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2013 AGWMR

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February 26, 2014

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: 2013 ANNUAL GROUNDWATER MONITORING REPORT
FORMER UNOCAL SOUTH VACUUM UNIT
NMOCD CASE NO. 1R-277
SECTION 36, TOWNSHIP 18 SOUTH, RANGE 35 EAST
LEA COUNTY, NEW MEXICO

Dear Mr. Von Gonten:

Enclosed is the *2013 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 Dana Koschel (Arcadis) at 714-508-2664 if you have any questions or comments.

Sincerely,

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

Attachments

xc: John MacLeod, Chevron EMC (San Ramon CA)
Dana Koschel, Arcadis U.S., Inc. (Irvine CA)
Geoffrey Leking, NMOCD District 1 (Hobbs NM)

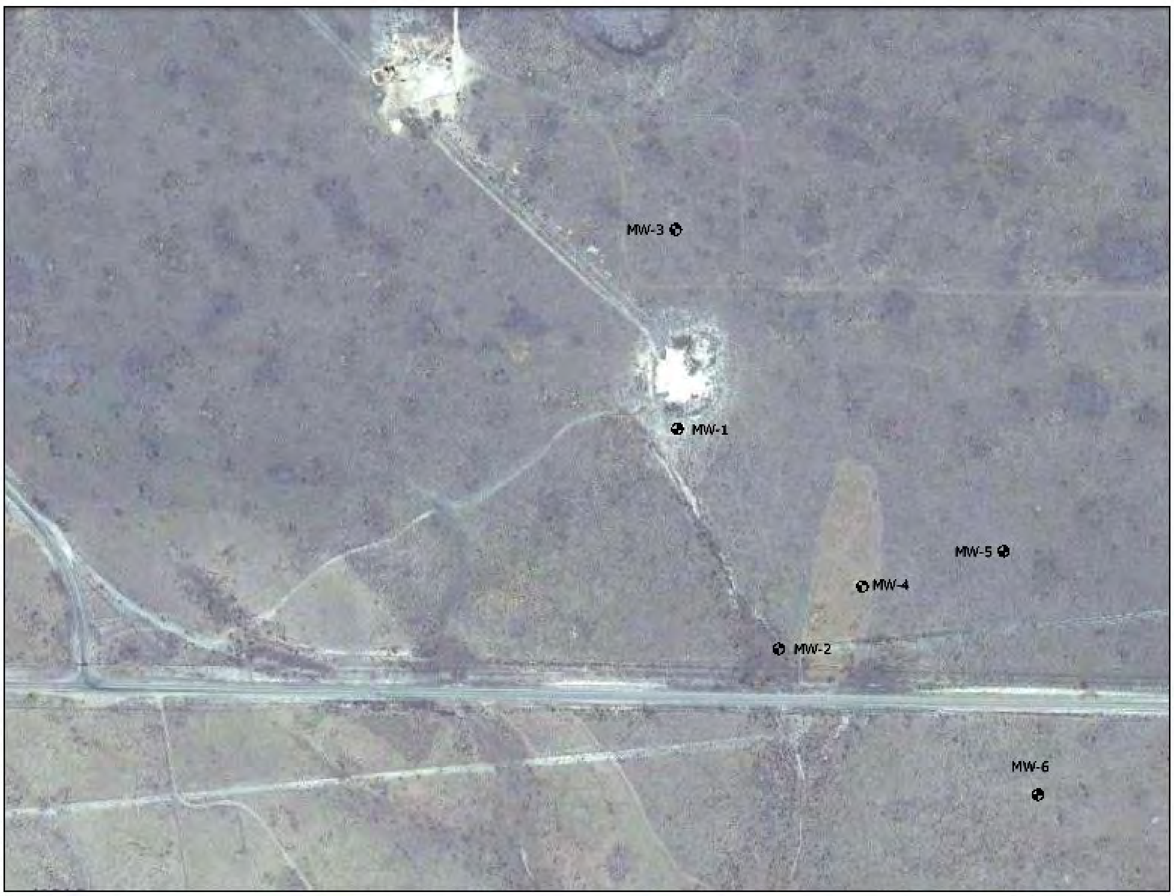
2013 ANNUAL GROUNDWATER MONITORING REPORT
FORMER UNOCAL SOUTH VACUUM UNIT
NMOCD CASE NO. 1R-277
SECTION 36, TOWNSHIP 18 SOUTH, RANGE 35 EAST
LEA COUNTY, NEW MEXICO

FEBRUARY 25, 2014

Prepared For:

Chevron Environmental
Management Company
6101 Bollinger Canyon Rd.

San Ramon, CA 94583



Prepared By:

TRIDENT ENVIRONMENTAL

P. O. Box 12177
Odessa, Texas 79768

2013 Annual Groundwater Monitoring Report

Former Unocal South Vacuum Unit

NMOCD Case NO. 1R-277

Section 36, Township 18 South, Range 35 East

Lea County, New Mexico

Prepared for:

Chevron Environmental Management Company

6101 Bollinger Canyon Road

San Ramon, CA 94583

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SUBMITTED BY:

DATE:

_________________________________ _________________________

Gilbert J. Van Deventer, PG, REM
Project Manager

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1.0 Executive Summary

Trident Environmental (Trident) was retained by ARCADIS, on behalf of Chevron Environmental Management Company (Chevron EMC), to perform the 2013 annual groundwater sampling and monitoring at the Former Unocal South Vacuum Unit (site), which is located at Township 18 South, Range 35 East, Section 36 in Lea County, New Mexico. Chevron EMC is managing Unocal's environmental liability at the site. This report documents the 2013 annual sampling event performed by Trident at the site on October 25, 2013. 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 some fluctuations since the 2004 sampling event. Similarly, chloride and TDS levels have decreased significantly in the closest downgradient well (MW-4) since 1999 when the well was installed, and have remained relatively stable since 2007. Fluctuating chloride and TDS concentrations in MW-4 over the past few years and next few years are expected as the center of the mass of the plume migrates past MW-4 during this time. Chloride and TDS concentrations in well MW-3 have shown slight but steadily increasing trends since 2000 indicating a possible offsite, 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. As with MW-4, fluctuating chloride and TDS concentrations in MW-2 are expected due to its close cross-gradient proximity to the center of the mass of the plume as it migrates downgradient in a southeasterly direction.

- 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 is a livestock (windmill) well located over one-half mile south of the source. The windmill has been dismantled and is no longer in operation due to declining water levels in the area.

- According to conservative model simulations, the chloride plume will travel a maximum of 3,200 feet southeast of the source in approximately 145 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 2,200 feet in approximately 80 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. The modeling also indicates that the livestock well will not 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.

Effective remedial actions were performed to the source area by Unocal, which include plugging of the SWD well in 1971 and encapsulating the former saltwater disposal pit with solidification material in 1995, thus preventing 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:

- Continue the 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 2014 annual groundwater monitoring report to OCD by April 1, 2015, to document natural attenuation conditions.

2.0 Groundwater Sampling Procedures

On October 25, 2013, 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 42 gallons of groundwater was purged from the site monitoring wells (5 to 10 gallons per well) using a 3-stage submersible pump which was decontaminated using an Alconox solution and a distilled water rinse between sampling points. 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 or when parameters stabilized. 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. 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 Eurofins Lancaster Laboratories (Lancaster, PA) for analysis.

3.0 Groundwater Elevations, Hydraulic Gradient and Flow Direction

Depth to groundwater ranged from approximately 49 feet (ft) at MW-2 to 69 ft at MW-6 below ground surface. Groundwater elevations are summarized in Table 1 and a groundwater gradient map depicting 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-aged Ogallala Formation. The Ogallala Formation unconformably overlies the impermeable red-beds of the Triassic Chinle Formation at an elevation of approximately 3,700 ft 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 86 to 95 feet.

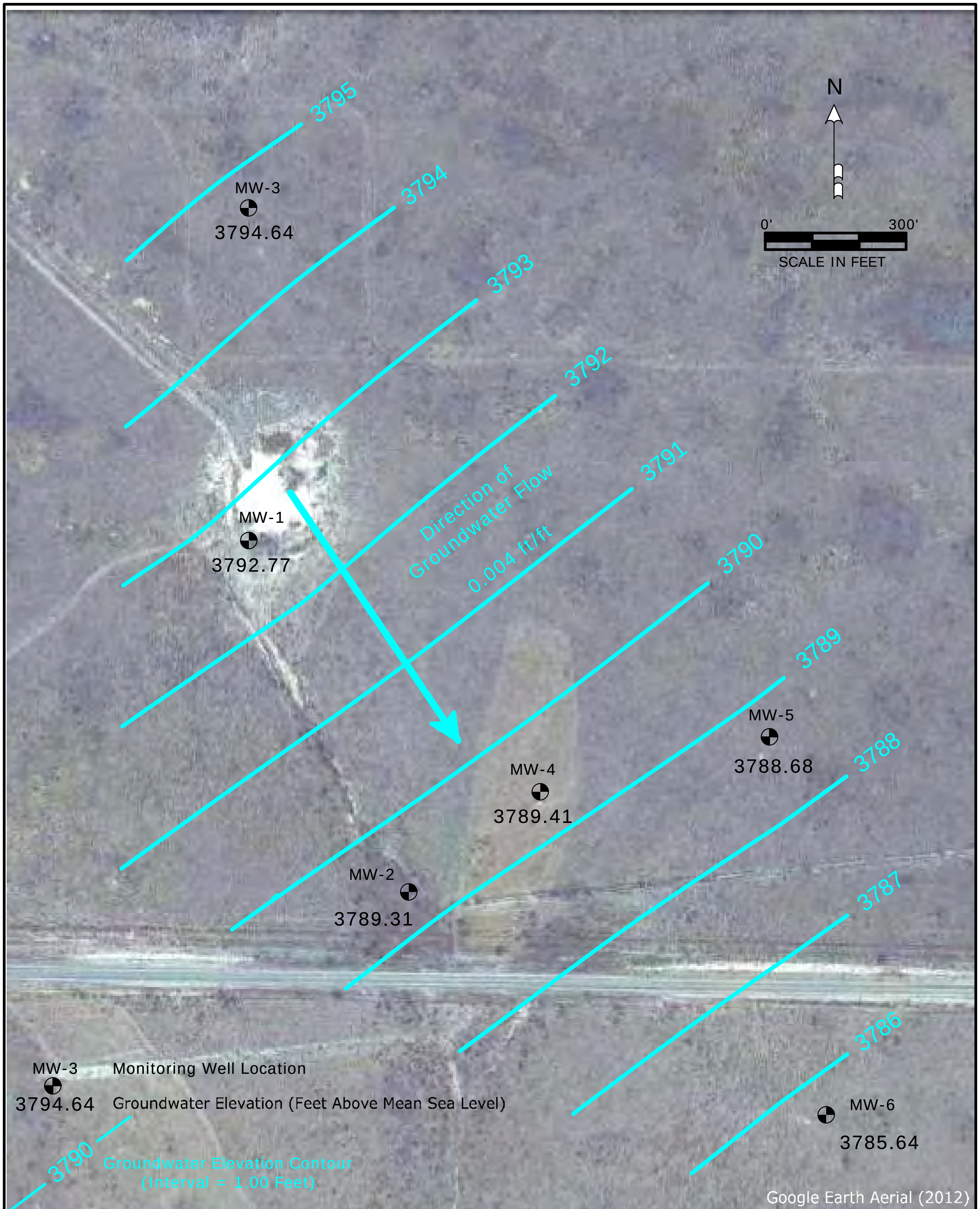

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FIGURE 1
Former Unocal South Vacuum Unit
Groundwater Gradient Map
October 25, 2013

Table 1
Summary of Groundwater Sampling Results

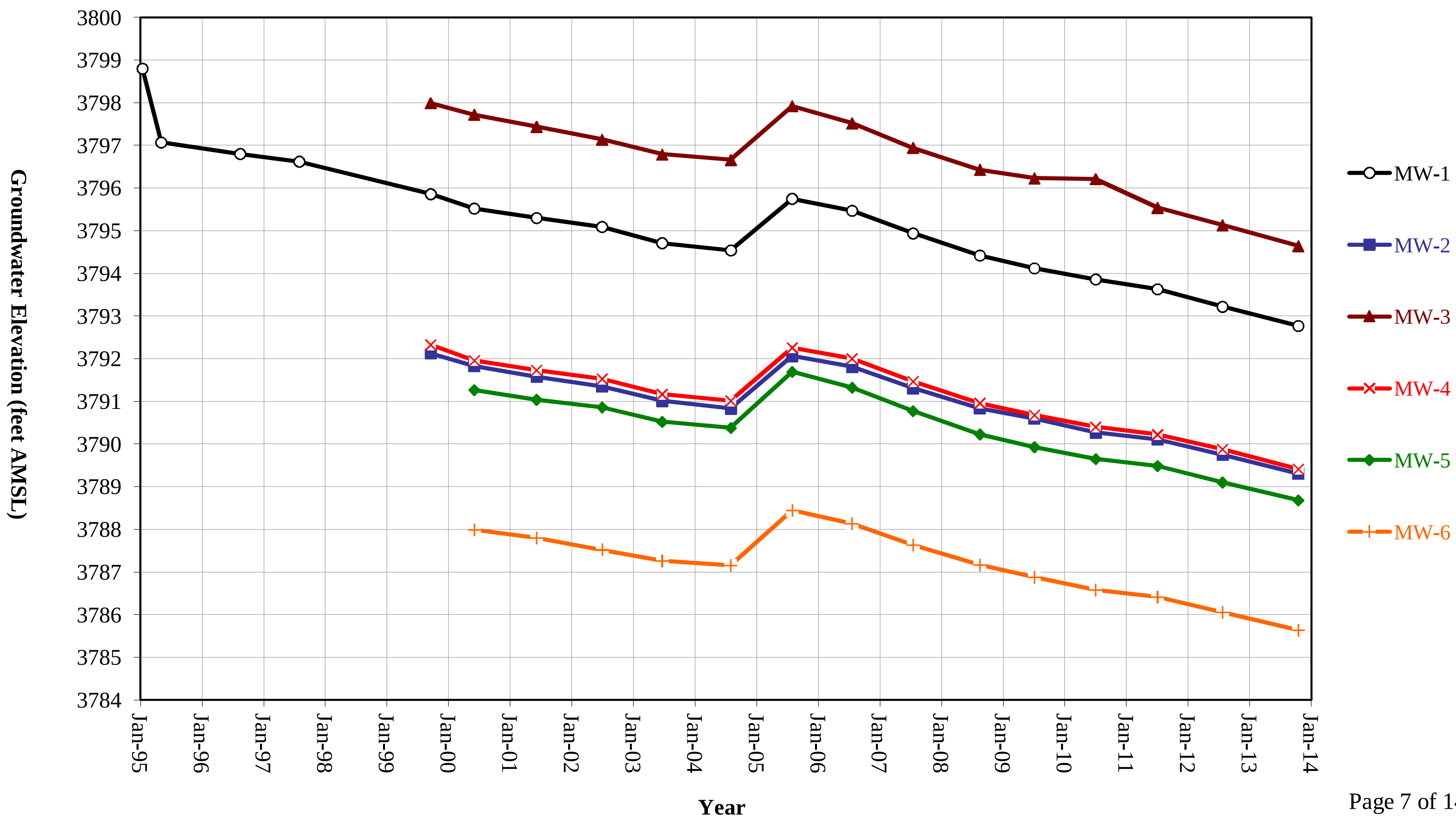
Monitoring Well	Sampling Date	Chloride (mg/L)	TDS (mg/L)	Depth to Groundwater (feet BTOC)	Top of Casing Elevation (feet AMSL)	Groundwater Elevation (feet AMSL)
MW-1	01/27/1995	**1174**	**2250**	59.57	3858.37	3798.80
	05/18/1995	**983**	**2251**	61.30	3858.37	3797.07
	08/28/1996	**1420**	**2730**	61.57	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
	07/13/2010	**934**	**2590**	64.51	3858.37	3793.86
	07/14/2011	**824**	**2370**	64.74	3858.37	3793.63
	08/02/2012	**854**	**2740**	65.15	3858.37	3793.22
	10/25/2013	**761**	**1700**	65.60	3858.37	3792.77
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
	07/13/2010	**494**	**1070**	51.37	3841.64	3790.27
	07/14/2011	**486**	974	51.53	3841.64	3790.11
	08/02/2012	**531**	**1110**	51.89	3841.64	3789.75
	10/25/2013	**483**	**1070**	52.33	3841.64	3789.31
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
	07/13/2010	207	859	68.52	3864.73	3796.21
	07/14/2011	205	816	69.19	3864.73	3795.54
	08/02/2012	232	**1010**	69.60	3864.73	3795.13
	10/25/2013	**273**	678	70.09	3864.73	3794.64

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-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
	07/13/2010	**687**	**1750**	62.11	3852.51	3790.40
	07/14/2011	**707**	**1600**	62.29	3852.51	3790.22
	08/02/2012	**804**	**1760**	62.63	3852.51	3789.88
	10/25/2013	**894**	**1890**	63.10	3852.51	3789.41
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
	07/13/2010	12.6	291	70.19	3859.84	3789.65
	07/14/2011	13.8	265	70.35	3859.84	3789.49
	08/02/2012	13.8	290	70.74	3859.84	3789.10
	10/25/2013	15.3	268	71.16	3859.84	3788.68
MW-6	06/14/2000	48.0	382	70.79	3858.78	3787.99
	06/18/2001	50.8	431	70.98	3858.78	3787.80
	07/11/2002	50.0	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	55.0	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
	07/13/2010	84.1	545	72.20	3858.78	3786.58
	07/14/2011	89.2	531	72.37	3858.78	3786.41
	08/02/2012	93.8	550	72.72	3858.78	3786.06
	10/25/2013	116	510	73.14	3858.78	3785.64
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 (2006-2011).
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.

Figure 2
Historical Groundwater Elevations



4.0 Groundwater Quality Conditions

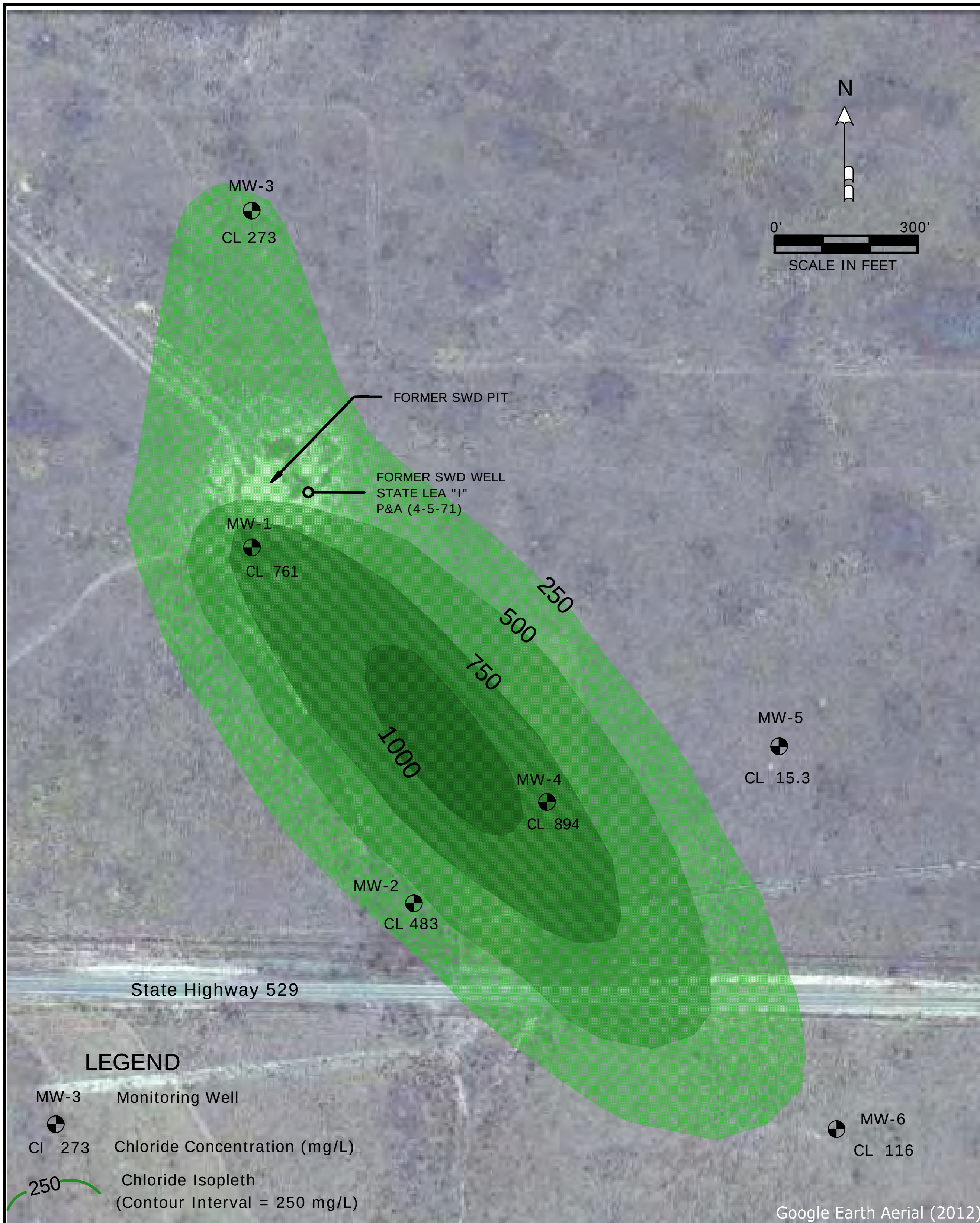
Groundwater sample analytical results are presented in Table 1 with the WQCC standards shown for comparison. Those constituents that recorded concentrations above the WQCC standards are highlighted in boldface type. The WQCC standard of 250 mg/L for chloride was exceeded in wells MW-1 (761 mg/L), MW-2 (483 mg/L), MW-3 (273 mg/L), and MW-4 (894 mg/L). The WQCC standard of 1,000 mg/L for TDS was exceeded in wells MW-1 (1,700 mg/L), MW-2 (1,070 mg/L), and MW-4 (1,890 mg/L). The groundwater samples obtained from downgradient wells MW-5 and MW-6 had chloride and TDS concentrations below WQCC standards.

The most recent chloride and TDS concentrations and estimated isopleths are depicted in Figures 3 and 4, respectively. Graphs depicting historical chloride and TDS 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 generally decreased since 1996 with the exception of some fluctuations since the 2004 sampling event. Similarly, chloride and TDS levels have generally decreased in the closest downgradient well (MW-4) since 1999 when the well was installed. Fluctuating chloride and TDS concentrations in MW-4 over the past few years and next few years are expected as the center of the mass of the plume migrates past MW-4 during this time. As with MW-4, minimal fluctuations of chloride and TDS concentrations in MW-2 are expected due to its close cross-gradient proximity to the center of the mass of the plume as it migrates downgradient in a southeasterly direction.

Monitoring well MW-3 has exhibited 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-5 and MW-6 have remained relatively consistent with previous years.

The above described trends indicate that encapsulating the former saltwater disposal pit with solidification material in 1995, has significantly reduced the threat of any continued release from the source.



Samples Obtained on October 25, 2013

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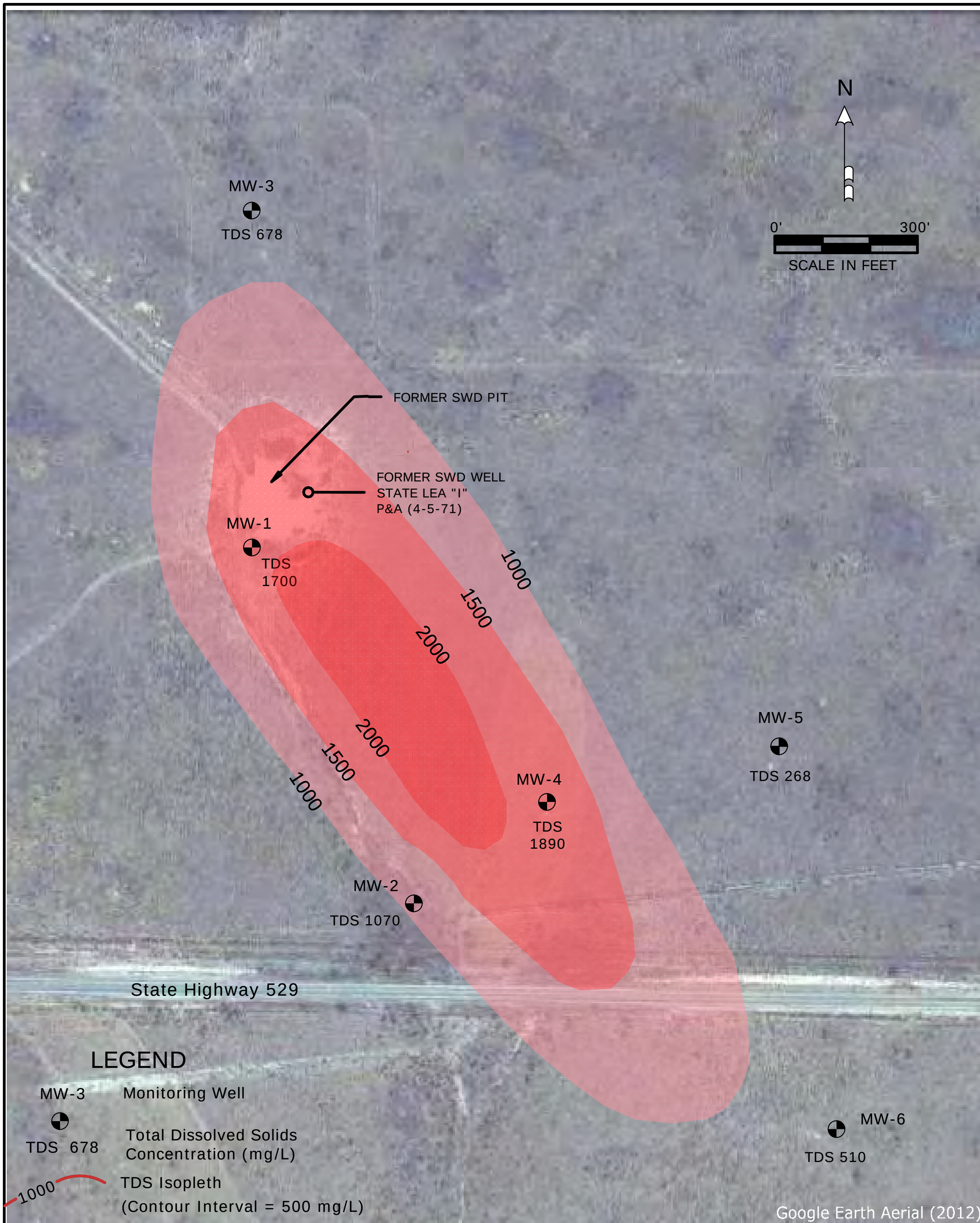
FIGURE 3

Former Unocal South Vacuum Unit
Chloride Isopleth Map
Current Conditions (2013)



Samples Obtained on October 25, 2013

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FIGURE 4

Former Unocal South Vacuum Unit
TDS Isopleth Map
Current Conditions (2013)

Figure 5
Chloride Concentrations Versus Time Graph

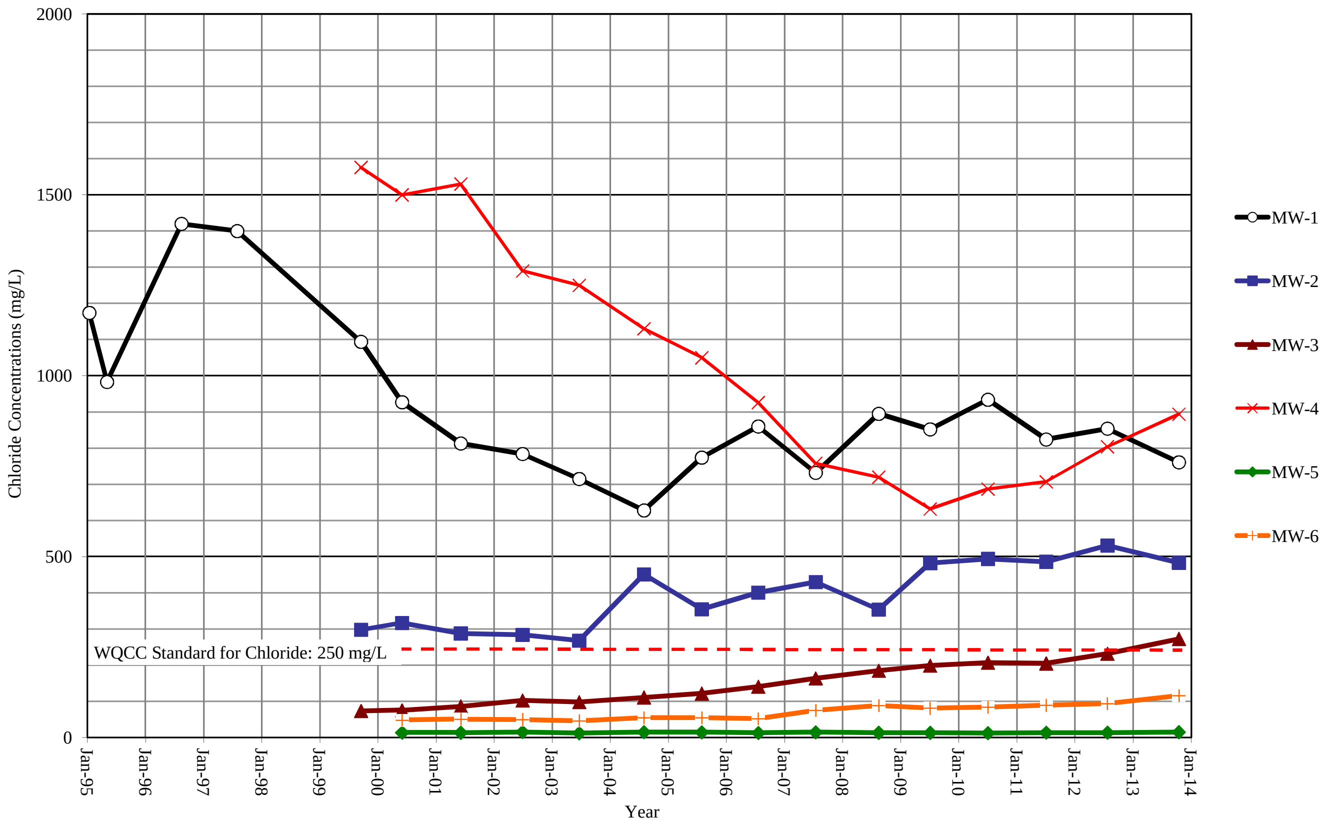
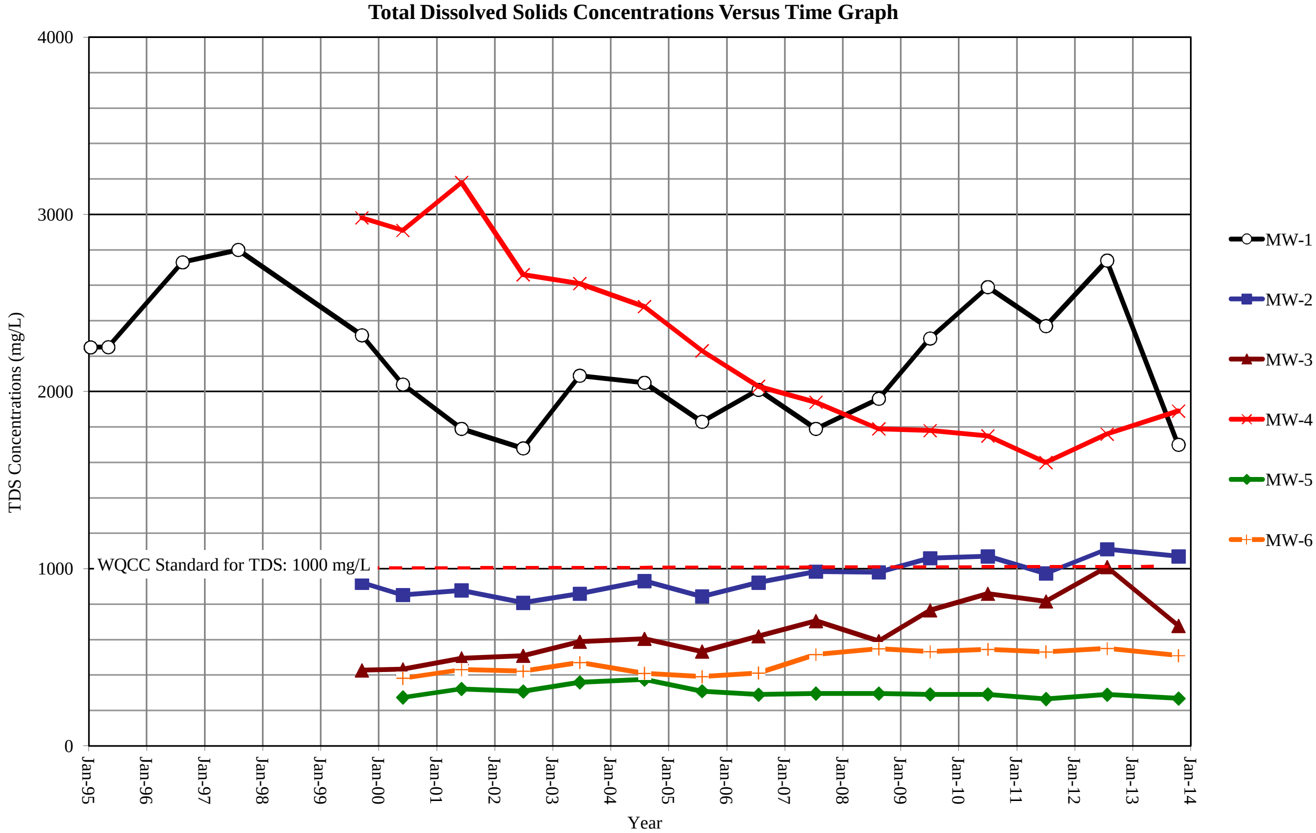


Figure 6
Total Dissolved Solids Concentrations Versus Time Graph



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 2157 for chloride and year 2093 for TDS, respectively). The center of the chloride plume is approximately 3,200 ft away from the pit and well source in the year 2157. The center of the TDS plume is approximately 2,200 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 closest of which is a livestock (windmill) well (NM File No. L05339) located over one-half mile south of the source. The windmill has been dismantled and is no longer in operation due to declining water levels in the area. 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 with the exception of some fluctuations since the 2004 sampling event. Similarly, chloride and TDS levels have decreased significantly in the closest downgradient well (MW-4) since 1999 when the well was installed, and have remained relatively stable since 2007. Fluctuating chloride and TDS concentrations in MW-4 over the past few years and next few years are expected as the center of the mass of the plume migrates past MW-4 during this time. Chloride and TDS concentrations in well MW-3 have shown slight but steadily increasing trends since 2000 indicating a possible offsite, 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. As with MW-4, fluctuating chloride and TDS concentrations in MW-2 are expected due to its close cross-gradient proximity to the center of the mass of the plume as it migrates downgradient in a southeasterly direction. The fate and transport modeling results continue to demonstrate that the chloride and TDS plume is not likely to impact existing sources of water supply, the closest of which is a livestock (windmill) well located 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 3,200 ft southeast of the source in approximately 145 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 2,200 ft in approximately 80 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. The modeling also indicates the livestock well will not 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 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

Effective remedial actions were performed to the source area by Unocal, which include plugging of the SWD well in 1971 and encapsulating the former saltwater disposal pit with solidification material in 1995, thus preventing 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:

- 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 2014 Annual Groundwater Monitoring Report to OCD by April 1, 2015, to document natural attenuation conditions.

APPENDIX A

Laboratory Analytical Reports

And

Chain-of-Custody Documentation

ANALYTICAL RESULTS

Prepared by:	Prepared for:
Eurofins Lancaster Laboratories Environmental 2425 New Holland Pike Lancaster, PA 17601	Chevron Environmental Mgmt Co 6101 Bollinger Canyon Road San Ramon CA 94583

November 05, 2013

Project: Former Unocal South Vacuum Unit, Lea County, NM

Submittal Date: 10/29/2013
Group Number: 1429770
PO Number: 0015120310
Release Number: MACLEOD
State of Sample Origin: NM

Client Sample Description	Lancaster Labs (LL) #
MW-1 Grab Groundwater	7255379
MW-2 Grab Groundwater	7255380
MW-3 Grab Groundwater	7255381
MW-4 Grab Groundwater	7255382
MW-5 Grab Groundwater	7255383
MW-6 Grab Groundwater	7255384

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	Trident Environmental	Attn: Gilbert Van Deventer
ELECTRONIC COPY TO	ARCADIS	Attn: Dana Koschel
ELECTRONIC COPY TO	ARCADIS	Attn: Sarah Huff
ELECTRONIC COPY TO	ARCADIS	Attn: Robin Simon

Respectfully Submitted,

Katherine A. Klinefelter

Katherine A. Klinefelter
Principal Specialist

(717) 556-7256

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Lancaster Laboratories Environmental

Analysis Report

2425 New Holland Pike, Lancaster, PA 17601 • 717-656-2300 • Fax: 717-656-2681 • www.LancasterLabs.com

Sample Description: MW-1 Grab Groundwater
Former Unocal South Vacuum Unit
Lea County, NM

LL Sample # WW 7255379
LL Group # 1429770
Account # 11969

Project Name: Former Unocal South Vacuum Unit, Lea County, NM

Collected: 10/25/2013 17:00 by GV

Submitted: 10/29/2013 10:15
Reported: 11/05/2013 15:12

Chevron Environmental Mgmt Co
6101 Bollinger Canyon Road
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
Wet Chemistry	**SM 2540 C-1997**		**mg/l**	**mg/l**	**mg/l**	
00212	Total Dissolved Solids	n.a.	1,700	77.6	240	1
	SM 4500-Cl C-1997		**mg/l**	**mg/l**	**mg/l**	
01124	Chloride (titrimetric)	16887-00-6	761	20.0	100	50

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	SM 2540 C-1997	1	13304021202B	10/31/2013 12:14	Susan E Hibner	1
01124	Chloride (titrimetric)	SM 4500-Cl C-1997	1	13308112401A	11/04/2013 12:50	Susan A Engle	50

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

Sample Description: MW-2 Grab Groundwater
Former Unocal South Vacuum Unit
Lea County, NM

LL Sample # WW 7255380
LL Group # 1429770
Account # 11969

Project Name: Former Unocal South Vacuum Unit, Lea County, NM

Collected: 10/25/2013 13:00 by GV

Submitted: 10/29/2013 10:15
Reported: 11/05/2013 15:12

Chevron Environmental Mgmt Co
6101 Bollinger Canyon Road
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
Wet Chemistry	**SM 2540 C-1997**		mg/l	mg/l	mg/l	
00212	Total Dissolved Solids	n.a.	1,070	77.6	240	1
	SM 4500-Cl C-1997		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	483	20.0	100	50

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	SM 2540 C-1997	1	13304021202B	10/31/2013 12:14	Susan E Hibner	1
01124	Chloride (titrimetric)	SM 4500-Cl C-1997	1	13308112401A	11/04/2013 12:50	Susan A Engle	50

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

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Analysis Report

2425 New Holland Pike, Lancaster, PA 17601 • 717-656-2300 • Fax: 717-656-2681 • www.LancasterLabs.com

Sample Description: MW-3 Grab Groundwater
Former Unocal South Vacuum Unit
Lea County, NM

LL Sample # WW 7255381
LL Group # 1429770
Account # 11969

Project Name: Former Unocal South Vacuum Unit, Lea County, NM

Collected: 10/25/2013 14:00 by GV

Submitted: 10/29/2013 10:15
Reported: 11/05/2013 15:12

Chevron Environmental Mgmt Co
6101 Bollinger Canyon Road
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
Wet Chemistry	**SM 2540 C-1997**		mg/l	mg/l	mg/l	
00212	Total Dissolved Solids	n.a.	678	38.8	120	1
	SM 4500-Cl C-1997		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	273	8.0	40.0	20

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	SM 2540 C-1997	1	13304021202B	10/31/2013 12:14	Susan E Hibner	1
01124	Chloride (titrimetric)	SM 4500-Cl C-1997	1	13308112401A	11/04/2013 12:50	Susan A Engle	20

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

Sample Description: MW-4 Grab Groundwater
Former Unocal South Vacuum Unit
Lea County, NM

LL Sample # WW 7255382
LL Group # 1429770
Account # 11969

Project Name: Former Unocal South Vacuum Unit, Lea County, NM

Collected: 10/25/2013 16:00 by GV

Submitted: 10/29/2013 10:15
Reported: 11/05/2013 15:12

Chevron Environmental Mgmt Co
6101 Bollinger Canyon Road
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
Wet Chemistry	**SM 2540 C-1997**		mg/l	mg/l	mg/l	
00212	Total Dissolved Solids	n.a.	1,890	77.6	240	1
	SM 4500-Cl C-1997		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	894	20.0	100	50

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	SM 2540 C-1997	1	13304021202B	10/31/2013 12:14	Susan E Hibner	1
01124	Chloride (titrimetric)	SM 4500-Cl C-1997	1	13308112401A	11/04/2013 12:50	Susan A Engle	50

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

Sample Description: MW-5 Grab Groundwater
Former Unocal South Vacuum Unit
Lea County, NM

LL Sample # WW 7255383
LL Group # 1429770
Account # 11969

Project Name: Former Unocal South Vacuum Unit, Lea County, NM

Collected: 10/25/2013 15:00 by GV

Submitted: 10/29/2013 10:15
Reported: 11/05/2013 15:12

Chevron Environmental Mgmt Co
6101 Bollinger Canyon Road
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
Wet Chemistry	**SM 2540 C-1997**		mg/l	mg/l	mg/l	
00212	Total Dissolved Solids	n.a.	268	9.7	30.0	1
	SM 4500-Cl C-1997		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	15.3	0.40	2.0	1

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	SM 2540 C-1997	1	13304021202B	10/31/2013 12:14	Susan E Hibner	1
01124	Chloride (titrimetric)	SM 4500-Cl C-1997	1	13308112401A	11/04/2013 12:50	Susan A Engle	1

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

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Analysis Report

2425 New Holland Pike, Lancaster, PA 17601 • 717-656-2300 • Fax: 717-656-2681 • www.LancasterLabs.com

Sample Description: MW-6 Grab Groundwater
Former Unocal South Vacuum Unit
Lea County, NM

LL Sample # WW 7255384
LL Group # 1429770
Account # 11969

Project Name: Former Unocal South Vacuum Unit, Lea County, NM

Collected: 10/25/2013 12:00 by GV

Submitted: 10/29/2013 10:15
Reported: 11/05/2013 15:12

Chevron Environmental Mgmt Co
6101 Bollinger Canyon Road
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
Wet Chemistry	**SM 2540 C-1997**		mg/l	mg/l	mg/l	
00212	Total Dissolved Solids	n.a.	510	19.4	60.0	1
	SM 4500-Cl C-1997		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	116	4.0	20.0	10

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	SM 2540 C-1997	1	13304021202B	10/31/2013 12:14	Susan E Hibner	1
01124	Chloride (titrimetric)	SM 4500-Cl C-1997	1	13308112401A	11/04/2013 12:50	Susan A Engle	10

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

Quality Control Summary

Client Name: Chevron Environmental Mgmt Co   Group Number: 1429770
Reported: 11/05/13 at 03:12 PM

Matrix QC may not be reported if insufficient sample or 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.

All Inorganic Initial Calibration and Continuing Calibration Blanks met acceptable method criteria unless otherwise noted on the Analysis Report.

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: 13304021202B	Sample number(s): 7255379-7255384								
Total Dissolved Solids	N.D.	9.7	30.0	mg/l	110	102	80-120	7	9
Batch number: 13308112401A	Sample number(s): 7255379-7255384								
Chloride (titrimetric)					100	99	95-103	0	20

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: 13304021202B	Sample number(s): 7255379-7255384 UNSPK: P254978 BKG: 7255379								
Total Dissolved Solids	98	110	51-144	5	23	1,700	1,550	9*	5
Batch number: 13308112401A	Sample number(s): 7255379-7255384 UNSPK: P256505 BKG: P256505								
Chloride (titrimetric)	72*	98	85-110	22*	3	437	432	1 (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.

Environmental Analysis Request/Chain of Custody

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Acct. # 11969 For Eurofins Lancaster Laboratories use only Group # 1429770 Sample # 7255379-84

Instructions on reverse side correspond with circled numbers.

COC # 333934

For Lab Use Only
FSC:
SCR#: 144947

(1) Client Information

Client: Chevron Environmental Mgmt. Co.	Acct. #: 11969
Project Name/#: Former Unocal S. Vacuum Unit	PWSID #:
Project Manager: John MacLeod (Chevron) Dana Koschel (Arcadis)	P.O. #:
Sampler: Gil Van Deventer (Trident Env.)	Quote #:
Name of state where samples were collected: New Mexico	

(4) Matrix: Sediment ☐ / Soil ☐; Water: Ground ☒, Surface ☐, Potable ☐, NPDES ☐; Other: ____

(5) Analysis Requested — Preservation Codes

Preservation Codes
H=HCl T=Thiosulfate
N=HNO_3 B=NaOH
S=H_2SO_4 O=Other

(6) Remarks

(2) Sample Identification	Collected Date	Collected Time	(3) Grab	Composite	Soil	Water	Other	Total # of Containers	TDS	Chloride (titrimetric)									Remarks
MW-1	10-25-13	1700	✓						✓	✓									
MW-2	10-25-13	1700	✓						✓	✓									
MW-3	10-25-13	1400	✓						✓	✓									
MW-4	10-25-13	1600	✓						✓	✓									
MW-5	10-25-13	1500	✓						✓	✓									
MW-6	10-25-13	1200	✓						✓	✓									

(7) Turnaround Time (TAT) Requested (please circle)

(Standard) Rush

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

Date results are needed: ____________

E-mail address: gil@trident-environmental.com

(8) Data Package Options (circle if required)

Type I (Validation/non-CLP) Type VI (Raw Data Only)

Type III (Reduced non-CLP) TX TRRP-13

Type IV (CLP SOW) MA MCP CT RCP

Relinquished by	Date	Time	Received by	Date	Time
[signature]	9/9/13	1350	[signature]	10/1/13	5:00pm
[signature]	10/28/13	1600	U.P.S.	10/28/13	1600
			[signature]	10/29/13	1015

(9)

EDD Required? Yes No
If yes, format: ____________

Site-Specific QC (MS/MSD/Dup)? Yes (No)
(If yes, indicate QC sample and submit triplicate sample volume.)

Relinquished by Commercial Carrier:
UPS X FedEx ____ Other ____

Temperature upon receipt 1.0 °C

Eurofins Lancaster Laboratories, Inc. • 2425 New Holland Pike, Lancaster, PA 17601 • 717-656-2300
The white copy should accompany samples to Eurofins Lancaster Laboratories. The yellow copy should be retained by the client.

Issued by Dept. 40 Management 7044.02

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Grp #1429770

Environmental Sample Administration Receipt Documentation Log

Client/Project: Chevron

Date of Receipt: 10/29/13

Time of Receipt: 1015

Source Code: Go

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	DT131	1.0	TB	WI	Y	B	
2							
3							
4							
5							
6							

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

Paperwork Discrepancy/Unpacking Problems:

Unpacker Signature/Emp#: [signature] 5700 **Date/Time:** 10/29/13 1125

Issued by Dept. 6042 Management

2174.06

Explanation of Symbols and Abbreviations

Eurofins Lancaster Laboratories Environmental

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

RL	Reporting Limit	**BMQL**	Below Minimum Quantitation Level
N.D.	none detected	**MPN**	Most Probable Number
TNTC	Too Numerous To Count	**CP Units**	cobalt-chloroplatinate units
IU	International Units	**NTU**	nephelometric turbidity units
umhos/cm	micromhos/cm	**ng**	nanogram(s)
C	degrees Celsius	**F**	degrees Fahrenheit
meq	milliequivalents	**lb.**	pound(s)
g	gram(s)	**kg**	kilogram(s)
µg	microgram(s)	**mg**	milligram(s)
mL	milliliter(s)	**L**	liter(s)
m3	cubic meter(s)	**µL**	microliter(s)
		pg/L	picogram/liter

< 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 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. All other results are reported on an as-received basis.

Data Qualifiers:

C – result confirmed by reanalysis.

J - estimated value – The result is ≥ the Method Detection Limit (MDL) and < the Limit of Quantitation (LOQ).

U.S. EPA CLP 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 quantitated on a diluted sample	**N**	Spike sample not within control limits
E	Concentration exceeds the calibration range of the instrument	**S**	Method of standard additions (MSA) used for calculation
N	Presumptive evidence of a compound (TICs only)	**U**	Compound was not detected
P	Concentration difference between primary and confirmation columns >25%	**W**	Post digestion spike out of control limits
		*****	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 meet all requirements of NELAC unless otherwise noted under the individual analysis.

Measurement uncertainty values, as applicable, are available upon request.

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.

Times are local to the area of activity. Parameters listed in the 40 CFR part 136 Table II as "analyze immediately" are not performed within 15 minutes.

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APPENDIX B

Monitoring Well Sampling Data Form

WELL SAMPLING DATA FORM

TRIDENT ENVIRONMENTAL

CLIENT: Chevron Environmental Management Corp.

SITE NAME: Former Unocal South Vacuum Unit (1R-277)

SITE LOCATION: T18S - R35E - Sec 35, Lea County, NM

SAMPLER: Gil Van Deventer

PURGING METHOD: ☐ Hand Bailed ☑ Pump, Type: Proactive Super Twister 3-Stage Pump

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

ISPOSAL METHOD OF PURGE WATER: ☐ On-site Drum ☐ Drums ☑ SWD Disposal Facility

Date	Time	Monitoring Well No.	Depth to Water (ft btoc)	Total Depth (ft)	Water Column Height (ft)	Well Factor 2"=.16 4"=.65	Calc. Well Vol. (gal)	Volume Purged (gal)	No. of Well Volumes Purged	Temp. °F	Cond. mS/cm	pH	PHYSICAL APPEARANCE AND REMARKS
10/25/2013	17:00	MW-1	65.60	70.00	4.40	0.16	0.7	5	7.1	67.1	2.71	7.35	Cloudy but clearing moderately quickly
10/25/2013	13:00	MW-2	52.33	71.00	18.67	0.16	3.0	10	3.3	66.9	1.75	8.26	Clear
10/25/2013	14:00	MW-3	70.09	77.00	6.91	0.16	1.1	5	4.5	67.0	1.13	7.71	Silty but cleared quickly
10/25/2013	16:00	MW-4	63.10	71.00	7.90	0.16	1.3	9	7.1	67.2	3.28	7.85	Cloudy but cleared quickly
10/25/2013	15:00	MW-5	71.16	79.00	7.84	0.16	1.3	8	6.4	65.8	0.42	7.02	Clear
10/25/2013	12:00	MW-6	73.14	77.20	4.06	0.16	0.6	5	7.7	64.5	0.80	6.97	Reddish-brown silty; clearing

COMMENTS: Equipment decontamination consists of gloves, Alconox, and Distilled Water Rinse.

Hanna Model 98130 instrument used to obtain pH, conductivity, and temperature measurements.

Shipped samples via FedEx to Lancaster Laboratories for chloride and TDS analysis.

APPENDIX C

Chloride and TDS Plume Simulations

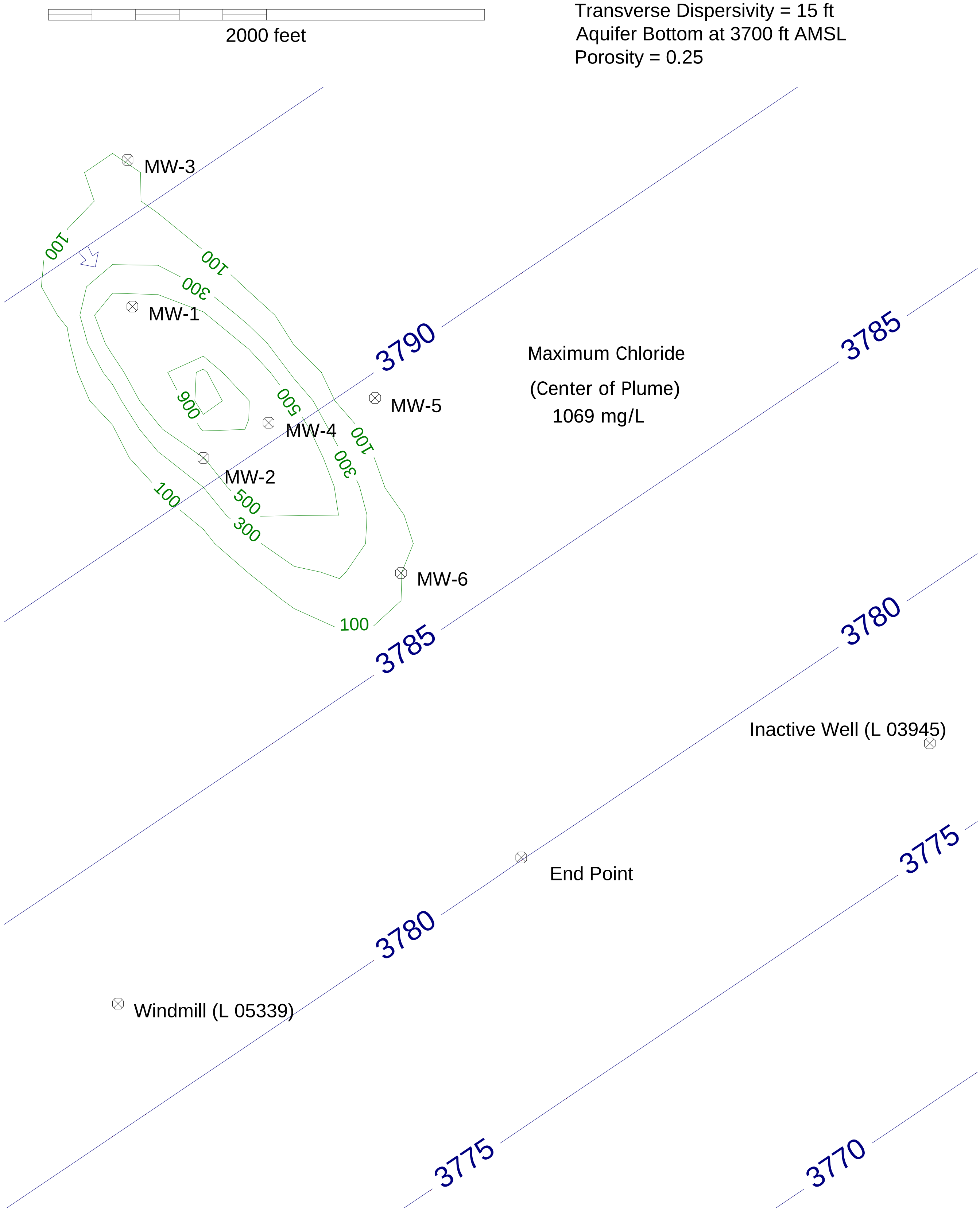
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2013)

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



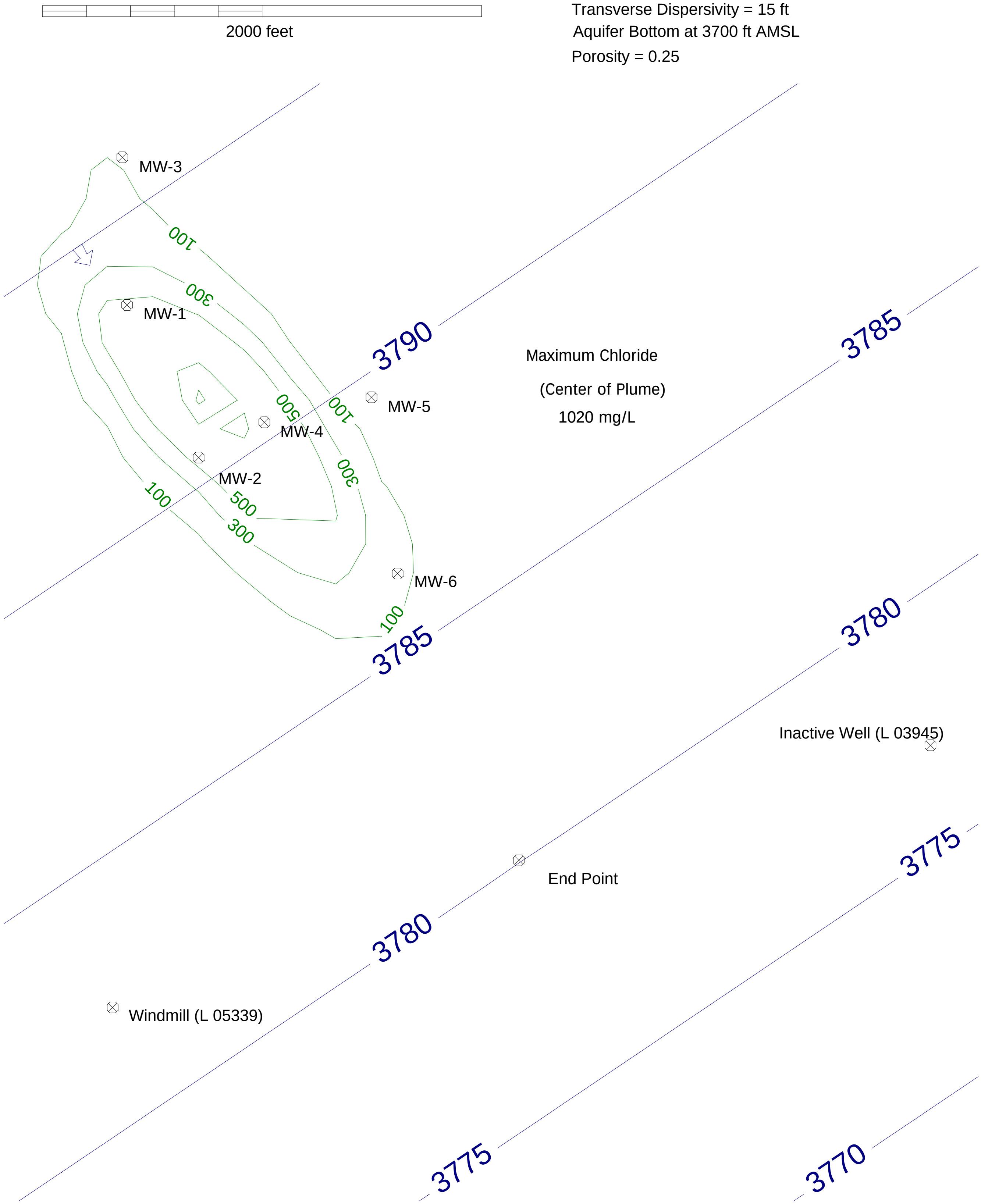
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

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

Chloride Plume (Year 2015)



WinTran Fate & Transport Modeling Results

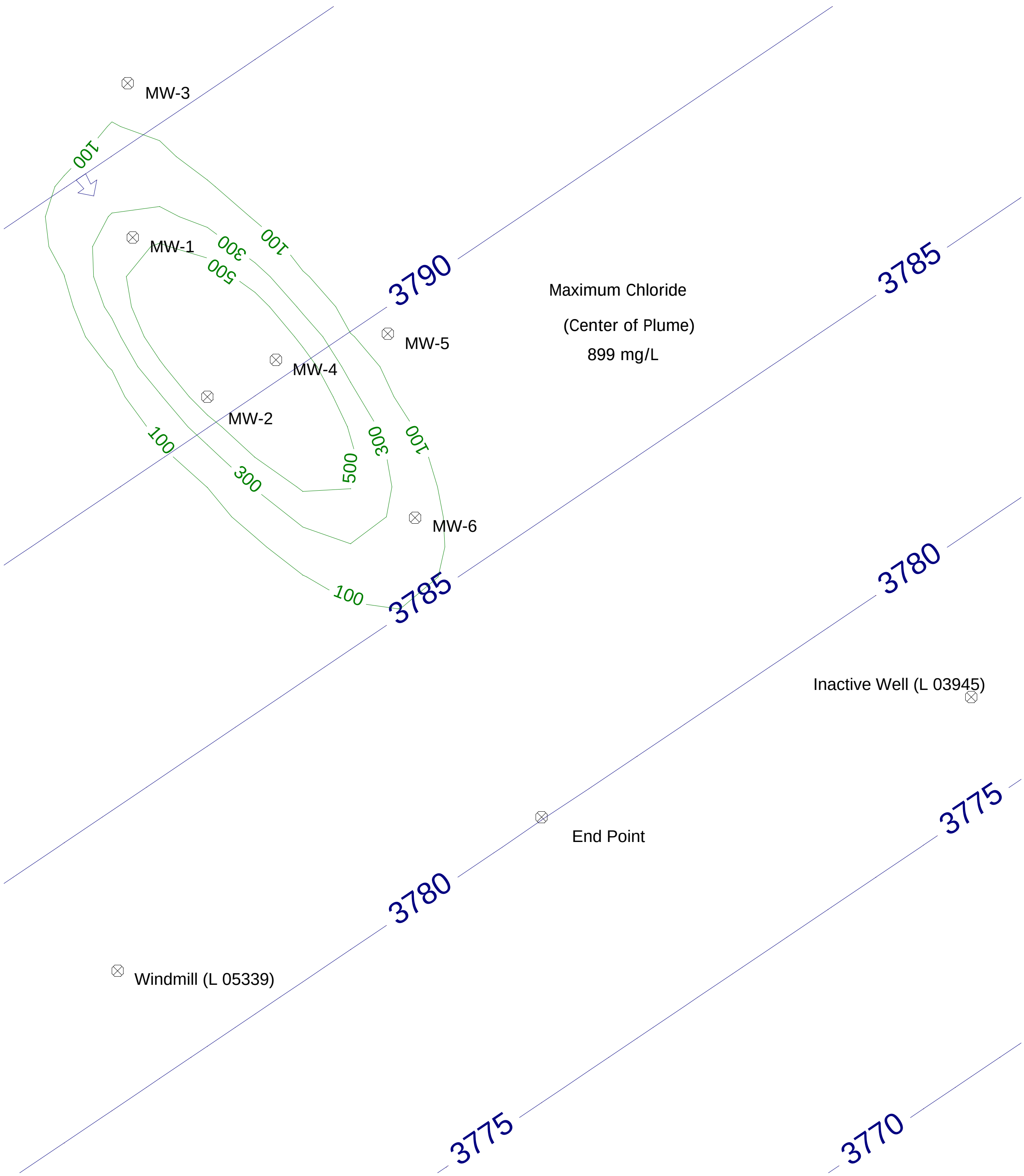
Former Unocal South Vacuum Unit Site

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

Chloride Plume (Year 2020)

2000 feet



WinTran Fate & Transport Modeling Results

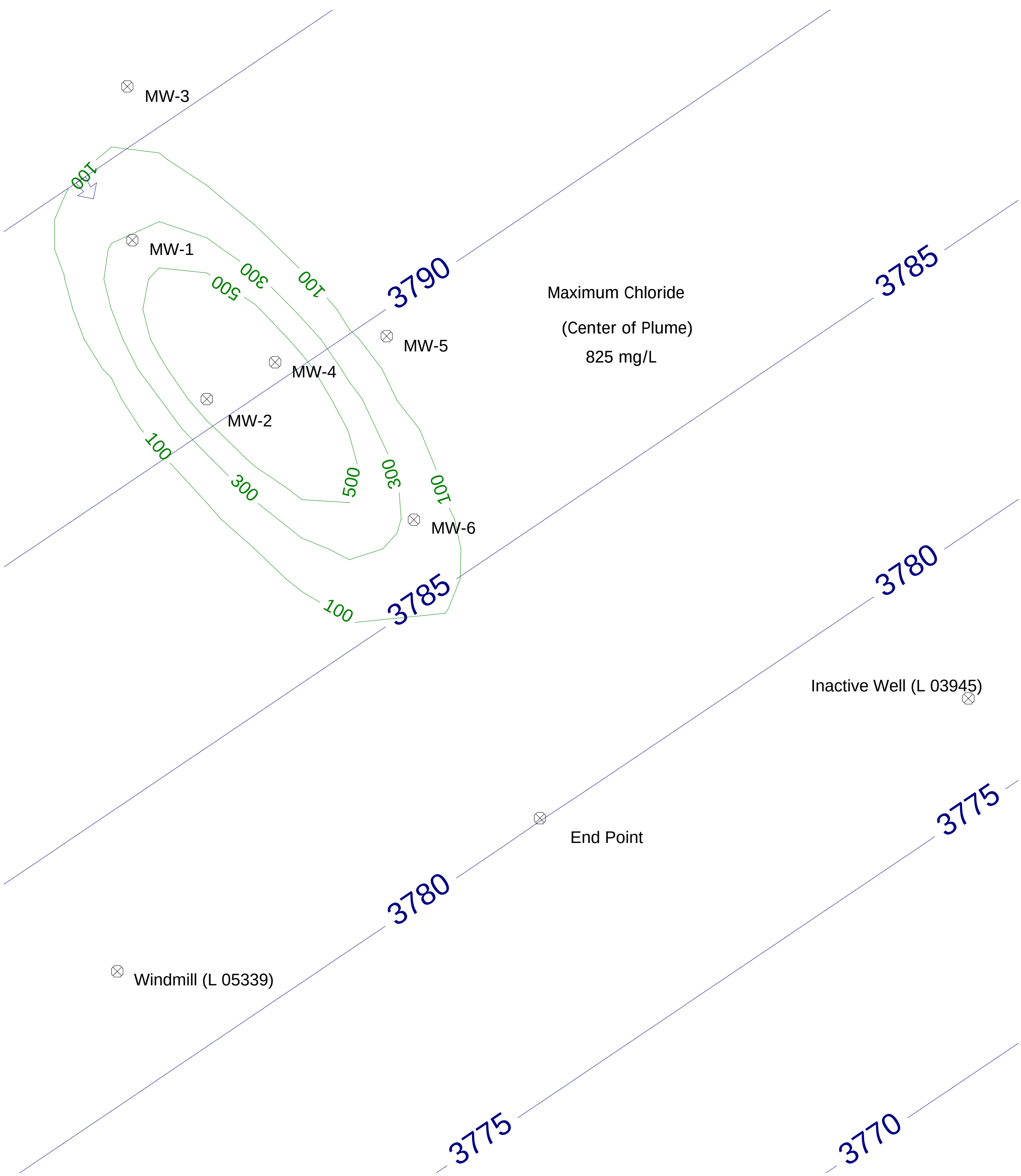
Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2025)

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 = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



WinTran Fate & Transport Modeling Results

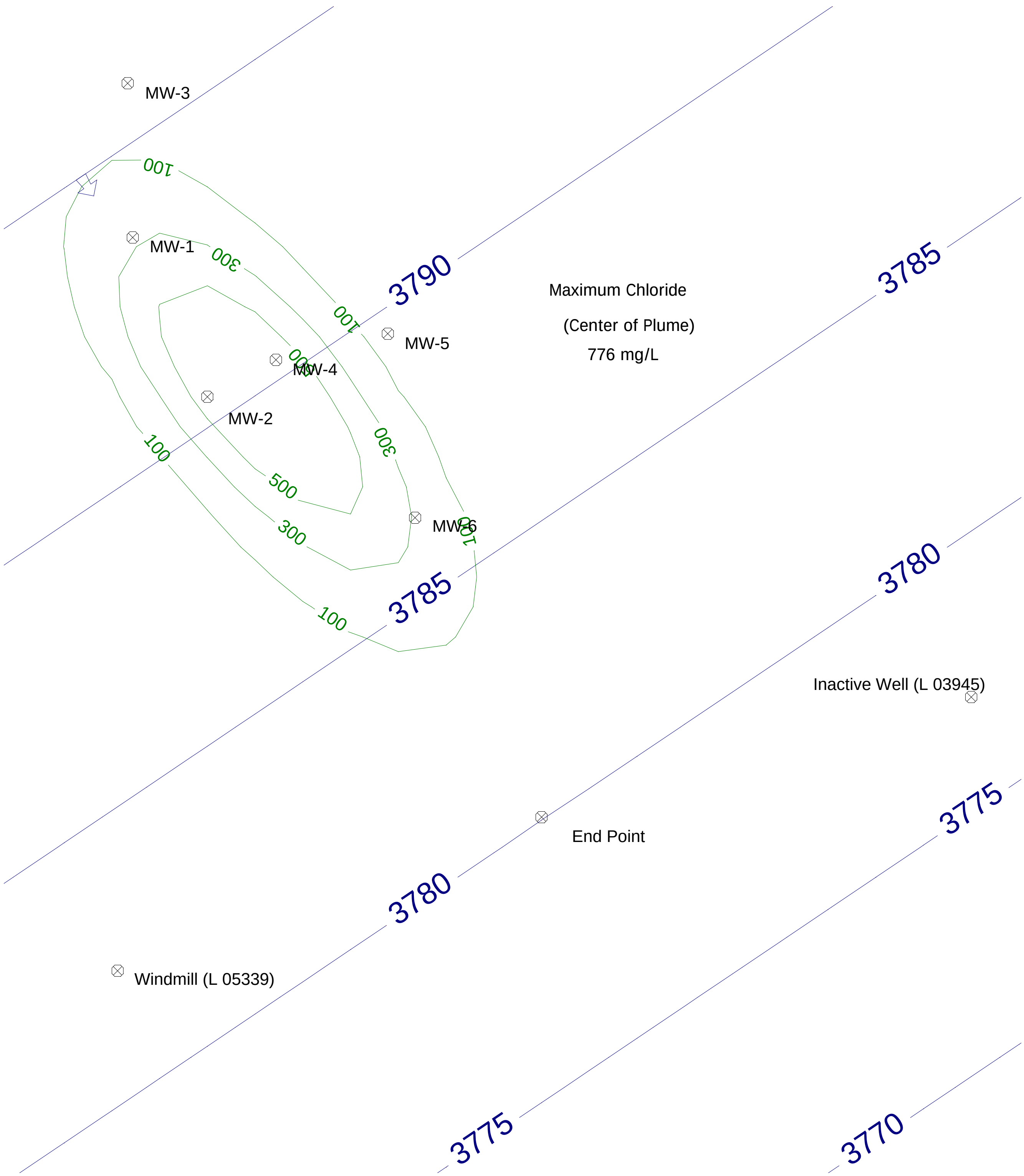
Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2030)

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 = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



WinTran Fate & Transport Modeling Results

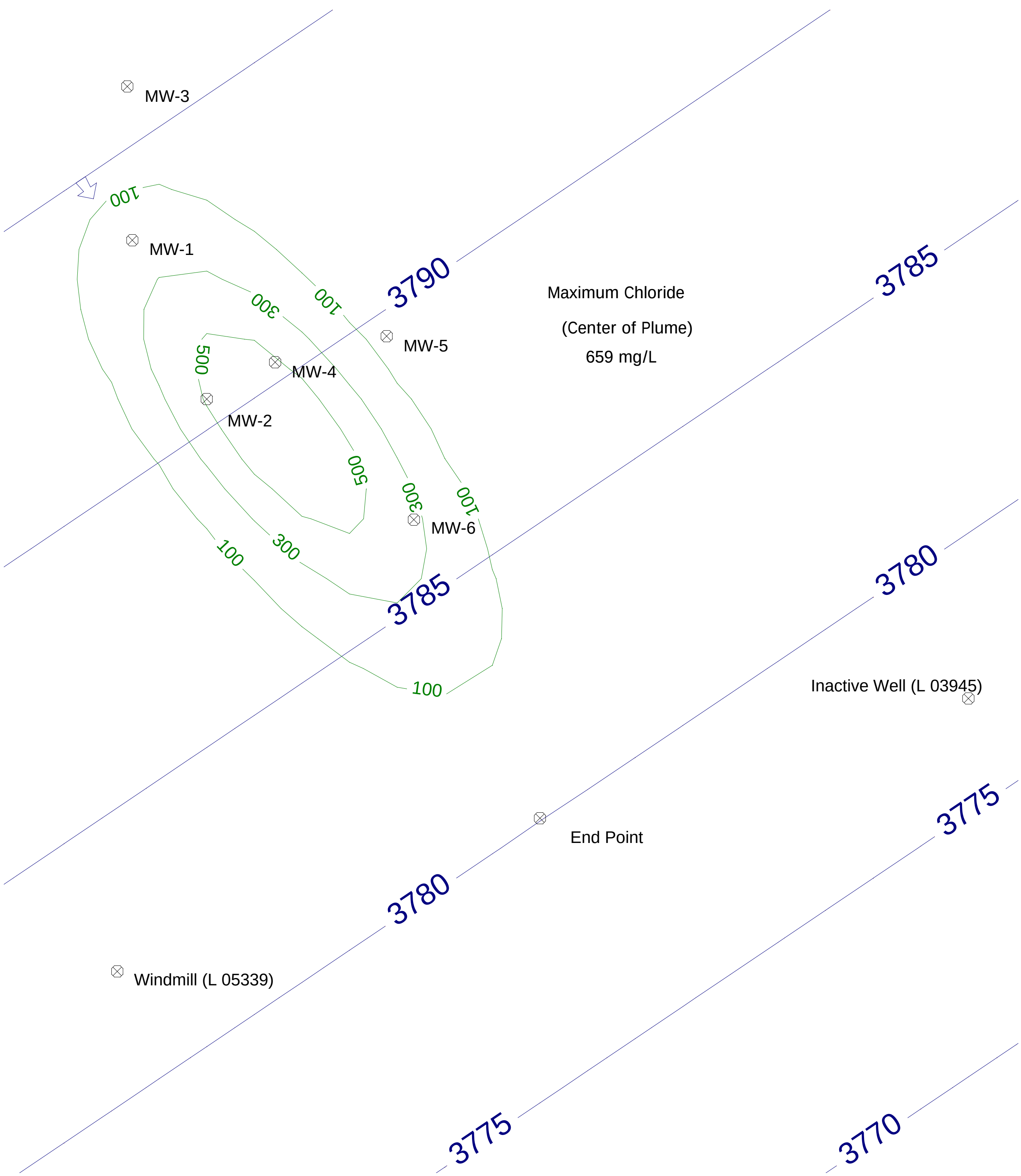
Former Unocal South Vacuum Unit Site

Chloride Plume (Year 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 = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



WinTran Fate & Transport Modeling Results

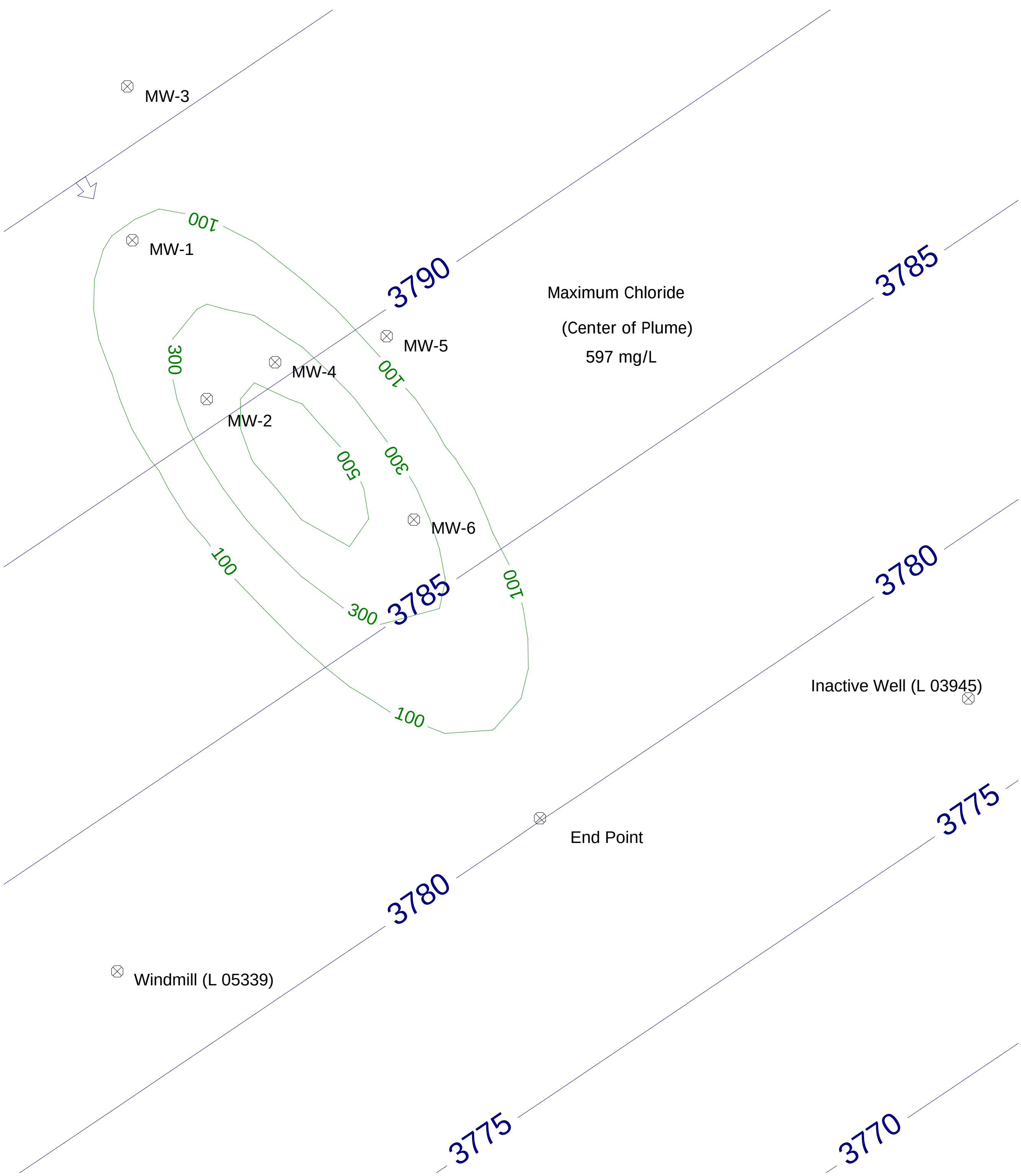
Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2050)

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 = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



WinTran Fate & Transport Modeling Results

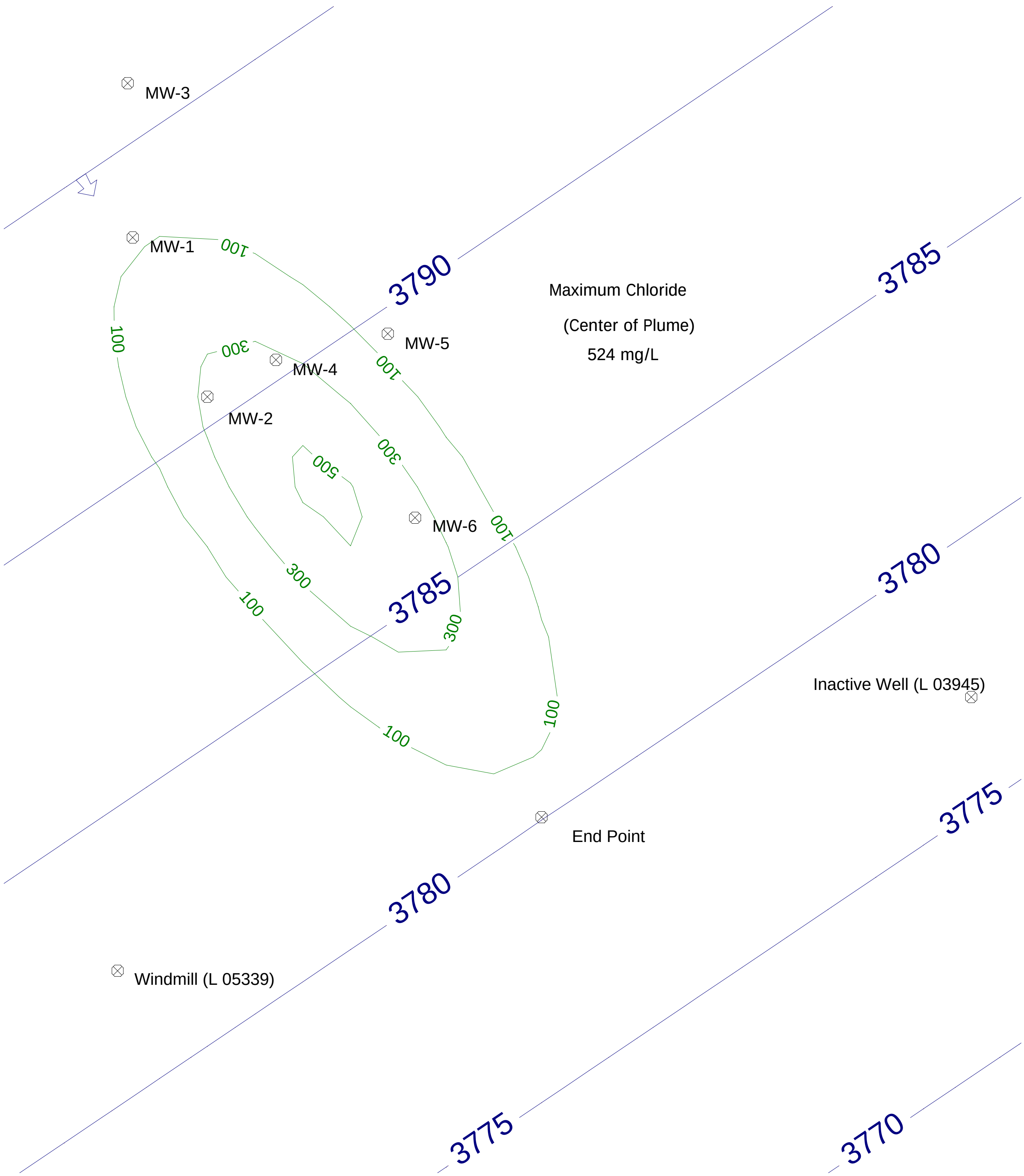
Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2060)

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 = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



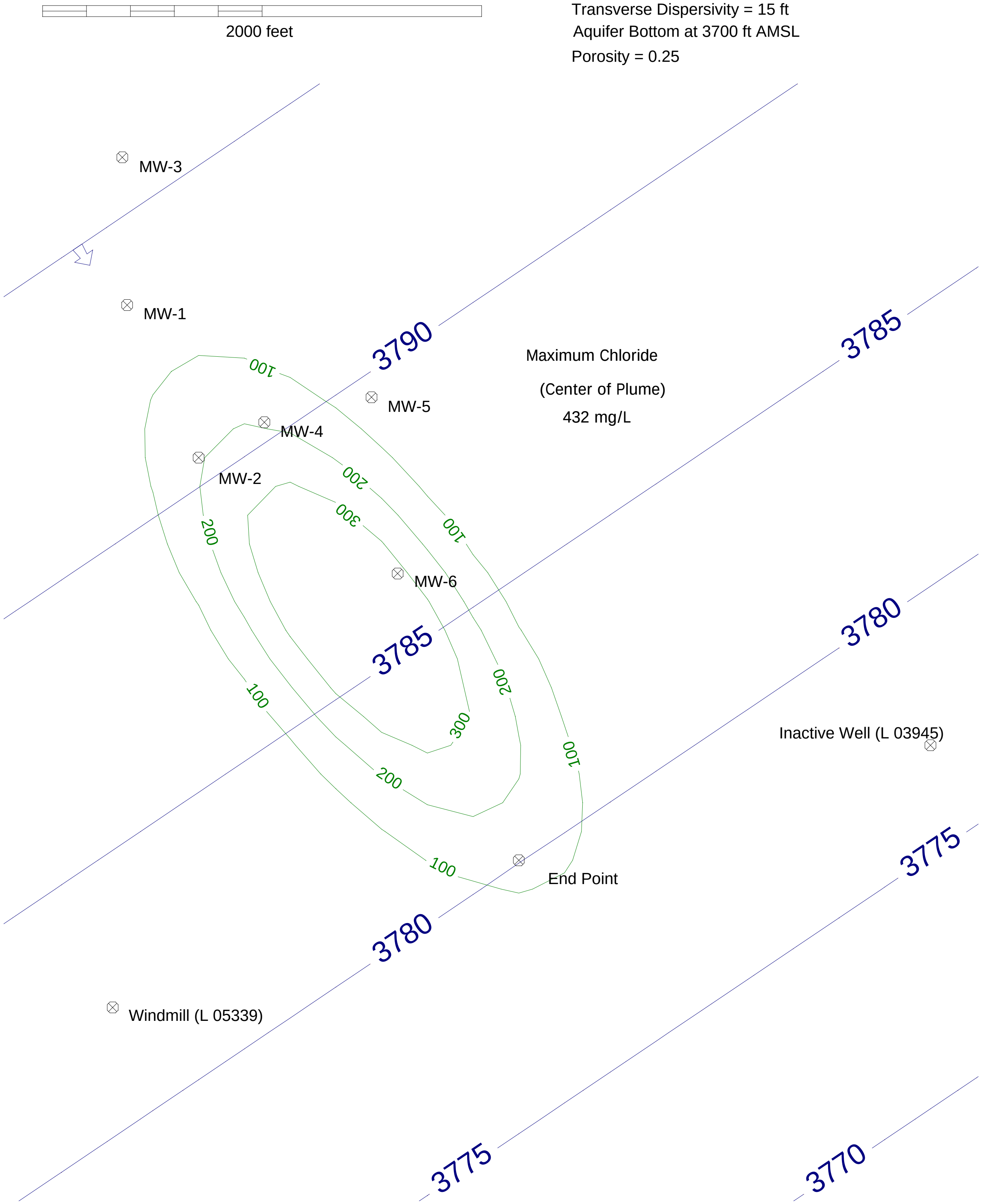
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 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 = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



WinTran Fate & Transport Modeling Results

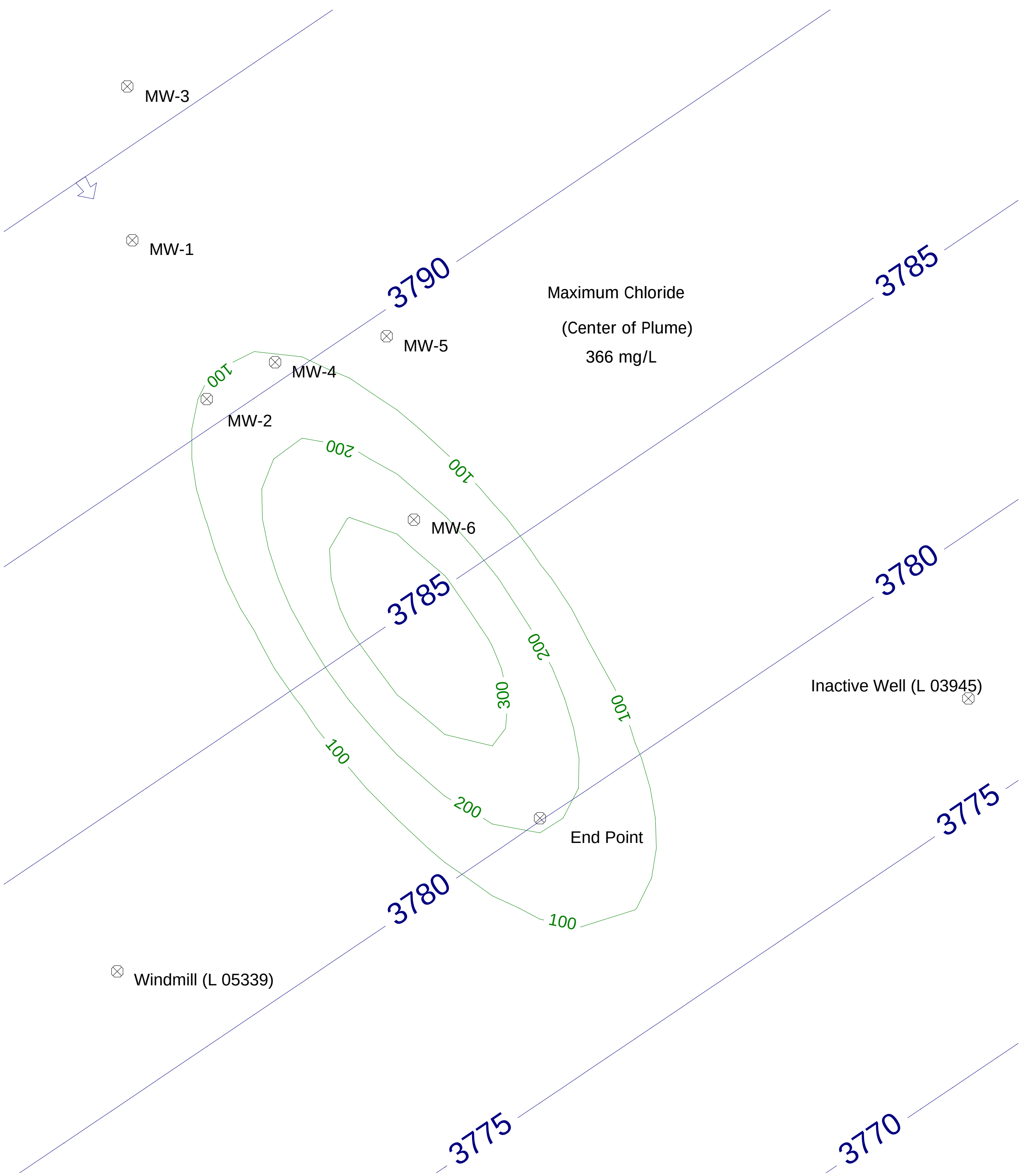
Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2100)

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 = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



WinTran Fate & Transport Modeling Results

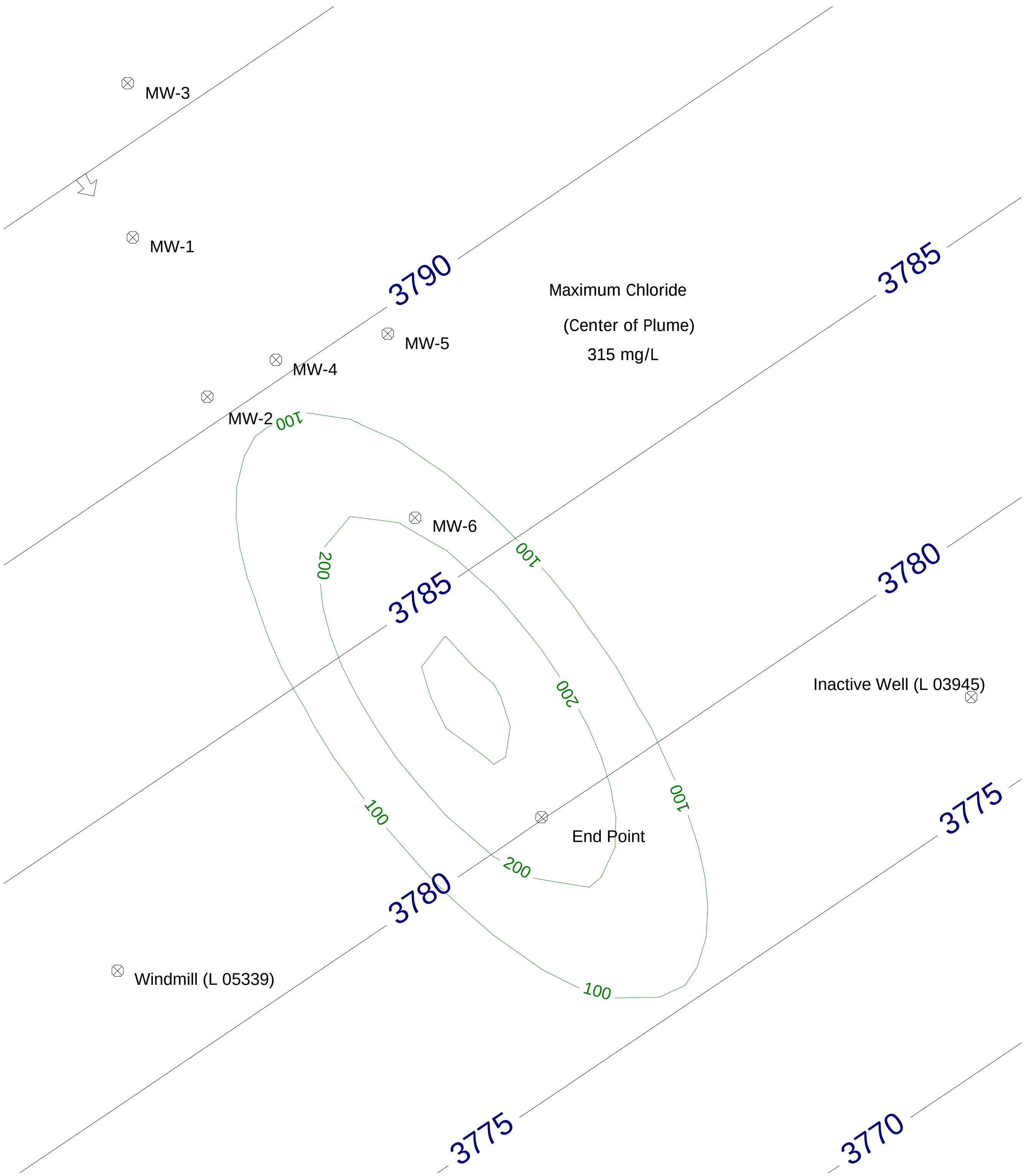
Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2120)

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 = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



WinTran Fate & Transport Modeling Results

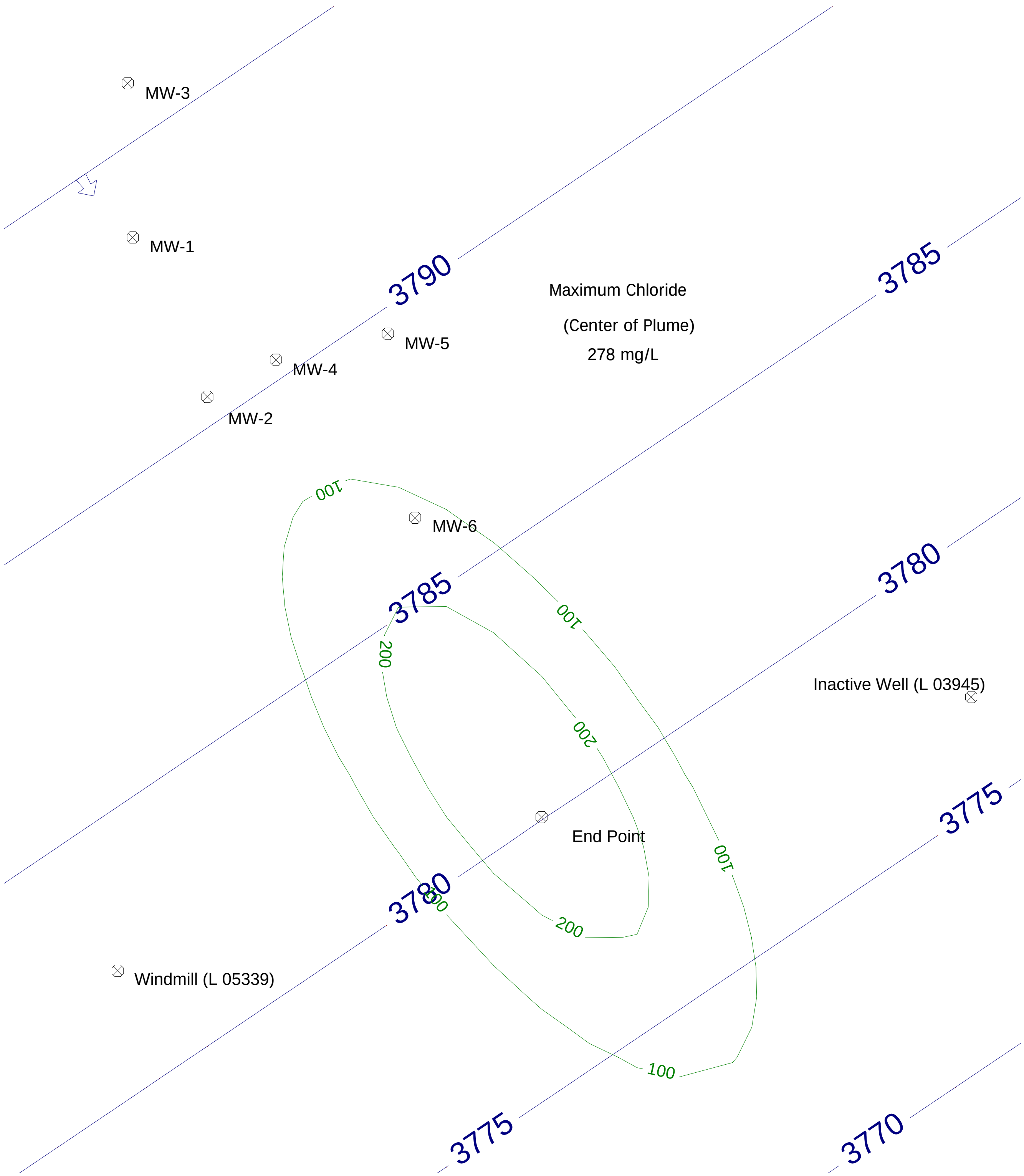
Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2140)

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 = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



WinTran Fate & Transport Modeling Results

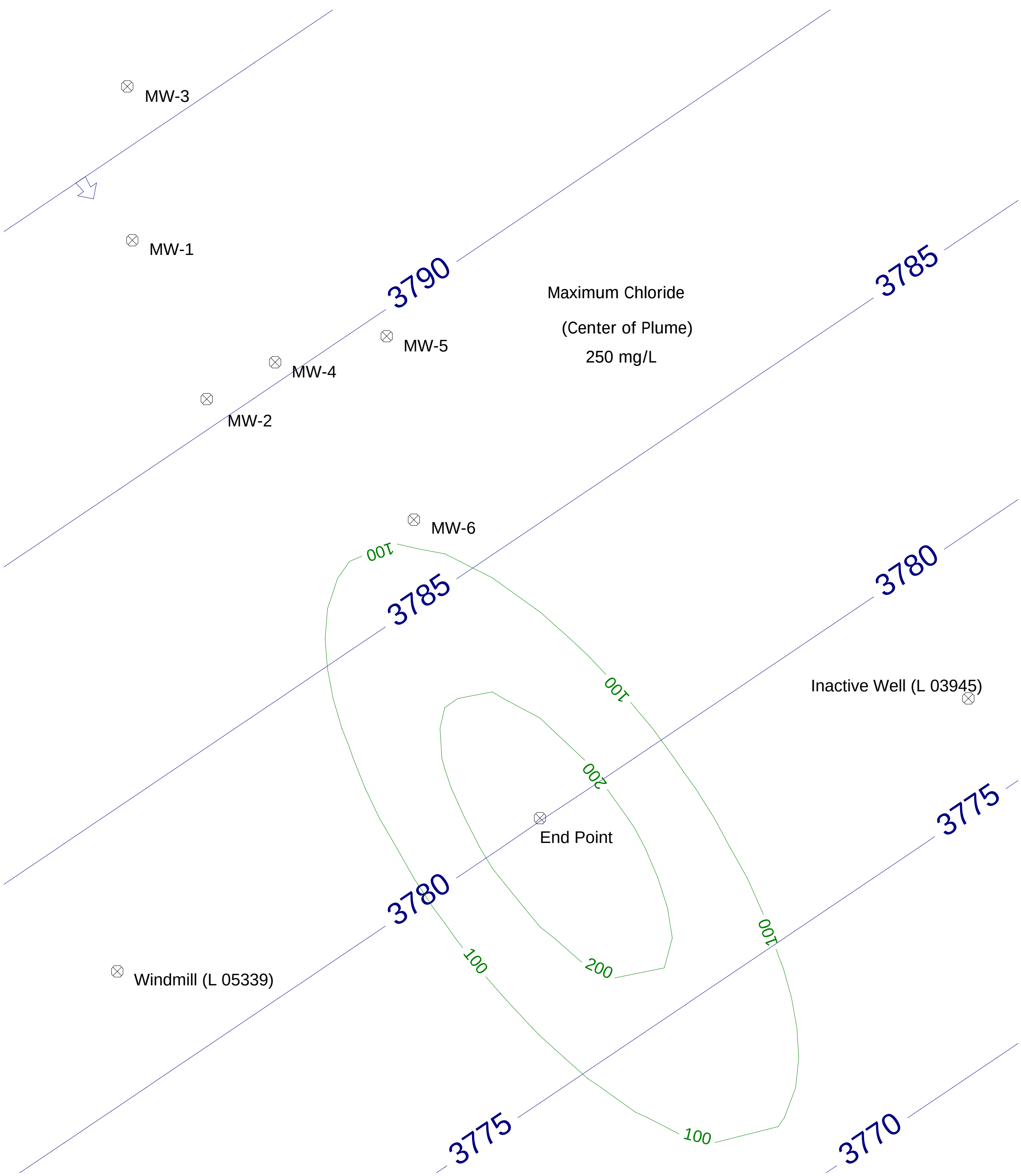
Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2158)

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 = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



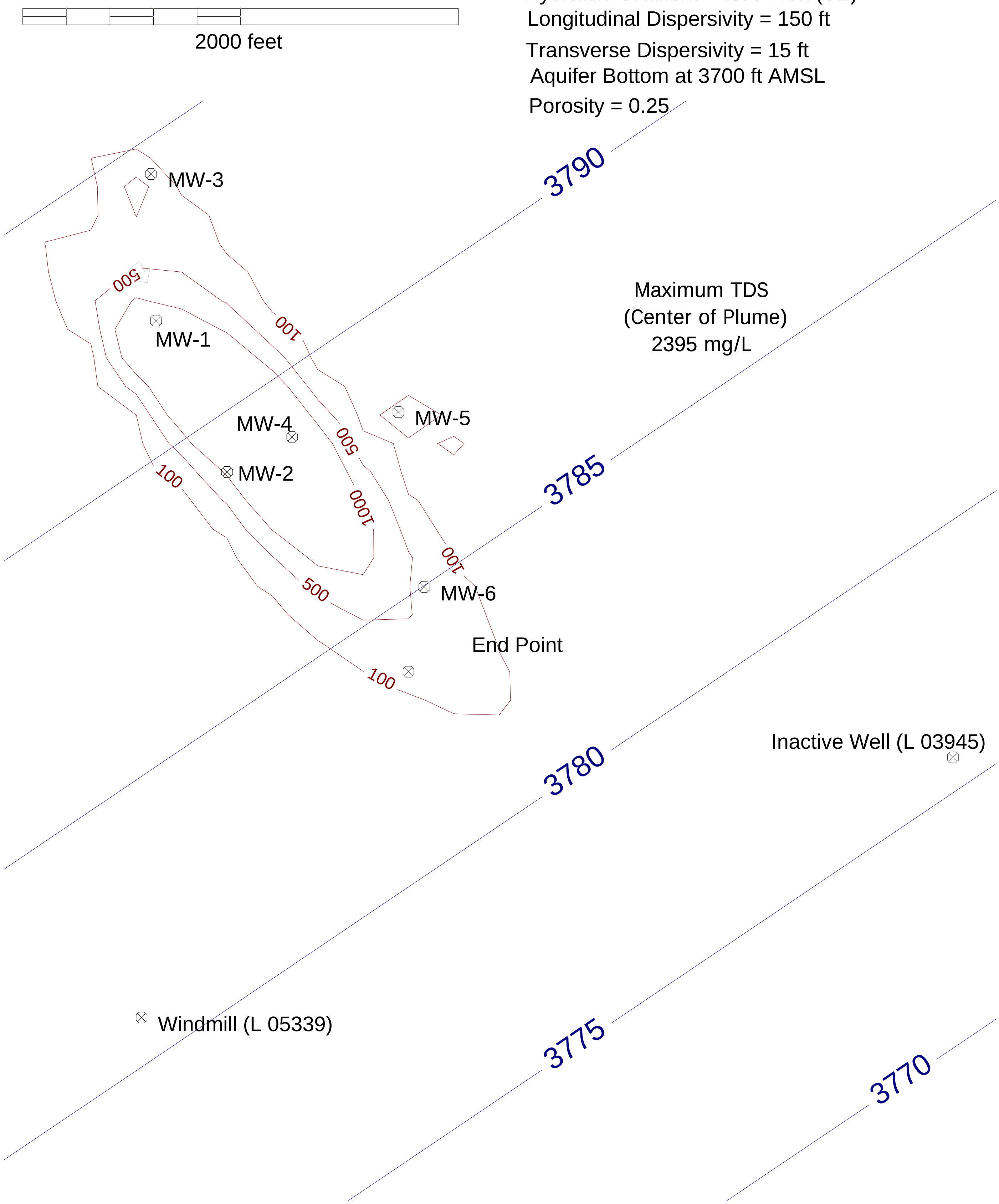
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2013)

Modeling Assumptions

Hydraulic Conductivity = 1000 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

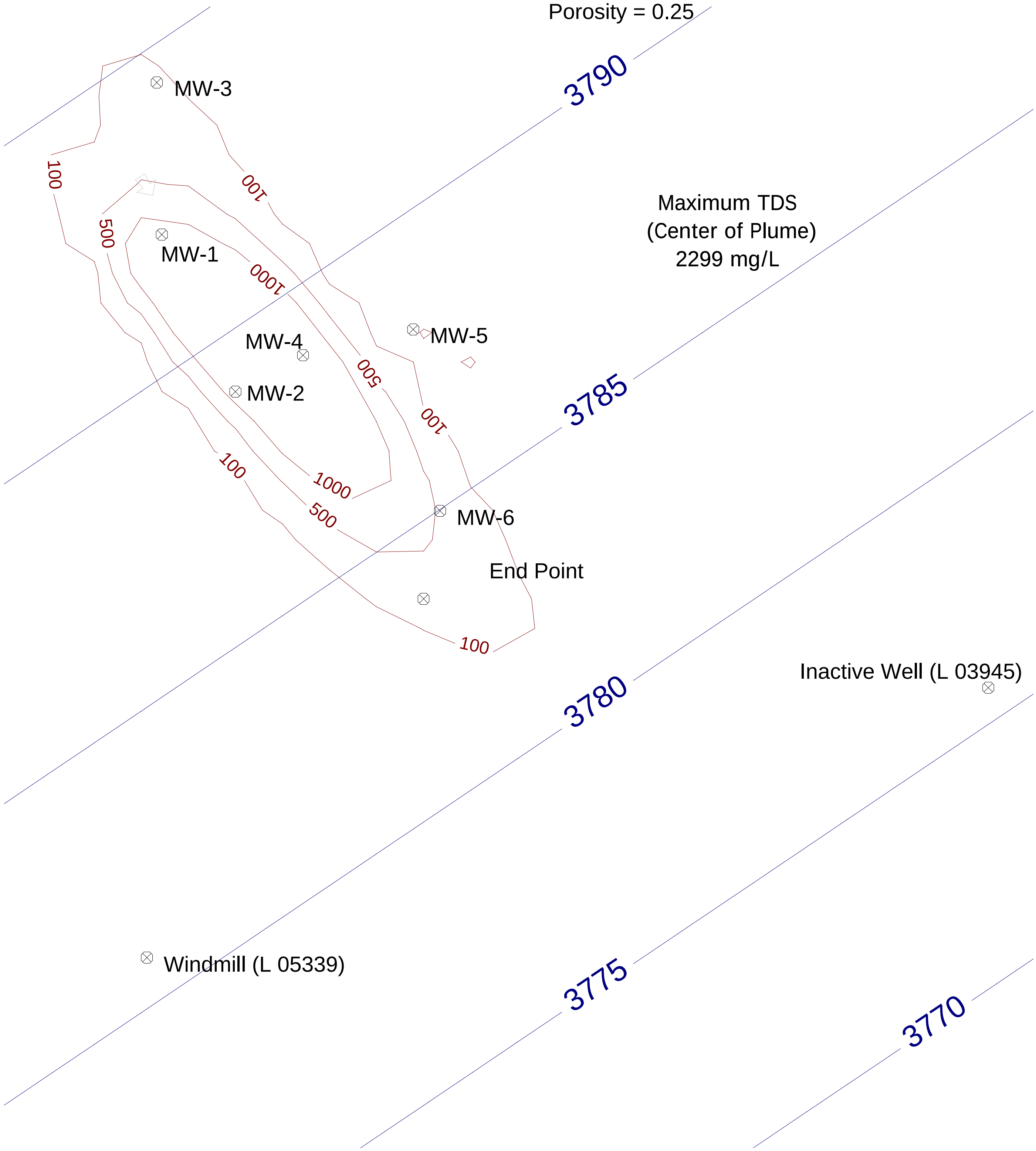
Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2015)

2000 feet

Modeling Assumptions

Hydraulic Conductivity = 1000 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

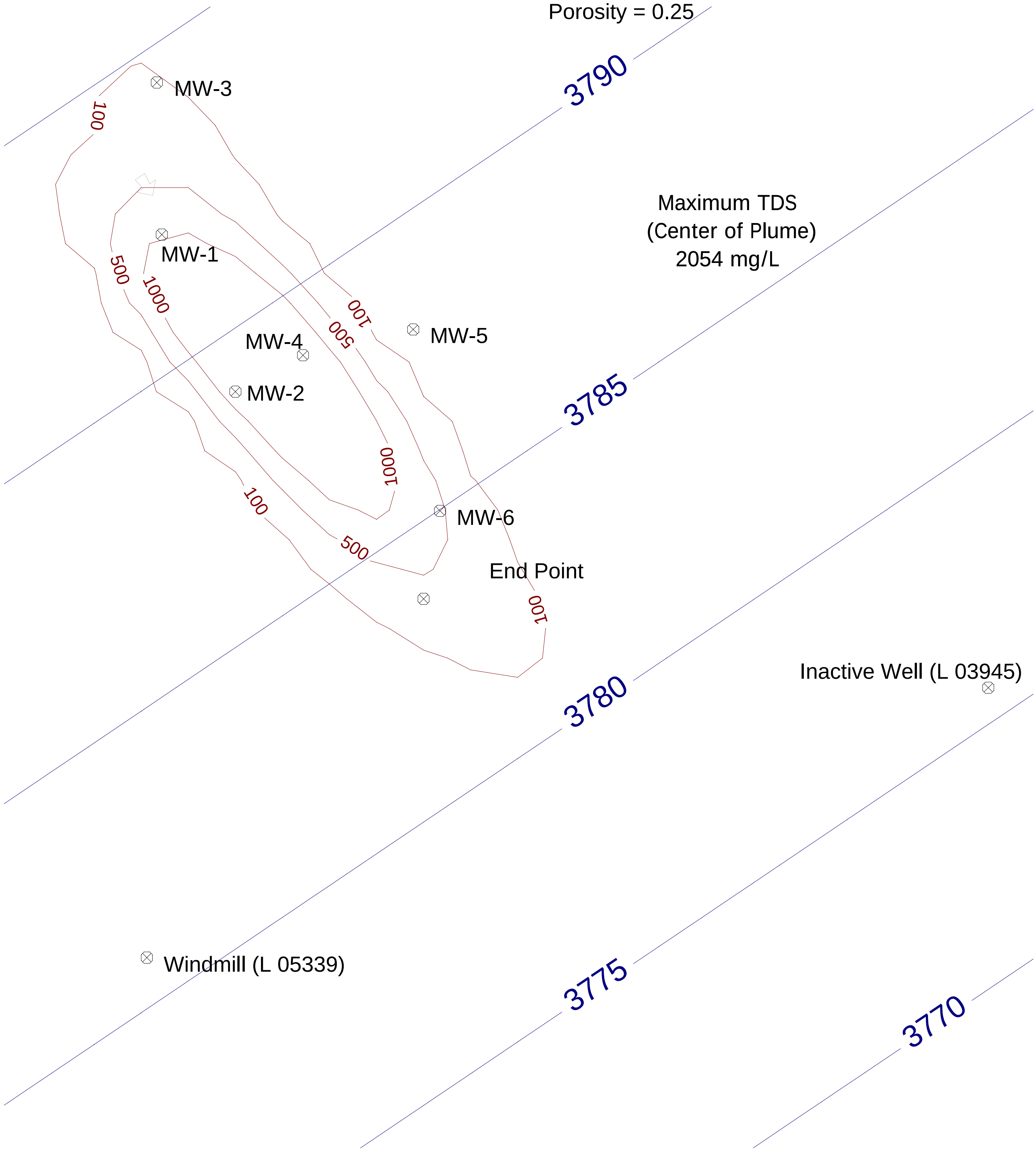
Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2020)

2000 feet

Modeling Assumptions

Hydraulic Conductivity = 1000 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

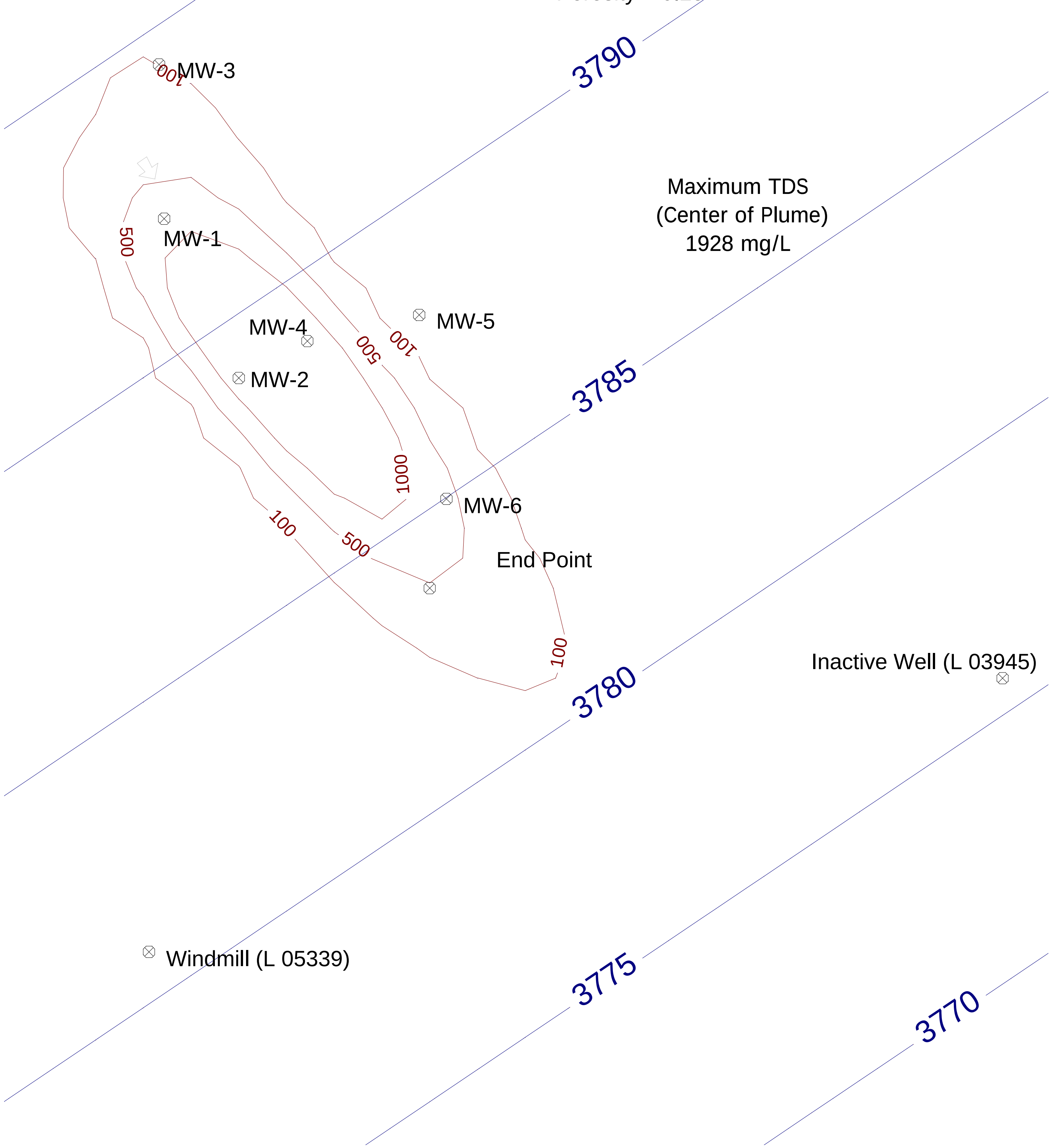
Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2025)

2000 feet

Modeling Assumptions

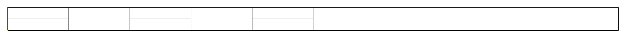
Hydraulic Conductivity = 1000 ft/Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

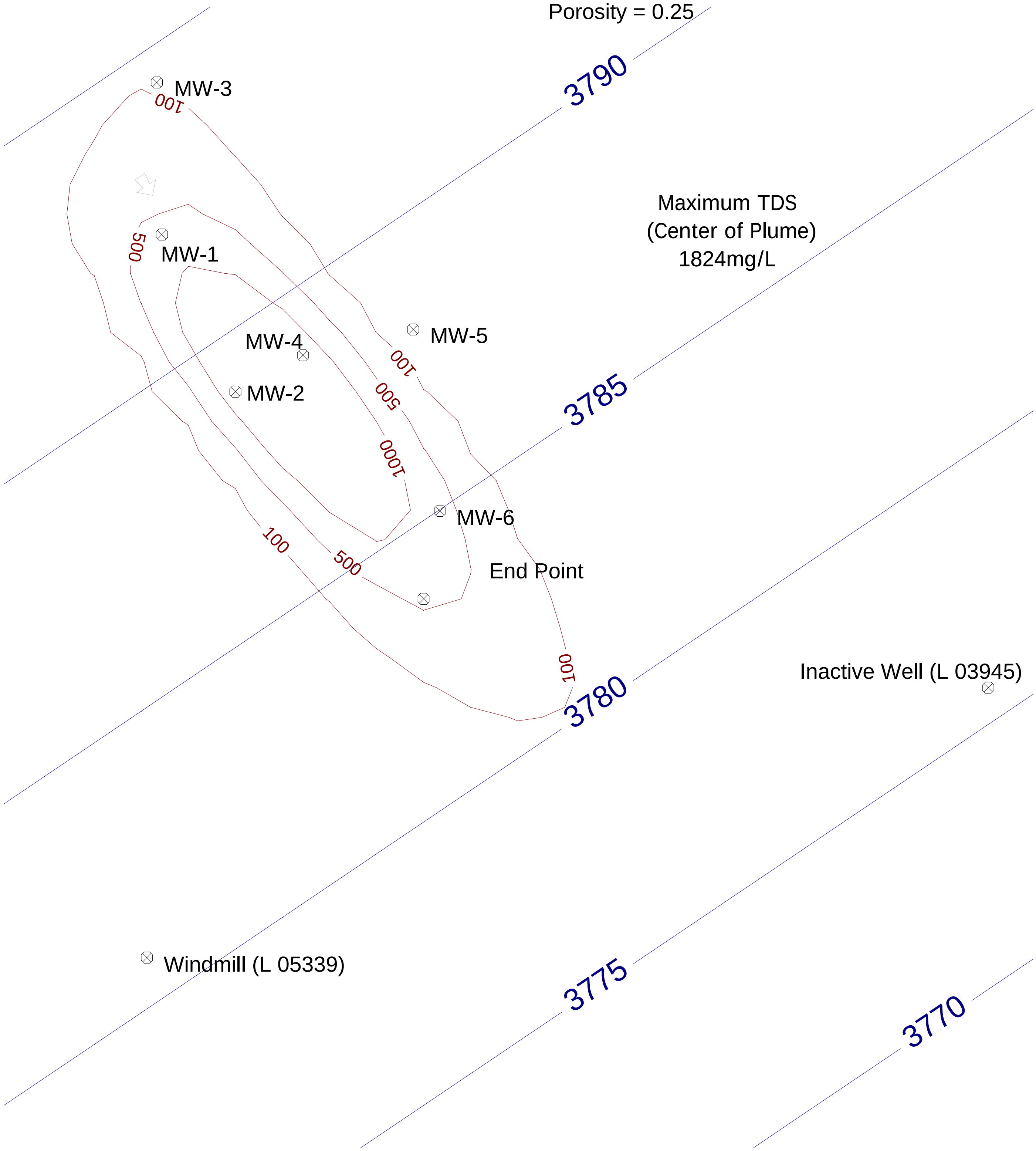
TDS Plume Simulation (Year 2030)



2000 feet

Modeling Assumptions

Hydraulic Conductivity = 1000 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

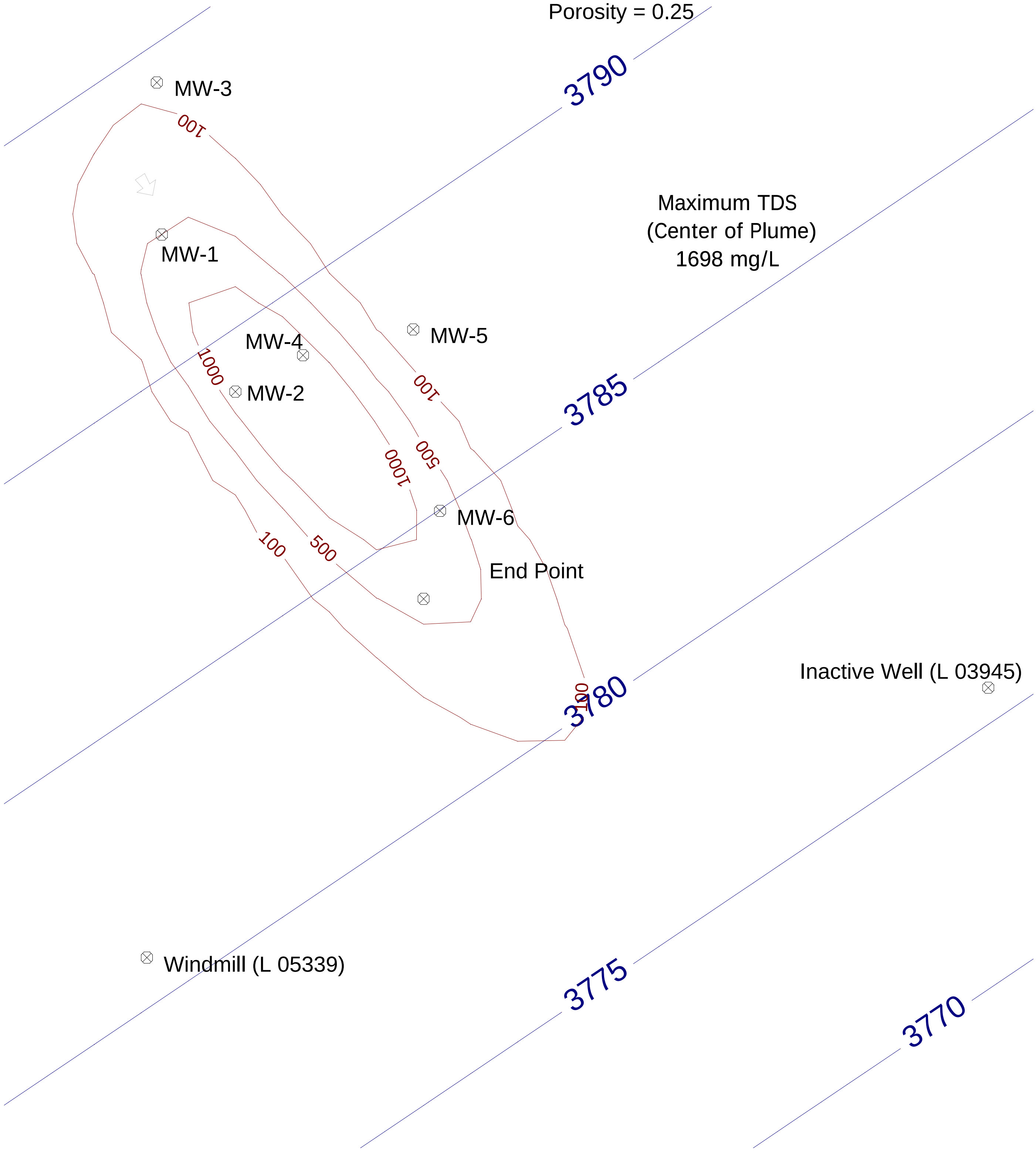
Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2035)

2000 feet

Modeling Assumptions

Hydraulic Conductivity = 1000 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

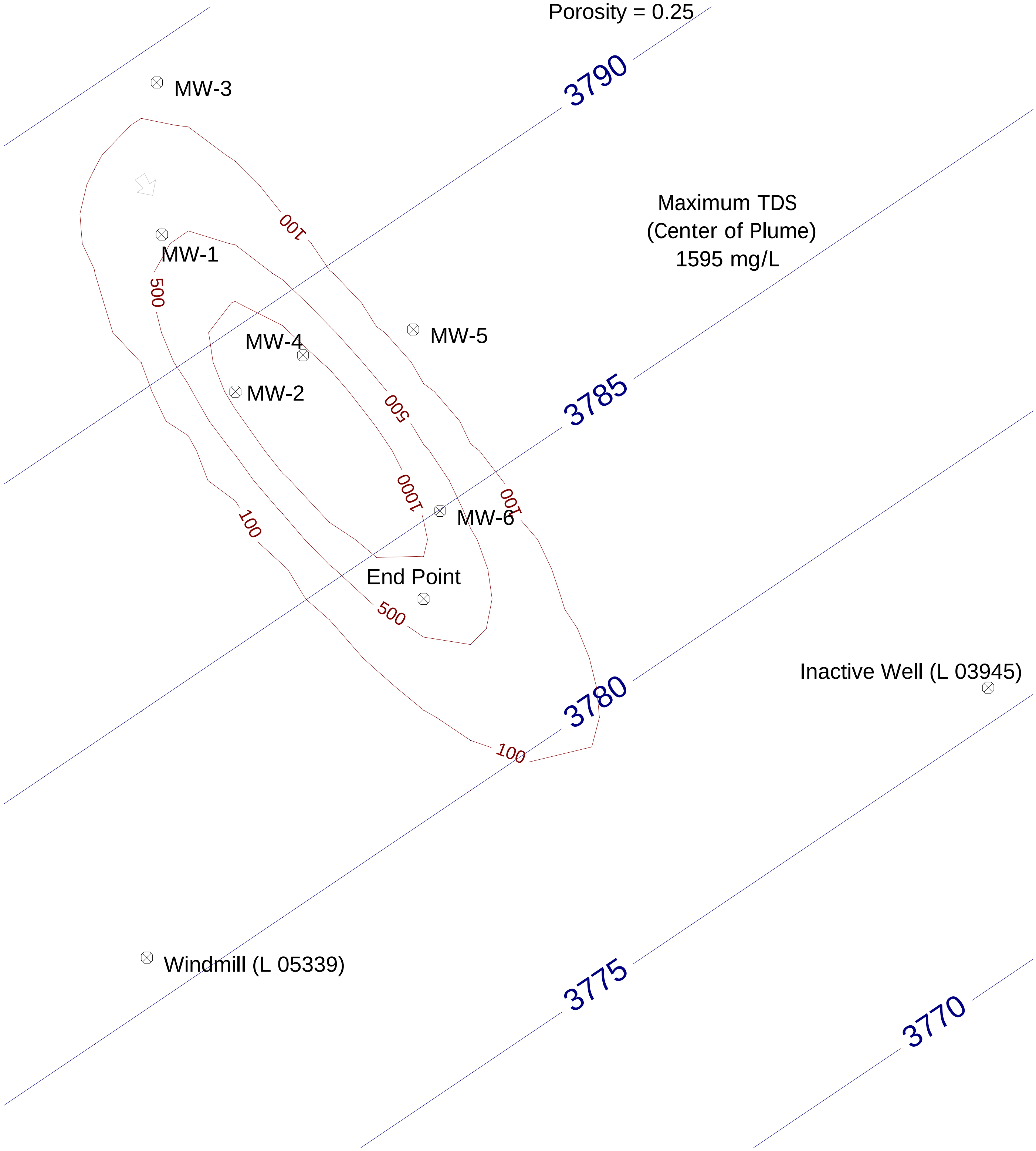
Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2040)

2000 feet

Modeling Assumptions

Hydraulic Conductivity = 1000 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



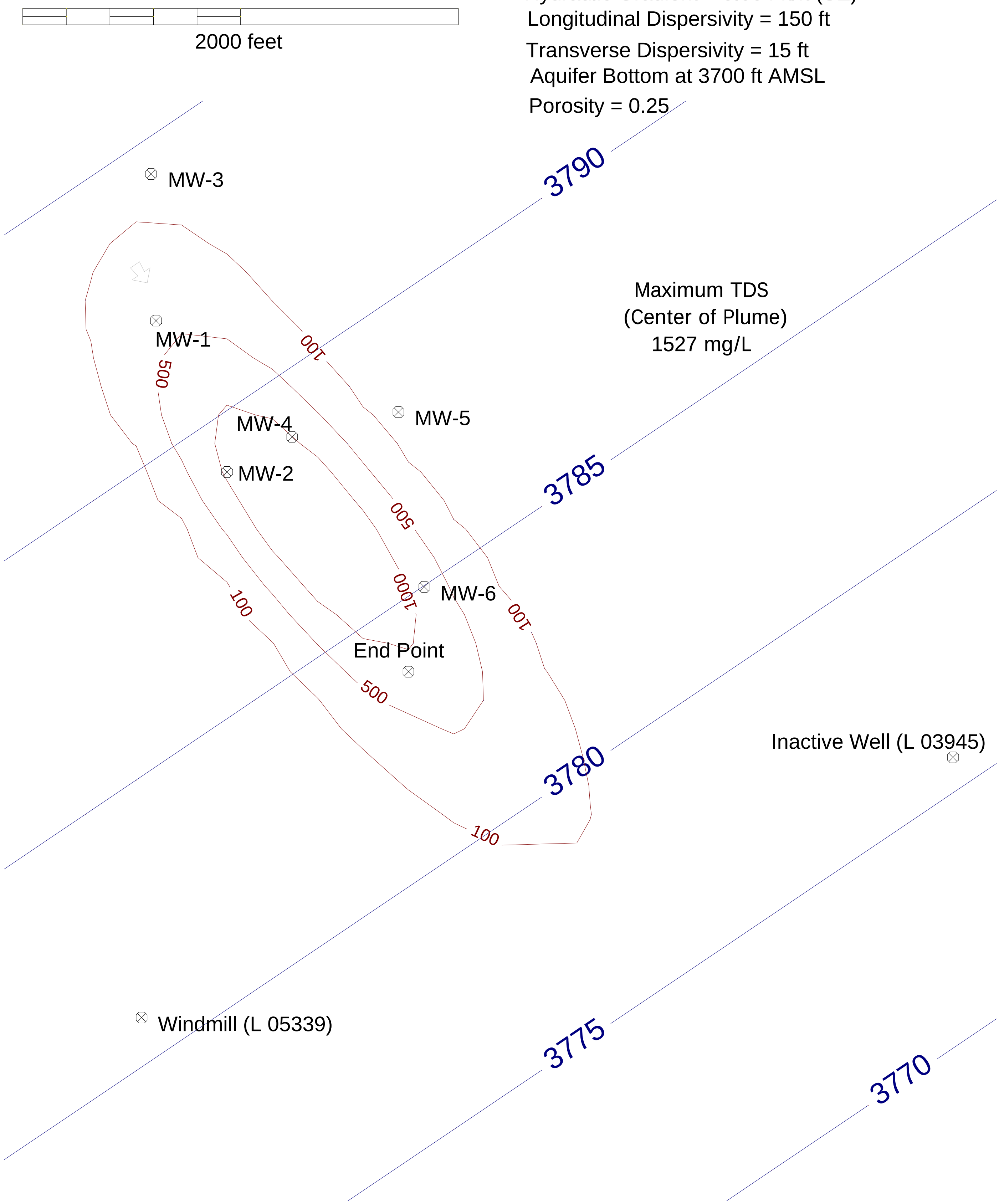
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2045)

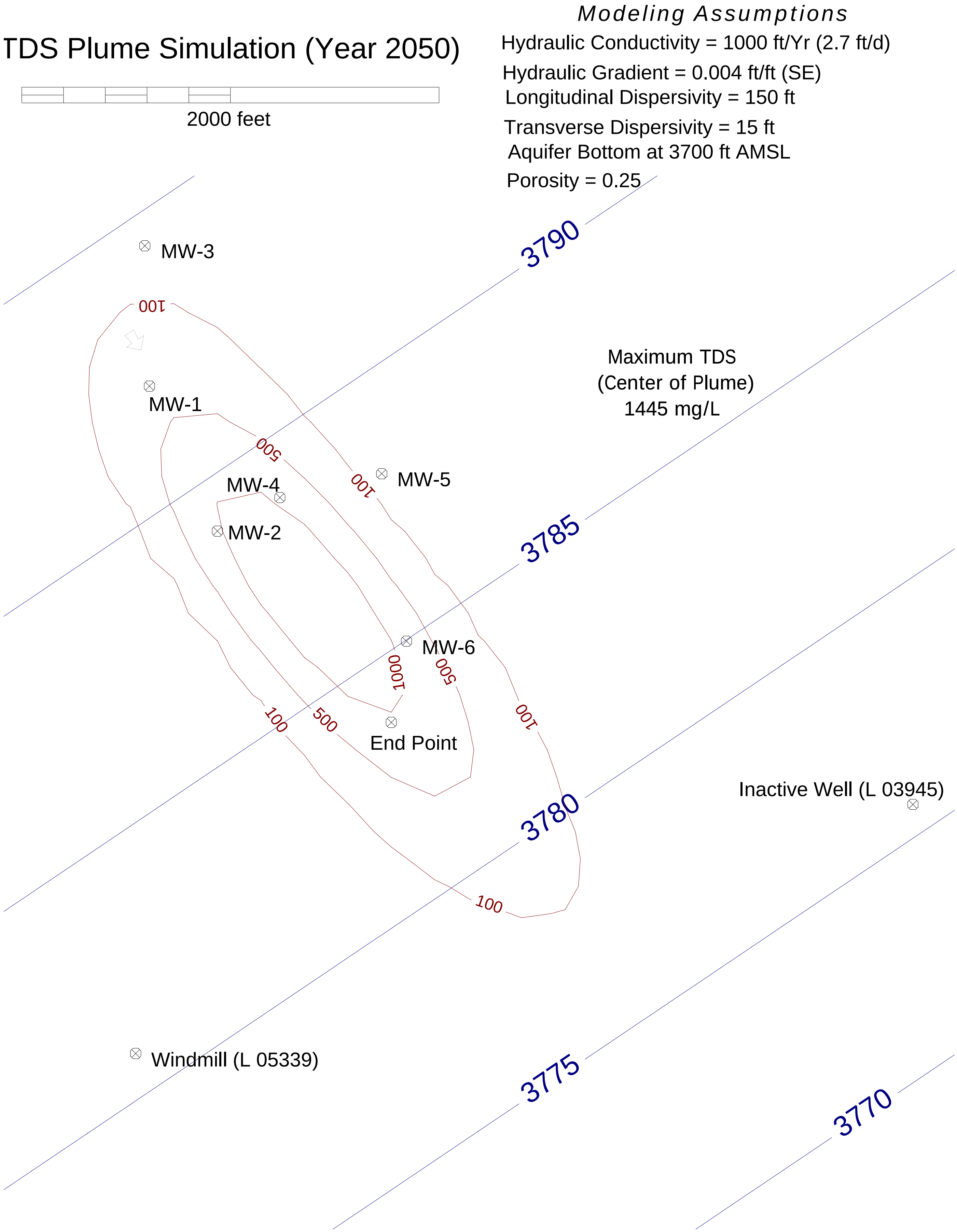
Modeling Assumptions

Hydraulic Conductivity = 1000 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



WinTran Fate & Transport Modeling Results

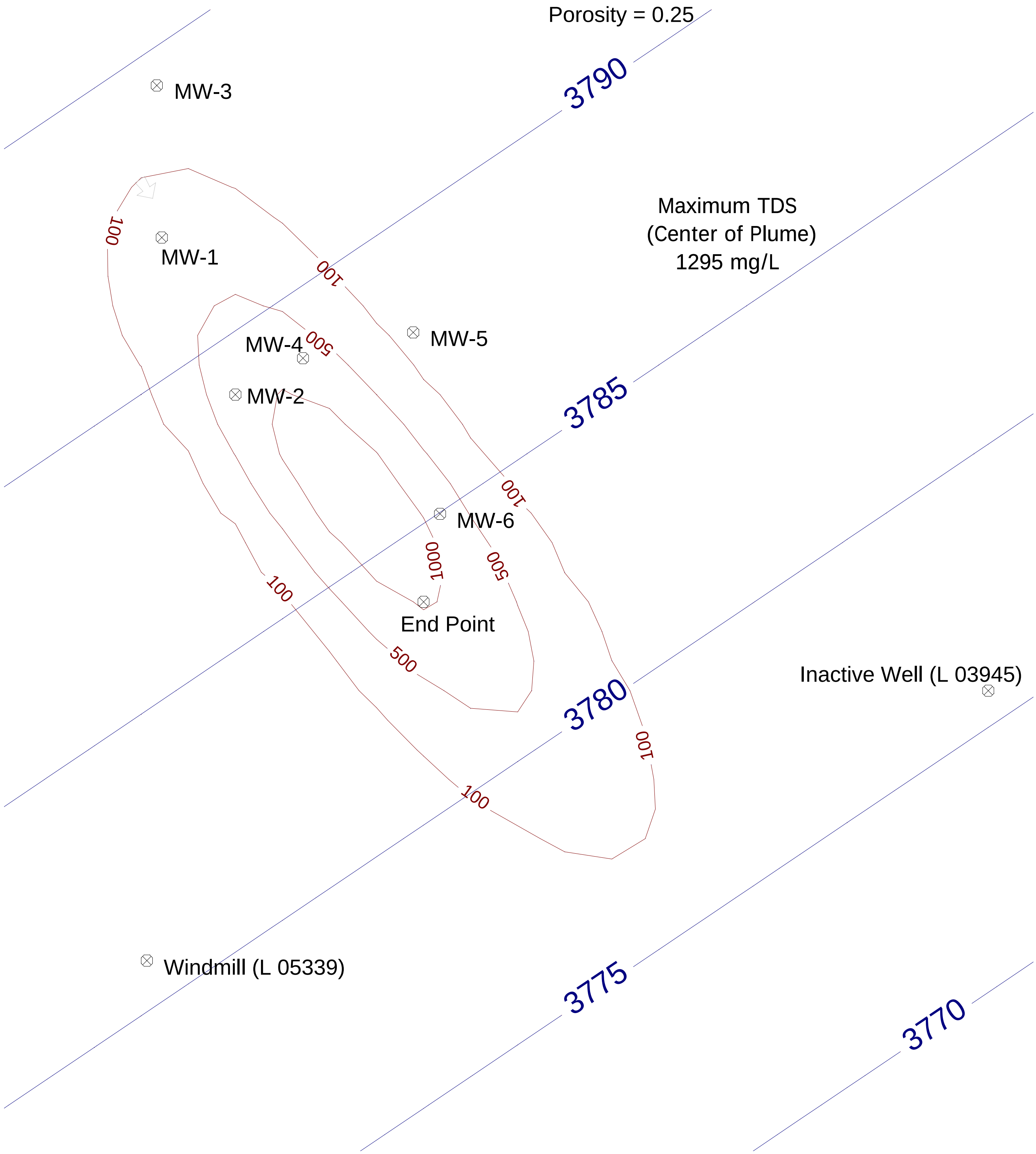
Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2060)

2000 feet

Modeling Assumptions

Hydraulic Conductivity = 1000 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



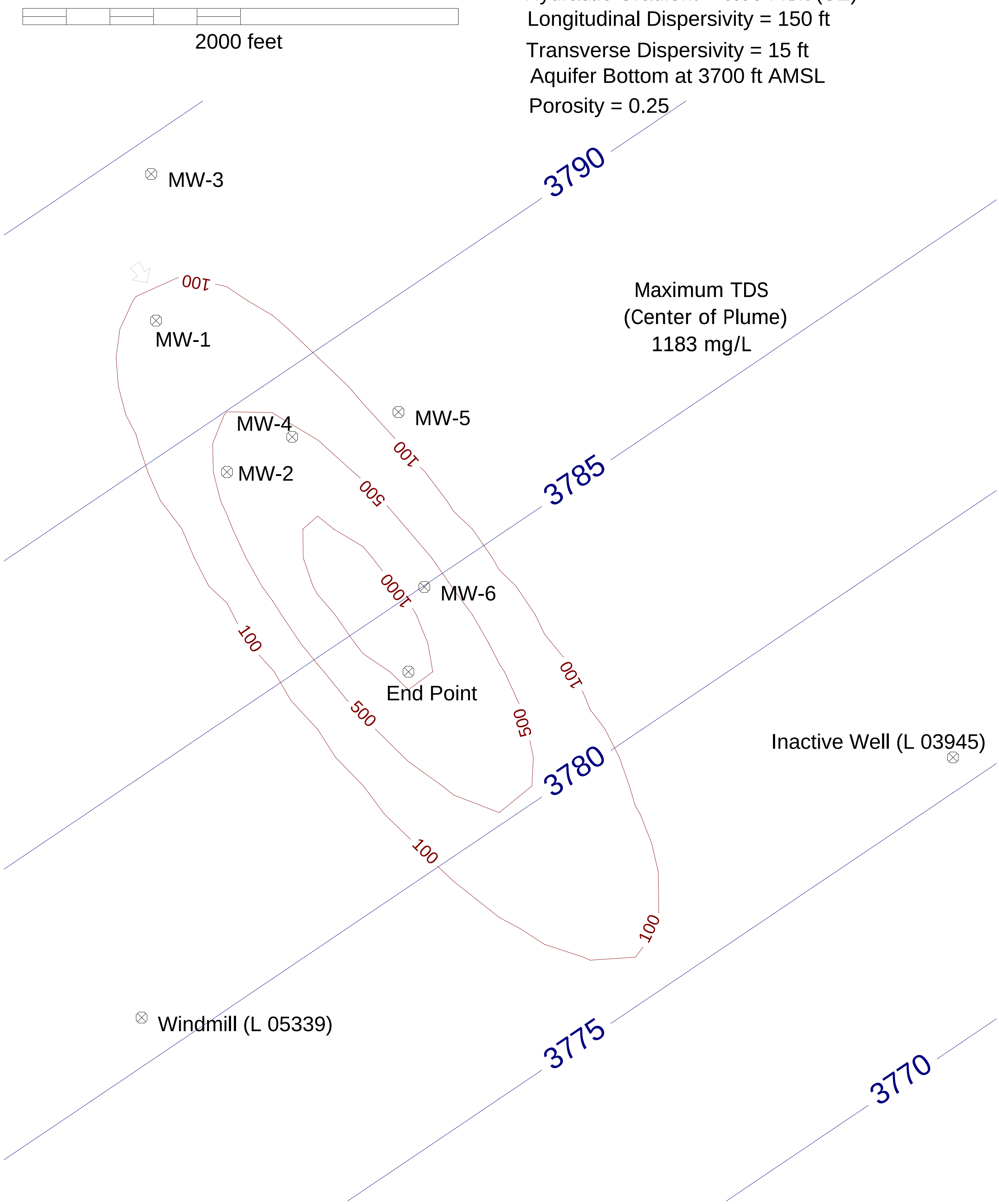
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2070)

Modeling Assumptions

Hydraulic Conductivity = 1000 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



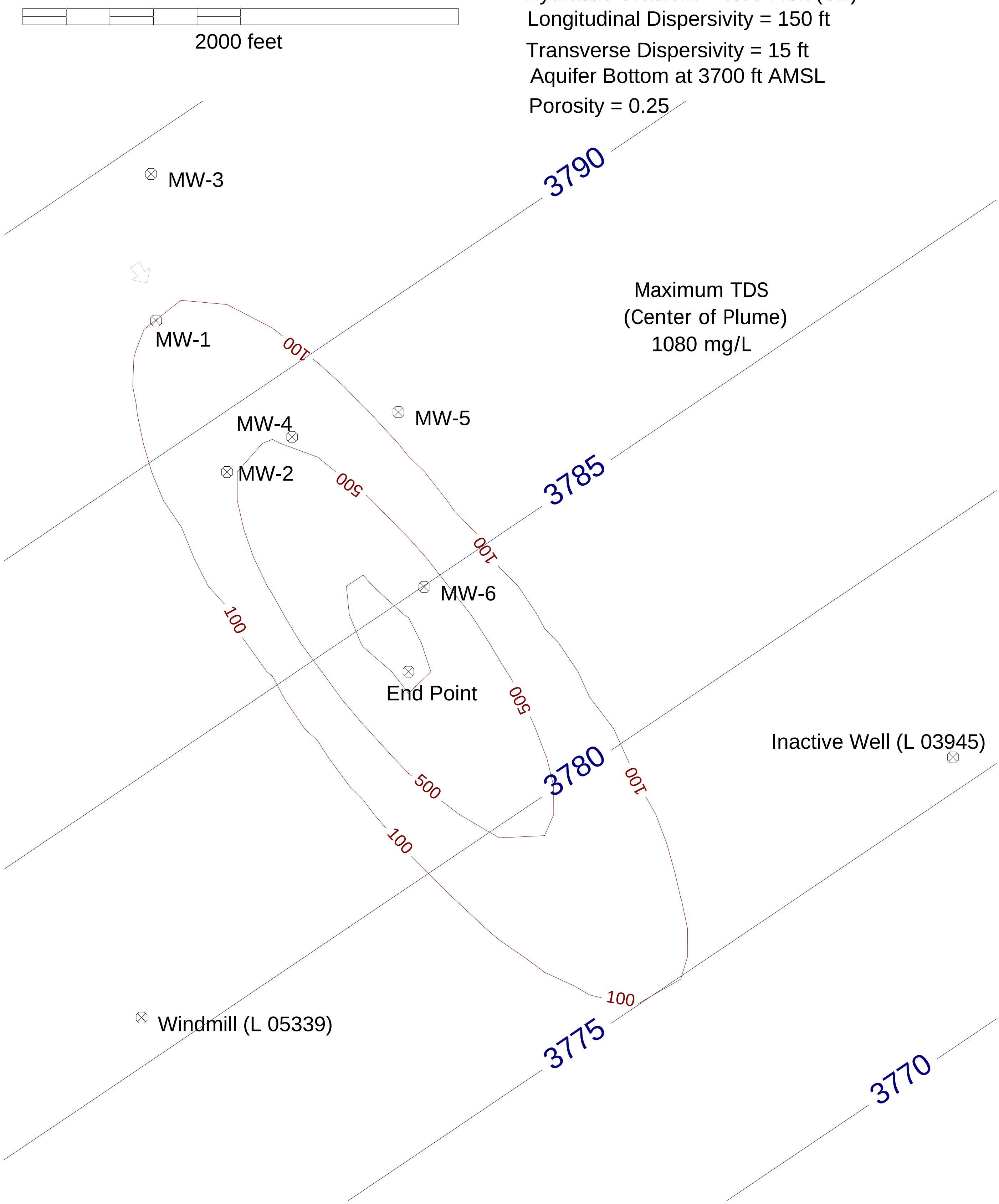
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

Modeling Assumptions

Hydraulic Conductivity = 1000 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)



WinTran Fate & Transport Modeling Results

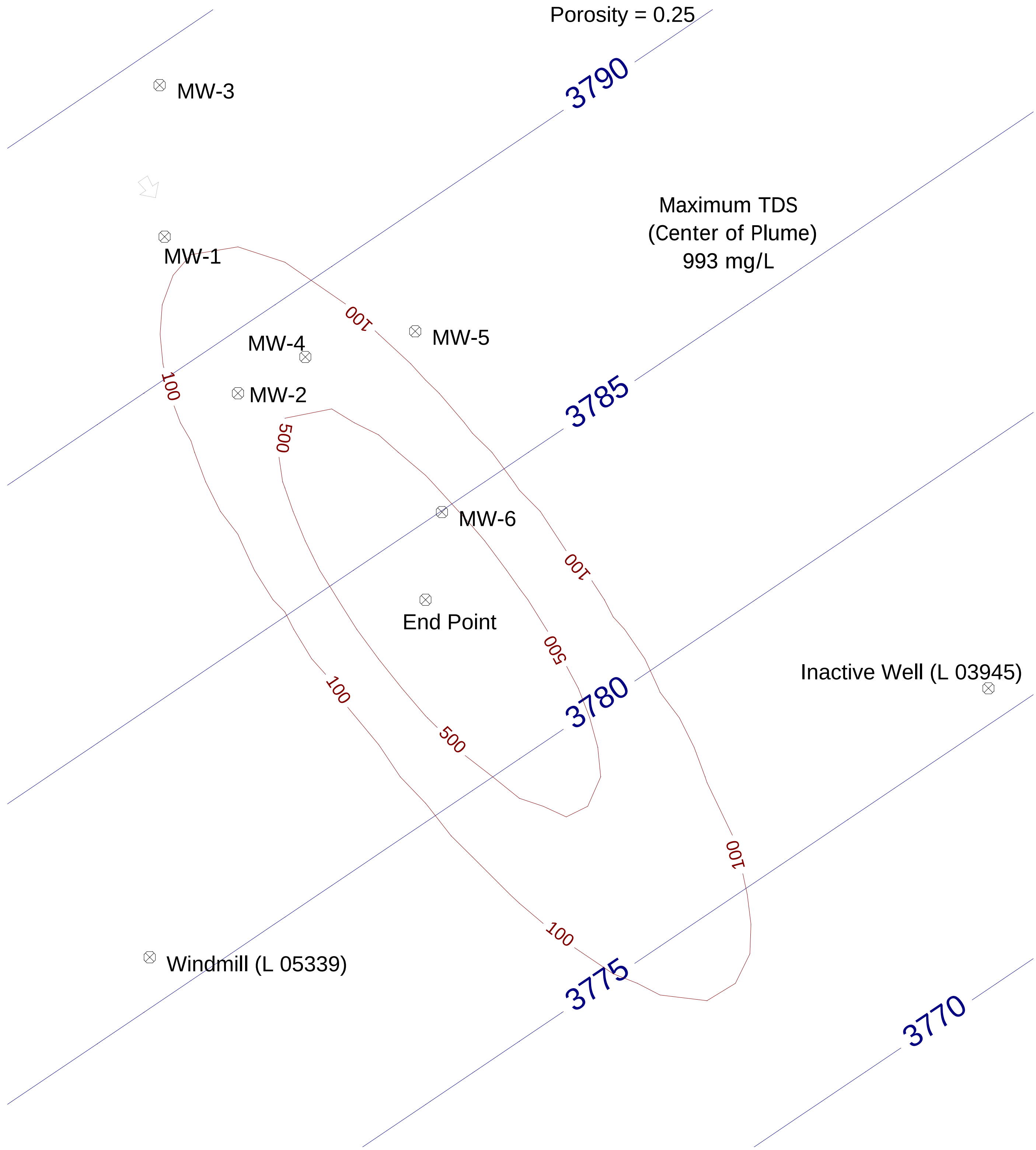
Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2093)

2000 feet

Modeling Assumptions

Hydraulic Conductivity = 1000 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



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 for a period of about 10 years. A dry hole (State Lea "I" No. 1), adjacent to the former pit, was approved for injection of produced water in 1962, however it was not used for that purpose since it was determined to be impractical; therefore it was later plugged in 1971. A chloride and TDS plume in groundwater continued to migrate southeastwards for the next approximately 29 years after the source input was stopped by encapsulation of the pit in 2000, 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 based on all site measurements reported by Trident.

- Direction of flow – measured direction of approximately 40° east of due south from 1961until 2009, and 34° east of due south from 2010 to 2013 based on 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 1000 ft/yr, or approximately 2.7 ft/day.

- Aquifer top and bottom elevations – bottom elevation of Ogallala Formation at 3700 feet according to Nicholson & Clebsch (Groundwater Report 6, 1961). The top elevation for an unconfined aquifer must be greater than the reference head so an elevation of 4,000 feet was assumed.

- Reference head – measured unconfined head of 3,793 feet adjacent to the former pit and upgradient well MW-1 from October 25, 2013 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 1,500 feet, a value of 150 feet was selected for longitudinal dispersivity. Based on professional judgment, hydrologists commonly assume the longitudinal dispersivity is about one-tenth the length of the plume and 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 October 25, 2013 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 3,700 feet) for a valid flow and transport solution.

The average groundwater velocity may be estimated using the Darcy expression: $v = (k \cdot i) / n$ 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 cannot account for the much more complex vadose zone transport algorithms, so the source input was 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 14 years (1999 to 2013) at one-year increments while matching 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 2013. 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 145 years in the future (Year 2158) produces a chloride plume center concentration of 250 mg/L (WQCC standard). 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 80 years in the future (Year 2093) produces a TDS plume center concentration of 1,000 mg/L (WQCC standard). The center of the TDS plume is approximately 2,200 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. The windmill has been dismantled and is no longer in operation due to declining water levels in the area.

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.

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

Developed by
James O. Rumbaugh, III
Douglas B. Rumbaugh

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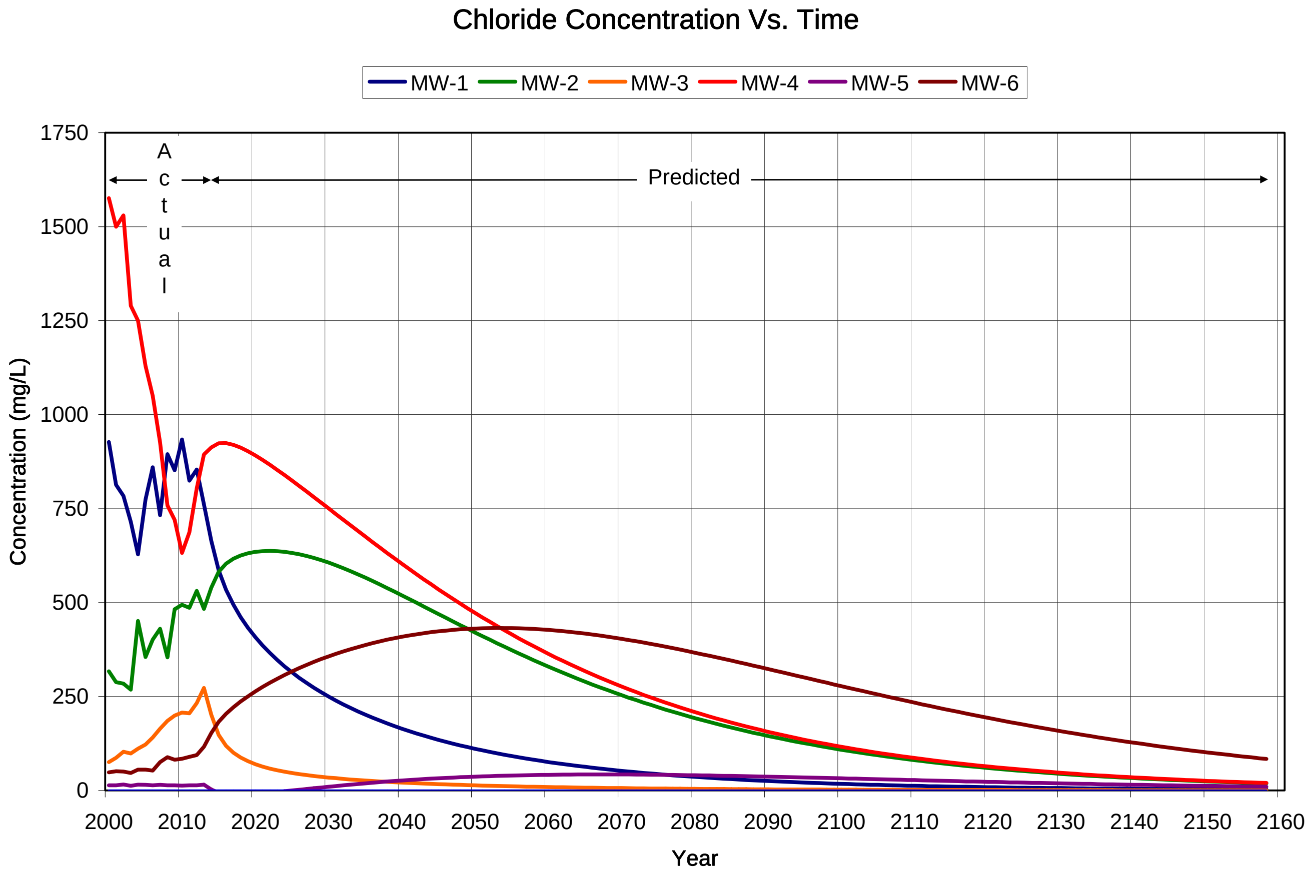
Chloride Fate & Transport Simulation run by:
Gilbert Van Deventer (Trident Environmental)

Date: 02/05/2014

Input File: 2013 CL.WTR



Model Entities	Aquifer Properties
Number of Wells = 8 MW #1 Center of Well -- x: 716.000000 y: 5281.000000 Radius = 1.000000 Pumping Rate = 0.000000 Concentration of Injected Water = 761.000000 Head at Well Radius = 3793.608913 MW #2 Center of Well -- x: 1041.670000 y: 4585.770000 Radius = 1.000000 Pumping Rate = 0.000000 Concentration of Injected Water = 483.000000 Head at Well Radius = 3790.477021 MW #3 Center of Well -- x: 694.000000 y: 5954.000000 Radius = 1.000000 Pumping Rate = 0.000000 Concentration of Injected Water = 273.000000 Head at Well Radius = 3795.896141 MW #4 Center of Well -- x: 1341.000000 y: 4747.000000 Radius = 1.000000 Pumping Rate = 0.000000 Concentration of Injected Water = 894.000000 Head at Well Radius = 3790.335273 MW #5 Center of Well -- x: 1829.000000 y: 4861.000000 Radius = 1.000000 Pumping Rate = 0.000000 Concentration of Injected Water = 15.300000 Head at Well Radius = 3789.581711 MW #6 Center of Well -- x: 1948.000000 y: 4058.000000 Radius = 1.000000 Pumping Rate = 0.000000 Concentration of Injected Water = 116.000000 Head at Well Radius = 3786.418876 Windmill (L 05339) 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 = 3782.306071 Windmill (L 03945) 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 = 3777.096595 Reference Head = 3795.000000 Defined at -- x: 490.030000 y: 5545.270000	.... 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...= 304.000000 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........= 145 Starting time value.........= 2013.000000 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..............= 2013.000000 Ending time................= 2158.000000 Number of time steps........= 145 (NOTE: following mass balance errors expressed as percent) Transport Mass Balance Error= 0.054193 Peclet Criterion...........= 1.388889 Courant Number.............= 0.045954 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 = 3738.597428 Maximum Head = 3798.498580

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)	End Point
Actual Data	2000	927	317	75.5	1576	13.7	48.0	0	0	0
	2001	813	288	86.4	1500	13.6	50.8	0	0	0
	2002	784	284	103	1530	15.5	50.0	0	0	0
	2003	715	268	98.3	1290	12.5	46.5	0	0	0
	2004	628	451	111	1250	15.3	55.1	0	0	0
	2005	774	355	122	1130	14.9	55	0	0	0
	2006	860	401	141	1050	13.3	52.4	0	0	0
	2007	732	430	164	926	14.9	75.3	0	0	0
	2008	895	354	185	758	13.6	88.5	0	0	0
	2009	852	482	199	720	13.4	81.4	0	0	0
	2010	934	494	207	632	12.6	84.1	0	0	0
	2011	824	486	205	687	13.8	89.2	0	0	0
	2012	854	531	232	804	13.8	93.8	0	0	0
	2013	761	483	273	894	15.3	116.0	0	0	0
Model Predicted Data	2014	664	540	201	913	2	153	0	0	0
	2015	586	582	147	924	-7	183	0	0	0
	2016	534	603	119	924	-10	204	0	0	0
	2017	494	616	100	920	-11	221	0	0	0
	2018	461	625	87	912	-11	236	0	0	0
	2019	433	631	77	902	-11	250	0	0	0
	2020	408	635	70	891	-9	263	0	0	0
	2021	386	637	63	879	-8	275	0	0	0
	2022	365	637	58	866	-6	287	0	0	0
	2023	347	637	54	853	-4	297	0	0	0
	2024	330	635	50	839	-2	307	0	0	1
	2025	314	632	46	825	0	317	0	0	1
	2026	300	628	43	810	2	325	0	0	1
	2027	286	624	41	795	4	334	0	0	1
	2028	273	619	38	780	6	342	0	0	1
	2029	261	613	36	765	8	349	0	0	2
	2030	250	606	34	750	10	357	0	0	2
	2031	239	599	32	735	12	363	0	0	3
	2032	229	591	31	720	13	370	0	0	3
	2033	219	583	29	705	15	376	0	0	4
	2034	210	575	28	690	17	381	0	0	4
	2035	202	566	26	676	19	387	0	0	5
	2036	193	557	25	661	20	392	0	0	6
	2037	186	548	24	646	22	396	0	0	6
	2038	178	538	23	632	23	401	0	0	7
	2039	171	529	22	617	25	405	0	0	8
	2040	164	519	21	603	26	409	0	0	9
	2041	158	509	20	589	28	412	0	0	11
	2042	152	499	19	575	29	415	0	0	12

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)	End Point
Model Predicted Data	2043	146	489	18	562	30	418	0	0	13
	2044	140	479	17	548	31	421	0	0	15
	2045	135	469	17	535	32	423	0	0	17
	2046	129	459	16	522	33	425	0	0	18
	2047	124	449	15	509	34	427	0	0	20
	2048	120	440	15	497	35	429	0	0	22
	2049	115	430	14	484	36	430	0	0	24
	2050	111	420	13	472	37	431	0	0	26
	2051	106	410	13	460	37	431	0	0	29
	2052	102	401	12	449	38	432	0	0	31
	2053	99	392	12	437	38	432	0	0	34
	2054	95	382	11	426	39	432	0	0	36
	2055	91	373	11	415	40	432	0	0	39
	2056	88	364	10	404	40	431	0	0	42
	2057	85	355	10	394	40	430	0	0	45
	2058	81	346	10	383	41	430	0	0	48
	2059	78	338	9	373	41	428	0	0	51
	2060	75	329	9	363	41	427	0	0	55
	2061	73	321	9	354	42	425	0	0	58
	2062	70	313	8	344	42	424	0	0	61
	2063	67	305	8	335	42	422	0	0	65
	2064	65	297	8	326	42	419	0	0	69
	2065	63	289	7	317	42	417	0	0	72
	2066	60	282	7	309	42	415	0	0	76
	2067	58	275	7	300	42	412	0	0	80
	2068	56	267	6	292	42	409	0	0	84
	2069	54	260	6	284	42	406	0	0	88
	2070	52	253	6	276	42	403	0	0	92
	2071	50	247	6	269	42	400	0	0	96
	2072	48	240	6	261	42	397	0	0	101
	2073	46	234	5	254	42	393	0	0	105
	2074	45	227	5	247	42	390	0	0	109
	2075	43	221	5	240	42	386	0	0	113
	2076	42	215	5	233	41	382	0	0	118
	2077	40	209	5	227	41	379	0	0	122
	2078	39	203	4	221	41	375	0	0	126
	2079	37	198	4	214	41	371	0	0	131
	2080	36	192	4	208	40	367	0	0	135
	2081	35	187	4	202	40	362	0	0	140
	2082	33	182	4	197	40	358	0	0	144
	2083	32	177	4	191	39	354	0	0	148
	2084	31	172	3	186	39	350	0	0	153
	2085	30	167	3	180	39	345	0	0	157

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)	End Point
Model Predicted Data	2086	29	162	3	175	38	341	0	0	161
	2087	28	158	3	170	38	336	0	0	166
	2088	27	153	3	165	37	332	0	0	170
	2089	26	149	3	161	37	327	0	0	174
	2090	25	145	3	156	37	323	0	0	178
	2091	24	141	3	151	36	318	0	0	182
	2092	23	137	3	147	36	314	0	0	186
	2093	22	133	2	143	35	309	0	0	190
	2094	22	129	2	139	35	305	0	0	194
	2095	21	125	2	135	34	300	0	0	198
	2096	20	122	2	131	34	296	0	0	202
	2097	19	118	2	127	33	291	0	0	206
	2098	19	115	2	123	33	286	0	0	209
	2099	18	111	2	120	32	282	0	0	213
	2100	17	108	2	116	32	277	0	0	216
	2101	17	105	2	113	32	273	0	0	220
	2102	16	102	2	109	31	268	0	0	223
	2103	16	99	2	106	31	264	0	0	226
	2104	15	96	2	103	30	259	0	0	230
	2105	14	93	2	100	30	255	0	0	233
	2106	14	91	2	97	29	251	0	0	236
	2107	13	88	1	94	29	246	0	0	238
	2108	13	85	1	91	28	242	0	0	241
	2109	13	83	1	89	28	238	0	0	244
	2110	12	80	1	86	27	233	0	0	246
	2111	12	78	1	84	27	229	0	0	249
	2112	11	76	1	81	26	225	0	0	251
	2113	11	74	1	79	26	221	0	0	253
	2114	10	71	1	76	25	217	0	0	255
	2115	10	69	1	74	25	213	0	0	257
	2116	10	67	1	72	24	209	0	0	259
	2117	9	65	1	70	24	205	0	0	261
	2118	9	63	1	68	24	201	0	0	263
	2119	9	61	1	66	23	197	0	0	264
	2120	8	60	1	64	23	193	0	0	266
	2121	8	58	1	62	22	189	0	0	267
	2122	8	56	1	60	22	185	0	0	268
	2123	8	54	1	58	21	182	0	0	269
	2124	7	53	1	56	21	178	0	0	270
	2125	7	51	1	55	21	174	0	0	271
	2126	7	50	1	53	20	171	0	0	272
	2127	7	48	1	51	20	167	0	0	273
	2128	6	47	1	50	19	164	0	0	273

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)	End Point
Model Predicted Data	2129	6	45	1	48	19	161	0	0	274
	2130	6	44	1	47	19	157	0	0	274
	2131	6	43	1	45	18	154	0	0	275
	2132	6	41	1	44	18	151	0	0	275
	2133	5	40	1	43	17	148	0	0	275
	2134	5	39	1	41	17	144	0	0	275
	2135	5	38	1	40	17	141	0	0	275
	2136	5	37	1	39	16	138	0	0	275
	2137	5	36	0	38	16	135	0	0	274
	2138	4	34	0	37	16	132	0	0	274
	2139	4	33	0	36	15	129	0	0	273
	2140	4	32	0	34	15	127	0	0	273
	2141	4	31	0	33	15	124	0	0	272
	2142	4	30	0	32	14	121	0	0	271
	2143	4	30	0	31	14	118	0	0	271
	2144	4	29	0	30	14	116	0	0	270
	2145	3	28	0	30	13	113	0	0	269
	2146	3	27	0	29	13	111	0	0	268
	2147	3	26	0	28	13	108	0	0	267
	2148	3	25	0	27	12	106	0	0	265
	2149	3	25	0	26	12	103	0	0	264
	2150	3	24	0	25	12	101	0	0	263
	2151	3	23	0	25	12	99	0	0	261
	2152	3	22	0	24	11	96	0	0	260
	2153	3	22	0	23	11	94	0	0	258
	2154	3	21	0	22	11	92	0	0	257
	2155	2	20	0	22	11	90	0	0	255
	2156	2	20	0	21	10	88	0	0	254
	2157	2	19	0	20	10	86	0	0	252
	2158	2	19	0	20	10	84	0	0	250

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

Developed by

James O. Rumbaugh, III

Douglas B. Rumbaugh

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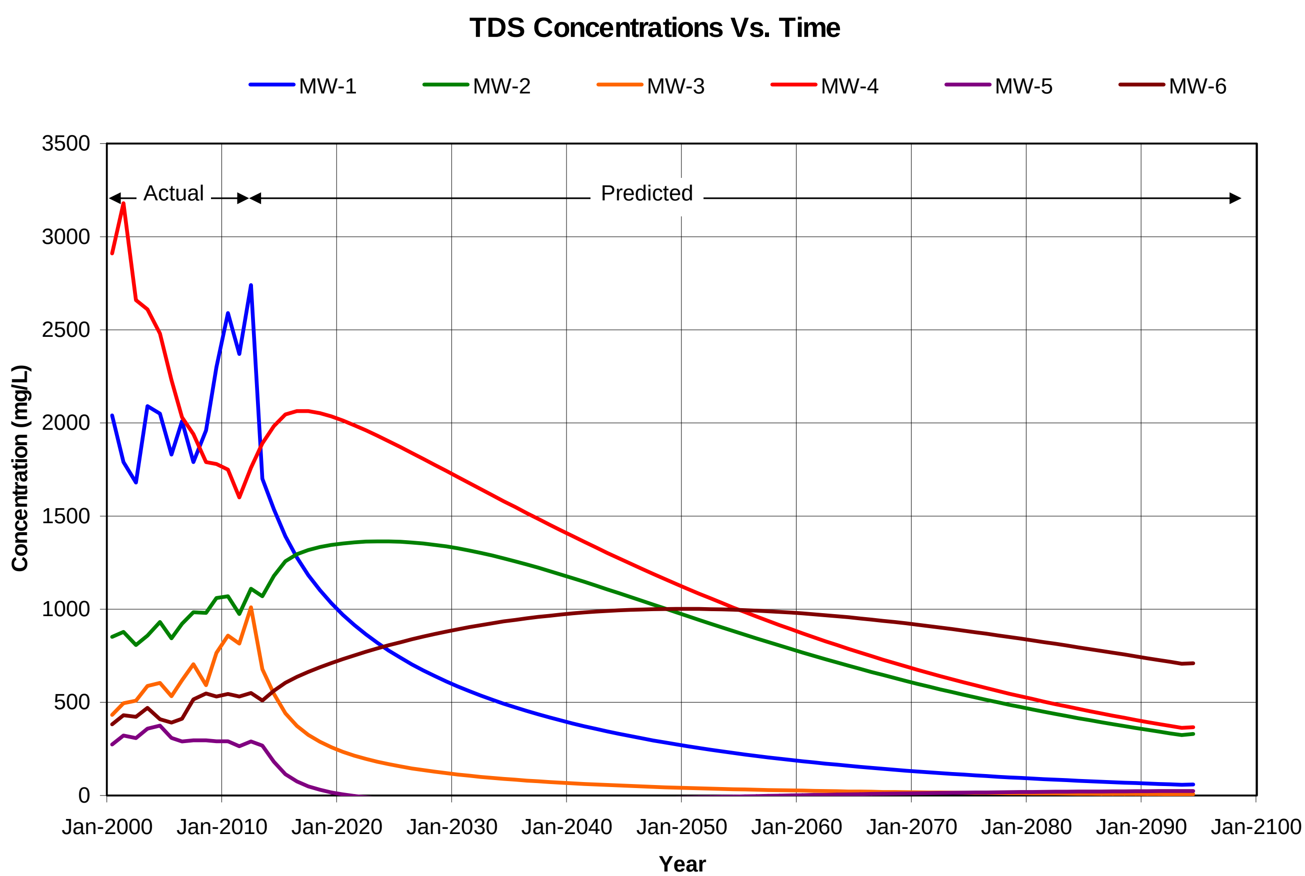
TDS Fate & Transport Simulation run by:
Gilbert Van Deventer (Trident Environmental)

Date: 02/04/2014

Input File: TDS 2013.WTR



TDS - Input Parameters for WinTran Simulation

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 = 2370.000000
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 = 974.000000
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 = 816.000000
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 = 1600.000000
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 = 265.000000
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 = 531.000000
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...= 304.000000
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........= 820
Starting time value.........= 2012.000000
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..............= 2012.000000
Ending time................= 2094.000000
Number of time steps........= 820

(NOTE: following mass balance errors expressed as percent)
Transport Mass Balance Error= 1.744046
Peclet Criterion...........= 1.388889
Courant Number.............= 0.004718
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 = 3738.597428
Maximum Head = 3798.498580

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)	End Point
Actual Data	2000	2040	852	433	2910	274	382	0	0	0
	2001	1790	878	495	3180	322	431	0	0	0
	2002	1680	808	509	2660	308	422	0	0	0
	2003	2090	859	588	2610	359	471	0	0	0
	2004	2050	931	605	2480	375	410	0	0	0
	2005	1830	844	533	2230	309	391	0	0	0
	2006	2010	922	619	2030	290	412	0	0	0
	2007	1790	984	705	1940	296	516	0	0	20
	2008	1960	980	592	1790	296	548	0	0	40
	2009	2300	1060	766	1780	291	532	0	0	40
	2010	2590	1070	859	1750	291	545	0	0	60
	2011	2370	974	816	1600	265	531	0	0	80
	2012	2740	1110	1010	1760	290	550	0	0	109
	2013	1700	1070	678	1890	268	510	0	0	183
Model Predicted Data	2014	1537	1179	546	1983	181	562	0	0	220
	2015	1392	1258	441	2045	114	606	0	0	241
	2016	1278	1296	374	2064	75	637	0	0	262
	2017	1183	1318	326	2063	49	664	0	0	283
	2018	1103	1334	289	2053	31	688	0	0	304
	2019	1033	1345	259	2035	17	711	0	0	326
	2020	971	1353	235	2013	6	732	0	0	348
	2021	915	1359	214	1988	-3	752	0	0	371
	2022	865	1363	197	1961	-9	772	0	0	394
	2023	820	1364	182	1932	-14	790	0	0	418
	2024	778	1364	168	1902	-18	807	0	0	442
	2025	740	1362	156	1871	-22	823	0	0	465
	2026	705	1358	146	1839	-24	839	0	0	489
	2027	672	1353	136	1807	-26	853	0	0	513
	2028	641	1346	128	1775	-27	867	0	0	536
	2029	613	1337	120	1742	-28	880	0	0	560
	2030	586	1327	113	1710	-29	892	0	0	583
	2031	561	1315	106	1677	-29	904	0	0	605
	2032	537	1302	100	1645	-29	915	0	0	628
	2033	514	1288	95	1612	-29	925	0	0	650
	2034	493	1273	90	1580	-28	934	0	0	671
	2035	473	1257	85	1548	-28	943	0	0	692
	2036	454	1240	80	1516	-27	951	0	0	713
	2037	436	1223	76	1485	-26	959	0	0	733
	2038	419	1205	72	1454	-25	966	0	0	753
	2039	403	1186	69	1423	-24	972	0	0	772
	2040	387	1167	65	1392	-23	977	0	0	791
	2041	372	1147	62	1362	-22	982	0	0	809
	2042	358	1127	59	1332	-21	987	0	0	827
	2043	344	1107	56	1303	-20	991	0	0	844
	2044	332	1087	54	1274	-19	994	0	0	861
	2045	319	1066	51	1245	-17	997	0	0	877
	2046	307	1046	49	1217	-16	999	0	0	892
	2047	296	1025	47	1190	-15	1000	0	0	907
	2048	285	1004	44	1162	-13	1001	0	0	922

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)	End Point
Model Predicted Data	2049	275	984	42	1136	-12	1002	0	0	936
	2050	265	963	41	1109	-11	1002	0	0	949
	2051	255	943	39	1083	-10	1002	0	0	961
	2052	246	923	37	1058	-8	1001	0	0	973
	2053	237	902	35	1033	-7	999	0	0	985
	2054	228	882	34	1008	-6	997	0	0	996
	2055	220	863	32	984	-4	995	0	0	1006
	2056	212	843	31	961	-3	992	0	0	1016
	2057	205	824	30	938	-2	989	0	0	1025
	2058	198	805	28	915	-1	986	0	0	1033
	2059	191	786	27	892	1	982	0	0	1041
	2060	184	768	26	871	2	977	0	0	1048
	2061	177	750	25	849	3	973	0	0	1055
	2062	171	732	24	828	4	968	0	0	1061
	2063	165	714	23	808	5	962	0	0	1066
	2064	159	697	22	787	6	957	0	0	1071
	2065	154	680	21	768	7	951	0	0	1075
	2066	149	663	20	748	8	944	0	0	1079
	2067	143	647	19	729	9	938	0	0	1082
	2068	138	631	19	711	10	931	0	0	1084
	2069	134	615	18	693	11	924	0	0	1086
	2070	129	600	17	675	12	917	0	0	1087
	2071	125	584	17	658	13	909	0	0	1088
	2072	120	570	16	641	14	901	0	0	1089
	2073	116	555	15	624	15	893	0	0	1088
	2074	112	541	15	608	15	885	0	0	1088
	2075	108	527	14	592	16	877	0	0	1086
	2076	105	513	14	577	17	868	0	0	1085
	2077	101	500	13	561	17	860	0	0	1082
	2078	97	487	13	547	18	851	0	0	1080
	2079	94	474	12	532	19	842	0	0	1076
	2080	91	462	12	518	19	833	0	0	1073
	2081	88	450	11	504	20	824	0	0	1069
	2082	85	438	11	491	20	814	0	0	1064
	2083	82	426	10	478	21	805	0	0	1060
	2084	79	415	10	465	21	796	0	0	1054
	2085	76	404	10	453	22	786	0	0	1049
	2086	74	393	9	440	22	776	0	0	1043
	2087	71	383	9	428	22	767	0	0	1037
	2088	69	372	8	417	23	757	0	0	1030
	2089	67	362	8	406	23	747	0	0	1023
	2090	64	353	8	395	23	737	0	0	1016
	2091	62	343	8	384	23	727	0	0	1009
	2092	60	334	7	373	24	718	0	0	1001
	2093	58	325	7	363	24	708	0	0	993
	2094	59	330	7	367	24	710	0	0	999