TECHNICAL MEMORANDUM
LOCKHEED MARTIN CORPORATION

December 11, 2009

TO: Mr. Gene Matsushita

FROM: Mr. Robert Johns

RE: Beaumont Site 1 Numerical Transport Model Development (EESHRLP02179_R605) Plume/COC Conceptual Model Technical Memorandum

EXECUTIVE SUMMARY

This technical memorandum (TM) summarizes Tetra Tech's efforts to develop and document a groundwater plume/contaminant of concern (COC) conceptual model for Lockheed Martin Corporation Beaumont Site 1, Beaumont, California. This TM is the first deliverable for this task order and was undertaken to construct a numerical groundwater transport model for the LMC Beaumont Site 1 Area. This TM utilizes some of the contaminant mass and mass flux information presented in an earlier site TM (Tetra Tech, 2009c).

Key elements of the groundwater plume/COC conceptual model include all aspects of the flow conceptual model given in the recent site groundwater flow model report, as well as the following transport components of the conceptual model:

- Contaminants of Concern – The COCs are perchlorate, 1,4-dioxane, 1,1-DCE, and TCE. There is generally one distinct plume at Site 1 that covers 278 acres. The estimated dissolved mass in groundwater of all COCs in the groundwater plume is 3,925 to 5,943 pounds, with perchlorate accounting for 3,400 to 5,100 pounds; 1,1-DCE accounting for 310 to 500 pounds; TCE accounting for 250 to 370 pounds; and 1,4-dioxane accounting for 100 to 150 pounds. In addition to the mass in groundwater, there is another 1,500 pounds of perchlorate in soils, but no 1,4-dioxane, 1,1-DCE, and TCE are present in soils. Statistical analysis of COC time trends confirms the observation that the overall extent and magnitude of the plume is relatively unchanged over the nearly 20 year monitoring period, though there is a small reduction in plume mass near the RMPA groundwater extraction and treatment system.
- COC Transport – The primary pathway for contaminant migration in groundwater appears to be the coarse-grained, high permeability alluvium/weathered Mount Eden that is primarily located at depth and in the center of valleys. The COCs are generally restricted to the alluvium and weathered Mt. Eden. Groundwater velocity is typically 600 feet per year within the main plume area, such that transport times are approximately 12 years across the 7,200 foot long plume. The maximum COC groundwater underflow rates across the entire plume width are approximately 30-40 pounds per year for 1,1-DCE; 20-30 pounds per year for TCE; 200-400 pounds per year for perchlorate; and 8-12 pounds per year for 1,4-dioxane.
- COC Source Areas – There are soil sources of perchlorate in the BPA and RMPA, containing approximately 1,500 pounds of perchlorate and releasing approximately 100 pounds per year of perchlorate into the groundwater. Calculations suggest that the perchlorate in soils may be enough to explain the perchlorate currently found in groundwater, but that remains somewhat uncertain and will be explored further in this study. There is one minor soil source of TCE in the BPA,

containing approximately 7 pounds of TCE and releasing approximately one-third of a pound per year of TCE into the groundwater. No soil sources are present for 1,4-dioxane and 1,1-DCE. There is a likely groundwater source in the BPA where contaminants are slowly leached by groundwater at rates of approximately 14 pounds per year of 1,1-DCE; 11 pounds per year of TCE; 3 pounds per year of 1,4-dioxane; and 46 pounds per year of perchlorate. There is a possible groundwater source in the RMPA where contaminants are slowly leached by groundwater at rates of approximately 4 pounds per year of 1,1-DCE; 5 pounds per year of TCE; 1.4 pounds per year of 1,4-dioxane; and 15 pounds per year of perchlorate.

- COC Fate Mechanisms – Evapotranspiration and degradation appear to be the dominant COC fate mechanisms, with evapotranspiration accounting for the loss of 50 to 80 percent of the COCs and degradation accounting for the loss of 10 to 40 percent of the COCs. The highest loss due to degradation is for perchlorate, which completely disappears from the plume in portions of the riparian area.

This CSM and completed mass flux budget will serve as a guide for the transport modeling effort.

An approach for developing the numerical transport model is proposed, including defining the model layering, plume extent, boundary conditions, stresses, transport properties, and calibration. Key elements of the numerical transport model approach include the following:

- Four layers with a grid block size of 35 feet, similar to the flow model;
- COC sources from the BPA and RMPA soils for perchlorate only, and the BPA groundwater for all COCs;
- COC sinks that will consist primarily of evapotranspiration and degradation, with smaller impacts from extraction when pumping wells are active and stream discharge;
- Transport model calibration covers 1992-2008, to evaluate whether model transport properties and source release rates are consistent with historical monitoring data that show quasi-steady state plume conditions during this period; and
- Primary transport model calibration targets will be the COC concentrations measured in the site monitoring program during the 1992 through 2008 period. A secondary calibration target will be the site mass flux budget given in the conceptual model.

1.0 BACKGROUND AND OBJECTIVES

The objective of task order EESHRLP02179_R605 is to develop a numerical groundwater transport model for the Lockheed Martin Corporation (LMC) Beaumont Site 1, Beaumont, California. More detailed objectives of the modeling task include the following:

- Develop a conceptual model of the plume and contaminants of concern (COCs);
- Quantify components of the COCs mass flux budget;
- Develop a calibrated numerical groundwater transport model; and
- Utilize the calibrated groundwater transport model to evaluate and aid in the design of groundwater remediation measures at the site.

The first deliverable for this task order is to complete a technical memorandum (TM) summarizing the plume/COC conceptual model, which will serve as a basis for constructing the numerical transport model and for evaluating groundwater remedial strategies at Beaumont Site 1.

This technical memorandum summarizes Tetra Tech's efforts to develop and document a groundwater plume/COC site conceptual model for the LMC Beaumont Site 1 Area. The conceptual model was developed based upon modeling guidance given in ASTM reports (ASTM D 5447-93; ASTM D 5609-94; ASTM D 5490-93; ASTM D 6170-97e, ASTM D 5891) and groundwater modeling guides (Anderson and Woessner, 1992). Per the project workplan, this Conceptual Model TM is submitted for LMC approval prior to construction of the numerical transport model.

Background

The groundwater conceptual model was recently updated in the recent groundwater numerical flow model task (Tetra Tech, 2009b). Key flow-related elements of the conceptual model include the following:

- Groundwater occurs in four primary units: shallow low permeability Quaternary alluvium, deep high permeability Quaternary alluvium/weathered Mount Eden, the competent Mount Eden Formation, and the granitic basement (Figures 1 and 2). The basement rocks provide a base for the shallow water bearing groundwater in the alluvium and weathered Mount Eden, since groundwater in the basement rocks is confined and only found in weathered or fracture zones;
- A small unconfined alluvial basin is found in Bedsprings Creek Valley near the confluence of Potrero and Bedsprings Creeks, with a 100-200 foot thick sequence of saturated recent alluvium located between the Potrero and Bedsprings Faults. All alluvial groundwater eventually discharges to Potrero Creek as the alluvium pinches out against the Mount Eden, although this pinchout occurs downgradient of the extent of the plume as defined by the COC MCLs;
- Groundwater flow is generally consistent with the direction of surface water flow and topography, with flow to the northwest at a gradient of 0.002 through the Bedsprings Creek alluvium turning southwest through the canyon at a gradient of 0.01 to 0.02 (Figure 3). There are downward vertical gradients in the alluvium in the southeast of the site where there is recharge, and there are upward vertical gradients in the alluvium in the northwest and west of the site where there is discharge to the riparian area and to Potrero Creek. There are significant fluctuations of groundwater levels on a seasonal basis in the burn pit area, which have the potential to impact continuing source releases. A small artesian zone with heads above ground surface occurs in the area with upward vertical gradients near the confluence of Bedsprings and Potrero Creeks, associated with the partial barrier effect of the faults in the area;
- Hydrologic Boundaries for the alluvium (Figure 4) are primarily no-flow conditions where the alluvium pinches out at the perimeter of the valley; a leakage boundary at the base of the alluvium; a flow recharge boundary along and under Bedsprings Creek; a flow discharge boundary along Potrero Creek; and partial flow barrier boundaries across Potrero Fault.;
- Aquifer hydraulic conductivity values are from 1 to 30 feet per day for the alluvium. Hydraulic conductivity values vary with depth and have a geometric mean of 4 feet per day for the shallow alluvium; 22 feet per day for the deep alluvium; 0.1 foot per day for the competent Mount Eden Formation; and 0.01 foot per day for the granite. Hydraulic conductivity values also vary by area, with the highest values between the RMPA and BPA and low values below the RMPA. Aquifer transmissivity values are roughly 1,500 ft^2 per day in the deep high permeability alluvium; 150 ft^2 per day in the shallow low permeability alluvium; and 20 ft^2 per day in the wells screened in the competent Mt Eden. Model transmissivity values are 20 ft^2 per day in the BPA, 1,500 ft^2 per day in the area between the RMPA and BPA, 100 to 500 ft^2 per day in the lower RMPA, and 2,500 ft^2 per day in middle Potrero Creek. A high model transmissivity in the area between the BPA and RMPA coincides with the flat gradients and thicker alluvium observed in this area; and

- During the 1992-2008 period (Figure 5), total recharge to the alluvium is estimated to be 246 acre feet per year with 110 acre feet per year due to diffuse recharge over the valley floor and 136 acre feet due to recharge from creeks. During the 1992-2008 period, total discharge from the alluvium is estimated to be 218 acre feet per year with 139 acre-feet per year due to evapotranspiration from the riparian area, 71 acre feet per year due to discharge to Potrero Creek, and 8 acre feet per year due to leakage down into the Mt Eden. During the 1992-2008 period, aquifer storage also increased by 28 acre feet per year.

The reader is referred to the recent flow model report for more details and supporting information on the groundwater conceptual model.

This memorandum presents a plume/COC conceptual model based upon the recently completed flow conceptual model. The plume/COC conceptual model includes all flow-related elements of the groundwater conceptual model, as well as the definition of soil source areas contributing COCs to groundwater, the definition of other sources of COCs inflow and loss, and the definition of the high permeability pathways acting as conduits for plume migration. To extend this plume/COC conceptual model to a numerical transport model, the memorandum also presents the proposed approach to modeling the plume, including layering, the plume extent, boundary conditions, aquifer stresses, initial ranges for transport properties, and the approach to calibration.

2.0 PLUME/COC CONCEPTUAL SITE MODEL

This section proposes a groundwater plume/COC conceptual model that is consistent with the available site data and the requirements for the numerical transport modeling task. Figures 2 and 6 through 9 show cross-sections and contour maps to support and illustrate the following text description of the conceptual model. The reader is also referred to prior site reports (Tetra Tech, 2009a, and 2009b) for additional supporting information on the groundwater conceptual model.

The plume/COC conceptual model of the study area was formulated based on interpretations of the assembled reports and information, the flow conceptual model given in the groundwater model report (Tetra Tech, 2009b), and some of the contaminant mass and mass flux information presented in an earlier site TM (Tetra Tech, 2009c). A summary of the transport aspects of the plume/COC conceptual model is as follows:

- Contaminants of Concern – The Contaminants of Concern (COCs) are perchlorate, 1,4-dioxane, 1,1-DCE, and TCE (Tetra Tech, 2009a). There are also minor amounts of cis-1,2-DCE, 1-1,DCA, 1,2-DCA, and 1,1,1-TCA present. At Site 1, 1,1,1-TCA was originally considered a COC, but the concentrations of 1,1,1-TCA quickly declined to trace levels in the early 1990s. Since the loss of 1,1,1-TCA from the plume also was coincident with increases in 1,1-DCE plume concentrations, and the transformation of 1,1,1-TCA to 1,1-DCE is a documented attenuation route for 1,1,1-TCA, the loss of 1,1,1-TCA is attributed to this fate mechanism. Total VOC concentrations and mass in the Site 1 plume are currently dominated by TCE and 1,1-DCE; other VOCs such as 1,1,1-TCA, 1,1-DCA and 1,2-DCA contribute very little to the current groundwater VOC mass.
- Contaminant Distribution –Maps depicting the distribution of site contaminants are given for the alluvium/weathered Mount Eden in Figures 6 through 9 (Tetra Tech, 2009a and 2009c). There is generally one distinct plume at Site 1 that covers approximately 278 acres, although the plume area does vary by COC due the varying concentrations and MCLs of the COCs. There are also small portions of the Site 1 plume that appear as separate islands of contamination further down Potrero Creek near wells MW-14, MW-18, and MW-70. However, this generally occurs as portions of the single Site 1 plume increase and decrease relative to the MCL, with trace levels of

COCs generally found between the main plume and the smaller plume bodies. However, additional sources are also present downgradient of the main COC plume, such as a significant soil source of perchlorate present at the F-33 site which impacts MW-70, and this also impacts the plume shape. The highest concentrations of contaminants have consistently been reported in groundwater samples collected from shallow screened wells located in the former BPA, and concentrations appear to rapidly decrease down gradient of the footprint of the former BPA. Although the lateral concentration trends are fairly well defined by the monitoring network and aquifer system boundaries, the vertical concentration trends are less well known, especially at areas without vertically paired wells. The vertical distribution of contaminants and plume thickness in groundwater was estimated by comparing COC data from vertically paired wells. The top of groundwater contamination typically occurs at the water table, with contamination typically decreasing with depth. An exception is in the riparian area, where deep well concentrations are either the same as or even higher than shallow wells. The COCs are generally restricted to the alluvium and weathered Mt. Eden, except in the BPA where sporadic detections of trace contamination may extend into bedrock. Estimates show the plume thickness generally ranges from 25 to 90 feet (Figure 10). Outside the BPA, contamination is generally not observed in the competent Mount Eden and granite formations (Tetra Tech, 2008 and 2009a). Contour maps of site contaminants are not given for the Mount Eden or granite because of the limited data; the large number of non-detects; and the general lack of a spatial trend in these units. Contamination observed in the weathered Mount Eden formation is lumped with the alluvium (Tetra Tech, 2009a). The plume maps given in Figures 6 through 9 reflect the highest concentration observed at any depth – or a depth maximum value. While Figures 6 through 9 are good depictions of the plume concentration for the entire saturated plume thickness in the riparian areas and the RMPA, they are somewhat higher than the concentration observed at depth in the BPA where there is a more distinct trend in concentrations versus depth. Appendix A gives separate COC plume contour maps for the shallow and deep alluvium/weathered Mount Eden that will be used in the transport modeling effort.

- Contaminant Migration Pathway – The primary pathway for contaminant migration in groundwater appears to be the coarse-grained, high permeability alluvium/weathered Mount Eden that is primarily located at depth and in the center of valleys. The Potrero Fault acts to restrict groundwater and plume migration. However, based upon COC detections in groundwater downgradient of the fault, the Potrero Fault is only a partial barrier to COC migration.
- Groundwater Velocity – Groundwater velocity values are estimated from the product of the hydraulic gradient and hydraulic conductivity divided by effective porosity. The aquifer effective porosity is estimated to be 10 percent, or approximately equal to the aquifer specific yield value in the recent Site 1 transient groundwater flow model calibration (Tetra Tech, 2009b). The hydraulic gradient for Site 1 varies from values of 0.002 to 0.015, with smaller values in the upper portion of the plume in Bedsprings Creek and larger values in Potrero Creek. The hydraulic conductivity for alluvium/weathered Mount Eden varies from 1 to 30 feet per day, with larger values in the upper portion of the plume in Bedsprings Creek and smaller values in the riparian area. The hydraulic gradient and hydraulic conductivity values in the recent groundwater model were used with the effective porosity to calculate groundwater velocity values. Groundwater velocity varies from 400 to 2,000 feet per year, but is typically 600 feet per year within the main plume area. Therefore, groundwater transport times are approximately 12 years across the 7,200 foot long plume. These groundwater velocity and transport time values are generally consistent with the observed length of the plume, the elapsed time since contaminant release, and other aspects of the conceptual model (Tetra Tech, 2009c).

- Contaminant Velocity –The groundwater contaminant velocity is equal to the groundwater velocity divided by the contaminant retardation factor. The retardation factor is assumed to be equal to one for all COCs. While this is a good assumption for perchlorate and 1,4-dioxane, it may be too low for the chlorinated organics (TCE and 1,1-DCE), which can adsorb onto organic carbon in the aquifer solids. This is likely to be most important in the riparian areas where aquifer organic carbon content may not be negligible (Tetra Tech, 2009c). However, since most of the high concentration areas of the Site 1 plume are in the BPA and RMPA above the riparian areas, the assumption of a retardation factor equal to one may not have that large of an influence on the mass of the plume. However, a TCE and 1,1-DCE retardation factor greater than one in the riparian area could have an impact on fate as TCE and 1,1-DCE migrate through the riparian areas into Potrero Creek. Estimates of the aquifer organic carbon content are not currently available, and this is identified as a data gap with recommended data collection for the next wells drilled at the site. For the purposes of this study, it is assumed the retardation factor is equal to 1 for the VOCs due to the low organic carbon content expected for deep groundwater systems in arid environments.
- Contaminant Time Trends – As given in Table 1, time trends in contaminant data for the entire site period of record from August 1986 through June 2009 were evaluated using groundwater quality statistical analysis methods (Tetra Tech 2008). Note that due to more limited sampling for perchlorate and 1,4-dioxane, the perchlorate and 1,4-dioxane period of record is effectively shorter than for the other contaminants. Time trends for the entire period show 43 percent of the data show predominantly a “stable” trend, 28 percent of the data show “no predominant trend”, 25 percent of the data show predominantly a “decreasing” trend, and only 4 percent of the data show predominantly an “increasing” trend. The statistical analysis confirms the observation that the overall extent and magnitude of the plume is relatively unchanged over the nearly 20 year monitoring period. The one major exception is 1,1,1-TCA, where time trends for the entire period show approximately one-half of the wells show predominantly a “decreasing” trend. This is attributed to 1,1,1-TCA degradation (see “Contaminants of Concern” above). A minor exception is also noted in the vicinity of the RMPA extraction and treatment system, where most contaminants show a decreasing trend attributed to the impact of the extraction system operation. In the BPA, the majority of the wells show stable or no trends over time, reflecting the persistence of the source in this area.
- Contaminant Mass and Plume Volumes – The total groundwater plume area is 278 acres, water volume is 3,018 acre-feet, and mass of all COCs is 3,925 to 5,943 pounds (Table 2, from Tetra Tech, 2009c). The plume mass and extent is generally driven by perchlorate, although in the riparian area of Bedsprings Creek the other COCs define the plume limits since perchlorate is generally below MCLs. There have been modest decreases of 316 pounds in the Total VOC plume mass over time between 1990 and 2009, which appears to correlate fairly well with the 205 pounds of the Total VOCs extracted and treated by the RMPA groundwater and extraction system (Table 3, from Tetra Tech, 2009c). The somewhat larger loss in Total VOC plume mass (316 pounds) than the extraction removal (205 pounds) may reflect either *in situ* plume attenuation; a decrease in contaminant release rate from sources; or the limited precision of the plume mass estimates.
- Soil Source Areas – Soil source areas and groundwater impacts for VOCs, perchlorate, and 1,4-dioxane are identified in the recent DSI report (Tetra Tech, 2009a; see also Figures 7 through 9). Generally, significant VOCs were not detected in recent site soil samples, including the suspected source areas in the BPA. One small portion of the BPA did show TCE concentrations as high as 11,000 $\mu g/m^3$ in soil gas samples. However, based upon these soil gas samples, the mass of TCE

in soils only amounts to approximately 7 pounds (Table 4), and the soil water phase concentrations in soils only amounts to approximately 33 µg/L. Given the very high groundwater TCE concentrations (as high as approximately 5,000 µg/L) and mass (250-350 pounds), it appears unlikely there is enough TCE in the soils in this area to provide a significant continuing source to the aquifer. Thus, TCE in groundwater is likely maintained at the current high levels due almost solely to the TCE releases from the groundwater sources discussed below. A 1,4-dioxane soil source area is also defined in the same area as the TCE soils source. However, given the very low 1,4-dioxane soil concentrations, the 1,4-dioxane mass and concentration in soils is very small relative to the mass and concentration in groundwater. The only significant soil source areas identified are for perchlorate (Table 4), with perchlorate concentrations over 10,000 µg/kg and a total perchlorate mass of approximately 1,500 pounds. These perchlorate soil sources are located primarily in the BPA (750 pounds), the F-33 area (220 pounds), and the B-11 area (280 pounds). Given that the plume contains approximately 3,000 to 5,000 pounds of perchlorate at concentrations as high as 71,000 µg/L, these perchlorate soil sources appear to be a significant contributor to sustaining the perchlorate levels observed in groundwater (see Mass Flux discussion below). The transport of contaminant mass through the vadose zone at this site may delay contaminant arrival in groundwater due to the large depth to groundwater in the BPA. However, based upon site data this delay appears to have happened long ago in a period prior to the historical calibration period (1993-2008). Therefore, transport of contaminant mass through the vadose zone will not delay contaminant releases for the chosen calibration period. Future releases from soils, however, may be impacted by the transport time to groundwater. A vadose zone transport model approach will be recommended in a separate Vadose Zone Transport TM to be prepared and implemented later in this project prior to performing the Future Simulations. This revised approach will likely consist of a combination of mechanistic vadose zone transport models, a simplified mass balance approach, and the use of Case Studies methods. This approach will consider the large depth to groundwater in the BPA.

- Groundwater Source Areas – NAPL has not been identified at the site, and generally the groundwater VOC concentrations are not indicative of NAPL (10 percent of the VOC solubility limit; US EPA, 1998). However, groundwater concentrations are within about 1 percent of the VOC solubility limit in a 1 acre portion of the BPA, and levels have remained this high for approximately 20 years despite the successful remediation of the site vadose zone soils by SVE in the mid 1990s. Thus, it is likely that there is a continuing groundwater source in this small area of the site, where contaminants are tightly trapped in the low permeability aquifer material in the BPA. This area likely represents a continuing source of VOC to groundwater unless the source of the contamination is remediated. These groundwater source areas account for the tailing effect often observed at sites like Beaumont Site 1, where cleanup times typically take longer than those predicted based on flushing and desorption. This area likely also represents a source of 1,4-dioxane given the high and stable levels of 1,4-dioxane in the groundwater, with no apparent 1,4-dioxane source in the soils. Given the high and stable levels of perchlorate in the groundwater in this area, there may also be a groundwater source for perchlorate, though this is less clear since a soils source is also present for perchlorate that may be enough to explain the perchlorate currently found in groundwater. One other area that may potentially be a groundwater source area is in the B-11 area, since groundwater VOCs and perchlorate concentrations in the B-11 area are elevated relative to the surrounding plume. However, the high B-11 area plume concentrations may also be a result of impacts from the B-11 perchlorate soils source and/or migration of the plume to the northeast during wet period water level conditions.

- Fate and Transport Mechanisms – The following fate and transport mechanisms appear important for the site based upon the spatial and time trends in COCs and the site conceptual model:
  - Degradation – Degradation is very important for 1,1,1-TCA and perchlorate, as 1,1,1-TCA concentrations throughout the plume declined over time to low-trace levels, and perchlorate concentrations in the riparian zone decline over distance to trace levels. Based upon the site conditions, 1,1,1-TCA appears to have undergone abiotic transformation to 1,1-DCE (US EPA, 1998). Rate constants for the abiotic transformation of 1,1,1-TCA to 1,1-DCE are reported as 0.27 $year^{-1}$ (US EPA, 1998). A site specific 1,1,1-TCA rate constant of 0.5 $year^{-1}$ is estimated using the trend magnitudes given for 1,1,1-TCA in Table 1. Biodegradation of perchlorate in groundwater is known to occur when significant levels of organic carbon are present, oxygen and nitrate are depleted, and perchlorate-degrading anaerobic bacteria are present (ITRC, 2005 and 2007). Analysis of geochemical data indicates these conditions are present in the Beaumont Site 1 riparian zone (Tetra Tech, 2008), and is a likely explanation for the lack of perchlorate observed in the riparian zone groundwater. Observations in the F-33 area also provide strong evidence of rapid degradation of perchlorate at the site. The biological reaction for perchlorate is reported to be nearly instantaneous (ITRC, 2005 and 2007). Site specific perchlorate reaction rates can be estimated (US EPA, 1998) using the ratio of the contaminant to an inert tracer and the travel time in groundwater. This results in perchlorate reaction rates of 2 $year^{-1}$ at Site 1, assuming 1,4-dioxane is an inert tracer and the 4 year travel time from the RMPA area to the riparian zone. The biological reaction for 1,1-DCE and TCE is reported to be fairly slow (US EPA, 1998). Using the ratio of 1,1-DCE and TCE to 1,4-dioxane and the travel time from the RMPA area to the riparian zone, site specific 1,1-DCE and TCE reaction rates are similarly estimated to be 0.02 and 0.04 $year^{-1}$, respectively.
  - Volatilization – 1,4-dioxane and perchlorate are not subject to volatilization from groundwater. Volatilization from groundwater also does not appear to be very important for the VOCs, as soil gas samples do not show very elevated VOCs above the water table. For example, the TCE detected at up to 11,000 $\mu g/m^3$ in the BPA soil gas samples equates through equilibrium partitioning to a groundwater phase concentration of only 33 µg/L and a soil TCE mass of about 7 pounds, which compares to measured groundwater TCE concentrations as high as 5,000 µg/L and a groundwater plume TCE mass of 250-359 pounds. The assumption that volatilization from groundwater is no longer important at the site is consistent with the low levels of VOCs remaining in the BPA after remediation and the low soil gas results in the DSI investigation.
  - Evapotranspiration – Evapotranspiration is likely to be a very important COC fate and transport mechanism since evapotranspiration accounts for approximately 60 percent of the groundwater budget and the concentrations of the COCs decline markedly in the riparian zone. The mass lost due the physical pumping of groundwater by plant extraction is estimated using the groundwater flow model evapotranspiration rates and the COCs shallow plume maps (see COC mass flux budget section below). However, physical pumping of groundwater only accounts for phytoextraction processes, and additional contaminant mass may also be removed by rhizodegradation processes (ITRC, 2009). The rates for rhizodegradation processes are best estimated from site-specific field studies since they are highly dependent on plant type and root zone geochemical conditions. Rhizodegradation studies have not yet been conducted at Beaumont Site 1, so for the purposes of the modeling study, the rhizodegradation rates will be addressed through data analysis methods, model calibration, and model sensitivity analyses.

- Dispersion – Dispersion is likely important for all COC given the spatial and temporal variations in flow velocity. Dispersion is estimated through the longitudinal, lateral, and vertical dispersivity values. These factors are dependent on the physical length of the plume. Typically the longitudinal dispersivity is estimated as function of the plume length using methods summarized in USEPA (1998), the lateral dispersivity is estimated as 10 to 33 percent of the longitudinal dispersivity, and the vertical dispersivity is estimated as 1 to 5 percent of the longitudinal dispersivity (US EPA, 1998). Given the 7,200 foot long plume at Beaumont Site 1, the longitudinal dispersivity would be estimated using methods summarized in USEPA (1998).as 50 feet, the lateral dispersivity is estimated as 5 to 17 feet, and the vertical dispersivity is estimated as 0.5 to 2.5 feet. These parameters are also typically adjusted during model calibration since direct measurement typically is not possible, and an upper end parameter range is set at for longitudinal dispersivity at 720 feet using the using methods summarized in USEPA (1998). Note that at this site, large dispersivity values may be needed to explain the high longitudinal concentration gradients observed downgradient of the BPA.
- Sorption – 1,4-dioxane and perchlorate are not subject to physical adsorption, though these contaminants may be retained by hydraulic constraints due to the low permeability of some areas of the aquifer. Sorption also is not likely to be very important for the VOCs since organic carbon fraction and hence sorption is likely small (see "Contaminant Velocity" discussion above). However, it is possible sorption may play a role in VOC transport in the riparian zone, so a retardation factor slightly greater than one may be considered for VOCs in the riparian zone as part of the model calibration and sensitivity analyses. Samples were collected recently from this riparian area during replacement of one of the wells, so data should be available soon for TOC.
- Extraction/Injection – Groundwater extraction and treatment removed VOCs from the aquifer during 1994 through 2002 at the rates shown in Table 3. Perchlorate and 1,4-dioxane were not removed by treatment, although they were transported from the EW-1 and EW-2 extraction locations to the IW-01 through IW-05 injection locations. For transport model purposes, the mass of perchlorate and 1,4-dioxane injected will be set to match the mass extracted for historical operations. For future simulations, the mass of all COCs removed will be calculated within the model based upon COC concentrations and the extraction rate, and the mass injected will be set to zero since it is assumed treatment will be modified to remove perchlorate and 1,4-dioxane.
- Conceptual Model Transport Properties – Based upon the discussion above, Table 5 presents a summary of key transport model parameters.

This plume/COC conceptual model is proposed as the basis for constructing a numerical transport model. Although there are uncertainties in some aspects of the conceptual model, this is typical for hydrogeologic studies, and there do not appear to be any data gaps that would preclude proceeding with a numerical transport model or design of remediation systems. One data gap that has been defined is the aquifer fraction organic in the riparian zone, however, since the bounds for this parameter are reasonably established, parameter uncertainty can be handled within this study as part of the model calibration and sensitivity analyses.

COC Mass Flux Budget

A preliminary groundwater COC mass flux budget is defined as part of the basis for constructing the numerical transport model. The underflow mass flux numbers are quite uncertain at this point in the study

and subject to change during calibration. Both soil and groundwater sources are considered as part of the conceptual model and COC mass flux budget, with a separate source life for the groundwater and soil sources and potentially each COC. Source life for soils sources is estimated based upon the current release rates and mass, though this method is really only important for perchlorate since TCE has only a very small soils mass and 1,4-dioxane and 1,1-DCE are not present in soils. Source life for groundwater sources is estimated based upon Case Studies at similar sites and the experience to date at this site, which strongly suggests that if left untreated these groundwater sources would likely continue for decades. Since the model cases anticipated in this project will likely be limited to periods on the order of 20 years, these groundwater source releases will be continued indefinitely into the future for future simulations with no groundwater source remediation and projected into the past for historical simulations. For model runs considering remediation of the groundwater sources, these groundwater source releases will be continued into the future for a time period on the order of 2 to 10 years depending upon the recommendations of the remedial action team.

Key elements of the groundwater COC mass flux budget are as follows:

- Alluvial Aquifer Recharge and Sources – Recharge to the alluvium is primarily from direct precipitation, creek recharge, and injection. COC mass flux for these items are as follows:
  - Direct Precipitation – COC mass flux is estimated for precipitation leaching COCs from the soil source areas into groundwater using the average diffuse recharge rate of 2.4 inches per year from the calibrated flow model, and the COC soil areas and concentrations identified in Figures 7 through 9 (Table 4). The main soil source is for perchlorate, with the total perchlorate flux from soils being approximately 100 pounds per year. Perchlorate flux from the BPA soils at C-22 is 73 of the 100 pounds per year, with 20 of the 100 pounds per year from the RMPA soils at B-9/B-11, and 7 of the 100 pounds per year from the other areas (Figure 7). There is also one small TCE soils source in the BPA, with a mass flux of approximately one-third of a pound per year. The duration of these soil sources generally varies between 10 to 25 years depending on the total mass present (Table 4), and the timing of these releases may vary seasonally with the seasonal variation in recharge and groundwater levels. There is no significant COC mass flux from soils for 1,1-DCE and 1,4-dioxane.
  - Recharge from Creeks – For all COCs, there is no significant COC mass flux due to creek recharge, as soils in the creek recharge areas do not appear to be contaminated.
  - Underflow – There is no significant underflow into the alluvium, so there is also no significant COC inflow from the alluvium boundaries. Soils are also assumed to be free from contamination at the upgradient limits of the alluvium. Within the alluvium, there are possible internal groundwater sources treated as underflow (see discussion below). The maximum COC underflow rates across the entire plume width are approximately 30-40 pounds per year for 1,1-DCE; 20-30 pounds per year for TCE; 200-400 pounds per year for perchlorate; and 8-12 pounds per year for 1,4-dioxane (Figure 11). These flux values decrease slightly with distance below the BPA until reaching the riparian area, where they decrease markedly. The decline in mass flux rate through the riparian area is greatest for perchlorate and least for 1,4-dioxane, with 1,4-dioxane having one of the higher COC mass flux rates in portions of the riparian area even though 1,4-dioxane has the lowest mass flux rate in the BPA. Figure 11 also shows an apparent rebound in perchlorate mass flux below the riparian area that may be attributed to the limited precision of the mass flux estimates, or potentially the back end of a pulse of higher concentration releases since site monitoring data has shown possible pulses of COCs moving through the Potrero Creek area. The rebound area is further complicated by

strong upward vertical hydraulic gradients and upward vertical concentration gradients. The proposed modeling will explore explanations for features such as these.

  - Injection – There is no significant mass flux due to injection for TCE and 1,1-DCE since these chemicals were removed during treatment prior to re-injection. Perchlorate and 1,4-dioxane were not removed during treatment prior to re-injection, so the perchlorate and 1,4-dioxane mass flux was estimated as 5 and 0.5 pounds per year, respectively, using the average historical re-injection rate (40 acre-feet per year) and the concentrations in the extraction area (200 µg/L for perchlorate and 20 µg/L for 1,4-dioxane).

- Alluvial Aquifer Discharge and Sinks – Discharge from the alluvium is primarily from evapotranspiration, discharge to Potrero Creek, extraction, and leakage into deeper aquifers. COC mass flux for these are as follows:
  - Extraction – Mass flux values for 1,1-DCE and TCE average 2.6 and 2.8 pounds per year, respectively (Table 3). Mass flux values for perchlorate and 1,4-dioxane mass flux are 5 and 0.5 pounds per year (see injection section above).
  - Evapotranspiration – Using the average evapotranspiration rates in the riparian areas (Figure 5) and the shallow COC maps in the riparian areas (Appendix A), COC mass flux is estimated as follows: 18 pounds per year for 1,1-DCE; 19 pounds per year for TCE; 63 pounds per year for perchlorate; and 8 pounds per year for 1,4-dioxane. Historical and current values are thought to be approximately the same, since concentrations and flows have not changed significantly over time in the riparian area.
  - Discharge to Potrero Creek – Using the average creek discharge rate into lower Potrero Creek (Figure 5) and the shallow data in lower Potrero Creek, historical COC mass flux is estimated as follows: 8 pounds per year for 1,1-DCE; 3 pounds per year for TCE; 5 pounds per year for perchlorate; and 2 pounds per year for 1,4-dioxane. Historical and current values differ since concentrations appear to have decreased over time in lower Potrero Creek; current mass flux values are approximately 1 pounds per year for 1,1-DCE; 0.3 pounds per year for TCE; 0.5 pounds per year for perchlorate; and 0.2 pounds per year for 1,4-dioxane.
  - Underflow – There is no significant underflow out of the alluvium, so there is no significant COC outflow from the alluvium boundaries. Internally within the alluvium, there are potential COC sinks (see discussion below).
  - Leakage – Using the leakage rate into deeper Mount Eden and the deep aquifer COC concentrations, COC mass flux is estimated as follows: 0.5 pounds per year for 1,1-DCE; 0.5 pounds per year for TCE; 1 pounds per year for perchlorate; and 0.1 pounds per year for 1,4-dioxane.
- Sources – COCs also appear to be added to the plume by the flow of clean groundwater through the aquifer source areas in the BPA and possibly the RMPA. Using the COC mass flux maps estimated in the groundwater model (Tetra Tech, 2009b), mass flux due to underflow through the 225 foot wide BPA groundwater source area is estimated as follows (Table 4): 14 pounds per year for 1,1-DCE; 11 pounds per year for TCE; 46 pounds per year for perchlorate; and 3 pounds per year for 1,4-dioxane. Similarly, mass flux due to underflow through the 500 foot wide RMPA groundwater source area is estimated as follows: 4 pounds per year for 1,1-DCE; 5 pounds per year for TCE; 15 pounds per year for perchlorate; and 1.4 pounds per year for 1,4-dioxane. These groundwater source release estimates are quite uncertain, however, the transport modeling work will also provide an assessment on the likely magnitude of current groundwater source release rates.

- Sinks – COCs also appear to be lost from the plume by degradation in the riparian area. The loss is most obvious for perchlorate, although COC trends suggest some degree of attenuation may also be occurring for 1,1-DCE and TCE. Using the COC decay rates given above, the COC mass flux rate into the riparian areas, and the 4 year residence time in the riparian area, the mass loss rate due to degradation in the riparian area is estimated as follows: 3 pounds per year for 1,1-DCE; 2 pounds per year for TCE; 40 pounds per year for perchlorate; and 0 pounds per year for 1,4-dioxane. There is considerable uncertainty in these degradation estimates, however, the transport modeling work will also provide an assessment on the likely magnitude of groundwater degradation rates.
- Net Budget – The net mass flux budget is summarized in flow diagrams in Figure 12. Generally, the mass inflow rates are approximately equal to the mass outflow rates, given the limited precision of these estimates. The flux diagram for perchlorate may imply accumulation of mass, but this is due to uncertainty in these estimates, and values will be refined during model calibration. The mass inflow/outflow rates are also approximately 0.1 to 0.05 of the total plume mass, implying approximately a 10 to 20 year residence time in the plume. This 10 to 20 year residence time in the plume is generally consistent with the 12 year transport time across the plume and the historical site conditions.

This groundwater COC mass flux budget is preliminary to serve as a guide for the model construction and calibration. Some elements of the COC mass flux budget will most likely be revised during the model calibration process.

3.0 PRELIMINARY NUMERICAL MODEL DESIGN

This section presents the proposed numerical transport model design including layering, plume extent, boundary conditions, aquifer stresses, transport properties, and calibration.

Layering

Based upon the four primary units defined in the hydrostratigraphic model (shallow Quaternary alluvium, deep Quaternary alluvium/weathered Mount Eden, competent Mount Eden Formation, and the granitic/metasedimentary basement complex), four layers were used in the numerical flow model. This layering scheme appears adequate for the transport model given the plume/COC conceptual model and the objectives of this modeling study. Depending on the model calibration results and the final groundwater remedy selected for the site, refinement of the model layering may be considered in the future, however, refinement does not appear to be warranted at this time.

Model and Plume Extent

The model areal extent is limited to the 665 acre area where the saturated alluvium is present (Figure 4). The grid block size of 35 feet used in the flow model is sufficient for transport modeling in order to resolve the features of interest at the site, reduce numerical dispersion, meet the model objectives, and fall within MODFLOW2000/MT3D memory and run time constraints. A constant grid spacing is used since constant grid spacing promotes stability in MODFLOW models and reduces numerical dispersion in the transport model. The vertical extent of the model covers the entire saturated alluvium and Mount Eden formation, and extends 127 feet into the granite.

The plume extent for the alluvium/weathered Mount Eden will be set based upon the shallow and deep plume contour maps given in Appendix A. The plume extent for the competent Mount Eden and granite

will be set to zero except for a very small area in the BPA where concentrations will be set based upon the sporadic detections observed in the competent Mount Eden and granite in the monitoring data.

Boundary Conditions

Boundary conditions are no-flow conditions against the sides of the valley floor; river boundaries (RIV) under Potrero and Bedspring Creeks; time varying head inflow boundaries in a very small area in the upper portion of the model; leakage between the alluvium and Mount Eden formations and the Mount Eden and granite; horizontal flow barrier (HFB) boundaries at the Potrero Fault; evapotranspiration boundaries in the riparian area; and diffuse recharge. For the transport model, COC concentrations will be assigned as zero at all inflow boundaries, except for the perchlorate and TCE concentrations at the soil sources, where the diffuse recharge will be assigned concentrations to match the mass flux values given in Table 4. COC concentrations will be assigned by model calculations at all outflow boundaries. Internally within the model domain, COC concentrations at the BPA and RMAP groundwater sources will be assigned concentrations to match groundwater monitoring data and the mass flux values given in Table 4.

Aquifer Stresses

Based upon the conceptual model and water budget, the model considers the following aquifer stresses: diffuse recharge that varies seasonally and inter-annually based upon precipitation; stream recharge/discharge that varies seasonally and inter-annually based upon precipitation and streamflows; evapotranspiration from the water table that varies depending upon the depth to groundwater; and well extraction/injection that varies based upon the historical operating data for the RMPA groundwater extraction and treatment system. In addition, flows across the model boundaries vary based upon the time-varying water levels measured in the monitoring program, but these flows are small since there is very little flow into the alluvium via boundaries. Stress periods are quarterly to allow seasonal variation in aquifer stresses. These flow stress periods are adequate for the transport model. In addition, the transport model uses transport model time steps that refine the transport model in time relative to the flow model stress periods. Transport model time steps are typically on the order of days to reduce numerical dispersion; the final transport model time step values used will be those calculated internally by the model using the automatic step-size control procedure (usually about 1 day).

Initial Ranges for Transport Properties

The initial ranges for aquifer transport properties will initially be set as defined in the "Conceptual Model Transport Properties" section above (Table 5).

Approach to Transport Model Calibration

The approach to Transport Model Calibration considers data availability, variations in aquifer stresses, the overall transport model objectives, and the flow model calibration time periods available. Since the COC data shows only minor variations in the extent and magnitude of the plume over time, the proposed approach is to perform a quasi-historical calibration during the 1992 through 2008 flow model calibration time period. Since the starting point for the transport calibration is the 1992 period, the 1992 concentrations will be used as the model initial condition and the model will be run up to today assuming current releases apply to the historical period. Since the groundwater transit time through the plume is on the order of 12 years, the model simulation time period should be sufficient to evaluate whether these initial concentration conditions and source releases rates are reasonably consistent with the monitoring data collected since 1992. This will evaluate whether the model transport properties and source release rates are consistent with historical monitoring data from the site, which show quasi-steady state plume conditions during the 1992 through 2008 period. Given the site conditions, if the transport model can

reasonably replicate historical conditions, it should provide some level of confidence that the model can be used in the same manner for future predictions.

Calibration Targets

Primary calibration targets will be the COC concentrations measured in the site monitoring program during the calibration period, and a secondary calibration target will be the site mass flux budget given in the conceptual model, including the mass removal at the extraction system since high quality data are available for this parameter. In particular, the mass flux outflow at the lower end of the valley and the evapotranspiration losses in the riparian area are good calibration targets since they are key components of the conceptual model.

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Table 1
Statistical Analysis of Groundwater Monitoring Data
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	TCE		TCE				DCE		1,1-DCE				Perc		Perchlorate[1]				Diox		1,4-Dioxane[2]			
			Mean		Magnitude of Trend				Mean		Magnitude of Trend				Mean		Magnitude of Trend				Mean		Magnitude of Trend	
Well	Num Samples	Num Detects	(µg/L)	Trend	(%/yr)	(µg/L/yr)	Num Samples	Num Detects	(µg/L)	Trend	(%/yr)	(µg/L/yr)	Num Samples	Num Detects	(µg/L)	Trend	(%/yr)	(µg/L/yr)	Num Samples	Num Detects	(µg/L)	Trend	(%/yr)	(µg/L/yr)
EW-01	11	11	140.0	D	-7.5	-10.4	12	12	290.0	PD	-16.1	-46.6												
EW-02	10	10	150.0	I	3.1	4.6	12	12	260.0	PD	-9.2	-23.9												
EW-08	5	5	10.0	S			5	5	17.0	S														
EW-09	5	5	140.0	NT			5	5	420.0	S														
EW-10	4	4	220.0	I	17.5	38.57	5	5	810.0	S														
EW-11	8	8	530.0	NT			15	15	1,000.0	NT														
EW-12	11	11	1,300.0	NT			15	15	2,600.0	S														
EW-13	23	23	1,400.0	I	3.9	55.2	28	28	7,500.0	I	4.5	339.7	10	1	1,900.0	D	-36.5	-694.0	10	10	1,800.0	NT		
EW-14	4	4	430.0	S			5	5	2,100.0	S									1	1		N/A		
EW-15	13	13	1,400.0	NT			17	17	8,200.0	NT			1	0	140,000.0	N/A					590.0			
EW-16	12	12	1,600.0	NT			16	16	7,200.0	NT														
EW-18	10	10	1,600.0	NT			16	16	5,900.0	S														
F33-TW1	2	1	0.2	N/A			2	2	0.5	N/A			0	0	0.2	N/A			2	2	3.0	N/A		
F33-TW2	4	0	0.1	S			4	2	0.3	S			0	0	0.2	S			4	4	3.0	NT		
F33-TW3	4	3	0.4	D	-81.8	-0.3	4	3	0.7	S			0	0	0.2	S			4	4	3.6	S		
F33-TW4	2	0	0.1	N/A			2	2	0.3	N/A			0	0	0.2	N/A			2	2	2.7	N/A		
F33-TW5	2	0	0.1	N/A			2	0	0.1	N/A			0	0	0.2	N/A			2	2	2.6	N/A		
F33-TW6	4	0	0.1	S			4	0	0.1	S			0	0	0.2	S			4	4	2.4	S		
F34-TW1	2	1	0.4	N/A			2	1	0.1	N/A			0	0	0.1	N/A			2	2	3.3	N/A		
IW-01	1	1	2.0	N/A			1	1	3.0	N/A														
IW-02	2	2	8.4	N/A			2	2	26.0	N/A														
IW-03	3	3	39.0	N/A			3	3	230.0	N/A														
IW-04	9	9	9.9	NT			10	9	24.0	NT			5	2	240.0	D	-65.7	-157.8	7	7	22.0	PD	-3.7	-0.8
IW-05	2	2	22.0	N/A			2	2	140.0	N/A														
MW-01	11	11	280.0	PD	-1.2	-3.3	11	11	230.0	D	-1.6	-3.7	7	0	890.0	PD	-0.9	-8.3	6	6	2.5	S		
MW-02	12	12	210.0	D	-3.1	-6.4	16	16	350.0	D	-3.9	-13.8	8	1	3,000.0	S			6	6	110.0	S		
MW-03	10	6	0.9	NT			10	4	0.9	NT			2	1	17.0	NT			5	1	0.3	S		
MW-04	14	14	140.0	D	-4.5	-6.3	18	18	120.0	D	-7.9	-9.5	2	0	1,300.0	N/A			1	1	14.0	N/A		
MW-05	17	17	130.0	S			23	23	160.0	D	-3.1	-4.9	9	1	2,900.0	D	-4.2	-122.9	8	8	27.0	NT		
MW-06	13	13	13.0	NT			13	12	22.0	NT			5	2	220.0	NT			5	4	16.0	NT		
MW-07	15	15	34.0	NT			19	18	12.0	NT			7	1	170.0	NT			6	4	6.3	NT		
MW-08	10	2	0.3	S			10	1	0.3	S			2	3	79.0	NT			6	2	1.1	NT		
MW-09	10	0	0.2	S			10	0	0.2	S			1	2	13.0	NT			7	6	4.1	NT		
MW-10	12	8	6.9	NT			14	11	8.6	NT			1	0	52.0	N/A			1	1	0.5	N/A		
MW-100	2	0	0.1	N/A			2	0	0.1	N/A			0	0	0.1	N/A			2	0	0.6	N/A		
MW-11	15	8	2.4	NT			20	13	2.2	NT			3	1	21.0	NT			4	1	0.3	S		
MW-12	9	0	0.2	S			9	0	0.3	S			1	2	15.0	NT			6	2	1.0	NT		
MW-13	15	3	4.7	NT			15	3	6.0	NT			1	2	8.8	NT			11	1	0.3	S		
MW-14	11	4	3.4	PD	-0.9	0.0	11	3	1.6	PD	-5.0	-0.1	7	1	20.0	NT			7	3	1.1	NT		
MW-15	17	14	1.0	I	4.5	0.0	17	14	2.6	NT			1	2	7.6	NT			13	12	6.5	D	-0.2	0.0
MW-16	5	0	0.2	S			5	0	0.2	S			0	0	25.0	S			3	1	1.1	N/A		
MW-17	20	18	9.6	S			24	22	11.0	D	-4.7	-0.5	9	1	680.0	S			8	8	28.0	PD	-9.1	-2.5
MW-18	17	16	2.2	D	-3.1	-0.1	17	17	5.3	D	-3.5	-0.2	13	1	13.0	S			13	11	5.8	S		
MW-19	22	22	8.5	I	4.7	0.4	27	27	20.0	I	4.8	1.0	8	1	170.0	NT			8	8	61.0	S		
MW-20	9	9	57.0	D	-7.0	-4.0	13	13	61.0	D	-8.0	-4.9	3	0	440.0	N/A			3	2	3.8	N/A		
MW-21	2	2	78.0	N/A			2	2	240.0	N/A														
MW-22	11	11	73.0	NT			11	11	120.0	PD	-4.2	-5.1	6	1	600.0	NT			6	6	39.0	NT		
MW-23	3	3	33.0	N/A			3	3	54.0	N/A			1	0	48.0	N/A								
MW-24	3	3	2,000.0	N/A			3	3	6,100.0	N/A			1	0	5,100.0	N/A								
MW-26	19	19	2,700.0	S			24	24	3,800.0	NT			7	0	7,800.0	D	-2.8	-216.52	7	7	350.0	NT		
MW-27	8	4	6.1	PD	-5.6	-0.3	8	3	5.9	NT			4	1	19.0	NT			5	2	1.8	NT		
MW-28	7	7	19.0	NT			7	7	27.0	NT			5	0	120	I	7.7	9.3	5	5	51	NT		
MW-29	6	6	42.0	PI	6.7	2.8	11	11	33.0	S														
MW-30	5	4	4.6	NT			5	3	18.0	NT			3	0	62.0	N/A			3	2	3.9	N/A		
MW-31	8	4	4.9	NT			8	4	8.8	NT			5	0	2.6	I	3.4	0.1	5	2	0.9	NT		
MW-32	9	4	2.6	NT			9	3	2.6	NT			2	1	0.7	NT			5	1	0.3	S		
MW-34	12	9	11.0	NT			12	7	13.0	NT			7	1	59.0	NT			7	1	0.4	S		
MW-35	12	4	1.0	PD	-3.9	0.0	12	3	1.5	PD	-5.3	-0.1	1	2	0.5	NT			8	1	0.4	S		
MW-36	19	10	1.5	PD	-2.2	0.0	23	13	1.5	NT			2	3	4.9	NT			8	2	1.1	NT		
MW-37	12	7	1.5	NT			12	10	2.6	PI	3.5	0.1	1	2	0.5	NT			9	8	5.5	S		
MW-38	4	1	0.7	NT			4	1	3.5	NT			1	0	1.8	N/A			1	1	0.5	N/A		
MW-39	9	9	68.0	I	6.0	4.1	13	13	94.0	NT			1	0	810.0	N/A			1	1	10.0	N/A		
MW-40	13	13	29.0	S			18	18	20.0	PD	-1.9	-0.4	8	0	740.0	S			8	7	18.0	S		
MW-41	12	12	150.0	S			17	17	160.0	D	-9.6	-15.4												
MW-42	14	14	100.0	D	-2.0	-2.05	18	18	160.0	D	-3.4	-5.38	5	1	65.0	D	-42.4	-27.54	8	8	26.0	S		
MW-43	6	6	11.0	S			7	7	27.0	D	-5.7	-1.5	5	0	96.0	S			5	5	14.0	S		
MW-44	8	8	170.0	NT			13	13	200.0	D	-4.5	-9.1												
MW-45	11	11	20.0	D	-4.7	-0.9	11	11	36.0	D	-6.3	-2.3	8	0	230.0	D	-5.0	-11.4	8	8	12.0	D	-4.2	-0.51
MW-46	11	9	2.6	NT			11	10	3.3	S			3	2	6.4	NT			7	6	8.2	S		
MW-47	10	1	0.4	NT			10	1	0.5	NT			8	0	11.0	D	-7.2	-0.8	8	2	2.1	NT		

Table 1
Statistical Analysis of Groundwater Monitoring Data
LMC Beaumont Site 1
Data from August 1986 to June 2009

	TCE		TCE Mean		TCE Magnitude of Trend		DCE		1,1-DCE Mean		1,1-DCE Magnitude of Trend		Perc		Perchlorate[1] Mean		Perchlorate[1] Magnitude of Trend		Diox		1,4-Dioxane[2] Mean		1,4-Dioxane[2] Magnitude of Trend	
Well	**Num Samples**	**Num Detects**	**(µg/L)**	**Trend**	**(%/yr)**	**(µg/L/yr)**	**Num Samples**	**Num Detects**	**(µg/L)**	**Trend**	**(%/yr)**	**(µg/L/yr)**	**Num Samples**	**Num Detects**	**(µg/L)**	**Trend**	**(%/yr)**	**(µg/L/yr)**	**Num Samples**	**Num Detects**	**(µg/L)**	**Trend**	**(%/yr)**	**(µg/L/yr)**
MW-48	6	1	0.6	NT			6	1	3.2	NT			0	0	0.2	S			4	2	2.8	NT		
MW-49	19	19	26.0	S			24	23	53.0	NT			7	0	700.0	S			7	6	15.0	S		
MW-50	12	12	43.0	NT			17	17	170.0	D	-24.8	-42.2	1	0	270.0	N/A			1	1	10.0	N/A		
MW-51	12	12	91.0	D	-9.4	-8.5	17	16	270.0	D	-24.8	-67.1												
MW-52	13	13	160.0	D	-8.2	-13.1	18	18	440.0	D	-14.3	-63.0												
MW-53	8	8	21.0	D	-7.3	-1.5	8	8	71.0	D	-11.8	-8.4	6	1	210.0	D	-11.5	-24.2	6	6	7.3	PD	-14.6	-1.1
MW-54	8	8	130.0	PD	-6.1	-8.0	8	8	480.0	NT			6	0	780.0	S			6	6	19.0	NT		
MW-55	15	15	160.0	NT			20	20	340.0	NT			5	0	1,300.0	I	7.2	93.1	5	5	43.0	NT		
MW-56A	16	13	42.0	D	-8.0	-3.4	21	18	66.0	D	-11.0	-7.2	1	2	0.6	NT			5	2	12.0	NT		
MW-56B	10	10	48.0	S			10	10	75.0	D	-2.3	-1.8	5	0	340.0	S			5	4	6.3	S		
MW-56C	19	19	100.0	D	-3.2	-3.2	24	24	130.0	D	-5.0	-6.5	7	0	920.0	PD	-7.9	-72.6	7	7	21.0	NT		
MW-56D	8	8	94.0	D	-2.8	-2.6	9	9	210.0	D	-5.1	-10.7	3	0	660	N/A			3	3	22	N/A		
MW-57A	13	13	120.0	D	-3.9	-4.7	18	18	220.0	PD	-5.3	-11.6	3	0	1,100.0	N/A			3	3	25.0	N/A		
MW-57B	7	7	71.0	S			7	7	120.0	D	-3.9	-4.7	3	0	540.0	N/A			3	3	27.0	N/A		
MW-57C	6	6	82.0	D	-3.2	-2.6	6	6	220.0	D	-5.1	-11.2	2	0	640.0	N/A			2	2	23.0	N/A		
MW-57D	7	7	160.0	D	-4.7	-7.5	7	7	370.0	D	-6.9	-25.4	3	0	1,100.0	N/A			3	3	30.0	N/A		
MW-58A	8	8	75.0	D	-3.1	-2.3	9	9	150.0	D	-5.0	-7.5	3	0	270.0	N/A			3	3	23.0	N/A		
MW-58B	6	6	53.0	D	-4.5	-2.4	6	6	98.0	D	-8.2	-8.0	3	0	570.0	N/A			3	3	27.0	N/A		
MW-58C	8	8	110.0	PD	-4.2	-4.7	8	8	260.0	D	-6.9	-17.9	3	0	1,000.0	N/A			3	3	25.0	N/A		
MW-58D	15	15	150.0	D	-5.3	-7.9	20	20	200.0	D	-6.9	-13.7	5	0	670.0	NT			5	5	27.0	NT		
MW-59A	7	7	16.0	NT			7	6	12.0	S			2	0	590.0	N/A			2	1	0.4	N/A		
MW-59B	13	13	260.0	PD	-1.9	-4.9	18	18	340.0	D	-2.9	-9.9	4	0	4,400.0	S			4	4	44.0	S		
MW-59C	7	7	82.0	I	7.2	5.9	8	8	130.0	NT			3	0	4,400.0	N/A			3	3	22.0	N/A		
MW-59D	15	15	250.0	NT			16	16	390.0	NT			12	0	6200	I	2.2	135.9	12	12	43	NT		
MW-60A	15	15	130.0	I	8.8	11.4	15	15	220.0	I	6.0	13.2	10	0	4,500.0	I	30.7	1,380.6	10	10	97.0	NT		
MW-60B	10	10	7.7	PI	3.5	0.3	11	11	33.0	I	6.6	2.2	6	0	1,600.0	D	-4.5	-72.5	6	4	2.0	I	16.1	0.3
MW-61A	9	9	190.0	D	-4.1	-7.8	10	10	4,200.0	NT			3	0	11,000.0	N/A			3	3	26.0	N/A		
MW-61B	12	12	2,000.0	D	-2.9	-58.4	13	13	12,000.0	D	-3.1	-368.2	6	0	87,000.0	PD	-4.5	-3,940.3	6	6	400.0	S		
MW-61C	7	7	12.0	NT			7	7	60.0	NT			4	1	3,100.0	D	-14.2	-439.3	4	4	4.5	S		
MW-61D	3	3	4.3	N/A			3	3	48.0	N/A														
MW-62A	18	18	120.0	D	-3.1	-3.7	24	24	160.0	D	-6.3	-10.1	8	0	1,300.0	S			8	7	31.0	S		
MW-62B	4	4	180.0	NT			5	5	470.0	D	-30.7	-144.2												
MW-63	5	5	37.0	S			9	9	64.0	NT			1	0	1,500.0	N/A			1	1	25.0	N/A		
MW-64	1	1	140.0	N/A			1	1	890.0	N/A			1	0	1,700.0	N/A			1	1	46.0	N/A		
MW-65	3	3	130.0	N/A			3	3	530.0	N/A														
MW-66	17	17	160.0	S			22	22	160.0	D	-2.3	-3.7	9	0	1,300.0	S			9	9	24.0	NT		
MW-67	11	0	0.3	S			11	0	0.2	S			0	0	0.3	S			11	4	0.5	I	9.5	0.1
MW-68	7	1	0.5	NT			7	7	1.7	NT			7	0	3,500.0	PI	5.1	179.0	7	7	3.8	I	26.3	1.00
MW-69	7	7	12.0	S			7	7	5.6	S			7	0	2,300.0	S			7	7	9.0	S		
MW-70	9	1	0.3	S			8	1	0.5	NT			4	2	10.0	NT			9	9	2.4	NT		
MW-71A	4	0	0.3	S			4	0	0.3	S			0	0	0.2	S			4	0	0.3	S		
MW-71B	5	0	0.3	S			5	0	0.3	S			5	0	300.0	I	13.3	39.9	5	0	0.3	S		
MW-71C	4	0	0.3	S			4	0	0.3	S			4	1	220.0	S			4	0	0.3	S		
MW-72A	4	0	0.3	S			4	0	0.3	S			0	0	0.2	S			4	0	0.3	S		
MW-72B	4	0	0.4	S			4	0	0.4	S			0	0	0.2	S			4	0	0.3	S		
MW-72C	4	0	0.4	S			4	0	0.4	S			1	2	5.7	NT			4	0	0.3	S		
MW-73A	4	0	0.4	S			4	0	0.4	S			4	0	2.4	NT			4	0	0.3	S		
MW-73B	4	0	0.4	S			4	0	0.4	S			1	2	7.6	NT			4	0	0.3	S		
MW-73C	4	0	0.4	S			4	0	0.4	S			0	0	0.2	S			4	0	0.3	S		
MW-74A	4	0	0.4	S			4	0	0.4	S			3	1	3.2	S			4	0	0.3	S		
MW-74B	5	0	0.4	S			5	0	0.4	S			5	0	16.0	S			5	2	1.0	NT		
MW-74C	4	0	0.4	S			4	0	0.4	S			4	0	10.0	I	19.0	1.9	4	0	0.3	S		
MW-75A	5	0	0.3	S			5	0	0.3	S			0	0	0.3	S			5	0	0.3	S		
MW-75B	6	0	0.3	S			6	0	0.3	S			4	1	1.5	D	-39.4	-0.6	6	0	0.3	S		
MW-75C	5	0	0.3	S			5	0	0.3	S			0	0	0.3	S			5	0	0.3	S		
MW-76A	5	0	0.3	S			5	0	0.3	S			0	0	0.3	S			5	4	1.6	NT		
MW-76B	6	0	0.3	S			6	0	0.3	S			0	0	0.2	S			6	0	0.3	S		
MW-76C	4	1	0.6	NT			4	4	2.4	NT			0	0	0.3	S			4	4	6.4	S		
MW-77A	4	0	0.4	S			5	0	0.3	S			0	0	0.3	S			5	0	0.3	S		
MW-77B	6	0	0.3	S			6	0	0.3	S			0	0	0.2	S			6	0	0.3	S		
MW-78	5	4	1.5	NT			5	5	4.6	S			5	0	22.0	D	-30.7	-6.7	5	4	1.9	NT		
MW-79A	5	1	0.3	NT			5	0	0.3	S			0	0	0.3	S			5	0	0.3	S		
MW-79C	4	4	6.6	S			4	4	6.7	S			4	0	80.0	S			4	4	3.7	S		
MW-80	5	1	0.5	NT			5	4	1.4	NT			0	0	0.3	S			5	5	4.7	NT		
MW-81	5	0	0.3	S			5	0	0.3	S			0	0	0.3	S			5	0	0.3	S		
MW-82	4	0	0.1	S			4	0	0.1	S			0	0	0.2	S			4	4	2.6	NT		
MW-83	4	1	0.2	S			4	2	0.3	S			0	0	0.2	S			4	4	3.2	S		
MW-84A	2	0	0.1	N/A			2	0	0.2	N/A			2	0	1.7	N/A			2	0	0.3	N/A		
MW-84B	2	0	0.1	N/A			2	0	0.2	N/A			0	0	0.2	N/A			2	0	0.3	N/A		
MW-85A	2	0	0.1	N/A			2	0	0.1	N/A			0	0	0.3	N/A			2	1	0.3	N/A		

Table 1
Statistical Analysis of Groundwater Monitoring Data
LMC Beaumont Site 1
Data from August 1986 to June 2009

	TCE		TCE Mean		TCE Magnitude of Trend		DCE		1,1-DCE Mean		1,1-DCE Magnitude of Trend		Perc		Perchlorate[1] Mean		Perchlorate[1] Magnitude of Trend		Diox		1,4-Dioxane[2] Mean		1,4-Dioxane[2] Magnitude of Trend	
Well	**Num Samples**	**Num Detects**	**(µg/L)**	**Trend**	**(%/yr)**	**(µg/L/yr)**	**Num Samples**	**Num Detects**	**(µg/L)**	**Trend**	**(%/yr)**	**(µg/L/yr)**	**Num Samples**	**Num Detects**	**(µg/L)**	**Trend**	**(%/yr)**	**(µg/L/yr)**	**Num Samples**	**Num Detects**	**(µg/L)**	**Trend**	**(%/yr)**	**(µg/L/yr)**
MW-85B	2	2	65.0	N/A			2	0	0.1	N/A			0	0	0.5	N/A			2	1	0.6	N/A		
MW-86A	2	0	0.1	N/A			2	0	0.1	N/A			0	0	0.2	N/A			2	1	1.3	N/A		
MW-86B	2	2	84.0	N/A			2	0	0.1	N/A			0	0	0.2	N/A			2	1	3.4	N/A		
MW-87A	2	2	0.5	N/A			2	1	0.3	N/A			0	0	0.2	N/A			2	2	5.1	N/A		
MW-87B	2	2	50.0	N/A			2	2	13.0	N/A			2	0	39.0	N/A			2	2	63.0	N/A		
MW-88	2	0	0.1	N/A			2	0	0.2	N/A			2	0	410.0	N/A			2	0	0.3	N/A		
MW-89	2	2	5.6	N/A			2	2	3.9	N/A			2	0	2,000.0	N/A			2	2	5.7	N/A		
MW-90	2	2	1.9	N/A			2	2	1.7	N/A			2	0	200.0	N/A			2	0	0.3	N/A		
MW-91	2	1	0.7	N/A			2	1	0.6	N/A			2	0	1,800.0	N/A			2	2	1.3	N/A		
MW-92	2	2	17.0	N/A			2	0	0.1	N/A			2	0	25.0	N/A			2	0	0.3	N/A		
MW-93	2	2	1.8	N/A			2	2	0.5	N/A			1	0	1.1	N/A			2	2	12.0	N/A		
MW-94	2	2	1.7	N/A			2	2	0.3	N/A			1	0	1.2	N/A			2	2	5.6	N/A		
MW-95	2	2	14.0	N/A			2	0	0.1	N/A			0	0	0.2	N/A			2	0	0.3	N/A		
MW-96	2	0	0.1	N/A			2	0	0.2	N/A			0	0	0.2	N/A			2	0	0.3	N/A		
MW-97	2	0	0.1	N/A			2	0	0.2	N/A			0	0	0.2	N/A			2	0	0.3	N/A		
MW-98A	2	0	0.1	N/A			2	0	0.1	N/A			0	0	0.2	N/A			2	0	0.3	N/A		
MW-98B	2	2	14.0	N/A			2	2	8.0	N/A			2	0	1,100.0	N/A			2	2	6.9	N/A		
MW-99	2	2	2.2	N/A			2	2	3.9	N/A			2	0	530.0	N/A			2	1	1.3	N/A		
OW-01	9	1	0.4	NT			8	1	1.9	NT			0	0	0.4	S			6	0	0.4	S		
OW-02	17	17	78.0	D	-5.1	-4.0	17	17	77.0	D	-5.3	-4.0	11	1	670.0	D	-4.2	-28.4	10	10	15.0	D	-4.5	-0.7
OW-03	13	13	200.0	D	-8.2	-16.4	16	16	160.0	D	-9.6	-15.4	2	0	1,900.0	N/A			1	1	45.0	N/A		
OW-08	9	0	0.2	S			9	0	0.2	S			0	0	17.0	S			5	0	0.4	S		
P-02	9	1	0.5	NT			9	1	1.7	NT			0	0	0.3	S			7	0	0.3	S		
P-03	7	1	0.5	NT			7	2	2.2	PD	-10.8	-0.2	1	2	0.8	NT			6	2	0.9	S		
P-04	4	1	0.7	NT			4	1	3.4	NT			0	0	0.2	N/A			3	0	0.2	N/A		
P-05	9	3	6.6	PD	-4.7	-0.3	9	3	5.7	PD	-6.0	-0.3	6	1	4.9	S			7	1	0.4	S		
Notes:	1,291 Total	948 Total	6.64 GeoMean				1,478 Total	1,135 Total	9.20 GeoMean				423 Total	64 Total	24.26 GeoMean				669 Total	424 Total	3.10 GeoMean			

Trend Categories	**TCE (# wells)**	**% Total**	**1,1-DCE (# wells)**	**% Total**	**Perchlorate (# wells)**	**% Total**	**1,4-Dioxane (# wells)**	**% Total**
"N/A"-Insufficient Data	36		36		51		50	
Blank-No data	0		0		23		25	
"NT" - No Trend	40	31	38	29	26	28	31	34
"S" - Stable	46	35	44	34	42	46	51	56
"I" - Increasing	8	6	4	3	7	8	3	3
"PI" -Probably Increasing	2	2	1	1	1	1	0	0
"D" - Decreasing	25	19	34	26	13	14	3	3
"PD" -Probably Decreasing	9	7	9	7	3	3	3	3
Definitions:	130	100	130	100	92	100	91	100

Table 1
Statistical Analysis of Groundwater Monitoring Data
LMC Beaumont Site 1
Data from August 1986 to June 2009

1,1,1,-TCA		1,1,1-TCA Mean		1,1,1-TCA Magnitude of Trend		1,1-DCA		1,1-DCA Mean		1,1-DCA Magnitude of Trend		1,2-DCA		1,2-DCA Mean		1,2-DCA Magnitude of Trend		cis--DCE		cis--DCE Mean		cis--DCE Magnitude of Trend	
Num Samples	Num Detects	(µg/L)	Trend	(%/yr)	(µg/L/yr)	Num Samples	Num Detects	(µg/L)	Trend	(%/yr)	(µg/L/yr)	Num Samples	Num Detects	(µg/L)	Trend	(%/yr)	(µg/L/yr)	Num Samples	Num Detects	(µg/L)	Trend	(%/yr)	(µg/L/yr)
11	11	19	D	-16.1	-3.1	9	8	1.9	S			11	11	8.6	D	-23.4	-2.0	4	4	0.75	S		
12	12	37.0	D	-17.5	-6.5	10	10	3.3	S			11	11	10.0	NT			5	5	0.8	S		
3	3	11.0	N/A			2	2	1.0	N/A			4	4	4.6	NT			2	2	1.0	N/A		
5	5	22.0	NT			2	2	13.0	N/A			5	5	22.0	NT			2	2	2.1	N/A		
5	5	190.0	D	-48.2	-91.60	2	2	14.0	N/A			5	5	110.0	S			2	2	2.2	N/A		
15	14	49.0	D	-14.2	-6.9	12	11	32.0	D	-12.6	-4.0	15	15	54.0	D	-5.8	-3.2	8	7	14.0	NT		
15	15	110.0	NT			13	13	37.0	S			15	15	83.0	S			8	7	17.0	S		
28	21	84.0	D	-13.0	-10.92	24	24	160.0	NT			28	28	300.0	I	5.6	16.66	19	19	320.0	I	9.5	30.39
5	5	380.0	NT			2	2	9.9	N/A			5	5	460.0	NT			2	2	4.7	N/A		
17	16	270.0	NT			13	13	180.0	I	14.0	25.2	17	17	290.0	NT			8	7	49.0	NT		
16	15	270.0	D	-19.0	-51.3	13	12	37.0	NT			16	15	450.0	NT			9	7	24.0	NT		
16	15	160.0	D	-20.5	-32.7	14	14	120.0	S			16	16	280.0	D	-10.4	-29.0	9	8	55.0	PD	-23.4	-12.9
2	0	0.1	N/A			2	0	0.1	N/A			2	0	0.1	N/A			2	1	0.1	N/A		
4	0	0.1	S			4	0	0.1	S			4	0	0.1	S			4	1	0.2	S		
4	0	0.1	S			4	1	0.2	S			4	0	0.1	S			4	2	0.2	S		
2	0	0.1	N/A			2	0	0.1	N/A			2	0	0.1	N/A			2	0	0.1	N/A		
2	0	0.1	N/A			2	0	0.1	N/A			2	0	0.1	N/A			2	0	0.1	N/A		
4	0	0.1	S			4	0	0.1	S			4	0	0.1	S			4	0	0.1	S		
2	0	0.1	N/A			2	0	0.1	N/A			2	0	0.1	N/A			2	0	0.1	N/A		
1	1	1.0	N/A									1	1	1.6	N/A								
1	1	6.2	N/A									1	1	1.6	N/A								
2	2	43	N/A									2	2	17	N/A								
9	2	3.2	NT			7	1	0.4	NT			9	2	1.7	NT			7	4	1.4	NT		
1	1	76.0	N/A									1	1	26.0	N/A								
11	11	59.0	D	-8.2	-4.8	10	9	15.0	D	-2.6	-0.4	11	9	13.0	NT			7	2	0.6	NT		
16	15	63.0	D	-12.9	-8.1	16	14	7.2	NT			16	15	5.8	NT			12	9	2.2	NT		
9	2	0.4	NT			9	1	0.3	NT			10	2	0.3	NT			7	1	0.3	NT		
18	17	15.0	D	-14.6	-2.2	16	13	3.0	S			18	14	1.9	NT			10	8	0.7	PD	-6.4	0.0
21	18	36.0	D	-8.5	-3.1	20	17	3.5	S			21	16	21.0	NT			12	5	0.7	NT		
12	6	2.0	NT			11	5	0.6	NT			12	5	1.1	NT			8	2	0.3	NT		
19	13	7.3	D	-11.4	-0.8	19	13	0.9	D	-5.1	0.0	19	13	1.2	NT			13	7	0.3	D	-3.4	0.0
10	1	0.3	S			10	1	0.3	S			10	1	0.2	S			6	0	0.2	S		
10	1	0.2	S			10	0	0.2	S			10	0	0.1	S			8	0	0.1	S		
15	11	0.7	NT			14	10	0.5	NT			15	12	0.7	NT			8	6	0.5	S		
2	0	0.1	N/A			2	0	0.1	N/A			2	0	0.1	N/A			2	0	0.2	N/A		
20	13	0.5	S			19	12	0.4	S			20	13	0.4	S			12	7	0.4	D	-0.8	0.0
9	1	0.3	NT			9	1	0.3	S			9	0	0.2	S			6	0	0.2	S		
15	2	0.4	NT			14	1	0.3	S			15	1	0.2	NT			11	0	0.1	S		
11	2	0.5	NT			10	0	0.3	S			11	1	0.2	NT			7	0	0.2	S		
16	1	0.4	NT			14	5	0.4	I	1.1	0.0	17	1	0.2	NT			13	3	0.2	NT		
5	0	0.2	S			5	0	0.2	S			5	0	0.1	S			5	1	10.0	NT		
24	22	5.3	D	-7.5	-0.4	23	14	0.6	D	-2.8	0.0	24	14	0.4	D	-0.8	0.0	18	9	0.6	D	-5.1	0.0
17	3	0.4	PD	-2.8	0.0	15	6	0.7	D	-4.7	0.0	17	2	0.2	NT			14	0	0.2	S		
27	20	2.2	D	-3.2	-0.1	25	25	2.4	I	1.4	0.0	27	19	0.6	NT			18	11	0.4	D	-2.9	0.0
14	10	12.0	D	-14.6	-1.8	13	7	1.5	D	-9.5	-0.1	14	9	1.2	NT			8	4	0.3	D	-12.1	0.0
2	2	110.0	N/A			1	1	12.0	N/A			2	1	5.3	N/A								
11	7	19.0	D	-12.6	-2.4	10	4	1.6	NT			11	6	1.8	NT			8	4	0.9	D	-7.2	-0.1
3	2	16.0	N/A			2	0	3.3	N/A			2	1	3.5	N/A			1	0	0.5	N/A		
3	2	660.0	N/A			2	1	43.0	N/A			3	3	600.0	N/A								
24	22	190.0	D	-12.0	-22.8	22	21	98.0	S			24	24	200.0	D	-1.0	-2.0	15	13	32.0	PD	-4.5	-1.4
8	2	1.2	NT			7	1	0.4	NT			8	2	0.4	NT			6	1	0.4	NT		
7	3	2.6	NT			6	4	0.56	S			7	5	2.2	NT			5	0	0.18	S		
11	9	1.1	PD	-5.8	-0.1	9	9	6.6	S			11	9	0.8	NT			7	7	2.0	NT		
5	2	1.0	NT			4	0	0.2	S			5	2	0.9	NT			3	0	0.1	N/A		
8	2	2.3	NT			7	0	0.3	S			8	1	0.3	NT			5	0	0.2	S		
9	2	0.7	NT			8	1	0.4	NT			9	2	0.3	NT			6	1	0.3	NT		
12	4	1.0	NT			11	3	0.7	NT			12	4	0.5	NT			9	2	0.4	PD	-4.8	0.0
12	4	0.8	D	-5.4	0.0	11	1	0.4	NT			12	2	0.3	NT			8	1	0.3	NT		
23	13	0.5	D	-2.5	0.0	22	12	0.5	D	-2.5	0.0	23	13	0.4	D	-3.2	0.0	15	8	0.4	D	-5.3	0.0
12	1	0.3	NT			11	3	0.4	NT			12	1	0.3	NT			9	1	0.2	NT		
4	1	0.9	NT			3	0	0.3	N/A			5	1	0.4	NT			1	0	0.1	N/A		
13	13	9.4	D	-9.1	-0.9	11	9	2.5	NT			13	11	2.3	NT			7	6	0.9	S		
18	10	1.8	D	-9.2	-0.2	17	14	1.2	NT			18	9	0.4	PD	-4.2	0.0	13	7	0.4	S		
17	17	7.8	D	-12.1	-0.9	15	14	2.6	NT			17	15	11.0	NT			9	8	1.1	S		
19	10	17.0	D	-9.9	-1.7	16	16	5.6	S			19	17	7.0	PD	-6.0	-0.4	14	14	1.6	I	2.9	0.0
7	2	1.6	PD	-8.5	-0.1	6	3	0.6	NT			7	1	0.4	NT			5	0	0.2	S		
13	13	11.0	D	-7.5	-0.8	11	11	4.8	D	-3.5	-0.2	13	12	7.5	NT			6	5	0.9	NT		
11	4	3.2	D	-10.4	-0.33	10	5	0.5	NT			11	2	0.5	NT			9	1	0.2	S		
11	3	0.4	PD	-2.6	0.0	10	5	0.4	S			11	3	0.4	PD	-2.2	0.0	7	4	0.6	NT		
10	1	0.3	NT			9	0	0.2	S			10	1	0.3	NT			8	0	0.1	S		

Table 1
Statistical Analysis of Groundwater Monitoring Data
LMC Beaumont Site 1
Data from August 1986 to June 2009

1,1,1,-TCA		Mean		1,1,1-TCA Magnitude of Trend		1,1-DCA		Mean		1,1-DCA Magnitude of Trend		1,2-DCA		Mean		1,2-DCA Magnitude of Trend		cis--DCE		Mean		cis--DCE Magnitude of Trend	
Num Samples	Num Detects	(µg/L)	Trend	(%/yr)	(µg/L/yr)	Num Samples	Num Detects	(µg/L)	Trend	(%/yr)	(µg/L/yr)	Num Samples	Num Detects	(µg/L)	Trend	(%/yr)	(µg/L/yr)	Num Samples	Num Detects	(µg/L)	Trend	(%/yr)	(µg/L/yr)
6	1	0.4	NT			5	0	0.3	S			6	1	0.4	NT			4	0	0.2	S		
24	23	5.1	D	-6.9	-0.4	23	16	1.2	D	-3.8	0.0	24	15	4.6	D	-7.7	-0.4	17	9	0.4	D	-6.9	0.0
17	17	16.0	D	-20.5	-3.3	15	15	0.8	D	-6.1	0.0	17	17	2.8	D	-9.9	-0.3	10	9	0.6	D	-8.8	-0.1
17	17	13.0	D	-12.3	-1.6	14	14	2.0	NT			17	16	9.2	D	-19.0	-1.7	9	8	0.6	D	-8.6	0.0
18	18	27.0	D	-14.6	-3.9	14	14	1.7	S			18	17	16.0	D	-20.5	-3.3	10	9	0.6	D	-8.8	-0.1
8	4	6.5	PD	-11.7	-0.8	6	0	0.3	S			8	2	5.4	PD	-12.6	-0.7	6	0	0.2	S		
8	4	92.0	D	-16.1	-14.8	6	3	0.7	NT			8	7	5.4	D	-9.5	-0.5	6	0	0.2	S		
20	18	12.0	D	-8.6	-1.0	18	18	2.9	S			20	20	3.3	NT			13	11	1.2	S		
21	16	2.2	D	-8.3	-0.2	18	13	0.5	D	-3.8	0.0	21	16	4.2	D	-9.1	-0.4	13	8	0.5	D	-6.4	0.0
9	5	5.4	D	-10.5	-0.6	7	7	1.4	S			10	8	6.8	D	-8.3	-0.6	7	2	0.4	PD	-5.7	0.0
24	22	9.3	D	-9.5	-0.9	21	20	2.0	D	-2.0	0.0	24	23	7.2	D	-4.2	-0.3	16	9	0.6	D	-5.7	0.0
8	6	9.9	D	-14.6	-1.4	6	6	1.8	D	-2.5	0.0	9	9	11	D	-8.5	-0.9	6	3	0.55	PD	-9.8	-0.1
18	18	12.0	D	-11.0	-1.3	16	16	2.1	NT			18	18	11.0	PD	-8.9	-1.0	11	8	0.9	D	-8.2	-0.1
7	6	8.5	D	-10.7	-0.9	5	5	1.6	S			7	7	3.3	NT			5	2	0.5	NT		
6	6	13.0	D	-10.5	-1.4	4	4	1.6	S			6	6	8.0	D	-6.9	-0.5	4	2	0.6	S		
7	6	21.0	D	-13.4	-2.8	5	5	1.6	D	-2.8	0.0	7	6	24.0	D	-12.9	-3.1	5	2	0.5	NT		
9	7	10.0	D	-14.6	-1.5	6	4	0.7	S			9	6	10.0	D	-13.7	-1.4	6	3	0.5	D	-9.8	0.0
6	5	9.0	D	-14.5	-1.3	5	2	0.8	PD	-8.0	-0.1	6	3	1.2	D	-10.8	-0.1	5	2	0.5	NT		
8	7	19.0	D	-14.6	-2.8	5	2	0.6	NT			8	5	26.0	D	-17.5	-4.6	5	2	0.5	NT		
20	19	15.0	D	-13.9	-2.1	17	17	2.2	S			20	19	18.0	D	-8.6	-1.6	12	7	0.5	D	-11.0	-0.1
6	4	1.8	D	-6.6	-0.1	5	3	0.9	S			7	5	2.5	D	-7.2	-0.2	4	2	0.6	S		
18	15	17.0	D	-14.2	-2.4	15	15	13.0	D	-1.9	-0.2	18	18	37.0	D	-3.7	-1.4	10	9	1.7	S		
8	5	5.3	PD	-11.1	-0.6	5	5	6.2	I	4.8	0.3	8	8	12.0	I	3.7	0.4	5	3	0.6	S		
16	11	12	D	-11.4	-1.4	13	13	16	NT			15	15	42	NT			13	11	1.8	NT		
14	12	1.6	D	-3.5	-0.1	12	12	3.6	I	4.7	0.2	15	15	5.5	I	3.4	0.2	12	11	1.4	I	2.2	0.0
10	4	0.7	D	-5.7	0.0	8	5	0.5	S			10	5	0.8	D	-5.1	0.0	8	2	0.4	PD	-4.4	0.0
10	8	20.0	D	-10.7	-2.1	6	6	3.2	NT			10	10	28.0	PD	-2.6	-0.7	5	4	1.1	S		
13	11	440.0	D	-11.4	-50.1	10	10	180.0	D	-2.8	-5.0	13	12	430.0	D	-7.2	-30.8	8	6	39.0	D	-5.3	-2.1
7	3	6.6	D	-10.1	-0.7	5	5	1.6	NT			7	7	4.8	NT			5	2	0.4	NT		
3	3	3.3	N/A			1	1	1.0	N/A			3	3	2.6	N/A			1	1	1.0	N/A		
24	22	35.0	D	-13.6	-4.8	21	20	2.0	D	-2.6	-0.1	24	19	41.0	D	-11.7	-4.8	16	8	0.4	D	-7.2	0.0
5	5	90.0	D	-36.5	-32.9	2	2	3.9	N/A			5	5	60.0	NT			2	2	1.0	N/A		
9	9	4.4	PD	-12.3	-0.5	8	8	1.2	NT			9	9	2.4	NT			5	4	0.4	S		
1	1	48.0	N/A									1	1	49.0	N/A								
3	3	35.0	N/A			2	2	4.0	N/A			3	3	4.7	N/A			2	2	1.0	N/A		
22	16	5.2	D	-14.6	-0.8	21	21	4.3	S			22	21	1.6	PD	-2.9	0.0	15	8	0.8	D	-8.2	-0.1
11	0	0.3	S			11	0	0.3	S			11	0	0.2	S			10	0	0.2	S		
7	0	0.2	S			7	0	0.2	S			7	0	0.2	S			7	0	0.3	S		
7	0	0.2	S			6	2	0.3	S			7	0	0.2	S			7	0	0.3	S		
9	0	0.2	S			8	0	0.2	S			9	0	0.2	S			9	0	0.2	S		
4	0	0.2	S			4	0	0.2	S			4	0	0.2	S			4	0	0.3	S		
5	0	0.2	S			5	0	0.2	S			5	0	0.2	S			5	0	0.3	S		
4	0	0.2	S			4	0	0.2	S			4	0	0.2	S			4	0	0.3	S		
4	0	0.2	S			4	0	0.2	S			4	0	0.2	S			4	0	0.3	S		
4	0	0.3	S			4	0	0.3	S			4	0	0.3	S			4	0	0.4	S		
4	0	0.3	S			4	0	0.3	S			4	0	0.3	S			4	0	0.4	S		
4	0	0.3	S			4	0	0.3	S			4	0	0.3	S			4	0	0.4	S		
4	0	0.3	S			4	0	0.3	S			4	0	0.3	S			4	0	0.4	S		
4	0	0.3	S			4	0	0.3	S			4	0	0.3	S			4	0	0.4	S		
4	0	0.3	S			4	0	0.3	S			4	0	0.3	S			4	0	0.4	S		
5	0	0.3	S			5	0	0.3	S			5	0	0.3	S			5	0	0.4	S		
4	0	0.3	S			4	0	0.3	S			4	0	0.3	S			4	0	0.4	S		
5	0	0.3	S			5	0	0.3	S			5	0	0.3	S			5	0	0.3	S		
6	0	0.3	S			6	0	0.3	S			6	0	0.2	S			6	0	0.3	S		
5	0	0.3	S			5	0	0.3	S			5	0	0.3	S			5	0	0.3	S		
5	0	0.3	S			5	0	0.3	S			5	0	0.3	S			5	0	0.3	S		
6	0	0.3	S			6	0	0.1	S			6	0	0.2	S			6	0	0.3	S		
4	0	0.3	S			4	2	0.5	NT			4	0	0.3	S			4	1	0.5	NT		
5	0	0.3	S			5	0	0.3	S			5	0	0.3	S			5	0	0.3	S		
6	0	0.3	S			6	0	0.3	S			6	0	0.2	S			6	0	0.3	S		
5	0	0.3	S			5	0	0.3	S			5	0	0.3	S			5	0	0.4	S		
5	0	0.3	S			5	0	0.3	S			5	0	0.3	S			5	0	0.3	S		
4	1	0.4	NT			4	2	0.4	NT			4	0	0.3	S			4	0	0.4	S		
5	0	0.3	S			5	3	0.4	S			5	0	0.3	S			4	1	0.4	NT		
5	0	0.3	S			5	0	0.3	S			5	0	0.3	S			5	0	0.3	S		
4	0	0.1	S			4	0	0.1	S			4	0	0.1	S			4	0	0.1	S		
4	0	0.1	S			4	0	0.1	S			4	0	0.1	S			4	0	0.1	S		
2	0	0.2	N/A			2	0	0.1	N/A			2	0	0.1	N/A			2	0	0.2	N/A		
2	0	0.2	N/A			2	0	0.1	N/A			2	0	0.1	N/A			2	0	0.2	N/A		
2	0	0.1	N/A			2	0	0.1	N/A			2	0	0.1	N/A			2	0	0.2	N/A		

Table 1
Statistical Analysis of Groundwater Monitoring Data
LMC Beaumont Site 1
Data from August 1986 to June 2009

1,1,1,-TCA		Mean	1,1,1-TCA	Magnitude of Trend	
Num Samples	Num Detects	(µg/L)	Trend	(%/yr)	(µg/L/yr)
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.2	N/A		
2	0	0.2	N/A		
2	0	0.2	N/A		
2	0	0.2	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.2	N/A		
2	0	0.2	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
9	1	0.6	NT		
16	11	31.0	D	-12.4	-3.8
17	17	49.0	D	-16.1	-7.9
9	0	0.2	S		
9	1	0.6	NT		
7	1	0.7	NT		
4	1	0.9	NT		
9	3	0.5	PD	-2.8	0.0
1,466	857				
Total	Total	GeoMean			

1,1-DCA		Mean	1,1-DCA	Magnitude of Trend	
Num Samples	Num Detects	(µg/L)	Trend	(%/yr)	(µg/L/yr)
2	1	0.2	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	1	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	1	0.2	N/A		
2	0	0.1	N/A		
8	0	0.3	S		
15	9	2.1	NT		
18	16	5.8	D	-10.2	-0.6
9	0	0.3	S		
8	0	0.3	S		
6	0	0.3	S		
3	0	0.2	N/A		
8	2	0.5	NT		
1,291	755	0.72			
Total	Total	GeoMean			

1,2-DCA		Mean	1,2-DCA	Magnitude of Trend	
Num Samples	Num Detects	(µg/L)	Trend	(%/yr)	(µg/L/yr)
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
9	1	0.2	NT		
15	4	0.5	NT		
17	14	1.9	NT		
9	0	0.1	S		
9	1	0.3	NT		
7	1	0.3	NT		
4	1	0.3	NT		
9	2	0.4	PD	-5.0	0.0
1,470	850	1.13			
Total	Total	GeoMean			

cis--DCE		Mean	cis--DCE	Magnitude of Trend	
Num Samples	Num Detects	(µg/L)	Trend	(%/yr)	(µg/L/yr)
2	1	0.2	N/A		
2	0	0.2	N/A		
2	2	1.3	N/A		
2	0	0.2	N/A		
2	0	0.2	N/A		
2	0	0.2	N/A		
2	0	0.2	N/A		
2	0	0.2	N/A		
2	0	0.2	N/A		
2	0	0.2	N/A		
2	0	0.1	N/A		
2	0	0.1	N/A		
2	0	0.2	N/A		
2	0	0.2	N/A		
2	0	0.2	N/A		
2	0	0.2	N/A		
2	0	0.2	N/A		
2	0	0.2	N/A		
5	0	0.2	S		
11	0	0.3	S		
8	7	3.1	D	-14.0	-0.4
5	0	0.2	S		
6	0	0.2	S		
5	0	0.2	S		
3	0	0.1	N/A		
7	1	0.3	NT		
1,015	422	0.44			
Total	Total	GeoMean			

1,1,1-TCA (# wells)	% Total	1,1-DCA (# wells)	% Total	1,2-DCA (# wells)	% Total	cis-DCE (# wells)	% Total
37		38		36		37	
0		5		0		7	
27	21	30	24	51	39	27	22
38	29	69	56	42	32	65	53
0	0	5	4	3	2	3	2
0	0	0	0	0	0	0	0
56	43	18	15	26	20	20	16
8	6	1	1	8	6	7	6
129	100	123	100	130	100	122	100

Table 2
2008 Aquifer Plume Volume and Mass Estimates
Beaumont Site 1

Site and COCs	Area above MCL (acres)	Water Volume above MCL (acre-feet)	Mass (pounds) using maximum concentration at any depth	Mass (pounds) using depth averaged concentration	Comment
Site 1					
Perchlorate	227	2,529	5,083	3,364	
1,1-DCE	154	1,742	496	312	
TCE	145	1,550	365	249	
1,4-dioxane	179	2,081	147	102	
All COCs	278	3,018	5,943	3,925	All COCs driven by Perchlorate except in the Riparian Areas where it drops below MCL
All VOCs	154	1,742	861	561	All VOCs driven by TCE and 1,1-DCE

Table 3
Site 1 RMPA Groundwater Extraction Volumes and Mass Removals

Quarterly Period	Start Date	End Date	End Cumulative Volume (gallons)	Period Volume (gals)	EW-1 Volume (gals)	EW-1 1,1-DCE Concentration (ug/L)	EW-1 1,1-DCE Mass Removal (Kg)	EW-1 TCE Concentration (ug/L)	EW-1 TCE Mass Removal (Kg)	EW-1 1,1,1 TCA Concentration (ug/L)	EW-1 1,1,1 TCA Mass Removal (Kg)	EW-1 DCAs Concentration (ug/L)	EW-1 DCAs Mass Removal (Kg)	EW-2 Volume (gals)	EW-2 1,1-DCE Concentration (ug/L)	EW-2 1,1-DCE Mass Removal (Kg)	EW-2 TCE Concentration (ug/L)	EW-2 TCE Mass Removal (Kg)	EW-2 1,1,1 TCA Concentration (ug/L)	EW-2 1,1,1 TCA Mass Removal (Kg)	EW-2 DCAs Concentration (ug/L)	EW-2 DCAs Mass Removal (Kg)
1	10/1/92	12/31/92	0	0	0	1,150.0		360.0		75.0		48.0		0	955.0		110.0		314.7		150.0	
2	12/31/92	4/1/93	0	0	0	646.0		101.6		68.0		42.0		0	595.8		87.0		39.9		131.9	
3	4/1/93	7/1/93	0	0	0	566.0		102.8		60.3		36.4		0	547.8		110.3		38.3		113.9	
4	7/1/93	10/1/93	0	0	0	486.0		104.0		52.6		30.9		0	499.9		133.6		36.8		95.8	
5	10/1/93	12/31/93	0	0	0	406.0		105.2		44.9		25.3		0	451.9		156.9		35.2		77.8	
6	12/31/93	4/1/94	0	0	0	326.0		106.4		37.1		19.8		0	403.9		180.1		33.7		59.7	
7	4/1/94	7/2/94	414,900	414,900	362,208	246.0	0.34	107.6	0.15	29.4	0.04	14.2	0.02	52,692	355.9	0.07	203.4	0.04	32.1	0.01	41.7	0.01
8	7/2/94	10/1/94	7,280,293	6,865,393	5,993,488	166.0	3.77	108.8	2.47	21.7	0.49	8.7	0.20	871,905	308.0	1.02	226.7	0.75	30.6	0.10	23.6	0.08
9	10/1/94	12/31/94	14,368,100	7,087,807	6,187,656	86.0	2.01	110.0	2.58	14.0	0.33	3.1	0.07	900,151	260.0	0.89	250.0	0.85	29.0	0.10	5.6	0.02
10	12/31/94	4/2/95	20,955,274	6,587,174	5,750,603	79.5	1.73	97.5	2.12	14.0	0.30	4.5	0.10	836,571	195.0	0.62	190.0	0.60	22.0	0.07	5.4	0.02
11	4/2/95	7/2/95	27,260,665	6,305,391	5,504,606	73.0	1.52	85.0	1.77	14.0	0.29	5.9	0.12	800,785	130.0	0.39	130.0	0.39	15.0	0.05	5.3	0.02
12	7/2/95	10/1/95	34,662,335	7,401,670	6,461,658	73.3	1.79	81.0	1.98	12.3	0.30	5.2	0.13	940,012	132.5	0.47	130.0	0.46	13.8	0.05	4.9	0.02
13	10/1/95	1/1/96	40,969,880	6,307,545	5,506,487	73.5	1.53	77.0	1.60	10.7	0.22	4.5	0.09	801,058	135.0	0.41	130.0	0.39	12.5	0.04	4.5	0.01
14	1/1/96	4/1/96	47,292,135	6,322,255	5,519,329	73.8	1.54	73.0	1.53	9.0	0.19	3.7	0.08	802,926	137.5	0.42	130.0	0.40	11.3	0.03	4.1	0.01
15	4/1/96	7/1/96	51,757,459	4,465,324	3,898,228	74.0	1.09	69.0	1.02	7.3	0.11	3.0	0.04	567,096	140.0	0.30	130.0	0.28	10.0	0.02	3.7	0.01
16	7/1/96	10/1/96	55,814,639	4,057,180	3,541,918	78.5	1.05	92.5	1.24	7.2	0.10	2.0	0.03	515,262	133.5	0.26	143.0	0.28	11.0	0.02	2.9	0.01
17	10/1/96	12/31/96	60,324,400	4,509,761	3,937,021	83.0	1.24	116.0	1.73	7.0	0.10	1.0	0.01	572,740	127.0	0.28	156.0	0.34	12.0	0.03	2.0	0.00
18	12/31/96	4/1/97	62,803,174	2,478,774	2,163,970	77.5	0.63	101.4	0.83	6.6	0.05	2.4	0.02	314,804	102.5	0.12	155.0	0.18	9.8	0.01	3.0	0.00
19	4/1/97	7/1/97	64,811,557	2,008,383	1,753,318	72.0	0.48	86.7	0.58	6.2	0.04	3.7	0.02	255,065	78.0	0.08	154.0	0.15	7.5	0.01	3.9	0.00
20	7/1/97	10/1/97	66,642,257	1,830,700	1,598,201	80.5	0.49	86.5	0.52	4.9	0.03	2.7	0.02	232,499	114.5	0.10	154.0	0.14	6.6	0.01	3.4	0.00
21	10/1/97	12/31/97	69,318,507	2,676,250	2,336,366	88.9	0.79	86.3	0.76	3.6	0.03	1.6	0.01	339,884	151.0	0.19	154.0	0.20	5.6	0.01	2.9	0.00
22	12/31/97	4/1/98	72,276,092	2,957,585	2,581,972	92.8	0.91	89.2	0.87	5.4	0.05	5.7	0.06	375,613	158.5	0.23	171.5	0.24	7.2	0.01	7.6	0.01
23	4/1/98	7/2/98	77,164,382	4,888,290	4,267,477	96.7	1.56	92.0	1.49	7.2	0.12	9.8	0.16	620,813	166.0	0.39	189.0	0.44	8.7	0.02	12.2	0.03
24	7/2/98	10/1/98	79,458,682	2,294,300	2,002,924	95.2	0.72	84.5	0.64	6.0	0.05	6.4	0.05	291,376	174.5	0.19	177.5	0.20	7.4	0.01	8.1	0.01
25	10/1/98	12/31/98	84,404,382	4,945,700	4,317,596	93.6	1.53	77.0	1.26	4.8	0.08	3.0	0.05	628,104	183.0	0.44	166.0	0.39	6.0	0.01	4.0	0.01
26	12/31/98	4/2/99	89,064,282	4,659,900	4,068,093	76.3	1.17	77.0	1.19	5.0	0.08	1.5	0.02	591,807	146.5	0.33	166.0	0.37	5.0	0.01	1.5	0.00
27	4/2/99	7/2/99	92,684,984	3,620,702	3,160,873	59.0	0.71	77.0	0.92	4.8	0.06	0.5	0.01	459,829	110.0	0.19	166.0	0.29	6.0	0.01	3.2	0.01
28	7/2/99	10/1/99	95,470,784	2,785,800	2,432,003	59.0	0.54	77.0	0.71	5.0	0.05	1.0	0.01	353,797	115.0	0.15	166.0	0.22	5.5	0.01	3.3	0.00
29	10/1/99	1/1/00	96,917,385	1,446,601	1,262,883	59.0	0.28	77.0	0.37	5.0	0.02	1.0	0.00	183,718	120.0	0.08	166.0	0.12	5.0	0.00	3.4	0.00
30	1/1/00	4/1/00	100,996,385	4,079,000	3,560,967	59.0	0.80	77.0	1.04	5.0	0.07	1.0	0.01	518,033	125.0	0.25	166.0	0.33	4.5	0.01	3.5	0.01
31	4/1/00	7/1/00	103,626,414	2,630,029	2,296,015	59.0	0.51	77.0	0.67	5.0	0.04	1.0	0.01	334,014	130.0	0.16	166.0	0.21	4.0	0.01	3.6	0.00
32	7/1/00	10/1/00	105,974,414	2,348,000	2,049,804	59.0	0.46	77.0	0.60	5.0	0.04	1.0	0.01	298,196	130.0	0.15	166.0	0.19	4.0	0.00	3.6	0.00
33	10/1/00	12/31/00	106,286,414	312,000	272,376	59.0	0.06	77.0	0.08	5.0	0.01	1.0	0.00	39,624	130.0	0.02	166.0	0.02	4.0	0.00	3.6	0.00
34	12/31/00	4/1/01	106,574,414	288,000	251,424	59.0	0.06	77.0	0.07	5.0	0.00	1.0	0.00	36,576	130.0	0.02	166.0	0.02	4.0	0.00	3.6	0.00
35	4/1/01	7/1/01	110,128,414	3,554,000	3,102,642	59.0	0.69	77.0	0.90	5.0	0.06	1.0	0.01	451,358	130.0	0.22	166.0	0.28	4.0	0.01	3.6	0.01
36	7/1/01	10/1/01	113,252,414	3,124,000	2,727,252	59.0	0.61	77.0	0.79	5.0	0.05	1.0	0.01	396,748	130.0	0.20	166.0	0.25	4.0	0.01	3.6	0.01
37	10/1/01	12/31/01	113,433,354	180,940	157,961	59.0	0.04	77.0	0.05	5.0	0.00	1.0	0.00	22,979	130.0	0.01	166.0	0.01	4.0	0.00	3.6	0.00
38	12/31/01	4/1/02	116,438,259	3,004,905	2,623,282	59.0	0.59	77.0	0.76	5.0	0.05	1.0	0.01	381,623	130.0	0.19	166.0	0.24	4.0	0.01	3.6	0.01
39	4/1/02	7/2/02	119,066,423	2,628,164	2,294,387	59.0	0.51	77.0	0.67	5.0	0.04	1.0	0.01	333,777	130.0	0.16	166.0	0.21	4.0	0.01	3.6	0.00
40	7/2/02	10/1/02	121,796,594	2,730,171	2,383,439	59.0	0.53	77.0	0.69	5.0	0.05	1.0	0.01	346,732	130.0	0.17	166.0	0.22	4.0	0.01	3.6	0.00
41	10/1/02	12/31/02	123,789,093	1,992,499	1,739,452	59.0	0.39	77.0	0.51	5.0	0.03	1.0	0.01	253,047	130.0	0.12	166.0	0.16	4.0	0.00	3.6	0.00
42	12/31/02	4/2/03	0	0	0									0								
43	4/2/03	7/2/03	0	0	0									0								
44	7/2/03	10/1/03	0	0	0									0								
45	10/1/03	1/1/04	0	0	0									0								
46	1/1/04	4/1/04	0	0	0									0								
47	4/1/04	7/1/04	0	0	0									0								
48	7/1/04	10/1/04	0	0	0									0								
49	10/1/04	12/31/04	0	0	0									0								
50	12/31/04	4/1/05	0	0	0									0								
51	4/1/05	7/1/05	0	0	0									0								
52	7/1/05	10/1/05	0	0	0									0								
53	10/1/05	12/31/05	0	0	0									0								
54	12/31/05	4/1/06	0	0	0									0								
55	4/1/06	7/2/06	0	0	0									0								
56	7/2/06	10/1/06	0	0	0									0								
57	10/1/06	12/31/06	0	0	0									0								
58	12/31/06	4/2/07	0	0	0									0								
59	4/2/07	7/2/07	0	0	0									0								
60	7/2/07	10/1/07	0	0	0									0								
61	10/1/07	1/1/08	0	0	0									0								
62	1/1/08	4/1/08	0	0	0									0								
63	4/1/08	7/1/08	0	0	0									0								
64	7/1/08	10/1/08	0	0	0									0								
Sum All VOCs = 93 KG			Totals	123,789,093	108,067,878		32.66		35.15		3.57		1.41	15,721,215		9.28		9.87		0.68		0.33

White = Measured Concentration
Yellow = Interpolated Concentration

Table 4
COC Mass Flux Summary

Unsaturated Zone Sources

		Comments	
Groundwater Diffuse Recharge Rate	2.42 in/yr	0.20	ft/yr
Soil Water Content	0.10		
Soil Air Content	0.20		

BPA TCE Soil Source (Figure 8)

area, acres	10	
thickness, feet	50	
Total Soil TCE Concentration, ug/kg	4	equilibrium with soil gas
Soil Gas TCE Concentration, ug/cm m	11,000	
Soil Water Conc ug/l	33	equilibrium with soil gas
bulk density, kg/cu m	1,500	
soil volume, L	13,653	area x thickness
soil mass, Kg	20,479	volume x bulk density
TCE Mass pounds	7	Total Soil Con x soil mass
TCE Mass Flux, pounds per year	0.29	Soil Water Conc x area x recharge
TCE Source Duration, year	25	Mass/Mass Flux

BPA (C-22) Perchlorate Soil Source (Figure 7)

area, acres	3.08	
Total Soil Concentration, ug/Kg >200	200	
area acres	1.4	
Total Soil Concentration, ug/Kg >1,000	1000	
area acres	0.3	
Total Soil Concentration, ug/Kg >10,000	25000	
Perchlorate Mass lbs	750	
Perchlorate Mass Flux, pounds per year	73.5	Soil Water Conc x area x recharge
Perchlorate Source Duration, year	10.2	Mass/Mass Flux

RMPA (B-11) Perchlorate Soil Source (Figure 7)

area, acres	5.34	
Total Soil Concentration, ug/Kg >200	200	
area acres	0.3	
Total Soil Concentration, ug/Kg >1,000	1000	
Perchlorate Mass lbs	277	
Perchlorate Mass Flux, pounds per year	10.7	Soil Water Conc x area x recharge
Perchlorate Source Duration, year	25.8	Mass/Mass Flux

RMPA (B-9/B-19) Perchlorate Soil Source (Figure 7)

area, acres	5.28	
Total Soil Concentration, ug/Kg >200	200	
area acres	0.05	
Total Soil Concentration, ug/Kg >1,000	1000	
Perchlorate Mass lbs	87.6	
Perchlorate Mass Flux, pounds per year	9.0	Soil Water Conc x area x recharge
Perchlorate Source Duration, year	9.7	Mass/Mass Flux

RMPA (B-10/B-20) Perchlorate Soil Source (Figure 7)

area, acres	0.638	
Total Soil Concentration, ug/Kg >200	200	
area acres	0.05	
Total Soil Concentration, ug/Kg >1,000	1000	
Perchlorate Mass lbs	21.85	
Perchlorate Mass Flux, pounds per year	1.4	Soil Water Conc x area x recharge
Perchlorate Source Duration, year	15.8	Mass/Mass Flux

Table 4
COC Mass Flux Summary

RMPA (B-14) Perchlorate Soil Source (Figure 7)

area, acres	0.35	
Total Soil Concentration, ug/Kg >200	200	
area acres	0.05	
Total Soil Concentration, ug/Kg >1,000	1000	
Perchlorate Mass lbs	21.85	
Perchlorate Mass Flux, pounds per yea	0.9	Soil Water Conc x area x recharge
Perchlorate Source Duration, year	24.0	Mass/Mass Flux

F-33 Perchlorate Soil Source (Figure 7)

area, acres	0.506887052	
Total Soil Concentration, ug/Kg >200	200	
area acres	0.253443526	
Total Soil Concentration, ug/Kg >1,000	1000	
Perchlorate Mass lbs	217	
Perchlorate Mass Flux, pounds per yea	2.5	Soil Water Conc x area x recharge
Perchlorate Source Duration, year	86.8	Mass/Mass Flux

Saturated Zone Sources

BPA

Width across hot spot, feet	225	perpendicular to groundwater flow
Perchlorate Mass Flux, pounds per yea	46	Estimated by Flow Model and Contour Maps; probablility of source uncertain since soil source also contributes to releases
1,4-dioxane Mass Flux, pounds per yea	3	Estimated by Flow Model and Contour Maps; probablility of source fairly certain since no soil source contributes to releases
TCE Mass Flux, pounds per year	11	Estimated by Flow Model and Contour Maps; probablility of source fairly certain since no soil source contributes to releases
1,1-DCE Mass Flux, pounds per year	14	Estimated by Flow Model and Contour Maps; probablility of source fairly certain since no soil source contributes to releases

RMPA

Width across hot spot, feet	500	perpendicular to groundwater flow
Perchlorate Mass Flux, pounds per yea	15	Estimated by Flow Model and Contour Maps; probablility of source uncertain since soil source also contributes to releases
1,4-dioxane Mass Flux, pounds per yea	1	Estimated by Flow Model and Contour Maps; probablility of source fairly certain since no soil source contributes to releases
TCE Mass Flux, pounds per year	5	Estimated by Flow Model and Contour Maps; probablility of source fairly certain since no soil source contributes to releases
1,1-DCE Mass Flux, pounds per year	4	Estimated by Flow Model and Contour Maps; probablility of source fairly certain since no soil source contributes to releases

Source Duration is considered indefinite for all satuared zone sources unless source remediation is considered

Table 5
Summary of Tranport Model Parameters
Beaumont Site 1

Parameter	Value	Source
Transport		
Total porosity[1]	0.2	Radian 1992 Hydrogeologic Study; Tetra Tech, 2009c
Effective porosity[2]	0.1	Flow Model Specific Yield Value, Tetra Tech, 2009b
Longitudinal dispersivity	50 feet	US EPA, 1998
Transverse dispersivity	1/10 to 1/3 * α_L	US EPA, 1998
Vertical dispersivity	1/100 to 1/20 * α_L	US EPA, 1998
Dry bulk density[3]	1.5 g/cm3	site data average
Fraction organic carbon	0 to 0.0001	assumption (VOC Retardation Factor ~ 1 to 1.2)
perchlorate degradation rate	2 $year^{-1}$	site data trends
TCE degradation rate	0.04 $year^{-1}$	site data trends
1,1-DCE degradation rate	0.02 $year^{-1}$	site data trends
1,4-dioxane degradation rate	0 $year^{-1}$	conservative transport

Definitions:

α_L - Longitudinal dispersivity.
g/cm^3 - Grams per cubic centimeter.

[1]The total porosity cited is not the true total porosity that would be measured in a lab sample, but a field scale value for model grid blocks and estimating plume mass. This value excludes lower permeability interbeds in the aquifer, and is hence less than the true total porosity. The 20 percent value is also consistent with the value used in earlier site mass estimates.

[2]The effective porosity excludes interbeds and also accounts for fast and slow paths through the remaining beds.

[3]The bulk density value is the true aquifer bulk density that would be measured in a lab sample, and thus may appear inconsitent with the field scale total porosity value given above.

FIGURES

X:\Public\Lockheed- Beaumont\Site 1 Transport Model TM\LMC1_NumTrnsMdl_TM\LMC1_NumTrnsMdl_TM_PDf\Graphics\Fig_01.cdr

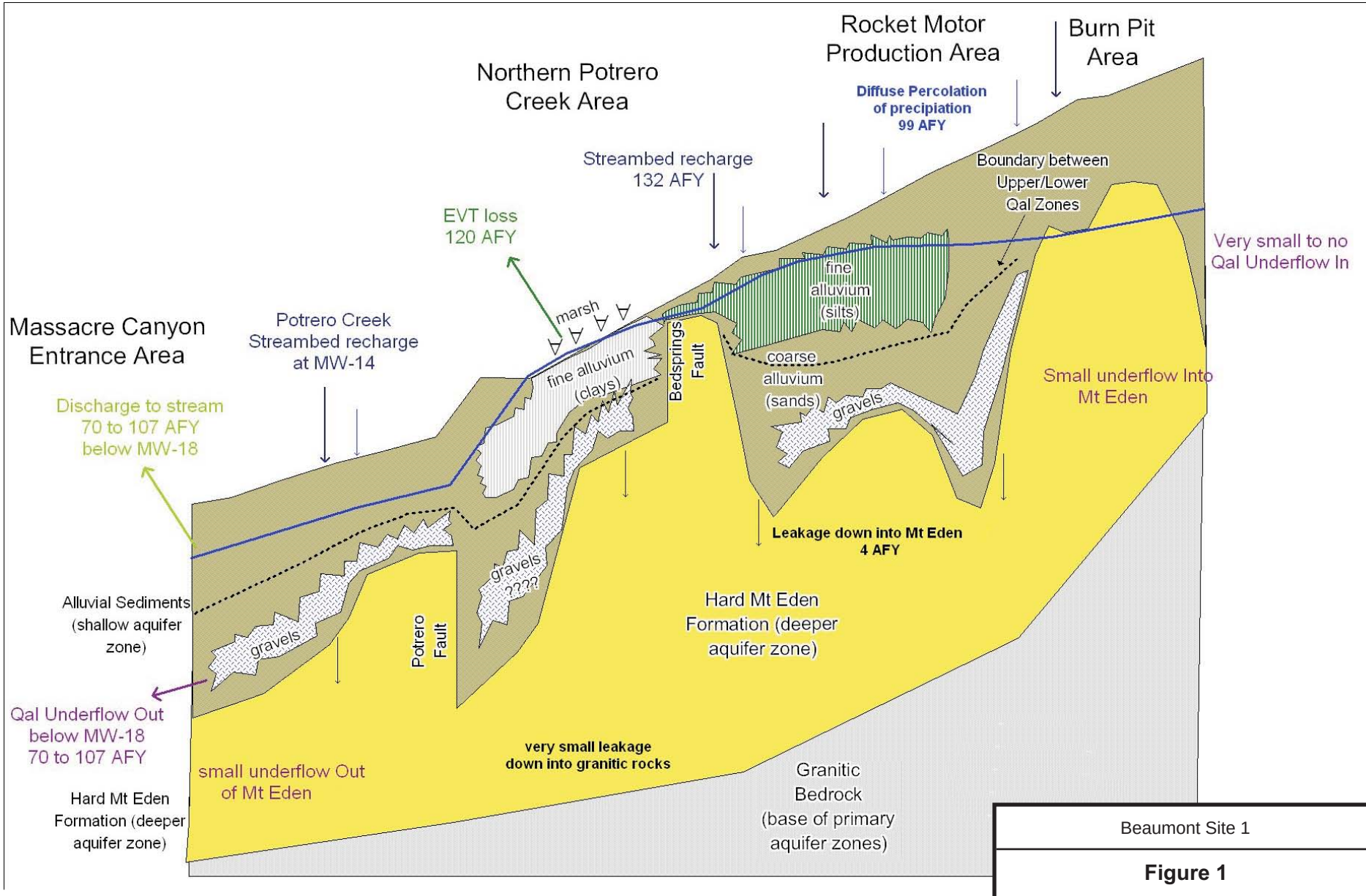


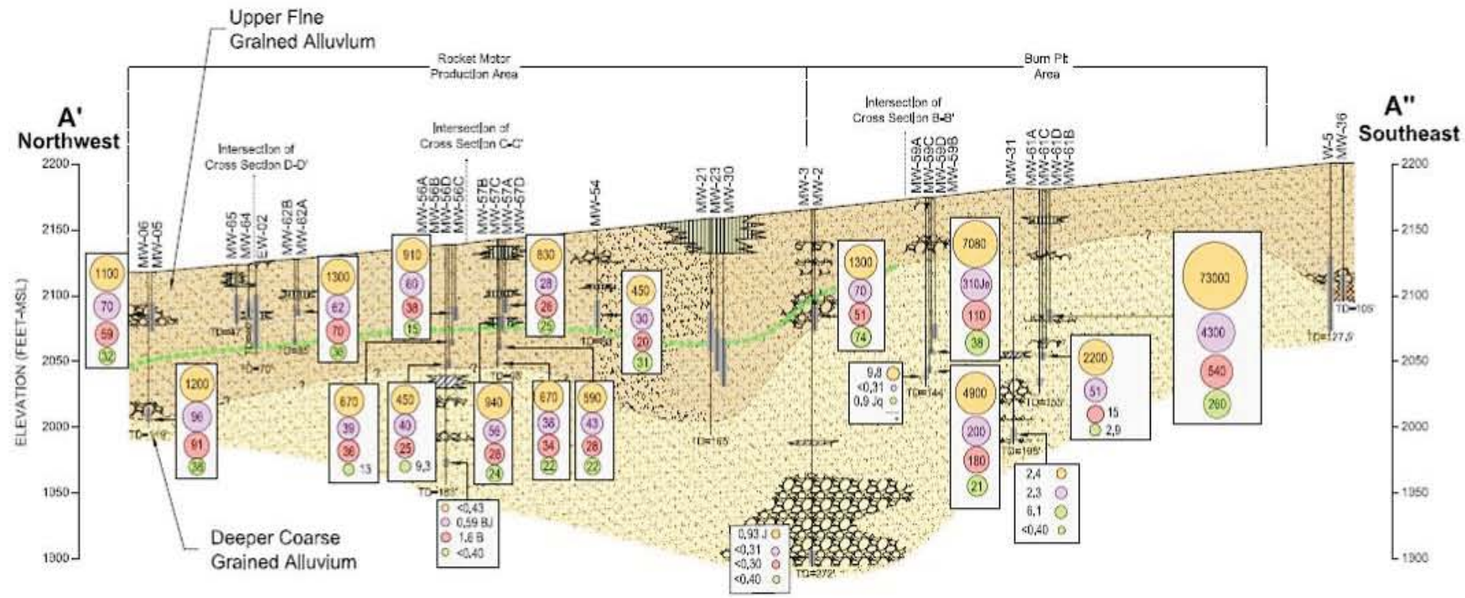
Illustration not to scale.

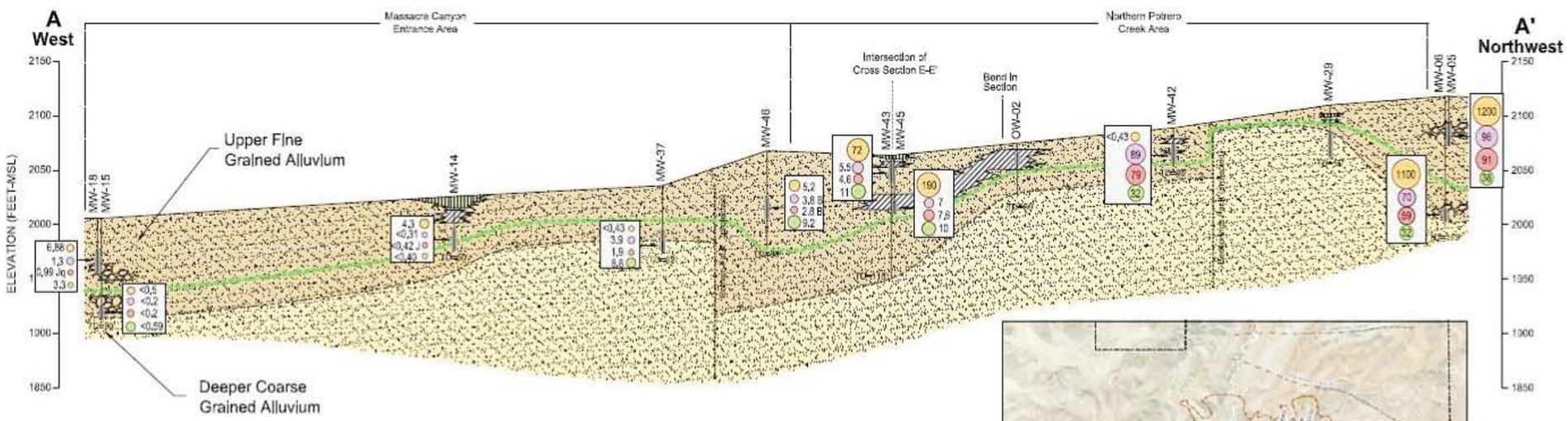
Beaumont Site 1

Figure 1

Updated Hydrostratigraphic Conceptal Model

TETRA TECH





Adapted from:
Faults from Hydrogeologic Investigations for Water Resources Development, Leighton and Associates, 1983.

LEGEND

Concentrations in µg/L

- 500 Perchlorate
- 200 1,1-DCE
- 200 TCE
- 50 1,4-Dioxane
- No Analysis

- Clay
- Silt
- Sand and Gravel
- Sandstone with some gravelly layering
- Weathered Granite or Granitic Boulder
- Boundary Between Upper and Lower Alluvium
- Inferred Contact
- Well
- Screened Interval
- TD=60' Total Boring Depth (feet)

Notes: COPC concentrations shown from 2nd Quarter 2006 Groundwater Monitoring Event, unless noted.

* 2Q02 Groundwater Monitoring Event.

B = The sample result is less than 5 times (10 times for common organic laboratory contaminants) the blank contamination. The result qualified for blank contamination is considered not to have originated from the environmental sample, since cross-contamination is suspected.

e = A holding time violation occured.

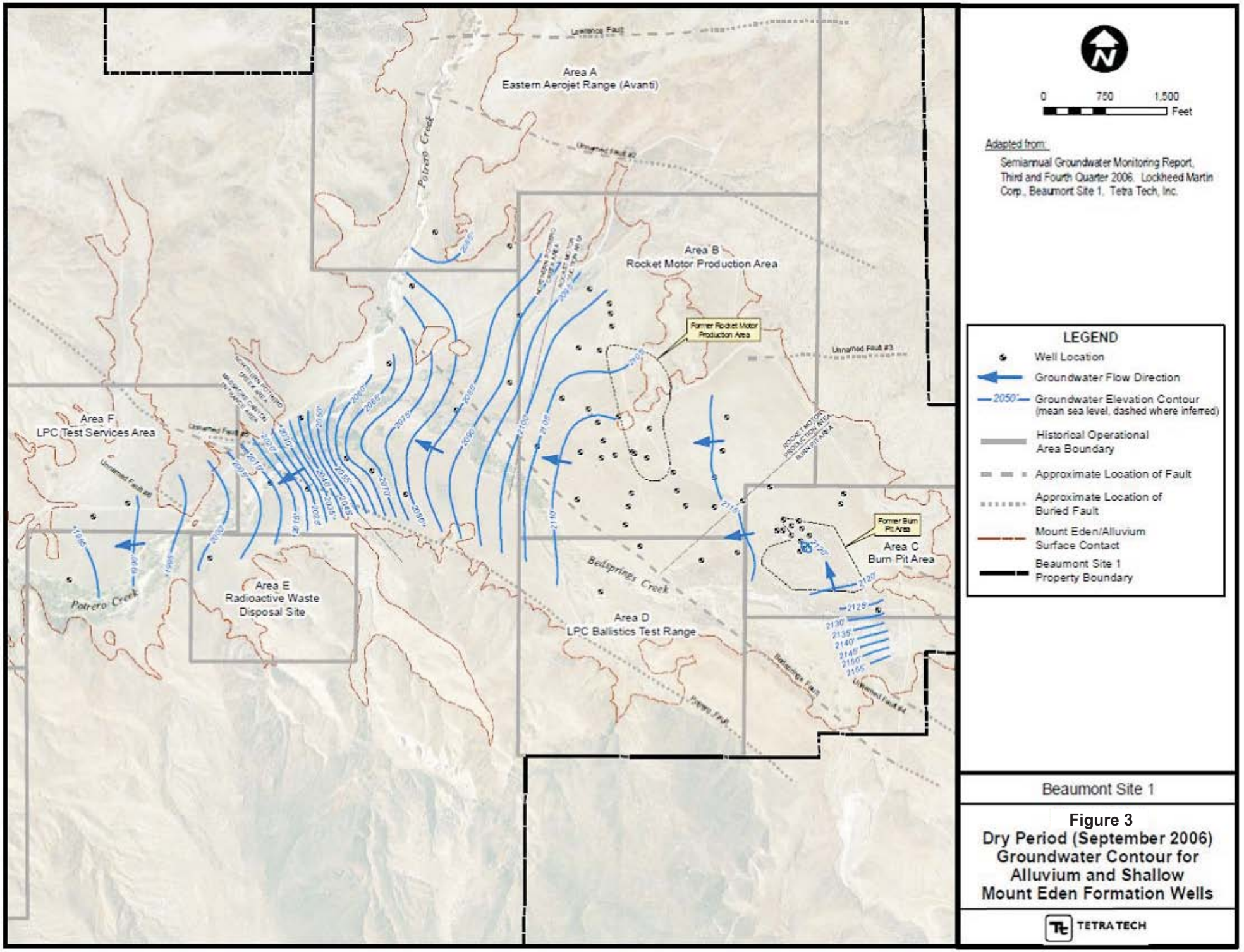
J = Analyte was positively identified and the reults is usable; however, the analyte concentration reported is an estimated value.

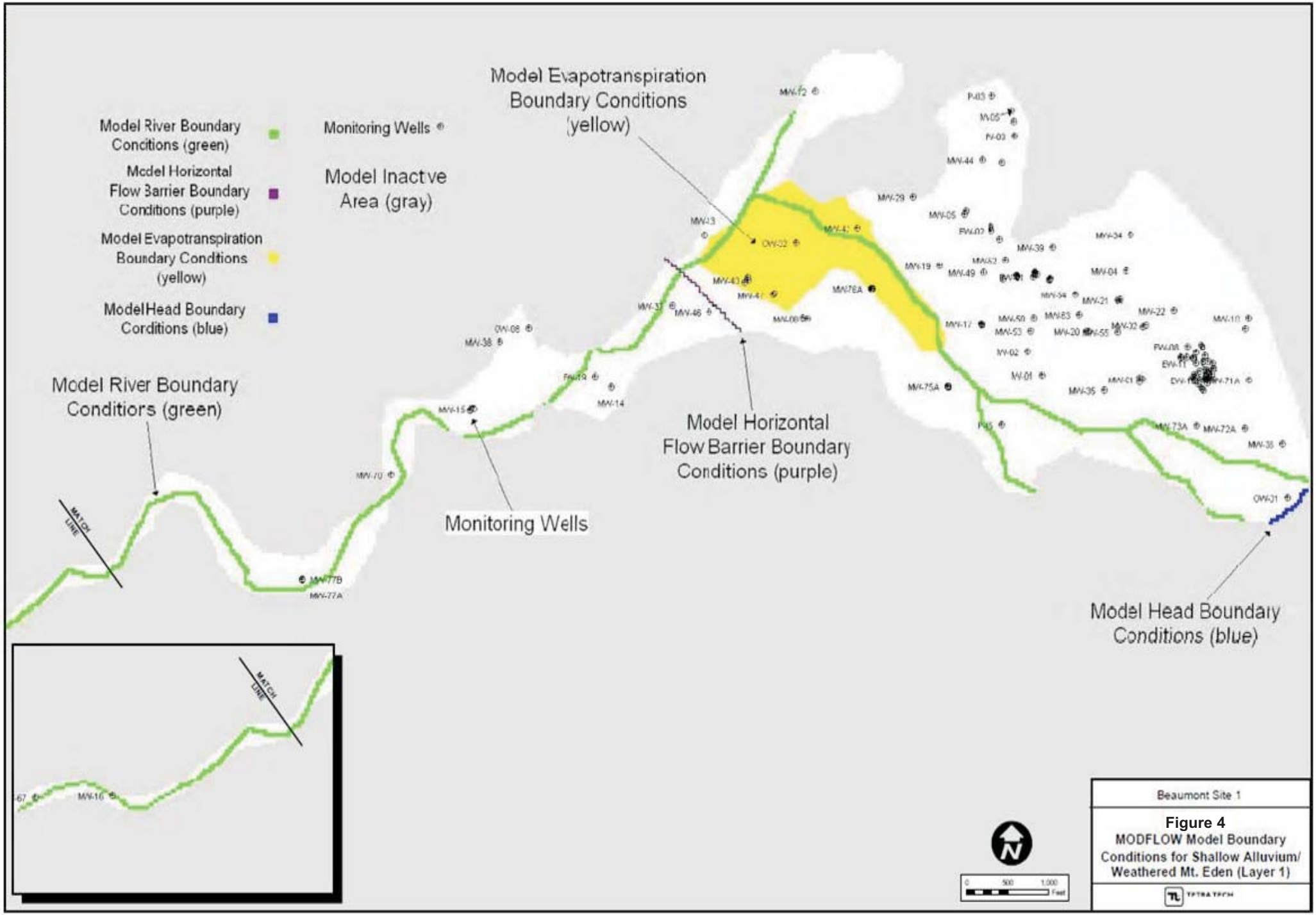
k = The analyte was found in the field blank.

Beaumont Site 1

Figure 2
Cross Section A-A'-A"

TETRA TECH


Area A
Eastern Aerojet Range (Avanti)
Area B
Rocket Motor Production Area
Former Rocket Motor Production Area
Area C
Burn Pit Area
Former Burn Pit Area
Area D
LPC Ballistics Test Range
Area E
Radioactive Waste Disposal Site
Area F
LPC Test Services Area
Potrero Creek
Bedsprings Creek
Lawrence Fault
Unnamed Fault #2
Unnamed Fault #3
Unnamed Fault #4
Unnamed Fault #5
Potrero Fault
Bedsprings Fault
0
750
1,500
Feet
Adapted from:
Semiannual Groundwater Monitoring Report, Third and Fourth Quarter 2006. Lockheed Martin Corp., Beaumont Site 1. Tetra Tech, Inc.
LEGEND
Well Location
Groundwater Flow Direction
2050' Groundwater Elevation Contour (mean sea level, dashed where inferred)
Historical Operational Area Boundary
Approximate Location of Fault
Approximate Location of Buried Fault
Mount Eden/Alluvium Surface Contact
Beaumont Site 1 Property Boundary
Beaumont Site 1
Figure 3
Dry Period (September 2006) Groundwater Contour for Alluvium and Shallow Mount Eden Formation Wells
TETRA TECH


Model River Boundary Conditions (green)
Model Horizontal Flow Barrier Boundary Conditions (purple)
Model Evapotranspiration Boundary Conditions (yellow)
ModelHead Boundary Conditions (blue)
Monitoring Wells
Model Inactive Area (gray)
Model Evapotranspiration Boundary Conditions (yellow)
Model River Boundary Conditions (green)
Model Horizontal Flow Barrier Boundary Conditions (purple)
Monitoring Wells
Model Head Boundary Conditions (blue)
MATCH LINE
MATCH LINE
Beaumont Site 1
Figure 4
MODFLOW Model Boundary Conditions for Shallow Alluvium/ Weathered Mt. Eden (Layer 1)
TETRA TECH

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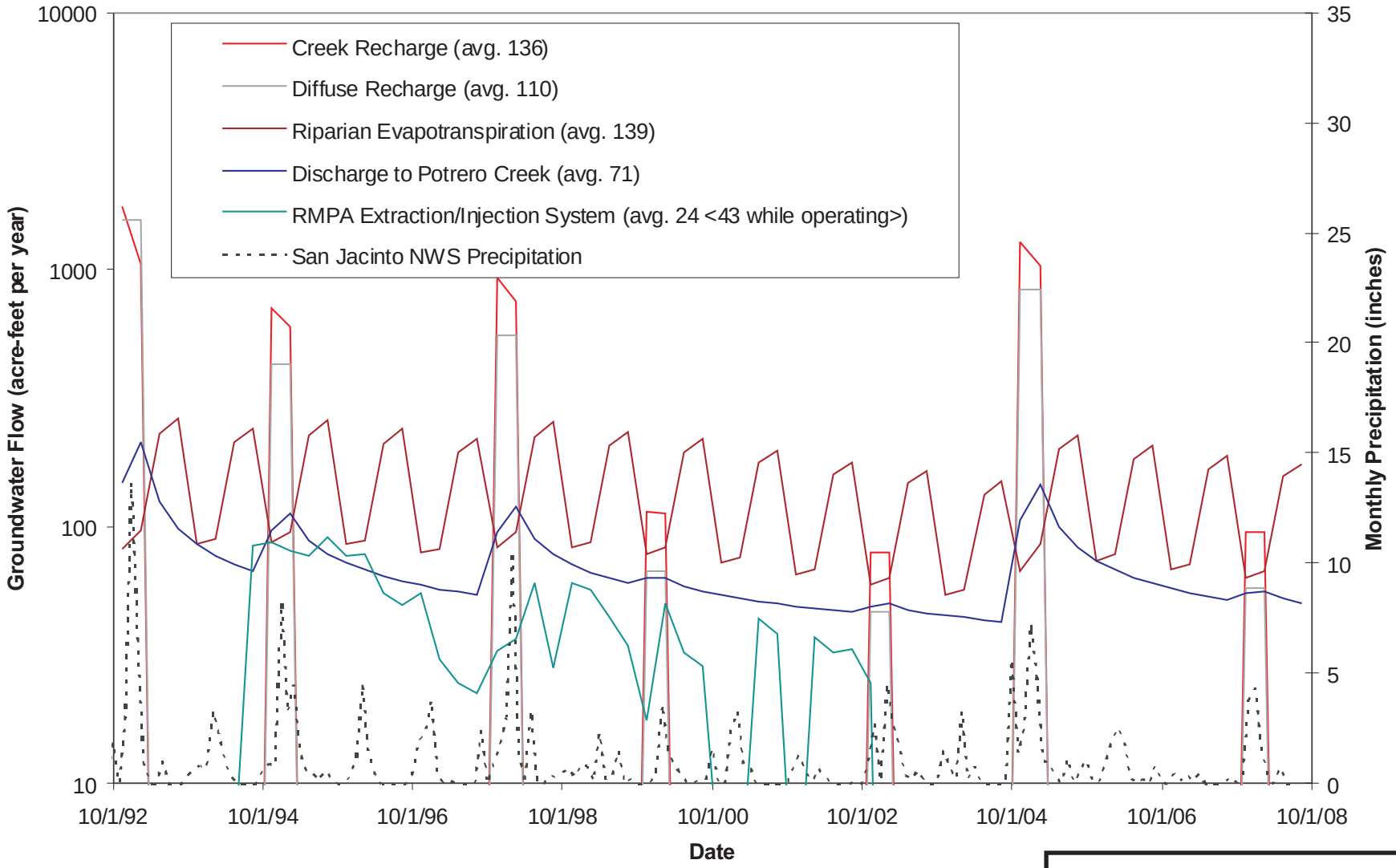

Beaumont Site 1

Figure 5

Groundwater Flow Predicted by the Model for 1992-2008 Transient Calibration

TETRA TECH

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Area A
Eastern Aerojet Range (Avanti)

Area B
Rocket Motor Production Area

Area C
Burn Pit Area

Area D
LPC Ballistics Test Range

Area E
Radioactive Waste Disposal Site

Area F
LPC Test Services Area

Area G
Helicopter Weapons Test Area

Former Rocket Motor Production Area

Former Burn Pit Area

Unnamed Fault #2

Unnamed Fault #3

Unnamed Fault #5

Unnamed Fault #6

Unnamed Fault #4

Potrero Creek

Bedsprings Creek

Bedsprings Fault

Potrero Fault

NORTHERN POTRERO CREEK AREA

MASSACRE CANYON ENTRANCE AREA

ROCKET MOTOR PRODUCTION AREA

ROCKET MOTOR PRODUCTION AREA BURN PIT AREA

MW-11, MW-12, MW-13, MW-14, MW-15, MW-18, MW-23, MW-26, MW-27, MW-28, MW-34, MW-37, MW-40, MW-41, MW-42, MW-43, MW-45, MW-46, MW-47, MW-48, MW-49, MW-53, MW-54, MW-55, MW-56A, MW-56B, MW-56C, MW-59A, MW-59B, MW-59D, MW-60A, MW-60B, MW-61A, MW-61B, MW-61C, MW-62A, MW-66, MW-68, MW-69, MW-71B, MW-71C, MW-72B, MW-72C, MW-73A, MW-73B, MW-73C, MW-74C, MW-75A, MW-75B, MW-75C, MW-76A, MW-76B, MW-76C, MW-77A, MW-77B, MW-79A, MW-79C, MW-80, MW-81, OW-01, OW-02, OW-05, OW-06, P-02, P-03, P-05, EW-13

0 500 1,000 Feet

Adapted from: March 2007 aerial photograph.
Well locations from Hiltwig and Goodrow survey, 2003.

LEGEND

- Groundwater Monitoring Well
- Perchlorate (6.0 µg/L MCL)- Dashed Where Inferred
- 1,1 DCE (6.0 µg/L MCL)- Dashed Where Inferred
- Trichloroethene (5.0 µg/L MCL)- Dashed Where Inferred
- 1,4-Dioxane (3.0 µg/L DWNL)- Dashed Where Inferred
- Historical Operational Area Boundary
- Approximate Location of Fault
- Approximate Location of Buried Fault
- Mount Eden/Alluvium Surface Contact
- Beaumont Site 1 Property Boundary

Notes:
Beaumont Site 1 property boundary is approximate.
Contours adapted from *Semiannual Groundwater Monitoring Report First Quarter and Second Quarter 2008*, Tetra Tech.

1,1-DCE - 1,1-Dichloroethene
DWNL - California Department of Health Services drinking water notification level.
MCL - Maximum Contaminant Level.
µg/L - Micrograms per liter.

Beaumont Site 1

Figure 6

Primary COPC Extents for Alluvium and Shallow Mount Eden Formation

TETRA TECH

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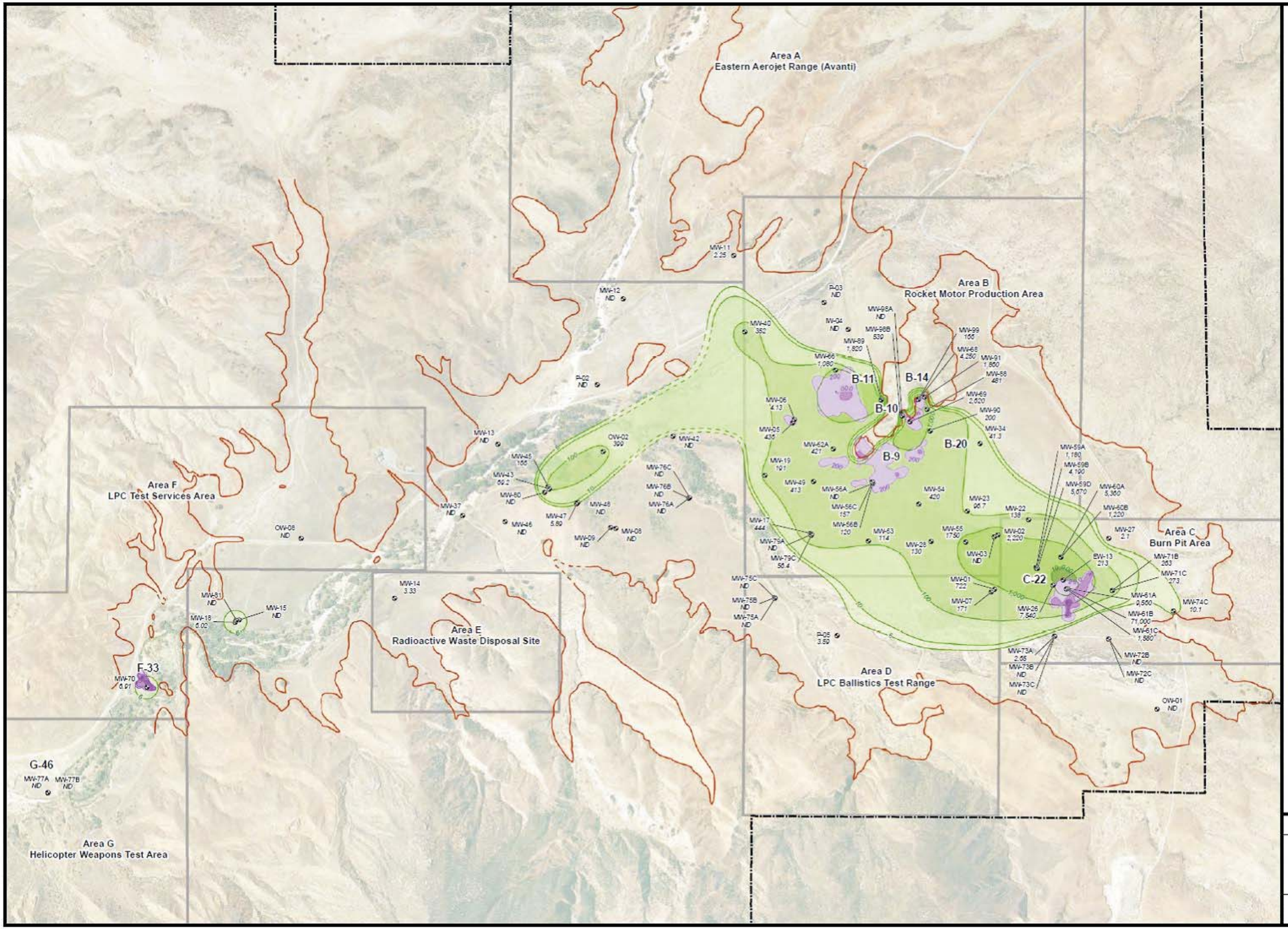

Beaumont Site 1

Figure 7
Perchlorate Soil Source Areas and Groundwater Impacts

TETRA TECH

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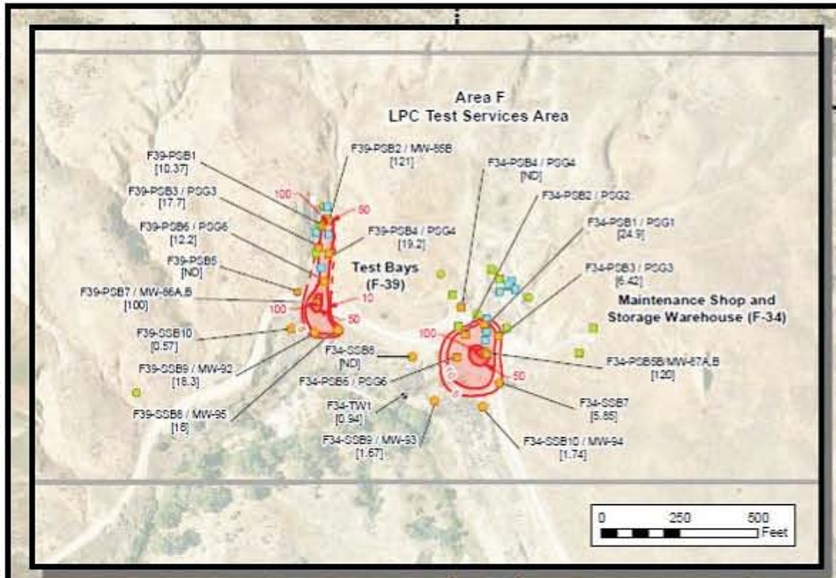

Area A
Eastern Aerojet Range (Avanti)

Area B
Rocket Motor Production Area

Area C
Burn Pit Area

Area D
LPC Ballistics Test Range

Area E
Radioactive Waste Disposal Site

Area F
LPC Test Services Area

Area G
Helicopter Weapons Test Area

B-9
B-10
B-11
B-14
B-20
C-22
F-33
G-46

0 500 1,000 Feet

Adapted from: March 2007 aerial photograph.

LEGEND

Sample Locations

- Primary Soil Boring, 2008
- Secondary Soil Boring
- Primary Soil Boring/Soil Vapor, 2008
- Soil Vapor, 2002
- Soil Boring/Soil Vapor, 2007
- Soil Boring, 2004
- Soil Boring/Soil Vapor, 2004
- Well

Trichloroethene (TCE) in Soil

- VOC Soil Source Area

Trichloroethene (TCE) Concentration in Groundwater

- >5 µg/L
- >10 µg/L
- >50 µg/L
- >100 µg/L
- >1,000 µg/L

- Alluvium / Bedrock contact
- Beaumont Site 1 Property Boundary
- Historical Operational Area Boundary

Note:

[#] - TCE results in µg/L.

µg/L - Micrograms per liter.

[ND] - Non-Detect.

Boring symbols with no labels indicate sample was not tested at depth interval.

Beaumont Site 1

Figure 8

TCE Soil Source Area and Groundwater Impacts

TETRA TECH

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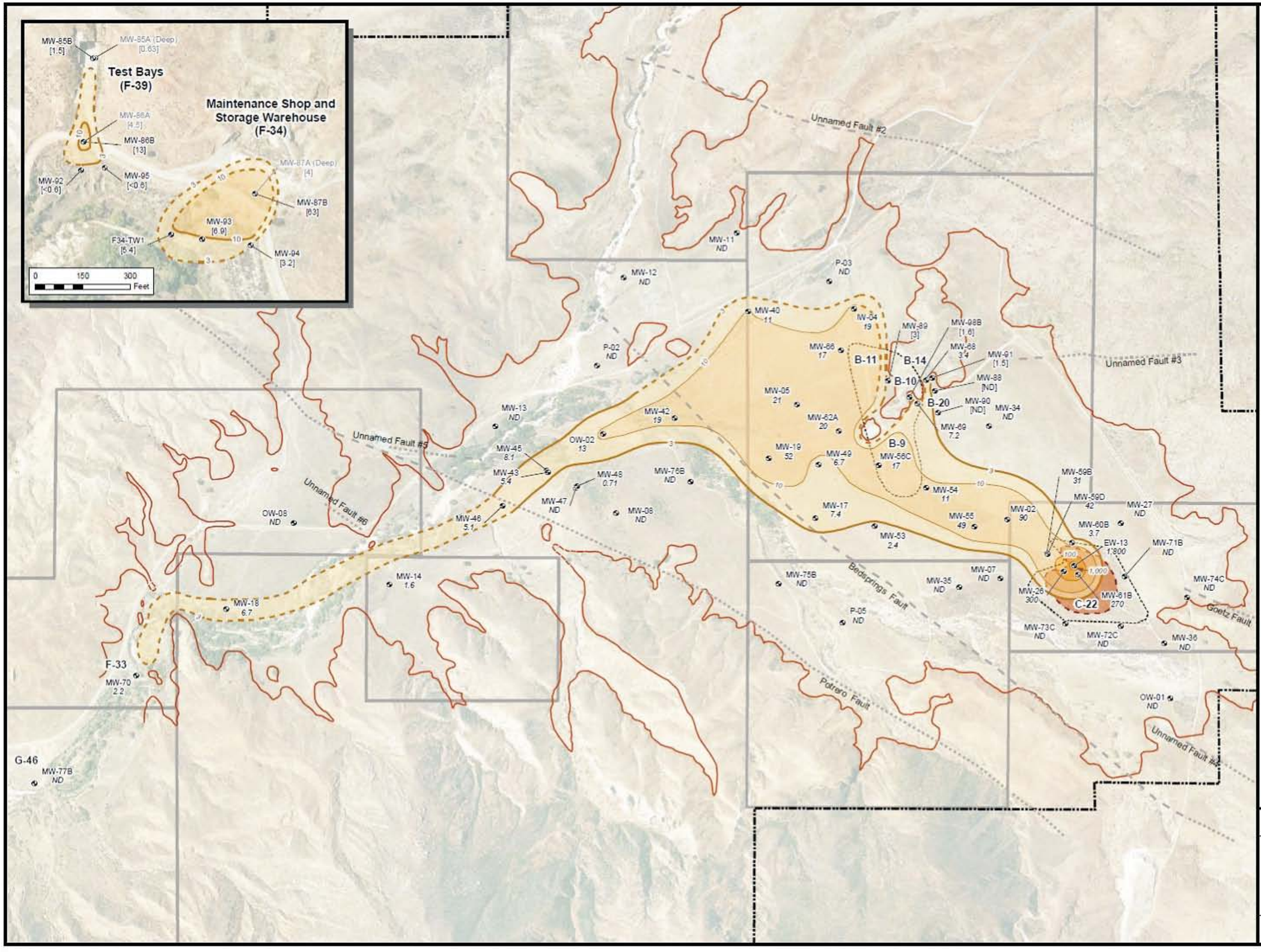

Beaumont Site 1

Figure 9
1,4-Dioxane Source Area and Groundwater Impacts

TETRA TECH

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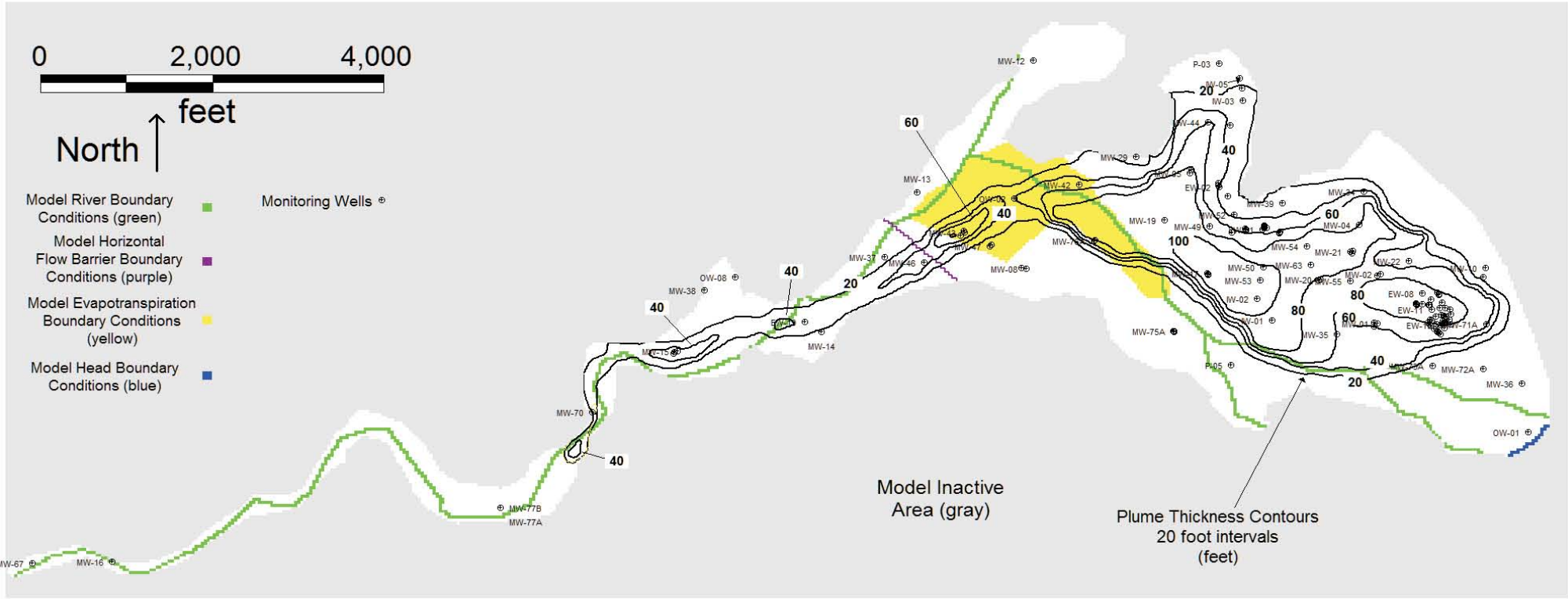


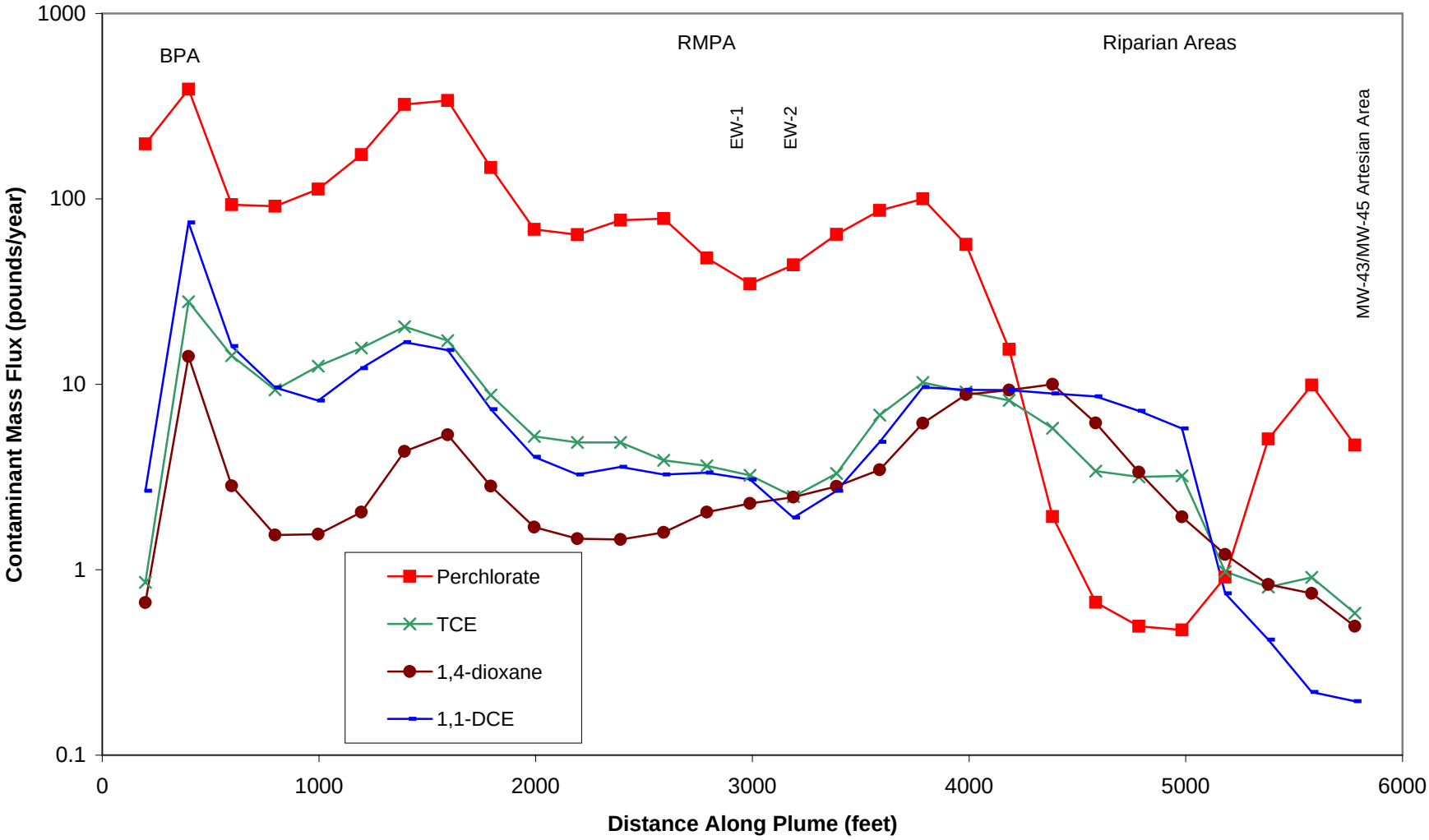
Beaumont Site 1

Figure 10

Plume Thickness Contour Map

TETRA TECH

Figure 11. COC mass flux rate across the entire plume width at various locations along plume.



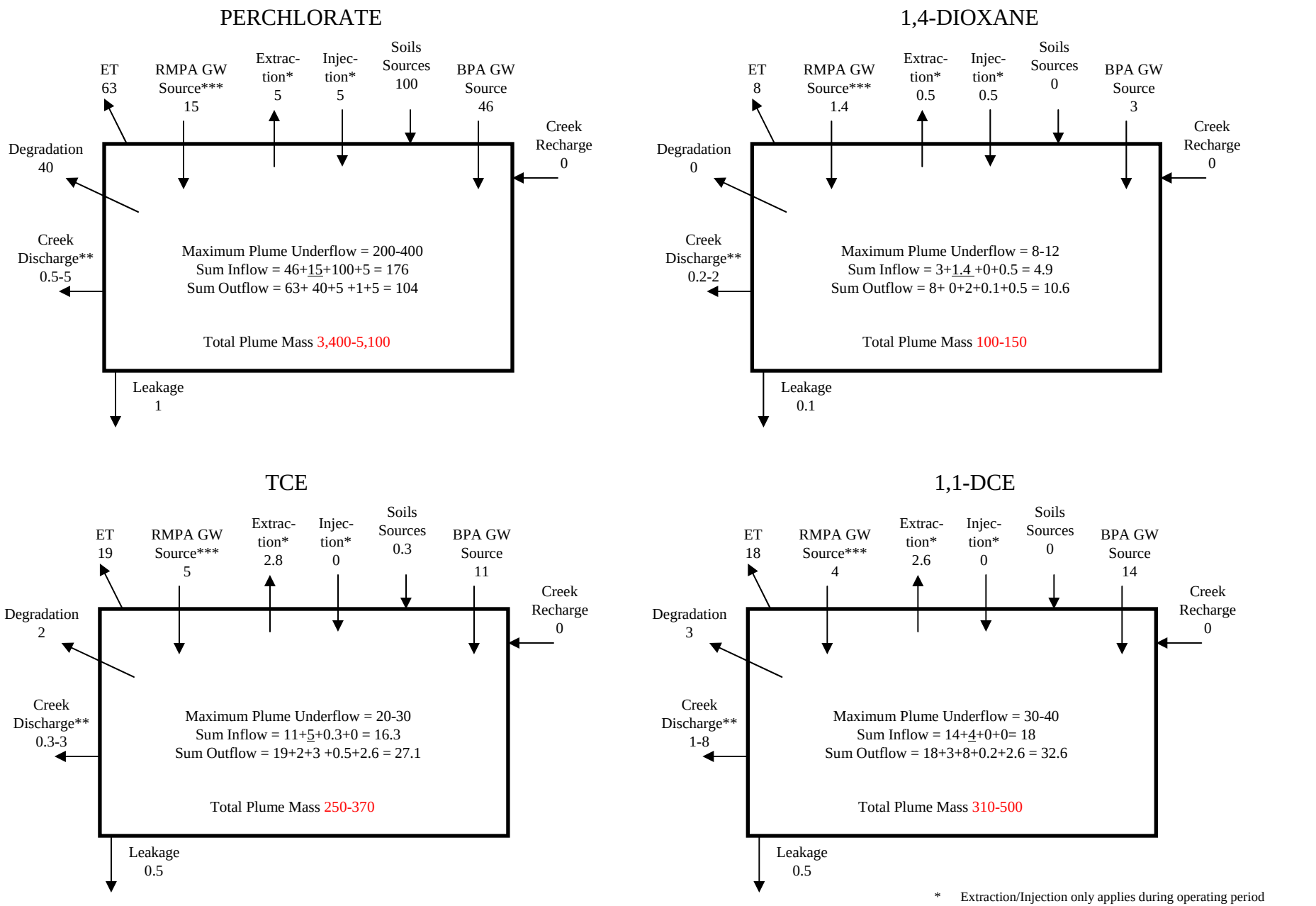


Figure 12. COC Mass Flux Diagrams