Triad Case Studies from the Navy

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The Navy PWC Road to Triad

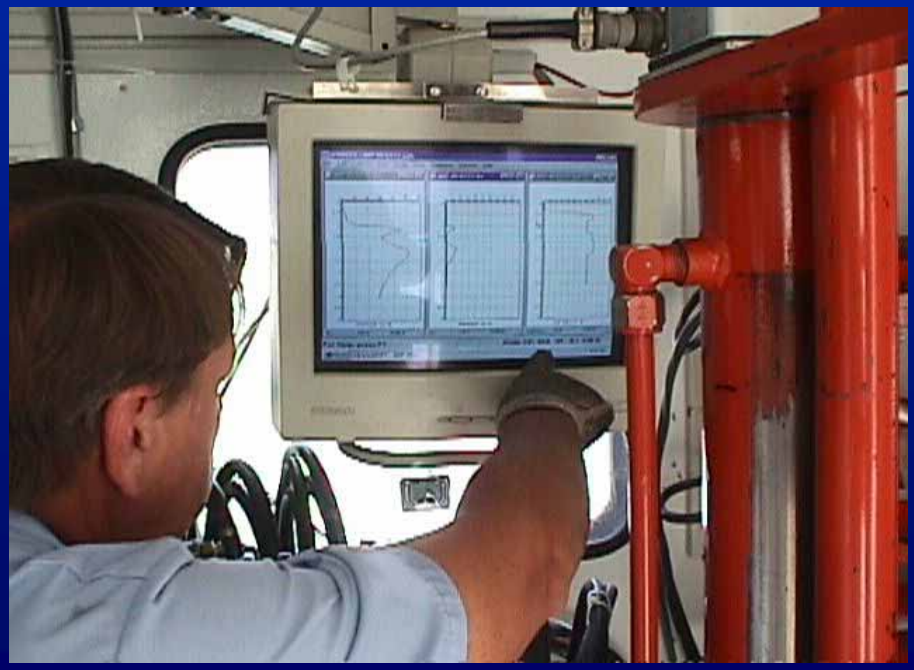
Site Characterization and Analysis Penetrometer System

1994 - Present

Site Characterization and Analysis Penetrometer System
S·C·A·P·S
TRI-SERVICE
Naval Command, Control and Ocean Surveillance Center RDT&E Division

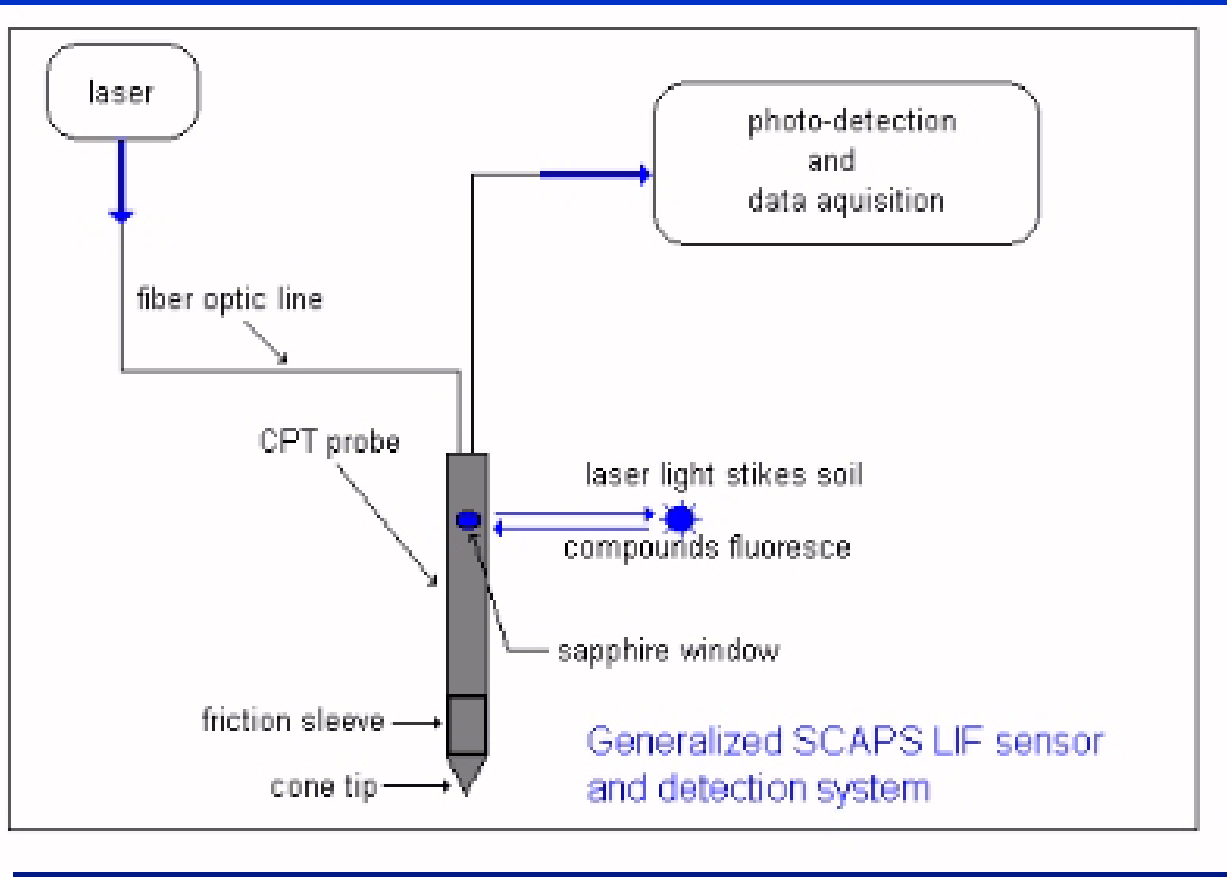
SCAPS in Action

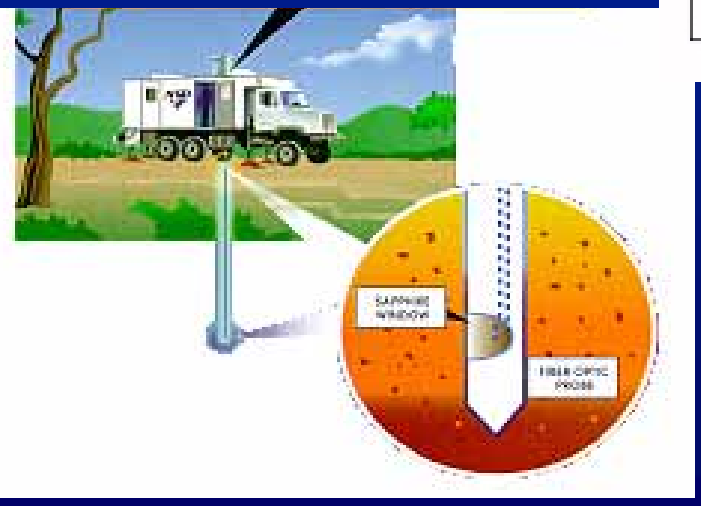
- Hydraulic rams grab the rod string and push it into the ground.
- The instrumented tool is at the bottom of the rod string.
- The investigator sees the data displayed immediately.



SCAPS Laser-Induced Fluorescence

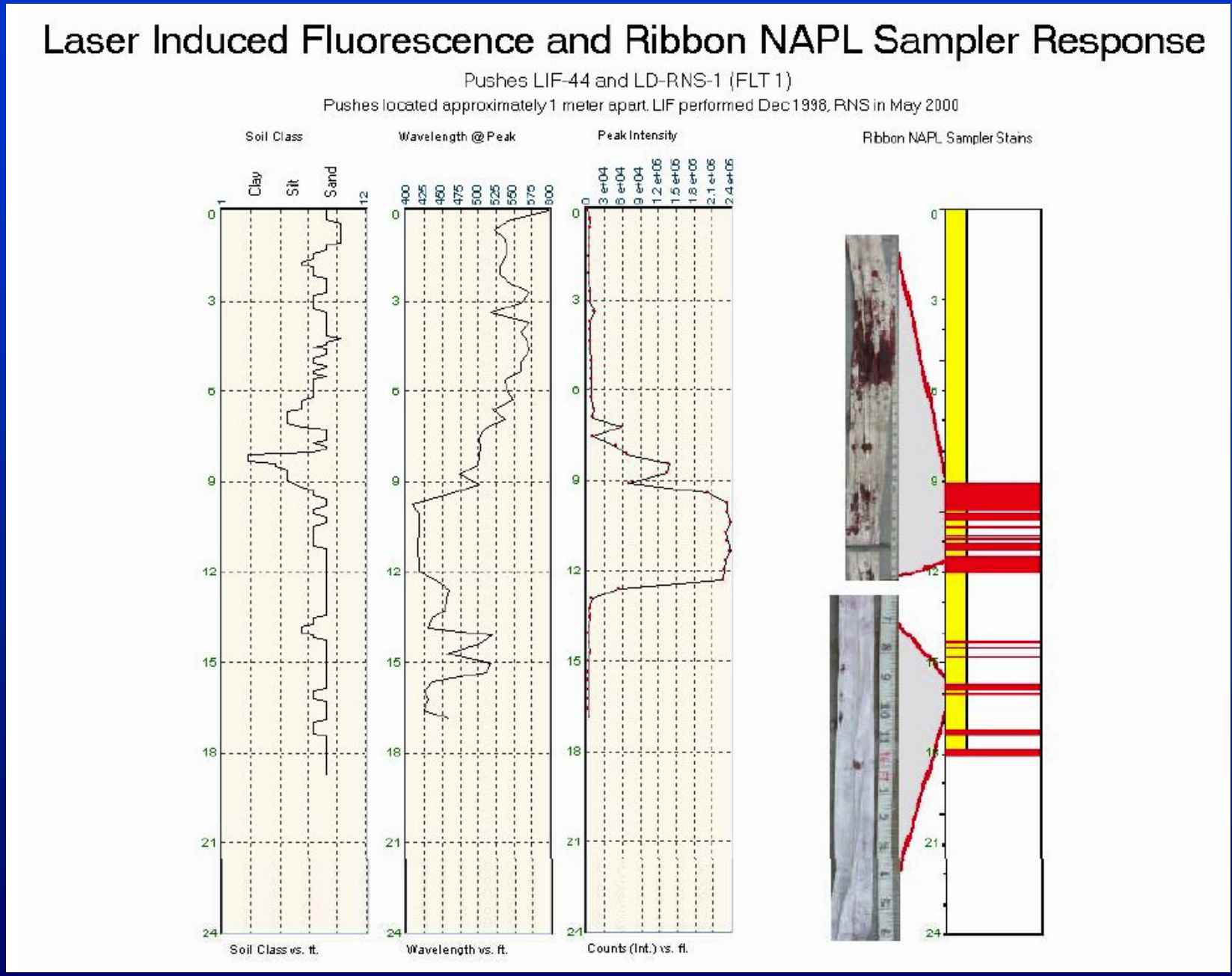
- Laser Source: Ultraviolet (308 nm) Xenon Chloride Eximer laser





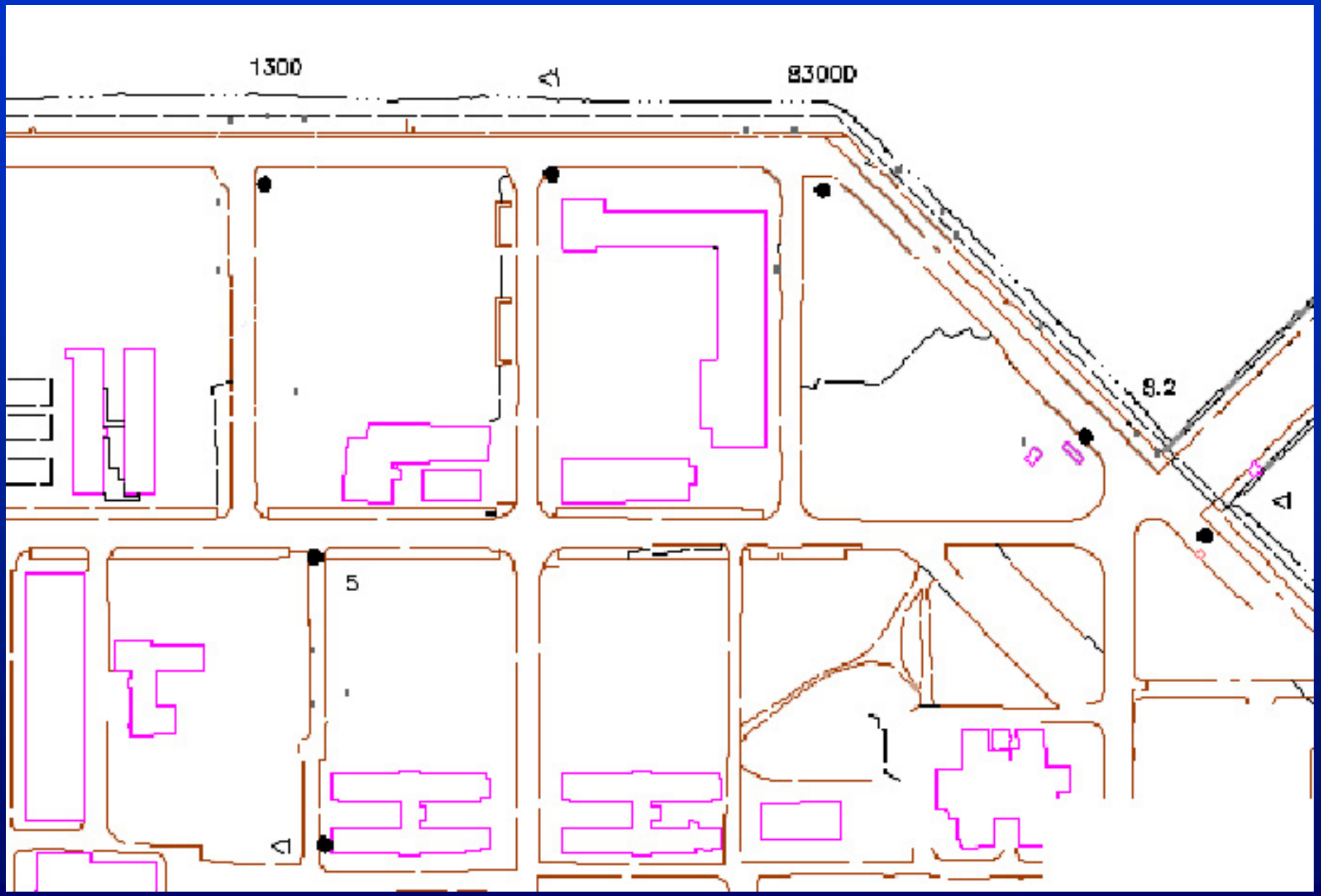
- Excites 2-ring and greater Polycyclic Aromatic Hydrocarbons
- LIF generally detects fuel concentrations greater than 100 ppm

Continuous Logs for Contaminants



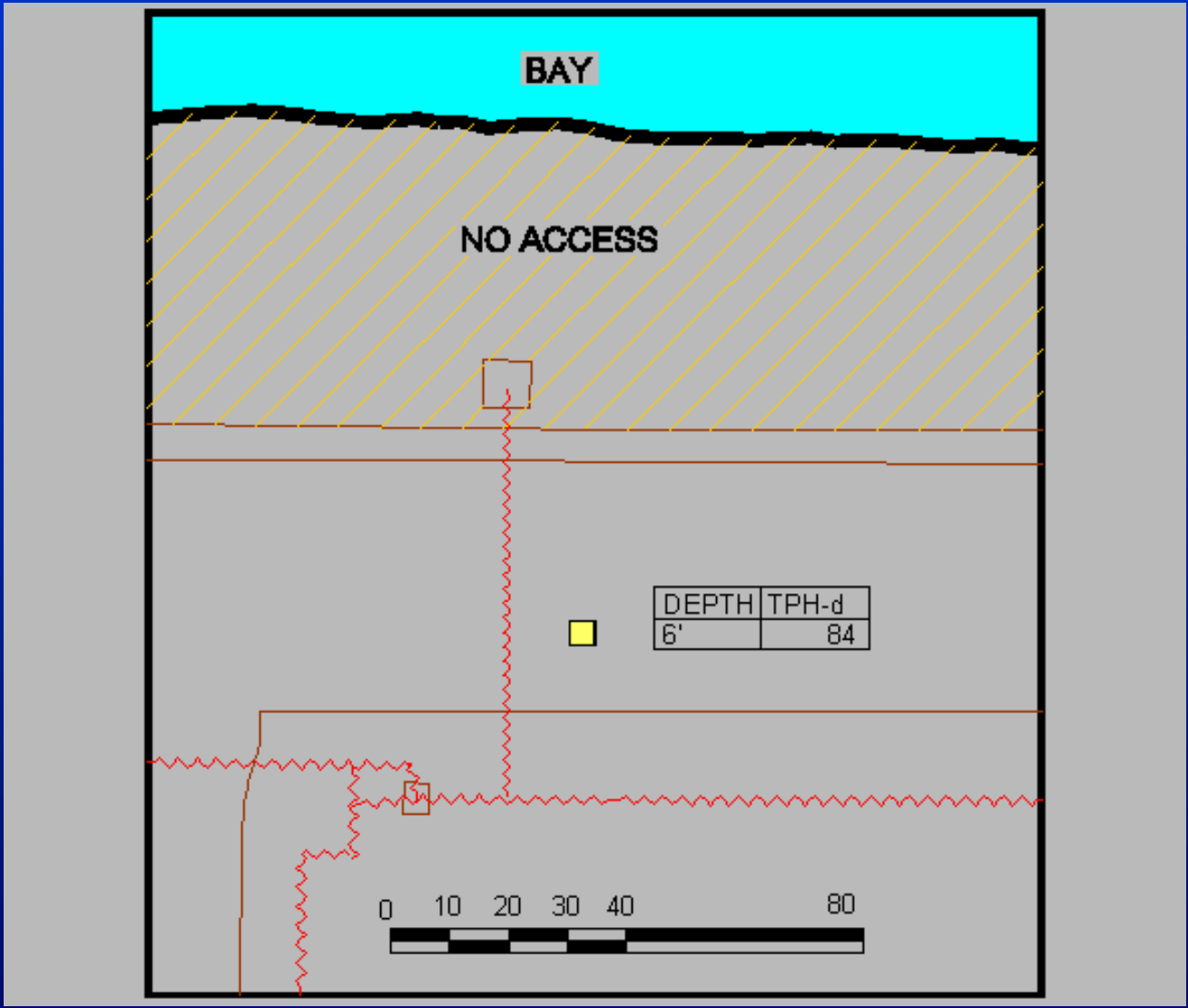
Fuel Pipeline Site, 1998

SI Results



Why Was SCAPS LIF Useful?

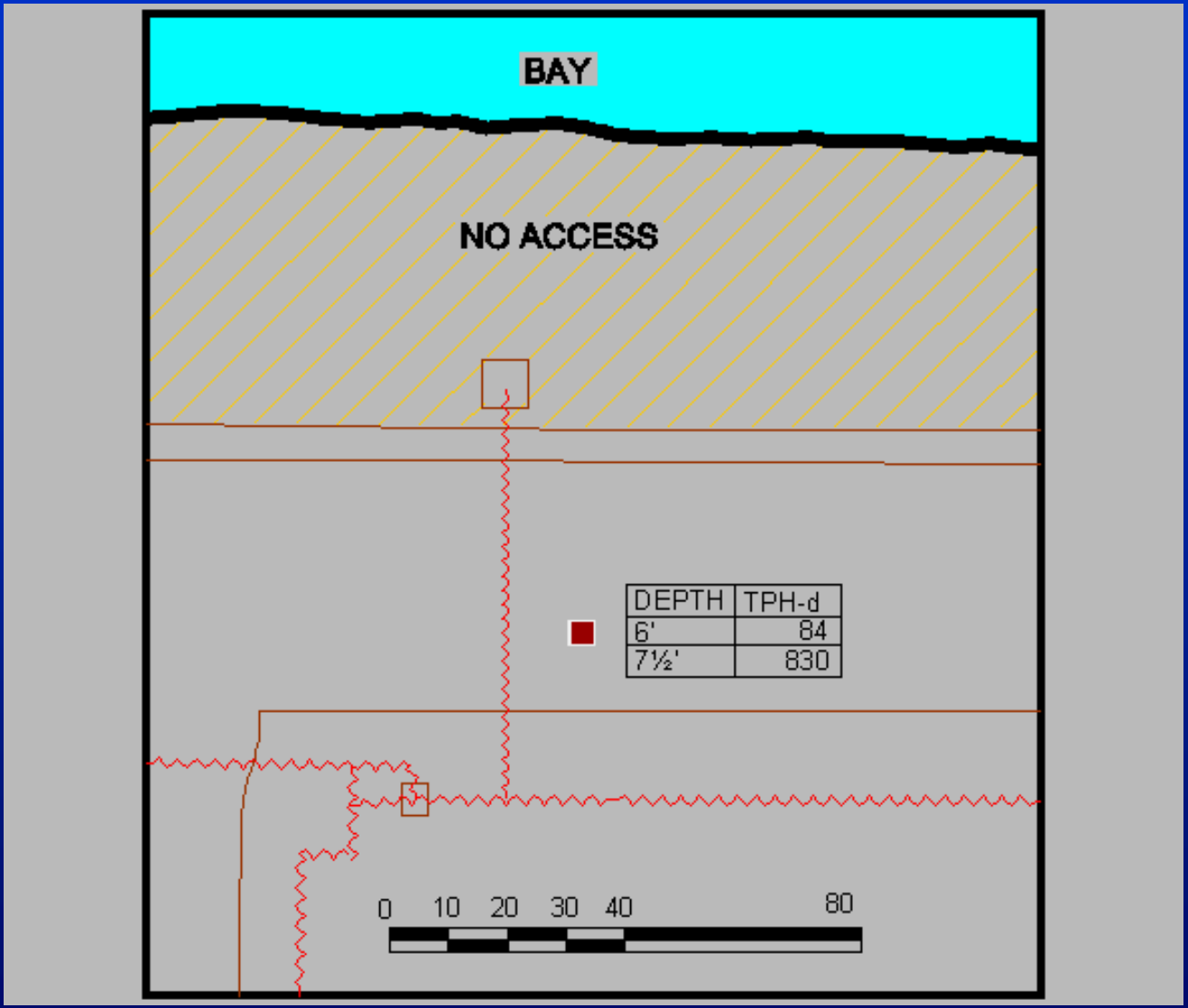
- Typical conventional sampling plans have low sample density due to high analytical costs.



Fuel Pipeline Site, investigated by Navy PWC San Diego SCAPS, 1998

Low Sample Density Does Not Adequately Address Heterogeneity

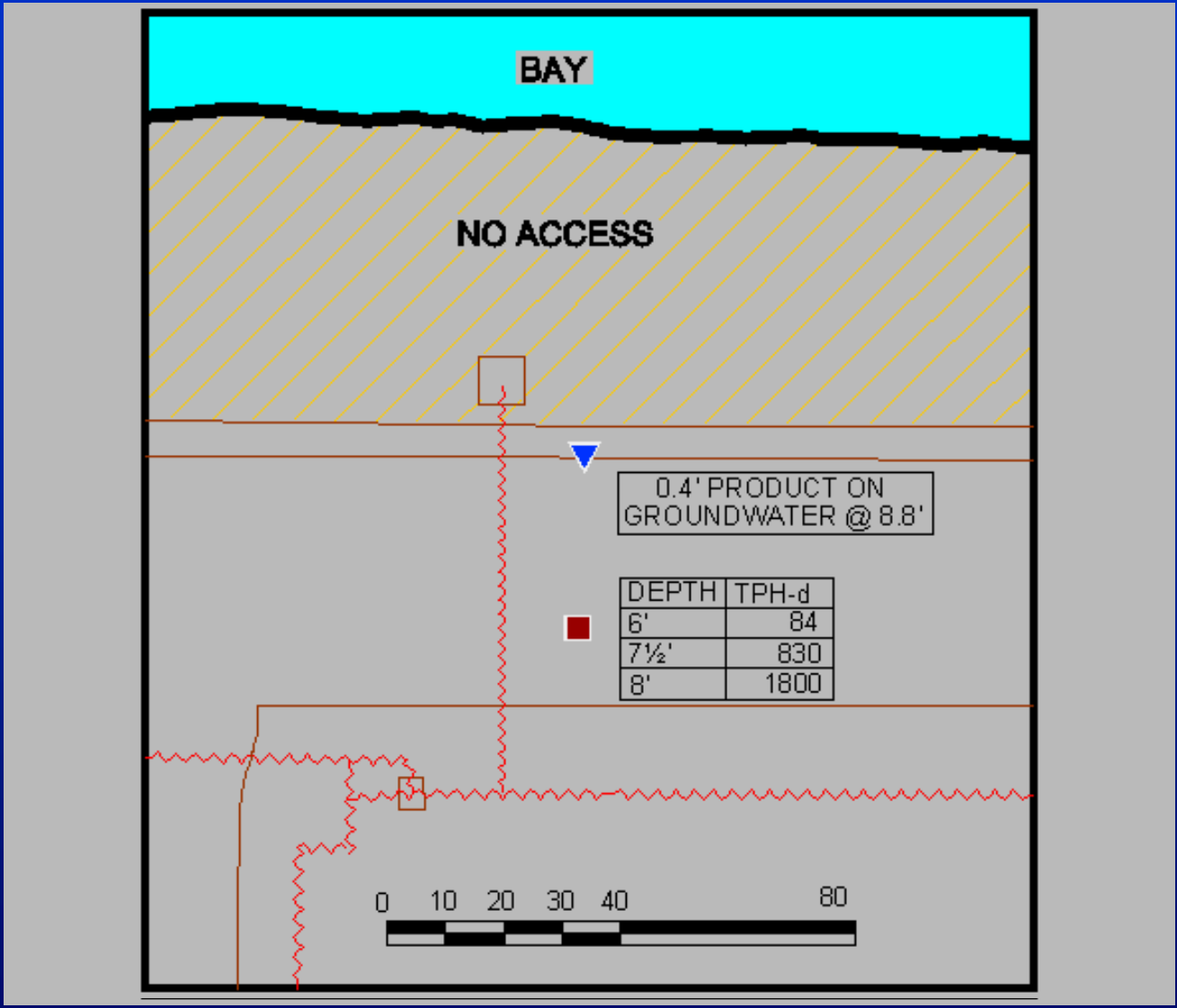
- In this case, a sample 18 inches deeper was significantly more contaminated.



Fuel Pipeline Site, investigated by Navy PWC San Diego SCAPS, 1998

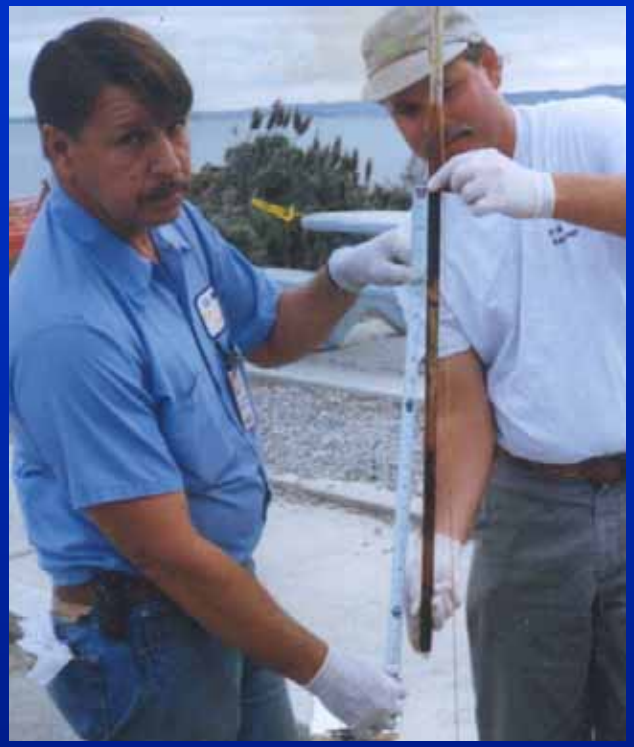
Discounting Heterogeneity Can Lead to an Inaccurate Conceptual Site Model

- Six more inches deeper, contamination more than doubled.
- Free product found 30 feet away.

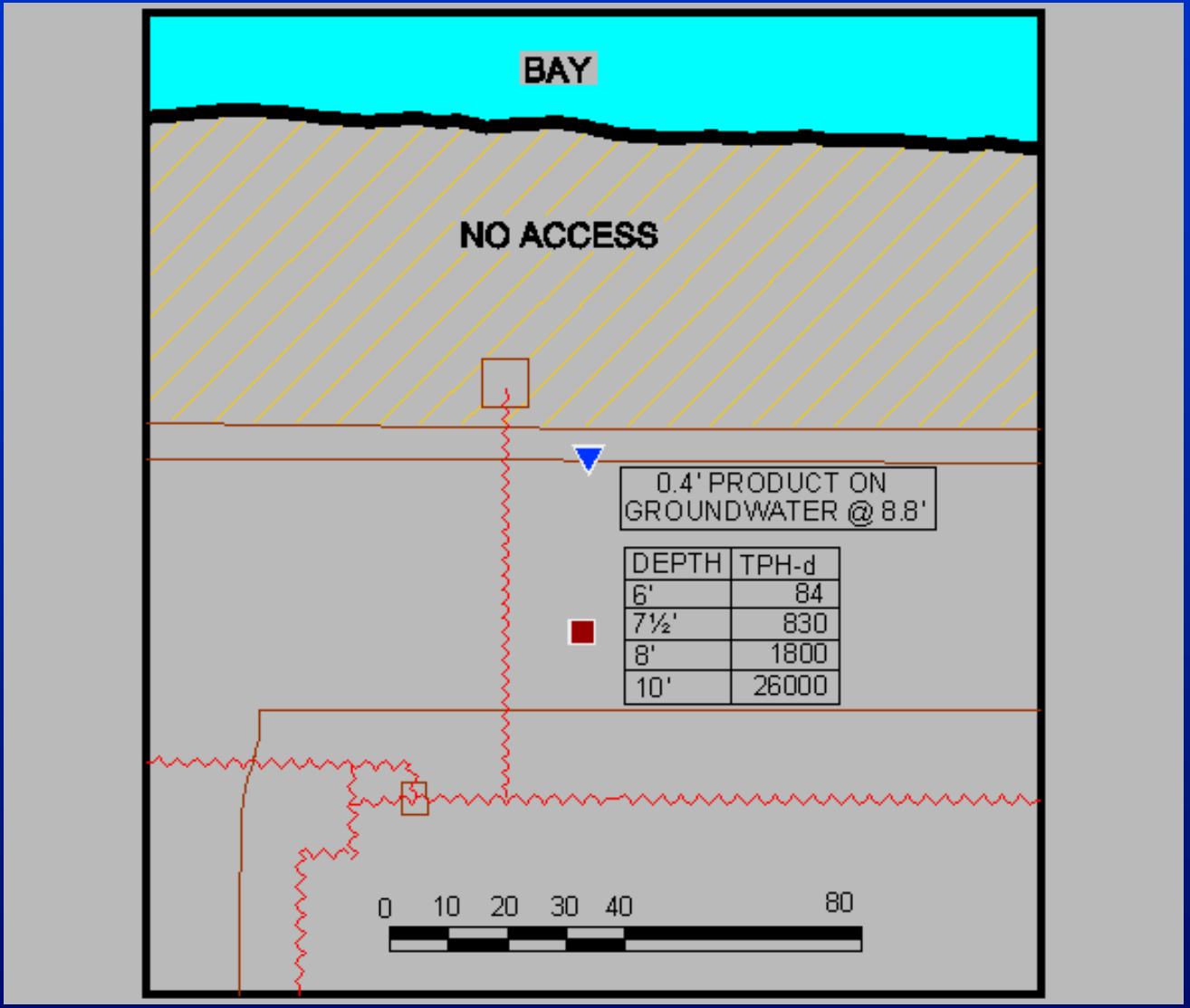


Fuel Pipeline Site, investigated by Navy PWC San Diego SCAPS, 1998

An Inaccurate CSM Can Lead to Poor Decisions



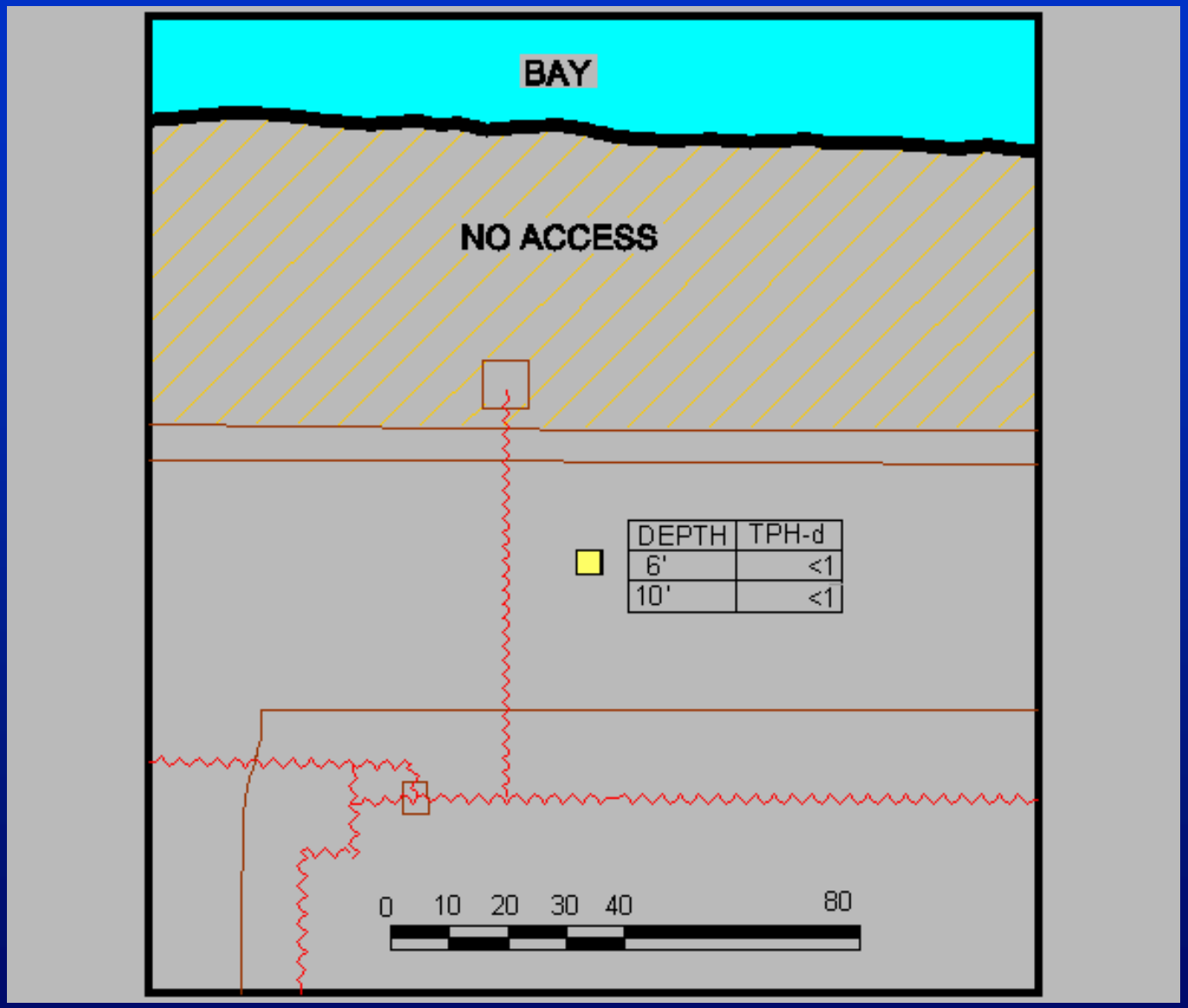
- Even higher levels of contamination 2 feet down.



Fuel Pipeline Site, investigated by Navy PWC San Diego SCAPS, 1998

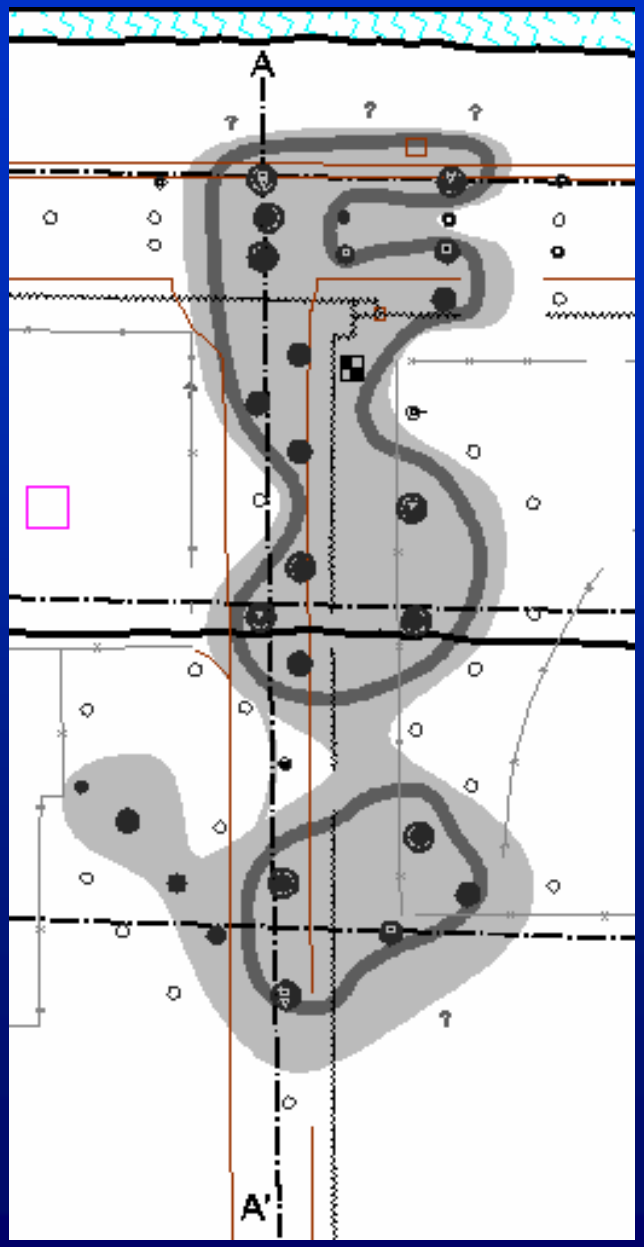
Without High Sample Density, Each Analytical Result Can Carry Too Much Decision Importance

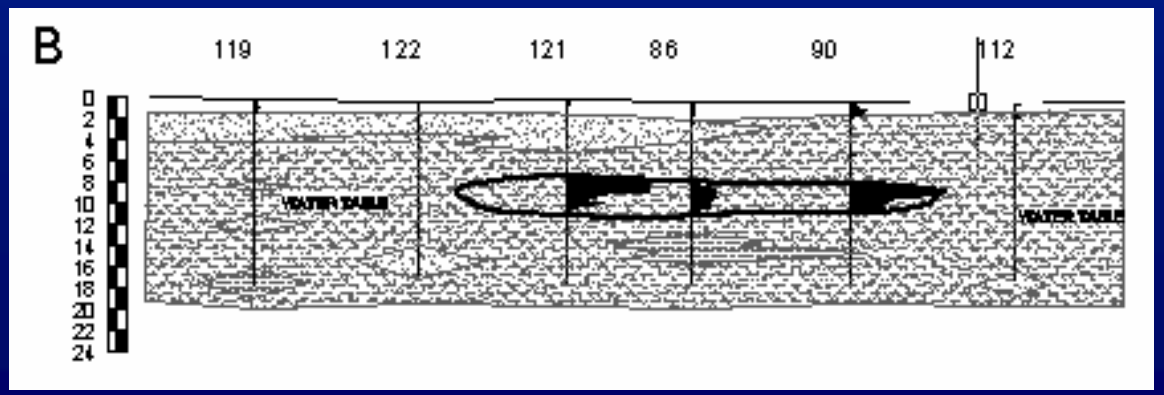
- Clean soil found in between contaminated sample locations.



Fuel Pipeline Site, investigated by Navy PWC San Diego SCAPS, 1998

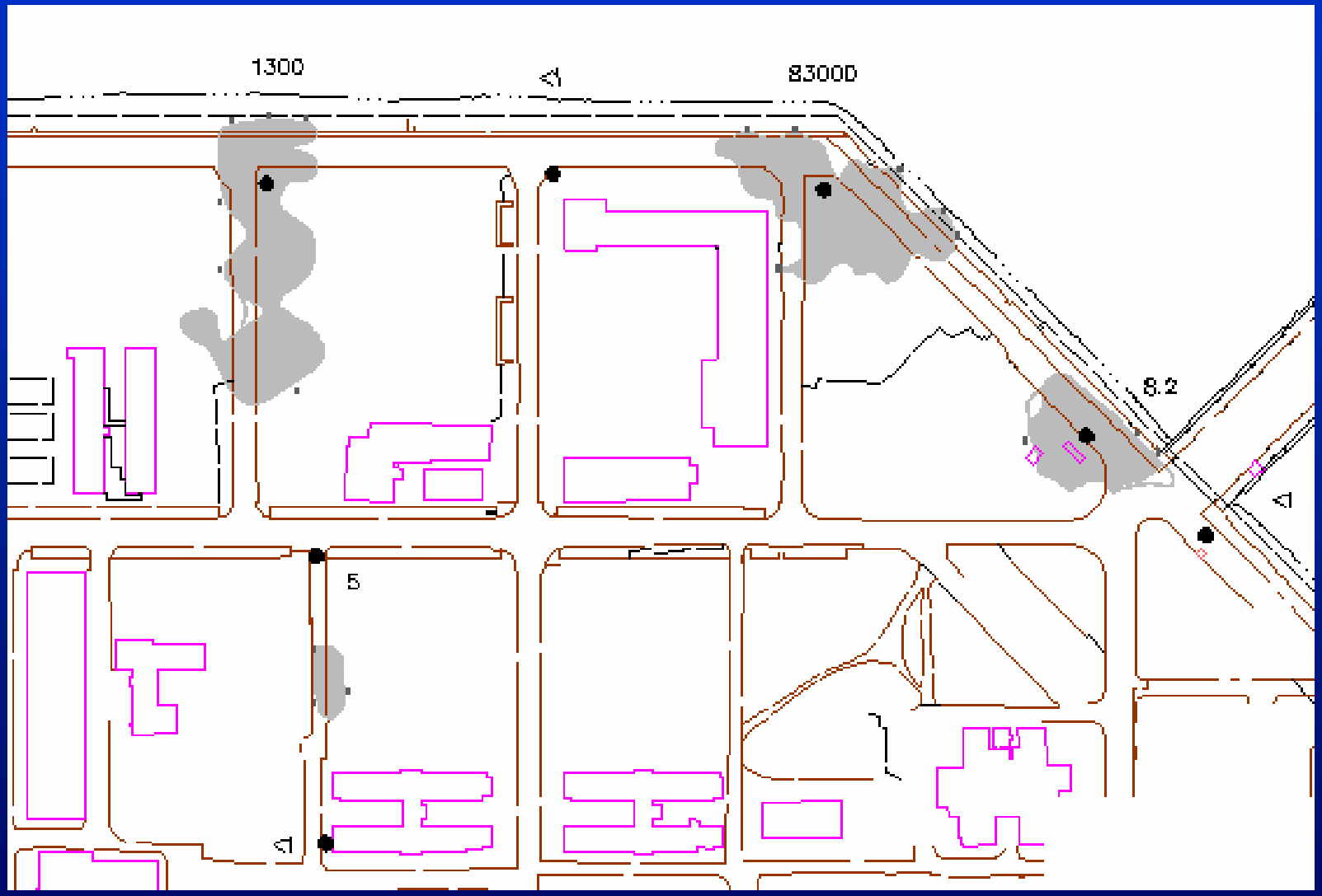
SCAPS Provided the Real-Time Analytical Technology to Enable a Dynamic Work Strategy





Fuel Pipeline Site, investigated by Navy PWC San Diego SCAPS, 1998

Real-Time Analytical Technology with a Dynamic Work Strategy Can Give More Data for the Dollar



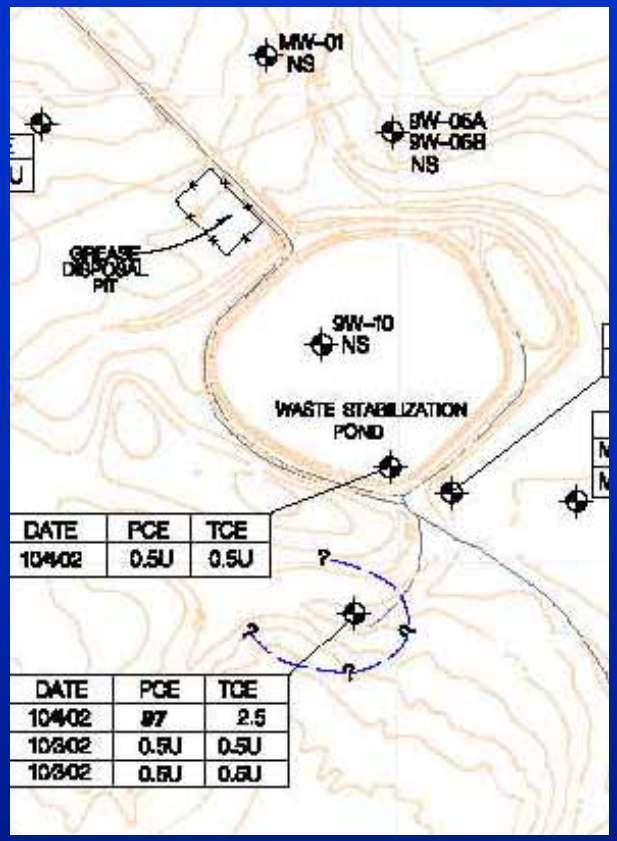
Fuel Pipeline Site, investigated by Navy PWC San Diego SCAPS, 1998

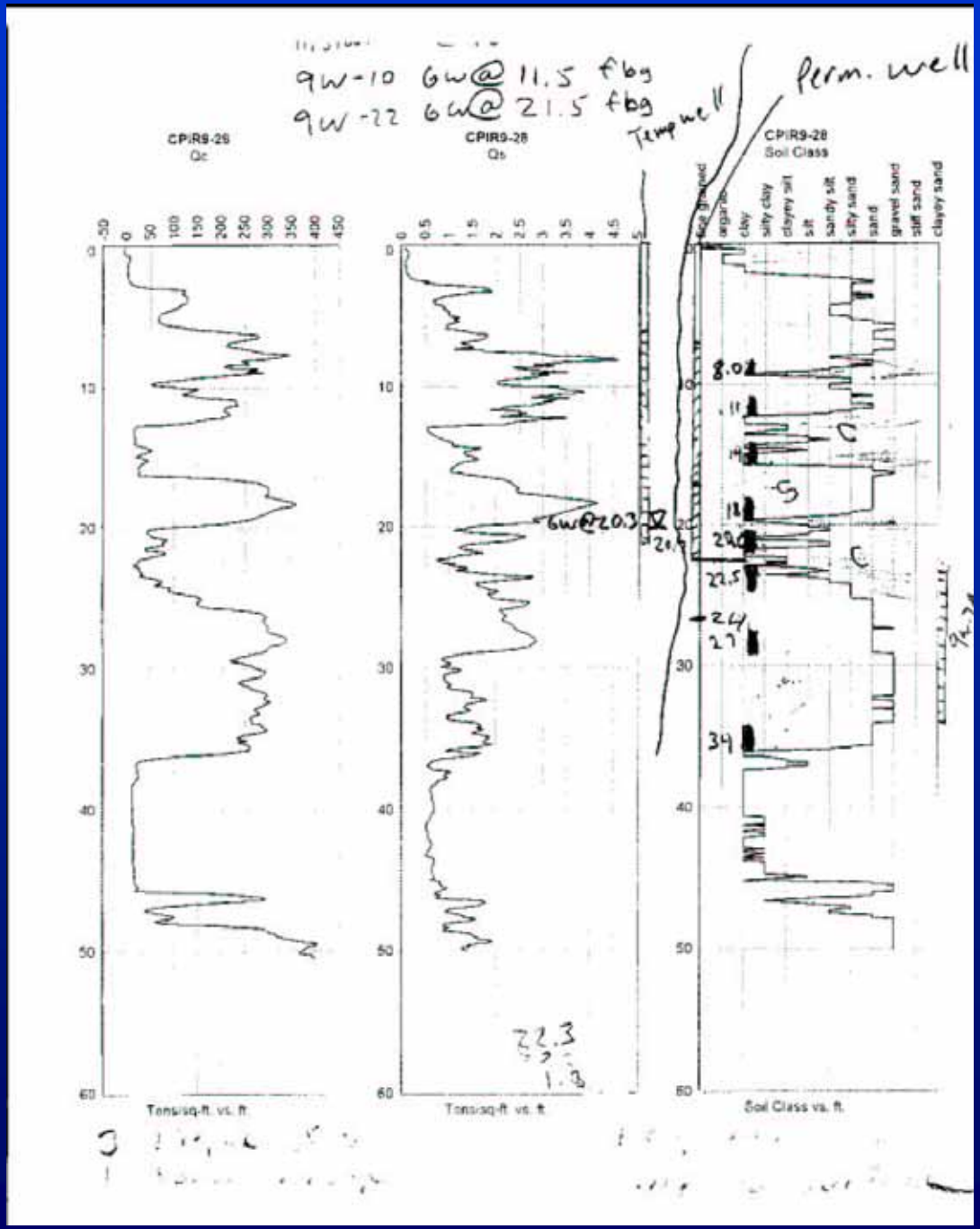
Using CPT Data to Field-Design a Small-Diameter Well

Before setting well:

- *Collected CPT data for stratigraphy*
- *Collected soil samples for contaminant data*
- *Set temporary piezometer*

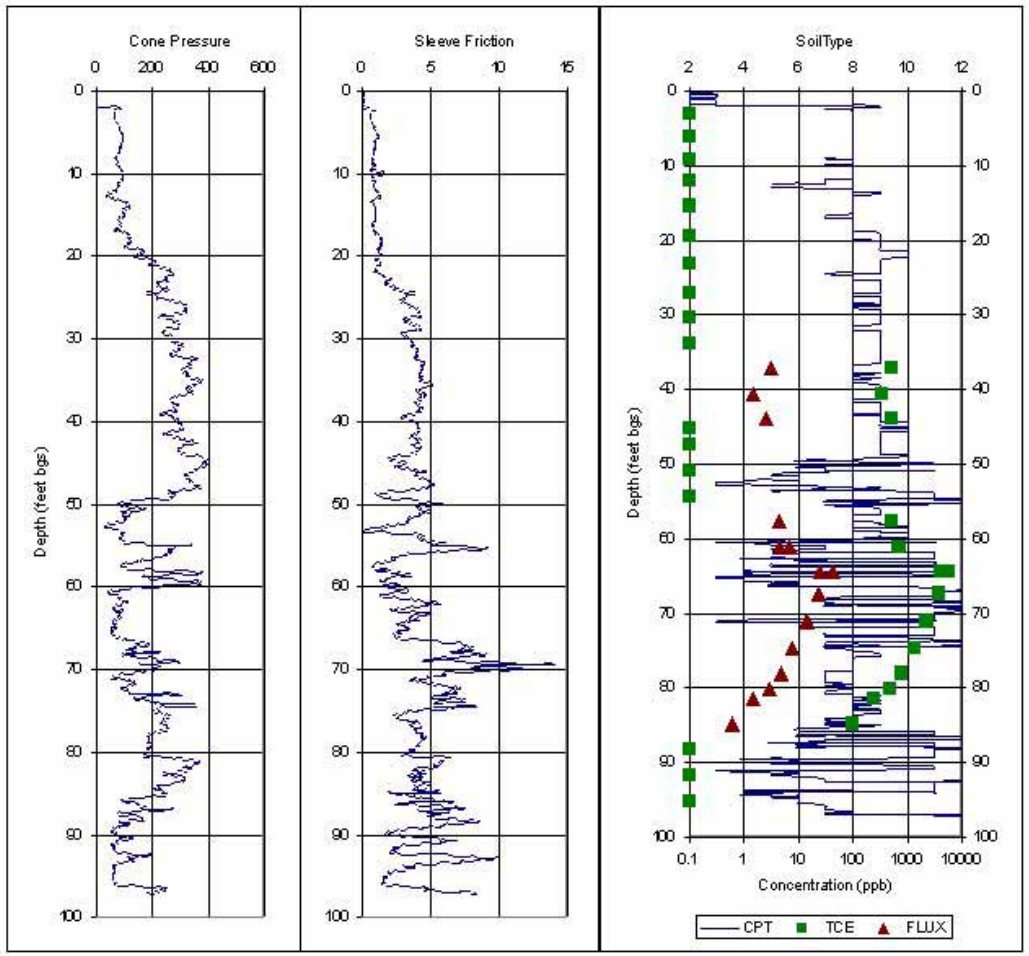
Real-Time Data for Well Sampling Design





Dissolved Volatile Organic Compounds

Using Membrane Interface Probe and Direct Sample Ion Trap Mass Spectrometry



Depth	TCE (ppb)
3.2	nd
6.1	nd
9.2	nd
12.1	nd
15.4	nd
19.4	nd
23.2	nd
27.0	nd
30.4	nd
33.8	nd
37.1	500
40.6	331
44.0	524
45.2	nd
47.4	nd
50.9	nd
54.3	nd
57.7	512
61.1	700
64.5	5,693

	TCE (ppb)	DCE
61.0	738	nd
64.4	4,217	355
67.4	3,904	333
71.1	2,294	202
74.6	1,318	nd
78.0	777	nd
80.1	485	nd
81.5	239	nd
84.8	103	nd
88.2	nd	nd
91.8	nd	nd
95.2	nd	nd

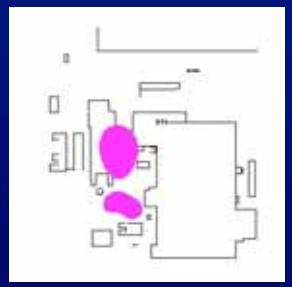
Discovering the True Source and Extent of a Plume

Traditional Phased Investigations, 1991 – 1998

Initial estimate of JP-5 and Stoddard Solvent free product plumes.

Based on wells installed during investigations in 1991 and 1993.

True nature and extent of contamination still unknown.



Product plume discovered to be larger than initial estimates after subsequent investigation.

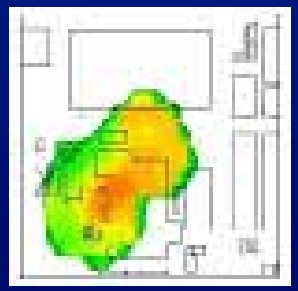
Twenty product recovery wells plus additional monitoring wells were installed.

TCE (Trichloroethylene) detected during analysis of product.

True nature and extent of contamination still unknown.

Plume of TCE dissolved in groundwater based on monitoring well sampling.

Vertical and horizontal characterization is incomplete.



Dynamic Investigations, 1998 - 2000

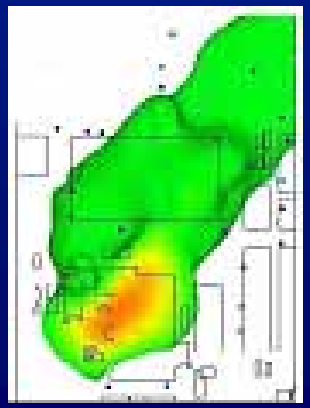
SCAPS Hydrosparge with DSITMS investigation in Summer of 1998.

Validation testing of a sensor used before the development of the MIP

Installation of temporary direct-push wells was necessary. Real time sensor was inserted into the well.

Contamination discovered deeper that previous data suggested.

True extent of contamination still unknown.

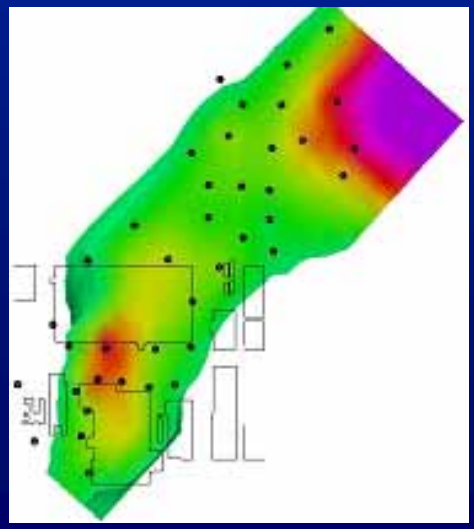


SCAPS MIP with DSITMS investigation in Summer of 1999.

Validation testing of MIP/DSITMS

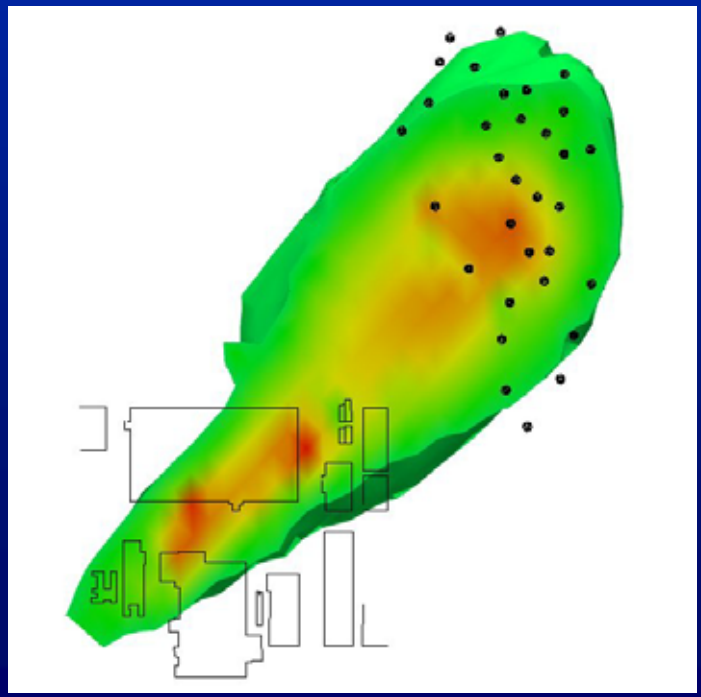
- 14 production days
- 207 measurements
- 40 Locations
- Over 2000 feet pushed.

Detected a second source downgradient.

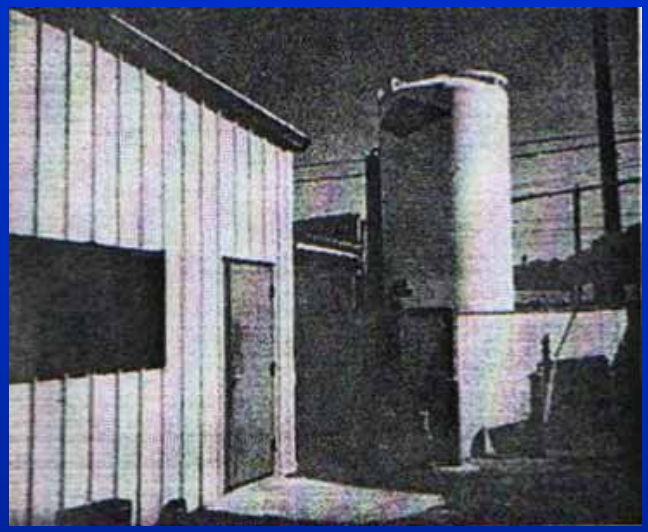


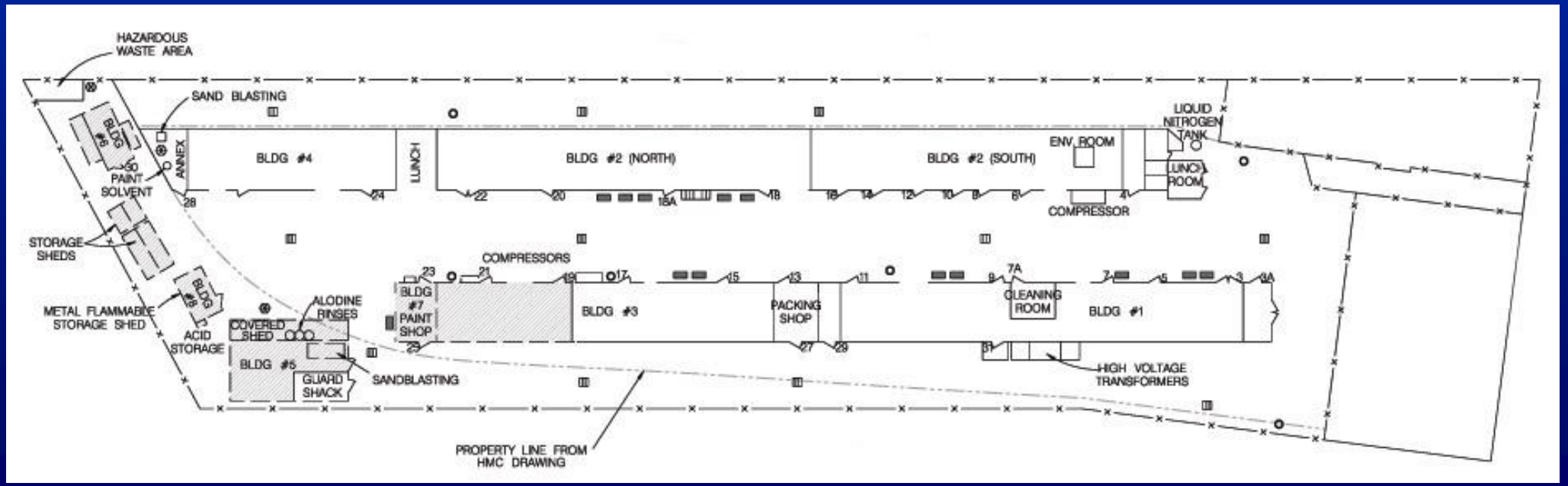
SCAPS MIP with DSITMS investigation in Spring 2000.

- Investigation completed
- 13 production days
- 485 measurements
- 29 locations
- Over 1900 feet pushed

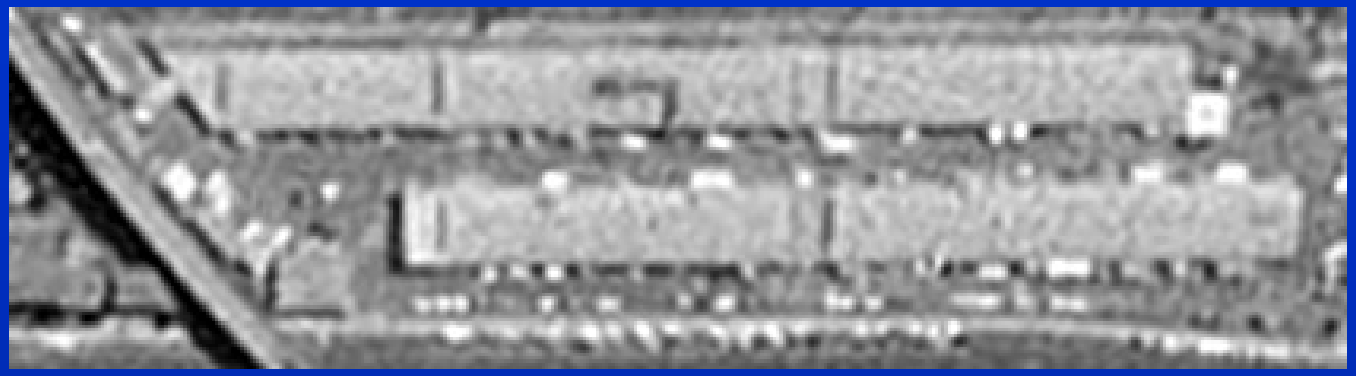


Case Study: Former Electronics Facility





Site History

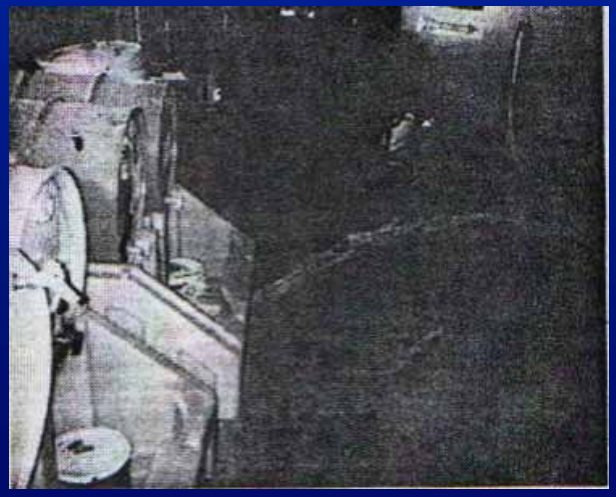


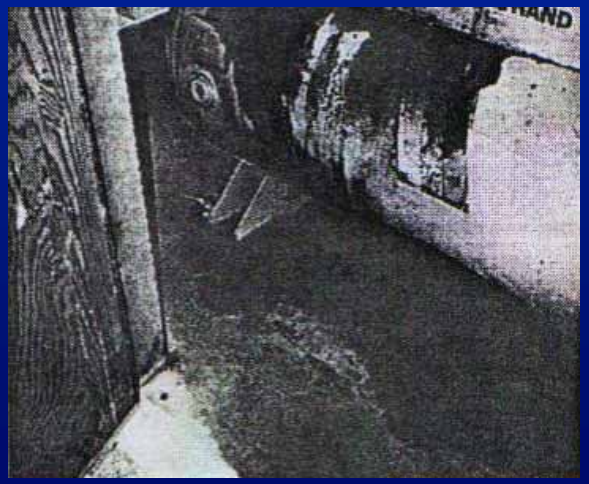
- Property developed during World War II. Electronics maintenance, testing, and evaluation of B-24 bombers by U.S Air Force (1941) and the U.S. Navy (1968)
- Navy occupied site from 1998 through 2003 for small maintenance projects and administrative purposes
- Three Previous Investigations Conducted
- Several buildings identified in the PA have been removed.
- Site is currently paved with asphalt with 5 operational buildings.

1996 Preliminary Assessment

Identified 14 Areas of Interest

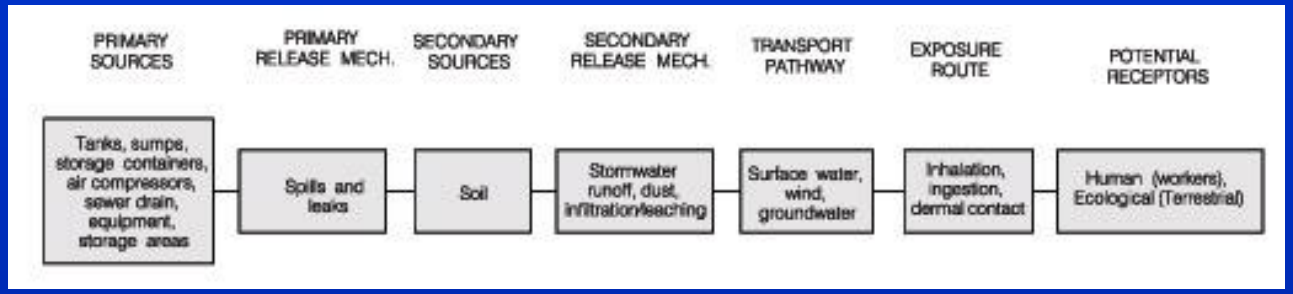
- Wastewater sumps
- Air Compressors
- Sewer line
- Silk screen shop
- Storage areas
- Transformers
- Annex to cleaning room
- Alodine line, sandblasting
- Former UST



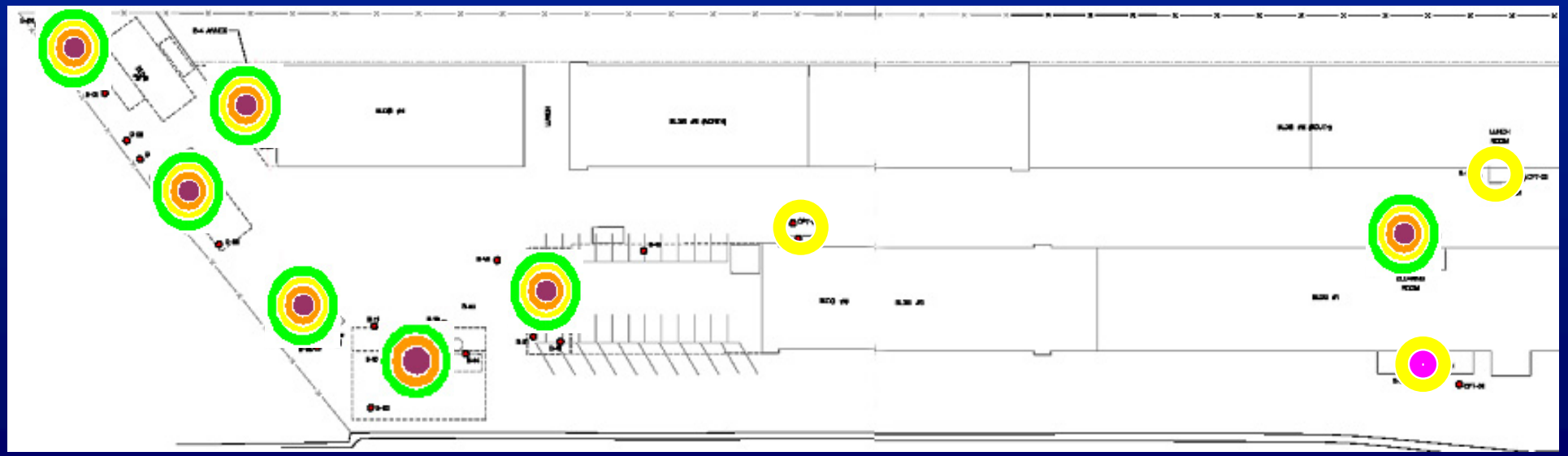


Contaminants of Potential Concern

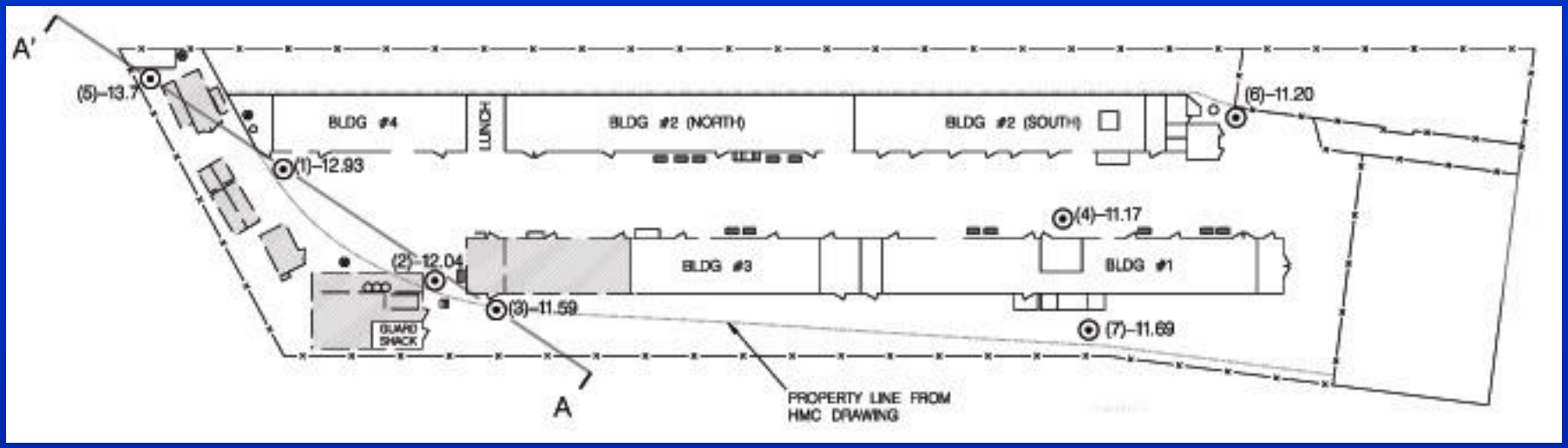
- VOCs
- Petroleum Hydrocarbons
- SVOCs
- PCBs
- Metals



Initial concept:
57 borings planned for
more than14 target areas

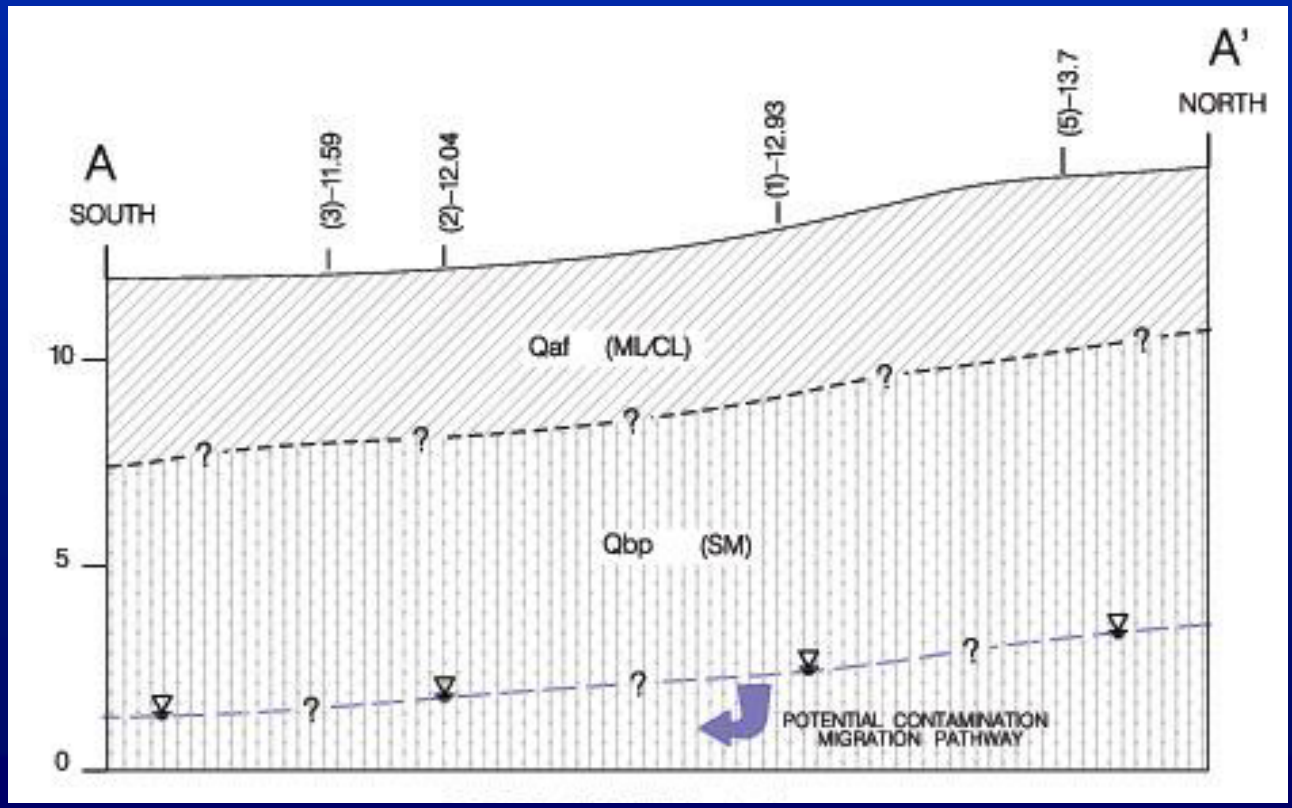


Initial Conceptual Site Model



At each of the 57 planned borings, collect :

- *A shallow soil sample*
- *A soil sample from presumed fill/native contact*
- *A groundwater sample*



First Cost Estimate for Initial Concept (Conventional Approach)

At each of the 57 planned boring locations, collect:

1 shallow soil sample
1 soil sample at presumed fill/native contact
1 groundwater sample

Analysis	Samples	QA/QC	Cost
VOC	150	31	38,770
SVOC	150	31	69,232
TPH-g	105	23	8,486
TPH-d/o	105	23	8,486
Metals	123	27	31,372
PCB	9	3	2,142
Estimated Analytical Total:			158,491

Triad - SI at Former Electronics Facility

- Decision Question:
  - Has there been a release related to site activities that caused subsurface contamination?

Yes → *Additional Investigation*

No → *No Further Action decision acceptable to all stakeholders*

SI Work Plan Characterization Options

Conventional

- 1 soil sample from fill
- 1 soil sample from native material
- 1 groundwater sample
- Depths and locations pre-determined
- Probable incomplete outcome due to budget constraints

Triad

- Continuous TPH data from LIF
- CPT data used to identify soil contact and guide sample depths
- 3X VOC data density using DSITMS analyses (EPA 8265)
- Smarter, cheaper sampling

Triad Elements Applied

Systematic Planning

- Decision Question:
  - Has there been a release related to site activities that caused subsurface contamination?

- Major Uncertainty:
  - Influence of stratigraphy in the lateral and vertical distribution of potential contaminants (TPH, VOCs, metals, PCBs) - Site heterogeneity.

- Uncertainty Management Strategy:
  - TPH and/or VOCs – target analytes in all 14 areas
  - LIF to provide continuous TPH data
  - CPT to identify soil contact and guide sample depths
  - DSITMS analyses (EPA 8265) to increase data density

Triad Elements Applied

Systematic Planning (Con't)

- Cultural change to accept DSITMS
- Decision tree to allow for fewer fixed lab analyses based on DSITMS (EPA 8265) results
- Resolution of calibration and lab certification issues
- Multidisciplinary Team (chemist, geologists, hydrogeologists)

Triad Elements Applied

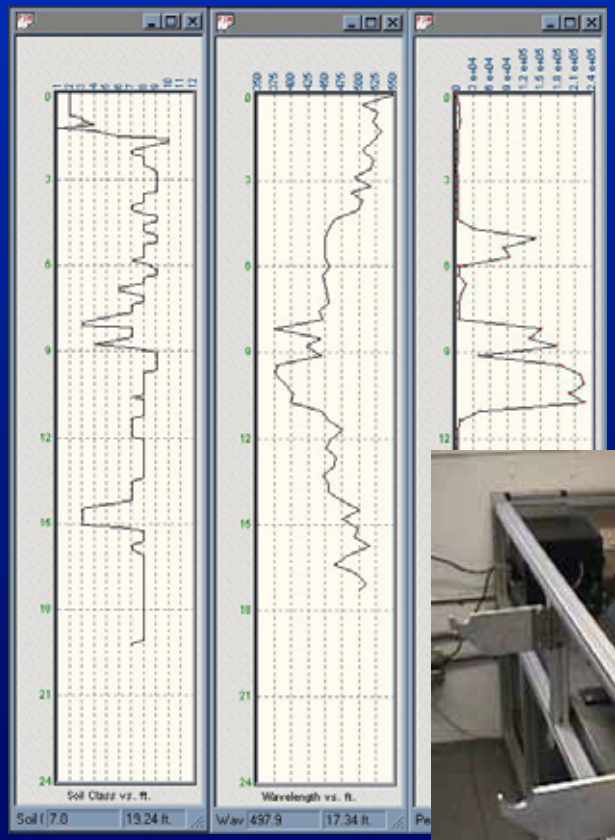
Dynamic Work Strategy

- CPT to determine sample depth and screen intervals
- DSTIMS to determine fix lab verification samples
- LIF to select TPH samples
- Flexibility to step out based on real-time measurements

Triad Elements Applied

Real-Time Measurements

- **CPT**
- **LIF**
- **DSITMS**



Method 8265: [PDF Format 158 KB]
Volatile Organic Compounds in Water, Soil, Soil Gas and Air by Direct Sampling Ion Trap Mass Spectrometry (DSITMS)

This method uses direct sampling ion trap mass spectrometry (DSITMS) for the rapid quantitative measurement, continuous real-time monitoring, and qualitative and quantitative preliminary screening of volatile organic compounds (VOCs) in water, soil, soil gas, and air. DSITMS introduces sample materials directly into an ion trap mass spectrometer by means of a simple interface (such as a capillary restrictor). There is little if any sample preparation and no chromatographic separation. The response of the instrument to analytes in a sample is nearly instantaneous. In addition, the instrument is field transportable, rugged, and relatively easy to operate and maintain.

Site Inspection (Phase I - Implementation)

- Soil and groundwater samples collected in each area of interest (total of 14 areas).
- 37 soil borings + 20 Temporary Wells
- Collaborative data set from on-site 8265 and fixed lab used to collect high quality/high density data set (total of 238 samples plus QC by 8265 in 3.5 days)

Phase I – Implementation
QA/QC Measures for Real-Time Data

Field Methods (EPA 8265)

- -Daily Calibration
- -Verification Check Standard
- -Initial and continue instrument blanks
- -Equipment Blanks
- -Field duplicates (groundwater only)

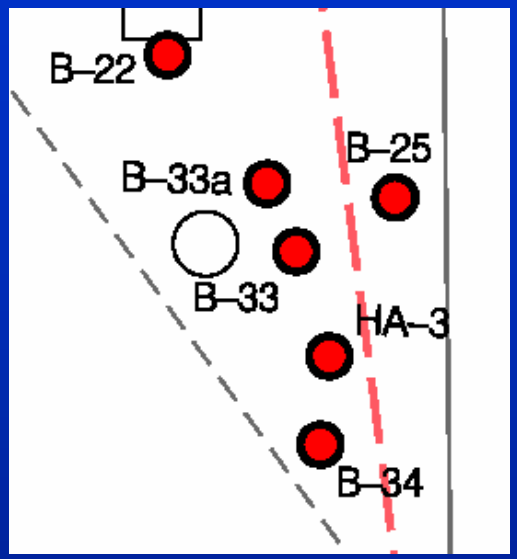
Site Inspection (Phase I - Results)

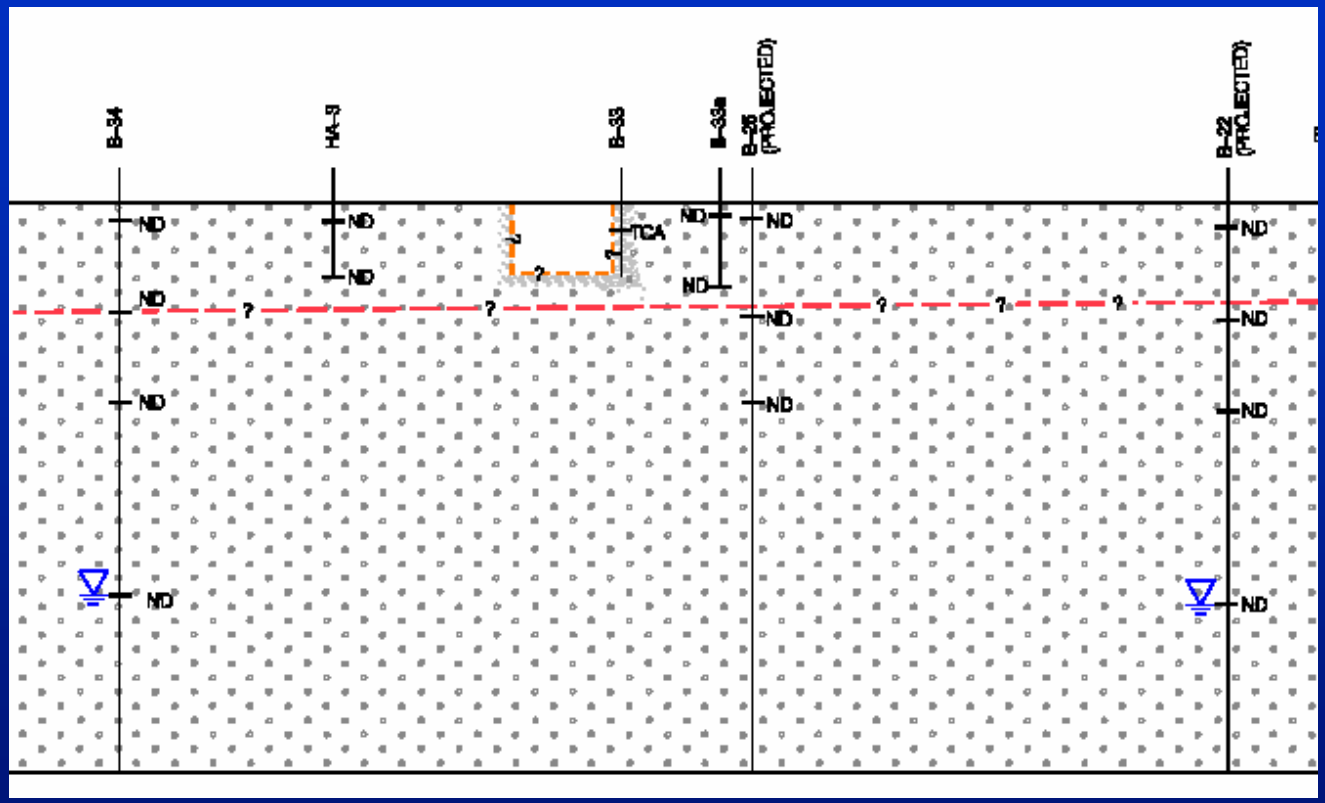
High concentration VOCs identified in localized area near drain.

Ambient low-level TPH and background metals present.

Phase II needed to further evaluate extent of COPCs above project action levels and remove impacted water perched in localized area.

Revised CSM Based on Phase I Results





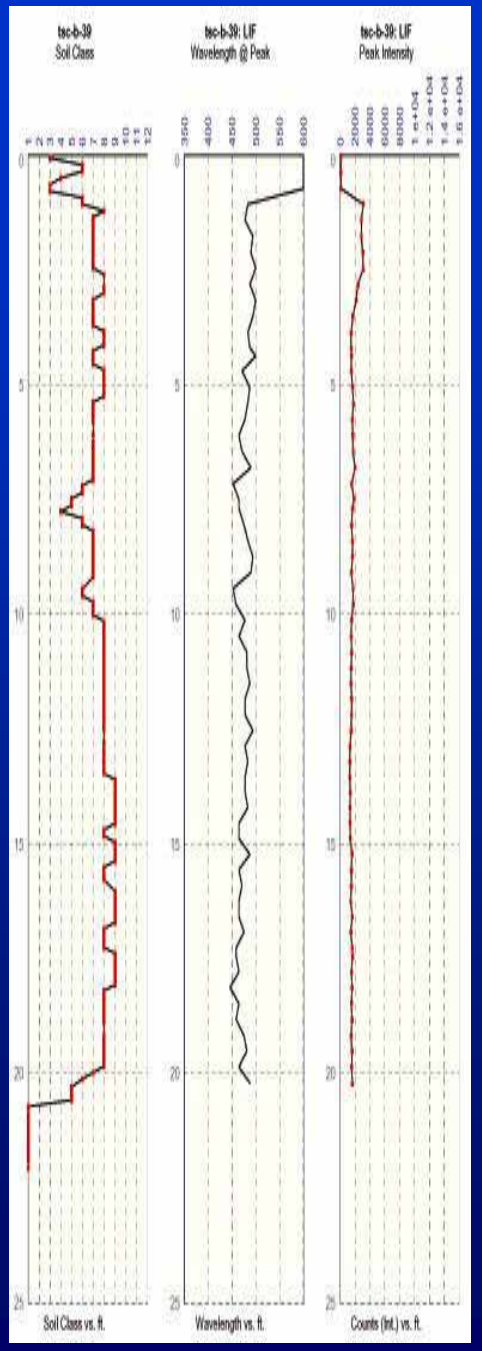
SI Phase II
VOC Source Identification

An intact concrete sump (2.5 feet long x 2.5 feet wide x 3.5 feet high) was encountered near the surface drain and removed

SI Phase II
VOC Source Remediation

SI Phase II
Ambient TPH

- 8 laser-induced fluorescence (LIF) borings advanced to address TPH
- 8 temporary microwells installed and sampled
- 24 soil samples plus QC samples collected and analyzed for TPH and VOCs (by mobile laboratory with confirmation at fixed laboratory)
- Apparent TPH detections found to be from granular asphalt in deep fill soils



SI Phase II – Results

Analytes detected during Phase II were consistent with sampling results from Phase I

Extent of elevated VOCs were limited to the area surrounding the surface drain (6 feet by 6 feet)

Confirmation sampling results (after sump removal) did not exceed action levels

Low levels of TPH and metals were detected in soil

Conclusions

Results from two phases of investigation suggest that site conditions are protective of human health and the environment.

No evidence of a release to soil or groundwater was found

Elevated concentrations found in association with an abandoned sump were limited to the sump area. Sump integrity was confirmed by visual inspection and confirmation sampling.

Regulators Concur With No Further Action Recommendation

Final Thoughts …

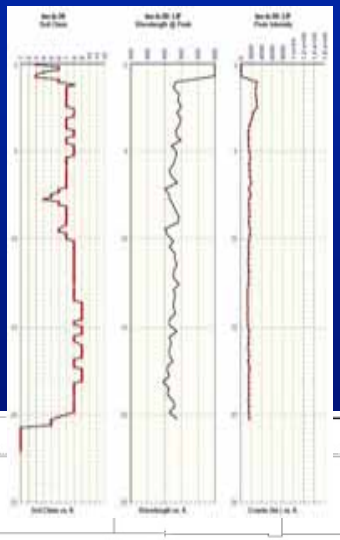
	Conventional Estimate			Triad Estimate		
Analysis	**Samples**	**QA/QC**	**Cost**	**Samples**	**QA/QC**	**Cost**
Real Time 8265				**238**	**110**	**14,440**
VOC	150	31	38,770	20	22	9,810
Real Time LIF				**~2,000**	**~74**	**18,150**
SVOC	150	31	69,232	87	25	45,024
TPH-g	105	23	8,486	22	18	3,040
TPH-d/o	105	23	8,486	23	18	3,587
Metals	123	27	31,372	87	25	26,530
Chromium 6+				87	25	12,768
PCB	9	3	2,142	9	9	2,700
Estimated Analytical Total:			**$158,491**			**$136,049**

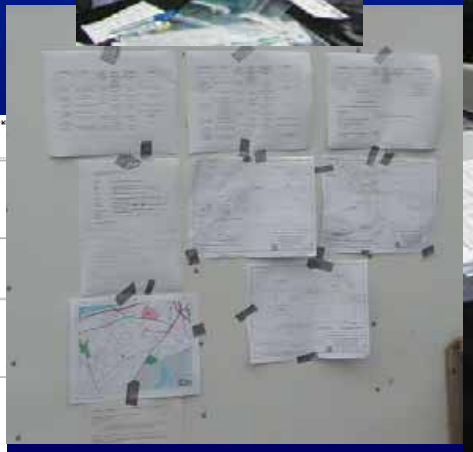
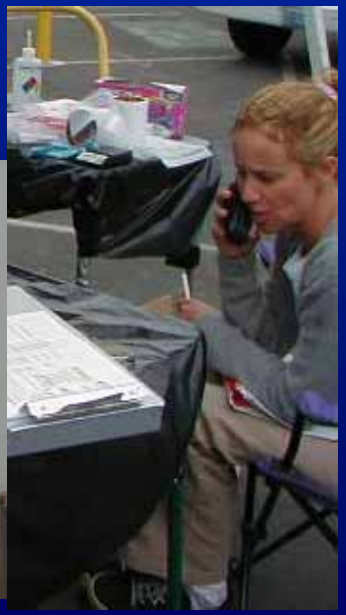
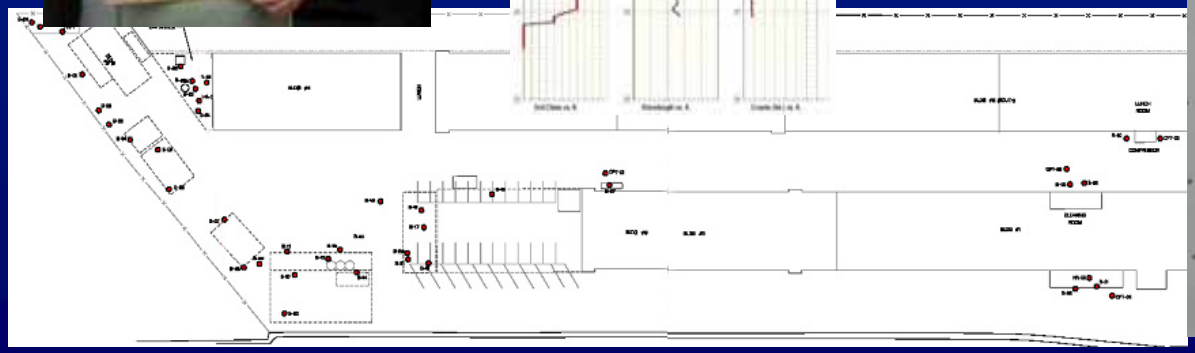
Effective Data … Less Cost

Final Thoughts…

- **Systematic Planning is *<u>crucial</u>* to implementing the Triad Approach.**

- **Structured, open, and ongoing communication is required to provide flexibility for implementing dynamic decisions and resolution of field issues/questions.**

Final Thoughts…

- **Realistic resource-planning key to successful project execution.**
- **Gained appreciation for meaning of Triad's "front-loading".**