

KRCEE Third Quarter DOE Report

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1. UK-KWRRI DOE Earmark Administration & Short-Term Project Quarterly Report

November 4, 2004

Project Title

KRCEE Administration & Short Term Projects

Project Goals

- Respond with research, review, and recommendations to DOE short-term project requests
- Coordinate, supervise, and integrate KRCEE-DOE earmark project activities

Project Team/Member Roles/Tasks

Dr. Lindell Ormsbee/Director, KRCEE-UK. Direct KRCEE-DOE earmark activities.

Steve Hampson/Asst. Director/KRCEE-UK . Program and daily activity lead.

Dr. John A. Volpe/KRCEE Contractor. Provide technical and regulatory expertise for KRCEE-DOE earmark projects.

Jim Kipp/Associate Director KWRRI-UK. Provide administrative and technical support for KRCEE-DOE earmark activities.

Edwin Ebrahimi/KRCEE Financial Officer - UK . Provide support for KRCEE-DOE earmark financial activities.

Anna Hoover/KRCEE-UK. Administrative support.

Project Status

Projected Completion Date

September, 2006

Percentage Completion to Date

Contractual arrangements with faculty and staff Project Teams that will conduct long-term projects related to Phase I DOE earmark activities at PGDP are **95%** completed.

100% of the short term projects requested by DOE to date have been completed. Because short-term projects are not scoped in advance no percentage completion is applicable.

Project Activity Status Summary

- Participated in quarterly activity meeting with DOE PPO August 2004.
- Completed contracting for Phase I Surface Water / Sediment Control with Dr. Warner/UK Agricultural Engineering.
- Continued reference document and PGDP project document digitization & uploads to ftp site.
- Conducted 2nd quarterly meeting with KRCEE-DOE Project Teams July 2004.
- Discussed site access requirements for Holocene Issues Project Team with DOE July – Sept 2004.
- Conducted field reconnaissance of seismic lines and Little Bayou Creek seeps with UK-Gly Sciences and KGS August 2004
- Meeting with GW Project Team at U of L to refine work efforts related to SnT data assessment and release characterization May 2004.
- Completed 2nd quarterly report for distribution July 2004
- Completed and distributed Phase II KRCEE-DOE earmark scope of work July 2004
- Developed Field Sampling and Analysis Plan for WKWMA drill site July 2004
- Coordinated field sampling and laboratory analysis of WKWMA drill site volatile and radiation samples July 2004.
- Collected, shipped, and obtained analyses for characterization of ⁹⁹Tc and TCE contamination at WKWMA Drill site April – May 2004.

- Prepared WKWMA Drill Site Report summarizing laboratory results for field samples
- Discussed ULF Holocene Displacement Investigation with Wm. Lettis & Associates, Miller Drilling & obtained initial cost and contract proposals July 2004.

Project Path Forward

TASK (completion date)

- KRCEE-DOE earmark-wide Project Team meeting (11/04)
- Meeting with DOE to discuss project needs (11/04)
- Develop HASP, QAPP, SAP templates for earmark-wide project use (10-11/04)
- Finalize validation of USEC market-available Nickel analyses, write and distribute report (10-11/04)
- Finalize & Distribute Nickel Background report (10-11/04)
- Meet with Bechtel-Jacobs regarding access requirement for ULF Holocene Project (11-12/04)
- Obtain cost estimate from ITR and Project Team, Drilling, and Field Oversight contractor participants (11-12/04)
- Kick off NDA (Phase II) project planning (11/04)
- Meet with DOE about NDA and SWOU implementation (11/04)
- Develop NDA scope and present to CAB and EPPC (11/04).
- Submit Holocene Project sub-contract information to SPA for approval (11-12/04).
- Continue work on SnT data analysis (10-12/04)

2. UK-Paducah Chemical Engineering Uranium Battery Project Quarterly Report

July 2004

Project Title

Development of Depleted Uranium Batteries

Project Goals

- Construct a battery with uranium dioxide as the cathode following characterization of uranium dioxide's electrochemical properties in various organic solvents/lithium salts commonly used in commercial battery industry.
- Manufacture uranium-lithium compounds to mirror the construction of manganese-lithium compounds commonly used in commercial batteries and characterize their electrochemical behavior in common organic solvent/lithium salts.
- Construct a battery consisting of lithium-uranium dioxide.

Project Team/Member Roles/Tasks

Dr. Paul Dunbar/Asst. Professor of Chemical and Materials Engineering-UK Paducah, **PI**. Perform electrochemical testing on experimental uranium-lithium cells.

Dr. Rhonda Lee/Assistant Professor of Chemical and Materials Engineering-UK Paducah, **Co-PI**. Perform electrochemical testing on experimental cells and make lithiated uranium compounds.

Dr. Stephen Lipka/Center for Applied Energy Research-UK, materials science consultant for electrochemical cell assemblage and data interpretation.

Walter Tracinski/Applied Power International. Lithium battery expert who will construct prototype batteries.

Graduate Student Technician to perform daily repetitive experiments.

Project Status

Projected Completion Date

September, 2005

Percentage Completion to Date

40%

Identification of major project tasks

- Conducted lithiated uranium experiments in a muffle furnace. It has become clear that our goal is to produce a lithium uranium compound with uranium having a +4 valence. This should be a battery active material that allows lithium intercalation.
- It has also been determined that reactions need to be performed in a tube furnace under a reducing atmosphere to produce the needed compound Li_2UO_3 . This compound has a +4 valence (See reaction 7 below).
- The following reactions have been performed and x-ray diffraction studies are underway to characterize the compounds.

Rxn 1: UO_2 1.10g (4.1mmol) Rxn 2: UO_2 1.38g (5.2mmol)

$\text{LiOH}\cdot\text{H}_2\text{O}$ 0.35g (8.3mmol) Li_2CO_3 0.38g (5.1mmol)

Reactants were ground together with a mortar and pestle, transferred to separate quartz crucibles, and calcined according to the following profile.

Step 1: Heat to 450 °C at 2 °C/min

Step 2: Soak at 450 °C for 1 hour

Step 3: Ramp to 650 °C at 2 °C/min

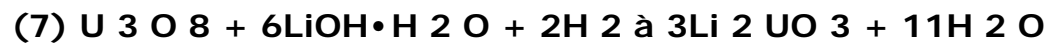
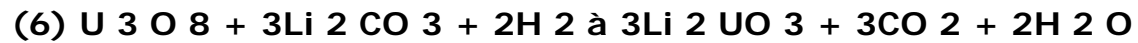
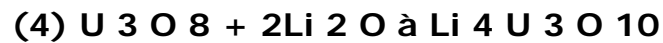
Step 4: Soak at 650 °C for 3 hours

Step 5: Turn oven off and allow to cool overnight.

Rxn 3: Rxn 4:

U_3O_8 1.70g (2.04mmol) U_3O_8 1.62g (1.94mmol)

$\text{LiOH}\cdot\text{H}_2\text{O}$ 0.17g (4.05mmol) $\text{LiOH}\cdot\text{H}_2\text{O}$ 0.49g (11.7mmol)



- Electrochemical measurements were delayed until the electrochemical cell could be duplicated, and test circuits for the frequency response analyzer manufactured. These tasks were completed and now measurements can be continued.

Project Path Forward

Laboratory work related to the project will continue in October - December 2004.

3. Murray State University Surface Water Modeling & TMDL Quarterly Report

KRCEE-DOE Quarterly Progress Report

October 25, 2004

Project Title

Surface Water Characterization and TMDL Development for the Paducah Gaseous Diffusion Plant and Associated Impaired Creeks

Identification of Project Goals

The project has two major goals as follows:

1. Hydrologic characterization of the PGDP area including a water budget analysis of the PGDP facility. Characterization will include the development and calibration of continuous simulation hydrologic models for the Bayou and Little Bayou creek watersheds using the HSPF watershed model or other appropriate tools.
2. Development of Total Maximum Daily Loads (TMDLs) for each creek. Constituents of concern for Bayou Creek are iron, lead, copper, mercury, and Tc-99. Constituents of concern for Little Bayou Creek are iron, lead, copper, and Tc-99.

Identification of Project Team

Mike Kemp, Ph.D./Murray State University, Department of Industrial and Engineering Technology, Principle Investigator (PI) – overall project administration, budget and schedule control, coordination with UK project management, primary lead on TMDL development, emphasizing water quality.

Andy Kellie, Murray State University, Department of Industrial and Engineering Technology, Co-PI – primary lead on hydrologic model development and calibration, secondary lead on TMDL development, emphasizing water quantity.

Jane Benson, Murray State University, Center for Reservoir Research and Department of Geosciences – Technical support on geographic information system operations and hydrologic model development and calibration.

John Hart, Murray State University, Department of Industrial and Engineering Technology – Technical support on computer systems hardware and software, network management, and field monitoring instrumentation and equipment acquisition, installation, and operation.

Matt Philips, Murray State University, Environmental Engineering Technology – student technical support on hydrologic model data entry and water quality data analyses.

Mike Matthews, Murray State University, Environmental Engineering Technology – student technical support on hydrologic model data entry and water quality data analyses.

Tammy Boyd, Murray State University, Department of Geosciences – student technical support on hydrologic model data input.

Identification of Major Project Tasks

(% Completion) (Projected Completion Date):

Hydrologic Model Development and Calibration (40%) (02/05)

1. Acquire Existing Plant Outfall and Creek Flow Data (80%) (12/04)
2. Acquire Model Input Existing Data (70%) (12/04)
3. Preliminary Model Development (60%) (12/04)
4. Initial Model Calibration (20%) (12/04)
5. Install Flow Measurement Equipment If Needed (0%) (2/05)
6. Calibrate Model Based on Actual Measurements (15%) (2/04)

TMDL Development (25%) (7/05)

1. Acquire Existing Water Quality Data (80%) (12/04)
2. Identify Waste Sources (60%) (12/04)
3. Input Model Mass Loadings to Model (0%) (2/05)
4. Allocate Mass Loadings (0%) (4/05)
5. Final Model Calibration and Long Term Run (0%) (7/05)

Task Summary and Significant Findings

1. General. A site inspection was conducted to assess the feasibility of adding a gaging station for the combined flow of Little Bayou and Big Bayou creeks between the confluence and the discharge at the Ohio River. Access is difficult, and the confluence may be too close to the Ohio River to prevent backwater effects. Further discussion is required. Work on the hydrologic model and development of TMDLs was slowed due to the time required to exhaustively extract OREIS data. Furthermore, the data are somewhat sporadic and substantial gaps exist at some sampling locations. Data mining is essentially complete, however, and work has progressed towards identification of potentially problematic waste streams and stream reaches that might be of most concern. Work on the overall water budget is proceeding slowly. Anecdotal information indicates that even though the water treatment plant has the capacity to process 30 MGD, typical production is less than 15 MGD. Detailed production reports have not been obtained.

2. Hydrologic model. Work on the hydrology of Bayou and Little Bayou Creeks continued this quarter. The objective of this work was to compute 7Q10 flows for both creeks. This was hampered by limited gaging data on the three gaging stations on these watersheds (03611800 and 03611850 on Bayou Creek and 036 11900 on Little Bayou Creek). Historic gaging data were available as follows: 03611800, 7 years (10/1/1996 to 9/30/2003; 03611850 and 03611900, 6 years, (10/1/1996 to 9/30/2002).

To augment these limited data sets, the procedures specified by Riggs (1972) were employed. This involved development of the mathematical relationship between gaging data for Bayou and Little Bayou Creeks and Massac Creek, a gaged watershed immediately east of Little Bayou Creek. Using the historic gaging data, minimum seven day flows were computed for each month and year for which data were available on Bayou Creek and Little Bayou Creek and for the most recent 20 year period on Massac Creek. The mathematical discharge relationships between each short term gages on Bayou Creek and Little Bayou Creek and the long term gage on Massac Creek were determined by regression analysis. This yielded equations relating flows on Bayou Creek and Little Bayou Creek to flows on Massac Creek.

Available gaging data for Bayou Creek and Little Bayou Creek were augmented by flow data based on the regression equations described above to generate yearly minimum flows for a 20 year period at each gage. At each

gage location, these data were ranked and a recurrence interval computed using the relationship

$$R.I. = (n + 1) / m \dots\dots\dots(1)$$

where R.I. = recurrence interval; n = number of years; and m = order number (rank).

Plotting discharge over recurrence interval yielded the seven day discharge curve. Regression analysis was used to obtain the curve equation at each gage, and from those equations the 7Q10 flow at each gage was computed. The results will be presented at the quarterly meeting.

3. TMDL development. Water quality and flow data for the plant outfalls and the surface water sampling sites have been retrieved from OREIS and annual environmental status reports. The data are sporadic, but the average annual concentrations of total hardness and all parameters of concern except Tc-99 have been summarized for each sampling location for the period from 1987 through 2004. Mass loadings have been computed for all parameters but Tc-99 based on average concentrations and average flow measurements at each of the sampling locations. For comparison, possible chronic toxicity water quality limits were calculated using average total hardness values for those parameters where appropriate. These data are presented in Excel files attached to this report. Work is underway to precisely locate the outfall and surface water sampling locations on a digital map and to graphically summarize the water quality data on the digital map.

References Cited

Riggs, H.C. (1972). Low-Flow Investigations . Chapter B1, Book 4, Hydrologic Analysis and Interpretation, Techniques of Water-Resources Investigations of the United States Geological Survey, U.S. Government Printing Office, Washington, D.C.

4. University of Louisville Groundwater & Burial Ground Project Report

October 25, 2004

Project Title

Evaluation of technology characterization for soils, landfills and groundwater, Part 1 (concentration of S and T landfills)

Project Goals

- Review & evaluate existing groundwater information/documents/data for the PGDP.
- Identify data gaps and provide recommendations for improvements in groundwater monitoring
- Provide updated recommendations relative to applicable groundwater technologies
- Evaluate landfill/burial ground information/documents/data for the PGDP.
- Provide summary of releases, release potential
- Provide BEP/BMP monitoring & remediation recommendations for landfills and burial grounds.

Project Team/Member Roles/Tasks

Dr. D. J. Hagerty/CEE Department-UL , Co-PI. Coordinate activities with KRCEE and project team colleagues, conduct document review, prepare comments, evaluate adequacy of characterization efforts to date.

Dr. James C. Watters/ChE Department-UL, Co-PI.

Rebecca Thompson/ChE Department-UL, Research Assistant . Conduct document reviews, prepare comments, evaluate adequacy of characterization efforts to date, coordinate activities with KCEE colleagues

Nick Uhl/CEE Department-UL – Research Assistant. Conduct document review, prepare comments, evaluate adequacy of characterization efforts to date, coordinate activities with KCEE colleagues

Project Status

Percentage Completion to Date

Projects and significant project tasks are identified below along with the percentage completion and the projected completion date as follows.

Project Tasks

(% Completion)(Projected Project Completion Date)

1. Landfill waste characterization and source evaluation (85%) (2/1/2005)

- Project 1A : Characterize the wastes in the S&T landfill and in other landfills on the PGDP site.
- Project 1B: Evaluate mobility of contaminants in the S&T Landfill and in other PGDP landfills and the likelihood that contaminants from PGDP landfills have entered the groundwater flow system, or the surface water flow system.
- Project 1C: Evaluate the collected data on site conditions and groundwater flow around the PGDP landfills to assess the adequacy of that data in identifying sources of contaminants and portraying concentration zones of those contaminants.

2. Groundwater Management/Remediation (35%) (12/31/2004)

- Project 2A: review and critique the process by which prior decisions were made relevant to groundwater remediation.
- Project 2B: Assess changes in technologies that were evaluated previously, and investigate new remediation technologies and/or new combinations of remediation technologies.

3. Surface Soils and Sediment Evaluation (0%) (9/30/2005)

- Project 3: Perform comprehensive review of collected data, identify zones of contaminated soils and sediments that require management, and recommend appropriate management strategies.

Project Activity Status Summary

An ongoing effort is directed at plotting all of the monitoring wells on the base maps, using Surfer. In order to plot all the wells, data previously mined for chemical characteristics of groundwater was revisited to obtain coordinates of all the wells. That mining is being completed, and data from the tests on samples from the monitoring wells will be displayed on the base

maps, for different sampling events. A different set of maps is being prepared for the various baseline sampling events, to reflect conditions in the upper third, middle third and lower third of the RGA. There is considerable overlap of data which requires this type of sorting. The new Excel files posted on the FTP site in August have not been assimilated yet.

The assessment of remediation processes has been developed against a broader perspective provided by a team meeting on August 16, 2004. In particular, several leads have been pursued, including the results of the study described in the article, "Chlorine Isotope Investigation of Natural Attenuation of TCE in an Aerobic Aquifer." The review of the remediation technologies selection process has also been improved by more information about the general types of passive reactive barriers and the various treatment media used with these barriers. Information provided by the project coordinator, Mr. Hampson, was very useful in expanding the research on full-scale studies of remediation techniques. From the FTP site, data were downloaded on remediation technologies used at the Portsmouth, Ohio, plant, and included in the review. Attention is being focused on the use of six-phase heating, as was recommended for the Paducah site.

Project Path Forward

- Compile/assess new OREIS database data to obtain the most up to date monitoring information for the SnT and U Landfills (Task 1A & B).
- Develop cross-sections depicting physical conditions underlying the SnT and U landfills reflecting the relationships of well screens to lithology, each other, and NSDD (Task 1A & B).
- Develop isoconcentration maps for select contaminants at SnT (Task 1A & B).
- Develop temporal contaminant trends for each well at SnT (Task 1A & B).
- Develop isococcentration trend maps at SnT (Task 1A & B).
- Finish Review ITRD report (Task 2A & B).
- Continue literature review of applicable technologies (Task 2A & B).

5. UK/CE Groundwater Modeling Project Quarterly Report

October 25, 2004

Project Title

Groundwater Modeling

Identification of Project Goals

- Evaluate the adequacy of existing groundwater models at the site.
- Recommend necessary improvements to the models.
- Conduct Sensitivity analyses for CAB/PGDP GW modeling team Water Budget Items
- Evaluate the potential use of natural attenuation for addressing off-site dissolved phase groundwater contaminants.
- Use the models to evaluate the efficiency of proposed groundwater remediation plans.

Project Team/Member Roles/Tasks

Srinivasa Lingireddy, Ph.D./Associate Professor of Civil Engineering/UK– PI. Coordinate the team activities, recruit and direct graduate students and post-doctoral scholars to help with the modeling efforts, prepare quarterly reports.

Steve Hampson, Assistant Director/KRCEE – Project Manager

Dr. Lindell Ormsbee, Director, KRCEE-UK. . Technical Advisor

Dr. Joe Hagerty, Professor of Civil Engineering, UL. Provide technical consultations and expert opinion on modeling activities

Prasad Manthana, Graduate Student, Department of Civil Engineering, Univ. of Kentucky.

Jim Kipp, Associate Director/KWRRI, Provide technical and administrative support

Project Status

Projected Completion Date

September, 2005 for existing tasks, additional time and tasks are expected as part of Phase I activities

Percentage Completion to Date

Identified with project tasks below.

Project Activity Status Summary

Activity(% Completion)(Projected Project Completion Date)

- Finalize reviews, evaluations, and recommendations from ongoing UK groundwater modeling activities for the PGDP site. (80%)(2/1/2005)
- Provide modeling assessment for a range of groundwater remedial approaches including natural attenuation, hydraulic containment, pump & treat, and source/dissolved phase removal/treatment. (30%) (06-30-2005)
- Provide modeling assessment for the efficiency and expected performance of proposed groundwater remediation plans. (30%) (9-1-2005)
- Provide an assessment of the adequacy of the USACOE web-based groundwater model for the PGDP. (0%) (9-30-2005)
- KRCEE discussed joint project with DOE contractors Navarro, Bechtel Jacobs, and SAIC (9/2004)
- Meeting with USACOE for overview of the FEFLOW model will be scheduled following DOE decision to include DOE contractors in joint project.
- Provide sensitivity analyses for Water Budget items identified by PGDP CAB and PGDP GW modeling team. (40%) (7/1/2005)
- Develop MS EXCEL macro for PGDP data evaluation relative to #analyses, # detects, # analyses exceeding health/regulatory/background thresholds. (70%) (1/2005)

Project Path Forward

Activity (Date)

- Complete MS EXCEL data macro (10/04-1/05)
- Continue GW Modeling (PGDP) Team sensitivity analyses (10/04 – 9/05)

- Continue model natural attenuation simulations (10/04 – 9/05)
- Obtain and verify groundwater withdrawals from TVA & vicinity (1/05)
- Evaluate boundary condition effects on current vicinity & SWMU scale models (9/04 – 12/04)
- Begin simulations and documentation of groundwater conditions when plant activities cease under a number of possible remedial scenarios with consideration of parameter sensitivity analyses (7/04 – 12/04)

Significant Findings

Precise estimation of inflows and outflows (water balance) to the groundwater model is essential for accurate prediction of contaminant transport. There are numerous/diverse inflows and outflows relative to the model and precise measurement of these quantities are often difficult and expensive to obtain. Prior to incurring expense for field data collection and measurement for the inputs/outputs, sensitivity analyses are being conducted to determine the sensitivity of the model to changes in particular inflow/outflow values. In this context, use of sensitivity analysis was employed to help pinpoint the data that influences short and long-term contaminant transport significantly in model output. The project team has identified the following tasks towards water balance related sensitivity analysis.

- Pumping at TVA Shawnee Plant
- River stage changes
- Recharge rates
- Plant recharges (lagoons)
- Rain recharges
- Leakage along the pipeline
- Plant shut down scenario
- No outflow to Little Bayou Creek
- Reduced outflow to Big Bayou Creek
- Several other tasks as identified at the water budget analysis meeting

The results from the sensitivity analyses were compared to the results from a baseline transport model acquired by the PIs. Some of the important characteristics of the baseline model are listed in the following.

- Calibrated model based on 1998 data
- 1st stress period – 10years
- 2nd stress period – 20years
- Normal rainfall and plant recharge
- Pumping rates at TVA Shawnee plant not included
- Ohio river stage changes from 300ft in 1st stress period to 306ft in 2nd stress period

Based on the sensitivity modeling results, it is clear that none of the parameters tested (Shawnee/DOE plant pumping rates, Ohio River stage, rainfall recharge, and plant recharge) seem to influence the TCE transport significantly.

A concerted effort, utilizing C++ and MS EXCEL, has been made to develop a spreadsheet macro that will enable investigators to evaluate groundwater data from individual monitoring wells and groundwater data sets relative to # samples, # analyses, # detects, health thresholds, regulatory thresholds, and background. Initial runs of the macro on SnT Landfill monitoring well groundwater data indicate that the macro, while still requiring some refinement, is nearing completion. Once investigators are satisfied that the macro handles groundwater data effectively it will be adapted to evaluate surface water, soil and sediment monitoring data.

6. UK-Paducah Chemical Engineering Nickel Project Quarterly Report

October 25, 2004

Project Title

Purification and Recovery of Radiologically-Contaminated Metals.

Projected Completion Date

October, 2004

Percentage Completion to Date

90%

Project Goals

- Investigate the radiological characteristics of market available Nickel
- Investigate the application of chemical vapor deposition (CVD) technology for the removal of radionuclides from radioactively-contaminated metal waste.
- If CVD is a viable method of purification, design and test a laboratory-scale reactor or evaluate demonstration of industrial scale reactor.
- Evaluate industrial-scale reactor for recovery of existing stockpiles of nickel waste.
- If CVD technology does not prove to be a suitable method for purification of radioactively-contaminated metal waste, explore use of electro-refining (ER) technology as a method of purification.
- If ER technology proves to be a viable method of purification, design and test laboratory-scale reactor
- Evaluate industrial-scale reactor for recovery of existing stockpiles of nickel waste.

Project Team/Member Roles/Tasks

Dr. Jim Smart /UK-Paducah Engineering, PI. Conduct background research, prepare experimental plan, interpret experimental results, prepare project reports, and coordinate budget.

Dr. Fuqian Yang/UK-College of Chemical & Materials Engineering, co-PI. Consult with PI to plan/interpret experimental plan. Assist in preparation of documents.

TBA – Post-Doctoral Fellow, to be hired. Retrofit existing CVD equipment. Run experiments and assist in preparation of documents.

Project Activity Status

Project Task (% Completion) (Projected Project Completion Date)

- Attend PACRO meetings about salvage of volumetrically contaminated Ni ingots at PGDP (80%) (10/03-9/04)
- Identify Nickel refiners and suppliers (100%)(9/03 – 10/03)
- Nickel powder and barstock obtained from three different U.S. Ni suppliers (100%)(10/03)
- Participate in meetings to develop laboratory analytical methods (100%)(9/03 – 10/04)
- Obtain & review CVD technology information (100%)(9/03)
- Raw material samples distributed to UK-Chem & Materials Engineering for standard laboratory preparation (100%)(10/03 - 11/03)
- Prepared laboratory samples obtained from UK-Chem & Materials Engineering (100%)(10/03 - 11/03)
- Track sample analyses (100%)(12/03 - 9/04)
- Complete review of validated CHS-REMS radiation lab and USEC virgin nickel radioisotope analyses (100%) (9-10/04).
- Identified graduate student and external consultant to become project participants (7-9/04)(100% complete).
- Process flow diagram for laboratory CVD reactor system complete (100% complete)(8/04).
- Literature and patent searches regarding background of previous or existing CVD operations is complete (7/04)(100%).

Project Path Forward

- Complete independent QC of laboratory analytical data from USEC (9/04)

- Compile & Evaluate Data & Write report summarizing laboratory findings (9/04 – 10/04)
- Attend CVD bench-scale demonstration in Va./W. Va. (VENDOR DECLINED TO ALLOW PARTICIPATION. KRCEE WILL NEED THE ASSISTANCE OF DOE AND PACRO IN ORDER TO OBTAIN PERMISSION FOR KRCEE OVERSIGHT PARTICIPATION IN THE CVDR PILOT TEST)
- Evaluate CVD Bench Scale Results from Vendor (TBD)
- Conduct Bench scale studies at UK using basic CVD technology application (6/05+)
- Order and setup laboratory CVD reactor system
- Bring UK CVD reactor on-line (TBD).
- Operate reactor system with nickel powder and optimize operating conditions. Get comfortable using ICP analytical test method to monitor purity of nickel product.
- Dose virgin nickel powder feedstock with appropriate surrogate contaminant to simulate recovery conditions.

Significant Findings :

1. Graduate student has been conducting literature and patent searches regarding chemical vapor deposition (CVD) of nickel. He is also getting familiar with all safety precautions surrounding the CVD process and formation of nickel carbonyl. Various analytical procedures (x-ray diffraction, ICP, AA, microscopy techniques, etc.) has been evaluated for best method to analyze for low levels of contaminants in purified nickel product.
2. An external CVD expert (Richard Westfall, Galactic Mining, Inc.) has been hired to provide background and advice regarding setup of initial laboratory testing.
3. A process flow diagram for laboratory testing has been prepared. Vendors for all equipment have been identified and a price/delivery schedule has been completed.

Implications/conditions that affect project:

- Need to identify what surrogate metal is a likely non-hazardous candidate for simulated recovery testing. Technetium-99 (Tc-99) is the primary radionuclide contaminant to be studied in the recovery of radiologically-contaminated metals. A non-hazardous metal will be identified and used in place of Tc-99 in initial laboratory testing.
- NEED TO OBTAIN SUPPORT OF DOE AND PACRO TO PARTICIPATE IN THE OVERSIGHT OF THE PILOT CVD DEMONSTRATION BEING CONDUCTED BY THE DEPARTMENT OF THE NAVY AND THE CVDR CORPORATION.

7. UK Chemical Engineering Nickel Project Quarterly Report

October 25, 2004

Project Title

Background research & chemical engineering evaluation of technologies for the removal of ^{99}Tc from volumetrically contaminated metals.

Projected Completion Date

June 30, 2004.

Percentage Completion to Date

100%

Project Goals

- Provide standard preparation of market available Ni for distribution to laboratories conducting analyses.
- Investigate the chemical/physical characteristics ^{99}Tc
- Evaluate market uses of Nickel
- Identify market uses where slightly volumetrically contaminated Ni might be utilized
- Conduct a thorough research & review effort to identify documented removal methods for ^{99}Tc from volumetrically contaminated material.
- Provide recommendations for bench scale study to evaluate removal of ^{99}Tc if processes other than commercially available CVD or electrochemical refining are promising.

Project Team/Member Roles/Tasks

Dr. Eric Grulke/UK-Chemical & Materials Engineering, PI. Lead project efforts.

Louie El Asami/UK-Chemical & Materials Engineering, Graduate Research Assistant. Conduct daily research & investigative efforts.

Dr. Lindell Ormsbee/Director, KRCEE-UK. . Technical Advisor.

Dr. John A. Volpe/KRCEE Contractor. Provide technical and regulatory expertise for radioactive material issues.

Steve Hampson/KRCEE. General project support.

Project Activity Status

Project Task (% Completion) (Projected Project Completion Date)

- Provide standard preparation of market available Ni for distribution to laboratories conducting analyses. (100%) (11/03)
- Meetings with project team to discuss chemistry, removal, and release issues (100%) (10/03, 11/03, 2/04, 6/04, 8/04, 9/04, 10/04)
- Conduct research into documented removal technologies (100%) (6/04)
- Identify promising technologies for removal (100%) (6/04)

Project Path Forward

Activity (completion date)

- Distribute final report (11/04)*

*Report recommends further investigation for promising distillation technology and will be distributed during November 2004.

Significant Findings

Chemical properties of ^{99}Tc and its properties associated with other materials are poorly distributed and not readily available if documented.

Russian research and obscure DOE-complex research have indicated that some simple chemical-physical processes that are less complex than CVD are likely to be successful for the removal of ^{99}Tc from volumetrically contaminated metal.

Bench-scale testing to verify ^{99}Tc properties and removal from metal matrices are being developed and preliminary testing should be conducted beginning in early CY 2005.

BASED ON THE FINDINGS FROM THIS PROJECT TEAM'S COMPLETION OF WORK, A RESEARCH AND DEVELOPMENT PROJECT FOR THE DEVELOPMENT OF $^{99}\text{Tc}/\text{Ni}$ DISTILLATION-SEPARATION PROCESS WAS INITIATED IN AUGUST 2004 AS PART OF KRCEE PHASE II ACTIVITIES.

8. UK – KGS & Geological Sciences Seismic Monitoring and Seismic Hazard Assessment Quarterly Report.

October 25, 2004

Project Title

Enhancing Earthquake Monitoring and Assessing Seismic Hazard for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*

**In budget information, earthquake monitoring and assessing seismic hazards are distinguished as separate projects. However, the co-PI's are the same individuals and the funding for these seismic-related projects was split between the co-PI's respective institutions - the UK-Kentucky Geological Survey and the UK-Department of Geological Sciences.*

Projected Completion Date

October, 2005

Percentage Completion to Date

50%

Project Goals

- To better monitor and locate earthquakes in the area
- To provide an independent and peer reviewed ground motion hazard assessment for the Paducah Gaseous Diffusion Plant (PGDP).

Project Team/Member Roles/Tasks

Dr. Zhenming Wang, Seismologist and Section Head (Geological Hazards)

Kentucky Geological Survey, University of Kentucky, Co-PI

Dr. Edward W. Woolery, Assistant Professor, Department of Geological Sciences

University of Kentucky, Co-PI.

Dr. John Kiefer, UK/KGS. Project Team member.

Jim Kipp, Associate Director, UK/KWRRRI. Project Team member.

Dr. Lindell Ormsbee, Director, KRCEE-UK. . Project Team member.

Steve Hampson, UK/KRCEE. General project management.

Project Activity Status

Project Task (% Completion) (Projected Project Completion Date)

Task 1. Installation of seismic stations in Jackson Purchase to enhance the existing seismic system network allow for monitoring of area micro-seismicity and the collection of seismic data directly related to and needed for ongoing and future DOE-PGDP activities.

- Identify new seismic station locations in the area (100%)(04/04)
- Contract driller for PGDP seismic station installation in WKWMA (100%) (3/04)
- Install WKWMA boreholes (100%) (4/04-8/04)
- Order PGDP seismic instruments (100%) (1/04)
- Completed installation seismic station at Paducah Airport (8/04)
- Completed installation seismic station in Lovelaceville (8/04)
- Prepared seismic instruments for the station at WKWMA (100%) (9/04)
- Prepare the site for installation at WKWMA (25%) (8/04-10/04)
- WKWMA seismic station installation (50%)(11-12/04)

Task 2. Thorough literature review: There are many new developments and data in seismic hazard assessment methodology, geology, and seismology locally, regionally, and nationally. The focus will be on the new geological and geophysical investigations in the area. The literature review will ensure the use of the best data and methodology for PGDP seismic related activities.

Task 3. Seismic source Characterization: Based on the information derived from Task 1 and 2, the seismic sources in and around PGDP and their characteristics will be defined.

Task 4. Probabilistic seismic hazard analysis (PSHA): PSHA will be performed based on the seismic source data from Task 3.

Task 5. Deterministic seismic hazard analysis (DSHA): DSHA will be performed based on the seismic source data from Task 3.

Task 6. Develop Preliminary report.

Task 7. Panel review. A 5-member review panel consisting of national and international experts will be formed to review the preliminary report.

9. UK-Geological Sciences PGDP Stratigraphic Model Project Quarterly Report

October 25, 2004

Project Title

Development of Conceptual Stratigraphic Model for the PGDP.

Projected Completion Date

October, 2005

Percentage Completion to Date

40%

Project Goals

- To develop a detailed, conceptual model of the stratigraphic framework at the PGDP

Project Team/Member Roles/Tasks

Dr. Alan Fryar/UK-Department of Geological Sciences, PI. Conduct background research, oversee collection of existing and field data, integrate data into compatible electronic model, prepare project reports, and coordinate budget.

Dr. Steve Greb/UK-Kentucky Geological Survey, co-PI. Consult with PI to plan/interpret experimental plan. Assist with field work.

Josh Sexton/Graduate Student. Perform daily tasks, organization of data, execution of field work relative to project goals.

Project Activity Status

Project Task (% Completion) (Completion Date)

This project officially started July 1, 2004.

- Participate in PGDP GW Modeling Team quarterly meeting (NA)(3/04)
- Identify existing information (75%)(10/04)

- Identify and recruit graduate student (100%)(4/04)
- Compile lithologic logs from site investigations in a geographic information system (GIS) using ArcView (25%)(9/05).
- Map exposures along Little Bayou and Bayou creeks and their tributaries (25%)(6/05).
- Correlate sedimentary facies in areal and cross-sectional views using ArcView, Surfer, and RockWorks 2002 (10%)(10/05)

Significant Findings

Dr. Greb requested and obtained information regarding the geology of the area from John Nelson at the Illinois State Geological Survey. Josh Sexton reviewed some literature from this correspondence, while other information has not been obtained yet. Dr. Greb also confirmed that the ISGS collected cores near the study area. These cores have not yet been viewed.

Josh Sexton contacted Amos Smith (TVA) and obtained D and MLS series boring logs that were available for the Shawnee Steam Plant on September 30th. These lithologic logs will be added to the current lithologic database for the area. Traci Thompson at the TVA Shawnee Steam Plant was also contacted. Ms. Thompson granted permission on September 20th to schedule a visit to the borrow pits on Shawnee Plant property. This visit will provide additional geologic data in the northeastern section of the site and should help delineate information about the gravel facies cropping out in stream exposures. Tim Kreher (WKWMA) was contacted and has submitted a map of private landowners along Bayou and Little Bayou Creeks. Landowners will be contacted during the next field visit. Josh will obtain a photo badge following a security briefing during the next field visit. Dr. Woolery and Josh met on October 6th and discussed the previous geophysical survey conducted in the area. Dr. Woolery also provided some literature about these surveys during this meeting.

Field Mapping

Josh Sexton and Stephen Greb conducted field mapping on September 18th and 19th. Mapping was focused on gravel facies cropping out along the lower reaches of Bayou and Little Bayou creeks in the WKWMA. During this survey, gravel facies exposures were deemed to have an origin other than the current depositional system. This determination was made by examining clast orientations and relating these orientations to the current fluvial system. The facies viewed in outcrop along both streams is more likely to

have resulted from a single depositional event rather than from two discrete events. Whether this facies represents the Lower Continental Deposits or a reworked alluvial deposit is not yet known. An additional field visit was scheduled for October 22 nd through 24 th but was canceled because rainfall raised the levels of creeks and borrow pits.

Conceptual Model Development

A database has been created consisting of 98 lithologic logs reviewed and selected from published PDGP literature. Logs were selected based upon spatial relationships, depth, and lithologic detail. Additional logs from the TVA Shawnee Plant and published PGDP reports have been selected and reviewed, but have yet to be added to the database. A gross correlation of stratigraphy has been started, but only preliminary correlations have been assigned.

A generalized base map including 7.5 minute (DRG) topographic maps and digital ortho photos has been created. This base map also contains field work locations plotted with hyperlinks to pictures and lithologic logs where important features exist. This preliminary map was constructed for displaying information acquired in the field, but it should be useful for creation of the conceptual model.

10. UK Agricultural Engineering Sediment/Contaminant Release Control Project

October 25, 2004

Project Title

Development and Design of Cost-effective, Real-Time Implementable Sediment and Contaminant Release Controls

Projected Completion Date

September 30, 2005.

Percentage Completion to Date

25%

Project Goals

- Provide soil/surface water/sediment transport model that will accurately predict soil/sediment and associated contaminant trends.
- Evaluate, design, assess and provide recommendations for sw/sediment/contaminant control remedial options that will be cost effective and will be able to be implemented in real time.

Project Team/Member Roles/Tasks

Dr. Richard Warner/UK-Agricultural Engineering, Surface Mining Institute, LLC, PI. Lead project efforts.

Dr. Lindell Ormsbee/Director, KRCEE-UK. . Technical Advisor.

Dr. John A. Volpe/KRCEE Contractor. Provide technical and regulatory expertise for radioactive material issues.

Mike Kemp, Ph.D./Murray State University, Technical Advisor

Steve Hampson, UK/KRCEE. General project support.

Identification major project tasks

(% Completion) (Projected Project Completion Date)

- Obtain and review site maps for relevant environmental and engineering features (30%)(3/05)
- Obtain and review rainfall records for PGDP site and vicinity (75%)(3/05).
- Obtain and review soil, sw, and sediment data for outfalls (30%)(3/05).
- Conduct review effort to identify applicable readily-implementable, cost-effective sw/sediment/contaminant control technologies (30%)(3/05).
- Complete scale evaluation of potentially applicable technologies (30%)(6/05)
- Conduct modeling efforts and evaluate performance of potential technologies (30%)(8/05)
- Provide report and design recommendations for outfalls (0%)(9/05)

Summary of tasks undertaken to date

(Including identification of significant findings and their implications on project goals and end products)

1. Hard copy maps were reviewed to determine location of outfalls, contributing watershed areas, current surface water and sediment control systems, potential current operations with respect to control options, space restrictions for future controls and utilization of ditches for surface water storage and dampening of peak flows.
2. Rainfall records were reviewed for Paducah to determine the frequency of exceeding various design storm events.
3. A coordination meeting was scheduled with the hydrologic team from Murray State University.
4. A study of the use of long-chain polymers for advanced sediment controls is being conducted for KRCEE-PGDP recommendations.
5. Techniques to assess the performance of flocculent as sediment control agents are being conducted.
6. The potential performance of a medium-flow sand filter to retain suspended sediment's being assessed.

11. UK Geological Sciences & KGS Field Determination of S & P Wave Velocities

October 15, 2004

Project Name

Field Determination of S & P Wave Velocities for Ground Motion Model Input at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky
Field Determination of S & P Wave Velocities for Ground Motion Model Input at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Projected Completion Date

October 2005

Percentage Completion to Date

20%

Project Team/Member Roles/Tasks

Dr. Zhenming Wang, Seismologist and Section Head (Geological Hazards)

Kentucky Geological Survey, University of Kentucky, Co-PI

Dr. Edward W. Woolery, Assistant Professor, Department of Geological Sciences, University of Kentucky, Co-PI.

Dr. John Kiefer, UK/KGS. Project Team member.

Jim Kipp, Associate Director, UK/KWRRI. Project Team member.

Dr. Lindell Ormsbee, Director, KRCEE-UK. . Project Team member.

Steve Hampson, UK/KRCEE. General project management.

Project Goals

- To obtain site-specific S- and P-wave velocity field measurements at the PGDP.
- To obtain field measurements of site specific soil damping properties at the PGDP.

- To provide measured P- and S-wave velocity models at each of the PGDP seismic monitoring sites.
- To provide accurate seismic models that reflect measured site specific S- and P-wave velocities and measured soil damping properties for the PGDP.
- Preliminary report and summary report summarizing the site specific P- and S-wave velocity models
- Preliminary report and summary report summarizing the measured damping properties of PGDP soils.
- Inclusion of site specific P- and S-wave velocity models and soil damping

Project Activity Status

(% completion) (date completed or projected completion date)

- Procure equipment (100%) (8/04)
- Conduct field measurements (0%) (11-12/04)
- Data Reduction and assessment (0%) (12/04 – 3/05)
- Preliminary report and summary report summarizing the site specific P- and S-wave velocity models (0%) (4/05 – 10/05)
- Preliminary report and summary report summarizing the measured damping properties of PGDP soils. (0%) (4/05 – 10/05)

12. UK-KRCEE Adaptive Sampling and Analysis Real-Time Remediation Project (ASARTR)

October 25, 2004

Project Title

Field Demonstration Project for the Application of real-time survey and analytical methods (Non Destructive Analyses) for Cost Effective, Real-time Remediation of Surface Water, Sediment, and Soil at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Projected Completion Date

May, 2005

Percentage Completion to Date

10%

Project Goals

- To demonstrate the effectiveness of real-time survey and analytical methods to:
 - Identify sediment and soil requiring remediation in a section of Outfall 011 at the PGDP.
 - Verify achievement of cleanup goals following remediation of a section of Outfall 011 at the PGDP.
 - Provide WAC characterization that is both time and cost-effective relative to presently deployed methods at the PGDP.
- Provide a general cost & time comparison for the deployment of real-time survey and analytical methods and remediation completion versus historical methods previously and presently utilized for site characterization and for conducting remedial actions at the PGDP.
- Present concept and proposed plans to CAB, regulatory decision makers, and DOE/contractors.
- Present results and recommendations for future utilization of process for soil and sediment remediation at the PGDP.

- Involve the developers of EPA TRIAD and Argonne National Laboratory ASAP

Project Team/Member Roles/Tasks

Project Manager: Steve Hampson, Assistant Director, Kentucky Research Consortium for Energy and Environment, University of Kentucky. Review of documents, methods, and contractors chosen for implementation of real-time characterization and cleanup demonstration.

Principle Investigator: Dr. John A Volpe, Technical Consultant, Kentucky Research Consortium for Energy and Environment. Conduct evaluation of methods for real-time site characterization and cleanup.

Dr. Lindell Ormsbee, Director, KRCEE-UK. Technical Advisor.

Dr. D. Joseph Hagerty, Professor, University of Louisville, College of Engineering . Technical Advisor

Dr. Mike Kemp, Professor, Murray State University . Technical Advisor

Dr. Richard Warner. UK Agricultural Engineering. Technical Support.

Identification of major project tasks

(% Completion) (Projected Project Completion Date)

1. KRCEE will develop a demonstration project utilizing real-time sampling, real-time analysis, and real-time cleanup of a section Outfall 011. A final status survey will employ statistical sampling of the remediated area to demonstrate utility of real-time methods and to confirm the attainment of cleanup goals.
 - KRCEE will develop sampling and analysis plans and quality assurance project plans to ensure the production of the quality data to support Data Quality Objectives.
 - KRCEE will utilize approaches developed by USEPA, DOE and DOE national laboratories to demonstrate the effectiveness of real-time assessment and cleanup of outfalls, ditches, and soils at the Paducah Gaseous Diffusion (PGDP).
 - The project will demonstrate utilization of appropriate radiation survey instruments, *in situ* gamma spectroscopy for

radionuclides, head space measurement/in-field electron capture gas chromatography for volatile organics, and XRF technology for metals

Summary of tasks

(Including identification of significant findings and their implications on project goals and end products)

- Internet and document search and reviews to evaluate the availability and applicability of adaptive sampling and analysis approach characterization, remediation, cleanup verification, and waste characterization methods applicable to soil and sediment remedial needs at the PGDP.
- Internet search to find companies that have the capability to implement real-time survey and analysis procedures. A number of companies have the capability of conducting a radiation walkover survey utilizing coupled radiological survey and data positioning. Real-time methods utilized by various companies employ a GPS systems coupled to a survey meter that permits measurement, recording, and mapping of impact areas. In comparison to other technologies real-time survey and mapping technologies allow for greater areal coverage and complete site characterization versus traditional multiple phases of random location sampling and laboratory analyses.
- Requested a quote from Canberra for in-situ gamma spectroscopy.
- Review of DRAFT DOE G 441.1-XX, "CONTROL AND RELEASE OF PROPERTY WITH RESIDUAL RADIOACTIVE MATERIAL for use with DOE 5400.5, *Radiation Protection of the Public and the Environment*", April 2002 .
- Reviewed EPA Triad methodology and decision making documents and Argonne National Laboratory Adaptive Sampling and Analysis Program (ASAP) documents.
- Reviewed Triad and ASAP remedial projects conducted at other sites and documented on the internet.
- Developed template for QAPP.
- Development of a final confirmation sampling approach utilizing Visual Sampling Program.

13. UK Chemical Engineering Nickel Distillation Project Quarterly Report

October 25, 2004

Project Title

Engineering Research and Development for Cost-effective Distillation Technology to Accomplish the Separation of ⁹⁹Tc/Ni and Decontamination of PGDP Nickel Ingots.

Projected Completion Date

September, 2005

Percentage Completion to Date

20%

Project Goals

- Design and Construct Mass Spectrometer to generate physical and chemical property data for ⁹⁹Tc and Nickel and other materials.
- Investigate and document the chemical/physical characteristics ⁹⁹Tc
- Investigate and document the chemical/physical characteristics Nickel.
- Apply research findings to develop bench-scale distillation unit for the separation of ⁹⁹Tc from nickel ingots.
- Conduct bench scale experiments.
- Apply research and bench scale experiment findings to the design of full-scale process.

Project Team/Member Roles/Tasks

Dr. Eric Grulke/UK-Chemical & Materials Engineering, PI. Lead project efforts.

Louie El Asami/UK-Chemical & Materials Engineering, Graduate Research Assistant. Conduct daily research & investigative efforts.

Dr. Tony Zhai/UK-Chemical & Materials Engineering, Metallurgy Technical Advisor

Dr. Lindell Ormsbee/Director, KRCEE-UK, Technical Advisor.

Mr. Bert Lynn/UK, Chemical & Materials Engineering, Mass Spectrometer Expert. Will advise project team on MS design, procurement of materials, and will construct the specialized MS equipment.

Dr. John A. Volpe/KRCEE Contractor. Provide technical and regulatory expertise for radioactive material issues.

Steve Hampson/KRCEE. General project support.

Project Activity Status

Project Task (% Completion) (Projected Project Completion Date)

- Conduct research to construct specialized MS.(100%) (11/03)
- Meetings with MS specialist to identify design parameters and suppliers (100%)(7/04)
- Submit equipment cost estimates (100%) (8/04)
- Begin procurement from suppliers (10%) (11/04)

Project Path Forward

Activity (completion date)

- Construct MS/Knudsen Cell (4/05)
- Begin analytical tests (4/05)

Significant Findings

TBD

14. UK–KRCEE, UK Geological Sciences & KGS Holocene Issues Project Team

October 25, 2004

Project Title

Field Study and Peer Review for Determination of Holocene Displacement at the C-746-U Landfill at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Projected Completion Date

May, 2005

Percentage Completion to Date

15%

Project Goals

- To determine whether Holocene displacement has occurred along target zones associated with faults identified at the C-746-U landfill.
- To provide an independent and peer reviewed report summarizing the results of the field investigation.

Project Team/Member Roles/Tasks

Dr. Zhenming Wang, Seismologist and Section Head (Geological Hazards)

Kentucky Geological Survey, University of Kentucky, Co-PI

Dr. Edward W. Woolery, Assistant Professor, Department of Geological Sciences

University of Kentucky, Co-PI.

Dr. Martitia Tuttle, Tuttle and Associates. (formerly Univ. of Maryland).
Project Team member-Independent Technical Review.

Dr. Roy Van Arsdale, University of Memphis. Project Team Member-
Independent Technical Review.

Mr. John Nelson, Illinois Geological Survey. Project Team.

Mr. John Nelson, Illinois Geological Survey. Project Team.

Dr. Bill Lettis, Dr. John Baldwin, Dr. Keith Kelsen (Lettis & Assoc. / Walnut Grove, Ca), Project Team Members, Field Oversight Contractors

Dr. Dave Amick (SAIC-Augusta). Project Team.

Mr. Marshall Davenport, Jacobs Engineering, Oak Ridge, Project Team

Steve Hampson, UK/KRCEE. General project management.

Project Activity Status

Project Task (% Completion) (Projected Project Completion Date)

Task 1. Recruit project and Independent Technical Review (ITR) teams comprised of experienced national and international experts.

Task 2. Hire experienced and qualified contractor to obtain DPT cores.

Task 3. Hire experienced field management team to oversee all aspects of fieldwork.

Task 4. Complete project scoping.

Task 5. Conduct field activities.

Task 6. Convene project team to write preliminary project report.

Task 7. Submit and revise project report based on ITR review.

Task 8. Final report for journal publication.

Project Findings

TBD