



Using HRSC Techniques to Identify Contaminant Transport Pathways and to Revise 3D CSM for Remedy Evaluation

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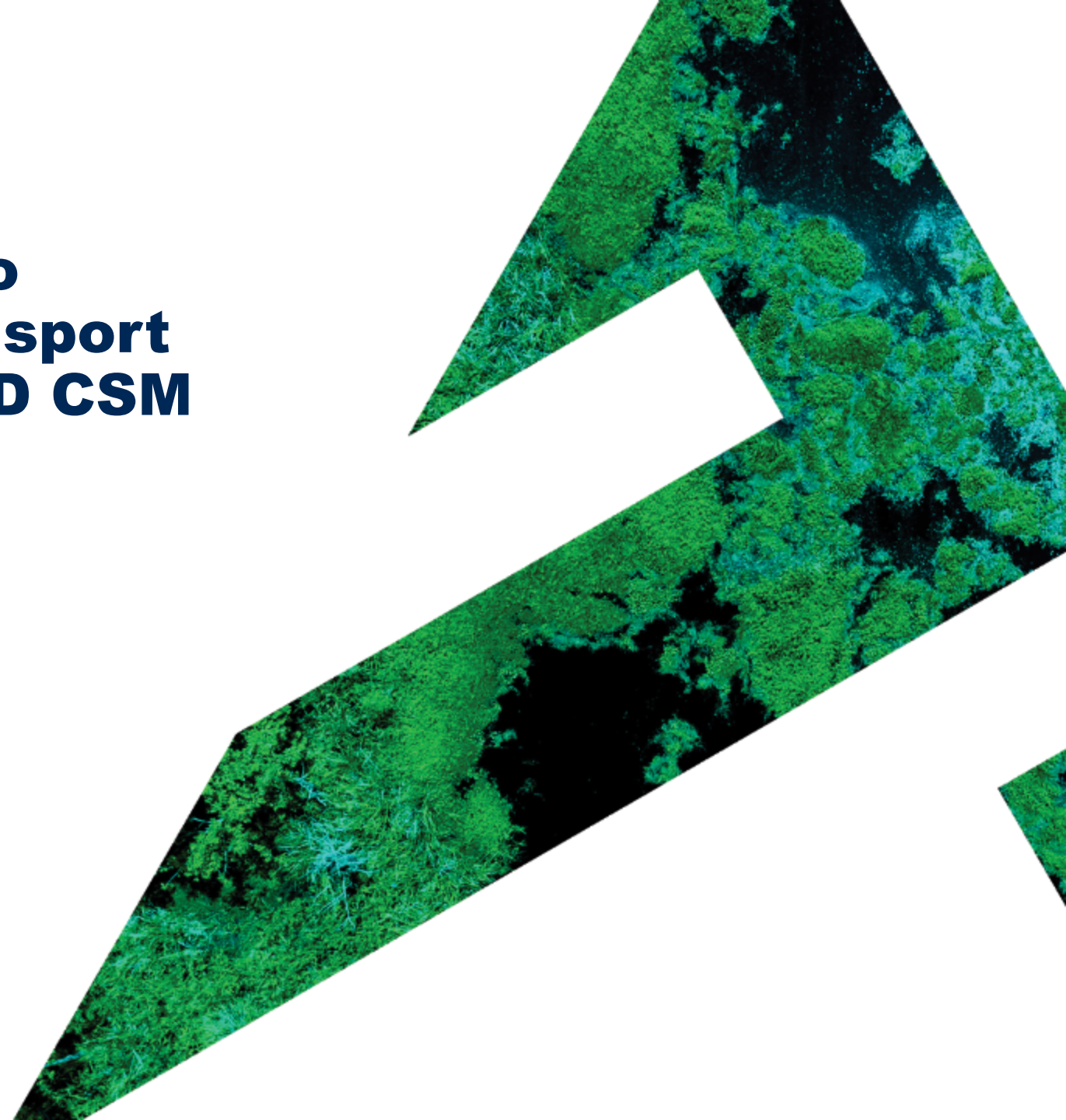


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 - Remedy Evaluation and Recommendation



HILL AIR FORCE BASE (HAFB) SUPERFUND SITE

Background

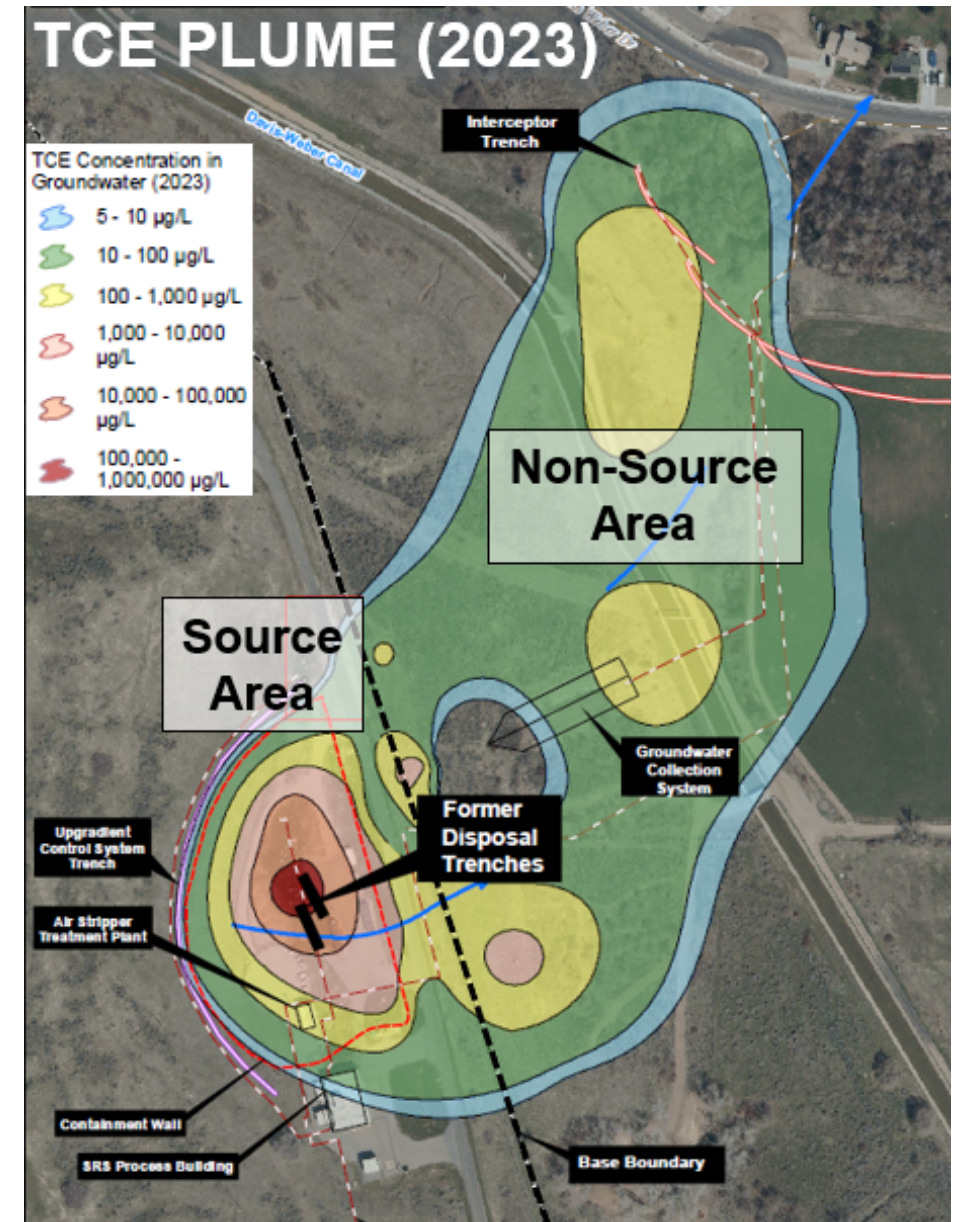


- Active 6,700-acre base
 - Heavy industrial operations began in 1957; military base since 1920
- Historical operations used solvents, petroleum products, acids, corrosives, metals, dioxanes, and PFAS
- Prior to 1980, chemicals and wastes were disposed of to nearest pit, landfill, or sewer
 - Formed many hazardous waste sites
- Added to National Priorities List in 1987
 - Currently 19 Operable Units (OUs)

OPERABLE UNIT 2

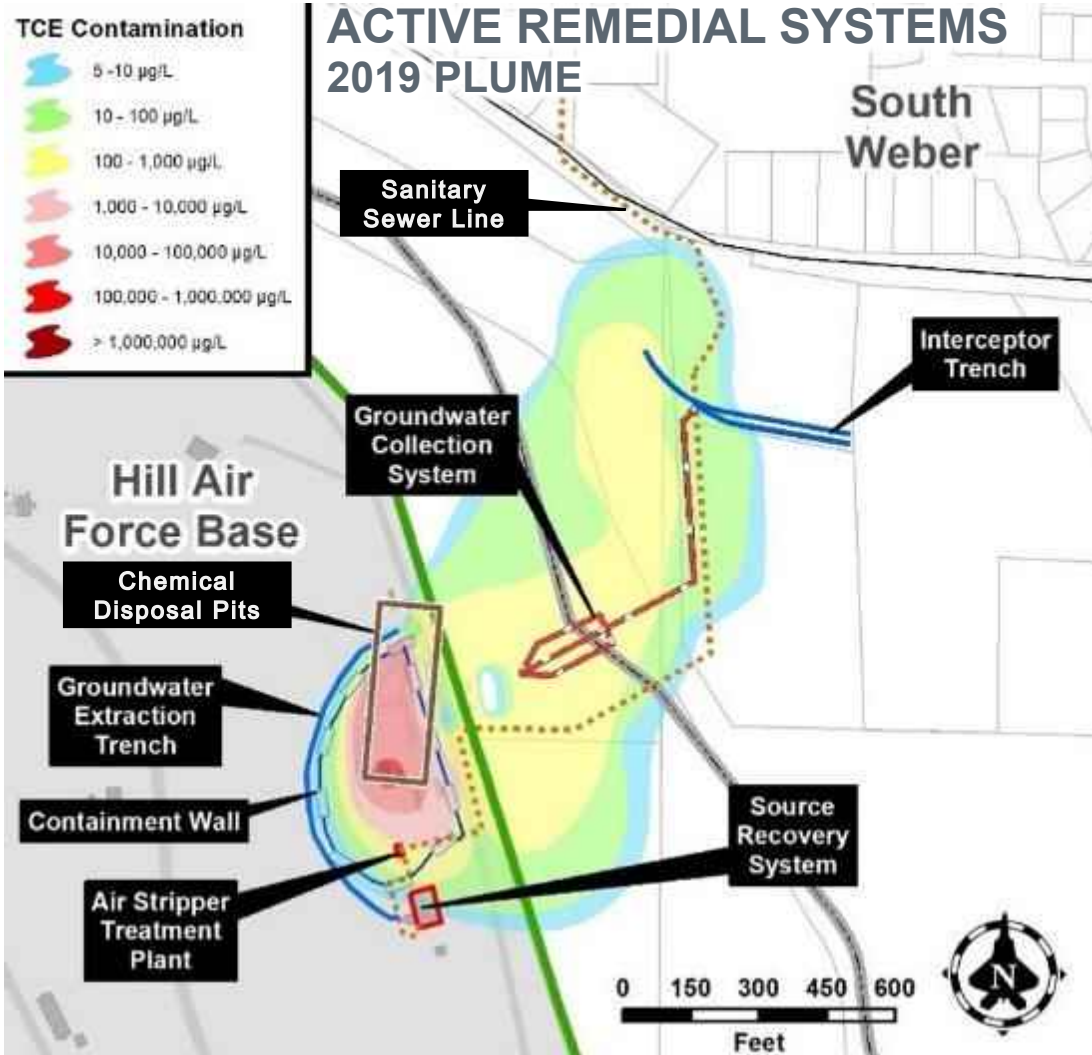
Background

- Remedial Investigation (RI) in early 1990s
- Estimated 50,000 gallons of chlorinated solvents dumped at unlined trenches from 1960s to 1970s
- Dense non-aqueous phase liquid (DNAPL) in Source Area: TCE, PCE, and 1,1,1-TCA
 - Downward movement of DNAPL restricted by clay paleochannel
- TCE in groundwater migrates to northeast, forming Non-Source Area plume
 - Migrating downhill and off-Base to residential areas





ACTIVE REMEDIAL SYSTEMS 2019 PLUME



OPERABLE UNIT 2

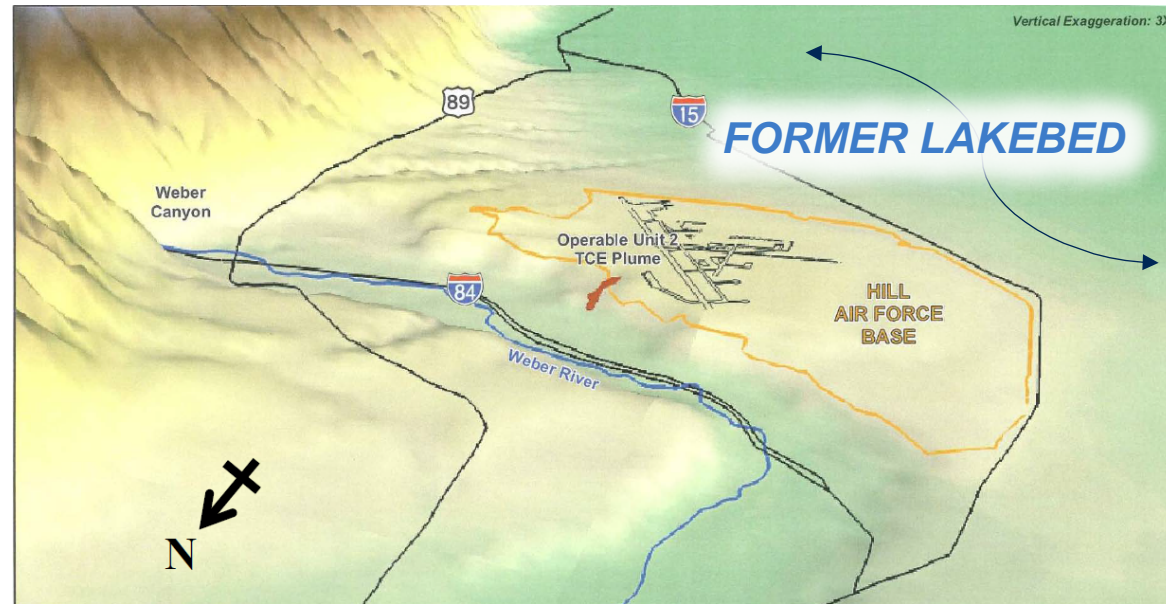
Implemented Remedial Systems

- Selected Remedy approved in 1996 ROD
- Source Area (installed 1993 to 1996):
 - Source Recovery System free-product and groundwater recovery well-field
 - Containment wall: in-situ bentonite slurry and soil mixture; 1500 feet long, 60 to 90 feet deep
 - Upgradient Groundwater Extraction Trench
 - Air Stripper Treatment Plant
- Non-Source Area (installed 1999):
 - Groundwater Collection System
 - Interceptor Trench

CONCEPTUAL SITE MODEL

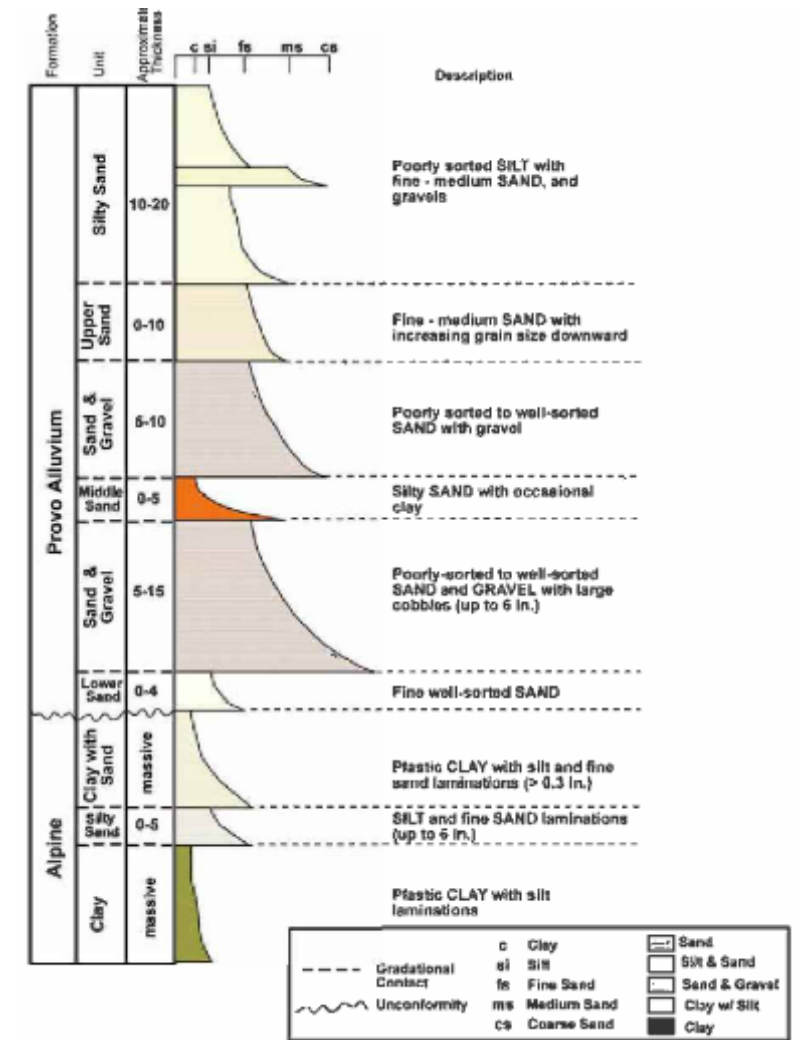
OU 2 – Geologic Setting

- Weber Delta formed by deposits from prehistoric Lake Bonneville and Weber River
- Heterogeneous, deltaic lithology
 - Interbedded lacustrine and fluvial sediment; lenticular



Source: OU2 Performance Standard Verification Report (USAF 2012)

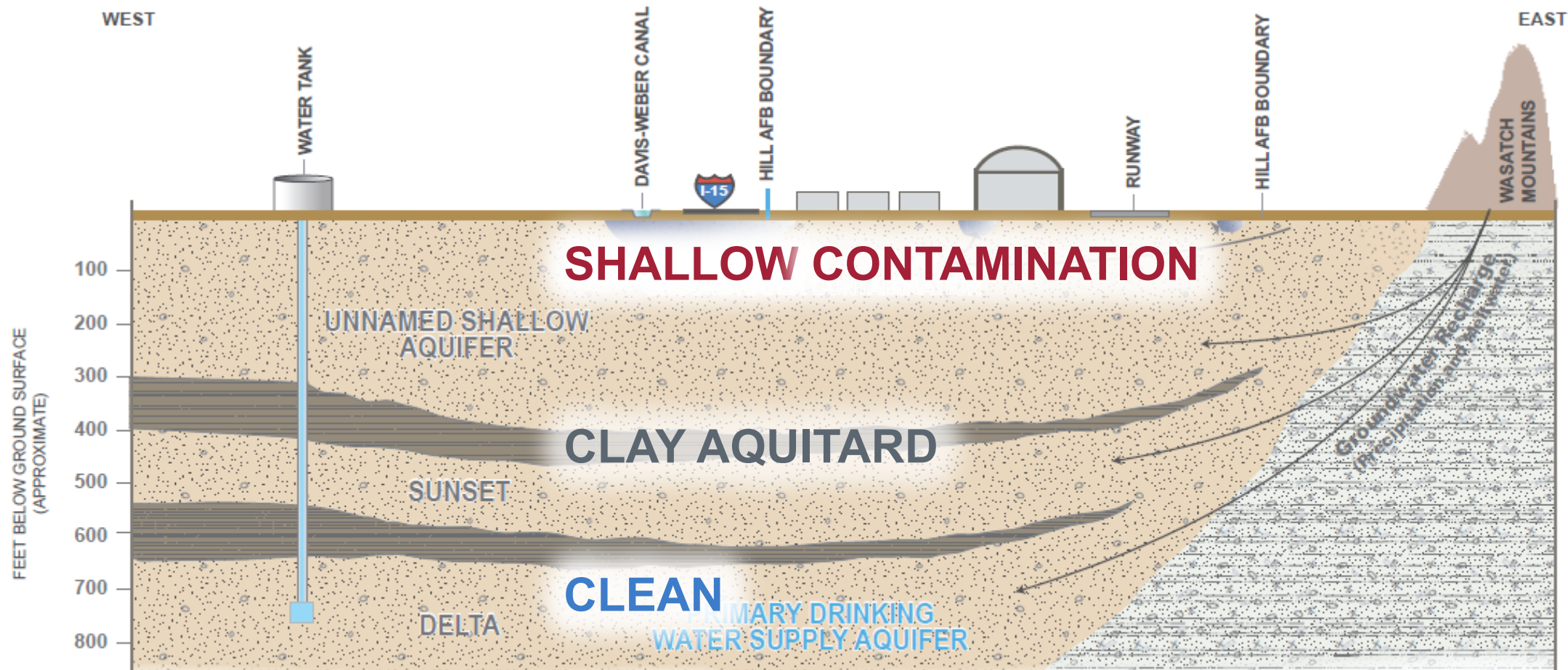
STRATIGRAPHY (SOURCE AREA)



Source: Conceptual Site Model OU2 Source Area (URS Corp and INTERA 2013)

CONCEPTUAL SITE MODEL

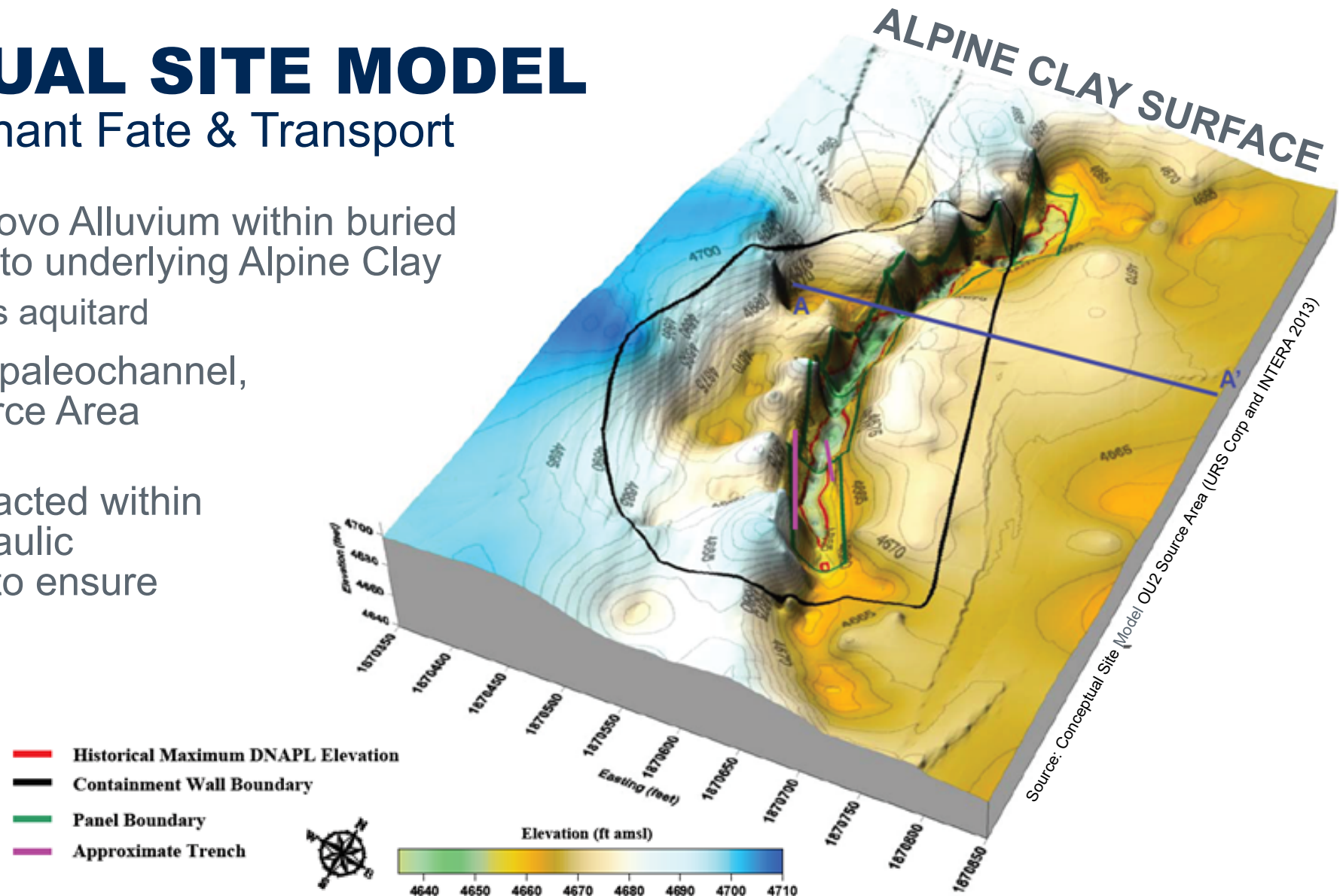
OU 2 – Hydrologic Units

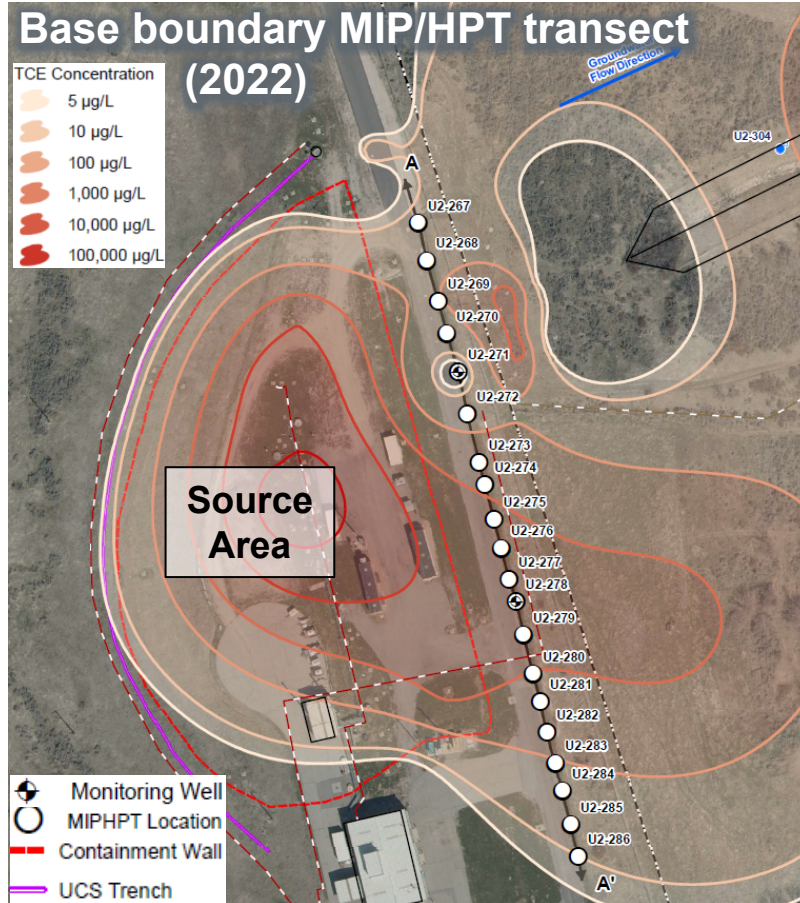


CONCEPTUAL SITE MODEL

OU 2 – Contaminant Fate & Transport

- Source Area in Provo Alluvium within buried channel incised into underlying Alpine Clay
 - Clay unit acts as aquitard
- DNAPL pooled in paleochannel, sources Non-Source Area plume
- Groundwater extracted within Source Area hydraulic containment wall to ensure inward gradient

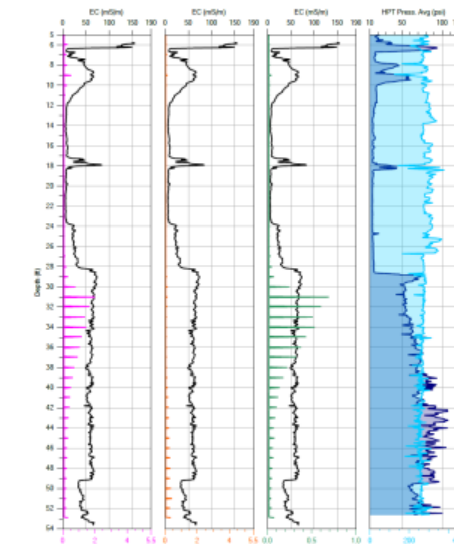




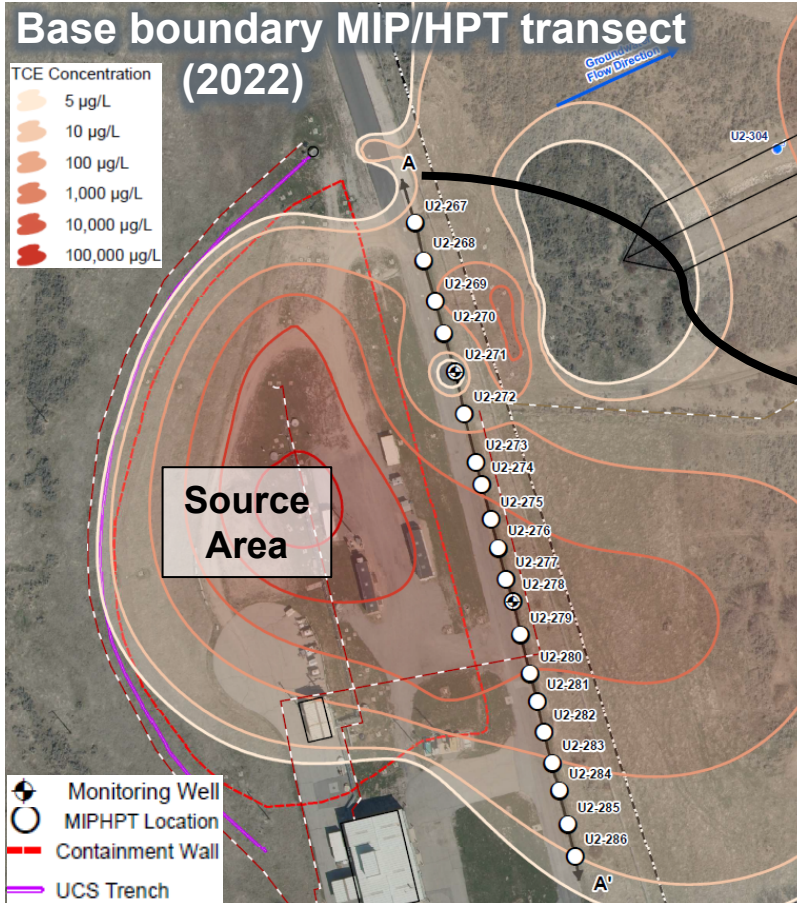
OU 2 SITE INVESTIGATION

1. Identify Contaminant Transport Pathways

- High Resolution Site Characterization (HRSC) techniques to identify localized transport pathways
- Used membrane interface probe/hydraulic profiling tool (MIP/HPT) at Base boundary transect
 - XSD = Halogen-specific detector
 - Confirmation soil and groundwater sampling

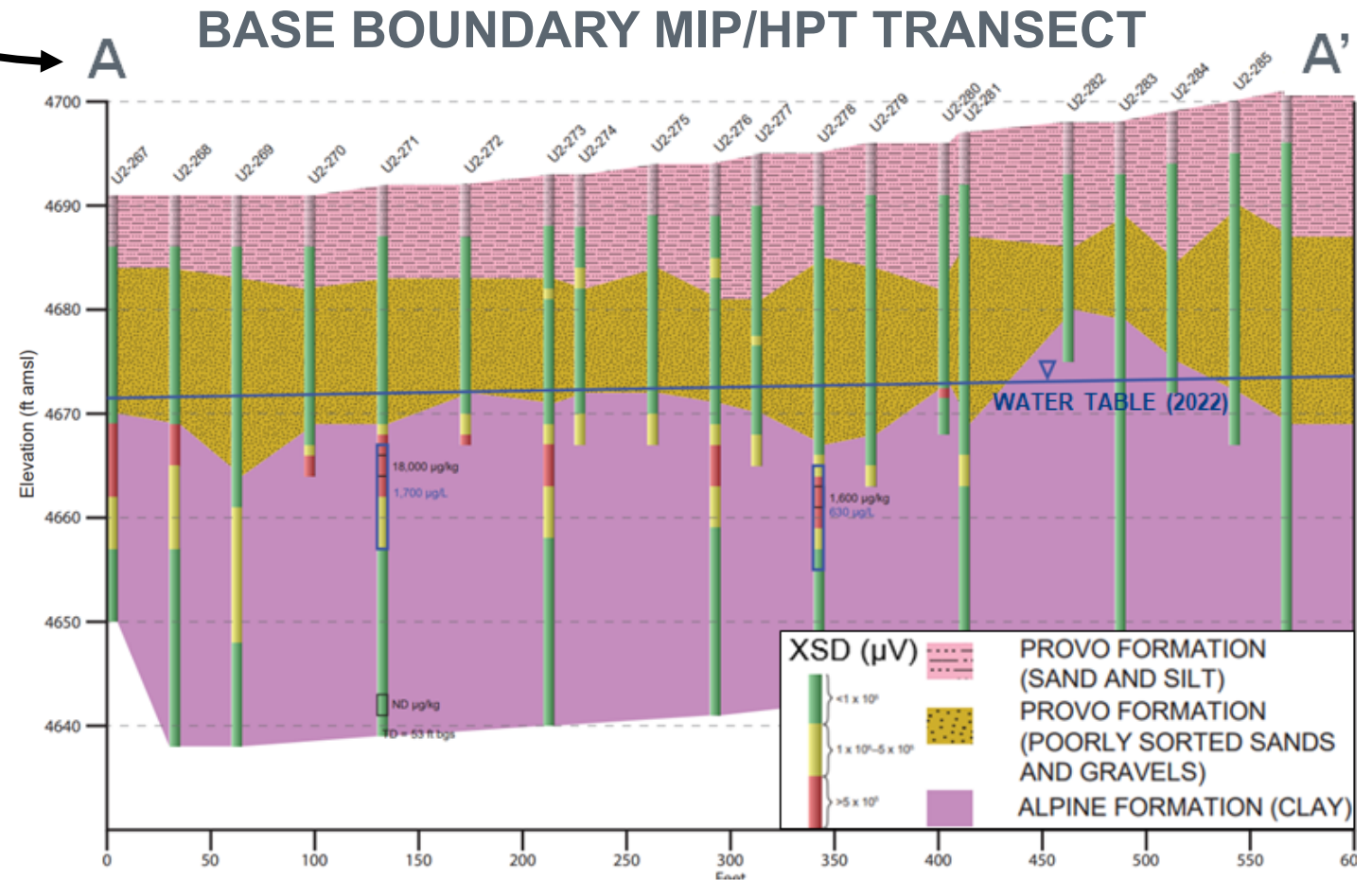


MIP/HPT tooling and logs for **PID**, **FID**, **XSD**, **HPT**



OU 2 SITE INVESTIGATION

Findings: TCE Impacts in Upper Alpine Clay



- TCE impacts in Alpine Clay
 - Serving as secondary source
- TCE absent from permeable Lower Provo formation
 - Previously “washed out”

OU 2 SITE INVESTIGATION

Findings: Transport through Upper Alpine Clay

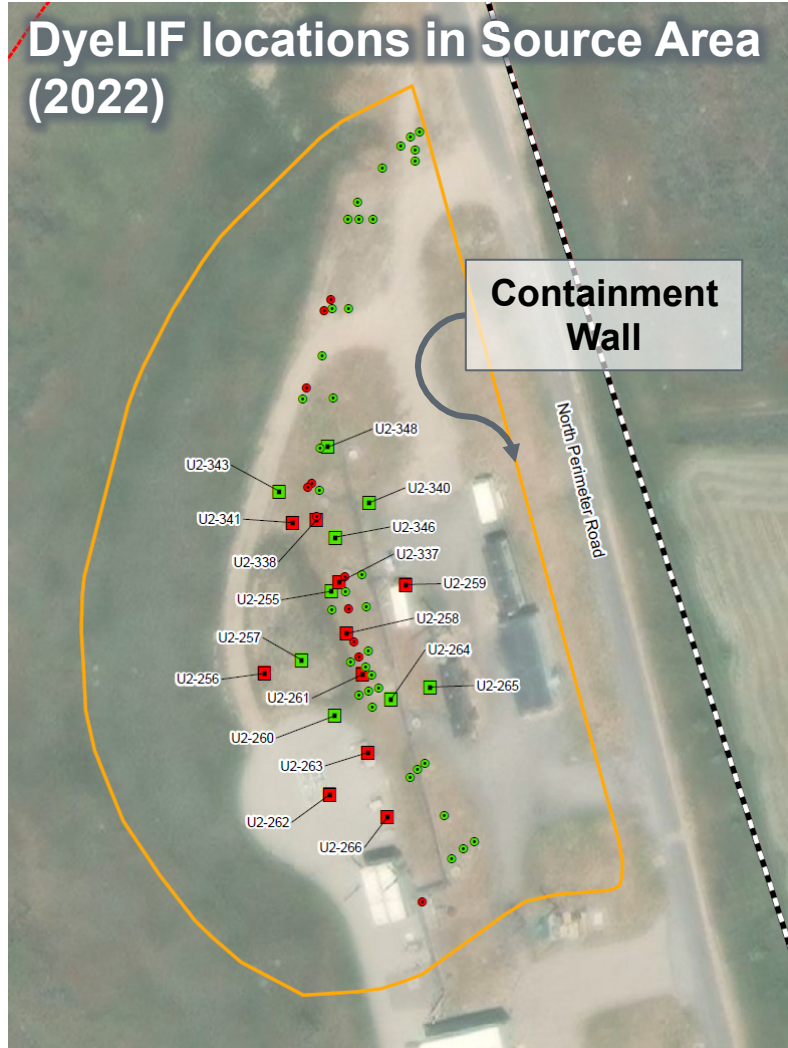
- Sand lenses observed within the upper Alpine Clay Formation during logging (left)
 - Permeable pathways through clay “aquitard”



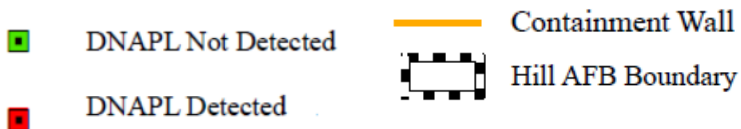
- DNAPL staining of Lower Provo sands and gravels above Alpine Clay contact (right)
 - Previous contamination “wash through”
- Wetness in Lower Provo (right)
 - Water table overtops lower saddle points in Alpine Clay



DyeLIF locations in Source Area (2022)



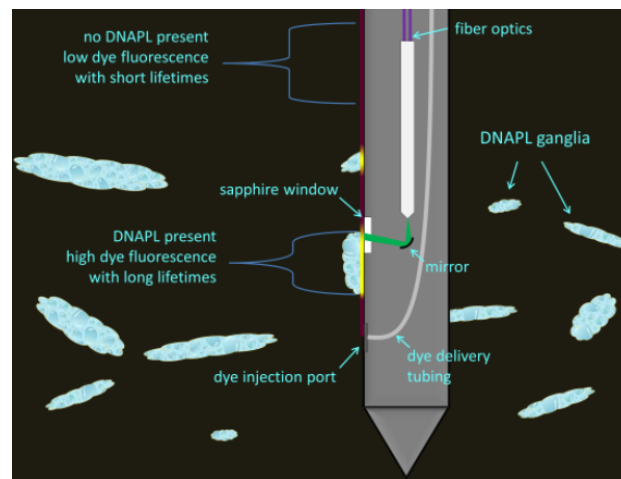
DyeLIF Location:



OU 2 SITE INVESTIGATION

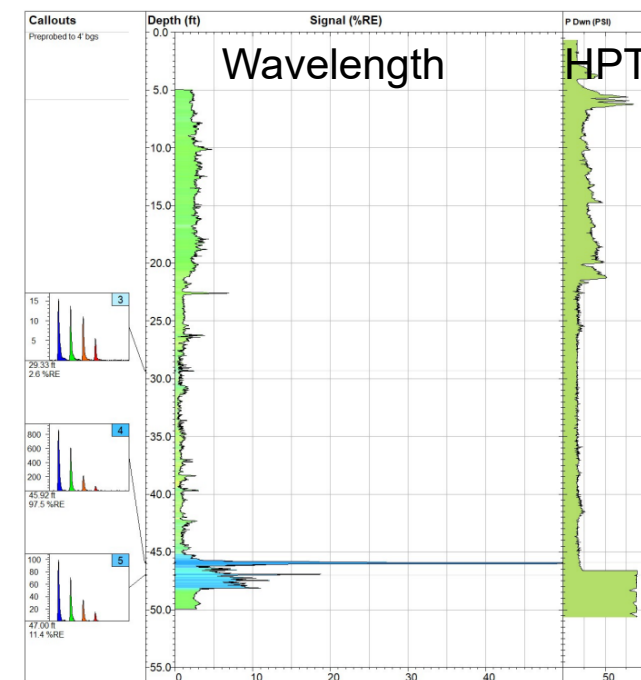
2. Further Define DNAPL Extent in Source Area

- Used Dye-enhanced laser induced fluorescence (DyeLIF) HRSC tool to detect and delineate DNAPL horizontally and vertically
- Confirmation soil logging and sampling

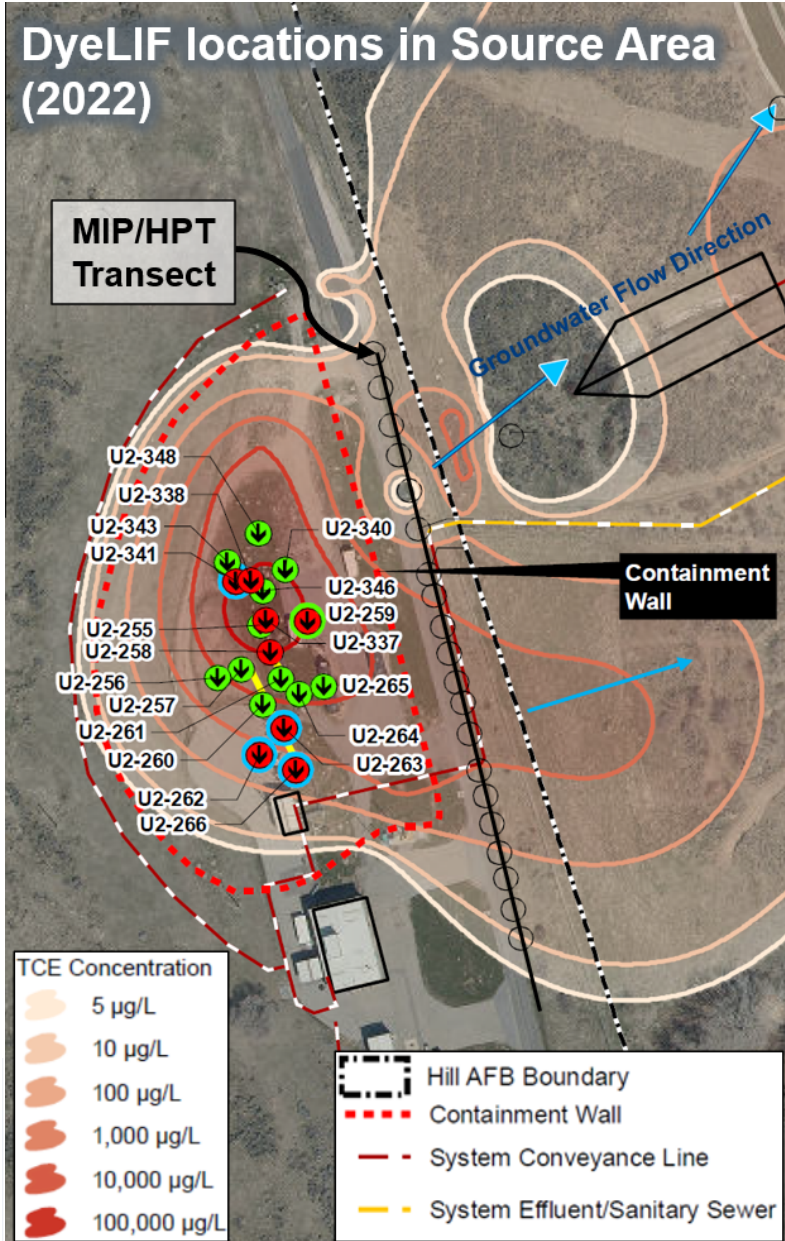


Source: <https://www.dakotatechnologies.com/services/dyelif>

DyeLIF tooling and log (right)



DyeLIF locations in Source Area (2022)



OU 2 SITE INVESTIGATION

Findings: DNAPL Extent not Defined by Paleochannel

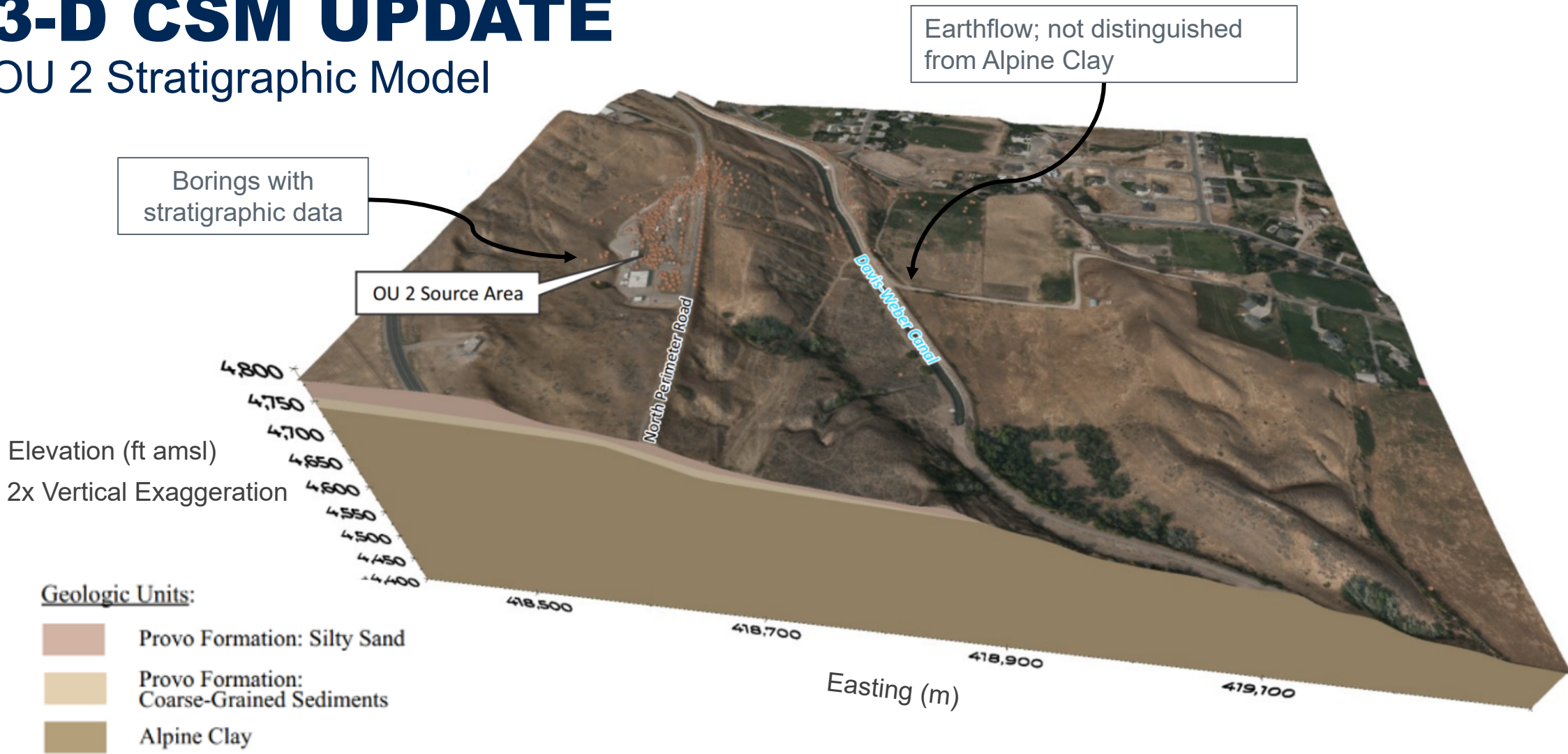
DyeLIF Investigation Result

-  DNAPL Present in 2022
-  DNAPL Not Present in 2022
-  DNAPL Present Within Clay Unit
-  DNAPL present within Vadose Zone Only
-  MIPHPT Location

- Isolated DNAPL pools in paleochannel trough
- Residual DNAPL in vadose zone and deeper within Alpine Clay
 - DNAPL present in paleochannel sidewalls

3-D CSM UPDATE

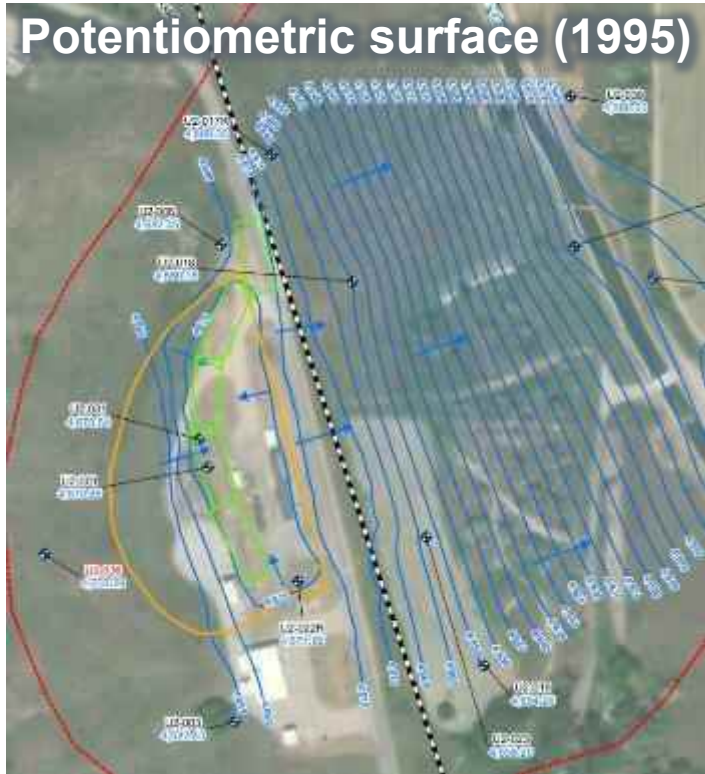
OU 2 Stratigraphic Model



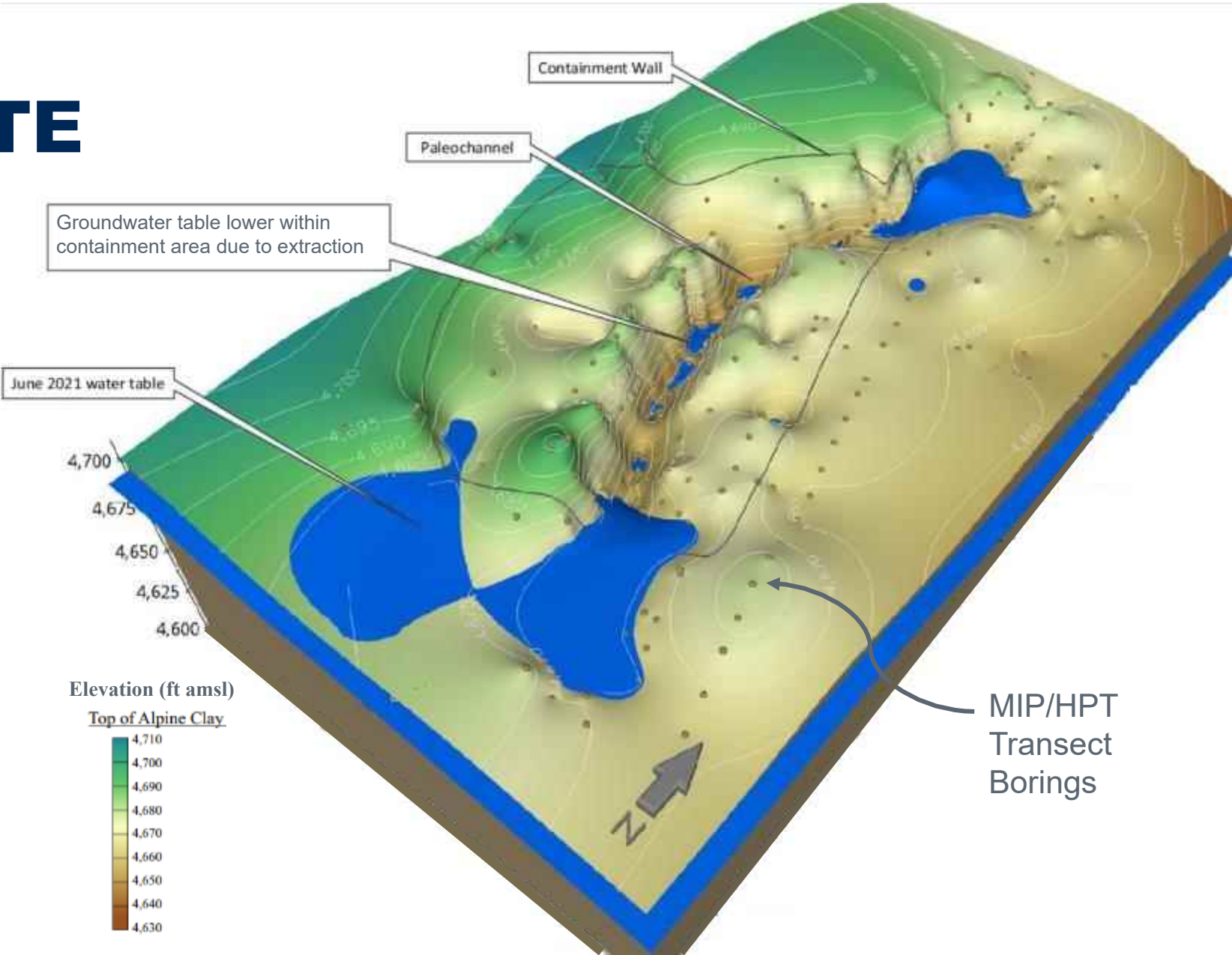
3-D CSM UPDATE

OU 2 Groundwater Model

Potentiometric surface (1995)

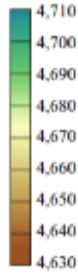


- Groundwater Elevation Contour
- Groundwater Flow Direction
- Containment Wall
- DNAPL Panel
- Operable Unit 2 Boundary
- Hill AFB Boundary



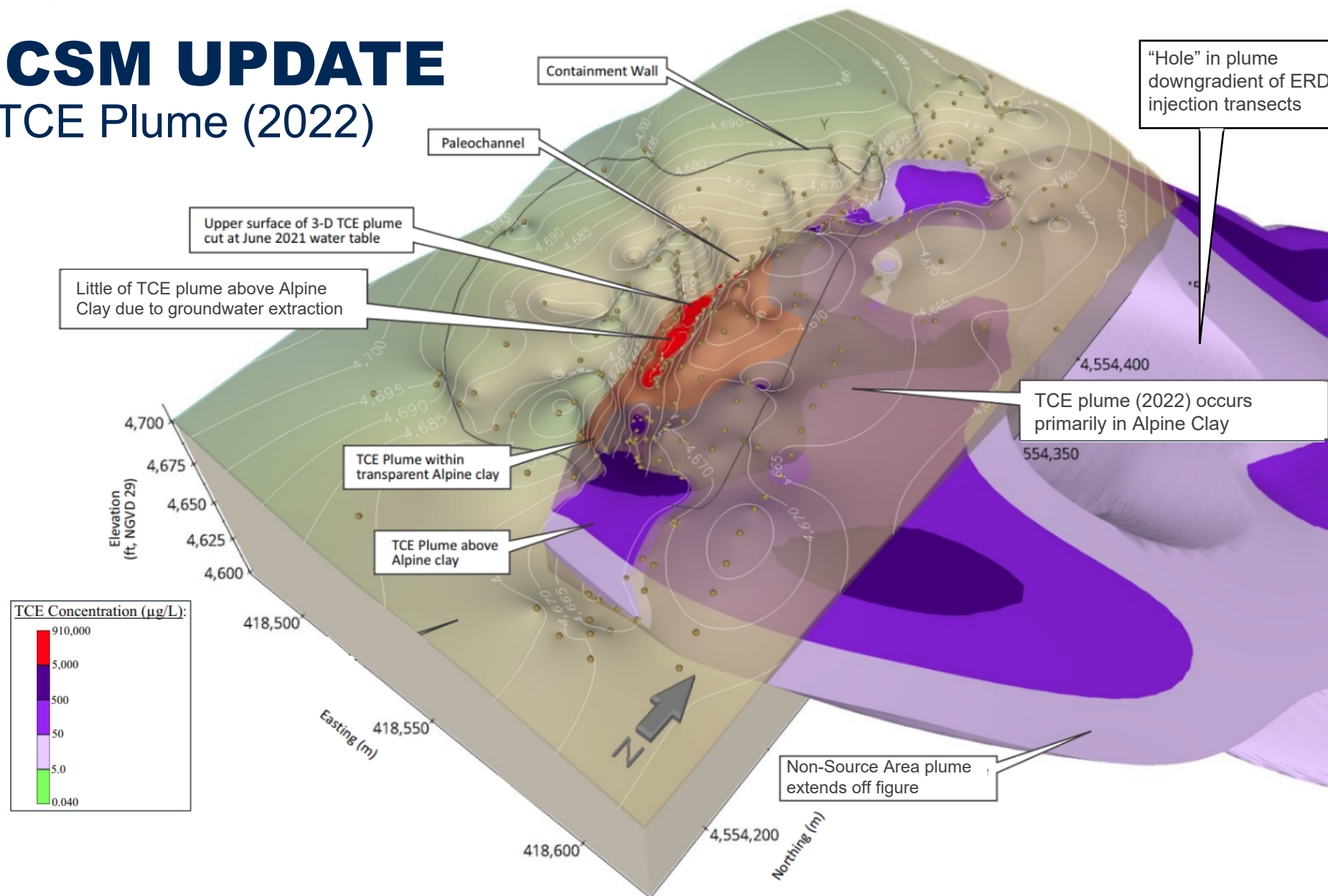
Elevation (ft amsl)

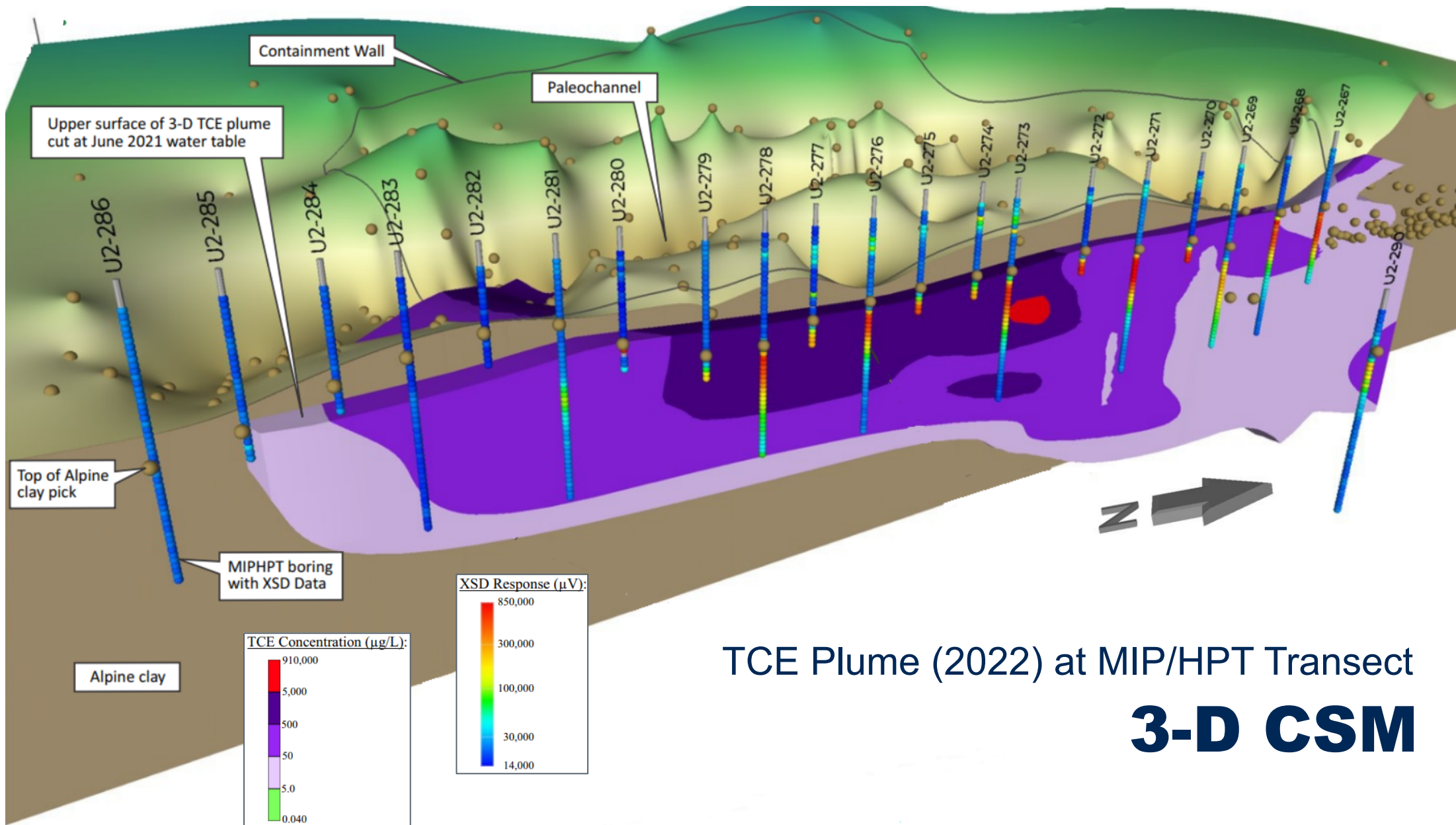
Top of Alpine Clay



3-D CSM UPDATE

OU 2 TCE Plume (2022)





TCE Plume (2022) at MIP/HPT Transect

3-D CSM

OU 2 CSM REVISIONS

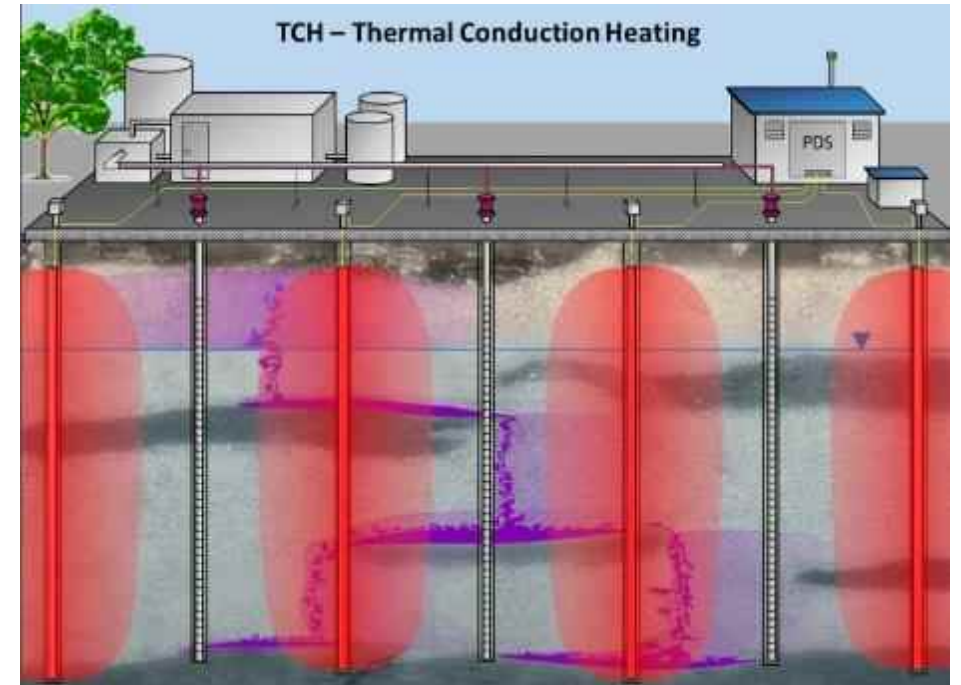
Conclusions

- TCE Fate and Transport:
 - TCE plume predominantly occurs in the Alpine Clay, which limits, *but does not prevent*, vertical and lateral plume migration
 - Sand- and silt-rich lenses permeate the Alpine Clay unit
- TCE Distribution:
 - TCE contained within immobile pore space in clay and will serve as long-term source to groundwater via slow, rate-limited diffusion
- Distribution of Remaining DNAPL:
 - DNAPL migrated through coarser-grained lenses in paleochannel sidewalls
 - Residual DNAPL present in unsaturated Lower Provo Formation
- Hydrogeology:
 - Without Source Area extraction, groundwater flow and contaminant transport occurs in the higher hydraulic conductivity Provo Formation

OU 2 NEXT STEPS

Remedy Evaluation and Recommendations

- Evaluate Alternate In Situ Contaminant Degradation Techniques:
 - Source Area: Assess thermal technologies to remove TCE predominantly occurring in clay
 - TCE in clay will serve as long-term source if not addressed
 - Non-Source Area: Assess bioremediation and bioaugmentation technologies
- Continue Existing Source Area Groundwater Extraction Remedy:
 - Ongoing extraction within the containment wall limits groundwater flow and contaminant transport to the lower hydraulic conductivity Alpine Clay



Source: <https://www.cascade-env.com/site-remediation/thermal-technology-by-terratherm/>

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Questions?



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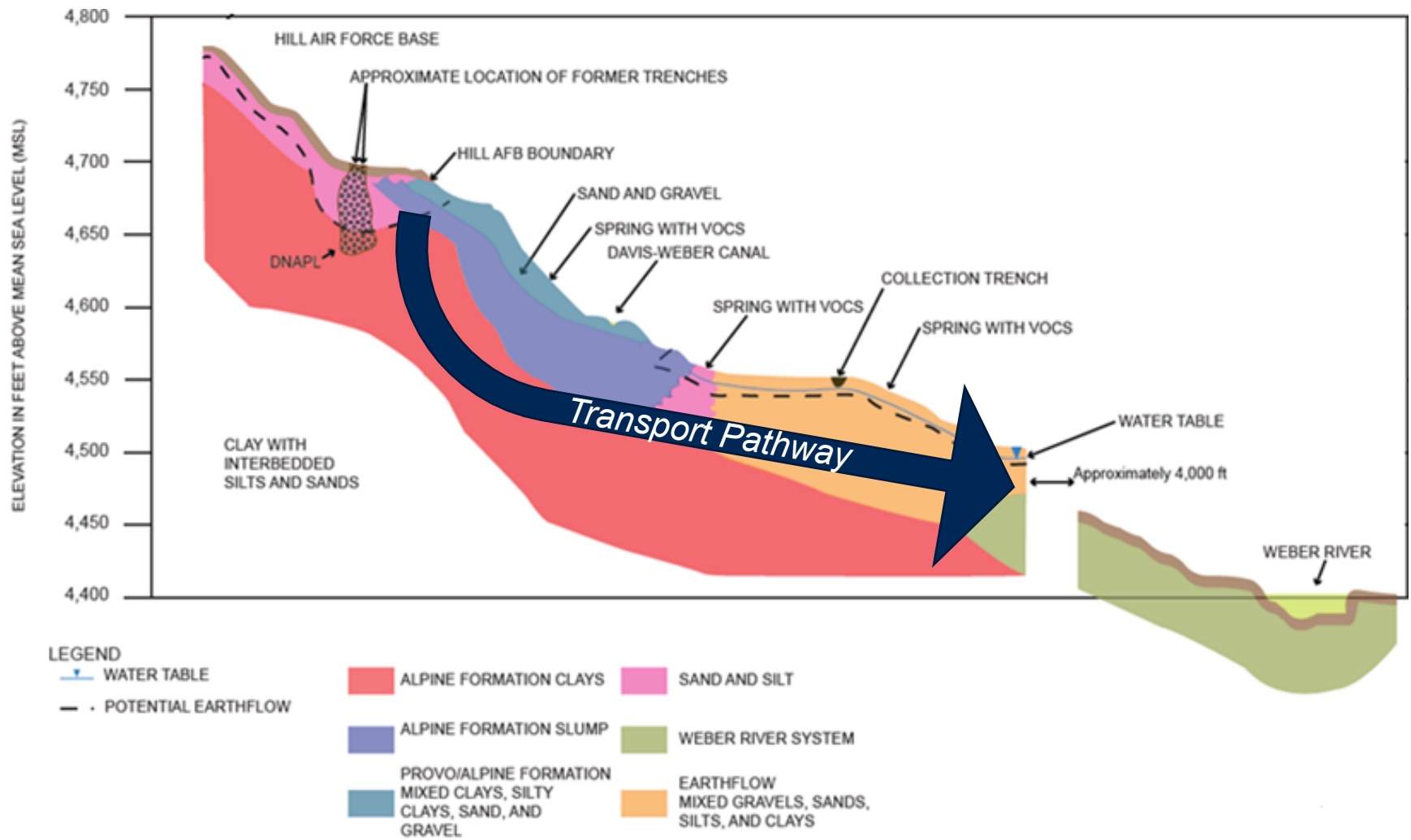
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CONCEPTUAL SITE MODEL

OU 2 – Within South Weber Landslide Complex



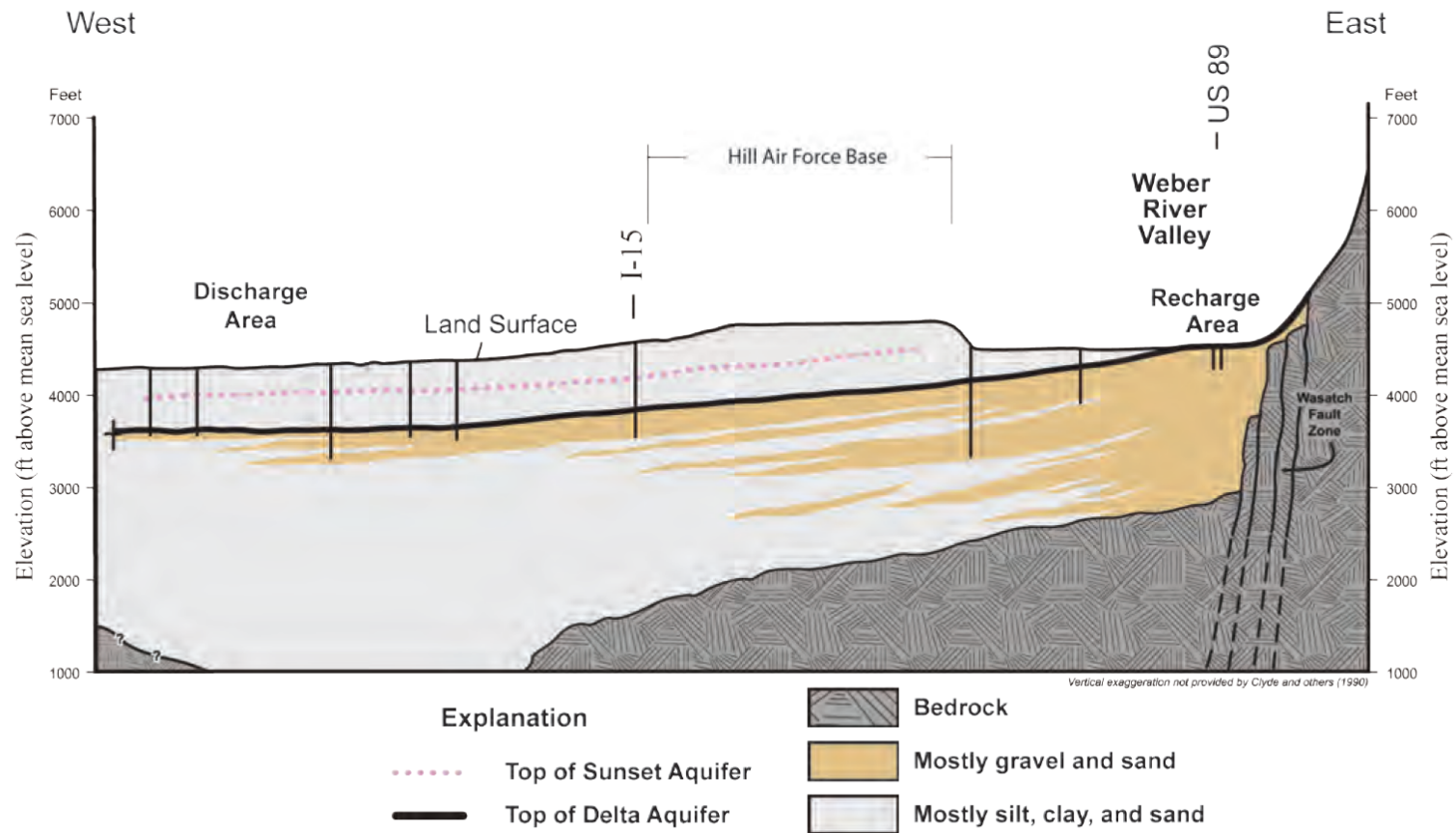


Figure 3. Geologic profile through the central Weber Delta subdistrict, east shore area of Great Salt Lake, Utah (modified from Hurlow and others, 2011).

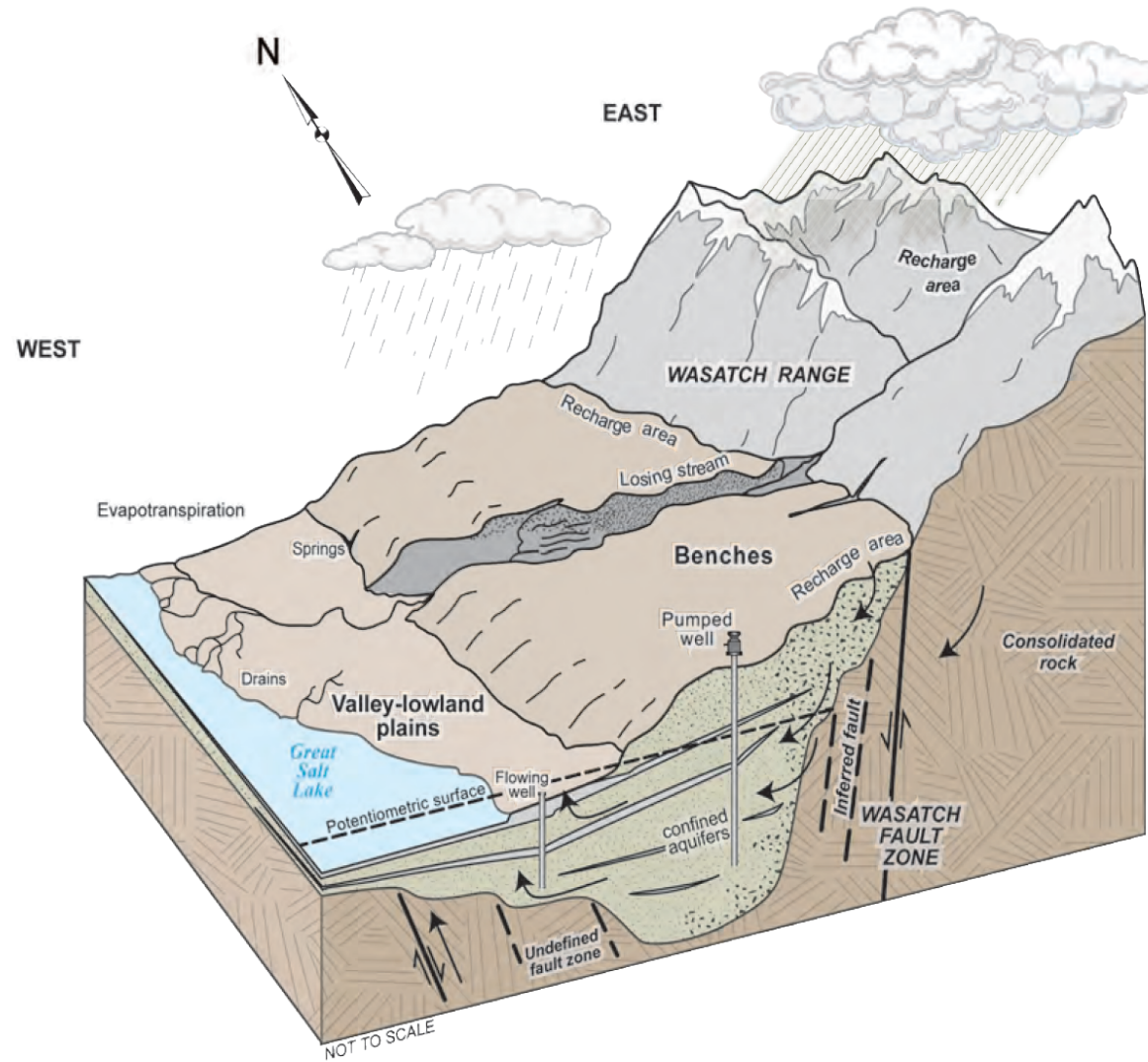
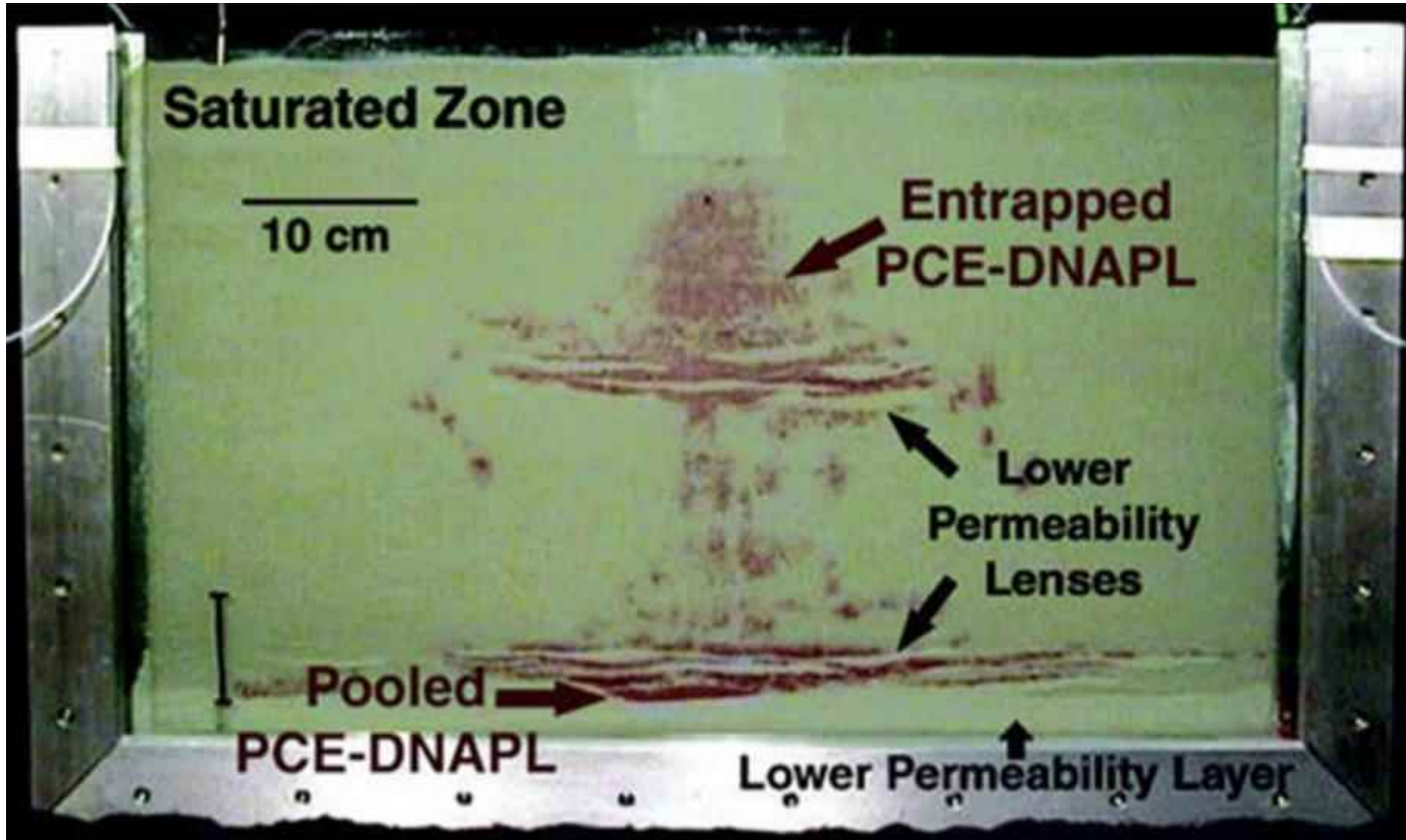


Figure 4. Generalized block diagram showing water-bearing formations, probable direction of groundwater movement (arrows), and areas of recharge and discharge, east shore area of Great Salt Lake, Davis County, Utah (after Clark and others, 1990).



Source: *Dense Chlorinated Solvents in Porous and Fractured Media* (Schwile, 1988)