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DOE-FIU Cooperative Agreement Annual Research Review – FIU Year 1

September 14, 2021		
9:00 - 9:05 am EDT	Kick-Off	Kurt Gerdes (Director, Technology Development) – DOE EM-3.2
9:05 - 9:10 am EDT	Welcoming Remarks (DOE-EM)	Nicole Nelson-Jean (Assoc. Principal Deputy Asst. Secretary for Field Ops) – DOE EM-3
9:10 - 9:15 am EDT	Welcoming Remarks (DOE-LM)	Carmelo Melendez (Director, Office of Legacy Management) – DOE LM-1
9:15 - 10:30 am EDT	Projects 4 & 5: STEM Workforce Development and Training	FIU, DOE HQ (EM & LM), SRNL, PNNL, WIPP, SRS, ORP, LBNL, WRPS, INL, Grand Junction
10:30 am - 12:00 pm EDT	Project 1: Chemical Process Alternatives for Radioactive Waste	FIU, DOE HQ, PNNL, WRPS, SRNL, SRS
1:30 - 3:00 pm EDT	Project 3: Waste and D&D Engineering & Technology Development	FIU, DOE HQ, SRNL, PNNL, LBNL, INL, ANL
3:00 - 4:30 pm EDT	Project 2: Environmental Remediation Science & Technology	FIU, DOE HQ, SRNL, PNNL, LANL, ORNL
September 15, 2021		
9:30 - 11:00 am EDT	Wrap Up (FIU Projects 1, 2, 3, 4 & 5)	FIU, DOE HQ (EM & LM)

PROJECT 2

Environmental Remediation Science & Technology

FIU Personnel and Collaborators

Principal Investigator: Leonel Lagos

Project Manager: Yelena Katsenovich

Faculty/Staff: Ravi Gudavalli, John Dickson, Vadym Drozd, Angelique Lawrence, Hamid Bazgirkhoob, *Muhammad Alam

Postdoctoral Fellows: *Yan Zhou, *Shambu Kandel

**DOE Fellows/Students: ***Silvina Di Pietro, Juan Morales, *Katherine De La Rosa, *Alexis Vento, Gisselle Gutierrez, *Nathalie Tuya, Mariah Doughman, Phuong Pham, Jonathan Williams, Stevens Charles, Angel Almaguer.

DOE-EM: Genia McKinley, Kurt Gerdes, Paul Beam, Skip Chamberlain, Nick Machara, John Mocknick

DOE-SRS: Jeff Crenshaw, Nixon Peralta

SRNL: Brian Looney, Hansell Gonzalez-Raymat, Carol Eddy-Dilek, Daniel Kaplan, Mark Amidon, Bruce Wiersma, Connie Herman

SREL: John Seaman

PNNL: Vicky Freedman, Nik Qafoku, Jim Szecsody, Hilary Emerson, Matthew Asmussen

LANL: Paul Dixon, Don Reed, Juliet Swanson, David Moulton

DOE-CBFO: Anderson Ward, Russ Patterson

ORNL: Eric Pierce, Alexander Johs

*Former staff/student contributors

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Project Tasks and Scope

TASK 1: REMEDIATION RESEARCH AND TECHNICAL SUPPORT FOR THE HANFORD SITE	
Subtask 1.1	Remediation Research of Ammonia Gas for Uranium Treatment
Subtask 1.2	Re-oxidation of Redox Sensitive Contaminants Immobilized by Strong Reductants **(NEW)**
Subtask 1.3	Eval. of Competing Attenuation Processes for Mobile Contaminants in Hanford Sediments **(NEW)**
Subtask 1.4	Experimental Support of Lysimeter Testing
TASK 2: REMEDIATION RESEARCH AND TECHNICAL SUPPORT FOR THE SAVANNAH RIVER SITE	
Subtask 2.1	Environmental Factors Controlling the Attenuation and Release of Contaminants in the Wetland Sediments at Savannah River Site Sediments **(NEW)**
Subtask 2.2	Humic Acid Batch Sorption Experiments with SRS Soil
TASK 3: CONTAMINANT FATE AND TRANSPORT MODELING FOR THE SAVANNAH RIVER SITE	
Subtask 3.1	Calibration of the Tims Branch Watershed Model and Scenario Analysis
Subtask 3.2	Model Development for the Fourmile Branch and/or Lower Three Runs Watersheds **(NEW)**
TASK 5: RESEARCH AND TECHNICAL SUPPORT FOR WIPP	
Subtask 5.2	Fate of Actinides in the Presence of Ligands in High Ionic Strength Systems
TASK 6: HYDROLOGY MODELING FOR WIPP	
Subtask 6.1	Digital Elevation Model and Hydrologic Network
Subtask 6.2	Model Development
TASK 7: ENGINEERED MULTI-LAYER AMENDMENT TECHNOLOGY FOR HG REMEDIATION ON OAK RIDGE RESERVATION (NEW)	

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Task 1

Remediation Research and Technical Support for the Hanford Site

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Subtask 1.1: Remediation Research of Ammonia Gas for Uranium Treatment

FIU Year 1 Research Highlights & Accomplishments:

- ***Identified multi U-removal processes:*** Four different mechanisms for U-sequestration:
  1. Fe-oxide formation (EMPA)
  2. Co-precipitation of reduced U(IV) (XANES)
  3. Coating of U phases with secondary phases (Al/Si from *incongruent dissolution phenomena*)
  4. Secondary calcite precipitation (XRD)
- ***Their search results were included in 6 peer-reviewed publications, 7 presentations on the WM Symposia and students posters***

- FIU completed Subtask 1.1 “Remediation Research of Ammonia Gas for Uranium Treatment”.
- The research results based on this task were included in two Master’s theses by:
- **Robert Lapierre** (May 2018, chemistry)
- **Alberto Abarca** (December 2018, environmental engineering)

- Two PhDs defended by:
- **Claudia Cardona** (May 2017, environmental engineering)
- And most recently **Silvina Di Pietro**, who successfully defended her thesis and graduated with a PhD degree in chemistry in April 2021. Silvina is currently working at NNSA as a postdoctorate fellow.

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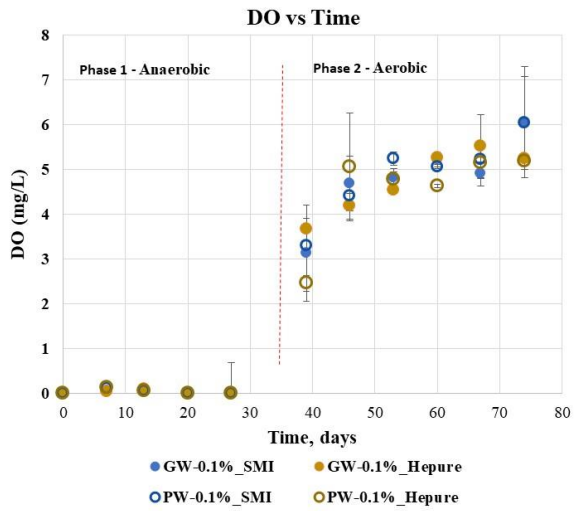
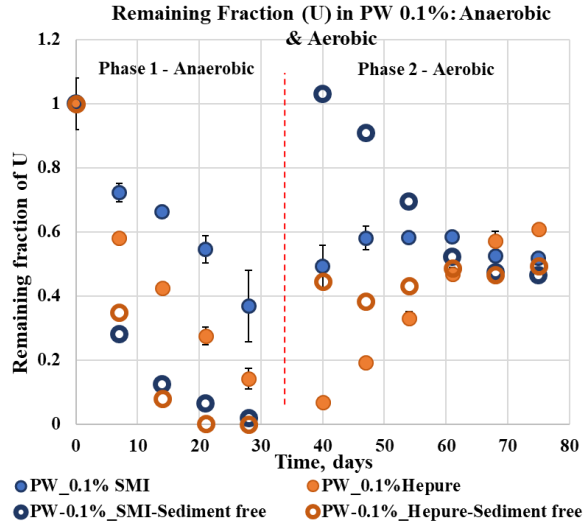
Subtask 1.2: Re-oxidation of Redox Sensitive Contaminants Immobilized by Strong Reductants

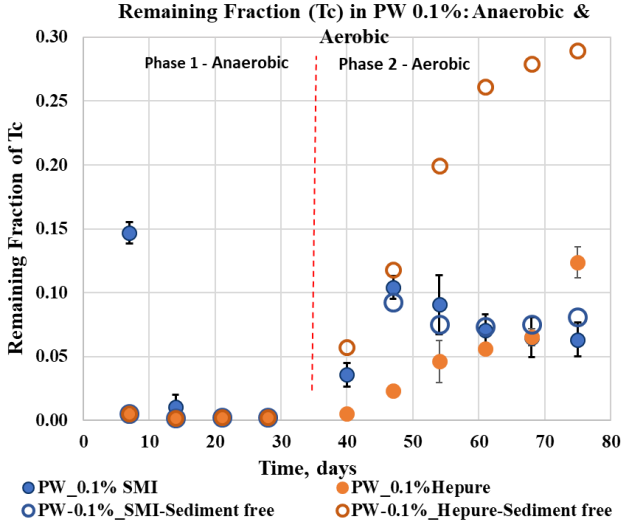
FIU Year 1 Research Highlights & Accomplishments:

- Batch experiments to study re-oxidation kinetics of reduced ^{99}Tc comingled with ^{238}U and nitrate after treatment with strong reductants- 0.1% Zero valent iron (ZVI) and 0.1% Sulfur modified iron (SMI) mass of GW or PW.
- Two phases of experiments:
  - 1. Reduction of ^{99}Tc, U and NO_3^- in the presence of strong reductants under anaerobic conditions for up to 30 days
  - 2. Re-oxidation of ^{99}Tc and other contaminants under aerobic conditions for up to 45 days. Total testing duration is 75 days
- In anaerobic conditions Hepure ZVI was more effective reductant than SMI.
- In aerobic conditions, SMI was more effective in resisting re-oxidation.
  - The same tendency in sediment-free samples.





Tc-sulfide compounds might form with SMI and slower oxidation of Tc (*Lukens et al, 2005*).



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Subtask 1.2: Re-oxidation of Redox Sensitive Contaminants Immobilized by Strong Reductants

FIU Year 2 Projected Scope

- Finalize analyses for nitrate/ nitrite via IC
- Conduct liquid measurements by ICP-OES (total S) or IC (SO_4^{2-}) to detect if Tc-sulfide compounds are being formed
- Conduct solid characterizations studies via XRD and SEM/EDS
- Conduct experiments using 1% ZVI and 1% SMI iron and 0.5% and 5% CPS reductants.

Experimental samples kept in the anaerobic glove box during Phase 1

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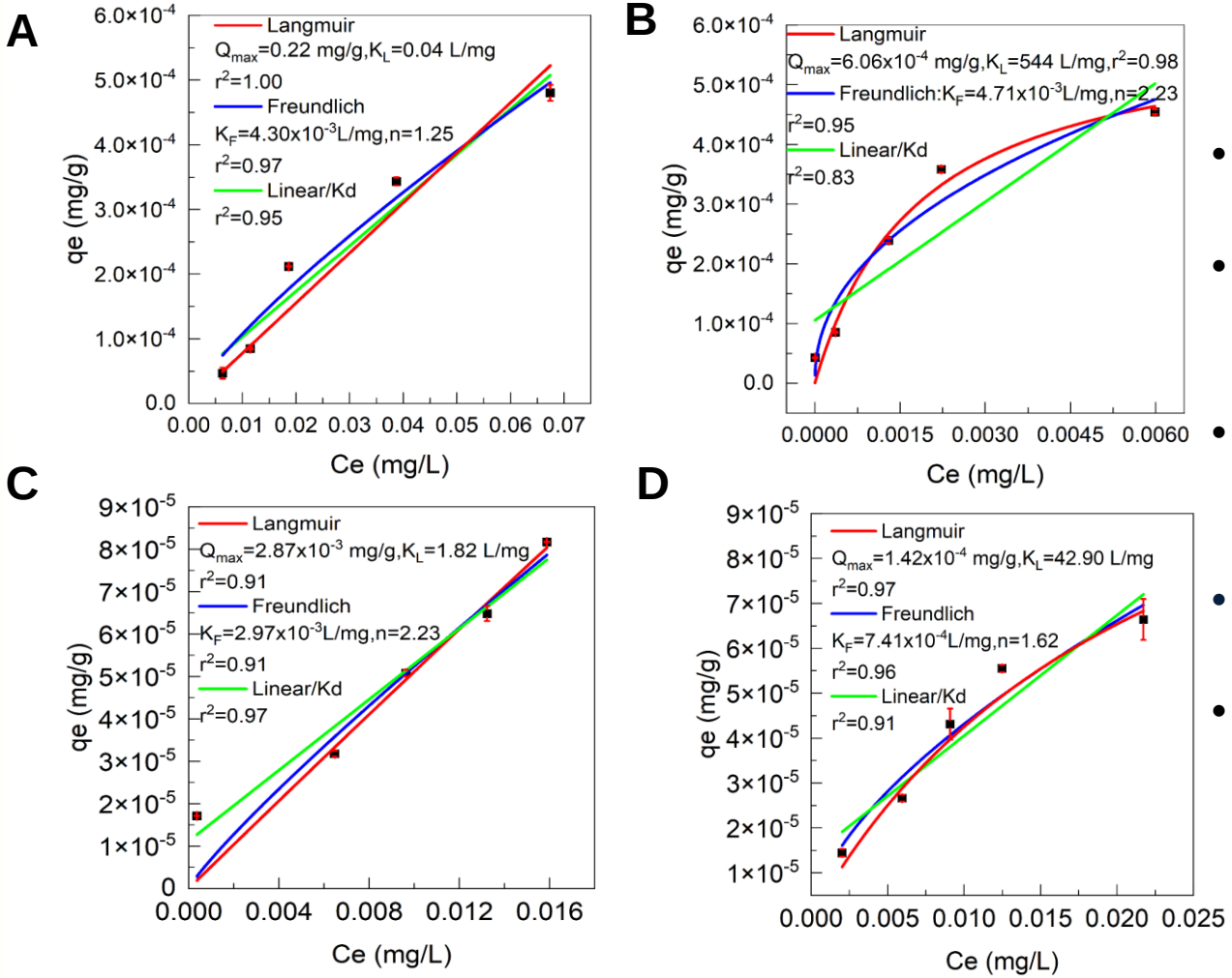
Subtask 1.3: Evaluation of Competing Attenuation Processes for Mobile Contaminants in Hanford Sediments

FIU Year 1 Research Highlights & Accomplishments:

Adsorption of **A** Cr (50-530 ppb) **B** Cr in the presence of I-127 (20-100 ppb) **C** I-127 **D** I-127 in the presence of Cr in AGW ($NaHCO_3$, $KHCO_3$, $MgSO_4 \cdot 7H_2O$, $MgCl_2 \cdot 6H_2O$, $CaCl_2 \cdot 2H_2O$, pH: 7.90 ± 0.03) onto Hanford Formation Sediment



- Adsorption is decreased for both I-127 and Cr by an order of one and three magnitudes
- Cr alone and competitive kinetic modeling follow pseudo-first order kinetics.
- I-127 alone and competitive kinetic modeling follow pseudo-second order kinetics.
- Completion of Tc-99 and U batch adsorption studies onto Hanford Sediments.
- Remote summer internship under the mentorship of Dr. Nikolla Qafoku.
- Poster presentation at Waste Management 2021 and ACS Fall 2021 meeting: Evaluation of Competing Attenuation Processes for Mobile Contaminants in Hanford Sediments

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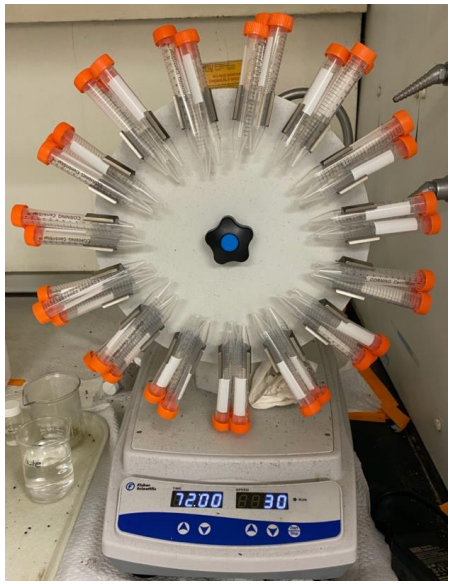
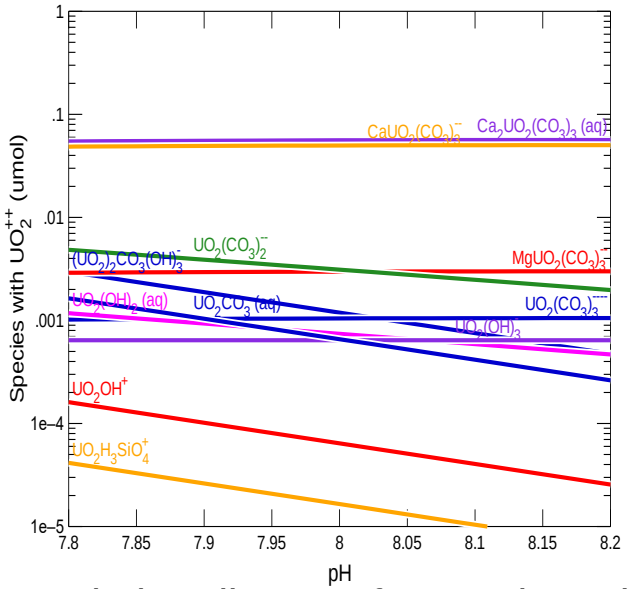
Subtask 1.3: Evaluation of Competing Attenuation Processes for Mobile Contaminants in Hanford Sediments

FIU Year 2 Projected Scope

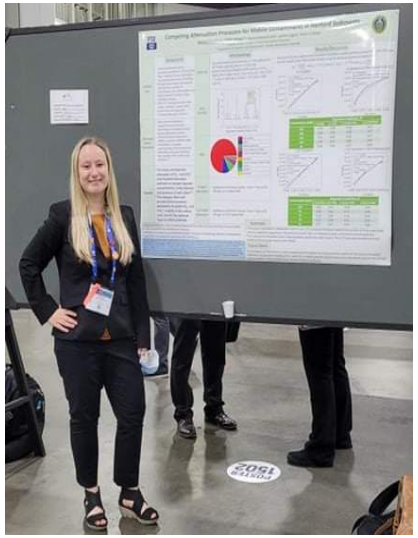
- Investigation of uranium batch adsorption studies in the presence of collocated contaminants (chromate, iodine-127, nitrate, and technetium-99)
- Speciation modeling of all contaminants using Geochemist Workbench program
- Solid phase characterization of post treated sediment (SEM-EDS and XRD analysis)
- Development of column studies to better understand uranium adsorption under site conditions.



Experimental samples on end-over-end tube revolver



Speciation diagram for uranium via GWB



DOE Fellow Mariah Doughman poster presentation at ACS Fall 2021 meeting

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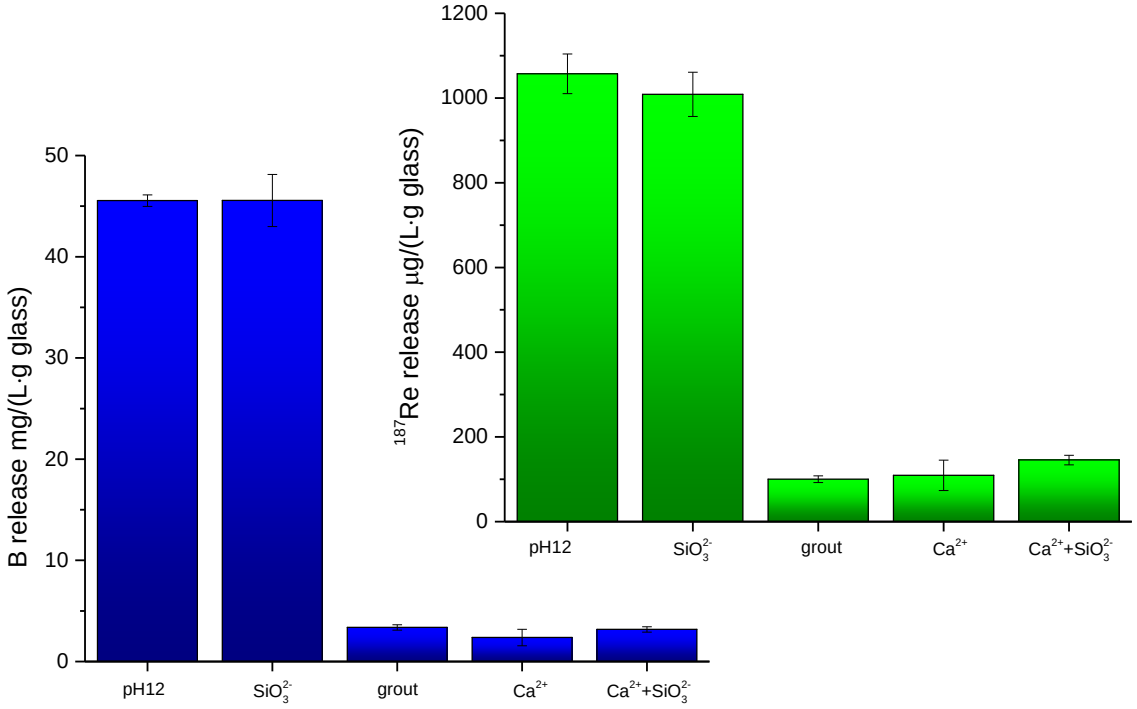
Subtask 1.4: Experimental Support of Lysimeter Testing

FIU Year 1 Research Highlights & Accomplishments:

- Investigated effects of major elements in the grout-contacted GW, Si, Ca and Al on dissolution behavior of ORLEC28 glass.
  - Test matrix in SPFT: duplicated reactors with Si-amended soln., a reactor with pH 12 buffered soln., flow rate 40mL/day at 25°C, 40°C, and 70°C.
  - Test matrix in PCT: triplicated reactors, pH 12 buffer, grout soln., Si (5 ppm), Ca (130 ppm) and Al-amended buffers at 90°C
- XRD analyses of treated glass and SEM/EDS measurements in cross-sections of glass coupons to study glass erosion



PCT results on the ^{187}Re and B release by ORLEC28 glass in different solutions at 90°C

Depth of alternation layers after static test

Solution	Na, μm	K, μm	Si, μm	Al, μm
pH 12	3.84	2.87	2.77	2.32
Na_2SiO_3	4.71	3.54	2.70	1.87
Grout-contacted	3.00	3.00	1.35	2.08

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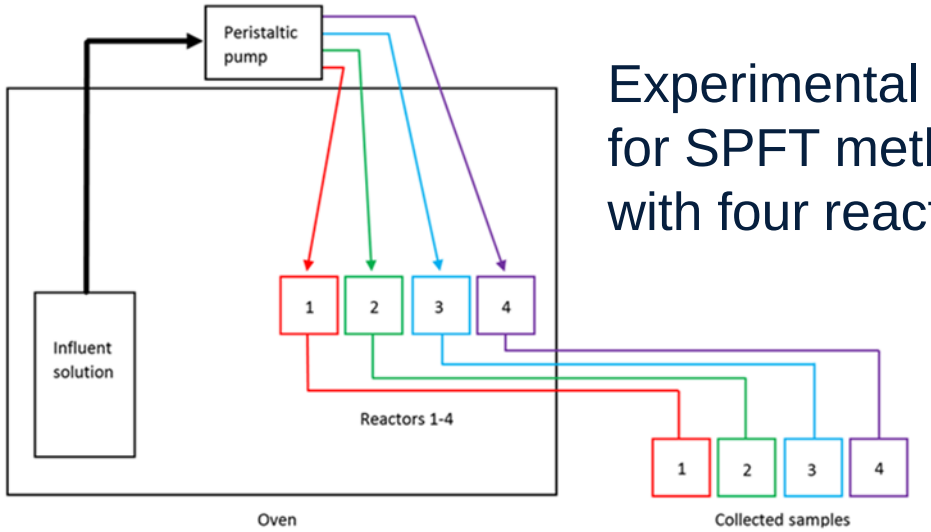
Subtask 1.4: Experimental Support of Lysimeter Testing

FIU Year 2 Projected Scope

- Continue SPFT dissolution experiments at different temperatures (25°C, 40°C and 70°C) with Ca- amended buffer solutions to measure glass dissolution rates
- Conduct long-term static PCTs at 90°C to measure depth of glass alternation layers.
- Study the effect of calcium carbonate on the release of elements from glass
- Investigate the effect of grout/sediment-contacted groundwater to simulate specific conditions being studied in the current field lysimeter experiment and measure the response of the glasses to these conditions

ORLEC28 glass coupons to study glass erosion



Experimental setup for SPFT method with four reactors.

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Task 2

Remediation Research and Technical Support for the Savannah River Site

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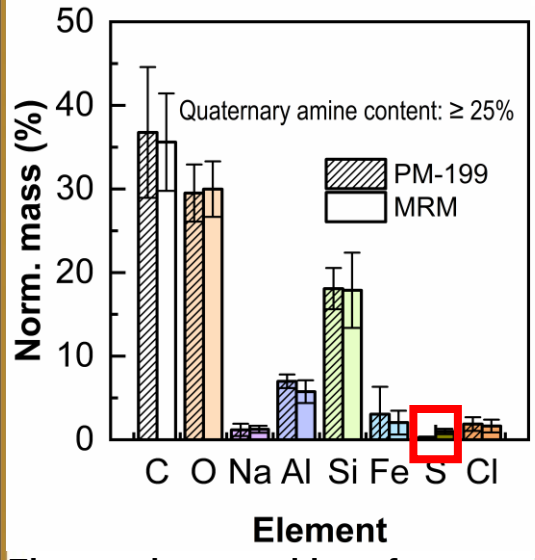
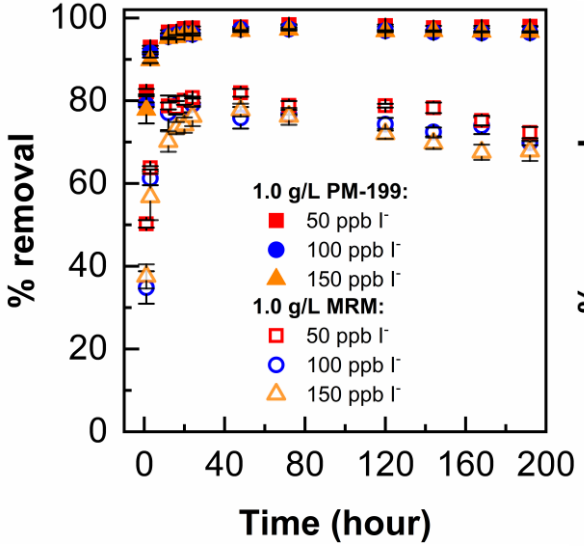
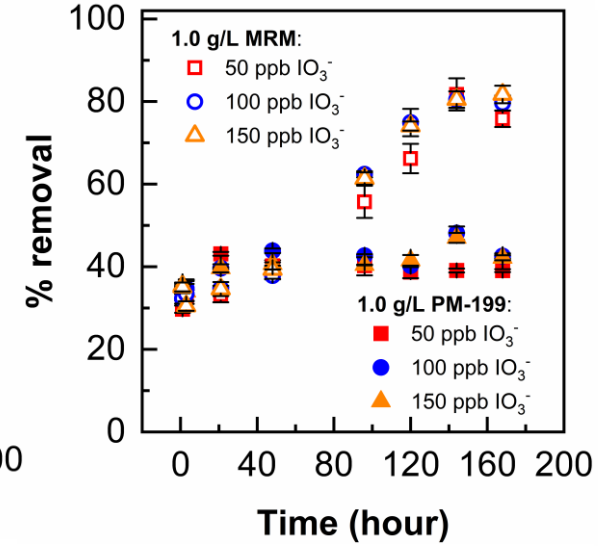
Subtask 2.1: Environmental Factors Controlling the Attenuation and Release of Contaminants in the Wetland Sediments at Savannah River Site (NEW)

FIU Year 1 Research Highlights & Accomplishments:

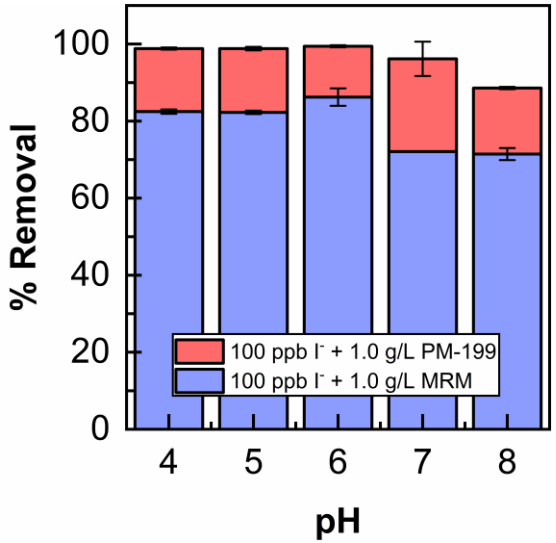


Elemental composition of organoclays





Kinetics of I sorption onto PM-199 and MRM



Effect of pH on I sorption onto PM-199 and MRM

- **Organoclay PM-199:**
  - ~ 40 % of the IO_3^- was adsorbed within 24 hours.
  - ~ 99 % of I^- was removed from the aqueous solution with in 12 hours.
- **Organoclay MRM:**
  - ~ 70 – 80 % of I^- and IO_3^- were removed from the aqueous solution by MRM with in 12 hours and 7 days, respectively.
- pH has a little effect on the removal of iodide by PM-199 and MRM
- Completion of organoclays PM-199 and MRM characterization
- Summer internship at SRNL working on the sorption of iodine species by wetland soils at different depth intervals
- Poster presentation at ACS Fall 2021 meeting: Effective removal of iodine species by organoclays PM-199 and MRM

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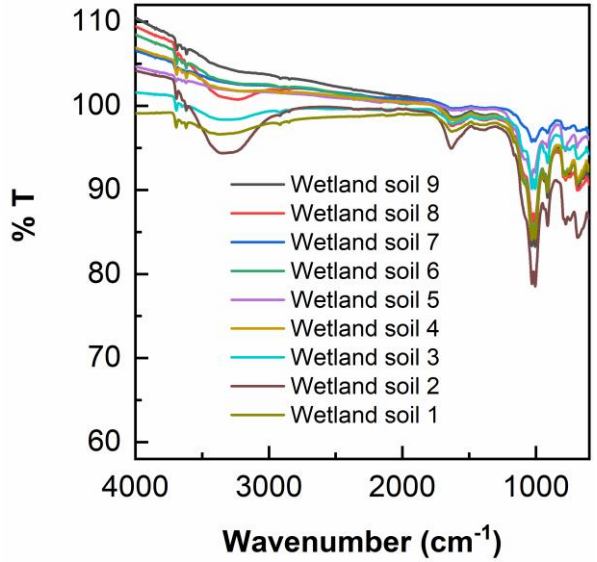
Subtask 2.1: Environmental Factors Controlling the Attenuation and Release of Contaminants in the Wetland Sediments at Savannah River Site (NEW)

FIU Year 2 Projected Scope

- Investigation of iodine speciation batch adsorption studies using organoclays in the presence and absence of wetland soils
- Sorption of iodine species on soils collected at different depth intervals
- Solid phase characterization of bulk wetland soils and fractionated soils
- Solid phase characterization of post treated soils and sorbents
- Development of column studies to better understand iodine sorption under site conditions.

DOE Fellows Phuong Pham at SRNL during summer internship and presenting poster at ACS



FTIR analysis of SRS wetland soil

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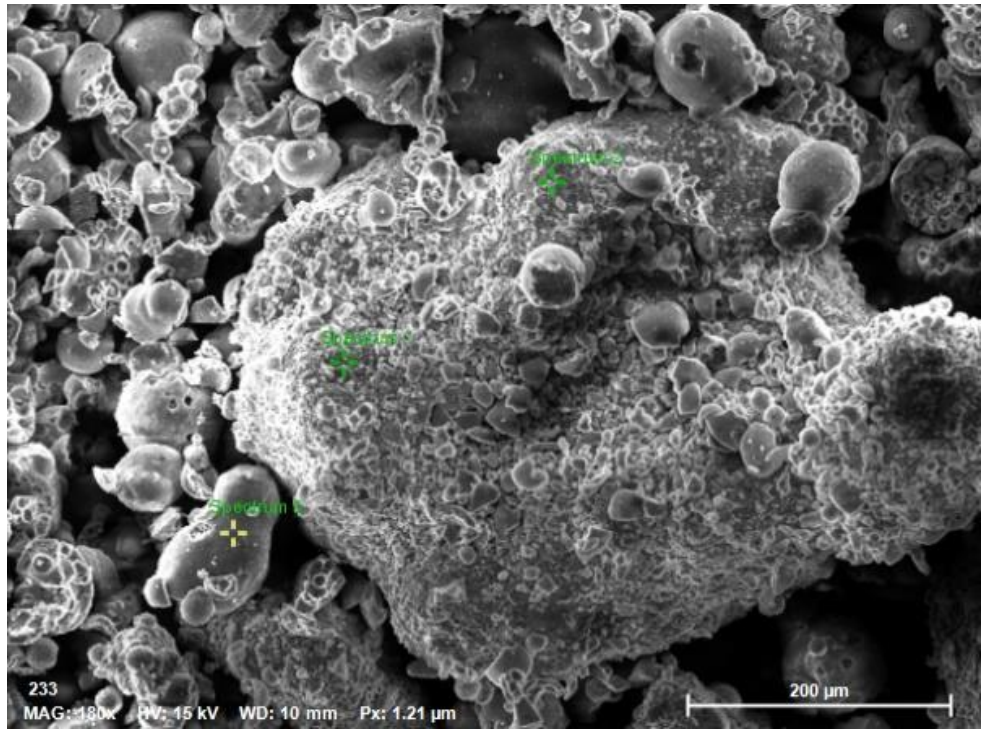
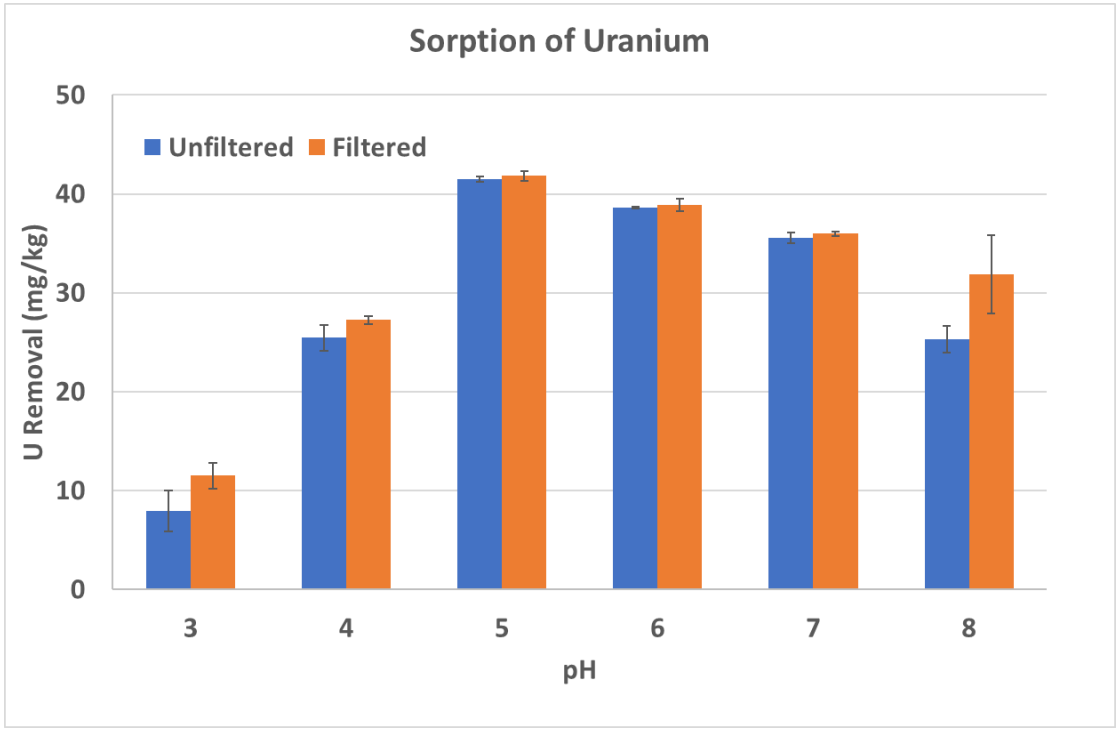
Subtask 2.2: Humic Acid Batch Sorption Experiments with SRS Soil

FIU Year 1 Research Highlights & Accomplishments:

- Completed characterization of KW-15 using SEM-EDS, potentiometric titration, FTIR
- Studied the sorption of uranium onto KW-15 coated sediment at pH 4
- Investigated the sorption new KW-30 humic materials on SRS sediment
- Presented 1 professional poster and two student posters at WM21 held virtually



SEM image of KW-15



Influence of pH on uranium removal with KW-15 coated sediment

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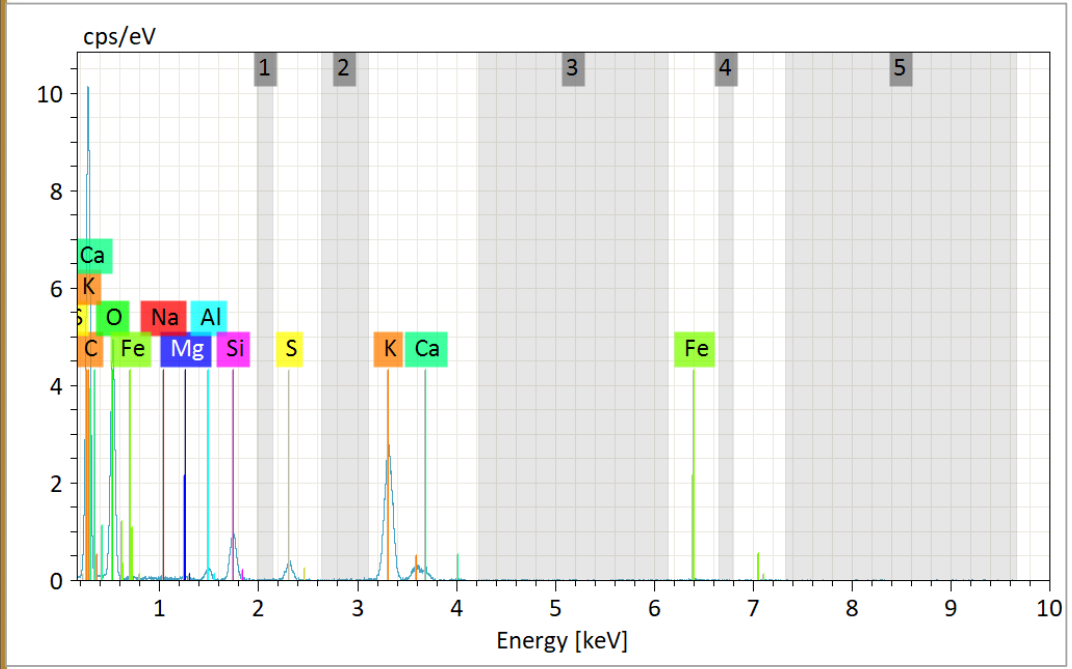
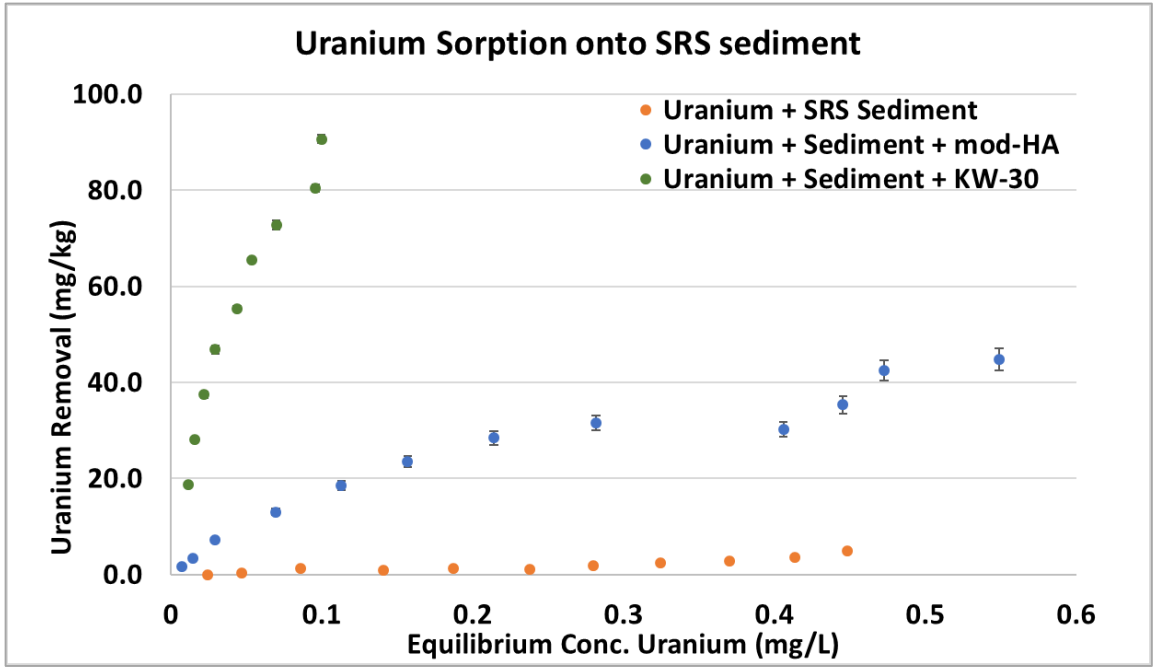
Subtask 2.2: Humic Acid Batch Sorption Experiments with SRS Soil

FIU Year 2 Projected Scope

- Study the effect of minerals of KW-30 sorption
- Extend isotherms to include higher U concentrations
- Conduct column experiments to evaluate KW-30 performance in flow through settings



Elemental composition of KW-15 obtained via EDS



Sorption of U onto SRS sediment W and W/O humate coating

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Task 3

Contaminant Fate and Transport Modeling for the Savannah River Site

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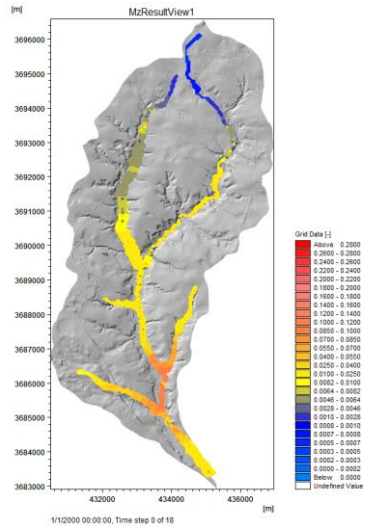
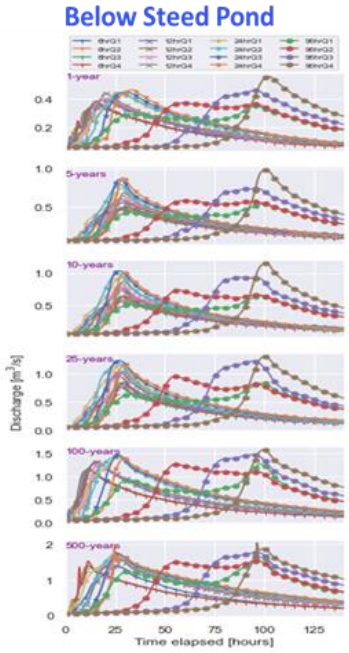
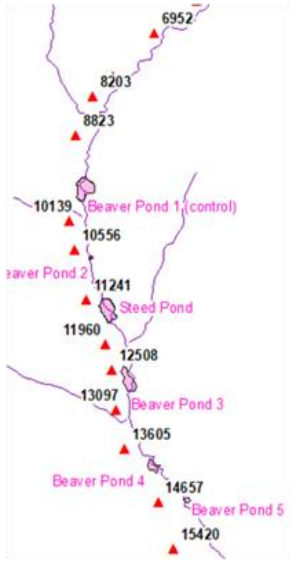
Subtask 3.1: Calibration of the Tims Branch (TB) Watershed Model and Scenario Analysis

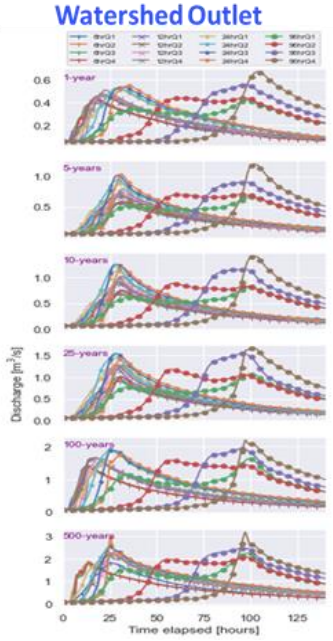
- Calibrated coupled SW/GW interaction model: Simulates Overland, Unsaturated & Saturated zone flow, and exchange of water between GW and river system.
- MIKE11 Advection-Dispersion module was set up, calibrated, and validated to simulate sediment transport process in TB based on available field data.
- Ran extreme event scenarios ranging from 500-yr to 5-yr return periods with storm durations ranging from 6-hr to 72-hr to simulate and differentiate sediment fluxes at key locations of the watershed **(below Steed Pond & TB watershed outlet**) under various design storm conditions.
- Shows potential hotspots for resuspension/remobilization of sediment-bound contaminants under different climate conditions.



Animation: Temporal distribution of Velocity*Flow Depth (U*D) for a 100-year 24-hour design storm event.







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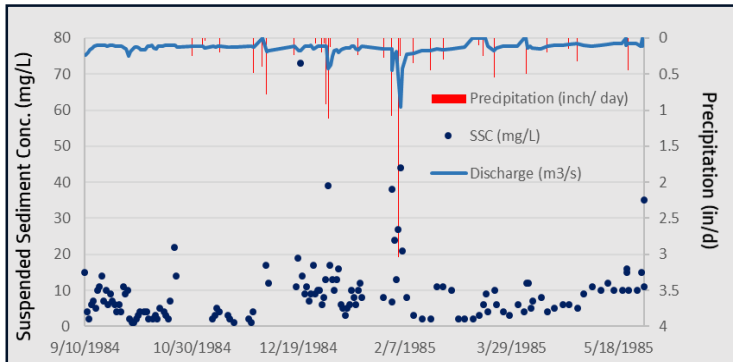
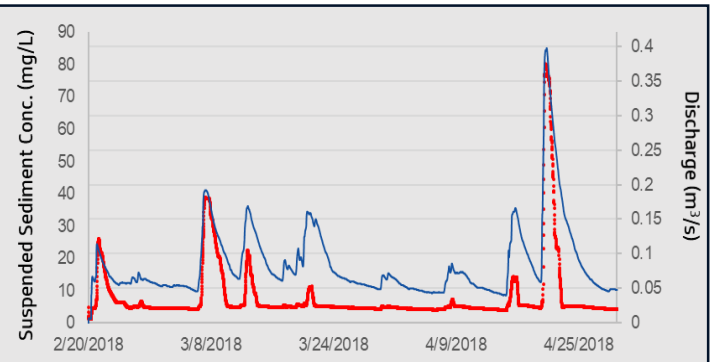
Subtask 3.1: Calibration of the Tims Branch Watershed Model and Scenario Analysis

FIU Year 1 Research Highlights & Accomplishments:

- Initiated contaminant transport model development based on site needs and contaminant data availability [Uranium (U), Tin (Sn), Nickel (Ni)]
- Metals mostly sediment-bound (Kaplan et., al 2017). Their presence and transfer related to transport of suspended sediments in TB stream (Batson et al., 1996).
- A (U) transport model has been set-up and is currently being calibrated.

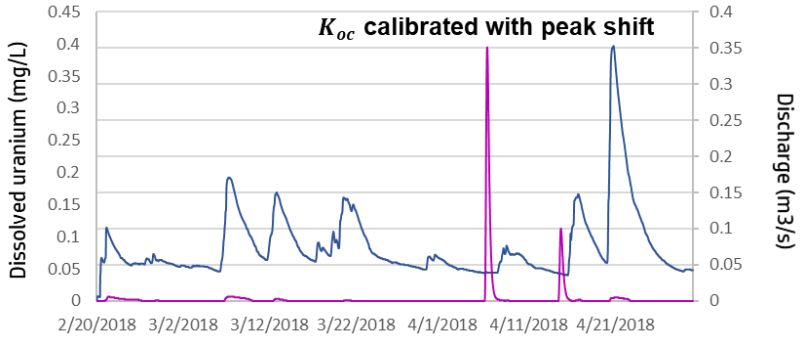


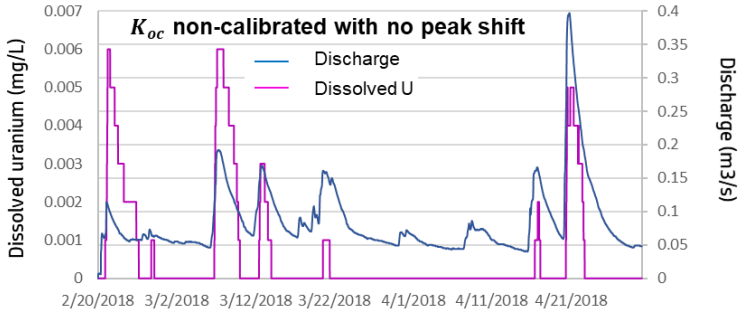
Field measurements of suspended sediment concentration (SSC) and streamflow collected 200 yards upstream of the confluence between Tims Branch and Upper Three Runs (Hayes, 1986)



Simulated suspended sediment concentration (SSC) and discharge. Computed results are in agreement between suspended sediment concentrations (SSC) and the observed values.

TBW - CALIBRATION OF URANIUM ENVIRONMENT USING MIKE ECO LAB				
Order	**Series number**	**Reference**	**Calibration Parameters**	**Approximate model runs**
1	Series 2	Peer-reviewed literature	K_{oc}, K_w, f_{oc}, porosity	55
2	Series 3	Calibrated hydrodynamic model	K_{oc}, f_{oc},	115
3	Series 4	Calibrated hydrodynamic model	K_w	NA





- Ongoing:
  - Calibration of MIKE 11 ECO Lab contaminant transport model to simulate U transport in TB watershed.
  - Sensitivity analysis to determine controlling variables and optimum values for parameters affecting uranium geochemical processes in the TB system.

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Subtask 3.1: Calibration of the Tims Branch Watershed Model and Scenario Analysis

FIU Year-2 Projected Scope:

- Complete calibration and validation of the U transport model for current hydrodynamic simulation time period.
- Conduct simulations of design storm events (500-yr, 100-yr, etc.) for U transport in TB *(delayed milestone 2020-P2-M11 due to loss of technical personnel)*.
- Set up contaminant transport model for other contaminants of interest (Sn & Ni).
- Continue maintenance of HOBO units and acquiring remote monitoring data at the TB watershed outlet to apply the model for other time periods.

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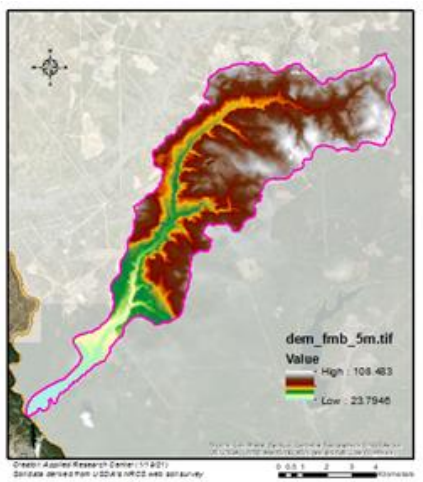
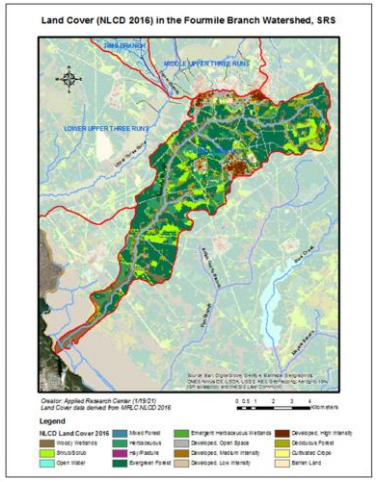
Subtask 3.2: Model Development for the Fourmile Branch and/or Lower Three Runs Watersheds (NEW)

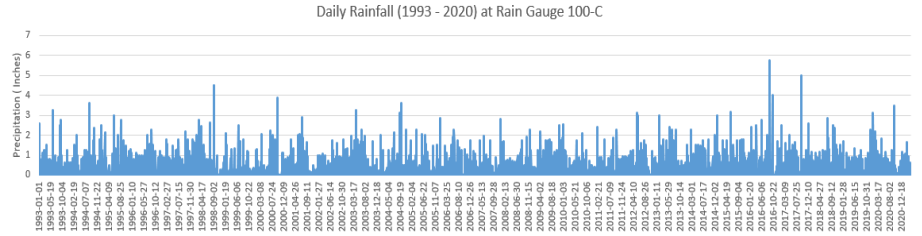
FIU Year 1 Research Highlights & Accomplishments:

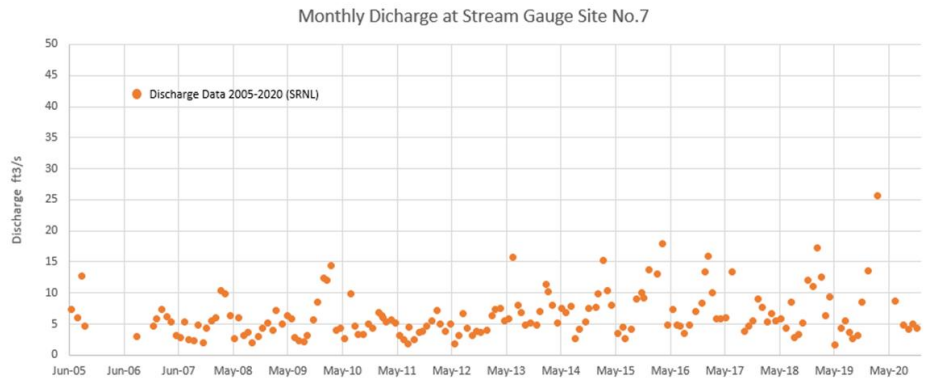




Phase 1 Initiated

- Lit. review of site background, history of contamination, applied remed. tech.
- Data retrieval from fed. & state databases (USGS/USDA/SCDNR), SRNS/SRNL
  - Climate: (RF, ET); Geospatial: (DEM, streams, soil, land cover, veg., monitoring sites, hydraulic structures (culverts, dams)); Hydrological: (river discharge & stage); Water quality: (contaminant conc., suspended sediment conc., partitioning coeff., desorption rate, critical velocity, settling velocity)
- Created geodatabase to store/manage GIS data.
- Applied ArcGIS geoprocessing & visualization tools to prepare model input data and map study area.
- Conducted analysis of timeseries data records (rainfall & discharge) to identify significant storm events.
- Simultaneous records of rainfall and discharge timeseries in time steps that would capture major storm events was limited. Remote monitoring at key locations in watershed needed to support model calibration & validation.
- FIU undergrad. student (DOE Fellow) was trained on geospatial mapping and analysis tools used and assisted in the data retrieval, processing and analysis.





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FIU Year 2 Projected Scope

- Complete milestones and deliverables related to the Project 2 Task 3 modeling efforts delayed due to loss of technical personnel. FMB watershed conceptual model development and numerical model development will be main priority.

Milestone/ Deliverable #	Milestone/Deliverable	Subtask	Orig. Due Date	Proj. Due Date
2020-P2-D3	Draft report on conceptual model development for Fourmile Branch watershed	3.2	6/30/2021	Reforecast to FIU Year 2
2020-P2-M10	Complete numerical model development for Fourmile Branch watershed	3.2	9/15/2021	Reforecast to FIU Year 2

Task 5

Research and Technical Support for WIPP

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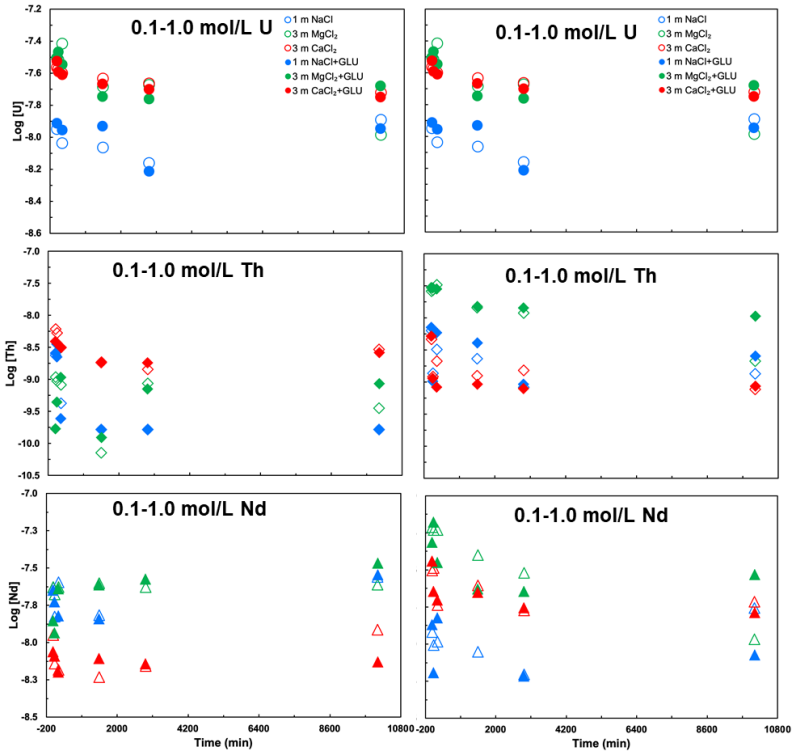
Subtask 5.2: Fate of Actinides in the Presence of Ligands in High Ionic Strength Systems

FIU Year 1 Research Highlights & Accomplishments:

- Conducted batch experiments to understand the impact of ionic strength and gluconic acid on sorption of actinide onto iron oxide mineral (magnetite) under anaerobic conditions. An actinide concentration ($[M]_{initial}$ = 10^{-8} M, where M= Nd, Th, U) was used in these studies.
- Evaluated brines are as follows: 0.1, 1.0 and 5.0 mol/L NaCl, $MgCl_2$, $CaCl_2$ and U[VI], neodymium (Nd[III]) and thorium (Th[IV]) were used as stable chemical analogs for americium and plutonium under anaerobic conditions.
- Addition of GLU had negligible impact on solubility of U, Th, Nd, suggesting absence of tertiary gluconate complex with the studied actinide.
- Brine types had a significant influence on actinide solubility.
- Higher ionic-strength brines tended to enhance the overall solubility of U, Th, Nd in $MgCl_2$ and $CaCl_2$ compared to NaCl brine.
- Study results from this task serves as the basis for a Master's thesis by Alexis Vento (July, 2021, Environmental Engineering). Alexis currently works at SCS, Consulting Engineers, Inc.



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FIU Year 2 Projected Scope

- Continue batch sorption experiments investigating the impact of GLU on the sorption of Nd(III), Th(IV), and U(VI) onto iron oxide minerals in WIPP-relevant brines (e.g. $MgCl_2$, $CaCl_2$ and GWB and ERDA-6) using higher concentration of concentration of An ($[An]_{initial}$ = 1000 *µg/L*).
- Continue to support ongoing research on actinide through identification of minerals and ligands of interest to the WIPP (iron oxides, key contaminants with co-located lead) for risk assessment models for the WIPP re-certification.

Task 6

Hydrology Modeling for WIPP

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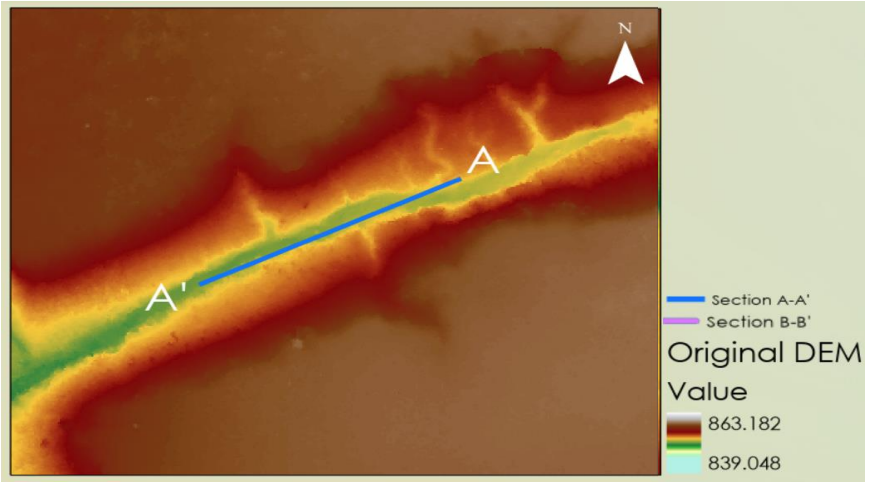
Hydrology Modeling for WIPP

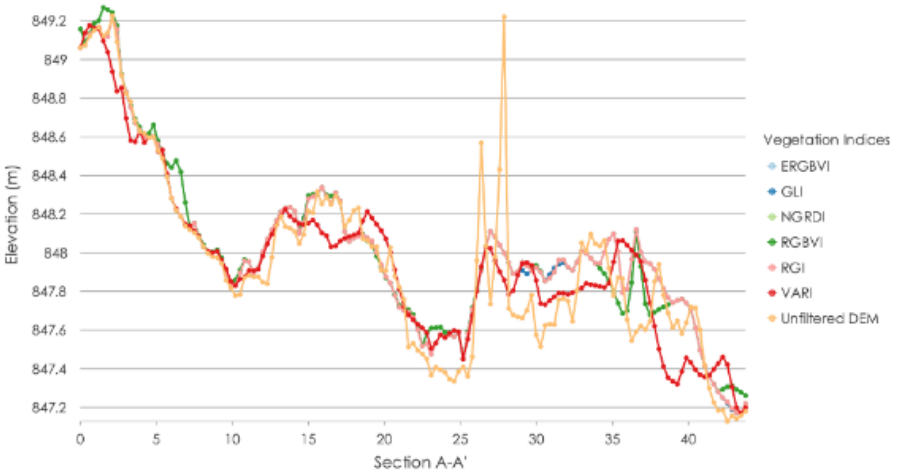
FIU Year 1 Research Highlights:

Subtask 6.1 - Development of DEM & Hydrologic Network:

DEM Development & Refinement:

- Tested RGB-based vegetation removal methods to refine DEM developed from drone imagery collected in Basin 6 in 2020, needed for LSM development and delineation of significant hydrological features (sink holes, brine lakes, gullies) that contribute to regional GW recharge.
- Promising results using libLAS with Python to determine optimum threshold value which separates vegetation from bare ground.
- Encountered shadow effect due to time of day data was collected, so tested several shadow removal methods with somewhat unsuccessful results.
- Proposed path forward: (1) Comparative analysis of veg. areas on high-res DEM vs. satellite imagery (Landsat 8, Sentinel or NAIP) by “scaling up” DEM to resolution of satellite imagery. (2) Comparative analysis of high-res DEM with NLCD vegetation density maps.





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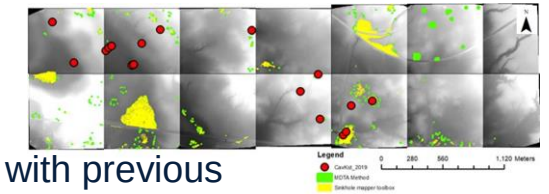
Hydrology Modeling for WIPP

Subtask 6.1 - Development of DEM & Hydrologic Network:

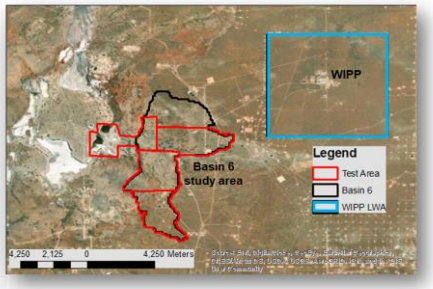


Sinkhole Detection:

- 2 GIS-based sinkhole detection methods tested using FIU's high-res DEM and results compared with previous sinkhole inventory derived from GPS field mapping in Basin 6. (Goodbar et al, 2020)
- Sinkholes from GIS-based detection (green & yellow areas) overlapped or were in close proximity to ground surveyed sinkholes (red dots). Additional depressions also identified with standard parameters used in the GIS-based detection methods.
- Sinkholes derived from Sinkhole Mapper Toolbox being incorporated to refine Basin 6 mesh using TINerator, for use in ATS.

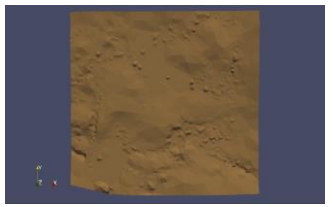
UAV-Based Field Survey of Basin 6:

- FIU team traveled to Carlsbad, NM (Aug. 2021) to collect complete imagery dataset for Basin 6 study area (~24 km^2), successfully capturing ~ 22 km^2. Site will be revisited early in FIU Yr 2 to complete the survey. Final data set to be processed as per established photogrammetry work flow.



Subtask 6.2 - Model Development:

- FIU team trained on ASCEM toolset including tutorials on Akuna GUI for GW model development.
- Existing Culebra MODFLOW model provided by CBFO from which several model inputs applied for prelim. ASCEM GW model development.
- FIU trained on data preprocessing tools (e.g., LaGriT) and creation of data layers for GW model including conversion of MODFLOW inputs.
- Land surface models evaluated and ATS selected. ATS training initiated by Drs. David Moulton & Daniel Livingston (LANL). DOE Fellow continued training with LANL during summer internship to acquire necessary skillset to support WIPP modeling work.
- FIU will maintain collaboration with LANL, CBFO and PNNL scientists to continue GW model and LSM development.



Five layer mesh of a part of Basin 6. Layer depths strongly exaggerated for effect.

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FIU Year 2 Projected Scope

- Complete milestones and deliverables related to the Project 2 Task 6 modeling efforts delayed due to travel postponements to conduct field-work and loss of technical personnel.
- Complete Basin 6 field survey (~ 2 km^2) and execute processing workflow established in FIU Year 1 to generate a high resolution DEM of Basin 6.

Milestone/ Deliverable #	Milestone/Deliverable	Subtask	Orig. Due Date	Proj. Due Date
2020-P2-M9	Complete DEM development for Basin 6	6.1	8/2/2021	Reforecast to FIU Year 2
2020-P2-M12	Complete LSM development for Basin 6	6.2	9/28/2021	Reforecast to FIU Year 2
2020-P2-D5	Draft report on ASCEM groundwater model development	6.2	9/15/2021	Reforecast to FIU Year 2

Task 7

Engineered Multi-Layer Amendment Technology for Hg Remediation on Oak Ridge Reservation (NEW)

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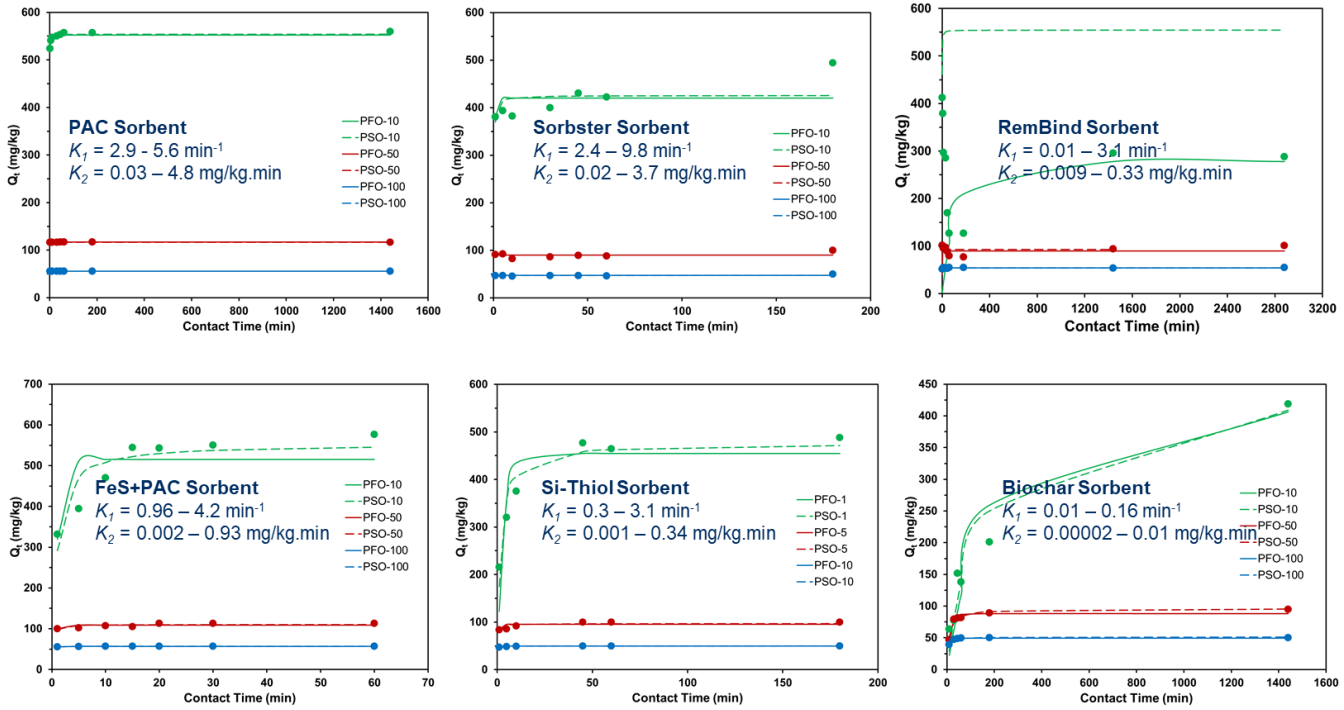
Task 7:Engineered Multi-Layer Amendment Technology for Hg Remediation on Oak Ridge Reservation (NEW)

FIU Year 1 Research Highlights & Accomplishments:

- Completed adsorption kinetic studies and determined pertinent kinetic parameters for select sorbent media using the Pseudo-first order (PFO) and pseudo-second order (PSO) kinetic models.
- PAC, FeS+PAC, Sorbster, Si-thiol exhibited rapid adsorption of Hg^{2+} within 10 min
- A conference abstract titled “Sorbent-based technology for mercury remediation in a freshwater aquatic system” was submitted to American Geophysical Union Fall meeting to be held in December, 2021.

$$Q_t = Q_e\left(1 - e^{-k_1 t}\right) \Rightarrow \text{PFO}$$

$$Q_t = \frac{Q_e^2 k_2 t}{1 + k_2 Q_e t} \Rightarrow \text{PSO}$$



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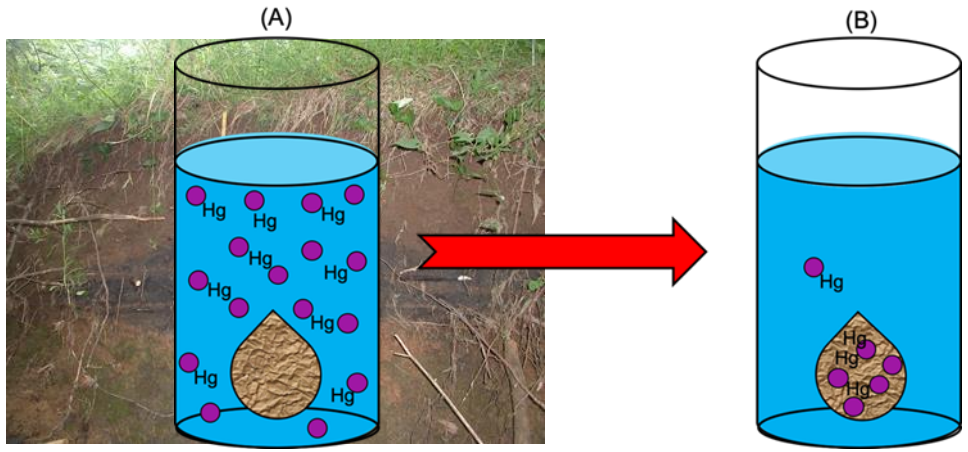
Task 7:Engineered Multi-Layer Amendment Technology for Hg Remediation on Oak Ridge Reservation (NEW)

FIU Year 2 Projected Scope

- Perform isotherm studies to determine the adsorptive capacity of select sorbent media in artificial creek water (ACW) and ACW amended with dissolved organic matter (DOM).
- Evaluate mercury species dynamic under conditions representative of EFPC using Geochemist Workbench program
- Characterize pristine and treated sorbent using microscopy and spectroscopy techniques (SEM-EDS and XRD analysis)



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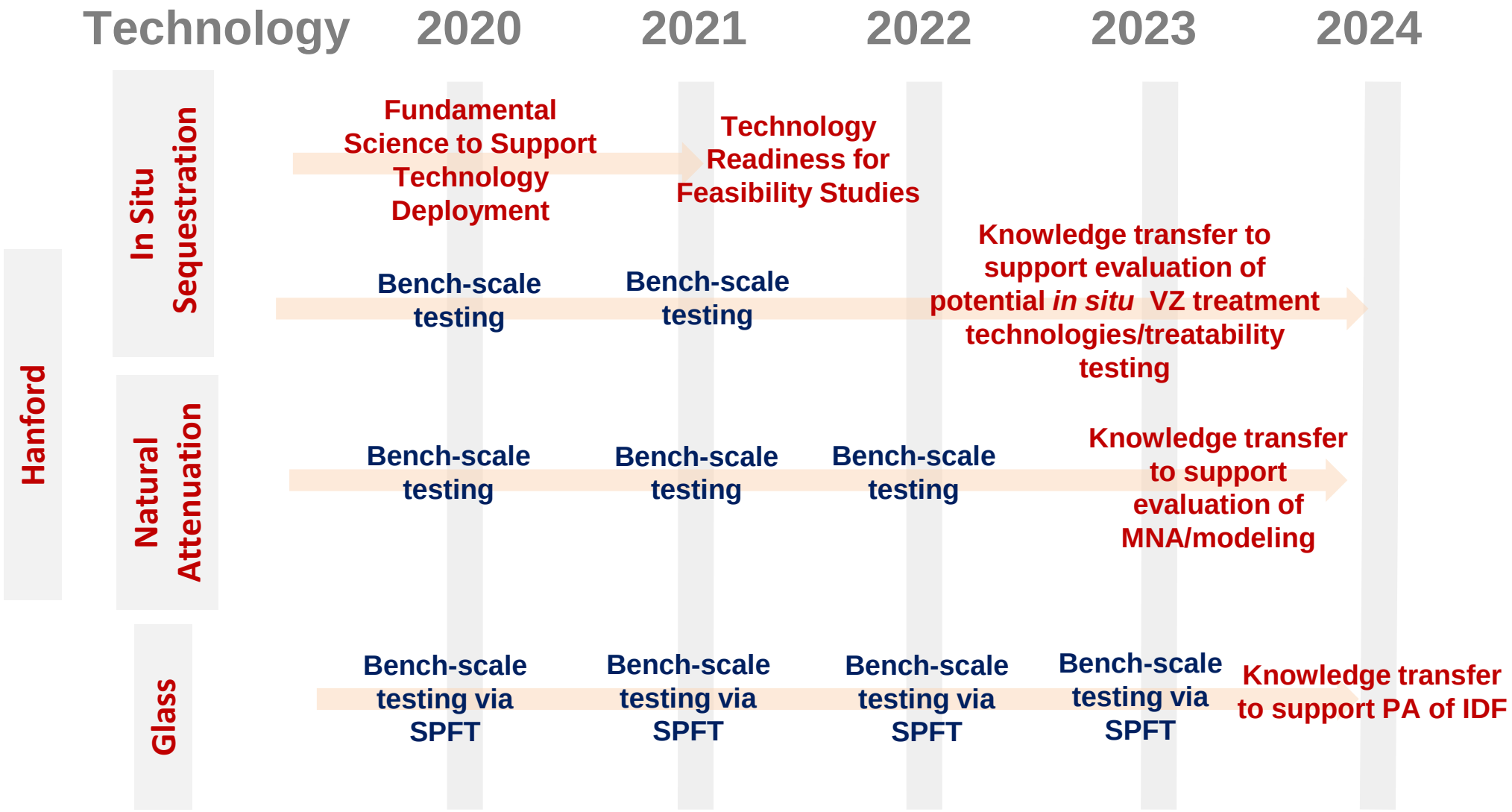
Technology Development and Deployment Road Map



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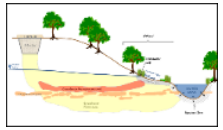
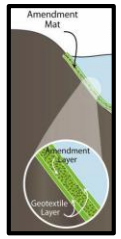
Technology Development and Deployment Road Map

Technology	2020	2021	2022	2023	2024
SRS	Environmental factors controlling contaminants at SRS  Bench-scale experiments	Bench-scale experiments	Bench-scale experiments	Knowledge transfer for long term monitoring	
SRS	Evaluation of Humic Acid for uranium sequestration  Bench-scale experiments	Knowledge transfer for long term monitoring			
Mercury ORNL	 Conceptual Design of Technology	Sorbents Development	In-house Testing	Site Testing	Site Deployment of Technology
WIPP	 Knowledge Development	Development /Testing	Development /Testing	Development /Testing	Knowledge Transfer

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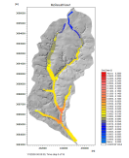
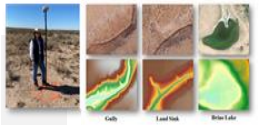
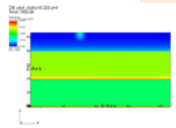
Technology Development and Deployment Road Map

Technology	2020	2021	2022	2023	2024
SRS	 Tims Branch: Integrated SW/GW Model Calibration	Sed. Transport Model Calibration/ Validation	Contaminant Transport Model Calibration/Validation	Contaminant Transport Model Calibration/Validation	Model Implementation/ Hand-over
SRS	 Fourmile Branch: Conceptual Model Dev't	Conceptual Model Dev't	Integrated SW/GW Model Dev't & Calibration	Sed. & Contam. Transport Model Calibration/ Validation	Model Implementation/ Hand-over
SRS	 DEM, BASIN 6: Pilot Study DEM dev't	Basin 6 DEM dev't	Basin 6 DEM Hand-over		
SRS	Amanzi-ATS LSM, Basin 6: Numerical Model Assessment	Numerical Model Dev't	Numerical Model Dev't	Model Implementation/ Hand-over	
WIPP	 ASCEM GWM, Basin 6: Numerical Model Dev't	Numerical Model Dev't	Model Implementation/ Hand-over		
WIPP			ASCEM GWM, WIPP (Nash Draw): Numerical Model Dev't	Numerical Model Dev't & Calibration	Model Implementation/ Hand-over
WIPP			LSM, WIPP (Nash Draw): Conceptual & Numerical Model Dev't	Numerical Model Dev't & Calibration	Model Implementation/ Hand-over

*DEM: Digital Elevation Model, LSM: Land Surface Model, GWM: Groundwater Model

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Thank You. Questions?