Using a Digital CSM to Expedite Workflow for DoD PFAS Site Investigations

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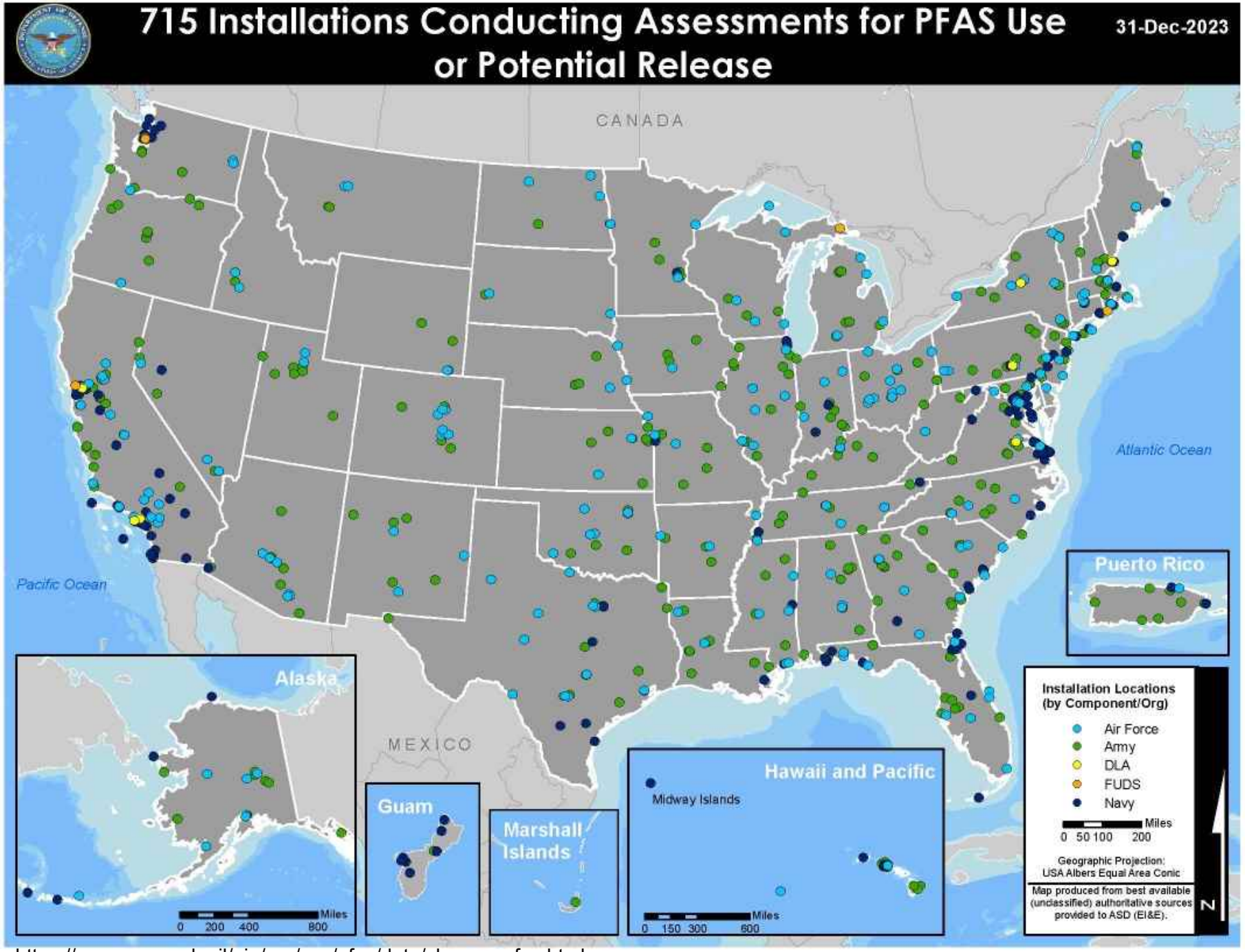
June 4, 2024

DoD PFAS Program

715 military sites requiring assessment for PFAS

- PA/SI complete at 707
  - ➢ 574 sites with confirmed releases
  - ➢ 133 NFA

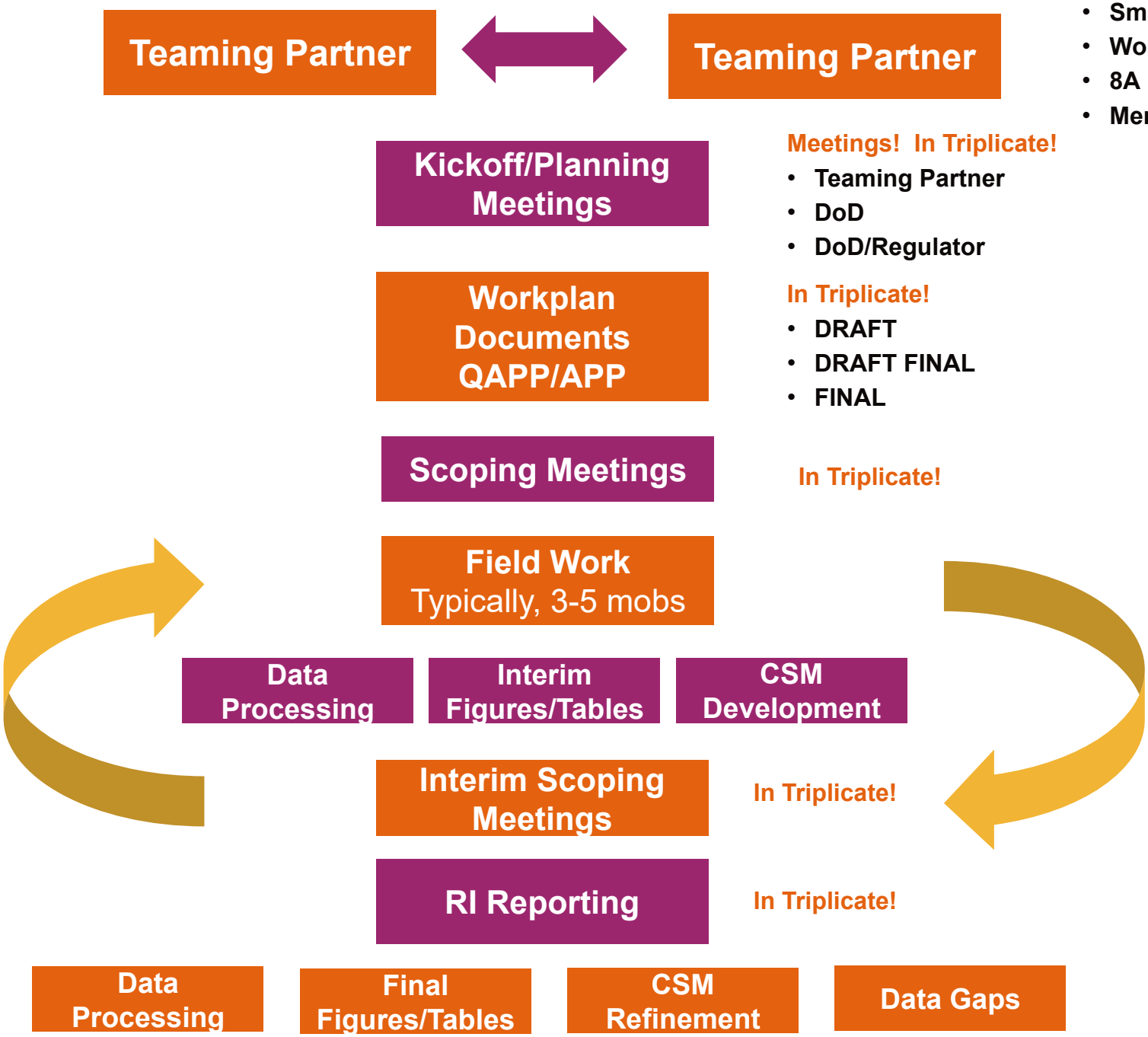


https://www.acq.osd.mil/eie/eer/ecc/pfas/data/cleanup-pfas.html

DoD PFAS RI Process

Typical Period of Performance (POP)

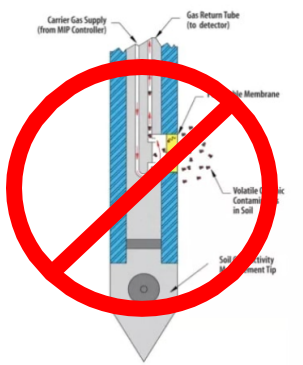
- **3-5 years!**



Current State of Practice for PFAS Site Investigations

Difficult to Accelerate Site Work

- No field screening options
- No PFAS direct sensing options
- No mobile labs



If doing DoD work:

- Currently requiring draft Method 1633
- Beginning to utilize “screening methods” to facilitate decision making

If doing commercial work:

- Regulatory environment varies by state
- EPA sites are using draft Method 1633
- Most state programs moving towards Method 1633
- A few states allowing legacy methods (e.g., USEPA Method 537M / Method 8327)

PFAS Site Work Problem Statement

Relying on definitive analytical methods (1633)

- Investigations are slow & expensive
- Expectations too high
  - ➢ Definitive data not needed for initial characterization

Laboratory Capacity

- Sample backlog & analytical delay
- Rising costs due to demand

Analytical Constraints Impact Overall Project Efficiency

Result:

- Old school prescriptive work strategies
- RIs require multiple field seasons
  - ➢ Higher lifecycle/reporting costs

- **Work pace has slowed, costs have risen**
- **Low resolution CSMs**
- **Site investigation methods regressing**

How Do We Streamline?

Digital Workflow

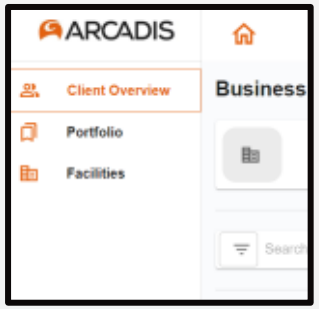
Analytical Screening Methods

Adaptive Scoping

Digital Workflow and the dCSM

Key Steps in the Digital Workflow

Plan



Streamlined scope set up to improve quality during field events

Collect

Electronic field data collection

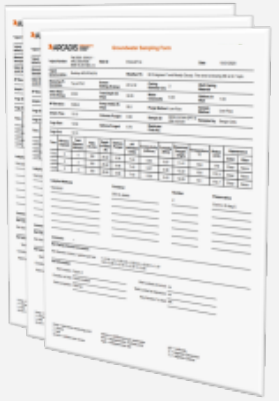
Ingest, Store & Process

Secure and automated data management including QA/QC tools

Visualize

Real-time interactive analytics and visualizations to improve decision making

Report



Automated reporting

Site Characterization Standard Data Flow

ARCADIS

Plan → **Collect** → **Process & Store** → **Visualize & Report**

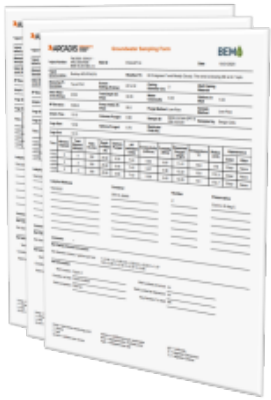
Plan locations in GIS Web Map then manually load to field planning tool.

<u>Plan & Manage:</u>
Location Data,
Analyte List, Screening Levels,
Work Orders

Single Database
(Source of Truth!)

Interactive analytics and visualizations to improve decision making

(Digital CSM)



Automated reporting

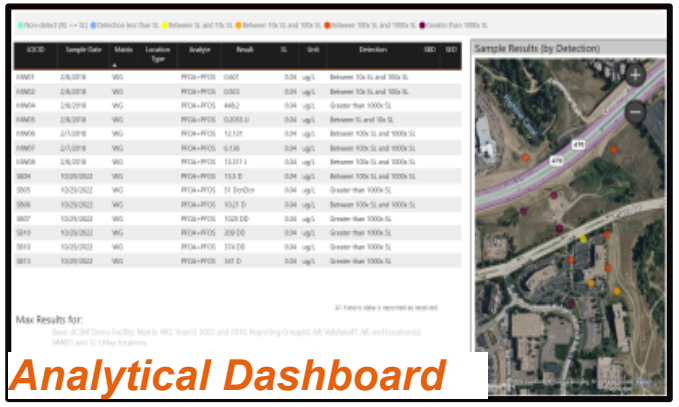
<u>Collect:</u>
Field Data Collection with Standardized Apps

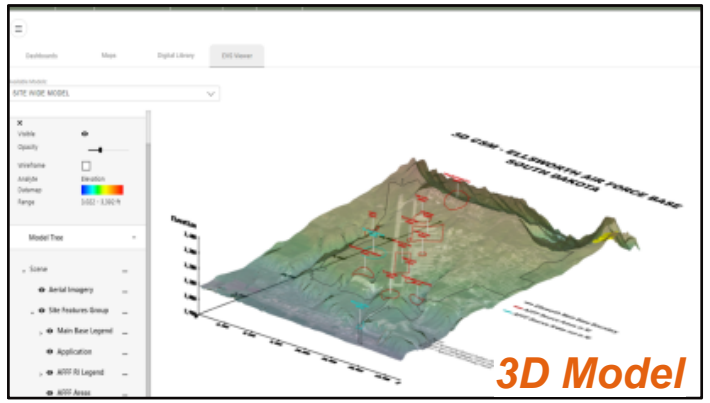
Digital Field Apps

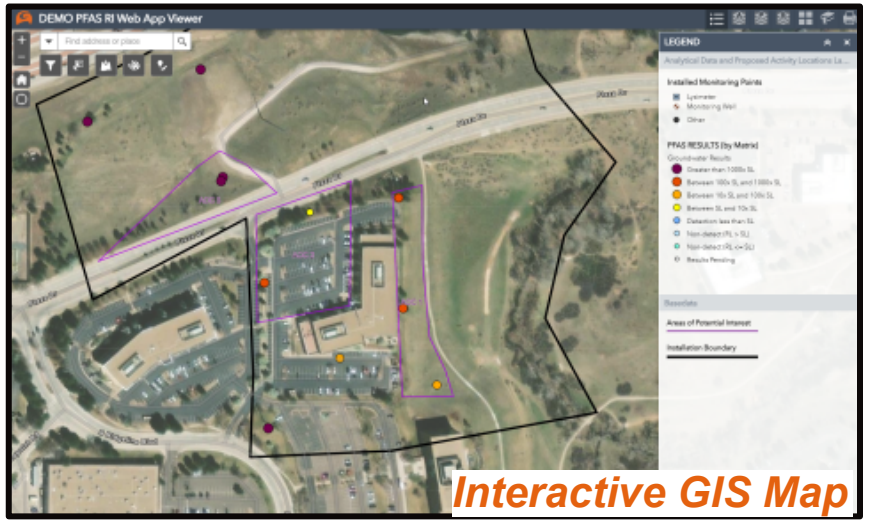
Analytical Data from Lab

Digital CSM Web Application Tools

- Portal for data visualization, communication, & planning
- Web platforms for team collaboration
- Accommodates adaptive site characterization approach (prescribed + adaptive RI phases)
- Reduces (or eliminates) interim reporting
- Reduces period of performance (PoP)







Adaptive Program Development

Decisions, Decisions…how to make them quicker

Screening Data (e.g., ASTM D8421)	Definitive Data (e.g., Method 1633)
Support interim decisions	**Support final decisions - risk assessment, compliance, delineation**
• Intial characterization of source and plume geometry ➢ Vertical aquifer profiling (VAP) ➢ Near surface soil sampling (HA) ➢ ISS - large/uncertain release areas • Use to focus definitive sampling (e.g., MW install)	• High DQOs – Requires quality assurance sufficient to use for risk assessment • Confirm delineation – nature and extent

PFAS Analytical Screening Options

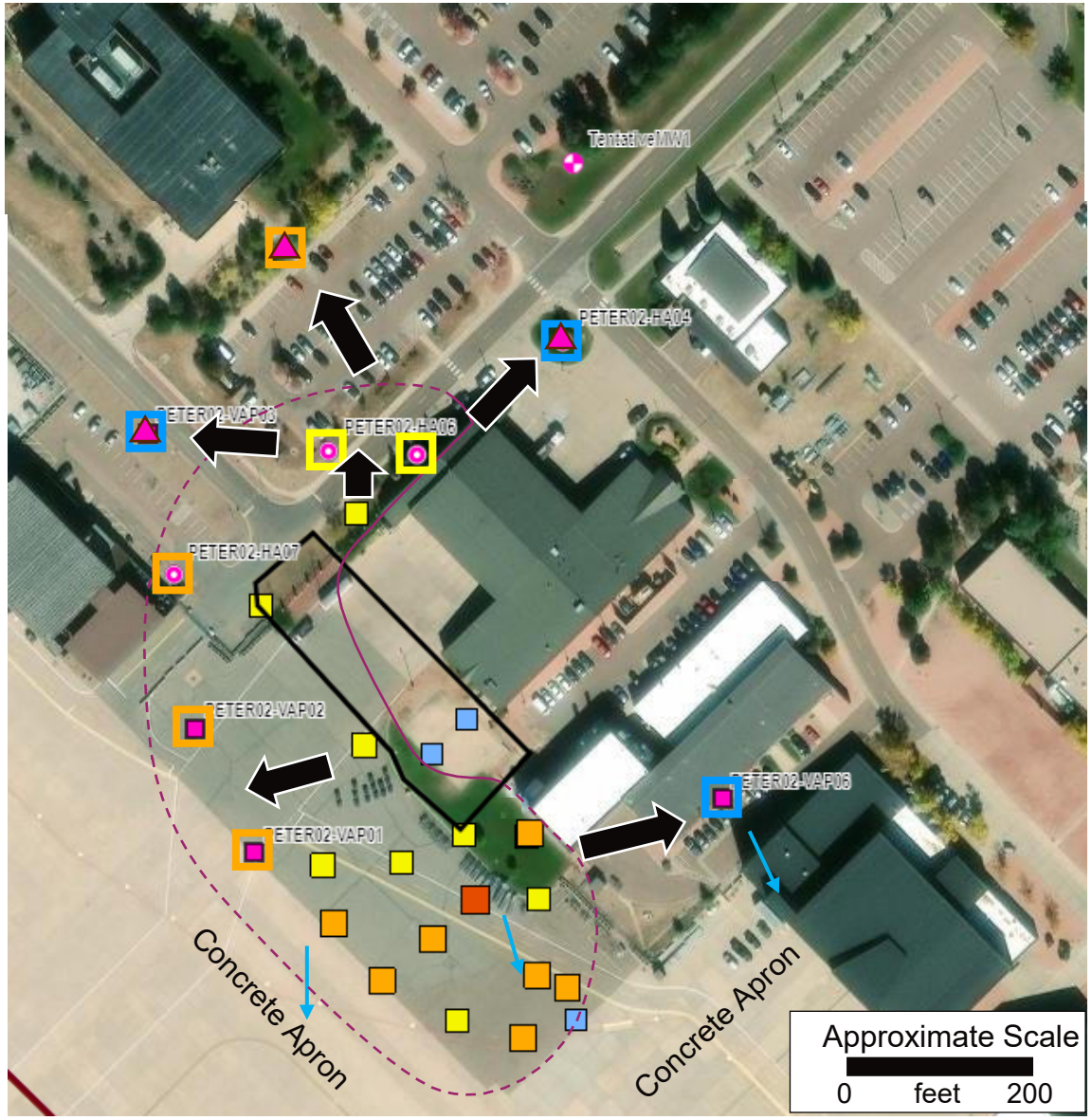
Method Parameter	Screening Method 8421/8327	EPA Draft Method 1633
Sample Preparation	Direct Aqueous Injection	Solid Phase Extraction
Isotope Dilution	Yes	Yes
# Analytes	44/24	40
Detection Limits	10 - 20 ng/L water 0.5 ug/kg soil	2 ng/L water 0.5 ng/Kg soil
TAT	5 – 10 days	15 – 40 days
Cost	$225 water/soil	*$350/400 water/soil*

Site Investigation – Adaptive and Flux Based

Screening and definitive methods are collaborative and can be applied across the site to meet objectives:

- Background sampling – definitive
- Source area delineation – collaborative
- Perimeter mass flux evaluation – screening
- Storm-water and sediment sampling – collaborative
- Surface water and sediment sampling – collaborative
- Flux-based groundwater monitoring – definitive

Petersen SFB Adaptive Sampling



Pre-field planning

- Establish screening criteria (SC) for comparison of screening results; typically, either the screening level (SL) or SL multiplied by a factor of safety.
- Confirm laboratory calibration range brackets SC

Decision logic, delineation step out sampling

- D8421 < SC → run 1633 to delineate
- D8421 > SC → step out to delineate

PFAS Analytical Results

- Soil Sample
- GW Sample

PFOS Result

- Result ND
- Result < SL
- Result > SL & < 10x SL
- Result > 10x SL & < 100x SL
- Result > 100x SL & < 1000x SL
- SL
- Result > 1000x SL

Hollow symbols represent NEW results. Hollow white symbols represent pending data.

Sample Location

- Deep Soil Boring
- Shallow Soil Boring (Hand Auger)
- Adaptive Soil Sample

Buckley SFB Phase 1 PFAS RI

Buckley SFB Digital Workflow

Field Data Collection

All data collected with tablets:

- Boring Logs
- Sampling Logs
- Slug tests
- Chain of Custody

Adaptive Scope of work

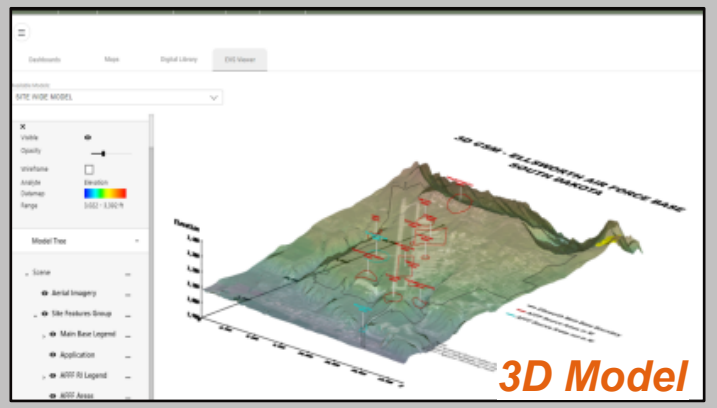
Work completed in phases

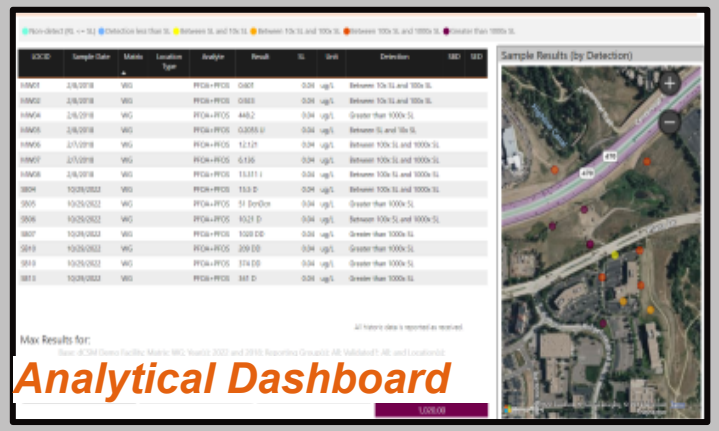
- Prescriptive Phase
- Adaptive Phases

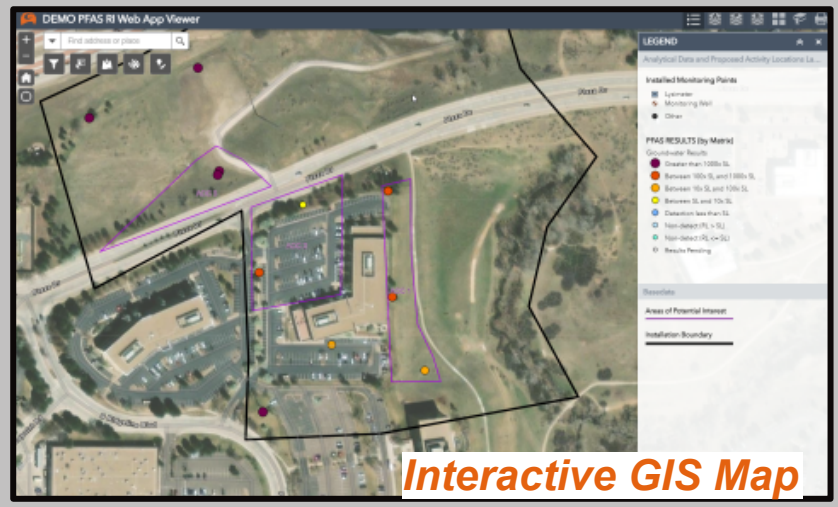
Digital CSM

All field and analytical data uploaded to the digital CSM:

- Accessible by all stakeholders
- Used as basis for interim meetings to streamline data sharing
- Foundation for RI analysis







Available Dashboards:

Sample Results

Comments

DoD Air Force PFAS RI Digital CSM - Buckley

BEM ARCADIS

RESET

MATRIX: Groundwater

LOCATION TYPE: All

ANALYTE: All

YEAR: All

REPORTING GROUP: All

START DEPTH: All

END DEPTH: All

VALIDATED?: All

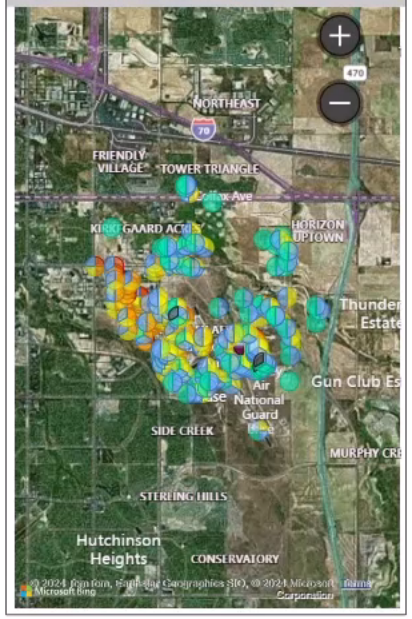
LOCATION: All

Rejected | Results Pending | Non-detect (RL <= SL) | Non-detect (RL > SL) | Detection less than SL | Between SL and 10x SL | Between 10x SL and 100x SL | Between 100x SL and 10... | Greater than 1000... | No RSL

LOCID	Sample Date	Matrix	Location Type	Analyte	Result	RSL	Unit	Sample Type	Detection	Start Depth
1000 Richfield St.	2/28/2020	Groundwater	Monitoring Well	PFBS	0.0038 U	0.601	ug/l	N	Non-detect (RL <= S...	
1000 Richfield St.	2/28/2020	Groundwater	Monitoring Well	PFOA	0.0038 U	0.006	ug/l	N	Non-detect (RL <= S...	
1000 Richfield St.	2/28/2020	Groundwater	Monitoring Well	PFOA + PFOS	0 UU	0.004	ug/l	N	Non-detect (RL <= S...	
1000 Richfield St.	2/28/2020	Groundwater	Monitoring Well	PFOS	0.0038 U	0.004	ug/l	N	Non-detect (RL <= S...	
1011MW01	11/3/2020	Groundwater	Monitoring Well	PFBA	0.0032 J	1.800	ug/l	N	Detection less than SL	44.00
1011MW01	7/12/2022	Groundwater	Monitoring Well	PFBA	0.0035 U	1.800	ug/l	N	Non-detect (RL <= S...	44.00
1011MW01	11/3/2020	Groundwater	Monitoring Well	PFBS	0.00099 J	0.600	ug/l	N	Detection less than SL	44.00
1011MW01	7/12/2022	Groundwater	Monitoring Well	PFBS	0.0013 J	0.600	ug/l	N	Detection less than SL	44.00
1011MW01	7/12/2022	Groundwater	Monitoring Well	PFHxA	0.00088 U	0.990	ug/l	N	Non-detect (RL <= S...	44.00
1011MW01	11/3/2020	Groundwater	Monitoring Well	PFHxA	0.0017	0.990	ug/l	N	Detection less than SL	44.00
1011MW01	11/3/2020	Groundwater	Monitoring Well	PFHxS	0.0011 J	0.039	ug/l	N	Detection less than SL	44.00
1011MW01	7/12/2022	Groundwater	Monitoring Well	PFHxS	0.0013 J	0.039	ug/l	N	Detection less than SL	44.00
1011MW01	11/3/2020	Groundwater	Monitoring Well	PFNA	0.00079 U	0.006	ug/l	N	Non-detect (RL <= S...	44.00
1011MW01	7/12/2022	Groundwater	Monitoring Well	PFNA	0.00088 U	0.006	ug/l	N	Non-detect (RL <= S...	44.00
1011MW01	7/12/2022	Groundwater	Monitoring Well	PFOA	0.00088 U	0.006	ug/l	N	Non-detect (RL <= S...	44.00
1011MW01	11/3/2020	Groundwater	Monitoring Well	PFOA	0.0059	0.006	ug/l	N	Detection less than SL	44.00

All historic data is reported as received.

Sample Results (by Detection)



Max Results for:

Base: BCKLY; Matrix: Groundwater; Year(s): All Years; Reporting Group(s): Historical, ARCADIS/BEM RI 2022, ARCADIS/BEM RI 2020 and ARCADIS/BEM RI 2021; Validated?: All; and Location(s): 1000 Richfield St. and 301 Other locations

PFBS (max)	PFOA (max)	PFOS (max)	(PFOA + PFOS) (max)
19.00	190.00	120.00	205.00

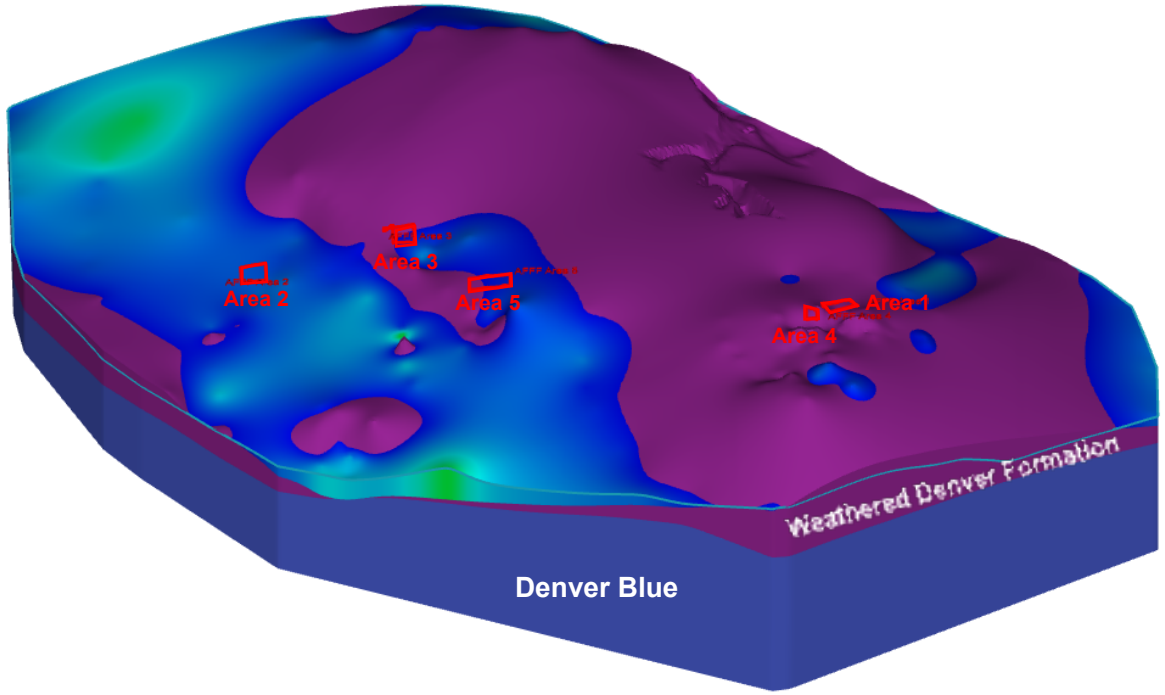
REFRESH DATE : 5/20/2024 5:01:58 PM

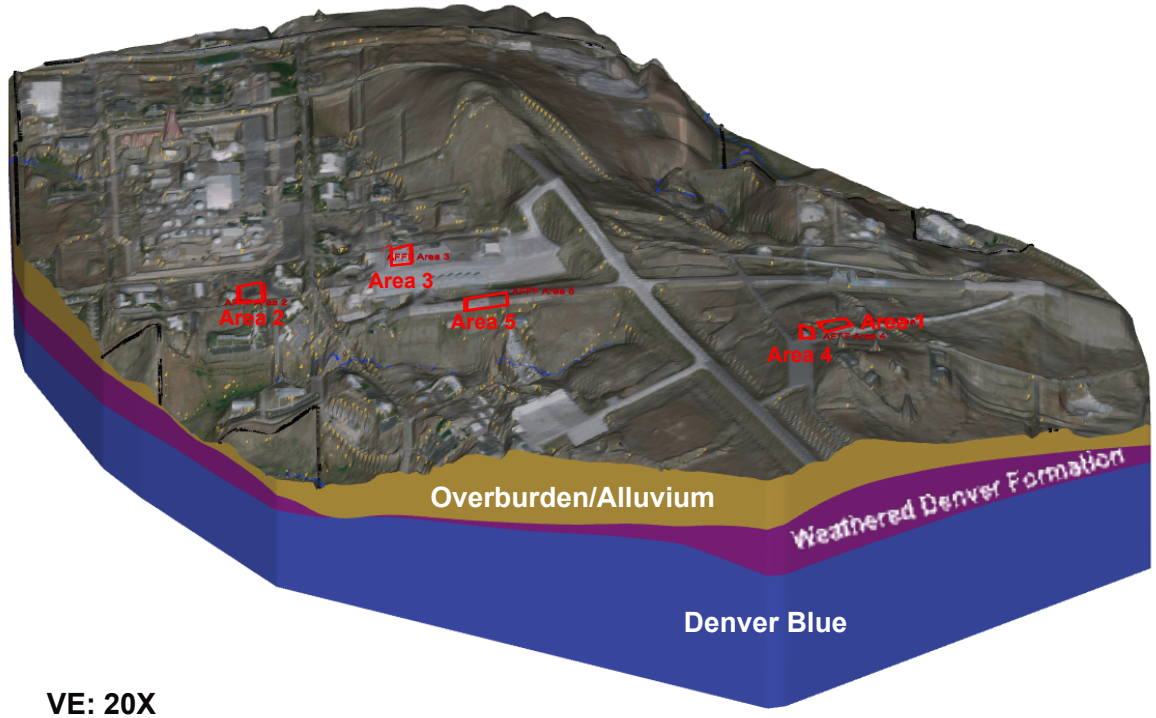
CONFIDENTIAL

Filters

Lithologic Model

Extent Saturated Overburden





VE: 20X

Stratigraphic Flux Model Development

Collect Data along Transects

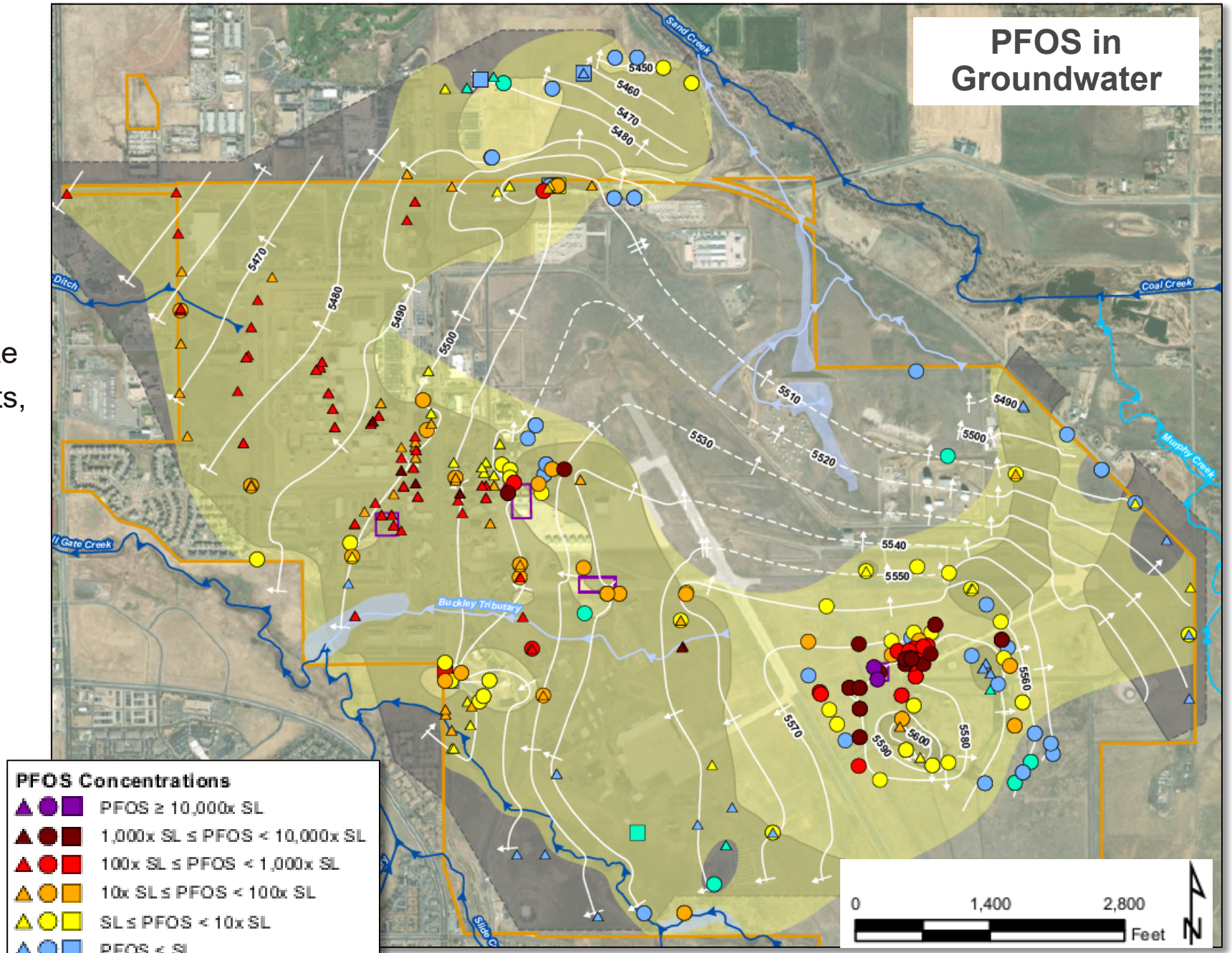
- Lithology: Observation and grain size
- Hydraulic Conductivity (K): Slug tests, low flow drawdown tests, and grain size analysis
- Concentration (C): VAP borings and monitoring wells

Develop Hydraulic Conductivity Distribution

- Interpolate lithology
- Correlate K with lithologic units

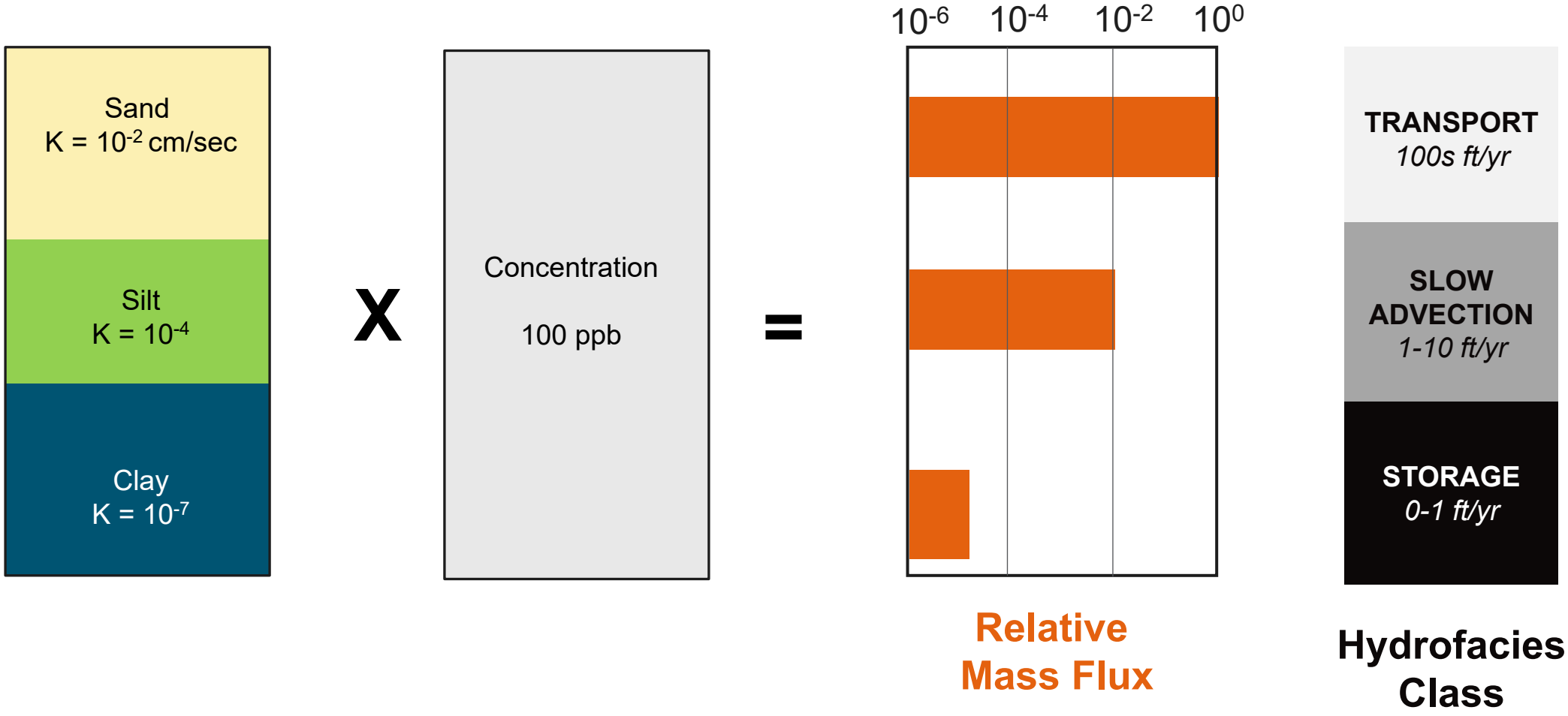
Develop Concentration Distribution

- Interpolate groundwater concentrations across transect



Stratigraphic Flux

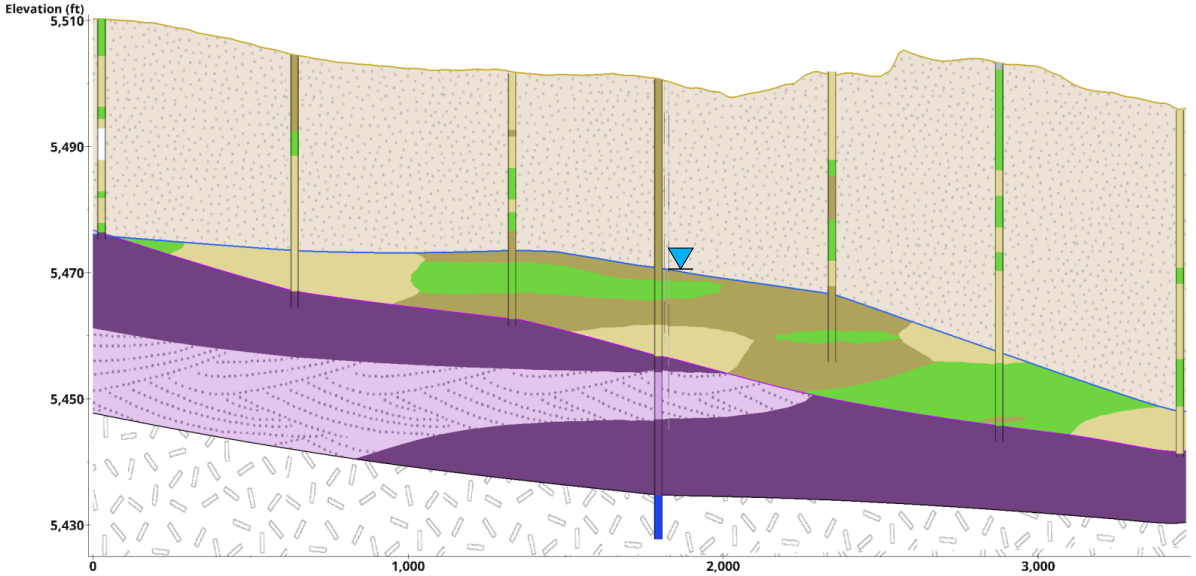
Mass Flux (J) = K i C



Transect F – PFOS Flux

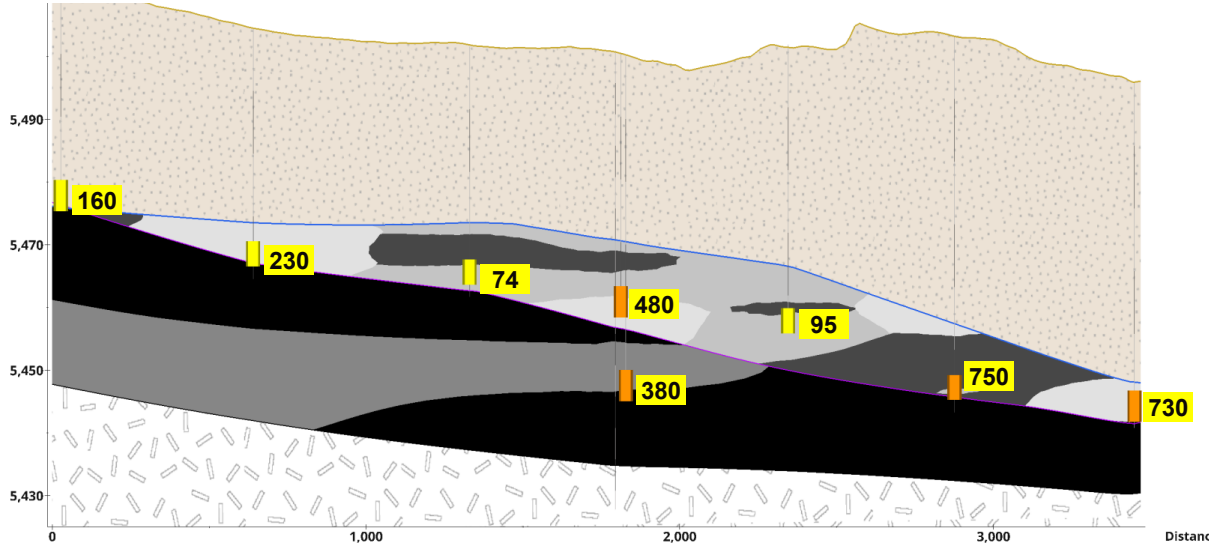
Geology

South North



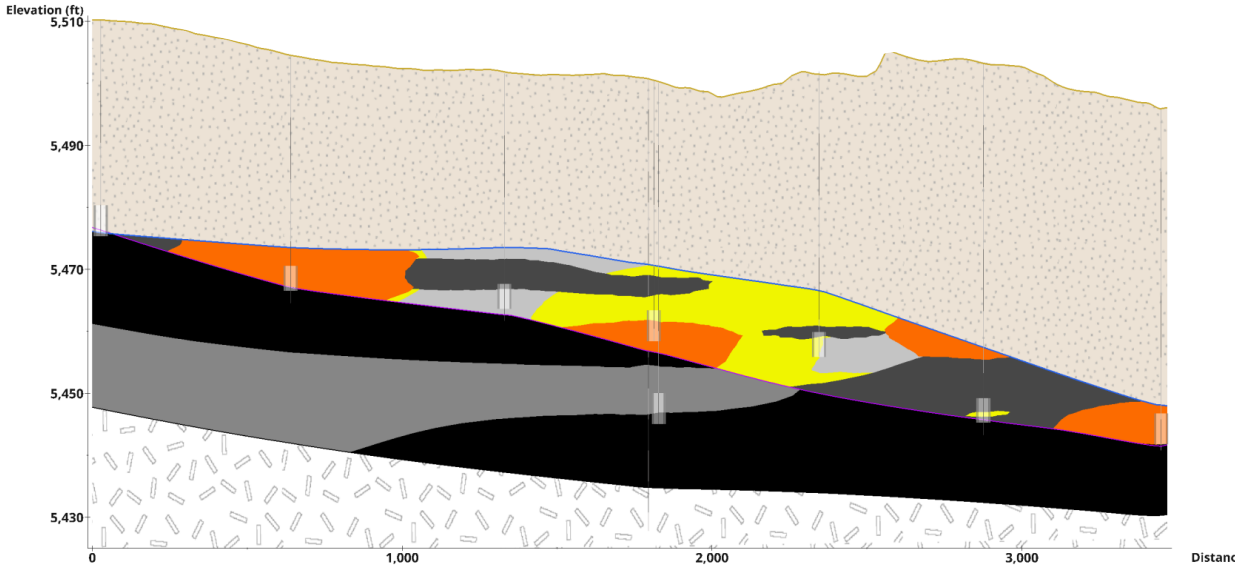
Hydraulic Conductivity and Sample Concentration

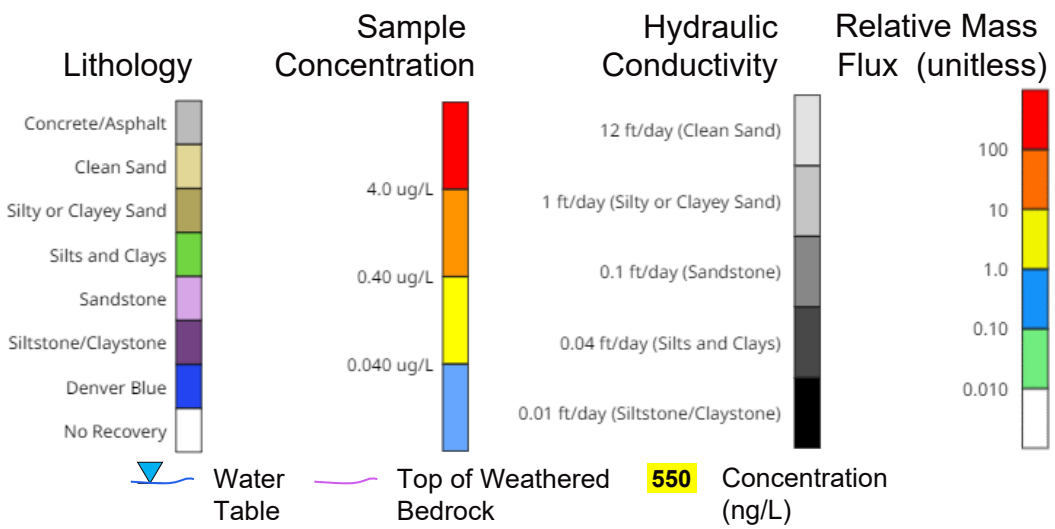
South North



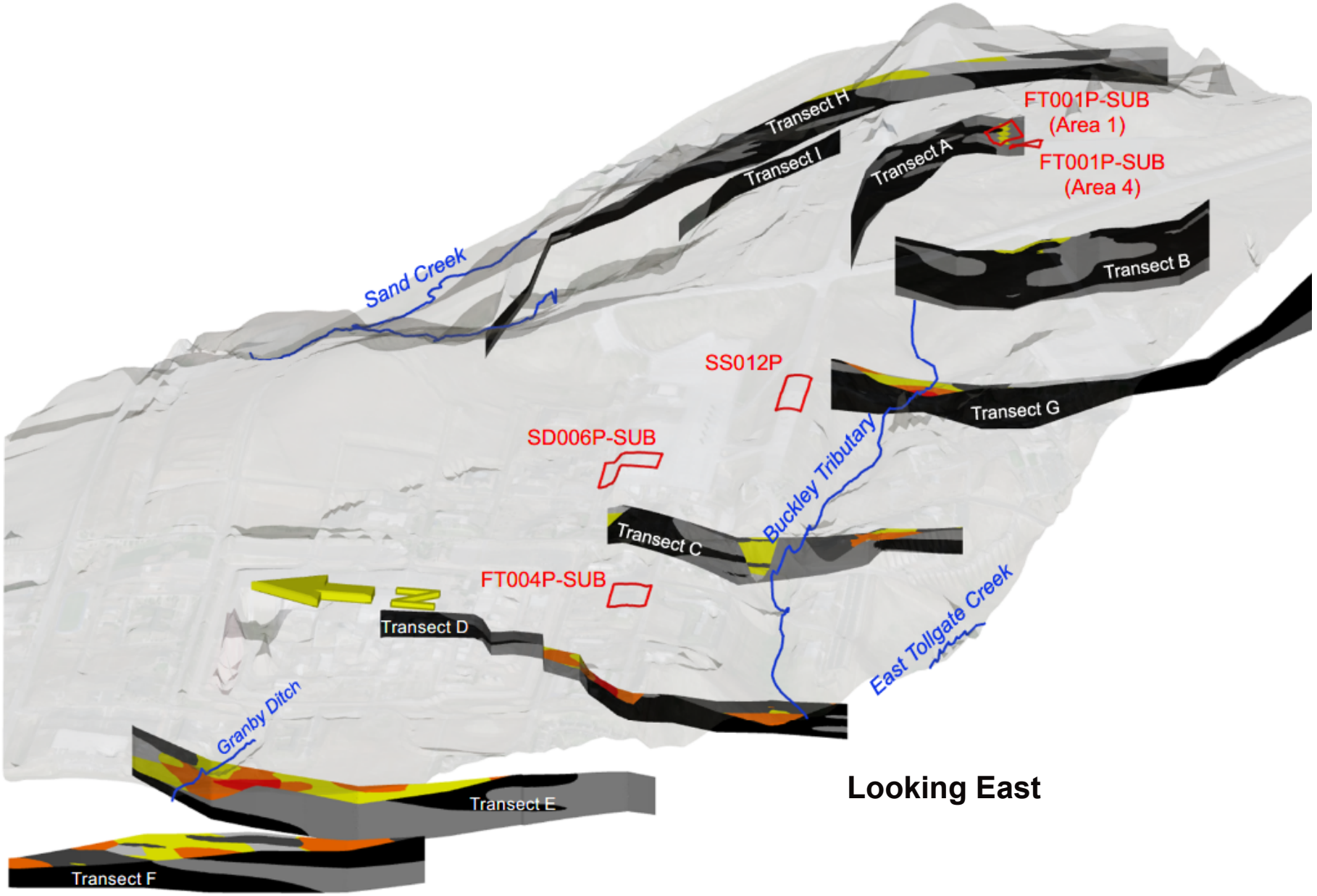
Relative Mass Flux

South North





Stratigraphic Flux Transects - Looking East - PFOS



Looking East

Legend

Relative Mass Flux

- > 100
- 10-100
- 1-10

Hydraulic Conductivity

(ft/day)

- 12 (Clean Sand)
- 0.8 (Silty/Clayey Sand)
- 0.1 (Sandstone)
- 0.04 (Silts/Clays)
- 0.01 (Siltstone/Claystone)

AFFF Area

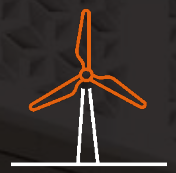
Stream

Wrap-Up

Digital tools and automation coupled with an adaptive approach are key to the efficient completion of large-scale DoD projects:

- DoD PFAS RIs are complicated with layers of project management, DOD personnel and multiple regulatory agencies
- Digital platforms can reduce the backend data compilation and evaluation effort and provide a collaborative space for stakeholders
- PFAS screening methods can reduce the number of mobilizations and the time to complete field efforts
- Digital tools can facilitate an adaptive approach, including intial prescriptive sampling followed by adaptive stepouts agreed upon during interim scoping sessions using the dCSM

About Arcadis



Founded in 1888 in the
Netherlands

Top Female Friendly Companies

in the World, named by Forbes in 2022

Ranked #1 ESG Risk Rating Score

In our industry by Sustainalytics

40,000+ Projects

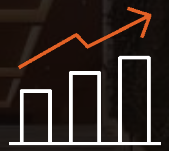
around the world

4th Largest

Architecture business in the world

Platinum Medal 2022

EcoVadis Sustainability Ratings



€4 Billion

in revenues in 2022