HCC 2026
Site Selection Process

Team

Nathaniel Holguin

Karsten Jones

Anthony Nuzzo

Dawson Stevens

PROJECT DESCRIPTION

- **Problem Statement:** Optimize the conversion of John C. Stennis Lock & Dam into a small-scale hydropower facility.

Dam Assessment

Evaluate the dam's hydraulic and structural characteristics to determine retrofit potential.

- Estimate head, flow rate, and discharge conditions.
- Analyze structural layout (spillway, gates, channel geometry).
- Identify constraints from navigation and flood management.

Feasibility of Integration

Assess technical and logistical feasibility of adding a turbine system.

- Measure proximity to power grid (≈ 900 m) using QGIS.
- Analyze site topography and floodplain to select turbine placement.
- Evaluate cost, environmental, and permitting considerations.

Optimizing Turbine Design

Optimize StreamDiver configuration for performance and reliability under site conditions.

- Match turbine size and runner geometry to flow data.
- Estimate power output and efficiency under variable river stages.
- Plan validation testing for structural integrity and energy output.

DESIGN REQUIREMENTS

Project title: HydroJacks
Project leader: Karsten Jones
Date: 11/5/2025

Correlation:

+	.	-
Positive	No correlation	Negative

Relationships:

9	3	1	
Strong	Moderate	Weak	None

	Desired direction of improvement (↑,0,↓)	0	0	0	0	0		Competitive evaluation (1: low, 5: high)		
1: low, 5: high Customer importance rating	Functional Requirements → Customer Requirements ↓	Generation Capacity (MW)	Net Head (m)	Design Flow (m^3/s)	Sediment Management (kg/m^2 yr)	Grid Connection (Km)	Weighted Score	RedRock	Uniontown	Holtwood
3	Reliable Power Supply	9	9	9	3	9	117	5	4	5
7	Structural Integrity	1	1	3	3	9	119	5	4	4
5	Competitive cost	9	9	9	3	9	195	3	5	4
4	Recreational & Aestetic Preservation	3	1	9	9	3	100	3	4	4
2	Low Enviromental Impact	3	3	9	9	9	66	4	4	4
6	Long Life Expectancy	3	9	9	9	1	186	5	4	4
1	Regulatory Compliance	3	3	9	9	3	27	5	5	4
	Technical importance score	118	146	210	162	174	810			
	Importance %	15%	18%	26%	20%	21%	100%			
	Priorities rank	5	4	1	3	2				

Engineering Requirement Targets

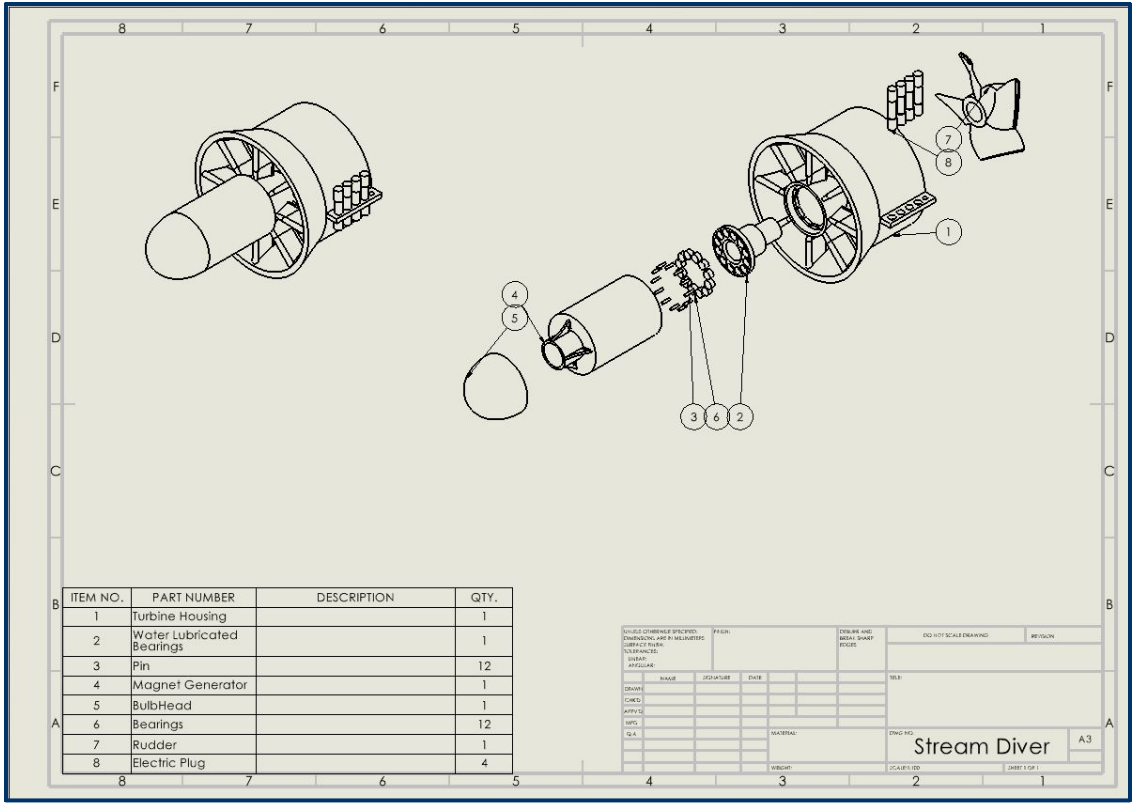
- Generation capacity between 1-10MW
- Net head between 2-12 meters
- Design flow of at least 30 m^3/s
- Sediment mass deposited in intake zone <5 kg/m^2 yr
- Grid connection distance < 8 km

DESIGN REQUIREMENTS

Customer requirements:

- Reliable power supply to the customer
  Relies heavily upon he generation capacity, and historic head and flows.
- Structural integrity
  Depends on dam quality and type such as earth/concrete.
- Competitive cost
  Relies on grid connection distance, location, and utility
- Recreational/aesthetic preservation
  Relies on sediment, and overall construction additions.
- Low environmental impact
  Relies on sediment and construction additions. as well as location of the site.
- Long life expectancy
  Relies on generation capacity, and historic head and flows and sediment management .
- Regulatory compliance
  Design must comply with FERC Subpart D and K licensing, Clean Water Act, and fish-passage standards.

DESIGN DESCRIPTION



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Turbine Housing		1
2	Water Lubricated Bearings		1
3	Pin		12
4	Magnet Generator		1
5	BulbHead		1
6	Bearings		12
7	Rudder		1
8	Electric Plug		4

Hydropower Turbine Model

- Turbine Housing - Encloses rotor and generator
- Fixed Blade Runner - A simple, low-maintenance design
- Fish Safe Blades - Rounded stainless-steel blades reduce strike risk
- Magnet Generator - Direct drive permanent magnet generator; eliminates need for a gearbox

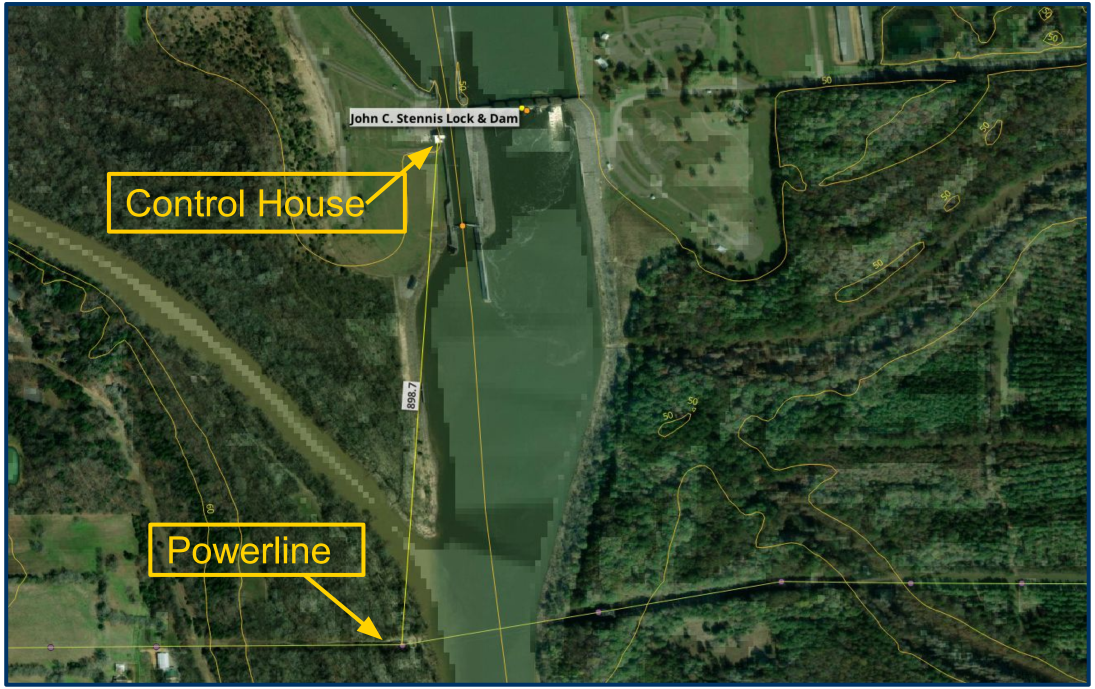
VOITH

JOHN C STENNIS DAM (COLUMBUS LAKE)

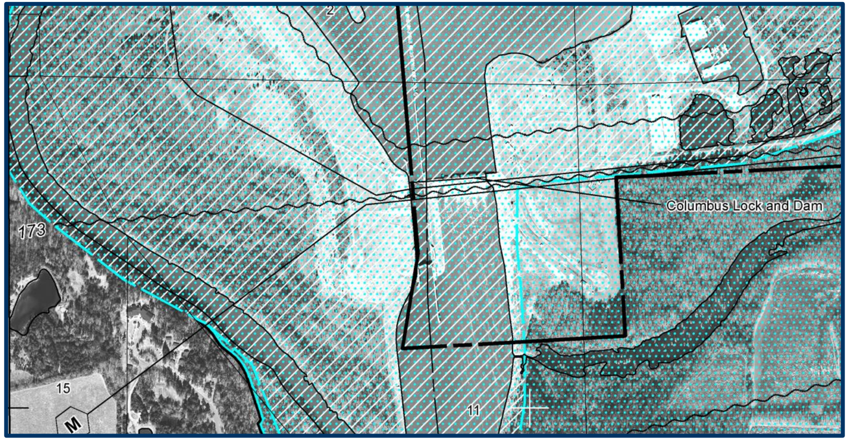
- Lock and Dam on Tennessee Tombigbee Waterway
- Columbus, Mississippi
- Operated by US Army Corps of Engineers.
- Outflow: 2800 cfs - 12250 cfs (79.3 - 346.9 m^3/s)
- 900m to nearest power line
- Gate size (6x): 60’x26’ (18.3 x 7.9m)
- Streambed: 126’ Top of dam: 188.6’
- Head: 27’ (8.2m) Head Range: 62.6’ (19.1m)

ENGINEERING MODEL - QGIS

- Created QGIS model to assess John C. Stennis Lock & Dam site.
- Identified key structures: Control house and nearby powerline. (899 m)
- Terrain and flow contours for turbine placement.
- Supports StreamDiver integration and floodplain evaluation.



ENGINEERING MODEL - QGIS



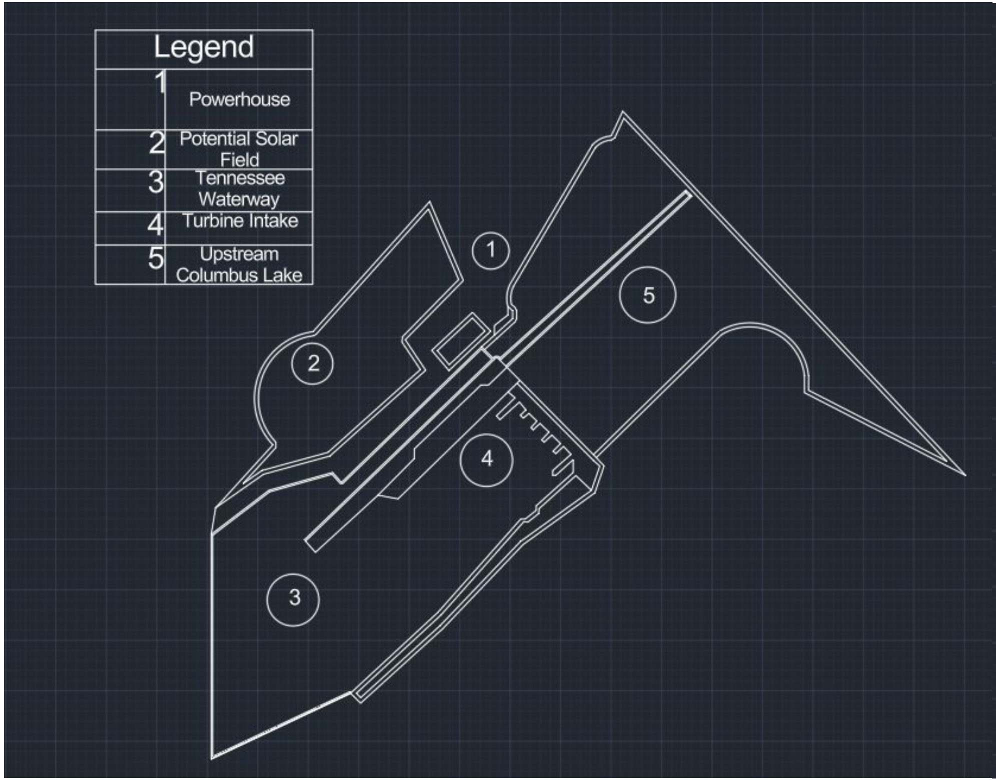
FEMA Flood Insurance Rate Map (FIRM Panel 28087C0165K, Effective Feb 18, 2011)
Zone AE – 100-year Floodplain (shown in blue hatching)

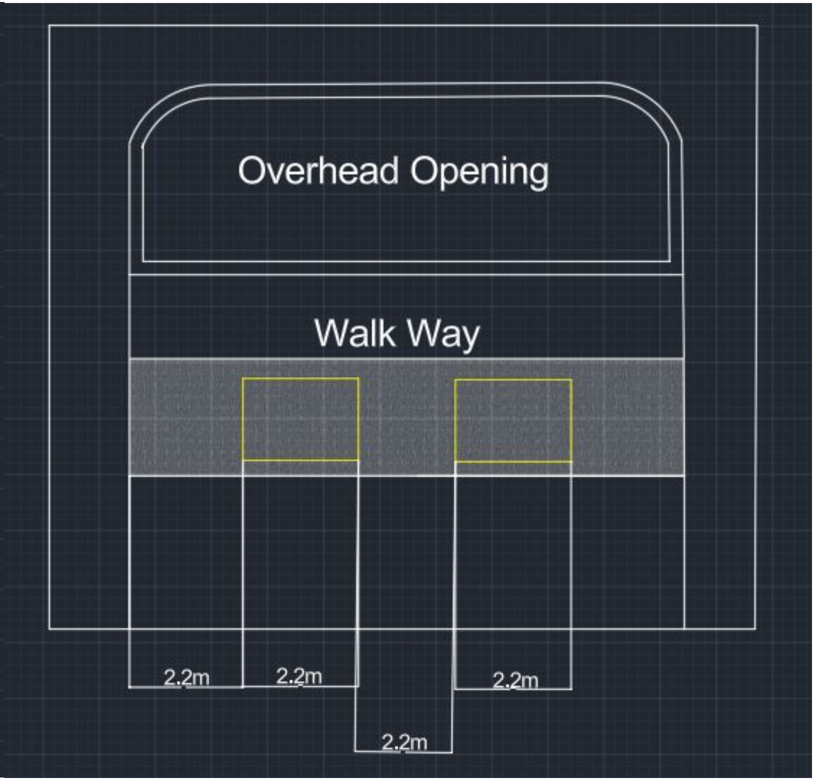
FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

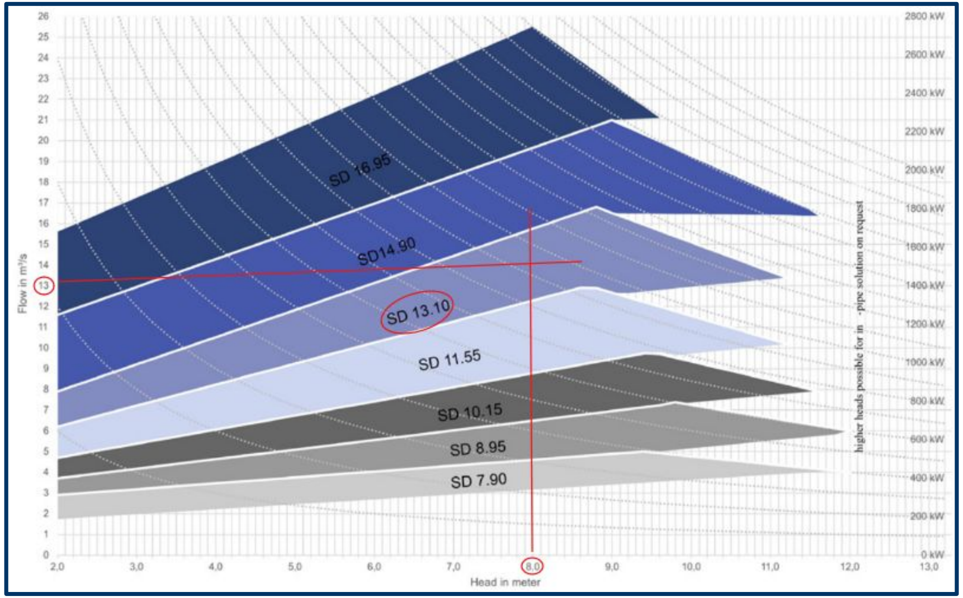
- Our dam lies directly within this mapped floodway, any retrofit design here must account for periodic flooding, high-flow conditions, and potential submersion of components.
- This confirms that flood resilience, through sealed housings, elevated controls, and durable materials, will be a key part of our hydropower system design moving forward.

ENGINEERING MODEL - AutoCAD





JOHN C STENNIS POWER OUTPUT



$$\text{Real Power} = \eta * \rho * Q_{per} * g * h * N$$

$$\text{Energy} = P_f * t$$

SD 13.1 → d = 1.31 m

Variable	Name	Value	Unit
h	Head/Height	8.2296	m
Q_{total}	General Outflow	79.2871	m^3/s
N	Number of Turbine units	6	
Q_{per}	Outflow per unit	13.2145	m^3/s
n	Efficiency	0.85	
P	Power	0.90681	MW
P_m	Shaft Power	0.77079	MW
P_f	Real Power	4.62475	MW
d	Diameter	1.31	m
t	Time used/operating	7000(80%)	hrs
E	Energy Produced in year	32,373	MWh

Economic Analysis

Present Worth is the net value of future income

$$P = A\left[\frac{(1+i)^t - 1}{i(1+i)^t}\right]$$

$/kWh = $0.1349
Cost Estimate = ~$5,000/kW = $23,100,000

Using this estimate, the project could be paid off as early as 7 years.

- Typical payback period for small hydro is 7-10 years

Next step is to expand upon this estimate to account for variable energy resources, price fluctuations, maintenance costs, etc.

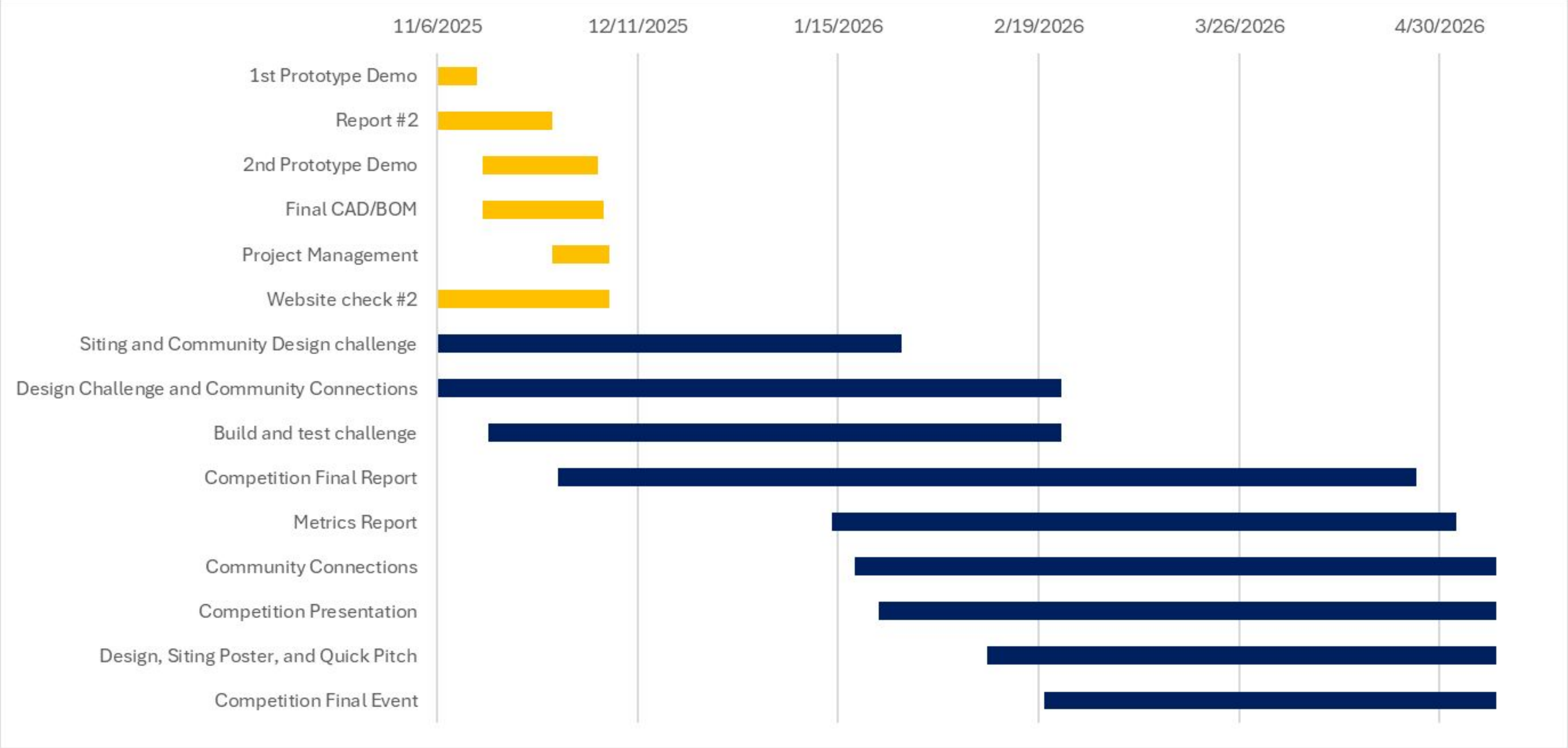
Year	Present Worth
1	$4,077,257.94
2	$7,887,779.39
3	$11,449,014.38
4	$14,777,271.38
5	$17,887,791.95
6	$20,794,820.51
7	$23,511,669.64
8	$26,050,780.97
9	$28,423,782.21
10	$30,641,540.39
11	$32,714,211.58
12	$34,651,287.45
13	$36,461,638.74
14	$38,153,555.83
15	$39,734,786.76

DESIGN VALIDATION - FEMA

Site Name: John C Stennis System Name: Turbine Subsystem Name: PMG Component Name: Fixed Runner		Development Team: HCC26		Page No 1 of 1 FEMA Date: 11/5/2025 RPN scale simplified 1:100	
Part # and Functions	Potential Failure Mode	Potential Effect(s) of Failure	Potential Causes and Mechanisms of Failure	RPN	Recommended Action
1. Generator Unit, Generates electricity	Generator shaft siezes, or failure	Electical production stops	Debris/sediment clogging the runner,erosion,wildlife	55	Utilize trashrack to filter animals and debris
2. Fixed Runner, Converts KE from water	Caviation	Runner becomes less efficient and in sevire cases cracks appear	Formation of vapor bubbles bursting around runner.extreme pressure fluctuations	40	High strength errosion resistant blades, improve pressure distribution shape of the blade.
3. Unit Casing, guides water to the runner	Leaks or cracks in housing	Electrical failure,erosion, loss of efficiency	Debris, excesive flow, trash	30	Utilize strong materials, trashrack, and aerodynamic design
4. Dam structure, supports water pressure from reservoir	Flooding	Downstream floods, wildlife impacts, components may erode	Irregular water volume moving above dam or through turbine	25	Regular inspection every 2-4 years to assess dam structure and integrity

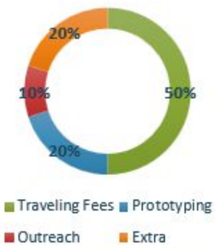
This competition's optional build and test challenge is primarily focused on a facility conceptual design. Testing and resources will be determined by our sponsor [1] at a later date.

SCHEDULE


11/6/2025
12/11/2025
1/15/2026
2/19/2026
3/26/2026
4/30/2026
1st Prototype Demo
Report #2
2nd Prototype Demo
Final CAD/BOM
Project Management
Website check #2
Siting and Community Design challenge
Design Challenge and Community Connections
Build and test challenge
Competition Final Report
Metrics Report
Community Connections
Competition Presentation
Design, Siting Poster, and Quick Pitch
Competition Final Event

BUDGET

How much do we have?	Where Do We Want To Allocate Money?		
Initial Amount			
$15,000.00	Traveling Fees	50%	$7,500
Total Expenses	Prototyping	20%	$3,000
$10,500.00	Outreach	10%	$1,500
Potential Savings	Extra	20%	$3,000
$4,500.00	Total	100%	$15,000



What is our income?

Description	Date	Amount
Project Application	9/18/2025	$5,000.00
January Submission	1/26/2026	$5,000.00
Febuary Submission	2/23/2026	
Build & Test Submission	2/23/2026	$3,000.00
Build & Test Presentation	2/23/2026	$2,000.00
Final Event	4/24/2026	$5,000.00
	Total Income	$20,000.00

What are our expenses?

Description	Expense amount	Distribution	
In Person Workshops	$1,000.00		
In person Conferances	$7,500.00	Prototype 1	$200
Prototyping Materials	$1,000.00	prototype 2	$200
Mapping Software	$500.00	Final Prototype	$500
Community Outreach	$500.00	Outreach Model	$100
Total Expenses	$10,500.00		$1,000.00

What are our expenses to date?

Description	Expense amount
3d Printer	$2,882.94
Total Expenses	$2,882.94
True remaining balance	$15,117.06

- Due to government shutdown no funds have been placed into our account yet.
- We do expect to receive these funds and continue with this budget as normal.

MOVING FORWARD

- With dam selected, we use mapping tools to guide our site assessment
- Moving forward with CAD model to help with preliminary design
- Contact USACE to gather more site-specific data
- Keep working with Voith and CFturbo for further turbine analysis; fundraising

SOURCES

[1] U.S. Department of Energy Water Power Technologies Office, “2026 Hydropower Collegiate Competition,” HeroX, 2025. [Online]. Available: https://www.herox.com/hydropower-collegiate-competition. [Accessed: Nov. 05 2025].

[2]U. Dorji and R. Ghomashchi, “Hydro turbine failure mechanisms: An overview,” *Eng. Fail. Anal.*, vol. 44, pp. 136–147, Sep. 2014.

THANK YOU!

NORTHERN ARIZONA UNIVERSITY