Revised

Additional Offsite Well Installation and Aquifer Testing Report
Lockheed Martin Corporation, Beaumont Site 2
Beaumont, California

Prepared for:

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TC# 23522-0503, 23522-0603 / October 2010

Comments from Dina Kourda, GSU		
Comment	Response	Proposed Action
Specific Comment 1. Figure 3-1: A distinct differentiation should be made between the contact linesa“fault, accur3 be Tr7-596 T5c7-55(nls T.92 re .665C)]TJ ET5(R)Tj-02 0 .0053 Tc eo13((ur3)5(be Tr7-m(R1t394 Tm [1(t))]Tp. be4 2 0		

TABLE OF CONTENTS

Section Page

LIST OF FIGURES

Page

Acronyms

af/yr	acre-feet per year
ASTM	American Society for Testing and Materials
bgs	below ground surface
CDHS	California Department of Health Services
CIMIS	California Irrigation Management Information System
DO	dissolved oxygen
DOC	dissolved organic carbon
DSI	Dynamic Site Investigation
DTSC	California Department of Toxic Substances Control
DWNL	Drinking Water Notification Level
ET	evapotranspiration
ft/day	feet per day
ft/sec	feet per second
ft^2/day	$feet^2$ per day
ft/ft	feet per foot
gpm	gallons per minute
GPS	global positioning system
HSA	hollow-stem auger
IDW	investigation-derived waste
LCS	

Section 1 Introduction

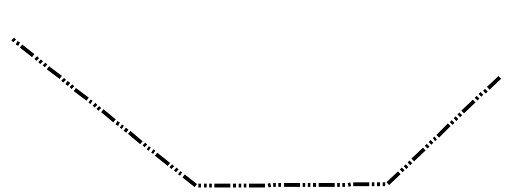
Tetra Tech, Inc. (Tetra Tech) has prepared this Additional Offsite Well Installation and Aquifer Testing Report on behalf of Lockheed Martin Corporation (LMC) for the Beaumont Jack Rabbit Trail facility (LMC Beaumont Site 2), hereinafter referred to as the Site. The Site is located southwest of the City of Beaumont, in Riverside County, California (Figure 1-1).

This report was prepared pursuant to Consent Order HSA 88/89 034 dated June 16, 1998, issued to LMC by the California Department of Health Services, Toxic Substances Control Division (CDHS; CDHS, 1989), and amended in 1991 (CDHS, 1991). The Consent Order required that LMC investigate and appropriately remediate any releases or threatened releases of hazardous substances to the air, soil, surface water, and groundwater at or from the Site.

1.1 Background

The recently-completed Draft Dynamic Site Investigation (DSI; Tetra Tech, 2009a) was conducted to characterize the nature and extent of contaminants in onsite soil and groundwater. The DSI found that two major perchlorate plumes are present in onsite groundwater: one originating in the Test Bay area, which extends approximately 2,100 feet downgradient from the source area, terminating onsite in Laborde Canyon; and one originating in the Waste Discharge Area (WDA), which extends beyond the southern boundary of the Site onto the adjacent former Wolfskill property.

Groundwater monitoring data indicates that perchlorate concentrations in shallow monitoring wells TT-MW2-7 and TT-MW2-8, located near the southern boundary of the Site (South Boundary Area; SBA), were 430 micrograms per liter (µg/L) and 290 µg/L, respectively, in May 2009 (Tetra Tech, 2010). Perchlorate was detected at 2.9 µg/L in well TT-MW2-19S, located approximately 4,200 feet south of the property boundary and was not detected in well TT-MW2-20S, located approximately 8,500 feet south of the property boundary (Tetra Tech, 2010). Two features of interest lie between the SBA and TT-MW2-19S: an area of riparian vegetation approximately 1,100 feet long located roughly 100 to 1,200 feet south of the property boundary,



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Section 2 Methodology

This investigation is one of a series of ongoing investigations that have been conducted at the Site starting in 2003. Field procedures followed in conducting the previous soil and groundwater investigations, as well as this investigation, have been previously presented in various work plans which were approved by the California Department of Toxic Substance Control (DTSC). Field activities and the corresponding DTSC-approved plans include the following:

- Drilling and soil sampling: Lockheed Martin Beaumont Site 1 and 2 Soil Investigation Work Plan (Tetra Tech, 2003).
- Groundwater monitoring well installation and development: Groundwater Monitoring Well Installation Work Plan Lockheed Martin Corporation, Beaumont Site 2 (Tetra Tech, 2006).
- Groundwater monitoring well sampling: Groundwater Sampling and Analysis Plan Lockheed Martin Corporation, Beaumont Site 2 (Tetra Tech, 2007; LMC, 2007).

2.1 Site Preparation

The following preparation activities were conducted prior to field work:

- Site Access: written permission was obtained to access the Wolfskill property for the purpose of conducting field work, in accordance with the existing access license agreement between LMC and the Western Riverside County Regional Conservation Authority.
- Utility Clearance: the proposed drilling locations were marked with stakes and white paint, and recorded using a handheld global positioning system (GPS) unit. Underground Service Alert was then contacted to perform underground utility clearance. In addition, all soil boring locations were hand-auger l.71-0.018 Tw <i 2(s-0.004 NA)2(l)-4(o)6urow(l)-2(2(ng)e)-erulrk(l)-2(10(g)10(.]TJ 0.

suspected areas of concern for Stephen's Kangaroo Rat (SKR). This included the ingress and egress routes as well as areas that would be occupied by heavy equipment during the actual field work. Prior to the beginning of field activities on each day, the biologist met workers at the entrance to the Site and escorted the drill rig and/or other equipment to the work location. At the end of each day, the biologist would escort the rig and equipment out of the work areas and remove any protective boards covering potential SKR burrows. The approved biologist also conducted pre- and post-activity burrow mapping according to Montgomery (2006) guidelines at each work location as part of the incidental take permit requirements. This study assesses the impacts of the work activities conducted at each location. The results of the study are included in the annual monitoring report submitted to the USFWS in February of each year. All onsite

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2.3 Well Installation

2.3.1 Drilling

Drilling procedures are described in Tetra Tech (2003b). Eight soil borings (designated TT-MW2-41A, TT-MW2-41B, TT-MW2-42A, TT-MW2-42B, TT-MW2-43, TT-SB2-44, TT-EW2-1, and TT-PZ2-2) were drilled at the Site between September 14 and October 13, 2009. Drilling was performed by Gregg Drilling and Testing, Inc., a California-licensed C-57 drilling contractor. The boring locations are shown in Figure 2-1, boring depths are summarized in Table 2-1.

All of the soil borings were drilled using the hollow-stem auger (HSA) method. Borings TT-MW2-41A, TT-MW2-41B, TT-MW2-42A, TT-MW2-42B, TT-MW2-43, and TT-SB2-44 are all located in a remote area accessed by a narrow foot trail. Due to access limitations, these borings were drilled using a track-mounted limited access drill rig. Borings TT-EW2-1 and TT-PZ2-1 are located in a more accessible area in the southern portion of the Site, and were drilled using a conventional truck-mounted drill rig.

2.3.2 Soil Sampling and Lithologic Logging

Procedures for collecting soil samples from HSA soil borings are described in Tetra Tech (2003). Soil samples were collected from all of the borings using conventional 18-inch long, 1.5- or 2-inch diameter split barrel samplers. Soil samples were collected at 5-foot depth intervals during drilling.

The soil borings were logged during drilling by a geologist working under the direct supervision of a California-licensed Professional Geologist. Unconsolidated materials (i.e., alluvium) were described in general accordance with the Unified Soil Classification System (USCS; American

Well ID	Date Installed	Well Type[1]	Ground Surface Elevation (feet msl)	TOC Elevation (feet msl)	Depth to Top of Screen (feet bgs)	Depth to Bottom of Screen (feet bgs)	Screen Length (feet)	Measured Depth of Well (feet toc)	Reported Depth of Borehole (feet bgs)	Borehole Diameter

2.3.3 Well Installation

Procedures for installing monitoring wells in HSA borings are described in Tetra Tech (2006). Borings TT-MW2-41A, TT-MW2-41B, TT-MW2-42A, TT-MW2-42B, TT-MW2-43, and TT-PZ2-2 were completed as 2-inch diameter monitoring wells using schedule 40 polyvinyl chloride (PVC) blank casing and 0.020-inch machine-slotted well screen. TT-MW2-41A and B and TT-MW2-42A and B are well clusters, consisting of a shallow completion (A-designated wells) screened across the water table, and a deeper piezometer (B-designated wells) with a 2-foot well screen installed at the base of shallow aquifer.

Boring TT-EW2-1 was completed as a 4-inch diameter extraction well using schedule 40 PVC blank casing and stainless steel wire-wrap screen. Prior to installing the well, sieve analyses were conducted on soil samples collected at depths of 20, 30, and 40 feet below ground surface (bgs) to evaluate the appropriate filter pack g

Construction details for the new wells are summarized in Table 2-1; well construction diagrams and copies of the sieve analysis data are provided in Appendix C.

2.3.4 Well Development

Well development procedures are described in Tetra Tech (2006). Wells TT-MW2-41A, TT-MW2-41B, TT-MW2-42A, TT-MW2-42B, TT-EW2-1, and TT-PZ2-2, and TT-EW2-1 were

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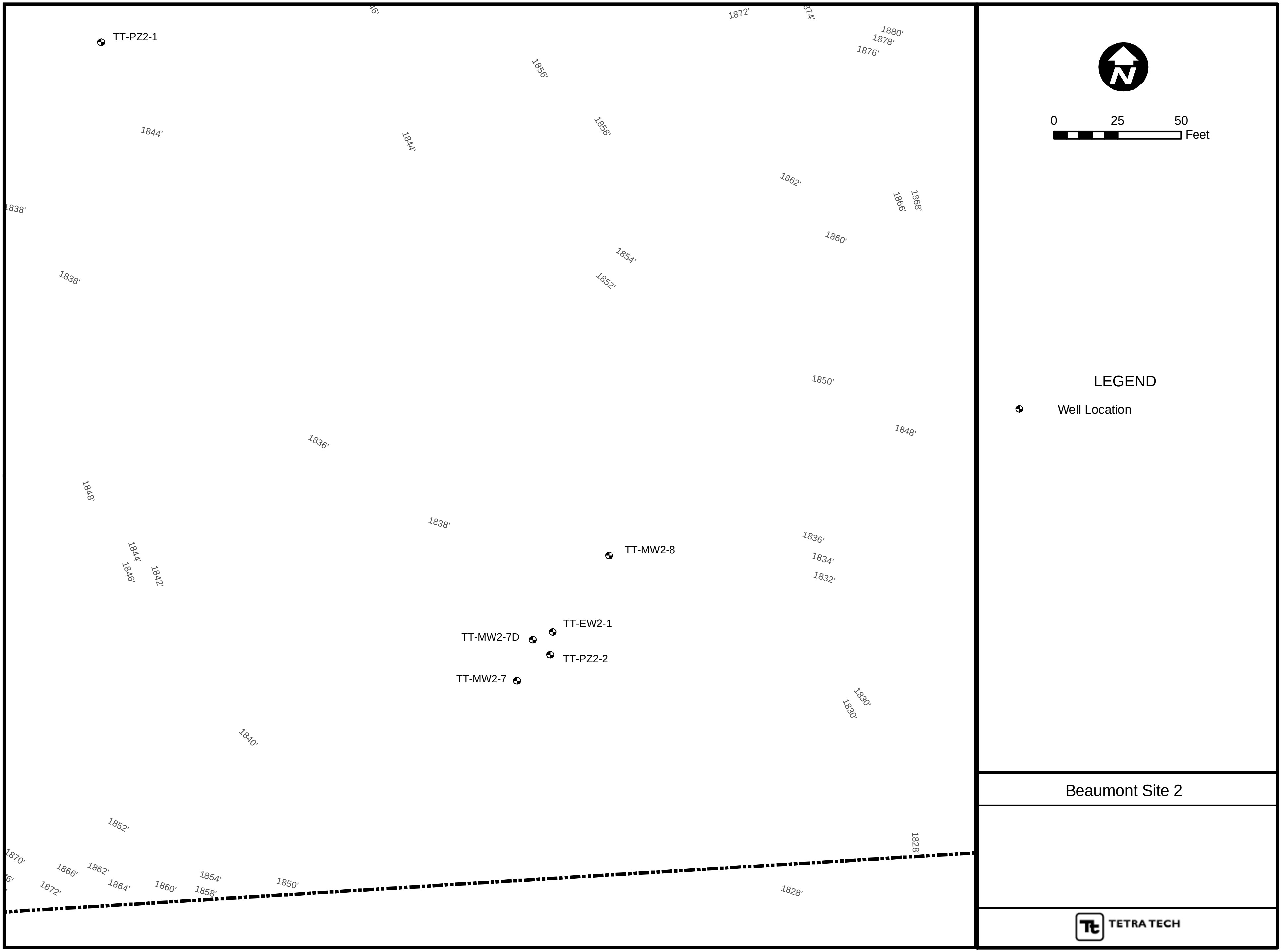


relationship that transmissivity [in feet^2 per day (ft^2/day)] equals 200 times specific capacity (gpm/ft; Dawson and Istok, 1991). Based on these

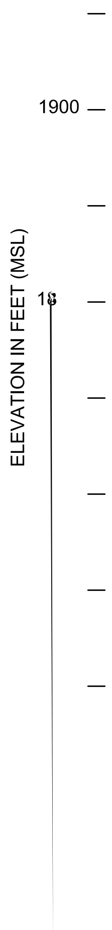
Copies of the water level records used for the ET evaluation are provided in Appendix H.

2.7 Investigation-Derived Waste

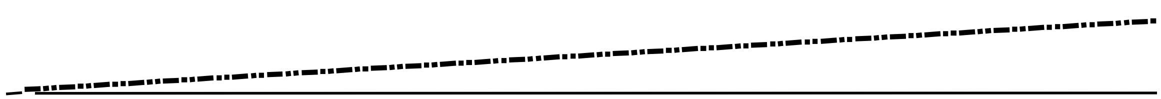
Section 3 Results

3.1 Geophysical Survey

Figure 3-1 shows the seismic profile location with respect to the fault mapped by Morton and Miller (2006). The seismic reflection profile (Appendix B) shows reflector offsets interpreted as a possible normal fault, which project to the surface approximately 240 feet from the eastern end of the profile line. The fault location, based on recent mapping of the area by Morton (presented in


1900
18
ELEVATION IN FEET (MSL)

The south boundary area is shown in more detail on Figure 3-3. Cross-section B-B' (Figure 3-4) shows the subsurface geology in the area of ETW2-1. Bedrock in this area consists of poorly indurated sandstones of the San Timoteo formation, which are overlain by alluvium consisting



Well ID	Date Measured	Measuring Point Elevation[1] (feet MSL)	Dec 2009 Depth to Water[2] (feet)	Dec 2009 Groundwater Elevation[3] (feet MSL)
Tt-MW2-1	12/01/09	2035.21	57.97	1977.24
Tt-MW2-2	12/01/09	2137.75	70.25	2067.50
Tt-MW2-3	12/01/09	2094.66	70.55	2024.11
Tt-MW2-4S	12/01/09	1986.94	50.86	1936.08
Tt-MW2-4D	12/01/09	1987.17	58.05	1929.12
Tt-MW2-5	12/01/09	1911.31	40.16	1871.15
Tt-MW2-6S	12/01/09	1908.00	36.71	1871.29
Tt-MW2-6D	12/01/09	1908.07	37.67	1870.40
Tt-MW2-7	12/01/09	1839.25	21.52	1817.73
Tt-MW2-7D	12/01/09	1838.96	19.00	1819.96
Tt-MW2-8	12/01/09	1836.32	18.21	1818.11
Tt-MW2-9S	12/01/09	1938.38	39.35	1899.03
Tt-MW2-9D	12/01/09	1938.78	43.24	1895.54
Tt-MW2-10	12/01/09	2001.57	57.83	1943.74
Tt-MW2-11	12/01/09	2004.51	49.88	1954.63
Tt-MW2-12	12/01/09	2016.26	50.85	1965.41
Tt-MW2-13	12/01/09	2049.39	66.59	1982.80
Tt-MW2-14	12/01/09	2074.78	66.31	2008.47
Tt-MW2-16	12/01/09	2137.20	62.20	2075.00
Tt-MW2-17S	12/01/09	2095.55	71.25	2024.30
Tt-MW2-17D	12/01/09	2095.33	71.45	2023.88
Tt-MW2-18	12/01/09	2035.32	57.88	1977.44
Tt-MW2-19S	12/01/09	1698.34	45.42	1652.92
Tt-MW2-19D	12/01/09	1698.37	26.36	1672.01
Tt-MW2-20S	12/01/09	1587.77	34.54	1553.23
Tt-MW2-20D	12/01/09	1587.48	33.79	1553.69
Tt-MW2-21	12/01/09	1978.45	66.32	1912.13
Tt-MW2-22	12/01/09	1975.86	65.14	1910.72
Tt-MW2-23	12/01/09	1995.17	82.94	1912.23
Tt-MW2-24	12/01/09	1964.26	53.78	1910.48
Tt-MW2-25	12/01/09	1966.96	63.96	1903.00
Tt-MW2-26	12/01/09	1944.43	38.19	1906.24
Tt-MW2-27	12/01/09	1948.27	50.25	1898.07

82.94Tt- T* [(S/09.27)-t-MW

Table 3-1
Groundwater Elevations, December 2009

Well ID	Date Measured	Measuring Point Elevation[1] (feet MSL)	Dec 2009 Dpth to Water[2] (feet)	Dec 2009 Groundwater Elevation[3] (feet MSL)
Tt-MW2-31A	12/01/09	2036.11	58.86	1977.25
Tt-MW2-31B	12/01/09	2036.15	66.61	1969.54
Tt-MW2-32	12/01/09	2004.87	53.69	1951.18
Tt-MW2-33A	12/01/09	2070.54	61.22	2009.32
Tt-MW2-33B	12/01/09	2070.54	65.95	2004.59
Tt-MW2-33C	12/01/09	2070.54	64.05	2006.49
Tt-MW2-34A	12/01/09	2066.84	65.97	2000.87
Tt-MW2-34B	12/01/09	2066.85	73.15	1993.70
Tt-MW2-34C	12/01/09	2066.84	74.77	1992.07
Tt-MW2-35A	12/01/09	2003.20	49.59	1953.61
Tt-MW2-35B	12/01/09	2003.20	55.05	1948.15
Tt-MW2-36A	12/01/09	2100.99	79.01	2021.98
Tt-MW2-36B	12/01/09	2101.04	79.78	2021.26
Tt-MW2-36C	12/01/09	2100.88	79.76	2021.12
Tt-MW2-37A	12/01/09	1963.62	63.25	1900.37
Tt-MW2-37B	12/01/09	1963.67	71.26	1892.41
TT-MW2-38A	12/01/09	2084.56	59.48	2025.08
TT-MW2-38B	12/01/09	2084.42	81.45	2002.97
TT-MW2-38C	12/01/09	2084.63	88.90	1995.73
TT-MW2-39	12/01/09	2079.53	61.95	2017.58
TT-MW2-40A	12/01/09	2096.28	72.48	2023.80
TT-MW2-40B	12/01/09	2096.24	83.82	2012.42
TT-MW2-40C	12/01/09	2096.28	88.88	2007.40
Tt-MW2-41A	12/01/09	1812.47	23.90	1788.57
Tt-MW2-41B	12/01/09	1812.22	21.06	1791.16
Tt-MW2-42A	12/01/09	1799.06	28.02	1771.04
Tt-MW2-42B	12/01/09	1799.07	25.60	1773.47
Tt-MW2-43	12/01/09	1771.44	Dry	Dry

data review documents from the United States Environmental Protection Agency (USEPA) (USEPA, 2008; USEPA, 2005).

Holding times, field blanks, laboratory control samples (LCS), method blanks, duplicate environmental samples, spiked samples, and surrogate and spike recovery data were reviewed. For each environmental sample, the sample-specific quality control spike recoveries were examined. These data examinations include comparing statistically calculated control limits to percent recoveries of all spiked analytes and duplicate spiked analytes. Relative percent difference (RPD) control limits are compared to actual matrix spike/matrix spike duplicate (MS/MSD) RPD results. Surrogate recoveries were examined for all organic compound analyses and compared to their control limits.

Environmental samples were analyzed by the following methods: Method E332.0 for perchlorate, Method SW8260B for volatile organic compounds (VOCs), Methods SW8270C for 1,4-dioxane, Method E521 for low level N-nitrosodimethylamine (NDMA), Method SM5310 for total and dissolved organic carbon, (TOC and DOC respectively), Methods SW6010B and E200.7 for metals, Method E300.0 for nitrate and chloride, Method AM23G for volatile fatty acids, and Method RSK-175 for ethane, ethene, and methane. Unless discussed below, all data results met required criteria, are of known precision and accuracy, did not require any qualification, and may be used as reported.

- Method SW8260B for VOCs had one detection of methylene chloride in the associated trip blank. Blank contamination caused 0.4 percent of the total SW8260B data to be qualified for blank contamination. The blank-qualified data should be considered not detected.

- Method E521 for low level NDMA had one holding time error that qualified as estimated 16.7 percent of the total E521 data. The data qualified as estimated are usable for the intended purpose.

- Method SM5310B for total and dissolved organic carbon had field duplicate RPD errors that qualified as estimated 16.7 percent of the total SM5310B data. The data qualified as estimated are usable for the intended purpose. Blank contamination caused 8.3 percent of the total SM5310B data to be qualified for blank contamination. The blank-qualified data should be considered not detected.

- Method AM23G for volatile fatty acids had LCS and matrix spike errors that qualified as estimated 3.7 percent of the total AM23G data. The data qualified as estimated are usable for the intended purpose. Blank contamination caused 9.3 percent of the total AM23G data to be qualified for blank contamination. The blank-qualified data should be considered not detected.

- Method RSK-175 for methane, ethane, and ethane had methane blank contamination that caused 11.1 percent of the total RSK-175 data to be qualified for blank contamination. The blank-qualified data should be considered not detected.

The validated, positively detected analytical results are summarized in Table 3-2 and Table 3-3. Complete validated analytical results are tabulated in Appendix J, copies of the laboratory reports are provided in Appendix K.

3.4.2 Perchlorate

Analytical results for perchlorate are summarized in Table 3-2. Perchlorate was detected in monitoring well TT-MW2-41A at concentrations of 0.66 µg/L and 0.36 µg/L in October and November, 2009, respectively. Perchlorate was not detected in monitoring well TT-MW2-42A during either sampling event. Perchlorate was detected in extraction well TT-EW2-1 at a concentration of 2.6 µg/L prior to the aquifer test, and at a concentration of 5.4 µg/L immediately following the aquifer test. All of the perchlorate detections were below the California Maximum Contaminant Level (MCL) of 6 µg/L.

The analytical results for perchlorate in TT-EW2-1 (2.6 and 5.4 µg/L) are significantly lower than for nearby wells TT-MW2-7 and TT-MW2-8 (430 and 290 µg/L, respectively, May 2009). These concentration differences may be related to well construction: TT-EW2-1 is screened across the entire 20 foot thickness of the shallow aquifer, whereas TT-MW2-7 and TT-MW2-8 are screened only in the upper 5 to 8 feet of the aquifer (Figure 3-4). The observed differences in perchlorate concentration between TT-EW2-1, TT-MW2-7, and TT-MW2-8 suggest that perchlorate-M3-ble6TJ 0 Tc 0 Tw he

Well No.	Date Sampled	Perchlorate[1] (µg/L)	Methylene Chloride[2] (µg/L)	1,4-Dioxane[3] (µg/L)	NDMA[4] (µg/L)
California MCL		6	5	-	-

							Acetic Acid	Butyric Acid	Hexanoic Acid	i-Hexanoic Acid	Lactic Acid and HIBA	Pentanoic Acid	i-Pentanoic Acid	Propionic Acid	Pyruvic Acid	Ethene	Ethane	Methane	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/L)	Ferrous Iron (mg/L)	Sulfide (mg/L)
	10/21/2009	1.2	1.7	4.1	<0.11	130	0.077	<0.006	4.5 Jc	<0.018	0.47 Jd	<0.016	0.11	<0.002	<0.026	0.52	0.06 Jq	1.1	63.3	1.09	0.21	0.1
	11/23/2009	1.6	11	11	0.34	130	0.052 BJkq	<0.006	<0.007	<0.018	0.23 Bk	<0.016	<0.032	<0.002	<0.026	0.53	0.11	1.2	-35.3	0.65	0.33	0.41
	10/22/2009	2.3	2.1 Bk	0.23	<0.11	57	0.088 Ba	<0.006	2.3	<0.018	<0.042	<0.016	<0.032	<0.002	<0.026	0.33	0.43	4.6	54.9	1.1	0.00	0.02
	11/23/2009	0.74 Ba	8.2	0.28	<0.11	46	0.11	<0.006	<0.007	<0.018	0.4	<0.016	<0.032	<0.002	<0.026	0.18	0.32	3.6	-6.1	0.93	0.03	0.03
TT-EW2-1	10/23/2009	0.61 Jq	0.76 Jf	0.39	<0.11 Jep	140	0.11 Bk	<0.006	<0.007	<0.018	<0.042	<0.016	<0.032	<0.002	<0.026	0.04 Jq	0.04 Jq	0.86 Bk	73.8	5.11	0.06	0.03

Notes:
mg/L: milligrams per liter.
µg/L: micrograms per liter

Data Qualifiers:
J: The analyte was positively identified, but the analyte concentration is an estimated value.

3.4.6 Monitored Natural Attenuation Parameters

The monitoring wells were also analyzed for several indicators of natural attenuation, including total and dissolved organic carbon, iron, nitrate, sulfate, volatile fatty acids, and dissolved gases (ethane, ethene, and methane). In addition, sulfide and ferrous iron were analyzed in the field using test kits, and field measurements of oxidation/reduction potential (ORP) and dissolved oxygen (DO) were collected during well purging. The results of the natural attenuation parameter analyses are provided in Table 3-3.

The October 2009 DO and ORP measurements for wells TT-MW2-41A, TT-MW2-42A [illegible]

Table 3-4
Summary of Slug Test Results

Well	Hydraulic Conductivity (ft/day)		
	Falling Head[1]	Rising Head[2]	Average[3]
Tt-MW-2-7	0.042	0.038	0.040
Tt-MW2-7D	0.090	0.079	0.08
Tt-MW2-8[4]	0.50	0.49	0.49
Tt-MW2-41A	0.00051	0.0040	0.0023
Tt-MW2-42A	0.065	0.043	0.054

Notes:
1. Data collected during falling-head (slug-in) phase of test.
2. Data collected during rising-head (slug-out) phase of test.
3. Mean of hydraulic conductivity values for falling- and rising-head tests.
4. Hydraulic conductivity values for slug tests considered upper bound because semi-log slope decreases with time.

		Transmissivity (ft^2/day)	Storativity	Transmissivity (ft^2/day)	Storativity
P	10.90	0.63	NA	0.90	NA
R	10.90	0.53	NA	0.75	NA
P	3.40	1.4	1.7E-03	1.6	2.0E-03
R	3.37	1.2	1.7E-03	1.2	2.3E-03
P	0.05	83	5.9E-02	50	8.6E-02
R	0.03	79	1.2E-01	36	1.6E-01
P	0.44	7.9	4.5E-03	8.3	2.6E-03
R	0.39	11	2.3E-03	10	3.2E-03

wells except for TT-PZ2-

aquifer transmissivity and hydraulic conductivity due to more intense weathering of the San Timoteo formation toward the center of Laborde Canyon.

Aquifer storativity values for wells showing a strong drawdown response (TT-EW2-1, TT-PZ2-2, and TT-MW2-8) range from 0.0019 to 0.0031, which most likely reflects semi-confined conditions since these storage values would represent an aquifer specific yield less than 0.5 percent. These results are generally consistent with the hydrogeologic model.

3.6 Evapotranspiration Assessment

A portion of the water level record for well TT-MW2-42A is provided in Figure 3-6. Figure 3-6 shows that water levels fluctuate approximately 0.03 to 0.08 feet on a daily basis, with decreasing water levels during the day and recovering levels at night. These diurnal water level fluctuations are consistent with groundwater ET. This interpretation is supported by the presence of obligate phreatophyte species (e.g., cottonwood and willow)

from the water level fluctuation data. Specific yield has not been directly measured in each of the wells; however, specific yield has been estimated to be 5 to 15 percent based on the observed soil types and the site water balance. Specific yield can also be indirectly evaluated using ET rates measured from at the nearby California Irrigation Management Information System (CIMIS; California Department of Water Resources, 2009) monitoring station at the University of California, Riverside (UCR) as follows (Lewis et al., 2002):

$$Sy = ET / (24r + s) \quad \text{Equation 3-2}$$

The specific yield values estimated from Equation 3-2 range from 9 to 12.5 percent, in fairly good agreement with the range of specific yield values estimated above.

The water level fluctuation data measured at the Site (Appendix H) were used with Equations 3-1 and 3-2 to estimate the ET rates in the riparian area south of the property boundary during October 2009. The results of this evaluation are shown in Figure 3-7. Also shown on Figure 3-7 are reference ET rates for the UCR CIMIS station. CIMIS stations are automated weather stations which are placed over a standard, well-watered grass surface. The weather stations collect data for a variety of weather parameters related to ET, including solar radiation, air temperature, relative humidity, and wind speed. These data are used to model reference ET rates for the standard grass crop. Actual ET values for a specific plant in the same microclimate as the CIMIS station may be calculated by multiplying the reference ET by a crop coefficient. The trends in the ET rates derived from the groundwater data are generally consistent with the UCR CIMIS site ET measurements. There is more variation in the ET rates estimated from the Site groundwater level fluctuations than those measured at the UCR site, similar to observations at other locations (e.g., Lewis et al., 2002). The Site ET rates are approximately one-half of those measured at the UCR CIMIS site.

The ET rates derived from the water level fluctuation data, combined with the presence of obligate phreatophyte species, the shallow depth to groundwater, the presence of deep-rooted plants, and the upward vertical hydraulic gradients strongly suggest that ET is removing groundwater from the shallow aquifer in the riparian area. Long-term annual average ET rates for the Site are likely to be roughly one-half of the 56.37 inches per year long-term annual average rate for the UCR CIMIS monitoring station, or approximately 28.2 inches per year. ET rates at specific locations are likely to depend upon depth to groundwater, with higher ET rates in areas with shallower groundwater.

Section 4 Updated Conceptual Site Model

4.1 Extent of Perchlorate in Groundwater

concentrations of perchlorate detected in surface water, surface water flow is not considered to be

4.2 Groundwater Underflow at the Site Boundary

Underflow in the shallow aquifer at the southern boundary of the Site under current conditions can

4.3 Perchlorate Mass Flow at the Site Boundary

The perchlorate mass flow (M) across the southern property boundary can be estimated from the underflow calculated estimate above and the average concentration (C) of perchlorate in the shallow water-bearing zone, using the mass balance equation:

$$M = Q \times C \text{ (equation 4-3)}$$

where M is the mass flow of perchlorate, Q is the underflow estimated in Section 4.2, and C is the average concentration of perchlorate in the shallow aquifer.

In May 2009, perchlorate concentrations in wells near the southern property boundary were approximately 430 µg/L in TT-MW2-7 and 290 µg/L in TT-MW2-8. Both of these wells are screened across the uppermost portion of the shallow-water-bearing zone, and, as previously noted, may not be representative of the average perchlorate concentration in the shallow-water-bearing zone. Much lower perchlorate concentrations were observed in TT-EW2-1, ranging from 2.6 µg/L prior to the aquifer test to 5.2 µg/L immediately following the aquifer test. Well TT-EW2-1 is screened across the entire shallow aquifer. As previously noted, the differences in perchlorate concentration between wells TT-MW2-7, TT-MW2-8, and TT-EW2-1 may appear to be related to vertical heterogeneity in the distribution of perchlorate within the shallow aquifer.

For the purpose of estimating the offsite mass flow, three values were assumed for the average perchlorate concentration in the shallow aquifer: the concentration detected in TT-EW2-1 after the pumping test (5.2 µg/L), the geometric mean of the perchlorate concentrations in TT-MW2-7, TT-MW2-8, and TT-EW2-1 (88 µg/L), and the maximum concentration detected at the Site (430 µg/L in TT-MW2-7). The calculations were performed for the full range of underflow estimates (0.12 to 0.62 gpm).

The resulting estimate of the perchlorate mass flow ranges from 0.0028 to 0.014 pounds per year (lbs/yr) for the low concentration estimate of 5.2 µg/L, 0.048 to 0.24 pounds per year for the intermediate concentration estimate of 88 µg/L, and 0.24 to 1.2 lbs/yr for the upper bound concentration estimate of 430 µg/L.

Section 5 Conclusions and Recommendations

5.1 Conclusions

The conclusions of this investigation are as follows:

- Perchlorate concentrations in shallow groundwater appear to attenuate to near non-detectable concentrations within several hundred feet of the southern Site boundary. Low perchlorate concentrations detected in MW2-19S, located further to the south, appear to represent a discontinuous, "stranded" segment of the perchlorate plume. The stranded segment is likely related to intermittent flow within more conductive alluvial sediments during periods when groundwater levels are higher than currently observed.
- Average aquifer transmissivity in the SBA is approximately 2 ft^2/day. Transmissivity

- There does not appear to be a need for an accelerated remedial response to control offsite perchlorate migration at this time. This recommendation is based on the limited extent of the offsite perchlorate plume, the relatively low perchlorate concentrations detected in the offsite area, the low groundwater velocity and perchlorate mass flow at the site boundary, and evidence for naturally-occurring perchlorate phytoremediation and bioreduction in the offsite riparian area. Possible remedial actions in the SBA will be considered further in the Feasibility Study and Remedial Action Plan for the Site.