FIFTH FIVE-YEAR REVIEW REPORT FOR
COMMENCEMENT BAY, SOUTH TACOMA CHANNEL SUPERFUND SITE
TACOMA, WASHINGTON

Prepared by

U.S. Environmental Protection Agency
Region 10
Seattle, Washington

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Office of Environmental Cleanup

9/28/2018
Date

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LIST OF ABBREVIATIONS & ACRONYMS

ft	feet
gpm	gallons per minute
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
µg/L	micrograms per liter
Agencies	EPA, Ecology and TPCHD
ARAR	Applicable or Relevant and Appropriate Requirement
bgs	below ground surface
BNSF	Burlington Northern Santa Fe Railway
CB-STC	Commencement Bay, South Tacoma Channel Superfund Site
CD	Consent Decree
City	City of Tacoma
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethylene
COC	contaminant of concern
CSCL	Confirmed and Suspected Contaminated Sites List
CSM	conceptual site model
1,1-DCA	1,1-dichloroethane
1,2-DCA	1,2-dichloroethane
1,2-DCE	1,2-dichloroenes
DNAPL	dense non-aqueous phase liquid
EAB	enhanced anaerobic biodegradation
Ecology	State of Washington Department of Ecology
ERH	electrical resistance heating
ESD	Explanation of Significant Differences
EPA	United States Environmental Protection Agency
FFS	Focused Feasibility Study
FS	Feasibility Study
GCCS	Gas collection and control system
GETS	Groundwater Extraction and Treatment System
FYR	Five-Year Review
HDPE	high-density polyethylene
HHRA	Human Health Risk Assessment
ICs	Institutional Controls
IRIS	Integrated Risk Information System
IRM	Interim Remedial Measure
ISTR	in situ thermal remediation
IUR	inhalation unit risk
Landfill	Tacoma Landfill Project Area
LFG	Landfill gas
LNAPL	light non-aqueous phase liquid
MCL	maximum contaminant level
MDE	mass discharge evaluation
MFS	Minimum Functional Standards
MNA	Monitored Natural Attenuation

MTCA	Washington State Model Toxics Control Act
NAPL	non-aqueous phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
OU	Operable Unit
PAH	polyaromatic hydrocarbon
Pb	lead
PCA	1,1,2,2-tetrachloroethane
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
POC	Point of compliance
PRG	Preliminary Remedial Goals
PRP	Potentially Responsible Party
QAPP	Quality Assurance Project Plan
RA	Remedial Action
RAO	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RfC	reference concentration
RfD	reference dose
RI	Remedial Investigation
RSL	regional screening level
ROD	Record of Decision
RODA	Amendment to the Record of Decision
RPM	Remedial Project Manager
SDICP	Site Development and Institutional Controls Plan
SF	slope factor
STC	South Tacoma Channel
STF	South Tacoma Field
TBC	To be considered
1,1,1-TCA	1,1,1-trichloroethane
TCE	trichloroethylene
TLF	Tacoma Landfill
TPCHD	Tacoma-Pierce County Health Department
TPH	total petroleum hydrocarbons
trans-1,2-DCE	trans-1,2-dichloroethylene
TTZ	thermal treatment zone
UAO	Unilateral Administrative Order
UST	underground storage tank
UU/UE	unlimited use and unrestricted exposure
VC	vinyl chloride
VES	Vapor Extraction System
VOC	volatile organic chemical

2018 Five-Year Review
Commencement Bay – South Tacoma Channel
Superfund Site

I. INTRODUCTION

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy to determine if the remedy is and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) is preparing this five-year review pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Contingency Plan (NCP)(40 CFR Section 300.430(f)(4)(ii)), and considering EPA policy.

This is the fifth FYR for the Commencement Bay, South Tacoma Channel Superfund Site (CB-STC Site). The triggering action for this statutory review is the previous FYR completed on September 10, 2013. The FYR has been prepared because hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure (UU/UE).

The Site consists of three Project Areas – Well 12A, South Tacoma Field (STF) and Tacoma Landfill (TLF) – and six Operable Units (OUs) as outlined in Table 1. The three Project Areas are all located in south Tacoma but have distinctly different problems, remedies and approaches to protectiveness (Figure 1).

A separate review has been conducted for each Project Area and presented in this FYR as a separate Section. Although Well 12A was historically divided into OUs 1, 2, and 3, currently, the Project Area is considered one OU (OU1). OU2 and OU3 will not be mentioned further in this FYR. A Sitewide Protectiveness Statement is presented in Section V of this report.

Table 1. Project Areas and Operable Units

FYR Section	Project Area	Operable Unit	
II	Well 12A	1	Well 12A - Groundwater
		2	Well 12A Burlington Northern Soil Removal
		3	Well 12A Soils (Vapor Extraction System)
III	South Tacoma Field	4	South Tacoma Field
IV	Tacoma Landfill	5	Tacoma Landfill - Cap
		6	Tacoma Landfill - Groundwater

The Commencement Bay, South Tacoma Channel Superfund Site Five-Year Review was led by Jeremy Jennings, EPA Region 10 and Chris Cora, EPA Region 10 (Well 12A Project Area). Participants will be identified in each section of the FYR. The review began on February 26, 2018.

Site Background

The Site is in a light industrial area in the southern portion of Tacoma. In the late 1800's, following the

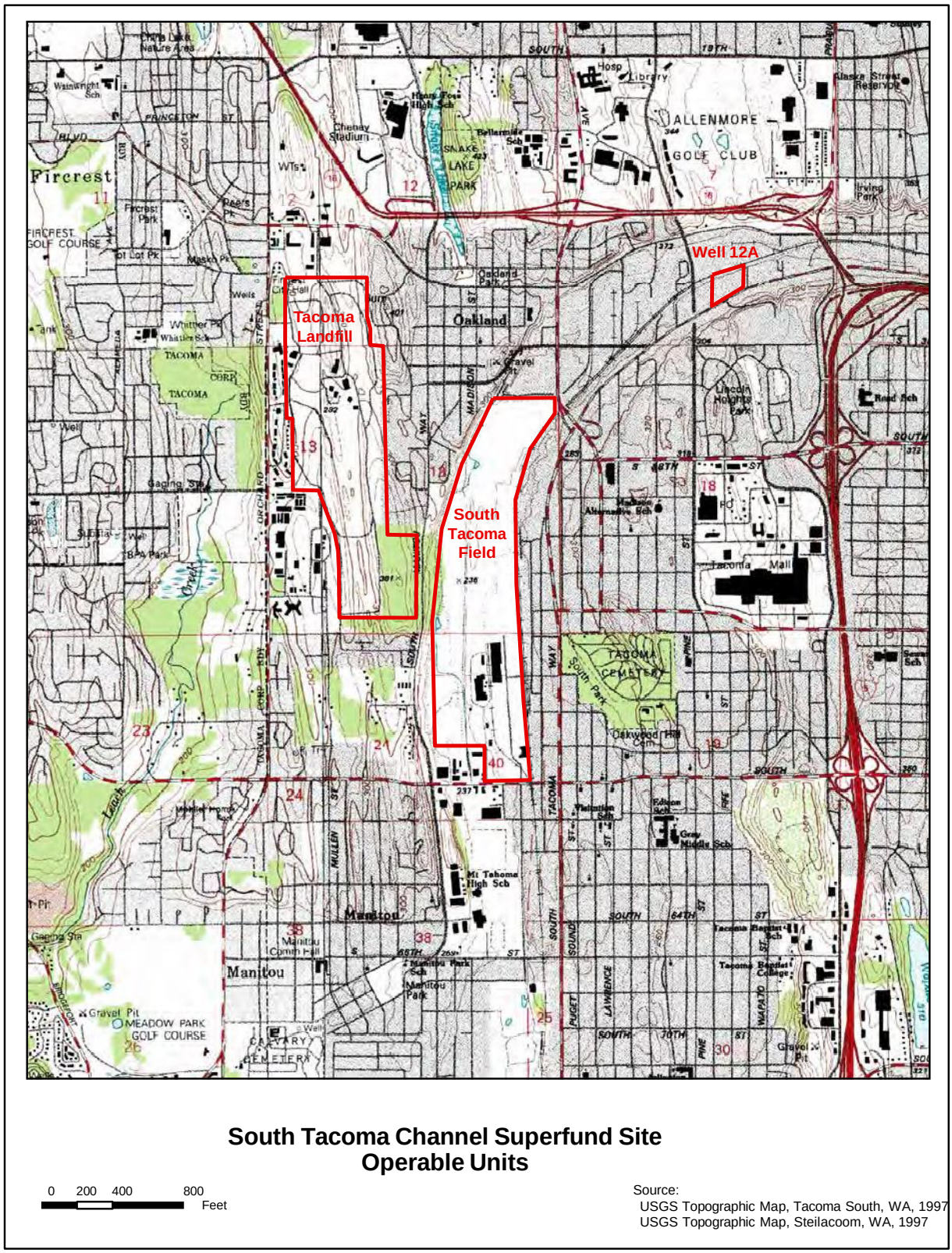

Figure 1. Location of Project Areas in the South Tacoma Channel Superfund Site

expansion of the railroad, many of the properties near the tracks were utilized for light industry and activities that supported the railroad. In 1960 the City of Tacoma opened a municipal landfill in the area. Discharge of contaminants from these activities generated the source areas addressed at the Site.

As the population grew, the City of Tacoma added several drinking water supply wells in the area to provide drinking water to residents. While the wells provided an alternative to drawing drinking water from individual wells near Site contamination, groundwater extraction has influenced groundwater flows across the Site. These impacts have been factored into the remedial actions at all three Project Areas.

The CB-STC Superfund Site was listed on the interim priority list by the U.S. Environmental Protection Agency (EPA) in 1981 and formally listed on the National Priorities List (NPL) in 1983.

Well 12A (OU1)

The Well 12A Project Area encompasses the source of contamination from the former Time Oil Company and Burlington Northern Railroad properties in south Tacoma. In 1981, chlorinated organic solvents were detected in groundwater at the City of Tacoma's Well 12A, a municipal water supply production well owned and operated by the City of Tacoma, at concentrations above the drinking water criteria. The well was shut-down until appropriate treatment was added. Investigations by EPA found the source of contamination to likely be from a waste oil and solvent recycler that had operated on the above properties from the 1920s through the 1960s.

The remedies for the Well 12A area were selected in the 1983 Record of Decision (ROD), 1985 first ROD Amendment (RODA), and a 2009 RODA. Minor changed to the 1985 remedy were documented in a 1987 remedial design change memorandum. A groundwater extraction and treatment system was installed in 1988 and five additional systems were installed in August 1993. In 2012, actions were undertaken to address VOC source areas through excavation, in-situ thermal treatment, soil vapor extraction, and enhanced anaerobic bioremediation. The remedial actions are being implemented by EPA.

South Tacoma Field (OU4)

The South Tacoma Field Project Area addresses several sources of soil and groundwater contamination on 260 acres of land adjacent to the railroad. Historical uses included railcar manufacturing, repair and maintenance; iron and brass foundries; transformer maintenance and unpermitted dumping of foundry, construction and domestic wastes. A 1994 ROD utilized a combination of treatment, containment and institutional controls for the contaminated soil throughout the site and treatment of contaminated groundwater at Pioneer Builders Supply. After contaminated soils at Pioneer Building Supply were removed, a 1999 ESD changed the treatment of contaminated groundwater at Pioneer Builders Supply to monitored natural attenuation (MNA).

In 1997, a dry well located on the Tacoma City Light property was remediated while most of the other efforts were conducted in 1999. In 2005, following a request by the landowners, EPA partially deleted the Soils portion of OU 4. Groundwater monitoring wells continue to be sampled annually. Work is being performed by the Potentially Responsible Parties (PRPs).

Tacoma Landfill (OUs 5 and 6)

The Tacoma Landfill remedial actions address releases of hazardous substances from a municipal landfill operated by the City of Tacoma. The 240-acre landfill operated from 1960 to 2013 and accepted municipal, industrial, construction, demolition, and bulk wastes, some of which have since been designated as hazardous substances. EPA's 1988 ROD required capping of filled areas; leachate, condensate and stormwater collection systems; collection of landfill gas; and groundwater extraction and treatment. The landfill was closed in December 2015 and most of the groundwater outside the landfill

footprint has attained cleanup levels. The remedial actions are being implemented by the PRP, the City of Tacoma.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Commencement Bay, South Tacoma Channel		
EPA ID: WAD980726301		
Region: 10	**State:** WA	**City/County:** Tacoma, Pierce

SITE STATUS	
NPL Status: Final	
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: EPA ***[If "Other Federal Agency", enter Agency name]*:**
Author name (Federal or State Project Manager): Jeremy Jennings (OU 4-5), Chris Cora (OU 1-3)
Authors affiliation: EPA Remedial Project Managers
Review period: 2/26/2018
Date of site inspection: See Project Area Sections
Type of review: Statutory
Review number: 5
Triggering action date: 9/10/2013
Due date *(five years after triggering action date)*: 9/10/2018

See Sections II, III and IV for the evaluation of each Operable Unit and the issues and recommendations and protectiveness statements for each Operable Unit.

V. SITEWIDE PROTECTIVENESS STATEMENT

Sitewide Protectiveness Statement	
Protectiveness Determination: Will be Protective	*Planned Addendum Completion Date:* 9/30/2020
Protectiveness Statement: The remedy at the CB-STC is expected to be protective of human health and the environment upon completion of the remedy at OU 1 (Well 12A). In the interim, remedial activities completed to date at OU1 have adequately addressed all exposure pathways that could result in unacceptable risks in these areas. For the remedy at OU4 to be protective in the long term, the elevated lead in groundwater at STM-3A and STM-4A needs to be addressed.	

VI. NEXT REVIEW

The next five-year review report for the Commencement Bay, South Tacoma Channel Superfund Site is required five years from the completion date of this review.

II.

Well 12A (OU1)

COMMENCEMENT BAY –
SOUTH TACOMA CHANNEL SUPERFUND SITE
PIERCE COUNTY, WASHINGTON

Prepared by

United States Army Corps of Engineers (USACE)
Seattle District
Seattle, Washington

Prepared for

U.S. Environmental Protection Agency
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FIVE-YEAR REVIEW FOR WELL 12A PROJECT AREA, COMMENCMENT BAY- SOUTH TACOMA CHANNEL SUPERFUND

1. INTRODUCTION

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy is and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) is preparing this five-year review pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Contingency Plan (NCP)(40 CFR Section 300.430(f)(4)(ii)), and considering EPA policy.

This is the fifth FYR for the Well 12A project area (EPA ID No. WAD980726301), OU1, Commencement Bay – South Tacoma Channel Superfund Site. The triggering action for this statutory review is the completion date of the previous FYR in September 2013. The FYR has been prepared due to the fact that hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure (UU/UE).

The Well 12A project area consists of three Operable Units (OUs) collectively called the Well 12A OU, and OU1 will be addressed in this FYR. OU1 addresses the overall remedy for the Well 12A OU. The two OUs that are not addressed in this FYR are OU2 and OU3, as they were designated for administrative purposes as components of the overall Well 12A OU remedy. Therefore, OU2 and OU3 are not mentioned further in this review.

The OU1 component of the Commencement Bay – South Tacoma Channel Superfund Site Five-Year Review was led by Christopher Cora, Remedial Project Manager from EPA. Participants included U.S. Army Corps of Engineers staff Leanna Woods Pan (Environmental Engineer) and Alison M. Suess, Ph.D. (Chemist). The review began on 4/2/2018.

1.1 Site Background

The Well 12A OU of the South Tacoma Channel (STC) Superfund site is located in Tacoma, Washington, a populated area approximately 5 miles south of Commencement Bay. The source of contamination is located at the property of the former Time Oil Company, near the junction of Interstate 5 and state Highway 16 (Figure 1-1). The Well 12A OU encompasses the property of the former Time Oil Company, and includes Well 12A, a municipal water supply production well owned and operated by the City of Tacoma. Well 12A is now typically pumped during the peak water demand seasons (summer or early fall), for testing, or to facilitate pumping capacity of nearby wells. The former Time Oil Company was located at 3011 South Fife Street. Approximately 0.4 miles distant from the source of contamination, Well 12A is located on Pine Street between 38th Avenue and South Tacoma Way. A Site Map is provided in Figure 1-2.

The former Time Oil property was historically used for various industrial practices including oil recycling and paint and lacquer manufacturing. Oil recycling and solvent processing began in the early 1920s and continued until 1991 with occasional interruptions due to changes in ownership and a large fire in 1976.

The Time Oil Company vacated the property in 1991, and the space has since been used for storage and small-scale manufacturing. In addition to a number of possible leaks and spills over the years, some of the filter cake generated during oil recycling was land-disposed around the Time Oil Building and additional filter cake was used as fill material in 1982 for constructing the Burlington Northern Railroad spur to the north of the Time Oil Property. Subsequent investigations have identified this filter cake as a primary source of 1,1,2,2-tetrachloroethane (PCA)[1], tetrachloroethylene (PCE), trichloroethylene (TCE), and other organic solvents discovered in the groundwater at Well 12A.

Current land use near the former Time Oil property and Well 12A is commercial and industrial. The former Time Oil property is currently under private ownership and the tenants include the owners of a storage facility and a metal recycler (Figure 1-3). Groundwater in the aquifer underlying the project area is currently used as a drinking water source for the City of Tacoma. Thirteen production wells located within the South Tacoma Channel are primarily used to augment inadequate supply from the Green River during periods of high demand or high turbidity. Well 12A is operated infrequently due to the expense of treatment. At a minimum, City of Tacoma wells are operated once every two years to check their operation.

Additional details including Site geology, hydrogeology, response to contamination, and a chronology of major activities for Well 12A are available in Appendix B.

[1] The number of atoms represented by the prefix per- (i.e., totally substituted) is not correctly defined as tetra- in this case, since ethane has six hydrogens. The use of the abbreviation "PCA" in this FYR is maintained for consistency with Site documents. A more modern abbreviation for this chemical is "TeCA".

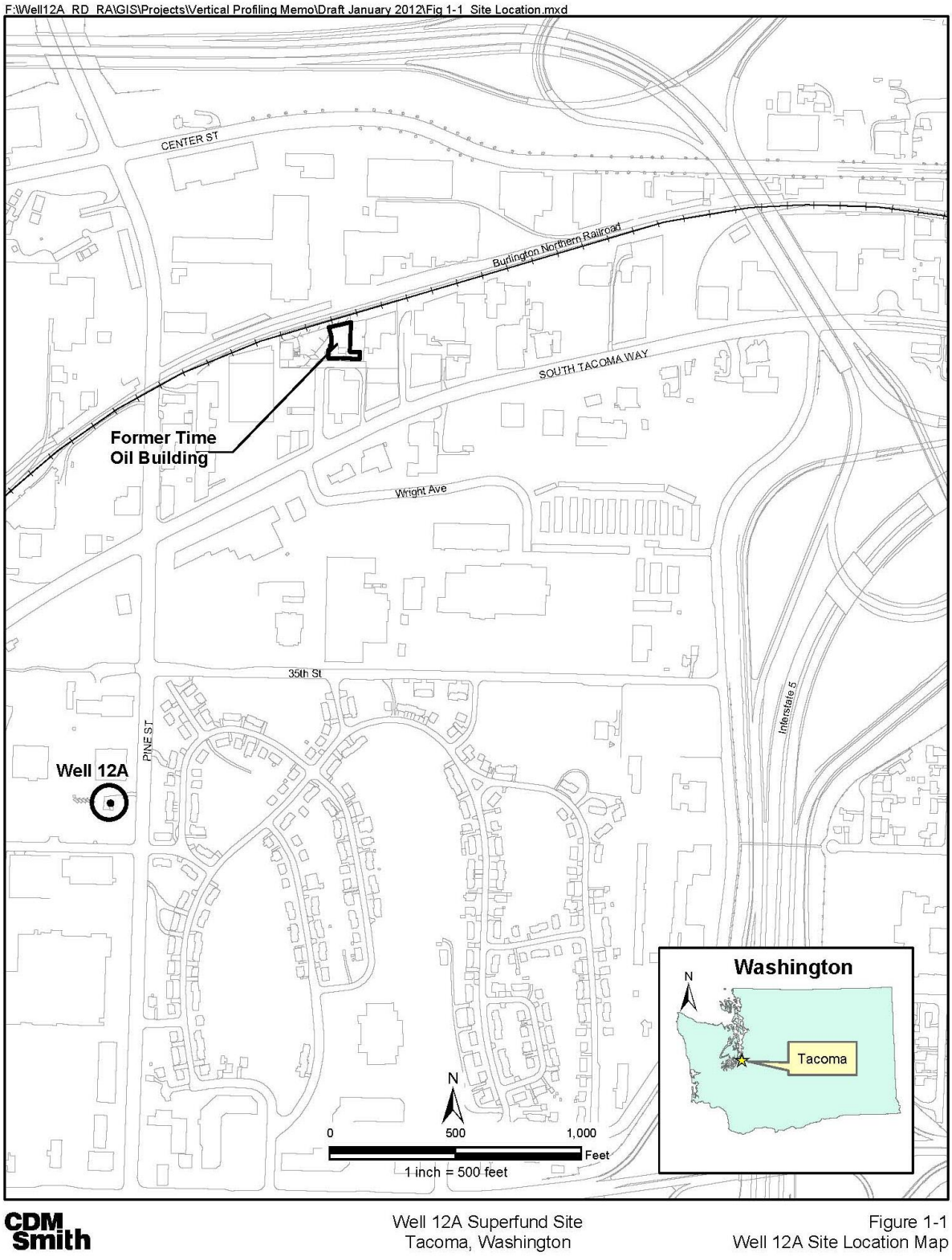

Figure 1-1. Site Location Map showing former Time Oil building and municipal Well 12A

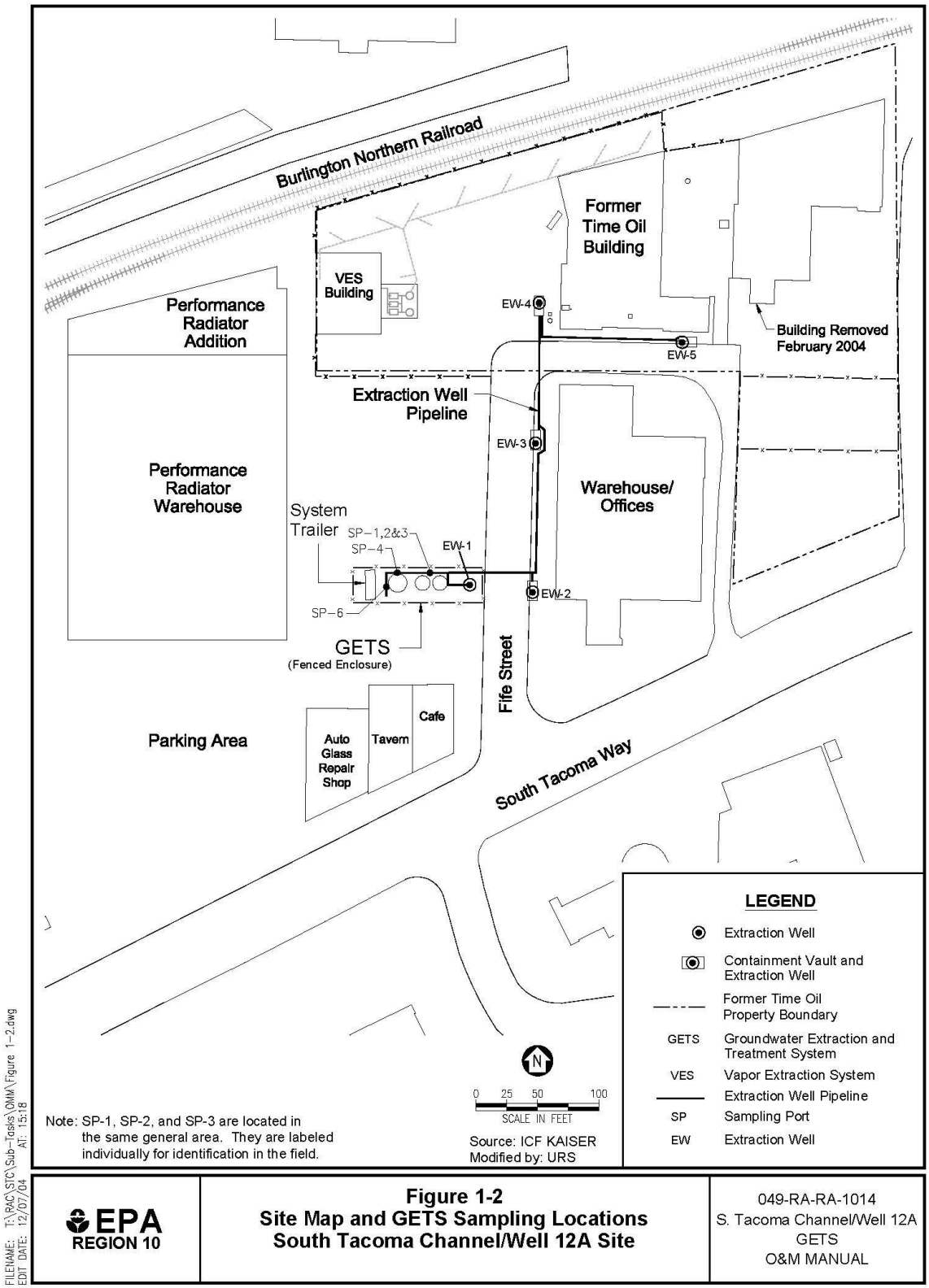

Figure 1-2. Site Map of former Time Oil building, South Tacoma Channel Well 12A OU

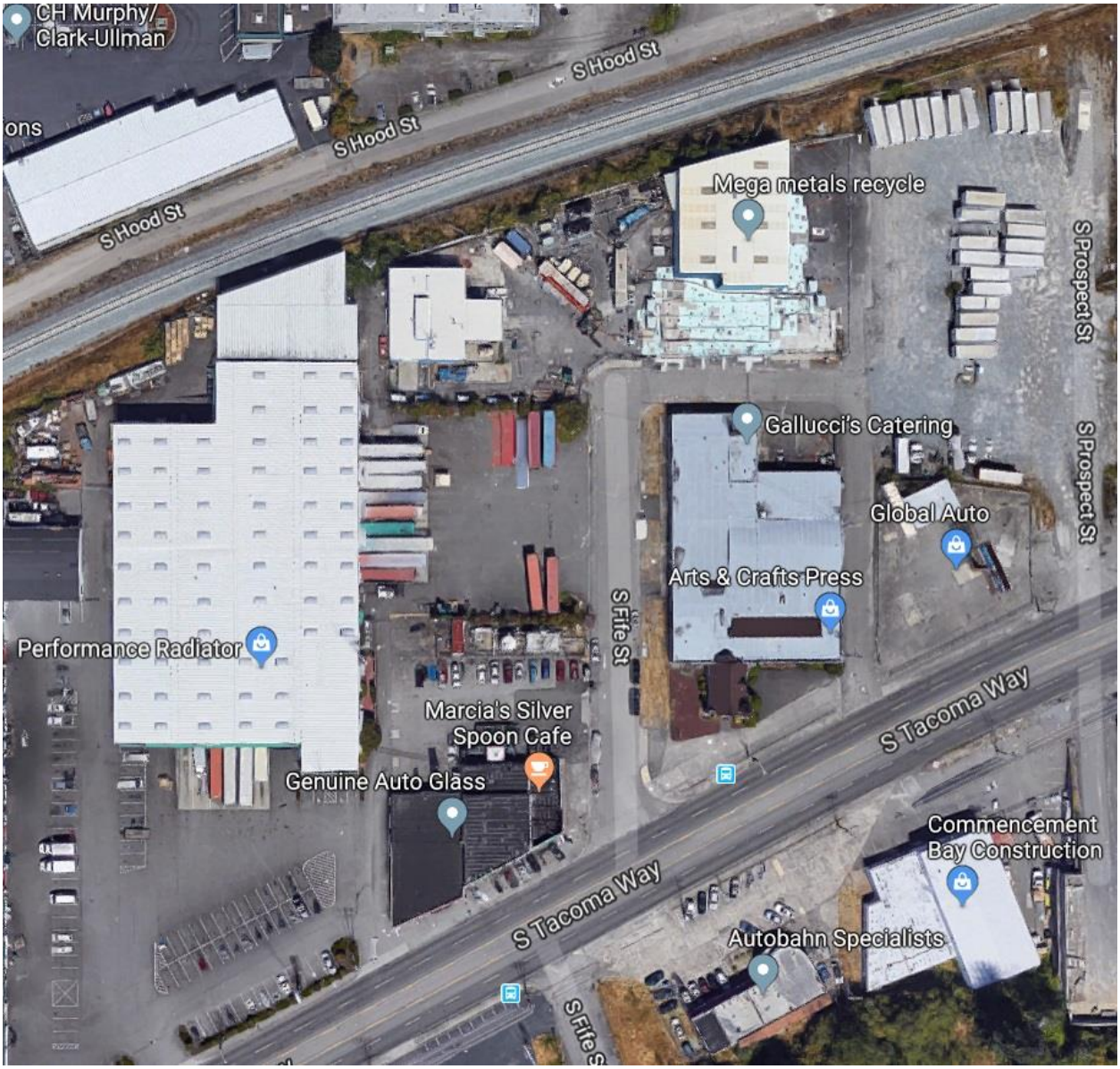

Figure 1-3. Satellite View of former Time Oil building location, South Tacoma Channel Well 12A OU

*Google satellite view obtained 5 April 2018, capture date July 2014

Table 1-1. Five Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Commencement Bay, South Tacoma Channel Superfund Site		
EPA ID: WAD980726301		
Region: 10	**State:** WA	**City/County:** Tacoma/Pierce County
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	**Has the site achieved construction completion?** No	
REVIEW STATUS		
Lead agency: EPA		
Author name (Federal or State Project Manager): Christopher Cora (OU1)		
Author affiliation: EPA Remedial Project Manager		
Review period: 4/2/2018 - 7/10/2018		
Date of site inspection: 4/4/2018		
Type of review: Statutory		
Review number: 5		
Triggering action date: 9/10/2013		
Due date *(five years after triggering action date)*: 9/10/2018		

2. RESPONSE ACTION SUMMARY

2.1 Basis for Taking Action

In 1981, chlorinated organic solvents were detected in groundwater at Well 12A that were above drinking water criteria at that time and the Site was added to the National Priority List (NPL) on September 8, 1983. The 1983 Remedial Investigation (RI) identified four Contaminants of Concern (COCs): trans-1,2-DCE, PCA, TCE, and PCE. The 2009 Record of Decision (ROD) Amendment 2 added two additional COCs (cis-1,2-DCE, and vinyl chloride), thereby establishing the current list of COCs in groundwater for the site as follows:

- cis-1,2-DCE
- trans-1,2-DCE
- PCA
- PCE

- TCE
- vinyl chloride

All COCs have been detected in groundwater at levels above either the Maximum Contaminant Levels (MCLs) or Washington State Model Toxics Control Act (MTCA) cleanup levels (USEPA, 2009). The Endangerment Assessment (associated with the Phase I FFS, discussed in Appendix B) determined that public health may be threatened either by direct contact at the source area or by consumption of contaminated drinking water if no additional remedial action was taken. On the basis of these findings, remedial action was determined to be warranted to mitigate risks to human health and the environment.

2.2 Response Actions

The remedy for the site as set forth in the 1983 Record of Decision (ROD), 1985 first ROD Amendment, and 1987 remedial design change memorandum included wellhead treatment at Well 12A using air strippers, vadose zone soil treatment by a Vapor Extraction System (VES), limited soil excavation, and a Groundwater Extraction and Treatment System (GETS) that uses carbon adsorption to treat extracted groundwater. Table 2-1 provides a summary of decision documents.

In October 2009, EPA released ROD Amendment #2. In order to protect human health and the environment, five Remedial Action Objectives (RAOs) were developed as part of ROD Amendment #2 to reduce contaminant mass and decrease the size of the contaminated area. The Amendment #2 RAOs replace the RAOs established in the ROD, ROD Amendment #1, and ESD, with the exception of the sixth RAO listed below, which is retained from the earlier decisions. With respect to groundwater, if it is potable (i.e., suitable for drinking in its natural state), MCLs are relevant and appropriate standards that need to be met wherever practicable.

ROD Amendment #1 specified "[t]he objectives of the proposed remedial action are the mitigation and control of contamination in the groundwater and in the soil at the source area." Additional RAOs were developed as part of this ROD Amendment #2 and include:

1. Eliminate the risk to human health posed by direct contact with filter cake and contaminated soil at and near the surface still present on the east side of the Time Oil building;
2. Prevent or minimize the migration of contamination from the highly contaminated shallow soil and filter cake area into the deeper soils to prevent further degradation of groundwater;
3. Remove sufficient contaminant mass within the source area to reduce the transport of contaminants from this highly contaminated source material into downgradient groundwater;
4. Reduce contaminant mass discharge by 90% from the source area into the low concentration groundwater treatment zone;
5. Reduce contaminant concentrations to meet cleanup levels selected in this amendment to be protective of human health and the environment and to comply with all ARARs at specified points of compliance.
6. Eliminate risk to human health from exposure to groundwater containing COCs in excess of protective levels.

ROD Amendment #2 further subdivided compliance with the RAOs into three tiers to allow implementation of a multi-component remedy and allow for decision-making such as when to transition from one treatment technology to another and when to transfer O&M to the State of Washington Department of Ecology (Ecology).

- 1st Tier - Address residual sources, minimize risk to receptors due to contaminated surface soils and achieve a contaminant mass discharge reduction of at least 90% from the high-concentration source area. Soil removal, ISTR, and EAB will be considered complete and the Remedy will be considered operational and functional when Tier 1 criteria have been met. O&M will be turned over to Ecology when Tier 1 criteria have been met.
- 2nd Tier – Achieve cleanup levels at interim performance monitoring points (within the current groundwater plume) to ensure groundwater concentrations are below applicable or relevant and appropriate requirements (ARAR)-specified levels at these locations.
- 3rd Tier – Determine if cleanup levels can be achieved in a reasonable timeframe throughout the contaminant plume by discontinuing GETS operation and continuing to monitor natural attenuation of any remaining contamination. If this demonstrates that cleanup levels could be achieved in a reasonable timeframe with MNA only, the MNA contingency will be implemented and GETS operation discontinued. If compliance with ARARs throughout the plume is deemed not feasible, additional remedial alternatives or a Technical Impracticability waiver may be sought for noncompliant portions of the aquifer.

Tier 2 and 3 are long term goals and EPA is currently assessing whether the source controls undertaken by the ROD Amendment #2 are adequate to achieve Tier 2 and 3 in a reasonable period of time. An evaluation is underway to determine whether or not adequate removal of source material will allow the natural attenuation capacity of the aquifer to reduce COC concentrations to below cleanup levels. The final report is anticipated to be submitted at approximately the same time this FYR is due for signature; therefore, this FYR will not include the conclusions of the evaluation.

The major components of the amended remedy selected by EPA for OU1 in this Amendment #2 include:

- Excavation and off-site disposal of filter cake and contaminated soils in a Resource Conservation and Recovery Act (RCRA) landfill
- *In situ* thermal remediation (ISTR) of soil and groundwater;
- *In situ* enhanced anaerobic bioremediation (EAB) of groundwater;
- Institutional controls (ICs) to avoid or limit exposure to site contamination and guide the use of the aquifer;
- Continued Operation and Maintenance (O&M) of the groundwater extraction system (GETS) selected in the ROD to prevent migration of contaminants while their mass is reduced (via excavation, ISTR and EAB), with a contingency for discontinuation of the groundwater extraction and treatment system and reliance on Monitored Natural Attenuation (MNA) for further remediation once the active measures have achieved interim objectives;
- Monitoring of the plume; and
- Continued O&M of the air stripping units and monitoring groundwater for Volatile Organic Compounds (VOCs) at Well 12A.

The remedy selected in ROD Amendment #2 is considered a final remedy for soils and an interim remedy for groundwater that will be protective and assist in achieving the long-term objective of restoring the aquifer to its beneficial use as a drinking water source for the City of Tacoma. During remedial design investigations, more residual source material was discovered beneath the Time Oil Building than was previously known. To address the additional source material, an Explanation of Significant Differences

(ESD) was completed in June 2012 that modifies the remedy to include removal of the Time Oil Building to allow access to highly contaminated soils.

A summary of the interim and final remedial actions by decision document is presented in Table 2-1. For further detail regarding remedial actions prior to this review period, see Appendix B. Cleanup levels specified in the ROD Amendment #2 are available in Table 2-2.

Table 2-1. Summary of ROD, ROD Amendments, and ESD for the Well 12A OU

Date	Decision Document	Remedial Action/Components
March 16, 1983	ROD	Interim Measure: • Installation of air stripping system at Well 12A • Pumping Well 12A to provide a hydraulic barrier
May 3, 1985	ROD Amendment #1	Address soil and groundwater contamination within source areas: • Excavation and removal of filter cake and contaminated soils in and around Time Oil Building and along the Burlington Northern Rail Road (BNRR) rail spur • Installation of GETS using air stripping for treatment • Soil flushing using treated water in areas of higher soil contamination • Capping in areas of lesser soil contamination
April 28, 1987	Remedial Design changes documented in Memorandum to Regional Administrator	Enhance soil and groundwater remedial action: • Installation of Soil Vapor Extraction (SVE) system instead of soil flushing • Use of carbon adsorption for GETS treatment instead of air stripping
October 29, 2009	ROD Amendment #2	Enhance soil and groundwater remedial action via: • Shallow excavation, in-situ thermal remediation (ISTR), and enhanced anaerobic bioremediation (EAB) of source material • IC requirement to avoid/limit exposure to contamination • Continued operation of air-stripping units at Well 12A with contingency for MNA • Continued plume monitoring • Continued O&M of the air strippers and groundwater monitoring at Well 12A
June 14, 2012	Explanation of Significant Differences (ESD)	Additional site characterization required modifications to the 2009 remedy: • Remove the Time Oil Building to allow access to highly contaminated soils

Table 2-2. Amended Groundwater Cleanup Levels for COCs at Well 12A

Contaminant	MTCA Method B (ingestion & inhalation) µg/L	MCL µg/L	Groundwater Cleanup Level µg/L	Basis for Cleanup Level
1,2-cis-Dichloroethylene (cis-DCE)	70	70	70	MCL
1,2-trans-Dichloroethylene (trans-DCE)	100	100	100	MCL
1,1,2,2-Tetrachloroethane (PCA)	0.2	NA	0.2	MTCA B 10^{-6} (no MCL)
Tetrachloroethylene (PCE)	0.8	5	0.8	MTCA B 10^{-5} < MCL
Trichloroethylene (TCE)	2.4	5	2.4	MTCA B non-carcinogenic risk; MTCA B 10^{-5} = 4.9
Vinyl chloride	0.3	2	0.3	MTCA B 10^{-5} < MCL

Notes:

MTCA - Washington State Model Toxics Control Act

MCL - Maximum contaminant level

µg/L - micrograms per liter

2.3 Status of Implementation

Collectively, the original ROD and ROD Amendments selected a multi-component remedy that was adapted as more information became available. To achieve the RAOs, a combination of treatment processes were utilized. The following residual source area interim RAs or activities were recently implemented to address contaminated soil and groundwater:

- Wellhead treatment at Well 12A using three air strippers to treat pumped groundwater. These air strippers were installed pursuant to the first ROD for the Site. The well is typically pumped during seasonal periods of peak demand;
    - Due to drought in 2015, Well 12A was pumped from May to October. There was minimal use of Well12A during all other years of this review period. Further details are provided in section B.5 of Appendix B.
- Excavation of highly contaminated soils, including filter cake. The excavation included a large railroad tanker underground storage tank and a 55 gallon drum with debris;
    - Between December 2011 and March 2012, excavation of shallow soils and filter cake in the east area of the Time Oil building at the Site was completed. Approximately 2,130 tons of contaminated soil and filter cake were excavated and disposed at a permitted offsite disposal facility. Also, a 14,280-gallon underground storage tank along with a 55 gallon drum, an empty cylinder, and other debris were removed and disposed.

- In Situ Thermal Remediation (ISTR) via high and low temperature electrical resistance heating (ERH) of soils and groundwater. Soil vapor extraction was used to treat the volatile organic vapors generated by the high temperature ERH;
    - As part of the groundwater interim RA, ISTR was implemented to address the COC source area present around and beneath the former Time Oil building at the Site in the deep vadose and saturated zones of the aquifer. ISTR implementation required partial demolition of the former Time Oil building to facilitate access for installation of the ISTR system. ISTR was implemented in this area between November 2013 and November 2014. ISTR was successful in removing COCs and non-aqueous phase liquids (NAPLs) from the vadose zone and saturated zone within the treatment footprint, with a target treatment interval between 0 and 55 feet below ground surface. ISTR achieved a 78% reduction in average soil COC concentrations and removed approximately 379 pounds of Site COCs during operation. In addition, approximately 22,000 pounds of other non-target compounds, predominantly petroleum hydrocarbons, were removed during ISTR operation and a small UST was discovered and removed during installation of ISTR subsurface components.
- Enhanced anaerobic biodegradation (EAB) of high-concentration groundwater plume through injection of a carbon substrate (emulsified vegetable oil, either LactOil® or EOS 100®, was selected based on well conditions) to enhance dechlorination under anaerobic conditions;
    - As part of the groundwater interim RA, EAB was implemented to address residual COC source areas located within the high-concentration groundwater plume at the Site. Specifically, EAB targeted areas where elevated COC concentrations (approximately greater than 300 micrograms per liter (µg/L) as TCE or cis-1,2-DCE) were present above and within low-permeability silt units, which are serving as both a boundary for dense non-aqueous phase liquid (DNAPL) vertical migration and as a continuing source of contamination through back diffusion. EAB amendment injections, consisting of emulsified oil and ethyl lactate, were completed between February 2014 and May 2014. In addition, two localized areas within the EAB treatment zone where DNAPL was encountered above the low-permeability silt units were targeted with low-temperature ERH, which increased the subsurface temperatures to between 40 and 50 degrees Celsius (°C) to accelerate DNAPL dissolution and biodegradation rates. The ERH system was installed in July 2015 with startup in August 2015, and was operated until February 2017 to thermally enhance the EAB remedy.
- Post Remedial Action Mass Discharge was evaluated using methodology established in the 2013 Quality Assurance Project Plan (QAPP);
    - The post-RA mass discharge evaluation results indicate a contaminant mass discharge reduction of approximately 87.5% from baseline (pre-RA) conditions. While just short of the 90% mass discharge reduction performance objective established for Tier 1 compliance in ROD Amendment #2, this represents a significant reduction in source strength from the Time Oil source area.

These activities have been completed and biodegradation is ongoing. Currently, EPA is assessing the success of the treatments and evaluating whether or not Tier 1 RAOs have been achieved. Groundwater monitoring will be used to determine if the GETS operation can remain offline and MNA can be relied on to achieve the long-term groundwater monitoring objectives of meeting cleanup levels in a reasonable

timeframe. Further detail regarding remedy implementation prior to this review period is available in the Site file (see Section 4.1).

2.4 IC Summary Table

Table 2-3. Summary of Planned or Implemented ICs

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Groundwater and Soil	Yes	Yes	4860000130, 4860000140, 4860000170, 4860000100, 4860000110, 4860000120,	Avoid or limit exposure to site contamination and guide the use of the aquifer to protect human health. Environmental Release and Disclosure Agreements are currently in place for these parcels, but ICs have not been implemented	Proprietary Controls, planned for Spring 2019

Table 2-4. IC Description

Type of IC	Description of IC	Planned Date
Environmental covenants for use restrictions	Shallow soil contamination was identified at three parcels at the time the draft IC plan was developed. This IC has not been implemented and will be re-evaluated following the achievement of Tier 1 objectives.	Spring 2019
Permits	Construction permits are required to regulate excavation on affected properties. Tacoma Municipal Code 13.09.080 requires a permit before "constructing, installing, substantially modifying, or changing the use of a facility or regulated facility." All properties affected by the soil contamination are within the South Tacoma Groundwater Protection District. Tacoma-Pierce County Health Department (TPCHD) is responsible for regulating pollution prevention in this District and utilizes institutional knowledge of the existing contamination at the Well 12A OU to preclude construction	In Place

	permitting. This IC is currently in place.	
Zoning & Covenants	Land use zoning to prevent residential development and uses. Properties where soil contamination has been identified are currently located within the City of Tacoma zoning district M2 (heavy industrial). This IC is currently in place; the M2 boundary was verified as part of the previous FYR. However, day care centers and schools are permitted within the M2 district per Tacoma Municipal Code Chapter 13.06.400.C. Other institutional controls (e.g., environmental covenant) will be needed to prevent use of these properties by these sensitive populations.	Spring 2019
Covenant	Environmental covenants for properties where wells are located. Re-evaluation of this IC and the need for environmental covenants will be completed following the development of a long-term groundwater monitoring program. According to April 2013 parcel access agreement information available from CDMSmith, 25 parcels are currently located above or adjacent to the 300-ppm COC groundwater plume.	Spring 2019
Permits	Well permitting process. According to communications with Sharon Bell of TPCHD as part of the previous FYR, drinking water well installations are not allowed within the City of Tacoma because it is a municipal service area. TPCHD is very aware of the problems with the Time Oil site and not likely to consider a well installation in that vicinity for drinking water purposes. Washington State regulations (WAC-1732-160-171) also prohibit installation of any drinking water wells within or near known or potential sources of contamination.	In Place

An IC plan was drafted in 2010 that recommended ICs for the protection of human health. EPA completed a title search prior to the development of the draft IC plan in 2010. EPA has obtained access agreements from property owners where investigation work and remedial activities were completed. In addition, six parcels, including the Time Oil property and adjacent properties, have Environmental Release and Disclosure Agreements in place to allow unencumbered access for purposes of remedial action activities.

Upon completion of the source remedy and achievement of Tier 1 RAO, a long term monitoring plan will be developed and the IC Plan will be finalized, thereby ensuring that the formal implementation of proprietary ICs at select parcels are based on post remedial action conditions. Parcels with residual soil contamination and those containing monitoring wells selected for long term monitoring will be recommended for proprietary ICs.

2.5 Systems Operations/Operation & Maintenance

Remedial activities with ongoing O&M are described below.

Well Head Treatment and Well 12A

The City of Tacoma owns and operates Well 12A and the five air stripping towers adjacent to the well. When in operation, treated water from Well 12A is added to the drinking water supply. Well 12A is pumped during periods of peak demand (the summer or early fall), on an every-other-year frequency for testing, or to facilitate pumping capacity of nearby wells. A mechanic from the City completes maintenance of either the well or pump house based on either an identified need for corrective maintenance or scheduled preventive maintenance. Further details are provided in section B.5 of Appendix B.

Operation of air stripping towers when Well 12A is in operation are used to reduce contaminant concentrations to levels below water quality standards. This is an engineering control operated by Tacoma Water and is currently in place. A pumping agreement has been made among EPA, Ecology, and Tacoma Water to coordinate pumping and implementation of the remedy so that operation of Well 12A does not disrupt certain phases of the remedy. This IC is currently in place; the agreement was signed in December 2010. Coordination meetings are conducted annually, as required by the agreement.

Groundwater Monitoring

Since the remedies selected in ROD Amendment #2 are implemented, the current groundwater monitoring program is focused on performance monitoring and evaluation of monitored natural attenuation. Groundwater monitoring objectives and wells to be sampled are determined for each sampling event prior to that event. Twelve rounds of monitoring have been completed since ROD Amendment #2 was signed. Further details are provided in section B.5 of Appendix B

The evaluation of the passive sampling devices during the December 2012 round of groundwater monitoring concluded that the Hydrasleeve™ would provide adequate representation of subsurface conditions during future performance monitoring events. Therefore, this sampling technology was utilized in subsequent sampling events to decrease costs associated with performance monitoring. However, it was also determined that HydraSleeve data should not be compared to historical groundwater sample results collected with low-flow methods, should not be compared to regulatory targets, and should not be used to measure mass discharge.

Summary of Costs of System Operations/O&M Effectiveness

Operating costs for Well 12A and the air stripping treatment system were provided by the City of Tacoma for this FYR. Well 12A was briefly run in 2013 (primarily in October), 2014 (3 part days in February and March), 2016 (1 part day in April), and 2018 (1 part day in February). Well 12A was not run at any time during 2017, but was run extensively in 2015 from May to October due to drought. Briefly turning on Well 12A restarts a 12-month series of demand charges from the power utility that are estimated to total nearly $19,000; this assumes 3 of the 60 hp blowers are run along with the 200 hp submersible motor. To avoid this, the City recently began utilizing a portable diesel generator to run the well (including the blowers) for sampling. If the well is run continuously for an entire month from line power, the monthly electric charge is over $9,000. If the well is then stopped and left off, the next 11 months is billed at nearly $1,500 per month. Additional costs are incurred for mechanics (maintenance and site inspections), engineers (technical questions and meetings), water rights reporting, electrical upgrades, treatment (chemical addition and adjustments), and sampling.

3 PROGRESS SINCE THE LAST REVIEW

This section includes the protectiveness determinations and statements from the **last** five-year review as well as the recommendations from the **last** five-year review and the current status of those recommendations.

Table 3-1. Protectiveness Determinations/Statements from the 2013 FYR

OU #	Protectiveness Determination	Protectiveness Statement
1	Short-term Protective	The remedy at Well 12A is currently protective of human health and the environment in the short term. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas. However in order for the remedy to be protective in the long term, the remedial actions for the source area should continue to be implemented.
Sitewide	Short-term Protective	The Commencement Bay, South Tacoma Channel Superfund Site is currently protective of human health and the environment in the short term. In order for the remedy to be protective in the long term, issues identified for OU 1 (Well 12A), OU 4 (South Tacoma Field) and OU 5/6 (Tacoma Landfill) need to be resolved.

Table 3-2. Status of Recommendations from the 2013 FYR

OU #	Issue	Recommendations	Current Status	Current Implementation Status Description
1	Selected cleanup levels for cis- and trans-1,2-DCE may no longer be protective following 2011 changes in toxicity values.	Re-evaluate the groundwater cleanup level for cis- and trans-1,2-DCE and adjust if necessary to maintain future protectiveness after achievement of Tier 1 criteria outlined in the 2009 ROD Amendment #2.	Ongoing	Groundwater cleanup levels for cis- and trans-1,2-DCE will not be further evaluated until after the achievement of Tier 1 criteria.
1	Evaluation of the vapor intrusion pathway is needed.	Evaluate vapor intrusion pathway after achievement of Tier 1 criteria.	Under Discussion	Evaluating whether Tier 1 criteria have been met. Allocation of funds to obtain contractor support is needed upon meeting Tier 1 criteria.

ROD Amendment #2 includes the need for an evaluation of vapor intrusion at the Site after achievement of Tier 1 criteria, as well as the need for finalization of an IC plan and implementation of proprietary controls.

4 FIVE-YEAR REVIEW PROCESS

4.1 Community Notification & Site Interviews

A public notice was made available by publication in the Tacoma Weekly on 5/11/2018, stating that there was a five-year review and inviting the public to submit any comments to the U.S. EPA. A copy of the public notice is provided in Appendix E. The results of the review and the report will be made available at the Site information repository located at the following addresses of online or physical locations.

Online: https://www.epa.gov/superfund/commencement-bay-stc

EPA Region 10 Superfund Records Center
1200 Sixth Avenue
Seattle, WA 98101
206-553-4494 (please call for an appointment)

Tacoma Public Library
Northwest Room
1102 Tacoma Avenue South
Tacoma, WA 98402
253-591-5666

During the FYR process, interviews were conducted via a mailed questionnaire to document any perceived problems or successes with the remedy that has been implemented to date**.** Interview questionnaires were completed by the City of Tacoma (Tacoma Water branch of Tacoma Public Utilities, Project Manager Craig Downs), Washington State Department of Ecology (Project Manager, Chris Maurer), and a local property owner. The results of these interviews are summarized below and questionnaires are available in Appendix F.

The response by the Washington State Department of Ecology (Ecology) indicates that it is the assessment of the agency that progress is being made toward successful remediation of the site. Furthermore, cooperation between the State and EPA has facilitated remediation of the site. The Ecology response notes that the Institutional Control Plan is outdated and needs revision.

The Local Property Owner, in their response, would like increased contact with EPA and a progress update. They are in contact with the O&M contractor and are happy with their communication. They note increased foot traffic for drop offs at the metal recycling facility since it has opened. EPA has followed up with the Local Property Owner to answer questions.

4.2 Data Review

This FYR included a review of relevant, project-related documents including the ROD, ROD amendments, one ESD, monitoring reports, investigation reports, and recent monitoring data. In addition, the Post-Remedial Action Mass Discharge Evaluation Report, In Situ Thermal Remediation Completion Report, and twelve groundwater monitoring reports including details regarding the EAB remedial action were reviewed. A complete list of the documents reviewed and citations can be found in Appendix A.

The following is a review of the data collected in conjunction with the remedial actions during the last five years. Data relevant to remedy performance and progress towards meeting RAOs will be discussed in

this section, including data trends to evaluate whether RAOs and associated cleanup levels established in the ROD are likely to be achieved, data relevant to support engineering performance, and data related to the site-specific groundwater remedy completion strategy.

4.2.1 Soil

Following the ROD Amendment #2, soil contamination at the Well 12A OU was addressed via excavation of shallow soils, in situ thermal remediation of vadose and saturated zones underneath and around the former Time Oil Building, as well as enhanced anaerobic bioremediation of saturated zones. Information regarding these remedial actions is provided in Appendix B. Post-ERH confirmation sampling was performed by CDM-Smith in July 2014. Average reduction in concentrations of the six COCs by sample location is presented below in Table 4-1. Based on all data recorded during the baseline and confirmatory sampling events, ERH achieved an overall contaminant reduction across the site of 77.7%. However, it should be noted that baseline levels were not obtained for some soil borings that later were found to contain high concentrations of COCs. Soil borings SB03 and SB09 did not have a baseline location and baseline sample B401 did not have a confirmatory location to derive a reduction percentage. High concentrations of COCs at SB-09 corresponded to observations by CDM Smith of DNAPL in the sample. Eliminating these data sets from the site-wide analysis indicates that the average reduction of contaminant concentrations of the six target COCs was 94.5%. Furthermore, analytical results indicated that the six COCs were not present in 58 of the 77 samples collected during confirmation sampling (i.e. over 75% of the confirmation samples were non-detect) and VOC reductions continued to occur in the TTZ until residual heat in the subsurface returned to natural conditions. Therefore, the percent reductions presented in Table 4-1 are considered conservative.

Table 4-1. Average COC Concentrations in Soil by location (Kemron, 2015)

	Soil Boring Location Baseline/Confirmation	Average Pre-ERH Concentration for 6 COCs (µg/kg)	Average Post-ERH Concentration for 6 COCs (µg/kg)	Percent Reduction
	B428 / SB01	72,785	397	99.5%
	B411 / SB02	6,782	3,733	44.45%
	No Baseline / SB03	--	403	--
	B413 / SB04	27,299	395	98.6%
	B402 / SB05	3,006	595	80.2%
	B400 / SB06	61,837	346	99.4%
	B432 / SB07	7,713	519	93.3%
	B407 / SB08	465	769	--
	No Baseline / SB09	--	27,670	--
	B401 / No Confirmation	6,782	--	--
Average Values	**All Data**	**17,100**	**3,800**	**77.8%**
	Baseline/Confirmation	**20,600**	**1,100**	**94.7%**

Following ISTR, the treatment goal for 90% reduction in average soil concentrations was met in the saturated zone and significant reductions in mass concentrations were reached in the vadose zone. Although the specific project goals were not met completely, significant and necessary progress toward the mass discharge goals was made. ISTR achieved a 78% reduction in average soil COC concentrations and removed approximately 379 pounds of Site COCs during operation. In addition, approximately

22,000 pounds of other non-target compounds, predominantly petroleum hydrocarbons, were removed during ISTR operation.

4.2.2 Non-Aqueous Phase Liquid

Analytical data trends for the thermally-enhanced bioremediation wells EAB-1, EAB-2, EAB-5, and INJ-30 are presented in Appendix C. Charts of the total COCs and chloride mass and molar flux at the DNAPL wells (EAB-1 and INJ-30) throughout the period of EAB treatment indicate notable increases in flux of COCs at both wells between June and September 2015, coinciding with the start of municipal pumping and the start of heating (Figures C-1 and C-2 of Appendix C). The general trends indicated by these calculated fluxes over time are described as follows:

- COC mass flux increased during implementation of EAB, due to enhanced dissolution resulting in increasing dissolved-phase concentrations;
- Increased mass flux due to enhanced groundwater flux induced by municipal pumping in June 2015;
- Increased mass flux due to additional dissolution of DNAPL source, combined with enhanced biological degradation, during heating as demonstrated at INJ-30 since September 2015;
- Decreased mass flux due to source depletion and enhanced biological degradation at EAB-1 since September 2015; and
- Decreasing mass flux has been observed at INJ-30 since the peak flux in February 2016, though flux remains elevated at INJ-30 when compared to EAB-1.

Thermally-enhanced bioremediation at EAB-1 has resulted in substantial reduction in COC concentrations in this DNAPL hotspot, indicative of source depletion. At EAB-1, August 2016 data shows that VOC concentrations have declined substantially since startup of low-temperature heating, and total VOC mass and molar concentrations and fluxes have exhibited a continual decline throughout ERH operation. Since EAB-1 is located in close proximity to a known high-conductivity preferential flow pathway below the low-permeability silt unit that is significantly impacted by the Well 12A pumping, the reduction in VOC mass at EAB-1 represents significant progress toward source mass reduction at a location which contributes significantly to mass discharge from the site to the receptor.

4.2.3 Groundwater

EPA is in the process of preparing the Remedial Action Completion Report for the remedy implemented per ROD Amendment #2; therefore, that data is not available for inclusion in this Five-Year Review. Initial results indicate that RAOs have been met.

Table 4-2 presents a summary of the percentage reductions in COC mass and molar concentrations since baseline sampling, completed prior to implementation of the EAB and ISTR remedies at the Well 12A OU. Many wells within the EAB treatment area have exhibited significant reductions (greater than 90%) in total COC mass during Groundwater Performance Monitoring Event #12. The median COC mass concentration reduction in the wells sampled during Groundwater Performance Monitoring Event #12 was 87%, and the median molar concentration reduction was 82% compared to baseline levels. These concentration reductions at the majority of the Well 12A OU monitoring wells indicate significant progress of the EAB remedy. Several monitoring wells have exhibited concentration increases since baseline sampling, primarily due to proximity to locations containing DNAPL or LNAPL (INJ-30, EAB-

5, MW-C, MW-314) or injection wells surrounding the INJ-30 thermally-enhanced bioremediation area where dissolution of the DNAPL source is still being enhanced.

Evaluating the change in the molar concentrations and fractions (or ratios) of parent compounds to dechlorination products is very useful in determining the efficacy of biodegradation brought about by edible oil injection. During biodegradation, the molar ratios of the compounds involved in the reaction chain will change. Looking at molar concentrations is more accurate and informative than evaluating changes in concentration alone for the parent/dechlorination products because of the different molecular weights of the compounds.

Table 4-2. Summary of Percentage Reduction in VOC Mass and Molar Concentrations at Performance Monitoring Wells (CDMSmith, 2016b)

Well ID	Baseline Total Mass Concentration (µg/L)	Current Total Mass Concentration (µg/L)	Percent Reduction from Baseline (%)	Baseline Total Molar Concentration (µmol/L)	Current Total Molar Concentration (µmol/L)	Percent Reduction from Baseline (%)
EAB-1	44,570.0	2,702.2	-94	292.84	20.40	-93
EAB-2	11,973.0	206.9	-98	82.25	2.92	-96
EAB-5	1,901.0	62,147.0	3169	13.62	758.77	5469
INJ-30	45,386.3	166,341.0	267	287.08	1140.43	297
CH2M-1	3,536.7	62.5	-98	29.05	0.81	-97
EAB-7	344.3	8.6	-98	3.59	0.11	-97
EAB-8	107.1	4.5	-96	0.95	0.05	-95
EAB-9	106.7	44.1	-59	0.86	0.49	-43
EAB-10	165.6	7.0	-96	1.35	0.08	-94
ICF-2	730.5	5.7	-99	6.69	0.06	-99
ICF-5D	2,196.3	282.1	-87	22.42	3.97	-82
MW-313	917.5	8.0	-99	7.14	0.09	-99
MW-314	2,386.0	12,982.7	444	20.06	137.92	588
MW-C	87.9	1,625.7	1750	0.67	14.97	2143
WCC-1B	2,499.9	11.4	-100	21.15	0.15	-99
INJ-3	1,758.2	614.1	-65	14.82	8.04	-46
INJ-15	1,411.4	1,908.2	35	12.24	19.97	63
INJ-16	1,511.6	28,200.0	1766	10.94	296.81	2613
INJ-17	101,330.0	49.7	-100	1029.30	0.62	-100
INJ-21	1,346.4	3,248.0	141	11.68	31.34	168
INJ-27	10,762.0	102.9	-99	112.67	1.30	-99
INJ-34	3,426.9	4.5	-100	30.14	0.05	-100
INJ-39	1,093.5	1,692.4	55	9.20	18.02	96
INJ-46	1,378.0	1,488.5	8	10.50	16.00	52
INJ-47	2,337.8	2,538.7	9	19.58	38.07	94
		Median % Reduction	-87		Median % Reduction	-82

Notes:

- Negative values indicate the percentage reduction from baseline levels
- Wells without analytical data prior to remedy implementation (INJ-19, INJ-33, INJ-37, INJ-41, INJ-43, INJ-44, INJ-45) are excluded from the table.
- The median % reduction is not indicative of the percentage reduction in mass discharge which would be measured through operation of the GETS.

- Wells within heated area for ERH include EAB-1, EAB-2, EAB-5, and INJ-30.
- DNAPL was present in wells EAB-1 and INJ-30.
- LNAPL was present in MW-314
- µg/L - micrograms per liter
- µmol/L - micromoles per liter
- DNAPL - dense non-aqueous phase liquid
- ERH - electrical resistance heating
- GETS - groundwater extraction and treatment system
- LNAPL - light non-aqueous phase liquid

While the remedy has made progress in reducing COC concentrations in most areas of the Well 12A OU, evaluation of analytical data from monitoring wells alone was not sufficient to determine the percentage reduction in mass discharge. Evaluation of concentration trends at GETS extraction wells over time during the GETS extraction well pumping test in August 2016 provided the necessary information to determine if the Tier 1 RAO (90% reduction in COC mass discharge from the source areas) is achievable at this time.

Consistent with the baseline MDE (CDM 2013a), mass discharge for the full-scale GETS pumping test and post-RA MDE sampling events was calculated as the product of flow rate and concentration. Using this methodology, the post-RA MDE results indicate a contaminant mass discharge reduction of approximately 87.5% from baseline (pre-RA) conditions. While just short of the 90% mass discharge reduction performance objective established for the first tier of compliance in ROD Amendment #2, this represents a significant reduction in source strength from the Time Oil source area. In addition, all COCs except vinyl chloride, are below their respective MCLs at the GETS influent sampling port. Vinyl chloride is quickly oxidized in the aerobic zone of the aquifer.

4.2.4 Vapor Intrusion

The health risk at the Well 12A OU due to vapor intrusion was considered by EPA, since VOCs may migrate from contaminated soils and groundwater through the subsurface and a building overlying elevated groundwater concentrations. Results of the Johnson and Ettinger computer modeling program indicate that unacceptable risk to onsite workers within the building is possible and that further evaluation is warranted. Furthermore, the vapor intrusion pathway was identified as a concern in the ROD Amendment #2, which stipulated that vapor intrusion should be evaluated after targeted soil and groundwater contamination is addressed. EPA plans to evaluate vapor intrusion in the near future, after completing a performance assessment of the recent remedial actions.

4.3 Site Inspection

The inspection of the Site was conducted on 4/4/2018. In attendance were U.S. Army Corps of Engineers staff Leanna Woods Pan, Alison Suess, and Karl Kunas. The purpose of the inspection was to assess the protectiveness of the remedy. The participants observed the paved areas near the location of the former Time Oil Building where the soil vapor extraction (SVE), bioremediation, excavation, and thermal remediation actions took place. The property encompassing the recycling business and the former SVE building is fenced, with gates open during the day for vehicle and pedestrian access. The participants also observed the GETS area and the Well 12A area. Well 12A and GETS are fenced and locked. Some signage at the area near the location of the former Time Oil Building and at the GETS area has peeling labels with contact phone number information. The inspection checklist and photos taken during the April 4 site visit are presented in Appendix D.

5 TECHNICAL ASSESSMENT

5.1 QUESTION A: Is the remedy functioning as intended by the decision documents?

Question A Summary:

Yes. Interim remedial actions described in ROD Amendment #2 have been implemented and appear to be functioning as intended based on data collected to date. Currently, EPA is assessing the success of the treatments and evaluating whether or not Tier 1 RAOs have been achieved. Shallow soil contamination to the east of the Time Oil building has been excavated and transported off-site for disposal. The implementation of ISTR and EAB have decreased contaminant mass at the Site and improved groundwater quality. Well 12A is operated during periods of high municipal water demand and water is treated via air stripping prior to use. The GETS is currently on stand-by, awaiting further evaluation of Tier 2 and Tier 3 RAO compliance. Engineering controls and governmental ICs are in place to prevent exposure and protect human health.

5.1.1 Remedial Action Performance

Progress had been made toward achieving the Tier 1 objective of a 90% reduction in mass discharge. Implementation of recent Remedial Actions (RA)s ISTR and EAB have substantially decreased contaminant mass at the Site. The post-RA mass discharge evaluation (MDE) results indicate a contaminant mass discharge reduction of approximately 87.5% from baseline (pre-RA) conditions. While short of the 90% mass discharge reduction performance objective established for the first tier of compliance in ROD Amendment #2, this represents a significant reduction in source strength from the Time Oil source area.

Achievements of the recent RAs are summarized in the following bullets:

- 87.5% reduction in mass discharge of COCs.
- 99% reduction in mass discharge of parent compounds (PCA, PCE, and TCE).
- 67% reduction in mass discharge of degradation compounds (cis-1,2-DCE, trans-1,2-DCE, and VC).
- Five of six COCs reduced to below MCLs in the GETS influent; only VC remains above the MCL at approximately 20 µg/L.
- Excavation of 2,130 tons of contaminated shallow soil and filter cake.
- Removal of two underground storage tanks.
- In-situ thermal treatment of approximately 379 pounds of COCs and over 22,000 pounds of other non-target petroleum hydrocarbons.
- EAB treatment of the high-concentration groundwater plume.
- Contingent shutdown of the GETS, which had been operational at the site for 29 years, pending confirmation of Tier 2 and 3 RAO compliance evaluations.
- Decommissioning of the former SVE system.

The remedial actions (RAs) implemented at the Site since the 1980s have resulted in a substantial improvement in groundwater quality in the region. In general, PCA and TCE concentrations have declined between one and three orders of magnitude since the initial sampling events at these wells. The recent reductions in source mass at the Site have continued to improve groundwater quality in the region.

5.1.2 System Operations/O&M

Current operation of Well 12A is limited to periods of high seasonal demand. When operational, the air-stripper treatment system at Well 12A is working as designed. Electrical and communication systems were upgraded in 2011/2012, but no other major repairs have occurred. Currently, only three of the five air stripping towers are utilized to treat groundwater, resulting in significant cost savings. All treated groundwater meets MCLs.

The GETS was utilized during implementation of the ISTR and EAB remedial activities. A baseline mass discharge measurement was completed in 2013 using a pumping test method conducted with the GETS. During remedial activities, the GETS remained offline. The GETS was restarted on November 14, 2016 for the post-RA pumping test to complete the Mass Discharge Evaluation. Currently, GETS O&M is on standby while assessment of the potential for MNA to address source area contamination is being completed. This assessment involves measuring mass flux reduction and modeling the attenuation capacity of the aquifer. With the substantial reductions in source COC mass and reductions in mass discharge, there is little substantive benefit in continued GETS operations for containment and mass removal of the Time Oil source area. Therefore, the GETS operations remain offline while EPA assesses whether or not Tier 2 and 3 RAO compliance may be attained in a reasonable amount of time (per ROD Amendment#2). The GETS may be reactivated if RAOs have not been met by the remedial actions in the future. Results of recent remedial actions are expected to be evaluated in a Remedial Action Completion Report, which is scheduled to be finalized by the end of 2018. It is anticipated that this report will discuss the potential achievement of Tier 1, 2, and 3 RAOs.

5.1.3 Implementation of Institutional Controls and Other Measures

Current ICs to prevent human exposure to shallow soil contamination include engineering controls and governmental controls (e.g. construction permits, zoning restrictions, and listing of the site on the State of Washington's Confirmed and Suspected Contaminated Sites List [CSCL]). Additional proprietary ICs (i.e. environmental covenants) were recommended to be placed on properties where soil contamination remains. Current governmental ICs to prevent ingestion of contaminated groundwater include pumping agreements with Tacoma Water and TPCHD's well permitting process

5.2 QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Question B Summary:

Yes. There have been some changes to toxicity values for cis-1,2-DCE and trans-1,2-DCE that may require future reevaluation of selected cleanup levels to ensure protectiveness is maintained. Those changes are discussed further below. However, the changes do not currently affect protectiveness due to governmental ICs in place to prevent exposure above the new standards. The RAOs are still valid, and implementation of RAs at the Time Oil source area has made significant progress towards meeting the RAOs.

5.2.1 Changes in Standards and TBCs

MCLs were selected as the cleanup levels for cis- and trans-1,2-DCE. Model Toxics Control Act (MTCA) values were selected as the cleanup levels for other COCs. Since ROD Amendment #2, there have been no revisions to the MCLs.

Vinyl chloride. The MTCA B cancer value for vinyl chloride has undergone two revisions since the ROD Amendment #2, but the overall effect is that the value has not changed and the revisions therefore do not affect protectiveness.

The ROD and subsequent amendments does not identify specific cleanup concentration standards for site soil contamination. For groundwater, ROD Amendment #2 requires a contaminant discharge reduction of at least 90% from the high-concentration source area near the Time Oil building to the dissolved-phase contaminant plume (RAO #1). Soil removal, ISTR, and EAB will be considered complete and the remedy will be considered operational and functional when this criteria has been met. This cleanup goal is specific to the project area and is not affected by changes in published numerical cleanup standards.

There have been no revisions to laws and regulations since the last Five Year Review that affect the protectiveness of the remedy.

5.2.2 Changes in Exposure Pathways

The exposure pathways for soil and groundwater presented in the RODs have not changed. Much of the project area is paved or covered with concrete, thus limiting the occupants' exposure to surface soil. No new or changed human health or ecological routes or receptors have been identified at this time.

5.2.3 Expected Progress Towards Meeting RAOs

Implementation of RAs at the Time Oil source area since the 1980s has resulted in improvement in water quality at the Well 12A OU, which has seen declines in concentration of TCE and PCA of more than an order of magnitude since the mid-1980s. The recent reductions in source mass at the Site due to implementation of the recent remedial actions (e.g. ISTR, EAB) are expected to continue this improving trend in groundwater quality in the region. The post-RA mass discharge evaluation results indicate a contaminant mass discharge reduction of approximately 87.5% from baseline (pre-RA) conditions. While just short of the 90% mass discharge reduction performance objective established for Tier 1 compliance in ROD Amendment #2, this represents a significant reduction in source strength from the Time Oil source area and progress towards meeting RAOs.

5.3 QUESTION C: Has any **other** information come to light that could call into question the protectiveness of the remedy?

No. Ecological risks have not been evaluated for the project area, because the area around the Site is heavily developed as a commercial/industrial area and lacks suitable habitat. Therefore, no significant ecological impacts are expected due to contamination. Furthermore, available data suggest that the contaminant plume does not currently reach local streams or rivers. Also, there have been no impacts to the project area due to natural disasters.

6 ISSUES/RECOMMENDATIONS

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
OU1

6.1 OTHER FINDINGS

In addition, the following are recommendations that were identified during the FYR and may improve performance of the remedy, but do not affect current and/or future protectiveness:

While exposure to groundwater is prevented due to permit and zoning restrictions, there are currently no proprietary institutional controls in place for parcels impacted by contamination. Following achievement of Tier 1 criteria, finalization of the IC Plan, and development of a long term monitoring plan, environmental covenants are recommended to be placed on properties where soil contamination remains, which will also ensure access to wells for long term monitoring.

7 PROTECTIVENESS STATEMENT

Protectiveness Statement(s)	
Operable Unit:1	*Protectiveness Determination:* Will be Protective
Protectiveness Statement: The remedy at OU1 is expected to be protective of human health and the environment upon completion. Interim remedial actions described in ROD Amendment #2 have been completed and appear to be functioning as intended based on data collected to date. Evaluation of Tier 1 RAOs are underway. Engineering controls and governmental ICs are in place to prevent exposure and protect human health.	

8 NEXT REVIEW

The next five-year review report for the Commencement Bay – South Tacoma Channel Well 12A Superfund Site is required five years from the completion date of this review.

III.

SOUTH TACOMA FIELD (OU4)

COMMENCEMENT BAY –
SOUTH TACOMA CHANNEL SUPERFUND SITE
PIERCE COUNTY, WASHINGTON

Prepared by

U.S. Environmental Protection Agency
Region 10
Seattle, Washington

Table of Contents

FIVE-YEAR REVIEW for the SOUTH TACOMA FIELD OPERABLE UNIT, COMMENCEMENT BAY – SOUTH TACOMA CHANNEL SUPERFUND SITE

1. INTRODUCTION – South Tacoma Field Operable Unit (OU 4)

This is the fourth FYR for the South Tacoma Field (STF) Operable Unit (OU), Commencement Bay-South Tacoma Channel (CB-STC) Superfund Site. (This OU was not included in the first FYR for the Site.) The FYR has been prepared since hazardous substances, pollutants, or contaminants remain above levels that allow for unlimited use and unrestricted exposure (UU/UE).

This section of the FYR addresses one OU, OU 4. Remedies were selected to address three separate source areas, two of which are reviewed in this FYR. The remedial action (RA) addressing sources on Tacoma City Light is not addressed in this FYR because the RA was completed in 1997 and the area remediated to levels that allow for UU/UE.

The FYR for the South Tacoma Field Operable Unit was led by Jeremy Jennings, EPA Region 10. An EPA human health risk assessor assisted with portions of the data review. The Burlington Northern-Santa Fe Railway Company (BNSF), the Potentially Responsible Party (PRP) was notified of the initiation of the FYR. The PRP and their technical consultant provided input during the review process. The review began on 4/1/2018.

Site Background

The South Tacoma Field (STF) Operable Unit 4 (OU4) consists of approximately 260 acres located along 8,000 feet of railroad tracks in the southwestern section of the City of Tacoma, Washington (Figure 1). The Site is situated in a lowland area that includes a filled swamp and lake bed. The Site is mostly open fields of grass with a few industrial and commercial facilities. Stormwater is conveyed across the western side of the Site in an open channel that discharges into a small wetland. Municipal water supply wells for the City of Tacoma are located east of the Site.

During the past 100 years, portions of the site have been used for a variety of industrial activities including the manufacture and repair of railroad cars and equipment; the operation of a brass and iron wheel foundry; a small airport runway, refueling depot, and repair facility; and Tacoma City Light's maintenance yard. Several parts of the Site were used as dump sites for industrial and construction materials, including slag and sand from the foundry operations.

The OU is currently zoned as a heavy industrial district consisting of manufacturing and industrial uses. However, an 18-acre strip along the western border is zoned for residential-commercial transitional use. While most of the OU is fenced, there appears to be some use of the Site for casual recreation and by homeless individuals.

See Section I for Five-Year Review Summary Form

2. RESPONSE ACTION SUMMARY

Basis for Taking Action

EPA began investigating the OU in 1981 as part of an investigation of potential sources influencing the South Tacoma Channel. Site investigations were conducted throughout the 1980s with a Remedial Investigation/ Feasibility Study (RI/FS) published in 1992. In 1990 and 1991, a non-CERCLA action had

been taken at the Amstead Property to address soil contamination from leaking underground storage tanks (see Figure 2 for locations of each area).

A 1993 Human Health Risk Assessment (HHRA) found that both cancer and non-cancer risks associated with ingestion of surface soils under residential and industrial scenarios exceeded EPA's risk thresholds. Potential risks from soil ingestion under a recreational scenario, however, did not exceed thresholds and thus, EPA determined that no action was needed. Groundwater at Pioneer Builders Supply also exceeded EPA's risk thresholds and was addressed in the ROD.

Both cancer and non-cancer risks from soil ingestion were primarily driven by arsenic. In some areas, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), copper and beryllium account for some of the cancer risk. Lead was present at levels above EPA's recommended thresholds in numerous locations.

Pioneer Builders Supply was the only area where groundwater consistently exceeded MCLs and MTCA Method B criteria. Ingestion of arsenic, and to a lesser extent, beryllium account for cancer risks associated with drinking groundwater. Arsenic, manganese, naphthalene and nickel account for most of the non-cancer risk.

A streamlined risk assessment was prepared for the petroleum contamination at the Amsted property. Risks associated with drinking water were found to be below EPA risk thresholds. EPA determined that the contamination in this area did not pose an unacceptable risk and thus, a CERCLA cleanup action was not necessary.

The results of a 1993 Ecological Risk Assessment indicated that potential ecological impacts from on-site contaminants were small and thus, did not require further action.

Response Actions

The September 29, 1994 ROD selected a combination of excavation, containment, treatment via air sparging and soil vapor extraction and institutional controls (ICs) to address contaminated soils and groundwater at the OU.

A September 29, 1999 Explanation of Significant Differences (ESD) changed the groundwater treatment method at Pioneer Builders Supply from air sparging and soil vapor extraction to monitored natural attenuation (MNA). The ESD only changed the treatment method to be used at Pioneer Builders Supply. It did not change the Remedial Action Objectives (RAOs), cleanup levels, ICs or any other elements of the remedy.

The overall cleanup goal for the OU was to protect human health and the environment by preventing current and future exposure to contaminated soil and groundwater.

The remedy selected in the ROD was presented as three separate actions - STF Soils, Pioneer Builders Supply and Tacoma City Light Dry Wells (Figure 2) - as described below. For a chronology of CERCLA activities, see Appendix B.

STF Soils

The main purpose of the STF Soils remedy is to prevent exposure to surface and subsurface soils contaminated by historical activities through a combination of excavation, treatment, containment and

institutional controls. The soils at Tacoma City Light are not included in this part of the remedy.

The STF Soils remedy requires the following actions:

- Excavate and solidify contaminated soils that exceed hot spot concentration thresholds identified in Table 1. Treated soil was to be placed back on site under a soil or asphalt cap.

Table 3. Hot Spot Threshold Concentrations for STF Soils

Contaminant of Concern	Soil Hot Spot Threshold (mg/kg)
Arsenic	570[a]
Lead	18,000[b]
cPAHs (Total)	50[c]
PCBs (Total)	50[d]
Copper	45,000[e]

[a]Set at the $1x10^{-4}$ risk level using MTCA assumptions
[b]Based on cost sensitivity analysis in the FS
[c]Set at 2.5 times the MTCA Industrial Method A concentration
[d]TSCA requirement
[e]Based on leaching to groundwater

- Excavate soil with PCBs above 50 milligrams per kilogram (mg/kg) and dispose off-site.

- Excavate, consolidate and cap soils with contamination above the identified capping level (Table 2) and below the hot spot threshold (Table 1).

Table 4. Soil Capping Levels for STF Soils

Contaminant of Concern	Soil Capping Levels[a] (mg/kg)
Arsenic	200
Lead	1000
cPAHs (Total)	20
PCBs (Total)	10

[a]Set at MTCA Industrial Method A soil cleanup level

- Implement ICs to protect residential uses on properties where soil contamination exceeds thresholds (established at MTCA residential cleanup levels) as identified in Table 3. ICs shall include, but are not limited to, deed restrictions, physical restrictions (e.g., fencing, barriers), warning signs, safety measures and educational programs. Land use in the area is restricted to industrial purposes. Deed restrictions shall also discuss measures to minimize soil disturbances during site development, routine maintenance and repair activities to maintain the integrity of the remedy.

- Monitor groundwater for changes to the currently low levels of contamination that may result from cleanup activities, leaving untreated hazardous substances in place under capped areas or previously removed petroleum hydrocarbon contamination at the Amsted Property to ensure they stay below MCLs and MTCA values. EPA will review the monitoring program every five years to determine whether additional actions are required or whether the monitoring program should be modified or discontinued.

Table 5. Institutional Control Thresholds

Contaminant of Concern	Institutional Control Threshold[a] (mg/kg)
Aluminum	80,000
Aldrin	0.059
Antimony	32
Arsenic	20
Beryllium	0.23
Copper	2,960
cPAHs (Total)	1
3,3-Dichlorobenzidine	2.2
Lead	250
Manganese	11,200
PCBs (Total)	1
Pentachlorophenol	8.3
Zinc	24,000

[a]Set at MTCA residential cleanup level

Pioneer Builders Supply

The objectives of the Pioneer Builders Supply remedy are to prevent further ground water contamination from subsurface soils and, in groundwater, to reduce total excess cancer risk from all carcinogens to no greater than 1 in 100,000 (10^{-5}) and a Hazard Index (HI) no greater than 1.

The remedy is limited to subsurface soils and groundwater at Pioneer Builders Supply (Figure 3).

The 1994 ROD selected air sparging and in situ vapor extraction to treat soil and groundwater contamination associated with the former USTs at Pioneer Builders Supply. In 1999, following the collection of additional data, EPA signed an ESD that changed the selected remedy to MNA and institutional controls. Groundwater cleanup levels were established at the MCLs or, for naphthalene where an MCL was not available, at MTCA Method B levels as identified in Table 4. Groundwater monitoring was required to determine the effectiveness of the remedy.

Table 6. Groundwater Cleanup Levels

Contaminant of Concern	Groundwater Cleanup Level (ug/L)
1,1,2-Trichlorethane	5
Naphthalene	32
Benzene	5
Toluene	1,000
Ethylbenzene	700

Upon request from Ecology, groundwater cleanup levels were established for xylene and total petroleum hydrocarbons (TPH) (Table 5). The ROD states that EPA will not use these levels to determine attainment.

Institutional controls in the form of restrictions on groundwater use in the vicinity of Pioneer Builders Supply until cleanup levels are achieved throughout the plume.

Table 7. Groundwater Cleanup Levels Enforced at the Discretion of Ecology

Contaminant of Concern	Groundwater Cleanup Level (ug/L)
Xylene	10,000
Total Petroleum Hydrocarbon (TPH)	1,000

Tacoma City Light Dry Wells

This portion of the remedy applies to contamination at the northernmost part of the OU, the Tacoma City Light property. The remedy required excavation of soils to MTCA Method B residential levels and off-site disposal (Table 6). Following completion of the remedy, no hazardous substances, pollutants, or contaminants would remain above levels that allow for UU/UE.

The soil remedy required the following actions be taken on property owned by Tacoma City Light:

- Excavate contaminated soil with PCB concentrations above 50 mg/kg or endrin concentrations above 0.13 mg/kg and transport off-site for incineration.

- Excavate soil in dry wells with PCB, PAH and other chemical concentrations above the levels identified in Table 6 and dispose off-site.

Table 8. Tacoma City Light Cleanup Levels

Contaminant of Concern	Tacoma City Light Cleanup Level (mg/kg)
Aldrin	0.059
Carbazole	50
cPAHs (Total)	1
1,2-Dichlorobenzene	42
3,3- Dichlorobenzidine	2.2
PCBs (Total)	1
Pentachlorophenol	8.3

Status of Implementation

STF Soils

The STF Soils remedy was implemented in 1998 and 1999. The Remedial Action Report was signed in September 2000, a Final Closeout Report was signed in 2005 and the soil media were partially deleted from the NPL in 2005.

As part of the remedial action:

- Approximately 6,300 tons of soil that exceeded the hot-spot concentrations were excavated and treated (i.e., stabilized with a phosphate-based reagent). The treated soils were consolidated in three containment areas and covered with a clean soil cap.

- 113,607 tons of soil with contaminant concentrations between the hot-spot and the capping level were consolidated and capped.

- Approximately 13.7 acres were capped.

- A groundwater monitoring network was established to monitor potential impacts of the containment areas on groundwater and the effectiveness of a previous non-CERCLA action at the Amstead Property.

- ICs were established to limit access, prohibit residential development and prohibit activities that would impair the integrity of the soil caps.

During remedial design, the PRP proposed to divide the OU into a series of grids, each measuring between 50 and 250 feet in either direction. The level of cleanup performed in each grid was determined by contaminate levels prior to the remediation. Grids where soils were above the hot spot thresholds (Table 1) were excavated, treated and place into one of three containment areas. Grids with soil concentrations above the capping levels (Table 2) were capped with at least 1 foot of soil or asphalt. Remaining grids with soil concentrations greater than those identified in Table 3 were identified as suitable for industrial uses. All other grids do not contain hazardous substances, pollutants, or contaminants and are not subject to any use restrictions. ICs were required for all grids except those in the last group above (below levels in Table 3).

A Post-Remedial Action Site Conditions Map identifies the grids that were remediated and/or capped, as well as areas where maintenance is required. COC concentrations in the orange and white grids are at levels protective of residential use while yellow, green and blue grids are protective of industrial uses (Figure 4). For safety reasons, several small areas beneath active rail lines were not remediated and identified in purple. The data for each area is presented in the Remedial Action Report while the map is included in the Operations and Maintenance (O&M) Plan and Site Development and Institutional Control Plan (SDICP).

Most of the Site was remediated to a level protective of industrial use but not residential use. Hazardous waste remains in the three containment areas, under all capped areas and areas where soils were at levels below capping levels and above the level protective of residential uses. The O&M Plan requires the containment areas and the capped areas to be visually inspected once a year.

Eleven (11) shallow monitoring wells have been installed near the three containment areas to monitor for changes that may result from the remedial actions (e.g. leaching of COCs into groundwater from the containment areas). The wells are sampled once a year and analyzed for lead. Lead was chosen as the indicator of leaching to the groundwater following a leaching study and review of historical data.

Three additional wells have been installed to monitor groundwater at the Amsted property (see Figure 2 for well locations). Samples are collected from the Amsted wells annually are analyzed for lead, petroleum hydrocarbons and volatile organic compounds (VOCs). Results are provided to EPA in the Annual Progress Report.

Partial NPL Deletion for Surface Soils: On February 24, 2005, EPA signed a Final Closeout Report for Soils, documenting the completion of the soil remedy for the South Tacoma Field Operable Unit, Commencement Bay- South Tacoma Channel Superfund Site. The soil cleanup levels had been attained, institutional controls were in place, all remedial action reports relevant to soils had been completed and the site was found to be protective of human health and the environment.

On June 14, 2005, the surface soils at the STF OU were deleted from the NPL. This partial deletion only applied to the soils, not the groundwater. Soil cleanup levels were established to protect industrial uses, and thus, residential uses are still restricted. In addition, restrictions continue to be in place to protect the

capping placed over soils where concentrations of COCs are above industrial cleanup levels. O&M is still required in these areas and protectiveness is required to be assessed by EPA at least once every five years.

Pioneer Builders Supply
In 1990 and 1991, during a non-CERCLA action, buried tanks and drums and visually contaminated soils were excavated from Pioneer Builders Supply. In addition,15.4 tons of soil with PCBs exceeding 50 mg/kg were excavated and disposed off-site.

In 1998, additional groundwater characterization indicated that the level of COCs in the groundwater had significantly decreased following source removal and were at a level that active groundwater treatment was no longer needed. On September 29, 1999, EPA signed an ESD changing the groundwater treatment method to MNA and institutional controls.

Five shallow monitoring wells have been installed to monitor the effectiveness of MNA. The wells are sampled annually and analyzed for petroleum hydrocarbons and VOCs. Total petroleum hydrocarbons and xylenes are monitored at the request of Ecology and are not used by EPA in evaluating performance of the remedy.

Tacoma City Light Dry Wells
The remedy was implemented in 1997 as documented in a November 1997 Remedial Action Report. A Final Closeout Report was signed by EPA on February 24, 2005. The soils were partially deleted from the NPL on June 14, 2005.

No ICs are required. In addition, no further FYRs are required for this portion of the OU has no hazardous substances, pollutants or contaminants remain above levels that allow for unlimited use and unrestricted exposure (UU/UE).

Institutional Controls
The STF Soils RA requires ICs to protect residential uses on properties where soil contamination exceeds the thresholds identified in Table 3. The Pioneer Builders Supply RA requires restrictions on groundwater use at Pioneer Builders Supply until cleanup levels are achieved. Both area require controls to protect the integrity of the remedy.

ICs required by the ROD are described in the Site Development and Institutional Control Plan (SDICP, 2000) and summarized in Table 6. Implementation, maintenance, and inspection of the ICs is performed by the BNSF Railway Company.

In 1997, BNSF Railway Company filed an Environmental Restrictive Covenants and Access Easement with the Pierce County Auditor covering 43 Property Tax Parcels owned by Burlington Northern. Thirty of these parcels are identified on a map reproduced in Figure 5 of this FYR. A note on that figure states that eight of the identified parcels are “no longer included” but the Site File does not contain any explanations or supporting documentation. The geographic scope of the covenants relative to the site should be reviewed to ensure ICs are in place where appropriate and to identify parcels where ICs are no longer needed.

The Site File contains conflicting information regarding the ICs that are in place to prohibit residential use and protect the containment area on the Amsted Property. Similarly, it is not clear whether a groundwater use prohibition is in place at Pioneer Builders Supply and whether residential use prohibitions exist for properties not owned by Burlington Northern.

Table 9. IC Summary Table

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Soils	Yes	Yes	Areas where soil concentrations exceed IC thresholds (Table 3)	Restrict residential land use	BNSF 1997 Restrictive Covenant; Status at Amsted is not clear
Soils	Yes	Yes	Capped Areas	Prevent exposure from contaminated soils	BNSF 1997 Restrictive Covenant; Status at Amsted is not clear
Soils	Yes	Yes	Capped Areas	Protect the integrity of soil caps	BNSF 1997 Restrictive Covenant; Status at Amsted is not clear
Soils Groundwater Wells	Yes	Yes	Perimeter of remediated area	Protect the integrity of the remedy	Fencing and signage in place
Groundwater	Yes	Yes	Pioneer Builders Supply Property	Restrict use of groundwater until cleanup levels achieved	BNSF 1997 Restrictive Covenant; Status at Pioneer Builders Supply is not clear

The BNSF covenants address all the restrictions and conditions identified in the ROD. They restrict residential use of the land, activities that disturb contaminated soil or the integrity of the capped areas and the use of groundwater for drinking water in the vicinity of Pioneer Builders Supply. In addition, the covenants require notification of EPA prior to any conveyance of the property. The access easement allows for perpetual access to the property for implementation of the remedial actions. The restrictive covenants, conditions and restrictions run with the land and are binding upon all successors, transferees and assigns.

The SDICP identifies the physical restrictions, warning signs and safety measures. These features are in place.

Operation & Maintenance

The Operation & Maintenance (O&M) Plan (Kennedy/Jenks, 2000) addresses ongoing monitoring and maintenance requirements. Kennedy/Jenks, on behalf of BNSF, conducts annual inspections of the three containment areas, the capped areas and security items such as fencing, gates, locks and signs. At each containment area, the condition of vegetation and side slopes along are noted as are any signs of erosion, settlement, ponding or seismic activity. All capped grids are inspected in a similar manner. All drainage systems (swales etc.) are evaluated and any signs of failures, erosion or ponding noted. Grid and settlement markers are located and any damage or settling reported. All groundwater monitoring wells and associated locks or other infrastructure are inspected. Finally, the security features around the perimeter of the area are evaluated. The contractor reported that these inspections typically span two days. All findings are recorded on Operations and Maintenance Inspection Report Forms and submitted to EPA in the Annual Report. Any deficiencies identified during the inspection or other activities are to be

addressed as soon as possible after discovery.

No major problems were noted at the inspections conducted during this FYR period. However, several locks were replaced and sections of fencing repaired.

During the site inspection, the PRP reported that several areas around the perimeter of the OU have been used for dumping of household wastes and temporary "residences" of homeless individuals. When discovered, items are removed by Burlington Northern staff.

Groundwater is monitored annually to track the progress of MNA (Pioneer Builders Supply) and ensure that wastes in the consolidation areas is not impairing the groundwater (STF Soils).

In January 2016, a new well, NMW-8A1, was installed at Pioneer Builders Supply to replace a previously damaged well. Two previously damaged and replaced Pioneer Builders Supply wells, NMW-8 and NMW-1A, were decommissioned in November 2016.

3. PROGRESS SINCE THE LAST REVIEW

This section includes the protectiveness determinations and statements from the **last** five-year review as well as the recommendations from the **last** five-year review and the status of those recommendations.

Table 8. Protectiveness Determinations & Statements from the 2013 FYR for OU 4 - South Tacoma Field

Protectiveness Determination	Protectiveness Statement
Short-term Protective	The remedy at the South Tacoma Field OU is currently protective of human health and the environment in the short term because ICs are in place to prevent direct contact with soil and use of groundwater at Pioneer Builders Supply as drinking water. However, for the remedy to be protective in the long term, the groundwater monitoring program needs to be revised to determine if there is an ongoing source to groundwater from the contaminated soils and to ensure protectiveness.

Table 9. Status of Recommendations from the 2013 FYR OU 4 - South Tacoma Field

#	Issue	Recommendation	Current Status	Current Implementation Status Description	Completion Date (if applicable)
1	Lead concentrations increased in two STF wells	Modify the groundwater monitoring program to determine if there is an ongoing source to groundwater from the contaminated soils.	Under Discussion	Ongoing	N/A
2	Wells STM-1A and NMW-8A are damaged and have not been repaired.	Replace wells STM-1A and NMW-8A to ensure the groundwater monitoring programs are complete.	Completed	Replaced by wells STM-1A1 and NMW-8A	1/29/2016

#	Issue	Recommendation	Current Status	Current Implementation Status Description	Completion Date (if applicable)
3	The effectiveness of MNA at Pioneer Building Supply has not been evaluated as recommended in the previous FYR.	Continue groundwater monitoring at Pioneer Builders Supply and complete an evaluation of MNA. If future sampling shows an increase in concentrations, similar to the historical fluctuations, the impact of potential residual soil contamination on groundwater concentrations should be investigated. This could include additional soil and groundwater sampling and an evaluation of groundwater flow variations on contaminant concentrations.	Completed	Monitoring data was evaluated. Samples indicate likely attainment, indicating MNA was likely successful.	4/26/2018

Notes:
Recommendation #1: The monitoring plan was not modified. However, a 2018 Optimization Review was performed and recommendations for addressing data gaps presented. The recommendations were provided to the PRP in May 2018. The PRP has reviewed the report and has redeveloped and resampled the wells. Their report will include recommendations to address the source.

Recommendation #3: All groundwater data was reviewed as part of the 2018 Optimization Report. Additional detail is provided in the data review.

4. FIVE-YEAR REVIEW PROCESS

Community Notification, Involvement & Site Interviews
A public notice was posted on the Site web page and published in the May 11, 2018 Tacoma Weekly (see Well 12A - Appendix E). Interested parties were invited to visit the site web page for more information and to submit comments to EPA. No comments were received. The FYR Report will be made available on the Site web page and at the Region 10 Records Center in Seattle.

EPA notified the State of Washington of the review. The State has not been actively involved at the OU and, thus, declined the opportunity to participate. They will be provided a copy of the final FYR Report.

The PRP was notified of the FYR via a March 19, 2018 letter. The letter included a summary of the FYR work to be completed and requested submission of the 2018 Annual Report, supplemental information on ICs and a table presenting all the lead data collected from two wells. During follow-up discussions, the PRP proposed that they redevelop and resample the two wells prior to completing the data analysis. Their report is scheduled to be submitted this fall.

A Site Inspection was conducted on May 22, 2018. During the inspection, EPA had discussions with the PRP and their technical consultant regarding progress at the Site. No new issues or concerns were raised during the inspection.

The PRP and consultant completed an interview form, providing their opinions on perceived problems and successes with the remedy. The tone and content of their responses mirrored that heard at the site inspection. Copies are provided in Appendix C.

Data Review

STF Soils

Soil Caps: Site inspection reports indicate that visual inspections of the capped areas were conducted once a year. However, each report was submitted later than the previous year. In reviewing the documentation, it does not appear a due date has been established for the submittal of the report. Such a date should be established.

Several small areas of localized ponding were observed during each year's inspection. The inspector determined these were minor and did not require maintenance. EPA inspected several of these areas during the Site Inspection and concurs that the extent of the ponding and any associated erosion is minimal and corrective actions are not required. However, if, in the future, erosion occurs on sloped surfaces, additional actions may be warranted.

During most inspections, there were areas of fencing, locks and/or signage identified as needing repair or replacement. These deficiencies appear to have been addressed.

It was reported that several homeless encampments have been observed on the property and within the fenced area. BNSF personnel facilitate the removal of these encampments and associated debris. It does not appear that the trespass has led to any damage to capped areas.

Groundwater: Groundwater is encountered between the ground surface and 35 ft below ground surface with seasonal fluctuations of up to 10 ft. Groundwater flow directions are highly variable due to seasonal mounding and a very shallow gradient. However, flow tends to be towards the northwest along the western part of the OU and north to east in the central part of the Site. In the southwestern corner, there is a relatively steep gradient to the southwest.

Leaching from containment areas: Each year, samples were collected from 11 monitoring wells, analyzed for lead and data submitted in the Annual Progress Report. During this FYR period, lead concentrations above the 15 µg/L cleanup level were reported at two wells, STM-3A and STM-4A. Lead concentrations at the other wells have been below the cleanup level since at least 2002. These results suggest that the remedial actions for soils in most areas have been effective at preventing leaching of contaminants. Given the length of time since cleanup levels have been exceeded at most wells, it is recommended that the monitoring program be reviewed to determine if the number of wells sampled and the frequency of sampling is still appropriate.

STM-3A and STM-4A are located along the western edge of the site, west and southwest of the southernmost containment area. Lead levels at these two wells were first reported above the cleanup level in 2010 (see Appendix D for data). During this FYR period, four of the five samples from each well exceeded the cleanup level. Concentrations at STM-4A were slightly higher than at STM-3A, the highest being a concentration of 230 µg/L (STM-4A, December 2014).

The 2018 Optimization Review identified the source of the elevated lead levels as a data gap and recommended that two new monitoring wells be installed downgradient of the wells to better delineate the extent of the plume. Depending on the results, several additional actions were suggested.

The PRP reviewed a copy of the report and suggested that the elevated lead levels may be correlated with elevated turbidity, suggesting the lead is not in the dissolved form and thus, not of concern to drinking water. However, field measurements, including turbidity monitoring, have been inconsistently reported in the annual report and may not have been collected during some sample events, despite it being required in the monitoring plan. In July 2018, the PRP redeveloped and then sampled both wells for total and dissolved lead. Turbidity was also to be reported. A report containing an analysis of the available lead and turbidity data and recommended actions are scheduled to be submitted to EPA this fall. Appropriate steps should be taken to address the source. There is no current or projected use of groundwater in this area and no human health exposure routes are currently present.

Amsted Property: Groundwater samples collected from the three Amsted wells were analyzed for lead and petroleum hydrocarbons. The only compounds detected this FYR period were diesel range hydrocarbons in 2012. Based on the data, it can be concluded that the pre-ROD removal at the Amsted Property has not led to the degradation of groundwater to levels below the MCLs. This finding should be documented and consideration given to terminating monitoring at these three wells (see Appendix E for data).

Pioneer Builders Supply

During this FYR period, annual samples are collected from five Pioneer Building Supply wells and analyzed for petroleum hydrocarbons and volatile organic compounds (VOC) (EPA Method 8260) (see Figure 3 for well locations). During this FYR period, there were no compounds found in the VOC scans in three of the samples. In the other two wells, NMW-1A and NMW-10A, no COCs were detected above the groundwater cleanup levels. However, on January 30, 2014 the concentration of 1,4-Dichlorobenzene (not a COC) at NMW-1A (110 µg/L) exceeded the MCL (75 µg/L). All other 1,4-Dichlorobenzene concentrations reported at this well were well below the MCL (37.5 to <1.0 µg/L).

Hydrocarbons were monitored at these wells at the request of Ecology for use outside of the CERCLA process. Hydrocarbons were regularly reported above detection levels at NMW-1A and NMW-10A and occasionally detected at NMW-9A. While no attempt was made to quantitatively evaluate the data, all but two data points appear to be below MTCA cleanup levels.

Groundwater data indicate that COCs at all Pioneer Builders Supply wells have been below cleanup levels since the 2012 sample event, suggesting that MNA has been successful. However, an attainment analysis should be performed and the cumulative risk at current groundwater concentrations calculated to ensure risks are no greater than 1 in 100,000 or a Hazard Index of 1. If additional data is required to complete the analysis, changing the sampling frequency to quarterly may speed the demonstration of attainment. If data indicate attainment, the continued need for groundwater monitoring and ICs should be evaluated.

Site Inspection

A Site Inspection was conducted on 5/22/2018. In attendance were Jeremy Jennings, RPM, two representatives of the BNSF Railroad and two technical consultants to the PRP. The purpose of the inspection was to assess the protectiveness of the remedy. Inspection notes are is provided in Appendix F. All photographs were taken as panoramic video and thus, are not included in this FYR but are available in the Site file.

The inspection consisted of observing the capped areas, vegetation, land use, fencing and signage. During

the site visit, several observations were noted:

- In general, the OU was heavily vegetated and in good condition. A strip in the SW corner is unvegetated; however, this should not impact the integrity of any cap.

- The caps were in good condition and had experienced only minimal settling since construction. The surface of most of the caps are in-grade with the surrounding area, thus limiting erosion potential. Minor ponding noted in reports appeared to be formed where the cap surface had settled a few inches, allowing water to puddle prior to seeping into the ground – no lateral erosion was observed.

- Monitoring wells were accessible and locked.

- The fence was in good condition and trespassing appeared to be minimal. The PRP reported that several chains and locks had been replaced during this FYR period.

- STM-3A and STM-4A were inspected. The wells are drilled in a depression along the western site boundary and thus, is stratigraphically below the bottom of the adjacent containment cap. A geological cross-section may be helpful in gaining a better understanding of the local hydrogeology. Plans for redevelopment and additional sampling of the wells were discussed.

- The integrity of the capped areas and the condition of fencing, gates and signage were observed. The controls appear to have limited trespassing. Consideration should be given to appropriate treatment of Scotch Broom and Himalayan Blackberry.

- It appeared that homeless individuals had taken shelter at several locations around the Site but, at the time of the inspection, none were on or near the capped areas. Miscellaneous trash was scattered here and there. The PRP reported that BNSF regularly patrolled the perimeter of the site and periodically removed trash and evicted homeless individuals residing on the property.

No significant concerns were identified by the PRP or its consultants. They indicated that the remedy had been fully implemented and was performing as required. The PRP suggested that the sample network and frequency of monitoring be reduced. Neither identified any community concerns.

5. TECHNICAL ASSESSMENT

QUESTION A: Is the remedy functioning as intended by the decision documents?

Question A Summary

Yes, the remedy is generally functioning as intended, except elevated lead levels in two shallow wells near the south containment area indicate a potential problem with either the cap or sampling methodology. Further investigation into the source is ongoing. All required soils have been capped and there are no drinking water wells are present in this area so there is no current exposure pathway. The STF Soils were partially deleted from the NPL in 2005.

STF Soils

The remedy has been implemented, and a Final Close-Out Report signed (EPA, 2005). The soil caps and containment areas are inspected once a year. The cap locations are clearly identified in the O&M Plan and SDICP. Groundwater monitoring is in place to facilitate assessment of cap performance.

Soil Caps: Annual inspections have found only minor issues with the soil caps. They are well vegetated, remain in good condition and appear to be functioning to isolate contaminated sediments from human exposure. However, elevated lead levels in monitoring wells STM-3A and STM-4A may either indicate migration of contaminants from the southern containment area or poor sampling practices.

Groundwater: A monitoring network has been established to monitor potential impacts to groundwater from wastes in the containment areas. Lead is used as an indicator of COCs that could migrate to groundwater. Data collected at the north containment area and the Amsted containment area do not show signs of impairment, indicating the remedy is functioning to prevent leaching of COCs to groundwater.

Elevated lead levels continued to be reported at wells STM-3A and STM-4A, downgradient of the southern containment area. This spring, the PRP redeveloped the wells and analyzed groundwater samples for both total and dissolved lead. All data from the wells is currently being evaluated and will be provided to EPA along with the PRP's recommendations for addressing the source.

Access Controls: Fences, locking gates, ecology blocks and signs are in place and limit access and potential disturbance of the capped areas as intended. ICs are in place to protect the integrity of the caps.

Pioneer Builders Supply
Groundwater data indicate that COCs at all Pioneer Builders Supply wells have been below cleanup levels since the 2012 sample event. An attainment analysis, including a calculation of cumulative risks, should be conducted to determine if remedial goals have been attained.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Question B Summary
Yes. The exposure assumptions, land uses and RAOs used at the time of the remedy selection are still valid. While there have been some changes to toxicity data and ARARs, the remedy remains protective.

Exposure Assumptions
Current anticipated future land use at and near the OU and exposure pathways remain unchanged. Most of the area is located within the South Tacoma Manufacturing/Industrial Center. Future residential use in unlikely.

Toxicity Data and Cleanup Levels
Soils: Toxicity values for arsenic, PAH's and lead have changed since cleanup levels were established in the ROD.

The MTCA Method A value for **arsenic** under an industrial uses scenario is currently 20 mg/kg, as opposed to 200 mg/kg in the ROD. To assess current protectiveness of the ROD cleanup level, potential risks from industrial use exposures were quantified. The total cancer risk was quantified at $6.7x10^{-5}$ and non-cancer risks at an HI of 0.42. Both risks are within EPA's acceptable risk range and thus, the ROD value for cleanup of arsenic in soils remains protective.

In 2017, EPA finalized a risk assessment for benzo(a)pyrene (BaP) and recommended that human health risks for **carcinogenic PAHs** be expressed as BaP toxic equivalents. Using the updated information, the cleanup goal for carcinogenic PAHs of 20 mg/kg equates to a $1x10^{-5}$ risk and thus remains protective.

In 2016 and 2017, EPA issued guidance that recommended changes to the method used to calculate human health risks from exposure to **lead** in soils. EPA OLEM Directive 9285.6-56 (May 17, 2017) recommends using the Adult Lead Methodology to assess lead risks from soil for the non-residential Superfund site scenarios. Using recommended inputs, a recommended soil Preliminary Remediation Goal of 1,050 mg/kg was calculated. This updated goal is less stringent than the original cleanup goal of 1,000 mg/kg. Therefore, the lead level in the ROD is still protective.

Groundwater: None of the **MCLs** for groundwater COCs have changed since the ROD was issued.

The MTCA value for **naphthalene** (32 µg/L) has increased to 160 µg/L. Since the new value is less stringent than the cleanup level in the ROD, the ROD value remains protective.

RAOs
The remedial action objectives – prevent excess risks from ingestion of contaminated soils, prevent further groundwater contamination from subsurface soils and reduce risks to below acceptable risk range - remain valid. A final evaluation of the attainment of RAOs will be completed when groundwater cleanup levels are attained.

QUESTION C: Has any **other** information come to light that could call into question the protectiveness of the remedy?

No. No other information has come to light that could call into question the protectiveness of the remedy.

6. ISSUES/RECOMMENDATIONS

Issues and Recommendations Identified in the Five-Year Review:				
OU 4	**Issue Category:** Remedy Performance			
	Issue: Source of elevated lead at STM-3A and STM-4a is unknown.			
	Recommendation: Investigate and identify actions necessary to address the source of elevated lead in groundwater at STM-3A and STM-4A.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	4/1/2019
OU 4	**Issue Category:** Institutional Controls			
	Issue: It is not clear if ICs are in place on non-BNSF properties.			
	Recommendation: Evaluate the ICs on all parcels to determine if appropriate ICs are in place.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	9/30/2019

OTHER FINDINGS

In addition, the following are recommendations that were identified during the FYR and may improve performance of the remedy, reduce costs, improve management of O&M or accelerate site close out, but do not affect current and/or future protectiveness:

- Conduct an attainment analysis at all wells consistent with EPA guidance for evaluating the completion of groundwater restoration remedial actions (OSWER 9355.0-129, OSWER 9283.1-44). Where the minimum number of samples needed for an attainment analysis are not available, consider increasing the sampling frequency to speed the demonstration of attainment. If attainment of cleanup levels has been reached, calculate cumulative risks, evaluate the attainment of RAOs and consider reduction of monitoring requirements.

- Review monitoring plan and consider determine if changes to the number of wells sampled or the frequency of sampling are appropriate.

- Record and report field parameters, including turbidity, consistent with the monitoring plan.

- Evaluate whether there are ICs on parcels where capping has not occurred or residential and/or groundwater cleanup levels have been attained. Consider revising covenants where appropriate.

- Establish a submission date for the Annual Reports.

7. PROTECTIVENESS STATEMENT

Protectiveness Statement(s)	
Operable Unit: 4 South Tacoma Field	*Protectiveness Determination:* Short-term Protective
Protectiveness Statement: The remedy at the South Tacoma Field OU is currently protective of human health and the environment in the short term because ICs are in place to prevent direct contact with contaminated soil and use of contaminated groundwater. However, for the remedy to be protective in the long term, the source of elevated lead in groundwater at STM-3A and STM-4A needs to be investigated and addressed.	

For Sitewide Protectiveness Statement, please see Section V.

IV.

TACOMA LANDFILL (OU5 & 6))

COMMENCEMENT BAY –
SOUTH TACOMA CHANNEL SUPERFUND SITE
PIERCE COUNTY, WASHINGTON

Prepared by

U.S. Environmental Protection Agency
Region 10
Seattle, Washington

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IV. FIVE-YEAR REVIEW for the TACOMA LANDFILL PROJECT AREA, COMMENCEMENT BAY- SOUTH TACOMA CHANNEL SUPERFUND SITE

I. INTRODUCTION - Tacoma Landfill Project Area (OU 5 and 6)

This is the fifth FYR for the Tacoma Landfill (TLF) Project Area (Landfill), Commencement Bay-South Tacoma Channel (CB-STC) Superfund Site. The FYR has been prepared due to the fact that hazardous substances, pollutants, or contaminants remain above levels that allow for unlimited use and unrestricted exposure (UU/UE).

The TLF Project Area consists of two Operable Units (OUs), both of which are reviewed in this FYR. The source areas are addressed in OU5 and the groundwater remedy in OU 6.

The FYR for the Tacoma Landfill Project Area was led by Jeremy Jennings, EPA Region 10. Participants included an EPA human health risk assessor as well as representatives from Washington Department of Ecology (Ecology) and the Tacoma-Pierce County Health District (TPCHD). The City of Tacoma (City), the Potentially Responsible Party (PRP) was notified of the initiation of the FYR. The City and their technical consultant provided input during the review process. The review began on 4/1/2018.

Site Background

The Tacoma Landfill Project Area includes OU 5 and 6 of the Commencement Bay, South Tacoma Channel Superfund Site (CB-STC) and is in Tacoma, Washington (Figure 1). The 240-acre landfill is situated near the western border of Tacoma, surrounded by light industrial, commercial, and residential properties. Leach Creek is located less than 0.5 miles west of the Site. In 1983, the Site was listed on the National Priorities List (NPL) as part of the CB-STC Superfund Site.

The City of Tacoma (City) began operating the Tacoma Landfill as a municipal landfill in 1960. The wastes disposed at the landfill include garbage, rubbish, industrial wastes, construction and demolition wastes, street refuse, litter, and bulky waste. The landfill did not accept hazardous waste for disposal; however, the landfill received wastes in the 1960s and 1970s that have since been designated as hazardous wastes under state and federal law. Disposal of solid waste is no longer accepted. The landfill achieved post-closure status under RCRA in December 2013.

The City of Tacoma has been identified as a PRP and is responsible for implementing the CERCLA remedial actions under the oversight of both EPA and the Ecology. Current operations are regulated under a Solid Waste Permit issued by the TPCHD. To facilitate consistency, the three agencies have worked collaboratively on oversight activities and thus, are jointly referred to as “the Agencies”.

Land near the landfill continues to be used for residential and commercial purposes. A large commercial warehouse has recently been developed adjacent to the southern portion of the western landfill boundary. The City is currently using portions of the capped area for solid and hazardous waste collection and recycling centers; a municipal waste transfer station; truck parking and dumpster storage; a CNG fueling facility; Solid Waste Management offices; a golf driving range; the Tacoma Urban Forestry Landfill Nursery and a model EnviroHouse and Rain Garden. The 2012 Institutional Controls (IC) Plan outlines the process to be used by the City to evaluate future redevelopment opportunities.

All drinking water in the area is currently supplied by municipal water systems. There are no downgradient residential or municipal wells that are used for drinking water within the area once impacted by the contaminant plume.

II. RESPONSE ACTION SUMMARY

Basis for Taking Action

In 1983, hazardous compounds, primarily volatile organic compounds (VOCs), were detected in groundwater and soil samples collected near the landfill. Further investigation indicated that elevated VOC concentrations extended beyond the perimeter of the landfill in all directions. To the southwest, the plume extended into a residential area that obtained drinking water from private wells. In addition, landfill gases were found to be migrating from the landfill toward adjacent residences and businesses. To address threats from these sources, in the mid-1980's, residences were connected to the municipal water supply system and, in 1986 the first stage of a landfill gas management system was constructed.

A human health risk assessment found that risks from consumption of groundwater impacted from Site sources exceeded EPA's acceptable risk levels for carcinogens. Vinyl chloride (VC) presented the greatest risks, however, other VOCs were also found to be at levels of concern. Health risks associated from inhalation of landfill gases (primarily methane) were found to be of secondary concern.

No ecological risks were identified at levels of concern. However, for protection of larval fishes and benthos, all groundwater extraction water discharged to Leach Creek was required to meet the ambient water quality criteria for protection of aquatic life as identified in the Washington State Water Quality Standards.

Response Actions

Through a cooperative agreement with EPA, Ecology initiated site investigations in 1984. Responsibility for the Remedial Investigation and Feasibility Study was transferred to the City under a 1986 Response Order on Consent issued by Ecology. Early actions included connecting homes with potentially impacted wells to municipal water (mid-1980's) and constructing the first phase of a landfill gas management system (1986).

On March 31, 1988, EPA issued the Record of Decision (ROD), that included source control using a landfill cap, gas extraction system and landfill closure plan; management of contaminant migration using a groundwater extraction and treatment system (GETS); monitoring and ICs to protect water supply wells.

Remedial Action Objectives (RAOs) are:

- Prevent further migration of the plume via the groundwater extraction-treatment system.
- Reduce the production of leachate by placing constraints on site operations and by properly grading and capping the landfill.
- Eliminate off-site gas migration through the gas extraction system.
- Further protect public health and the environment via monitoring of groundwater, surface water, gas probes, and air emissions and providing alternate water supplies where necessary.

The ROD required the following remedial actions:

- Source Control – Landfill Cap (OU 5)

- Cap unlined areas of the landfill to minimize infiltration and maximize run-off.
- Develop storm drainage plan to address increased run-off from caps.
- Identify and approve the number and location of leachate head wells in the Central Area.
- Develop a schedule for closure of the landfill. Include waste minimization measures.
- Collect and monitor gas generated from the landfill. Collected gas shall be burned by combustors and condensate collected from the flare stations shall be treated or discharged to the sanitary sewer.

- Management of Migration of Groundwater (OU 6)

  - Control migration through use of a groundwater extraction and treatment system (GETS).
    - Minimum flows shall be maintained in Leach and Flett Creeks during extraction.
    - The treatment process shall be permanent; effectively reduce the toxicity, mobility and volume of contaminants; and meet treatment performance goals.
    - Discharge of treated water may be to Leach Creek, Flett Creek or the sanitary sewer.
    - Air emissions from the treatment system shall be designed to meet appropriate ambient air quality values.
  - The treatment may be shut off when water quality within the plume and outside of the compliance boundary (defined as the edge of the filled area) consistently meet or exceed federal drinking water standards (MCLs) or other established health-based criteria.

- Monitoring (OU 6)

  - Groundwater monitoring wells shall be installed in locations appropriate for obtaining information on the spread of the plume, the extent of the plume migration, potential impacts to Leach Creek and the Fircrest well system and the presence of a dense plume migrating from the Site.
  - Monitor both water quality and quantity in Leach Creek or other surface waters receiving effluent or drainage from the landfill.
  - Monitor effluent from the treatment system to assure that discharge limits are not exceeded.
  - Monitor private wells in the path of the plume at least quarterly and the Fircrest wells monthly. If any well becomes contaminated due to the landfill, replace the well and supply water from the existing City of Tacoma water supply system.

- Institutional Controls (OU 6**)**

  - Tacoma, in cooperation with the Town of Fircrest and Pierce County, shall pursue the establishment of an ordinance, or other suitable methodology, to restrict drilling of water supply wells in the area delineated in the ROD.

Status of Implementation

A Remedial Design – Remedial Action Consent Decree (CD) between EPA, Ecology, and the City to implement the actions in the ROD was executed in federal court on November 13, 1989 and entered by the Court on May 17, 1991. The CD was amended in 1996 to address flows in Leach Creek.

Source Control (OU 5)

There are six management areas at the landfill. Each area was filled, closed and capped at different times. The areas are illustrated in Figure 2.

Landfill Closure Schedule: An initial schedule for closure of the landfill identified milestones for construction of a bottom liner for the Central Area, capping of the unlined areas in the early 1990's and a

December 31, 1999 final closure date. Three five-year extensions were granted to allow the Central Area to receive of municipal wastes through 2012. The Central Area Cap was completed in November 2013. This portion of the remedial action was completed in April 2015 when TPCHD determined the landfill to be "closed" and transferred to "post-closure" status. EPA and Ecology reviewed the final construction reports but, consistent with the ROD, deferred the compliance evaluation to TPCHD.

Capping Unlined Cells: Between 1990 and 1992 the north and south areas were leveled and covered with two HDPE liners separated by a leak detection system. Drainage from the cap was managed with a system of gravity drains as identified in a storm drainage plan. Leachate and condensate was collected and drained into collection tanks, pumped through a pH dosing chamber and discharged to the sanitary sewer system. In September 1999, EPA signed a Preliminary Close-Out Report documenting that construction of a landfill cap for all unlined areas of the landfill was complete.

Capping the Central Area: In 1987, an additional waste cell was created on the vacant land in the middle of the landfill (Central Area). A bottom liner and leachate collection system were constructed to Minimum Functional Standards (MFS) and municipal wastes received through 2012. The remedial action was completed when the Central Area cap was completed in November 2013.

The *Environmental Operations and Maintenance Plan* (O&M Plan) and the *Leachate and Condensate Management Plan* outline current O&M and monitoring requirements for the landfill. Both reports were updated on March 11, 2016. A summary of the data and activities are reported in the *Annual Summary of Inspections for the Tacoma Landfill Cap, Condensate Collection System and Central Area Leachate System* report.

Waste Reduction Measures: In 1990 the City developed the *Prevention of Hazardous Substances and Liquids Minimization Plan* that included waste reduction measures as required by the ROD. The hazardous waste collection area and recycling station were constructed pursuant to the City's efforts to minimize wastes. Additional waste reduction measures are required under the Solid Waste Permit issued by the TPCHD. The minimization plan is currently housed in the *Tacoma Landfill Operations Plan*

Landfill Gas: Starting in July 1986, landfill gas (LFG) has been collected by a series of extraction wells and conveyed to a Biogas Flare System. The gas collection and control system (GCCS) system is monitored with a series of probes located throughout the landfill footprint, along the perimeter of the landfill and outside the property boundary. Each probe station has up to five probes completed at different depths. Data collected at the probe and flare stations is used to manage the flow of gas from individual wells to optimize performance.

As of April 2017, the GCCS consisted of 196 operating extraction wells, 43 perimeter wells and 92 wells scheduled for suspension (shut-off) (Figure 3). There were 119 probe stations, 84 of which were located at or near the landfill boundary and were part of the compliance monitoring network. Thirty-five off-site probe stations were used to monitor migration of gas beyond the footprint of the landfill. Monitoring, management and maintenance plans were updated in 2018 (*2018 Post-Closure Landfill Gas Management Plan, August 10, 2018*).

In response to the introduction of more efficient technology, in 2015 the City changed the type of meter used to monitor gas concentrations and pressures at the probe stations. The sensor on the new meter relays data to a handheld computer and is then downloaded to the City's environmental database. To digitally store and retrieve monitoring data, the City is currently developing a Landfill Gas Management Database.

In 2014, the City requested Landau Associates (Landau) to review the LFG operational and monitoring data for six gas monitoring wells and six extraction wells at the north end of the landfill and identify potential system modifications that could optimize performance. The evaluation looked at one gas monitoring well on the adjacent Home Depot property, five gas monitoring wells on the landfill and six gas extraction wells located on the north end of the landfill. The evaluation found the north end gas extraction system was operating effectively and preventing gas migration north of the landfill. In addition, a secondary source was identified as the likely source of the elevated gas concentrations on the Home Depot property, not the landfill.

A similar review for the entire landfill was documented in a March 10, 2016, Technical Memorandum. Due to a decrease in the gas production, it was recommended that the GCCS be updated and sized appropriately for existing and future conditions. Furthermore, it was recommended that, while the GCCS prevents the lateral migration of LFG, decommissioning some extraction wells and probes would likely lead to removing redundant collection devices and increase system efficiency. Finally, it was recommended that inactive extraction wells be decommissioned and the continued need for the other extraction wells and monitoring probes be evaluated.

On June 21, 2016, the City proposed a three-tiered approach to remove system redundancies and improve system performance. Under Tier 1, monitoring was discontinued at 32 redundant offsite probes following the August 2016 sampling event, 92 unused extraction wells were capped, the vacuum reduced throughout the system and flows rebalanced. Under Tier 2, the City has evaluated discrete vertical zones of extraction and used the results to simplify the system and maximize gas extraction. Finally, under Tier 3, the City plans to reevaluate if further actions would improve the efficiency of the system. The approach is described in the *2018 Post Closure Landfill Gas Management Plan*.

In July and August 2016, five probes on or near the former Hansen Pipe Property immediately west of the landfill were permanently decommissioned to accommodate construction. Where appropriate, replacement wells were added along the landfill boundary. At the same time, seven redundant perimeter extraction wells were converted to monitoring probes.

Actions taken to manage the LFG are reported to EPA in the *Tacoma Landfill Gas Evaluation Report*. Reports were submitted biannually through 2017. In November 2017, the Agencies approved the City's request to reduce the frequency of reporting to once a year.

Management of Migration of Groundwater (OU 6)

In 1992 and 1993, a network of 19 point-of-compliance (POC) extraction wells and nine edge-of-plume (EOP) extraction wells were installed, a ground water treatment facility constructed and groundwater extraction and treatment initiated. Seven additional extraction wells were installed between 1995 and 1997 (Figure 4).

Extraction water was initially collected in the holding area, treated and discharged either to the sanitary sewer system or Leach Creek. In 2002, water quality improvements allowed for the water to be directly discharged to the creek without treatment. Both the outfall and the creek have been monitored. The treatment facility remains on-site but has not been used since 1998.

The ROD indicates that the extraction system may be shut off when water quality consistently meets or exceeds MCLs or other risk/health-based criteria. The Consent Decree provides a process to develop a list of indicator parameters to be used throughout the remainder of the RD and RA. The list of monitored contaminants and the associated performance criteria (MCLs except 1,1-DCA and chloroethene) are identified in Table 1.

TABLE 1. Groundwater Performance Criteria.

Contaminant	Performance Criteria (ug/L)	Contaminant	Performance Criteria (ug/L)
1,1,1-TCA	200	Benzene	5
1,1-DCA	20	Chloroethane	20
1,2-DCA	5	PCE	5
1,2-DCE (total)	70	TCE	5
cis-1,2-DCE	70	VC	2
trans-1,2-DCE	100		

Following a review of the existing data, in 2009 and 2010, extraction was shutdown at the 14 off-site extraction wells and 17 of the POC wells. Rebound monitoring was initiated. As of April 2018, four extraction wells along the western landfill boundary were active.

An April 2018 *Optimization Review Report* prepared by EPA and evaluating the groundwater remedy indicated the selected remedy had been effective at reducing contaminant concentrations consistent with the RAOs at all but, potentially, two wells (TL-11A and TL-26A). To gain a better understanding of the source in that area, additional landfill gas monitoring near TL-11A was recommended.

Under a 1996 amendment to the CD, the City was required to maintain 1.7 cubic feet per second flow in Leach Creek to offset the effect of GETS pumping on groundwater recharge to the creek. A deep augmentation well near the Leach Creek holding basin and, until 2003, was used to supplement flows. The City decommissioned the well in 2018.

In February 2014, the City decommissioned three off-site wells that were shown to be in attainment of the performance criteria and not likely to be needed in the future. All decommissioning was performed by a licensed well driller and consistent with State requirements.

Groundwater Monitoring – OU 6

Groundwater monitoring was initiated in 1986. In 1996, all active monitoring plans were integrated into a Sitewide groundwater monitoring plan.

In 2010, the monitoring plan was updated to monitor potential rebound as extraction wells were shutdown. Four VOCs and four indicator parameters were removed from the analyte list at that time. In 2013, EPA reviewed the rebound data and recommended that the procedures be revised. The *Rebound Monitoring Plan Addendum*, issued on July 28, 2014, addressed many of EPA's concerns, removed wells where performance criteria had been attained and added procedures to remove additional wells in the future.

From 2014 through 2016, pursuant to a State requirement, total and dissolved metals were analyzed in a subset of nine background wells (*Background Groundwater Monitoring Plan, April 22, 2014)*. The data was submitted to the Agencies quarterly and used to further the understanding of background metal concentrations.

In 2014, a *Post-Closure Groundwater and Surface Water Compliance Monitoring Plan* was developed to identify the post-closure monitoring required under the Solid Waste Permit for post-closure care. The 17 wells included in the plan were selected to meet long-term monitoring requirements of the Solid Waste Permit and the CERCLA action. The plan included monitoring seven wells located along the western landfill boundary to determine if groundwater performance standards are being met at the POC; eight off-site, downgradient, post-closure monitoring wells used to evaluate migration of the contamination beyond

the POC; two background wells; the GETS outfall and Leach Creek. As part of the Optimization Review, no data gaps were identified in the post-closure monitoring network.

The *Post Closure Water Quality Monitoring, Sampling and Analysis Plan* was prepared in February 2017 to present one groundwater monitoring program that addresses the long-term monitoring requirements included in the federal, state and local regulations applicable to the landfill.

Data and analysis are reported quarterly in the *Summary of Groundwater and Surface Water Data for Tacoma Landfill*. In addition, the *Tacoma Landfill Consent Decree Annual Report* provides an evaluation of groundwater and surface water quality relative to groundwater performance criteria, including an evaluation of the extent of plume migration.

Private and Municipal Wells: In the late 1980's the City began routine sampling at private wells and municipal wells operated by the town of Fircrest. Where chemical concentrations in a well were greater than half the groundwater performance criteria, the City connected the property to the City of Tacoma's municipal water supply system. Furthermore, all new construction in the potentially affected area was required to connect to the municipal system.

In 1995, the City reduced the volume of water extracted from two municipal wells near the landfill and requested that Fircrest limit extraction from their municipal well closest to the landfill. In exchange for temporarily closing the Fircrest well, the City agreed to drill a new municipal well further from the landfill.

In 2008, the City reviewed all data collected from residential wells and completed a door-to-door survey to verify if existing wells were being used as a drinking water supply. Based on the results, it was determined that none of the remaining wells had been impacted by the landfill and that sampling was no longer needed.

Institutional Controls

The remedy calls for the City to pursue establishing an ordinance that restricts drilling water supply wells within the area of the plume, thus limiting potential exposure from drinking groundwater. The Tacoma and University Place Municipal Codes have been revised to include a prohibition for construction of new drinking water wells around the plume. In addition, the neighboring Town of Fircrest has prohibited the drilling or installation of wells at any location within the town boundaries.

On November 16, 2001, the City filed a Restrictive Covenant with the Pierce County Auditor's Office restricting activity at the landfill that may impair the protectiveness of the remedy and restricted the extraction and residential use of groundwater (see Appendix C). The Covenant has been attached to the property deed.

Institutional Controls are described in the *Tacoma Landfill Institutional Controls Plan* (2012). There were no changes to the ICs or IC Plan during this FYR period.

Systems Operations/Operation & Maintenance

The City originally had O&M plans for each element of the remedy. In 2016, the City made appropriate updates to each plan and combined them in a site-wide *Environmental Operations and Maintenance Plan*. Components of the site-wide O&M plan are included above for each OU.

Table 2: Summary of Planned and/or Implemented ICs

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Off-Site Groundwater	Yes	Yes	Parcels with water supply wells downgradient of the Site	Restrict installation of ground water wells and ground water use in area of the plume.	Drilling prohibitions in Pierce County, Tacoma & Fircrest Codes
Groundwater	Yes	Identified in Consent Decree	Landfill	Restrict use of groundwater to prevent impacts to human health	Restrictive Covenant - Pierce County No. 200111160567; November 11, 2001
Integrity of Remedy - Cap, gas and groundwater	Yes	Identified in Consent Decree	Landfill	Protect the integrity of the remedy	Restrictive Covenant - Pierce County No. 200111160567; November 11, 2001

During this FYR period, routine inspections, maintenance and sampling of groundwater extraction system, groundwater monitoring well network, landfill cap, GCCS, and the leachate and condensate collection systems were conducted. Preventative maintenance was conducted consistent with O&M plans and minor repairs were made as needed. In January 2016, the City hired a contractor to remove the accumulation of orange iron hydroxide on well screens, riser pipes and discharge lines.

In 2015 and 2016, the City regraded eight areas of the cap where ponding had been identified or the strain exceeded 1%, as determined through a comparison of 2015 to August 1995 elevations.

III. PROGRESS SINCE THE LAST REVIEW

This section includes the protectiveness determinations and statements from the **last** five-year review as well as the recommendations from the **last** five-year review and the current status of those recommendations.

Table 3: Protectiveness Determinations/Statements from the 2013 FYR

OU #	Protectiveness Determination	Protectiveness Statement
5/6	Short-term Protective	The remedy at the Tacoma Landfill is currently protective of human health and the environment in the short term because the groundwater and landfill gas is being controlled through the GETS and landfill gas management system, the Central Area final cover will be complete by December 31, 2013, and institutional controls are in place. However, in order for the remedy to be protective in the long term, the following actions need to be taken to ensure protectiveness: continue operation optimization of gas

		extraction wells at the north end of the Landfill; re-grade areas of the landfill cap prone to ponding and subsidence, update the following management plans to ensure the monitoring program is effective and response action procedures are in place: Operations and Maintenance Plan for the Landfill Cap, Condensate Collection System and Central Area Leachate Collection System; Leachate and Condensate Management Plan; Rebound Monitoring Plan; Groundwater Monitoring Plan and Institutional Controls Plan.

Table 4: Status of Recommendations from the 2013 FYR

OU #	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
5/6	Water ponding and cap subsidence continue to occur on areas of the landfill cap.	Regrade areas of the landfill cap that continue to have significant ponding and subsidence	Completed	Repairs made; currently inspected per Environmental O&M Plan	7/6/2015
5/6	The 2010 Groundwater Monitoring Plan reduced the analyte list to those VOCs useful for evaluating rebound. While this may be acceptable for the rebound monitoring wells, it should not be used at locations used to determine compliance with ROD criteria, such as Leach Creek surface water sampling and GETS effluent samples.	Update the 2010 Groundwater Monitoring Plan to include the full list of ROD COCs for sampling locations used to determine compliance (e.g. Leach Creek and GETS effluent).	Completed	Post-Closure Groundwater and Surface Water Compliance Plan	7/30/2014
5/6	The Operations and Maintenance Plan for the Landfill Cap, Condensate Collection System and Central Area Leachate Collection System, and the Leachate and Condensate Management Plan may not reflect current conditions following closure of the Central Area.	Update the Operations and Maintenance Plan for the Landfill Cap, Condensate Collection System and Central Area Leachate Collection System, and the Leachate and Condensate Management Plan.	Completed	Environmental O&M Plan; Post-Closure Plan	3/11/2016

5/6	Landfill gas continues to be detected near the Home Depot Property at the north end of the landfill.	Continue operation optimization of gas extraction in wells on the northern edge of the Landfill near the Home Depot property.	Completed	Data reviewed in *North End Landfill Gas Control Evaluation.* Home Depot gas likely from a secondary source. Recommended follow-up actions.	9/22/2014
5/6	The Rebound Monitoring Plan statistical methodology is too restrictive, leading to numerous exceedances of the contingent action criteria, and the response action procedures described in the plan have not been followed.	Update the Rebound Monitoring Plan.	Completed	Rebound Monitoring Plan Addendum; Post-Closure Plan	7/28/2014

IV. FIVE-YEAR REVIEW PROCESS

Community Notification, Involvement & Site Interviews

A public notice was posted on the Site web page and published in the May 11, 2018 Tacoma Weekly (see Well 12A, Appendix E). Interested parties were invited to visit the site web page for more information and to submit comments to EPA. No comments were received. The FYR Report will be made available on the Site web page and at the Region 10 Records Center in Seattle.

In addition, EPA notified Ecology, TPCHD and the PRP of the review. They will be provided a copy of the final FYR Report. A FYR Meeting was held on May 1, 2018 and attended by Jeremy Jennings, EPA RPM; a representative from Ecology and TPCHD; the PRP and their technical consultant and a second EPA RPM. Major activities during this FYR period were summarized, upcoming work and optimization opportunities were discussed at the meeting.

Following the meeting, an interview form and request to complete the form was emailed to each participant (see Appx D for responses). All responses indicated that the remedy has been successful in accomplishing the objectives and was close to being complete. No significant issues were raised.

Data Review

OU 5 – Landfill Cap – Source Control

Cap: Capping of the landfill was completed in November 2013 when the Central Area cap was completed. The landfill was "Closed" and moved to RCRA "Post-Closure" status in April 2015.

The *Environmental Operations and Maintenance Plan* outlines the inspection program, maintenance procedures and the sampling and documentation requirements for the landfill cap and the leachate and condensate collection systems. A summary of the inspection findings is submitted to EPA in the *Annual Summary of Inspections Landfill Cap, Condensate Collection System and Central Area Leachate*

Collection System. During this FYR period, the City completed O&M actions consistent with the plans. The minor deficiencies identified were documented and actions were taken to address the issue.

The O&M Plan requires a demonstration of functional stability at least once every five years and elevation surveys take place annually. When settlement exceeds thresholds, corrective actions are initiated. The areas of ponding identified in the 2013 FYR were regraded and repaired during 2015 and 2016 while similar work on a few areas of the parking lot was scheduled for the summer of 2018. No other significant settlement issues have been identified.

During the May 1, 2018 FYR Meeting, EPA was informed that the City desired to revise the O&M Plan to reduce quantitative surveys to once every five years and change the allowable biaxial strain from 1% to 6% (regulatory limit is 10%). Visual surveys would continue to take place annually. The City was encouraged to provide the Agencies with the recommended changes for review prior to implementation.

Gas: The GCCS is actively managed using data from the monitoring probes to is used to adjust the flow of gas from individual wells and make decisions on system-wide improvements to optimize performance. Perimeter gas probes are monitored weekly while extraction wells are monitored and adjusted quarterly. Data and information are reported in the *Gas System Evaluation Report* (biannual prior to 2017, annual thereafter). In addition, during this FYR period, several Technical Memoranda were produced to evaluate optimization opportunities and systems operation.

As would be expected for a closed landfill, the rate of methane gas production is currently in decline across the landfill and actively managed for optimal performance. Gas concentrations are generally highest in the most-recent and the deepest fill areas (see Figure 5 for 2017 concentrations). In addition, they found that the GCCS was preventing the lateral migration of LFG outside the property boundaries, with concentrations above 5% (by volume) reported at only 8 of the 83 perimeter compliance monitoring probes. Concentrations at 6 of the 8 wells were adjusted by increasing the flow rates at nearby extraction wells. Additional study of gas concentrations at the other 2 wells, located just north of the landfill on Home Depot property, is likely generated by a secondary source, not the landfill.

In a 2016 Technical Memorandum, Landau recommended a three-tier process to "right-size" the GCCS by systematically testing to identify redundant collection devices and targeting extraction to the zones of greatest gas production. Tier I, completed in early 2017, ceased extraction at all off-site wells and closed probes found to be redundant and unnecessary. Tier II, completed between October and December 2017, monitored changes when extraction from one or more extraction zone was suspended and evaluated the data to determine if further extraction was necessary. Tier III will remove 10 to 15 poor-performing wells from service and monitor the changes. Following completion of Tier, I and II, the extraction network was reduced from 655 to 165 individual extraction wells. Most closed wells were left in place so that they could be used for future monitoring or extraction. Continued efforts to optimize the GCCS should be encouraged.

O&M reports indicate that inspections, preventative maintenance and other O&M activities have been consistently implemented. No major issues with the LFG systems have been identified this FYR period.

OU 6 – Groundwater

GETS: During this FYR period, approximately 100 gallons per minute (gpm) of groundwater has been extracted from five extraction wells, piped to the Leach Creek Holding Basin and discharged to Leach Creek. Due to the quality at the point of discharge, no treatment has been required and no exceedences of the discharge limits have been reported. The treatment system has not been used since 1998 and thus, decommissioning of the system may be appropriate.

The five active extraction wells (W-01, W-02/W-03R, W-04, W-15 and W-16) are in the southern half of the landfill, along the western boundary. From 2013 to 2015, well W-02 was off-line due to problems with the well screen and, in 2015 was replaced by a new well labeled W-03R. Due to improved water quality, terminating extraction at some of these wells may be appropriate.

Flow: Groundwater flow direction and gradients have not significantly changed during this FYR period (Figure 6).

Groundwater Quality: Groundwater performance criteria for VC, 1,2-DCA and benzene are routinely met at all monitoring wells. TCE and PCE criteria are regularly met at all but two wells, one of which the most recent measurements were slightly below the performance criteria. The first well, TL-11A, is located along the western boundary and is a POC well. The second, TL-26A, is located approximately 800 feet west of the western boundary and slightly north of TL-11A. During this FYR period, TL-11A has shown consistently high concentrations of PCE (4.0 – 13 ug/L) and TCE (7.7 – 20 ug/L). (The MCL for both contaminants is 5 ug/L.) The concentration trends for both COCs are relatively variable (Figure 7). There is no current route of exposure.

While currently just below the performance criteria, TCE and PCE at TL-26A increased to above the performance criteria following the 2010 shutdown of extraction. Concentrations peaked just above the performance criteria in the third quarter of 2015 and the second quarter of 2014 respectively. For the last several years, concentrations of both the COCs have been in decline, suggesting the source is controlled and the plume naturally attenuating (Figure 8). There is no current route of exposure (Figure 8).

To illustrate the reduction in plume size over time, two concentration contour maps have been generated for PCE, TCE, 1,2-DCA, VC and benzene and provided in Appendix B. The first contour map for each contaminant was generated using the maximum contaminant concentration recorded at each well, illustrating the maximum plume size. The second contour map presents the most recent data collected from each well (November 2017 or last sample last sample before well removed from sampling program), thus illustrating the current plumes. he only current mappable plumes are in the southwest corner near TL-11A and TL-26A. However, both the PCE and TCE plumes are significantly smaller than their maximum size.

Quarterly rebound monitoring data has been conducted at the current network of wells since 2009 and 2010. After some early fluctuations, contaminant concentrations in all wells have either stabilized or are decreasing. Given the time since shut-down, the continued value of rebound monitoring should be evaluated.

Arsenic concentrations along the western edge of the landfill remain slightly elevated. However, a 2009 review this was due to redox conditions, not a release from the landfill.

A groundwater attainability analysis could be performed at most wells to determine where sufficient data has been collected to demonstrate groundwater has met groundwater performance goals. Based on the results, it may be appropriate to reduce monitoring at some wells. Prior to close-out, documentation of attainment should be prepared for each well.

Surface Water Quality: Extracted groundwater is monitored just prior to being discharged to the Leach Creek Holding Basin. Since the water quality at that point has consistently met performance criteria, the current monitoring plan does not require instream monitoring. The frequency of monitoring transitioned from semi-annual to quarterly during the second quarter of 2015.

O&M: O&M inspections and routine maintenance were performed as scheduled. In 2015, following failure of the well screen, extraction well W-02 was replaced by W-03R. In 2016, wells with an accumulation of iron hydroxide were rehabilitated.

Following the decommissioning of 11 extraction wells this FYR period, all off-site groundwater extraction wells have been decommissioned. In addition, three monitoring wells and the Leach Creek augmentation well were decommissioned in 2017 and other off-site wells are being considered for decommissioning. The wells identified for post-closure monitoring or immediately downgradient of a non-attainment well have not been considered candidates for decommissioning. Decommissioning was performed by a licensed well driller and only permitted following Agency review. A similar evaluation should be conducted prior to the decommissioning of additional wells. The locations of the decommissioned wells are identified by a grey circle in Figure 4.

All O&M, sampling and management plans have been updated since the last FYR.

Site Inspection

The inspection of the Site was conducted on 5/1/2018. In attendance were Jeremy Jennings, EPA RPM; a representative from Ecology; the PRP and their technical consultant and a second EPA RPM present to learn from the process. The purpose of the inspection was to assess the protectiveness of the remedy.

The inspection included a driving tour around the top of the landfill with stops at locations where major work had occurred during the FYR period. The landfill appeared to be well maintained. The City appeared to be proactive in addressing potential concerns as they were identified. Throughout the tour, EPA had discussions with the PRP, their technical consultant and the State regarding progress, problems and successes at the Site. No issues or concerns were raised during the inspection that had not been previously noted by the PRP.

V. TECHNICAL ASSESSMENT

QUESTION A: Is the remedy functioning as intended by the decision documents?

Question A Summary:

Yes, all elements of the remedy appear to be functioning as intended. All source controls have been implemented and groundwater performance criteria are being met at most wells.

OU 5 – Landfill Cap – Source Control

Remedial Action Performance: All waste-collection areas have been capped and stormwater, condensate and leachate collection systems are in place. All appear to be functioning as intended. Areas where ponding was identified during the last FYR have been regraded and repaired.

A gas extraction system is preventing the lateral migration of gas and is functioning as intended. As gas production has decreased, the City has taken steps to optimize operations through decommissioning of redundant extraction wells and managing flows in the remaining wells.

The landfill was closed and moved into Post-Closure status in April 2015.

O&M: Routine inspections and maintenance are occurring, thus allowing for the continued functioning of the remedial action. All O&M, sampling and management plans have recently updated.

OU 6 – Groundwater
Remedial Action Performance: Performance criteria have been met and extraction shut down at all but five of the groundwater extraction wells. Rebound monitoring has not indicated a need to resume extraction at any of the wells. Extracted groundwater consistently meets performance criteria at the discharge to the Leach Creek Holding Basin and does not require treatment prior to discharge to Leach Creek.

Performance criteria are being met at all but two wells (TL-11A and TL-26A), thus indicating contaminants have been contained except for a small area in the southwest corner of the landfill. TCE and PCE concentrations in the two wells are relatively close to the MCLs. However, the concentration trend at TL-11A is variable and may not lead to attainment in the next several years. Additional investigation of the source is recommended to shorten the time to attainment. No exposure pathways are currently present.

O&M: Routine inspections and maintenance are occurring, thus allowing for the continued functioning of the remedial action. Following the malfunction of the well screen in W-02, a replacement well (W-03R) was drilled. The O&M Plan was updated in 2016.

Institutional Controls
Required institutional controls are in place and functioning as intended. A 2001 Restrictive Covenant restricts groundwater use and residential development on the Landfill property. In addition, three communities downgradient of the landfill have revised their Municipal Codes to restrict or prohibit installing new wells for domestic purposes.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Question B Summary:
Yes, the exposure assumptions, toxicity data, performance criteria (cleanup levels) and RAOs used at the time of remedy selection are still valid. There have been no changes that would call into question the protectiveness of the remedy.

Groundwater - There are no changes to the health-based criteria that would call into question the protectiveness of the remedy. The Safe Drinking Water Act and the Washington State Hazardous Waste Cleanup Act were identified as ARARs. Groundwater performance criteria were established at the MCL or, if no MCL was available, at risk/health-based criteria based on the residential use of drinking water.

No MCLs have become more stringent since the time the ROD was written. However, three MCLs (1,1-DCA, ethyl benzene, toluene and xylenes) have become less stringent. These changes do not call into question the protectiveness of the remedy.

Two health-based criteria were used in the ROD (chloroethene and 1,1-DCA). The current EPA Regional Screening Level (RSL) for resident tap water for chloroethene is 21,000 ug/L, less stringent than the ROD performance criterion of 20 ug/L. The current EPA RSL for 1,1-DCA is 2.8 ug/L, more stringent than the ROD performance criterion of 20 ug/L. The risk associated with the ROD performance criterion for 1,1-DCA is 7.3E-6, and thus, is within EPA's acceptable risk range (see Appendix G for risk calculations).

Vapor Intrusion - The potential risk due to vapor intrusion was evaluated by the City in 2009. Use of the J&E Model to screen for vinyl chloride and 1,2-DCA indicated residual concentrations in groundwater

off-site did not pose a risk to residents. VOC concentrations have decreased since this time due to implementation of the remedy.

As part of this FYR, the Vapor Intrusion Screening Level (VISL) Calculator was used to assess the exposure potential from TCE in the groundwater. In 2017, TCE was detected at six wells, all located near the southwest corner of the landfill. The highest reported concentration at the boundary was 11 ug/L (TL-11A) while the highest off-site contamination was 4.3 ug/L (TL-26A). The well screen at these two wells are located at the top of the water table, 90 and 105 feet below the ground surface.

Using the VISL calculator and the default values for TCE, the groundwater screening value for short-term noncancer endpoints was 22 ug/L, twice the highest concentration measured in 2017. This does not consider any attenuation that may take place between the screen depth and the ground surface. Potential exposure from intrusion of TCE vapors should not impact the protectiveness of the remedy.

Source Areas - Remedial actions selected for source control have been constructed, are currently operating and appear to be in good condition. No quantitative performance criteria for gas were established in the ROD. However, methane concentrations of 5% by volume remains a protective target.

Other - There have been no changes in contaminant characteristics, risk assessment methods, exposure pathways or other changes that might impact RAOs or protectiveness of the remedy.

Progress Towards Meeting RAOs – The remedy has been effective. All source areas have been capped and systems are in place to control gas, leachate, condensate and stormwater. Groundwater performance criteria are met at all but one small area in the southwest corner.

QUESTION C: Has any **other** information come to light that could call into question the protectiveness of the remedy?

No.

VI. ISSUES/RECOMMENDATIONS

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
OU 5 & 6

OTHER FINDINGS

The following are recommendations that were identified during the FYR and may improve performance of the remedy, reduce costs, accelerate site close out, etc., but do not affect current and/or future protectiveness. Implementation of some of the recommendations may require Agency approval.

OU 5 – Source Control

- Review the methods and criteria used to evaluate functional stability of the landfill cap and consider adjustments where appropriate.

- As the gas generation rate declines, continue to adjust flows for optimal performance.

OU 6 - Groundwater

- Consider further investigation of the source at TL-11A and, if appropriate, implement measures to accelerate attainment of performance criteria.
- Consider conducting an attainability analysis at active extraction wells and evaluate the need for continued extraction.
- Prior to close-out, perform a groundwater attainability analysis at all wells.
- Review current scope and need for the rebound monitoring program and modify as appropriate.
- Eliminate quarterly groundwater reports and, instead, include all information in the annual report. (Note: This change was request and approved by emails dated August 21 and 22, 2018.)
- Consider decommissioning the GETS Treatment Plant.

VII. PROTECTIVENESS STATEMENT

Protectiveness Statement(s)	
Operable Unit: 5	*Protectiveness Determination:* Protective
Protectiveness Statement: The remedy at OU 5 is protective of human health and the environment. All areas are capped, the landfill has closed and stormwater, condensate and leachate collection systems are functioning. O&M activities are being implemented consistent with the O&M Plan. No current exposure pathways are present.	

Protectiveness Statement(s)	
Operable Unit: 6	*Protectiveness Determination:* Protective
Protectiveness Statement: The remedy at OU 6 is protective of human health and the environment. Migration of the plume is under control and groundwater performance levels have been attained at all but two wells. Groundwater continues to be extracted near the remaining PCE and TCE plumes. All ICs are in place and no current exposure pathways are present.	

VIII. NEXT REVIEW

The next five-year review report for the Commencement Bay, South Tacoma Channel Superfund Site is required five years from the completion date of this review.

FIGURES

Extracted From:
2014 Post-Closure Monitoring Plan
2017 Annual Consent Decree Report
VOC Figures generated by City of Tacoma, 2018
Optimization Review Report, April 2018
2018 Post-Closure Landfill Gas Management Plan

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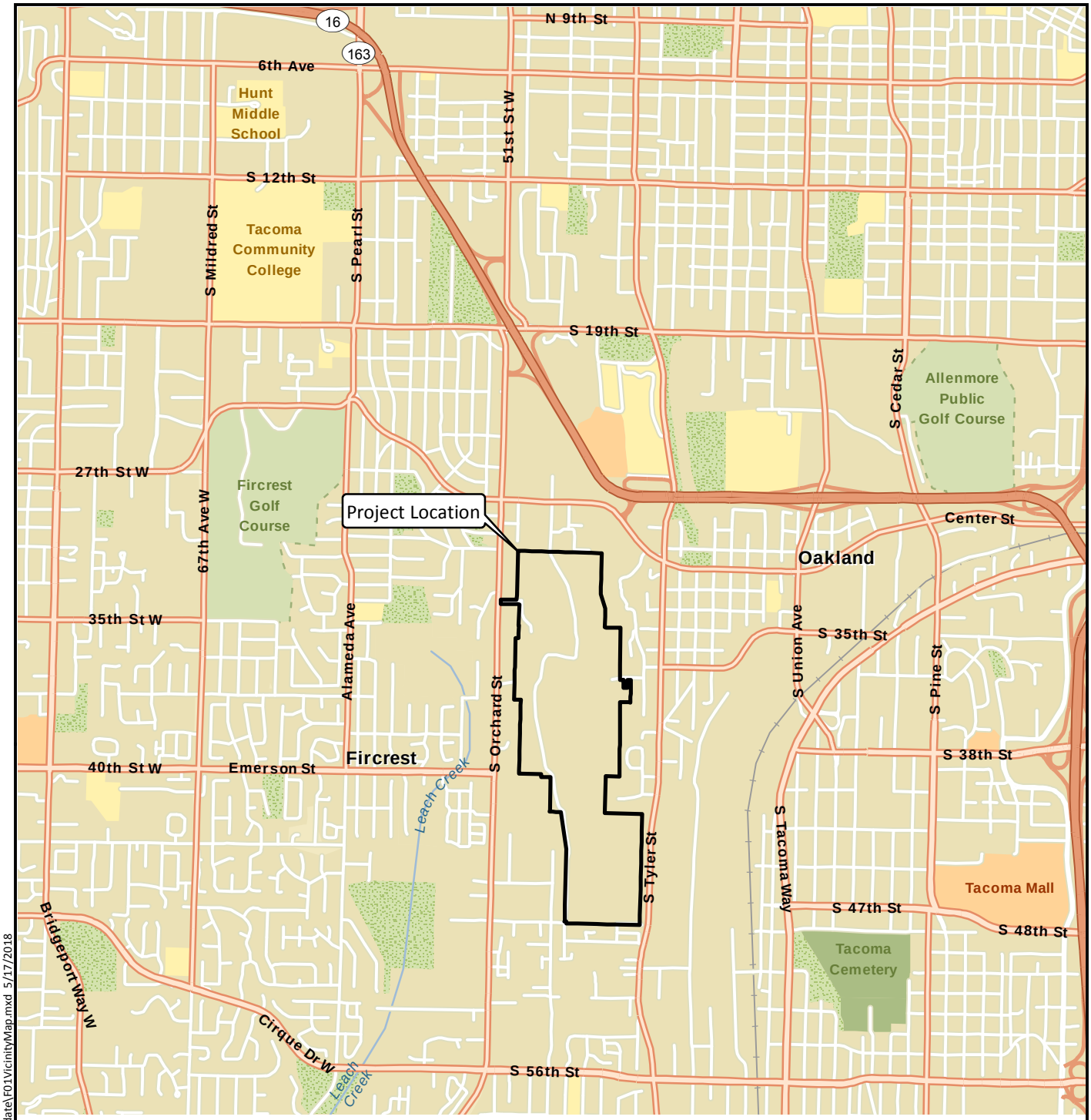

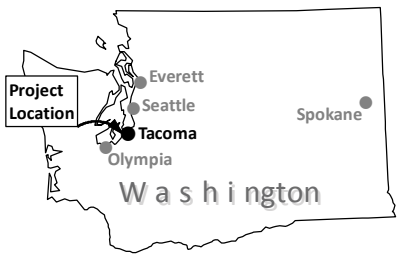

Data Source: Esri 2012

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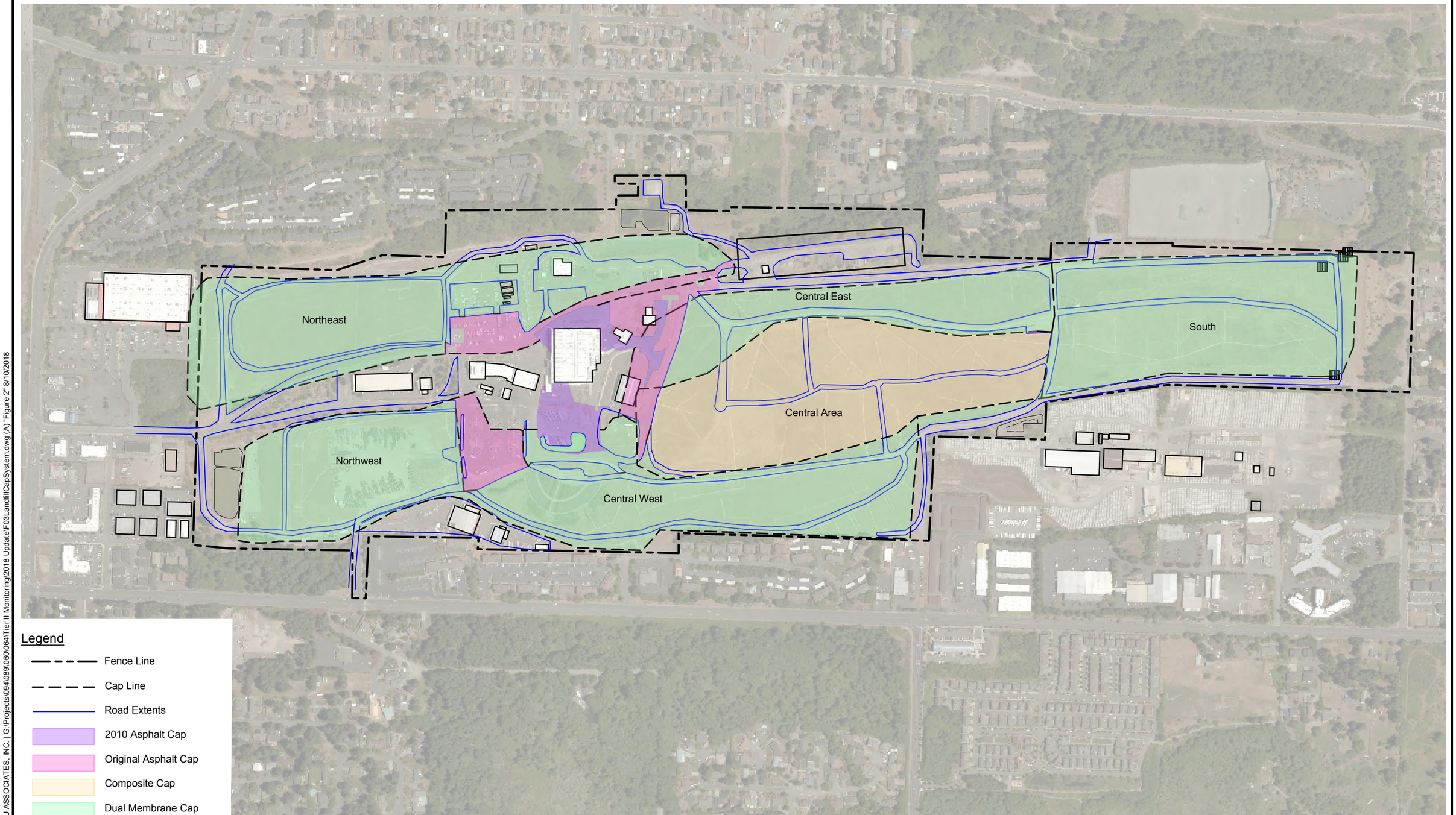
LANDAU ASSOCIATES

City of Tacoma Landfill Tacoma, Washington	**Vicinity Map**	Figure 1



Legend

- Fence Line
- Cap Line
- Road Extents
- 2010 Asphalt Cap
- Original Asphalt Cap
- Composite Cap
- Dual Membrane Cap

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

N

0 500 1000

Scale in Feet

Source: © Bing Maps; City of Tacoma, 2014

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City of Tacoma Landfill
Tacoma, Washington

Landfill Areas

Figure 2

N

Northeast Area

Central East Area

South Area

Blower and Flare Station

Central Area

Northwest Area

Central West Area

Legend

- Interior Extraction Well - Operating
- Perimeter Monitoring Probe
- Perimeter Extraction Well - Operating
- Perimeter Extraction Well Converted to Monitoring Probe
- Subject Property
- Cap Line
- Landfill Gas Collection Header (Exposed)
- Landfill Gas Collection Header (Buried)
- Horizontal Collector

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 500 1,000

Scale in Feet

Data Sources: Tacoma Landfill Stage 1-North Closure, Parametrix, May, 1990; Tacoma Landfill Stage 1-South Closure, Black & Veatch, June 1990; Tacoma Landfill Stage 2 Closure, Black & Veatch, June 1991; Esri World Imagery.

G:\Projects\094\089\060\0064\Tier II Monitoring\2018 Update\F04GasCollectionOverview.mxd 8/10/2018

LANDAU ASSOCIATES

City of Tacoma Landfill Tacoma, Washington	**Gas Collection and Control System Overview**	Figure 3

G:\Projects\094\089\010\015\VOC Contours\F02_PostClosureMonitoringLocations.mxd 7/22/2014 NAD 1983 StatePlane Washington South FIPS 4602 Feet

Legend

PW-25	Post-Closure Monitoring Well
LC-01	Compliance Monitoring Location
TL-10A,B	Tacoma Landfill Monitoring Well (Multiple Completion in One Borehole)
TL-12	Tacoma Landfill Monitoring Well (Single Completion)
W-40	Decommissioned Monitoring Well
W-34	GETS Extraction Well
PW-3/4	GETS Performance Monitoring Well
LC-02	Leach Creek Sampling Location
EW-13	Other Monitoring Well
	Landfill Boundary

Source: City of Tacoma 2004; ESRI World Imagery 2010

Note
1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 700 1,400
Scale in Feet

LANDAU ASSOCIATES

City of Tacoma
Tacoma, Washington

Post-Closure Groundwater Monitoring Locations

Figure 4

N

Legend

- Interior Extraction Well - Operating
- Perimeter Monitoring Probe
- Perimeter Extraction Well - Operating
- Subject Property
- Cap Line

Methane Concentrations (% by Vol)

- 0 - 5
- 5 - 15
- 15 - 35
- 35 - 55
- 55+

Notes

1. Section boundaries are not included in the interpolation.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 500 1,000

Scale in Feet

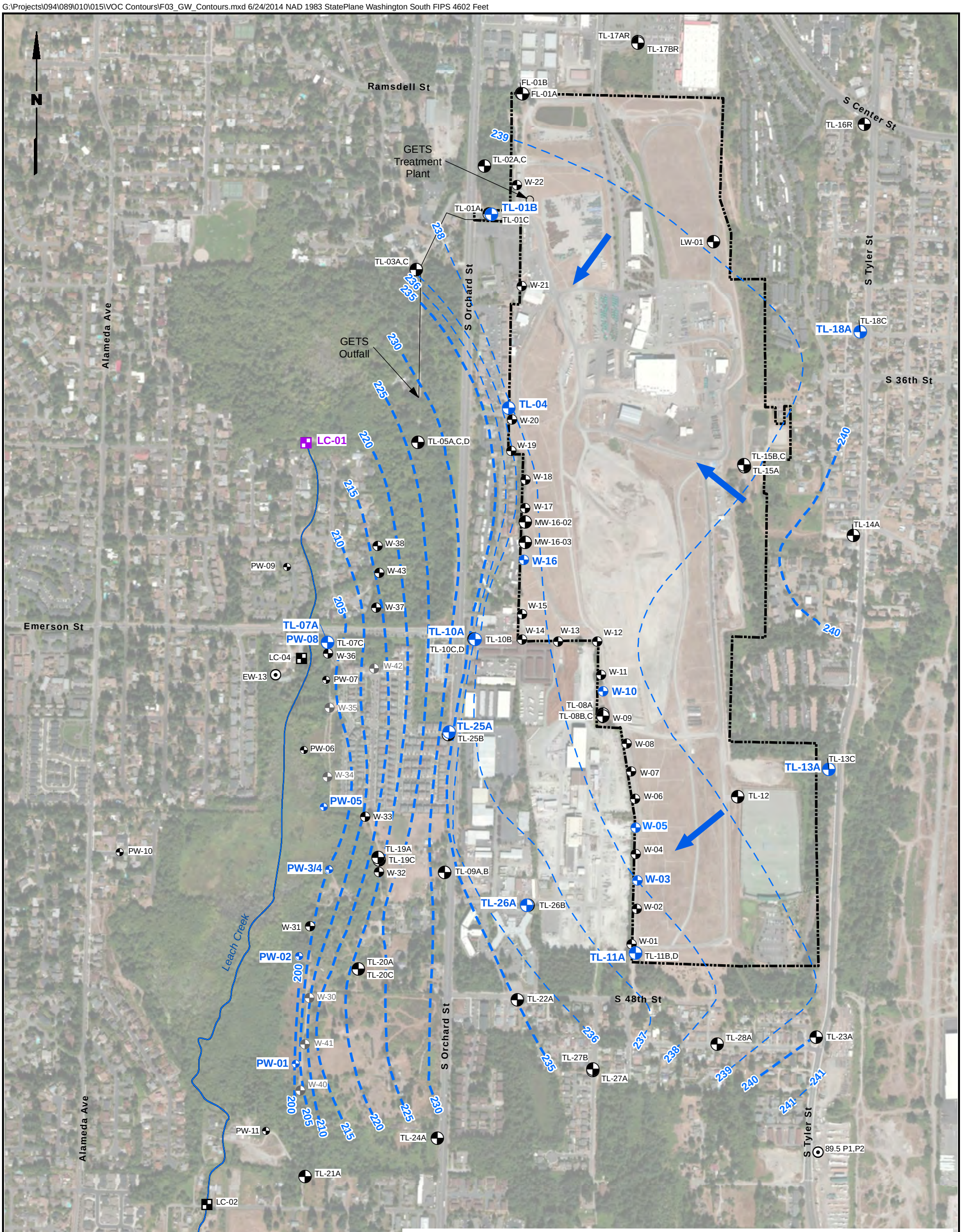
Data Sources: Tacoma Landfill Stage 1-North Closure, Parametrix, May, 1990; Tacoma Landfill Stage 1-South Closure, Black & Veatch, June 1990; Tacoma Landfill Stage 2 Closure, Black & Veatch, June 1991; Esri World Imagery.

LANDAU ASSOCIATES

City of Tacoma Landfill Tacoma, Washington	**Methane Concentrations: December 2017**	Figure 5

G:\Projects\094\089\060\064\Tier II Monitoring\Dec17\F03MethaneSiteWide.mxd 1/29/2018

G:\Projects\094\089\010\015\VOC Contours\F03_GW_Contours.mxd 6/24/2014 NAD 1983 StatePlane Washington South FIPS 4602 Feet



Legend

PW-25		Post-Closure Monitoring Well
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TL-10A,B		Tacoma Landfill Monitoring Well (Multiple Completion in One Borehole)
TL-12		Tacoma Landfill Monitoring Well (Single Completion)
W-40		Decommissioned Monitoring Well
W-34		GETS Extraction Well
PW-3/4		GETS Performance Monitoring Well
LC-02		Leach Creek Sampling Location
EW-13		Other Monitoring Well

Groundwater Elevation Contour 1-Foot Interval Measured 4th Quarter 2012

Groundwater Elevation Contour 5-Foot Interval Measured 4th Quarter 2012

Landfill Boundary

Groundwater Flow Direction

0 700 1,400

Scale in Feet

Source: City of Tacoma 2004; ESRI World Imagery 2010

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

LANDAU ASSOCIATES

City of Tacoma
Tacoma, Washington

Post-Closure Groundwater Monitoring Locations and Groundwater Contours

Figure 6

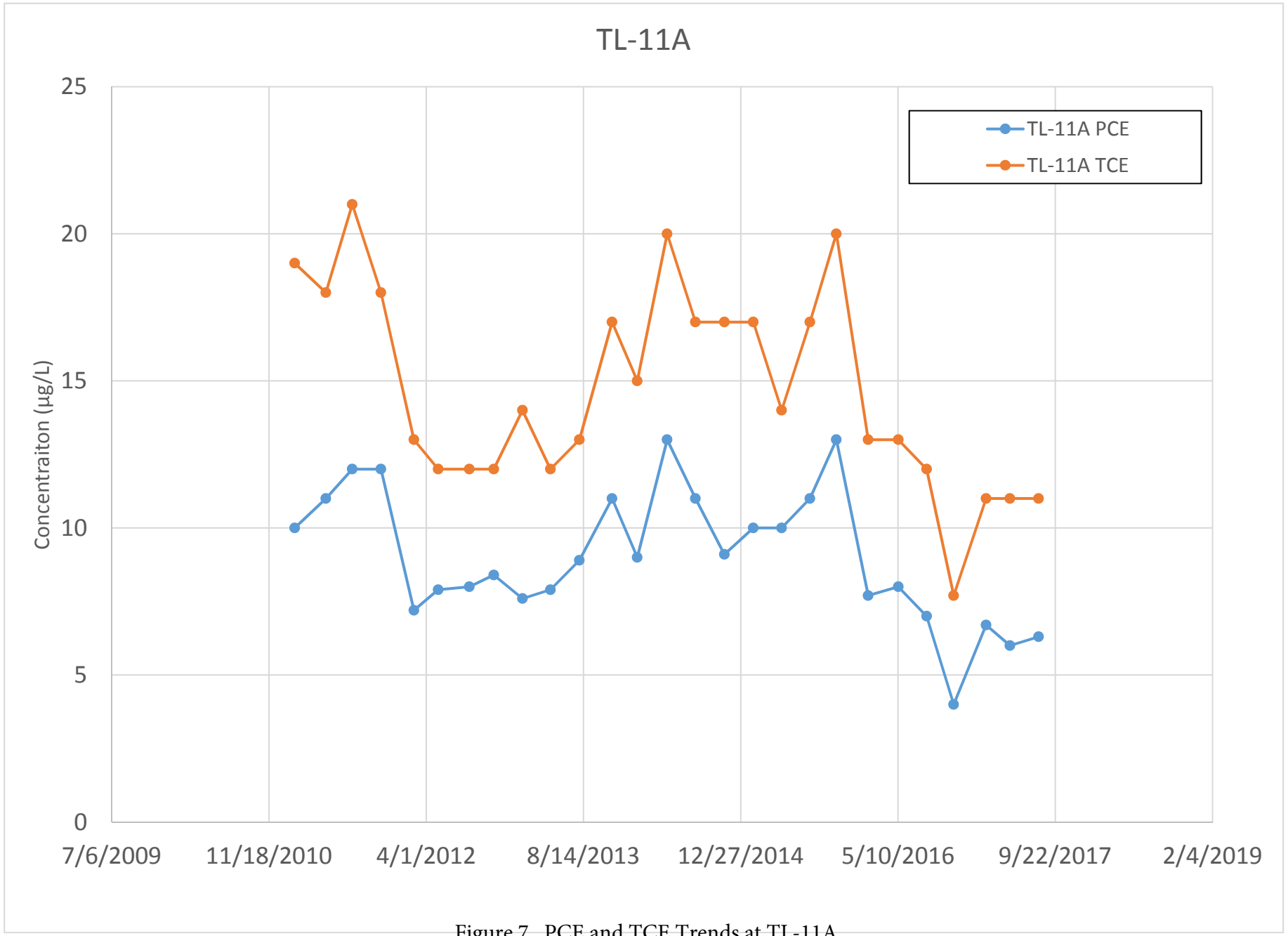

Figure 7. PCE and TCE Trends at TL-11A

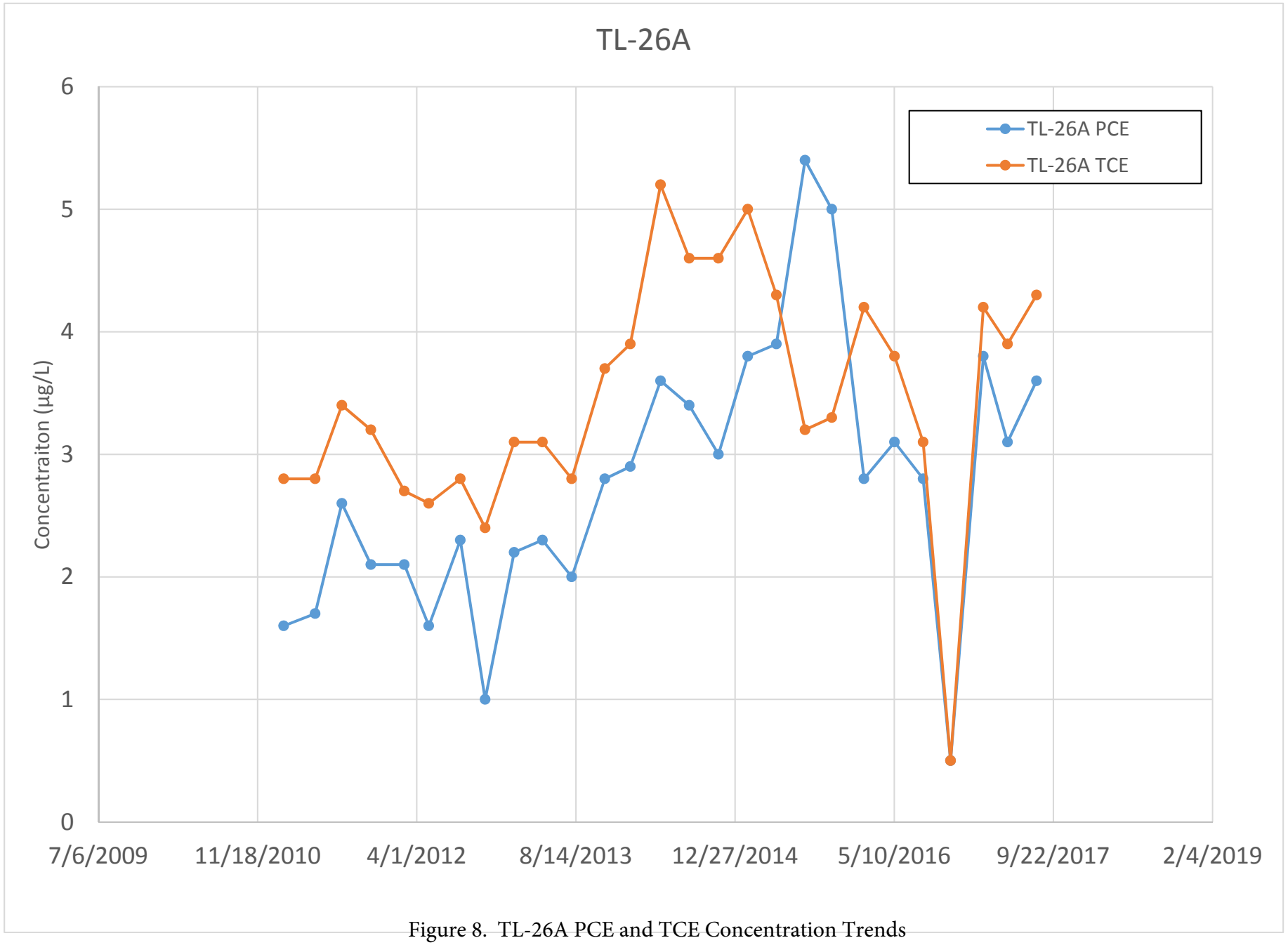

Figure 8. TL-26A PCE and TCE Concentration Trends