Hoover Dam's Environmentally Sustainable Energy Storage Solution

SESS CO. (E-1)

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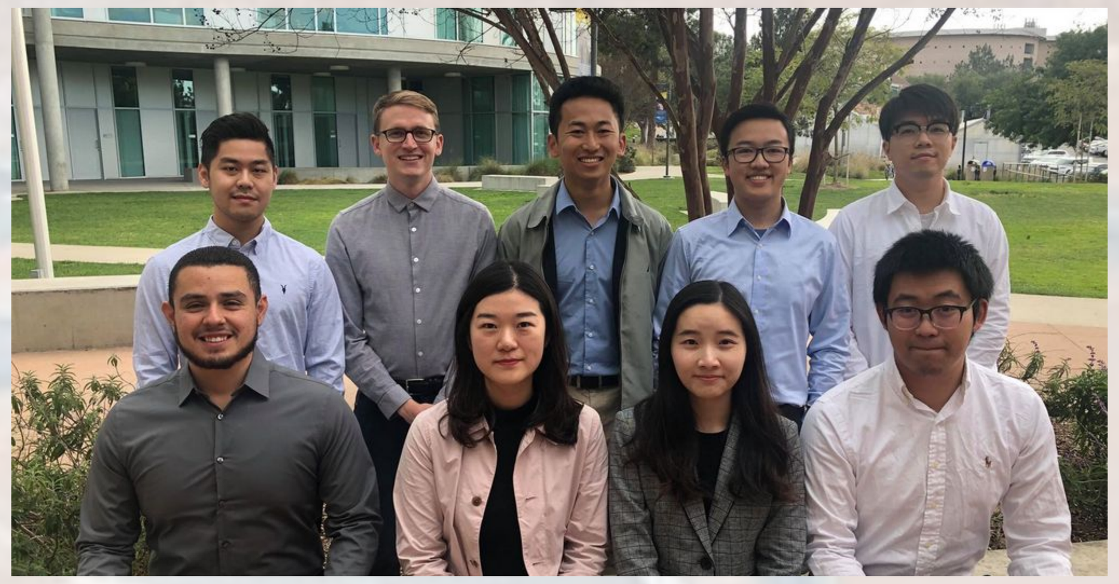
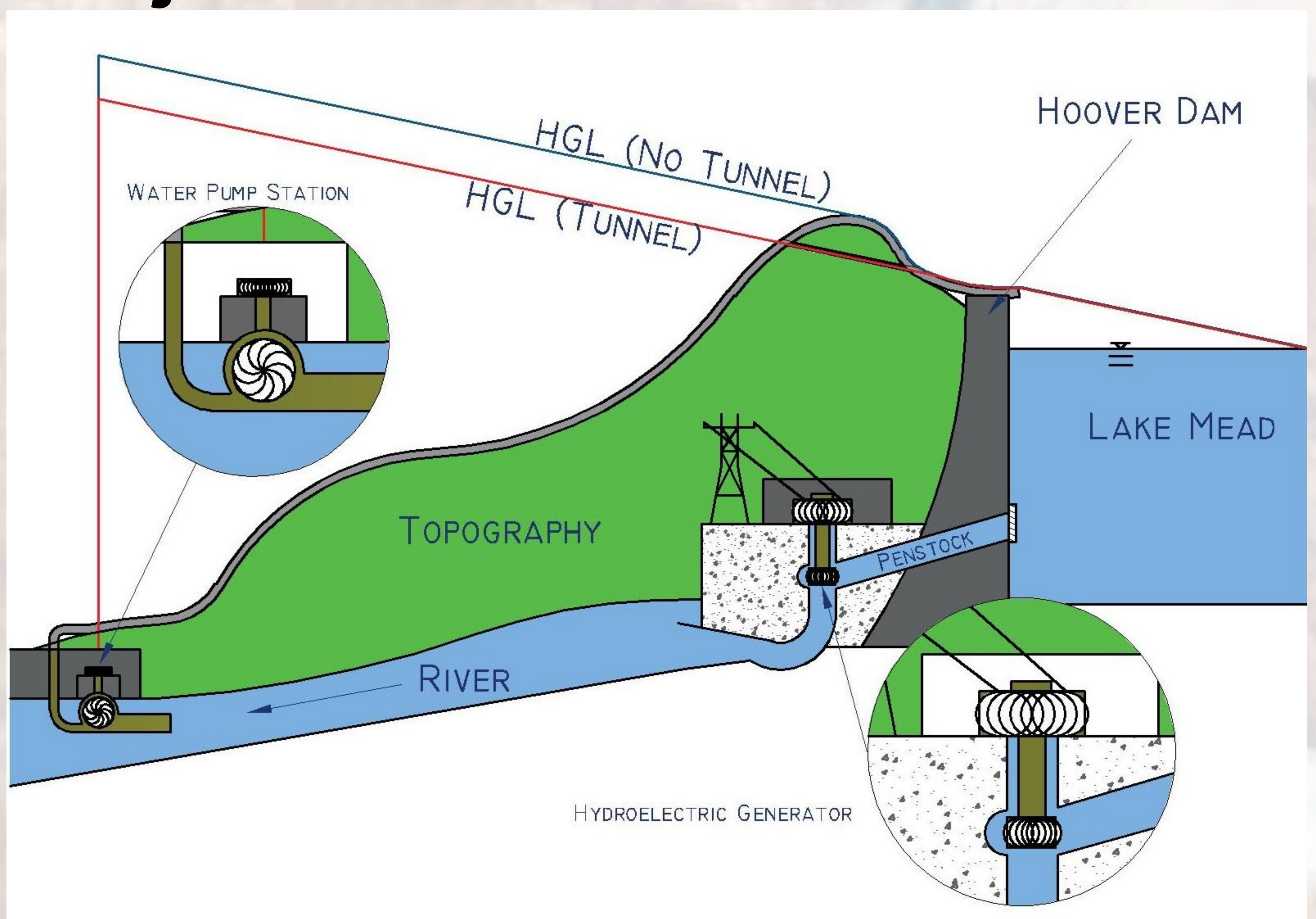


Winter Design Review 2019

Project Description

The goal of this infrastructure project is to store "hydroelectric energy" during periods of abundant renewable energy production by pumping from the Colorado River to Lake Mead. During periods of high energy demands, power will be generated from this water storage. The pumping cycle would require the construction of new facilities including a Colorado River Intake, Pump Station, Conveyance System (either pipeline or tunnel), and a Reservoir Outlet Structure. Capital costs are estimated to be in the range of $5B to $10B.

Project Schematic



Optimal Cost and Design

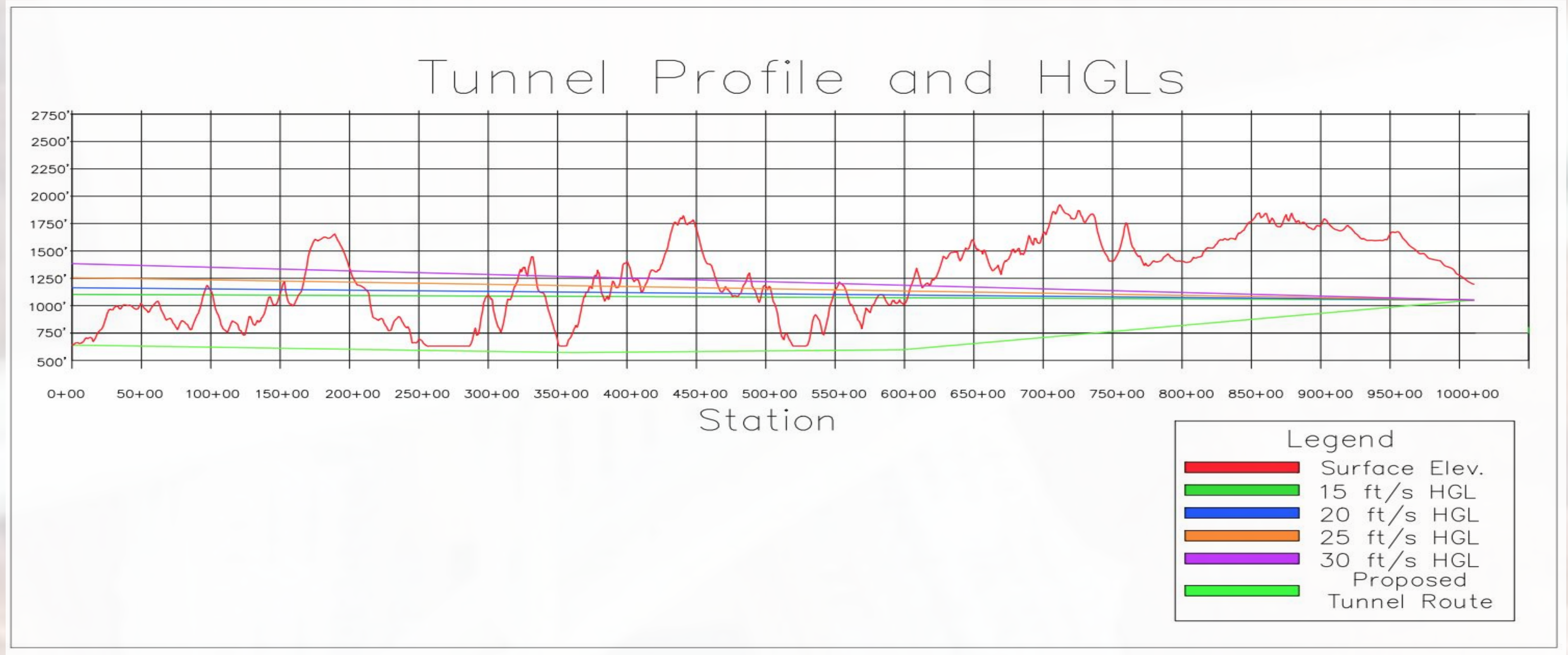
	Surface Pipeline	Tunnel
Diameter	34 ft	32 ft
Velocity	10 ft/s	11 ft/s
Pump Power	1515 MW	460 MW
30 Years Operating Cost Present Worth	$18.6 Billion	$5.7 Billion
Capital Cost	$2.6 Billion	$3.2 Billion

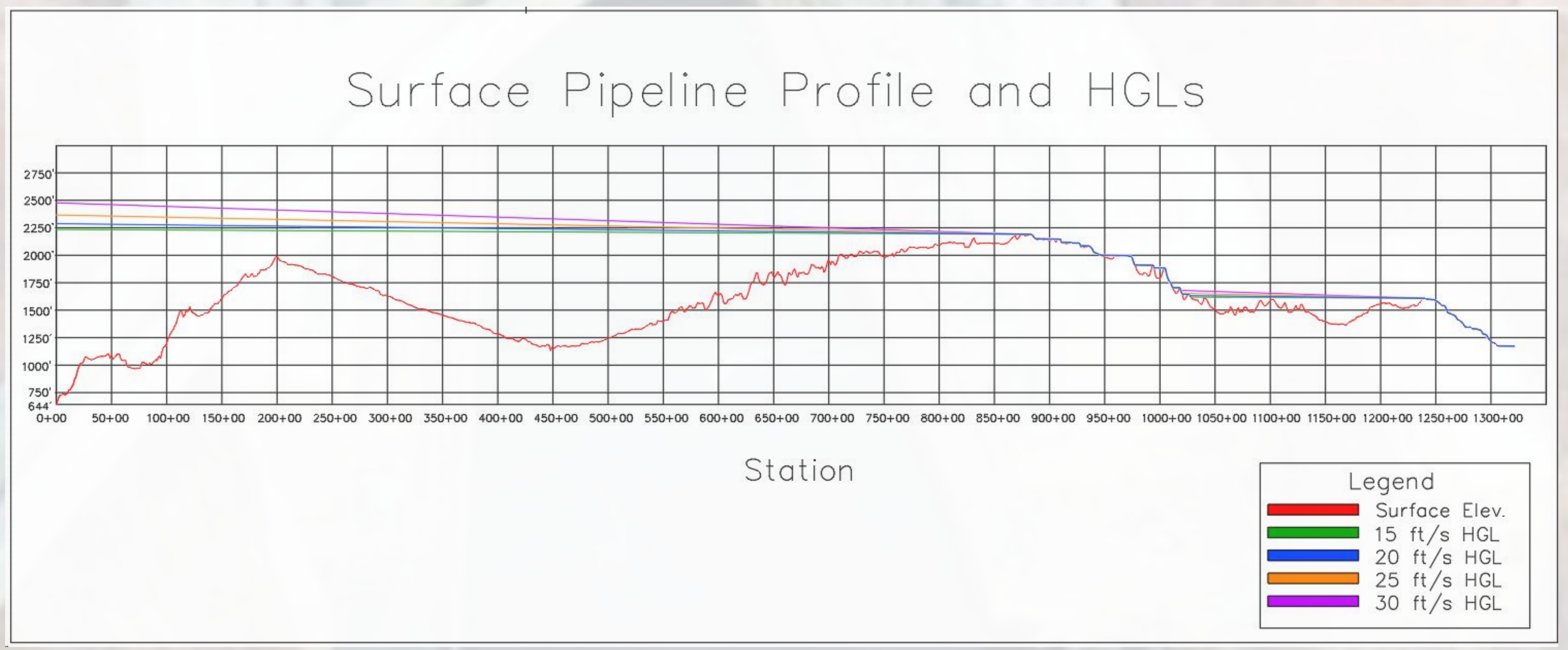
Design Constraints & Parameters

1. Pump Station Site about 19 miles below dam to minimize environmental impact. Assume water surface 647ft
2. Discharge into Lake Mead at Kingsman Wash (just upstream and east of dam)
3. Assume water surface in Lake Mead is 1081 ft (use as reference)
4. Assume the hydro at Lake Mead generates 500 MV for 5 hours over 24 hours and the pumping cycle is 10 hrs over 24 hours. The pump returns the volume of water used for generation over this period
5. Generator Efficiency = 92%, Turbine Efficiency = 82%, Pump Efficiency = 85% and Motor Efficiency = 95%
6. Costs of pumping = 10 cents/kwh and planning period = 30 years

Design Approach

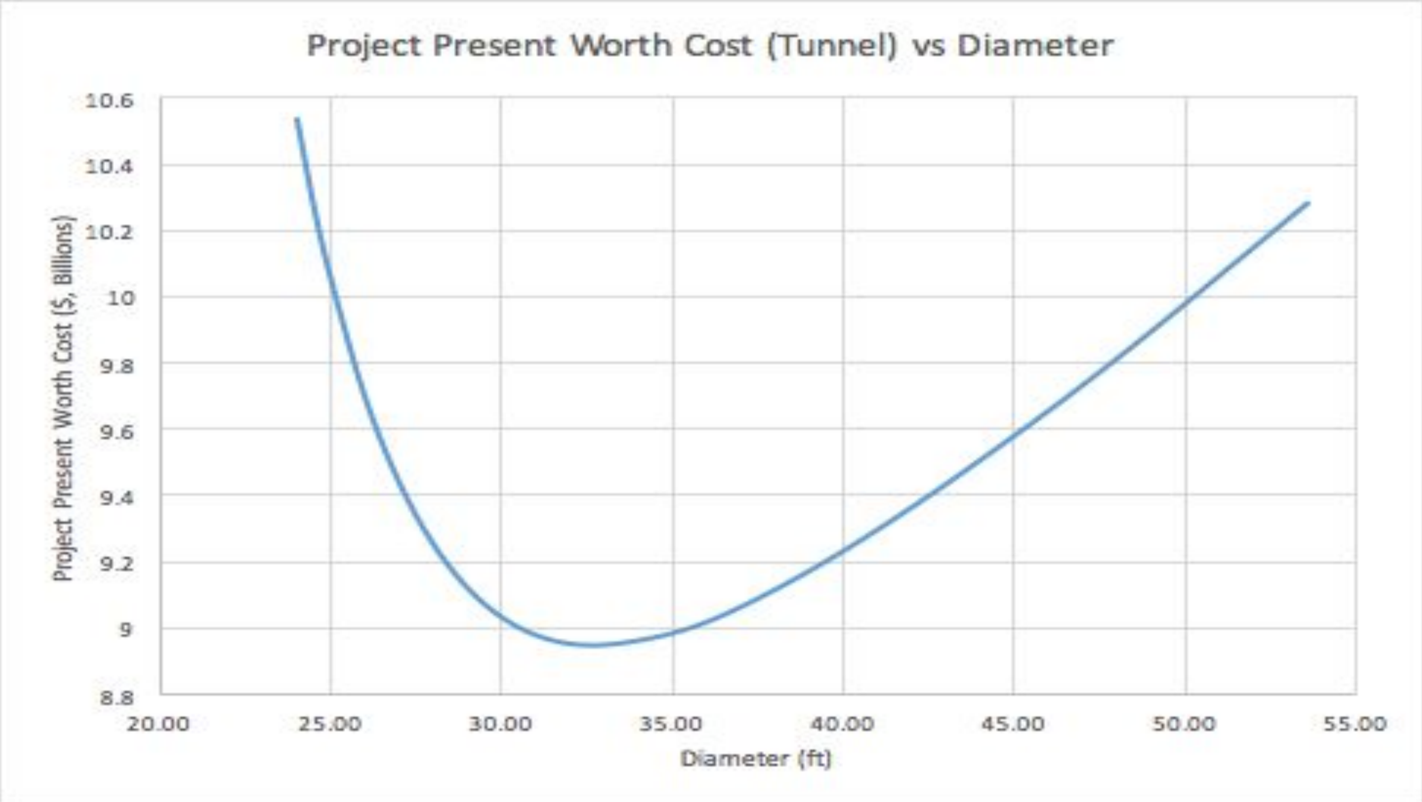
- Topographic map for the alignments of the pipeline and tunnel
- Draw elevation profile and hydraulic grade lines
- Obtain friction loss, pump head, pressure and power required
- Perform present worth cost analysis

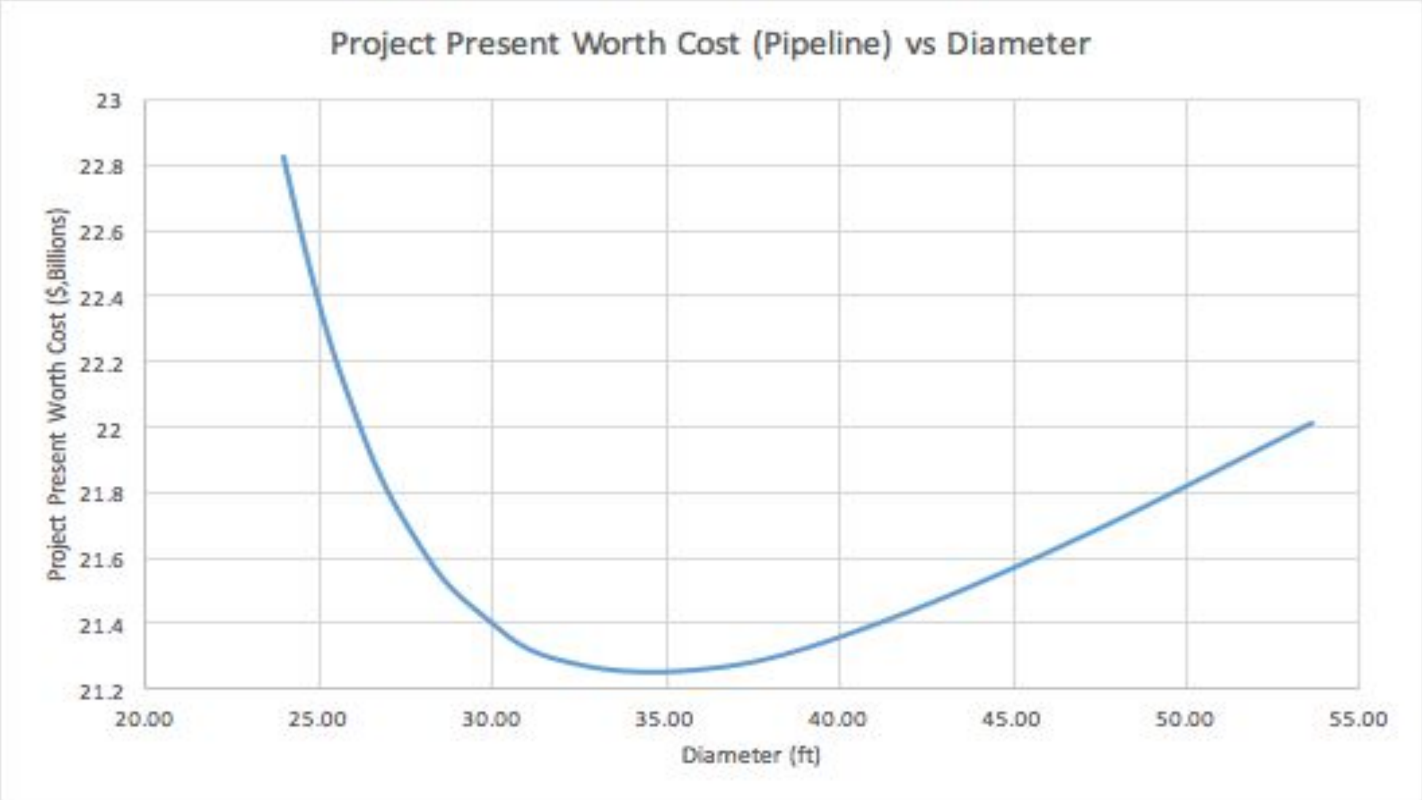




Preliminary Design Results

The optimal pipe diameter for the surface profile is 34 feet and the associated velocity is 10 ft/s. The estimated present worth cost will be over 21 billion dollars. The optimal diameter for the tunnel is 32 feet and the associated velocity is 11 ft/s. The estimated cost is almost 9 billion dollars. Hence, the tunnel is the best solution.





Plan for Next Phase

The next phase includes performing a sensitivity analysis [cost of energy and planning period], designing new facilities such as the Pump Station, performing stress analysis on the pipe to find the ideal tunnel design.

Penn, I., GrÖndahl, M., Banks, D. W., Haner, J., & Williams, J. (2018, July 24). The $3 Billion Plan to Turn Hoover Dam Into a Giant Battery. Retrieved from https://www.nytimes.com/interactive/2018/07/24/business/energy-environment/hoover-dam-renewable-energy.html

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