CC-CleanTech LLC
Crescent City Clean Technologies

CREPS: Coastal Restoration and Energy Production System

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Introduction

One of the greatest coastal management issues facing SE Louisiana stakeholders is getting freshwater and sediment from the Mississippi River in to the delta wetlands. To rebuild the wetlands, sediment must be deposited into areas outside of the levees, to allow for plant wildlife to replenish lost land. If efficient solutions are not implemented soon, thousands of acres of coastal land will be lost to erosion every year, drastically altering the geography of the region.

Three primary methods have been used with varying degrees of success, and all with significant issues: major diversions, dredging, and piping with or without siphons. Wetland stakeholders must make efficient use of finite financial resources by utilizing the most efficient methods.

Objective

The Coastal Restoration and Energy Production System (CREPS) is an innovative solution to coastal restoration as it diverts freshwater and sediment via the piping method without the need for outside power. It both replenishes eroded land while simultaneously generating electricity. It is unique in that there is no existing method of coastal restoration that has self-sustaining power capabilities.

The systems functions by diverting water and sediment from a natural water system (e.g. the Mississippi River) via a pipe running under a levee, to be deposited at a target area outside of the levee. The flow is generated by the head differential, with electricity generated by the flow through a hydrokinetic turbine.

The objective of this research is to show the benefits of this innovative approach, with respect to volume of water and sediment diverted, and the potential for hydrokinetic power generation.

Methods

A CREPS diversion will generate flow due to the output point of the pipe with respect to the level of the river. This delta is defined as head (h). For this research the output point was set at 1ft elevation. The river level was determined using data inputs from the historical Mississippi River gauge logs of the U.S. Army Corps of Engineers. Data was obtained for the calendar year January 1 to December 31, 2015 at the Reserve gauge (river mile 138.7) and West Point a la Hache gauge (river mile 48.7). A gauge reading of 2' would signify the control valve being shut off due to lack of head to warrant operation.

Volumetric flow rate (Q) was calculated by the equation:

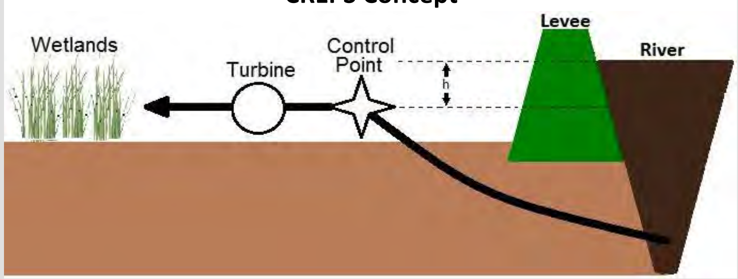
$$Q = \frac{\pi}{4}D^2V \quad \text{where } V(velocity) = \sqrt{2gh} \quad \text{and } g = 32.2\ ft/s^2$$

Theoretical power (P) in kW was calculated by the equation:

$$P = \frac{h\,Q\,n}{11.81} \quad \text{with n (turbine efficiency) of 80\%}$$

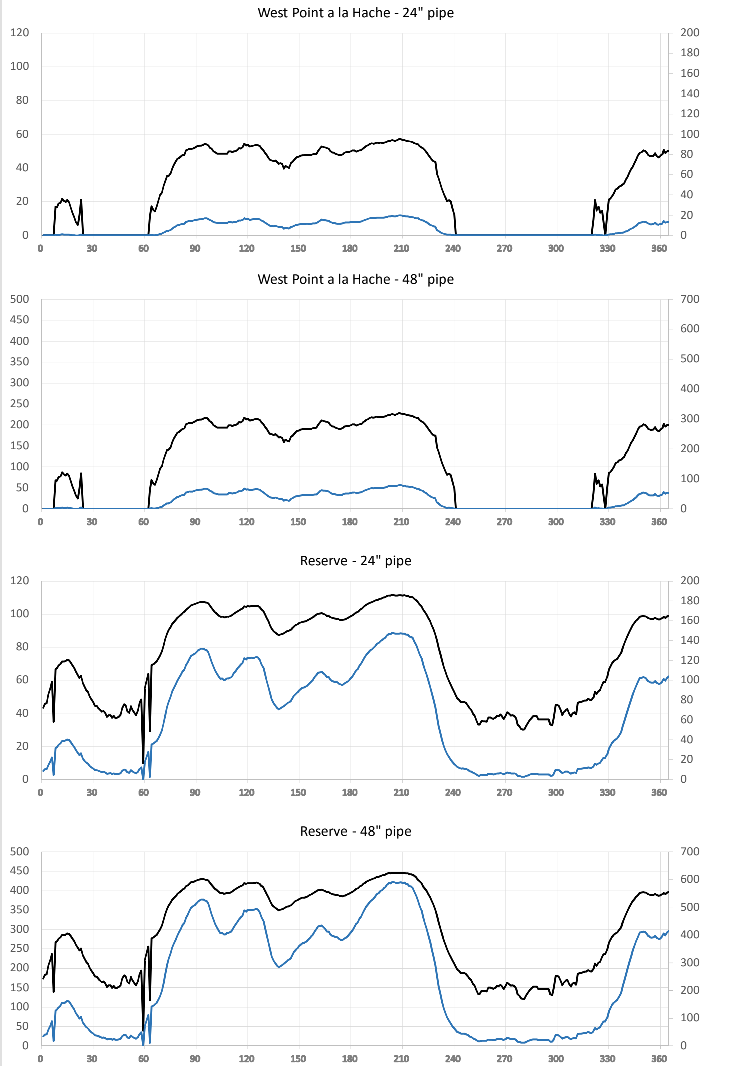
Four graphs are plotted, depicting daily flow rate (Q) and power output (P) for each location with 24" and 48" pipe diameters (D).

CREPS Concept



Results

Q (cfs) ■ x-axis Calendar Days (2015) ■ P (kW)



Conclusions

The model shows that the volumetric flow and power generated increased along with the diameter of the pipe. At each location the output deltas between pipe sizes were further magnified by the pipe diameter. There are substantial benefits in a larger pipe. While the pipe sizes differed by a factor of 2, the associated flow and power generated differ by a factor of 4 due to the squaring of the diameter.

In a real world setting, depending on the cost difference to install the larger pipe, the model suggests the larger diameter pipe would have significant payback in power generation.

The location upriver by nearly 100 miles of the Reserve gauge vs the West Point a la Hache gauge resulted in significantly more volume and power generated. This is due to the head having a difference of 2 to 4 times between the two locations.

The cost to install a system in areas where there is not enough head to warrant system operation should be considered. With this sample set, at the West Point a la Hache location there would be approximately 4 months where the system would be shut down.

These results indicate a CREPS system could have significant advantages compared to existing methods of coastal restoration with respect to diverted water and sediment and the potential for a return on investment from the power generated.

Limitations

- Sediment control and interference of a control structure at the input from the river was not reflected in this research.
- Efficiency loss on the flow can be expected, dependent on the frictional characteristics and length of piping.
- The fluid density of water was assumed to be .0624 lb/ft^3, although in practical application it would be somewhat higher given varying degrees of sediment concentration.

Next Steps

The physics and economics of the concept have been proven feasible. A physical pilot project or demonstration system is needed to exhibit the functionality in a real wetland setting. Multiple sites are potential candidates in Plaquemines, St. Bernard, and Jefferson Parishes.

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