Attachment E

REFERENCE DOCUMENTS

(CAMPs and QUARTERLY PROGRESS REPORT APPENDICES)

E-1.0 QUARTER PROGRESS REPORT 53 APPENDIX D

2009 PIRM AIR SPARGE TRANSITION PLAN

TESORO ALASKA REFINERY

PREPARED FOR

TESORO ALASKA COMPANY

SUBMITTED: FEBRUARY 27, 2009

KENT & SULLIVAN, INC.

KSI PROJECT NO: 01-13

ENVIRONMENTAL CONSULTANTS

Table of Contents

1.0 INTRODUCTION

Tesoro constructed an air sparging (AS) system in the PIRM area to serve as an in-situ corrective measure for the A-aquifer plume (*Corrective Action Program Plan* contained in Tesoro's Permit Attachment D). The PIRM AS system is intended to replace the existing pump-and-treat system as the primary corrective measure for the PIRM area. This document presents the AS system transition plan which includes the stepwise process to reach this goal and the supplemental gauging and sampling that will be conducted to minimize the potential for uncontrolled plume migration during the transition to air sparging.

The AS well network was installed in July 2006 and consists of 15 AS wells (PAS-1 to PAS-15) installed in a line approximately 20 feet east of the E-150 lobe injection wells (Figure 1). The blowers, air pipelines, and other AS system components were installed in September, and the system began operation in October 2006. The wells are spaced 12 to 20 feet apart with closer spacing used in the southern part of the well network (wells PAS-7 to PAS-14) where the aquifer is thin. Blowers supply air to the wells through individually controlled and metered pipelines. Spare pipelines were included to facilitate potential expansion of the air sparge line to the north, south, or east. The wells operate at 10 to 20 cubic feet per minute (cfm) of air injection. The AS wells cycle on and off to promote groundwater mixing within the sparge treatment zone and to provide an appropriate duration of sparging for groundwater passing through the AS treatment zone.

Currently, four groundwater recovery wells pump at approximately 90 gpm and two injection wells operate at ~20 gpm. Groundwater pumping will be reduced in steps during the transition period to the lowest rates possible while maintaining complete plume capture by the AS system. Sampling and gauging will be conducted to demonstrate capture and adequate hydrocarbon removal and to assess possible changes in contaminant migration pathways.

Upon reaching normal steady-state operation, air injection and groundwater pumping (if any) will be maintained at rates that are demonstrated during the transition period to capture and control the plume. Sampling and gauging will be conducted in accordance with the corrective action monitoring program, and the transition monitoring described in this plan will be discontinued.

2.0 TRANSITION OPERATION PLAN

Groundwater pumping from the PIRM recovery wells will be decreased during the transition period resulting in higher water levels and greater flux through the AS treatment zone. Monitoring will be performed to evaluate the continued effectiveness of the system and potential contaminant migration around the AS system as the existing groundwater recovery and hydraulic capture approach is progressively scaled back. The objective of the transition period is to minimize groundwater recovery and reach a point where the AS system reliably controls plume migration to the maximum extent possible.

The steps that will be taken to reach the objective will depend on the monitoring results obtained during the process. It is anticipated that pumping will be first reduced then stopped in well R-41, followed by R-

44, R-48, and finally R-47. A pumping rate change will be reversed if the AS treatment effectiveness drops to an unacceptable level or monitoring shows evidence of plume migration around the AS system. In addition, additional AS wells can be installed north, south, or east of the existing line of wells to improve effectiveness or prevent plume migration around the ends of the treatment zone. The transition monitoring program will be continued for three months following the last significant pumping rate change to assure that adequate plume control can be maintained.

Normal steady-state operation will begin after completion of the transition monitoring. At this point the effectiveness of the AS system will have been demonstrated with a high level of certainty and the risk of plume migration around the AS system will have been adequately evaluated. The ongoing effectiveness of the AS system and the potential for plume migration will be evaluated as part of the quarterly corrective action monitoring program.

3.0 TRANSITION MONITORING PLAN

3.1 GROUNDWATER GAUGING

Groundwater gauging will be conducted monthly to evaluate changes in groundwater elevations and flow patterns during the transition period. Table 1 lists and Figure 1 shows the wells that will be gauged. Monthly groundwater contour maps will be constructed and groundwater flow patterns will be evaluated. Significant changes in the flow patterns will be assessed for potential impacts to contaminant migration routes and the overall effectiveness of the AS system.

3.2 GROUNDWATER SAMPLING PLAN

Groundwater sampling will be conducted to assess the effectiveness of the AS treatment system and the potential for contaminants to migrate around or below the treatment system. Table 2 lists the sampling wells, and Figure 1 shows their locations.

Effectiveness is defined as the ability of sparging to remove contaminants within the treatment zone and supply dissolved oxygen to groundwater downgradient of the treatment zone. To assess effectiveness, AS monitoring wells (piezometers PI-2, PI-3, PI-4, and PI-5 and wells E-172 and E-185) will be sampled after every significant decrease in groundwater pumping rates to assess the effectiveness of the AS system as the groundwater level rises and flux through the AS treatment zone increases. Samples will be collected weekly for four weeks following a pumping rate decrease and analyzed for BTEX and dissolved oxygen (DO). The sample collected during week 4 will also be analyzed for DRO.

Contamination that migrates past the sparge zone will be evaluated by sampling additional wells located downgradient of the AS monitoring wells at one-month intervals if BTEX or DRO concentrations significantly increase in the AS monitoring wells. The downgradient wells that will be used for monitoring include E-186, E-189, E-187A, and E-190A. Tesoro will increase groundwater pumping rates or add additional AS wells if contaminant concentrations increase above the TGPS in these wells.

The weekly BTEX samples will be analyzed at either the Tesoro laboratory or SGS Analytical Services (SGS) in Anchorage, and all DRO samples will be analyzed at SGS.

4.0 REPORTING

The transition gauging, groundwater contouring, and sampling results will be provided in Tesoro's quarterly reports. The operation changes and their impacts on the effectiveness of the AS system and the potential for uncontrolled plume migration will be described and evaluated. Any changes to the Permit's long-term monitoring that will be required to adequately assess the effectiveness of the final operational system will be proposed for EPA's approval.

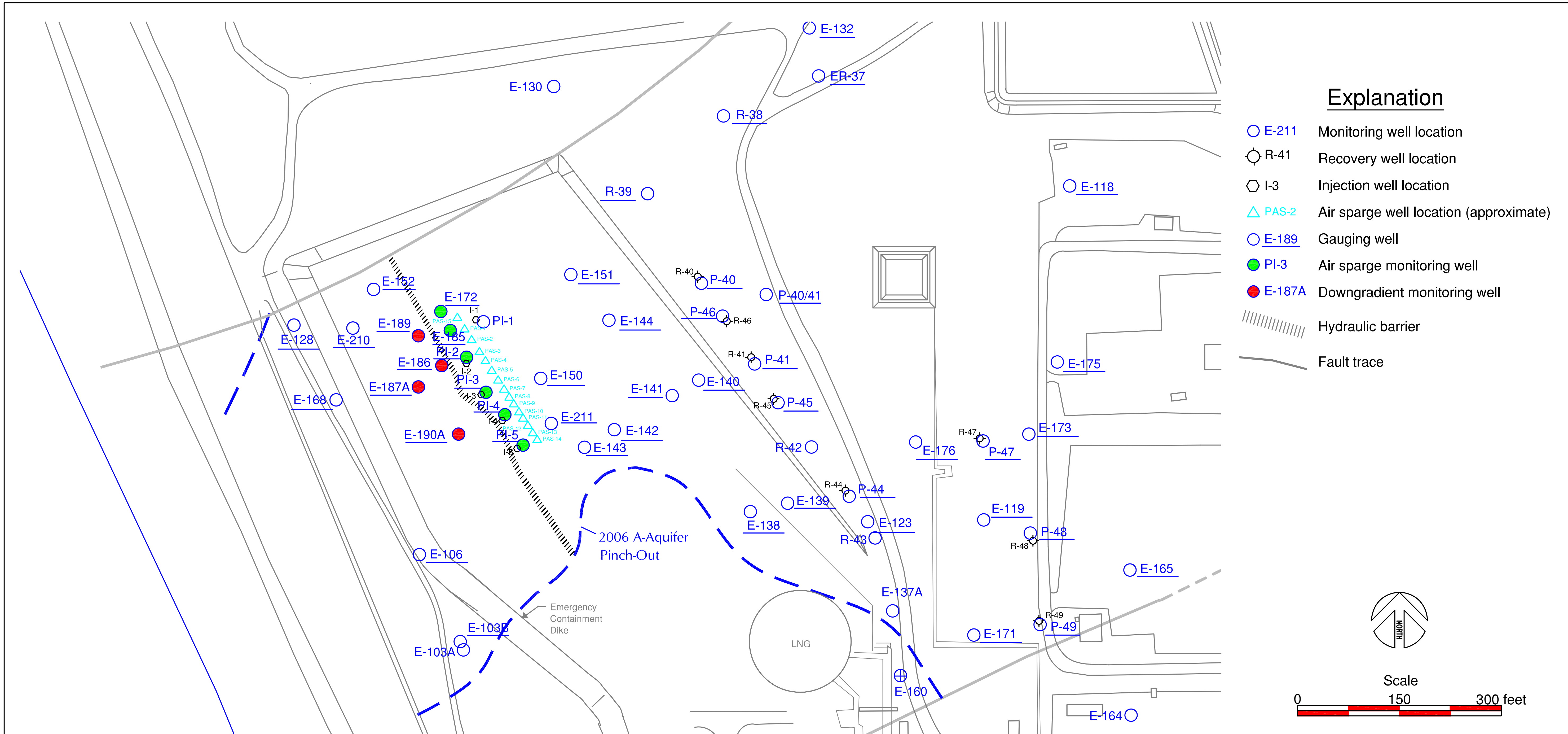
Table D-1. Gauging wells, PIRM air sparging transition plan

	Wells	
E-103A	E-165	P-40
E-106	E-168	P-40/41
E-118	E-171	P-41
E-119	E-172	P-44
E-123	E-173	P-45
E-128	E-175	P-46
E-132	E-176	P-47
E-138	E-185	P-48
E-139	E-186	P-49
E-140	E-187A	PI-2
E-141	E-189	PI-3
E-142	E-190A	PI-4
E-143	E-210	PI-5
E-144	E-211	
E-150	ER-37	
E-151	R-38	
E-152	R-39	

Table D-2. Sampling schedule, PIRM air sparging transition

Well ID	Weekly	Monthly
AS Monitoring Wells		
PI-2	BTEX + DO	BTEX + DRO + DO
PI-3	BTEX + DO	BTEX + DRO + DO
PI-4	BTEX + DO	BTEX + DRO + DO
PI-5	BTEX + DO	BTEX + DRO + DO
E-172	BTEX + DO	BTEX + DRO + DO
E-185	BTEX + DO	BTEX + DRO + DO
Downgradient Wells		
E-186	BTEX + DO	BTEX + DRO + DO
E-187A	BTEX + DO	BTEX + DRO + DO
E-189	BTEX + DO	BTEX + DRO + DO
E-190A	BTEX + DO	BTEX + DRO + DO

BTEX Benzene, toluene, ethylbenzene, & xylenes
DRO Diesel-range organics
DO Dissolved oxygen



Monitoring Well Network
PIRM Air Sparge Transition

TESORO ALASKA COMPANY

Date: 9/12/2009 Drawn by: BKJ

Proj. No.: 01-13 Checked by:

File: 01-13/Q53\PIRM AS Location.dwg

FIGURE D-1

KENT & SULLIVAN, INC.

E-2.0 QUARTERLY PROGRESS REPORT 16-1 APPENDIX C

SI AREA DATA REVIEW AND PLAN FOR REMEDY ENHANCEMENT

February 18, 2016

Project #: 39B-004-001

SUBMITTED BY: Trihydro Corporation

1252 Commerce Drive, Laramie, WY 82070

Table of Contents

List of Tables

List of Figures

1.0 INTRODUCTION

This appendix presents a data review of the SI area, including examination of December 2015 sampling results for trichloroethene (TCE) and TCE daughter products in SI area wells and air sparge points. The review is used to develop a generalized plan for remedy enhancement, including a detailed work plan for air sparge system optimization.

Historical data for select wells associated with each of the three surface impoundments are reviewed in Section 2.0 in the context of historical corrective measures. Three types of corrective measures have been employed in the SI area: in situ chemical oxidation (ISCO) by potassium permanganate injection, air sparging, and groundwater pumping. Each are described briefly below.

ISCO was first conducted as a set of pilot tests at SMW-12A near Surface Impoundment 2 (Figure C-1) in May 2002 and May 2003. The tests were designed to assess permanganate consumption rates, aquifer oxidant demand, and impact on BTEX concentrations (KSI 2004). The tests were followed with observed reduction in LNAPL thickness in the treatment well. ISCO was also tested at Surface Impoundment 3 in September through November 2010, with injection at IWS-5. This well, located at ground surface north of the surface impoundment, was drilled at an angle such that the injection point was below the capped impoundment. The injection solution included both potassium permanganate for an assessment of oxidant consumption and potassium bromide for assessment of groundwater flow velocity. The oxidant demand for this test injection was considered to be substantial based on an absence of permanganate observed in downgradient well SMW-34 despite groundwater flow to this well (bromide arrival).
Air sparging was initiated in the SI area in October 2005 and operations are ongoing. The system includes a northern and southern line of 2-inch diameter PVC wells with 2.5-ft screens placed approximately 14 feet below the water table (Figure C-1 and Figure C-2). This provides a transect of sparge points across the downgradient face of the surface impoundments. The sparge system is operated continuously, with flow cycled on 20-minute intervals between even- and odd-numbered wells (KSI 2007). With injection of air into the aquifer, the system may remediate contaminants through a combination of volatilization (i.e., “stripping”) and enhanced aerobic biodegradation (biologically-mediated oxidation).

A groundwater pumping system in the vicinity of the southern air sparge line consists of recovery well RS-2. The system has previously extracted groundwater at a rate between 10 and 20 gallons per minute (gpm) in an effort to direct the flow of groundwater from the northern air sparge treatment zone to the southern zone (KSI 2007). The system is currently not considered useful for remediation purposes and is not operated.

The Section 2.0 data review provides an updated understanding of the effect of historical and current remedial operations on contaminant fate and transport. The data is used to guide a generalized plan for improved contaminant remediation in the SI area (Section 3.0), starting with an optimization test for the existing air sparge system. A detailed work plan for the optimization is presented in Section 4.0.

2.0 DATA REVIEW

A special sampling event was conducted in the SI area on December 2, 2015. Select wells were sampled for BTEX compounds, as well as TCE and its daughter products cis-1,2-DCE, vinyl chloride, and ethene. The sampling included several air sparge points. The sparge system was temporarily shut down approximately 1 hour prior to sampling so that inflowing groundwater adjacent to the points could be characterized.

Figure C-1 presents a TCE contour map based on the December sampling results. Full sampling results are displayed in Table C-1 in the main body of this report. TCE concentrations greater than 10 μg/L were present as far north as SMW-34, extending south through SMW-I-1 to SMW-31. The sampling at the air sparge points indicated elevated TCE concentrations at multiple locations (benzene was non-detect), with five of the eight points having measured concentrations greater than 5 μg/L. The results suggest a current TCE plume that shows little attenuation with distance and an air sparge system that is largely ineffective at decreasing the contaminant concentrations.

Improved corrective actions appear to be needed to reduce TCE concentrations downgradient of the surface impoundments. Review of historical data in the context of previous corrective actions provides background for alternative assessment. Table C-2 presents a compilation of the SI Area routine monitoring data, and Figures C-3 through C-5 present data from key wells. The historical data review below, begins upgradient with Surface Impoundment 3.

2.1 SURFACE IMPOUNDMENT 3

Figure C-3 displays concentration versus time plots for SD-3 and SMW-34, as well as key December 2015 data (bar graph) for SMW-34. Based on these plots, SI-3 is an area with a mixture of petroleum hydrocarbons and chlorinated compounds. SD-3 has tended to have elevated BTEX concentrations. For the 2006 to 2011 timeframe, this well had low BTEX values, but a rebound was observed in 2013 to present. This rebound may be related to the higher groundwater elevation, possibly as the groundwater intersected shallower hydrocarbons below the surface impoundment.

SMW-34 has limited historical data, with most of it collected around the time of the permanganate injection pilot in 2010. The pilot injected permanganate into well IWS-5, 45 feet upgradient of SMW-34. The pilot was successful at injecting permanganate, but the chemical was not observed at SMW-34 (KSI 2011). The rich hydrocarbon mixture may have imparted too much demand to the oxidant. Supporting this is reported residual free-phase hydrocarbons observed when drilling IWS-5, and current TCE concentrations similar to those in 2010.

Despite the absence of a decreasing SMW-34 TCE concentration versus time trend, there does appear to be biodegradation occurring in the vicinity of the well. This was the only location sampled in December 2015 with significant concentrations of TCE daughter products (Figure C-3 bar graph). The contaminant mixture is likely a factor in TCE attenuation at SMW-34, with benzene and other hydrocarbons possibly providing electron donors for reductive dechlorination.

Back-diffusion of chlorinated compounds from fine-grain layers is sometimes a mechanism for observed elevated concentrations in monitoring wells (Chapman and Parker 2005, Liu and Ball 2002). The observed TCE daughter products at SMW-34, combined with the lack of a decreasing TCE concentration trend, would fit such a scenario. This well is screened across the water table and not across the underlying aquitard (Figure C-2). While not a definitive inference, the shallow screen and contaminant mixture suggests that the aquitard is not acting as a strong back-diffusion source to groundwater. If back-diffusion is occurring, then the available data suggest that it would be from unidentified fine-grain layers closer to the water table.

2.2 SURFACE IMPOUNDMENT 2

Figure C-4 displays concentration versus time plots for SMW-12A, SMW-32, and SMW-33. SI-2 is an area with previous elevated hydrocarbon but not TCE concentrations. The 2002 and 2003 permanganate push-pull tests were reported as successful at delivering permanganate for consumption, but no immediate and consistent effect on BTEX compounds was discerned (KSI 2004). LNAPL within the well was reduced to non-detect or a sheen (KSI 2010), suggesting some treatment effect. Later groundwater sampling from the well also suggests an effect. The post-2005 benzene and ethylbenzene concentrations (no 2004 data are available) were generally lower than pre-2005 concentrations (Figure C-4). Based on this trend, it is possible that the permanganate injection had a delayed effect on these two constituents. Decreased benzene, ethylbenzene, and xylenes concentrations were also observed at downgradient well SMW-33, with data collection for this well beginning in 2005. The hydrocarbon concentration decreases at SMW-33 might be related to a combination of the permanganate injection and air sparging that was initiated in October 2005. However, natural attenuation at both SMW-12A and SMW-33 cannot be ruled out as the dominant factor.

Well SMW-12C has a screen that contacts the underlying clay aquitard (Figure C-2). This well was sampled in 2004 (Table C-2). Neither benzene nor TCE were detected at a reporting limit of 1 μg/L. Low-level (max 6.6 μg/L) ethylbenzene and xylenes detections were measured. The results suggest that the clay aquitard was not a back-diffusion source of contaminants in this area at the time of sampling.

SMW-32, located side / downgradient of Surface Impoundment 1, has had sporadic benzene detections above the 5 μg/L cleanup level (Figure C-4). Sparge system adjustments proposed in Section 4.0 might improve conditions at this well.

2.3 SURFACE IMPOUNDMENT 1

Figure C-5 displays concentration versus time plots for SMW-I-1, SMW-21A, SMW-21B, and SMW-31, as well as key December 2015 data (bar graphs) for SMW-I-1 and SMW-31. Surface Impoundment 2 is primarily a TCE-impacted area, especially at SMW-I-1 and recently downgradient at SMW-31. Some benzene and other hydrocarbons have been detected in the area previously, but the concentrations were less than 100 μg/L to begin with and have been even lower in recent years. TCE daughter products were not observed in December 2015, suggesting that the low level of co-contaminants means an insufficient supply of electron donors for reductive dechlorination. Possibly some TCE attenuation has occurred, as a regression line for the constituent at SMW-I-1 would indicate a decreasing trend.

Well SMW-21B has a screen that contacts the underlying clay aquitard (Figure C-2). This well was sampled from 1994 to 2001. Over that timeframe, low (max 10 μg/L) BTEX concentrations were measured, and TCE was not detected (Figure C-5). This suggests that the clay aquitard was not acting as a back-diffusion source to groundwater. SMW-31, with recent elevated TCE concentrations, is screened shallower than the clay aquitard. This provides an additional, though not definitive, line of evidence that the aquitard is not acting as a source to groundwater and that dissolved TCE is present nearer to the water table.

The reason for the SMW-31 elevated TCE concentrations since 2011 (Figure C-5) is not known. One hypothesis is that TCE required sufficient travel time to move from the source area to this well. Using a seepage velocity of 1.3 ft/day (from KSI 2011), the travel time from SMW-I-1 and SMW-31 would be approximately 240 days. This very simple calculation would suggest that TCE should have arrived at SMW-31 far sooner than 2011, and that the sparge system up until 2011 was successfully remediating the migrating TCE. However, the travel time calculation does not take into account possible TCE retardation via sorption to organic matter. Such retardation would not be expected to be significant based on low natural organic matter content in the aquifer (KSI 2011), but other residual contaminants could also be a sorption sink. Another hypothesis is that TCE was previously remediated by the air sparge system, but that the system efficacy has decreased in recent years. The SMW-31 data do not strongly support this, since elevated TCE was not observed at this well in 2005 at the time of sparge system startup.

The available data are not sufficient to discern the cause of elevated TCE at SMW-31. Still, the data indicate that the air sparge system is currently not remediating this compound. This is considered in Section 3.0 and 4.0 with a plan for remedy enhancement.

2.4 DATA SYNTHESIS

The above data review suggests that previous corrective measures have had an uneven effect on contaminant concentrations in the SI area. This may be related to variation in groundwater elevation and flow direction, like fluctuations in 2012, but except for SD-3 any correlation with contaminant concentrations is difficult to discern. With chlorinated compounds, back-diffusion from fine grain layers can also be a factor. For this area, the available data suggest that the underlying clay aquitard is not a strong back-diffusion source. The contaminant zone appears to be closer to the water table.

ISCO appears to have been previously successful at remediating contaminants, LNAPL at a minimum and possibly BTEX constituents, in the vicinity of Surface Impoundment 2. ISCO did not have a discernible treatment effect at Surface Impoundment 3. One reason for the difference is possibly a higher oxidant demand at Surface Impoundment 3. But perhaps more importantly, one documented distinction between the two areas is the contaminant type. At Surface Impoundment 2, the contaminants are primarily petroleum hydrocarbons, while at Surface Impoundment 3, the contaminants are a mixture of hydrocarbons and chlorinated compounds. For this site, ISCO by permanganate injection may be more effective in treating petroleum hydrocarbons versus chlorinated compounds, or in treating groundwater with less of a mix of contaminant types.

There is some uncertainty in the historical effectiveness of the air sparge system. Most of the wells immediately downgradient of the system, except for SMW-6, were first sampled in September 2005, providing only one sample prior to system startup. The pre-sparge samples for well SMW-6 had generally low contaminant concentrations, including values below 5 μg/L for benzene and TCE (Table C-2). SMW-33 does show strongly decreasing trends over time (Figure C-4), but this may be related at least in part to upgradient permanganate injection at SMW-12A. While the monitoring data for wells immediately downgradient of the sparge system have limitations in discerning a treatment effect, a comparison map in KSI (2010) does indicate benzene and TCE plumes beyond the sparge lines in 1998 and generally truncated plumes at the sparge lines in 2010. Regardless of the uncertainty in historical air sparge system effectiveness, the December 2015 results suggest that currently the system has low efficacy for TCE remediation.

Previous remedial efforts have focused on contaminant oxidation, volatilization, and aerobic biodegradation. The first two mechanisms are theoretically viable for BTEX compounds and TCE, and aerobic biodegradation is theoretically viable for BTEX. The efforts appear to have been most effective in treating BTEX compounds. TCE, on the other hand, has not shown as discernible of a treatment effect. This suggests that an alternate approach to TCE treatment should be considered. The December 2015 data for SMW-34 suggest that reductive dechlorination is a viable attenuation mechanism, with a likely requirement of a sufficient electron donor. Other areas with elevated TCE might benefit from addition of electron donors so that reductive dechlorination is enhanced.

3.0 GENERAL PLAN FOR REMEDY ENHANCEMENT

Based on the Section 2.0 data analysis, a general plan for remedy enhancement is proposed. First, the existing air sparge system should be optimized in an effort to increase the degree of volatilization that is achieved. This may be sufficient to decrease TCE concentrations via volatilization and maintain continued low benzene concentrations downgradient of the SI area. If so, then the optimized air sparge operating parameters will be employed long term. If the system optimization does not result in improved remediation of TCE, then Tesoro will conduct pilot testing of enhanced reductive dechlorination. Enhancement might be achieved through injection of electron donors (e.g., lactate or molasses). Candidate areas for the latter pilot include the IWS-5 injection location and the vicinity of SMW-I-1. If enhanced reductive dechlorination is tested and is determined to be viable as a component of the long term corrective measures, then the air sparge system could still be an important component of the remedy approach. Reductive dechlorination upgradient of the sparge system could generate vinyl chloride. This constituent has an especially high volatility, so sparging could be used as polishing step to strip this contaminant as groundwater moves downgradient from the reductive dechlorination area.

The first step of the general plan for remedy enhancement is optimization of the air sparge system. A work plan for this optimization is presented in Section 4.0.

4.0 WORK PLAN FOR AIR SPARGE SYSTEM OPTIMIZATION

The air sparge system optimization will be conducted in two phases. The first phase will identify a theoretically optimal sparge schedule based on operating pressure and nearby well dissolved oxygen (DO) concentrations. The second phase will test the new pulsing schedule for a longer period of time to assess the effect on concentrations in the vicinity of the sparge points.

4.1 PHASE 1 TEST

For Phase 1, the pulse duration will be tested while measuring the effect on pressure as measured with the sparge point gauge. This approach is based on a paradigm for air injection presented in Suthersan (1999). The early portion of injection is characterized by an expansion in the region of airflow within the saturated zone. This is accompanied by mounding of the groundwater surface as air fills previously water-filled pores, although such mounding is sometimes difficult to discern with well gauging. Following the early portion of injection, the air breaks through to the vadose zone, and the region of air flow in the saturated zone shrinks as channeling forms. This air injection zone shrinkage can initially provide additional mixing as groundwater moves back into the partially air-filled pores, but eventually a steady state injection zone is established with minimal mixing and less efficient delivery of air into the saturated zone.

Phase 1 testing will identify the pulse time at which the transition from air injection zone expansion to shrinkage occurs, based on pressure tracking at each of the sparge points. At a given sparge point, the blower will be operated at an individual sparge point target flowrate of approximately 15 cubic feet per minute (cfm). The pressure gauge readings for the given point will be recorded at approximate 1-minute intervals immediately following startup at the point. The initial pressure increase (air zone expansion) and subsequent decrease (air zone shrinkage) will be tracked, as well as transition to steady state. Measurement recordings will be considered complete when five minutes of measurements have shown a change no greater than 0.25 pounds per square inch. This process will be conducted for all of the operational sparge points at least three times. A template field form for the pressure measurements is provided as Table C-3.

The pressure testing will provide an approximate air expansion time for each sparge point. This expansion time will be assessed further with measurements of DO within the subsurface. Field measurements will be taken with a downhole probe, such as a YSI 556. First, system operations will be suspended for approximately 24 hours, followed by DO measurements at each of the sparge points. Once these baseline measurements are taken, individual sparge points will be pulsed at 1.5 times the expansion time (to incorporate air zone expansion and some shrinkage) for at least three pulses, with concurrent DO measurement in adjacent sparge points. The DO measurements will be taken at least once during and after each pulse for a given sparge point. This information will be used to adjust pulse duration to a value that further increases DO concentration in the adjacent points. A template field form for the DO measurements is provided as Table C-4.

With the above testing, an optimal pulse duration will ideally be identified for each sparge point. If the DO concentrations are not observed to increase with adjustments to pulse duration, then the entire process will be repeated with an adjusted blower flow rate. The adjusted flow rate will be determined based on the data collected to that point.

4.2 PHASE 2 TEST

Phase 2 will test whether the optimal pulse duration identified for each sparge point results in improved groundwater conditions in the vicinity of the sparge system. First, the system will be operated for approximately one week under normal pulsing (approximately 20 minute pulses across three separate banks). The system will then be temporarily shut down, DO will be measured with the downhole probe, and groundwater samples will be collected that day from at least half of the air sparge points. The analyte list will include BTEX compounds, TCE, and TCE daughter products cis-1,2-dichloroethene, vinyl chloride, and ethene. Sampling methods will follow the site permit Appendix C protocols and will match methods used for the December 2015 sampling.

Following the baseline data collection, the air sparge system will be programmed to implement the optimal pulsing duration for each of the sparge points. As possible, sparge points with similar pulse durations will be grouped into banks. The optimal pulsing schedule will then be implemented, with cycling through banks for continuous operation of the blower. The operation will continue for approximately one week. The system will then be temporarily shut down and groundwater samples will be collected using the same procedures as the baseline sampling.

The groundwater samples will be submitted for laboratory analysis under standard turnaround time. The results will be presented with data interpretation in the Q16-2 (Q82) report, including discussion of the implications for the general plan for remedy enhancement. In the meantime, the air sparge system will be run at the optimal pulsing schedule so long as this does not result in a permit violation.

5.0 REFERENCES

Chapman, S.W., and Parker, B.L. 2005. Plume Persistence Due to Aquitard Back Diffusion Following Dense NonAqueous Phase Liquid Source Removal or Isolation. *Water Resources Research*, 41(12).

Kent & Sullivan (KSI). 2004. 2003 Potassium Permanganate In-Situ Chemical Oxidation Test. Memorandum to Peter Ribbens. April 5.

KSI 2007. Attachment D, 2007 Corrective Action Program Plan,, RCRA Post-Closure Permit No. AKD 04867 9682, Tesoro Alaska Company.

KSI 2010. SI 2010 TCE Corrective Action Modification Plan (CAMP), Tesoro Kenai Refinery. June 15.

KSI 2011. Appendix C, SI 2010 TCE Potassium Permanganate In-Situ Chemical Oxidation Completion Report, Quarterly Progress Report No. 61, November & December 2010 and January 2011, RCRA Post-Closure Permit No. AKD 04867-9682, Tesoro Alaska Company. February 28.

Liu, C. and Ball, W.P. 2002. Back Diffusion of Chlorinated Solvent Contaminants from a Natural Aquitard to a Remediated Aquifer Under Well-Controlled Field Conditions: Predictions and Measurements. *Ground Water*, 40(2), 175-184. March-April.

Suthersan, S.S. 1999. In Situ Air Sparging, in Remediation Engineering: Design Concepts. Ed. Suthersan, S.S. CRC Press LLC, Boca Raton.

TABLES

TABLE C-1. RESULTS FROM SUPPLEMENTAL SI SAMPLING EVENT
Q16-1 (81) QUARTERLY REPORT
TESORO KENAI REFINERY
NIKISKI, ALASKA

Location	Sample Date	Trichloroethene (µg/L)	cis-1,2-Dichloroethene (µg/L)	Vinyl Chloride (µg/L)	Ethene (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	m,p-Xylene (µg/L)	o-Xylene (µg/L)
SAS-3	12/4/2015	11	1.8	ND(1)	ND(1.1)	ND(1)	ND(1)	ND(1)	ND(2)	ND(1)
SAS-4	12/4/2015	20	2.4	ND(1)	ND(1.1)	ND(1)	ND(1)	ND(1)	ND(2)	ND(1)
SAS-5	12/4/2015	4.4	ND(1)	ND(1)	ND(1.1)	ND(1)	ND(1)	ND(1)	ND(2)	ND(1)
SAS-6	12/4/2015	18	1.4	ND(1)	ND(1.1)	ND(1)	ND(1)	ND(1)	ND(2)	ND(1)
SAS-7	12/4/2015	8.2	ND(1)	ND(1)	ND(1.1)	ND(1)	ND(1)	ND(1)	ND(2)	ND(1)
SAS-8	12/4/2015	22	2	ND(1)	ND(1.1)	ND(1)	ND(1)	ND(1)	ND(2)	ND(1)
SAS-9	12/4/2015	4.6	ND(1)	ND(1)	ND(1.1)	ND(1)	ND(1)	ND(1)	ND(2)	ND(1)
SAS-11	12/4/2015	ND(1)	ND(1)	ND(1)	ND(1.1)	ND(1)	ND(1)	ND(1)	ND(2)	ND(1)
SD-3	12/2/2015	3	--	--	--	34	2.9	160	120	3.2
SMW-I-1	12/2/2015	11	1.6	ND(1)	ND(1.1)	1.2	ND(1)	ND(1)	ND(2)	ND(1)
SMW-05	12/2/2015	ND(1)	--	--	--	ND(1)	ND(1)	ND(1)	ND(2)	ND(1)
SMW-08	12/2/2015	ND(1)	--	--	--	ND(1)	ND(1)	ND(1)	ND(2)	ND(1)
SMW-09	12/3/2015	ND(1)	ND(1)	ND(1)	ND(1.1)	ND(1)	ND(1)	ND(1)	ND(2)	ND(1)
SMW-11	12/3/2015	6.5	ND(1)	ND(1)	ND(1.1)	ND(1)	ND(1)	ND(1)	ND(2)	ND(1)
SMW-29	12/3/2015	1.2	--	--	--	1.2	ND(1)	ND(1)	ND(2)	ND(1)
SMW-31	12/3/2015	26	3.8	ND(1)	ND(1.1)	2	ND(1)	ND(1)	ND(2)	ND(1)
SMW-32	12/2/2015	ND(1)	--	--	--	ND(1)	ND(1)	ND(1)	ND(2)	ND(1)
SMW-33	12/1/2015	ND(1)	--	--	--	ND(1)	ND(1)	ND(1)	ND(2)	ND(1)
SMW-34	12/3/2015	24	19	13	ND(1.1)	29	1.4	6.6	2.8	ND(1)

Notes
SAS indicates air sparge well

ND - not detected at reporting limit

µg/L - micrograms per liter

TABLE C-2. COMPILATION OF HISTORICAL ROUTINE ANALYTICAL DATA, SI AREA
Q16-1 (81) REPORT
TESORO KENAI REFINERY
NIKISKI, ALASKA

Sample Source	Sample Date	Benzene (ug/L)	Ethylbenzene (ug/L)	Toluene (ug/L)	Xylenes, Total (ug/L)	Trichloroethene (ug/L)	Vinyl Chloride (ug/L)	1,2-Dibromoethane (EDB; ug/L)	1,2-Dichloroethane (ug/L)	Gasoline Range Organics (ug/L)	Diesel Range Organics (ug/L)
SD-1	4/14/2000	10	1.9	1 U	1 U	2.6	0.34 J	2 U	0.66 U	--	--
SD-1	6/15/2004	7.6	4.7	1 U	1 U	3.1	--	--	--	--	--
SD-1	5/23/2005	55	8.05	0.547	4.66	--	--	--	--	225	--
SD-1	3/20/2006	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SD-3	7/19/1994	41	6.7 J	14	22 J	2.8 J	10 U	--	10 U	--	--
SD-3	10/19/1994	1 U	1 U	1 U	2 U	--	--	--	--	--	--
SD-3	7/18/1995	86	4.9	1 U	6.5	7	2 U	1 U	1 U	--	--
SD-3	8/1/1996	280	110	160	290	3.2	2 U	1 U	1 U	--	--
SD-3	7/15/1997	240	52	1 U	42	15	2 U	1 U	1 U	--	--
SD-3	7/8/1998	420	88	17	114	35	5.9	1 U	1 U	--	--
SD-3	7/1/1999	1100	99	4.8	102	39	6.1	1 U	1 U	--	--
SD-3	9/28/1999	1200	280	1 U	170	--	--	--	--	2900	290
SD-3	1/11/2000	270	120	10 U	93	--	--	--	--	--	--
SD-3	4/10/2000	310	140	25 U	110	31	25 U	50 U	25 U	1000	--
SD-3	10/12/2000	84	33	1 U	15	9.1	2	1 U	1 U	--	--
SD-3	12/11/2000	78	27	1 U	10	9.4	1 U	1 U	1 U	--	--
SD-3	3/27/2001	73	22	1 U	9	9.1	1 U	1 U	1 U	--	--
SD-3	9/11/2001	76	17	1.3	13	6.7	1 U	1 U	1 U	260	556 U
SD-3	4/10/2002	39 B	15	2 U	8.1	6.3	2 U	4 U	2 U	330	50 U
SD-3	9/10/2002	61	28	1 U	14	7.4	--	--	--	--	--
SD-3	3/12/2003	26 J	17	1 U	10	4.6	1 U	2 U	1 U	250 U	250 U
SD-3	9/4/2003	8	3.3	1 U	2.6	--	--	--	--	--	--
SD-3	10/16/2003	--	--	--	--	4.4	--	--	--	--	--
SD-3	12/8/2003	11	5.9	1 U	4.6	2.8	--	--	--	--	--
SD-3	12/8/2003	13	2.8	1 U	2.7	3	--	--	--	--	--
SD-3	3/9/2004	22	16	1 U	11	3.6	1 U	1 U	1 U	--	--
SD-3	8/30/2004	44	65	1 U	50	8.2	--	--	--	--	--
SD-3	3/7/2005	9.5 J	24	5 U	27	5 U	5 U	10 U	5 U	100 U	250 U
SD-3	9/7/2005	1.8	1 U	1 U	1 U	1 U	--	--	--	--	--
SD-3	3/20/2006	3.9	1.5	1 U	1.6	1.2	--	--	--	--	--
SD-3	9/19/2006	1 U	1 U	1 U	1 U	1.2	--	--	--	--	--
SD-3	3/1/2007	1 U	1 U	1 U	2 U	1 U	1 U	--	--	100 U	250 U
SD-3	9/19/2007	1.8	1 U	1 U	2 U	1 U	--	--	--	--	--
SD-3	3/26/2008	1.3	1 U	1 U	2 U	1 U	1 U	--	--	100 U	250 U
SD-3	9/30/2008	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SD-3	3/9/2009	1.8	1 U	1 U	3 U	1.4	1 U	--	--	100 U	250 U
SD-3	9/2/2009	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SD-3	3/24/2010	1.7	1 U	1 U	3 U	1.1	1 UJ	--	--	100 U	250 U
SD-3	8/13/2010	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SD-3	3/10/2011	1	1 U	1 U	3 U	1 U	1 U	--	--	100 U	100 U
SD-3	9/19/2011	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SD-3	3/5/2012	1 UJ	1 UJ	1 UJ	3 UJ	1 UJ	1 UJ	--	--	100 UJ	100 UJ
SD-3	9/10/2012	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SD-3	3/21/2013	51	430	25	650	20 U	20 U	--	--	2600	7400
SD-3	6/24/2013	59	640	190	1170	18	--	--	--	--	--
SD-3	9/9/2013	29	200	37	371	12	--	--	--	--	--
SD-3	3/12/2014	9.3	16	1 U	10	2.7	1.9	--	--	120	290
SD-3	6/18/2014	13	1 U	1 U	3 U	5.4	--	--	--	--	--
SD-3	9/17/2014	160	160	27	74	19	--	--	--	--	--
SD-3	12/9/2014	88	190	2 U	88	21	--	--	--	--	--
SD-3	3/5/2015	190	670	160	890 J-	20 U	20 U	--	--	4900	2200 J-
SD-3	9/9/2015	28	81	1 U	8	3.8	--	--	--	--	--
SMW-04	3/20/2006	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-05	12/12/1989	33	0.5 U	2.7	5.3	--	--	--	--	--	--
SMW-05	5/11/1998	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-05	4/14/2000	0.22 J	1 U	1 U	1 U	1 U	1 U	2 U	1 U	--	--
SMW-05	6/15/2004	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-05	9/7/2005	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-05	3/1/2007	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--
SMW-05	9/19/2007	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--
SMW-05	3/26/2008	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--
SMW-05	9/30/2008	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-05	3/9/2009	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-05	9/2/2009	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-05	3/24/2010	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-05	8/13/2010	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-05	3/10/2011	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-05	9/19/2011	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-05	3/5/2012	1 UJ	1 UJ	1 UJ	3 UJ	1 UJ	--	--	--	--	--
SMW-05	9/10/2012	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-05	4/4/2013	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-05	9/10/2013	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-05	3/12/2014	4.7	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-05	6/18/2014	4	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-05	9/17/2014	4.1	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-05	12/8/2014	4.3	1 U	1 U	3 U	1.6 J	--	--	--	--	--
SMW-05	3/4/2015	3	1 U	1 U	3 UJ	1.1	--	--	--	--	--
SMW-05	6/8/2015	1.7	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-05	9/9/2015	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-06	4/14/2000	0.23 J	1 U	1 U	1 U	1 U	0.52 J	2 U	1 U	--	--
SMW-06	9/7/2005	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-06	12/12/2005	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-06	3/20/2006	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-06	6/20/2006	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-06	9/19/2006	6.4	1 U	1 U	1 U	--	--	--	--	--	--
SMW-06	12/13/2006	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-06	3/1/2007	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--
SMW-06	6/20/2007	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--
SMW-06	3/27/2008	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--
SMW-06	12/8/2011	0.2	0.2 U	0.2 U	0.6 U	0.6	--	--	--	--	--
SMW-06	3/5/2012	1 UJ	1 UJ	1 UJ	3 UJ	1 UJ	--	--	--	--	--
SMW-06	6/26/2012	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-06	9/10/2012	1 U	1 U	1 U	3 U	1.2	--	--	--	--	--

TABLE C-2. COMPILATION OF HISTORICAL ROUTINE ANALYTICAL DATA, SI AREA
Q16-1 (81) REPORT
TESORO KENAI REFINERY
NIKISKI, ALASKA

Sample Source	Sample Date	Benzene (ug/L)	Ethylbenzene (ug/L)	Toluene (ug/L)	Xylenes, Total (ug/L)	Trichloroethene (ug/L)	Vinyl Chloride (ug/L)	1,2-Dibromoethane (EDB; ug/L)	1,2-Dichloroethane (ug/L)	Gasoline Range Organics (ug/L)	Diesel Range Organics (ug/L)
SMW-06	12/3/2012	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-06	4/4/2013	1 U	1 U	1 U	3 U	1.3	--	--	--	--	--
SMW-06	9/10/2013	1 U	1 U	1 U	3 U	1	--	--	--	--	--
SMW-06	11/14/2013	1 U	1 U	1 U	3 U	1.1	--	--	--	--	--
SMW-06	3/12/2014	1 U	1 U	1 U	3 U	1	--	--	--	--	--
SMW-07	5/23/2005	16	16.8	0.5 U	16	--	--	--	--	125	--
SMW-07	9/7/2005	1 U	9.7	1 U	1 U	--	--	--	--	--	--
SMW-07	12/12/2005	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-07	3/20/2006	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-07	3/1/2007	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--
SMW-07	3/27/2008	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--
SMW-08	5/11/1998	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-08	9/8/2005	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-08	12/8/2014	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-09	1/25/1994	1 U	1 U	1 U	2	--	--	--	--	--	--
SMW-09	4/11/1994	1 U	1 U	1 U	2 U	--	--	--	--	--	--
SMW-09	7/18/1994	10 U	10 U	10 U	10 U	10 U	10 U	--	10 U	--	--
SMW-09	10/19/1994	1 U	1 U	1 U	2 U	--	--	--	--	--	--
SMW-09	1/16/1995	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	4/17/1995	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	7/17/1995	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	--	--
SMW-09	10/23/1995	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	1/4/1996	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	4/2/1996	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	8/1/1996	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	--	--
SMW-09	10/7/1996	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	1/14/1997	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	4/9/1997	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	7/15/1997	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	--	--
SMW-09	10/8/1997	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	--	--
SMW-09	1/13/1998	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	4/7/1998	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	7/9/1998	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	--	--
SMW-09	10/27/1998	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	1/12/1999	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	4/6/1999	1 U	1 U	48	1 U	--	--	--	--	--	--
SMW-09	7/1/1999	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--
SMW-09	9/28/1999	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	1/12/2000	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	4/4/2000	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	6/12/2000	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--
SMW-09	9/28/2000	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	12/11/2000	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	3/27/2001	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	6/26/2001	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--
SMW-09	9/19/2001	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--
SMW-09	1/3/2002	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-09	1/3/2002	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--
SMW-09	4/11/2002	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	250 U	250 U
SMW-09	6/25/2002	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	--	--
SMW-09	9/10/2002	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-09	12/10/2002	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-09	3/11/2003	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	250 U	--
SMW-09	3/19/2003	--	--	--	--	--	--	--	--	--	250 U
SMW-09	6/23/2003	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-09	9/9/2003	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-09	12/9/2003	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-09	3/16/2004	1 U	1 U	1 U	1 U	1 U	1 U	--	--	100 U	250 U
SMW-09	6/15/2004	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-09	8/30/2004	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-09	12/6/2004	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-09	3/7/2005	1 U	1 U	1 U	1 U	1 U	1 U	--	--	100 U	250 U
SMW-09	6/6/2005	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-09	9/8/2005	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-09	12/12/2005	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-09	3/20/2006	1 U	1 U	1 U	1 U	1 U	1 U	--	--	100 U	330
SMW-09	6/20/2006	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-09	9/19/2006	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-09	3/1/2007	1 U	1 U	1 U	2 U	1 U	1 U	--	--	100 U	250 U
SMW-09	3/27/2008	1 U	1 U	1 U	2 U	1 U	1 U	--	--	100 U	250 U
SMW-09	3/10/2009	1 U	1 U	1 U	3 U	1 U	1 U	--	--	100 U	250 U
SMW-09	3/16/2010	1 U	1 U	1 U	3 U	1 U	1 U	--	--	100 U	250 U
SMW-09	3/10/2011	1 U	1 U	1 U	3 U	1 U	1 U	--	--	100 U	100 U
SMW-09	4/9/2012	1 U	1 U	1 U	3 U	1 U	1 U	--	--	100 U	100 U
SMW-09	9/10/2012	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-09	12/3/2012	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-09	4/3/2013	1 U	1 U	1 U	3 U	1 U	1 U	--	--	100 U	230
SMW-09	3/13/2014	1 U	1 U	1 U	3 U	1 U	1 U	--	--	100 U	150
SMW-09	6/19/2014	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-09	9/17/2014	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-09	12/9/2014	1 U	1 U	1 U	3 U	1.1	--	--	--	--	--
SMW-09	3/5/2015	1 U	1 U	1 U	3 UJ	1 U	1 U	--	--	100 U	100 UJ
SMW-09	9/9/2015	1.3	1 U	1 U	3 U	1.2	--	--	--	--	--
SMW-11	5/11/1998	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-11	4/14/2000	0.59 J	1 U	1 U	1 U	1.7	1 U	2 U	1 U	--	--
SMW-11	9/7/2005	1 U	1 U	1 U	1 U	3.6	--	--	--	--	--
SMW-11	3/22/2011	1 U	1 U	1 U	3 U	30	--	--	--	--	--
SMW-12A	7/19/1994	1400 E	570	230	1270	50 U	50 U	--	50 U	--	--
SMW-12A	10/19/1994	330	5 U	7	920	--	--	--	--	--	--
SMW-12A	7/18/1995	1600	570	510	2760	10 U	20 U	10 U	10 U	--	--
SMW-12A	8/1/1996	2200	630	490	2820	100 U	200 U	100 U	100 U	--	--
SMW-12A	7/15/1997	2000	560	40	2610	1 U	2 U	1 U	1 U	--	--
SMW-12A	4/10/2002	2400	470	50 U	1300	50 U	50 U	50 U	50 U	14000	52000

TABLE C-2. COMPILATION OF HISTORICAL ROUTINE ANALYTICAL DATA, SI AREA
Q16-1 (81) REPORT
TESORO KENAI REFINERY
NIKISKI, ALASKA

Sample Source	Sample Date	Benzene (ug/L)	Ethylbenzene (ug/L)	Toluene (ug/L)	Xylenes, Total (ug/L)	Trichloroethene (ug/L)	Vinyl Chloride (ug/L)	1,2-Dibromoethane (EDB; ug/L)	1,2-Dichloroethane (ug/L)	Gasoline Range Organics (ug/L)	Diesel Range Organics (ug/L)
SMW-12A	9/10/2002	1000	490	3.8	1210	1 U	--	--	--	--	--
SMW-12A	3/7/2005	330	460	4.4	880	1 U	1 U	--	--	7600	42000
SMW-12A	9/7/2005	7.8	1 U	1 U	1.3	1 U	--	--	--	--	--
SMW-12A	3/21/2006	3.7 J	10 U	10 U	11	10 U	10 U	20 U	10 U	630	100000
SMW-12A	9/19/2006	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-12A	2/28/2007	100 U	100 U	100 U	100 U	100 U	100 U	200 U	100 U	260	36000
SMW-12A	6/23/2010	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-12A	3/11/2014	0.13 U	0.1 U	0.25 U	0.18 U	0.13 U	0.22 U	0.22 U	0.22 U	100 U	4600
SMW-12A	3/3/2015	1.5	1 U	1 U	6 U	0.4 U	0.4 U	1 U	1 U	100 UJ	2600
SMW-12B	7/8/1998	66	61	1 U	110	1 U	2 U	1 U	1 U	--	--
SMW-12B	7/1/1999	140	55	4 U	132	4 U	4 U	4 U	4 U	--	--
SMW-12B	4/10/2000	150	96	10 U	93	10 U	10 U	20 U	5.3 U	260	--
SMW-12B	9/9/2003	1 U	24	1 U	23	--	--	--	--	--	--
SMW-12B	10/16/2003	--	--	--	--	1 U	--	--	--	--	--
SMW-12B	3/11/2004	1 U	19	1 U	17	1 U	1 U	--	--	100	250 U
SMW-12B	3/24/2008	260	150	1.6	140	1 U	1 U	2 U	1 U	1900	3900
SMW-12B	3/10/2009	100 J	4.7	1 U	140 J	1 U	1 U	2 U	1 U	380 J	1900
SMW-12B	3/9/2010	170	120	10 U	180	10 U	10 U	20 U	10 U	1800	800
SMW-12B	3/7/2011	170	140	10 U	250	10 U	10 U	20 U	10 U	1800	1600
SMW-12B	2/29/2012	160	91	5 U	72	5 U	5 U	10 U	5 U	920	1300
SMW-12B	3/4/2013	680	270	5 U	580	2.6 U	4.4 U	4.4 U	4.4 U	3600	1600
SMW-12C	8/30/2004	1 U	6	1 U	6.6	1 U	--	--	--	--	--
SMW-21A	1/25/1994	43	12	1 U	9	--	--	--	--	--	--
SMW-21A	4/11/1994	41	10	1 U	6	--	--	--	--	--	--
SMW-21A	7/19/1994	52	4.9 J	10 U	2.2 J	3.5 J	10 U	--	10 U	--	--
SMW-21A	10/19/1994	72	8	1 U	5	--	--	--	--	--	--
SMW-21A	1/18/1995	44	6	1 U	2.5	--	--	--	--	--	--
SMW-21A	4/18/1995	38	15	1 U	9.1	--	--	--	--	--	--
SMW-21A	7/18/1995	23	9.6	1 U	5.1	3.8	2 U	1 U	1 U	--	--
SMW-21A	10/23/1995	26	12	1 U	6	--	--	--	--	--	--
SMW-21A	1/4/1996	23	10	1 U	5.4	--	--	--	--	--	--
SMW-21A	4/2/1996	20	9.4	1 U	4.1	--	--	--	--	--	--
SMW-21A	7/31/1996	18	9.7	1 U	3.7	3.2	2 U	1 U	1 U	--	--
SMW-21A	10/8/1996	18	14	1 U	9.7	--	--	--	--	--	--
SMW-21A	1/14/1997	21	14	1 U	9.7	--	--	--	--	--	--
SMW-21A	4/8/1997	25	14	1 U	10	--	--	--	--	--	--
SMW-21A	7/15/1997	27	19	1 U	16	2	2 U	1 U	1 U	--	--
SMW-21A	10/7/1997	11	11	1 U	11	--	--	--	--	--	--
SMW-21A	1/13/1998	6.3	7.2	1 U	7.9	--	--	--	--	--	--
SMW-21A	4/7/1998	6.5	5.3	1 U	4.4	--	--	--	--	--	--
SMW-21A	7/8/1998	13	6.3	1 U	5	1.9	2 U	1 U	1 U	--	--
SMW-21A	10/27/1998	30	6	1 U	3.6	--	--	--	--	--	--
SMW-21A	1/11/1999	23	4.9	1 U	2.9	--	--	--	--	--	--
SMW-21A	4/6/1999	7.4	1 U	1 U	1 U	--	--	--	--	--	--
SMW-21A	7/1/1999	24	6.7	1 U	4.7	3	1 U	1 U	0.5 J	--	--
SMW-21A	9/28/1999	10	1.8	1 U	1.7	--	--	--	--	--	--
SMW-21A	1/11/2000	16	1 U	1 U	8	--	--	--	--	--	--
SMW-21A	4/10/2000	19	5.2	1 U	1.6	2.6	1 U	2 U	0.89 U	150	--
SMW-21A	6/12/2000	17	6.2	1 U	1.1	--	--	--	--	--	--
SMW-21A	9/27/2000	7.8	1.7	1 U	1 U	--	--	--	--	--	--
SMW-21A	12/11/2000	14	7.1	1 U	1 U	--	--	--	--	--	--
SMW-21A	3/27/2001	17	8.6	1 U	1 U	--	--	--	--	--	--
SMW-21A	9/19/2001	10	18	1 U	2.4	1.2	1 U	1 U	1 U	--	--
SMW-21A	4/10/2002	8.2	1.2	1 U	1 U	2	1 U	1 U	1 U	250 U	380
SMW-21A	9/10/2002	13	2.1	1 U	1 U	3.7	--	--	--	--	--
SMW-21A	3/10/2003	14	1 U	1 U	1 U	3.5	1 U	1 U	1 U	250 UJ	250 U
SMW-21A	9/9/2003	6.8	1 U	1 U	1 U	2.3	--	--	--	--	--
SMW-21A	3/11/2004	12	1 U	1 U	1 U	3.6	1 U	--	--	100	250 U
SMW-21A	8/30/2004	15	1 U	1 U	1 U	2.9	--	--	--	--	--
SMW-21A	3/7/2005	5.9	1 U	1 U	1 U	1.3	1 U	--	--	160	280
SMW-21A	9/8/2005	14	1 U	1 U	1 U	2	--	--	--	--	--
SMW-21A	12/12/2005	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-21A	3/20/2006	1 U	1 U	1 U	1 U	1 U	1 U	--	--	100 U	250 U
SMW-21A	9/19/2006	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-21A	3/1/2007	1 U	1 U	1 U	2 U	1 U	1 U	--	--	100 U	250 U
SMW-21A	9/19/2007	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--
SMW-21A	3/26/2008	1 U	1 U	1 U	2 U	1 U	1 U	--	--	100 U	250 U
SMW-21A	9/30/2008	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-21A	3/13/2009	3.5	0.2 U	0.2 U	0.6 U	0.8	0.2 U	--	--	100 U	250 U
SMW-21A	9/2/2009	4	1 U	1 U	3 U	1	--	--	--	--	--
SMW-21A	3/24/2010	1 U	1 U	1 U	3 U	1 U	1 U	--	--	100 U	250 U
SMW-21A	8/13/2010	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-21A	3/10/2011	1 U	1 U	1 U	3 U	1 U	1 U	--	--	100 U	100 U
SMW-21A	9/19/2011	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-21A	3/15/2012	1 U	1 U	1 U	3 U	1 U	1 U	--	--	100 U	100 U
SMW-21A	9/10/2012	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-21A	12/3/2012	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-21A	3/21/2013	1 U	1 U	1 U	3 U	1 U	1 U	--	--	100 U	140
SMW-21A	9/10/2013	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-21A	3/12/2014	1 U	1 U	1 U	3 U	1 U	1 U	--	--	100 U	130
SMW-21A	9/17/2014	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-21A	3/5/2015	1 U	1 U	1 U	3 UJ	1 U	1 U	--	--	200 U	100 J-
SMW-21A	9/9/2015	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-21B	1/25/1994	1 U	1 U	1 U	2 U	--	--	--	--	--	--
SMW-21B	4/11/1994	5	1 U	1 U	2 U	--	--	--	--	--	--
SMW-21B	7/19/1994	8 J	10 U	10 U	10 U	10 U	10 U	--	10 U	--	--
SMW-21B	10/19/1994	5	1 U	1 U	2 U	--	--	--	--	--	--
SMW-21B	1/18/1995	2.9	1 U	1 U	1 U	--	--	--	--	--	--
SMW-21B	4/18/1995	6.5	1 U	1 U	1 U	--	--	--	--	--	--
SMW-21B	7/18/1995	2.4	1 U	1 U	1 U	1 U	2 U	1 U	1 U	--	--
SMW-21B	10/24/1995	2.1	1 U	1 U	1 U	--	--	--	--	--	--
SMW-21B	1/4/1996	1.6	1 U	1 U	1 U	--	--	--	--	--	--
SMW-21B	4/2/1996	2	1 U	1 U	1 U	--	--	--	--	--	--

TABLE C-2. COMPILATION OF HISTORICAL ROUTINE ANALYTICAL DATA, SI AREA
Q16-1 (81) REPORT
TESORO KENAI REFINERY
NIKISKI, ALASKA

Sample Source	Sample Date	Benzene (ug/L)	Ethylbenzene (ug/L)	Toluene (ug/L)	Xylenes, Total (ug/L)	Trichloroethene (ug/L)	Vinyl Chloride (ug/L)	1,2-Dibromoethane (EDB; ug/L)	1,2-Dichloroethane (ug/L)	Gasoline Range Organics (ug/L)	Diesel Range Organics (ug/L)
SMW-21B	8/2/1996	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	--	--
SMW-21B	10/8/1996	3.2	1 U	1 U	1 U	--	--	--	--	--	--
SMW-21B	1/13/1997	6.7	3.6	1 U	3.5	--	--	--	--	--	--
SMW-21B	4/9/1997	1.5	1.5	1 U	1.5	--	--	--	--	--	--
SMW-21B	7/16/1997	3	2	1 U	3	1 U	2 U	1 U	1 U	--	--
SMW-21B	10/7/1997	1.5	1.5	1 U	2.5	--	--	--	--	--	--
SMW-21B	1/13/1998	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-21B	4/7/1998	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-21B	7/9/1998	2.6	1 U	1 U	1 U	1 U	2 U	1 U	1 U	--	--
SMW-21B	10/27/1998	7.7	1 U	1 U	1 U	--	--	--	--	--	--
SMW-21B	1/11/1999	6	1 U	1 U	1 U	--	--	--	--	--	--
SMW-21B	4/6/1999	4.7	1 U	1 U	1 U	--	--	--	--	--	--
SMW-21B	7/1/1999	10	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--
SMW-21B	9/28/1999	9.4	1 U	1 U	1 U	--	--	--	--	--	--
SMW-21B	1/11/2000	6.8	1 U	1 U	1 U	--	--	--	--	--	--
SMW-21B	4/4/2000	5.8	1 U	1 U	1 U	--	--	--	--	--	--
SMW-21B	6/12/2000	5.8	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--
SMW-21B	9/27/2000	2.8	1 U	1 U	1 U	--	--	--	--	--	--
SMW-21B	12/11/2000	4.4	1 U	1 U	1 U	--	--	--	--	--	--
SMW-21B	3/27/2001	3.4	1 U	1 U	1 U	--	--	--	--	--	--
SMW-24	5/11/1998	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-24	9/19/2001	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--
SMW-24	4/10/2002	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	250 U	250 U
SMW-24	9/10/2002	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-24	3/10/2003	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	250 U	250 U
SMW-24	9/9/2003	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-24	3/11/2004	1 U	1 U	1 U	1 U	1 U	1 U	--	--	100 U	250 U
SMW-24	8/30/2004	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-24	3/7/2005	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 U	--	--	100 U	250 U
SMW-24	9/7/2005	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-24	3/20/2006	1 U	1 U	1 U	1 U	1 U	1 U	--	--	100 U	250 U
SMW-24	9/19/2006	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-24	3/1/2007	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--
SMW-24	9/19/2007	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--
SMW-24	3/27/2008	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--
SMW-24	9/30/2008	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-24	3/13/2009	0.2 U	0.2 U	0.2 U	0.6 U	0.2 U	--	--	--	--	--
SMW-24	9/2/2009	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-24	3/24/2010	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-24	8/13/2010	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-24	3/10/2011	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-24	9/19/2011	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-24	6/26/2012	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-24	9/10/2012	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-24	4/4/2013	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-24	6/24/2013	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-24	9/10/2013	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-24	3/12/2014	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-24	9/17/2014	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-24	3/4/2015	1 U	1 U	1 U	3 UJ	1 U	--	--	--	--	--
SMW-24	9/9/2015	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-25	5/11/1998	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-25	10/2/2008	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-25	6/21/2011	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-27	3/19/1998	7.8	2.2	1 U	1 U	--	--	--	--	--	--
SMW-27	4/16/1998	9.3	1.6	1 U	1 U	--	--	--	--	100 U	630
SMW-27	5/11/1998	9.2	1.3	1 U	1 U	--	--	--	--	--	--
SMW-27	6/26/2001	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--
SMW-27	9/19/2001	1.8	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--
SMW-27	1/3/2002	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-27	1/3/2002	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--
SMW-27	4/8/2002	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	--	--
SMW-27	6/25/2002	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	--	--
SMW-27	9/10/2002	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-27	12/10/2002	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-27	3/11/2003	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-27	6/23/2003	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-27	9/9/2003	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-27	12/8/2003	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-27	3/10/2004	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-27	6/15/2004	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-27	8/30/2004	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-27	12/6/2004	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-27	3/7/2005	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-27	6/6/2005	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-27	9/8/2005	2.4	1 U	1 U	1 U	1.8	--	--	--	--	--
SMW-27	12/12/2005	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-27	3/20/2006	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-27	6/20/2006	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-27	9/19/2006	1 U	1 U	1 U	1 U	1 U	--	--	--	--	--
SMW-27	10/1/2008	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-27	6/21/2011	1 U	1 U	1 U	3 U	6.4	--	--	--	--	--
SMW-27	9/19/2011	5.2	1 U	1 U	3 U	4.3	--	--	--	--	--
SMW-27	12/8/2011	0.6	0.2 U	0.2 U	0.6 U	4.9	--	--	--	--	--
SMW-27	6/26/2012	1 U	1 U	1 U	3 U	4.6	--	--	--	--	--
SMW-27	9/10/2012	1 U	1 U	1 U	3 U	4.1	--	--	--	--	--
SMW-27	12/3/2012	1 U	1 U	1 U	3 U	2.5	--	--	--	--	--
SMW-27	4/3/2013	1 U	1 U	1 U	3 U	2.4	--	--	--	--	--
SMW-27	6/25/2013	1 U	1 U	1 U	3 U	2.6	--	--	--	--	--
SMW-27	9/9/2013	1 U	1 U	1 U	3 U	2.6	--	--	--	--	--
SMW-27	11/14/2013	1 U	1 U	1 U	3 U	2.1	--	--	--	--	--
SMW-27	3/13/2014	1 U	1 U	1 U	3 U	2	--	--	--	--	--
SMW-27	6/18/2014	1 U	1 U	1 U	3 U	2	--	--	--	--	--

TABLE C-2. COMPILATION OF HISTORICAL ROUTINE ANALYTICAL DATA, SI AREA
Q16-1 (81) REPORT
TESORO KENAI REFINERY
NIKISKI, ALASKA

Sample Source	Sample Date	Benzene (ug/L)	Ethylbenzene (ug/L)	Toluene (ug/L)	Xylenes, Total (ug/L)	Trichloroethene (ug/L)	Vinyl Chloride (ug/L)	1,2-Dibromoethane (EDB; ug/L)	1,2-Dichloroethane (ug/L)	Gasoline Range Organics (ug/L)	Diesel Range Organics (ug/L)
SMW-27	3/4/2015	1 U	1 U	1 U	3 UJ	1.5	--	--	--	--	--
SMW-29	6/2/1998	9.1	1 U	2.4	1 U	--	--	--	--	100 U	310
SMW-29	7/8/1998	12	1 U	1 U	1 U	--	--	--	--	100 U	250 U
SMW-29	12/8/2011	0.7	0.2 U	0.2 U	0.6 U	0.6	--	--	--	--	--
SMW-29	6/26/2012	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-29	9/10/2012	1 U	1 U	1 U	3 U	1.3	--	--	--	--	--
SMW-29	11/30/2012	1 U	1 U	1 U	3 U	1	--	--	--	--	--
SMW-29	4/3/2013	1 U	1 U	1 U	3 U	1.2	--	--	--	--	--
SMW-29	6/25/2013	1 U	1 U	1 U	3 U	1.1	--	--	--	--	--
SMW-29	9/10/2013	1 U	1 U	1 U	3 U	1.3	--	--	--	--	--
SMW-29	11/14/2013	1 U	1 U	1 U	3 U	1.2	--	--	--	--	--
SMW-29	3/13/2014	1 U	1 U	1 U	3 U	1.2	--	--	--	--	--
SMW-29	6/19/2014	1 U	1 U	1 U	3 U	1.3	--	--	--	--	--
SMW-29	12/9/2014	1.1	1 U	1 U	3 U	1.5	--	--	--	--	--
SMW-29	3/4/2015	1.1	1 U	1 U	3 UJ	1.1	--	--	--	--	--
SMW-30	7/8/1998	1 U	1 U	1 U	1 U	--	--	--	--	110	260 U
SMW-30	3/30/2000	1.2	1 U	1 U	1 U	--	--	--	--	--	--
SMW-30	6/12/2000	1 U	1 U	1 U	1 U	--	--	--	--	--	--
SMW-31	6/8/2005	23.8	0.5 U	0.726 J	1.5 U	--	--	--	--	--	424 U
SMW-31	9/8/2005	10	1 U	1 U	1 U	--	--	--	--	--	--
SMW-31	12/12/2005	3.9	1 U	1 U	1 U	4.1	--	--	--	--	--
SMW-31	3/20/2006	1.7	1 U	1 U	1 U	3.7	--	--	--	--	--
SMW-31	6/20/2006	3.6	1 U	1 U	1 U	4	--	--	--	--	--
SMW-31	9/19/2006	1 U	2	1 U	14	--	--	--	--	--	--
SMW-31	12/13/2006	4.5	1 U	1 U	1 U	2.3	--	--	--	--	--
SMW-31	3/1/2007	2.6	1 U	1 U	2 U	2.3	--	--	--	--	--
SMW-31	6/20/2007	3.3	1 U	1 U	2 U	2.3	--	--	--	--	--
SMW-31	9/19/2007	2.8	1 U	1 U	2 U	2.5	--	--	--	--	--
SMW-31	12/12/2007	2.1	1 U	1 U	2 U	2.6	--	--	--	--	--
SMW-31	3/26/2008	3.2	1 U	1 U	2 U	3.1	--	--	--	--	--
SMW-31	6/9/2008	3.8	0.2 U	0.2 U	0.6 U	3	--	--	--	--	--
SMW-31	9/30/2008	2.4	1 U	1 U	3 U	2.8	--	--	--	--	--
SMW-31	12/19/2008	2.7 J	0.2 U	0.2 U	0.6 U	2.4	--	--	--	--	--
SMW-31	3/13/2009	2.8	0.2 U	0.2 U	0.6 U	2.6	--	--	--	--	--
SMW-31	6/1/2009	2.5	1 UJ	1 U	3 U	2.8 J	--	--	--	--	--
SMW-31	9/2/2009	1.9	1 U	1 U	3 U	1.8	--	--	--	--	--
SMW-31	11/30/2009	1.8	1 U	1 U	3 U	2.4	--	--	--	--	--
SMW-31	3/16/2010	2.5	1 U	1 U	3 U	2.6	--	--	--	--	--
SMW-31	6/23/2010	2.7	1 U	1 U	3 U	3.1	--	--	--	--	--
SMW-31	8/13/2010	2.5	1 U	1 U	3 U	2.9	--	--	--	--	--
SMW-31	12/2/2010	1.8	1 U	1 U	3 U	2.5	--	--	--	--	--
SMW-31	3/10/2011	1.6	1 U	1 U	3 U	2.7	--	--	--	--	--
SMW-31	6/21/2011	1.8	1 U	1 U	3 U	3.5	--	--	--	--	--
SMW-31	9/19/2011	1.9	1 U	1 U	3 U	7.7	--	--	--	--	--
SMW-31	12/8/2011	2.4	0.2 U	0.2 U	0.6 U	7.5	--	--	--	--	--
SMW-31	3/5/2012	2.6 J	1 UJ	1 UJ	3 UJ	6.4 J	--	--	--	--	--
SMW-31	6/26/2012	2.1	1 U	1 U	3 U	6.9	--	--	--	--	--
SMW-31	9/10/2012	2.3	1 U	1 U	3 U	9	--	--	--	--	--
SMW-31	12/3/2012	1.1	1 U	1 U	3 U	11	--	--	--	--	--
SMW-31	4/4/2013	1.5	1 U	1 U	3 U	18	--	--	--	--	--
SMW-31	6/25/2013	1.6	1 U	1 U	3 U	19	--	--	--	--	--
SMW-31	9/9/2013	1.6	1 U	1 U	3 U	21	--	--	--	--	--
SMW-31	11/14/2013	1.2	1 U	1 U	3 U	20	--	--	--	--	--
SMW-31	3/13/2014	1 U	1 U	1 U	3 U	16	--	--	--	--	--
SMW-31	6/19/2014	1 U	1 U	1 U	3 U	14	--	--	--	--	--
SMW-31	9/17/2014	1.2	1 U	1 U	3 U	17	--	--	--	--	--
SMW-31	12/8/2014	1.8	1 U	1 U	3 U	36	--	--	--	--	--
SMW-31	3/4/2015	1.6	1 U	1 U	3 UJ	32	--	--	--	--	--
SMW-31	6/8/2015	1.4	1 U	1 U	3 U	36	--	--	--	--	--
SMW-31	9/9/2015	1.9	1 U	1 U	3 U	28	--	--	--	--	--
SMW-32	6/8/2005	20	37.8	0.5 U	33	--	--	--	--	--	391 U
SMW-32	9/8/2005	130	530	73	1530	--	--	--	--	--	--
SMW-32	12/12/2005	1.2	8.9	1.6	18	1 U	--	--	--	--	--
SMW-32	3/20/2006	1.9	15	1 U	20	1.3	--	--	--	--	--
SMW-32	6/20/2006	1 U	4.7	1 U	13	1.1	--	--	--	--	--
SMW-32	9/19/2006	1.2	1.1	1 U	4	--	--	--	--	--	--
SMW-32	12/13/2006	1 U	1 U	1 U	1 U	1.4 J	--	--	--	--	--
SMW-32	3/1/2007	1 U	1 U	1 U	1.3	1 U	--	--	--	--	--
SMW-32	6/20/2007	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--
SMW-32	9/19/2007	1.2	6	1 U	10	1 U	--	--	--	--	--
SMW-32	12/12/2007	1.2	14	1 U	20	1.1	--	--	--	--	--
SMW-32	3/27/2008	1.8	3	1 U	7.6	1.6	--	--	--	--	--
SMW-32	6/9/2008	2.8	29	0.6 U	42	1.1	--	--	--	--	--
SMW-32	10/2/2008	1.7	1.7	1 U	6.3	1.6	--	--	--	--	--
SMW-32	12/18/2008	0.7	0.8	0.2 U	1.3	0.3	--	--	--	--	--
SMW-32	3/13/2009	1.7	1.5	0.2 U	2	0.2 U	--	--	--	--	--
SMW-32	6/1/2009	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-32	9/2/2009	1.6	1.1	1 U	3 U	1 U	--	--	--	--	--
SMW-32	11/30/2009	5.4	27	1 U	20	1 U	--	--	--	--	--
SMW-32	3/16/2010	5.4	12	1 U	12	1 U	--	--	--	--	--
SMW-32	6/23/2010	4.6	2	1 U	2.9	1 U	--	--	--	--	--
SMW-32	8/13/2010	4.8	2.1	1 U	3.9	1 U	--	--	--	--	--
SMW-32	12/2/2010	1.4	1	1 U	3 U	1 U	--	--	--	--	--
SMW-32	3/10/2011	3.1	1.1	1 U	2	1 U	--	--	--	--	--
SMW-32	6/21/2011	110	20	1 U	4.6	2.7	--	--	--	--	--
SMW-32	9/19/2011	3.7	1.1	1 U	3 U	1 U	--	--	--	--	--
SMW-32	12/8/2011	26	2.3	0.2 U	9.2	0.5	--	--	--	--	--
SMW-32	3/6/2012	9.7 J	1 UJ	1 UJ	6.3 J	1 UJ	--	--	--	--	--
SMW-32	6/26/2012	16	1 U	1 U	2.4	1 U	--	--	--	--	--
SMW-32	9/10/2012	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-32	12/6/2012	28	2.8	1 U	10	1 U	--	--	--	--	--
SMW-32	4/4/2013	78	1 U	1 U	63	1 U	--	--	--	--	--
SMW-32	6/24/2013	110	2 U	2 U	130	2 U	--	--	--	--	--

TABLE C-2. COMPILATION OF HISTORICAL ROUTINE ANALYTICAL DATA, SI AREA
Q16-1 (81) REPORT
TESORO KENAI REFINERY
NIKISKI, ALASKA

Sample Source	Sample Date	Benzene (ug/L)	Ethylbenzene (ug/L)	Toluene (ug/L)	Xylenes, Total (ug/L)	Trichloroethene (ug/L)	Vinyl Chloride (ug/L)	1,2-Dibromoethane (EDB; ug/L)	1,2-Dichloroethane (ug/L)	Gasoline Range Organics (ug/L)	Diesel Range Organics (ug/L)
SMW-32	9/9/2013	12	1 U	1 U	9.6	1 U	--	--	--	--	--
SMW-32	11/14/2013	3.4	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-32	3/12/2014	16	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-32	6/18/2014	3	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-32	9/17/2014	5.6	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-32	12/8/2014	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-32	3/4/2015	1 U	1 U	1 U	3 UJ	1 U	--	--	--	--	--
SMW-32	6/8/2015	18	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-32	7/27/2015	15	0.2 U	0.2 U	0.57	--	--	--	--	--	--
SMW-32	9/9/2015	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-33	6/8/2005	147	843	5 U	2100	--	--	--	--	--	12000
SMW-33	9/8/2005	120	880	10 U	2330	--	--	--	--	--	--
SMW-33	3/27/2008	11	590	10 U	1560	10 U	10 U	--	--	8000	45000
SMW-33	12/19/2008	22	240	10 U	1000 J	10 U	--	--	--	--	--
SMW-33	3/11/2009	58	310	3 U	830	3 U	3 U	--	--	3600	13000
SMW-33	6/1/2009	3 U	110	3 U	780 J	3 U	--	--	--	--	--
SMW-33	7/8/2009	9.85	155	2 U	645	--	--	--	--	3090 J	11900
SMW-33	8/5/2009	6.11	174	2.85	624	--	--	--	--	3570 J	10900
SMW-33	9/2/2009	2.7	230	2.4	880	1 U	--	--	--	--	--
SMW-33	9/2/2009	2.47	272 J	10.7	812 J	--	--	--	--	3830 J	8460
SMW-33	9/30/2009	6.6	238	3.27	844	--	--	--	--	3140 J	8860
SMW-33	10/28/2009	5 U	222	20 U	742	--	--	--	--	3520	12200
SMW-33	11/30/2009	3 U	270	3 U	896	3 U	--	--	--	--	--
SMW-33	3/16/2010	10 U	260	10 U	800	10 U	--	--	--	--	--
SMW-33	6/23/2010	10 U	120	10 U	397	10 U	--	--	--	--	--
SMW-33	8/13/2010	10 U	85	10 U	258	10 U	--	--	--	--	--
SMW-33	12/2/2010	1	51	1 U	201	1 U	--	--	--	--	--
SMW-33	3/10/2011	5 U	38	5 U	93	5 U	--	--	--	--	--
SMW-33	6/21/2011	4	71	3 U	164	3 U	--	--	--	--	--
SMW-33	9/19/2011	1 U	25	1 U	93	1 U	--	--	--	--	--
SMW-33	12/8/2011	2.2	69	1 U	156	1 U	--	--	--	--	--
SMW-33	3/6/2012	3 UJ	53 J	3 UJ	140 J	3 UJ	--	--	--	--	--
SMW-33	6/26/2012	1	18	1 U	46	1 U	--	--	--	--	--
SMW-33	9/10/2012	1 U	9.9	1 U	33	1 U	--	--	--	--	--
SMW-33	12/6/2012	1 U	5.6	1 U	17.2	1 U	--	--	--	--	--
SMW-33	4/4/2013	1	21	1 U	62	1 U	--	--	--	--	--
SMW-33	6/25/2013	1 U	30	1 U	79.5	1 U	--	--	--	--	--
SMW-33	9/9/2013	1 U	14	1 U	68.8	1 U	--	--	--	--	--
SMW-33	11/14/2013	1 U	11	1 U	57.8	1 U	--	--	--	--	--
SMW-33	3/12/2014	1 U	7.9	1 U	49.8	1 U	--	--	--	--	--
SMW-33	6/18/2014	1 U	7.2	1 U	38.2	1 U	--	--	--	--	--
SMW-33	9/19/2014	1 U	8.3	1 U	45.7	1 U	--	--	--	--	--
SMW-33	12/8/2014	1 U	12	1 U	93	1 U	--	--	--	--	--
SMW-33	3/4/2015	1 U	4.6	1 U	38	1 U	--	--	--	--	--
SMW-33	6/8/2015	1 U	9.1	1 U	71	1 U	--	--	--	--	--
SMW-33	9/9/2015	1 U	1 U	1 U	3 U	1 U	--	--	--	--	--
SMW-34	6/14/2010	--	--	--	--	33.9	--	--	--	--	--
SMW-34	7/21/2010	38	23.1	1 U	8.58	11.1	1 U	1 U	0.5 U	--	833 U
SMW-34	9/2/2010	--	--	--	--	13.3	--	1 U	--	--	--
SMW-34	10/14/2010	60	43	1 U	25	16.5	--	--	--	--	--
SMW-34	10/21/2010	54	36.2	1 U	20	16.7	--	--	--	--	--
SMW-34	10/28/2010	53	29	1 U	12	12.5	--	--	--	--	--
SMW-34	11/10/2010	87	32.5	1 U	13	13	--	--	--	--	--
SMW-34	11/18/2010	157	42	1 U	24	18.5	--	--	--	--	--
SMW-34	12/8/2010	206	32.4	1 U	19	14.9	--	--	--	--	--
SMW-34	1/5/2011	93	23.3	1 U	14	18.1	--	--	--	--	--
SMW-34	1/25/2011	92.7	32.2	1 U	19	27	--	--	--	--	--
SMW-34	3/10/2011	160	25	5 U	15	31 J	--	--	--	--	--
SMW-I-1	5/11/1998	22	1 U	1 U	1 U	--	--	--	--	--	--
SMW-I-1	4/14/2000	19	2 U	2 U	2 U	76	1.1 J	4 U	0.67 U	--	--
SMW-I-1	9/19/2001	19	1 U	1 U	1 U	74	1 U	1 U	1 U	--	--
SMW-I-1	4/10/2002	18	1 U	1 U	1 U	52	1.2	1 U	1 U	250 U	250 U
SMW-I-1	9/10/2002	17	1 U	1 U	1 U	68	--	--	--	--	--
SMW-I-1	3/10/2003	16	1 U	1 U	1 U	57	1 J	1 U	1 U	250 UR	250 U
SMW-I-1	9/4/2003	18 J	1 U	1 U	1 U	--	--	--	--	--	--
SMW-I-1	10/16/2003	--	--	--	--	84	--	--	--	--	--
SMW-I-1	3/11/2004	20	1 U	1 U	1 U	84	1.1 M	--	--	310 J	250 U
SMW-I-1	8/31/2004	16	1 U	1 U	1 U	66	--	--	--	--	--
SMW-I-1	3/7/2005	17	1 U	1 U	1 U	50	1 U	--	--	310 J	250 U
SMW-I-1	9/7/2005	14	1 U	1 U	1 U	52	--	--	--	--	--
SMW-I-1	3/21/2006	12	1 U	1 U	1 U	47	1 U	--	--	120	250 U
SMW-I-1	9/19/2006	5.4	1 U	1 U	1 U	150	--	--	--	--	--
SMW-I-1	3/1/2007	3.2	1 U	1 U	2 U	86	1 U	--	--	100 U	250 U
SMW-I-1	6/19/2007	7.3	1 U	1 U	2 U	51	--	--	--	--	--
SMW-I-1	9/19/2007	6	1 U	1 U	2 U	100	--	--	--	--	--
SMW-I-1	12/12/2007	4.8	1 U	1 U	2 U	98	--	--	--	--	--
SMW-I-1	3/26/2008	6.2	1 U	1 U	2 U	50	1 U	--	--	170	250 U
SMW-I-1	6/9/2008	4.7	2 U	2 U	6 U	120	--	--	--	--	--
SMW-I-1	9/30/2008	2.9	1 U	1 U	3 U	94	--	--	--	--	--
SMW-I-1	12/18/2008	5	0.2 U	0.2 U	0.6 U	110	--	--	--	--	--
SMW-I-1	3/16/2009	6	0.2 U	0.2 U	0.6 U	49	0.5	--	--	100 U	250 U
SMW-I-1	6/1/2009	1 U	1 U	1 U	3 U	73	--	--	--	--	--
SMW-I-1	9/2/2009	1 U	1 U	1 U	3 U	63	--	--	--	--	--
SMW-I-1	11/30/2009	1 U	1 U	1 U	3 U	61	--	--	--	--	--
SMW-I-1	3/18/2010	5.2	1 U	1 U	3 U	58	1 U	--	--	100 U	250 U
SMW-I-1	6/23/2010	4.3	1 U	1 U	3 U	49	--	--	--	--	--
SMW-I-1	8/13/2010	1 U	1 U	1 U	3 U	44	--	--	--	--	--
SMW-I-1	12/2/2010	1 U	1 U	1 U	3 U	54	--	--	--	--	--
SMW-I-1	3/10/2011	4.3	1 U	1 U	3 U	40	1 U	--	--	100 U	110 U
SMW-I-1	6/21/2011	1 U	1 U	1 U	3 U	44	--	--	--	--	--
SMW-I-1	9/19/2011	1.3	1 U	1 U	3 U	65	--	--	--	--	--
SMW-I-1	12/8/2011	1.8	0.2 U	0.2 U	0.6 U	88	--	--	--	--	--
SMW-I-1	3/6/2012	4.3 J	1 UJ	1 UJ	3 UJ	46 J	1 UJ	--	--	100 UJ	100 UJ

TABLE C-2. COMPILATION OF HISTORICAL ROUTINE ANALYTICAL DATA, SI AREA
Q16-1 (81) REPORT
TESORO KENAI REFINERY
NIKISKI, ALASKA

Sample Source	Sample Date	Benzene (ug/L)	Ethylbenzene (ug/L)	Toluene (ug/L)	Xylenes, Total (ug/L)	Trichloroethene (ug/L)	Vinyl Chloride (ug/L)	1,2-Dibromoethane (EDB; ug/L)	1,2-Dichloroethane (ug/L)	Gasoline Range Organics (ug/L)	Diesel Range Organics (ug/L)
SMW-I-1	6/26/2012	1 U	1 U	1 U	3 U	44	--	--	--	--	--
SMW-I-1	9/10/2012	1.2	1 U	1 U	3 U	61	--	--	--	--	--
SMW-I-1	12/6/2012	3.5	1 U	1 U	3 U	35	--	--	--	--	--
SMW-I-1	4/4/2013	4	1 U	1 U	3 U	38	1 U	--	--	100 U	100 U
SMW-I-1	6/25/2013	3.8	1 U	1 U	3 U	36	--	--	--	--	--
SMW-I-1	9/9/2013	3.4	1 U	1 U	3 U	35	--	--	--	--	--
SMW-I-1	11/14/2013	2.8	1 U	1 U	3 U	32	--	--	--	--	--
SMW-I-1	3/13/2014	3.8	1 U	1 U	3 U	35 J	1 U	--	--	100 U	100 U
SMW-I-1	6/19/2014	3.2	1 U	1 U	3 U	35	--	--	--	--	--
SMW-I-1	9/17/2014	4.4	1 U	1 U	3 U	39	--	--	--	--	--
SMW-I-1	12/9/2014	5.1	1 U	1 U	3 U	55	--	--	--	--	--
SMW-I-1	3/5/2015	7.3	2 U	2 U	6 U	110	2 U	--	--	100 U	100 UJ
SMW-I-1	6/8/2015	1.5	1 U	1 U	3 U	12	--	--	--	--	--
SMW-I-1	9/9/2015	1 U	1 U	1 U	3 U	10	--	--	--	--	--

Notes
E - Calibration range exceedance

U - Not detected at reporting limit

ug/L - micrograms per liter

TABLE C-3. FIELD FORM FOR PHASE 1 PRESSURE TESTING
Q16-1 (81) REPORT
TESORO KENAI REFINERY
NIKISKI, ALASKA

	PRESSURE (PSI)																				
Location	1 MINUTE	2 MINUTES	3 MINUTES	4 MINUTES	5 MINUTES	6 MINUTES	7 MINUTES	8 MINUTES	9 MINUTES	10 MINUTES	11 MINUTES	12 MINUTES	13 MINUTES	14 MINUTES	15 MINUTES	16 MINUTES	17 MINUTES	18 MINUTES	19 MINUTES	20 MINUTES	Notes
SAS-3																					
SAS-5																					
SAS-7																					
SAS-9																					
SAS-11																					
SAS-13																					
SAS-15																					
SAS-17																					
SAS-19																					
SAS-21																					
SAS-4																					
SAS-6																					
SAS-8																					
SAS-10																					
SAS-12																					
SAS-14																					
SAS-16																					
SAS-18																					
SAS-20																					
SAS-22																					

Note - Discontinue measurements once 5 consecutive measurements have shown a change no greater than 0.25 psi

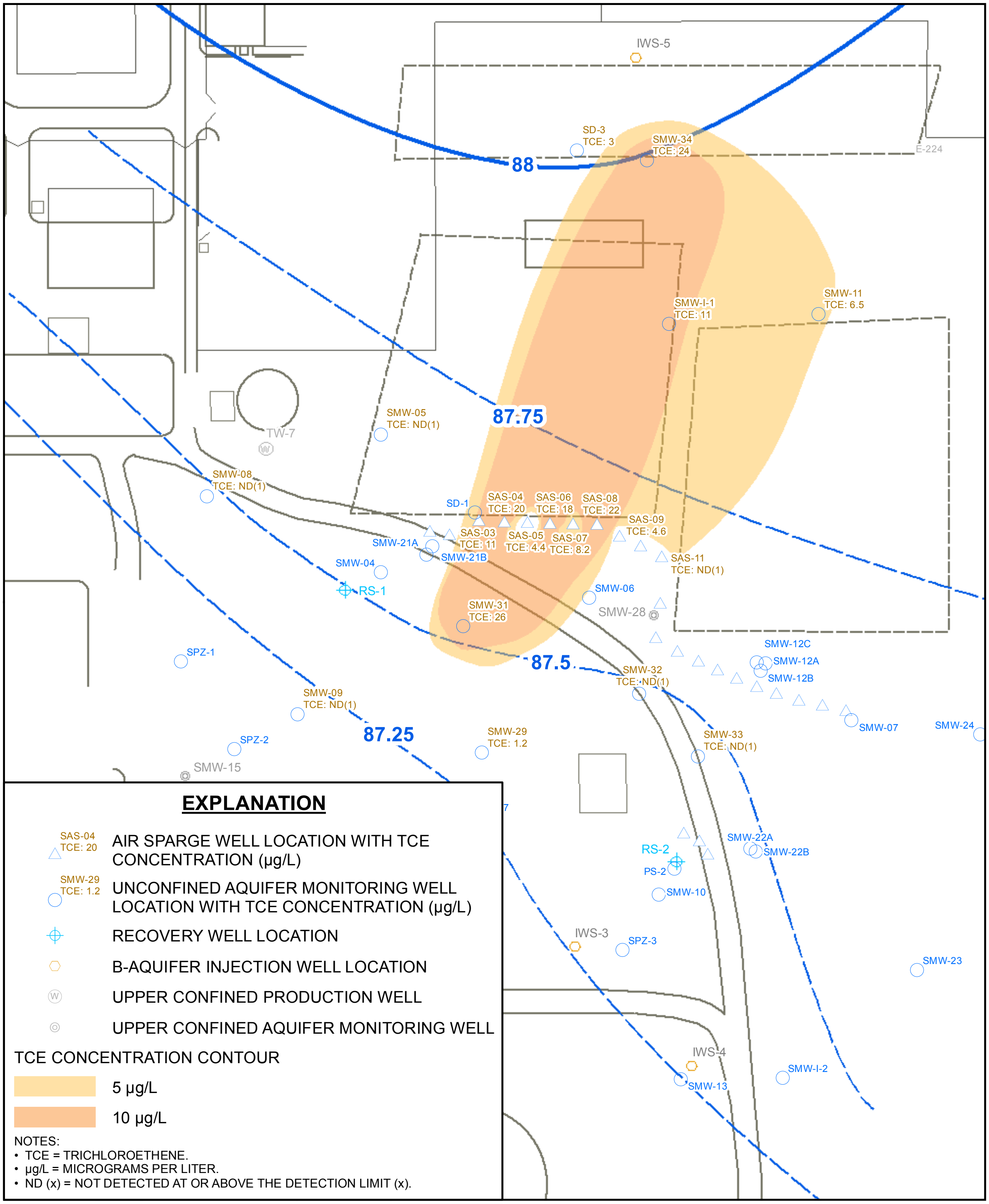
TABLE C-4. FIELD FORM FOR PHASE 1 DISSOLVED OXYGEN MEASUREMENTS
Q16-1 (81) REPORT
TESORO KENAI REFINERY
NIKISKI, ALASKA

		DISSOLVED OXYGEN (mg/L)						
PULSE LOCATION	MEASUREMENT LOCATION	DURING PULSE 1	AFTER PULSE 1	DURING PULSE 2	AFTER PULSE 2	DURING PULSE 3	AFTER PULSE 3	Notes
SAS-3	SAS-4							
SAS-4	SAS-3							
	SAS-5							
SAS-5	SAS-4							
	SAS-6							
SAS-6	SAS-5							
	SAS-7							
SAS-7	SAS-6							
	SAS-8							
SAS-8	SAS-7							
	SAS-9							
SAS-9	SAS-8							
	SAS-10							
SAS-10	SAS-9							
	SAS-11							
SAS-11	SAS-10							
	SAS-12							
SAS-12	SAS-11							
	SAS-13							
SAS-13	SAS-12							
	SAS-14							

TABLE C-4. FIELD FORM FOR PHASE 1 DISSOLVED OXYGEN MEASUREMENTS
Q16-1 (81) REPORT
TESORO KENAI REFINERY
NIKISKI, ALASKA

PULSE LOCATION	MEASUREMENT LOCATION	DISSOLVED OXYGEN (mg/L) DURING PULSE 1	AFTER PULSE 1	DURING PULSE 2	AFTER PULSE 2	DURING PULSE 3	AFTER PULSE 3	Notes
SAS-14	SAS-13							
	SAS-15							
SAS-15	SAS-14							
	SAS-16							
SAS-16	SAS-15							
	SAS-17							
SAS-17	SAS-16							
	SAS-18							
SAS-18	SAS-17							
	SAS-19							
SAS-19	SAS-18							
	SAS-20							
SAS-20	SAS-19							
	SAS-21							
SAS-21	SAS-20							
	SAS-22							
SAS-22	SAS-21							
	SAS-23							

FIGURES



EXPLANATION

SAS-04 TCE: 20 — AIR SPARGE WELL LOCATION WITH TCE CONCENTRATION (µg/L)

SMW-29 TCE: 1.2 — UNCONFINED AQUIFER MONITORING WELL LOCATION WITH TCE CONCENTRATION (µg/L)

RECOVERY WELL LOCATION

B-AQUIFER INJECTION WELL LOCATION

UPPER CONFINED PRODUCTION WELL

UPPER CONFINED AQUIFER MONITORING WELL

TCE CONCENTRATION CONTOUR

5 µg/L

10 µg/L

NOTES:
- TCE = TRICHLOROETHENE.
- µg/L = MICROGRAMS PER LITER.
- ND (x) = NOT DETECTED AT OR ABOVE THE DETECTION LIMIT (x).

N

0 125'

Trihydro CORPORATION

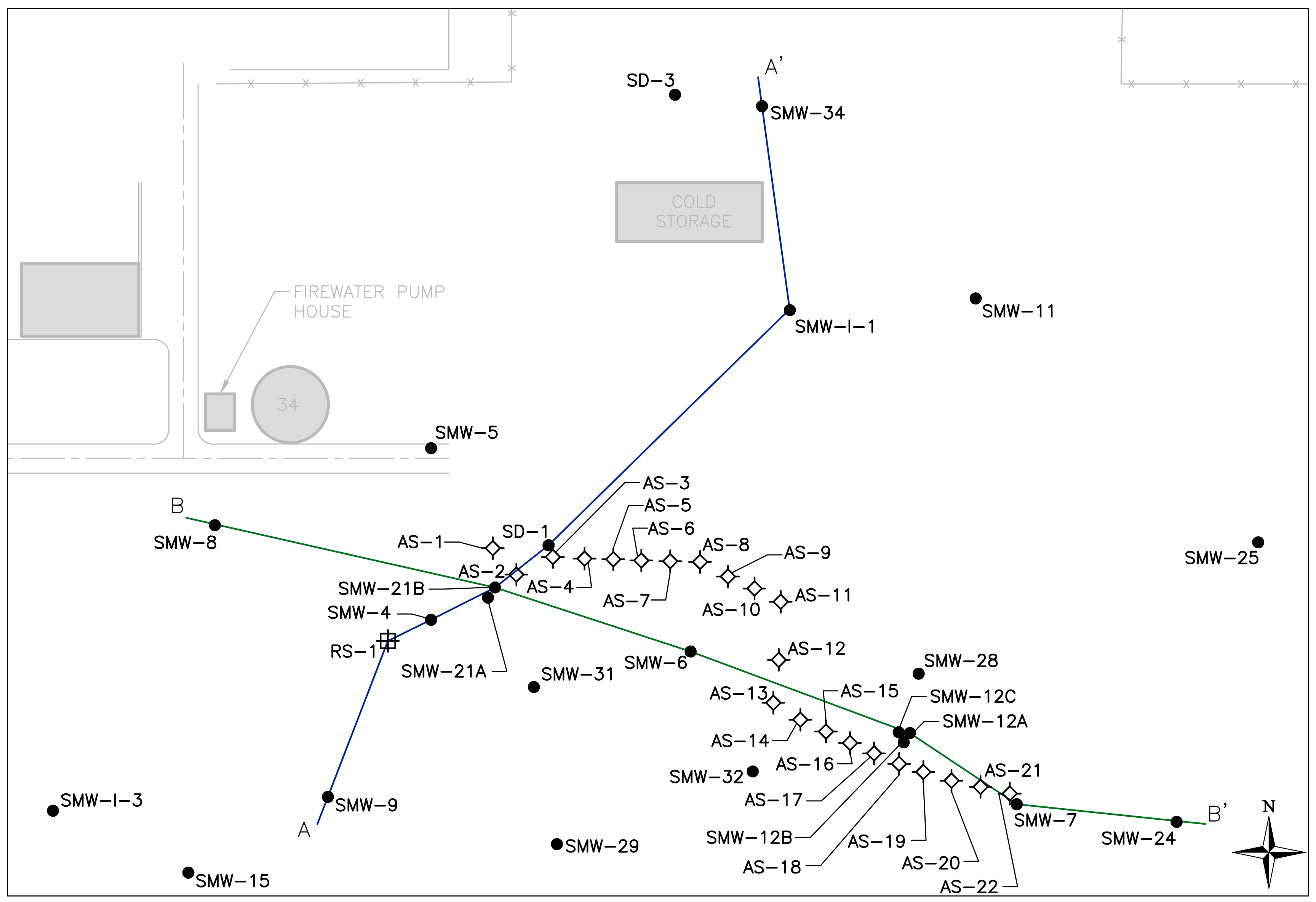
1252 Commerce Drive
Laramie, WY 82070
www.trihydro.com
(P) 307/745.7474 (F) 307/745.7729

FIGURE C-1

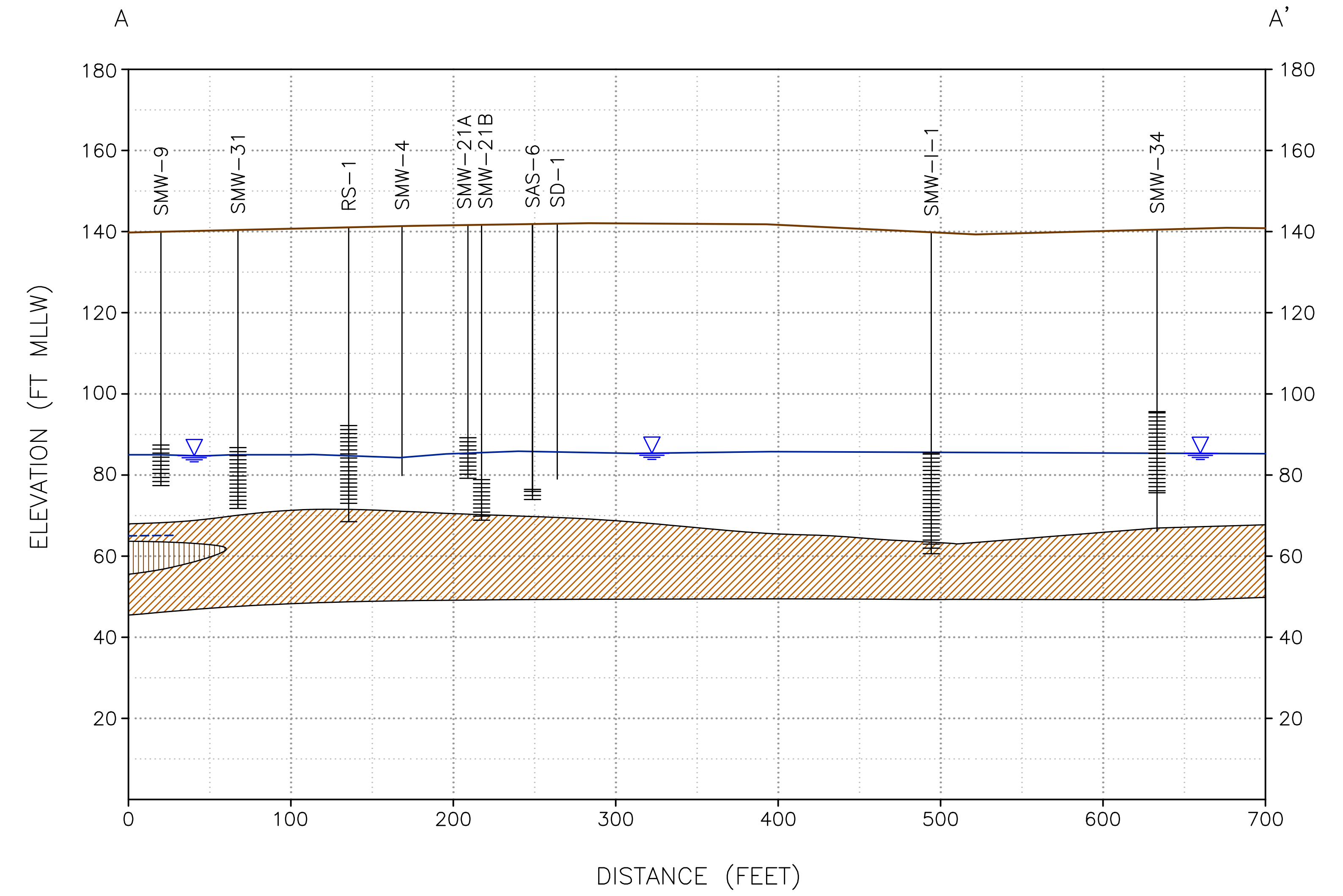
DECEMBER 2015 TCE CONCENTRATIONS

Q16-1 (81) REPORT
TESORO KENAI REFINERY
NIKISKI, ALASKA

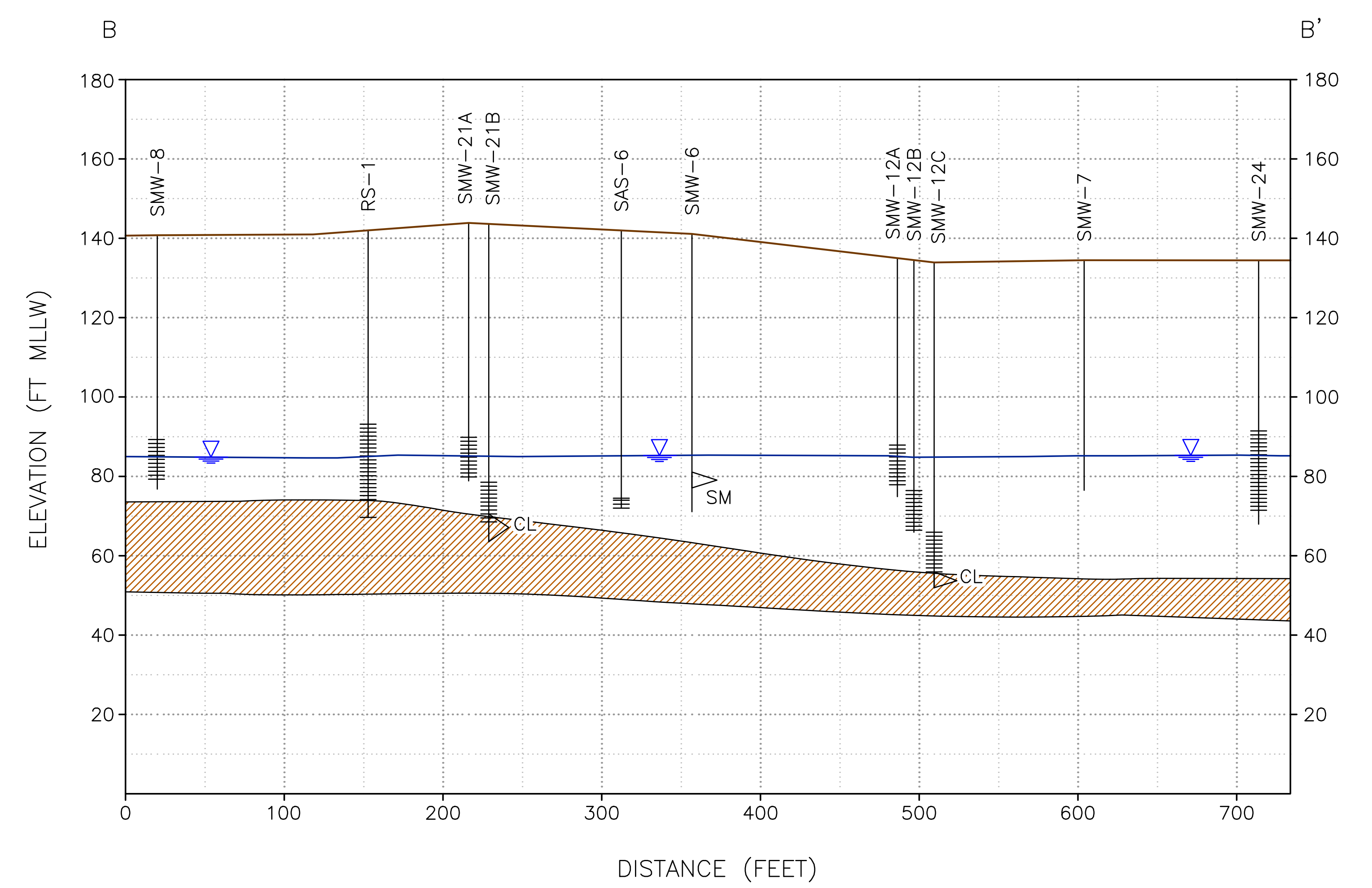
Drawn By: BLM	Checked By: DH	Scale: 1" = 125'	Date: 1/28/16	File: Q16-1-81_SI_Chem.mxd



1 **GEOLOGIC CROSS SECTION LOCATION MAP**
SCALE: 1" = 100'
0 100'



A **CROSS SECTION (A-A')**
SCALE: H: 1" = 100' V: 1" = 40'
0 100' HORIZONTAL
0 40' VERTICAL
VERTICAL EXAGGERATION = 2.5X



B **CROSS SECTION (B-B')**
SCALE: H: 1" = 100' V: 1" = 40'
0 100' HORIZONTAL
0 40' VERTICAL
VERTICAL EXAGGERATION = 2.5X

EXPLANATION

SMW-24	WELL DESIGNATION
	MONITORING WELL OR BORING
	MONITORING WELL SCREENED INTERVAL
	STATIC WATER LEVEL (FT MLLW)
	GROUND SURFACE
	UNCONFINED AQUIFER WATER TABLE (APRIL 1998)
	UPPER CONFINED AQUIFER POTENTIOMETRIC SURFACE (APRIL 1998)
	MAIN AQUITARD (MASSIVE AND VARVED CLAY AND UNDIFFERENTIATED SEQUENCES)
	MAIN AQUITARD (INTERBEDDED CLAY, SILT, SILTY SAND, AND SAND)
CL	CLAY (LOW PLASTICITY)
FT MLLW	FEET MEAN LOWER LOW WATER
SM	SILTY SAND
SMW-24	MONITORING WELL AND DESIGNATION
RS-1	RECOVERY WELL AND DESIGNATION
AS-22	AIR SPARGE WELL AND DESIGNATION
A — A'	CROSS SECTION (A-A')
B — B'	CROSS SECTION (B-B')
	FENCE
	ROAD (CENTERLINE)
	BUILDING, TANK, OR OTHER STRUCTURE
SI	SURFACE IMPOUNDMENT

NOTES:

1. BASE MAP AND DATA SOURCE; KENT & SULLIVAN, INC., JULY 10, 1998
2. GROUNDWATER ELEVATION BASED ON DECEMBER 2015 GAUGING

Trihydro CORPORATION
1252 Commerce Drive
Laramie, Wyoming 82070
www.trihydro.com
(P) 307/745.7474 (F) 307/745.7729

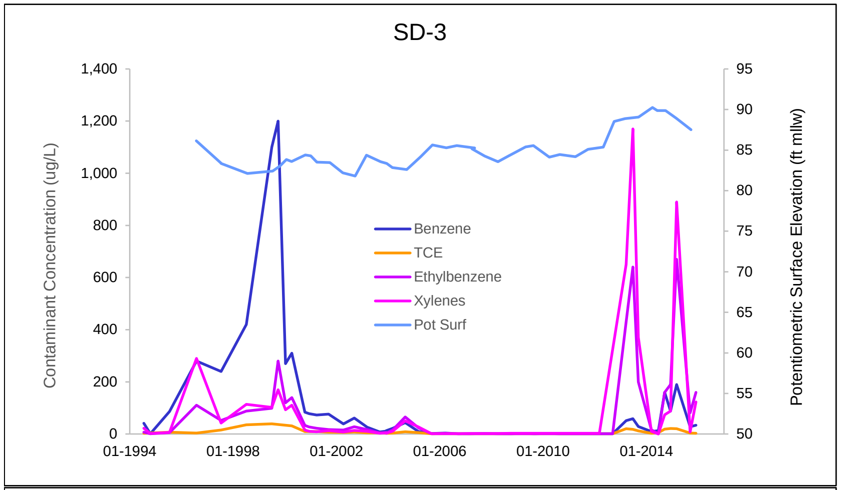
FIGURE C-2

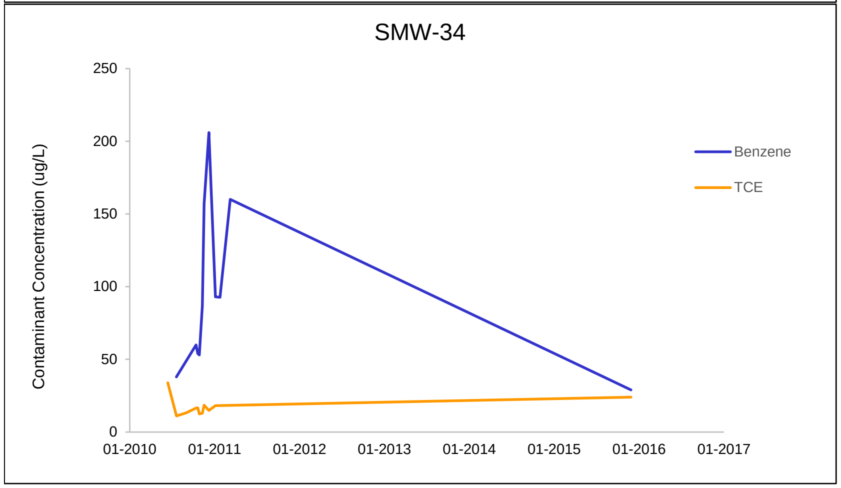
GEOLOGIC CROSS SECTION LOCATION MAP AND GEOLOGIC CROSS SECTIONS A-A' AND B-B' (SI AREA)

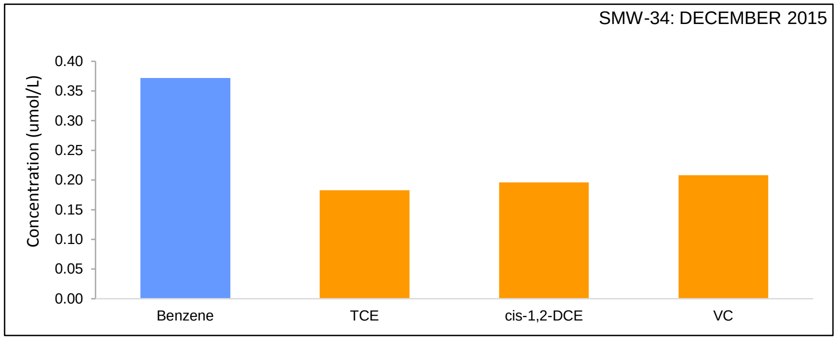
TESORO KENAI REFINERY
NIKISKI, ALASKA

Drawn By: RJ	Checked By: BM	Scale: AS SHOWN	Date: 2/23/2016	File: 36C-KENAI_CROSSSECTION_20160129

FIGURE C-3. DATA PLOTS FOR SELECTED WELLS IN VICINITY OF SURFACE IMPOUNDMENT 3
TESORO KENAI REFINERY
NIKISKI, ALASKA

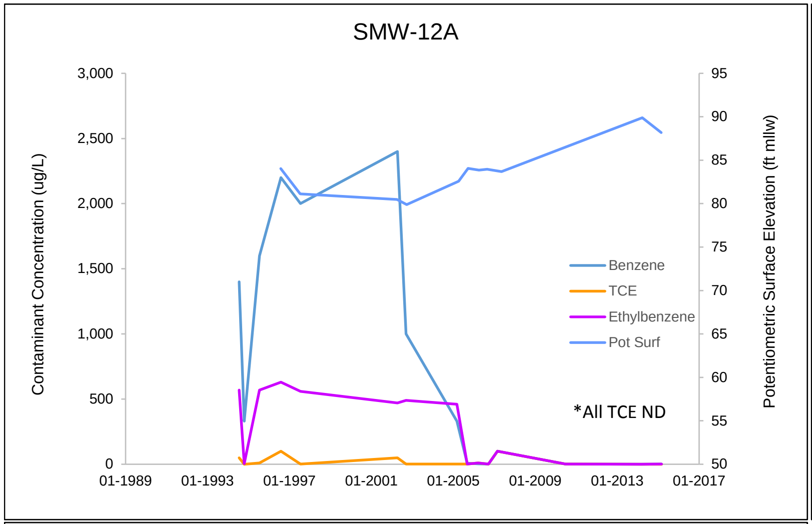


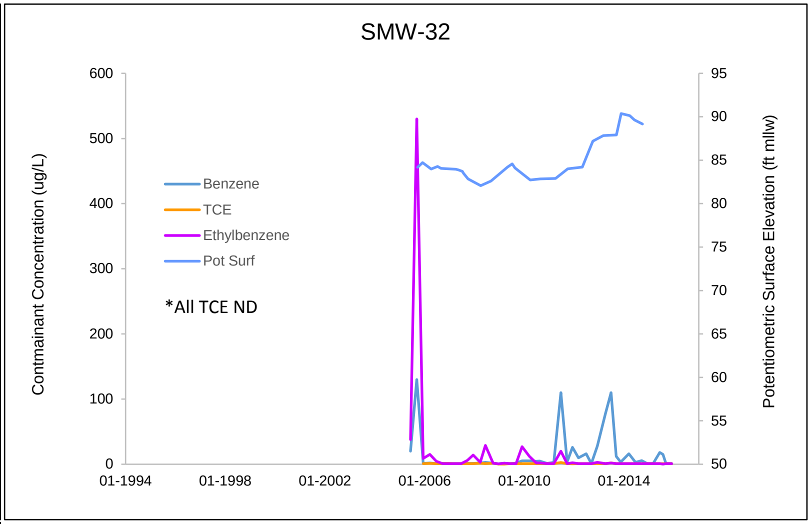


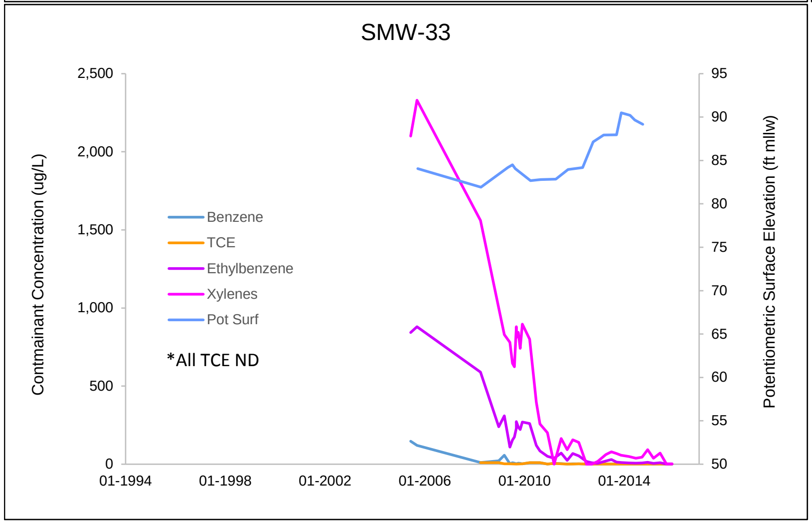


Notes
Non-dectects set to detection limit
Bar graph uses micromoles per liter (umol/L) for comparison between TCE and daughter products
Pot surf: potentiometric surface
TCE: trichloroethene
cis-1,2-DCE: cis-1,2-dichloroethene
VC: vinyl chloride

FIGURE C-4. DATA PLOTS FOR SELECTED WELLS IN VICINITY OF SURFACE IMPOUNDMENT 2
TESORO KENAI REFINERY
NIKISKI, ALASKA

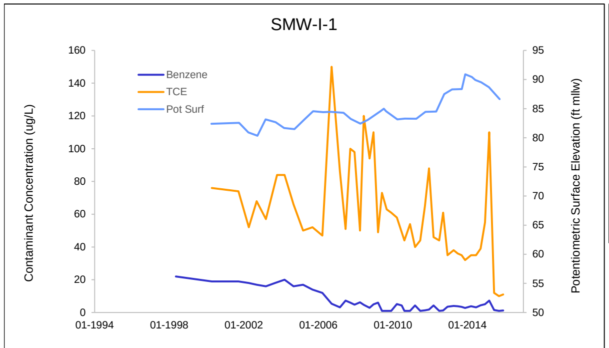


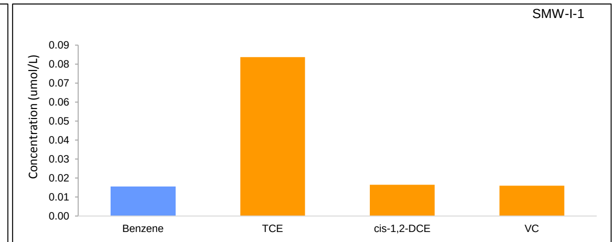


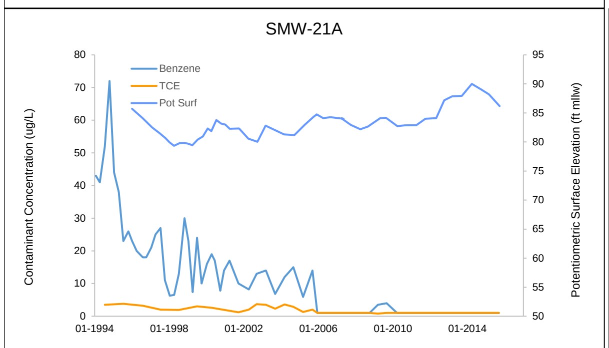


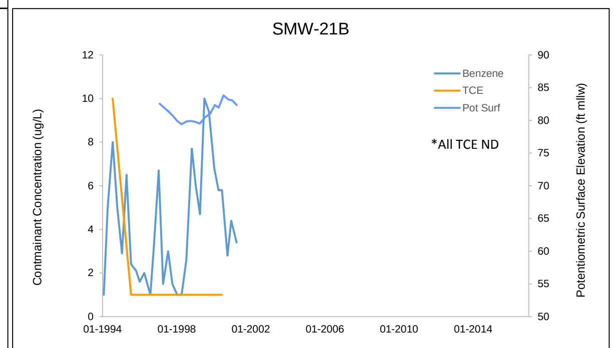
Notes
Non-dectects set to detection limit
Pot surf: potentiometric surface
TCE: trichloroethene

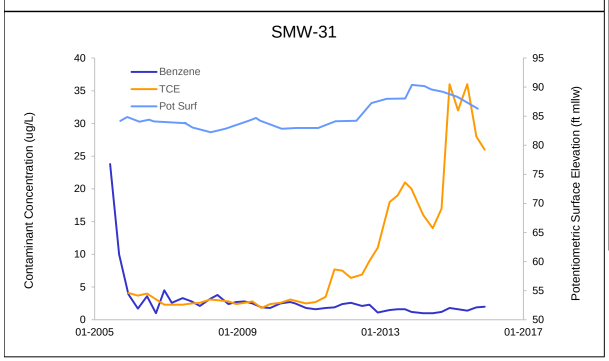
FIGURE C-5. DATA PLOTS FOR SELECTED WELLS IN VICINITY OF SURFACE IMPOUNDMENT 1
TESORO KENAI REFINERY
NIKISKI, ALASKA

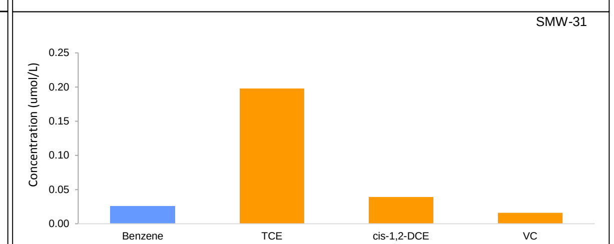












Notes
Non-dectects set to detection limit
Bar graphs use micromoles per liter (umol/L) for comparison between TCE and daughter products
Pot surf: potentiometric surface
TCE: trichloroethene
cis-1,2-DCE: cis-1,2-dichloroethene

E-3.0 E-219 CORRECTIVE ACTION MODIFICATION PLAN

E-219 CORRECTIVE ACTION MODIFICATION PLAN (CAMP)

FOR RESTARTING THE LOWER TANK FARM (LTF)
AIR SPARGE AND SOIL VAPOR EXTRACTION (AS/SVE) SYSTEM
TESORO ALASKA REFINERY

PREPARED FOR
TESORO ALASKA COMPANY

KENT & SULLIVAN, INC.
Environmental Consultants

Table of Contents

Figures

E-219 CORRECTIVE ACTION MODIFICATION PLAN

FOR RESTARTING THE LOWER TANK FARM AS/SVE SYSTEM

This *Corrective Action Modification Plan* (CAMP) has been developed to address the benzene concentration increase at well E-219. This CAMP is prepared in accordance with condition III.D.1[1] of Tesoro's Kenai Refinery RCRA Post-Closure Permit (No. AKD 04864 9682) that was triggered based on the results of the semi-annual adequate progress demonstration (Permit condition III.D.3)[2] for well E-219 performed during Quarterly Progress Report (QPR) No. 76. The benzene concentration at well E-219 has a statistically-significant positive trend based on sampling data since Quarter 47.

BACKGROUND

The lower tank farm (LTF) air sparge and soil vapor extraction (AS/SVE) system was built in 2000 and 2001 and operated as a supplemental corrective measure from 2002 to 2009. The system consists of 18 sparge wells (RR-01AS through RR-17AS and E-222AS) and four SVE wells (RR-01VE, RR-07VE, RR-14VE, and E-222VE) located in the northern part of the refinery's lower tank farm (Figure C-1). The sparge wells are spaced 22 to 28 feet apart in a line approximately perpendicular to groundwater flow and create a treatment zone approximately 370 feet wide. The wells are located within a lined secondary tank containment dike with the well heads buried beneath the liner. The secondary containment liner acts as a confining cap for the SVE system which facilitates capture of sparge air by the SVE system.

The LTF area is the principal source of contamination in the northern portion of the PM plume. The plume in this area has high benzene concentrations as a result of releases of light-end products and intermediates containing significant benzene fractions. The A- and B-aquifers are merged and have historically been only 10 to 20 feet thick such that contaminants impact the full thickness of the aquifer in this area. The merged aquifer thickness increases to the west, and divergent groundwater flow distributes the plume throughout the vertical extent of the aquifer as it migrates downgradient. The LFT AS/SVE system is, therefore, located where it can cut off contaminant migration from near a source area that impacts both the A- and B-aquifers.

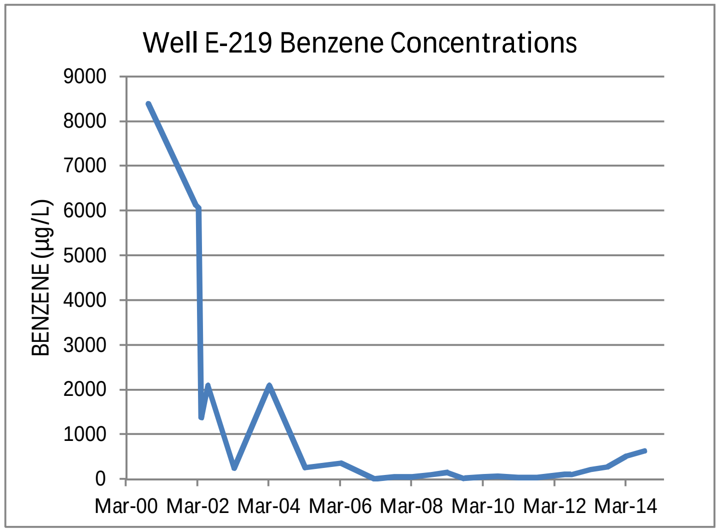
The LFT system lost effectiveness over time because the wells are completed below the containment liner and are not accessible for redevelopment and repairs. The operating pressure of at least 12 of the wells increased to greater than the maximum pressure of the sparge blower and ceased working. The casings or air line connections to two of the sparge wells (RR-12 and RR-14) appear to have

[1] *III.D.1 The Permittee shall implement the Corrective Action Program to meet the performance standards contained in permit conditions III.D.2 through III.D.4. If the Permittee cannot meet these requirements, the Permittee shall submit to the Agency a Corrective Action Modification Plan (CAMP) to more effectively meet these standards and a schedule for implementing this plan. The CAMP and its implementation schedule shall be submitted within one hundred twenty (120) calendar days of the Permittee's determination that it cannot demonstrate effective performance or within one hundred twenty (120) calendar days of the Permittee's receipt of a written request from the Agency.*

[2] *III.D.3 The Permittee shall implement the Corrective Action program in a manner that makes adequate progress toward achieving the Program goals, as defined below in permit conditions III.D.3.a.i through III.D.3.a.iv. The progress of the Program shall be considered adequate if:*
III.D.3.a The Permittee demonstrates a non-positive trend in dissolved-phase contamination . . .

broken because the lines operate at below the well break-out pressures. Tesoro shut the system off because of these problems.

The positive benzene concentration trend in well E-219 since 2007 is caused by shutting off the LTF system. When installed in 2000, groundwater at well E-219 contained 8,390 µg/L benzene and over 10,000 µg/L combined toluene, ethylbenzene, and xylenes. Contaminant concentrations decreased during LTF system operation to between 1 and 140 µg/L benzene and less than 500 µg/L combined toluene, ethylbenzene, and xylenes from 2007 to 2009 as shown by the adjacent graph. Benzene concentrations have increased to 640 µg/L in Quarter 76 but remain an order of magnitude less than the concentration in 2000.



Contaminant concentrations in other LTF area wells have remained relatively stable since the AS/SVE system was shut off suggesting that the increase at well E-219 is localized and not part of a broader pattern. Given this, and the fact that the increase is a relatively minor rebound from successful operation of the AS/SVE system, a modification of the existing PM corrective measure is not warranted. Nonetheless, Tesoro intends to restart the LTF system as a supplemental corrective measure to further reduce benzene migration from this source area, and this may reverse the positive concentration trend at well E-219.

LOWER TANK FARM AS/SVE RESTART

This CAMP describes the steps that will be taken to revamp and restart the LTF AS/SVE system as a supplemental corrective measure. The work will be performed in phases. The SVE system and 12 of the sparge wells that remain operable will be restarted in the first phase. The sparge wells that require redevelopment, repair or replacement (~5) will be addressed in a second phase of work if the first phase of the restart is successful and an acceptable means of accessing the wells and pipelines beneath the containment liner can be found. The first phase of work is described in the following sections.

AS System Modifications

The regenerative blowers used in the original system will be replaced with a 10-horsepower positive-displacement rotary lobe blower capable of operating at a maximum of 15 pounds per square inch (psi) pressure and 110 cubic feet per minute (cfm) air flow. The higher pressure blower is needed to handle the increased sparge well breakout pressures in several of the wells. In addition, the regional rise in water levels since 2012 has increased operating pressures by 2 to 3 psi above those during the original period of operation. The electrical supply system will be modified to run the larger blower.

The sparge piping system will be revamped to two banks of six wells each with flow switched between the banks using the existing electrically-actuated three-way valve. The original orifice-plate flow meters will be replaced with rotometer flow meters.

SVE System Modifications

The existing regenerative blower will be used in the revamped system together with the existing piping and controls. The blower operates at 250 to 300 cfm and 50 to 70 inches water vacuum.

A thermal oxidizer was originally used for SVE off-gas treatment because of the high initial hydrocarbon loading. Vadose zone hydrocarbons are thought to have been largely depleted during the first period of operation, and it is likely that a catalytic oxidizer or granular activated carbon adsorption filter can now be used for off-gas treatment. The treatment alternatives are less expensive to operate and have a much smaller carbon output. The appropriate treatment method will be determined by first restarting the SVE blower and testing the SVE wells to confirm proper operation. The pressure response in observation wells will be used to confirm that the air lines to the SVE wells are connected. Once proper operation is confirmed, the flow stream from each well will be sampled for hydrocarbons, oxygen, and carbon dioxide using a multi-gas meter. A sample of the combined flow stream will be collected in a Summa canister and submitted to the Air Toxics Folsom, California laboratory for analysis by EPA method TO-3 for BTEX and total petroleum hydrocarbons and ASTM method D-1946 for fixed gases including oxygen, carbon dioxide and methane. The off-gas treatment method will be selected based on these sampling results. Changing out the thermal oxidizer to an alternative method will require a change to the refinery's Air Quality Operating Permit.

System Startup

The revamped LTF system will be restated after the SVE off-gas treatment unit is in place. The sparge wells will be tested to determine which 12 will be operated and how they will be divided into the two banks. Based on previous testing, it is likely that RR-wells 1, 3, 5, 8, 9, 10, 11, 13, 15, 16, 17, and 18 will be restarted. The wells will be tuned to operate at ~15 cfm each, and the three-way valve set to switch between the two banks of wells at 30-minute intervals.

The SVE wells will be adjusted to maximize total flow while obtaining relatively uniform vadose zone vacuum. The capture of sparge air by the SVE system will be evaluated by measuring vadose vacuum/pressure at 10 monitoring wells (E-1, E-2, E-3, E-13, E-108, MW-32, MW-42, MW-52, E-217A, and E-223). Adequate capture is likely given that SVE flow occurs under a confining layer and is expected to be 2.5 to 3 times greater than sparge air flow.

Air sampling of the SVE system will be performed in accordance with the refinery's Air Quality Operating Permit.

SCHEDULE AND REPORTING

The work described in this CAMP is in progress and is expected to be completed by the end of February, 2015. The system will be started when the modifications are complete and the SVE off-gas treatment is permitted.

Tesoro will operate the LTF system as a supplemental corrective measure. Tesoro will take weekly readings of AS and SVE air flow and pressure but, since the system is a supplemental measure, the readings will not routinely be provided in the Quarterly Progress Reports. The performance of the SVE off-gas treatment will be monitored and reported as required by the refinery's Air Quality Operating Permit.

Supplemental groundwater samples will be collected from well E-219 quarterly for four quarters to evaluate the impact of operation on benzene concentrations. Other supplemental groundwater samples will be collected periodically as needed to evaluate the effectiveness of the system. These sample results will be reported and discussed in the Quarterly Progress Reports.

♦ · ♦ · ♦

E-4.0 SWAMP CORRECTIVE ACTION MODIFICATION PLAN

CORRECTIVE ACTION MODIFICATION PLAN (CAMP) FOR PM AREA SWAMP

TESORO ALASKA REFINERY

PREPARED FOR

TESORO ALASKA COMPANY

KENT & SULLIVAN, INC.
ENVIRONMENTAL CONSULTANTS

Table of Contents

Tables

Figures

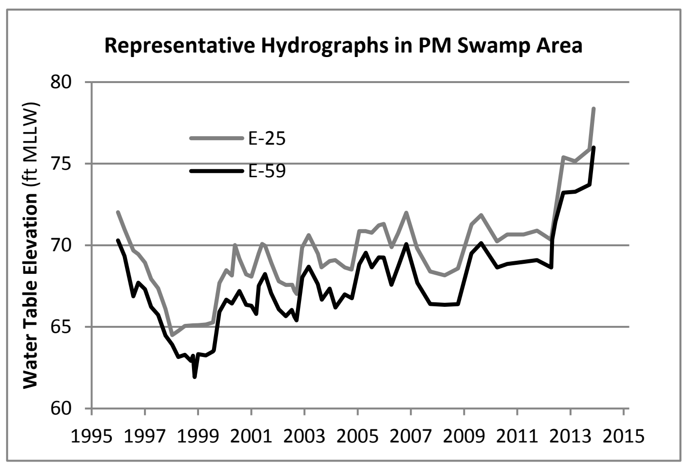
CORRECTIVE ACTION MODIFICATION PLAN FOR PM AREA SWAMP

This *Corrective Action Modification Plan* (CAMP) has been developed to address the impacts on hydrocarbon transport and fate caused by a swamp that has developed west the Tesoro Alaska (Figure D-1) refinery in response to historically high groundwater levels. This CAMP is prepared in accordance with condition III.D.2[1] of Tesoro's Kenai Refinery RCRA Post-Closure Permit (No. AKD 04864 9682) that was triggered based on the results of the semi-annual performance demonstration (Permit condition III.E.4.b)[2] performed during Quarterly Progress Report (QPR) No. 72. Groundwater flow paths from the northern part of the PM plume, including corrective action monitoring wells E-4, E-25 and E-228, cannot be shown to be within the capture zone of the PM or PIRM corrective measure because of the effects of the swamp on groundwater flow paths.

BACKGROUND

The PM swamp is located between the Tesoro refinery and the Kenai Spur Highway largely on property owned by ConocoPhillips (Figure D-1). The area occupies a natural topographic depression without a drainage outlet. The depression is dammed on the west by the highway embankment, and there is no culvert under the highway. The depression has historically been a joint-grass wetlands with areas of marshy ground and small isolated ponds with the water table occurring within a few feet of the surface. Birch and alder trees are established in the eastern part of the area where the water table was slightly deeper. There may have been localized and ephemeral interactions with groundwater, but the wetlands did not have a major impact on groundwater flow patterns or plume migration.

Conditions changed in late summer 2012 when heavy rainfall across the western Kenai Peninsula caused regional groundwater levels to rise. Unconfined aquifer water levels in the PM area rose ~5 feet between the April and September 2012 gauging events as shown on the adjacent hydrograph. Rain storms in fall 2013 caused an additional ~3 feet rise in water levels which are now ~9 feet above the 2000 to 2010 decade average. The rise in groundwater levels has



[1] *III.D.1 The Permittee shall implement the Corrective Action Program to meet the performance standards contained in permit conditions III.D.2 through III.D.4. If the Permittee cannot meet these requirements, the Permittee shall submit to the Agency a Corrective Action Modification Plan (CAMP) to more effectively meet these standards and a schedule for implementing this plan. The CAMP and its implementation schedule shall be submitted within one hundred twenty (120) calendar days of the Permittee's determination that it cannot demonstrate effective performance or within one hundred twenty (120) calendar days of the Permittee's receipt of a written request from the Agency.*

[2] *III.D.2 The Permittee shall operate each CM in a manner that is effective as defined below in permit conditions III.D.2.a through III.D.2.c. The Permittee shall provide an effectiveness demonstration in the next spring or fall progress report after a CM is placed into operation and every six months thereafter based on the results of the groundwater monitoring data obtained as specified in Part IV of this permit. The CM shall be considered effective if:*
III.D.2.b Each quarter that a CM monitoring well listed on Table 4 is sampled, either: a) the sample contains the indicator parameter(s) listed on Table 3 in concentrations that are below the TGPS, or b) the groundwater flowpath through the well intersects the capture zone or, if applicable, the in-situ treatment zone of the CM, . . .

inundated the wetlands and created a swamp with contiguous surface water covering ~10 acres (Figure D-1).

The surface water in the swamp is in direct contact with groundwater and forms a constant-head boundary at the top of the unconfined aquifer. The constant-head boundary is expected to influence groundwater flow causing lateral and vertical flow into the eastern part of the swamp and lateral and vertical flow out of the western part of the swamp. In addition, the swamp crosses the surface trace of the north fault (Figures D-1 and D-2). The north fault is a hydraulic barrier in the unconfined aquifer with >50 feet of head difference across the fault. At normal, lower groundwater levels the fault barrier effectively separates the portion of the unconfined aquifer impacted by the refinery groundwater plumes from the aquifer north and west of the fault. Infiltration from the swamp northwest of the fault may connect the two previously isolated groundwater regimes.

The changes in groundwater flow patterns appear to have impacted PM plume migration. Before water levels rose, the northern plume boundary ran from northeast to southwest beneath the wetlands, and flow paths throughout the PM plume were demonstratively within a PM or PIRM corrective measure system capture zone as required under the Permit. At current high water levels, flow paths in the northern part of the PM plume run into the swamp, and capture cannot be demonstrated for an area north of a divide running from near well E-213 west to near well E-19 (Figure D-3). In addition, groundwater flow bends around the southeast part of the swamp in response to the constant-head boundary and has pushed the PM plume to the northwest so that the northern part of the plume is able to migrate past the northern end of the Highway air sparge (AS) system.

The swamp is expected to revert back to wetlands when precipitation and surface water infiltration revert to the "average" conditions observed for many years before 2012. The impacts associated with the swamp surface water body will disappear as groundwater levels fall, but the rate at which this may occur has not been evaluated.

INITIAL INVESTIGATION RESULTS

Tesoro has conducted work to investigate and respond to rising groundwater levels and development of the PM Swamp. The results of the work are summarized in the following paragraphs.

- Nested monitoring wells E-245A and B were installed in June 2013 as a northern sentinel location for the Highway AS system (Figure D-1). Well E-245A is completed in the upper part of the merged unconfined aquifer and well E-245B is completed at the base of the aquifer. Benzene was detected in well E-245A at 530 and 320 µg/L in, respectively, July and September 2013 which indicated that the plume was migrating north of the AS system. Benzene, toluene, ethylbenzene and total xylenes (BTEX) were not detected in well E-245B.

- Four new Highway system sparge wells (HAS-18 to HAS-21) were installed in November 2013 to extend the treatment zone ~125 feet to the north (Figure D-1). Nested wells E-246A and E-246B were installed as northern sentinel monitoring wells. The new sparge wells began operation in January 2014. Wells E-246A and E-246B were sampled in January 2014. The well E-246A sample contained 140 µg/L benzene; BTEX were not detected in well E-246B. The presence of benzene in well E-246A indicates the plume extends north past the extended sparge well line.

- Surface water samples were collected from the swamp in early December 2013 and January 2014. Three samples were collected in December and five in January at the locations shown on Figure D-1. The December sampling was completed less than two weeks after the swamp froze over. The ice was ~12 inches thick at the time of the January sampling event. The December samples were analyzed for BTEX at the Tesoro refinery laboratory whereas the January samples were analyzed at a commercial laboratory. Table C-1 summarizes the analytical results. Benzene was detected at maximum concentrations of 4.1 µg/L in December and 900 µg/L in January. Although unlikely, the difference in results may be sample and/or analytical problems with the December samples that caused false negative results. More likely, the difference reflects an actual increase in hydrocarbon concentrations in swamp surface water associated with winter conditions.

- Eleven wells and the swamp level were gauged on December 7, 2013 to evaluate groundwater flow patterns south of the swamp. The gauging data are provided in Table C-2, and the interpreted potentiometric surface elevation contours and flow paths are shown on Figure D-1. Based on these data, groundwater is interpreted to curve around the southeast edge of the swamp in a reverse “S” pattern which is responsible for pushing the benzene plume to the north.

PM SWAMP CORRECTIVE ACTION MODIFICATION PLAN (CAMP)

The purpose of the PM swamp CAMP is to characterize the impacts of the swamp on groundwater flow and plume migration and fate. The available data show that the northern part of the PM plume flows into the swamp and impacts surface water quality in the eastern part of the swamp at least in the winter. The fate of hydrocarbons that enter the swamp will likely determine what if any modifications to the PM corrective measure are needed. Groundwater outside of the PM or PIRM corrective measure system capture zones may be impacted if hydrocarbons spread across most or all of the swamp and persist for a sufficient time. The corrective measure systems may need to be expanded in this case. Conversely, hydrocarbon may be limited to the eastern part of the swamp and/or natural attenuation processes in the swamp may be sufficient such that the presence of the swamp does not cause impacts that extend beyond the existing corrective measure systems. Significant changes to the PM or PIRM corrective measures would not be needed in this case.

A CAMP monitoring program will be conducted in winter and spring 2014 to investigate plume migration and fate. The CAMP monitoring program is intended to 1) assess the extent and levels of hydrocarbons in swamp surface water during the winter and after the ice melts in the spring, 2) evaluate lateral and vertical groundwater flow patterns in the northwest PM area to characterize the swamp impacts, and 3) monitor swamp water levels to potentially estimate when the swamp will drain if weather patterns revert to conditions seen before 2012. Two new monitoring well pairs will be installed (four individual wells) to expand the monitoring network near the swamp and the Highway AS system will be further expanded to the north to intercept the known benzene plume.

Surface Water Sampling

The increase in hydrocarbon concentrations in swamp water observed between the December 2013 and January 2014 sampling events suggests that natural attenuation processes in the swamp (such as microbial degradation and/or volatilization) decrease during the winter allowing hydrocarbon concentrations to increase and spread westward. Swamp surface water from 13 locations (Figure D-2) will be sampled three times to characterize the levels and extent of hydrocarbons in the swamp. Samples will be collected February 11 and 12 and again in late March or early April to assess conditions when the swamp is iced over. The third sampling event will be conducted in early June to assess conditions when the swamp surface is open and plants are actively growing.

Surface water samples will be collected using a peristaltic pump with new tubing at each location. The tubing end will be attached to a rod and set ~6 inches off the bottom to collect the sample. The winter samples will be collected through holes bored through the ice, and the spring samples will be collected from a boat. The sample locations will be marked using with steel and plastic pipe stakes that extend several feet above the ice level. Temperature, pH, conductivity, and oxidation-reduction potential (ORP) will be measured at each sample location. Dissolved oxygen will be measured during the second and third sampling events. Samples from each location will be collected for BTEX analysis by EPA method 8021B. Samples will be collected at locations SW-3 and SW-4 in March and June for polynuclear aromatic hydrocarbon analyses by EPA method 8270D SIMS. Duplicate samples will be collected during each event at a rate of one per twenty primary samples. The analyses will be performed by a commercial laboratory. In addition, samples will be collected from each location during the second and third sampling events for natural attenuation parameter analyses. Nitrate, sulfate and ferrous iron analyses will be performed by KSI using spectrophotometer methods, and methane analyses will be performed by a commercial laboratory using method RSK 175.

Groundwater Sampling

Groundwater samples will be collected from the wells surrounding the PM swamp shown on Figure D-2 and listed on Table C-2. Four wells (E-25, E-59, E-215 and E-228) are corrective action monitoring wells that are sampled quarterly and have extensive historical data sets. Twelve additional existing wells and four new monitoring wells will be sampled as part of the CAMP. Seven of the wells are upgradient of the swamp and will provide information on hydrocarbon levels in groundwater that enters the swamp or is influenced by the swamp constant-head boundary. Four of wells are downgradient of the swamp and will be sampled to evaluate possible surface water to groundwater impacts. One of the downgradient wells (MW-93) monitors groundwater that may infiltrate from the part of the swamp located northwest of the north fault.

Six monitoring wells (E-61, E-64, E-65, E-231, E-232A and E-232B) are located in the swamp but the casings have been submerged. Tesoro will try to locate these wells and extend the well riser pipes above the water level. The wells will be sampled if they can be accessed and appropriate connections can be made to the riser pipes.

The wells will be sampled during the Quarter 74 event in March 2014 and during the Quarter 75 event in June 2014. Quality control samples will be collected as required by the corrective action sampling program, and the samples will be analyzed by the ARI Seattle laboratory. All of the samples will be analyzed for BTEX by EPA method 8021B.

Swamp Sediment Sampling

A root zone and organic mat is presumed to be present at the bottom of the swamp. Hydrocarbons infiltrating into the swamp may be adsorbed and accumulate in this organic layer. Samples will be collected at three locations from the upper 24 inches of the swamp bottom material to evaluate this possibility. The samples will be collected 10 feet from the surface water sampling locations SW-2, SW-3 and SW-4 (Figure D-2) after the March surface water sampling event. A 24-inch stainless steel core barrel will be lowered to the bottom through a hole bored in the ice and then hand-driven to its full depth or refusal. A zone containing abundant decayed organic material, if present, will be sampled for laboratory analyses. The sediment samples will be analyzed for BTEX by EPA method 8021B and PAHs by EPA method 8270D SIMS.

Groundwater and Surface Water Gauging

All of the monitoring wells in the vicinity of the PM swamp will be gauged in March as part of the Quarter 74 monitoring event. The A- and B-aquifer wells in the vicinity of the swamp will be gauged again in June. A staff gauge point will be established in the swamp near location SW-9 (Figure D-2) to measure the surface water level. Surface water levels will be measured when the swamp is iced over by drilling a hole through the ice adjacent to the staff gauge.

Continuous water level measurements will be made in the swamp and in two nearby monitoring wells using data-logging transducers. The data will be used to evaluate water level changes in the swamp area before the spring thaw and the response of surface and groundwater to the thaw. Transducers will be set in well E-227 located upgradient of the swamp and well E-59 located downgradient. The transducer used in the swamp will be attached to the staff gauge near location SW-9.

Highway Air Sparge System Expansion

Two new sparge wells will be installed and well E-246B converted to a sparge well to extend the Highway AS system treatment zone further to the northwest. The extended sparge well line is intended to intercept the benzene plume that has been pushed north by the influence of the swamp constant-head boundary. The maximum capacity of the Highway AS/SVE system will be reached with this phase of expansion.

The new well locations are shown on Figure D-2. The wells will be drilled using hollow-stem auger methods and constructed as the existing Highway system sparge wells with two-foot long, 0.020-inch slot, pre-packed, polyvinyl chloride (PVC) well screens set at an elevation of ~35 feet. The screens will be set in a 10x20 silica sand filter packs extending ~1.5 feet above the top of the screens. Bentonite seals will be placed from the top of the sand packs to a depth of ~5 feet.

Air will be delivered to the wells with separately metered and controlled air pipelines run below ground from the Highway system connex. Because of the shallow depth to groundwater in this area, sparge air from the new wells will be collected using horizontal soil vapor extraction points set in the air line piping trench to the new sparge wells.

Monitoring Well Installation

Two new paired monitoring wells will be installed along the southwest edge of the swamp at the locations shown on Figure D-2. The wells will be installed in separate boreholes ~5 feet apart. Well pair E-247A and E-247B will be located at the northwest end of the line of Highway system sparge wells. Well pair E-247A and E-248B will be located at the southwest end of the swamp. Both well pairs are intended to monitor groundwater that is thought to be flowing laterally and vertically out of the southwest part of the swamp. In addition, wells E-247A and B will serve as a sentinel monitoring location for the expanded Highway AS system.

The wells will be drilled with a hollow-stem auger rig. One well in each pair will be screened from five to 15 feet below the current water table and the second well will be screened 35 to 40 feet below the water table. The wells will be constructed as typical monitoring wells with two-inch PVC screen and risers, 10x20 silica sand filter packs, bentonite seals, and above-ground completions protected by steel monuments.

The wells will be developed by surging, sand bailing, and pumping. The wells will be sampled no less than 24 hours after development and the samples analyzed at a commercial laboratory for BTEX by EPA method 8021B. The well locations and top-of-casing elevations will be surveyed, and the wells will be added to the CAMP groundwater gauging list.

SCHEDULE AND REPORTING

The CAMP monitoring program will begin in February 2014 and is expected to be completed by July 1, 2014. Surface water sampling will be conducted in February, late-March or early-April, and early June. The drilling and well installation work will be performed in March. Groundwater sampling and gauging will be performed in conjunction with the Quarter 74 and Quarter 75 corrective action monitoring events in March and June.

Tesoro intends to provide EPA with updates during the CAMP including preliminary data tables and maps. A final report documenting the CAMP findings and recommendations will be submitted with Quarterly Progress Report 75 by August 31, 2014.

♦ · ♦ · ♦

E-5.0 TREATED GROUNDWATER INJECTION PLAN

TREATED GROUNDWATER INJECTION PLAN

TESORO ALASKA REFINERY

NIKISKI, ALASKA

May 17, 2017

Project #: 39B-003-002

SUBMITTED BY: Tesoro Alaska Company

54741 Tesoro Road, Kenai, AK 99611

PREPARED BY: Trihydro Corporation

312 Tyee St., Soldotna, AK 99669

ENGINEERING SOLUTIONS. ADVANCING BUSINESS.

Table of Contents

List of Tables

List of Figures

List of Abbreviations and Acronyms

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
BTEX	benzene, toluene, ethylbenzene, and xylenes
EPA	United States Environmental Protection Agency
GAC	granular activated carbon
gpd	gallon per day
HCl	hydrochloric acid
na	not applicable
PM	Phillips-Marathon
QEP	qualified environmental professional
RCRA	Resource Conservation and Recovery Act
SI	closed surface impounds
Tesoro	Tesoro Alaska Company
Trihydro	Trihydro Corporation
µg/L	micrograms per liter

1.0 INTRODUCTION

This plan is submitted to the Alaska Department of Environmental Conservation (ADEC) by Tesoro Alaska Company (Tesoro) to describe the process that will be used to treat and dispose hydrocarbon-contaminated groundwater at the Tesoro Alaska refinery located in Nikiski, Alaska (Figure 1). This plan applies to the disposal of non-domestic wastewater that is generated during the treatment of recovered groundwater and is submitted to ADEC to comply with 18 Alaska Administrative Code (AAC) 72.600.

The owner and operator of the property is:

Tesoro Alaska Company LLC

The point of contact for work performed under this plan is:

Micheal Harper, Environmental Supervisor
Tesoro Alaska Company LLC
54714 Tesoro Road
Kenai, AK 99611
(907) 776-8191

2.0 WASTEWATER SOURCES COVERED BY THIS PLAN

Groundwater corrective actions at the Tesoro refinery are regulated by the U.S. Environmental Protection Agency (EPA) under Tesoro's Resource Conservation and Recovery Act (RCRA) Part B Post-Closure Permit No. AKD 04867 9682 (RCRA Permit). Attachment D in Tesoro's RCRA Permit details the groundwater recovery and treatment systems.

Tesoro operates two treatment plants which dispose treated groundwater to the unconfined aquifer. Figure 3 shows the locations of Tesoro's groundwater treatment and injection systems. The Phillips-Marathon (PM) unit disposes treated groundwater to an equalization lagoon and then injects it via trenches 5 and/or 6 (with trenches 1 and 2 as standby units). The Calgon unit injects treated groundwater via wells IR-29 through IR-32.

3.0 WASTEWATER EFFLUENT MONITORING PLAN

3.1 WASTEWATER INJECTION LIMITATIONS

Tesoro will inject treated groundwater into the unconfined aquifer via the injection trenches or wells shown on Figure 3 within the limitations shown in Table 1.

TABLE 1. EFFLUENT LIMITS

Characteristic	PM Unit	Calgon Unit
Individual Unit Maximum	750,000 gpd	1,000,000 gpd
Maximum Total Flow	Combined 1 million gallons per day	
Benzene	4.6 µg/L	4.6 µg/L*
Toluene	1,100 µg/L	1,100 µg/L
Ethylbenzene	15 µg/L	15 µg/L
Total Xylenes	190 µg/L	190 µg/L

* Not applicable during GAC replacement period
µg/L – micrograms per liter
na – not applicable
gpd – gallons per day

The effluent limitations meet the State of Alaska groundwater criteria contained in 18 AAC 75.345. The benzene effluent limit (4.6 µg/L) will trigger accelerated confirmation sampling and possible granular activated carbon (GAC) replacement in the Calgon unit, as described below.

To ensure the full use of the GAC prior to initiating replacement, three confirmation samples will be collected weekly after a benzene detection above 4.6 µg/L. If the confirmation sample results indicate benzene exceeds 4.6 µg/L, the GAC replacement process will be initiated. A purchase requisition for the GAC replacement will be placed within 7 days of the last sample result. If the confirmation sample results indicate the first result was anomalous (i.e., a subsequent result is less than 4.6 µg/L), effluent sampling frequency will return to monthly.

Only groundwater from the PM and Calgon units will be routed to the injection wells or trenches shown on Figure 2. No other treated or untreated wastewater, sludge, or other materials will be discharged unless approved by ADEC.

3.2 EFFLUENT MONITORING

Tesoro will monitor the weekly total flow as shown in Table 2 and a qualified environmental professional (QEP), in accordance with 18 AAC 75.333, will collect analytical samples of the treated wastewater effluent as it is being discharged at the frequency shown in Table 2 and using the analytical method listed in the footnotes of Table 2:

TABLE 2. MONITORING REQUIREMENTS

Characteristic	PM	Calgon	Sample Type
Total Flow	Weekly[1]	Weekly[1]	Meter
Benzene[2]	Monthly	Monthly[3]	Grab
Toluene[2]	Monthly	Monthly	Grab
Ethylbenzene[2]	Monthly	Monthly	Grab
Total Xylenes[2]	Monthly	Monthly	Grab

Monthly – Calendar month
[1] Total flow will also be recorded by a qualified environmental professional in conjunction with monthly analytical sample collection
[2] EPA Method 8260
[3] Three consecutive weeks if effluent limit it exceeded

Analytical samples will be collected at the treatment unit's effluent by filling three 40-ml VOA vials containing hydrochloric acid (HCl) preservative for the benzene, toluene, ethylbenzene, and xylenes (BTEX) sample. The sample bottles will be stored at 4±2° C and shipped under chain-of-custody to an ADEC approved (18 AAC 75.355[e]) laboratory for analysis.

3.3 REPORTING

Tesoro will submit the monitoring results to ADEC within 15 days after the last month in the quarter (Table 3) or 15 days after receipt of the laboratory report, whichever comes later. The reports will be prepared and signed by a QEP and include a description of the work performed and summary tables with the following information:

- Flow readings for each unit
- Analytical results from the required effluent samples
- Copy of purchase requisition for replacement GAC, if applicable.

TABLE 3. REPORTING SCHEDULE

Quarter	Months	Submittal Date
Spring	January, February, March	April 15
Summer	April, May, June	July 15
Fall	July, August, September	October 15
Winter	October, November, December	January 15

3.4 NONCOMPLIANCE NOTIFICATION

The Tesoro point of contact, or his representative, will verbally notify ADEC as soon as possible if Tesoro is unable to comply with the effluent limitations specified in Section 3.1.

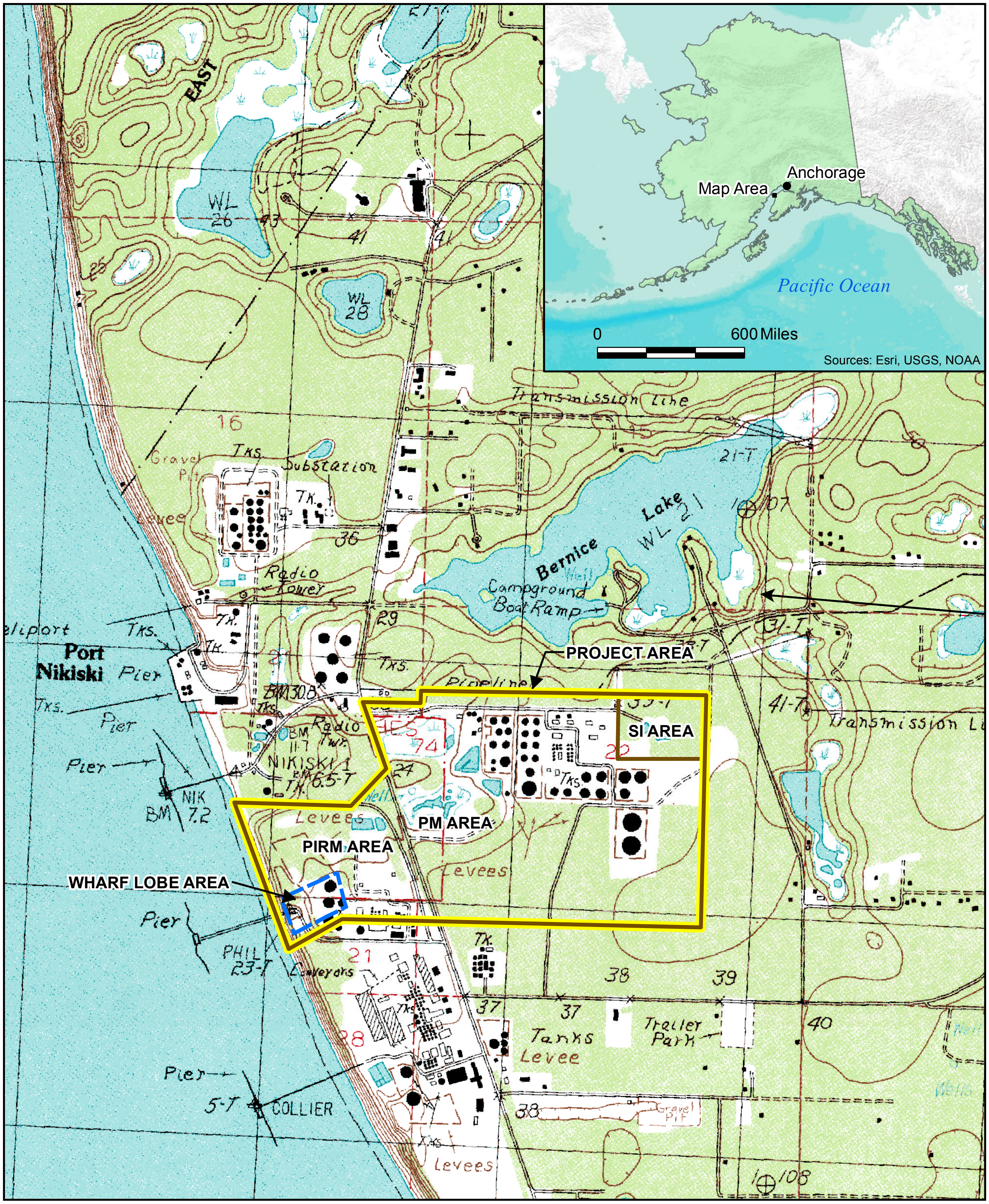
Tesoro will submit a follow-up written report within 14 days of the noncompliance event containing the following information:

- Times and dates on which the event occurred, and if not corrected, the anticipated time the noncompliance is expected to continue.
- A detailed description of the event, including quantities and types of materials involved.
- Details of any actual or potential impact on the receiving environment or public health.
- Details of actions taken or to be taken to correct the causes of the event.
- Details of actions taken or to be taken to correct any damage resulting from the event.

4.0 REFERENCES

Kent and Sullivan, Inc. 2006. *Tesoro Groundwater Injection Plan.* Prepared for Tesoro Alaska Company.

FIGURES



SOURCE: USGS 7.5' QUAD SHEET KENAI (C-4) NW, AK PROVISIONAL EDITION 1986

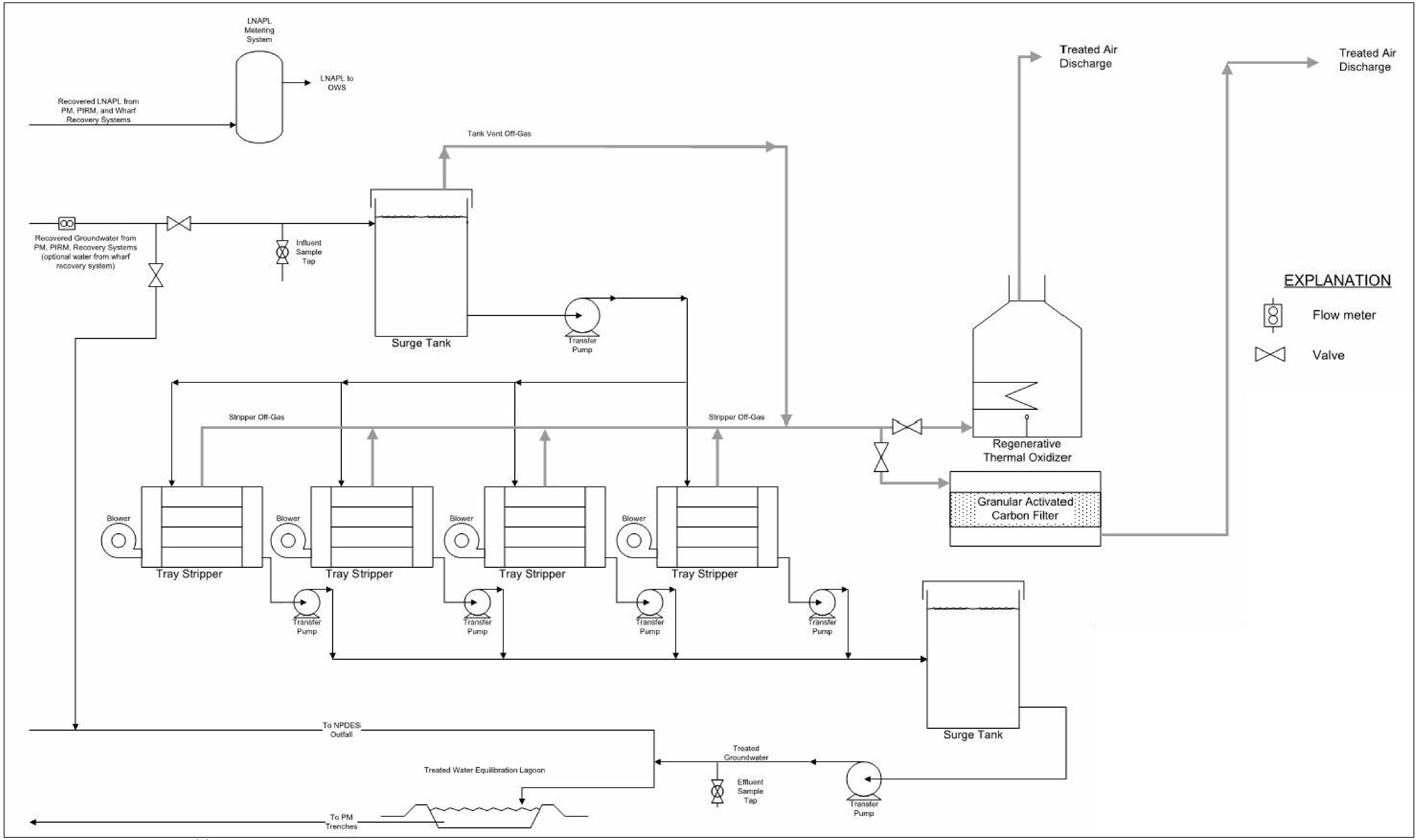
Trihydro CORPORATION
1252 Commerce Drive
Laramie, WY 82070
www.trihydro.com
(P) 307/745.7474 (F) 307/745.7729

FIGURE 1

SITE LOCATION MAP

TREATED GROUNDWATER INJECTION PLAN
TESORO KENAI REFINERY
NIKISKI, ALASKA

Drawn By: DH	Checked By: SP	Scale: 1" = 2,000'	Date: 2/16/17	File: Fig1_Kenai_Site_Location.mxd



Source Drawing From: Kent & Sullivan Inc., 4/1/2007

NOTE:

PHILLIPS INTERIM REMEDIAL MEASURE (PIRM) NOW REFERRED TO AS PHILLIPS REMEDIAL MEASURE (PRM)

ABBREVIATIONS

LNAPL	LIGHT NON-AQUEOUS PHASE LIQUID
NPDES	NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
OWS	OIL WATER SEPARATOR
PIRM	PHILLIPS INTERIM REMEDIAL MEASURE
PM	PHILLIPS MARATHON

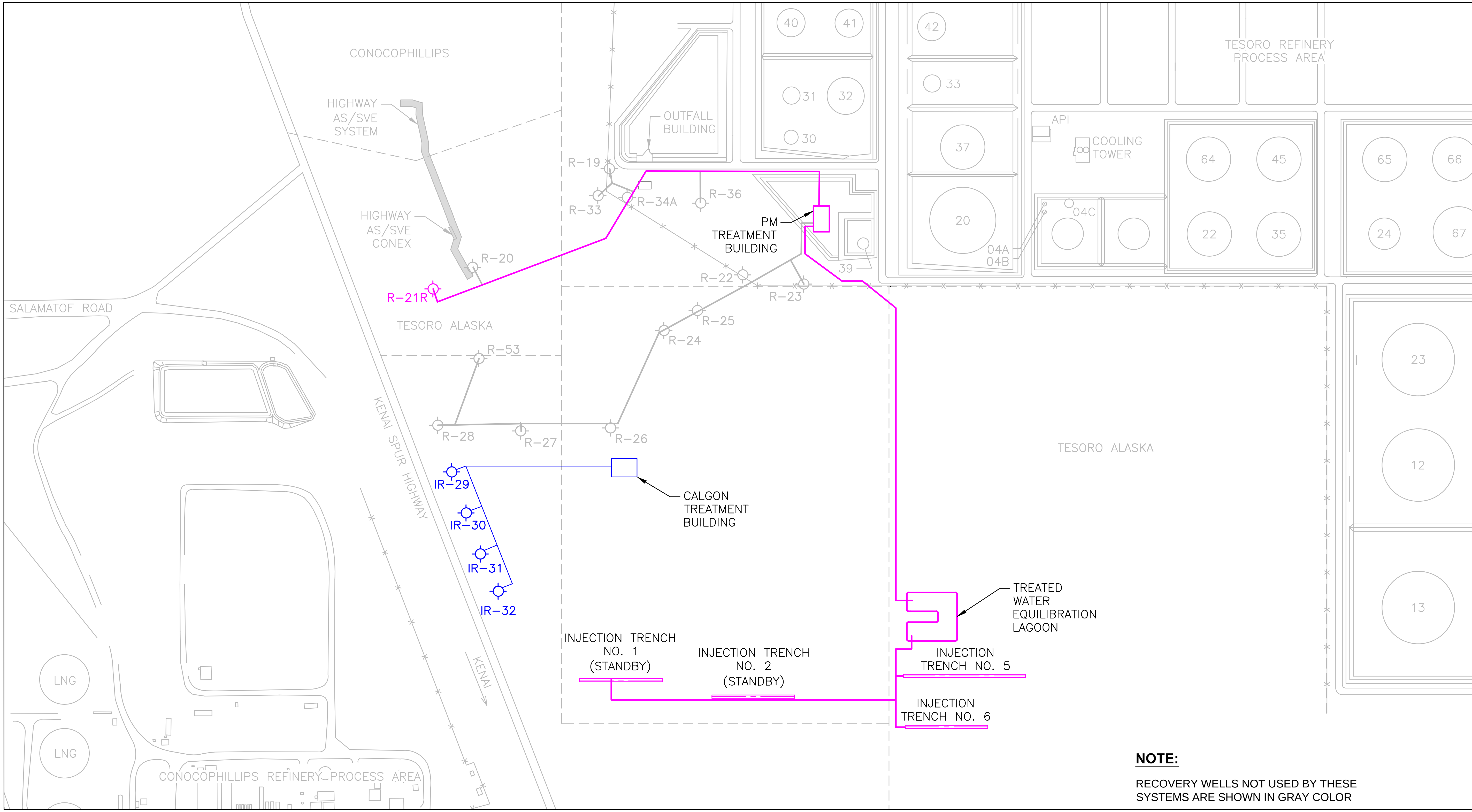
Trihydro CORPORATION
1252 Commerce Drive
Laramie, Wyoming 82070
www.trihydro.com
(P) 307/745.7474 (F) 307/745.7729

FIGURE 2

PROCESS FLOW DIAGRAM
PM CORRECTIVE MEASURE

TREATED GROUNDWATER INJECTION PLAN
TESORO KENAI REFINERY
NIKISKI, ALASKA

Drawn By: RJ | Checked By: SP | Scale: NONE | Date: 2/2/2017 | File: 36C-KENAI-ADEC-WWPM_PM-PANDID



NOTE:

RECOVERY WELLS NOT USED BY THESE SYSTEMS ARE SHOWN IN GRAY COLOR

EXPLANATION

IR-32	INJECTION WELL AND DESIGNATION		PM AIR SPARGE AND SVE LINE (HIGHWAY SYSTEM)
IR-29	RECOVERY WELL AND DESIGNATION	AS	AIR SPARGE
	CALGON TREATMENT SYSTEM PIPELINE	NO.	NUMBER
	PM TREATMENT SYSTEM PIPELINE	PM	PHILLIPS MARATHON
	PM INJECTION TRENCH	SVE	SOIL VAPOR EXTRACTION

N

0 300'

Trihydro CORPORATION
1252 Commerce Drive
Laramie, Wyoming 82070
www.trihydro.com
(P) 307/745.7474 (F) 307/745.7729

FIGURE 3

GROUNDWATER TREATMENT AND INJECTION SYSTEMS

TREATED GROUNDWATER INJECTION PLAN
TESORO KENAI REFINERY
NIKISKI, ALASKA

Drawn By: RJ	Checked By: SP	Scale: 1" = 300'	Date: 2/16/2017	File: 36C-KENAI-ADEC-WWPM_GW-TRTMNT-INJCTN

M:\STOV\TESORO\CADD\KENAIREFINERY\GENERAL_SUPPORT\ALASKADEPARTMENTOFENVIRONMENTALCONSERVATION-WASTEWATERPERMITMODIFICATION\36C-KENAI-ADEC-WWPM_GW-TRTMNT-INJCTN

EXPLANATION

- CALGON TREATMENT SYSTEM INJECTION WELL
- A-AQUIFER MONITORING WELL LOCATION
- A-AQUIFER RECOVERY WELL LOCATION
- A-AQUIFER AIR SPARGE WELL
- B-AQUIFER MONITORING WELL LOCATION
- B-AQUIFER RECOVERY WELL LOCATION
- B-AQUIFER INJECTION WELL LOCATION
- UPPER CONFINED AQUIFER MONITORING WELL LOCATION
- UPPER CONFINED PRODUCTION WELL LOCATION
- SURFACE WATER SAMPLE
- INJECTION TRENCH
- WATER LEVEL CONTOUR (1 FT INTERVAL)
- WATER LEVEL CONTOUR (IRREGULAR INTERVAL)
- GROUNDWATER FLOW DIRECTION
- APPROXIMATE EXTENT OF GROUNDWATER RECOVERY CAPTURE ZONE
- HYDRAULIC BARRIER
- ESTIMATED EXTENT OF BENZENE CONCENTRATIONS GREATER THAN 5 µg/L
- APPROXIMATE EXTENT OF LNAPL
- ESTIMATED EXTENT OF SPARGE-TREATED GROUNDWATER FROM HIGHWAY AS/SVE SYSTEM
- DRY ZONE

NOTES:

1. µg/L = MICROGRAMS PER LITER
2. MLLW = MEAN LOWER LOW WATER
3. LNAPL = LIGHT NON-AQUEOUS PHASE LIQUID
4. AS = AIR SPARGE
5. SVE = SOIL VAPOR EXTRACTION
6. E-165 66.77' WELL ID AND POTENTIOMETRIC SURFACE ELEVATION MEASURED IN SEPTEMBER 2016 (IN FEET MLLW), IN PARENTHESES IF NOT USED TO CONTOUR

Trihydro CORPORATION
1252 Commerce Drive
Laramie, WY 82070
www.trihydro.com
(P) 307/745.7474 (F) 307/745.7729

FIGURE 4

GROUNDWATER TREATMENT SYSTEM CAPTURE

TREATED GROUNDWATER INJECTION PLAN
TESORO KENAI REFINERY
NIKISKI, ALASKA

Drawn By: DH	Checked By: BLM	Scale: 1" = 200'	Date: 2/16/17	File: Fig4_.GW_Treatment_Map.mxd