

NORTHROP GRUMMAN

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25 January 2016

Ms. Melanie Morash
Remedial Project Manager
U. S. Environmental Protection Agency
Region 9
75 Hawthorne Street, SFD-7-1
San Francisco, CA 94105

Re: Addendum to the Technical Memorandum
in Response to the 2014 Five-Year Review Report
Former TRW Microwave Site, 825 Stewart Drive, Sunnyvale, California

Dear Ms. Morash:

Northrop Grumman Systems Corporation is submitting the enclosed Addendum to the Technical Memorandum in Response to the 2014 Five-Year Review Report to provide additional information on two key issues addressed in the memorandum. These issues include the effects of the 2014 source removal activities on onsite groundwater quality and the impacts to the site from offsite sources. The information provided consists of updated site-wide groundwater analytical data from the 2015 annual monitoring event and the results of a recent contaminant migration pathways evaluation.

If you have any questions regarding the information provided in this addendum, please do not hesitate to contact me at 310-332-5057, or our project manager, Linda Niemeyer, at 760-944-9490.

Sincerely,



Joseph P. Kwan
Corporate Director, Environmental Remediation
on behalf of Northrop Grumman Systems Corporation

Enclosure: Addendum to the Technical Memorandum
in Response to the 2014 Five-Year Review Report

cc: Rebecca Mora - AECOM
Linda Niemeyer - Watermark



**ADDENDUM TO THE TECHNICAL
MEMORANDUM IN RESPONSE TO THE
2014 FIVE-YEAR REVIEW REPORT**

**FORMER TRW MICROWAVE SITE
825 STEWART DRIVE
SUNNYVALE, CALIFORNIA**

January 2016

**ADDENDUM TO THE TECHNICAL MEMORANDUM
IN RESPONSE TO THE 2014 FIVE-YEAR REVIEW REPORT**

**FORMER TRW MICROWAVE SITE
825 STEWART DRIVE
SUNNYVALE, CALIFORNIA**

January 25, 2016

Prepared by:

**AECOM
999 W. Town and Country Road
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Prepared for:

**Northrop Grumman Systems Corporation
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**Rebecca Mora
Senior Engineer/Project Manager**

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1.0 INTRODUCTION AND BACKGROUND

On behalf of Northrop Grumman Systems Corporation (Northrop Grumman), AECOM Inc. (AECOM) has prepared this *Addendum to the Technical Memorandum in Response to the 2014 Five-Year Review Report* (Technical Memorandum Addendum) for the former TRW Microwave site located at 825 Stewart Drive in Sunnyvale, California (Site).

The purpose of this Technical Memorandum Addendum is to provide additional information on two key issues addressed in the *Technical Memorandum in Response to the 2014 Five-Year Review Report (Technical Memorandum)* (AECOM, 2015b). These key issues include 1) effects of the late 2014 source area removal activities on onsite groundwater quality, and 2) impacts from offsite sources. Provided herein are results and discussion of the October 2015 site-wide groundwater monitoring event, which represents groundwater conditions one year after source removal activities. Also provided in this addendum are results from a contaminant migration pathway evaluation that support migration of off-site contaminants onto the Site. This information was shared with the United States Environmental Protection Agency (USEPA) in a meeting on December 10, 2015.

2.0 UPDATE ON GROUNDWATER QUALITY FOLLOWING SOURCE TREATMENT

As discussed in the Technical Memorandum, a total of approximately 590 tons of soil and semi-solids and approximately 9,000 gallons of water were removed from the Site source area in November 2014. A detailed description of the 2014 excavation activities at the Site is provided in the *Source Area Soil Removal Report* (Orion Environmental Inc., 2015). Following the excavation activities, enhanced anaerobic bioremediation (EAB) injections were conducted to address remaining source area contamination that was not accessible during excavation. A description of the EAB injections is provided in the *Annual Groundwater Monitoring and Remedial Progress Report* (AECOM, 2015a).

As part of the 2015 annual groundwater sampling event, 26 site monitoring wells were sampled in October, approximately one year after the source area removal activities. Figures 1 and 2 show October 2014 (pre-source removal) and October 2015 (post-source removal) analytical results for the primary Site contaminants (trichloroethene [TCE], cis-1,2-dichloroethene [cDCE], and vinyl chloride [VC]) for Zones A and B1, respectively. Zones A and B1 correspond to the excavation depth of the source removal activities. For some wells, June 2015 sampling data were also collected and are included on the figures. Below are some key observations when comparing October 2014 (pre-source removal) and June/October 2015 (post-source removal) concentrations.

Zone A

- TCE concentrations increased slightly in the area downgradient of the onsite building; however, concentrations in T-8A, T-15A, and T-16A decreased. All onsite TCE concentrations are less than the TCE concentration in well T-7A, which represents contamination migrating onto the site from upgradient.

- cDCE was generally stable before and after source removal with concentrations in some wells slightly increasing (T-8A, T-13A, and T-25A) and in some wells slightly decreasing (T-9A and T-17A). The cDCE concentration in two wells (T-8A and T-13A) recently increased above the cDCE concentration in well T-7A.
- VC concentrations were generally stable with the exception of downgradient well T-16A, which showed an increase from 2.5 to 23 µg/L.

Zone B1

- TCE concentrations decreased in all downgradient wells, with the exception of well T-17B. The TCE concentration in upgradient well T-7B also decreased.
- cDCE concentrations decreased substantially in all downgradient wells, ranging from 29 to 89 percent reductions.
- VC concentrations were generally stable.

Based on these data and observations, the 2014 source area removal activities have appreciably improved downgradient groundwater quality, with more substantial improvements observed in Zone B1. Future trends in groundwater concentrations will continue to be monitored through the site annual groundwater monitoring program.

3.0 UPDATE ON CONTAMINANT MIGRATION PATHWAYS

As discussed in Section 4.0 of the Technical Memorandum, historic and current data suggest that impacts from offsite sources are contributing to increasing contaminant concentrations in some of the onsite, downgradient monitoring wells. This is based on multiple lines of evidence including:

- Substantially higher TCE concentrations in some of the downgradient onsite wells compared to upgradient onsite wells;
- Historic and/or current presence of Freon 113 in onsite downgradient wells which is not attributed to the Site but is attributed to known offsite sources;
- Evidence of historic onsite groundwater extraction causing migration of offsite contamination onto the Site;
- Proximity of some of these downgradient wells to the western Site boundary, bordering the Philips site.

Based on these primarily chemical lines of evidence, it was decided to perform an evaluation of the local subsurface stratigraphy to better understand contaminant migration pathways at and near the Site. The geologic setting is composed of high permeability sand and gravel channel-fill deposits encased in low permeability clay and silt floodplain deposits and/or paleosol

horizons. The sand channels result in complex groundwater flow and contaminant migration pathways. A technique referred to as Environmental Sequence Stratigraphy (ESS) was used to map out channel systems in the vicinity of the Site that serve as primary groundwater flow pathways. ESS methodology uses existing Site lithology data and a keen understanding of the depositional environment to construct stratigraphic cross sections to map out the channel system.

Results and Recommendations

Appendix A includes the presentation slides from a December 10, 2015 meeting with USEPA where results from the ESS evaluation were presented. As shown in these slides, the Site is located in a complex channelized system with strong evidence for lithologic/channel control on contaminant migration. Based on this evaluation, contaminant pathways from offsite sources are apparent in Zones A, B1, and B2.

In Zone A, there is a northeast-oriented channel that traverses the upgradient Philips site and continues onto and across the former TRW Microwave site in the vicinity of well 38-S (Slide 17, Appendix A). Chemistry data (primarily Freon 113 and cis-1,2-DCE concentrations [Slides 7 and 8, Appendix A]) support the conclusion that well 38-S is impacted by offsite sources. Therefore it is recommended that going forward well 38-S not be used to evaluate onsite contaminant concentration trends or effectiveness of onsite remediation.

In Zone B1, two channel deposits underlying the Site were mapped, one of which traces back to the onsite source area, and another which is oriented oblique to the presumed groundwater gradient and is interpreted as a contaminant pathway from offsite sources (Slide 9, Appendix A). Analysis of contaminant constituents associated with these two pathways revealed differing “chemical fingerprints” (Slides 10-12, Appendix A) and indicates that these channel deposits are in fact separate and distinct hydrostratigraphic units (HSUs), referred to as HSU1 and HSU2. The deeper HSU2 is in communication with offsite contaminant source areas to the southwest that significantly contribute to contamination found in onsite wells T-17B, T-4B, and T-9B. Therefore, it is recommended that going forward wells T-17B, T-4B, and T-9B not be used to evaluate onsite contaminant concentration trends or effectiveness of onsite remediation (Slide 18, Appendix A).

In Zone B2, a lower permeability unit oriented to the north-northeast traverses the Site (Slide 13, Appendix A). Onsite well T-10C is located on the western side of this low permeability unit, indicating separation from onsite contamination and communication with contamination coming from offsite. This stratigraphic finding is further supported by the significantly different contaminant concentrations detected in well T-10C compared to onsite wells in Zone B2 (Slide 13, Appendix A). Well T-10C is clearly associated with offsite sources and it is recommended that it should not be used to evaluate onsite contaminant concentration trends or effectiveness of onsite remediation (Slide 20, Appendix A).

4.0 REFERENCES

AECOM, 2015a. *Annual Groundwater Monitoring and Remedial Progress Report*, Former TRW Microwave Site, 825 Stewart Drive, Sunnyvale, California. February 6.

AECOM, 2015b. *Technical Memorandum in Response to the 2014 Five-Year Review Report*, Former TRW Microwave Site, 825 Stewart Drive, Sunnyvale, California. March 31.

Orion Environmental, Inc. 2015. Source Area Soil Removal Report, Former TRW Microwave Site, 825 Stewart Drive, Sunnyvale, California. March 20.

FIGURES



LEGEND

- A-ZONE MONITORING WELL
- B1-ZONE MONITORING WELL
- B2-ZONE MONITORING WELL
- B3-ZONE MONITORING WELL
- B4-ZONE MONITORING WELL
- EDUCATOR
- MONITORING WELL - DESTROYED 2014
- MONITORING WELL - DESTROYED 2004
- - - PROPERTY BOUNDARY

ABBREVIATIONS

- / DENOTES DUPLICATE SAMPLE
- < NOT DETECTED AT OR ABOVE THE DETECTION LIMIT SHOWN
- cDCE cis-1,2-DICHLOROETHENE ANALYSIS RESULTS
- TCE TRICHLOROETHENE
- VC VINYL CHLORIDE

WELL	
ANALYTE	CONCENTRATION IN MICROGRAMS PER LITER

APPROXIMATE ZONE A GROUNDWATER FLOW DIRECTION

T-19A			
Analyte	October 2014	June 2015	October 2015
TCE	<0.50	<0.50	<0.50
cDCE	15	12	13
VC	11	32	33
Freon 113	<0.50	<0.50	<0.50

T-25A			
Analyte	October 2014	June 2015	October 2015
TCE	4	25	27
cDCE	39	61	60
VC	35	38	39
Freon 113	<0.50	<0.50	<0.50

T-14A		
Analyte	October 2014	October 2015
TCE	3.6	23
cDCE	62	56
VC	29	34
Freon 113	<0.50	<0.50

T-7A			
Analyte	October 2014	June 2015	October 2015
TCE	230/170	220	170/190
cDCE	75/64	83	79/90
VC	<2.5/<2.5	<0.50	<2.5/<5.0
Freon 113	<2.5/<2.5	<0.50	<2.5/<5.0

T-13A			
Analyte	October 2014	June 2015	October 2015
TCE	1.4	1.7/2.1	23
cDCE	76	80/96	120
VC	33	3.3/3.9	4
Freon 113	<0.50	<0.50	<0.50

T-8A			
Analyte	October 2014	June 2015	October 2015
TCE	110	67	62
cDCE	56	81	100
VC	<0.50	5.4	2.5
Freon 113	<0.50	<0.50	<0.50

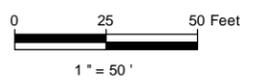
T-16A		
Analyte	October 2014	October 2015
TCE	97	38
cDCE	78	72
VC	2.5	23
Freon 113	<0.50	<0.50

T-15A		
Analyte	October 2014	October 2015
TCE	140	100
cDCE	51	58
VC	<0.50	<0.50
Freon 113	<0.50	<0.50

38-S		
Analyte	October 2014	October 2015
TCE	45	83
cDCE	200	98
VC	12	4.9
Freon 113	1.3	1

T-17A			
Analyte	October 2014	June 2015	October 2015
TCE	62	76	63
cDCE	30	16	12
VC	<0.50	0.71	0.6
Freon 113	<0.50	<0.50	<0.50

T-23A			
Analyte	October 2014	June 2015	October 2015
TCE	32	78	64
cDCE	51	53	61
VC	6.5	4.7	7.8
Freon 113	<0.50	<0.50	<0.50



Former TRW Microwave Site
Zone A Analytical Results
October 2015

Date 01-2016	NORTHROP GRUMMAN	Figure
Project No. 60238860		1



T-19B		
Analyte	October 2014	October 2015
TCE	52	49
cDCE	2.2	1.8
VC	<0.50	<0.50
Freon 113	1.2	1

T-18B		
Analyte	October 2014	October 2015
TCE	<0.50	<0.50
cDCE	<0.50	<0.50
VC	<0.50	<0.50
Freon 113	<0.50	<0.50

T-8B			
Analyte	October 2014	June 2015	October 2015
TCE	10	<5.0	1.2
cDCE	270	150	29
VC	16	55	24
Freon 113	<0.50	<5.0	<0.50

T-10B		
Analyte	October 2014	October 2015
TCE	45	31
cDCE	180	97
VC	16	23
Freon 113	<0.50	<0.50

T-9B			
Analyte	October 2014	June 2015	October 2015
TCE	390	310	150
cDCE	210	220	150
VC	<5.0	2.3	<2.5
Freon 113	<5.0	1	<2.5

T-4B			
Analyte	October 2014	June 2015	October 2015
TCE	5.2	4.9	4.3
cDCE	500	130	120
VC	<5.0	<0.50	<0.50
Freon 113	<5.0	<0.50	<0.50

T-17B			
Analyte	October 2014	June 2015	October 2015
TCE	75	230	280
cDCE	400	310	290
VC	<5.0	0.5	0.5
Freon 113	<5.0	11	9.9

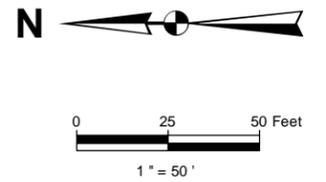
T-7B			
Analyte	October 2014	June 2015	October 2015
TCE	170/170	140/150	72/73
cDCE	11/12	10/9.8	4.8/4.8
VC	<0.50/<0.50	<0.50/<0.50	<0.50/<0.50
Freon 113	3.2/4.4	2.6/2.8	0.81/0.81

T-5B		
Analyte	October 2014	October 2015
TCE	1,500/1,600	1,700/1,800
cDCE	58/64	62/62
VC	<10/<25	<0.50/<0.50
Freon 113	140/160	120/130

- LEGEND**
- A-ZONE MONITORING WELL
 - B1-ZONE MONITORING WELL
 - B2-ZONE MONITORING WELL
 - B3-ZONE MONITORING WELL
 - B4-ZONE MONITORING WELL
 - EDUCTOR
 - MONITORING WELL - DESTROYED 2014
 - MONITORING WELL - DESTROYED 2004
 - - - PROPERTY BOUNDARY

- ABBREVIATIONS**
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 - < NOT DETECTED AT OR ABOVE THE DETECTION LIMIT SHOWN
 - cDCE cis-1,2-DICHLOROETHENE ANALYSIS RESULTS
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 - VC VINYL CHLORIDE

WELL	
ANALYTE	CONCENTRATION IN MICROGRAMS PER LITER



Former TRW Microwave Site
Zone B1 Analytical Results
 October 2015

Date 01-2016	NORTHROP GRUMMAN	Figure
Project No. 60238860		2

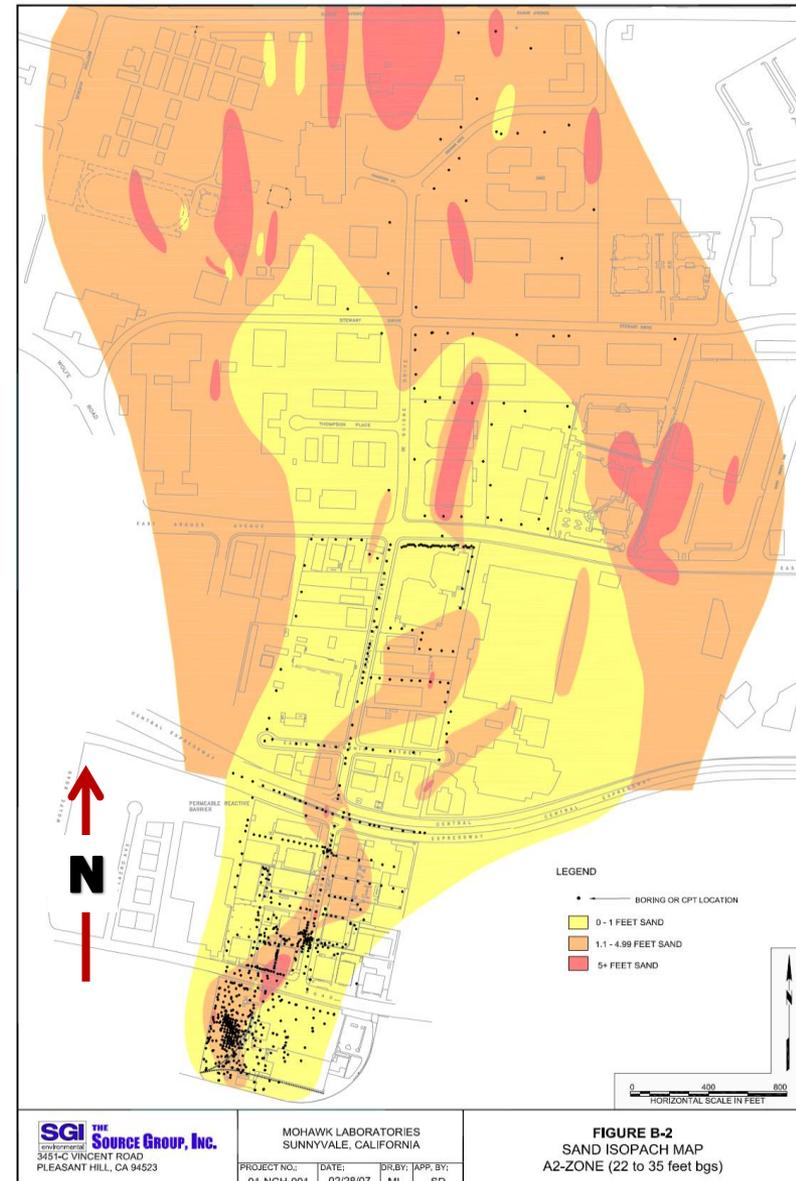
APPENDIX

Environmental Sequence Stratigraphy Slides
from December 10, 2015 Meeting with USEPA

Guiding the Interpretation

Santa Clara Basin Hydrostratigraphy

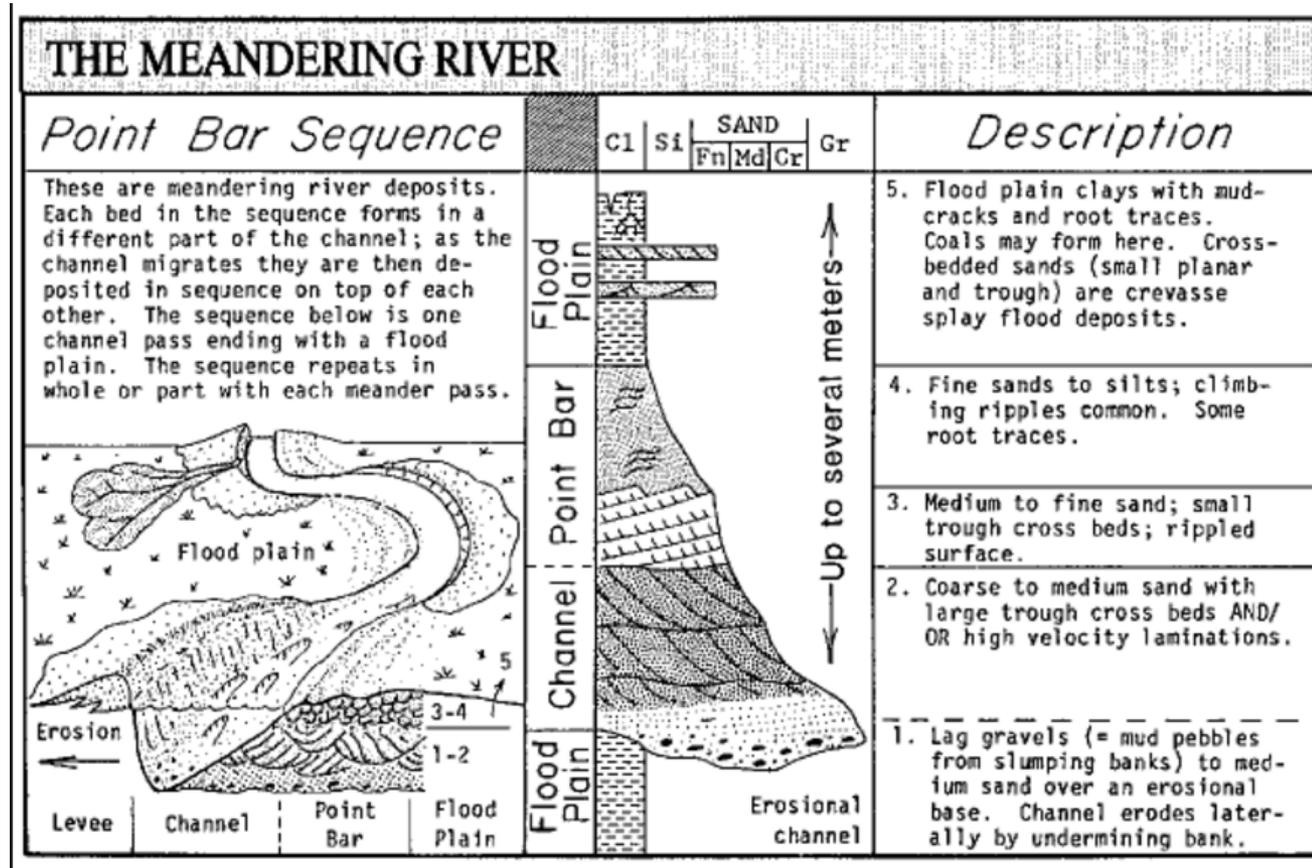
- Mohawk CPT dataset provides “high-resolution” frame of reference
- Dense lithology dataset south of Arques (CPT transects with 50’ spacing)
- Moderate to low-sinuosity channel sands and gravels encased in silt and clay
- Channel orientations N-NNE to NNW
- Thickness about 5’, width about 100’



Depositional Environment

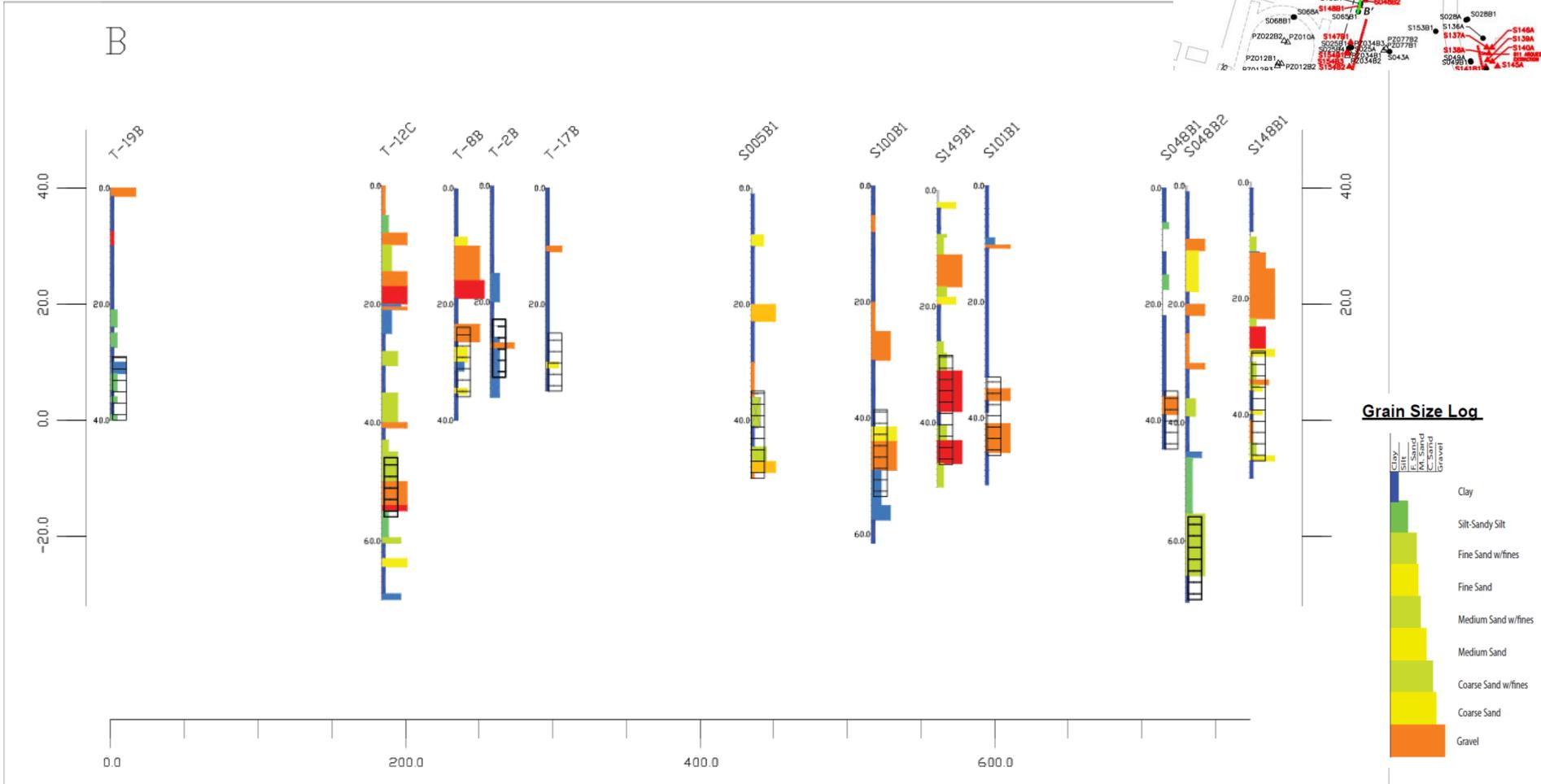
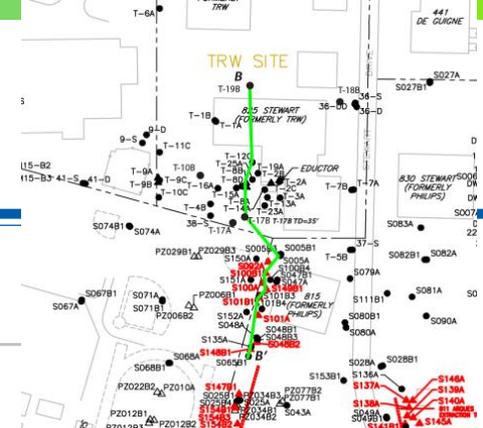
Fining-upward sequence: River channel deposit

- TRW underlain by river deposits, channel and point bar deposits, splays, floodplain deposits
- Highest perm in "lag" deposits at bases of channel sequences
- Minor lateral migration, channels "confined" by floodplain deposits



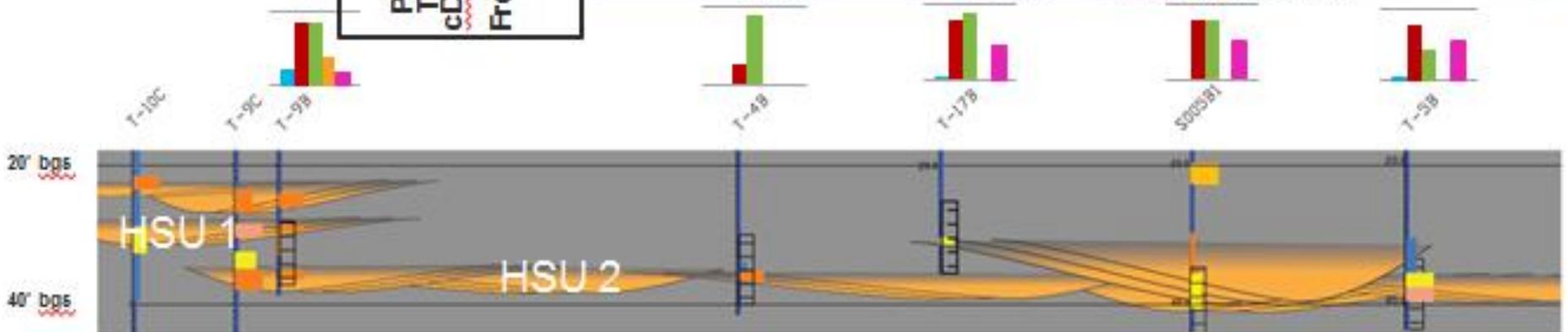
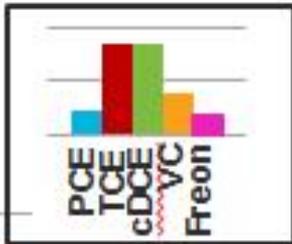
Create ESS Cross Sections

Post GSLs and well screens



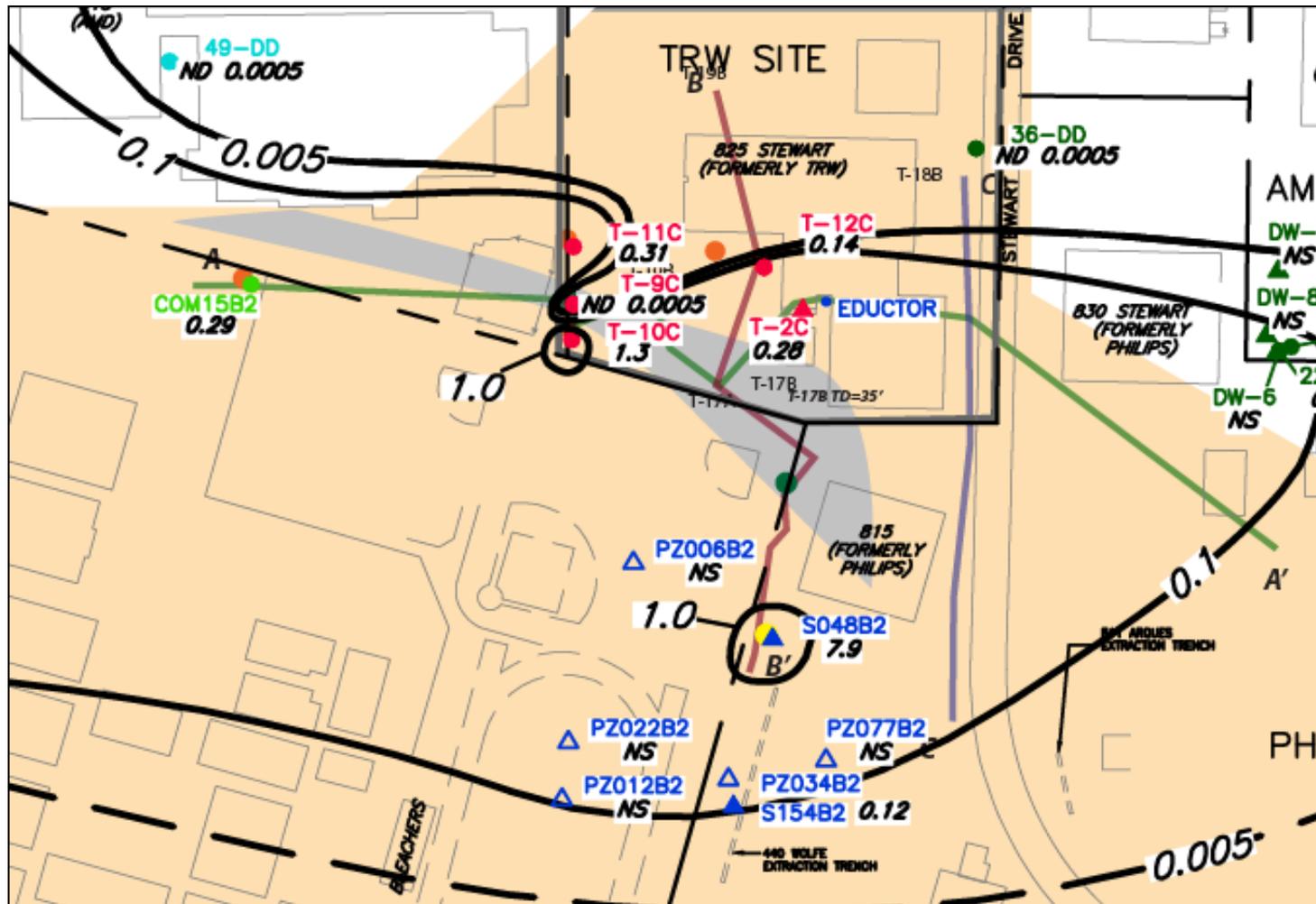
Down-channel view of HSU 2

- Down-channel cross section with facies map @ approx 35-40'
- T-17B: TD@35' tapping channel margin lateral to S005B1, may be back-diffusion impacted



B2 Zone Lithology

- 50-60' Facies Map with Zone B2 TCE Concentrations



- Impacts from off-site sources complicates evaluation of contaminant trends in onsite wells. The 2014 FYR is a perfect example.

Representative Excerpts from 2014 FYR

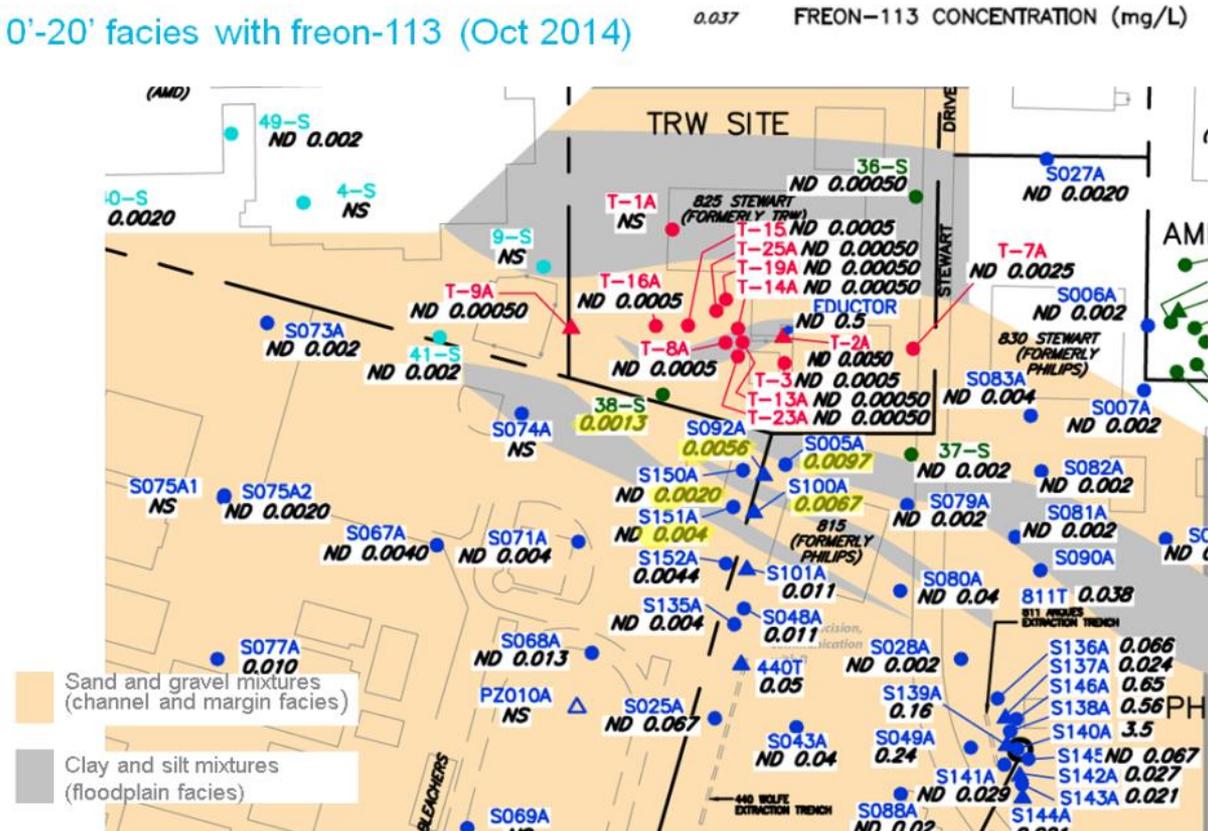
Ref	2014 FYR Interpretation	Revised Interpretation
p. 56, last paragraph	B1 and B2 cDCE and TCE increase downgradient, indicating onsite remedy not effective and vertical migration from onsite source.	Downgradient B1 and B2 cDCE and TCE concentrations are affected by off-site sources to the west.
p. 56, 2 nd paragraph	High concentrations in Zone B2 are from the onsite source.	High concentrations in Zone B2 are likely related to off-site sources.

- Propose a revised groundwater monitoring strategy that more accurately monitors TRW-related impacts and effects of onsite remediation.
- Base well monitoring network on:
 - Recently refined contaminant migration pathways (HSUs)
 - Upgradient and downgradient wells along migration pathways
 - Chemistry data
 - Freon 113 as a tracer for off-site impacts
 - Vinyl chloride as a tracer for TRW impacts
- Two types of well designations for revised monitoring network
 - TRW-related well: Use to evaluate contaminant trends and effectiveness of onsite remediation efforts.
 - Off-site related well: Monitor, but do not use for evaluating contaminant trends or effectiveness of onsite remediation efforts.

Zone A

- Well 38-S is not representative of TRW-related impacts
- 38-S should be classified as an off-site related well and not used for trend analysis, etc...

10'-20' facies with freon-113 (Oct 2014)

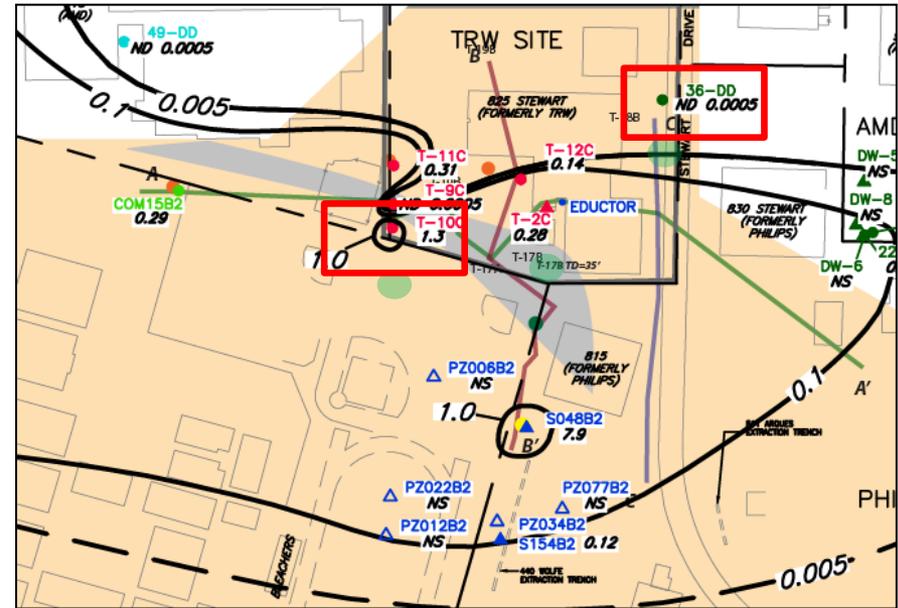


Zone B2

Well T-10C is clearly associated with off-site sources and should be classified as an off-site related well.

Well T-11C is a downgradient well.

Well T-9C should be reclassified as a Zone B3 well.



In the FYR, 36-DD was used as u/g well and T-10C was used as d/g well for interpretations

Table 14. TRW Maximum 2013 Annual Groundwater Concentration by Aquifer Zone and Location

COC	Cleanup Level (µg/L)	Up-gradient			Former source area				Down-gradient		
		A	B1	B2	Eductor	A	B1	B2	A	B1	B2
1,1-DCA	5	ND	0.56	ND	ND	ND	1	ND	0.78	0.43 J	ND
1,2-DCB	600	ND	2.2	ND	1800	19	10	ND	0.35 J	ND	ND
cDCE	6	81	73	11	160,000	340	140	44	150	830	85
tDCE	10	1.8 J	1.8 J	0.9	ND	86	1.6	ND	12	8.8	1.5
1,1-DCE	6	ND	2.3 J	ND	ND	0.70 J	ND	ND	0.7	3.3 J	2.4 J
Freon 113	1200	ND	190	ND	ND	0.61 J	ND	ND	1.4	1.5 J	170
PCE	5	2.3	4.8 J	ND	ND	1.9	ND	ND	2	2.2 J	ND
TCE	5	250	1500	ND	8800	250	ND	110	110	410	1100
1,1,1-TCA	200	0.5	0.59	ND	ND	ND	ND	ND	0.35 J	ND	ND
Vinyl chloride	0.5	ND	0.39 J	1.3	1800	430	150	ND	42	17	4.8