WBS 1.1.1.508 – National Conduit Resource Assessment

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July 27, 2022

Project Overview

Project Summary

- The hydropower potential from man-made water conduits (e.g., pipelines, irrigation ditches, water conveyance canals) has been estimated as being relatively small but having the highest development feasibility. This type of small hydropower development does not require the construction of new dams and may qualify for an expedited 45-day regulatory process through HREA of 2013 and its amendments in AWIA of 2018. To quantify the national conduit hydropower resource potential, a reconnaissance-level assessment is being conducted for main water sectors in the United States.

Intended Outcomes

- The main product will be a publicly accessible resource assessment report that aggregates resource findings to both state and county levels without revealing sensitive site information.
- Currently, many water agencies have limited knowledge of the federal reforms created by HREA and have little understanding of how small hydropower can be quickly built using existing water infrastructure. The products of this assessment can help raise public awareness of this clean and renewable resource potential.

Project Information

Principal Investigator(s)

- Shih-Chieh Kao, Carly Hansen, Scott DeNeale

Project Partners/Subs

- Small Hydro Consulting (Subcontractor)
- Telluride Energy (Subcontractor)
- Upstream Tech (Subcontractor)
- Kearns & West (Subcontractor)

Project Status

Ongoing

Project Duration

- Project Start Date: October 1, 2019
- Project End Date: September 30, 2023

Total Costed (FY19–FY21)

$595,094

Project Objectives: Relevance

- **The project supports the following elements in the WPTO Multi-year Program Plan**
  - Challenges:
    - *"Limited opportunities for new, affordable hydropower growth"*
  - Approaches & Activities:
    - *"Innovations for low-impact hydropower growth"*
      - *"Explore opportunities for new development in which hydropower is a critical enabler of a larger suite of benefits"*
  - Intermediate Outcomes
    - *"Increased developer interest in hydro projects that utilize new value propositions beyond generation"*
  - Long-term Outcomes
    - *"Deployment of new, small, low-impact hydropower projects in the U.S. that integrate multiple social, ecosystem, and energy needs"*
- **Overall, we expect to raise public awareness and promote further growth of the US conduit hydropower**

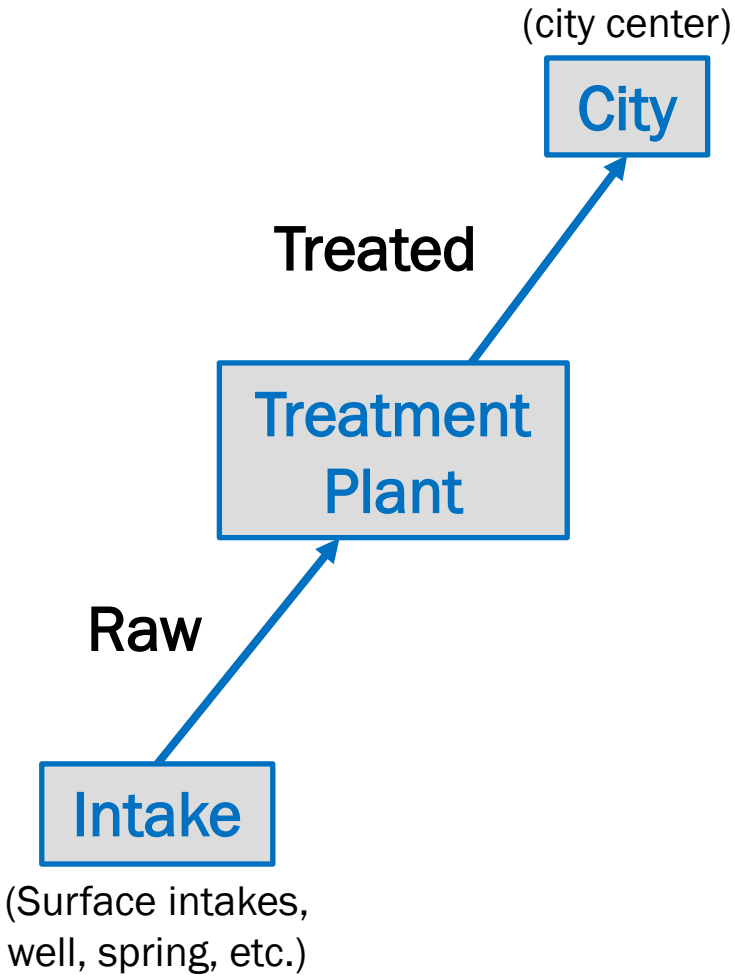
Project Objectives: Approach

- **Conduit hydropower is a low hanging fruit**
  - Use **existing** water pipelines, irrigation canals, and other industrial water conveyance structures
  - Low development risk & environmental concerns
  - Potential for net metering
  - Expedited 45-day permitting process through HREA of 2013 and AWIA of 2018
- **The total resource potential has not been quantified.**
  - Roughly 1–2 GW was guesstimated by DOE (2016)
- **We are conducting a reconnaissance level hydropower resource assessment to understand the total conduit potential across the nation**
  - Municipal sector
  - Agricultural sector
  - Industrial sector

Water withdrawals by sector (Maupin et al., 2014)

Assessment Procedure – Public Water System

- Biggest source for both municipal and industrial sectors
- Pilot study for CO and OR (Kao and Johnson, 2018)
- Simplified conduit model, 2-part analysis
  - Part 1 – **raw water**, from intake to treatment plant
  - Part 2 – **treated water**, from treatment plant to city center
- Flow
  - Q_{annual} = service population (from EPA) * 2011–2015 per capita water use (from USGS)
  - $Q_{turbine} = Q_{annual}$ / (capacity factor)
  - Flow contains both domestic, industrial/commercial
- Head
  - H_{net} = elevation drop – estimated head loss
- Power and energy
  - Power = c * γ * efficiency * H_{net} * $Q_{turbine}$
  - Energy = Power * Time



Assessment Procedure – Agricultural Irrigation System

- Identify drop locations within open water ditches and canals that are primarily used for irrigation
- Use remote sensing imagery and feature detection techniques for systematic identification of national canal drop sites
  - Uses NAIP imagery as input. Training data includes:
    - Known sites
    - USBR (2012) inventory
    - Other public datasets (Campbell, 2012)
  - Use USBR Canal Design Standard to approximate canal geometry and flow

Project Objectives: Expected Outputs and Intended Outcomes

Outputs:

- **Estimated conduit hydropower potential across the US**
  - By sectors, counties, and states
- **A publicly accessible resource assessment report**
  - Similar to 2012 NPD and 2014 NSD
- **Resource data aggregated to both state and county levels without revealing sensitive site information.**
  - Share through ORNL HydroSource

Outcomes:

- **Raise public awareness of this clean and renewable resource potential.**
  - Many water agencies have limited knowledge of the federal reforms created by HREA and have little understanding of how small hydropower can be quickly built using existing water infrastructure.
- **Inform WPTO future RD&D activities for US conduit hydropower**

Project Timeline

FY20

- **Municipal**
  - Data collection
  - Estimate 30% of states
- **Agricultural**
  - Colorado pilot study (go/no-go)
- **Industrial**
  - Water utilization analysis

FY21

- **Municipal**
  - Estimate potential for all states
- **Agricultural**
  - Implementation across 17 western states
- **Industrial**
  - Resource evaluation

FY22/23

- **Documentation**
- **External review**
  - May 2022
- **Report & data release**
  - Expected Oct 2022
- **Stakeholder engagement meetings**
  - Now through 2023

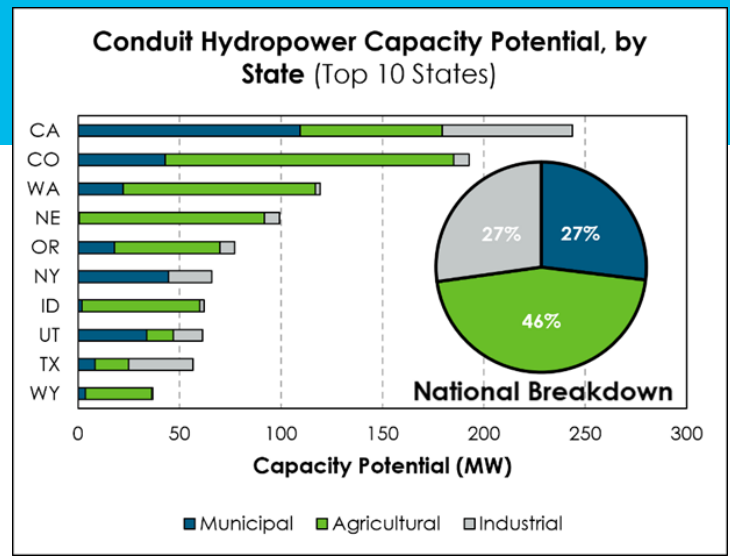
Project Budget

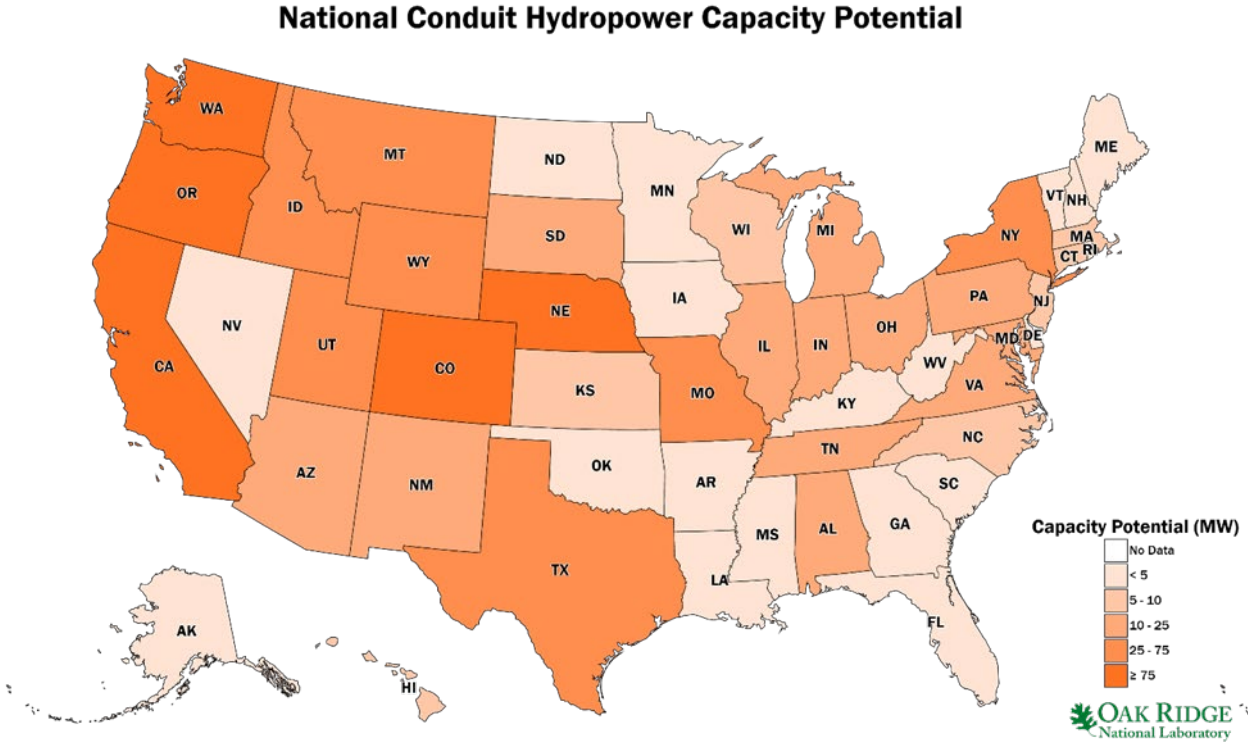
FY19	FY20	FY21	Total Actual Costs FY19–FY21
Costed	**Costed**	**Costed**	**Total Costed**
$0K	$268K	$327K	$595K

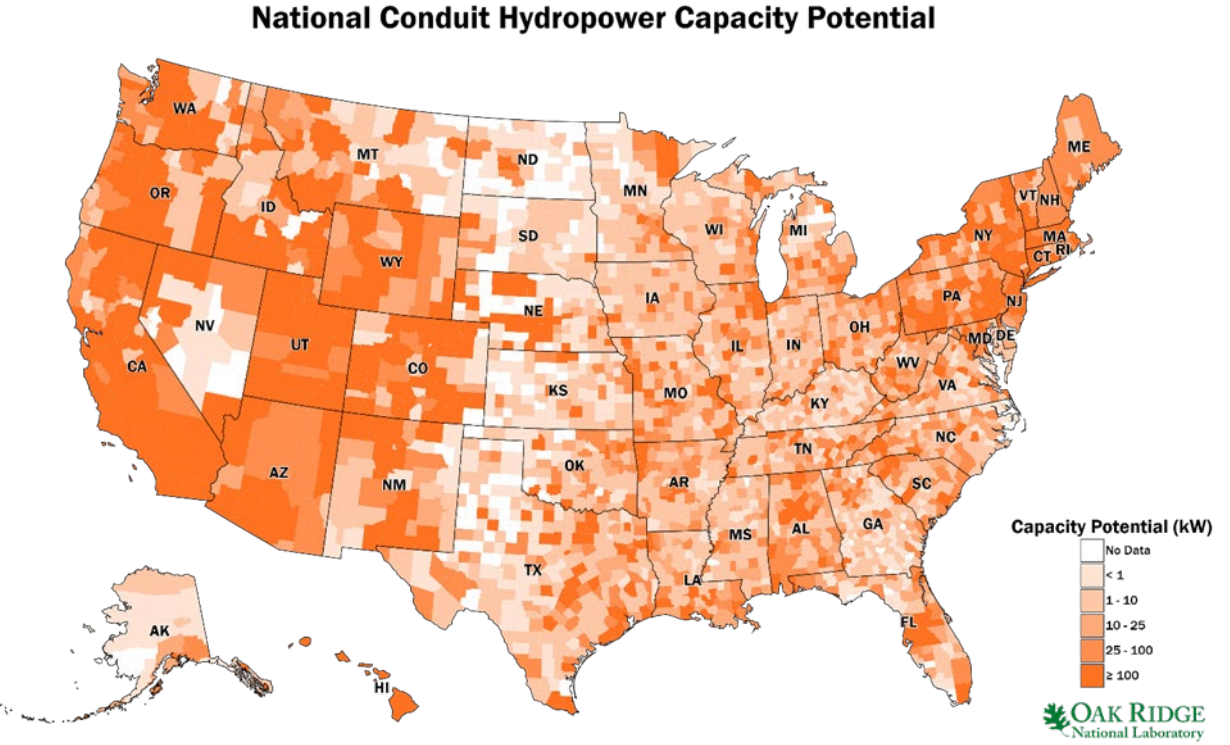
- The original project timeline and spending were adjusted from two years to three years due to the impacts of COVID-19.

Performance: Accomplishments and Progress

- **Preliminary findings:**
  - Total: 1,395 MW
  - Municipal: 381 MW / Agricultural: 637 MW / Industrial: 378 MW







End-User Engagement and Dissemination

- **Engaged leading industrial partners in the assessment team**
  - Small Hydro Consulting, Telluride Energy, Upstream Tech
- **Conducted expanded external review to solicit stakeholder feedbacks**
  - May 2022 – Invited over 30 external experts (researchers, asset owners, consultants, agency staff)
- **Targeted stakeholder engagement meetings during FY22–FY23**
  - Supported by Kearns & West
  - Two national stakeholder meetings
    - Clean Currents
    - American Water Resources Association
  - Three regional stakeholder meetings
    - States with highest conduit potentials (TBD)
- **Final report and data will be distributed through the ORNL HydroSource Portal.**

Next Steps

- FY22/FY23
  - External review (May 2022)
  - Report & data release (Expected Oct 2022)
  - Stakeholder engagement meetings (Now through 2023)
- Potential future work
  - **Enhance conduit hydropower resource characterization**
    - Collaborate with water and irrigation districts to understand the most likely opportunities, as well as the regional challenges and considerations
  - **Understand the development challenges and required incentives**
    - Better understand the cost-benefit aspect of conduit hydropower development through a comprehensive techno-economic assessment, particularly in regard to suitable mechanisms for cost recovery.
  - **Explore novel water distribution concepts and technologies**
    - Consider conduit hydropower development through an integrated site development approach
  - **Increase public awareness**
    - Continue to raise awareness among water entities across multiple sectors

Q&A