1RP-277

GW Monitor Report

DATE:
2009

RECEIVED

2009 DEC 30 PM 1 33

TRIDENT
ENVIRONMENTAL

December 23, 2009

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: 2009 Annual Groundwater Monitoring Report
Former Unocal South Vacuum Unit
NMOCD Case No. 1R-277
Section 35, Township 18 South, Range 35 East
Lea County, New Mexico

Dear Mr. Von Gonten:

Enclosed is the *2009 Annual Groundwater Monitoring Report* for the Former Unocal South Vacuum Unit site located in Lea County, New Mexico (hard copy and compact disk). Chevron Environmental Management Company has been managing the groundwater monitoring activities for the site since their acquisition of Unocal Corporation in 2005.

Please contact me at 432-638-8740, Mr. John MacLeod (Chevron EMC) at 925-842 2477, or Allen Just (Arcadis) at 714-730-9052 Ext. 38 if you have any questions or comments.

Sincerely,

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

Attachments

xc: John MacLeod, Chevron EMC (San Ramon CA)
Allen Just, Arcadis (Irvine CA)
Larry Hill, NMOCD-District 1 (Hobbs NM)

2009 ANNUAL GROUNDWATER MONITORING REPORT
FORMER UNOCAL SOUTH VACUUM UNIT
NMOCD CASE NO. 1R-277
SECTION 35, TOWNSHIP 18 SOUTH, RANGE 35 EAST
LEA COUNTY, NEW MEXICO

DECEMBER 23, 2009

Prepared For:

Chevron Environmental
Management Company
6111 Bollinger Canyon Rd.
San Ramon, CA 94583

Prepared By:

TRIDENT
ENVIRONMENTAL

P. O. Box 7624
Midland, Texas 79708

2009 Annual Groundwater Monitoring Report
Former Unocal South Vacuum Unit
NMOCD Case NO. 1R-277
Section 35, Township 18 South, Range 35 East
Lea County, New Mexico

Prepared for:

Chevron Environmental Management Company
6111 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, REM
Project Manager

DATE:
12-23-09

STATE OF TEXAS
Gilbert J. Van Deventer
Geology
3678
LICENSED
PROFESSIONAL GEOSCIENTIST

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1.0 Executive Summary

Trident Environmental (Trident) was retained by ARCADIS, on behalf of Chevron Environmental Management Company (Chevron EMC), to perform the 2009 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 is managing Unocal's environmental liability at the site. This report documents the 2009 annual sampling event performed by Trident at the site on July 15, 2009. 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 well MW-3 have shown slight but steadily increasing trends indicating an upgradient contributing source of these constituents. Chloride and TDS concentrations in the remaining wells (MW-2, MW-5, and MW-6) have remained relatively consistent with previous levels.

- The fate and transport modeling results continue to support the conclusion that the chloride and TDS plume is not likely to impact existing sources of water supply, the closest of which, a livestock (windmill) well (permit number L 05339) lies over one-half mile south of the source. Operation of the windmill well has been discontinued due to declining water levels in the area and the shallow depth of the well.

- According to conservative model simulations, the chloride plume will travel a maximum of 3,400 feet southeast of the source in approximately 147 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 84 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 saltwater disposal 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 resumed since 2005.

Exemplary remedial actions were performed to the source area by Unocal, including plugging of the SWD well in 1971 and encapsulating the former saltwater disposal pit 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.

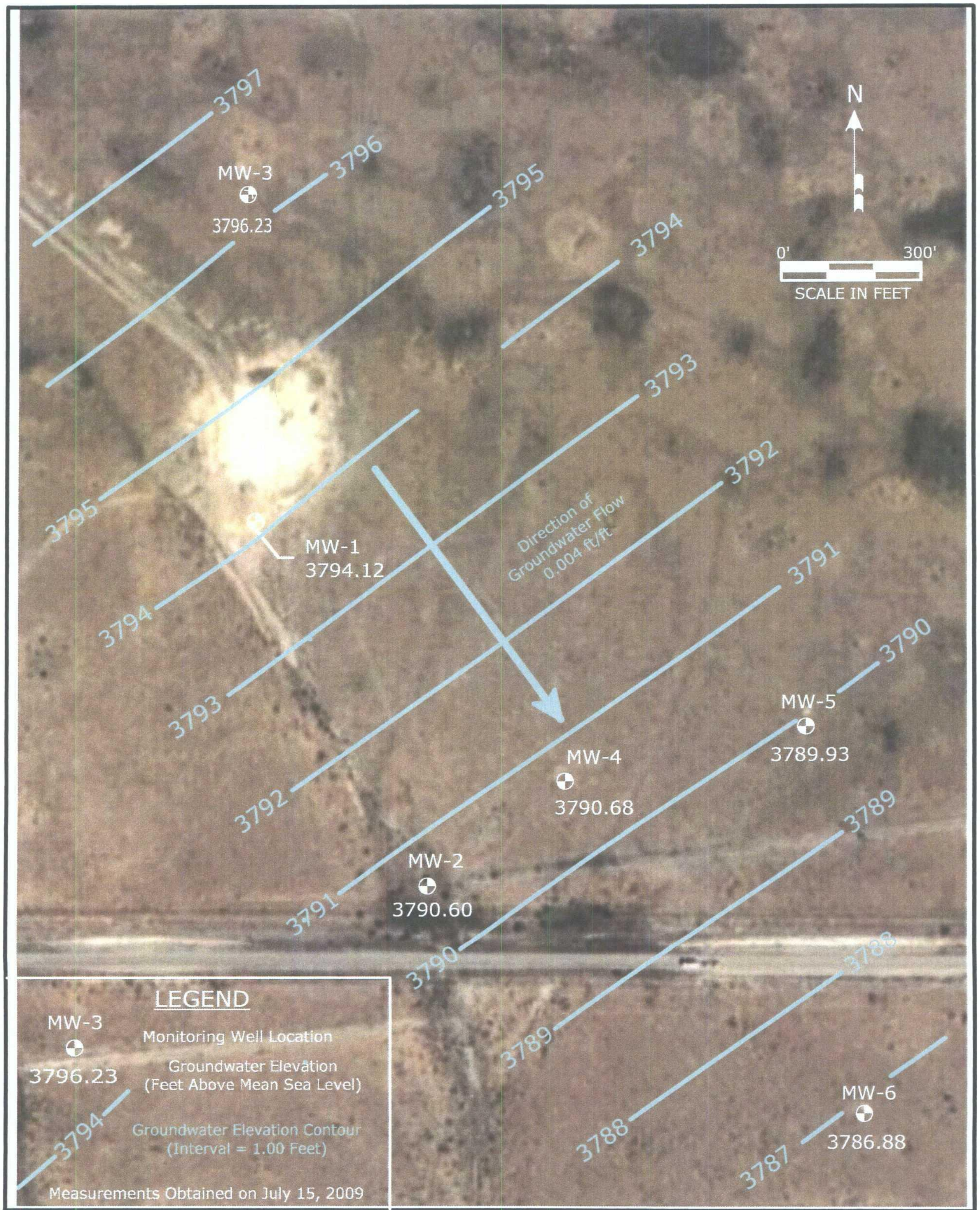
- Submit the 2010 annual groundwater monitoring report to OCD in January 2011 to document natural attenuation conditions.

2.0 Groundwater Sampling Procedures

On July 15, 2009, 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 39 gallons of groundwater was purged from the site monitoring wells (3 to 10 gallons per well) using a decontaminated 2-inch diameter PVC bailer. Groundwater parameters (pH, temperature, and conductivity) were measured using a Hanna Model 98130 multimeter until a minimum of three wells volumes was purged from each well. Water samples for each monitoring well were transferred into 1,000 milliliter (ml) plastic containers for laboratory analysis of chloride using EPA Method SM-4500-Cl-C and TDS using EPA Method SM-2541 and. 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 (Lancaster, PA) for analysis.

3.0 Groundwater Elevations, Hydraulic Gradient and Flow Direction

Depth to groundwater varies from approximately 51.04 ft at MW-2 to 71.90 feet at MW-6 below top of well casing. 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 3,700 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 96 feet.



TRIDENT
ENVIRONMENTAL

FIGURE 1
Former Unocal South Vacuum Unit

Groundwater Gradient Map

Figure 2
Historical Groundwater Elevations

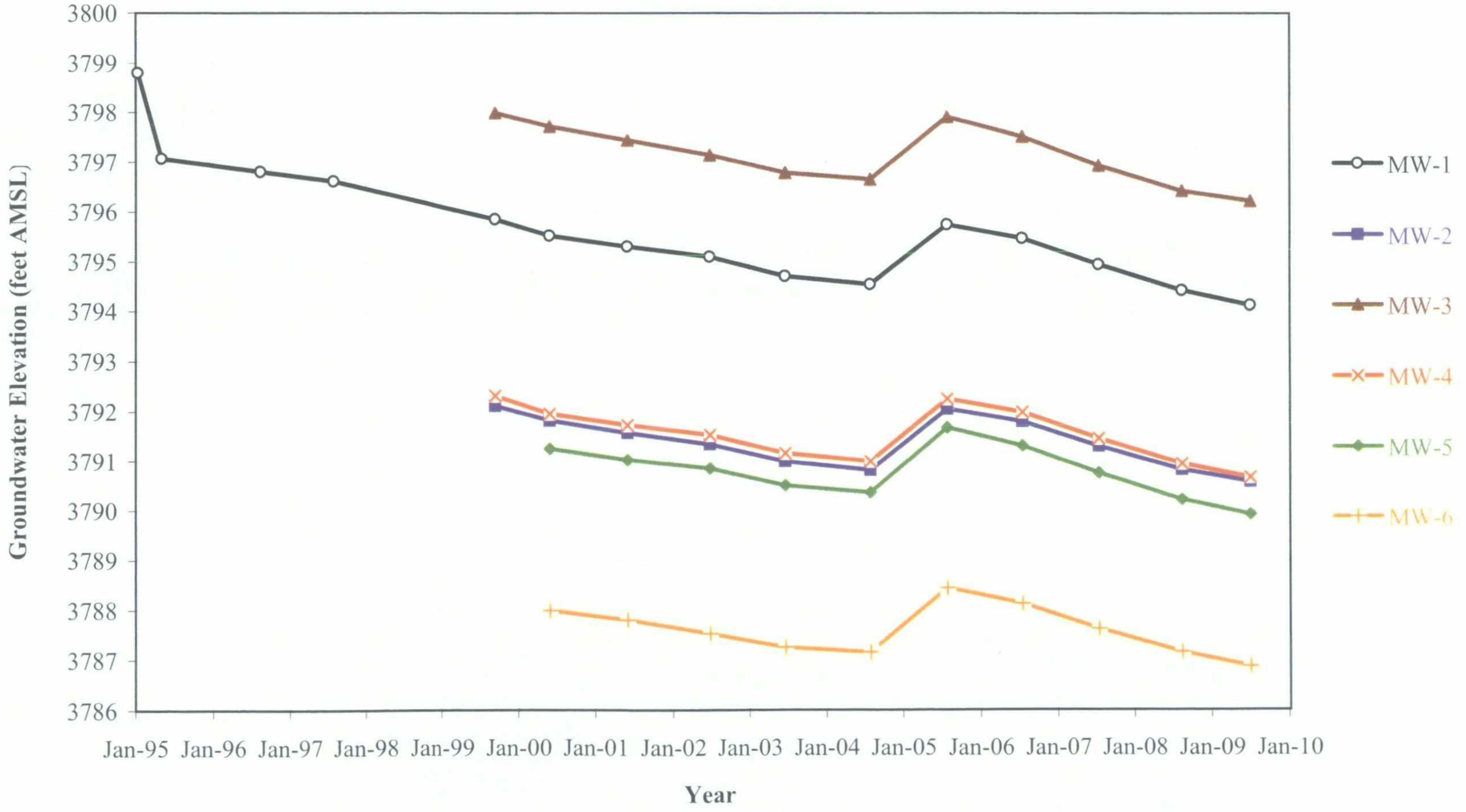


Table 1
Summary of Groundwater Sampling Results

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	01/27/1995	**1174**	**2250**	59.57	3858.37	3798.80
	05/18/1995	**983**	**2251**	61.30	3858.37	3797.07
	08/28/1996	**1420**	**2730**	61.57	3858.37	3796.80
	08/13/1997	**1400**	**2800**	61.75	3858.37	3796.62
	09/30/1999	**1094**	**2318**	62.51	3858.37	3795.86
	06/14/2000	**927**	**2040**	62.85	3858.37	3795.52
	06/18/2001	**813**	**1790**	63.07	3858.37	3795.30
	07/11/2002	**784**	**1680**	63.28	3858.37	3795.09
	07/02/2003	**715**	**2090**	63.66	3858.37	3794.71
	08/12/2004	**628**	**2050**	63.83	3858.37	3794.54
	08/10/2005	**774**	**1830**	62.62	3858.37	3795.75
	07/31/2006	**860**	**2010**	62.90	3858.37	3795.47
	07/27/2007	**732**	**1790**	63.43	3858.37	3794.94
	08/26/2008	**895**	**1960**	63.95	3858.37	3794.42
	07/15/2009	**852**	**2300**	64.25	3858.37	3794.12
MW-2	09/30/1999	**298**	922	49.51	3841.64	3792.13
	06/14/2000	**317**	852	49.81	3841.64	3791.83
	06/18/2001	**288**	878	50.06	3841.64	3791.58
	07/11/2002	**284**	808	50.29	3841.64	3791.35
	07/02/2003	**268**	859	50.63	3841.64	3791.01
	08/12/2004	**451**	931	50.81	3841.64	3790.83
	08/10/2005	**355**	844	49.58	3841.64	3792.06
	07/31/2006	**401**	922	49.83	3841.64	3791.81
	07/27/2007	**430**	984	50.33	3841.64	3791.31
	08/26/2008	**354**	980	50.80	3841.64	3790.84
	07/15/2009	**482**	**1060**	51.04	3841.64	3790.60
MW-3	09/30/1999	73.6	427	66.74	3864.73	3797.99
	06/14/2000	75.5	433	67.01	3864.73	3797.72
	06/18/2001	86.4	495	67.29	3864.73	3797.44
	07/11/2002	103	509	67.59	3864.73	3797.14
	07/02/2003	98.3	588	67.94	3864.73	3796.79
	08/12/2004	111	605	68.07	3864.73	3796.66
	08/10/2005	122	533	66.81	3864.73	3797.92
	07/31/2006	141	619	67.21	3864.73	3797.52
	07/27/2007	164	705	67.79	3864.73	3796.94
	08/26/2008	185	592	68.30	3864.73	3796.43
	07/15/2009	199	766	68.50	3864.73	3796.23
MW-4	09/30/1999	**1576**	**2981**	60.18	3852.51	3792.33
	06/14/2000	**1500**	**2910**	60.55	3852.51	3791.96
	06/18/2001	**1530**	**3180**	60.78	3852.51	3791.73
	07/11/2002	**1290**	**2660**	60.98	3852.51	3791.53
	07/02/2003	**1250**	**2610**	61.34	3852.51	3791.17
	08/12/2004	**1130**	**2480**	61.50	3852.51	3791.01
	08/10/2005	**1050**	**2230**	60.25	3852.51	3792.26
	07/31/2006	**926**	**2030**	60.51	3852.51	3792.00
	07/27/2007	**758**	**1940**	61.04	3852.51	3791.47
	08/26/2008	**720**	**1790**	61.55	3852.51	3790.96
	07/15/2009	**632**	**1780**	61.83	3852.51	3790.68

Continued on next page

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-5	06/14/2000	13.7	274	68.57	3859.84	3791.27
	06/18/2001	13.6	322	68.80	3859.84	3791.04
	07/11/2002	15.5	308	68.98	3859.84	3790.86
	07/02/2003	12.5	359	69.32	3859.84	3790.52
	08/12/2004	15.3	375	69.46	3859.84	3790.38
	08/10/2005	14.9	309	68.15	3859.84	3791.69
	07/31/2006	13.3	290	68.52	3859.84	3791.32
	07/27/2007	14.9	296	69.07	3859.84	3790.77
	08/26/2008	13.6	296	69.61	3859.84	3790.23
	07/15/2009	13.4	291	69.91	3859.84	3789.93
MW-6	06/14/2000	48	382	70.79	3858.78	3787.99
	06/18/2001	50.8	431	70.98	3858.78	3787.80
	07/11/2002	50	422	71.26	3858.78	3787.52
	07/02/2003	46.5	471	71.52	3858.78	3787.26
	08/12/2004	55.1	410	71.62	3858.78	3787.16
	08/10/2005	55	391	70.33	3858.78	3788.45
	07/31/2006	52.4	412	70.64	3858.78	3788.14
	07/27/2007	75.3	516	71.15	3858.78	3787.63
	08/26/2008	88.5	548	71.61	3858.78	3787.17
	07/15/2009	81.4	532	71.90	3858.78	3786.88
Windmill	07/31/2006	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. (1995-1998), SPL, Inc. (1999-2005), and Lancaster Laboratories (2006-2009).
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.

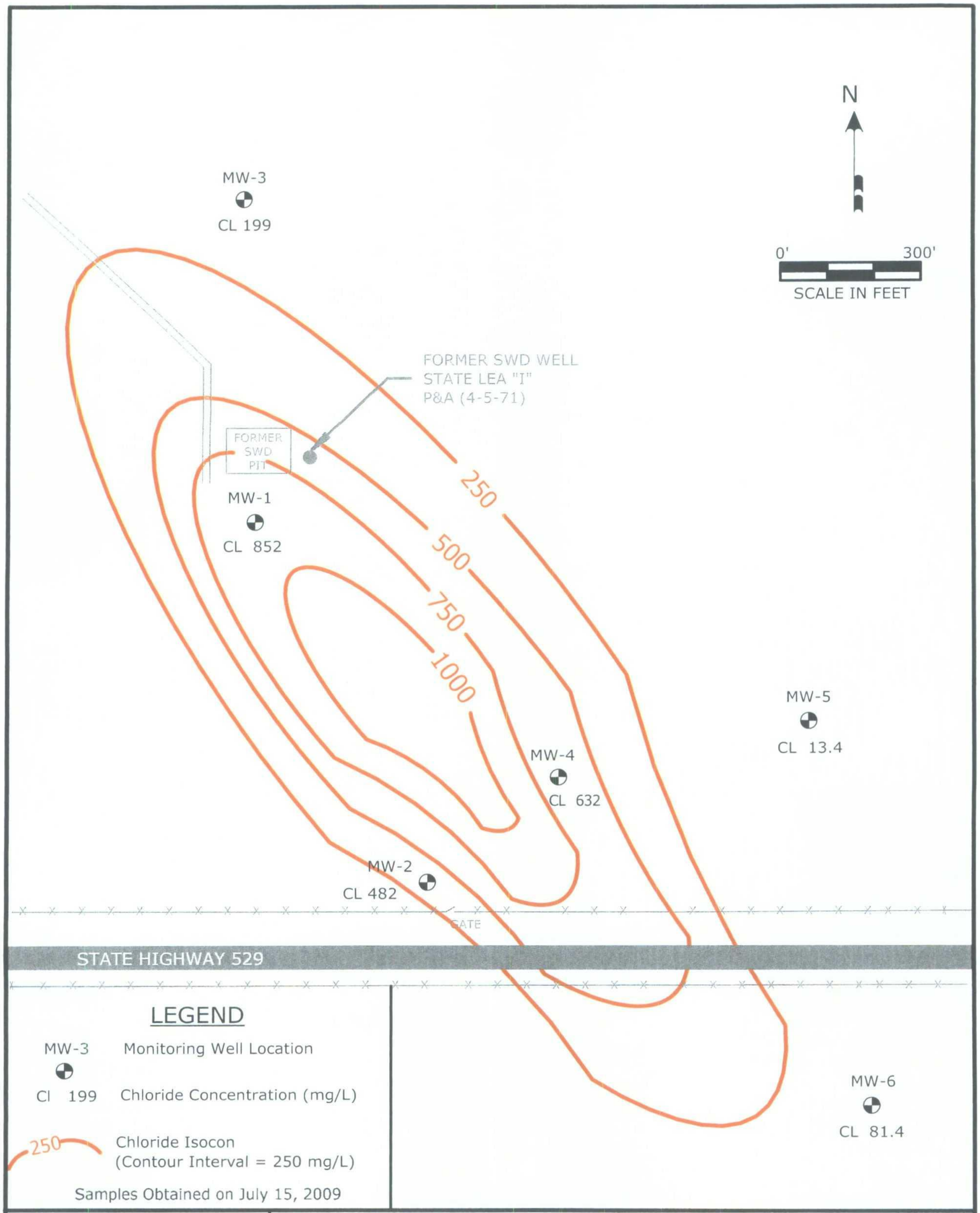
4.0 Groundwater Quality Conditions

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 (852 mg/L), MW-2 (482 mg/L), and MW-4 (632 mg/L). The WQCC standard of 1,000 mg/L for TDS was exceeded only in MW-1 (2,300 mg/L) and MW-4 (1,780 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. 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 former source area, have consistently decreased since 1996, with the exception of slight fluctuations since the 2003 sampling event. Similarly, chloride and TDS levels have steadily decreased in the closest downgradient well, MW-4, since 1999 when that well was installed. This indicates that encapsulating the former saltwater disposal pit with solidification material in 1995, has eliminated the threat of any continued release from the source.

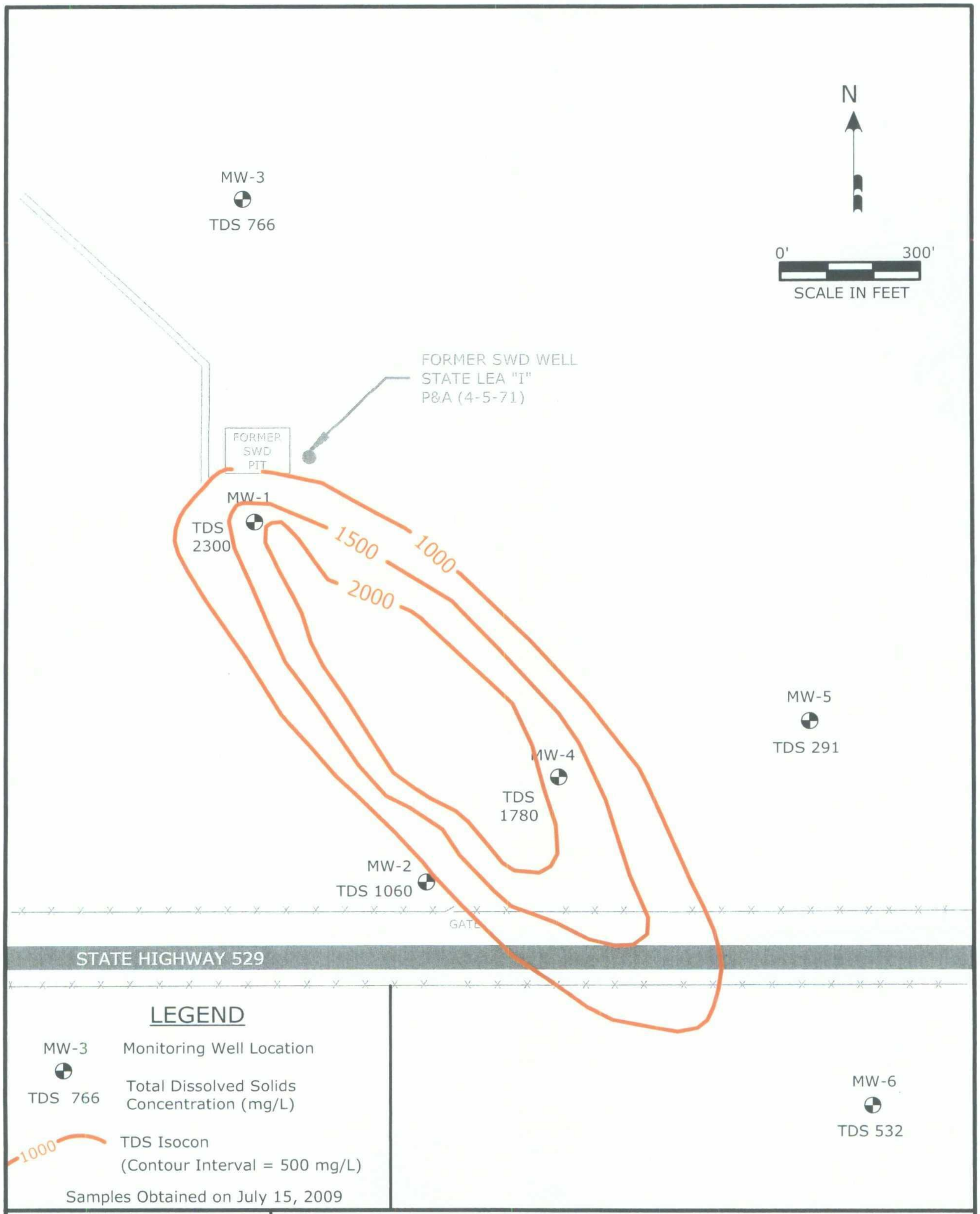
Monitoring well MW-3 continues to exhibit slight but steady increases in chloride and TDS concentrations since 2000, which suggests a possible offsite source of chlorides and TDS located upgradient (northwest) from the site. Chloride and TDS levels in MW-2, MW-5, and MW-6 have remained relatively consistent with previous years.



TRIDENT
ENVIRONMENTAL

FIGURE 3

Former Unocal South Vacuum Unit
Chloride Concentration Map
Current Conditions (2009)



TRIDENT ENVIRONMENTAL

FIGURE 4

Former Unocal South Vacuum Unit
TDS Concentration Map
Current Conditions (2009)

Figure 5
Chloride Concentrations Versus Time Graph

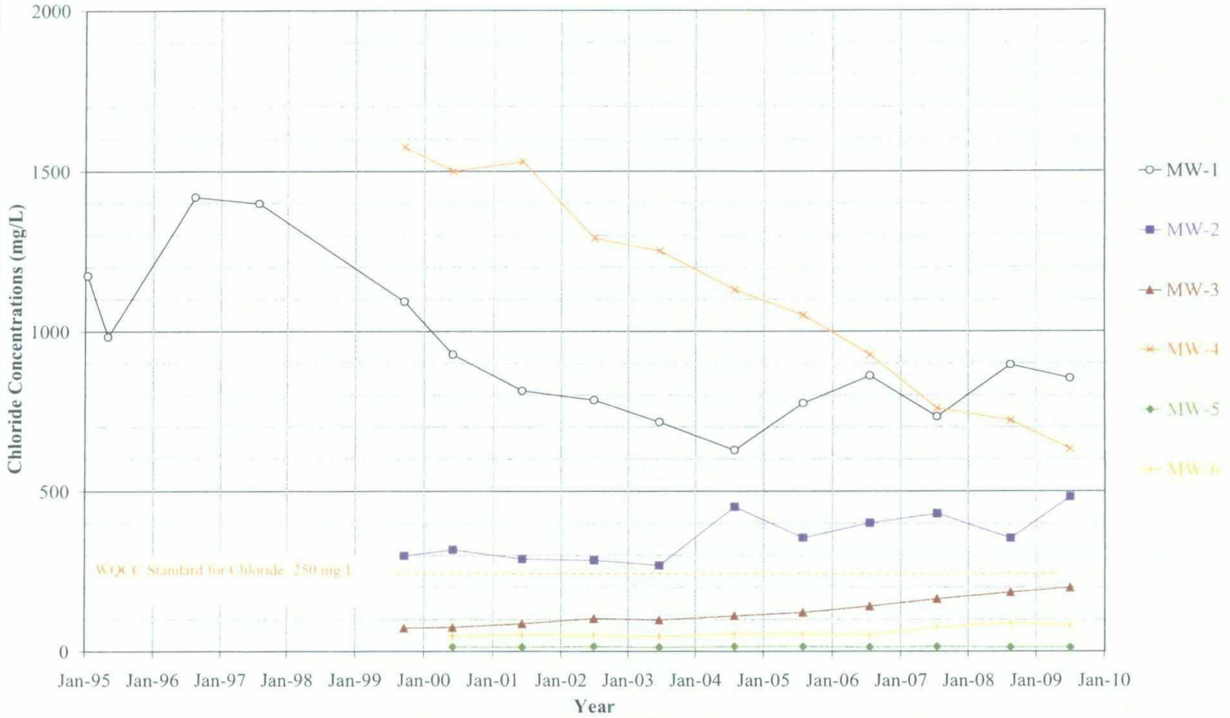
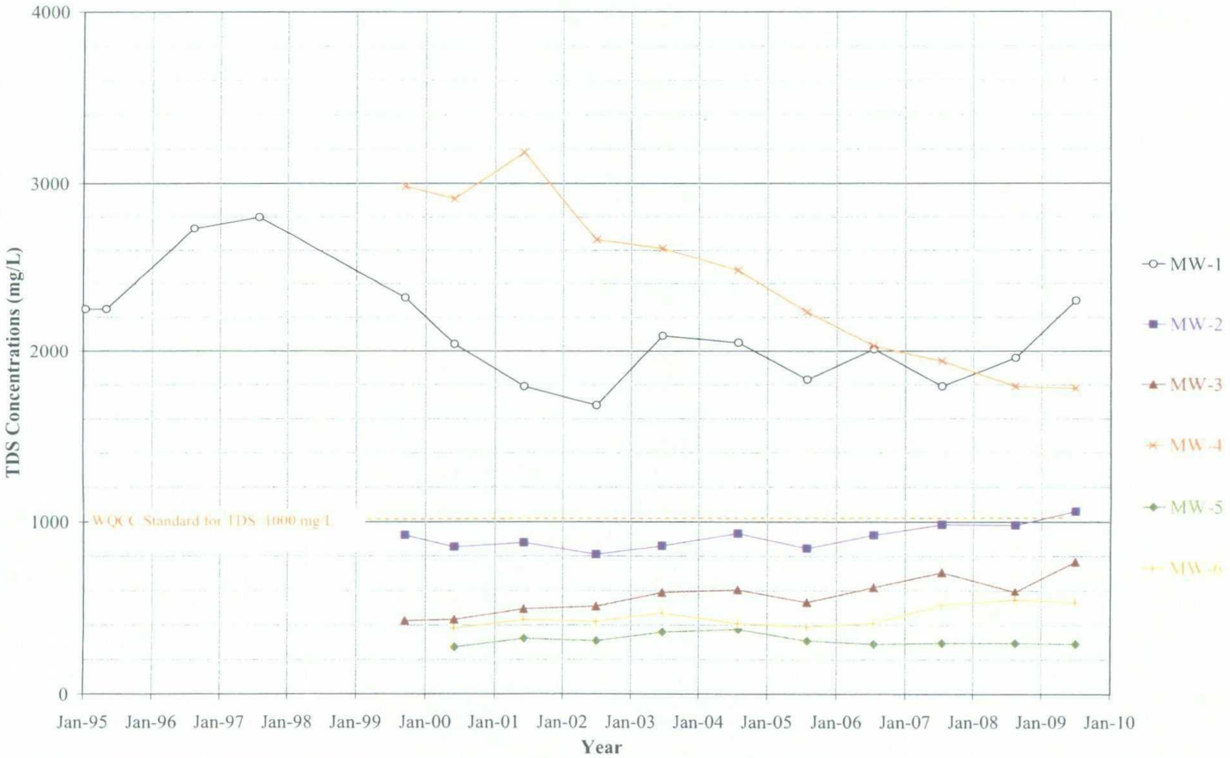


Figure 6
Total Dissolved Solids Concentrations Versus Time Graph



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 2156 for chloride and year 2093 for TDS, respectively). The center of the chloride plume is approximately 3,400 ft away from the pit and well source in the year 2156. The center of the TDS plume is approximately 2,300 ft away from the pit and well source in the year 2093.

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 results of the updated fate and transport model are consistent with those determined in previous annual reports.

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 significantly decreased in the closest downgradient well, MW-4, since 1999 when that well was installed. Chloride and TDS concentrations in well MW-3 have shown slight but steadily increasing trends indicating an upgradient contributing source of these constituents. Chloride and TDS concentrations in the remaining wells (MW-2, 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 (windmill) well (permit number L 05339) lies over one-half mile south of the source. Operation of the windmill well has been discontinued due to declining water levels in the area and the shallow depth of the well.
- According to conservative model simulations, the chloride plume will travel a maximum of 3,400 feet southeast of the source in approximately 147 years before concentrations return to levels below the WQCC standard of 250 mg/L. The same analysis indicates that the TDS plume will travel only 2,300 feet in approximately 84 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 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 increased to an elevation similar to the 1999 level. The recent rise may be attributed to higher than normal rainfall during 2004 and 2005. The decreasing groundwater elevation trend has resumed since 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 saltwater disposal pit 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 2010 annual groundwater monitoring report to OCD in January 2011 to document natural attenuation conditions.

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:

Chevron Environmental Mgmt Co
6111 Bollinger Canyon Road
BR1Y / 3354
San Ramon CA 94583

925-543-2357

Prepared by:

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

July 23, 2009

SAMPLE GROUP

The sample group for this submittal is 1153897. Samples arrived at the laboratory on Friday, July 17, 2009. The PO# for this group is 0015038386 and the release number is MACLEOD.

Client Description	Lancaster Labs Number
MW-1 Grab Water Sample	5725681
MW-2 Grab Water Sample	5725682
MW-3 Grab Water Sample	5725683
MW-4 Grab Water Sample	5725684
MW-5 Grab Water Sample	5725685
MW-6 Grab Water Sample	5725686

METHODOLOGY

The specific methodologies used in obtaining the enclosed analytical results are indicated on the Laboratory Sample Analysis Record.

ELECTRONIC COPY TO	ARCADIS	Attn: Mark M. Miller
ELECTRONIC COPY TO	ARCADIS	Attn: Allen Just
ELECTRONIC COPY TO	ARCADIS	Attn: Dana Koschel
ELECTRONIC COPY TO	ARCADIS	Attn: Sarah Huff

ELECTRONIC COPY TO	ARCADIS	Attn: Robin Simon
ELECTRONIC COPY TO	Trident Environmental	Attn: Gilbert Van Deventer
ELECTRONIC COPY TO	Chevron Environmental Mgmt Co	Attn: John MacLeod

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

Respectfully Submitted,

Robert Heisey

Robert Heisey
Senior Specialist

Lancaster Laboratories Sample No. WW 5725681

Group No. 1153897
NM

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

Collected: 07/15/2009 11:25 by GV

Account Number: 11969

Submitted: 07/17/2009 08:50
Reported: 07/23/2009 at 13:32
Discard: 08/23/2009

Chevron Environmental Mgmt Co
6111 Bollinger Canyon Road
BR1Y / 3354
San Ramon CA 94583

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Dilution Factor
SM20 2540 C	**Wet Chemistry**		mg/l	mg/l	mg/l	
00212	Total Dissolved Solids	n.a.	2,300	77.6	240	1
SM20 4500 Cl C	**Wet Chemistry**		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	852	20.0	100	50

General Sample Comments

[illegible]l QC is compliant unless otherwise noted. Please refer to the Quality [illegible]ntrol Summary for overall QC performance data and associated samples.

Laboratory Sample Analysis Record

CAT No.	Analysis Name	Method	Trial#	Batch#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	SM20 2540 C	1	09201021201A	07/20/2009 09:23	Susan E Hibner	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	09201112401A	07/20/2009 12:40	Susan A Engle	50

---

*=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 5725682

Group No. 1153897
NM

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

Collected: 07/15/2009 13:51 by GV

Account Number: 11969

Submitted: 07/17/2009 08:50
Reported: 07/23/2009 at 13:32
Discard: 08/23/2009

Chevron Environmental Mgmt Co
6111 Bollinger Canyon Road
BR1Y / 3354
San Ramon CA 94583

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Dilution Factor
SM20 2540 C	Wet Chemistry		mg/l	mg/l	mg/l	
00212	Total Dissolved Solids	n.a.	1,060	38.8	120	1
SM20 4500 Cl C	Wet Chemistry		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	482	8.0	40.0	20

General Sample Comments

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

Laboratory Sample Analysis Record

CAT No.	Analysis Name	Method	Trial#	Batch#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	SM20 2540 C	1	09201021201A	07/20/2009 09:23	Susan E Hibner	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	09201112401A	07/20/2009 12:40	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 5725683

Group No. 1153897
NM

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

Collected: 07/15/2009 09:40 by GV

Account Number: 11969

Submitted: 07/17/2009 08:50
Reported: 07/23/2009 at 13:32
Discard: 08/23/2009

Chevron Environmental Mgmt Co
6111 Bollinger Canyon Road
BRIY / 3354
San Ramon CA 94583

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Dilution Factor
SM20 2540 C	**Wet Chemistry**		mg/l	mg/l	mg/l	
00212	Total Dissolved Solids	n.a.	766	19.4	60.0	1
SM20 4500 Cl C	**Wet Chemistry**		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	199	8.0	40.0	20

General Sample Comments

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

Laboratory Sample Analysis Record

CAT No.	Analysis Name	Method	Trial#	Batch#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	SM20 2540 C	1	09201021201A	07/20/2009 09:23	Susan E Hibner	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	09201112401A	07/20/2009 12:40	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 5725684

Group No. 1153897
NM

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

Collected: 07/15/2009 10:55 by GV

Account Number: 11969

Submitted: 07/17/2009 08:50
Reported: 07/23/2009 at 13:32
Discard: 08/23/2009

Chevron Environmental Mgmt Co
6111 Bollinger Canyon Road
BR1Y / 3354
San Ramon CA 94583

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Dilution Factor
SM20 2540 C	Wet Chemistry		mg/l	mg/l	mg/l	
00212	Total Dissolved Solids	n.a.	1,780	77.6	240	1
SM20 4500 Cl C	Wet Chemistry		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	632	20.0	100	50

General Sample Comments

[illegible]l QC is compliant unless otherwise noted. Please refer to the Quality [illegible]ntrol Summary for overall QC performance data and associated samples.

Laboratory Sample Analysis Record

CAT No.	Analysis Name	Method	Trial#	Batch#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	SM20 2540 C	1	09201021201A	07/20/2009 09:23	Susan E Hibner	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	09201112401A	07/20/2009 12:40	Susan A Engle	50

---

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

Lancaster Laboratories

Analysis Report

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

Lancaster Laboratories Sample No. WW 5725685

Group No. 1153897
NM

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

Collected: 07/15/2009 10:19 by GV

Account Number: 11969

Submitted: 07/17/2009 08:50
Reported: 07/23/2009 at 13:32
Discard: 08/23/2009

Chevron Environmental Mgmt Co
6111 Bollinger Canyon Road
BR1Y / 3354
San Ramon CA 94583

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Dilution Factor
SM20 2540 C	**Wet Chemistry**		mg/l	mg/l	mg/l	
00212	.Total Dissolved Solids	n.a.	291	9.7	30.0	1
SM20 4500 Cl C	**Wet Chemistry**		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	13.4	1.6	8.0	4
	The reporting limit for the analyte above was raised due to matrix interference.					

General Sample Comments

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

Laboratory Sample Analysis Record

CAT No.	Analysis Name	Method	Trial#	Batch#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	SM20 2540 C	1	09201021201A	07/20/2009 09:23	Susan E Hibner	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	09201112401A	07/20/2009 12:40	Susan A Engle	4

---

*=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 5725686

Group No. 1153897
NM

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

Collected: 07/15/2009 14:46 by GV

Account Number: 11969

Submitted: 07/17/2009 08:50
Reported: 07/23/2009 at 13:32
Discard: 08/23/2009

Chevron Environmental Mgmt Co
6111 Bollinger Canyon Road
BR1Y / 3354
San Ramon CA 94583

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Dilution Factor
SM20 2540 C	**Wet Chemistry**		mg/l	mg/l	mg/l	
00212	Total Dissolved Solids	n.a.	532	9.7	30.0	1
SM20 4500 Cl C	**Wet Chemistry**		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	81.4	1.6	8.0	4

General Sample Comments

[illegible]l QC is compliant unless otherwise noted. Please refer to the Quality [illegible]ntrol Summary for overall QC performance data and associated samples.

Laboratory Sample Analysis Record

CAT No.	Analysis Name	Method	Trial#	Batch#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	SM20 2540 C	1	09201021201A	07/20/2009 09:23	Susan E Hibner	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	09201112401A	07/20/2009 12:40	Susan A Engle	4

---

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

Lancaster Laboratories

Analysis Report

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

Quality Control Summary

Client Name: Chevron Environmental Mgmt Co
Reported: 07/23/09 at 01:32 PM

Group Number: 1153897

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: 09201021201A	Sample number(s): 5725681-5725686								
Total Dissolved Solids	N.D.	9.7	30.0	mg/l	99		80-120		
Batch number: 09201112401A	Sample number(s): 5725681-5725686								
Chloride (titrimetric)					99		95-103		

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: 09201021201A	Sample number(s): 5725681-5725686 UNSPK: 5725682 BKG: 5725682								
Total Dissolved Solids	99	99	54-143	0	12	1.060	1.040	1	9
Batch number: 09201112401A	Sample number(s): 5725681-5725686 UNSPK: 5725683 BKG: 5725683								
Chloride (titrimetric)	96	96	85-110	0	3	199	203	2 (1)	5

*- 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 unspiked result was more than four times the spike added.

Chevron Generic Analysis Request/Chain of Custody

Lancaster Laboratories
Where quality is a science.

013536

For Lancaster Laboratories use only
Acct. #: 11969 Sample #: 5725681-86 SCR#: 28172

Grp#1153897

Facility #: Chevron EMC
Site Address: Section 35, T18S, R35E, Lea County, NM
Chevron PM: John Mac Leod Lead Consultant: Arcadis
Consultant/Office: 3240 El Camino Real, Ste 200, Irvine CA 92602-1385
Consultant Prj. Mgr.: Allen C. Just, P.E.
Consultant Phone #: 714-730-9052 ext 36 Fax #: 714-730-9345
Sampler: Gil VanDeventer
Service Order #: 78172 ☒ Non SAR: ______

Analyses Requested

Preservation Codes

Sample Identification	Date Collected	Time Collected	Grab	Composite	Matrix: Soil	Matrix: Water ☒ Potable ☐ NPDES	Matrix: Oil ☐ Air ☐	Total Number of Containers	BTEX + MTBE 8021 ☐ 8260 ☐ Naphth ☐	8260 full scan	____ Oxygenates	____ TPH G	____ TPH D ☐ Extended Rng. ☐ Silica Gel Cleanup	Lead Total ☐ Diss. ☐ Method ____	VPH/EPH	NWTPH H HCID ☐ quantification	Chloride ~~(325.3)~~ SM20 4500ClC ⊗	TDS ~~(160.1)~~ SM20 2540C ⊗		
MW-1	7/15/09	1125	✓			✓											✓	✓		
MW-2	7/15/09	1351	✓			✓											✓	✓		
MW-3	7/15/09	0940	✓			✓											✓	✓		
MW-4	7/15/09	1055	✓			✓											✓	✓		
MW-5	7/15/09	1019	✓			✓											✓	✓		
MW-6	7/15/09	1446	✓			✓											✓	✓		

Preservative Codes

H = HCl	T = Thiosulfate
N = HNO$_3$	B = NaOH
S = H$_2$SO$_4$	O = Other

☐ J value reporting needed
☐ Must meet lowest detection limits possible for 8260 compounds

8021 MTBE Confirmation
☐ Confirm MTBE + Naphthalene
☐ Confirm highest hit by 8260
☐ Confirm all hits by 8260
☐ Run ____ oxy's on highest hit
☐ Run ____ oxy's on all hits

Comments / Remarks

Please email reports to:
allen.just@arcadis-us.com
john macleod@chevron.com
gil@trident-environmental.com

⊗ Reference MUR methods per Gil VanDeventer.
KAK1885, 7/20/09

Turnaround Time Requested (TAT) (please circle)

[✓ STD. TAT] 72 hour 48 hour
24 hour 4 day 5 day

Data Package Options (please circle if required)

QC Summary Type I - Full
Type VI (Raw Data) Disk / EDD
WIP (RWQCB) Standard Format
Disk ______ Other.

Relinquished by:	Date	Time	Received by:	Date	Time
	7-7-09	1939		7/10/09	1200
	7/16/09	5:00p	~~Received by:~~	Date	Time
~~Relinquished by:~~	Date	Time	Received by:	~~Date~~	Time

Relinquished by Commercial Carrier:
UPS [✓ FedEx] Other ______
Temperature Upon Receipt 1.3°C C°

Received by: Date 7/17/09 Time 850
Custody Seals Intact? [✓ Yes] No

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.

3566 Rev. 1/31/02

Lancaster Laboratories
2425 New Holland Pike • Lancaster, PA 17601

Environmental Sample Administration
Receipt Documentation Log

Client/Project: Arcadis

Date of Receipt: 7/17/09

Time of Receipt: 850

Source Code: 60-1

Unpacker Emp. No.: 2316

Shipping Container Sealed: [✓ YES] NO

Custody Seal Present * : [✓ YES] NO

* Custody seal was intact unless otherwise noted in the discrepancy section

Package: [✓ Chilled] Not Chilled

Temperature of Shipping Containers

Cooler #	Thermometer ID	Temperature (°C)	Temp Bottle (TB) or Surface Temp (ST)	Wet Ice (WI) or Dry Ice (DI) or Ice Packs (IP)	Ice Present? Y/N	Loose (L) Bagged Ice (B) or NA	Comments
1	0429583	1.5°C	TB	WI	Y	B	
2							
3							
4							
5							
6							

Number of Trip Blanks received NOT listed on chain of custody: 0

Paperwork Discrepancy/Unpacking Problems:

Sample Administration Internal Chain of Custody

Name	Date	Time	Reason for Transfer
	7/17/09	1240	Unpacking 1 to Storage
Kristin Leigh	7-17-09	1303	Place in Storage or [✓ Entry]
			Entry
			Entry

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

A	TIC is a possible aldol-condensation product
B	Analyte was also detected in the blank
C	Pesticide result confirmed by GC/MS
D	Compound quatitated on a diluted sample
E	Concentration exceeds the calibration range of the instrument
J	Estimated value
N	Presumptive evidence of a compound (TICs only)
P	Concentration difference between primary and confirmation columns >25%
U	Compound was not detected
X,Y,Z	Defined in case narrative

Inorganic Qualifiers

B	Value is <CRDL, but ≥IDL
E	Estimated due to interference
M	Duplicate injection precision not met
N	Spike amount not within control limits
S	Method of standard additions (MSA) used for calculation
U	Compound was not detected
W	Post digestion spike out of control limits
*	Duplicate analysis not within control limits
+	Correlation coefficient for MSA <0.995

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.

WARRANTY AND LIMITS OF LIABILITY – In accepting analytical work, we warrant the accuracy of test results for the sample as submitted. THE FOREGOING EXPRESS WARRANTY IS EXCLUSIVE AND IS GIVEN IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED. WE DISCLAIM ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING A WARRANTY OF FITNESS FOR PARTICULAR PURPOSE AND WARRANTY OF MERCHANTABILITY. IN NO EVENT SHALL LANCASTER LABORATORIES BE LIABLE FOR INDIRECT, SPECIAL, CONSEQUENTIAL, OR INCIDENTAL DAMAGES INCLUDING, BUT NOT LIMITED TO, DAMAGES FOR LOSS OF PROFIT OR GOODWILL REGARDLESS OF (A) THE NEGLIGENCE (EITHER SOLE OR CONCURRENT) OF LANCASTER LABORATORIES AND (B) WHETHER LANCASTER LABORATORIES HAS BEEN INFORMED OF THE POSSIBILITY OF SUCH DAMAGES. We accept no legal responsibility for the purposes for which the client uses the test results. No purchase order or other order for work shall be accepted by Lancaster Laboratories which includes any conditions that vary from the Standard Terms and Conditions of Lancaster Laboratories and we hereby object to any conflicting terms contained in any acceptance or order submitted by client.

APPENDIX B

Monitoring Well Sampling Data Forms

WELL SAMPLING DATA FORM

CLIENT: Chevron EMC
WELL ID: MW-1
SITE NAME: Former Unocal S. Vacuum Unit
DATE: 07/15/09
PROJECT NO. V-107
SAMPLER: Van Deventer

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

SAMPLING METHOD: ☑ Disposable Bailer ☐ Direct from Discharge Hose ☐ Other:

DESCRIBE EQUIPMENT DECONTAMINATION METHOD BEFORE SAMPLING THE WELL:

☑ Gloves ☑ Alconox ☑ Distilled Water Rinse ☐ Other:

DISPOSAL METHOD OF PURGE WATER: ☐ Surface Discharge ☐ Drums ☑ Disposal Facility

TOTAL DEPTH OF WELL: 70.00 Feet
DEPTH TO WATER: 63.95 Feet
HEIGHT OF WATER COLUMN: 6.05 Feet
3.0 Min. Gallons to purge 3 well volumes
WELL DIAMETER: 2.0 Inch

TIME	VOLUME PURGED	TEMP. oC	COND. mS/cm	pH	DO mg/L	PHYSICAL APPEARANCE AND REMARKS
12:48	0					Started hand bailing
12:54	1.3	20.5	3.03	7.52		Clear
12:59	2.7	20.2	3.12	7.45		Clear
13:02	4.0	19.9	3.05	7.62		Collected sample
0:14	Total Time (hr:min)		4	Total Vol (gal)	0.29	= Average Flow Rate (gal/min)

COMMENTS: Parameters obtained using a calibrated Hanna Model 98130 Multimeter.

Sample placed into 1000 ml plastic container, and put on ice in cooler.

Delivered sample to Lancaster Laboratories (Lancaster PA) for Chloride and TDS analyses.

WELL SAMPLING DATA FORM

CLIENT: Chevron EMC

WELL ID: MW-2

SITE NAME: Former Unocal S. Vacuum Unit

DATE: 07/15/09

PROJECT NO. V-107

SAMPLER: Van Deventer

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

SAMPLING METHOD: ☑ Disposable Bailer ☐ Direct from Discharge Hose ☐ Other:

DESCRIBE EQUIPMENT DECONTAMINATION METHOD BEFORE SAMPLING THE WELL:

☑ Gloves ☑ Alconox ☑ Distilled Water Rinse ☐ Other:

DISPOSAL METHOD OF PURGE WATER: ☐ Surface Discharge ☐ Drums ☑ Disposal Facility

TOTAL DEPTH OF WELL: 71.00 Feet

DEPTH TO WATER: 50.80 Feet

HEIGHT OF WATER COLUMN: 20.20 Feet 9.9 Min. Gallons to purge 3 well volumes

WELL DIAMETER: 2.0 Inch

TIME	VOLUME PURGED	TEMP. °C	COND. mS/cm	pH	DO mg/L	PHYSICAL APPEARANCE AND REMARKS
11:13	0					Started hand bailing
11:25	3	20.2	1.60	8.71		Clear
11:38	7	20.5	1.67	9.16		Clear
11:50	10	20.1	1.70	9.16		Collected sample

0:37 Total Time (hr:min) | 10 Total Vol (gal) | 0.27 = Average Flow Rate (gal/min)

COMMENTS: Parameters obtained using a calibrated Hanna Model 98130 Multimeter.

Sample placed into 1000 ml plastic container, and put on ice in cooler.

Delivered sample to Lancaster Laboratories (Lancaster PA) for Chloride and TDS analyses.

WELL SAMPLING DATA FORM

CLIENT: Chevron EMC
WELL ID: MW-3
SITE NAME: Former Unocal S. Vacuum Unit
DATE: 07/15/09
PROJECT NO. V-107
SAMPLER: Van Deventer

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

SAMPLING METHOD: ☑ Disposable Bailer ☐ Direct from Discharge Hose ☐ Other:

DESCRIBE EQUIPMENT DECONTAMINATION METHOD BEFORE SAMPLING THE WELL:

☑ Gloves ☑ Alconox ☑ Distilled Water Rinse ☐ Other:

DISPOSAL METHOD OF PURGE WATER: ☐ Surface Discharge ☐ Drums ☑ Disposal Facility

TOTAL DEPTH OF WELL: 77.00 Feet
DEPTH TO WATER: 68.30 Feet
HEIGHT OF WATER COLUMN: 8.70 Feet 4.3 Min. Gallons to purge 3 well volumes
WELL DIAMETER: 2.0 Inch

TIME	VOLUME PURGED	TEMP. °C	COND. mS/cm	pH	DO mg/L	PHYSICAL APPEARANCE AND REMARKS
12:06	0					Started hand bailing
12:12	2	20.2	0.90	7.72		
12:18	4	19.8	0.90	7.95		
12:25	6	20.3	0.89	7.88		Collected sample
0:19	Total Time (hr:min)		6	Total Vol (gal)	0.32	= Average Flow Rate (gal/min)

COMMENTS: Parameters obtained using a calibrated Hanna Model 98130 Multimeter.

Sample placed into 1000 ml plastic container, and put on ice in cooler.

Delivered sample to Lancaster Laboratories (Lancaster PA) for Chloride and TDS analyses.

WELL SAMPLING DATA FORM

CLIENT: Chevron EMC WELL ID: MW-4
SITE NAME: Former Unocal S. Vacuum Unit DATE: 07/15/09
PROJECT NO. V-107 SAMPLER: Van Deventer

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

SAMPLING METHOD: ☑ Disposable Bailer ☐ Direct from Discharge Hose ☐ Other:

DESCRIBE EQUIPMENT DECONTAMINATION METHOD BEFORE SAMPLING THE WELL:

☑ Gloves ☑ Alconox ☑ Distilled Water Rinse ☐ Other:

DISPOSAL METHOD OF PURGE WATER: ☐ Surface Discharge ☐ Drums ☑ Disposal Facility

TOTAL DEPTH OF WELL: 71.00 Feet
DEPTH TO WATER: 61.55 Feet
HEIGHT OF WATER COLUMN: 9.45 Feet 4.6 Min. Gallons to purge 3 well volumes
WELL DIAMETER: 2.0 Inch

TIME	VOLUME PURGED	TEMP. °C	COND. mS/cm	pH	DO mg/L	PHYSICAL APPEARANCE AND REMARKS
10:27	0					Started hand bailing
10:33	2	20.2	2.99	8.44		Clear
10:40	4	20.1	2.97	8.41		Clear
10:50	6	20.4	3.04	8.40		Sample collected
0:23 Total Time (hr:min)			6 Total Vol (gal)		0.26 = Average Flow Rate (gal/min)	

COMMENTS: Parameters obtained using a calibrated Hanna Model 98130 Multimeter.
Sample placed into 1000 ml plastic container, and put on ice in cooler.
Delivered sample to Lancaster Laboratories (Lancaster PA) for Chloride and TDS analyses.

WELL SAMPLING DATA FORM

CLIENT: Chevron EMC
WELL ID: MW-5
SITE NAME: Former Unocal S. Vacuum Unit
DATE: 07/15/09
PROJECT NO. V-107
SAMPLER: Van Deventer

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

SAMPLING METHOD: ☑ Disposable Bailer ☐ Direct from Discharge Hose ☐ Other:

DESCRIBE EQUIPMENT DECONTAMINATION METHOD BEFORE SAMPLING THE WELL:

☑ Gloves ☑ Alconox ☑ Distilled Water Rinse ☐ Other:

DISPOSAL METHOD OF PURGE WATER: ☐ Surface Discharge ☐ Drums ☑ Disposal Facility

TOTAL DEPTH OF WELL: 79.00 Feet
DEPTH TO WATER: 69.61 Feet
HEIGHT OF WATER COLUMN: 9.39 Feet 4.6 Min. Gallons to purge 3 well volumes
WELL DIAMETER: 2.0 Inch

TIME	VOLUME PURGED	TEMP. °C	COND. mS/cm	pH	DO mg/L	PHYSICAL APPEARANCE AND REMARKS
9:27	0					Started hand bailing
9:38	3	19.9	0.41	7.95		Clear
9:57	7	20.4	0.42	7.62		Clear
10:10	10	20.2	0.41	7.77		Collected sample

0:43 Total Time (hr:min)	10 Total Vol (gal)	0.23 = Average Flow Rate (gal/min)

COMMENTS: Parameters obtained using a calibrated Hanna Model 98130 Multimeter.

Sample placed into 1000 ml plastic container, and put on ice in cooler.

Delivered sample to Lancaster Laboratories (Lancaster PA) for Chloride and TDS analyses.

WELL SAMPLING DATA FORM

CLIENT: Chevron EMC
WELL ID: MW-6
SITE NAME: Former Unocal S. Vacuum Unit
DATE: 07/15/09
PROJECT NO. V-107
SAMPLER: Van Deventer

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

SAMPLING METHOD: ☑ Disposable Bailer ☐ Direct from Discharge Hose ☐ Other:

DESCRIBE EQUIPMENT DECONTAMINATION METHOD BEFORE SAMPLING THE WELL:

☑ Gloves ☑ Alconox ☑ Distilled Water Rinse ☐ Other:

DISPOSAL METHOD OF PURGE WATER: ☐ Surface Discharge ☐ Drums ☑ Disposal Facility

TOTAL DEPTH OF WELL: 77.20 Feet
DEPTH TO WATER: 71.61 Feet
HEIGHT OF WATER COLUMN: 5.59 Feet 2.7 Min. Gallons to purge 3 well volumes
WELL DIAMETER: 2.0 Inch

TIME	VOLUME PURGED	TEMP. °C	COND. mS/cm	pH	DO mg/L	PHYSICAL APPEARANCE AND REMARKS
16:45	0					Started hand bailing
16:49	1	20.4	0.76	8.05		Clear
16:52	2	19.8	0.78	8.09		Well bailing dry (1/2 bailers)
16:56	3	19.8	0.79	8.08		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 Multimeter.

Sample placed into 1000 ml plastic container, and put on ice in cooler.

Delivered sample to Lancaster Laboratories (Lancaster PA) for Chloride and TDS analyses.

APPENDIX C

Chloride and TDS Plume Simulations

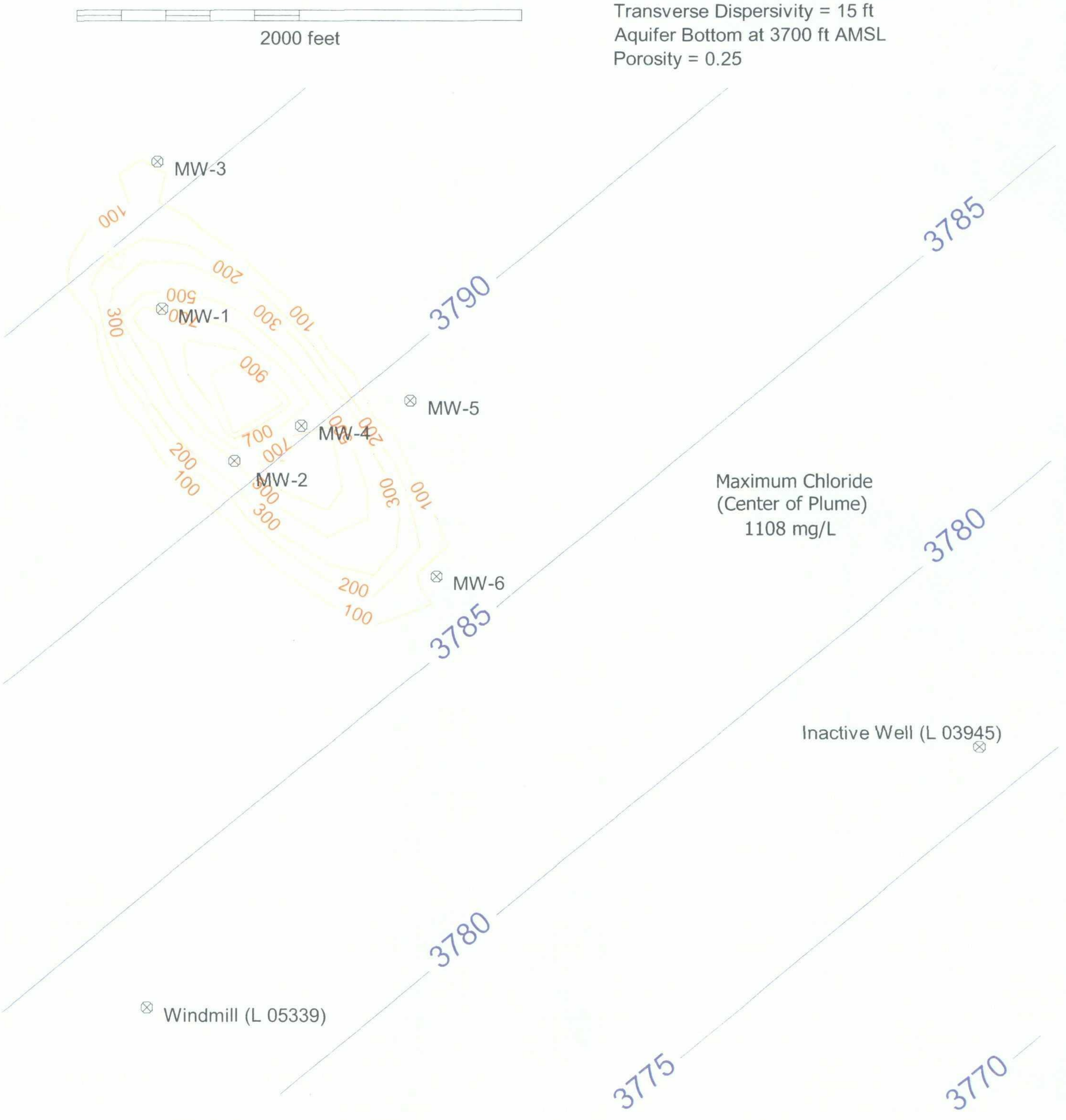
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2009)

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/year (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



WinTran Fate & Transport Modeling Results

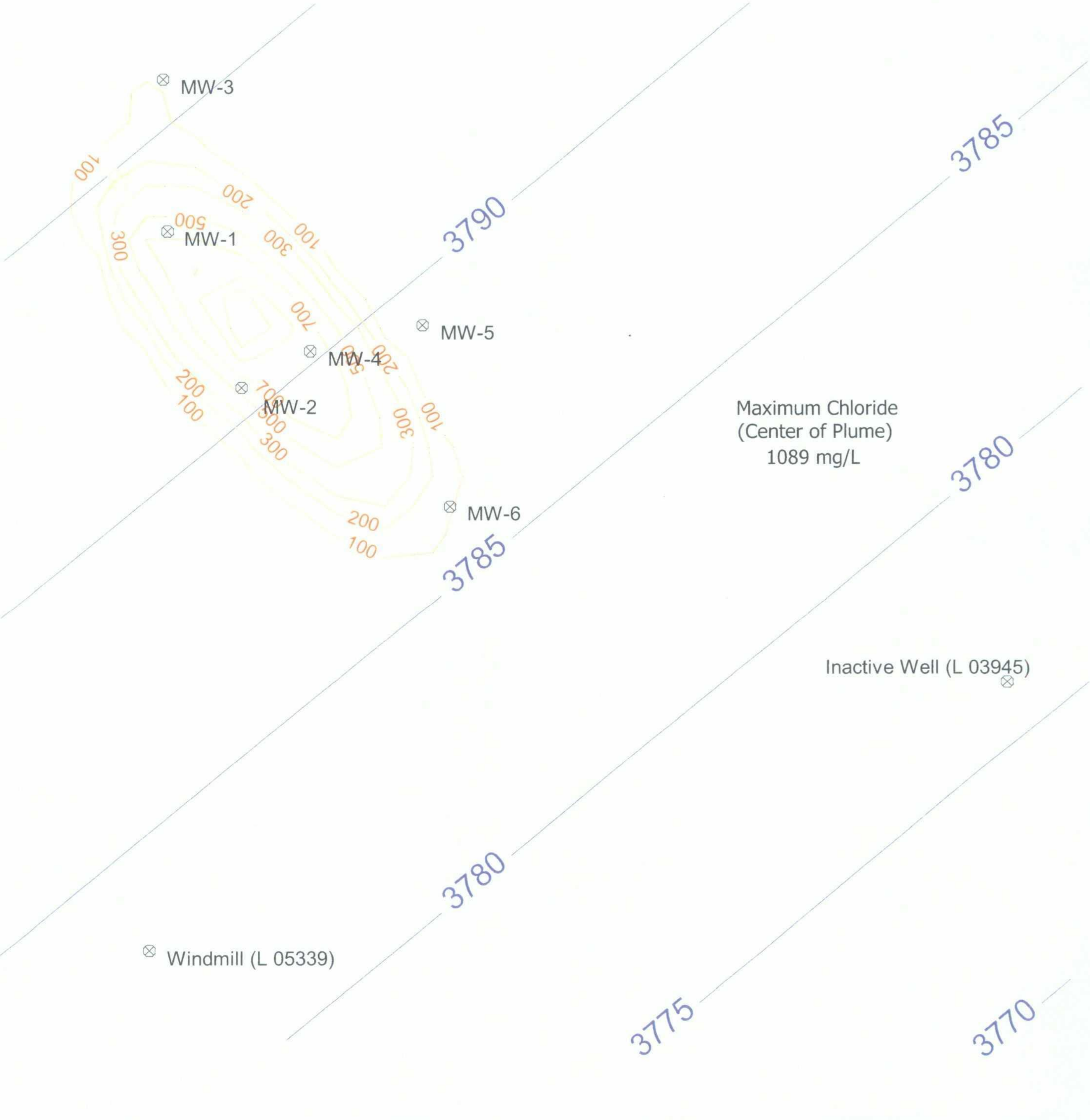
Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2010)

2000 feet

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/year (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

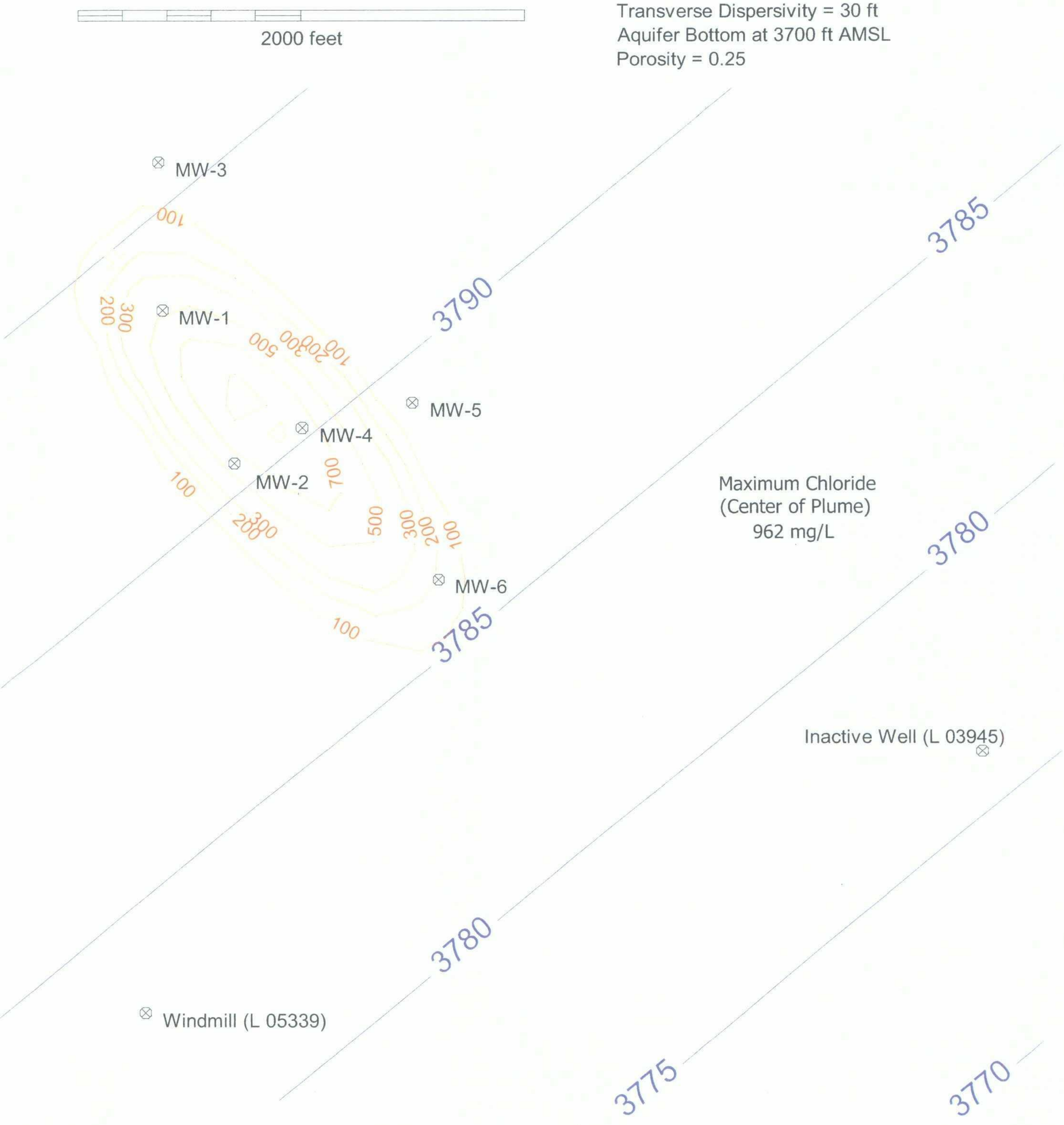


WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2015)

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/year (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



Maximum Chloride
(Center of Plume)
962 mg/L

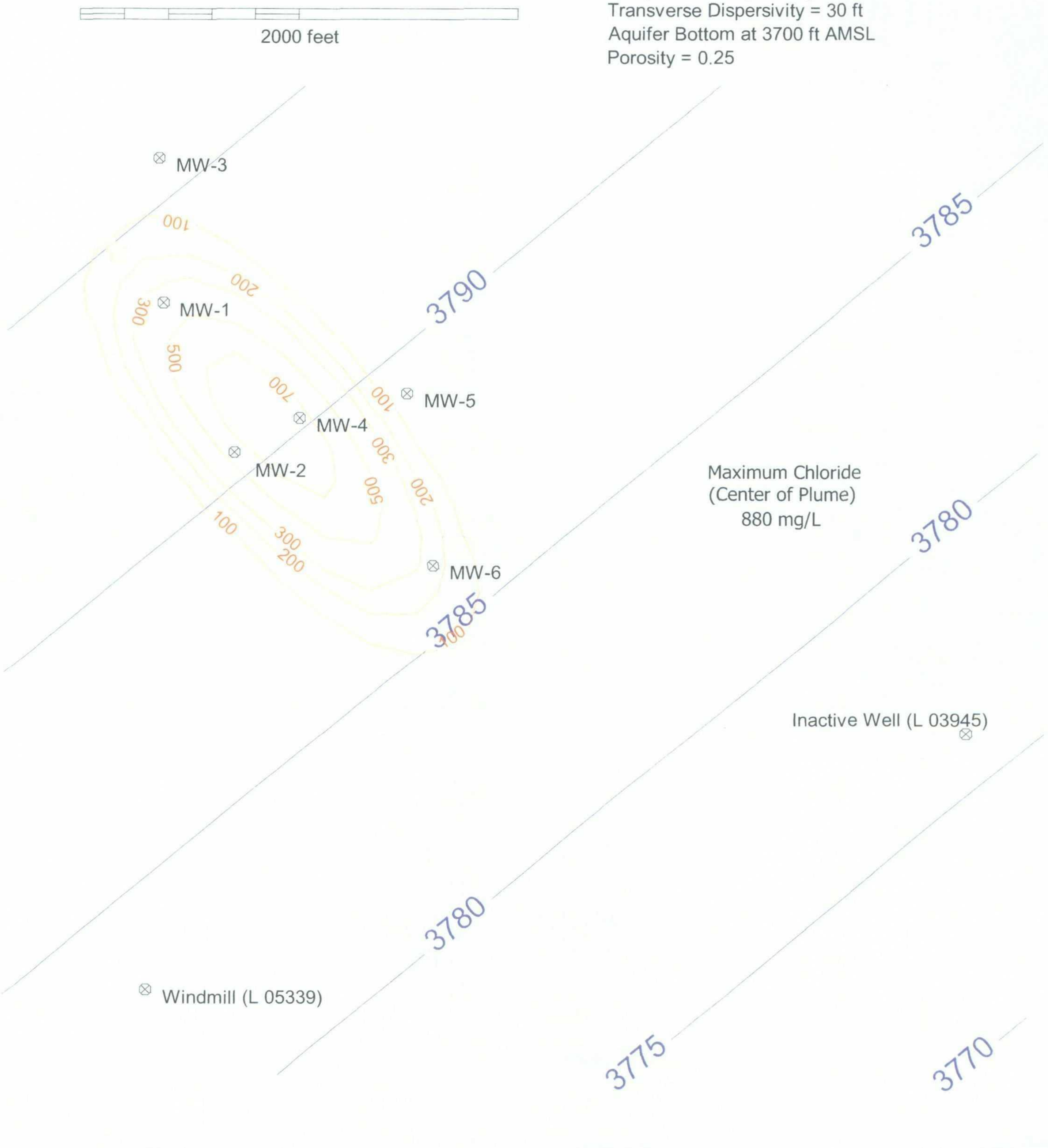
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2020)

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/year (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



Maximum Chloride
(Center of Plume)
880 mg/L

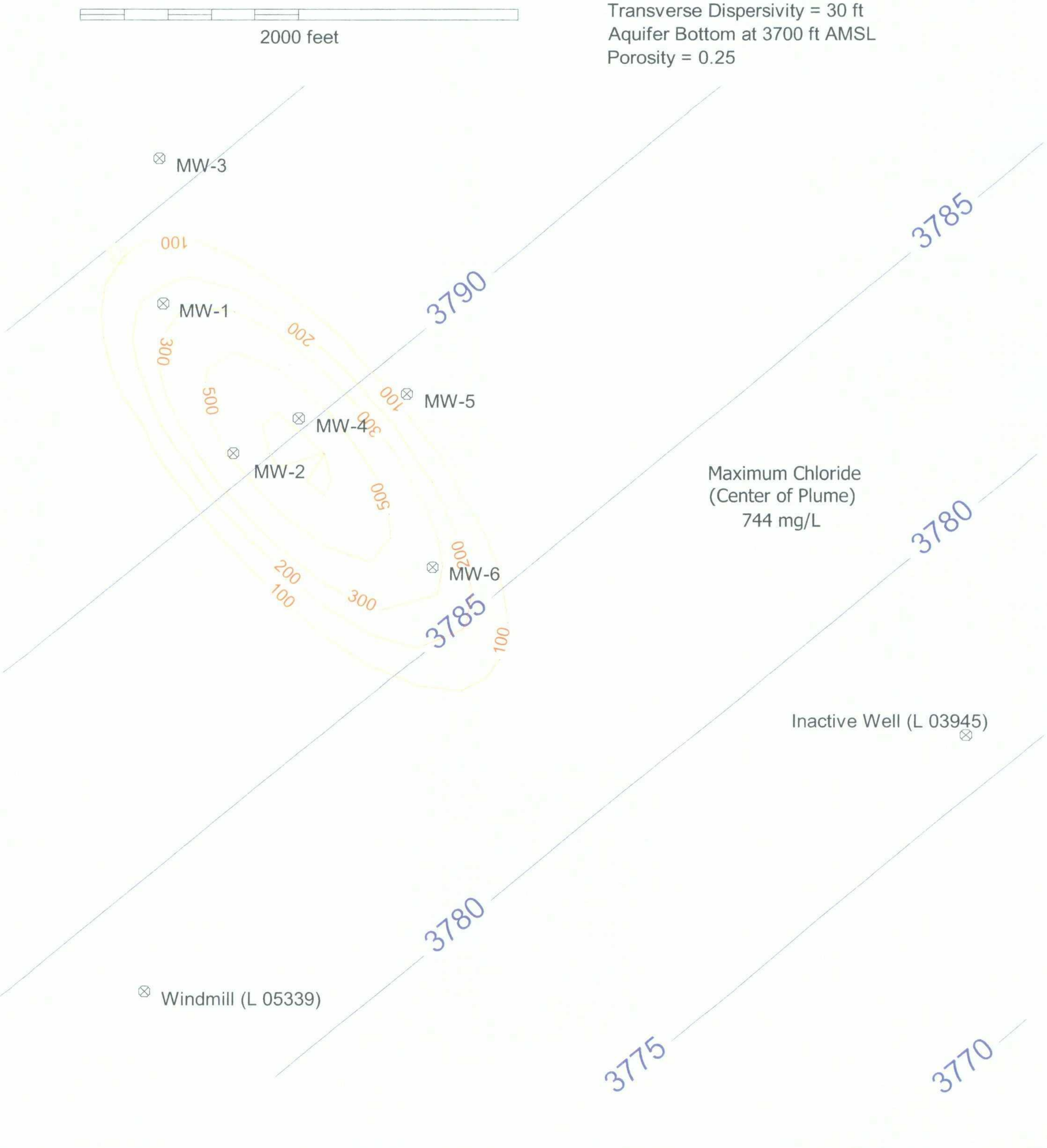
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2030)

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/year (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



Maximum Chloride
(Center of Plume)
744 mg/L

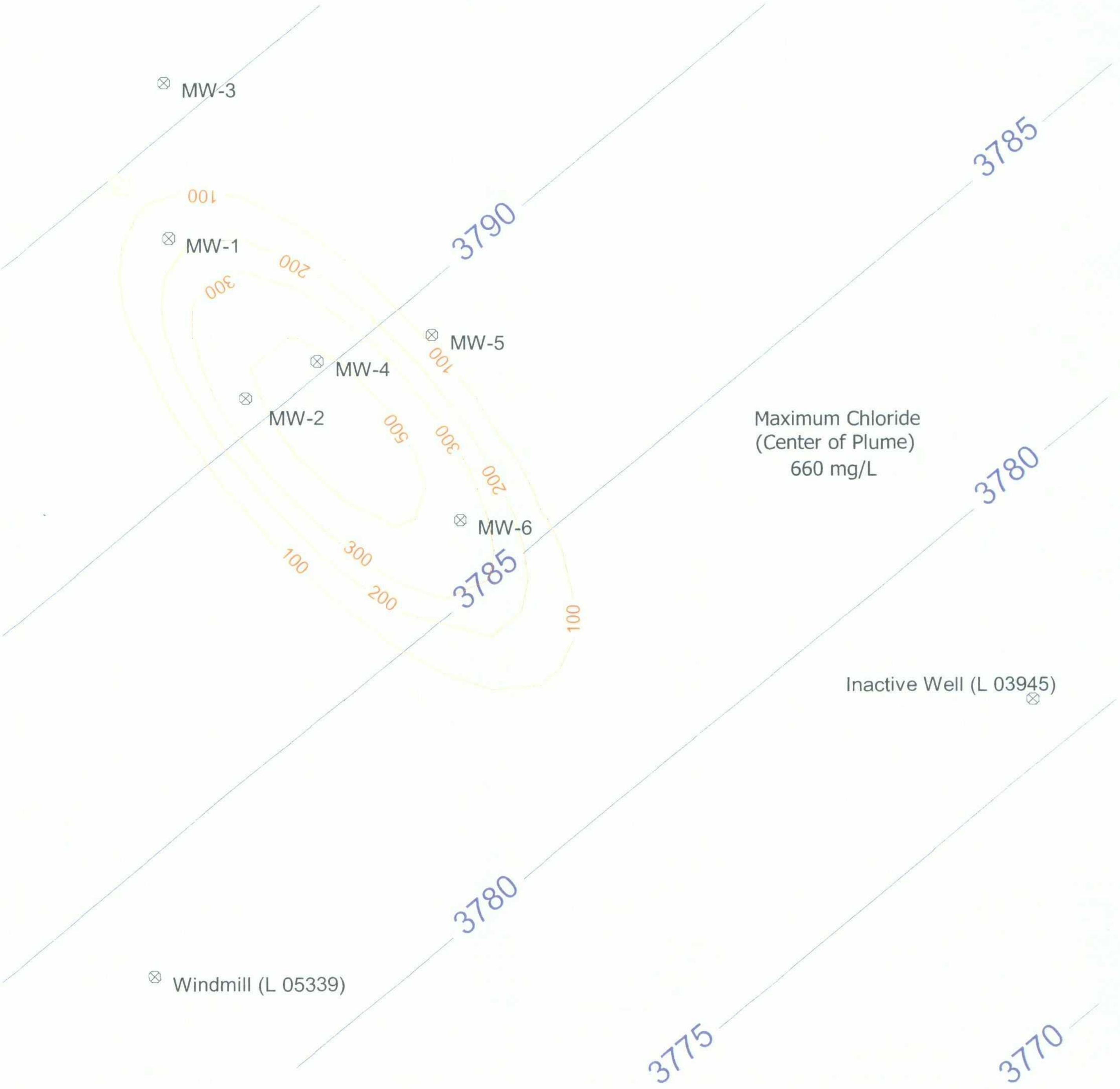
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2040)

2000 feet

Modeling Assumptions
Hydraulic Conductivity = 1000 ft/year (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



Maximum Chloride
(Center of Plume)
660 mg/L

WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2050)

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/year (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

Maximum Chloride
(Center of Plume)
571 mg/L

WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2060)

Modeling Assumptions
Hydraulic Conductivity = 1000 ft/year (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

Maximum Chloride
(Center of Plume)
523 mg/L

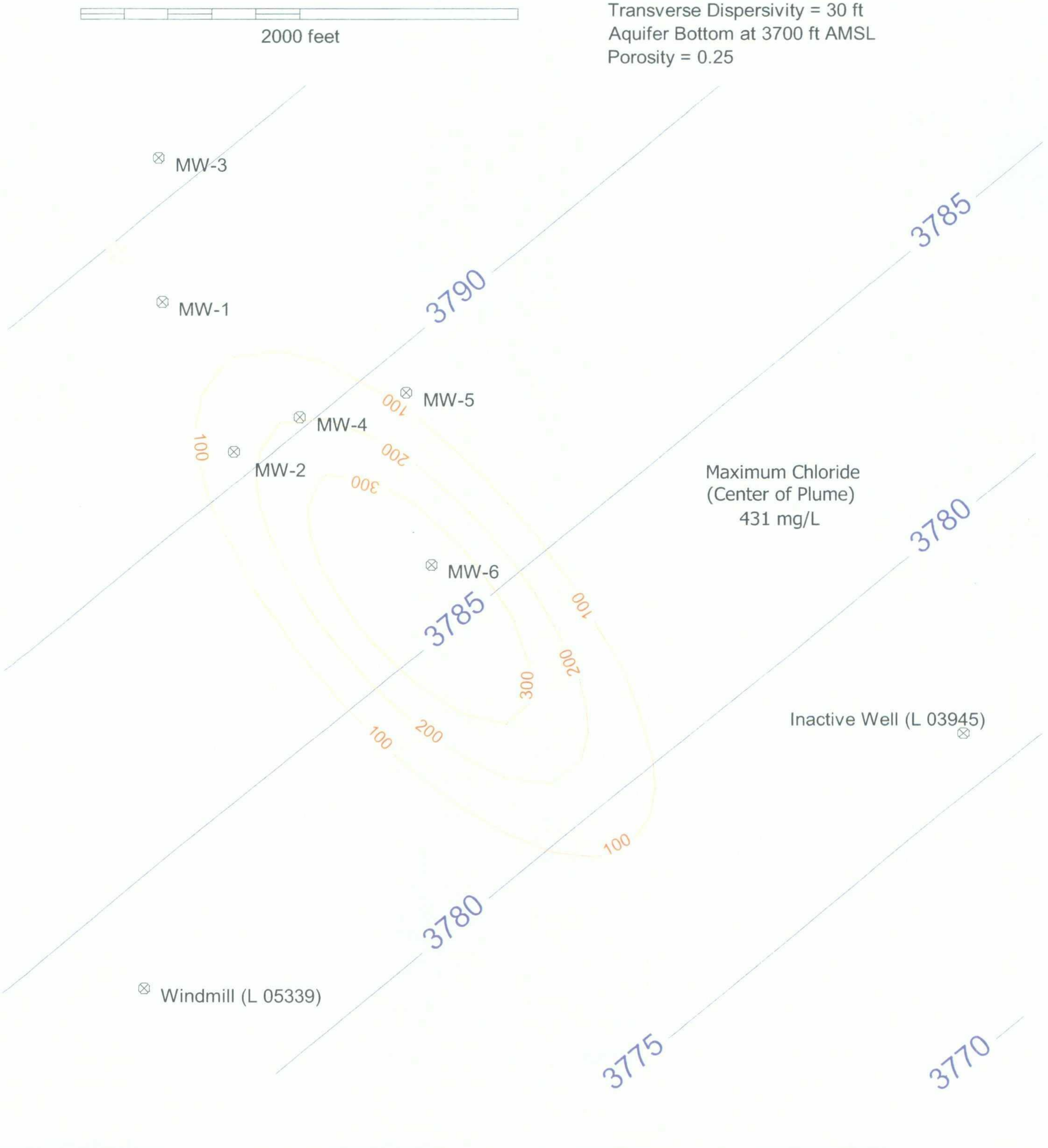
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2080)

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/year (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



Maximum Chloride
(Center of Plume)
431 mg/L

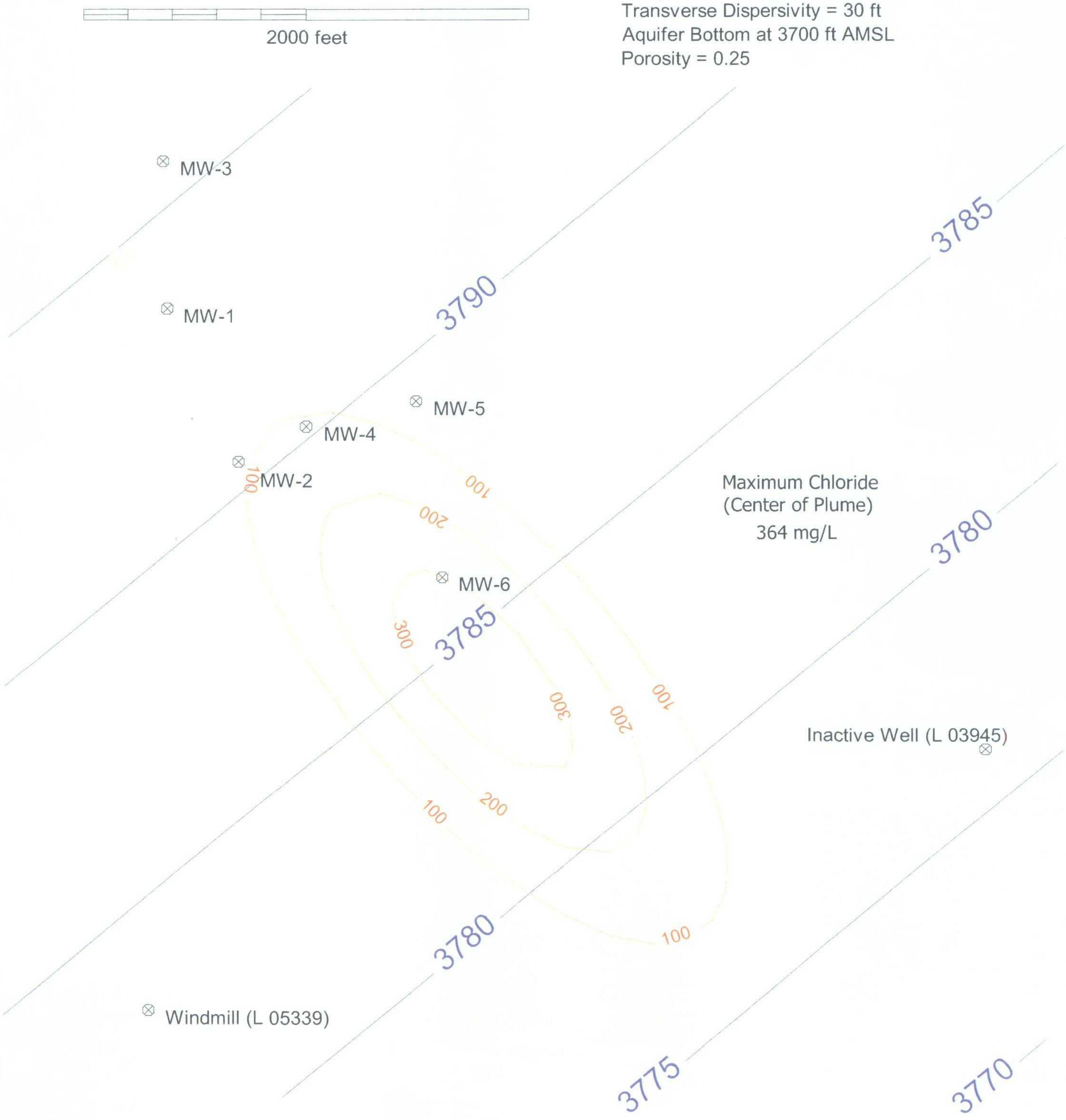
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2100)

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/year (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



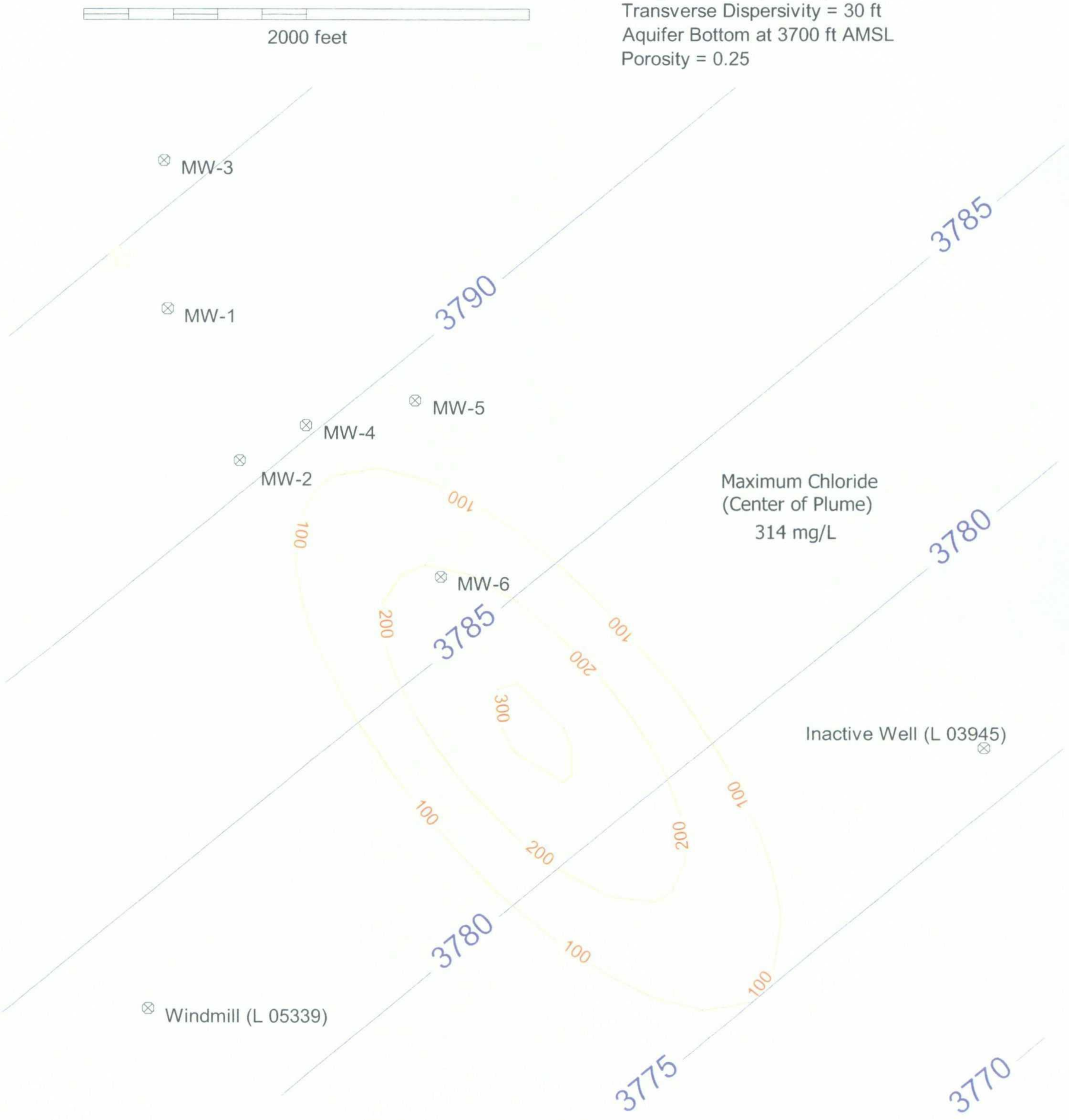
Maximum Chloride
(Center of Plume)
364 mg/L

WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2120)

Modeling Assumptions
Hydraulic Conductivity = 1000 ft/year (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



Maximum Chloride
(Center of Plume)
314 mg/L

WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2140)

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/year (2.7 ft/d)

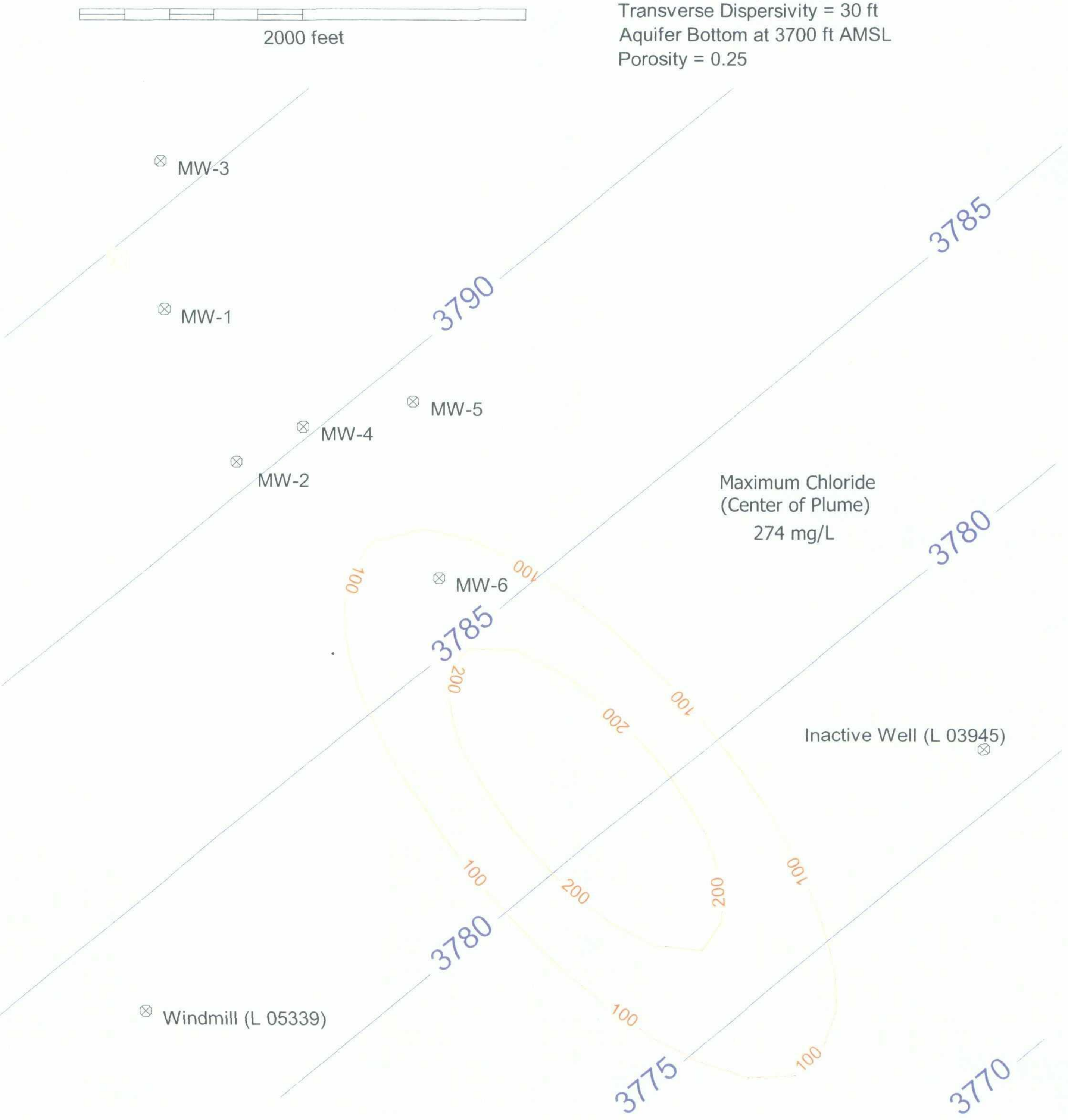
Hydraulic Gradient = 0.004 ft/ft (SE)

Longitudinal Dispersivity = 150 ft

Transverse Dispersivity = 30 ft

Aquifer Bottom at 3700 ft AMSL

Porosity = 0.25



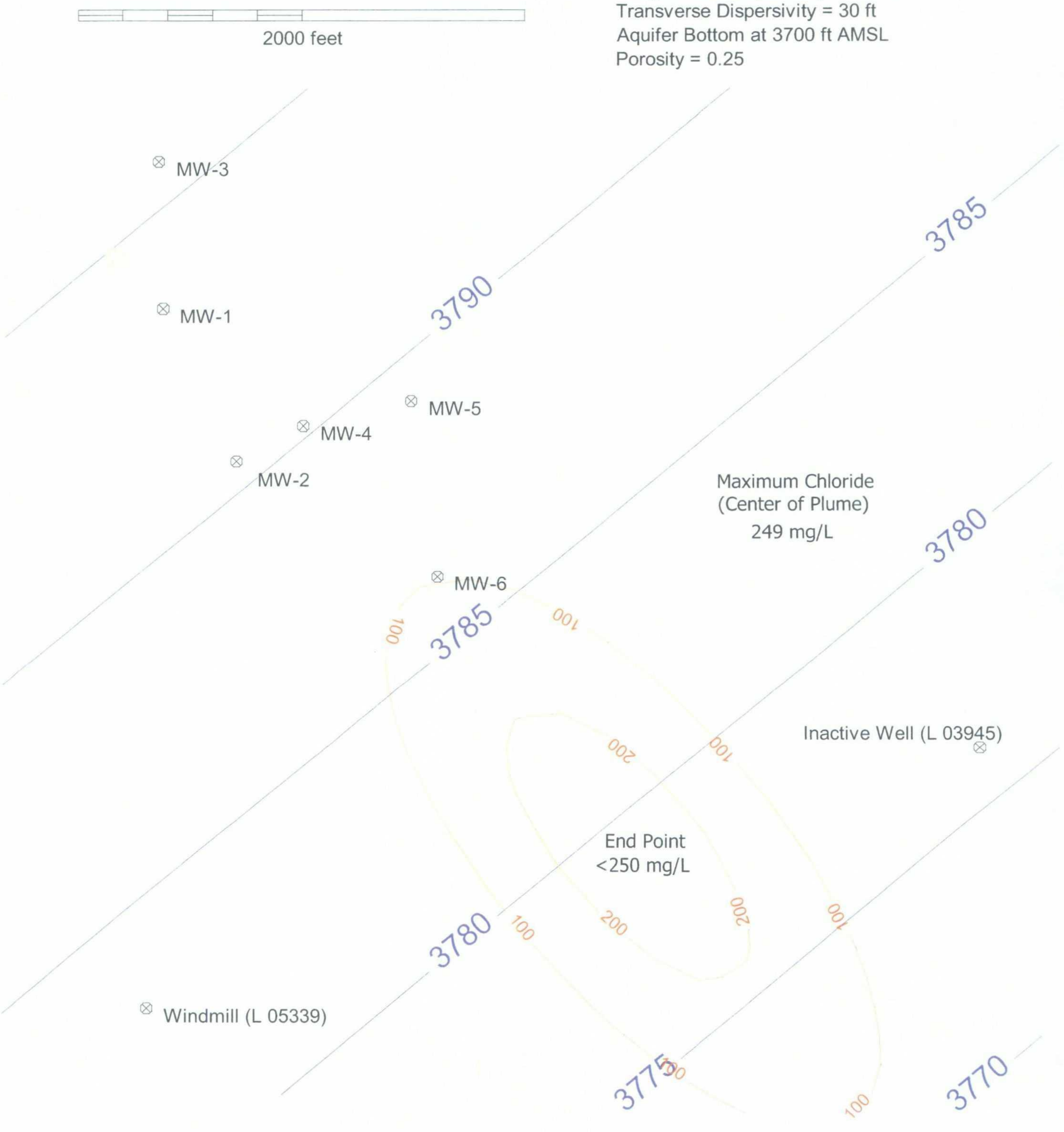
Maximum Chloride (Center of Plume)
274 mg/L

WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2156)

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/year (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 30 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

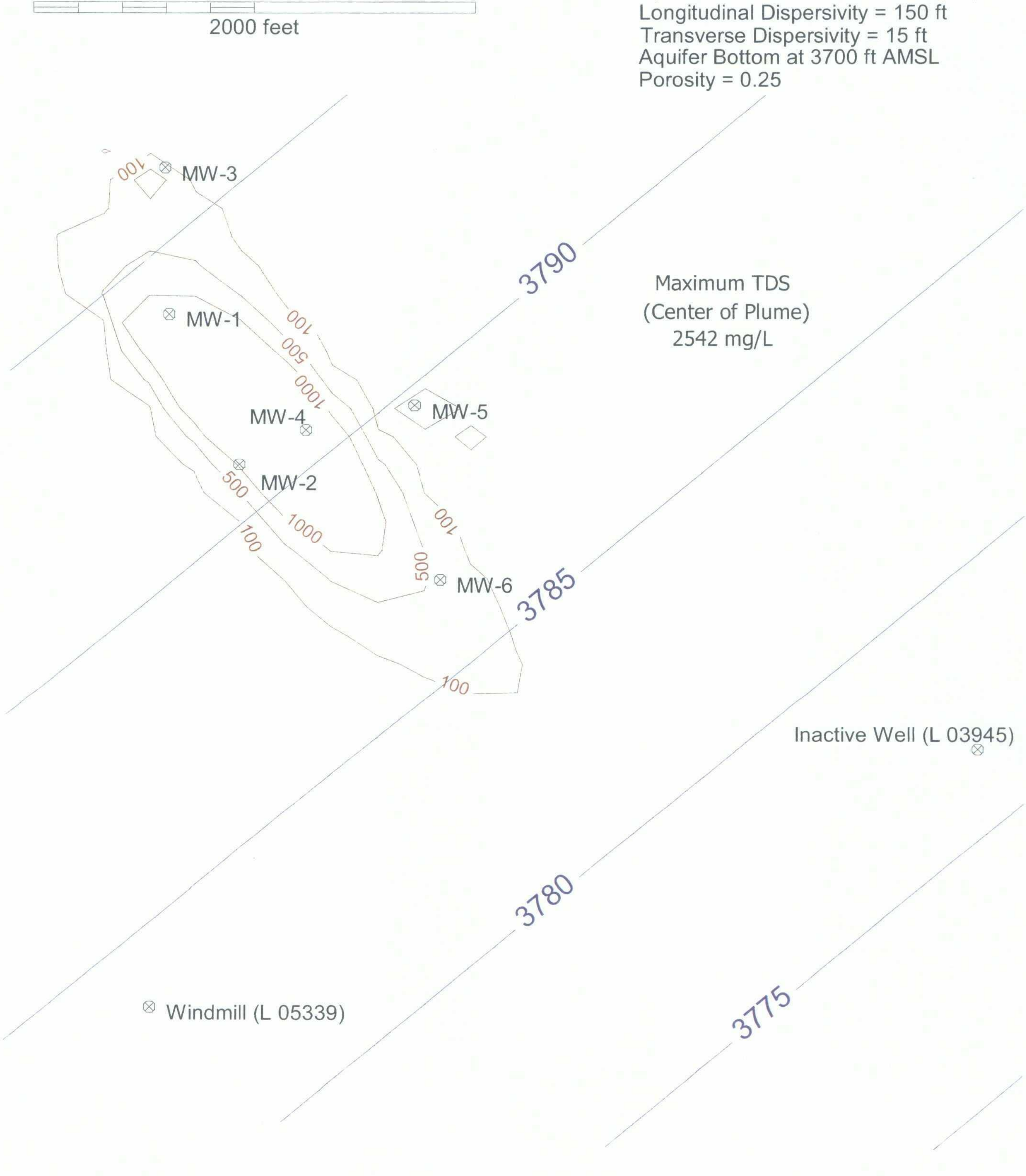


WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2009)

Modeling Assumptions

Initial Source Concentration=30000 mg/L
Hydraulic Conductivity = 100 ft'Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

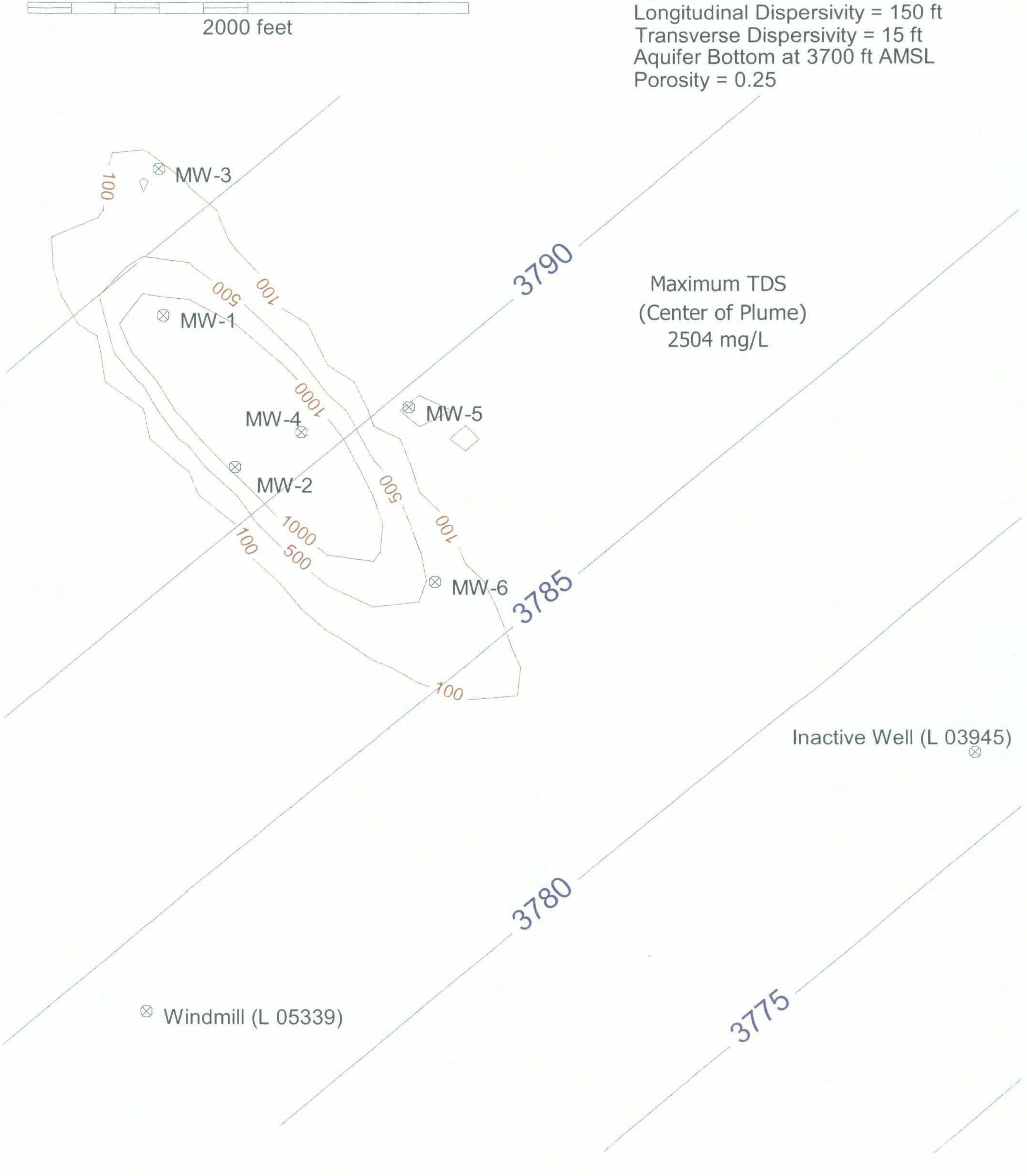


WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit

Modeling Assumptions

Initial Source Concentration=30000 mg/L
Hydraulic Conductivity = 100 ft'Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

TDS Plume Simulation (Year 2010)



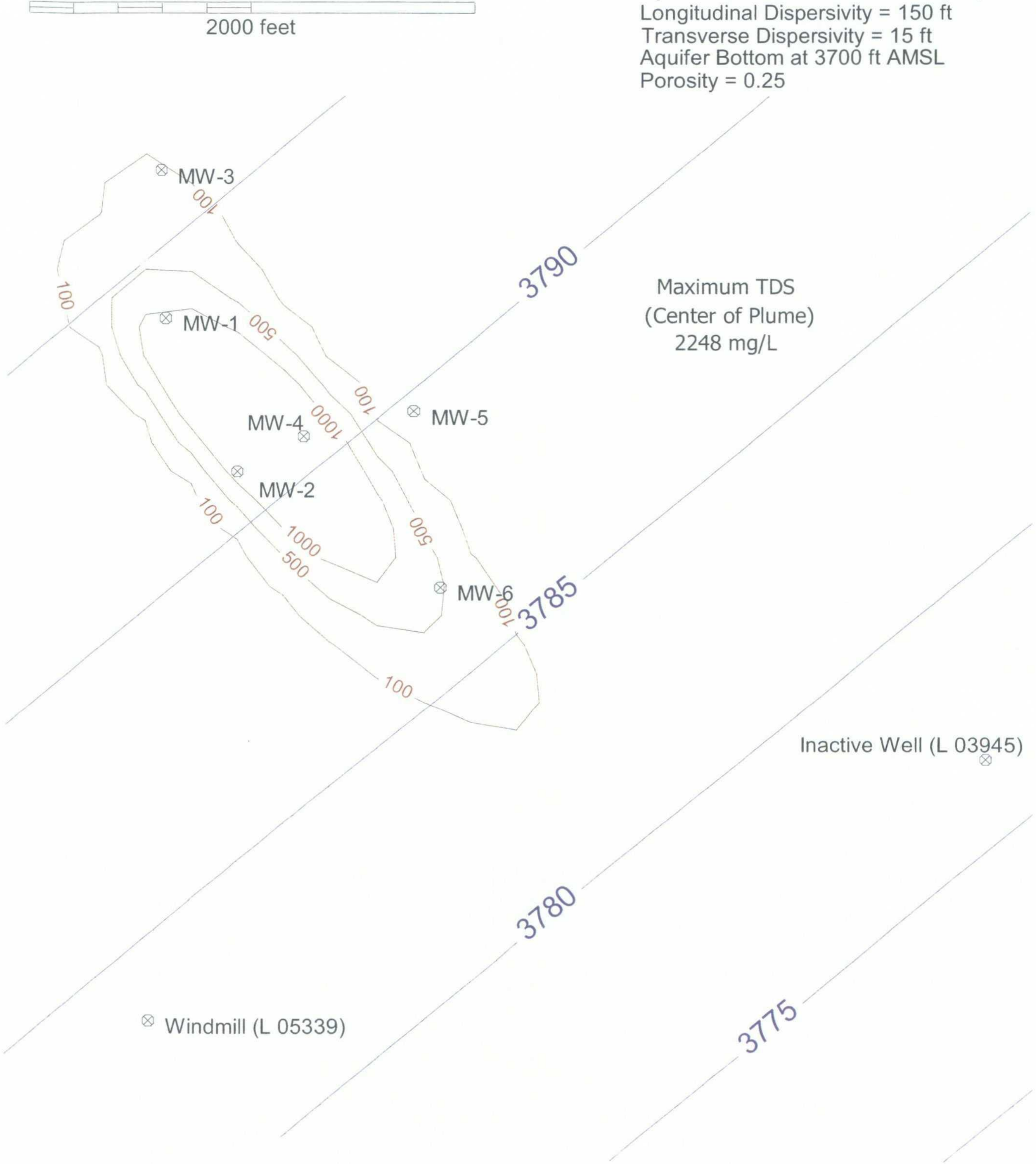
Maximum TDS
(Center of Plume)
2504 mg/L

WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit

Modeling Assumptions

Initial Source Concentration=30000 mg/L
Hydraulic Conductivity = 100 ft'Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

TDS Plume Simulation (Year 2015)

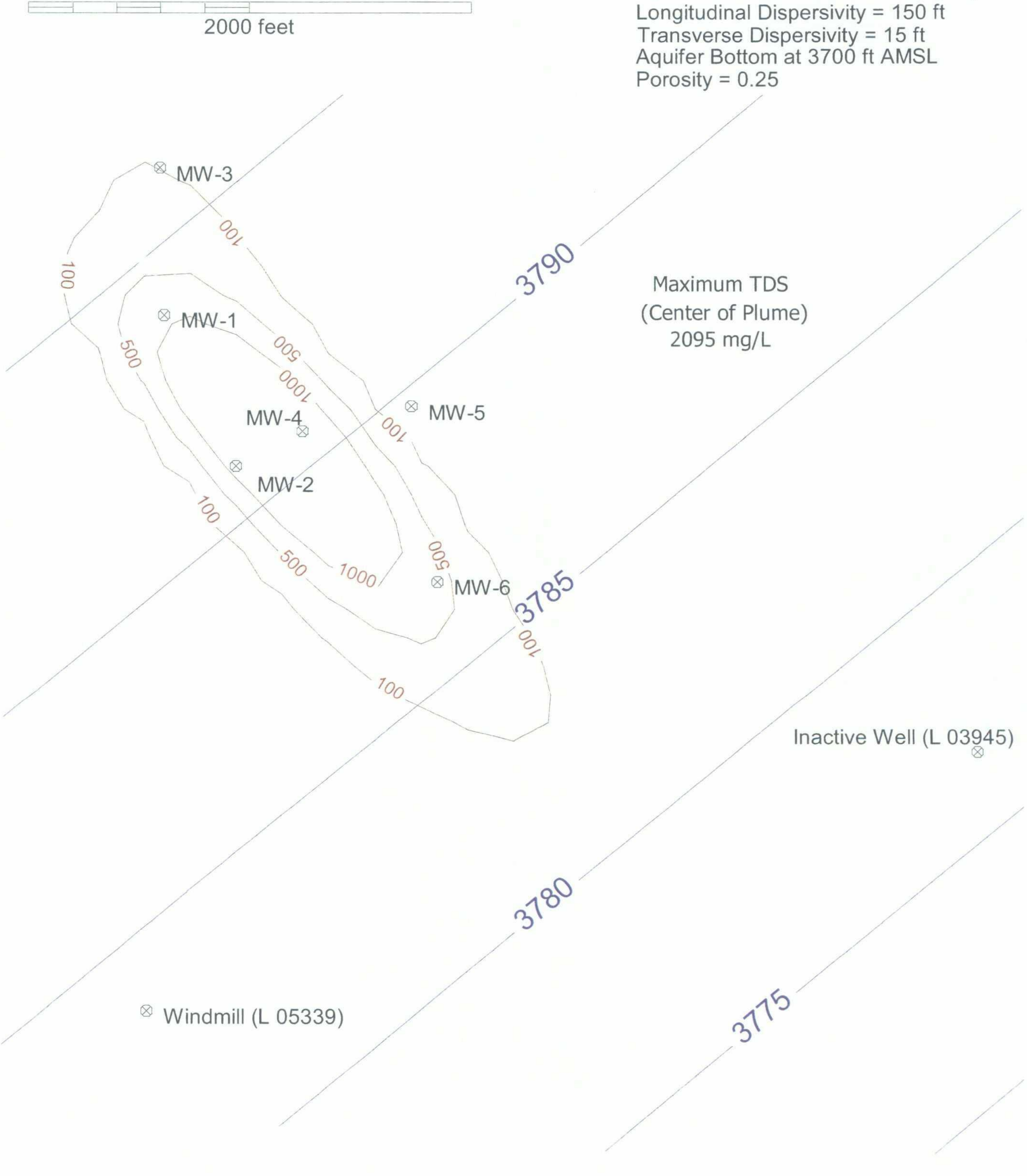


WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit

Modeling Assumptions

Initial Source Concentration=30000 mg/L
Hydraulic Conductivity = 100 ft'Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

TDS Plume Simulation (Year 2020)



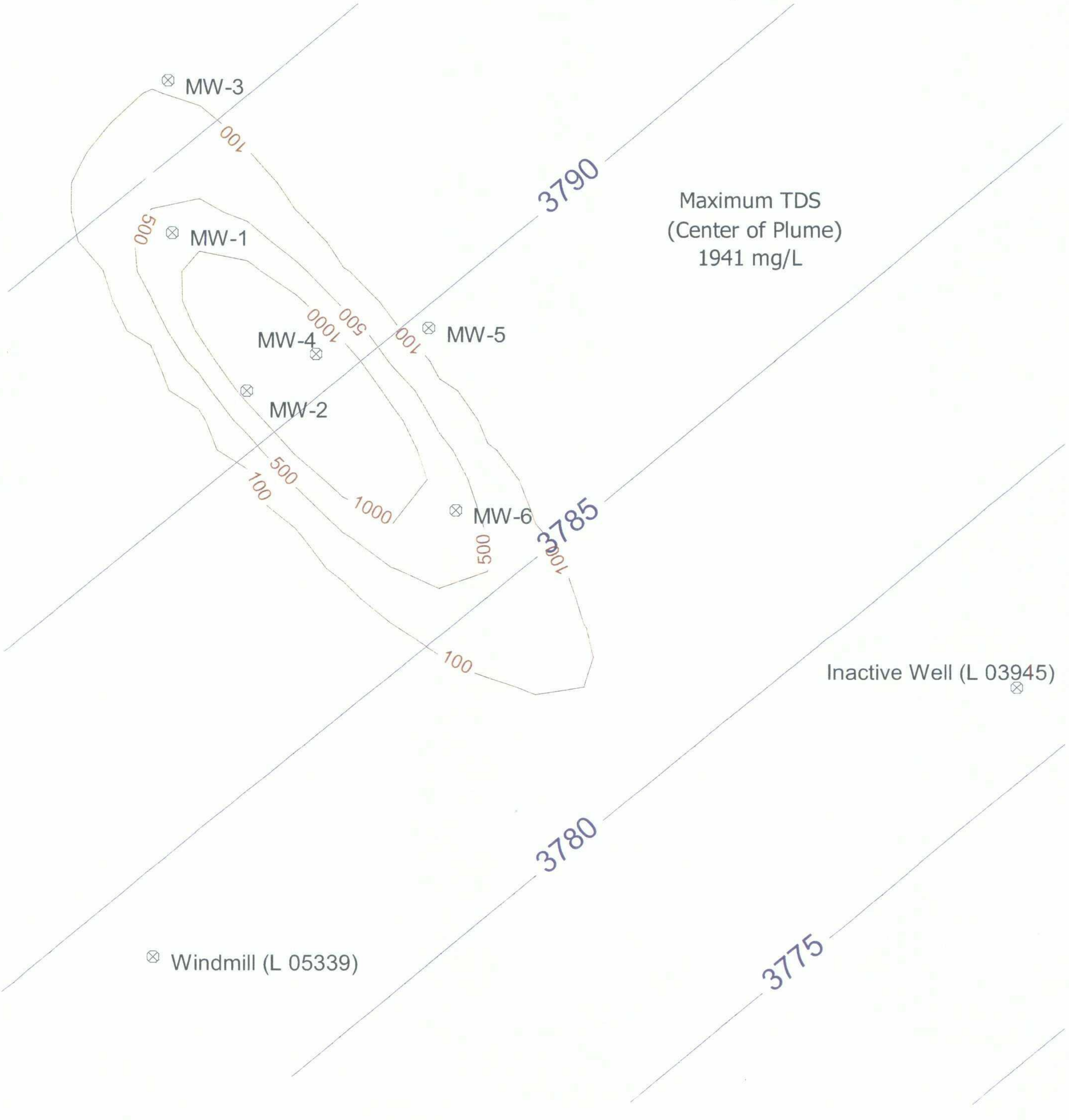
Maximum TDS
(Center of Plume)
2095 mg/L

WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit

Modeling Assumptions

Initial Source Concentration=30000 mg/L
Hydraulic Conductivity = 100 ft'Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

TDS Plume Simulation (Year 2025)



Maximum TDS
(Center of Plume)
1941 mg/L

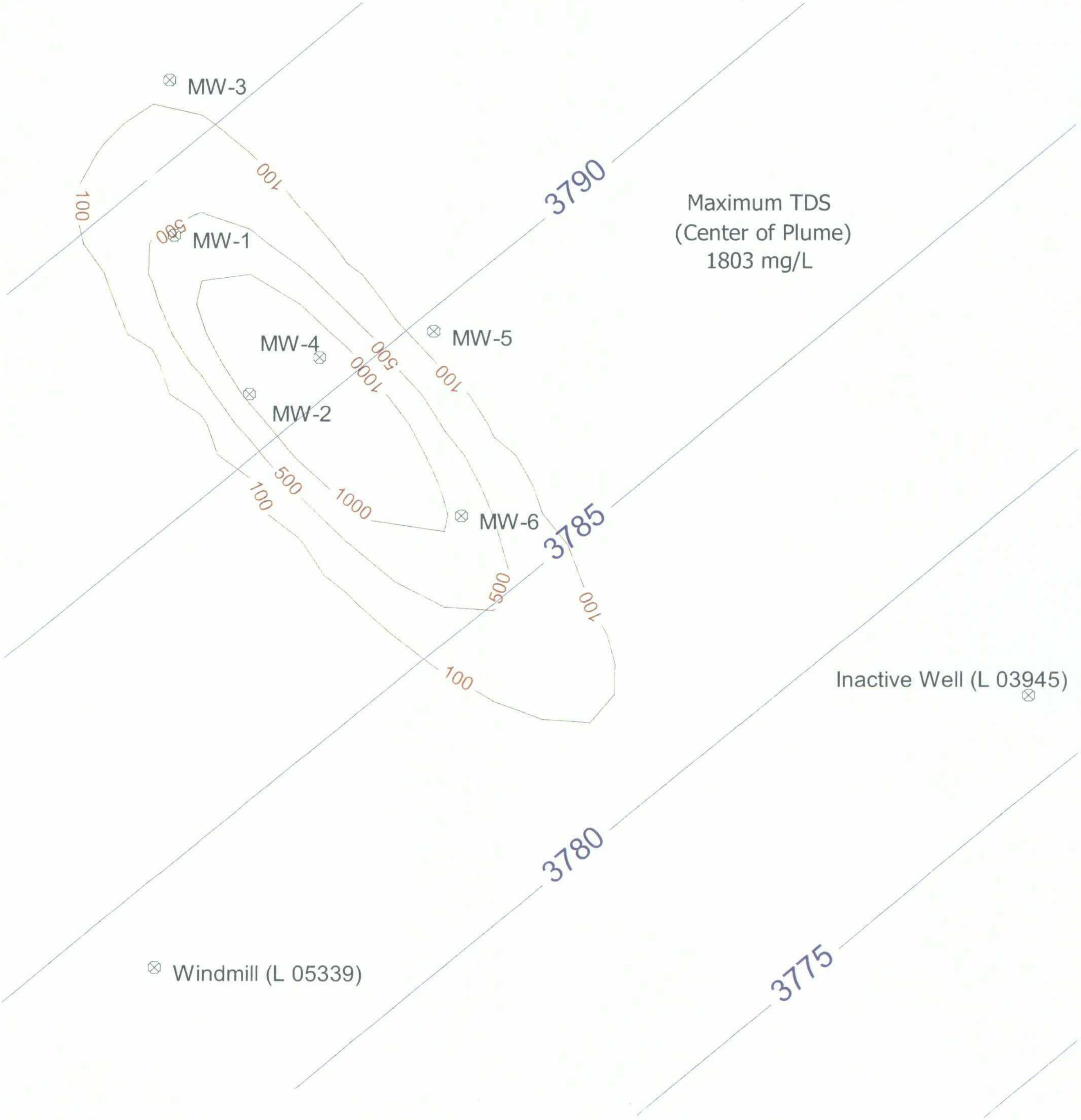
WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit

Modeling Assumptions

Initial Source Concentration=30000 mg/L
Hydraulic Conductivity = 100 ft'Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

TDS Plume Simulation (Year 2030)

2000 feet



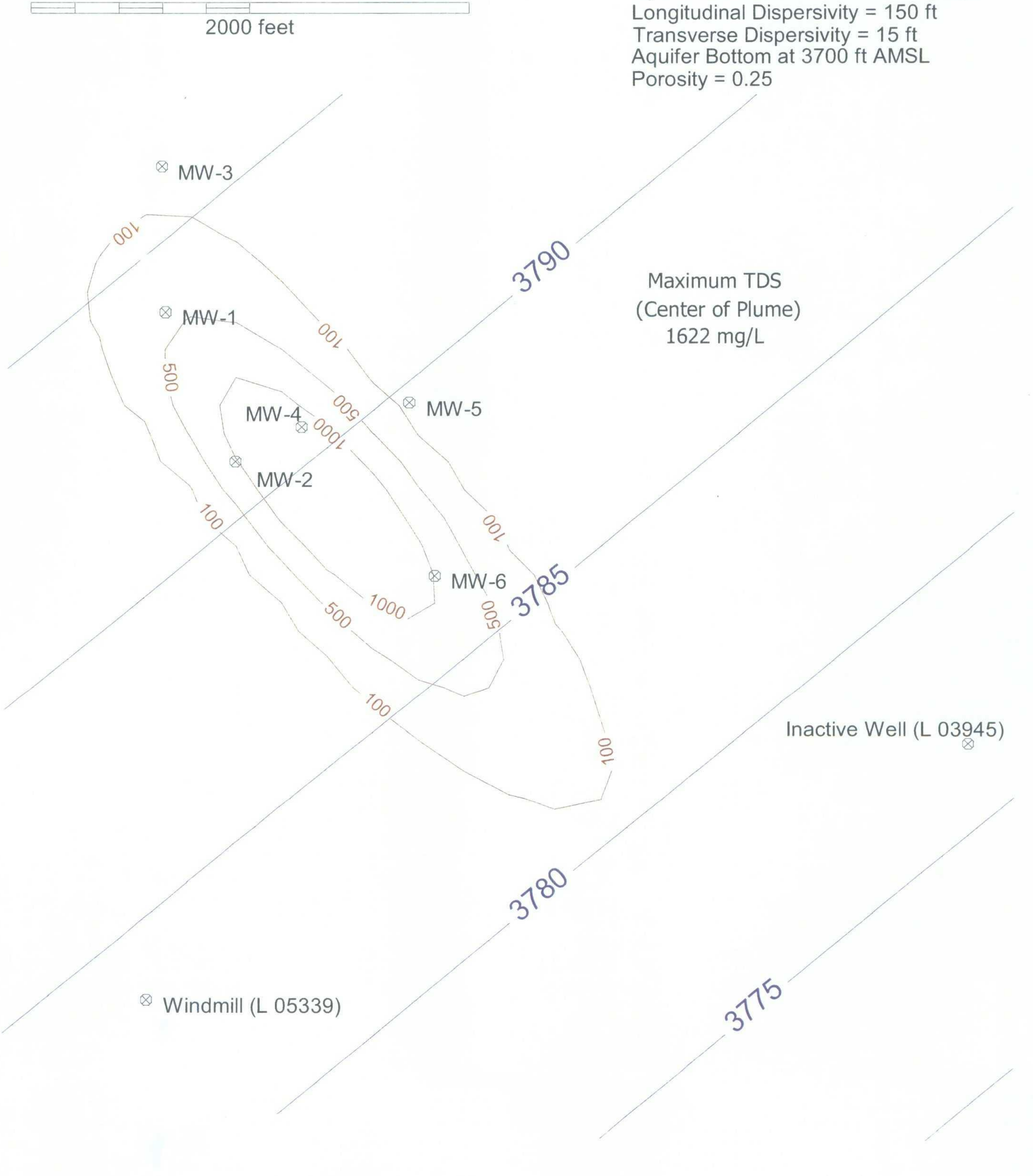
Maximum TDS
(Center of Plume)
1803 mg/L

WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2040)

Modeling Assumptions

Initial Source Concentration=30000 mg/L
Hydraulic Conductivity = 100 ft'Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



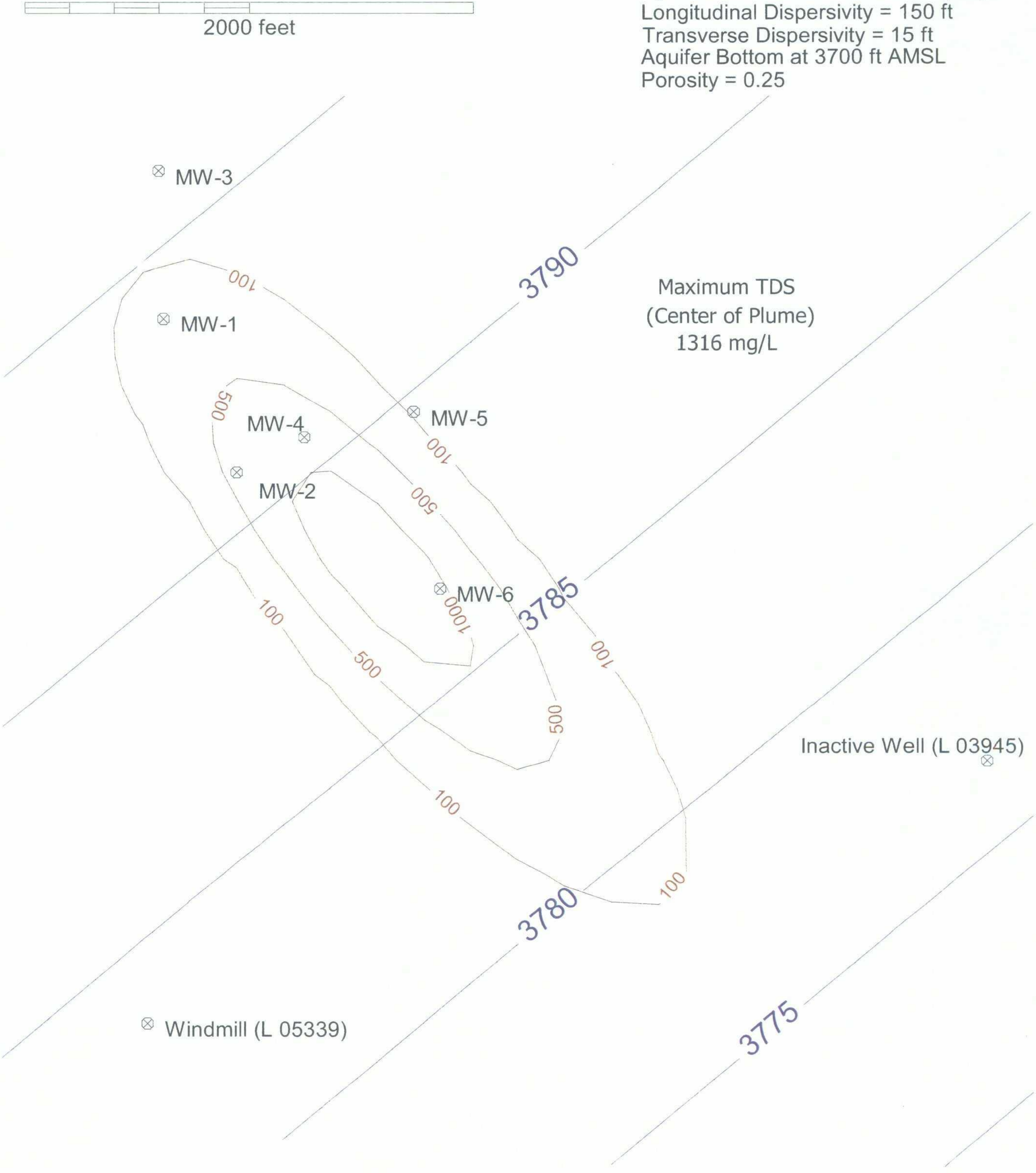
Maximum TDS
(Center of Plume)
1622 mg/L

WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2060)

Modeling Assumptions

Initial Source Concentration=30000 mg/L
Hydraulic Conductivity = 100 ft'Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

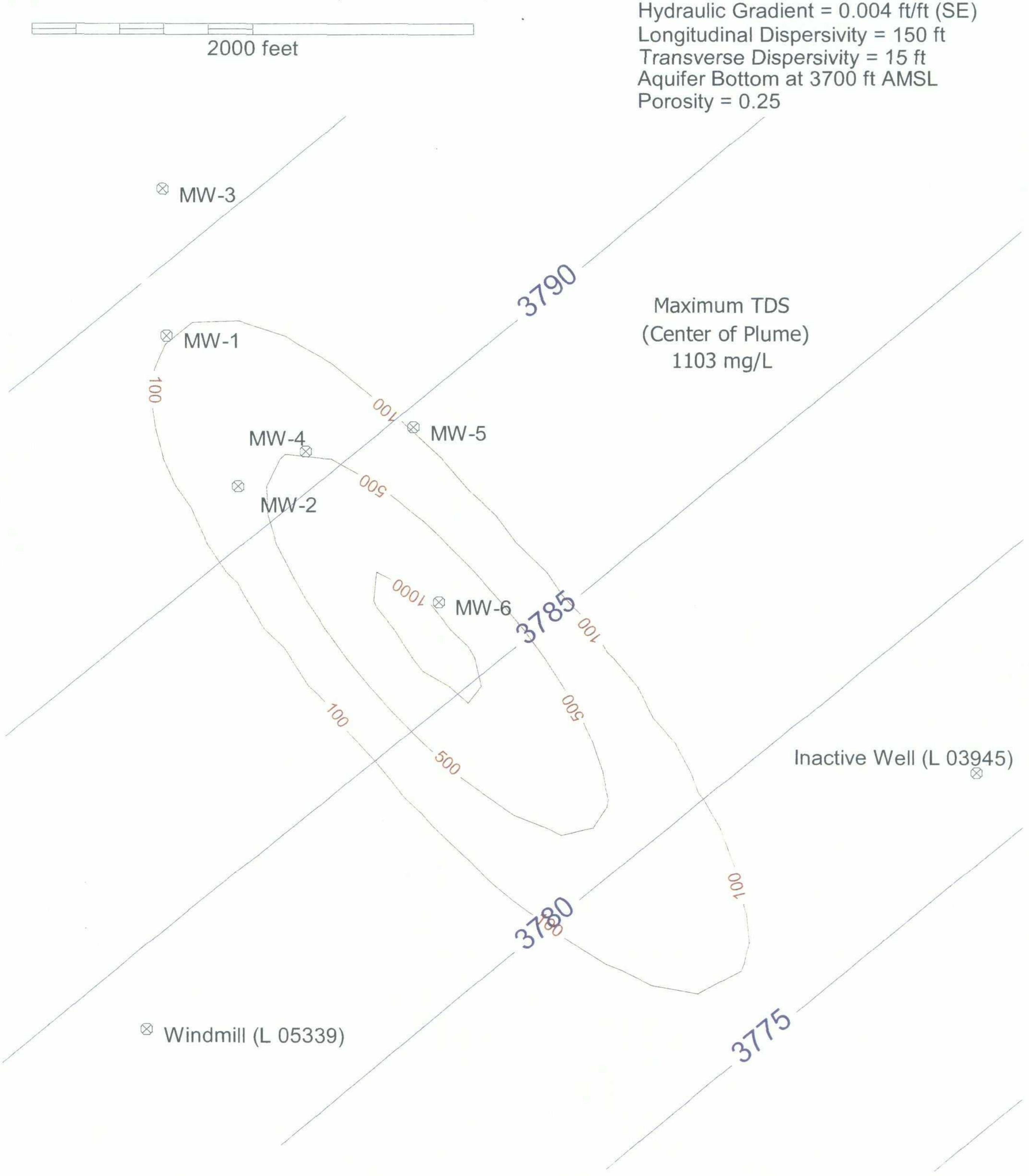


WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit

Modeling Assumptions

Initial Source Concentration=30000 mg/L
Hydraulic Conductivity = 100 ft'Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

TDS Plume Simulation (Year 2080)



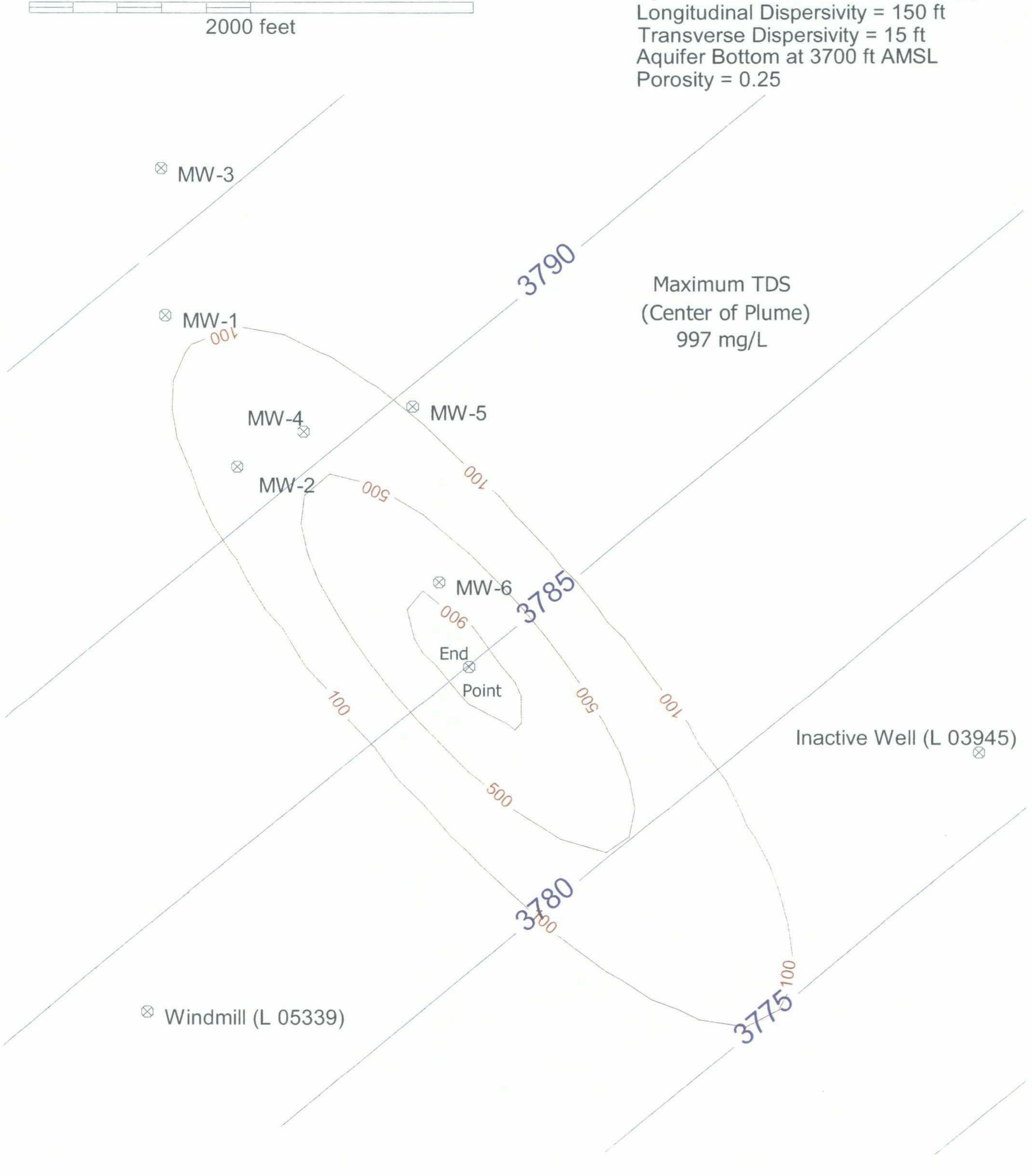
Maximum TDS
(Center of Plume)
1103 mg/L

WinTran Fate & Transport Modeling Results
Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2093)

Modeling Assumptions

Initial Source Concentration=30000 mg/L
Hydraulic Conductivity = 100 ft'Yr (2.7 ft/d)
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)
997 mg/L

APPENDIX D

Description of Fate and Transport Modeling
And
Input/Output Data

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 was created using the New Mexico State Plane Coordinates for each monitoring well which were determined by a registered surveyor after installation.

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 15, 2009 site measurements reported by Trident.

- Direction of flow – measured direction of approximately S 40° E from July 15, 2009 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 2.7 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 feet adjacent to the former pit and upgradient well MW-1 from July 15, 2009 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. Based on professional judgment, hydrologists commonly assume the longitudinal dispersivity is 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 15, 2009 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 that it corresponded to actual 1999 conditions, the model was again run for 10 years (1999 to 2009) 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 2009. 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.

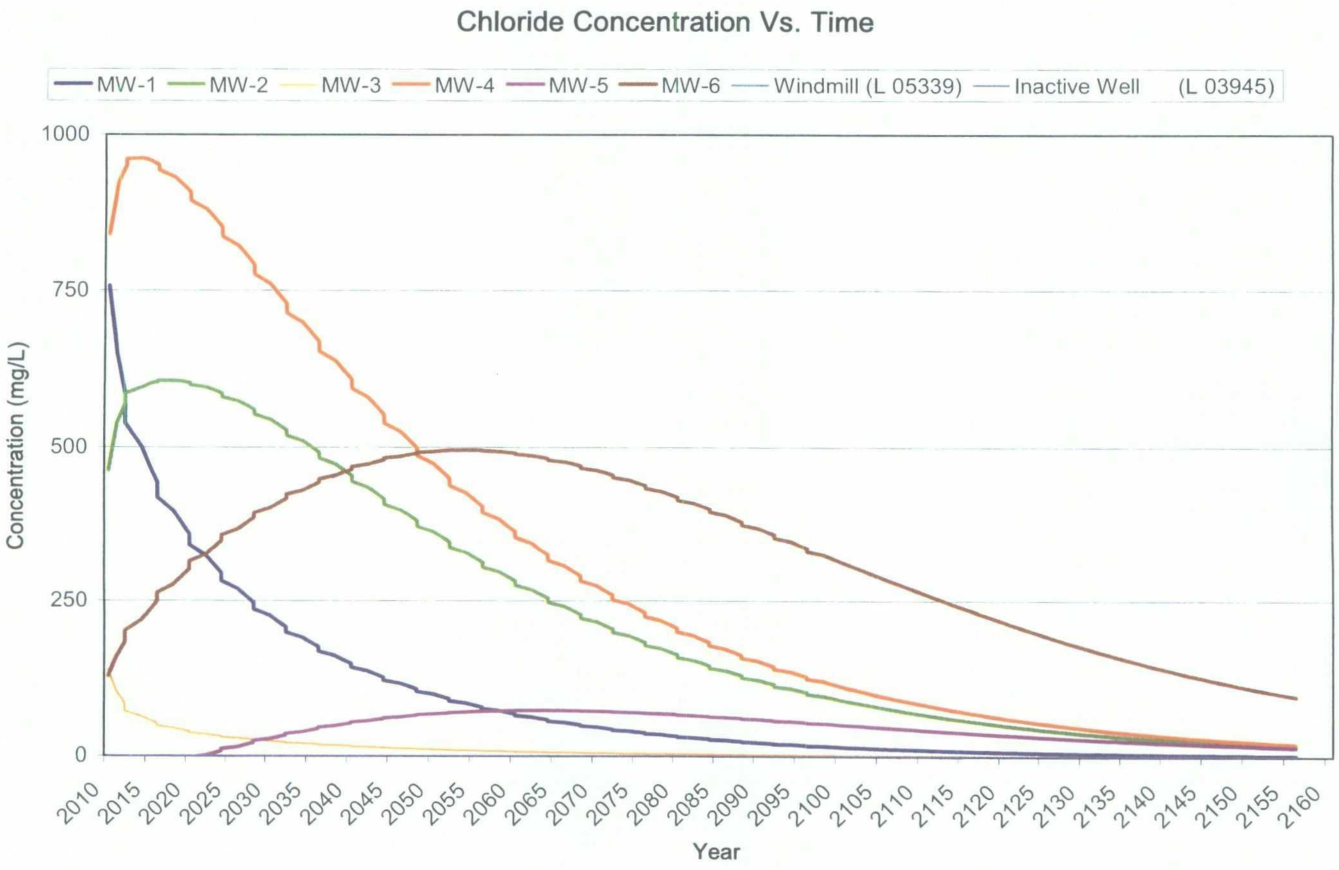
Running the model for 147 years in the future (Year 2156) produces a chloride plume center concentration of 248 mg/L (below the WQCC standard of 250 mg/L). The center of the chloride plume is approximately 3,400 ft away from the former pit and well source at that time.

Running the model for 84 years in the future (Year 2093) produces a TDS plume center concentration of 997 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 conclusion 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 over one-half mile south of the source. Operation of the windmill has been discontinued due to declining water levels in the area and the shallow depth of he well.

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


                          (c) 1995 Environmental Simulations, Inc.

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

Date: 11/6/09
Time: 17:53:02.00


Input File: 2009 CL.WTR
:
```



```
==================================================================================

                              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 = 852.000000
        Head at Well Radius           = 3793.557161
     Well #2
        Center of Well --  x: 1041.670000   y: 4585.770000
        Radius = 1.000000
        Pumping Rate = 0.000000
        Concentration of Injected Water = 482.000000
        Head at Well Radius           = 3790.493575
     Well #3
        Center of Well --  x: 694.000000   y: 5954.000000
        Radius = 1.000000
        Pumping Rate = 0.000000
        Concentration of Injected Water = 199.000000
        Head at Well Radius           = 3795.684412
     Well #4
        Center of Well --  x: 1341.000000   y: 4747.000000
        Radius = 1.000000
        Pumping Rate = 0.000000
        Concentration of Injected Water = 632.000000
        Head at Well Radius           = 3790.203804
     Well #5
        Center of Well --  x: 1829.000000   y: 4861.000000
        Radius = 1.000000
        Pumping Rate = 0.000000
        Concentration of Injected Water = 13.400000
        Head at Well Radius           = 3789.245166
     Well #6
        Center of Well --  x: 1948.000000   y: 4058.000000
        Radius = 1.000000
        Pumping Rate = 0.000000
        Concentration of Injected Water = 81.400000
        Head at Well Radius           = 3786.250006
     Well #7
        Center of Well --  x: 650.000000   y: 2081.000000
        Radius = 1.000000
        Pumping Rate = 10.000000
        Concentration of Injected Water = 0.000000
        Head at Well Radius           = 3783.199397
     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           = 3776.143897


Reference Head = 3795.000000    Defined at -- x: 473.850000   y: 5545.270000
```

```
================================================================================
                                 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........= 147
     Starting time value.........= 2009.000000
     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..............= 2009.000000
     Ending time................= 2156.000000
     Number of time steps........= 147

     (NOTE: following mass balance errors expressed as percent)
     Transport Mass Balance Error= 0.000007

     Peclet Criterion............= 1.388889
     Courant Number.............= 0.051968
     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 = 3733.806516
Maximum Head = 3798.435342
```

Direct Chloride Concentration (mg/L) Output from WinTran Simulation

Year	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	Windmill (L 05339)	Inactive Well (L 03945)
2010	757	463	139	840	-3	128	0	0
2011	650	538	104	921	-14	160	0	0
2012	585	570	84	951	-19	183	0	0
2013	539	587	72	961	-21	201	0	0
2014	502	596	64	962	-20	218	0	0
2015	471	602	57	958	-19	234	0	0
2016	443	605	52	951	-17	249	0	0
2017	419	607	48	942	-15	263	0	0
2018	397	607	45	931	-12	277	0	0
2019	377	606	42	919	-9	290	0	0
2020	358	604	39	907	-6	302	0	0
2021	341	600	37	894	-2	314	0	0
2022	325	597	35	880	1	326	0	0
2023	310	592	33	866	4	337	0	0
2024	296	587	31	851	8	347	0	0
2025	282	581	30	837	11	357	0	0
2026	270	575	28	822	14	367	0	0
2027	258	568	27	807	17	376	0	0
2028	247	560	26	791	21	385	0	0
2029	236	553	25	776	24	394	0	0
2030	226	545	23	761	27	402	0	0
2031	216	536	22	745	30	410	0	0
2032	207	528	22	730	33	417	0	0
2033	199	519	21	714	35	424	0	0
2034	191	510	20	699	38	431	0	0
2035	183	501	19	684	41	437	0	0
2036	175	492	18	668	43	444	0	0
2037	168	483	18	653	46	449	0	0
2038	161	473	17	638	48	455	0	0
2039	155	464	16	624	50	460	0	0
2040	149	454	16	609	52	464	0	0
2041	143	445	15	595	54	469	0	0
2042	137	435	14	580	56	473	0	0
2043	131	426	14	566	58	477	0	0
2044	126	417	13	553	59	480	0	0
2045	121	408	13	539	61	483	0	0
2046	117	398	12	526	62	486	0	0
2047	112	389	12	512	64	488	0	0
2048	108	380	11	499	65	490	0	0
2049	103	371	11	487	66	492	0	0
2050	99	363	11	474	67	493	0	0
2051	96	354	10	462	68	494	0	0
2052	92	345	10	450	69	495	0	0
2053	88	337	9	438	70	495	0	0

Direct Chloride Concentration (mg/L) Output from WinTran Simulation

Year	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	Windmill (L 05339)	Inactive Well (L 03945)
2054	85	329	9	427	70	496	0	0
2055	82	321	9	416	71	495	0	0
2056	79	313	8	405	72	495	0	0
2057	76	305	8	394	72	494	0	0
2058	73	297	8	383	72	493	0	0
2059	70	289	8	373	73	492	0	0
2060	67	282	7	363	73	491	0	0
2061	65	275	7	353	73	489	0	0
2062	62	268	7	343	73	487	0	0
2063	60	261	7	334	73	485	0	0
2064	58	254	6	325	73	482	0	0
2065	56	247	6	316	73	480	0	0
2066	54	240	6	307	73	477	0	0
2067	52	234	6	299	73	474	0	0
2068	50	228	5	290	72	470	0	0
2069	48	222	5	282	72	467	0	0
2070	46	216	5	274	72	463	0	0
2071	44	210	5	266	71	460	0	0
2072	43	204	5	259	71	456	0	0
2073	41	198	4	252	71	452	0	0
2074	40	193	4	245	70	447	0	0
2075	38	188	4	238	69	443	0	0
2076	37	182	4	231	69	439	0	0
2077	35	177	4	224	68	434	0	0
2078	34	172	4	218	68	429	0	0
2079	33	168	4	212	67	425	0	0
2080	32	163	3	205	66	420	0	0
2081	30	158	3	200	66	415	0	0
2082	29	154	3	194	65	410	0	0
2083	28	150	3	188	64	405	0	0
2084	27	145	3	183	64	400	0	0
2085	26	141	3	177	63	395	0	0
2086	25	137	3	172	62	389	0	0
2087	24	133	3	167	61	384	0	0
2088	23	129	3	162	60	379	0	0
2089	23	126	3	158	60	374	0	0
2090	22	122	2	153	59	368	0	0
2091	21	119	2	148	58	363	0	0
2092	20	115	2	144	57	357	0	0
2093	20	112	2	140	56	352	0	0
2094	19	109	2	136	55	347	0	0
2095	18	105	2	132	55	341	0	0
2096	17	102	2	128	54	336	0	0
2097	17	99	2	124	53	331	0	0

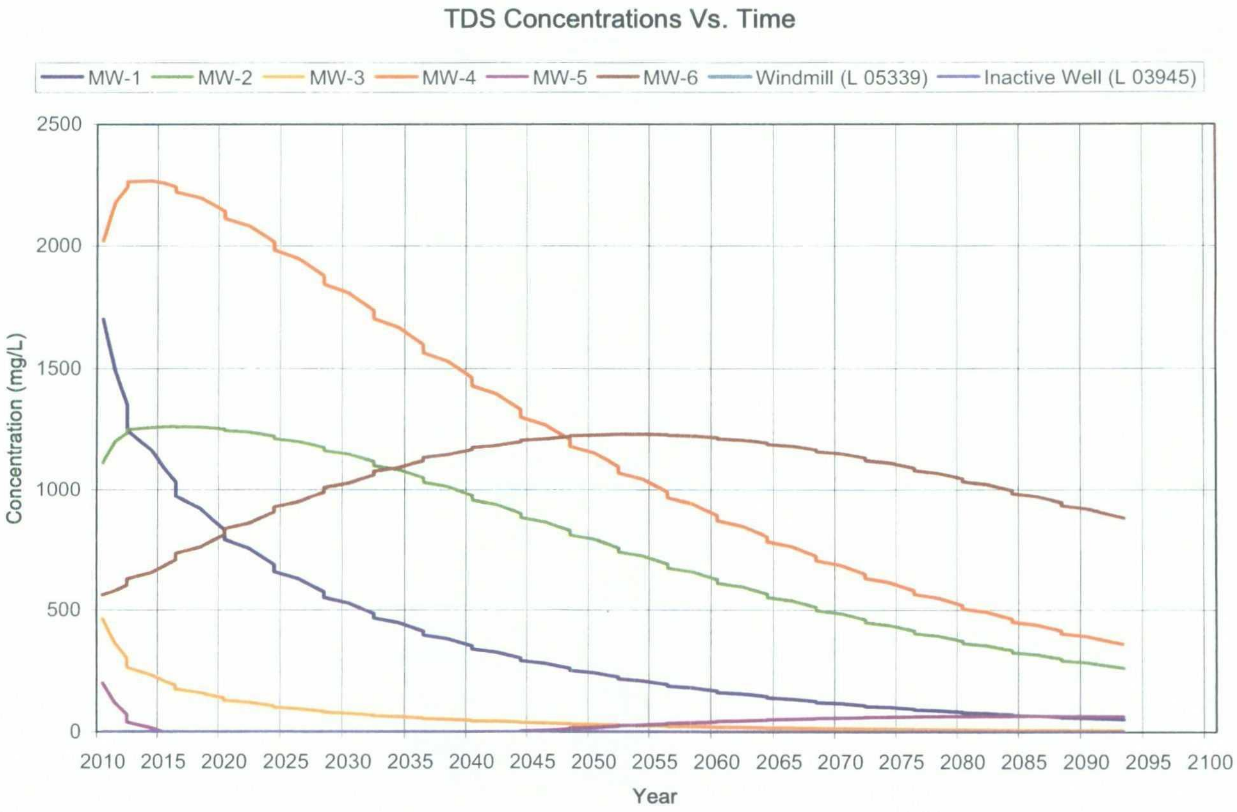
Direct Chloride Concentration (mg/L) Output from WinTran Simulation

Year	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	Windmill (L 05339)	Inactive Well (L 03945)
2098	16	97	2	120	52	325	0	0
2099	16	94	2	117	51	320	0	0
2100	15	91	2	113	50	315	0	0
2101	15	88	2	110	49	309	0	0
2102	14	86	2	107	49	304	0	0
2103	14	83	2	104	48	299	0	0
2104	13	81	1	100	47	294	0	0
2105	13	78	1	97	46	288	0	0
2106	12	76	1	95	45	283	0	0
2107	12	74	1	92	44	278	0	0
2108	11	72	1	89	44	273	0	0
2109	11	69	1	86	43	268	0	0
2110	10	67	1	84	42	263	0	0
2111	10	65	1	81	41	258	0	0
2112	10	63	1	79	40	253	0	0
2113	9	62	1	76	40	248	0	0
2114	9	60	1	74	39	244	0	0
2115	9	58	1	72	38	239	0	0
2116	8	56	1	70	37	234	0	0
2117	8	55	1	68	37	230	0	0
2118	8	53	1	66	36	225	0	0
2119	8	51	1	64	35	221	0	0
2120	7	50	1	62	34	216	0	0
2121	7	48	1	60	34	212	0	0
2122	7	47	1	58	33	207	0	0
2123	7	45	1	56	32	203	0	0
2124	6	44	1	54	32	199	0	0
2125	6	43	1	53	31	195	0	0
2126	6	41	1	51	30	191	0	0
2127	6	40	1	50	30	187	0	0
2128	5	39	1	48	29	183	0	0
2129	5	38	1	47	28	179	0	0
2130	5	37	1	45	28	175	0	0
2131	5	36	1	44	27	171	0	0
2132	5	34	1	43	26	168	0	0
2133	5	33	1	41	26	164	0	0
2134	4	32	1	40	25	160	0	0
2135	4	31	0	39	25	157	0	0
2136	4	30	0	38	24	153	0	0
2137	4	30	0	36	24	150	0	0
2138	4	29	0	35	23	147	0	0
2139	4	28	0	34	23	143	0	0
2140	4	27	0	33	22	140	0	0
2141	3	26	0	32	22	137	0	0

Direct Chloride Concentration (mg/L) Output from WinTran Simulation

Year	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	Windmill (L 05339)	Inactive Well (L 03945)
2142	3	25	0	31	21	134	0	0
2143	3	25	0	30	21	131	0	0
2144	3	24	0	29	20	128	0	0
2145	3	23	0	28	20	125	0	0
2146	3	22	0	27	19	122	0	0
2147	3	22	0	27	19	119	0	0
2148	3	21	0	26	18	116	0	0
2149	3	20	0	25	18	114	0	0
2150	3	20	0	24	17	111	0	0
2151	2	19	0	24	17	108	0	0
2152	2	19	0	23	17	106	0	0
2153	2	18	0	22	16	103	0	0
2154	2	17	0	21	16	101	0	0
2155	2	17	0	21	15	99	0	0
2156	2	16	0	20	15	96	0	0

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

                             Developed by

                        James O. Rumbaugh, III

                         Douglas B. Rumbaugh

                  (c) 1995 Environmental Simulations, Inc.

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


Date: 11/6/09
Time: 18:16:04.00


Input File: TDS 2009.WTR
Map File:
```



```
=================================================================================
                              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........= 90
     Starting time value.........= 2009.000000
     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..............= 2009.000000
     Ending time................= 2099.000000
     Number of time steps........= 90

     (NOTE: following mass balance errors expressed as percent)
     Transport Mass Balance Error= 0.000487

     Peclet Criterion...........= 1.388889
     Courant Number.............= 0.050438
     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
```

```
================================================================================
                                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 = 2300.000000
        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 = 1060.000000
        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 = 766.000000
        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 = 1780.000000
        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 = 291.000000
        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 = 532.000000
        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
```

Direct TDS Concentration (mg/L) Output from WinTran Simulation

Year	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	Windmill (L 05339)	Inactive Well (L 03945)
2010	1701	1113	464	2019	196	561	0	0
2011	1491	1204	363	2179	118	579	0	0
2012	1353	1238	302	2241	70	602	0	0
2013	1249	1253	261	2264	39	627	0	0
2014	1165	1260	231	2266	16	653	0	0
2015	1093	1264	207	2258	0	680	0	0
2016	1029	1265	188	2242	-13	707	0	0
2017	973	1264	172	2221	-23	734	0	0
2018	921	1262	158	2197	-30	760	0	0
2019	875	1258	146	2170	-35	786	0	0
2020	831	1254	136	2142	-40	811	0	0
2021	791	1248	127	2112	-43	836	0	0
2022	754	1241	118	2081	-45	860	0	0
2023	720	1233	111	2048	-46	884	0	0
2024	687	1224	104	2016	-46	906	0	0
2025	656	1213	98	1982	-46	928	0	0
2026	628	1202	93	1948	-46	949	0	0
2027	601	1190	88	1913	-45	970	0	0
2028	575	1177	83	1878	-43	990	0	0
2029	551	1163	79	1843	-42	1009	0	0
2030	528	1148	75	1808	-40	1027	0	0
2031	506	1133	71	1773	-38	1045	0	0
2032	485	1117	67	1738	-36	1061	0	0
2033	466	1100	64	1703	-33	1077	0	0
2034	447	1083	61	1668	-30	1093	0	0
2035	429	1066	58	1633	-28	1107	0	0
2036	412	1048	56	1598	-25	1121	0	0
2037	396	1030	53	1564	-22	1134	0	0
2038	380	1012	51	1530	-19	1146	0	0
2039	365	994	48	1496	-16	1157	0	0
2040	351	975	46	1463	-13	1168	0	0
2041	338	957	44	1430	-10	1177	0	0
2042	325	938	42	1397	-7	1186	0	0
2043	313	920	40	1365	-4	1194	0	0
2044	301	901	39	1333	-1	1202	0	0
2045	289	883	37	1302	2	1208	0	0
2046	278	864	35	1271	5	1214	0	0
2047	268	846	34	1241	8	1219	0	0
2048	258	828	33	1211	11	1223	0	0
2049	248	810	31	1182	14	1227	0	0
2050	239	792	30	1153	17	1229	0	0

Direct TDS Concentration (mg/L) Output from WinTran Simulation

Year	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	Windmill (L 05339)	Inactive Well (L 03945)
2051	230	774	29	1125	20	1231	0	0
2052	222	757	28	1097	22	1233	0	0
2053	214	739	26	1070	25	1233	0	0
2054	206	722	25	1043	27	1233	0	0
2055	199	705	24	1017	30	1232	0	0
2056	191	689	23	991	32	1231	0	0
2057	184	673	22	966	35	1228	0	0
2058	178	656	22	941	37	1226	0	0
2059	171	641	21	917	39	1222	0	0
2060	165	625	20	894	41	1218	0	0
2061	159	610	19	870	43	1214	0	0
2062	154	595	18	848	45	1209	0	0
2063	148	580	18	826	46	1203	0	0
2064	143	566	17	804	48	1197	0	0
2065	138	552	16	783	49	1190	0	0
2066	133	538	16	762	51	1183	0	0
2067	128	524	15	742	52	1176	0	0
2068	124	511	15	723	54	1168	0	0
2069	119	498	14	703	55	1159	0	0
2070	115	485	14	684	56	1150	0	0
2071	111	473	13	666	57	1141	0	0
2072	107	460	13	648	58	1132	0	0
2073	103	448	12	631	59	1122	0	0
2074	100	437	12	614	60	1112	0	0
2075	96	425	11	597	60	1101	0	0
2076	93	414	11	581	61	1091	0	0
2077	89	403	10	565	62	1080	0	0
2078	86	393	10	550	62	1068	0	0
2079	83	382	10	534	63	1057	0	0
2080	80	372	9	520	63	1045	0	0
2081	78	362	9	506	63	1034	0	0
2082	75	352	9	492	63	1022	0	0
2083	72	343	8	478	64	1009	0	0
2084	70	334	8	465	64	997	0	0
2085	67	325	8	452	64	985	0	0
2086	65	316	7	439	64	972	0	0
2087	63	307	7	427	64	960	0	0
2088	61	299	7	415	64	947	0	0
2089	59	291	7	403	64	934	0	0
2090	57	283	6	392	64	921	0	0
2091	55	275	6	381	63	908	0	0
2092	53	268	6	370	63	895	0	0
2093	51	260	6	360	63	883	0	0