SAND2014-3566C

FIELD MEASUREMENT TEST PLAN TO DETERMINE EFFECTS OF HYDROKINETIC TURBINE DEPLOYMENT ON CANAL TEST SITE IN YAKIMA, WA, USA

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

NNSA National Nuclear Security Administration

Sandia National Laboratories

Motivations

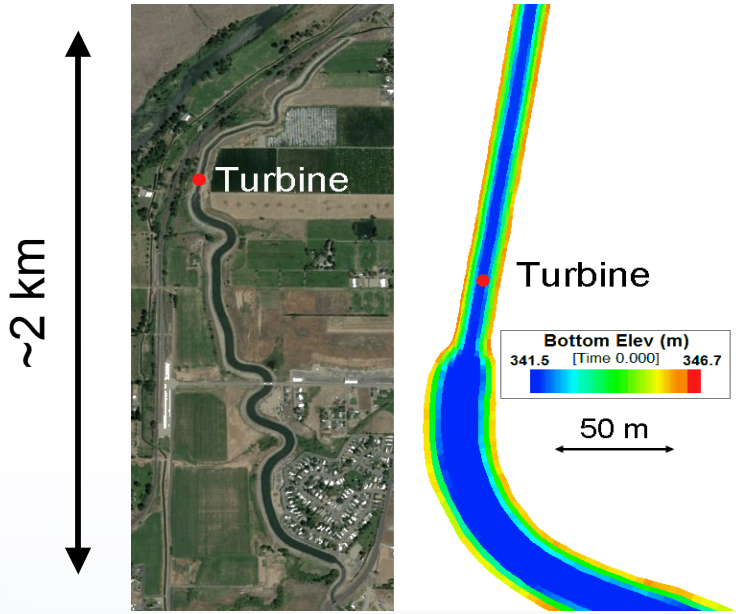
The US canal system comprises tens of thousands of miles of canals; some have the potential to be developed as a HK energy site.

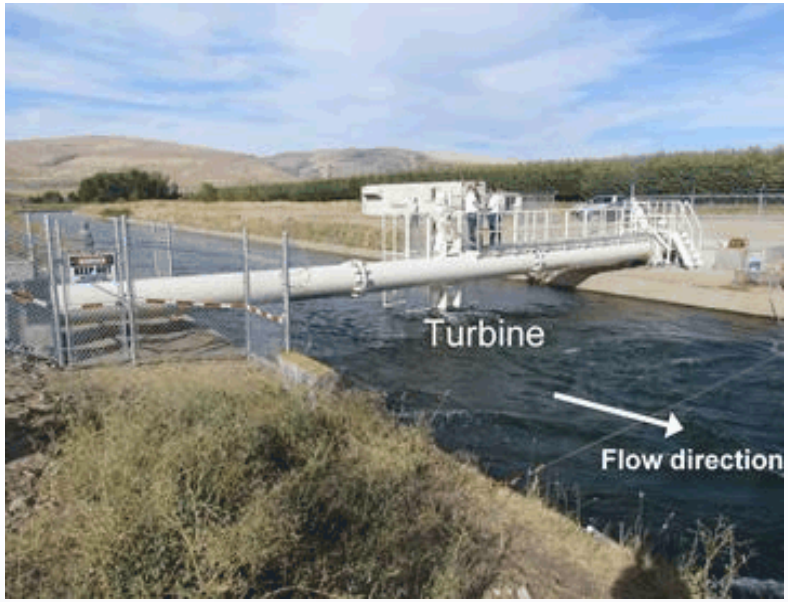
- Effect of turbine deployment on water operations in canals is not well understood
- Full-scale testing of HK device in canals is lacking

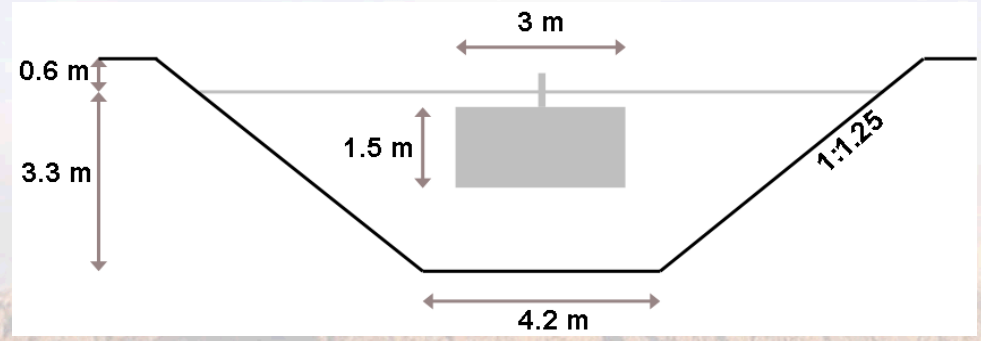
Objective: Conduct a set of comprehensive measurements at a HK test site in Roza Canal, Yakima, WA, to study the effect of turbine deployment on water operation, the wake flow dynamics and the turbine performance

Measurements include: water level, velocity, thrust, torque, bathymetry

Site characteristics







Measurement test plan (2014)

Performance testing and analysis

Field measurements

- Water levels (pressure transducers, ADCP)
- Inflow and wake velocities (ADCP, ADV)
- Turbulence (ADV, ADCP)
- Thrust and torque
- Bathymetry (echo sounder)

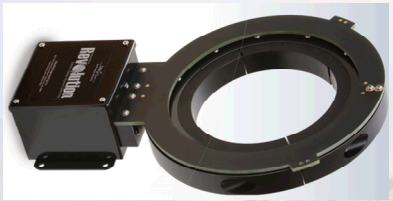
– **Analysis of all flow field measurements around device**

– **Develop performance curves**

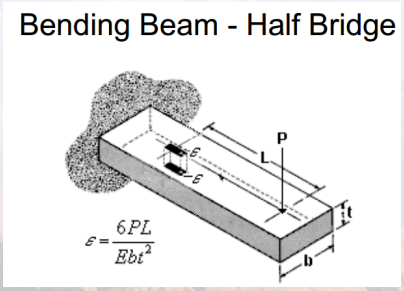
– **Measurement uncertainty quantification and propagation**

ADCP tethered boat

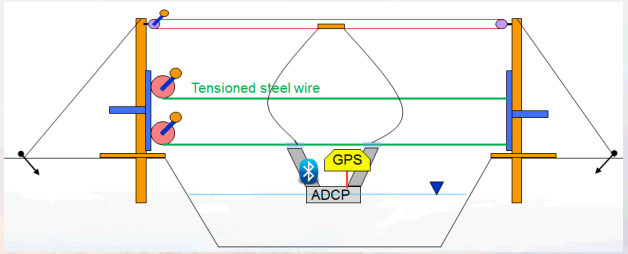
Remotely controlled survey boat with GPS



Torque and thrust sensors

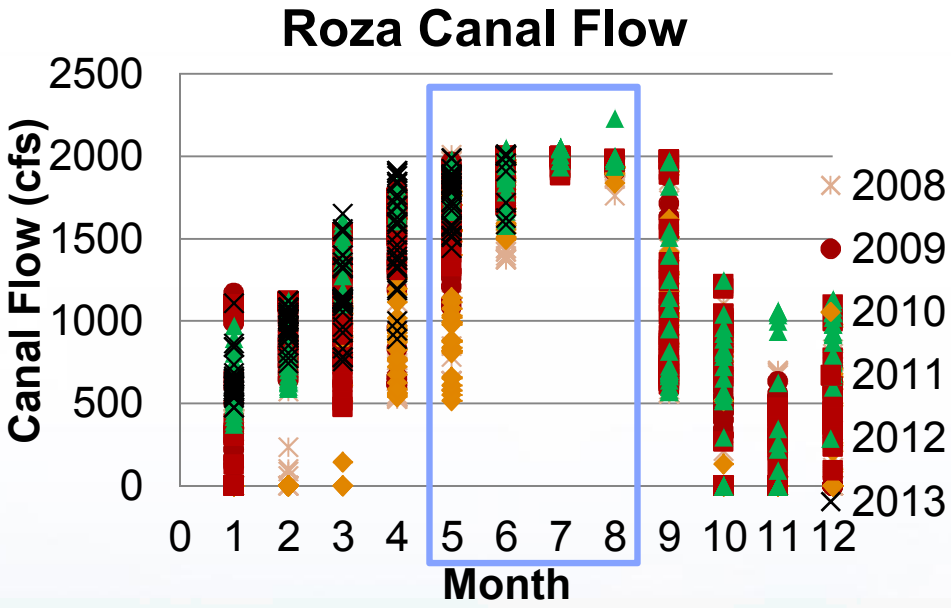


Thrust calculation from strain measurement

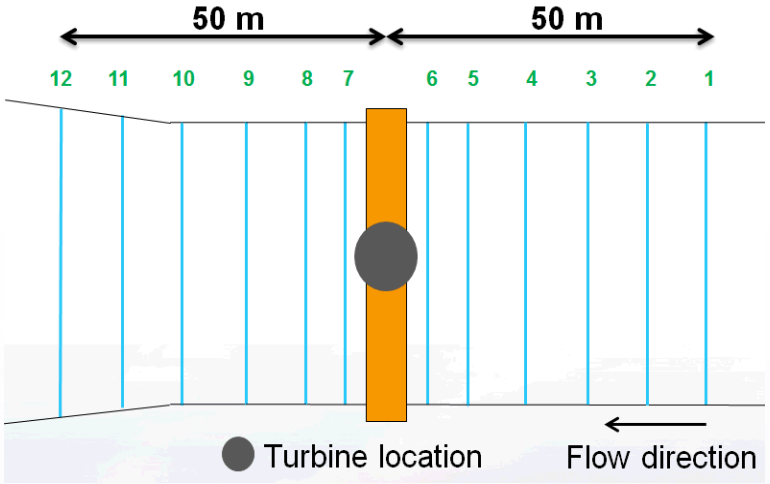


Cableway system for ADCP and ADV deployments

Measurement test plan (2014)



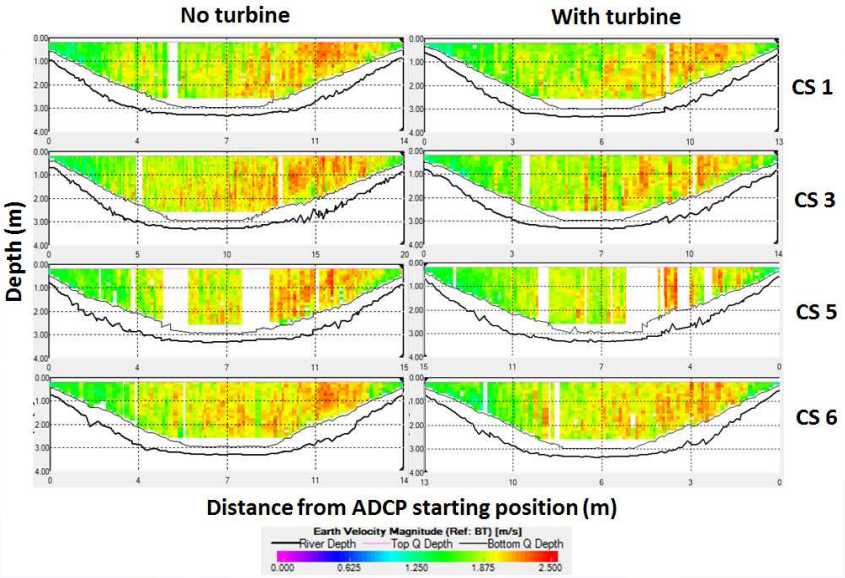
Daily canal flow (2008 -2013)

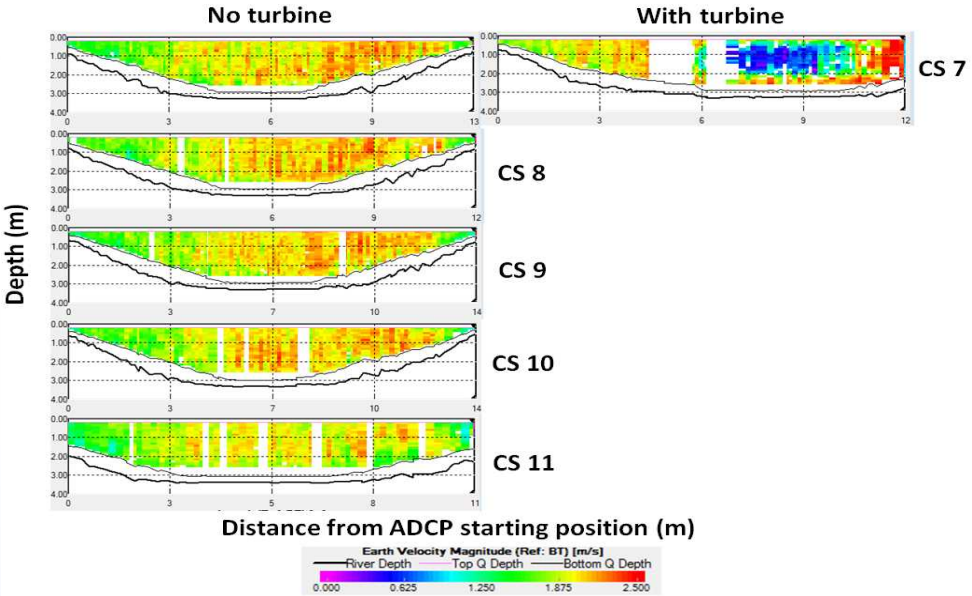


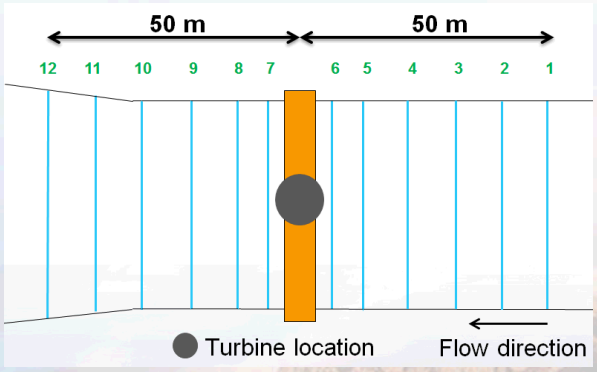
Locations of water level and velocity measurements (blue lines)

$$z_1 + y_1 + \alpha_1 \cdot \frac{{V_1}^2}{2g} = z_2 + y_2 + \alpha_2 \cdot \frac{{V_2}^2}{2g} + h_m + h_f + h_t + h_b$$

Test measurements 2013



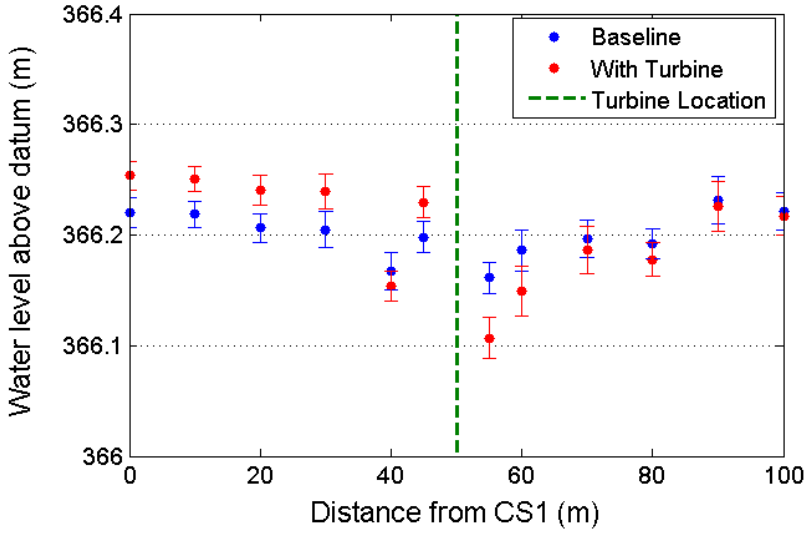




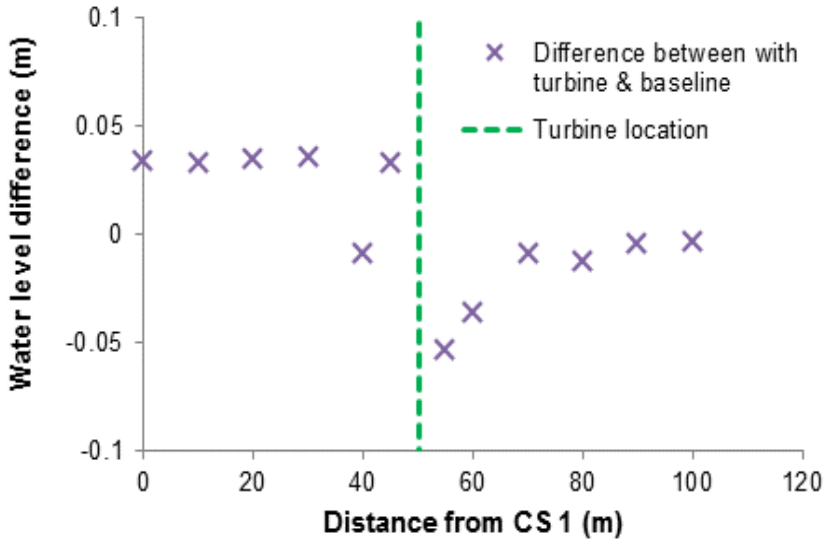
Upstream turbine

Downstream turbine

Water level differences



Water levels, baseline and with turbine



Water level difference
(with turbine –baseline)

Summary

- Canals have the potential to be developed as a HK energy site, however, effect of turbine deployment on water operations in canals is not well understood
- Effect of HK turbine deployment on water operations in Roza Canal, WA, will be investigated using a set of comprehensive water level and velocity measurements
- Impact of HK turbine deployment on the power production in a nearby downstream hydropower plant will be quantified
- Wake flow dynamics and turbulence will be investigated using ADCPs and ADVs
- Turbine performance will be analyzed using inflow, power, torque and thrust measurements (pending to agreement to disclose the data)
- It is expected that this study will help industry and regulators evaluate the impact of HK turbine deployment in canals/rivers and apply appropriate mitigation measures for the negative impacts that may occur

Acknowledgements

This research was made possible by support from the U.S. Department of Energy's (DOE) Energy Efficiency and Renewable Energy (EERE) Office's Wind and Water Power Technologies Office. Sandia is a multi-program laboratory managed and operated by Sandia Corporation, a Lockheed Martin Company, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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