2018 Annual Report Update

Livermore Site Remedial Project Managers (RPM) Meeting

Wednesday May 1, 2019

Environmental Restoration Department
Hydrogeology Division
Presentation Outline

- 2018 Annual Report review
  - Summary
  - Remediation Performance Evaluation

- FY 2019 Drilling

- ESAR Treatability Test Update
  - TFD Helipad *in situ* bioremediation
  - TFE Eastern Landing Mat thermally-enhanced remediation
  - TFC Hotspot ZVI emplacement for *in situ* chemical reduction
2018 Annual Report Highlights

- Livermore Site restoration activities in 2018 continued to be focused on enhancing and optimizing ongoing operations at treatment facilities.

- With very few exceptions, groundwater concentration and hydraulic data indicate consistent long term declines, subtle in many areas, in both the magnitude and areal extent of VOC plumes in 2018.

- VOCs in the offsite TFA area continued to decline in response to pumping along the Arroyo Seco Pipeline, which was extended in 2012.

- Hydraulic containment along the western and southern site boundaries was fully maintained in 2018, and steady, incremental progress was made toward interior plume and source area cleanup.
2018 Annual Report Highlights (continued)

- The Remediation Evaluation (REVAL) process, was completed during the year at VTF518 Perched Zone

- Continued a re-evaluation of the inhalation risk for VOCs migrating from subsurface soil into indoor ambient air, including the sampling of a prioritized list of Livermore Site buildings

- Three ESAR treatability tests continued during the year:
  1) TFD Helipad *in situ* bioremediation,
  2) TFE Eastern Landing Mat thermally-enhanced remediation, and
  3) TFC Hotspot zero-valent iron (ZVI) emplacement for *in situ* chemical reduction

- Drilling activities:
  - Installed three wells (W-3401 – W-3403)
  - Fourteen obsolete wells were decommissioned in accordance with Alameda County Zone 7 Water Agency guidelines
2018 Annual Report Highlights (continued)

- Less precipitation and infiltration occurred during 2018 as compared to 2017
- As a result, water levels declined somewhat in most Livermore Site hydrostratigraphic units (HSUs) during the year as groundwater extraction once again exceeded recharge
- And the size and geometry of capture areas and pumping-induced groundwater depressions were similar to those presented in Annual Report figures prior to 2017
2018 Annual Report Highlights (continued)

- 43 kg of VOCs were removed from the Livermore Site subsurface during the year:
  - 32 kg from groundwater
  - 12 kg from soil vapor

- The 2018 yearly mass removal rate is very similar to that in 2017, with slightly more mass removed from soil vapor during 2018

- Since remediation began in 1989, about 6 billion gallons of groundwater and 923 million cubic feet of soil vapor have been treated, removing an estimated 3,355 kg (3.7 tons) of VOCs from the subsurface
2018 TVOC Mass Removed From Groundwater
2018 TVOC Mass Removed From Soil Vapor

- **Millions of cubic feet treated**
- **VOC mass removed**

**Volume of soil vapor treated (Mcf)**

**Calendar Year**

**Estimated total VOC mass removed (kg)**
Conceptual Site Model
HSU-1B Groundwater Elevations: 2016 - 2018
HSU-1B

- 4.3 kg of VOCs removed from groundwater in 2018
- Water levels declined about 2 ft during the year
- Hydraulic containment of HSU-1B plumes maintained along the western margin
- All offsite TFA monitor wells below cleanup standards for the first time since 2015
- Onsite concentrations at TFA, TFB, TFC, and TFG remained essentially unchanged in 2018
- VOCs remained below cleanup standards in northern TFC rebound test area
HSU-2 Groundwater Elevations: 2017 vs. 2018
HSU-2 Total VOCs Above MCLs: 2017 vs. 2018

- Groundwater extraction wells
- Groundwater extraction well (not operating)
- Well discussed in text
- 10 ppt isocconcentration contour of total VOCs above cleanup standards (ppt):
- Tick marks indicate depression contour
- LLNL Site Boundary

VOC concentration above
map standards (ppt)
1 - 4
5 - 9
10 - 24
25 - 49
50 - 99
100 - 249
250 - 499
500 and above

Estimated hydraulic capture area
Pumping-induced depression

Lake Hausmann

W-151
W-404
W-109
W-409
W-404
W-404
W-457
W-903
W-260
W-415
W-1111
Area where HSU-2 is unsaturated

2017

W-2501
W-2502
W-2501
W-1205
W-3102
W-355
W-365
W-413
W-263
W-1226
W-1009
W-1807
W-1701
W-124
W-2501
W-404
W-415
W-1111
Area where HSU-2 is unsaturated

W-151
W-1420
W-2802
W-440
W-260
W-404
W-454
W-903
W-260'
W-415
W-1111
Area where HSU-2 is unsaturated

2018
7.0 kg of VOCs removed from groundwater in 2018

All offsite TFA wells below cleanup standards except two:
- PCE concentrations at W-1424 were 6.1 µg/L in October 2018
- PCE concentrations at W-654 were 5.7 µg/L in July 2018

At TFB, TCE along the western boundary continued to decline due to pumping at W-2501 and W-2502
- Wells W-422 and W-1420 remained below the TCE cleanup standard in 2018

Water levels declined about three feet during the year

Hydraulic containment along the western margin remained in place
TCE concentrations at W-568 continued to rise, then declined slightly:
- 13 µg/L in March 2013 to 77 µg/L in February 2017
- 47 µg/L and 46 µg/L in May and December 2018, respectively

Downgradient hydraulic containment by TFC East extraction well W-413

Elsewhere, onsite concentrations at TFA, TFB, TFE, and TFG remained essentially unchanged or declined slightly during 2018
HSU-3A Groundwater Elevations: 2017 vs. 2018
HSU-3A Total VOCs Above MCLs: 2017 vs. 2018

![Map showing comparison of HSU-3A Total VOCs Above MCLs for 2017 and 2018, highlighting areas above and below MCLs with various color codes and contour lines.](Image)

- **2017**
- **2018**

Legend:
- Monitor well or piezometer
- Groundwater extraction well
- Groundwater extraction well (not operating)
- Well or borehole discussed in text
- Total VOCs above cleanup standard (mg/L)
- 5 mg/L concentration contour
- Lake Hausmann boundary
- Total VOC concentration above cleanup standard (mg/L)
- 1 - 4 mg/L
- 5 - 9 mg/L
- 10 - 24 mg/L
- 25 - 49 mg/L
- 50 - 99 mg/L
- 100 - 249 mg/L
- 250 - 499 mg/L
- 500 - 999 mg/L
- 1,000 - 2,499 mg/L
- 2,500 and above
- Estimated hydraulic capture area
- Pumping-induced depression
- Lake Hausmann

Lawrence Livermore National Laboratory
LLNL-PRES-773200
HSU-3A

- 6.3 kg of VOCs removed from groundwater in 2018
- The few notable changes occurred in source areas on the eastern side of the site
  - Long term, gradual TCE decline at B551 source area well W-1304 due to pumping from nearby HSU-3A extraction wells W-1301, W-2005, and W-1603
  - At TFE East well W-1225, TCE concentrations declined from a high of 960 µg/L (August 2016) to 540 µg/L (August 2018)
    - low, stable concentrations at downgradient well W-3304 do not indicate westward migration of the plume
- Water levels declined 1 to 2 feet during 2018
Geometry of pumping-induced groundwater depressions and capture areas similar to those prior to 2017

Former Building 419 area tritium activities remained above the cleanup standard at W-3004 in 2018
  – Decreased from 49,500 pCi/L (August 2017) to 36,200 pCi/L (November 2018)
  – The large increase then decline in activities may be related to the water level rise observed there during 2017 (4.7 ft)
  – Tritium activities will continue to be closely monitored there in 2019
HSU-3B Groundwater Elevations: 2017 vs. 2018
HSU-3B Total VOCs Above MCLs: 2017 vs. 2018

Legend
- Monitor well or piezometer
- Groundwater extraction well (not operating)
- Concentration contour of total VOCs above cleanup standards (µg/L)
- Well discussed in text
- 5 µg/L isocurvature contour of total VOCs above cleanup standards (µg/L)

Boundary
- LLNL Site Boundary
- Total VOC concentration above cleanup standards (µg/L)

Area with HSU-3B unsaturated or absent

Pumping-induced area

Lake Hausmann

Area where HSU-3B is unsaturated or absent
HSU-3B

- 3.7 kg of VOCs removed from groundwater in 2018
- Overall size, geometry, and location of HSU-3B VOC plumes unchanged in 2018
- Few notable concentration changes observed during the year either
- In the TFD Southeast area
  - TCE at W-2006 remains elevated (540 µg/L)
  - Increased from 200 µg/L to above 500 µg/L since 2012 with more continuous pumping operations there
  - Long term concentration trends suggest W-2006 is located near but not in the highest source area concentrations
  - Concentrations increase with continuous, active pumping
  - Concentrations decrease once pumping ceases or becomes more infrequent
In the TFD South area, the impact of ground water extraction at W-1504 is evident over the long term, but not necessarily year-to-year.

- TCE concentrations have decreased from 750 µg/L (November 2003) to 170 µg/L (August 2018) at W-1511.
- TCE concentrations have fallen from 94 µg/L (March 2004) to 37 µg/L (February 2018) at W-1421.

During 2018, HSU-3B contaminant plumes were either under hydraulic control of TFD, TFE, or TFH extraction wells, or were contained within the large pumping-induced HSU-3B groundwater depression.
HSU-4 Groundwater Elevations: 2017 vs. 2018
HSU-4 Total VOCs Above MCLs: 2017 vs. 2018
4.8 kg of VOCs removed from groundwater in 2018

TFD Helipad source area monitor well TCE concentrations rose back to 2016 levels as level-control extraction well flow rates decreased in response to the depletion of groundwater from the 2017 recharge event

- At W-1253, TCE rose from 560 µg/L (November 2017) to 1,600 µg/L (August 2018)
- At W-1250, TCE increased from 1,500 µg/L (November 2017) to 3,000 µg/L (August 2018)
- At W-1252, TCE rose from 240 µg/L (November 2017) to 460 µg/L (August 2018)
Level Control vs. Flow Control under reduced recharge conditions

- **Recharge conditions**
  - **Constant level, variable flow**
  - **Reduced Recharge conditions**
    - **110 ft-bmp**
    - **20 gpm**
    - **15 gpm**

- **Reduced Recharge conditions**
  - **110 ft-bmp**
  - **20 gpm**

- **Constant flow, variable level**
  - **Recharge conditions**
  - **Reduced Recharge conditions**
    - **100 ft-bmp**
    - **Change in water level**

In both the B551 and T5475 areas, 2018 decreases in TCE reflect the natural variability in concentrations characteristic of many Livermore Site source areas - not concentration trends.

In the TFE West area, TCE was 6 µg/L at newly-installed HSU-4 monitor well W-3401.

- W-3401 will be used to monitor the TCE plume emanating from the T5475/eastern TFE area, and appears to be located near the leading edge of the plume.

All HSU-4 VOC groundwater plumes continued to be hydraulically contained by TFD, TFE, and TFH groundwater extraction wells and their pumping-induced groundwater depression.
HSU-5 Total VOCs Above MCLs: 2017 vs. 2018
HSU-5

- 5.8 kg of VOCs removed from groundwater in 2018

- In the TFD Southshore area, TCE at newly-installed monitor well W-3402 was 110 µg/L (September 2018)
  - Data from W-3402 will be used to help identify the source of the HSU-5 TCE groundwater plume present in the TFD Southshore area

- At newly-installed HSU-5 monitor well W-3403, located downgradient and west of TFE Southwest, TCE was < 0.5 µg/L (December 2018)
  - W-3403 will be used to optimize and monitor the performance of TFE Southwest HSU-5 extraction well W-1516 and help refine the hydrostratigraphy of the area
  - Initial concentration values at new wells are often low, and samples collected later may be more representative of conditions in the surrounding aquifer
HSU-5 (continued)

- In the TFH area
  - 1,1-DCE concentrations at formerly de-watered well W-107 were 9.8 µg/L (July 2018)
  - W-107 will be sampled in 2019 if over-drafting of the aquifer does not once again de-water well

- South of TF406, on property operated by Sandia National Laboratory
  - TCE remained below cleanup standards at W-509 (3.3 µg/L in August 2018)
  - The increased sustainable yield at TF406 HSU-5 extraction well W-1310 considered responsible for the concentration decline seen at W-509
FY 2019 Drilling

- Two CPT direct-push sampling surveys are proposed for FY 2019

- In the Former Building 419 (B419) area, a CPT direct-push drilling rig will be used further investigate the source of the elevated tritium at B419 monitor well W-3004
  - Soil samples will be collected for VOC and tritium analysis in a closely-spaced grid around W-3004

- In the TFD area, a CPT direct-push drilling rig will be used to further delineate the Building 551 and TFD East Traffic Circle South source areas
  - Both soil vapor and soil samples will be collected for VOC analysis

- Work plans for the proposed direct push surveys will be submitted to the RPMs for review shortly

- No wells are proposed for installation or decommissioning in FY 2019
FY 2019 Drilling – Proposed Locations
Enhanced Source Area Remediation (ESAR) Treatability Test Update

- TFD Helipad \textit{in situ} bioremediation

- TFE Eastern Landing Mat thermally-enhanced remediation

- TFC Hotspot ZVI emplacement for \textit{in situ} chemical reduction
TFD Helipad - *In situ* Bioremediation
TFD Helipad - *In situ* Bioremediation
Nitrate and Sulfate
TFD Helipad - *In situ* Bioremediation
TCE and 1,2-DCE
TFE Eastern Landing Mat - Thermally-Enhanced Remediation

Figure H-1. Locations of wells and treatment facilities in the TFE Eastern Landing Mat thermally-enhanced remediation treatability test area.
TFC Hotspot ZVI Emplacement - *in situ* Chemical Reduction

![Map of TFC Hotspot Enhanced Source Area Remediation treatability test site and performance monitoring well locations.](image)

Figure I-1. TFC Hotspot Enhanced Source Area Remediation treatability test site and performance monitoring well locations.
TFC Hotspot ZVI Emplacement - *in situ* Chemical Reduction

Figure 1-3. Methane concentration trends at TFC Hotspot performance monitor wells.
TFC Hotspot ZVI Emplacement - *in situ* Chemical Reduction

Figure I-6. Trichloroethene, cis-1,2-Dichloroethene, and ethane concentration trends at TFC Hotspot performance monitor wells W-1212 and W-2612.