Remedial Design Optimization Using Environmental Sequence Stratigraphy

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For the best of reasons

Special Thanks

Special Thanks to those who helped make this presentation possible

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Abstract

- **Background/Objectives.** Groundwater remediation at many Air Force installations is inherently complex due to long histories of multiple releases, multiple source areas and numerous chemicals of concern including emerging contaminants. This presentation will introduce the decision logic and approach for using Environmental Sequence Stratigraphy (ESS) principles to refine a conceptual site model (CSM) and support optimization of groundwater remediation strategies to reduce life-cycle costs and accelerate remedial systems towards cleanup goals.

- **Approach/Activities.** The ESS approach presented in the 2017 U.S. Environmental Protection Agency [USEPA] Groundwater Forum Technical Issue Paper [EPA/600/R-17/293] examines existing subsurface data available in the context of appropriate depositional environments (e.g., facies analogues) and uses vertical trends in grain size to identify packages of sediment deposited at roughly the same point in geological time. For groundwater restoration projects, a sequence stratigrapher identifies and correlates genetically-related chronostratigraphic units, rather than lithostratigraphic units, resulting in a more representative definition of hydrostratigraphic units (HSUs) and understanding of their connectivity.

- **Results/Lessons Learned.** The case study for site ST-69 at Duke Field, Eglin Air Force Base in Okaloosa County, Florida. Specifically, the case study shows the benefits of using ESS methods to resolve contaminant migration uncertainty and target active remediation to treat contaminant mass associated with preferential pathways. The ESS method also has proven valuable in assessing feasibility of treating contaminant mass associated with low permeability contaminant storage zones and developing appropriate cost-effective remediation strategies. Relatively small upfront capital investment in analysis and data interpretation of existing site data, regardless of the current phase of site cleanup, can substantially enhance remedy effectiveness, provide significant cost avoidances, and reduce project life-cycle costs.

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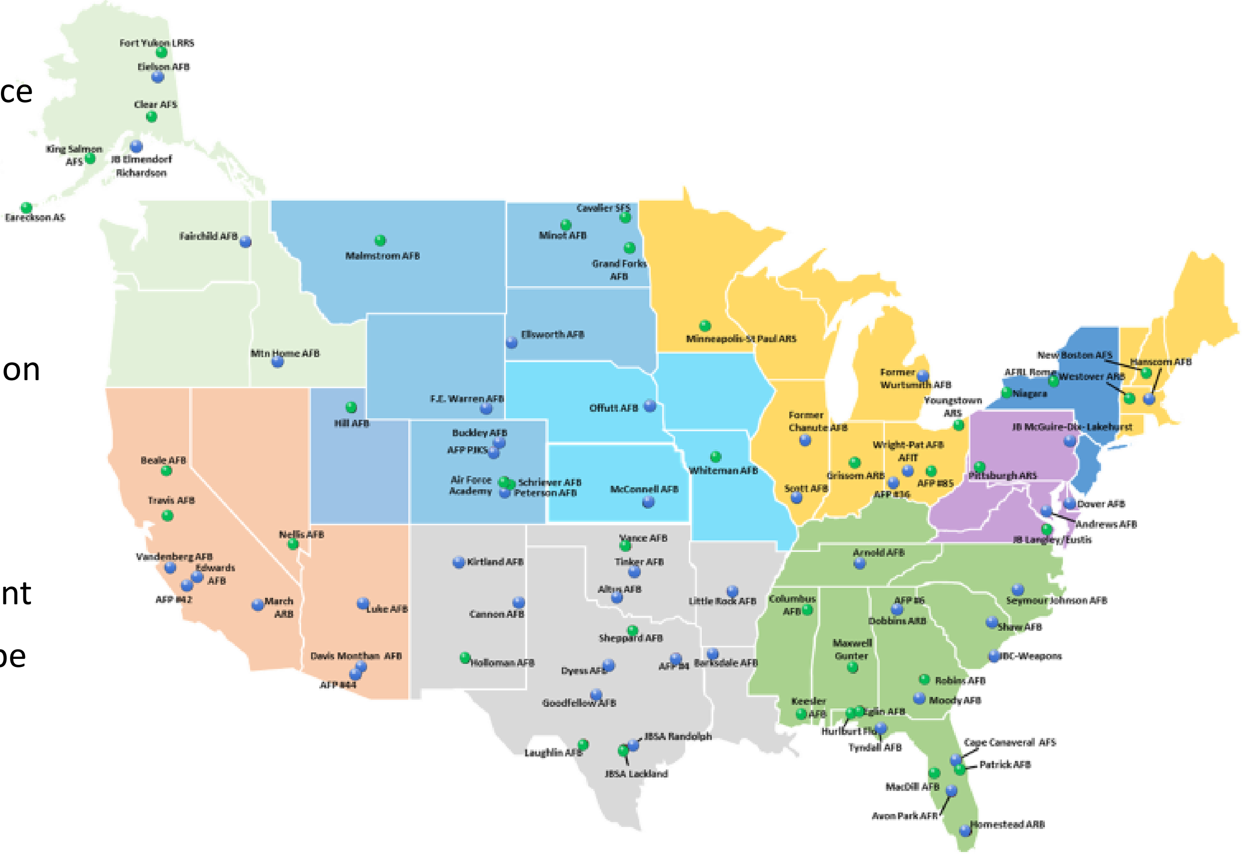
Agenda

- AFCEC Environmental Sequence Stratigraphy – Conceptual Site Model Library
- Case Study
  - Eglin AFB, Duke Field, Site ST-69
- Lessons Learned

Environmental Sequence Stratigraphy Library

- AFCEC conducted an enterprise-wide study to capture performance and lessons-learned information related to application of ESS principles to inform site remedial approaches.
- 58 ESS Reports at Active Installation in the Library
- Reports ranging from Regional, Basewide to Site-Specific - Additional Reports In Development
- Over the next 4 years, USAF will be developing 43 additional ESS reports across the AF inventory



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ST-69 – Former Waste Oil Tank, Building 3073 Duke Field Site Case Study

- A waste oil tank was the contamination source at IRP Site No. ST-69. The fabricated waste oil tank had a 6-inch diameter hole in the bottom that drained south to a stone leach field. The waste oil tank was connected by underground piping to former Building 3072.
- Roughly divided the Sand and (&) Gravel Aquifer into three zones: the shallow zone (50 to 80 feet [ft] below land surface [bls]), the intermediate zone (100 to 150 ft bls), and the deep zone (175 to 276 ft bls).
- Source Area Remediated Accomplished via Excavation.
- Estimated extent of diffuse low-level PCE contamination in the intermediate and deep zones exceeding GCTLs is approximately 57 acres
- TCE, DCE and VC have never been detected at the site.

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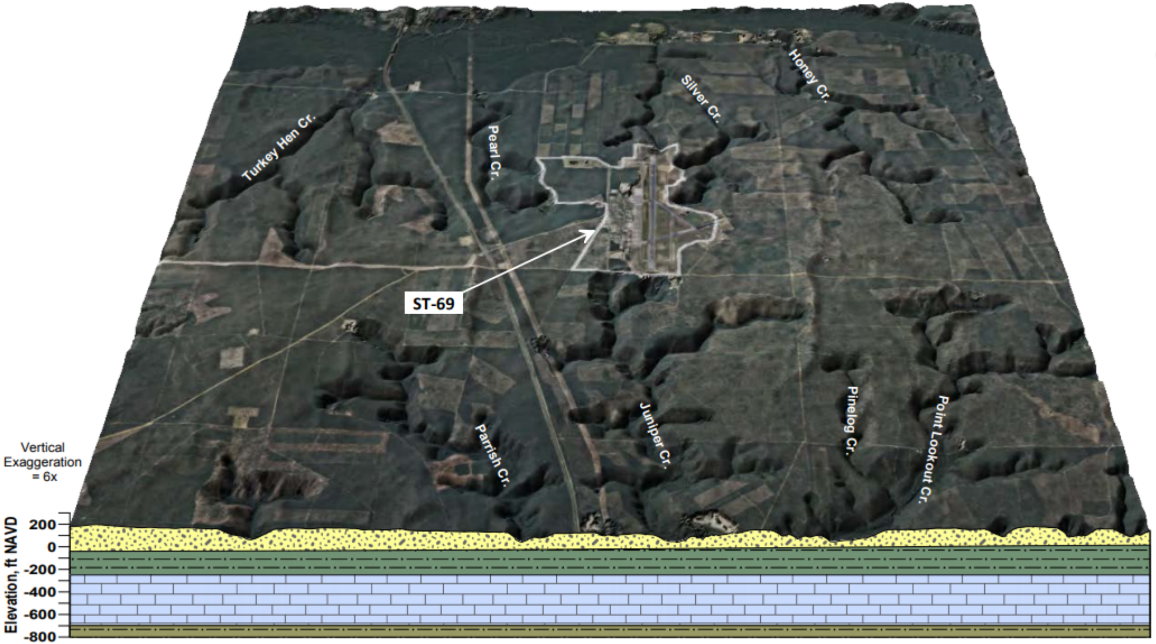
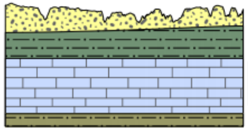
Generalized Section Beneath Duke Field And Vicinity





Lithostratigraphic Unit	Hydrostratigraphic Unit
Citronelle Fm / Pliocene Recent Sands Unit	Sand & Gravel Aquifer
Alum Bluff Group	Intermediate System Confining Unit
Bruce Creek Limestone Chickasawhay & Tampa Stage Limestones Ocala Group Limestones	Floridan Aquifer System
Lisbon/Tallahatta Formations	Sub-Floridan System

Notes:
This information is depicted to provide visual aid within the context of this report and should not be used as a sole reference in precise dimensioning of features indicated. Please verify the location of all features including underground and aboveground utilities prior to conducting any subsurface exploration or site assessment.

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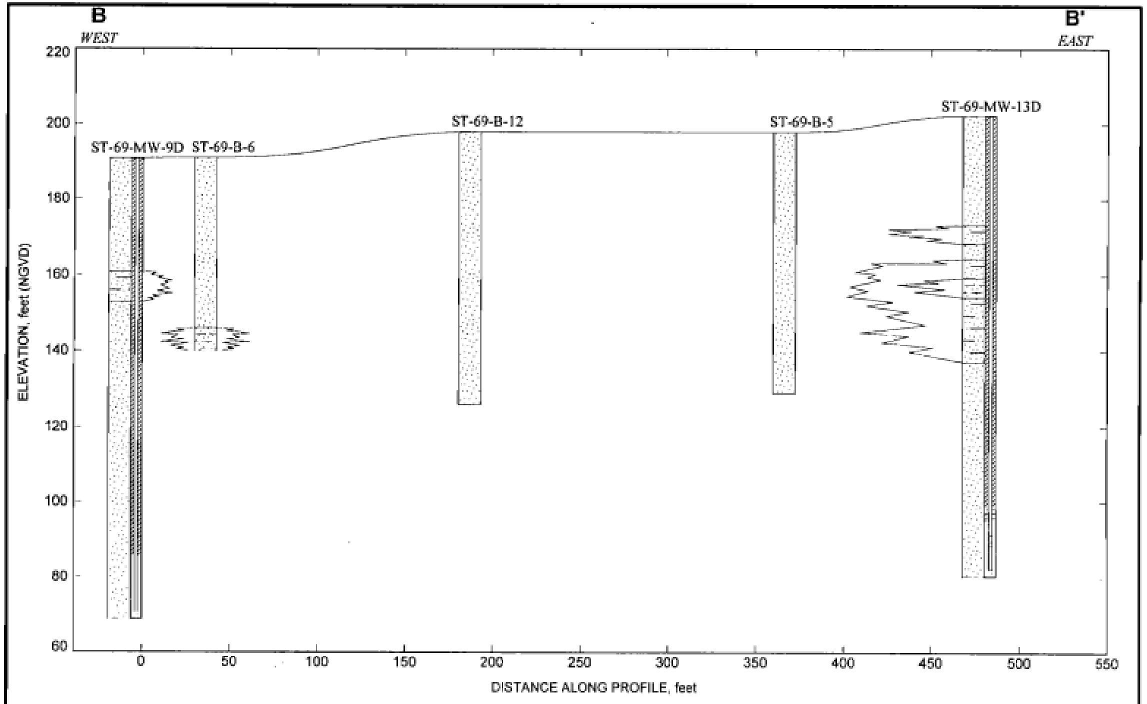
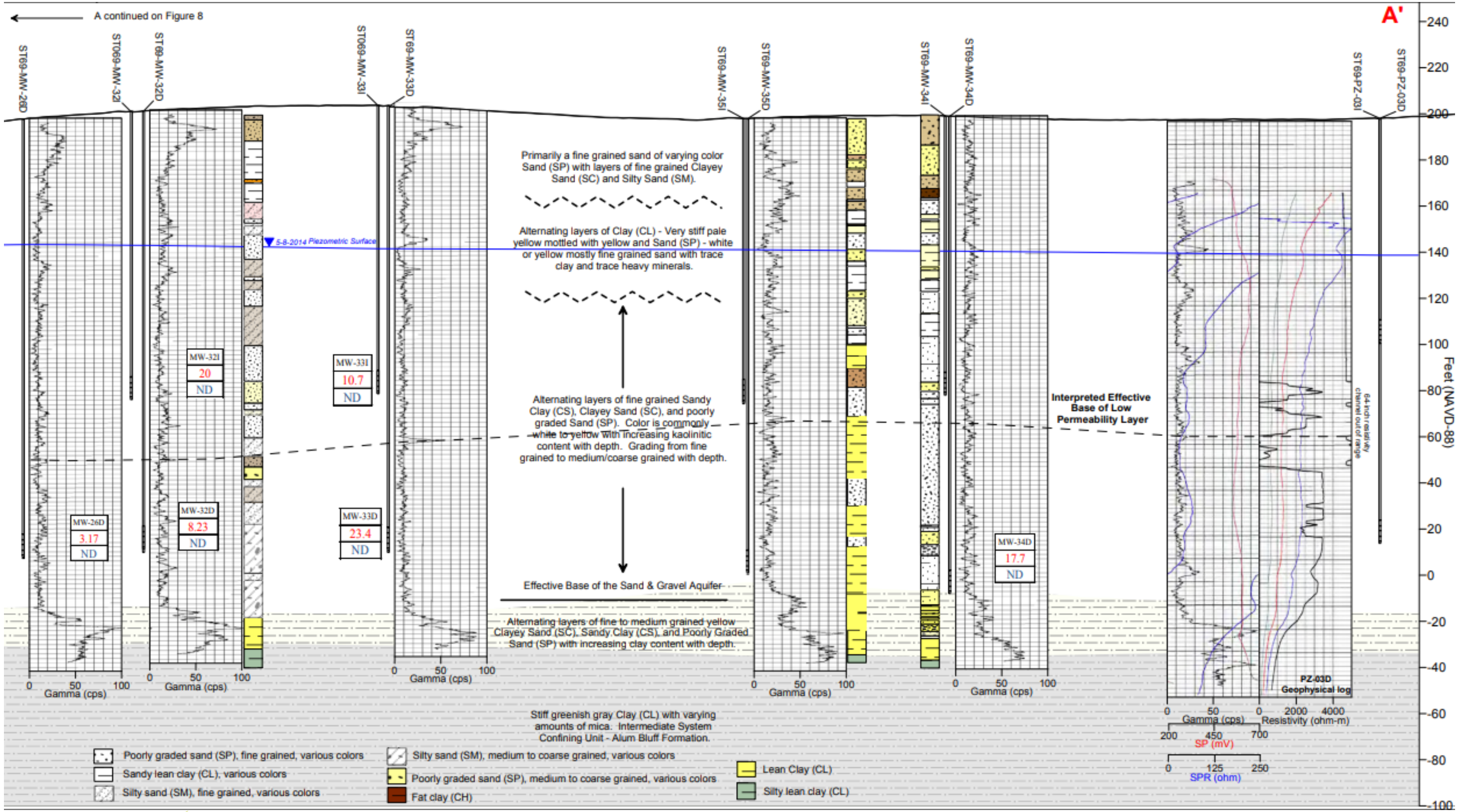
Traditional Geologic Cross Section at ST-69



IRP SITE ST-69 BLDG. 3073 DUKE FIELD	**URS Greiner Woodward Clyde** Tallahassee, Florida DATE: Feb 17, 99 / SCALE: GRAPHIC C:\gintw\drawings\ST69RFI.GPJ Temp. XSBB	CROSS SECTION B - B'	PROJECT NUMBER 01F000004010 FIGURE NUMBER 2.2

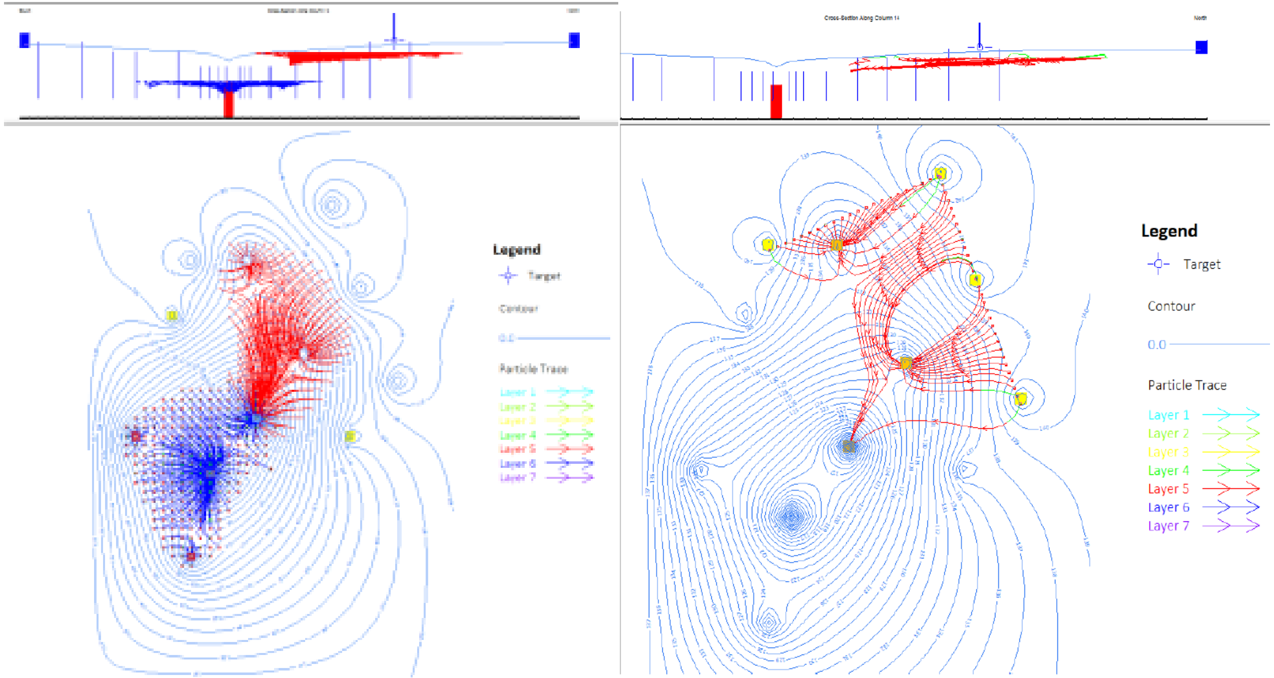
Pre-ESS Lithostratigraphic Cross Section



From the traditional CSM as well as the project geologist characterized the site as "***a big ole' sandbox***"

Site ST-69 Groundwater Model - Capture

- Pump test data was used to generated a 3-dimensional steady state groundwater flow model
- Observed Heads - Calibration 9.5%. Less than 10% is considered “A Good Calibration”.
- Simulated pump and treat with recirculating groundwater remediation system and was able to demonstrate complete capture of PCE contamination and recirculated water.

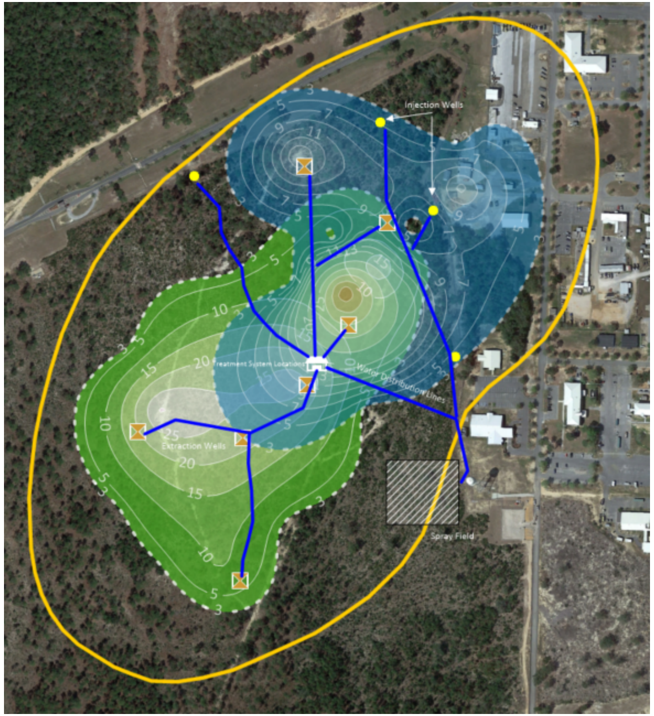


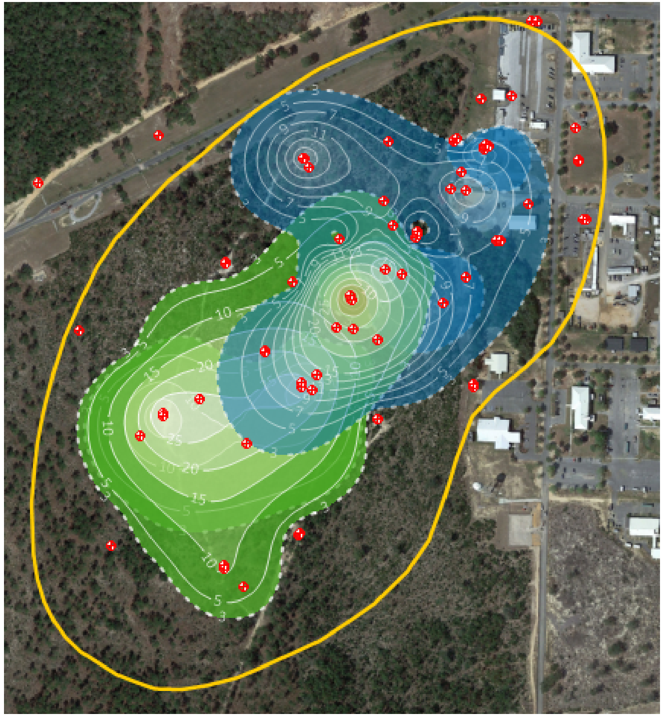
Site ST-69 Baseline Sampling Event and Treatment System Layout

- Original design was a ground water recirculation system composed of five extraction wells, five reinjection wells and sprinkler irrigation.

- Extracted groundwater was treated using a 400 GPM air stripping column.

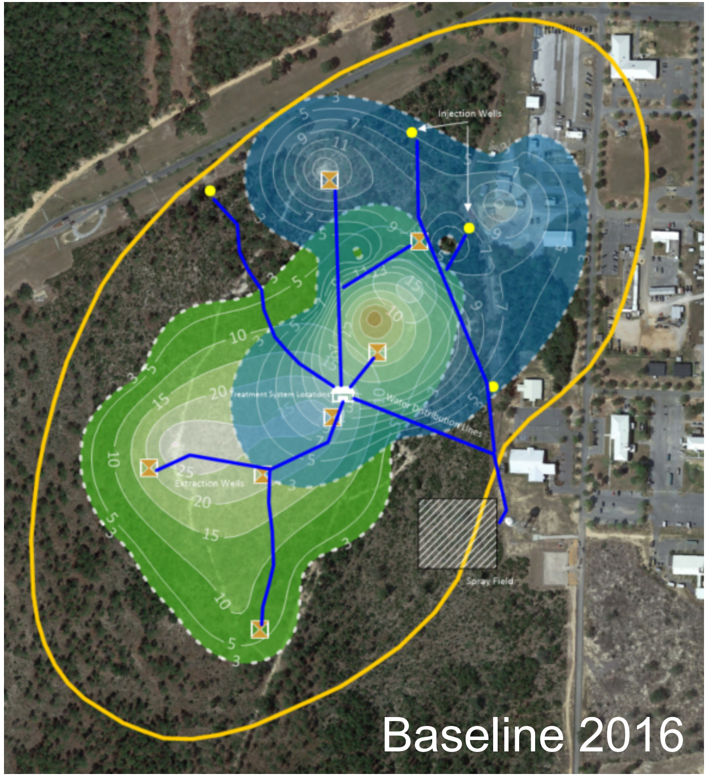
- **and on paper the system looked dynamite until …..**

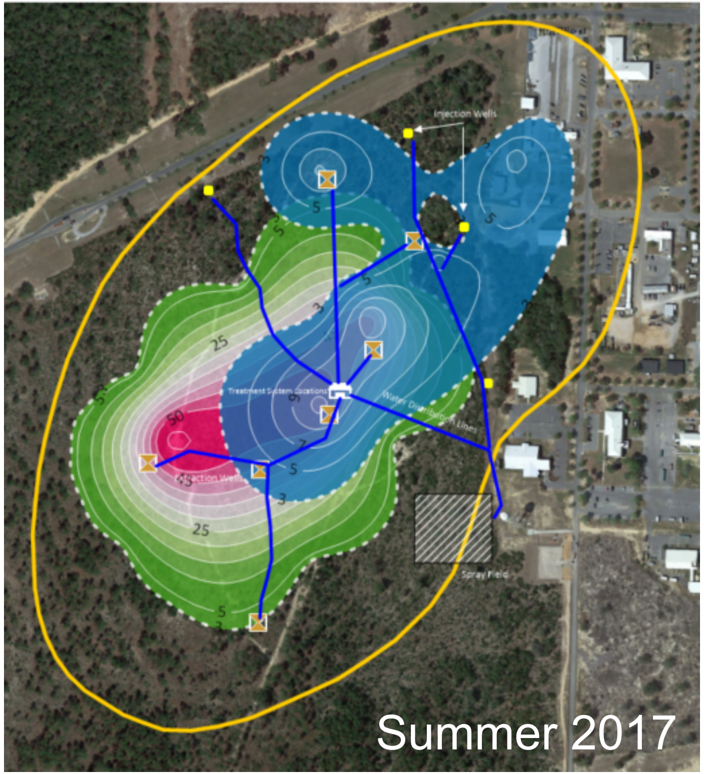




Site ST-69 Plume Map 2017 Sampling Event

- Deep Zone Contamination Increased Significantly Following System Activation
- Turned to Environmental Sequence Stratigraphy



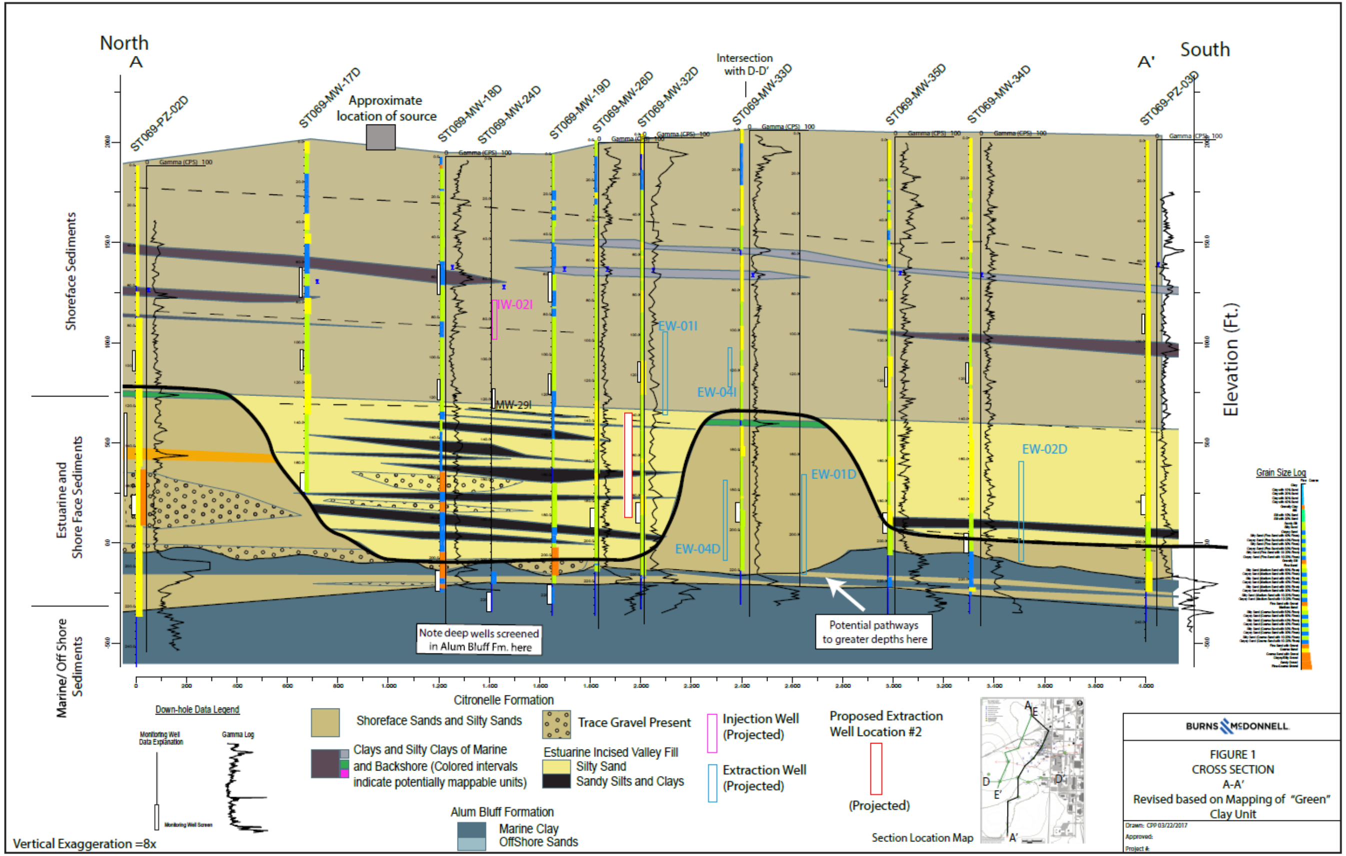


Environmental Sequence Stratigraphy

- According to the ESS - CSM and an educated and experience Sequence Stratigrapher ***"its definitely not a big ole' sandbox"***

- Contaminant pathway suggested "stair stepping" which promoting vertical and lateral migration.

- Deep zone extraction well positively impacted intermediate level contamination.



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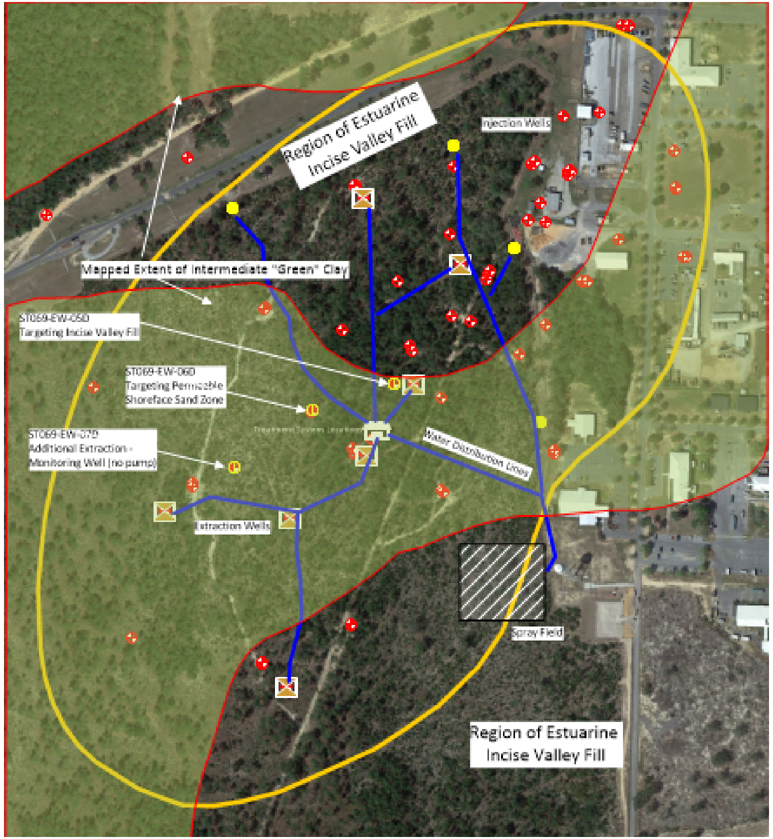
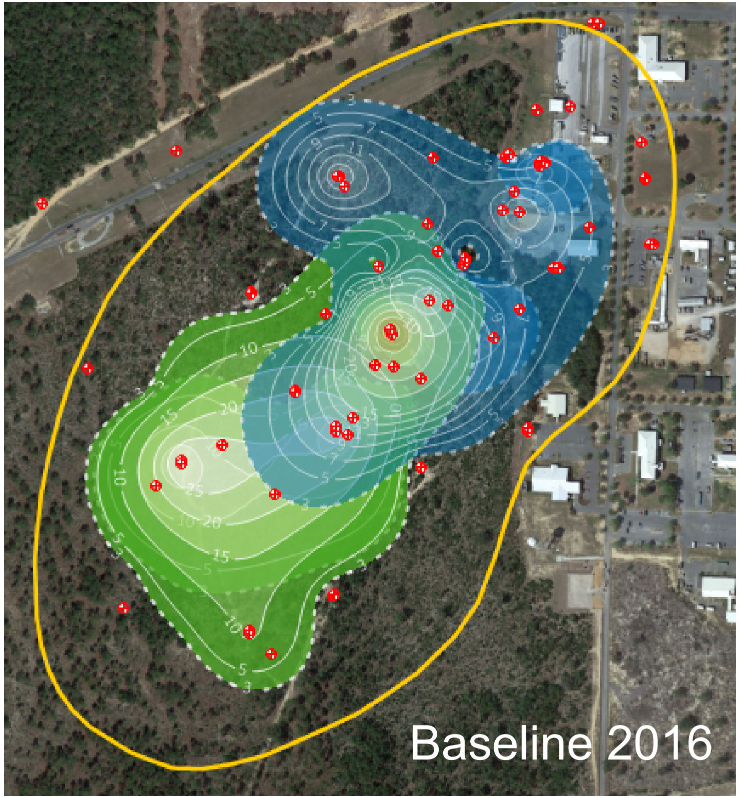
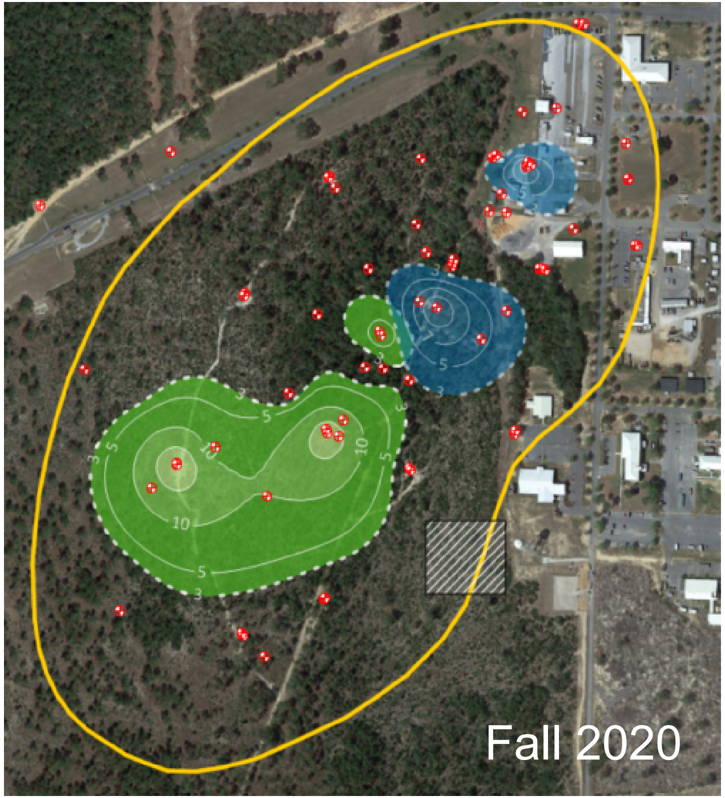
Environmental Sequence Stratigraphy - Planview

- Detection of Estuarine Incised Valley Fill
- Plank’s Lightning Bolt!!
- Transmissivities were generally greater parallel to the shoreline than perpendicular
- Isotropy versus Anisotropy – Assumed $K_x = K_y$
- Impacts on groundwater modeling
- Two extraction wells were installed



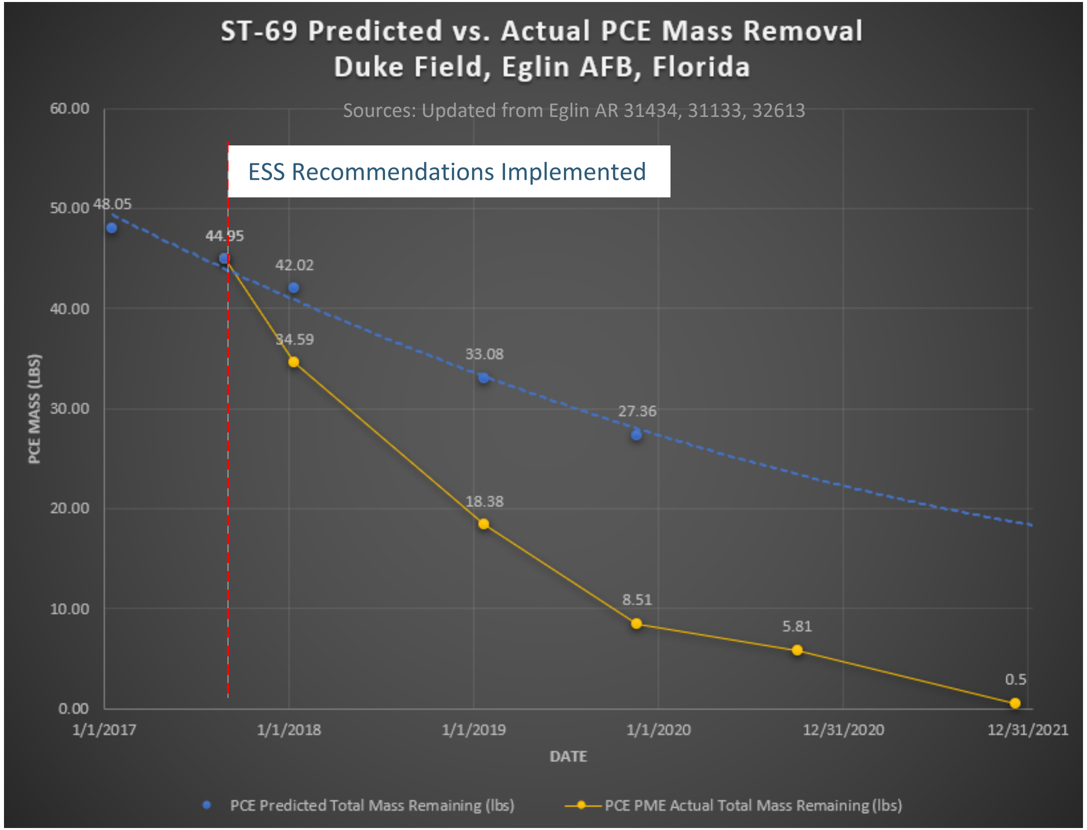
Performance Monitoring Data Post ESS Implementation





Performance Model

- Prior to ESS, Predicted SC date is 2032 plus PARM
- Post ESS implementation 2022 plus PARM
- Implementation of ESS is reducing the time to achieve site closure by 10 years.
- 87% PCE Mass Reduction in 3 years



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Duke Field Site Case Study
Summary

- The reduction in treatment time by 10 years represents a $700,000 reduction in life cycle cost based on annual recurring cost, O+M, sampling, FYR, PARM and documentation.
- Implementation of the ESS process prior to the PBR handoff would have likely resulted in achieving the performance milestone of SC.
- Results of the ESS approach provided a better understanding of the site geology and a means of optimization of the remedial design.
- Experience and educated Sequence Stratigrapher identified the significant differences between ESS and the Traditional Conceptual Site Model
- Regardless of site status within the remediation process, ESS can produce significant project savings. – Implementation early in the remedial process is preferred.
- Optimization of existing remedial systems at Duke Field Site was conducted in near real-time.

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Lessons Learned

- In general, the ESS methodology provides a better understanding of the site geology and a more effective means of designing, installing and optimizing a remedial system.
- Minimizing site uncertainties prevents overdesigning of remedial systems.
- Increasing site knowledge and identification of key hydrostratigraphic units is critical to achieve ever more stringent regulatory requirements.
- Regardless of site status, implementation of the ESS approach in the restoration/remediation flow train, can produce significant project avoidance and/or reduce LCC.
- ESS has shown that it can accelerate the remedial process, on average two to four years.
- Experienced and formally educated sequence stratigraphers are essential.

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