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Fourth Five-Year Review
for
National Semiconductor Corporation
2900 Semiconductor Drive
Santa Clara, Santa Clara County, California

September 2013

Approved By:

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9/30/13
Date

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List of Abbreviations and Acronyms

ARARs	Applicable or Relevant and Appropriate Requirements
ASTDR	Agency for Toxic Substances and Disease Registry
AMD	Advanced Micro Devices
BGS	Below Ground Surface
BPHE	Baseline Public Health Evaluation
COC	Chemicals of Concern
DCE	Dichloroethene
ESL	Environmental Screening Level
EISB	Enhanced In-Situ Bioremediation
FYR	Five Year Review
GWET	Groundwater Extraction and Treatment
HVAC	Heating, ventilation, and air conditioning
IRIS	Integrated Risk Information System
MCL	Maximum Contaminant Level
NSC	National Semiconductor Corporation
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
SVE	Soil Vapor Extraction
O & M	Operation and Maintenance
OS	Ozone Sparging
OU	Operating Unit
PCE	Tetrachloroethene, perchloroethene
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
Water Board	San Francisco Bay Regional Water Quality Control Board
SCR	Site Cleanup Requirements
SU	Subunit
SVE	Soil Vapor Extraction
TCA	1,1,1-trichloroethane
TCE	Trichloroethene
TI	Texas Instruments, Incorporated
U.S. EPA	United States Environmental Protection Agency
UTC	United Technologies Corporation
VOC	Volatile Organic Compound

Executive Summary

This is the fourth Five-Year Review of the National Semiconductor Corporation (NSC) Superfund site (Site) in Santa Clara, Santa Clara County, California. The purpose of this Five-Year Review (FYR) is to review information from the previous five years to assess the nature of any contamination left on-site and determine whether or not the remedy remains protective of human health and the environment. The triggering action for this fourth FYR was the signing of the previous FYR on September 30, 2008.

Texas Instruments, Incorporated, (TI) acquired the NSC Site through a merger with NSC in September 2011. Through this merger TI has assumed responsibility of the Site. The groundwater contaminant plume in the A- and B1-zones is approximately 5,000 feet long and 2,100 feet wide, and extends to Highway 101. The plume has remained stable and concentrations of volatile organic compounds (VOCs) have declined across the plume. NSC and TI have continued to conduct soil cleanup and groundwater extraction and treatment during the past five years. The VOC mass removed during this review period from soil by excavation at the Leak L5 Area equaled approximately 2,795 pounds. The VOC mass removed between 2006 and 2011 from groundwater by groundwater extraction and treatment (GWET) was approximately 603 pounds. Additional mass of VOCs have been removed by in-place treatment approaches including enhanced in-situ bioremediation (EISB) and chemical oxidation. Mass removal calculations are difficult to estimate for in-place treatments; however, concentration reductions up to 90% have been observed at the treatment areas. In-situ chemical oxidation is being implemented at Building C Leak 5 Area and bioremediation pilot studies are occurring at Building E, G and 9 areas to further reduce contaminant mass in-place, also groundwater extraction and treatment systems are operating in onsite and offsite areas to reduce concentrations and contain the migration of VOCs.

Maximum VOC groundwater concentrations in on-site source areas have been reduced from over 100,000 ug/L to less than 1,000 ug/L. In 2012, TCE, PCE and cis-1,2-DCE were the predominant VOCs detected in groundwater at a maximum concentration of 480 ug/L, 760 ug/L and 410 ug/L, respectively.

A protectiveness determination of the remedy at the NSC Superfund Site cannot be made until a vapor intrusion assessment is completed at all buildings overlying the contamination. Recent indoor air sampling at on-property buildings south of the Central Expressway have indicated that there is vapor intrusion; however, the exposure levels are below screening health levels while the heating, ventilation, and air conditioning (HVAC) systems are operating. All other exposure pathways that could result in unacceptable risks are being controlled, and institutional controls are preventing exposure to, or the ingestion of contaminated groundwater. To be protective in the long term, new restrictive covenants need to be recorded, the site management plans needs to be revised to include operation and maintenance (O&M) requirements for the HVAC systems, and the Site Cleanup Requirements (SCR) and Record of Decision (ROD) will need to be amended to select a new remedy. Once the source area and downgradient vapor intrusion assessment is completed a protectiveness determination will be made. The Five-Year Review addendum, which will include the protectiveness determination, will be completed by December 31, 2014.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: National Semiconductor Corporation		
EPA ID: CAD041472986		
Region: 9	**State:** CA	**City/County:** Santa Clara/Santa Clara

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

REVIEW STATUS
Lead agency: State **If "Other Federal Agency" was selected above, enter Agency name:**
Author name (Federal or State Project Manager): Max Shahbazian
Author affiliation: California Regional Water Quality control Board, San Francisco Bay Region
Review period: September 2008 – September 2013
Date of site inspection: November 13 and 14, 2012
Type of review: Policy
Review number: 4
Triggering action date: 9/30/2008
Due date *(five years after triggering action date)*: 9/30/2013

Five-Year Review Summary Form (continued)

Issues/Recommendations				
Issues and Recommendations Identified in the Five-Year Review:				
OU(s): **OU1 Subunit 1**	**Issue Category:** Remedy Performance			
	Issue: Sampling results indicate that vapor intrusion is occurring when HVAC systems are turned off in select buildings south of the Central Expressway.			
	Recommendation: Amend ROD and revise the Site Management Plan to include O&M requirements for the HVAC systems. Meanwhile, continue sampling indoor air and require operation of buildings HVAC systems.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	State	12/2015
OU(s): OU1 Subunit 1	**Issue Category:** Institutional Controls			
	Issue: Existing deed restriction is not consistent with State law because it was recorded prior to the passage of California Civil Code section 1471.			
	Recommendation: A new restrictive covenant should be recorded for the TI property that is consistent with current California law.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	State	State	12/2014
OU(s): OU1 Subunit 1	**Issue Category:** Human Exposure			
	Issue: Further vapor intrusion assessment is required off-property.			

	Recommendation: Conduct indoor air sampling at off-property buildings downgradient of the source area.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
Yes	Yes	PRP	State	9/2014

Protectiveness Statement(s)		
Operable Unit: OU1 Subunit 1	*Protectiveness Determination:* Protectiveness Deferred	*Addendum Due Date (if applicable):* July 30, 2014
Protectiveness Statement: A protectiveness determination of the remedy at the NSC Superfund Site cannot be made until a vapor intrusion assessment is completed at all buildings overlying the contamination. Recent indoor air sampling at on-property buildings south of the Central Expressway have indicated that there is vapor intrusion; however, the exposure levels are below screening health levels while the heating, ventilation, and air conditioning (HVAC) systems are operating. All other exposure pathways that could result in unacceptable risks are being controlled, and institutional controls are preventing exposure to, or the ingestion of contaminated groundwater. To be protective in the long term, new restrictive covenants need to be recorded, the site management plans needs to be revised to include operation and maintenance (O&M) requirements for the HVAC systems, and the Site Cleanup Requirements (SCR) and Record of Decision (ROD) will need to be amended to select a new remedy. Once the source area and downgradient vapor intrusion assessment is completed a protectiveness determination will be made. The Five-Year Review addendum, which will include the protectiveness determination, will be completed by December 31, 2014.		

Fourth Five-Year Review
Texas Instruments, Incorporated
(Former National Semiconductor Corporation)
2900 Semiconductor Drive
Santa Clara, California

1 Introduction

The purpose of the five-year review is to determine whether the remedy at a site is protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in Five-Year Review reports. In addition, Five-Year Review reports identify issues found during the review, if any, and identify recommendations to address them.

The Agency is preparing this Five-Year Review report pursuant to CERCLA §121 and the National Contingency Plan (NCP). CERCLA §121 states:

If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.

The Agency interpreted this requirement further in the NCP; 40 CFR §300.430(f)(4)(ii) states:

If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.

The California Regional Water Quality Control Board, San Francisco Bay Region, conducted the five-year review of the remedy implemented at the National Semiconductor Corporation in Santa Clara, Santa Clara County, California. This is the fourth five-year review for the Site. The triggering action for this statutory review is the completion of the third five-year review on September 30, 2008. The five-year review is required due to the fact that hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure.

2 Site Chronology

The following table lists the dates of important events for the NSC Site

Table 1. Chronology of Site Events

Event	Date
NSC begins manufacturing semiconductors at the site	1967
Soil and groundwater contamination discovered at the site	1982
Removal of 22 underground solvent storage tanks and acid waste sumps and associated piping; Excavation of 400 cubic yards of contaminated soils	1982 - 1991
Groundwater extraction and treatment begins. NPDES permit issued for discharge of treated effluent.	1984
NSC accepts responsibility for groundwater contamination from adjacent UTC facility	1987
NSC site and AMD site (1165 East Arques Avenue) added to NPL	July 1987
Baseline Public Health Evaluation completed for NSC site	July 1990
Water Board and U.S. EPA approve NSC's Final RI/FS work plan	Sept 1991
Water Board adopts Orders No. 91-137, 91-139, and 91-140, the Final Site Cleanup Requirements for Subunits 1, 2, and 3 of OU 1.	Sept 1991
U.S. EPA issues Record of Decision (ROD) for NSC and AMD sites	Sept 1991
NSC submits first (State-required) Five-Year Review Report to Water Board.	Sept 1996
Preliminary Close-out Report	Oct 1997
Water Board submits first EPA-required Five-Year Review Report to EPA, Region 9	Sept 1998
Low levels of perchlorate detected at former UTC facility	2000
Ozone sparging/soil vapor extraction system installed at a former source area	2001
NSC submits second (State-required) Five-Year Review Report to Water Board	Aug 2001
Water Board submits second EPA-required Five-Year Review Report to EPA, Region 9	Sept 2003
Focused Risk Assessment Report, Potential Vapor Intrusion	July 2004
SVE systems shut down	Feb and Mar 2005
NSC submits third Five-Year Review Report to Water Board	Nov 2006
Pilot Study Work Plan for Vegetable Oil Injection to Accelerate Remediation of Chlorinated Volatile Organic Compounds at Building E	Nov 2006
Field Sampling Report in Support of Remedial Alternatives Evaluation, Building C: Tank T13/Leak L5 Areas	Nov 2006
Injected Vegetable Oil at Building C	Jan 2007
Remedial Action Plan for Building C: Tank T13 and Leak 5 Areas	Nov 2007
Work Plan for In-Situ Chemical Oxidation (ISCO) Pilot Study at Building C: Leak 5 Area	Feb 2008
Implemented ISCO pilot study at Building C: Leak 5 Area	March & July 2008
Water Board submits third EPA-required Five-Year Review Report to EPA, Region 9	Aug 2008
OS/SVE was discontinued at Building G in the E zone due to required repairs.	Jan 2009
Leak L5 Area Work Plan submitted to the Water Board and subsequently approved	Dec 2009
Leak L5 Area remediation conducted. Excavate and disposal of 1,440 tons of soil	Dec 2009

Event	Date
and injection pipe installed.	and Jan 2010
Well Installation Report for Hydrogen Peroxide Injection at Building G submitted	Jan 2010
Former SVE wells abandoned at Building C	Feb-Mar 2010
No Further Action granted for former source area Tank T13	June 2010
Bioremediation pilot study began at Building 9	July 2010
Bioremediation pilot study began at Building G	Jun 2011
TI acquired the NSC site through a merger with NSC	Sept 2011
Pilot study persulfate injection event conducted at Building C	Nov 2011
First full persulfate injection event at Building C completed	Mar 2012
Vapor intrusion assessment conducted on-property	Dec 2012 – Jan 2013

3 Background

3.1 Physical Characteristics

The Site is approximately 60 acres in size and is located between Kifer Road, Central Expressway, and Lawrence Expressway in the city of Santa Clara, California. A groundwater contaminant plume extends down-gradient from the property to beneath an off-property commercial area. Contaminants from other source areas, including one other Superfund site, commingle with the NSC plume in the off-property area. The groundwater plume from the NSC facility and adjacent sites is managed by the Water Board as Operable Unit 1 (OU 1). OU 1 has been subdivided into Subunits 1, 2, and 3, as shown on the attached map. Subunit 1 lies within the cities of Santa Clara and Sunnyvale and consists of the NSC campus, the down-gradient area to East Arques Avenue and the adjacent former United Technologies Corporation (UTC) facility at 1050 East Arques Avenue. Subunit 2 consists of another Superfund site, the former Advanced Micro Devices, also known as Monolithic Memories (AMD/MMI) site at 1165 East Arques Avenue in Sunnyvale. Subunit 3 consists of the commingled solvent plume down-gradient of the NSC, UTC, and AMD/MMI facilities and lies entirely within the city of Sunnyvale. Santa Clara and Sunnyvale each have populations of approximately 100,000, and are part of the San Francisco Bay Metropolitan Region, which has a total population of about six million. OU 1 is located in a light industrial and commercial area dominated by the electronics industry. Most buildings in the area are low-rise developments containing office space and research and development facilities. NSC occupied the facility continuously since 1967. Semiconductors were manufactured at the facility between 1967 and 1999. The facility is now used for offices, laboratories, and support services. Texas Instruments, Incorporated, (TI) acquired the NSC Site through a merger with NSC in September 2011.

This five-year review covers remedial activities conducted by NSC and TI in Subunits 1 and 3 only. Because the AMD/MMI site at 1165 East Arques Avenue is a separate U.S. EPA Superfund site, remedial activities performed by AMD in Subunit 2 will be addressed in a separate five-year review report.

3.2 Hydrogeology

Groundwater flows to the north-northeast towards San Francisco Bay. The Site is located in the Santa Clara Valley, a structural basin filled with marine and alluvial sediments. The coarser deposits are probably the result of deposition in or near stream channels that drain the highlands that surround the basin. Finer-grained deposits result from a variety of conditions with the eventual result of a heterogeneous sequence of inter-bedded sands, silts, and clays. Municipal water supply wells tap an extensive deep regional confined aquifer that lies generally greater than 200 to 300 feet below ground surface (bgs). A thick, relatively impermeable aquitard separates this deep confined aquifer from a complex series of laterally discontinuous aquifers and aquitards that can extend upward within a few feet of the ground surface. Four distinct water-bearing zones in the upper 100 feet bgs have been characterized at this site. These coarse-grained, transmissive units are generally composed of sand or sandy gravel. The first encountered water-bearing zone, called the A-zone, is found from 5 to 30 feet bgs. The next encountered water-bearing zone is called the B1-zone and is found from about 30 to 45 feet bgs. The B2-zone is typically found between 45 and 60 feet bgs, and the B3-zone typically occurs between 70 and 90 feet bgs. The aquifer zones are separated by variable thicknesses composed of clay to silty sand. There is some degree of hydraulic connection between the zones due to the discontinuous nature of the sediment types. The highest concentrations of contaminants exist in the A-zone and B1-zone, and in some locations within the plume, monitoring and extraction wells have been screened across both units. Low levels of VOCs have been detected in the B2-zone, while contaminants have only rarely been detected in the B3-zone. Groundwater flows from south to north in all zones. The groundwater contaminant plume in the A- and B1-zones is approximately 5,000 feet long and 2,100 feet wide, and extends to Highway 101. The shallow water bearing zones are not currently used as a source of drinking water. The City of Santa Clara supplies drinking water within the city limits.

3.3 Land and Resource Use

The Site is located in a light industrial and commercial area dominated by the electronics industry, with residential areas about one mile north of the Site boundary. Most buildings in the area are low-rise developments containing office space and research and development facilities. NSC has occupied the facility continuously since 1967. Semiconductors were manufactured at the facility between 1967 and 1999. The facility is now used for offices, laboratories, and support services.

3.4 History of Contamination

Site investigations, which began in 1982, identified VOCs in soil and groundwater. Fourteen separate sources of contamination have been identified at the TI Site. The main chemicals of concern are trichloroethene (TCE), 1,1,1-trichloroethane (TCA), cis-1,2-dichloroethene (cis-1,2-DCE), 1,1-dichloroethene, and Freon 113. Relatively low concentrations of other chemicals, including the inorganic salt perchlorate, are also present within the plume in Subunit 1. The perchlorate was released from the former UTC facility, which operated at 1050 East Arques Avenue between 1960 and 1982. NSC assumed responsibility for contamination from the former

UTC facility in 1987. VOCs in groundwater are limited to water-bearing units in the upper 60 feet and have not impacted deeper aquifers used for public water supply.

TWC Storage, LLC, purchased the former AMD/MMI site for redevelopment in 2005. On July 15, 2005, during site redevelopment activities, an electrical transformer was damaged in an equipment area located in the northwest corner of the property. Approximately 250 gallons of PCE were released from the damaged transformer. Remedial activities such as soil excavation and dual phase extraction have been conducted at the former AMD/MMI site to address the release of PCE. PCE-impacted soil and shallow groundwater from the release of PCE from the electrical transformer have been remediated to the extent feasible by TWC Storage, LLC.

NSC and AMD reached a settlement concerning the groundwater cleanup in OU1. Beginning on January 31, 2002, NSC took the lead on groundwater remediation in all of OU1 (including Subunits 1, 2, and 3). Remedial systems operation, monitoring, and reporting in OU1 are now integrated. NSC obtained the required NPDES permits. The common objective of both parties is to optimize the cleanup without regard to property boundaries. This will, for example, allow a reconfiguration of remedial systems to eliminate redundant pumping. TI will be the responsible party for all purposes under the Water Board's Order Nos. 91-137 and 91-140 for Subunits 1 and 3 of OU1. AMD will remain the responsible party for all purposes under the Water Board's Order No. 91-139 and will retain certain specific responsibilities, including any soil remediation required in Subunit 2 of OU1 and any environmental studies or remediation required in connection with redevelopment activities in Subunit 2 of OU1.

3.5 Initial Response

Remedial action at the NSC facility began in 1982 with the removal of underground acid waste sumps and solvent storage tanks. Initially, numerous sumps and tanks were removed along with over 400 cubic yards of contaminated soils, which were excavated and disposed of. Groundwater extraction and treatment (GWET) began in 1984 and is ongoing. Soil vapor extraction and treatment (SVE) began in 1995 and concluded in 2005.

3.6 Basis for Taking Action

The site overlies the Santa Clara Valley groundwater basin. Groundwater from this basin provides up to 50% of the municipal drinking water for over 1.4 million residents of the Santa Clara Valley. The NSC site was made a Superfund site primarily because of the past chemical releases' potential threat to this valuable resource.

4 Remedial Actions

4.1 Remedy Selection

A Baseline Public Health Evaluation (BPHE) was submitted July 3, 1990. The Remedial Investigation/Feasibility Study (RI/FS) was approved by U.S. EPA and the Water Board in September 1991. These documents form the basis of the remedial action plan. The Water Board adopted Final Site Cleanup Requirements (SCRs), Order No. 91-137, 91-139, and 91-140 for

Subunits 1, 2, and 3 of OU 1 in September 1991. Also, the U.S. EPA issued a Record of Decision (ROD) in September 1991. The Final SCRs and the ROD contain the approved remedy for cleanup at the site. The remedy selected in the SCRs and ROD for final site cleanup consisted of the following elements:

1) Soil vapor extraction and treatment
2) Groundwater extraction
3) Treatment of extracted groundwater by air stripping
4) Discharge of treated water under NPDES permit
5) Deed restriction prohibiting the use of shallow groundwater for drinking water.
6) Long-term groundwater monitoring

The SCRs set cleanup standards at California proposed or adopted Maximum Contaminant Levels (MCLs), EPA MCLs, California Action Levels, or levels based on a risk assessment. Applicable groundwater cleanup standards contained in the Final SCR were reviewed. There have been no changes in the cleanup standards contained in the SCR. These cleanup standards are listed in the following table:

Table 2. Groundwater Cleanup Standards

Chemical	Cleanup Standard (micrograms/Liter)
Benzene	1
Chloroform	5
Chloromethane	5
4-Chloro-3methylphenol	7
1,2-Dichlorobenzne	60
1,4-Dichlorobenzne	5
1,1-dichloroethane (1,1-DCA)	5
1,1-dichloroethene (1,1-DCE)	6
cis-1,2-dichloroethene (cis-1,2-DCE)	6
trans-1,2-dichloroethene (trans-1,2-DCE)	10
2,4-dimethylphenol	46
2,4-Dinitrophenol	5
Ethylbenzene	68
Freon 113	1,200
2-Methyl-4,6-dinitrophenol	1
Pentachlrophenol	1

Chemical	Cleanup Standard (micrograms/Liter)
Phenol	5
Tetrachloroethene (PCE)	5
1,1,1-Trichloroethane (1,1,1-TCA)	200
Trichloroethene (TCE)	5
Vinyl Chloride	0.5
Xylene (total)	1,750

4.2 Remedy Implementation

4.2.1 Groundwater

Groundwater extraction and treatment has been conducted continuously since 1984. NSC added additional groundwater extraction capabilities in 1986, 1988, 1990, and 1992. During the five-year period covered by this review (2008 to 2013), NSC operated three separate groundwater extraction systems within the plume (on the NSC campus, along East Arques Avenue, and AMD E-1, which was shut down in April 2005) and a dewatering/extraction system at the down-gradient end of the plume (at Lakeside Drive near Highway 101). NSC operated 38 extraction wells and the Lakeside dewatering system from 2001 to 2005. In February 2005, extraction from 20 wells was suspended with Water Board approval. These wells were shutdown because they had low VOC mass removal, low pumping rates, or both. Effluent from the treatment systems is treated by air stripping and ozone technologies and then discharged to Calabasas Creek under NPDES Permit No. CAG 912003. Since October 1991, NSC and TI have removed approximately 5,290 pounds of VOC mass from groundwater. The VOC mass removed between 2006 and 2011 was 604 pounds.

NSC installed an ozone sparging (OS) system with soil vapor extraction (SVE) and treatment in September 2001 to address lingering high VOC concentrations in groundwater at a former source area near former Buildings 2, 3, and 4. As clean up progressed in various zones, ozone injection was stopped. Ozone injections into various zones were stopped in March 2007 and in February 2008. OS/SVE was discontinued in the A zone at the end of January 2009 due to required OS/SVE system repairs. Alternative in-place remedial approaches have been evaluated within the E zone and therefore, the OS/SVE system has not been restarted.

4.2.2 Soil

Soil vapor extraction (SVE) and treatment was initiated in 1992 and has been conducted in 14 former source areas on the NSC Site. By February 2005, SVE was concluded in all but one of these source areas, upon receiving confirmation from the Water Board that soil cleanup standards were met. The SVE system at Building C Leak 5 Area was shut down in March 2005. Total VOC mass removed to date by the SVE system is 26,261 pounds.

4.2.3 Deed Restrictions

In May 1993, National Semiconductor recorded a covenant for the NSC property, as required by the ROD. The property owner will record a new deed restriction(s) in 2013 consistent with current State law (California Civil Code section 1471).

4.2.4 AMD/MMI Site

As indicated in Section 3 above, because the AMD/MMI site in Subunit 2 of the OU1 is a separate U.S. EPA Superfund site, remedial activities performed by AMD and TWC Storage, LLC, in Subunit 2 will be addressed in a separate five-year review report, due September 30, 2014.

4.3 Operation and Maintenance (O&M)

The property owner submits annual groundwater monitoring, soil vapor monitoring reports and quarterly NPDES reports.

The GWET systems operated as designed during the five-year period covered by this report. The main costs associated with the operation and maintenance of the GWET systems are sampling, analytical laboratory fees, electricity, parts, and consulting fees.

Other costs associated with the cleanup of soil and groundwater at the Site were as follows:

- Excavation and removal of VOC-impacted soil from Building C Leak 5 source area
- In-place treatment of soil by chemical oxidation injection Building C
- Enhanced In-situ Bioremediation (EISB) pilot studies at Buildings E, G and 9

The cost incurred during the period of September 2006 through May 2011 for all activities related to groundwater and soil cleanup at the site was $3.317 million. The following table provides details of the costs.

Table 3. O&M Costs

From	To	Total Cost
September 1991	August 2001	$8.93 million
September 2001	August 2006	$3.514 million
September 2006	May 2011	$3.317 million

5 Progress Since Last Review

5.1 Previous Five-Year Review Protectiveness Statement and Issues

The protectiveness statement from the 2008 FYR for the NSC Site stated the following:

"The remedy is considered to be protective of human health and the environment because 1) the remedy is functioning as intended and is being evaluated to enhance the effectiveness of the existing remedies, 2) exposure pathways that could result in unacceptable risks are being controlled, and 3) institutional controls are preventing exposure to, or the ingestion of, contaminated groundwater."

The 2008 FYR included three issues and recommendations. Each recommendation and the current status are discussed below.

Table 4. Status of Recommendations from the 2008 Five-Year Review

Issues from Previous Review	Recommendations	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
Declining effectiveness of GWET system over time	Evaluate alternative cleanup technologies such as chemical oxidation, bioremediation, and ozone sparging.	NSC	9/30/2013	Operated three GWET and one OS systems and removed VOCs. Bioremediation pilot study at Bldgs. 9 and G, and chemical oxidants (persulfate injection) at Bldg. C	2009-2013
Declining effectiveness of SVE and treatment system over time	Evaluate and implement alternative remedial technologies such as chemical oxidation.	NSC	9/30/2013	Excavated impacted soil from Leak 5 Area. Conducted bioremediation pilot study at Bldgs. 9 and G, and chemical oxidation (persulfate injection) at Bldg. C	2009-2013
Deed restriction is not consistent with current California law	A new restrictive covenant must be recorded that is consistent with current California law.	NSC, EPA, Water Board	9/30/2010	New restrictive covenant will be recorded by September 2013	9/30/2013

5.2 Progress Since the Previous Five Year Review

Groundwater

Following discontinuation of OS/SVE, NSC implemented a vegetable oil injection pilot study at the Building E area in January 2007 to accelerate biological dechlorination of VOC-impacted groundwater. The data collected to date did not demonstrate that this method of vegetable oil bioremediation fully addresses the VOCs present at the Site and therefore, it is not appropriate for expansion to other areas of the facility.

NSC also implemented an in-situ chemical oxidation pilot study at the Building C Leak 5 Area in March and July 2008 to evaluate the effectiveness of this technology in breaking down VOCs and SVOCs in shallow groundwater.

A hydrogen peroxide pilot study was conducted to determine the effectiveness in further decreasing chlorinated VOC concentrations in A-zone groundwater. A total of 17 wells were installed in August 2009 as part of the hydrogen peroxide injection and monitoring program. Groundwater monitoring results following injections indicated little change in VOC or petroleum based solvent concentrations from baseline values. Further injections of hydrogen peroxide injections were not conducted.

Following the hydrogen peroxide pilot study, an enhanced in-situ bioremediation (EISB) pilot study was conducted between June 2011 and July 2012 to evaluate anaerobic bioremediation as a method for reducing VOC concentrations in groundwater through bioaugmentation and carbon substrate injection. This EISB pilot study was conducted north of Building G in an area approximately 35- by 40-feet in area.

Prior to performing the injection, a baseline groundwater monitoring event was performed in June 2011. A comparison of the baseline and post-injection sampling results confirmed that the EISB approach successfully reduced chlorinated VOCs concentrations in highly impacted areas. NSC is currently evaluating expanding this remedial approach.

A bioremediation pilot study was designed and conducted north of Building 9 to evaluate the effectiveness of delivering a low-solubility electron donor in-situ along with a naturally-occurring bacterial culture to stimulate the degradation of chlorinated ethenes present in groundwater at the Site. This pilot study showed that EISB, with lactate and emulsified vegetable oil as electron donors and bioaugmentation of KB-1®, could be a viable and highly-effective treatment technology for in-situ reductive dechlorination of chlorinated ethenes in groundwater at the Site.

NSC implemented a chemical oxidation treatment program at the Leak L5 Area located beneath Building C, following the soil excavation. Alkaline-activated persulfate was injected in November 2011, March 2012, and July 2012. Based on the initial groundwater monitoring results, it appears the injections have effectively treated the targeted contaminants, but additional injection events will be performed to further reduce Site concentrations at the Leak L5 Area.

Soil

In December 2009 and January 2010, approximately 1,440 tons of VOC-impacted soil exceeding the cleanup criteria (1 mg/kg) was removed from the Leak 5 Area and sent to a permitted landfill. The VOC mass removed during this review period from soil by excavation at the Leak L5 Area equaled approximately 2,795 pounds. The excavation footprint was approximately 70 feet by 30 feet and extended approximately 11 feet below the bottom of the slab elevation. Following the remedial excavation, a lateral injection pipe was installed within a 2-foot drain rock layer across the former remedial excavation area footprint at an elevation approximately 10 feet bgs. This PVC pipe was plumbed to the ground surface and set in a well box for future chemical oxidation injection treatments. The infiltration gallery system was installed to facilitate the chemical treatment of unsaturated soils below 11 feet bgs and the underlying saturated soil and groundwater. The excavated area was backfilled with drain rock, controlled-density fill, and "clean" imported soil.

The Leak L5 Area soil unit is defined as soil existing from the ground surface to 12 feet bgs. Soil exceeding the cleanup criteria has been excavated and removed to a depth of 11 feet bgs. The remaining soil between 11 and 12 feet bgs will be treated by chemical oxidation. The closure request for this soil unit will be addressed following additional chemical oxidation treatments.

6 Five-Year Review Process

6.1 Administrative Components

The Water Board is the lead agency for the Site. The Water Board began the five-year review in January 2013 and scheduled its completion for August 2013. The Water Board effort was led by Max Shahbazian, remedial project manager (RPM) for the NSC site. The EPA team for the Site was led by Matt Salazar, RPM and also included the EPA Site attorney Thanne Cox, and hydrogeologist Herb Levine. A review schedule was established that consisted of the following:

- Community notification;
- Document review;
- Data collection review;
- Site inspection; and
- Five-year review report development and review

6.2 Community Involvement

A public notice was placed in the Santa Clara Valley Weekly on May 1, 2013, announcing that the FYR was being conducted, and to contact the Water Board or EPA if the public had any questions or concerns or information to share about the remedy being conducted at the Site. A copy of the public notice, published on May 1, 2013 in the Santa Clara Valley Weekly, is presented in Appendix A.

The FYR report will be made available to the public once it has been finalized. Copies of this document will be placed on the Water Board's website at http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=SL720841216 , and EPA's website at www.epa.gov/region9/nationalsemiconductor.

6.3 Document Review

This five-year review included a review of relevant, site-related documents including the remedial action reports, ROD, NSC's Fourth Five-Year status report (submitted to the Water Board on March 25, 2013), annual groundwater monitoring reports, a risk assessment report and a field sampling report. A complete list of the documents reviewed can be found in Appendix B.

6.3.1 ARARs Review

Section 121(d)(2)(A) of CERCLA specifies that Superfund remedial actions must meet any federal standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate requirements (ARARs). ARARs are those standards, criteria, or limitations promulgated under federal or State law that specifically address the hazardous substance, pollutant, contaminant, RA, location, or other circumstance at a CERCLA site.

The regulations selected as ARARs and cleanup goals listed in the ROD have remained unchanged from the date of the original ROD (June 1991). An evaluation of ARARs and a summary of chemical-specific ARAR changes are provided in Tables 5 and 6.

Table 5. Summary of Groundwater Chemical-Specific ARAR Changes

Contaminants of Concern	1991 ROD		Current Regulations		Standard Changed Since ROD?
	Ground water Clean- up Level (µg/L)	Basis for Clean- up Level	Federal MCL (µg/L)	State MCL (µg/L)	
Benzene	1	CA MCL	5	1	No
Chloroform	5	CA MCL	4	5	No
Chloromethane	5	CA MCL		7	No
4-Chloro-3methylphenol	7	CA MCL		7	No
1,2-Dichlorobenzene	60	CA MCL	60	60	No
1,4-Dichlorobenzene	5	CA MCL	75	5	No

Contaminants of Concern	1991 ROD		Current Regulations		Standard Changed Since ROD?
	Ground water Clean- up Level (µg/L)	Basis for Clean- up Level	Federal MCL (µg/L)	State MCL (µg/L)	
1,1-Dichloroethane (1,1-DCA)	5	CA MCL	NA	5	No
1,1-Dichloroethene (1,1-DCE)	6	CA MCL	7	6	No
Cis-1,2-Dichloroethene (cis-1,2-DCE)	6	CA MCL	70	6	No
Trans1,2-Dichloroethene (trans-1,2-DCE)	10	CA MCL	100	10	No
2,4-dimethylphenol	46	CA MCL		46	No
2,4-Dinitrophenol	5	CA MCL		5	No
Ethlylbenzene	68	Risk-based	700	300	No
Freon 113	1,200	CA MCL	NA	1,200	No
2-Methyl-4-6-dinitrophenol	1	CA MCL		1	No
pentachlorophenol	1	CA MCL	1	1	No
Phenol	5	CA MCL		5	No
Tetrachloroethene (PCE)	5	CA MCL	5	5	No
1,1,1-Trichloroethane (1,1,1-TCA)	200	CA MCL	200	200	No
Trichloroethene (TCE)	5	CA MCL	5	5	No
vinyl chloride	0.5	CA MCL	2	0.5	No
Xylenes	175	Risk-based	10,000	1,750	No

Table 6. Applicable or Relevant and Appropriate Requirements Evaluation

Medium/Authority	ARAR	Requirement	Effect on Protectiveness
Contaminant-Specific ARAR	Citation		
Groundwater - Federal Drinking Water Standards	Federal SDWA[1] Section 1412, 42 USC §300f-1 and 40 CFR Part 141.11-141.6 National Primary Drinking Water Regulations	Standards have been adopted as enforceable standards for public drinking water systems.	There have been no changes to the federal MCLs since the last FYR. Protectiveness is not affected.
Groundwater - State Drinking Water Standards	CA SDWA Health and Safety Code, Div 5, Part 1, Chapter 7, 4020 et seq., California Domestic Water Quality Monitoring Regulations, CAC Title 22, Division 4, Chapter 15,§ 64401 et seq.	Establishes state MCL used to establish groundwater cleanup levels if more stringent than the federal MCL.	There have been changes to the state MCLs since the last FYR. Protectiveness is not affected
Action Specific ARAR	Citation		
Groundwater – Porter - Cologne Water Quality Control Act	California Water Code Division 7, Chapter 4, Article 4 §13263	Establishes authority for State and Regional Water Boards to determine site-specific discharge requirements.	The groundwater extraction and treatment system has been in operation since 1984.
Groundwater discharge - Federal Clean Water Act (CWA)	33 USC 1251 et seq. Section 402 NPDES and California Water Code Division 7, Chapter 3 Article 4, §13160	Establishes authority for State to be the water pollution control agency for all purposes stated in the CWA NPDES requirements (Section 402 of CWA).	The groundwater extraction and treatment system has been in operation since 1984
Treatment by carbon adsorption system	Solid Waste Hazardous Waste Control as amended by Resource Conservation and Recovery Act 42 USC §6901 and California Hazardous Waste Control Health and Safety Code Division 20, Chapter 6.5, Articles 2, 4, 4.5, 5, 6, 6.5, and 7.7	Remedial activities involving on-site management of hazardous wastes from spent carbon disposal, storage, and handling.	The groundwater extraction and treatment system has been in operation since 1984

Medium/Authority	ARAR	Requirement	Effect on Protectiveness
Underground Injection Control – Safe Drinking water Act	Safe Drinking Water Act 40CFR 144.13(4)(C)	Treatment requirements for water if it is re-injected into the groundwater	The groundwater extraction and treatment system has been in operation since 1984

6.3.2 Human Health Risk Assessment Review

A Baseline Public Health Evaluation (BPHE) was performed in July 1990 by Clement Associates, Inc., under contract to the Water Board, to evaluate the risk posed by the site in its condition as of 1989, when remediation was already underway. The BPHE evaluated the chemicals present at the site and possible routes of exposure to humans and animals for each potentially contaminated medium, including groundwater, soil, air and surface water. The air pathway was not fully evaluated as part of the BPHE due to a high level of uncertainty associated with contaminant concentrations in soil at the time of the assessment. Using very protective assumptions regarding pollution concentrations, distributions, toxicity, and potential routes of exposure for the current land use, the BPHE indicated that based on the modeling conducted that there were no risks for unacceptable indoor air exposure at down-gradient locations. Additionally the BPHE stated that based on the restriction limiting domestic use of shallow groundwater, NSC's continued soil and groundwater cleanup was appropriate to reduce hypothetical future risks to acceptable levels.

Soil vapor extraction (SVE) and soil excavation and disposal have been the primary remedial approaches to reducing concentrations of contaminants in site soils. SVE has been successful at remediating source area unsaturated zone soils at all the former source areas. To date, the Water Board has granted no further action at 13 of the 14 source areas after total VOC concentrations were measured to be below the site cleanup criteria of 1 milligram per kilogram. The Leak L5 Area is the last remaining soil unit that has not yet obtained a "No Further Action" determination from the Water Board. The Leak L5 Area is located beneath Building C and therefore, the exposure pathway associated with soils in the Leak L5 Area is not complete. With the exception of small landscaped areas, the site is covered with asphalt parking or buildings and therefore, the exposure pathway to site soils is not complete.

The current groundwater extraction systems continue to demonstrate stable and adequate capture areas for containment of groundwater impacts in SU1, SU2 and SU3. Groundwater extraction is effective in containing and reducing concentrations in the groundwater plume, but achieving groundwater cleanup goals with this technology may not be technically feasible. A deed restriction prohibits the use of the A- and B-aquifers as a source of drinking water until groundwater cleanup standards have been achieved and therefore, the groundwater exposure pathway is not complete.

At the request of the Water Board in July 2004, Treadwell & Rollo prepared a Focused Risk Assessment Report to present the results of a re-evaluation of the vapor intrusion pathway for the site using both the new EPA provisional TCE cancer slope factor and the current Cal EPA TCE

cancer slope factor. In May 2004, soil gas, sub-slab, ambient and indoor air samples were collected from Buildings A, B, E, 9, 19, 39 and the Solvent Pad as part of this assessment. Overall, no commercial or residential total chemical excess cancer risks for each of the buildings exceeded a value of $1x10^{-06}$, a general regulatory risk considered protective. Excess cancer risks less than 1E-06 are considered by regulatory agencies to be insignificant. None of the non-cancer hazards for each of the buildings exceeded the threshold value of 1. Non-cancer hazards less than 1 indicate that there is no risk of non-cancer health hazards.

6.3.3 Vapor Intrusion

EPA's understanding of contaminant migration from soil gas and/or groundwater into buildings has evolved over the past few years, leading to the conclusion that vapor intrusion may have a greater potential for causing risk to human health than assumed when the ROD was prepared. In April 2013, EPA released a final draft version of its vapor intrusion guidance, *OSWER Final Guidance* for *Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air (External Review Draft),* to the public for comments.

The potential for vapor intrusion is evaluated following a "multiple lines of evidence" approach. TCE is a concern because of its volatile properties and the recent toxicological assessment by EPA. Factors to be considered in evaluating vapor intrusion include:

- Concentrations of TCE in the groundwater make vapor intrusion a potential concern for building occupants of the former NSC buildings.
- The depth to groundwater can be as low as 10 feet. TCE vapors often follow preferential pathways.
- Building C lies above the highest concentrations of TCE contamination.
- Preferential pathways for subsurface indoor air movement (e.g., subsurface fractures) and/or conduits for vapor migration into adjacent areas (e.g., utility lines, sumps) likely exist due to the age of the buildings.

An additional vapor intrusion assessment was required in August 2012 and is ongoing. To assess the potential vapor intrusion pathway, indoor air samples were collected with heating, ventilation, and air conditioning (HVAC) systems operating normally and turned off, as well as sub-slab soil gas samples. A total of seven buildings located on the property, which is south of the Central Expressway, were assessed. The buildings assessed were overlying groundwater concentrations exceeding 100 micrograms per liter of TCE and included Buildings 9, 19, 39, C, E, F, and G. Indoor air samples were collected from each building at locations approved by the Water Board and EPA. It was found that there were no indoor air exceedances and only one pathway air exceedance while the HVAC was operating, however, when the HVAC was turned off, PCE was above the screening level in Building C. There were also pathway air concentration levels above the ESLs in Building 39, C and E. The results of the sampling are included in further detail in the data review section, Section 6.4.3.

Monitoring of the subsurface-to-indoor air vapor intrusion pathway is currently ongoing for the on-property TI (formerly NSC) buildings. An off-property vapor intrusion investigation will be necessary to evaluate impacts to commercial and industrial properties located hydraulically

downgradient of the source site, north of the Central Expressway. There are no residences overlying the existing TCE plume.

6.3.4 Toxicity Values

Since the 1991 health evaluation, there have been a number of changes to the toxicity values for certain contaminants of concern at the Site. Revisions to the toxicity values for 1,1-DCE and vinyl chloride indicate a lower risk from exposure to these chemicals than previously considered.

Groundwater results are compared to U.S. EPA Regional Screening Levels (RSLs) as a first step in determining whether response actions may be needed to address potential human health exposures. The RSLs are chemical-specific concentrations that correspond to an excess cancer risk level of $1x10^{-6}$ (or a Hazard Quotient (HQ) of 1 for non-carcinogens) developed for standard exposure scenarios (e.g., residential and commercial/industrial). RSLs are not de facto cleanup standards for a Superfund site, but they do provide a good indication of whether actions may be needed. In September 2011, EPA completed a review of the TCE toxicity literature and posted on Integrated Risk Information System (IRIS) both cancer and non-cancer toxicity values which resulted in lower RSLs for TCE (see Table 7). The screening level for chronic exposure for cancer excess risk level of $1x10^{-6}$ is 0.44 µg/L. EPA uses an excess cancer risk range between $1x10^{-4}$ and $1x10^{-6}$ for assessing potential exposures, which means a TCE concentration between 0.44 and 44 µg/L. The current MCL for TCE of 5 µg/L is within the revised protective carcinogenic risk range. EPA's 2011 Toxicological Review for TCE also developed safe levels that include at least a 10 fold margin of safety for health effects other than cancer. Any concentration below the non-cancer RSL indicates that no adverse non-cancer health effect from exposure is expected. Concentrations significantly above the RSL may indicate an increased potential of non-cancer effects. The non-cancer screening level for TCE is 2.6 µg/L. EPA considers the TCE MCL of 5 µg/L protective for both cancer and non-cancer effects.

Table 7. Summary of Drinking Water RSLs For Contaminant Of Concern

Contaminant of concern	RSL for cancer excess risk level of 1x10-6 (ug/L)	For non-cancer hazard (ug/L)
TCE	0.44	2.6

6.4 Data Review

The data presented in the above mentioned reports were reviewed and are summarized below.

6.4.1 Groundwater Data

Groundwater monitoring data collected from 2006 to 2012 were reviewed to evaluate progress in remediating the groundwater pollutant plume. The data review shows that the VOC concentrations in groundwater in the former source areas and across the plume continue to decline. VOC concentrations in monitoring wells located along the down-gradient and perimeter edges of the off-property area have remained stable at low to non-detectable concentrations, demonstrating that hydraulic control of the VOC plume has been achieved.

Table 8. TCE Concentrations in Monitoring Wells

TCE Concentrations in Off-property Down-gradient and Perimeter Wells (ug/L)

Well No.	2006	2007	2008	2009	2010	2011	2012
62A	25	16	20	20	26	41	56
97A/B1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
128A	NS	NS	4.7	2.2	3.3	5.0	3.1
139A	<0.5	<0.5	<0.5	<0.5	NS	NS	NS
MM33A	8.3	6.7	5.1	4.5	5.0	2.6	3.4
MM34A	79	39	48	34	10	16	44
MM40A	110	39	24	17	23	1.5	21
83B1	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
124B1	1.5	1.5	1.7	1.7	0.7	0.65	0.7
125B1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
126B1	95	110	120	100	91	130	130
127B1	15	10	10	8.6	11	9.4	7.6

TCE Concentrations in Source Area Wells (ug/L)

Well No.	2006	2007	2008	2009	2010	2011	2012
11A	2.6	3.1	2.9	3.7	3.3	2.7	3.8
30A	130	120	130	160	140	130	98
89A	29	28	32	40	9.7	22	12
46A	610	740	420	850	360	610	480
15B1	120	130	65	93	96	130	110
112A/B1	130	75	69	25	54	43	44
113A	50	53	40	40	36	19	35
114A/B1	89	77	47	41	32	47	40
45A/B1	150	170	150	2.6	110	100	130
14B1	49	57	36	68	68	59	68
111A/B1	49	46	37	21	25	24	25
39A	17	36	19	16	NS	NS	NS
141A	20	16	20	19	NS	NS	NS
142A	130	110	88	120	NS	NS	NS
143A	<5.0	<5.0	ND<10	ND<10	NS	ND<20	NS
144A	830	180	300	550	NS	73	NS

Notes:
ND = Not detected
NS = Not sampled

Between January 2006 and December 2011, approximately 219 million gallons (MG) of groundwater were extracted, from which 604 pounds of VOCs were removed. In comparison, almost 1,370 pounds of VOCs were removed during the previous five-year period. The amount of VOCs removed during the last five years has thus declined by 56% from the previous five-year period. Mass removal efficiency during the last five years compared with the previous five-year period has remained at about 2.7 pounds of VOCs per MG of water extracted. Between

October 1991 and December 2011, an estimated 5,290 pounds of VOCs were removed by the groundwater extraction system.

The combination of OS/SVET and GWET has been successful in controlling migration of the plume, in removing VOC mass from saturated soils, and reducing concentrations of VOCs in groundwater. After almost 22 years of groundwater extraction; however, the amount of VOC mass being removed has declined considerably and VOC concentrations in groundwater may be stabilizing. This observation of an initial significant reduction in VOC concentrations followed by a leveling off of the reduction in VOC concentrations has been found to occur at many other sites in the area and around the country.

Remedial efforts have reduced VOC concentrations in groundwater in source areas and across the plume. Maximum VOC concentrations in on-site source areas have been reduced from over 100,000 ug/L to less than 1,000 ug/L. In general, TCE concentrations are significantly less than 1,000 µg/L across the plume; however, elevated concentrations are still present near Building C and Building G. Several VOCs such as TCE, PCE, cis-1,2-DCE, ethylbenzene, xylenes, and chlorobenzene in groundwater remain above cleanup standards due to the complexity of site hydrogeology, recalcitrance of the chlorinated solvents, and limitations in current cleanup technology. In 2012, TCE, PCE and cis-1,2-DCE were the predominant VOCs detected in groundwater at a maximum concentration of 480 ug/L, 760 ug/L and 410, ug/L, respectively. The elevated concentrations of TCE and cis-1,2-DCE are limited in horizontal and vertical extent and are currently undergoing active remediation.

No potentially toxic or mobile transformation products have been identified during sampling that were not already present at the time of the Record of Decision.

6.4.2 Soil Data

Soil vapor monitoring data collected from 2001 to 2012 were reviewed to evaluate progress in remediating VOCs and SVOCs in unsaturated soil beneath the site. The data review shows that VOC and SVOC concentrations in unsaturated soil at 13 of the 14 former source areas have declined and soil cleanup standards have been achieved.

To date, SVE systems have removed a total of 26,261 pounds of VOCs. The majority of VOC mass (23,400 pounds) was removed from the Tank 13 and Leak L5 source areas at Building C. Additional mass has been remediated in place by various pilot and full-scale remedial approaches. VOC and SVOC soil cleanup standards for the Leak L5 source area have not been achieved.

Analytical results of the confirmation soil samples obtained during well installation at the former UTC property (1050 East Arques Avenue) indicated chlorinated VOCs were the only COCs. The VOC soil cleanup standard of 1.0 mg/kg for the former UTC property has been achieved.

6.4.3 Soil Vapor and Indoor Air Data

An additional vapor intrusion assessment was required in August 2012 to assess the potential vapor intrusion pathway with the HVAC operating both normally and when off. Samples of indoor air, pathway air, and sub-slab soil were collected by the Water Board and EPA during both HVAC states. A total of seven buildings located on TI's property were assessed. The buildings assessed were overlying groundwater concentrations exceeding 100 micrograms per liter of TCE and included Buildings 9, 19, 39, C, E, F, and G.

Indoor Air Sampling Results with HVAC System Operating

The results indicate that indoor air concentrations are below Water Board and USEPA screening criteria and therefore, vapor intrusion is not impacting indoor air quality with the HVAC units operating normally in the buildings sampled. The only sample location with a concentration (16 $\mu g/m^3$) above USEPA RSLs and/or Water Board Environmental Screening Levels (ESLs) with HVAC units operating was collected from the subterranean tunnel located beneath Building E. This tunnel is no longer in use and is secured by a locked door, rarely visited, and is only accessible to facilities and security staff. The tunnel previously housed utility and drain line conduits, which have been removed.

Indoor Air Sampling Results with HVAC System Turned Off

Concentrations of PCE in indoor air samples collected with the HVAC system turned off from Building C are above the PCE ESL. With the HVAC systems turned off, indoor air samples indicate that vapor intrusion is occurring or can occur in Building C. Concentrations of PCE and/or TCE in the pathway air samples collected from Buildings C, E and 39 with the HVAC system turned off are above their ESLs. With the HVAC systems turned off, pathway samples indicate vapor intrusion is occurring or can occur in Buildings C, E and 39.

Maximum PCE and TCE concentrations detected in soil vapor, pathway and indoor air samples are summarized in Tables 9 and 9b below. PCE and TCE concentrations that exceed their respective ESLs are shown with bold font.

Table 9. PCE and TCE Concentrations in Indoor Air and Sub-Slab Soil Gas Samples with HVAC Systems Operating

PCE/TCE ($\mu g/m^3$) **ESLs**	**Bldg. 9**	**Bldg. 19**	**Bldg. 39**	**Bldg. C**	**Bldg. E**	**Bldg. F**	**Bldg. G**
	HVAC operated	HVAC operated	HVAC uncertain	HVAC operated	HVAC operated	HVAC operated	Not occupied
Indoor air 2/3	0.54/0.59	0.15/0.98	0.081/0.31	1.8/0.22	<0.14/0.35	<0.14/0.27	0.32/1.4
Pathway air 2/3	NS	0.16/1.2	0.47/2.4	1.3/0.34	1.6/**16**	NS	0.084/0.25
Soil gas 2,000/3,000	380/2,500	230/**5,300**	210/1,000	**5,200**/69	81/800	<8.2/<11	250/660

Notes: Samples collected with HVAC operating normally in 2012 and 2013.
PCE data is presented first (i.e. 0.54/0.59 µg/m ^{3} represents a detected PCE concentration of 0.54 and a detected TCE concentration of 0.59 µg/m ^{3}).
Indoor air samples were collected from areas normally occupied during business hours and pathway samples were collected from areas not normally occupied during business hours.
PCE and TCE concentrations that exceed their respective ESLs are shown with bold font.

Table 9b: PCE and TCE Concentrations in Indoor Air and Sub-Slab Soil Gas Samples with HVAC Systems Turned Off

PCE/TCE (µg/m ^{3}) ESLs	Bldg. 9	Bldg. 19	Bldg. 39	Bldg. C	Bldg. E	Bldg. F	Bldg. G
Indoor air 2/3	0.58/1.8	0.31/2.1	0.44/0.96	**18**/0.37	0.21/0.36	0.17/0.31	0.35/1.3
Pathway air 2/3	NS	0.29/1.9	**6.2/27**	**17**/0.4	1.8/**18**	NS	0.23/0.89
Soil gas 2,000/3,000	380/2,500	230/**5,300**	210/1,000	**5,200**/69	81/800	<8.2/<11	250/660

Notes: Samples collected with HVAC turned off in 2012 and 2013.
PCE data is presented first (i.e. 0.58/1.8 µg/m ^{3}) represents a detected PCE concentration of 0.58 and a detected TCE concentration of µg/m ^{3}).
Indoor air samples were collected in 2012/2013 from areas normally occupied during business hours and pathway samples were collected from areas not normally occupied during business hours.
PCE and TCE concentrations that exceed their respective ESLs are shown with bold font.

Additional vapor intrusion monitoring is currently ongoing on-site and future assessments are being planned for the area down-gradient of TI's property. There are no residences over the TCE plume.

6.5 Site Inspection

Site inspections were conducted on November 13 and 14, 2012, by Regional Water Board and US EPA staff. The purpose of the inspection was to assess the conditions of the Site and select locations for sub-slab vapor and indoor air sampling in the Site buildings. No activities that could interfere with cleanup of the site were observed. Institutional controls that are in place include prohibitions on the use of groundwater until the cleanup levels are achieved. No activities were observed that would have violated the institutional controls.

6.6 Interviews

Regional Water Board and US EPA staff did not conduct interviews during this FYR.

6.7 Institutional Controls

The institutional controls that are in place include prohibitions on the use of groundwater as the source of drinking water and for controlling on-site activities that could endanger public health

or the environment due to exposure to VOCs until cleanup levels are achieved. The Regional Water Board and EPA expect to have an updated covenant recorded by September 30, 2013.

The following table lists the ICs associated with the Site.

Table 10. Institutional Controls Summary Table

Media	ICs Called for in the Decision Documents	IC Objective	Instrument in Place	Notes
Groundwater	Yes	Restrict installation of groundwater wells, groundwater use, and on-site activities that could endanger public health	Deed restriction	Will be updated in September 2013
Sediment	No	No ICs necessary as only groundwater was found at unacceptable risk levels in the1991 ROD	None	None
Surface Water	No	No ICs necessary as only groundwater was found at unacceptable risk levels in the1991 ROD	None	None
Soil	Yes	Restrict soil excavation and on-site activities in the former source areas that could endanger public health	Deed restriction	Will be updated in September 2013

7 Technical Assessment

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

The groundwater remedy is functioning as intended, although groundwater extraction efficiency is decreasing. The SVE system was shut down in 2005 due to its decreased efficiency in removing the VOCs and SVOCs from soil, but the system was able to achieve the cleanup goals before it was shut down. The current groundwater monitoring program is sufficient to track the plume and detect any migration beyond the current plume boundaries, as well as track the effectiveness of remedial actions. Down-gradient monitoring wells have remained at non-detect or below the cleanup level. Thus, the plume has not expanded in size and has not migrated vertically. Contamination remains confined to the shallow groundwater bearing zones.

The combination of GWET, soil excavation, pilot EISB and chemical oxidation, continued to remove significant VOC mass from soil and groundwater, and VOC concentrations have declined across the plume. The efficiency of VOC removal through groundwater extraction has declined considerably since the previous five-year review period; however, TI is evaluating alternate groundwater cleanup technologies such as chemical oxidation and EISB to determine whether other methods could achieve cleanup standards more quickly than the methods currently

employed. Actions taken by TI include the following: implementing an in-situ chemical oxidation pilot study at the Building C Leak 5 Area in March and July 2008, excavating 1,440 tons of impacted soil from Leak L5 Area at Building C, and developing an EISB pilot study at Buildings 9 and G in July 2010 and June 2011, respectively. More recent activities include conducting a full scale persulfate injection event at Building C in March 2012 and conducting a vapor intrusion assessment on-property in December 2012 and January 2013.

The institutional controls in place include prohibitions on the use of groundwater until cleanup levels are achieved. No activities were observed that would have violated the institutional controls. However, in 1995, California passed California Civil Code Section 1471, which creates a framework for environmental restriction covenants and specifies how they are to be recorded and made applicable to successors. A new covenant or covenants must be recorded to be consistent with current state law.

7.2 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?

There have been no changes to the physical conditions of the site that would affect the protectiveness of the remedy. The use of the site and the down-gradient area under which the groundwater plume has migrated remains commercial, light industrial, and office space.

There have been no changes to ARARs for the site and no new standards that would affect the protectiveness of the remedy. TCE, PCE and cis-1,2-DCE are the primary chemicals whose concentrations still routinely exceed the cleanup standards. Groundwater cleanup standards for these chemicals have not changed since the ROD was issued.

The exposure assumptions used to develop the Human Health Risk Assessment were for potential future exposure if untreated groundwater were to be used for drinking water and if residential uses were to occur on the site. The changes to the toxicity factors that were used in the baseline risk assessment for the contaminants of concern do not affect protectiveness. Institutional controls prohibit the use of groundwater and groundwater is not currently used at the Site. The land use of the site is primarily commercial/industrial. Vapor intrusion is currently being assessed as an issue.

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

No new information has been identified that could affect the protectiveness of the remedy.

7.4 Technical Assessment Summary

According to the data reviewed and the site inspection, the remedy is functioning as intended by the Record of Decision. The institutional controls in place include prohibitions on the use of groundwater until cleanup goals are achieved. However, in 1995, California passed California Civil Code Section 1471, which creates a framework for environmental restriction covenants and specifies how they are to be recorded and made applicable to successors. A new covenant or

covenants must be recorded to be consistent with current state law. There have not been any changes in the physical condition or land use of the site that would affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy other than the potential for vapor intrusion. Sampling results indicate that vapor intrusion can occur when HVAC systems are turned off in select buildings. Additional vapor intrusion assessment is currently ongoing, on and down-gradient of TI's property. In order to prevent vapor intrusion into indoor air, the buildings' HVAC systems should be operated and maintained in accordance with a revised site management plan.

8 Issues

Table 11 summarizes the current issues for the Texas Instruments Site.

Table 11. Current Issues for the Texas Instruments Site

Issue	Affects Current Protectiveness (Yes or No)	Affects Future Protectiveness (Yes or No)
Sampling results indicate that vapor intrusion can occur when HVAC systems are turned off in select buildings south of the Central Expressway.	No	Yes
Existing deed restriction is not consistent with State law because it was recorded prior to the passage of California Civil Code section 1471.	No	Yes
Further vapor intrusion assessment is required off-property.	Yes	Yes

9 Recommendations and Follow-up Actions

Table 12 provides recommendations to address the current issues.

Table 12. Recommendations to Address the Current Issues at the Texas Instruments Site

Issue	Recommendations and Follow-Up Action	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Yes or No)	
					Current	Future
Sampling results indicate that vapor intrusion is occurring when HVAC systems are turned off in select buildings.	Amend the ROD and revise the Site Management Plan to include O&M requirements for the HVAC systems.	PRP	Water Board	12/2015	N	Y
Existing deed restriction is not consistent with State law because it was recorded prior to the passage of California Civil Code section 1471.	A new restrictive covenant should be recorded for the TI property that is consistent with current California law.	PRP, Water Board, US EPA	Water Board	12/2014	N	Y
Further vapor intrusion assessment is required both on and off-property.	Conduct indoor air sampling at previously unsampled on -property buildings and at off-property buildings downgradient of the source area.	PRP	Water Board	09/2014	Y	Y

10 Protectiveness Statement

A protectiveness determination of the remedy at the NSC Superfund Site cannot be made until a vapor intrusion assessment is completed at all buildings overlying the contamination. Recent indoor air sampling at on-property buildings south of the Central Expressway have indicated that there is vapor intrusion; however, the exposure levels are below screening health levels while the heating, ventilation, and air conditioning (HVAC) systems are operating. All other exposure pathways that could result in unacceptable risks are being controlled, and institutional controls

are preventing exposure to, or the ingestion of contaminated groundwater. To be protective in the long term, new restrictive covenants need to be recorded, the site management plans needs to be revised to include operation and maintenance (O&M) requirements for the HVAC systems, and the Site Cleanup Requirements (SCR) and Record of Decision (ROD) will need to be amended to select a new remedy. Once the source area and downgradient vapor intrusion assessment is completed a protectiveness determination will be made. The Five-Year Review addendum, which will include the protectiveness determination, will be completed by December 31, 2014.

11 Next Review

This is a policy Five-Year Review that requires ongoing FYRs as long as waste is left on-site that does not allow for unrestricted use and unlimited exposure. The next FYR for this Site will be due within five years of the signature date of this FYR.