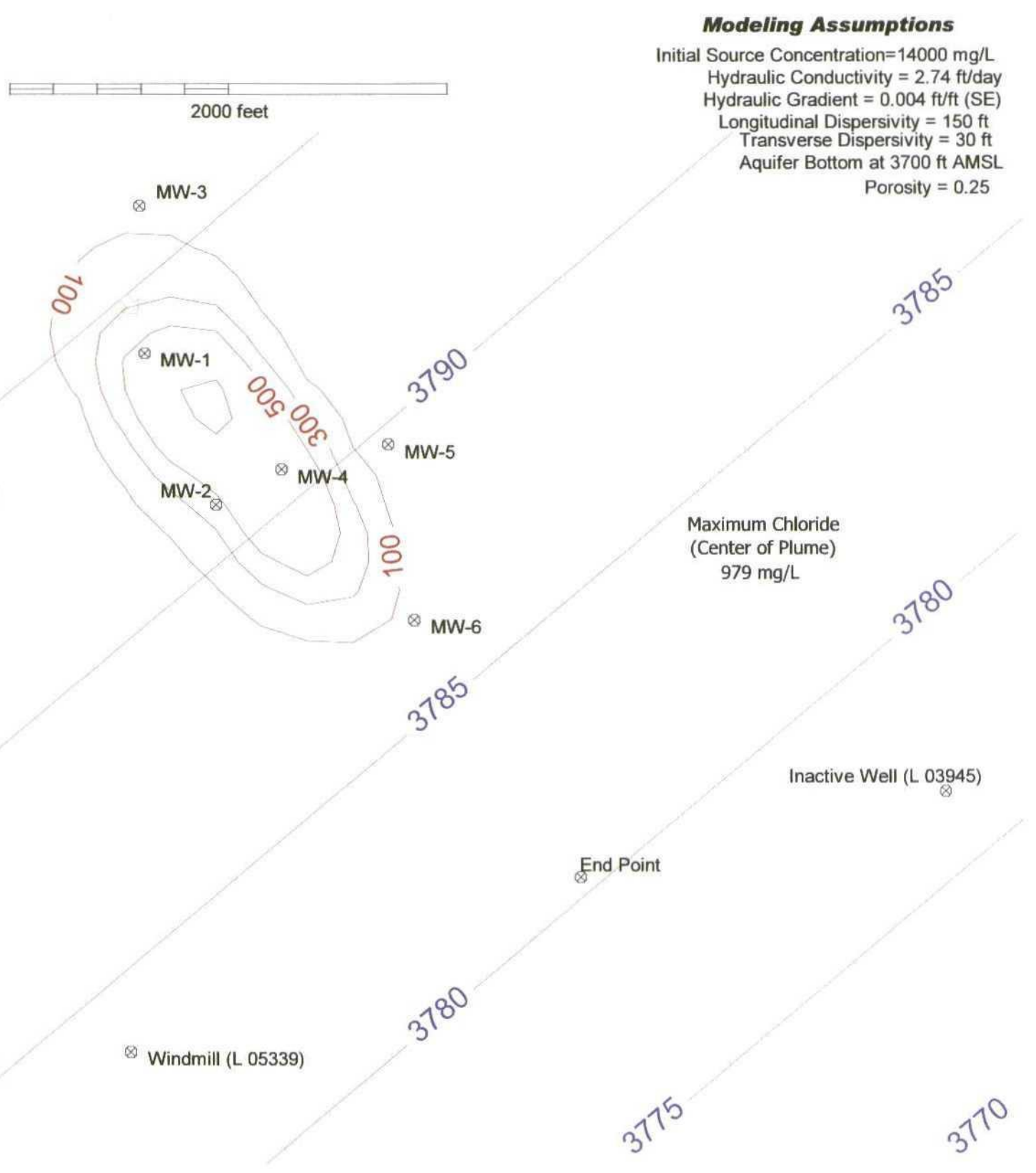
WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit Site
Chloride Plume (Year 2009)



Modeling Assumptions

Initial Source Concentration=14000 mg/L
Hydraulic Conductivity = 2.74 ft/day
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

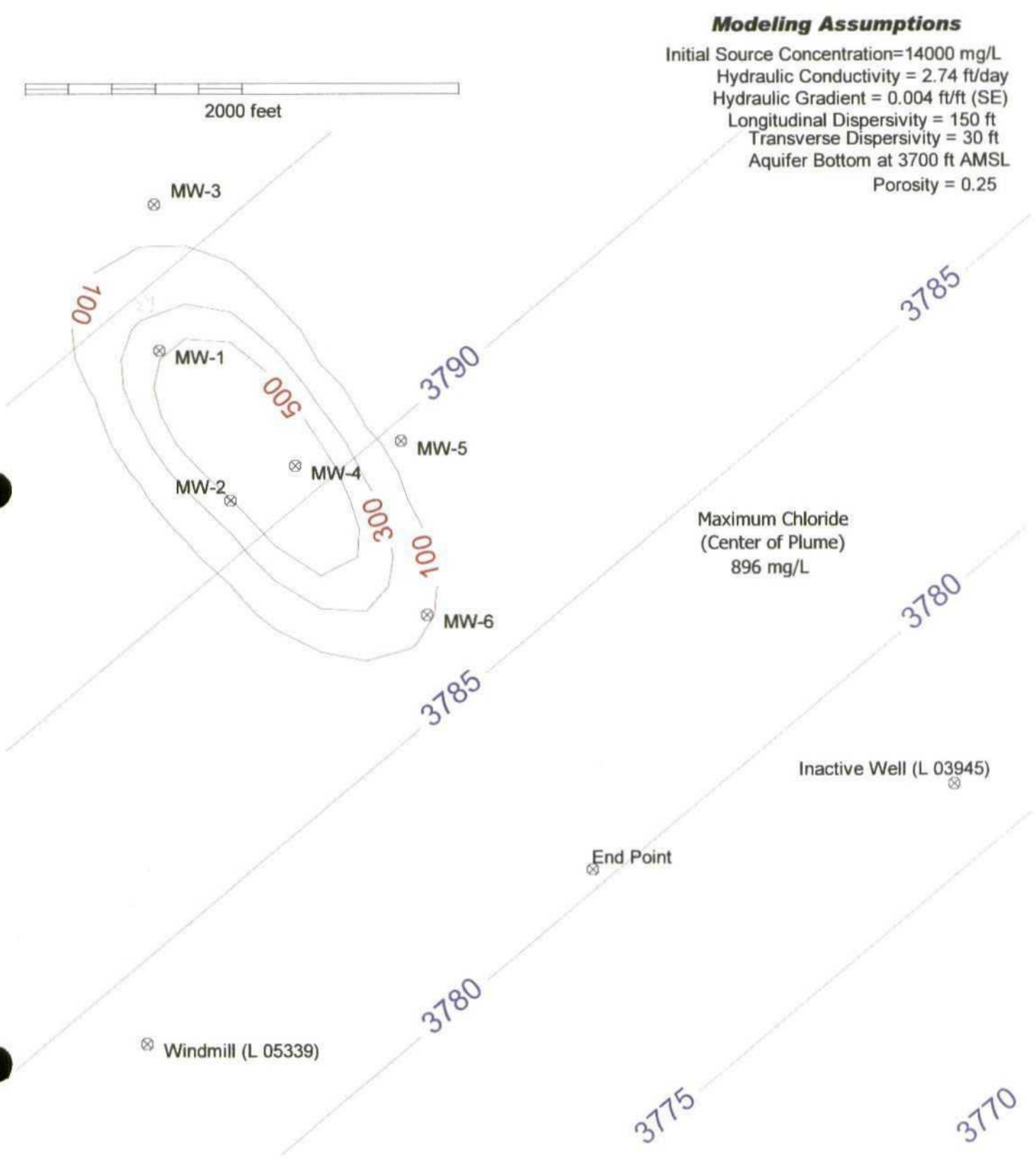
WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit Site
Chloride Plume (Year 2010)



Modeling Assumptions

Initial Source Concentration=14000 mg/L
Hydraulic Conductivity = 2.74 ft/day
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

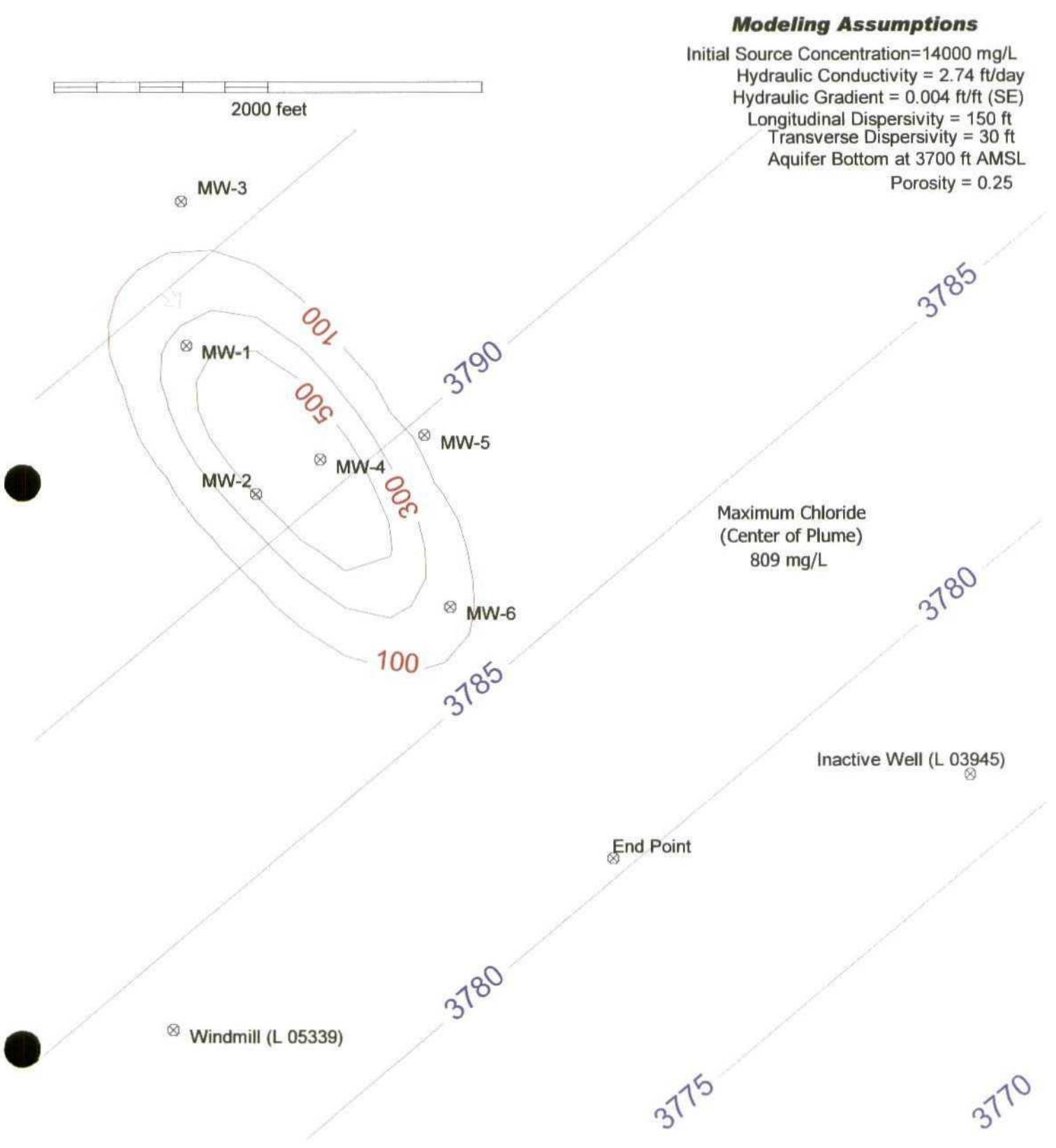
WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit Site
Chloride Plume (Year 2015)



Modeling Assumptions

Initial Source Concentration=14000 mg/L
Hydraulic Conductivity = 2.74 ft/day
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

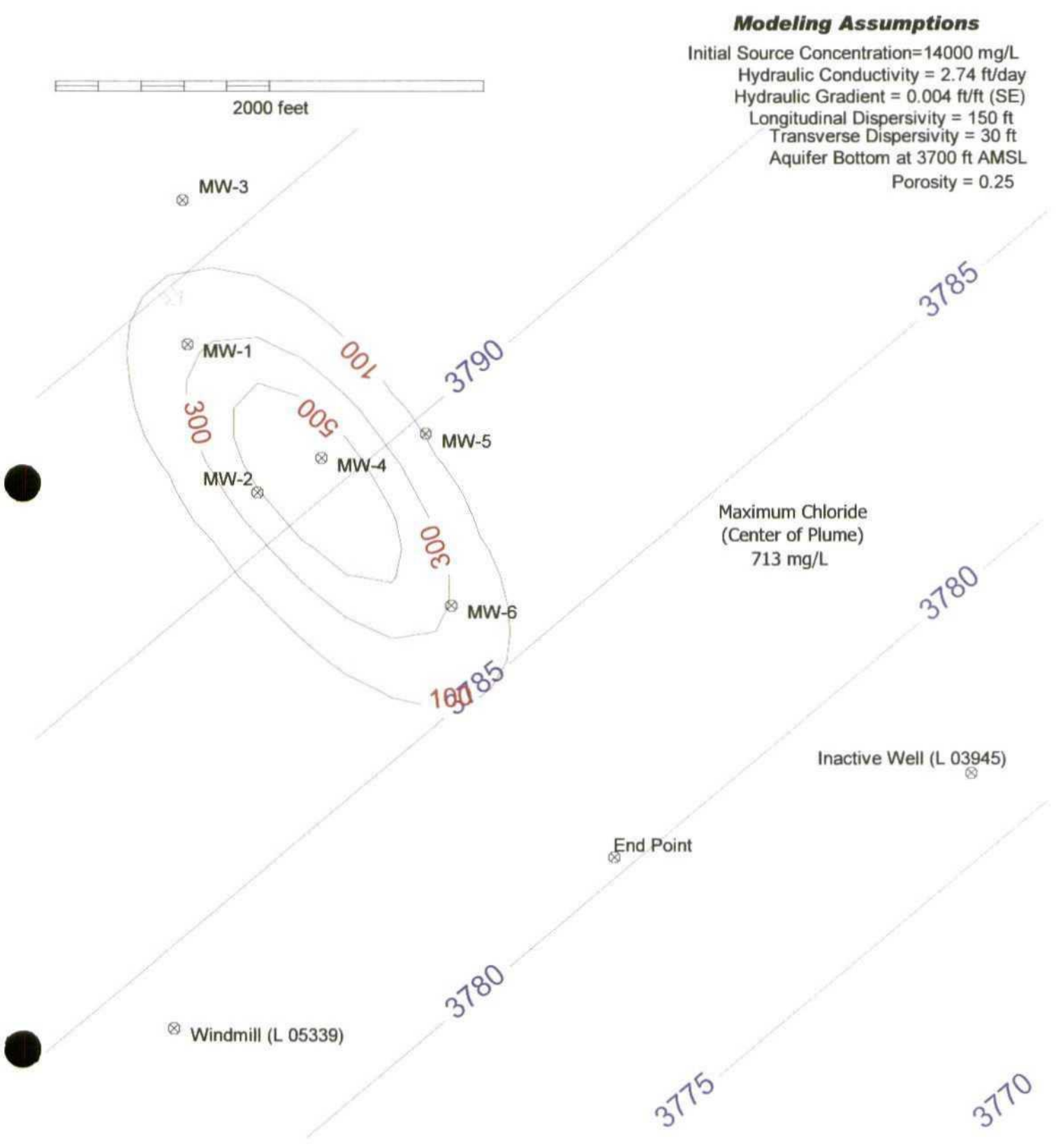
WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit Site
Chloride Plume (Year 2020)



Modeling Assumptions

Initial Source Concentration=14000 mg/L
Hydraulic Conductivity = 2.74 ft/day
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

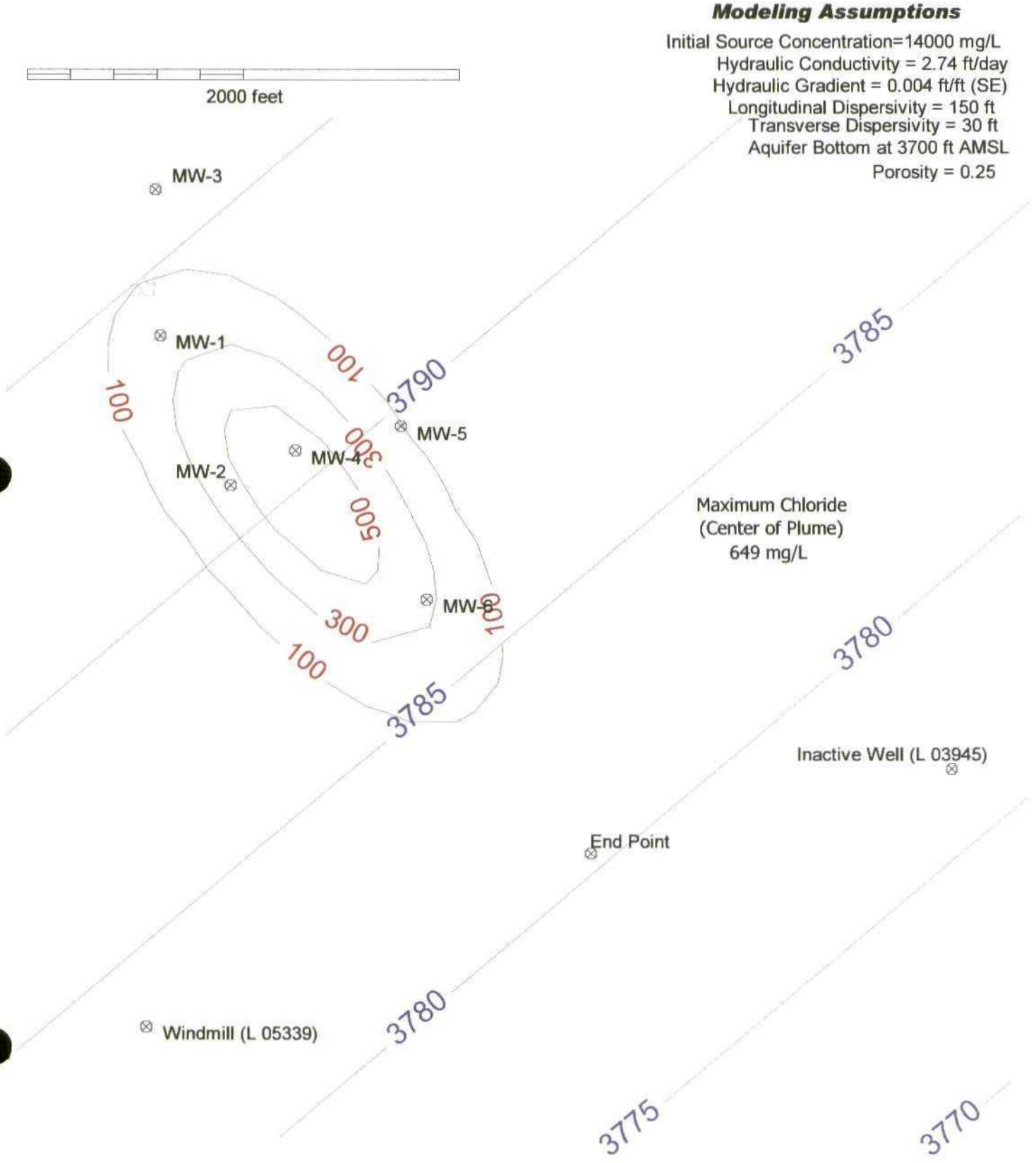
WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit Site
Chloride Plume (Year 2030)



Modeling Assumptions

Initial Source Concentration=14000 mg/L
Hydraulic Conductivity = 2.74 ft/day
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

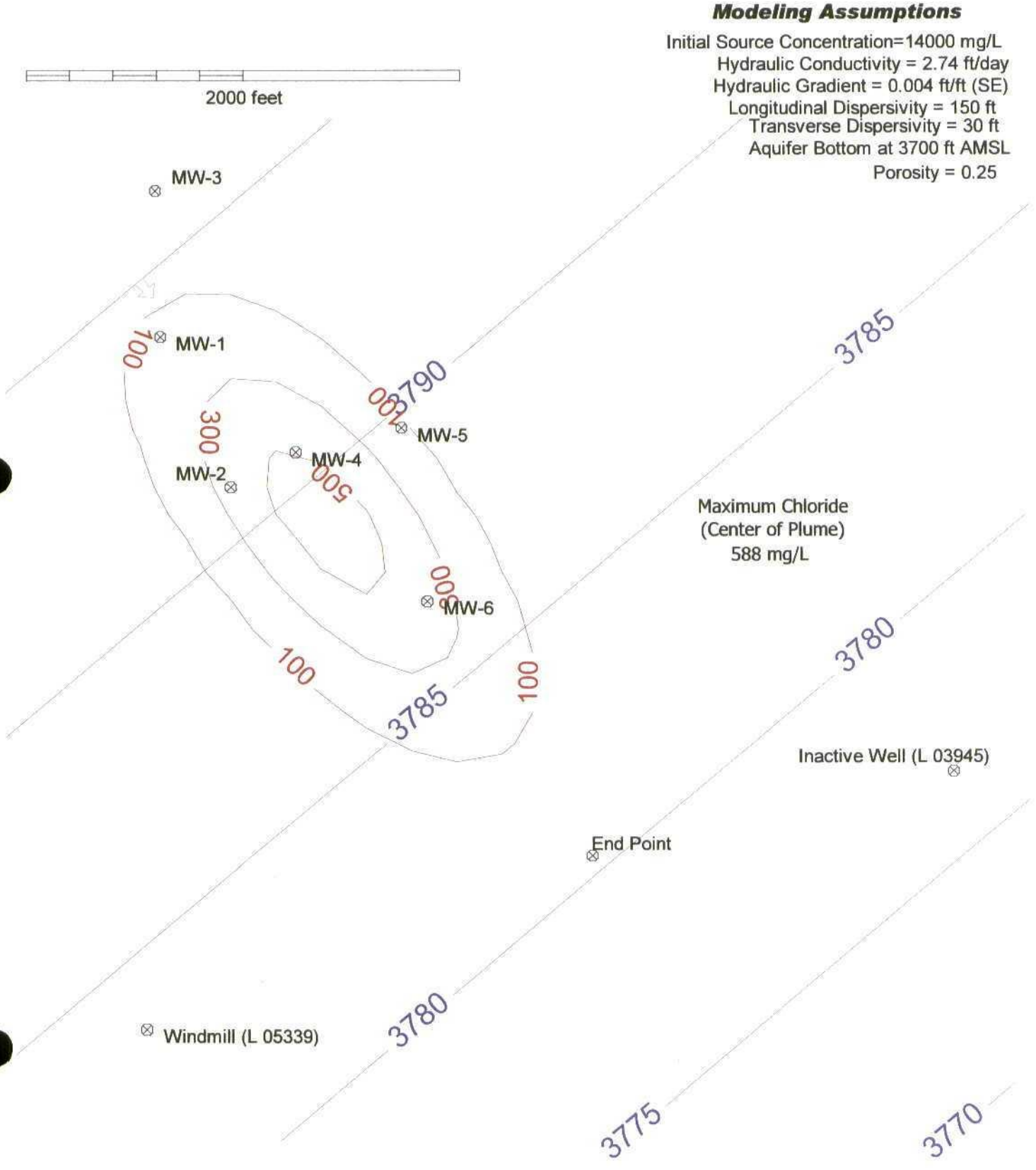
WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit Site
Chloride Plume (Year 2040)



Modeling Assumptions

Initial Source Concentration=14000 mg/L
Hydraulic Conductivity = 2.74 ft/day
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

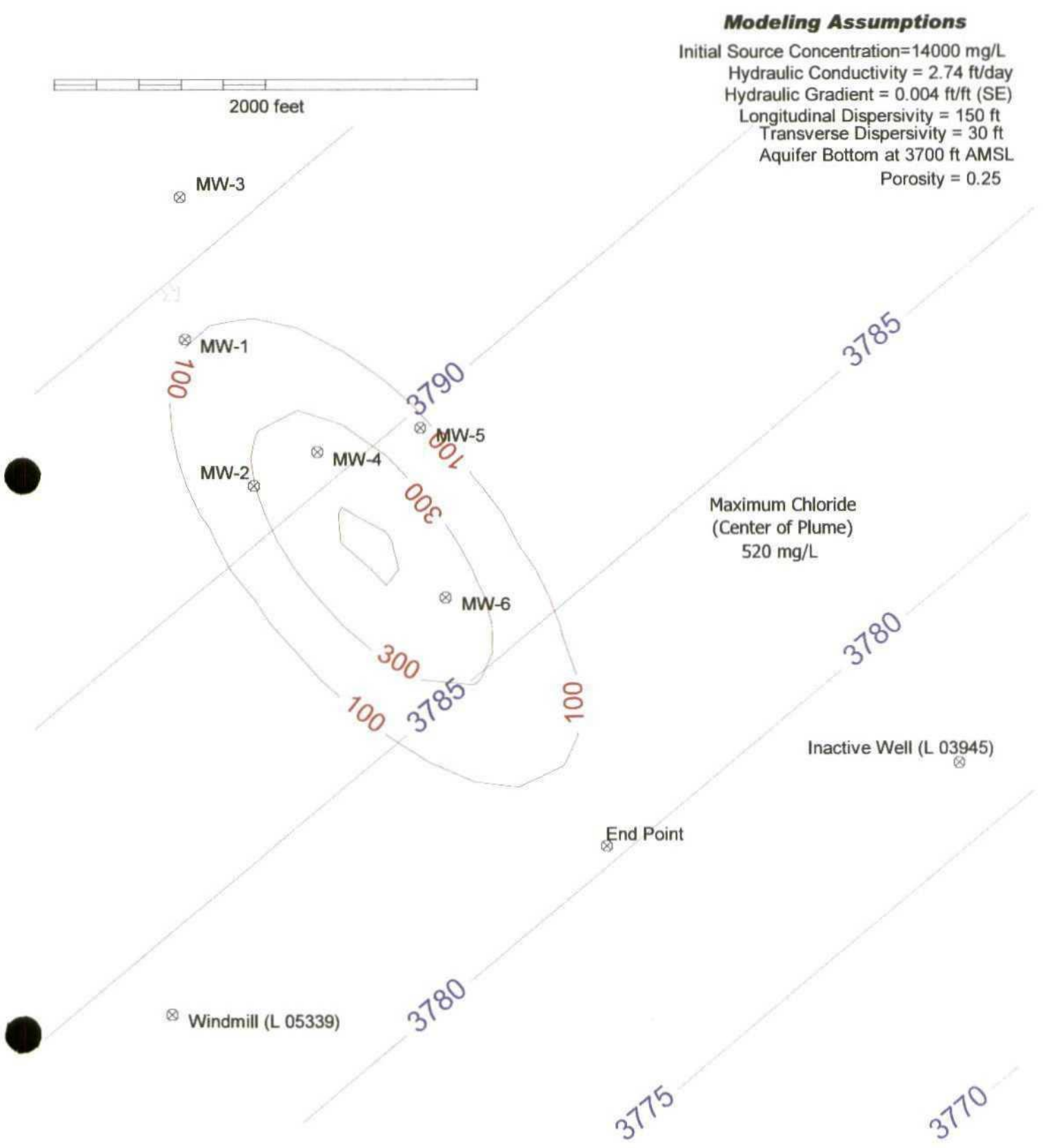
WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit Site
Chloride Plume (Year 2050)



Modeling Assumptions

Initial Source Concentration=14000 mg/L
Hydraulic Conductivity = 2.74 ft/day
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

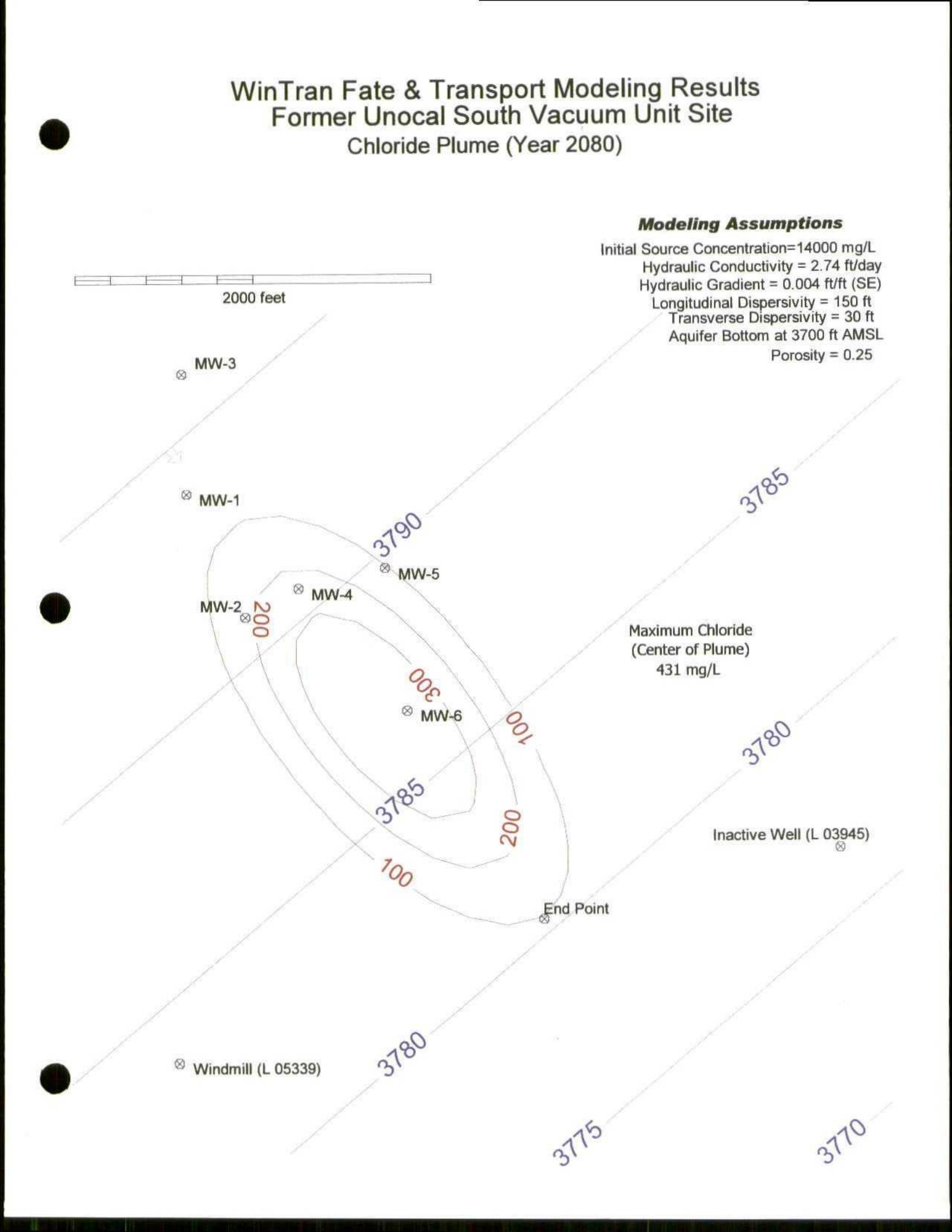
WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit Site
Chloride Plume (Year 2060)



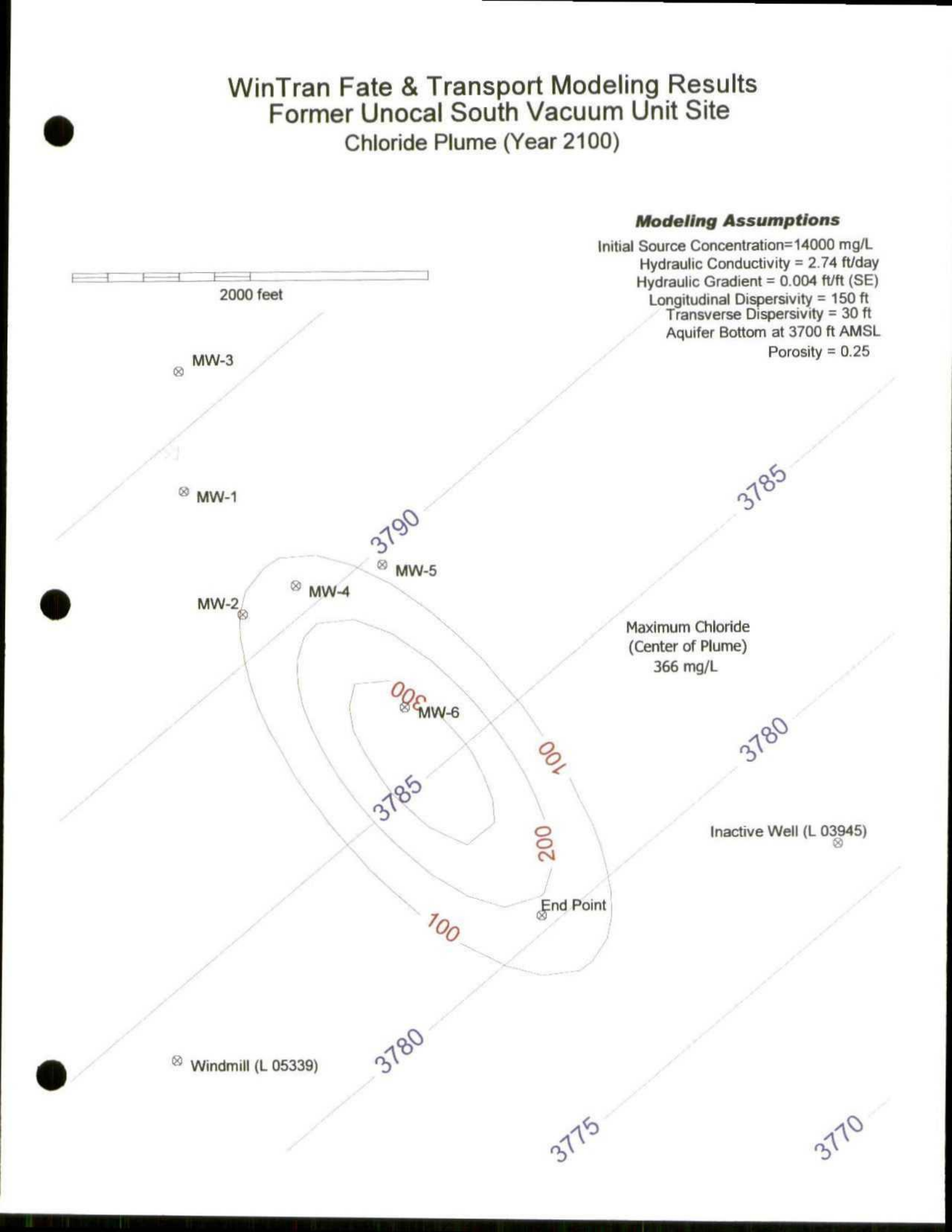
Modeling Assumptions

Initial Source Concentration=14000 mg/L
Hydraulic Conductivity = 2.74 ft/day
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

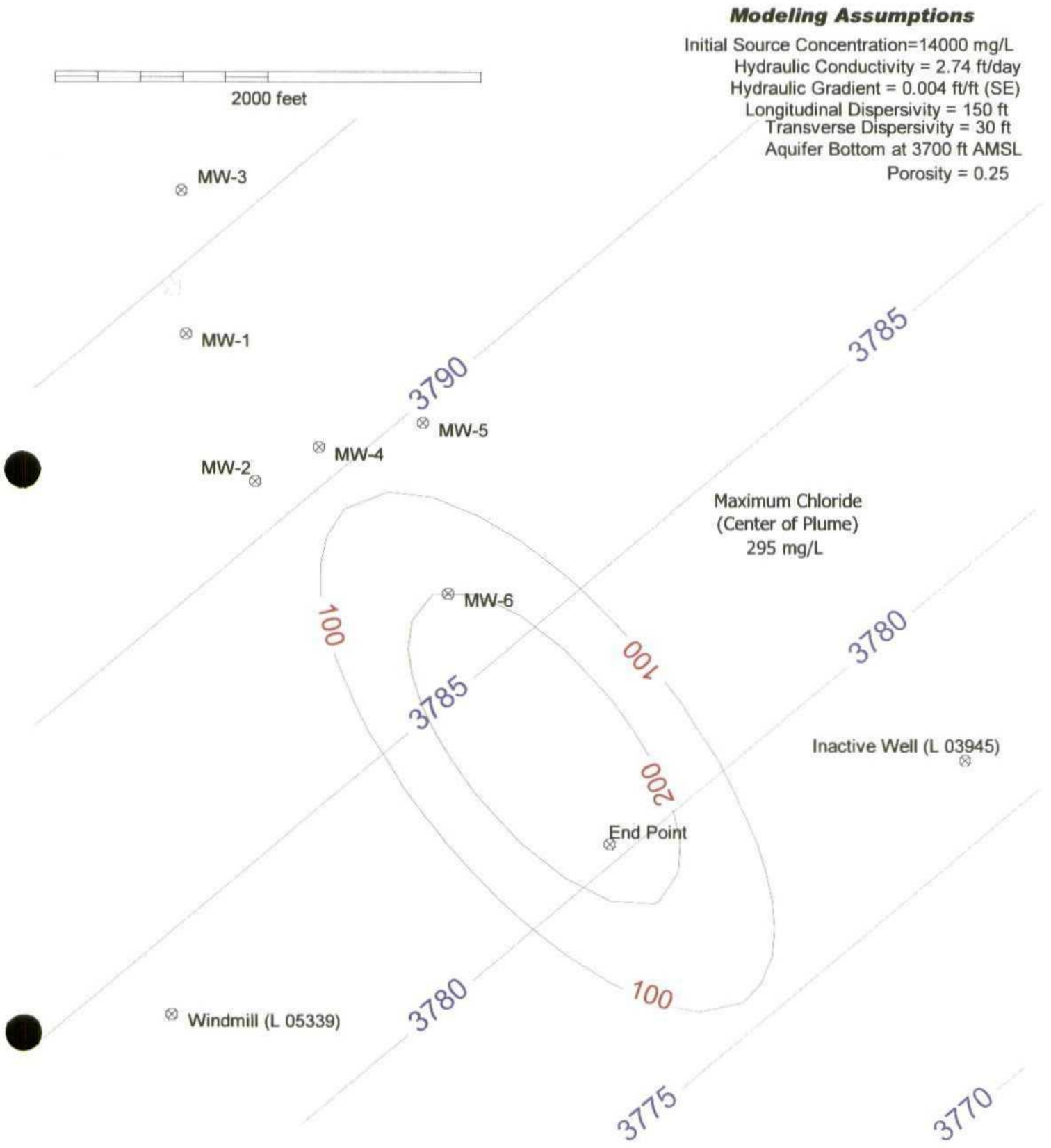
WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit Site
Chloride Plume (Year 2080)



WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit Site
Chloride Plume (Year 2100)



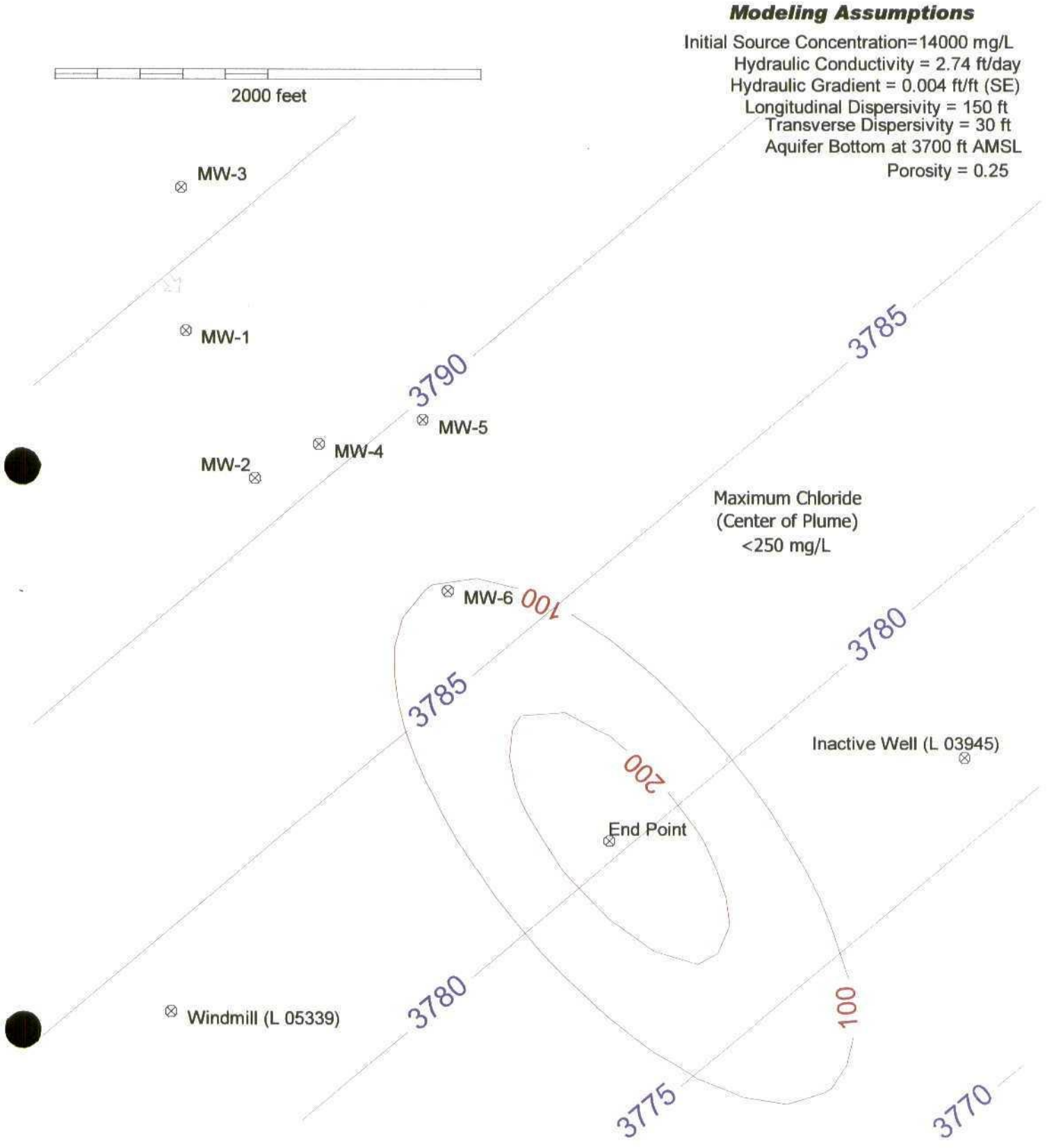
WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit Site
Chloride Plume (Year 2130)



Modeling Assumptions

Initial Source Concentration=14000 mg/L
Hydraulic Conductivity = 2.74 ft/day
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

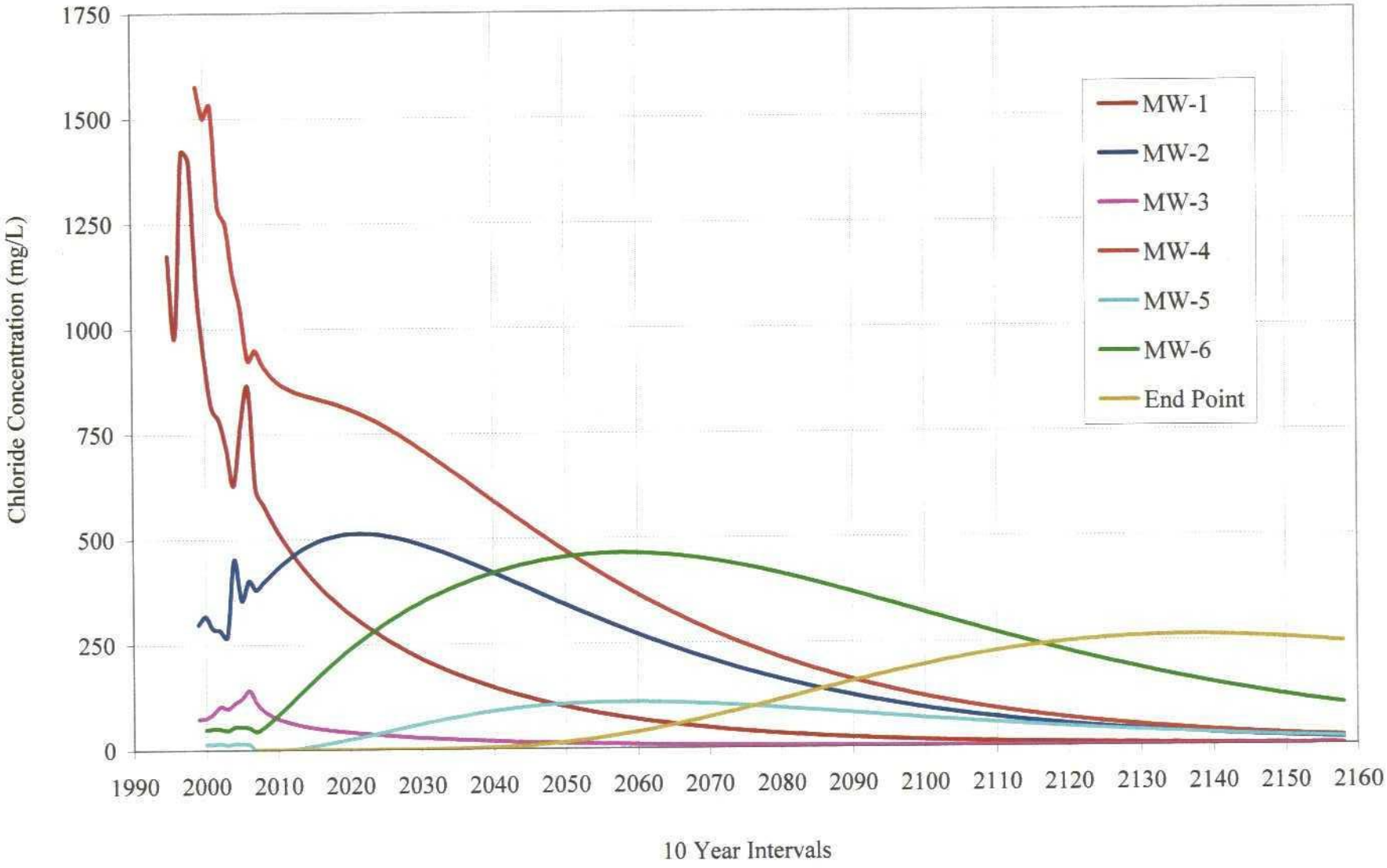
WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit Site
Chloride Plume (Year 2158)



Modeling Assumptions

Initial Source Concentration=14000 mg/L
Hydraulic Conductivity = 2.74 ft/day
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

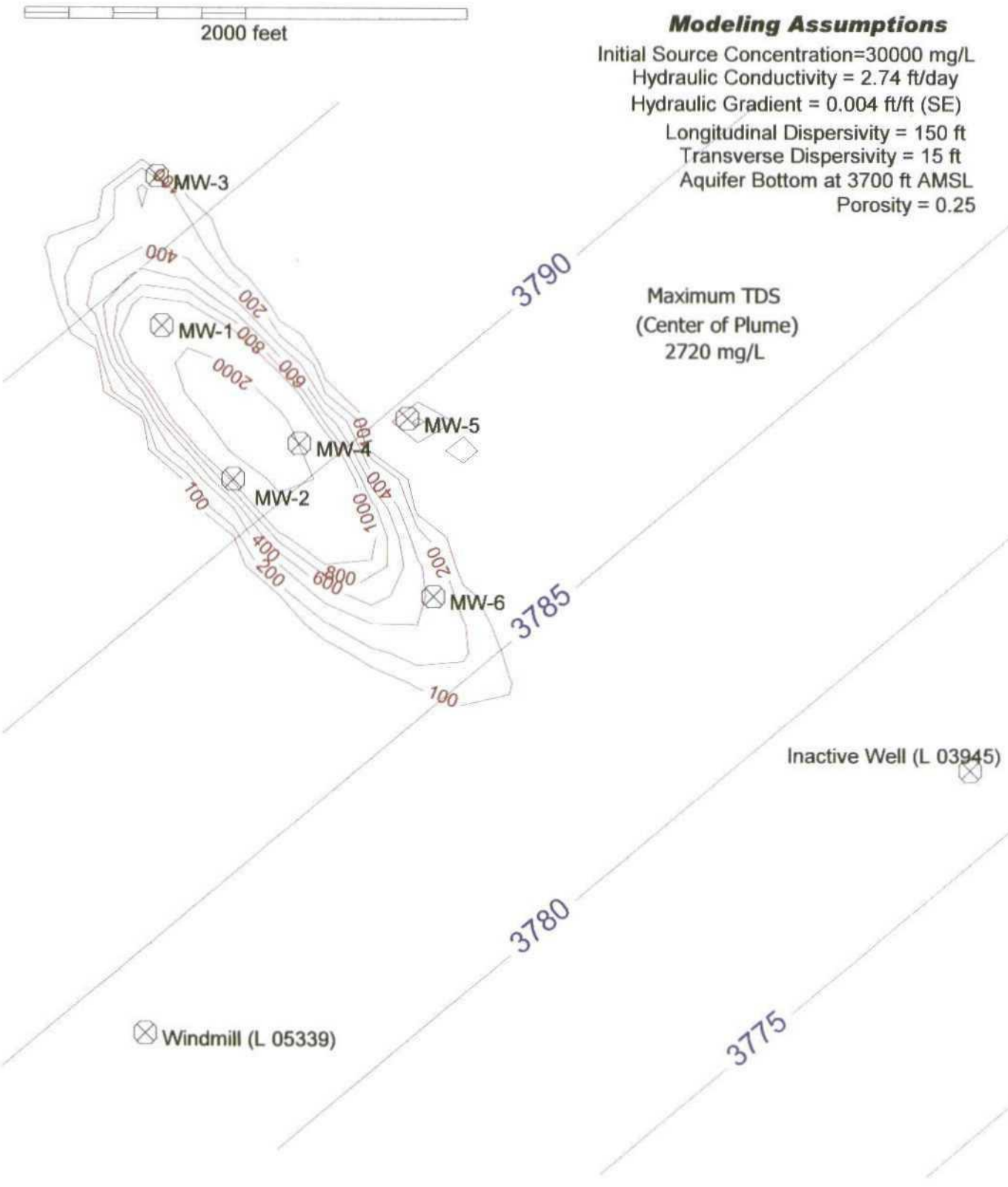
WinTran Fate & Transport Modeling of Chloride Concentrations Vs. Time



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

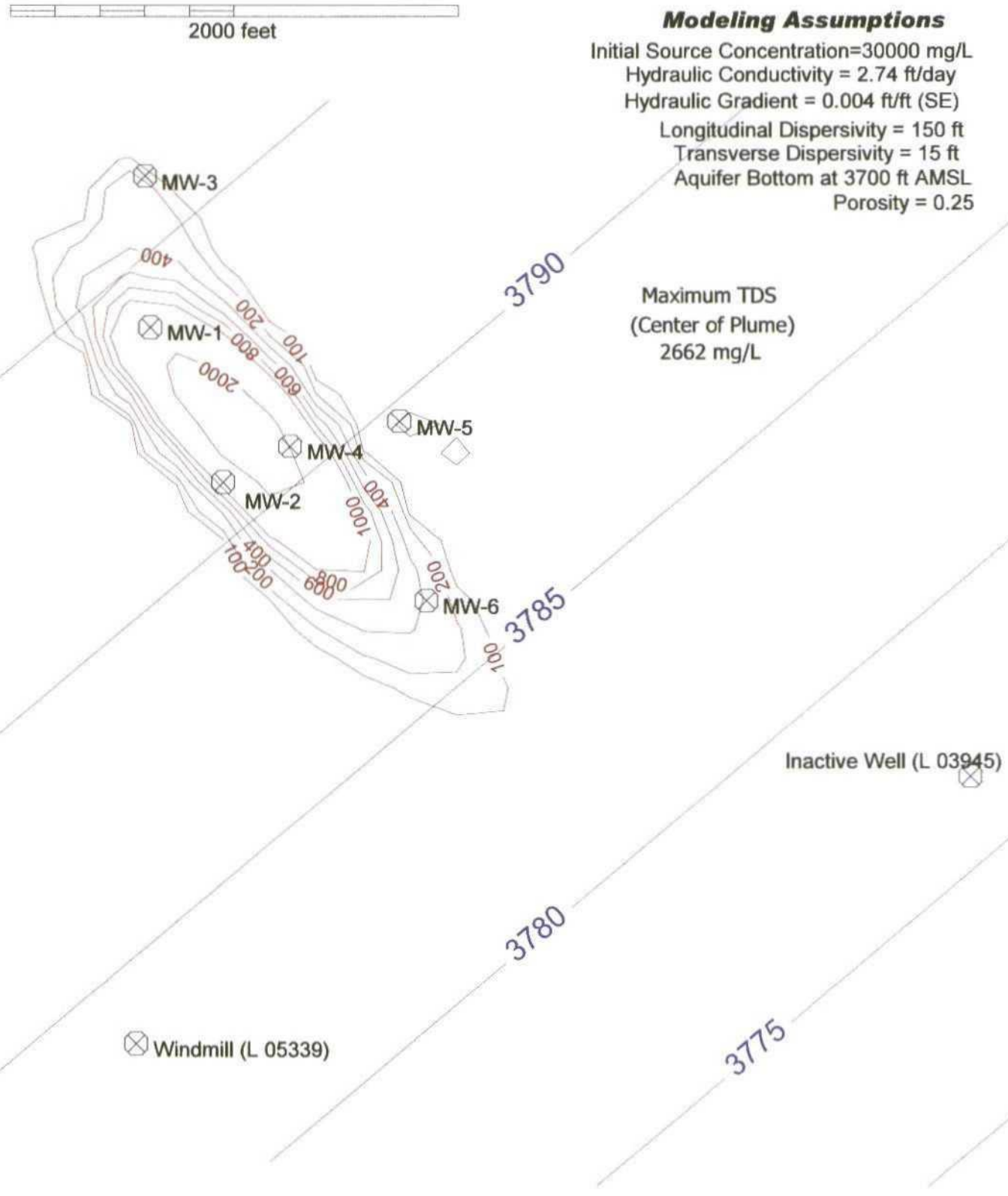
TDS Plume Simulation (Year 2007)



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

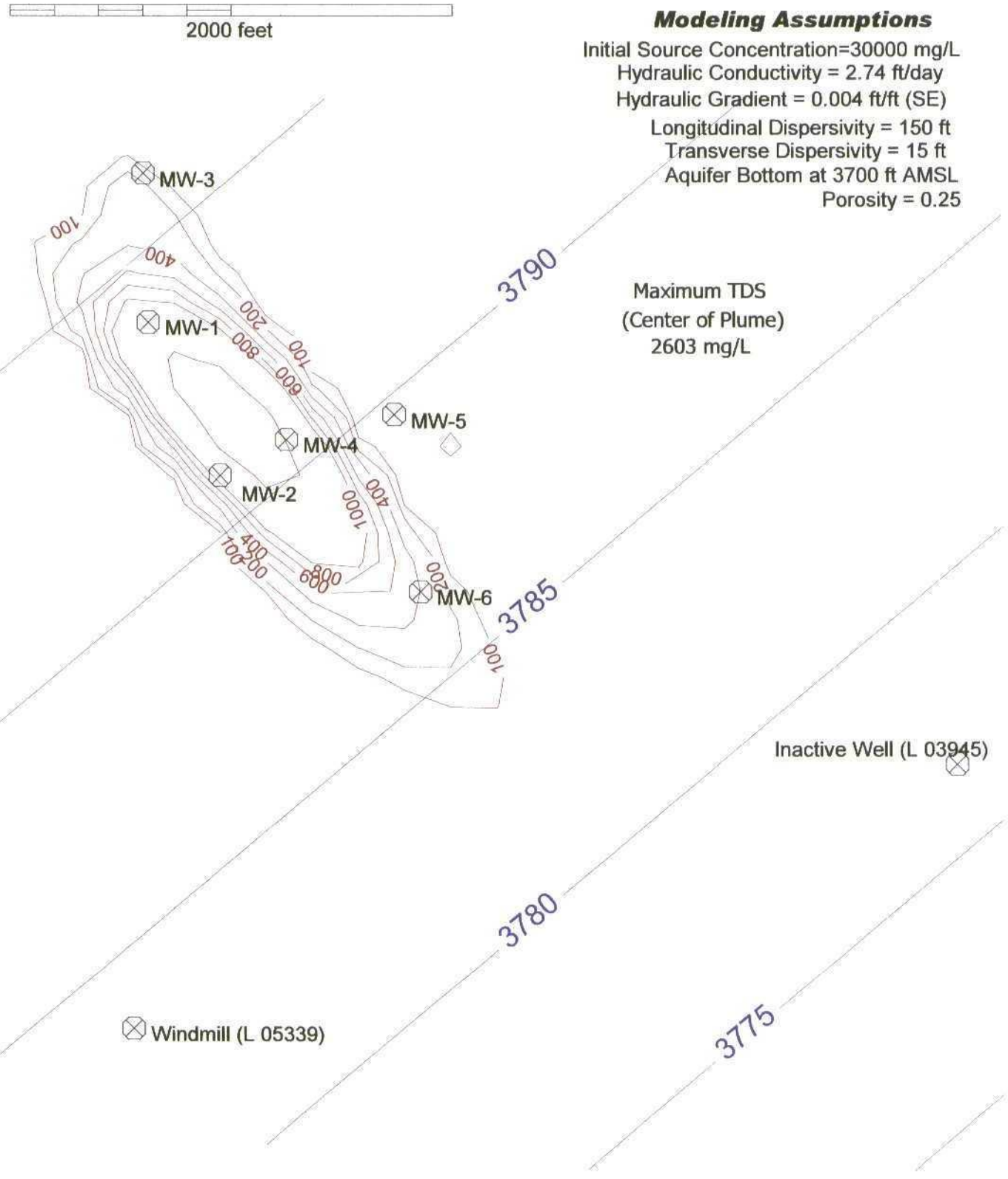
TDS Plume Simulation (Year 2008)



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

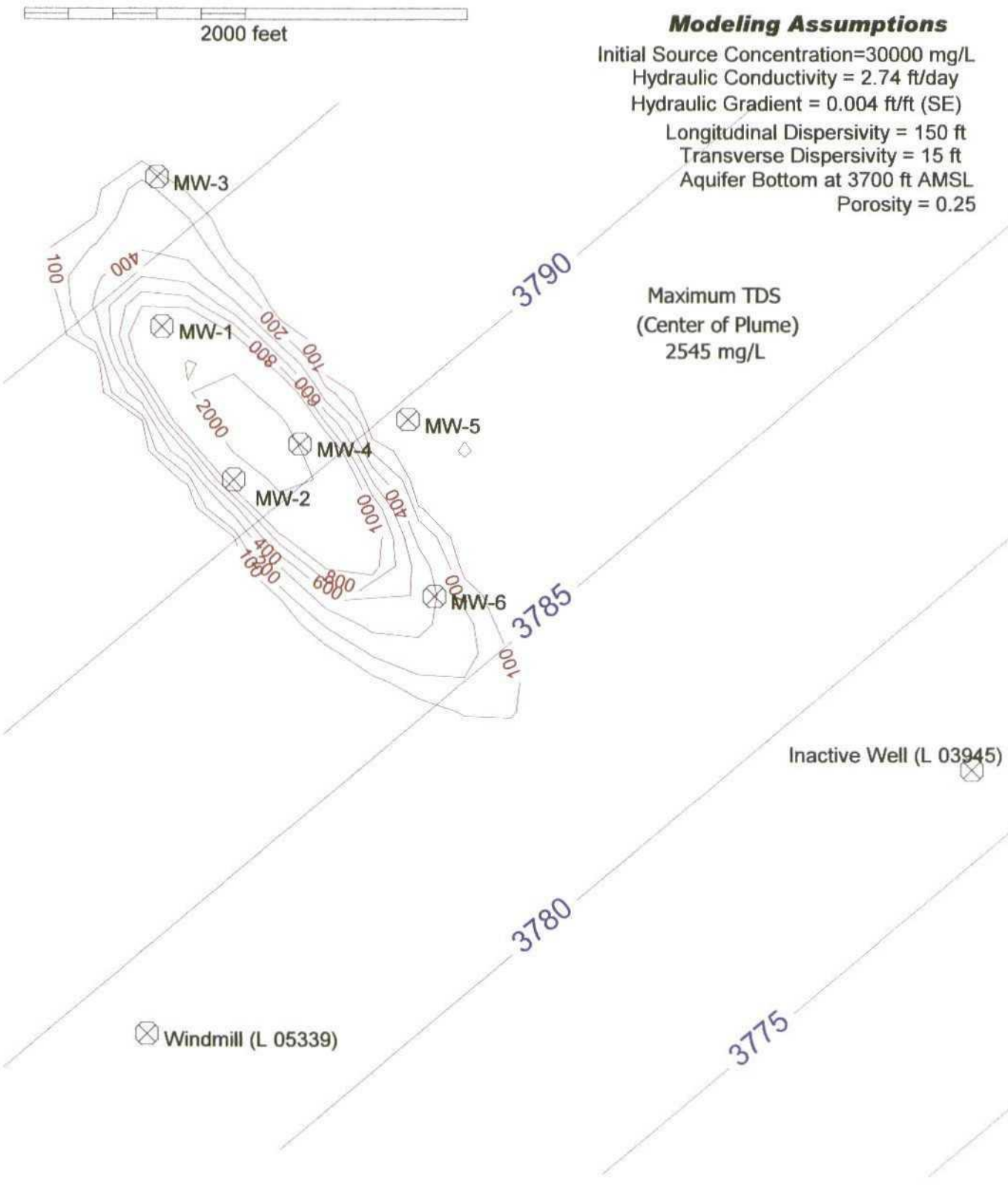
TDS Plume Simulation (Year 2009)



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

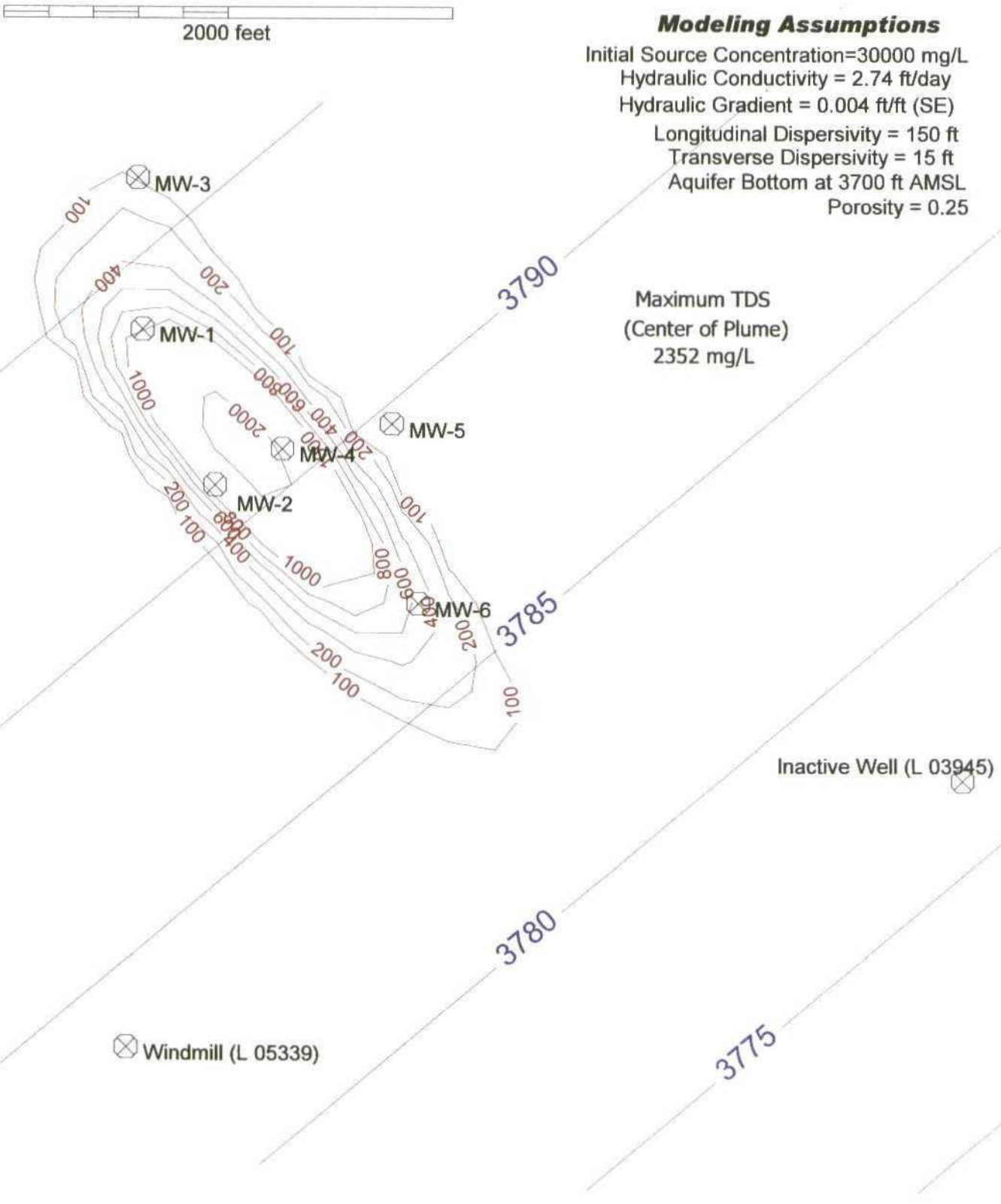
TDS Plume Simulation (Year 2010)



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

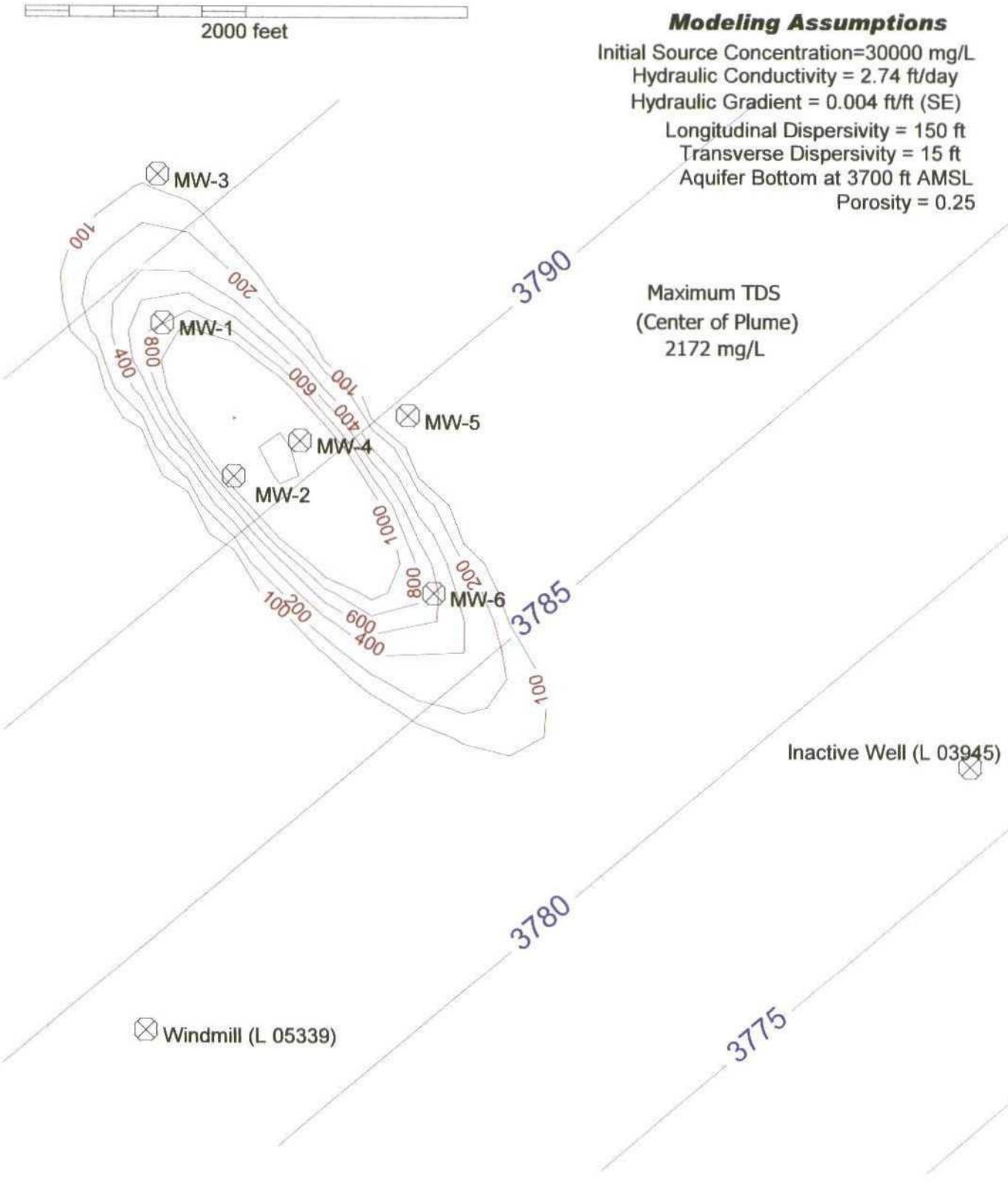
TDS Plume Simulation (Year 2015)



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

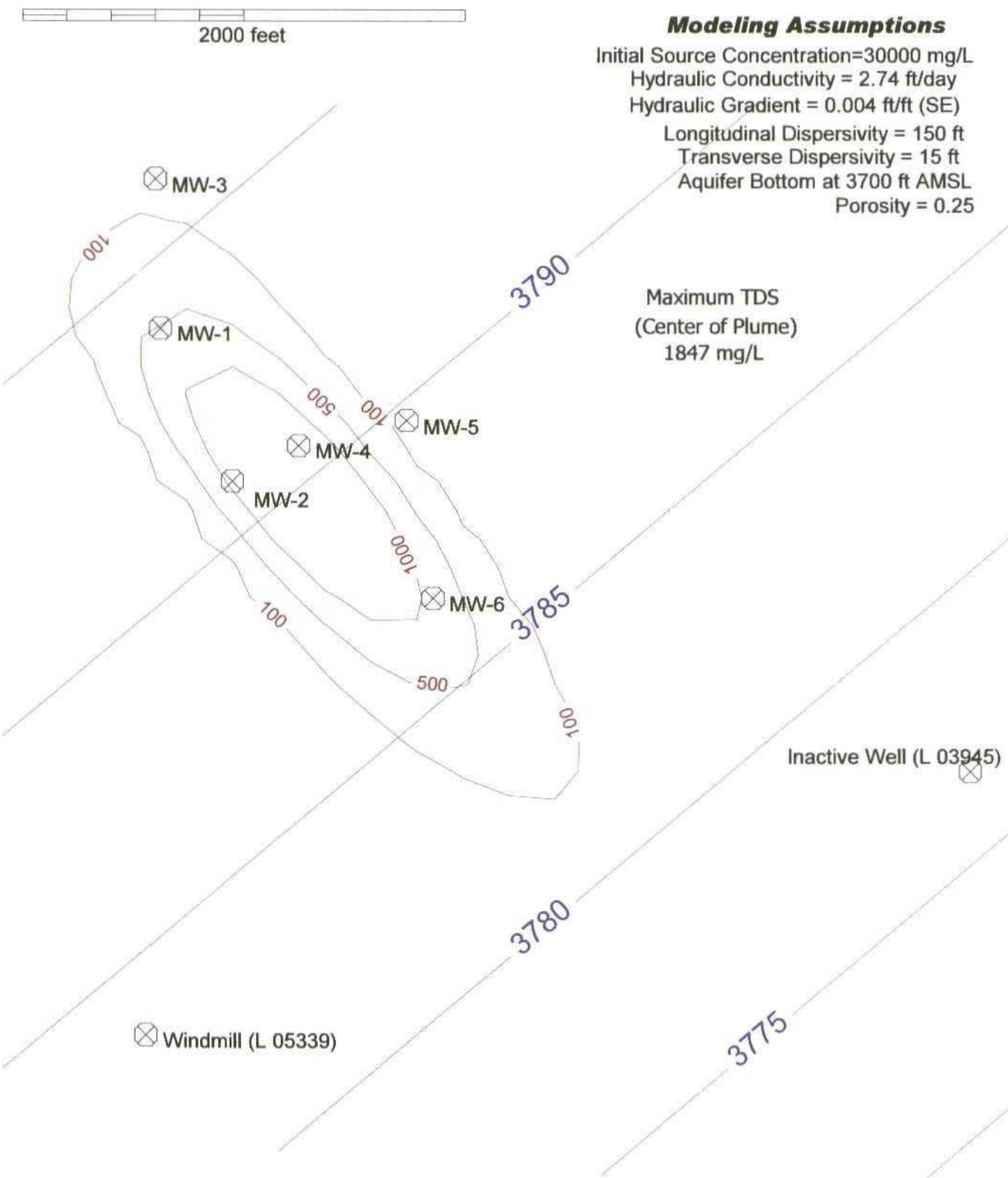
TDS Plume Simulation (Year 2020)



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

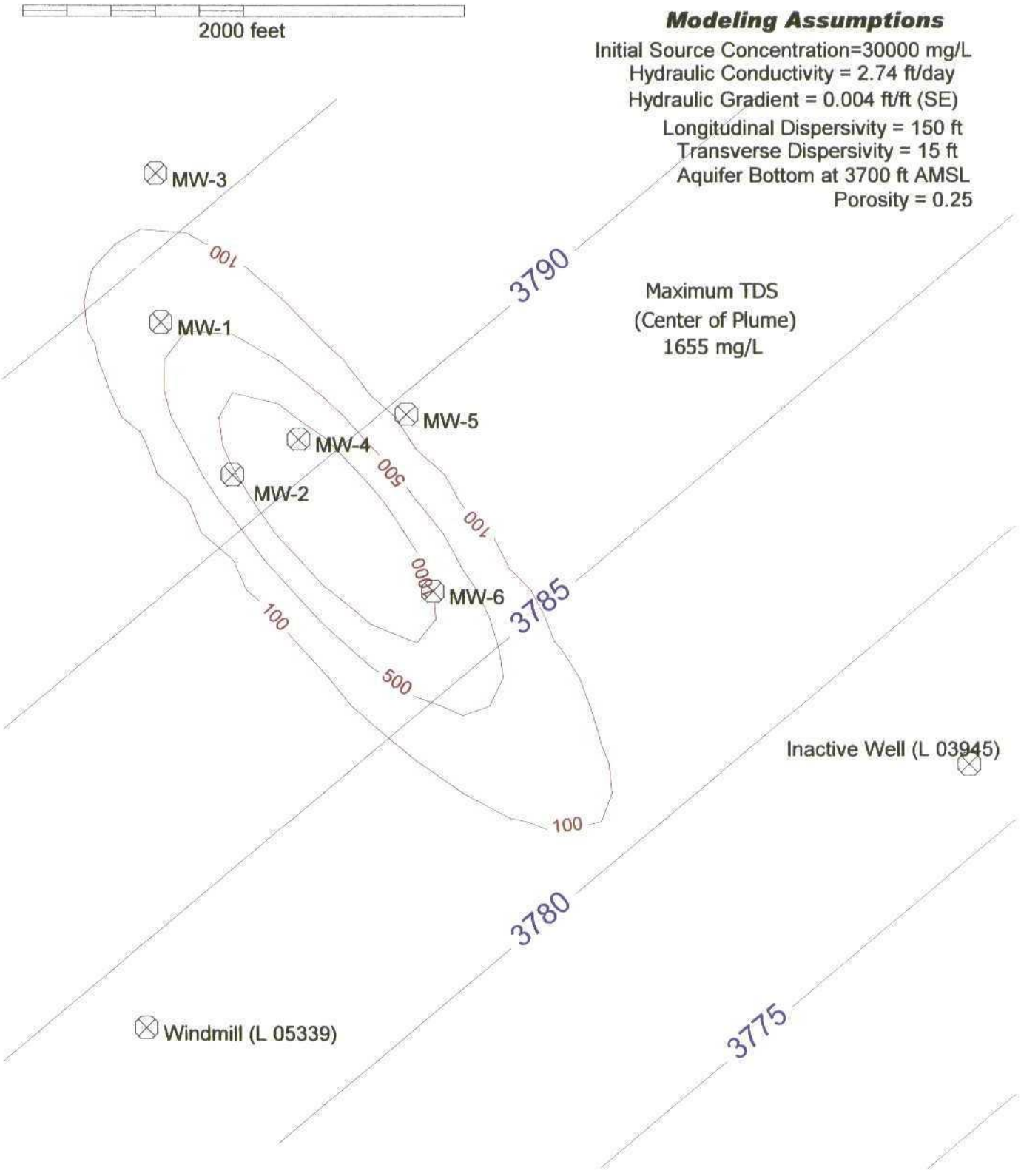
TDS Plume Simulation (Year 2030)



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

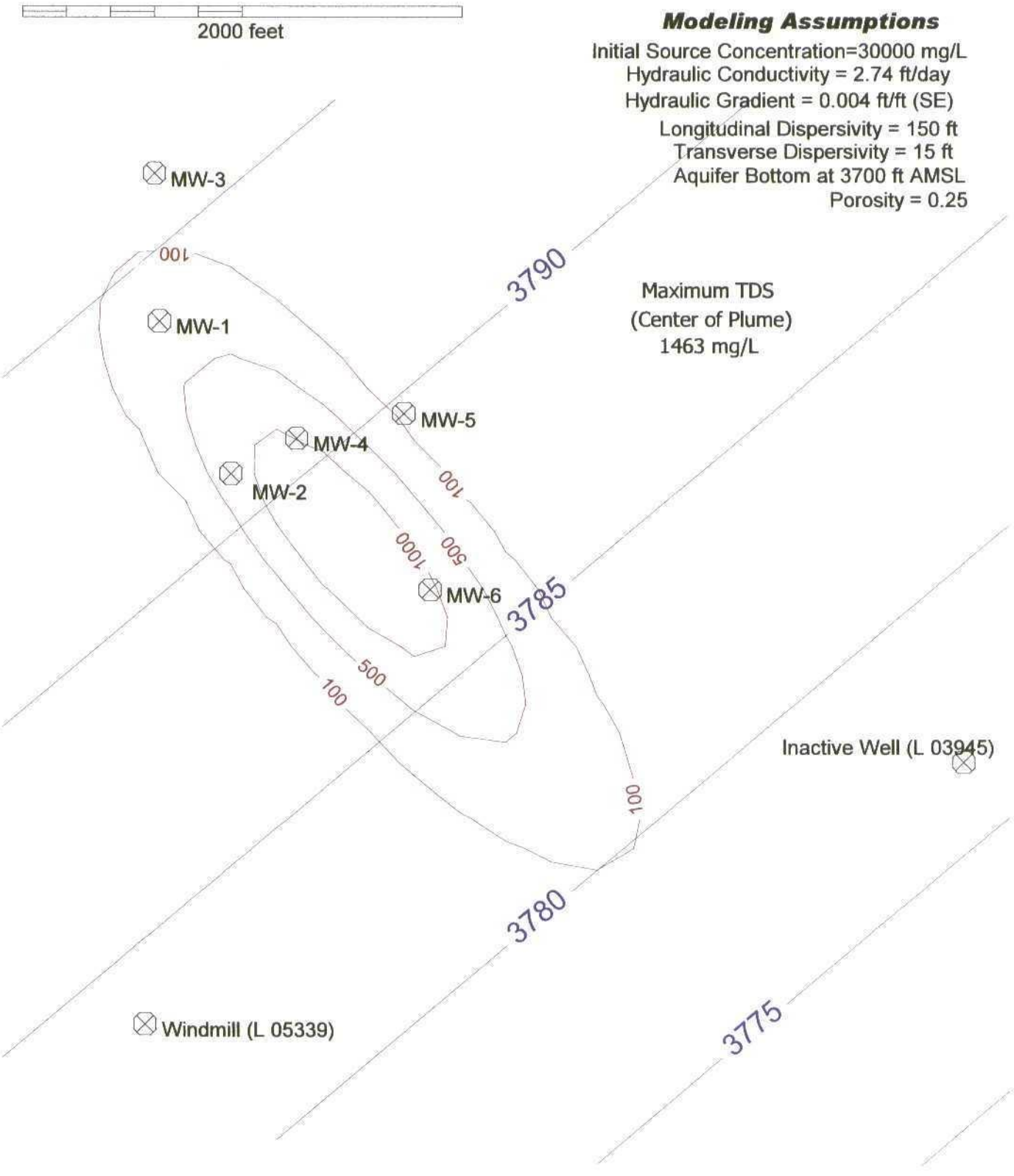
TDS Plume Simulation (Year 2040)



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

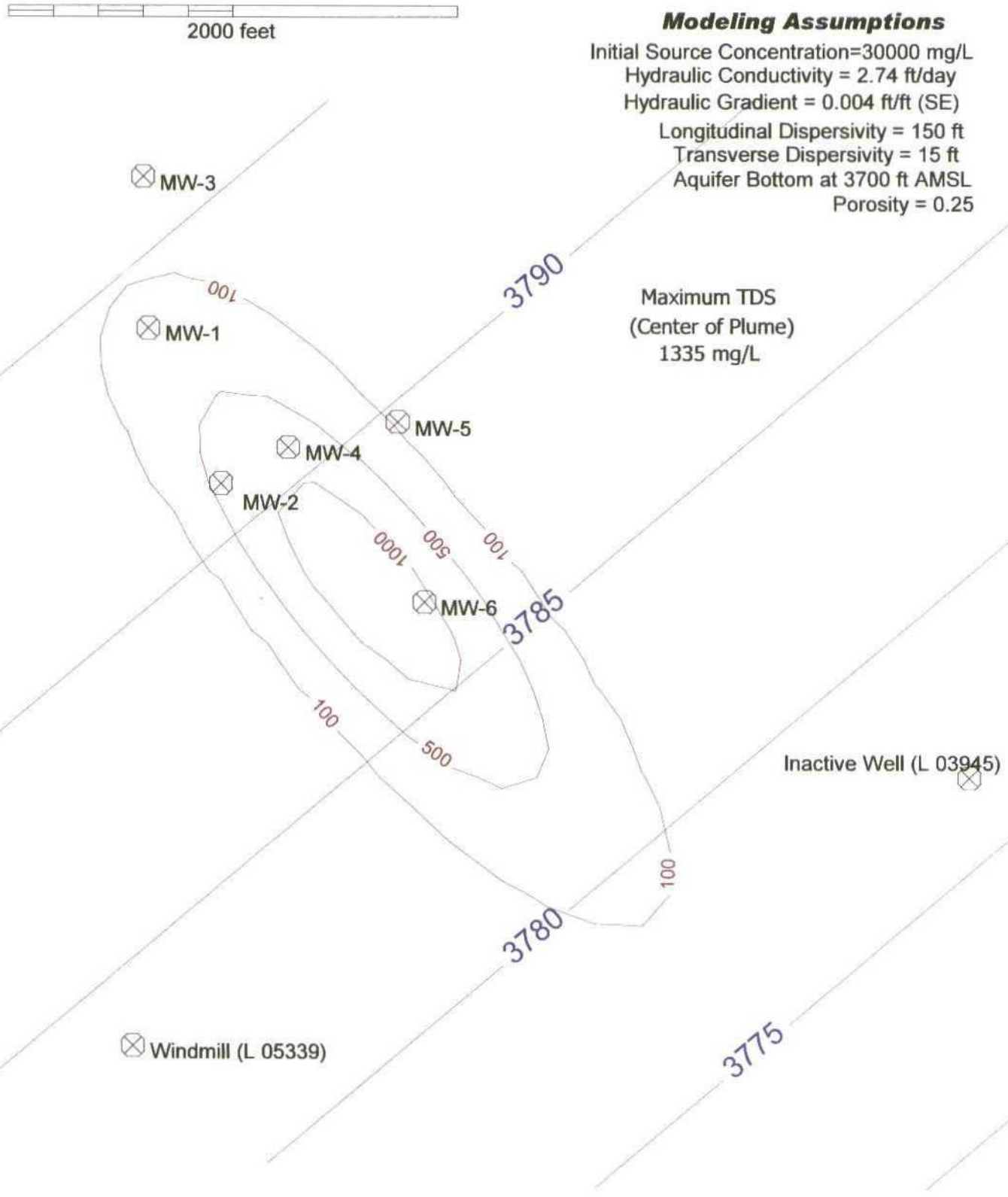
TDS Plume Simulation (Year 2050)



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

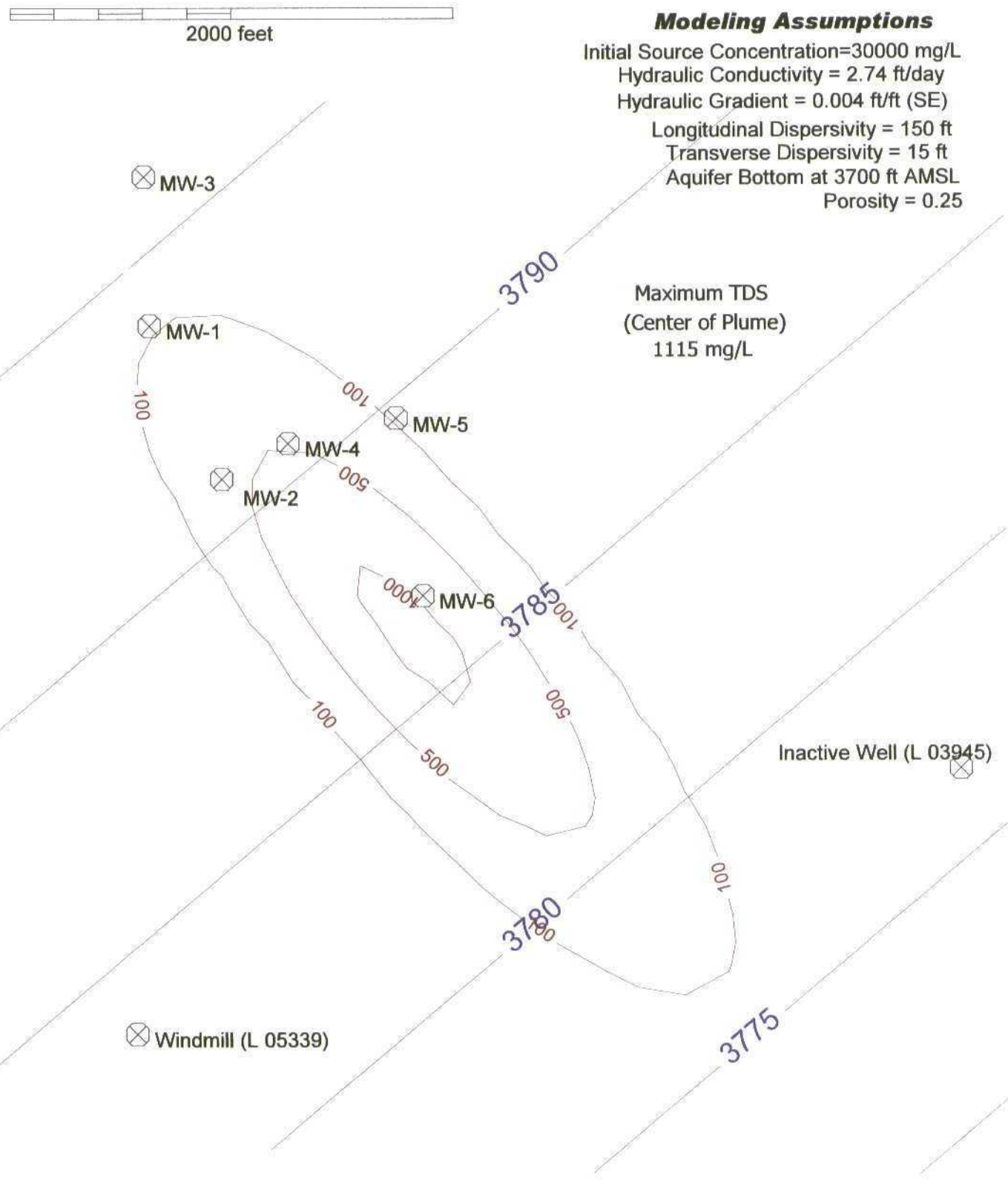
TDS Plume Simulation (Year 2060)



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

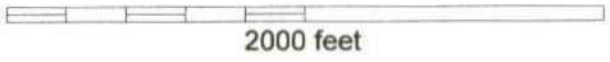
TDS Plume Simulation (Year 2080)



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2090)



Modeling Assumptions

Initial Source Concentration=30000 mg/L
Hydraulic Conductivity = 2.74 ft/day
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

Maximum TDS
(Center of Plume)
1028 mg/L

MW-3
MW-1
MW-5
MW-4
MW-2
MW-6
Inactive Well (L 03945)
Windmill (L 05339)

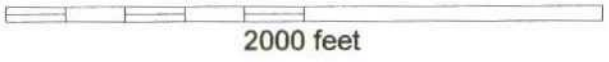
3790
3785
3780
3775

100
500
900

WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2095)



Modeling Assumptions

Initial Source Concentration=30000 mg/L
Hydraulic Conductivity = 2.74 ft/day
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

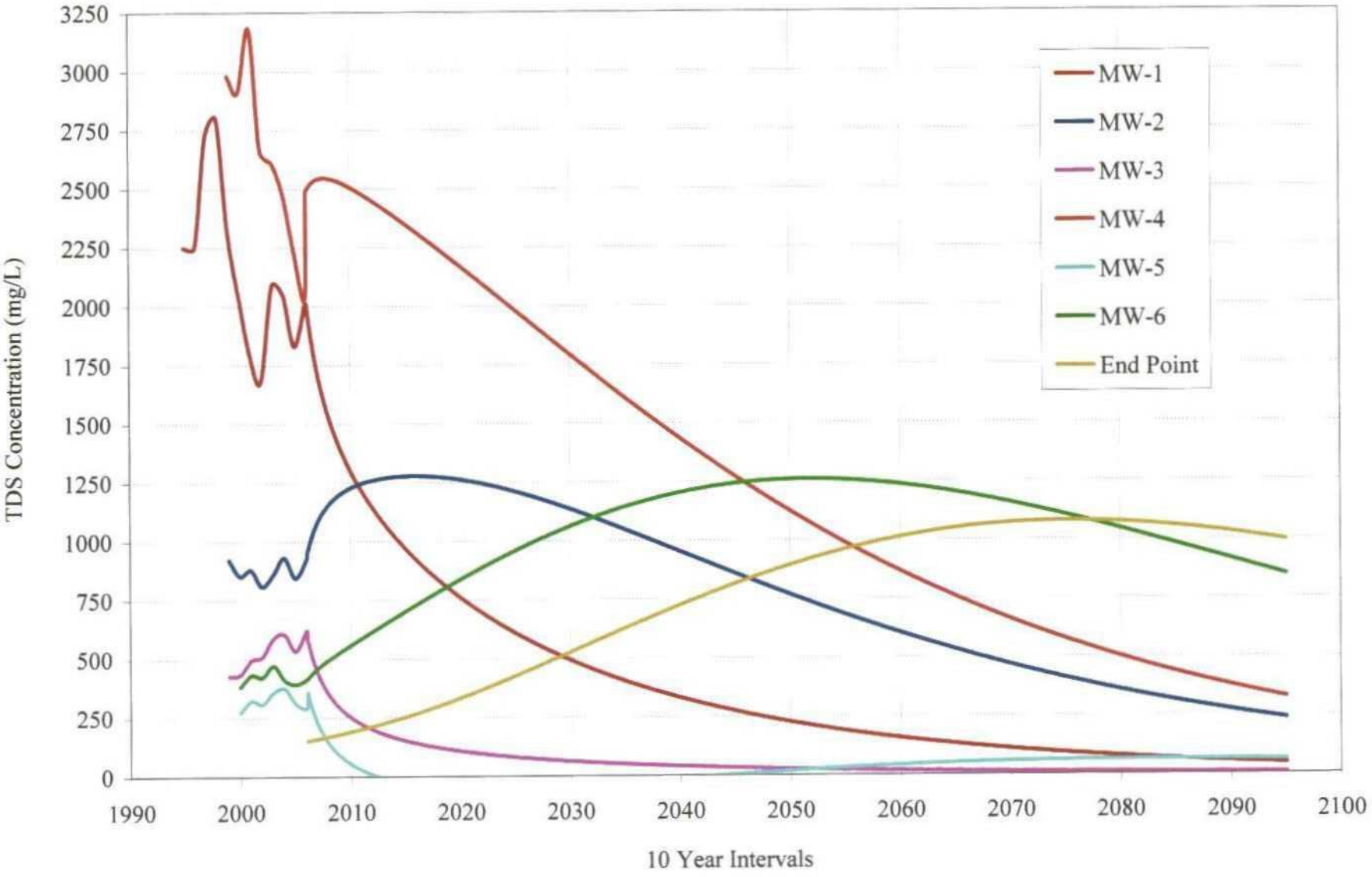
Maximum TDS
(Center of Plume)
<1000 mg/L

MW-3
MW-1
MW-5
MW-4
MW-2
MW-6
Inactive Well (L 03945)
Windmill (L 05339)

3790
3785
3780
3775

100
500
900

WinTran Fate & Transport Modeling of TDS Concentrations Vs. Time



APPENDIX D

Description of Fate and Transport Modeling

And Output Files

Description of Fate and Transport Modeling

Conceptual Model

Produced water containing high concentrations of chloride, and resultant high levels of total dissolved solids (TDS), was reportedly discharged into a surface pit and adjoining injection well for a period of about 10 years, until the well was plugged and abandoned in1971. The chloride and TDS plume continued to migrate southeastwards for the next approximately 30 years after the source input was stopped, producing the configuration and constituent concentration distribution observed currently. Extrapolating from current conditions for decades into the future, taking account of both advective flow and attenuation by hydrodynamic dispersion, enables prediction of the probable distance that the residual plume will travel as well as the gradually declining concentrations in the plume.

Basic Site Data

Information about site conditions was obtained from data in a TRW Inc. "Report of Additional Groundwater Investigation, Former Unocal South Vacuum Unit, Lea County, New Mexico" (July 18, 2000). This included lithologic records from well installations, water level data, and water quality analytical results.

Simulation Model

Simulations were conducted with the two-dimensional groundwater flow and contaminant transport model WinTran, version 1.03 (1995) designed and distributed by Environmental Simulations, Inc. (ESI) of Herndon, Virginia. WinTran is built around a steady-state analytical element flow model, linked to a finite element contaminant transport model. The Windows interface allows for rapid data input, processing, parameter manipulation and optimization, and output in multiple formats. The fundamental mathematics of the model solutions, model verification (benchmarked against MODFLOW), and use of WinTran is documented in the "Guide to Using WinTran" published by ESI.

Base Map

A simplified site base map, edited with TurboCAD (Version 7), was exported to a universal drawing exchange file (DXF) file format. The DXF base map was imported into WinTran, which preserves the original units of measurement.

Flow Parameters

Input requirements for the steady-state groundwater flow simulation include: hydraulic gradient and direction of flow, hydraulic conductivity, aquifer top and bottom elevations, and reference head. The values used were based on the following sources:

- Hydraulic gradient – measured gradient of 0.004 feet/foot from July 31, 2006 site measurements reported by Trident.

- Direction of flow – measured direction of approximately S 40° E from July 31, 2006 site measurements reported by Trident.

- Hydraulic conductivity – no site measurements were available; therefore, a literature value based on the saturated zone lithology was selected. Typical lithology is described as silty sand and very fine sand. Fetter (1988, Table 4.5, p. 80) cites an average range of 10^{-5} to 10^{-3} cm/sec for hydraulic conductivity of silty sands and fine sands. A conservative upper limit was selected, and converted from S.I. unit to 2.8 ft/day, or approximately 1000 ft/yr.

- Aquifer top and bottom elevations – bottom elevation of Ogallala Formation at 3700 feet reported by Trident. The top elevation for an unconfined aquifer must be greater than the reference head. An elevation of 4000 feet was assumed.

- Reference head – measured unconfined head of 3795.5 feet adjacent to the former pit and upgradient well MW-1 from July 31, 2006 measurements reported by Trident.

Transport Parameters

Input requirements for the contaminant transport numerical simulation include: longitudinal and transverse dispersivity, porosity, diffusion coefficient, contaminant half-life, and retardation coefficient. The values used were based on the following sources:

- Longitudinal and transverse dispersivity – no site measurements were available; therefore, a literature value based on the plume length was selected. Fetter (1993, Section 2.11, pp. 71-77) notes the apparent scale-dependency of longitudinal dispersivity, which typically may be about 0.1 times the flow length. For the current site scale and plume length of approximately 1500 feet, a value of 150 feet was selected for longitudinal dispersivity. According to the WinTran user's guide (ESI, 1995, p.11), longitudinal dispersivity is usually 5 to 10 times higher than transverse dispersivity; therefore, a value of 30 feet (i.e., one-fifth of the longitudinal value) was selected for transverse dispersivity.

- Porosity – no site measurements were available; therefore a literature value based on saturated zone lithology was selected. Typical lithology is described as silty sand and very fine sand. A range of 0.25 to 0.50 is typically given for unconsolidated "sand" (e.g., Freeze & Cherry, 1979, Table 2.4, p. 37); however, the Ogallala Formation is predominantly very fine grained, compacted and partly cemented, and may also fit within the range of 0.05 to 0.30 for sandstone. Fetter (1988, Table 4.3 and Figure 4.10, pp. 74-75) cites an average value of 0.20 for the specific yield of very fine sands. Specific retention of silty fine sand is approximately 0.05, for a total porosity of 0.25, which is the value selected for the transport modeling. WinTran uses the porosity term to estimate groundwater velocity, and actually requires an effective porosity value. Fetter (1988, Section 4.4, pp. 84-85) notes that pores of most sediments down to clay size are interconnected and that the effective porosity is virtually equal to the total porosity.

- Diffusion coefficient – this parameter is normally only relevant for very slow fluid movement, and is commonly assumed to be zero for advective-dominated transport, as in the present case.

- Contaminant half-life – this parameter accounts for chemical decay (e.g., radioisotopes, biological transformation of organic molecules); however, the species of interest in the present case are inorganic ions and are not expected to decay to any appreciable extent. A conservative value of 1000 years was used, which produces a negligible decay coefficient of less than 0.001 yr^{-1}.

- Retardation coefficient – this parameter accounts for sorption processes that slow the movement of contaminants relative to the groundwater velocity. Inorganic ions such as chloride are commonly taken as conservative tracers in groundwater and are not considered to be retarded; therefore, a value of 1.0 was selected for the retardation coefficient.

Flow Model Calibration

The vicinity of the site where water level measurements were recorded in July 31, 2006 is simulated closely by the flow model. It is known that groundwater levels in the Ogallala Formation are decreasing slowly (approximately 0.3 ft/yr), but this effect cannot be reproduced in the steady-state flow model. Water levels were probably somewhat higher than the present day during the period of brine disposal and initial transport. Even if the declining trend continues into the future, it does not affect the transport model solution for long extrapolation times, since sufficient saturated thickness remains (i.e., above the assumed aquifer base elevation of 3700 feet) for a valid flow and transport solution.

The average groundwater velocity may be estimated using the darcy expression: $v = (k \,.\, i) / n$ where k is the hydraulic conductivity (1,000 ft/yr), i is the hydraulic gradient (0.004 ft/foot), and n is the effective porosity (0.25). The resultant average velocity is 16 ft/yr.

Transport Model Calibration

The objective of the transport modeling was to first obtain a plume configuration with concentration values that closely match current observed values. This was done by simulating an initial contaminant release to groundwater for a period of 11 years (c. 1960 to 1971) with a constant source concentration located at the pit and injection well, then simulating a 28-year transport period (c. 1971 to 1999) with no further contaminant input but restarting the model from the end of Year 11 by retaining the mass of contaminant from the initial plume. An iterative approach was needed to optimize the initial source concentration so that the plume at Year 39 resembled the actual plume conditions in 1999. An initial value of 14,000 mg/L for chloride and 30,000 mg/L for TDS were found to produce the best match. The initial chloride value was also chosen because it is typical of chloride concentrations within the producing formation (Devonian) in the South Vacuum Oil Field according to chemists at Martin Water Laboratories (verbal communication, 12-05-01). Actual disposal concentrations during the 1960s are unknown, and may have been higher than these values, but it is presumed that some attenuation and dilution may have occurred in the vadose zone, which is currently 48 to 68 feet thick. WinTran does not account for vadose zone transport, and the source input is treated as an injection well with instantaneous transfer of contaminant mass to groundwater.

After calibrating the model such it corresponded to actual 1999 conditions, the model was again run for 7 years (1999 to 2006) at one-year increments after entering in the known concentrations at each monitoring well.

Simulation of Fate and Transport

Estimation of chloride and TDS fate and transport was achieved by restarting the transport model in 2006. Figures displaying modeled simulations of the chloride and TDS plumes over various time increments are included in Appendix C. Advective flow moves the center of plume mass downgradient as depicted in the simulations. The simulations also demonstrate how hydrodynamic dispersion serves to broaden the dimensions of the plume while reducing the concentrations in the middle of the plume.

Running the model for 152 years in the future (Year 2158) produces a chloride plume center concentration of 247 mg/L (below the WQCC standard of 250 mg/L). The center of the chloride plume is approximately 3,200 ft away from the former pit and well source at that time.

Running the model for 89 years in the future (Year 2093) produces a TDS plume center concentration of 995 mg/L (below the WQCC standard of 1,000 mg/L). The center of the TDS plume is approximately 2,300 ft away from the pit and well source at that time.

These results support the contention that the chloride and TDS plume is not likely to impact any existing sources of water supply, the closest of which is a windmill (NM File No. L05339) located approximately 3,000 feet south of the source.

The trend of decreasing concentration is not linear (exponential e^{-kt} function). Interestingly, the center of the plume moves at a greater rate (22 feet/year) over successive time intervals than would be assumed from the groundwater velocity alone (16 feet/year), due to the added effect of dispersion.

WinTran
Analytical Model of 2D Ground-Water Flow and
Finite-Element Contaminant Transport Model

Developed by

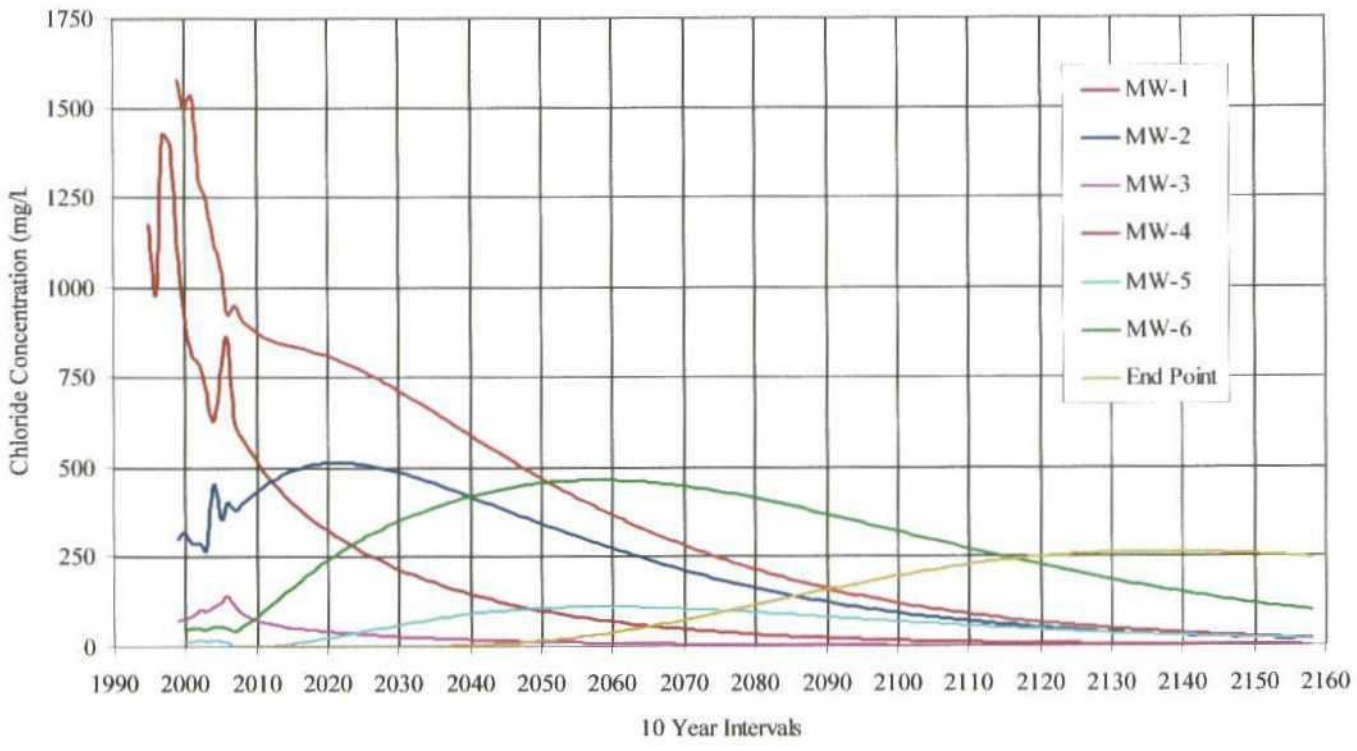
James O. Rumbaugh, III

Douglas B. Rumbaugh

TDS Fate & Transport Simulation run by:
Gilbert Van Deventer (Trident Environmental)

Date: 0/26/107
Time: 16:50:18.00
Input File: CL2006

WinTran Fate & Transport Modeling of Chloride Concentrations Vs. Time



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Model Entities

Number of Wells = 9

Well #1
Center of Well -- x: 716.000000 y: 5281.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 860.000000
Head at Well Radius = 3793.961507

Well #2
Center of Well -- x: 1041.670000 y: 4585.770000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 401.000000
Head at Well Radius = 3790.911078

Well #3
Center of Well -- x: 694.000000 y: 5954.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 141.000000
Head at Well Radius = 3796.080078

Well #4
Center of Well -- x: 1341.000000 y: 4747.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 926.000000
Head at Well Radius = 3790.622589

Well #5
Center of Well -- x: 1829.000000 y: 4861.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 13.300000
Head at Well Radius = 3789.668312

Well #6
Center of Well -- x: 1948.000000 y: 4058.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 52.400000
Head at Well Radius = 3786.686972

Well #7
Center of Well -- x: 650.000000 y: 2081.000000
Radius = 1.000000
Pumping Rate = 10.000000
Concentration of Injected Water = 38.200000
Head at Well Radius = 3783.653167

Well #8
Center of Well -- x: 4375.000000 y: 3275.550000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 0.000000
Head at Well Radius = 3776.638926

Well #9
Center of Well -- x: 2708.330000 y: 2882.490000
Radius = 1.000000
Pumping Rate = 1000.000000
Concentration of Injected Water = 0.000000
Head at Well Radius = 3780.353129

Reference Head = 3795.000000 Defined at -- x: 619.470000 y: 5537.180000

Aquifer Properties

.... Steady-State Flow Model ....

Permeability.....= 1000.000000 [L/T]
Porosity.....= 0.250000
Elevation of Aquifer Top....= 4000.000000
Elevation of Aquifer Bottom.= 3700.000000
Uniform Regional Gradient...= 0.004000
Angle of Uniform Gradient...= 310.000000
Recharge.....= 0.000000

.... Transient Transport Model ....

Longitudinal Dispersivity...= 150.000000 [L]
Transverse Dispersivity.....= 30.000000 [L]
Diffusion Coefficient.....= 0.000000 [L2/T]
Contaminant half-life..... = 1000.000000 [T]
Retardation Coefficient.....= 1.000000
Upstream Weighting in X.....= 0.000000
Upstream Weighting in Y.....= 0.000000

.... Time Stepping Information ....

Number of time steps.....= 152
Starting time value.....= 2006.000000
Initial time step size.....= 1.000000
Time step multiplier..... = 1.000000
Maximum time step size.....= 1.000000
Time stepping scheme.....= Central Differencing

.... Simulation Summary ....

Starting time.....= 2006.000000
Ending time.....= 2158.000000
Number of time steps.....= 152

(NOTE: following mass balance errors expressed as percent)
Transport Mass Balance Error= 0.141442

Peclet Criterion.....= 1.388889
Courant Number.....= 0.050431
Flow Model Type.....= Analytic Element

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Head Contour Matrix

Number of nodes in the X-direction = 49
Number of nodes in the Y-direction = 49

Minimum X Coordinate = 0.000000
Minimum Y Coordinate = 0.000000

Maximum X Coordinate = 10000.000000
Maximum Y Coordinate = 6289.062500

Minimum Head = 3734.914131
Maximum Head = 3798.820267

WinTran
Analytical Model of 2D Ground-Water Flow and
Finite-Element Contaminant Transport Model

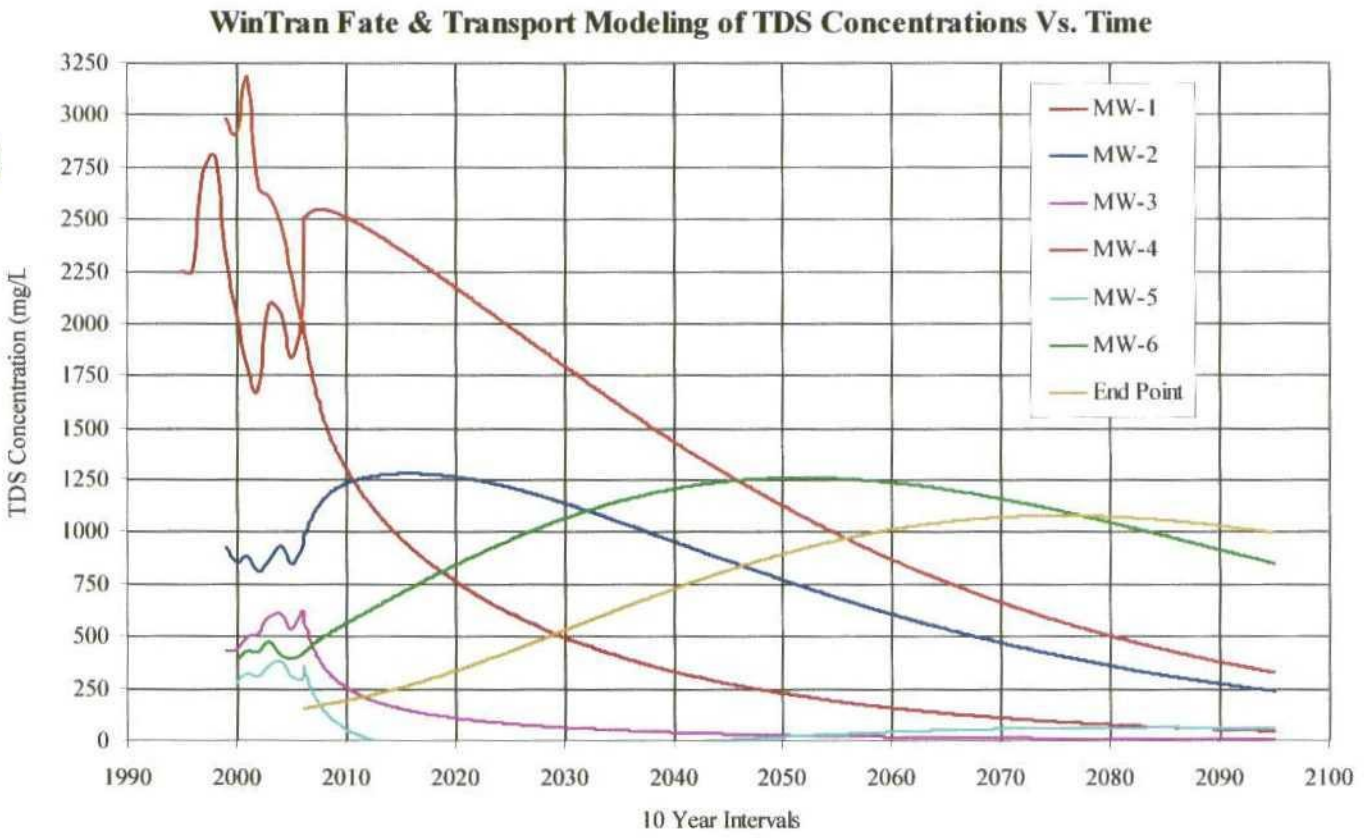
Developed by

James O. Rumbaugh, III

Douglas B. Rumbaugh

TDS Fate & Transport Simulation run by:
Gilbert Van Deventer (Trident Environmental)

Date: 01/29/2007
Time: 14:15:51.00
Input File: TDS2006



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Model Entities

Number of Wells = 8

Well #1
Center of Well -- x: 716.000000 y: 5281.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 2010.000000
Head at Well Radius = 3793.961643

Well #2
Center of Well -- x: 1041.670000 y: 4585.770000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 922.000000
Head at Well Radius = 3790.911689

Well #3
Center of Well -- x: 694.000000 y: 5954.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 619.000000
Head at Well Radius = 3796.079940

Well #4
Center of Well -- x: 1341.000000 y: 4747.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 2030.000000
Head at Well Radius = 3790.623255

Well #5
Center of Well -- x: 1829.000000 y: 4861.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 290.000000
Head at Well Radius = 3789.669101

Well #6
Center of Well -- x: 1948.000000 y: 4058.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 412.000000
Head at Well Radius = 3786.688589

Well #7
Center of Well -- x: 650.000000 y: 2081.000000
Radius = 1.000000
Pumping Rate = 10.000000
Concentration of Injected Water = 400.000000
Head at Well Radius = 3783.653976

Well #8
Center of Well -- x: 4375.000000 y: 3275.550000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 0.000000
Head at Well Radius = 3776.640336

Reference Head = 3795.000000 Defined at -- x: 619.470000 y: 5537.180000

Aquifer Properties

.... Steady-State Flow Model ....

Permeability.....= 1000.000000 [L/T]
Porosity.....= 0.250000
Elevation of Aquifer Top....= 4000.000000
Elevation of Aquifer Bottom.= 3700.000000
Uniform Regional Gradient...= 0.004000
Angle of Uniform Gradient...= 310.000000
Recharge.....= 0.000000

.... Transient Transport Model ....

Longitudinal Dispersivity...= 150.000000 [L]
Transverse Dispersivity.....= 15.000000 [L]
Diffusion Coefficient.....= 0.000000 [L2/T]
Contaminant half-life..... = 1000.000000 [T]
Retardation Coefficient.....= 1.000000
Upstream Weighting in X.....= 0.000000
Upstream Weighting in Y.....= 0.000000

.... Time Stepping Information ....

Number of time steps.....= 890
Starting time value.....= 2006.000000
Initial time step size.....= 0.100000
Time step multiplier..... = 1.000000
Maximum time step size.....= 0.100000
Time stepping scheme.....= Central Differencing

.... Simulation Summary ....

Starting time.....= 2006.000000
Ending time.....= 2095.000000
Number of time steps.....= 890

(NOTE: following mass balance errors expressed as percent)
Transport Mass Balance Error= 0.000499

Peclet Criterion.....= 1.388889
Courant Number.....= 0.005044
Flow Model Type.....= Analytic Element

Head Contour Matrix

Number of nodes in the X-direction = 49
Number of nodes in the Y-direction = 49

Minimum X Coordinate = 0.000000
Minimum Y Coordinate = 0.000000

Maximum X Coordinate = 10000.000000
Maximum Y Coordinate = 6289.062500

Minimum Head = 3734.910293
Maximum Head = 3798.819859