Executive Summary

The Monterey County Water Resources Agency, (MCWRA) in partnership with the Central Coast Regional Water Quality Control Board (CCRWQCB) and the County of Monterey, Department of Health, Division of Environmental Health [or Monterey County of Environmental Health Division] (MCEHD), agreed to perform a subsurface investigation to characterize the nature and extent of Methyl *tertiary*-butyl ether (MTBE) that significantly impacts the City of Salinas municipal groundwater supply and to find the party or parties responsible for the MTBE release(s) so that the CCRWQCB staff can take appropriate enforcement actions to direct the cleanup of the MTBE release and recover incurred costs including Cleanup and Abatement Account expenditures.

The objectives of this investigation included identification and location of possible MTBE contamination sites; analysis of shallow groundwater samples from the sites and deeper groundwater samples from contaminated wells to determine geochemical forensic similarities, analysis of all available groundwater and subsurface information to determine probable groundwater flow from the sites to the contaminated wells, and classification of the sites so that additional work on the MTBE contamination impacts can be performed.

Between February 2002 and April 2010, the fuel oxygenate MTBE was detected in five California Water Service Company (CWS) production wells (Wells 1-04, 13-02, 13-01, 15-01, and 28-01)[1] in Salinas, California. MTBE maximum concentrations had increased to 400 micrograms per liter (µg/L) in one well (Well 13-02) by July 2004. The California primary maximum contaminant level (MCL) of MTBE is 13 µg/L. The cleanup goal used by the CCRWQCB is the secondary MCL of 5 µg/L. The presence of MTBE in the water supply wells resulted in the destruction of one well (Well 1-04), removal from service for three wells (inactive Wells 13-02, 15-01, and 28-01), and placement on standby for the fifth well (Well 13-01). Three of the wells (1-04, 13-02, and 13-01) had a combined pumping capacity of over 2,800 gallons per minute (gpm).

The CCRWQCB compiled records of permitted gasoline storage facilities and known leaking underground storage tank (LUST) cases within a 0.5-mile radius of Wells 1-04, 13-01, and 13-02 between February 2002 and December 2004. However, the CCRWQCB was unable to identify the responsible parties for any significant MTBE release of a magnitude that may have resulted in the known impacts to the CWS production wells. The MCEHD conducted a brief investigation resulting in a poster dated May 31, 2005 and titled "MTBE Contamination of a Salinas Drinking Water Well".

In December 2007, the MCWRA and the CCRWQCB conducted an informational meeting inviting interested consultants and parties to participate in a subsurface investigation to determine potential source(s) of the MTBE. The MCWRA asked for and

[1] The wells detected MTBE in the stated order. At the time of the initial proposal in January 2008 only wells 1-04, 13-01, and 13-02 were known to be impacted by MTBE.

reviewed Concept Proposals from qualified consultants in January 2008, solicited final proposals due by April 3, 2008 from qualified firms in February 2008, and awarded the project to the Todd Engineers and Kennedy/Jenks Consultants team on June 23, 2008. The contract was executed and the MCWRA issued a notice to proceed on July 2, 2008.

For this project, Todd Engineers initiated a phased approach with specific tasks to identify potential MTBE source(s) that may have contributed to contamination of initially three CWS production wells at Stations 1 and 13 (Wells 1-04, 13-01, and 13-02) and ultimately a fourth and a fifth well at Stations 15 and 28 (Well 15-01 and 28-01). The focus of this investigation was on Stations 1 and 13 while a preliminary assessment of Stations 15 and 28 was conducted to assess their supporting part in hydrogeology and forensic groundwater chemistry. The Phase 1 background investigation was conducted to obtain relevant and existing hydrogeologic, hydraulic, and environmental information in the project area. The Phase 1 investigation was used to develop Phase 2 work plans and to refine project goals. An additional objective was to identify potential locations of conduit wells with thorough review of regulatory agency files. CWS pumping records and MTBE analytical data were used to estimate a mass balance to determine possible minimum amounts of released MTBE and gasoline from potential source(s). The Phase 1 background investigation concluded that a correlation existed between the MTBE contamination detected in individual production wells and monthly production volumes.

At least 26 potential responsible parties (PRPs) selected from 26 LUST cases were identified within a one-mile radius of Well 1-04. Several possible conduit wells were identified providing potential pathways from the Shallow Groundwater Zone to the underlying aquifers, and estimated volumes of MTBE pumped from the production wells were calculated to be approximately 29 gallons contributed from about 282 gallons of gasoline. The MTBE analytical, production, and areal distribution data suggested that one source may be located near CWS Wells 1-04, 13-01, and 13-02. The Phase 1 report was reviewed by the MTBE Investigative Group, who advised Todd Engineers to proceed with the Phase 2 investigation. Phase 2 was summarized in the Interim Technical Memorandum prepared in February 2010.

The Phase 2 investigations included the installation of two shallow monitoring wells, forensic geochemical sampling and analysis of one production well, and forensic geochemical sampling and analysis of nine PRP sites and the two recently installed monitoring wells. The Phase 2 investigation concluded that the Shallow Groundwater Zone in the vicinity of Station 13 (MW 13-03) did not contain MTBE and CWS Wells 13-01 and 13-02 were probably not conduit wells. Sampling of the Shallow Groundwater Zone in the vicinity of Station 1 (MW 1-05) detected *tertiary*-butyl alcohol (TBA), a degradation product of MTBE, suggesting that the destroyed wells (Wells 1-01 to 1-04) at Station 1 may serve as conduit wells allowing MTBE to migrate from the Shallow Groundwater Zone to the underlying aquifers.

The general water quality mineral and physical analyses were not useful in fingerprinting different groundwater source(s). Large sulfate variations in groundwater

from the PRP sites were due to oxidation/reduction occurring at sites where petroleum hydrocarbon releases were present. The Schoeller and Brine Differentiation plots showed a wide variation in sulfate concentrations due to these biogeochemical changes. In contrast, stable oxygen-hydrogen isotopes in water showed that the Shallow Groundwater Zone and underlying aquifers are a mixture of surface water infiltration and precipitation sources. Isotopic fractionation had occurred for some of the PRP samples, indicating that errors occurred in the sample collection protocols. Radiogenic hydrogen-3 (tritium) was used to estimate groundwater ages on a relative and non-quantitative basis; deeper groundwater (Pressure 180-Foot Aquifer and Pressure 400-Foot Aquifer) was most likely two or three times older than water in the Shallow Groundwater Zone.

Delta carbon-13 isotope in MTBE analysis did not result in determinative MTBE source(s) identification because most MTBE has either not degraded to TBA, MTBE was from more recent releases, or MTBE had completely degraded below reported detection limits. Therefore, delta carbon-13 in MTBE analyses was plotted for those PRPs that reported MTBE. Almost identical delta carbon-13 signatures were noted between several PRP sites suggesting similar contaminant source(s) but no unique signature was identified between the PRP and CWS production well data.

Evaluation of the Phase 2 investigations resulted in several supplemental tasks in 2010. The project budget and schedule constrained the selection and completion of these additional investigations. These supplemental tasks included development of a probabilistic groundwater modeling analysis by Kennedy/Jenks Consultants, confirmation sampling of several PRPs, forensic sampling of two additional PRPs and two CWS MTBE-contaminated production wells, and forensic sampling of the nearby Reclamation Ditch. This additional information concluded that water samples collected from the CWS wells followed the established collection protocol and the data (MW 1-05, Well 13-01, Well 15-01, and Well 28-01) for both the stable isotopes in water and for the stable isotopes of MTBE grouped on their respective graphs and may represent a single source.

The probabilistic groundwater model identified a source area (2.4 square miles) that may have led to MTBE contamination in the underlying aquifers and observed in CWS production wells. The potential source areas were assigned relative probabilities of low, moderate, or high. A review of available hydrogeologic data, a regional- and local-scale hydraulic gradient analysis (see Kennedy/Jenks, October 22, 2010) and physically based solute transport simulations formed the foundation for a source area probability analysis based on fundamental hydraulic principles. An overall source probability distribution shows the highest probability for source areas extends to the south and southwest from just north of Station 13.

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