1. **Total Project Funding**

   Denali Commission $830,325  
   ORPC Alaska $1,128,449

2. **Updated schedule and milestone information as identified in the Project Work Plan.**

   • AHERC foundation and debris diversion literature surveys, data collection and final reports completed Dec 31, 2010

   AHERC will complete its literature surveys on best practices for riverine foundation systems and the state of the art of debris diversion systems. The foundation study will pay special attention to applicability to Alaskan River environments and deployability with available infrastructure in mind. The debris diversion study will focus on debris diversion concepts that are adaptable to in river hydrokinetics and will incorporate reports on the data collection efforts performed during the 2010 field season. As there will be a late start to the field season this year as funds will not be available until August 2010 some of the debris data collection efforts may be shifted to take place as part of the foundation system deployment in 2011.

   • ORPC environmental and site characterization data collection for project design and FERC draft license application performed by October 1, 2010

   ORPC will complete the data collection efforts necessary for choosing optimal locations for RivGen™ deployments based on bathymetry and current velocity measurements. ORPC will also complete data collection at sites of interest to quantify the river bed substrate to allow for the completion of foundation support frame design.

   • Prototype Bottom Support Frame And Debris Diversion system fabricated, deployed, tested, and retrieved at Nenana Site July – September 2011

   Prototype bottom support frames and debris diversion systems will be designed by ORPC engineers based on AHERC literature surveys and data collection efforts. These system components will be fabricated in the 2nd Quarter 2011 for deployment and testing in the 3rd Quarter 2011. The testing will include verifying the efficacy of deployment and retrieval procedures as well as testing the persistence of the foundation system and debris diversion system in the Tanana River. Additional data collection will be undertaken by ACEP to further the quantification of debris loading and impact energy on the foundation and debris diversion systems.

   • Additional field work required for Final Pilot License Application completed by Oct 31, 2011

   Any additional field work required for prudent project implementation and completion of successful permitting for the project will be completed in the 2nd and 3rd quarters 2011. This additional work will be scoped as required by project engineering data needs and resource agency consultations.
• FERC Final License Application submitted by Dec 31, 2011

After agency review of ORPC’s Draft Pilot License Application for the Project, ORPC will submit the FERC Final Pilot License Application allowing the recommended six month lead time for FERC and Agency approval to issue ORPC a Pilot License to interconnect the RivGen™ Power System to the GVEA grid in June 2012.

• RivGen™ TGU built and tested at Eastport Maine test site by Dec 31, 2011

ORPC will complete the fabrication of the RivGen™ TGU including the turbines, support frame, and generator. This system will be tested aboard ORPC’s state of the art Energy Tide 2 test facility in Cobscook Bay, Maine to verify that the turbine meets power output and performance specifications prior to its shipment to Alaska.

• Final Report on Nenana site characterization work and foundation system and debris diversion system performance submitted to ACEP by Dec 31 2011

ORPC will submit its final report on the performance of the foundation system and debris diversion system with input from AHERC data collection efforts to ACEP for inclusion in ACEP’s final report on the project.

• Final performance report on RivGen™ test in Maine submitted to ACEP by Feb 15, 2012

ORPC will submit a final performance report on the RivGen™ TGU test in Maine for inclusion in ACEP’s final report on the project.

3. Narrative Summary

As ORPC Alaska (ORPC) and Alaska Center for Energy and Power (ACEP) were finalizing contract documents until September 10, 2010, some of the work scheduled for this quarter was delayed. This includes, specifically, AHERC’s plan to collect data on debris in the Tanana River, which will now be re-scoped and rescheduled to take place in summer 2011. ORPC, however, has moved forward with site characterization efforts employing TerraSond Ltd to perform a detailed bathymetry and ADCP transects to measure current velocity in the area of the Tanana River now being considered as the prime location for the RivGen™ deployment. Although the ACEP contract was not fully executed, ORPC approved this work on the assumption that EETG funding would be available to reimburse this cost near the time of its billing to ORPC. To economize on field mobilization, this effort was undertaken in conjunction with work performed for AHERC by TerraSond as part of AHERC’s AEA funded project to characterize the reach of river being investigated for the RivGen™ Power Project. TerraSond performed this work in early August 2010 and issued a preliminary representation of the data to ORPC and AHERC. This has been included as Appendix A.

Considering this new data ORPC, AHERC and TerraSond came to an agreement on the area to focus TerraSond’s second expedition in early October 2010. The purpose of this expedition is to characterize the sub-bottom profile of the proposed deployment area to inform AHERC’s foundation literature survey, and ORPC’s subsequent bottom support frame design and engineering. Based on this recommendation, Monty Worthington, ORPC Project Director, travelled to Nenana on October 1, 2010 and met with the City of Nenana, the Nenana Native Council, and Inland Barge representatives to confirm that the new site would not create any conflicts with existing uses. Details of this meeting and TerraSond’s October expedition will be included in the next quarterly report.
Despite the delay in debris data collection in the Tanana River by AHERC, ORPC anticipates being able to maintain the schedule as proposed in the grant documents, with the possible exception of a delay in the construction of prototype debris diversion device, as this may be dependent on initial data on debris distribution, size, and frequency for a prudent design to be completed. The project remains on budget. The only costs incurred have been the work contracted to TerraSond for the August expedition to Nenana.

4. **Before and After pictures**

None available at this time.

**Total Project Expenditures for the Project as of the end of the Reporting Period**

To date, ORPC had not received any invoices for this Project as of the end of the reporting period, September 30, 2010.
Appendix A   TerraSond Report
SITE RECOMMENDED FOR FURTHER INVESTIGATION
SEE DETAILS

HYDROKINETIC SITE

3D CROSS SECTION DETAIL

CROSS SECTION DETAIL
1. **Total Project Funding**

   Denali Commission $830,325  
   ORPC Alaska $1,128,449

2. **Updated schedule and milestone information as identified in the Project Work Plan.**

   AHERC submitted a modified proposal and Scope of Work to ORPC on December 9, 2010. The updated schedule and milestone information in the Project Work Plan follows:

   **Project Deliverables**
   
   **Foundation Study Deliverables**
   1. Report on the literature of riverine foundations; December 30, 2010
   3. Final report for foundation study including foundation system(s) that appear to be most viable at the NHTS as well as commentary on systems for the remainder of Alaska; December 30, 2011

   **Debris Study Deliverables**
   1. A report surveying existing trash rack technology and recommendations on how this technology might be applied to design a debris mitigation system for ORPC’s demonstration RivGen™; February 2011.
   2. A detailed design for a debris detection system integrated with the foundation system; April 2011.
   3. Debris statistics for the Tanana River at Nenana in the river reach where ORPC’s RivGen™ will be deployed. The statistics will be correlated with available data on current velocity, debris size and type, and river stage. December 31, 2011.
   4. Final reports detailing methods, results and analysis of debris statistics; December 31, 2011.

   **TimeLine**
   
   **Foundation Study Timeline**
   - November 2010 - December 2010: Literature review of riverine foundations
   - July 2011 - October 2011: Review of construction and cost aspects of a riverine hydrokinetic turbine foundation
   - November 2011 - December 2011: Prepare final report

   **Debris Study Timeline**
   - November 2010 - December 2010: Review literature and existing debris mitigation technology and engineering
   - December 2010 - January 2011: Provide results from literature review to ORPC about existing debris mitigation methods to help their design of a preliminary mitigation system. Provide preliminary concept designs for debris detection grate system
November 2010 - April 2011    Design methods and equipment to measure debris statistics in conjunction with the foundation design study
January 2011 - June 2011    Consult with ORPC on debris detection system during construction and installation
June 2011 - September 2011   Measure debris statistics data from the foundation grate system and other available instruments
October 2011 - December 2011  Analyze data from the measurement program and approach, and provide data to ORPC for their debris mitigation system design for their 2012 demonstration. Prepare and deliver final reports.

As data on debris was not collected by AHERC during the 2010 field season, ORPC is reevaluating if it is prudent to design and test a debris diversion system in advance of this data collection effort in 2011. If a schedule change for testing the debris diversion system is necessary ORPC will submit an updated schedule for this in the next quarterly report.

3. Narrative Summary

ORPC Alaska (ORPC) and Alaska Center for Energy and Power (ACEP) finalized the contract documents on October 5, 2010 and subsequently signed a modification with a change in the end date to February 15, 2012. The period of performance for the contract is August 17, 2010 through February 15, 2012. Paperwork with University of Alaska Fairbanks (UAF) has been completed for purchasing.

ORPC hosted a visit in Eastport, Maine on October 6-7, 2010 with Jerry Johnson and Jack Schmid from the Alaska Hydrokinetic Energy Research Center (AHERC) and NREL representatives to discuss the work that AHERC will perform on the RivGen™ foundation survey and the debris diversion work. We reviewed the progress to date and the work to be performed over the next year in Alaska. AHERC will re-scope their debris diversion study one last time prior to executing the contract with AHERC to make the efforts more relevant to the RivGen™ design and testing. In the meantime, UAF will set up an assumption account to begin work on the foundation study.

On November 10, 2010 ORPC and AHERC had the first monthly Nenana Project conference call to discuss project progress and the AHERC scope of work modifications under the Denali Commission EETG funding. ORPC and AHERC discussed how changes to the SOW could be incorporated into their current budget and timeline. It also became clear that AHERC would need more time to complete the final foundation study and that it would be important to prioritize deliverables to inform the prototype foundation design for the 2011 installation, and the debris detection system design that AHERC would complete for integration into this foundation.

Work got underway on design concepts for the RivGen™ debris deflection scheme and the RivGen™ generator design, which parallels ORPC’s TidGen™ work at CPI. Some equipment has been ordered.

Initial loads specification for the RivGen™ foundation have been developed and communicated to AHERC for use in their foundation design effort. Subsequently, AHERC has developed some design concepts, which ORPC is reviewing.
TerraSond has delivered an initial interpretation of sub-bottom geophysical data for the Nenana site from the data collection effort in October; a final report is expected at the end of December 2010. TerraSond offered to provide time to verbally explain the data to clarify the interpretation. ORPC set up a teleconference with TerraSond on December 8; however AHERC was unable to attend. It is expected that AHERC will follow up with TerraSond directly to inform their interpretation.

ORPC and AHERC held a monthly call on December 1 to go over the project status. As agreed in the previous meeting ORPC had communicated load data, and TerraSond promised the geophysical sub-bottom interpretation by the COB in order for AHERC to have all of the information to complete their work for the December 30 and January 3 deliverable deadlines. ORPC and AHERC reviewed a preliminary foundation design and a preliminary debris detection design provided by Andrew Metzger. It was decided that a follow up with ORPC engineering to determine if the concept warranted further investigation would be coordinated.

ORPC and AHERC held several calls the week of December 6 to further refine the AHERC SOW to reflect the discussions during the Eastport meeting and the monthly status call. A new SOW was delivered to ORPC on December 9. Pending a few minor changes this SOW should lead to an executed subcontract between ORPC and AHERC before the end of the year. In the meantime AHERC has set up an assumption account to allow them to move forward with their work.

4. **Before and After pictures**

None available at this time.

**Total Project Expenditures for the Project as of the end of the Reporting Period**

One expenditure has been made on this Project as of the end of the reporting period, December 15, 2010: $59,258 to TerraSond.

**Modified Budget**

ORPC may submit a modified budget if necessary after executing a subcontract with AHERC, but at this time we have no budget modifications.
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<th>ID</th>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
<th>Predecessors</th>
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Project: Nenana RivGen Power Project
Date: Wed 12/1/10
UAF 11-0017
NENANA, ALASKA HYDROKINETIC RivGen™ POWER SYSTEM

PROGRESS REPORT: 1Q2011

MARCH 15, 2011

Ocean Renewable Power Company, LLC
120 Exchange Street, Suite 508
Portland, ME 04101
Phone: (207) 772-7707
UAF 11-0017: NENANA, ALASKA HYDROKINETIC RivGen™ POWER SYSTEM

Progress Report: FY 2011, 1st Quarter
Submitted: March 15, 2011

1. Total Project Funding

Denali Commission $830,325
ORPC Alaska $1,128,449

2. Updated schedule and milestone information as identified in the Project Work Plan

Project Deliverables

• AHERC foundation and debris diversion literature surveys, data collection and final reports:
  
  Foundation Study Deliverables
  AHERC is no longer performing a foundation study for the project. ORPC is utilizing third party engineering resources to complete the design.

  Debris Study Deliverables
  Draft report delivered to ORPC on January 18, 2011. Final report with appendices still to come. Work on Debris Detection System conceptual design has begun.

• ORPC environmental and site characterization data collection for project design and FERC draft license application:
  
  The TerraSond report on the Nenana geophysical work was completed and submitted to ORPC on January 6, 2011, this included a detailed analysis of the bathymetry, ADCP current velocity, and sub-bottom data collected during the 2010 field season. This report is available upon request but has not been included in this report due to the large file size.

• Prototype bottom support frame and debris diversion system fabricated, deployed, tested, and retrieved at Nenana site:
  
  The prototype bottom support frame is currently under design. The debris diversion system design and construction is dependent on debris data that will be collected during the 2011 field season, so it has not begun at this time.

• Additional field work required for FERC final pilot license application:
  
  ORPC is participating in a meeting facilitated by AEA including key agency personnel form ADF&G, NMFS, and others at the ADF&G offices in Fairbanks on March 31, 2011 to scope required fish studies for the project permitting and licensing.

• FERC Final License Application submitted by December 31, 2011:
  
  No work to report
• RivGen™ TGU built and tested at Eastport, Maine test site:
  
  RivGen™ Generator is under final design.

• Final Report on Nenana site characterization work and foundation system and debris diversion system performance:
  
  No work to report

• Final performance report on RivGen™ TGU test in Maine submitted to ACEP:
  
  No work to report

**TimeLine**

• AHERC foundation and debris diversion literature surveys, data collection and final reports completed December 31, 2010 (now anticipated December 31, 2011):

  **Foundation Study Timeline**
  November 2010 - December 2011 The foundation study has been removed from the AHERC scope of work due to the loss of the key faculty performing the work. It will no longer be performed as part of this project.

  **Debris Study Timeline**
  November 2010 - December 2010 Review literature and existing debris mitigation technology and engineering.

  December 2010 - January 2011 Provide results from literature review to ORPC about existing debris mitigation methods to help their design of a preliminary mitigation system. Provide preliminary concept designs for debris detection grate system.

  November 2010 - April 2011 Design methods and equipment to measure debris statistics in conjunction with the foundation design study.

  January 2011 - June 2011 Consult with ORPC on debris detection system during construction and installation.

  June 2011 - September 2011 Measure debris statistics data from the debris detection system and other available instruments.

  October 2011 - December 2011 Analyze data from the measurement program and approach, and provide data to ORPC for their debris mitigation system design for their 2012 demonstration. Prepare and deliver final reports.

• ORPC environmental and site characterization data collection for project design and FERC draft license application performed by October 1, 2010:

  October 10, 2010 TerraSond geophysical field work completed.

  January 6, 2011 Final report on geophysical work submitted to ORPC.
• Prototype bottom support frame and debris diversion system fabricated, deployed, tested and retrieved at Nenana site, July – September 2011:
  
    March 1, 2011    PND selected to design bottom support frame design

• Additional field work required for FERC final pilot license application completed by October 31, 2011:
  
    March 31, 2011    Meeting scheduled with Agencies in FAI to scope fish studies for project

• FERC final pilot license application submitted by December 31, 2011
• RivGen™ TGU built and tested at Eastport Maine test site by December 31, 2011
• Final Report on Nenana site characterization work and foundation system and debris diversion system performance submitted to ACEP by December 31 2011
• Final performance report on RivGen™ TGU test in Maine submitted to ACEP by February 15, 2012

3. Narrative Summary

AHERC work
ORPC has submitted a contract, which includes an IP agreement, to AHERC for signature on March 7, 2011. It is currently under review by their attorney.

The UAF faculty member who was assigned to provide the literature survey and design advisement on the RivGen™ bottom support frame has removed himself from the project. This put the RivGen™ bottom support frame work behind schedule. AHERC has agreed to reapportion $44,842 of their Denali Commission EETG subaward to ORPC to allow ORPC to find another contractor for this work. This will leave $147,158 in the budget for AHERC to complete their debris study and debris data collection efforts. ORPC received a draft report on debris diversion structures from AHERC, which provided good information on the problems and issues facing us. We are awaiting the final report complete with appendices detailing the current state of the art in diverting river debris. AHERC was unable to collect debris data during the 2010 field season, as EETG funds were not available to the project in time to release them to begin the work in 2010. AHERC is currently working on the design of a debris detection system to install with the Bottom Support Frame and collect debris data in 2011.

RivGen™ Bottom Support Frame
With UAF no longer contributing to bottom support frame and foundation design work, ORPC had to add additional engineering resources to perform this work. After considering in-house and outside resources for this work, ORPC selected PND Engineering in Anchorage, Alaska, as the primary contractor for this work. ORPC produced a RivGen™ Bottom Support Frame Design requirements document to guide PND in their work and help them develop an accurate quote (see attached). PND delivered a quote within budget for the work and has since begun preliminary design work on the bottom support frame and anchoring/attachment system.

Geophysical Information
Geophysical information collected by TerraSond for the Nenana project site was submitted in a final report to ORPC on January 6, 2011 and is now available using a Fledermaus viewer.
program. We are working with SGC Engineering, LLC to import this data into an ARC GIS format, which is easier for us to use. We are processing river stage information from the U.S. Geological Survey to understand how to apply the river heights to the bathymetry data that we have collected.

ORPC also consulted with Michael Baker Corp, an Anchorage-based engineering firm who was recently completing a core sample job on the Tanana River near the project site as part of a proposed gas line project. ORPC investigated the possibility of taking advantage of the mobilized equipment to perform concurrent geotechnical samples at the project site. It was determined, based on engineering requirements and the cost of the work, that it was neither required nor within the budget for this project to complete this work. Core samples, therefore, were not taken at the project site. PND engineering is comfortable designing a bottom support frame and attachment system without this information.

**RivGen™ TGU**
The design of the RivGen™ turbine generator unit (RivGen™ TGU) is proceeding in parallel with ORPC’s TidGen™ TGU design work at Comprehensive Power Inc (CPI). ORPC held a mini-design review with CPI to discuss the RivGen™ TGU electronics arrangement and decided to continue with the arrangement suggested by CPI and to keep power electronics connected directly to the generator underwater. The primary rationale for this choice is to keep control signals close to and integrated with the generator rather than transferring data to shore for processing, and then transmitting control signals from shore.

4. **Before and After Pictures**

None at this time.

**Total Project Expenditures for the Project as of the end of the Reporting Period**

Two expenditures from TerraSond for a total of $80,000 have been made on this Project as of the end of the reporting period, March 15, 2011.

**Modified Budget**
ORPC may submit a modified budget if necessary after executing a subcontract with AHERC and making changes to the over all grant agreement with ACEP, but at this time we have no budget modifications.
UAF 11-0017
NENANA, ALASKA HYDROKINETIC
RivGen™ POWER SYSTEM

PROGRESS REPORT: 2Q2011

JUNE 15, 2011

ORPC ALASKA, LLC
725 Christensen Drive, Suite 4A
Anchorage, Alaska 99501
Phone: (207) 221-0965
UAF 11-0017: NENANA, ALASKA HYDROKINETIC RivGen™ POWER SYSTEM

Progress Report: FY 2011, 2nd Quarter
Submitted: June 15, 2011

1. Total Project Funding

Denali Commission $830,325
ORPC Alaska $1,128,449

2. Updated schedule and milestone information as identified in the Project Work Plan

Project Deliverables

- Alaska Hydrokinetic Energy Research Center (AHERC) foundation and debris diversion literature surveys, data collection and final reports:

  Foundation Study Deliverables
  AHERC is no longer performing a foundation study for the project. ORPC Alaska, LLC (ORPC) is utilizing third party engineering resources to complete the design.

  Debris Study Deliverables
  The final report on the debris study was submitted to ORPC on April 14, 2011 (provided upon request).

- ORPC environmental and site characterization data collection for project design and Federal Energy Regulatory Commission (FERC) draft license application:

  No additional site characterization work has been completed.

- Prototype bottom support frame (BSF) and debris diversion system fabricated, deployed, tested, and retrieved at Nenana site:

  The prototype bottom support frame is nearly complete and undergoing final design details. The debris diversion system design and construction is dependent on debris data that will be collected during the 2011 field season, so it will not be designed or tested this year. ORPC has entered into an agreement with Marsh Creek, LLC as the lead contractor on the fabrication, deployment, testing, and retrieval of the bottom support frame.

- Additional field work required for FERC final pilot license application:

  ORPC has worked with University of Alaska Fairbanks (UAF) and consulted primarily with Alaska Department of Fish and Game (ADF&G), but also with National Marine Fisheries Service (NMFS) and other agencies on a pre deployment fish study plan. The pre deployment plan was approved by ADF&G and will be implemented beginning July 1, 2011.
• FERC Final License Application submitted by December 31, 2011:

ORPC met with Golden Valley Electric Association (GVEA) on April 21, 2011 to discuss interconnect options and potential partnership on the Nenana RivGen™ Project. ORPC has continued to discuss the Nenana RivGen™ licensing pathway internally and will meet with GVEA in late June to define the ORPC/GVEA relationship and the permitting/licensing process.

• RivGen™ turbine generator unit (TGU) built and tested at Eastport, Maine test site:

  RivGen™ generator is under final design.

• Final Report on Nenana site characterization work and foundation system and debris diversion system performance:

  No work to report. Although there will be no debris diversion system tested, a report on the debris detection system will be written by AHERC.

• Final performance report on RivGen™ TGU test in Maine submitted to Alaska Center for Energy and Power (ACEP):

  No work to report

• A revised Scope of Work will be submitted in June 2011 (see Attachment A).

**TimeLine**

• AHERC foundation and debris diversion literature surveys, data collection and final reports completed December 31, 2010 (now anticipated December 31, 2011):

  **Foundation Study Timeline**
  November 2010 - December 2011

  The foundation study has been removed from the AHERC scope of work due to the loss of key faculty performing the work. It will no longer be performed as part of this project.

  **Debris Study Timeline**
  November 2010 - December 2010

  Review literature and existing debris mitigation technology and engineering.

  December 2010 - January 2011

  Provide results from literature review to ORPC about existing debris mitigation methods to help their design of a preliminary mitigation system. Provide preliminary concept designs for debris detection grate system.

  November 2010 - April 2011

  Design methods and equipment to measure debris statistics in conjunction with the foundation design study.

  January 2011 - June 2011

  Consult with ORPC on debris detection system during construction and installation.
August 2011 - September 2011  Measure debris statistics data from the debris detection system and other available instruments.

October 2011 - December 2011  Analyze data from the measurement program and approach, and provide data to ORPC for their debris mitigation system design for their 2012 demonstration. Prepare and deliver final reports.

- ORPC environmental and site characterization data collection for project design and FERC draft license application performed by October 1, 2010:
  
  October 10, 2010  TerraSond geophysical field work completed.
  January 6, 2011  Final report on geophysical work submitted to ORPC.

- Prototype bottom support frame and debris diversion system fabricated, deployed, tested and retrieved at Nenana site, July – September 2011:
  
  March 1, 2011  PND Engineers, Inc. (PND) selected to design bottom support frame
  May 1, 2011  Conceptual design selected
  June 7, 2011  Design drawings completed for review
  June 13, 2011  Permits for bottom support frame (BSF) testing submitted to Alaska Department of Natural Resources (ADNR), United States Army Corps of Engineers (USACE), and ADF&G
  August 1, 2011  Bottom Support Frame and anchoring system assembly completed
  August 15- Oct 1 2011  Bottom Support Frame tested and retrieved

- Additional field work required for FERC final pilot license application completed by October 31, 2011:
  
  March 31, 2011  Meeting with Agencies in to scope fish studies for project
  June 7, 2011  Fish Study plan finalized between ORPC and UAF
  July 1 – Sept 1 2011  Fish Study performed

- TGU fabricated and tested at Eastport Maine Test site
  
  Dec 31, 2011  TGU Fabrication complete

- FERC final pilot license application submitted
  
  Jan 31, 2012  All permit and license applications completed

- RivGen™ TGU built and tested at Eastport Maine test site
  
  March 31, 2012  Eastport testing complete

- Final Report on Nenana site characterization work and bottom support frame and anchoring system and debris detection system performance submitted to ACEP
3. Narrative Summary

RivGen™ Bottom Support Frame and Debris Detection System

On March 1, 2011 ORPC selected PND and a contract was execute to perform the BSF design. Beginning in March 2011 ORPC began conversations with Marsh Creek as the potential lead contractor on the BSF fabrication, assembly, operation, testing, and decommissioning. A contract with Marsh Creek to perform this work was signed on June 3, 2011.

During April 2011 PND and ORPC worked through preliminary design concepts ranging from piling based concepts to an anchor and bottom support frame system. Marsh Creek joined in the preliminary design process on April 26. On May 11, 2011 a conceptual design was selected with consensus from all parties based on the BSF and anchor concept (see figure 1). A formal requirements document was submitted to PND on May 29, 2011. By June 7, PND had final review drawings out, and details of the design were refined through several meetings, the last on June 13, 2011 which included Marsh Creek, ORPC and PND. This design will allow for the testing of several methods of deployment and retrieval including testing components that would be critical to a piling based system to determine the viability of pilings for future deployments as well.

On June 8th ORPC and Marsh Creek employees travelled to Nenana to meet with local barge companies to discuss the project plans to be sure that there were no navigational or operational concerns with ORPC’s deployment plans this season (see figure 2 for deployment area location) and to scope out contractors for barge and marine service support for the Project. This included meetings with Inland Barge, Crowley, and Ruby Marine. Based on this visit and work sourcing materials and construction cost estimates Marsh Creek is currently performing a cost estimate for the fabrication and testing of the BSF and anchor system.

Beginning in May 2011 the instrumentation package for data collection during the testing of the BSF and the debris detection system were being scoped at ORPC and AHERC respectively. Final decisions on the BSF instrumentation were made on June 3, 2011, and for the debris detection system on June 8, 2011. The components for this data acquisition are currently being ordered.

By June 13, 2011 all of the relevant permits for ORPC’s BSF testing were submitted to agencies including submissions to ADF&G on June 6, ADNR on June 9 and USACE on June 13th. Permits for the fish study work to be completed by UAF were also submitted by UAF during this time.

Based on estimates for fabrication, assembly, transport, and mobilization for field work a target date of Aug 7, 2011 has been selected for the deployment of the prototype BSF and anchoring system, while this is later than the initial target date it will allow for the full 30 days of testing prior to removal by the end of October 2011.
AHERC Debris Detection and Fish Study

AHERC has been working with Jon Holmgren of Jon’s Machine Shop on the Debris Detection System design. Following a completed design, ORPC contracted Jon’s Machine Shop to build a prototype “tine” of the Debris Detection System (See Figure 2); the eventual system would consist of several of these tines. The prototype did not function as designed, so a second prototype is in the design process and will be fabricated to address the initial design issues. AHERC researched the required instrumentation for data collection from the Debris Detection System and submitted preliminary quotes to ORPC. A quote for the construction of a second tine is in the works, and ORPC will then be prepared to make a decision on how many tines and the associated instrumentation can be ordered within budget for the project.

Professor Andy Seitz of UAF fisheries working with AHERC has designed a pre deployment fish study, and a target start date of July 1, 2011 has been set for the study. AHERC has applied for the permits for the mooring of a fish study barge, and the ultimate start date will be dictated most likely by the timing for the acquisition of these permits, and the completion of contractual documents with UAF. Equipment for the study, including nets anchoring gear and the lease of a fish study barge, have begun to be ordered for the study.

RivGen™ TGU

Design of the RivGen™ TGU continues for testing in Eastport, Maine.

4. Before and After Pictures

![Figure 1. Design Review drawing of bottom support frame and anchoring system](image-url)
Figure 2: Deployment area for anchors and BSF in red box. Nenana railroad bridge is evident. Colors indicate water depth and riverbed surface features.
Figure 3. Prototype Debris Detection System tine

Total Project Expenditures for the Project as of the end of the Reporting Period

Total Project expenditures as of the end of 2Q2011 include the following:

Denali Funds
1. Site Characterization Consultant (TerraSond): $80,000 (invoiced UAF and received reimbursement/grant funds)
2. Foundation Design, BSF (PND Engineers): $14,000 (have not yet invoiced UAF)

ORPC Alaska Share
1. ORPC personnel time: $23,606.73
2. RivGen™ Generator and Electronics Design (CPI): $124,646.64
3. Instrumentation Consultant (R. M. Beaumont Corp): $1,332.00
4. Structural Engineer (R. M. Beaumont Corp): $1,123.00
5. GIS Consultant(s) (SGC, TerraSond): $3,455.00

**Modified Budget**

Based on the more accurate quotes received for the project over the past months, and the inclusion of new and necessary line items for project completion, as well as the omission of debris diversion system construction several changes to the original project budget have been made. This new budget and the revised scope of the project will be submitted in June 2011.
ATTACHMENT A

NENANA RIVGEN™ POWER PROJECT PHASE 1: Q3 2010 – Q1 2012

This document describes recent revisions to the scope of work and schedule for the Nenana RivGen™ Power Project Phase 1 (Project), which is funded in part by an Emerging Energy Technology Grant (EETG) awarded to ORPC by the Denali Commission and administered by the Alaska Center for Energy and Power (ACEP). ORPC is requesting changes to the Project Work Plan section of the Professional Service Contract with University of Alaska Fairbanks (UAF), dated 08/20/10 (see suggested edits to the work plan) and awaits ACEP for final revisions to the contract.

The previously approved Project’s scope of work included the following:

- ORPC’s environmental and site characterization data collection for project design and Project Licensing/Permitting completed
- Prototype bottom support frame and debris diversion system fabricated, deployed, tested, and retrieved at Nenana site
- Project permitting and licensing applications submitted
- RivGen™ turbine generator unit (TGU) built and tested at Eastport, Maine
- AHERC debris diversion literature surveys, data collection and final reports completed
- Final report on Nenana site characterization work and bottom support frame and debris diversion system performance completed
- Final performance report on RivGen™ TGU test in Maine completed

ORPC will complete all of this work as planned with three primary revisions:

- It was originally anticipated that data from AHERC’s debris study would be available in 2011 to inform the design of the debris diversion system. Due to Project delays no data was collected in 2010, so the debris diversion system will not be built in 2011. Instead, a debris detection system will be designed, built and operated to provide the data on debris to inform design parameters for a debris diversion system, which will be built and installed as needed based on this debris data in 2012, prior to turbine installation.
- The testing schedule of the RivGen™ TGU in Eastport, Maine has changed. As it is unlikely to test during December 2011 according to the current schedule, testing will be done in the 1st Quarter 2012. Exact dates are TBD based on when the RivGen™ TGU fabrication and attachment to the Energy Tide 2 research vessel is complete. An updated test schedule will be provided by October 2011 with advance notice to ACEP personnel to allow observation of the RivGen™ TGU testing in Maine.
- ORPC is reallocating a portion of the Denali Commission funding to support a pre-deployment fish study by AHERC from July - September 2011 at the Nenana site. This will be critical to permitting the RivGen™ Power System installation in 2012.
The revised Project will unfold as follows:

- In August 2010, ORPC completed data collection for choosing optimal locations for RivGen™ TGU deployments based on bathymetry and current velocity measurements. ORPC also completed data collection at sites of interest to quantify the river bed substrate for the completion of bottom support frame design.

- Any additional field work required for the Project’s implementation and permitting will be completed in the second and third quarters 2011. This additional work will be scoped as required by project engineering and resource agency consultations. This will include pre-deployment fish studies, which will be completed by UAF fisheries personnel under AHERC’s work at the Nenana site from July – September 2011.

- ORPC will oversee design and fabrication of a bottom support frame for the Nenana site, which will be ready for deployment and testing by August 2011. Concurrently AHERC will provide ORPC with a final design and parts list for a debris detection system in time to fabricate it and integrate it with the bottom support frame prior to deployment. The testing of the bottom support frame will verify the efficacy of deployment and retrieval procedures, as well as its persistence in maintaining location in the Tanana River.

- AHERC will oversee data collection from the debris detection system to quantify debris loads in the water column used by the RivGen™ TGUs.

- ORPC will complete the fabrication of the RivGen™ TGU including the turbines, TGU chassis, and generator. This system will be tested aboard ORPC’s state-of-the-art Energy Tide2 research vessel in Cobscook Bay, Maine, to verify that the TGU meets power output and performance specifications prior to its shipment to Alaska. This testing will be completed in the first quarter 2012.

- AHERC completed its literature survey on the state-of-the-art debris diversion systems on April 14, 2011 and submitted it to ORPC. AHERC will also compile a report on the 2011 debris detection system testing and data collection. These reports will help to inform the design of a debris diversion system if one is deemed necessary from the 2011 debris detection system data collected.

- By January 31, 2012 ORPC will submit a report on the performance of bottom support frame and debris data collection to ACEP for inclusion in their final report on the Project.

- By April 31, 2012 ORPC will submit a final performance report on the RivGen™ TGU test in Maine.
UAF 11-0017: NENANA, ALASKA HYDROKINETIC RivGen™ POWER SYSTEM

Progress Report: FY 2011, 3rd Quarter
Submitted: September 15, 2011

1. Total Project Funding

Denali Commission $830,325
ORPC Alaska $1,128,449

2. Updated schedule and milestone information as identified in the Project Work Plan

Project Deliverables

• Alaska Hydrokinetic Energy Research Center (AHERC) foundation and debris diversion literature surveys, data collection and final reports:

  Foundation Study Deliverables
  AHERC is no longer performing a foundation study for the Project. ORPC Alaska, LLC (ORPC) is utilizing third party engineering resources to complete the design.

  Debris Study Deliverables
  The final report on the debris study was submitted to ORPC on April 14, 2011 and may be provided upon request.

• ORPC environmental and site characterization data collection for Project design and Federal Energy Regulatory Commission (FERC) draft pilot license application:

  No additional site characterization work has been completed.

• Prototype bottom support frame and Debris Detection System fabricated, deployed, tested, and retrieved at Nenana site:

  The prototype bottom support frame fabrication was completed in early August 2011. Fabrication of two anchors was also completed, and the prototype Debris Detection System was mounted to one of the anchors. Due to concerns about the potential difficulty of removing the bottom support frame from the sedimentation on the river bottom and the escalated costs associated with retrieval should the bottom support frame be imbedded in sediment, it was decided to forgo the bottom support frame testing at Nenana this fall. One anchor, however, is still scheduled for deployment on September 13, 2011, and it will include the Debris Detection System, which will undergo a week of testing and calibration during this deployment to validate the system. This anchor test will also provide data to better inform sedimentation concerns at the Nenana site. ORPC is currently investigating alternative bottom support frame testing locations with lesser sedimentation concerns, including sites in Maine and Alaska.
• Additional field work required for FERC final pilot license application:

The University of Alaska Fairbanks School of Fisheries conducted two weeks of pre-deployment fish studies during August 15 – 28, 2011 (Figure 1).

![Figure 1. UAF researchers engaged in fish study.](image)

• FERC Final Pilot License Application

ORPC met with Golden Valley Electric Association (GVEA) on several occasions and convened two meetings with FERC to discuss the licensing of the Project. It has been decided that the most economic and facilitated path forward at this time will be to install the initial phases of the Project under the parameters of an exemption under the precedent of the Verdant Declaratory Order. In order to do this, the initial power from the Project will be donated to GVEA rather than sold. These early Project phases will inform the decision of whether licensing the Project will prove economical.
• RivGen™ turbine generator unit (TGU) built and tested at Eastport, Maine test site:

  The RivGen™ generator is under construction; initial RivGen™ turbine designs have been sent to manufactures for bid; the design parameters for the RivGen™ power electronics are being finalized, and all other TGU components are scheduled to be completed, assembled, and ready for testing by February 1, 2012.

• Final Report on Nenana site characterization work and foundation system and Debris Detection System performance:

  No work to report.

• Final performance report on RivGen™ TGU test in Maine submitted to Alaska Center for Energy and Power (ACEP):

  No work to report.

• A revised Scope of Work, budget and timeline will be submitted in September 2011.

Timeline

• AHERC foundation and debris diversion literature surveys, data collection and final reports completed December 31, 2010 (now anticipated December 31, 2011):

  Foundation Study Timeline
  November 2010 - December 2011  The foundation study has been removed from the AHERC scope of work due to the loss of key faculty performing the work. It will no longer be performed as part of this Project.

  Debris Study Timeline
  November 2010 - December 2010  Review literature and existing debris mitigation technology and engineering.

  December 2010 - January 2011  Provide ORPC with results from literature review of existing debris mitigation methods to help their design of a preliminary mitigation system. Provide preliminary concept designs for debris detection grate system.

  November 2010 - April 2011  Design methods and equipment to measure debris statistics in conjunction with the foundation design study.

  January 2011 - September 2011  Consult with ORPC on Debris Detection System during construction and installation.

  September 2011  Calibrate Debris Detection System.

  October 2011 - December 2011  Analyze data from the measurement program and
approach, and provide ORPC with guidance on design of a prototype Debris Mitigation Device.

May- September 2012 Operate Debris Detection System to collect data on debris in Tanana River; submit debris report to ORPC.

- ORPC environmental and site characterization data collection for Project design and FERC draft license application completed by October 1, 2010:
  
  October 10, 2010 TerraSond geophysical field work completed.
  
  January 6, 2011 Final report on geophysical work submitted to ORPC.

- Prototype bottom support frame and Debris Detection System fabricated, deployed, tested and retrieved at Project site, July – September 2011:
  
  March 1, 2011 PND Engineers, Inc. selected to design bottom support frame.
  
  May 1, 2011 Conceptual design selected.
  
  June 7, 2011 Design drawings completed for review.
  
  June 13, 2011 Permits for bottom support frame testing submitted to Alaska Department of Natural Resources, United States Army Corps of Engineers, and Alaska Department of Fish and Game.
  
  August 12, 2011 Completed anchor system shipped to Nenana.
  
  August 16, 2011 Bottom support frame assembly completed.
  
  
  September 13 – 22, 2011 Anchor and Debris Detection System deployed, tested, and retrieved.
  
  November 30, 2011 Bottom support frame quality check performed to ensure its fabrication is to spec. Location for bottom support frame systems testing selected.
  
  April 31, 2012 Bottom support frame systems testing complete at test site. Bottom support frame prepared to accept TGU for RivGen™ device testing.

- Additional field work required for FERC final pilot license application completed by October 31, 2011:
  
  March 31, 2011 Meeting with Agencies to scope Project’s Fish Study.
June 7, 2011  Fish Study plan finalized between ORPC and UAF.

August 15 – Sept 1 2011  Fish Study performed.

May 15 – August 15, 2012  Fish Study performed.

• TGU fabricated and tested at Eastport, Maine test site:
  February 1, 2012  TGU fabrication and assembly complete.
  March 1, 2012  TGU testing in Eastport, Maine complete.

• FERC final pilot license application submitted, or Verdant exemption qualification confirmed:
  January 31, 2012  FERC strategy and necessary permitting timeline defined.

• RivGen™ TGU built and tested at Eastport Maine test site
  March 1, 2012  Eastport testing complete.

• Final Report on Nenana site characterization work, bottom support frame and anchoring system, and Debris Detection System performance submitted to ACEP:

• Final performance report on RivGen™ TGU test in Maine submitted to ACEP:

3. Narrative Summary

RivGen™ Bottom support frame and Debris Detection System

Following the completion of the final design for the bottom support frame and anchor system, Marsh Creek, under contract to ORPC, began fabricating the bottom support frame and two prototype anchors. Marsh Creek hired a subcontractor Van Weld North to complete the fabrication on schedule. Fabrication of the bottom support frame and anchors was completed by August 16, 2011 (See Figures 2 and 3). As the bottom support frame was nearing completion, initial cost estimates of the testing at Nenana, which was also intended to be subcontracted to Marsh Creek, came in well beyond the budgeted amounts. The high estimates were due in large part to the oversized crane needed to account for uncertainties in retrieval loads. After several meetings discussing alternatives methods for retrieving the bottom support frame, ORPC and March Creek concluded that due to the potential for large sediment loads at Nenana a large crane would be required for safe operations. Because of this, the most reasonable way of bringing the initial bottom support frame testing costs within budget will be to test it at an alternate location without large sediment concerns. ORPC is currently investigating several options for this testing, including sites
in both Alaska and Maine, and intends to finalize a decision on the bottom support frame testing by November 2011.

*Figure 2. Entire bottom support frame under fabrication in early August 2011.*
While the Debris Detection System was undergoing prototype design, fabrication, and modification at Jon’s Machine Shop in Fairbanks, instrumentation was ordered. In addition, ORPC oversaw the assembly of the completed Debris Detection System and the installation of the System onto one of the prototype anchors (Figure 4). This system was ready for deployment on August 26, 2011, but due to concerns about deployment, this was delayed until September 13, 2011. Once deployed, AHERC will perform validation testing and calibration of the Debris Detection System until September 20, 2011, at which time it will be removed from the river for winter storage.
As part of the Debris Detection System deployment, the anchor will also undergo an initial deployment, retrieval, and pull tests. Additionally, testing the anchor’s retrievability after one week of deployment will provide the first quantifiable results that are necessary to inform sedimentation concerns for later phases of the Project.

**AHERC Debris Detection and Fish Study**

Due to delays in the deployment of the Debris Detection System, AHERC will be unable to collect rigorous data on debris loads in the Tanana River this 2011 season. AHERC will, however, calibrate the system over the week of its deployment, so that the system is validated and ready for a full season of deployment in 2012.

The UAF Fish Study, directed by Dr. Andy Seitz, began on August 15, 2011. This was later than scheduled due to delays in permitting, equipment acquisition, and field tests of the fyke net system. While operational, the fishing method proved effective and fishing efforts continued through August 30, 2011. UAF will continue this study in 2012 in order to complete a full season of pre-deployment data at the Project site.
RivGen™ TGU

Design of the RivGen™ TGU continues in preparation for testing in Eastport, Maine. Initial designs for the TGU components have either been finalized or are nearing completion. Fabrication of the generator is underway and is expected to be completed in November 2011. The initial turbine design is complete and has been sent out for fabrication bids. Vendors for the power electronics are also being selected as the power electronics design criteria have been established. Additional components are being designed and the TGU fabrication and assembly is scheduled to be completed in January 2012 with TGU testing in Eastport to begin in February 2012.

4. Before and After Pictures

See Figures 1-4.

Total Project Expenditures for the Project as of the end of the Reporting Period

Total Project expenditures as of the end of 3Q2011 include the following:

- Denali Funds $266,028.92
- ORPC Alaska Share $605,238.87

Total Expenditures to Date: $871,267.79

Modified Budget

Based on the more accurate quotes received for the Project over the past months and the addition of necessary line items for Project completion, as well as the omission of debris diversion system construction, several changes to the original Project budget have been made. This new budget and the revised Project scope will be submitted in September 2011.
UAF 11-0017: NENANA, ALASKA HYDROKINETIC RivGen™ POWER SYSTEM

Progress Report: FY 2011, 4th Quarter
Submitted: December 15, 2011

1. Total Project Funding

Denali Commission $830,325
ORPC Alaska $1,128,449

2. Updated schedule and milestone information as identified in the Project Work Plan

Project Deliverables

- Alaska Hydrokinetic Energy Research Center (AHERC) foundation and debris diversion literature surveys, data collection and final reports:

  Foundation Study Deliverables
  AHERC is no longer performing a foundation study for the Project. ORPC Alaska, LLC (ORPC) is utilizing third party engineering resources to complete the design.

  Debris Study Deliverables
  The final report on the debris study was submitted to ORPC on April 14, 2011 and may be provided upon request.

- Prototype bottom support frame (BSF) and Debris Detection System fabricated, deployed, tested, and retrieved at Nenana site.

  The Debris Detection System tests were completed at Nenana.
  After much consideration of the environmental and physical aspects of the Nenana site, ORPC determined that other sites would be better suited for testing the BSF. Therefore, the hydrostatic test was completed in Wasilla, AK, and all other tests were successfully conducted in Nikiski, AK. Please see details below in the narrative.

- RivGen™ turbine generator unit (TGU) built and tested at Eastport, Maine test site:

  Construction of the RivGen™ TGU continues in Maine. The Nenana project manager has relocated there from Alaska to facilitate construction. Details below.

- Final Report on Nenana site characterization work, foundation system, and Debris Detection System performance:

  AHERC has not completed the report on the debris detection system this will occur in Q1 2012.

- Final performance report on RivGen™ TGU test in Maine submitted to Alaska Center for Energy and Power (ACEP):

  No work to report.
Timeline

• AHERC foundation and debris diversion literature surveys, data collection and final reports completed December 31, 2010 (now anticipated December 31, 2011):

  Foundation Study Timeline
  November 2010 - December 2011 The foundation study has been removed from the AHERC scope of work due to the loss of key faculty performing the work. It will no longer be performed as part of this Project.

  Debris Study Timeline
  November 2010 - December 2010 Review literature and existing debris mitigation technology and engineering.
  December 2010 - January 2011 Provide ORPC with results from literature review of existing debris mitigation methods to help their design of a preliminary mitigation system. Provide preliminary concept designs for debris detection grate system.
  November 2010 - April 2011 Design methods and equipment to measure debris statistics in conjunction with the foundation design study.
  January 2011 - September 2011 Consult with ORPC on Debris Detection System during construction and installation.
  September 2011 Calibrate Debris Detection System, and perform initial deployment to verify the System’s design

• Prototype bottom support frame and Debris Detection System fabricated, deployed, tested and retrieved at Project site, July – September 2011:

  March 1, 2011 PND Engineers, Inc. selected to design bottom support frame.
  May 1, 2011 Conceptual design selected.
  June 7, 2011 Design drawings completed for review.
  June 13, 2011 Permits for bottom support frame testing submitted to AK Department of Natural Resources, US Army Corps of Engineers, and AK Dept. of Fish & Game.
  August 12, 2011 Completed anchor system shipped to Nenana.
  August 16, 2011 Bottom support frame assembly completed.

September 13 – 22, 2011  Anchor and Debris Detection System deployed, tested, and retrieved.

October 17, 2011  Bottom support frame quality check performed to ensure its fabrication is to spec. Location for bottom support frame system testing selected.

October 30 – Nov. 9, 2011  Bottom Support Frame tested in Nikiski, AK.

- **Fish Study:**
  - March 31, 2011  Meeting with Agencies to scope Project’s Fish Study.
  - June 7, 2011  Fish Study plan finalized between ORPC and UAF.
  - August 15 – Sept 1, 2011  Fish Study performed.
  - Winter 2011-12  Report completed as Master’s Thesis and submitted to peer review journal (to be determined and not part of this funding).

- **TGU fabricated and tested at Eastport, Maine test site:**
  - February 15, 2012  TGU fabrication and assembly complete.

- **RivGen™ TGU built and tested at Eastport Maine test site**
  - March 31, 2012  Eastport testing complete.

- **Final Report on Nenana site characterization work, bottom support frame and anchoring system, and Debris Detection System performance submitted to ACEP:**

- **Final performance report on RivGen™ TGU test in Maine submitted to ACEP:**
3. Narrative Summary

RivGen™ Bottom support frame (BSF) and Debris Detection System

Hydrostatic (QC) Test, 10/17/11
The goal of this test was to verify that the BSF was fabricated to specifications. Specifically, to verify that the main pontoons of the BSF were water-tight and that the riser tubes and air system worked to expel water from the main chambers.

Transport of BSF to Nikiski test site, 10/31-11/1/2011
The location of the testing was chosen to be in Nikiski, AK, at the Arctic Slope Regional Corporation’s (ASRC) facility. The successful delivery of the BSF to the ASRC facility showed that the BSF could be transported without incident and could be loaded and unloaded relatively easily with the proper equipment. A few concerns did arise. The height of the BSF was more than the legal limit due to the bow in the low-boy trailer. While this was not an issue for transporting the BSF within the state of Alaska, it could present a much bigger issue if attempting to transport the BSF across state lines. The loading was done successfully without incident, but it did show that the loading technique is important.

Loading/unloading was easily done with a big enough loader or a crane, however it may be difficult to accomplish in remote areas using the equipment on hand.

Figure 1: Layout of the Nikiski site.
The choice to ship the BSF on two trucks instead of one came from a nearly equal shipping cost for two trucks vs. one and the avoided complications associated with shipping on one truck. Part of the requirements for shipping the BSF on one truck was that additional oversized load permits would needed because of the total width of the shipment. Also, for an oversized load to be shipped, it needs to be “irreducible”: this would have required that the two main sections be welded together. Finally, additional cribbing may have been necessary to ship the BSF on one truck. Because of those complications, it made sense to ship the BSF on two trucks for this short trip. Future transport may require either due to cost or space (on a barge etc.) that the BSF is shipped on one truck. This procedure was not, however, tested during this transit.
BSF Assembly at Test Site, 11/1-2/2011

The assembly itself went quickly. Once the pieces of the BSF were lifted into place, it took about 10 minutes to bolt them together. The biggest concern from ASRC about the assembly was that they needed to use a crane in order to line up the second main section. In discussing this with the Marsh Creek field crew, they felt confident that a crane was not needed, but that using a loader and/or excavator to line up the sections would take significantly longer. ASRC however did not feel comfortable using their equipment to perform this. It was later pointed out that part of the hesitancy on ASRC’s part might have been a result of their experience in the oil industry, where any damage to a pipe ruins the pipe. Before going to a remote site, it will be necessary to attempt to assemble the BSF using equipment similar to what is going to be available at that site. This may require convincing operators to step outside of their comfort zone in order to use smaller equipment even when bigger machines might be available.

Figure 2: Unloading the BSF sections using the ASRC crane


The objective was to test the entire BSF system before placing it in the water. Specifically, this test validated that the air and water systems could successfully pump water into and out of the BSF and that it was possible to control the flows in and out of individual chambers. It would also determine the time needed to perform the operation.

All of the major issues that were encountered during the land-based test centered around the water system. It was clear that the pumping system needs to be refined. The original pumps may still work in the field, since the actual suction head is unlikely to be more than the height of a barge/boat deck, however these pumps need to be vetted before they can be relied on in a remote application. While the low-pressure of the screw-sucker pump was beneficial for a first test because it greatly reduced the risks associated with higher pressure, operating at such a low pressure may not be recommended in the field.

The water hoses themselves constituted the next major issue. The 2” vinyl discharge hoses were chosen for this test because of their flexibility, availability, and relatively low cost. It quickly became apparent that the hose’s flexibility was more of a detriment than a benefit. Because any pinch in the hose resulted in reduced flow, it took a large amount of work to ensure that water was continually able to flow.

Figure 3: Lifting the second main BSF section into place
Because the water was not able to flow through each hose at the same rate, having a reliable way to measure the amount of water in each chamber became even more important. Unfortunately, the water gauges/flow meters purchased for this purpose were found to be unreliable. This test made clear that a more reliable system needs to be determined for measuring the amount of water in each chamber. This is true not only for when the water is entering the BSF but also when it is being discharged.

Figure 4: Fully Assembled BSF with trained air and water hoses

Despite the issues with the water system, the overall test was generally successful. The water was able to completely fill the BSF in an acceptable amount of time, and it was able to be pumped out of the chambers with even more efficacy. Additionally, the system was shown to be able to operate, and even operate better, at pressures up to 100psi. While there are greater risks associated with higher pressures, they do result in faster discharge of the water and reduce the issues associated with kinked hoses.

Water-Based Systems Test, 11/3-4/2011

The objective was to test the entire BSF system in still water. This included picking the BSF with a crane and lowering it to the intertidal zone to “launch” it, securing the BSF to the ASRC RigTenders dock, confirming flotation when the tide came in, performing a sink test by filling the BSF with water, performing a float test by purging the water and refloating the BSF, and removing the BSF from the Inlet with a second pick by crane.

Description of Tasks Sequence:

Initial Crane Pick

Following the completion of the land-based test, the water hoses were removed from the BSF and the air hoses were secured to the BSF. Peak Oilfield Services arrived onsite at approximately 5:30pm in order to conduct the first lift during low tide.

Once the rigging was completed, the BSF was lifted by Peak’s 100ton crane and rotated over the water-based testing area. It was then lowered into place. During the pick, the total weight of the BSF was measured at 27,500lbs. This was 500lbs over the estimated weight, but well within the crane’s capacity. Once lowered, the BSF was adjusted over the landing area, in order to get the BSF as far from the dock as possible the crane extended until it reached the full 75% capacity that was the maximum allowed by the lifting plan. The BSF was grounded approximately 7ft from the dock. At which time the Peak rigger detached the rigging and Peak moved their crane to a storage location in the middle of the ASRC dock.
Prior to the lift there had been some concern that the pick points, which were mounted vertically on the main BSF pontoons, would be bent during the lift. This proved not to be an issue.

**Securing the BSF**

ASRC had developed a plan for securing the BSF that included driving two pipes into the gravel of the inter-tidal zone. These pipes would be used to pull the BSF away from the dock. This would allow the BSF to be secured from each of its four ends, two from the dock and two from the pipes. In preparation for this, ASRC cut two 5” pipes on 1 1/2 and welded 1” holes into the top of them. ORPC provided shackles to go through these holes on which ropes could be secured.

While the posts were intended to prevent the BSF from contacting the dock, tires were tied onto the BSF on the outside of both main pontoons to act as fenders and to protect the BSF should it hit the dock.

Once the second post was driven into place the BSF was secured to the posts using 3/4” nylon rope. Because the posts would be below the water line for much of the time that the BSF was floating, the ropes were secured to the angled pick-points (between the main pontoon and the diagonal braces) on the BSF.
These ropes were tied nearly tight at a length of 10ft from the post. The length was chosen so that the BSF would be pulled away from the dock as the water level rose, but would be long enough so there would be some slack even at high tide.

The BSF was fixed to the dock using 1” polyrope. These lines were fixed to the BSF at the diagonal pick-points via 1” shackles. They were then sent up to the dock to cleats on the dock where they could be adjusted as the water rose. An additional 3/4” nylon rope was tied from the vertical pick-point on the near side of the cross sectional pipe. This too was secured to a cleat on the dock face.

After checking the air hoses, the BSF was deemed ready for the tide to come in. The entire securing process took approximately 30 minutes.

Because the dockside ropes would need adjusting as the tide came in and because this would represent the first time the BSF floated, it was determined that at least one person needed to be present the entire time the BSF was in the water. In order to accommodate this, one member of the Marsh Creek crew started his shift at 3pm and would be able to stay on site until 1am at which point ORPC would take over the watch.

An additional light source was also rented from ASRC to illuminate the BSF.

Approximately 3 hours after the BSF was first secured the water reached a level that allowed it to fully float. Although the area was generally protected from waves, the surf was large enough so that as the BSF floated it routinely put tension on its lines. By high tide the ¾” rope which ran from the pad eye on the cross-sectional pipe had broken. This break was due to the abrasion at the pad eye where a shackle was not used. In addition, the two 1” polyrope lines were being abraded by the ends of the tie-down rail, and one of the polyrope lines had broken two out of three of its strands. In order to prevent the line from breaking entirely and to help keep the other polyline from being abraded further, additional slack was kept in both of the main lines, allowing the two ¾” lines to take on most of the load.

In order to help secure the BSF, two additional lines of ¾” rope were, from the pier, looped around the two access ports on the dockside pontoon. These lines were kept loose as safety lines in the event that the lines holding the BSF were also abraded through. A line was also slid down the un-broken 1” polyrope. The free end of this line could be pulled from the dock in order to keep the polyrope line from abrading on the tie-down rail.

At 6:30am the Marsh Creek crew and ORPC returned to the BSF. The polyrope lines were attached to the pick-points at the top of the BSF pontoons so as to avoid rubbing against the tie-down rail. The ¾” line that was attached to the dock-side pick-point on the center section was replaced by instead looping the rope around the entire center pipe, which eliminated the edges of the pick point. The lines connecting the BSF to the pipes were inspected and no issues were found on them. The 1” polyrope lines were replaced.
and attached to the upper pick-points on the main pontoon rather than the side points. By attaching to the upper points, the hand-rail abrasion issue was avoided.

*Initial Water Test*

During the first low tide, at 6:30am on 11/4, in addition to refining the securing method (as detailed above) the Marsh Creek crew and ORPC attached the water hoses to the BSF and carefully trained them to the surface, in order to help avoid the problem of constrictions developing in the flexible hose.

By 8:00am the hoses were successfully trained and the BSF secured, at which point the tide began to rise and by 10:30am the BSF was again floating.

Although it was calculated that the BSF could sink without filling the cross-sectional chamber, it was determined that the chamber should be filled to ensure that the BSF would sink. At 10:50am the center chamber began to fill. This section was completely filled by 11:16am, at which point its meter read 1186gal, which was nearly the capacity of the chamber. The center member was completely filled before filling the remaining four chambers to help ensure stability and prevent sloshing that could be associated with a partially filled cross-member.
At 11:16am the remaining four chambers began to be filled, at which point only two of the remaining water meters appeared to be registering flows. After 12min of pumping, the “upstream” side of the BSF was noticeably lower than the “downstream” side; as a result the lines to chambers 3 and 4 were partially closed. Over the next 30min, the flows were consistently adjusted to maintain the orientation of the BSF as much as possible.

At 12:05pm, 46minutes after the four main chambers began to be filled, the “downstream” end of the BSF submerged and engaged the bottom. Once submerged, the lines to chambers 1 and 2 were closed so that chambers 3 and 4 could better fill. After 12minutes of pumping, at 12:17pm the entire BSF was submerged. At 12:18pm all of the hoses were re-opened in order to completely fill the remaining chambers. Chambers were determined to be full once water was pushed out of the air hoses. At 12:21pm chamber 3 was completely full although its gauge read 0gal. At 12:32pm chamber 4 was full, its gauge read 1711gal. At 12:38pm chamber 1 was full; its gauge read 1423gal, and the final chamber was full at 12:40pm with a gauge reading of 0gallons. The calculated capacity of each of the main chambers was 1697gallons.
Once the BSF was completely filled, the air hoses were attached to the air manifold and the water hoses were trained so that they would pump the water back into the Inlet. The pipes with the flow meters were left on during this test in order to see if the gauges could work. Otherwise, there is little way of gauging the amount of water that is being forced out of each chamber.

At 1:07pm, the air compressor was turned on and all of the hoses were opened. As Figure 10 shows, high flow were achieved out of each of the five chambers. Although the flow meters were not reliable during the filling of the BSF, throughout the evacuation, each of the five flow meters indicated rates of up to 100gal/min flowing out of each chamber. At 1:14pm, after 7 minutes of pumping, the “upstream” chambers 3 and 4 surfaced. 3 minutes later, the entire BSF was floating. At 1:26pm chamber 5 was empty, and at 1:29pm, 22 minutes after evacuation began, all five chambers were emptied. Throughout the test, the pressure in each line was kept between 50 and 80psi.
Throughout the raising and lowering of the BSF, the polyrope lines attaching the BSF to the dock were loosened and tightened as needed without incident.

**Second Crane Pick**

At about 6pm enough water had receded so that Marsh Creek and ORPC could begin to detach the BSF rigging, air hoses, water hoses, and pump out the remaining water from each of the five chambers. This was completed by 6:30pm, at which time Peak was ready to begin the lift. As with the initial lift, Peak used their lift plan and were able to remove the BSF without incident. Once over the dock, the BSF was blocked as carefully as possible in order to facilitate the disassembly. By 7pm the BSF pick was complete and the rigging removed.

![Figure 16: Second Crane Pick and BSF Blocking](image)

**Conclusions/Recommendations:**

**First Crane Pick**

The first pick went well. Peak arrived with a good lift plan in place and they were able to follow the plan without incident. In order to get the BSF away from the dock and into the designated testing area, the crane reached 75% of its rated capacity. While that was acceptable for this lift, if there was additional weight or if the landing location was farther from the dock, then the lift would have been considered critical and further preparation and oversight would have been necessary. This points to the likelihood that a larger crane will be necessary when the TGU is included on the BSF.

**Initial Water Test**

The initial water test proved the concept for raising and lowering the BSF and generally increased ORPC’s confidence in using this method for deployment and retrieval of the device. Throughout both filling and evacuating the BSF, the water and air manifolds provided a good level of control, and for most of the test the BSF was able to maintain its orientation as desired. The notable exception to this came at the instant that one half of the BSF overcame its buoyancy. At this point, the “downstream” end of the BSF sank until it encountered the bottom. While this was not intended during the initial testing, it is likely to be the desired manner for sinking the BSF. By sinking one half of the BSF at a time, there remains an element of the BSF which is surface piercing thus allowing overall stability to be maintained. In addition, once the submerged side of the BSF engages with the bottom that creates a pivot point that also adds to the stability of the BSF as it sinks. In order to enhance this effect, it may be necessary to add extension pieces to the downstream end of the BSF so that it can engage with the bottom more easily, especially when the upstream end is attached to anchors or when the water depth increases.
The largest issue that came about during the test, which needs to be addressed, is the system for pumping water into the BSF. Although the water hoses were carefully trained, some of the hoses still had constrictions, which slowed the flow to their chambers. The result was that throughout the filling, some of the hoses had to be shut off in order to allow for other chambers to fill. One possible solution to this problem is to use stiffer hose and to hard-plumb the hose on the BSF, since that is the area where the hoses will encounter bending and kinking. In addition, the flow meters proved to be ineffective, possibly because the flow through each pipe was not enough to completely fill the cross-sectional area, or perhaps because flow was not fully developed when it reached the flow meter. It may also be that the flow meters were simply faulty. Regardless of the cause, it is clear that a solution needs to be determined in order to accurately gauge how much water has entered each chamber. During this test, the amount of water in each chamber was monitored by visually judging the orientation of the BSF as it filled. While this was not precise, it was effective and showed that even without the best information; the BSF could safely be submerged. Additionally, the rate at which the BSF filled and submerged met expectations.

During evacuation, many of the issues regarding the slowing flow through hose constrictions, was not noticed. All of the chambers were evacuated at roughly the same rate. It is suspected that the increased pressure of the system during evacuation allowed the water to more easily push through any constrictions. This points to a possible solution in filling the BSF, which is to use higher pressure pumps. While the Screw-Sucker pump was effective in overcoming the suction head and in moving large volumes of water, it did so at a very low pressure. This was initial seen as positive from a safety standpoint, however during evacuation, increasing the pressure had clear benefits to effectively moving the water. The rate at which the BSF was evacuated and returned to the surface greatly exceeded expectations; this was very pleasing as it will potentially allow for much faster removal of the device.

In addition to refining the hose and flow monitoring systems, the next rounds of testing should be conducted using the same pumps and compressor(s) that will be in the field. In both cases, the pump and compressor used in the first round of testing were likely larger versions of what will be available in remote locations. In order to overcome the suction head issue that small pumps encounter, it may be necessary to conduct the next tests from a boat, which will also help to better replicate the environment that will be encountered in the field.

BSF Disassembly and Storage, 11/5-8/2011
The objective of this stage was to prepare the BSF for winter storage including flushing out the BSF chambers in order to dilute the salt concentration. Ideally the BSF would remain assembled throughout the winter to facilitate future testing operations. Unfortunately size restrictions at the ASRC storage facility would not allow this, so the BSF had to be disassembled.

Description of Tasks Sequence:
At 7am the Marsh Creek crew began to disassemble the BSF. They began by removing most of the bolts from the two main flanges. Once the ASRC 120 loader arrived, the center section was secured to it and the loader pulled tension on the center section. Once secured to the loader, the remaining bolts were removed and the center section was pulled away from the rest of the BSF. The disassembly took about 30min, although additional time was spent waiting for the loader.

Following the disassembly, the Marsh Creek and ORPC crews had a formal debrief about the entire test period, the conclusions of which have been included in the previous sections.
On 11/7 the majority of the components were prepared for storage. This mostly consisted of flushing all of the hose ends, bolts, manifolds, and other metallic parts with fresh water. In addition, the bolts for the main BSF flanges were dried and sprayed with oil to prevent corrosion. These bolt were then sealed in 5gallon containers. The rest of the components were dried, boxed, and placed in fish totes for winter storage.

Because of difficulties getting their water truck running, the ASRC water truck was filled over the night of 11/7, under the supervision of ORPC. On 11/8, this truck was moved to the BSF in order to use its water to flush out the BSF.
The fresh water from the water truck was pumped into each of the four main chambers. Fresh water was also used to rinse the entire outside of the BSF and the entire cross-sectional member, inside and out. Using both of the trash pumps, it took approximately 7hrs to completely flush out the entire BSF.

On 11/21, ASRC was able to move the BSF up to their upper yard. The delay was caused because that was the first availability of their 45ton crane. The three sections were moved to the storage facility in less than two hours.

Conclusions/Recommendations
The original plan was to leave the BSF assembled for winter storage. This however, was deemed to be impractical. Because of the large size of the assembled BSF it would have been extremely difficult to move it up to ASRC’s storage location. In general the storage of the BSF was successful. Although the time needed to flush out the BSF was more than expected, the water truck and pump system eventually worked to clean each of the chambers. Despite that, corrosion is still a concern, as are the effects of freezing and thawing water which could collect in cavities of the BSF. The true efficacy of the storage will be seen in the spring.

AHERC Debris Detection and Fish Study
AHERC completed the field work for the debris detection device calibration in September, but has not yet begun data analysis and reporting AHERC completed the fish study in August and has completed some data analysis of the 2011 work.

RivGen™ TGU
The RivGen™ TGU is on track for testing in Eastport Maine in March 2012. Fabrication on the driveline components has begun; seals have been ordered, and the bearings are being ordered. ORPC has decided to re-use the Beta couplings, which will be “refurbished” starting in the end of December. ORPC’s engineering team in Maine has completed the turbine design and tooling fabrication will be completed by December, 31. The generator is nearly completed, as it is currently scheduled to be completed in early January and tested through the end of January at Comprehensive Power Inc. (CPI). Design for the chassis/frame is underway and will be complete by the end of December; fabrication of the frame is scheduled to begin before January. The design of the power electronics and the SCADA system is nearly complete, and most of the power electronics and instrumentation for the ET2 testing have been ordered.


Total Project Expenditures for the Project as of the end of the Reporting Period

Total Project expenditures as of the end of 4Q2011 include the following:

- **Denali Funds**
  - $483,322

- **ORPC Alaska Share**
  - $760,323

Total Expenditures to Date: $1,243,645
UAF 11-0017
NENANA, ALASKA HYDROKINETIC RivGen™ POWER SYSTEM

PROGRESS REPORT: 4Q2012

MARCH 15, 2012

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Progress Report: FY 2012, 4th Quarter
March 15, 2012

Narrative Summary
The goal of the Nenana, Alaska, Hydrokinetic RivGen™ Power System Project (Project) was to assess and demonstrate the potential of a hydrokinetic power system in Alaska (Figure 1). The Project proposed to finalize site and technology concerns in preparation for deployment of ORPC’s RivGen™ turbine generator unit (TGU) at Nenana, Alaska. The Project included the design and building of a bottom support frame and debris diversion system as well as pre-deployment fish studies, which were completed by University of Alaska Fairbanks School of Fisheries under AHERC’s work at the Nenana site in August 2011.

Figure 1. The RivGen™ device.

During the last quarter of the Project (January – March 2012), construction of the RivGen™ generator, a direct-drive permanent magnet generator, was completed in February 2012. The generator was then shipped to Alexander’s Welding and Machine in Greenfield, Maine, for final assembly to the rest of the turbine generator unit (TGU) on March 19.

Meanwhile, the RivGen™ advanced design cross flow (ADCF) turbines were fabricated and assembled by Hall Spars and Rigging of Newport, Rhode Island. The foil molds were completed on January 6. Once the molds were completed, foil fabrication began. On February 1 the first RivGen™ foil was fabricated, and by February 16 all of the foils were completed and ready for the foam core to be added (Figure 2).
The final designs for the disks, shaft, and alignment system were analyzed and accepted in early January. The steel turbine shaft fabrication and machining were completed on February 15, and by February 24 all of the turbine components were completed. Assembly of the turbines was completed and inspected by early March, and the turbines were shipped on March 5, 2012 (Figure 3).

The entire assembly was completed on March 26 and was shipped on a flatbed truck to ORPC’s testing facility in Eastport, Maine, on March 27 (Figure 4).
Once the TGU arrived in Eastport, Maine, at Perry Marine and Construction’s (PMC) Deep Cove facility, it was prepared for attachment to ORPC’s research vessel, the Energy Tide 2.

On March 29, the Energy Tide 2 was brought from its mooring to the boat ramp at the PMC facility and then driven from the staging area to the boat ramp (Figure 5). During this pick, the total weight of the TGU was confirmed to be 21,800 lbs.

Figure 4. Assembled TGU.

Figure 5. Initial loading pick.
Once at the boat ramp, the two cranes lifted the TGU off of the flatbed and moved the TGU to the Energy Tide 2 (Figure 6).

![Image](image_url)

*Figure 6. Moving the TGU to the Energy Tide 2.*

On April 6, the Energy Tide 2 was moved from the boat ramp to the Shackford Head mooring during the morning’s high tide. The Energy Tide 2 was successfully attached to the mooring and preparations were made for the first tests of the RivGen™ TGU, which commenced in April 2012 (Figure 7).
Figure 7. Moving the RivGen™ TGU on the Energy Tide 2 to the test site.