Air Force Civil Engineer Center

Former Williams AFB ST012

Philip H. Mook, Jr., P.E.
AFCEC/CIBW
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Purpose

Former Williams AFB ST012

To provide a background and status briefing for:

- ***Angeles Herrera, Assistant Director, Superfund Division, EPA Region IX***
- ***Tina LePage, Remedial Projects Section Manager, Waste Programs Division, ADEQ***

Overview

- **ST012 Selected Remedy**
  - Is implementation consistent with selected remedy? **YES**
- **Design and Work Plan**
  - Was LNAPL mass outside the thermal treatment zone a known element of remedy selection and design? **YES**
- **SEE/EBR Transition**
  - Is SEE/EBR transition consistent with Work Plan? **YES**
- **EBR Implementation**
  - Can EBR achieve remedial objectives? **YES**
  - Will additional characterization and optimization be necessary to achieve objectives? **YES**
- **Recommendation –**
  - Continue remedy implementation towards remedial objectives
  - Optimize remedy based on site conditions and remedy effectiveness

ST012 Selected Remedy

- **What is the ST012 Selected Remedy?**
  - **Final Record of Decision Amendment 2, Groundwater, Operable Unit 2 (OU-2), Site ST012, Former Williams Air Force Base**
  - **Section 1.4, Description of the Revised Selected Remedy**
    - "The revised Selected Remedy for ST012 groundwater is **FFS Alternative ST012-3**: Steam Enhanced Extraction and Enhanced Bioremediation."

ST012 Selected Remedy

- **What is FFS Alternative ST012-3?**
  - **Final Focused Feasibility Study, Remedial Alternatives for Operable Unit 2 Site ST012**
  - **Section 5.3, Description of Remedial Alternatives, Alternative ST012-3, Steam Enhanced Extraction and Enhanced Bioremediation**
    - First sentence: "Alternative ST012-3 is a combination of technologies designed to **address the contamination in groundwater and deep soil gas, while reducing the trapped LNAPL source.**"

ST012 Selected Remedy

- **What was conceptual design for FFS Alternative ST012-3?**
  - Treatment areas defined in FFS Section 4.3
  - Figures 4-1 and 4-2 (from FFS Section 4.3) were "developed to identify source area treatment areas for the UWBZ and LSZ that would **address the majority of highly contaminated media at ST012 while remaining within accessible boundaries within which it would be feasible to implement in-situ technologies." "The portion of the plume beneath South Sossaman Avenue was deemed inaccessible…**"
  - Preliminary Design, FFS Figure 5-1

{See backup slides for referenced figures}

ST012 Design and Work Plan

- Was contaminant mass outside thermal treatment zone a known element of remedy selection and design? YES
  - Yes, mass outside of TTZ was part of FFS remedial alternative and RODA selected remedy
  - Yes, mass outside of TTZ was part Remedial Design and Remedial Action Work Plan

ST012 Selected Remedy

- **Conceptual and Remedial Design**

Parameter	FFS	RD/RA
Steam Injection Wells	31	34
Multi-phase Extraction Wells	45	51
Treatment Area (square feet)	173,000	199,000
Treatment Volume (cubic yards)	371,000	410,000

- **Wells and treatment zones increased 10-15% based on Pre-Design Investigation (optimized design)**

ST012 Selected Remedy

- **What were transition criteria for SEE/EBR?**
  - **RODA 2: Section 1.4, Description of the Revised Selected Remedy**
    - "When the effectiveness of contaminant mass removal by SEE has diminished, the remedial action will transition to enhanced bioremediation. The criteria that will be evaluated for this transition will be developed jointly by the AF, EPA, and ADEQ as part of the Remedial Design/Remedial Action Work Plan."

ST012 Selected Remedy

- **RD/RAWP: Section 4.2.4, Transition to EBR**
  - **Criteria**
    - Achieving target subsurface temperatures (primary criterion)
    - Diminishing mass removal rates (primary criterion)
    - Completion of multiple pressure cycles
    - Benzene concentrations
    - Steam injection quantity (guideline)
    - "criteria will be tracked and presented as part of routine progress reports particularly as treatment approaches the transition point" **{presented monthly beginning Nov 2015}**
    - "The evaluation for completion of thermal operations will be made between AMEC and TerraTherm and discussed with the AF, EPA, and ADEQ prior to termination of steam injection." **{Nov 2015-Mar 2016; steam injection ended 4 Mar 2016}**

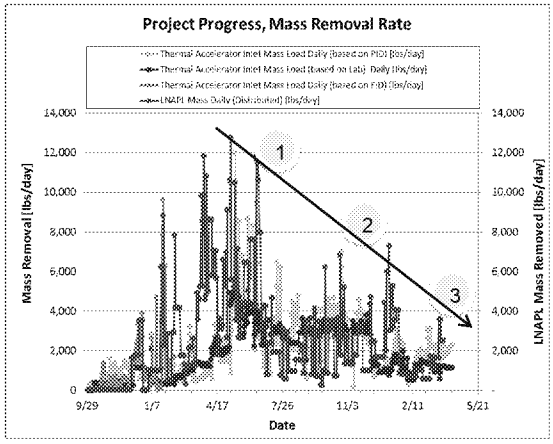
ST012 Selected Remedy

- **Transition Criteria Status, April 2016**

Transition Criteria	Progress
Primary Criteria	
Target Temperature Achievement	• Target temperature achieved in all zones • Steam breakthrough observed at all interior MPE wells
Mass Removal Status	• Mass removal approached 10% target (~12%)
Secondary Criteria	
Pressure Cycling Status	• Multiple pressure cycles completed in each zone (CZ = 5, UWBZ = 9, LSZ = 7)
Benzene Concentrations	• Benzene concentrations <500 µg/L in LSZ; suitable for transition to natural attenuation • Benzene concentrations at interior CZ and UWBZ locations <5,500 µg/L; suitable for transition to EBR
Steam Injection Status (guideline)	• 302.4 MM pounds injected versus 320 MM operations guide (94%) • Achieved average TTZ flushing of 1.8 pore volumes as water

Notes:
< - less than
% - percent
CZ – cobble zone
EBR – enhanced bioremediation
ft bgs – feet below ground surface
LSZ – lower saturated zone
MM – million
TTZ – thermal treatment zone
µg/L – micrograms per liter
UWBZ – upper water bearing zone

Site ST012 SEE System Mass Removal



- **Total Contaminant Mass Removal: 2,648,316 lbs recovered**
- **1: Clear peak mass removal**
- **2: Clear diminishing mass removal rate with SEE transition from LSZ to CZ/UWBZ**
- **3: Clear diminishing removal rate with transition to site wide depressurization sequences**

ST012 SEE/EBR Transition

- **Was SEE terminated in accordance with the Work Plan? Yes**
  - Criteria were tracked and reported as part of routine weekly and monthly reports or meetings
  - Evaluation of thermal operations addressed in detail through reporting, presentations, meetings, responses to comments and correspondence
  - Criteria were achieved as defined in RD/RA WP
  - Decision between AMEC and TerraTherm discussed with the AF, EPA, and ADEQ prior to termination of steam injection (AF concurred)

ST012 SEE/EBR Transition

- **Is contamination contained? Yes**
  - **Monitoring has not indicated a loss of contaminant containment; downgradient perimeter wells < MCL**
  - **An extraction/injection ratio of at least 1.5 and usually >2 was maintained to ensure containment**
  - **Hydraulic gradients during extraction prevented contaminant migration**
  - **Remedy and RD/RA WP use EBR to address dissolved contaminant plume remaining after SEE**

ST012 EBR Remedy

- **What is remaining LNAPL mass and will it keep EBR from achieving remedial objectives?**
  - **Total pre-SEE and post-SEE mass is less than originally estimated and EBR is expected to achieve remedial objectives.**
  - **RD/RA WP, Appendix E, EBR Model (pre-SEE)**
    - 483,000 gallons LNAPL remaining post-SEE (based on conservative distribution)
    - Benzene cleanup level achieved in estimated remedial timeframe
  - **RD/RA WP Addendum #2 (EBR)(post-SEE)**
    - Updated mass estimate – approximately 275,000 gallons remaining (midpoint of base and conservative distributions)
    - Model will be updated based on initial EBR results

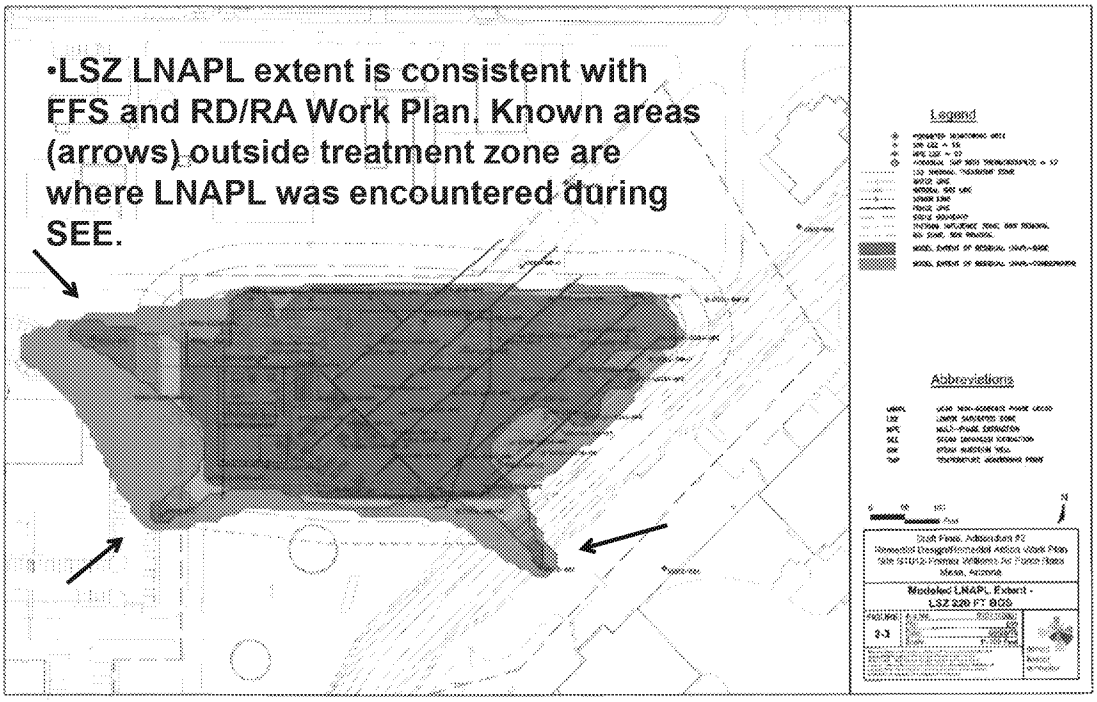
ST012 EBR Remedy

- **RD/RA WP Appendix E**

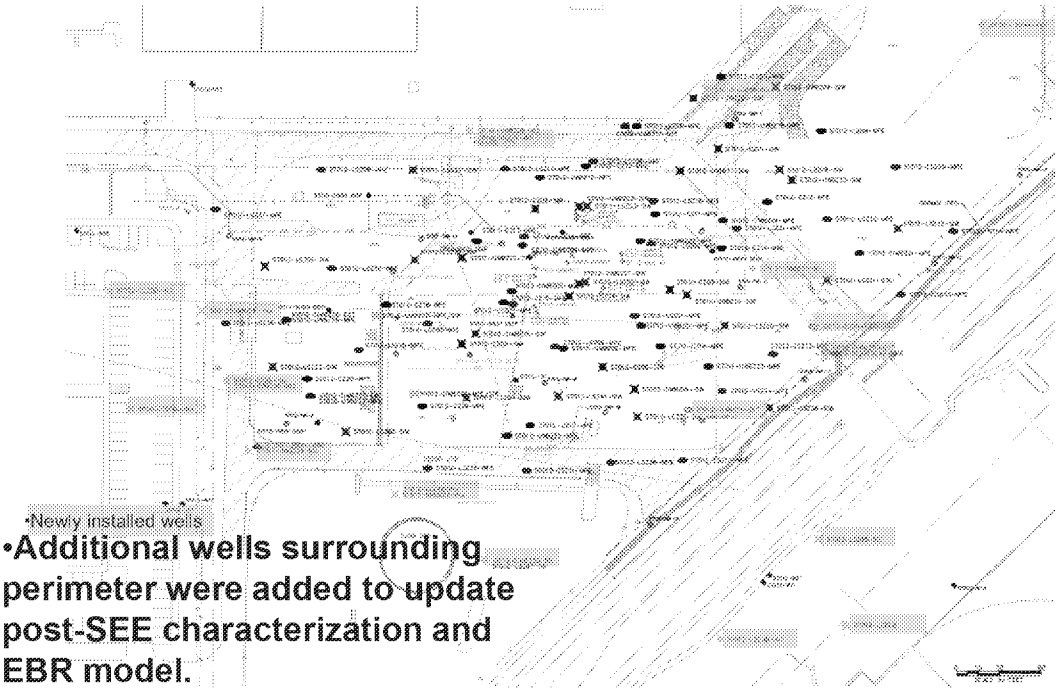
Table E-4.15 Predicted Maximum and Average Dissolved Benzene Concentrations Following Sulfate-Reducing EBR

Hydrostratigraphic Zone	Date (month/year)	Predicted Benzene Concentration (µg/L)		Notes
		Average	Maximum	
Cobble Zone	04/2017	21	27	End of EBR Recirculation/TEA Addition
	04/2025	1.25	7.8	~8 years following EBR
	01/2031	0.08	0.95	~15 years following EBR
Upper Water Bearing Zone	04/2017	210	1,400	End of EBR Recirculation/TEA Addition
	04/2025	5.5	9.5	~8 years following EBR
	01/2031	1.0	3.3	~15 years following EBR
Lower Saturated Zone	04/2017	31	270	End of EBR Recirculation/TEA Addition
	04/2025	1.9	6.8	~8 years following EBR
	04/2031	0.64	2.8	~15 years following EBR

ST012 EBR Remedy



Site ST012 EBR Remedy
New EBR Wells



- **Additional wells surrounding perimeter were added to update post-SEE characterization and EBR model.**

Summary

- **Commitment – Air Force remains committed to achieving ST012 remedial objectives**
- **Progress – Approximately 500,000 gallons of contamination removed in first three years of remedy**
- **Plans – Plans and implementation consistent with ROD Amendment and Work Plan**
- **Optimization – Phased implementation allows iterative optimization and modifications over 17 year period to achieve estimated remedial timeframe**

Recommendations

- Lift work stoppage and avoid remedy delays
- Continue remedy implementation towards remedial objectives
- Optimize remedy based on site conditions and remedy effectiveness
- Complete remedy evaluations in quarterly and annual reports
- Five Year Reviews in 2016, 2021, 2026 and 2031 to be completed within estimated remedial timeframe

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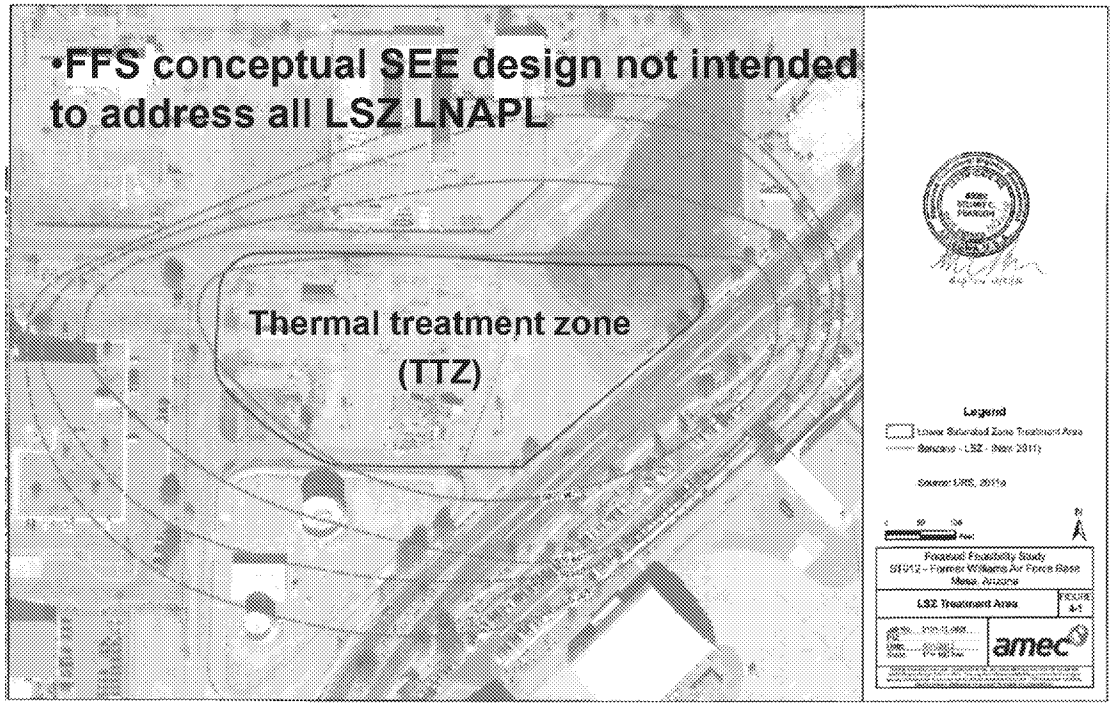
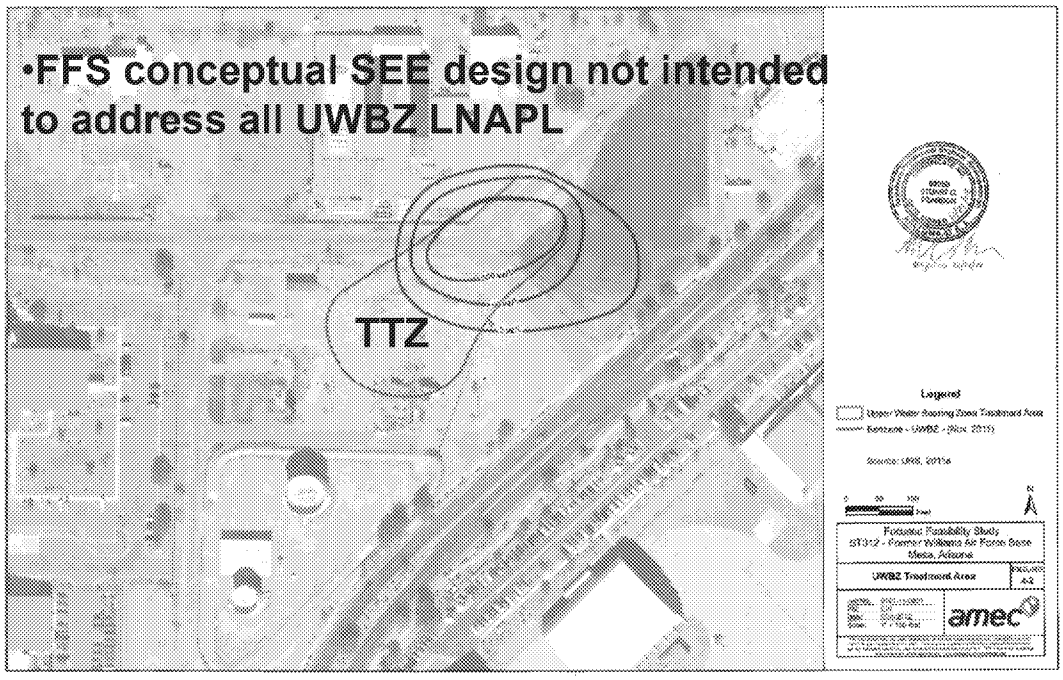
Williams AFB ST012

- **Backup Slides**

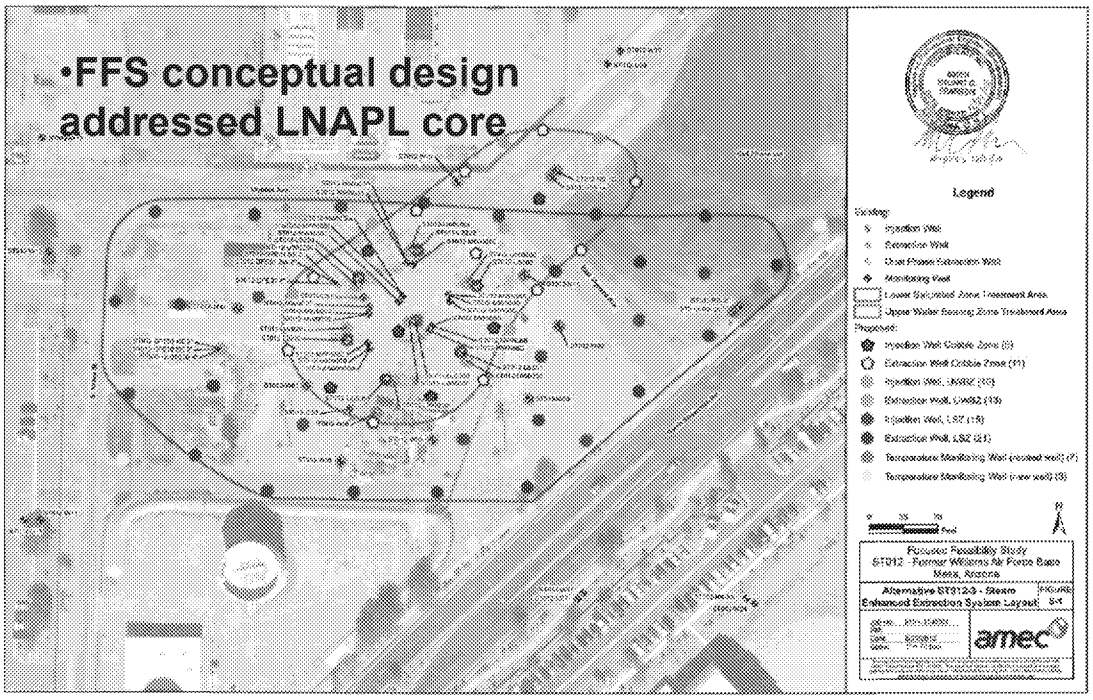
ST012 Selected Remedy
FFS Alternative ST012-3



ST012 Selected Remedy
FFS Alternative ST012-3



ST012 Selected Remedy
FFS Alternative ST012-3



ST012 Design and Work Plan – Mass Estimates

- **Table 3.2 estimated mass outside TTZs**

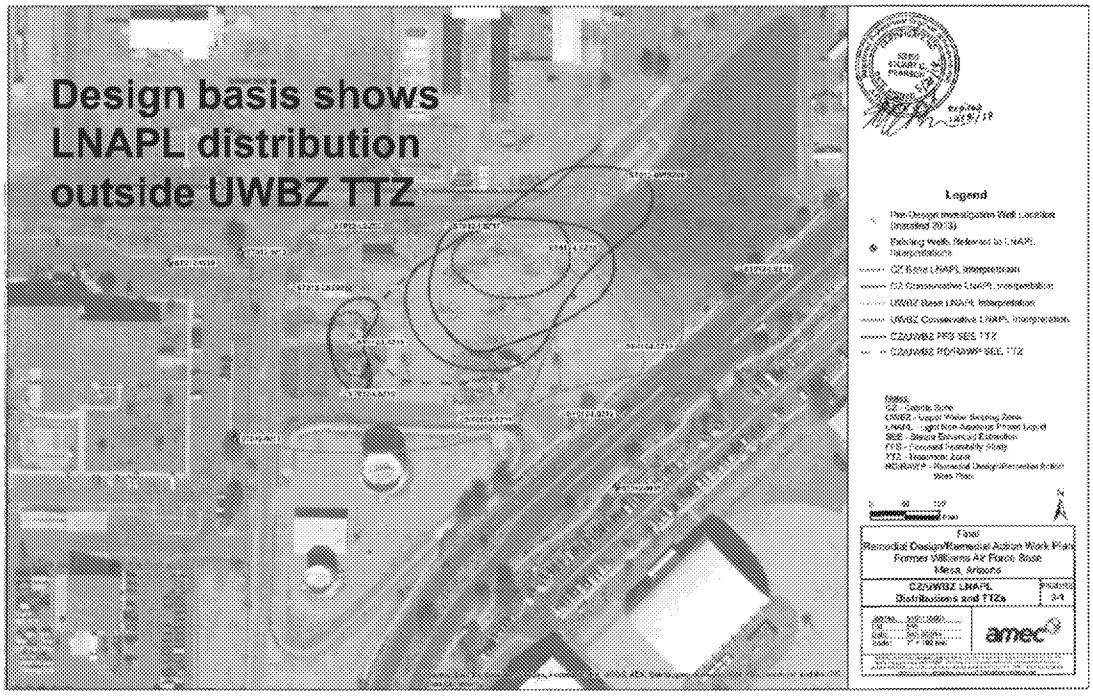
Table 3-2 Results of LNAPL Quantity Calculations (Saturated Zones)

LNAPL Distribution Interpretation	Calculation Method	TTZ	Range of LNAPL Within TTZ (gallons)	Range of LNAPL Outside the TTZ (gallons)
Base Distribution (focus on recent data (Pre-Design investigation borings supported by dissolved concentration distribution, and measured LNAPL in wells))	Hawthorne & Kirkman Method	CZ/UWBZ	190,000 – 250,000	110,000 – 320,000
		LSZ	240,000 – 330,000	30,000 – 60,000
		Total	430,000 – 580,000	140,000 – 270,000
	Literature Saturation Values	CZ/UWBZ	150,000 – 200,000	80,000 – 160,000
		LSZ	560,000 – 740,000	66,000 – 130,000
		Total	710,000 – 940,000	140,000 – 290,000
Conservative Distribution (includes historical borings and measure LNAPL in wells)	Hawthorne & Kirkman Method	CZ/UWBZ	230,000 – 300,000	270,000 – 360,000
		LSZ	270,000 – 360,000	90,000 – 120,000
		Total	500,000 – 660,000	360,000 – 480,000
	Literature Saturation Values	CZ/UWBZ	170,000 – 230,000	200,000 – 260,000
		LSZ	620,000 – 830,000	200,000 – 270,000
		Total	790,000 – 1,050,000	400,000 – 530,000

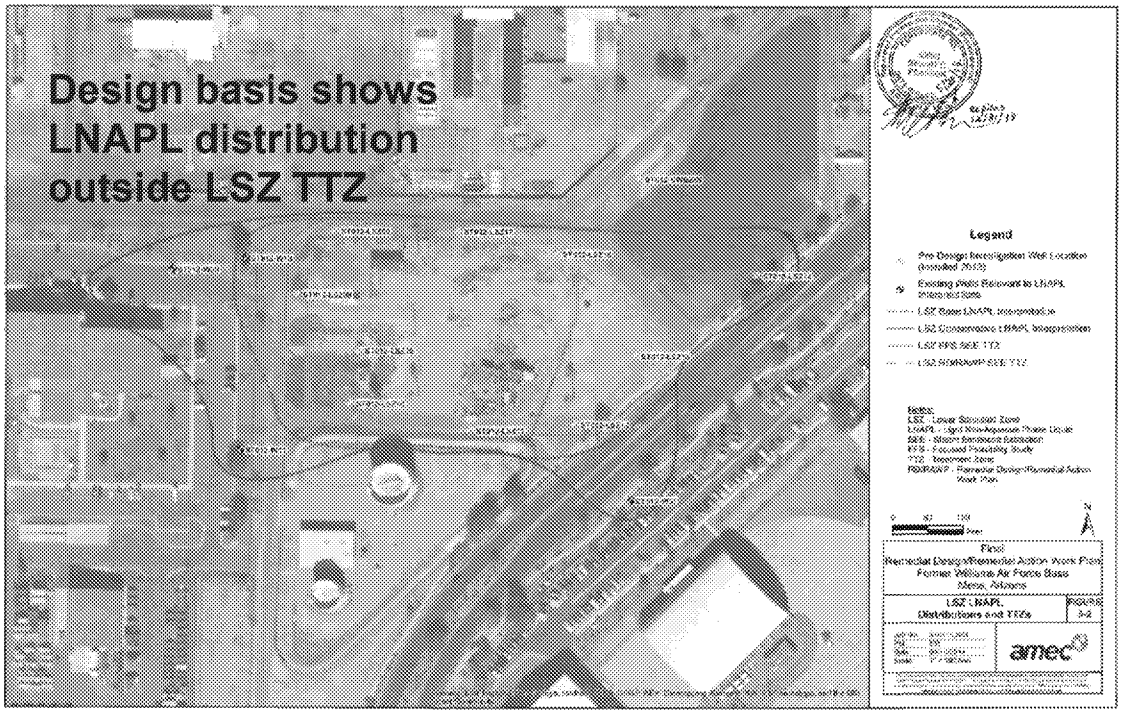
Notes:
CZ - cobble zone
LNAPL - light non-aqueous phase liquid
LSZ - Lower Saturated Zone
UWBZ - Upper Water Bearing Zone
TTZ - thermal treatment zone

RD/RA Work Plan provided estimate for LNAPL mass outside TTZs.

ST012 RD/RA Work Plan – Design Basis



ST012 RD/RA Work Plan – Design Basis



ST012 EBR Remedy

- **RD/RA WP Addendum #2 refined LNAPL mass estimate (approximately 275,000 outside TTZs)**

Draft Final ST012 RD/RAWP Addendum 2, Appendix A	Calculation Based Estimate, Base Interpretation	Calculation Based Estimate, Conservative Interpretation
Within TTZ	350,000-470,000	480,000-640,000
Outside TTZ	90,000-190,000	170,000-330,000
Estimated pre-SEE Total	440,000-660,000	650,000-970,000
Removed by SEE, (Table 1)	403,000	403,000
Estimated Volume Remaining, Total	37,000-257,000 (based on mass removed through April 2016, Table 1) 160,300-245,000 (based on Appendix A)	247,000-567,000 (based on mass removed through April 2016, Table 1) 242,200-388,000 (based on Appendix A)