IPRO 343

Technical and Market Integration of Hydroelectric Energy

Affordable Renewable Energy for the Future

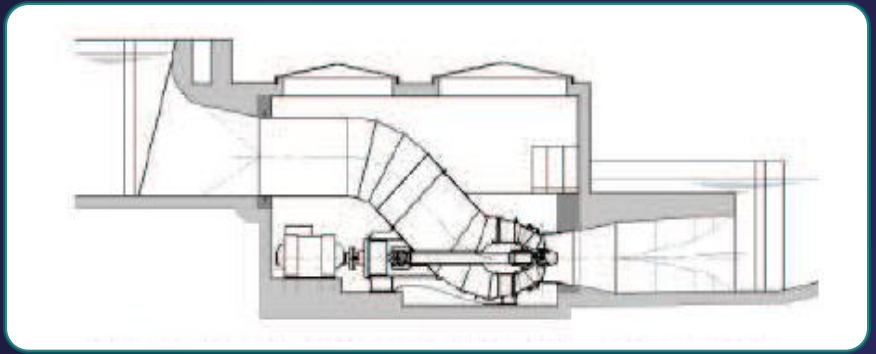
IPRO 343 – Fall 2006 Team
www.iit.edu/~ipro343f06

Outline

- Introduction
- Objective
- Feasibility Study
- Technical Design
- Environmental Assessment
- Conclusion

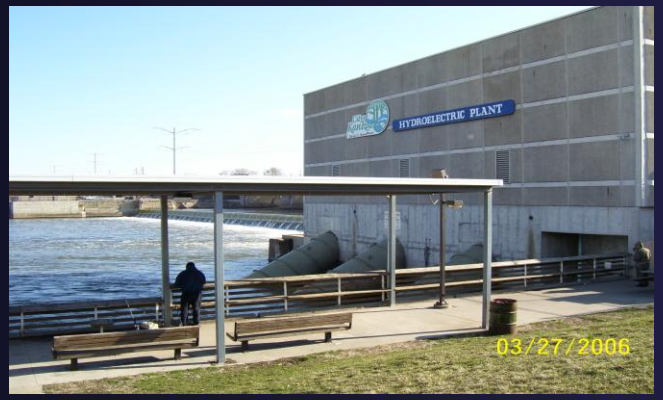
Introduction to Hydroelectric Energy

- Conventional power plants are responsible for:
  - 67 % of Sulfur Dioxide (SO_2) emissions
  - 23 % of Nitrogen Oxide (NO_x) emissions
  - 40 % of Carbon Dioxide (CO_2) emissions
- Renewable Energy and Emission Free
- Kinetic & Potential Energy to Electrical Energy
- Main Parts
  - Turbine
  - Generator
  - Powerhouse



Scale of Hydroelectric Power Plants

- Large-scale hydroelectric plants require large dams, high civil works, and huge investment.



- IPRO approach is focused on small-scale plants, with low costs and minimum environmental impacts

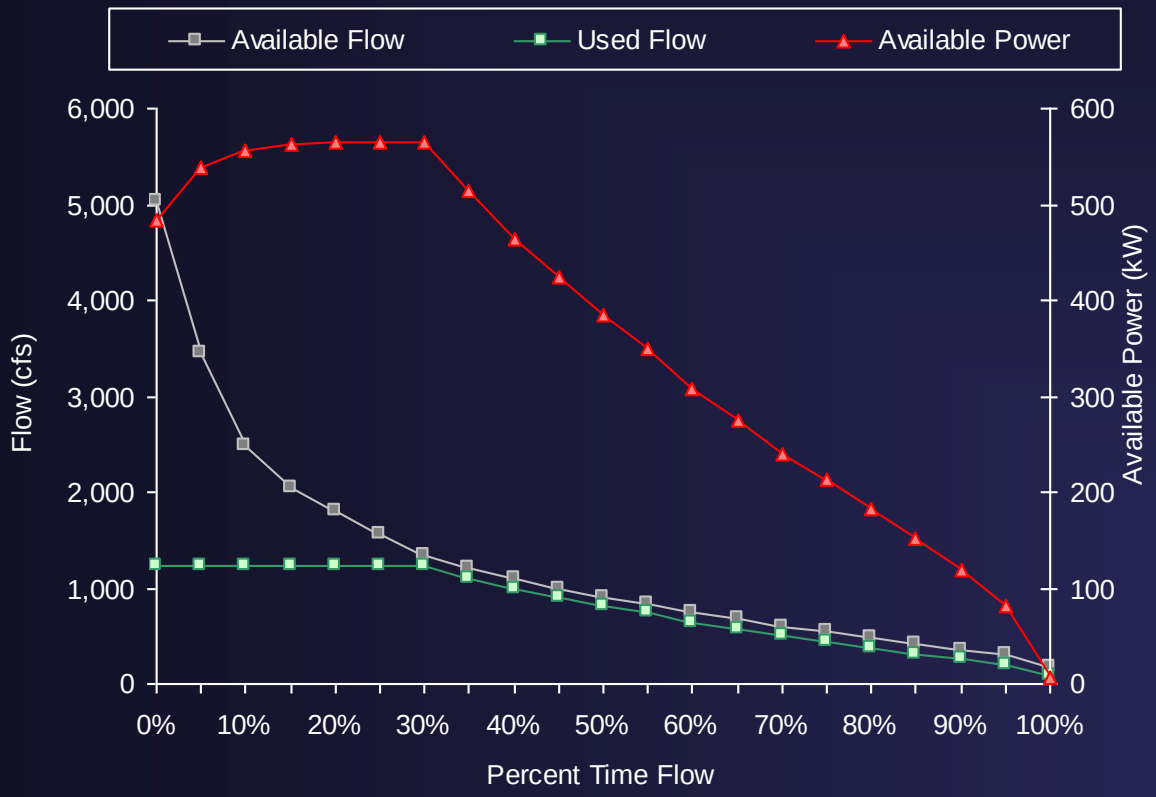
IPRO 343 Goals

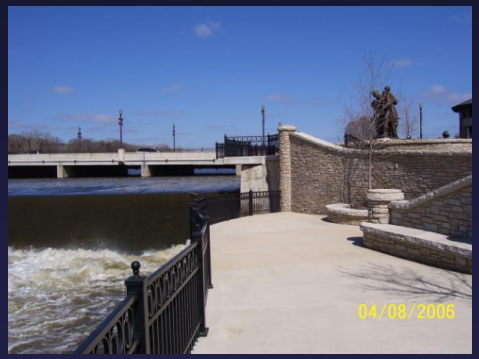
- Objective
  - To design a small hydroelectric power plant at an existing dam on the Fox River
- Sub Teams
  - Design
  - Environment
  - Marketing

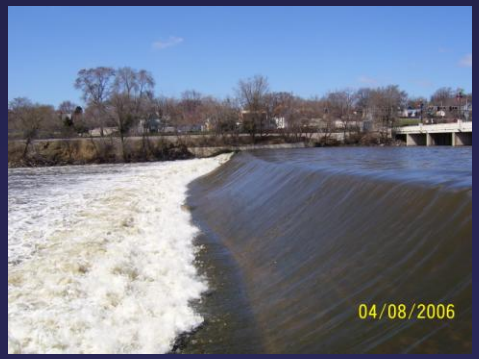
Elgin Dam, Elgin IL

Flow Duration Curve

- Elgin Dam (Elgin, IL)



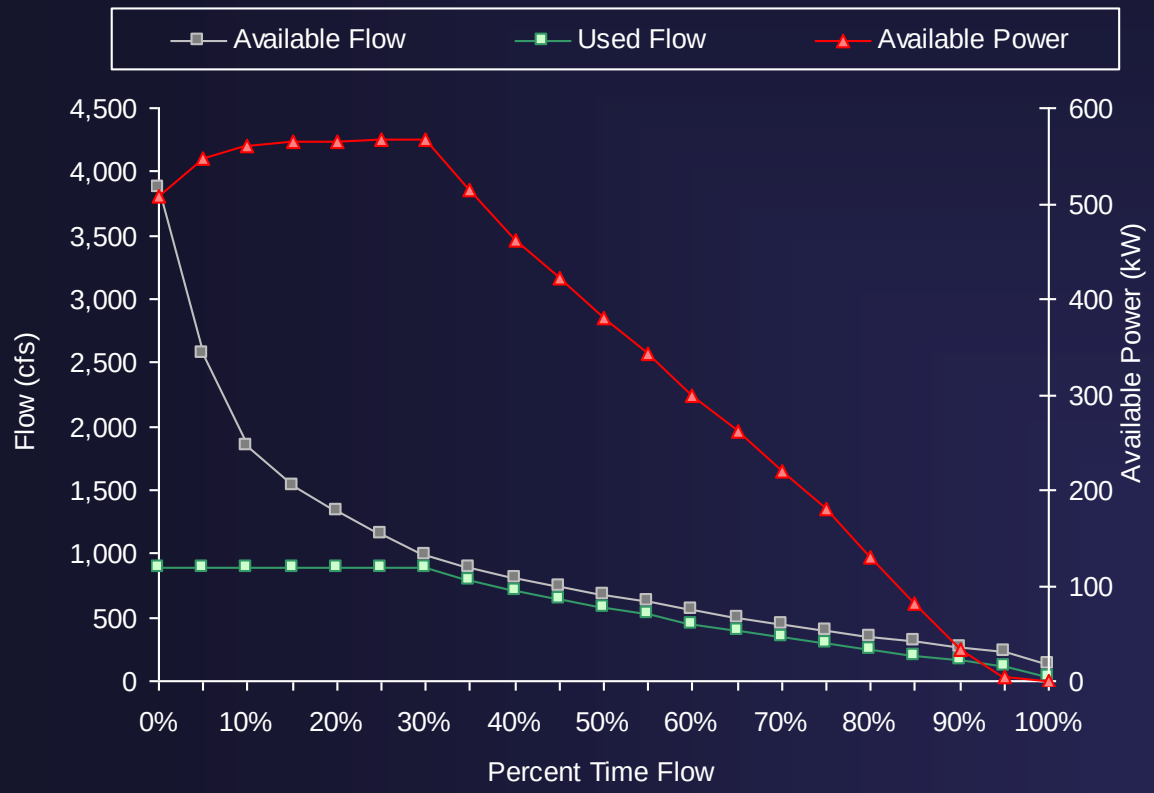




Stolp Island East Dam, Aurora IL

Flow Duration Curve

- Stolp Island East Dam (Aurora, IL)



Microsoft Excel - HYDRO3.xls

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F23

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Canada

RETScreen® International

Clean Energy Project Analysis Software

Small Hydro Project Model

Click Here to Start

- Description & Flow Chart
- Colour Coding
- Online Manual

Worksheets

- Energy Model
- Hydrology & Load
- Equipment Data
- Cost Analysis
- Greenhouse Gas Analysis
- Financial Summary

Features

- Product Data
- Weather Data
- Cost Data
- Unit Options
- Currency Options
- CDM / JI Project Analysis
- Sensitivity Analysis

Clean Energy Decision Support Centre

www.retscreen.net

- Training & Support
- Internet Forums
- Marketplace
- Case Studies
- e-Textbook

Partners

NASA UNEP GEF

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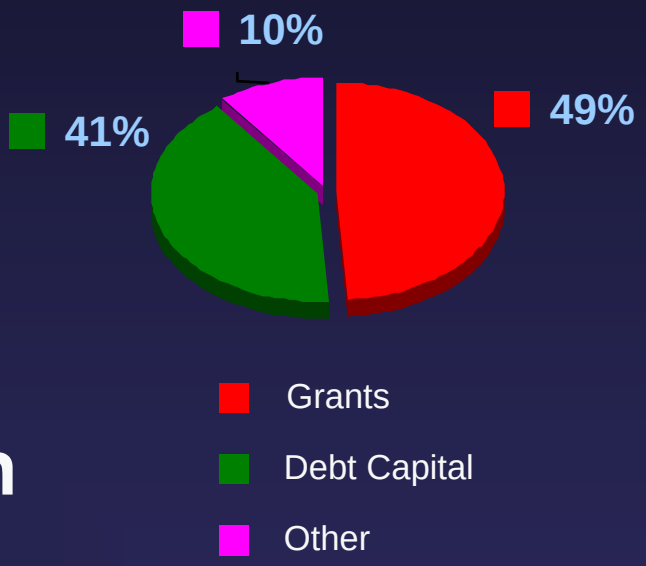
Intro | Energy Model | Hydrology & Load | Equipment Data | Cost Analysis | GHG Analysis | Financial Summary | Sensitivity | Sh

Ready NUM

RETScreen Software

Feasibility Study Inputs

- Dam Height
  - Elgin Dam: 13 ft
  - Stolp Island East: 8 ft
- Gross Head
  - Elgin Dam: 7.2 ft
  - Stolp Island East: 7 ft
- Electricity Price: 0.051$/kWh
- Costs: US$ 2,000,000.00
- Grants & Tax Credits



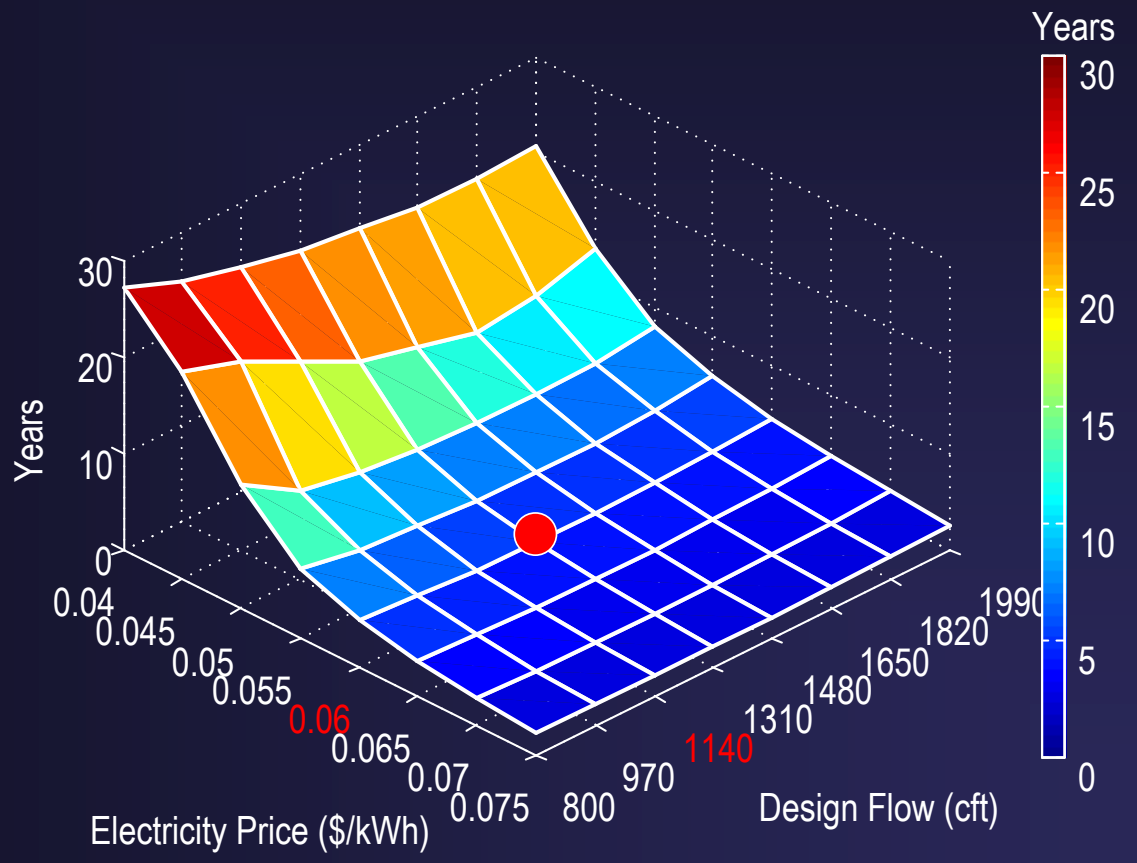
Feasibility Study Results

Technical Parameters	Elgin	Stolp Island East
Design Flow	1237 cft	992 cft
Maximum Plant Output	566 kW	630 kW
Annual Energy Production	3,071,000 kWh	3,502,000 kWh

Economic Indicator	Elgin	Stolp Island East
Simple Payback	12.5 yr	9.9 yr
Year-to-positive cash flow	6.5 yr	4.1 yr
Net Present Value - NPV	$ 274,234.00	$ 518,807.00

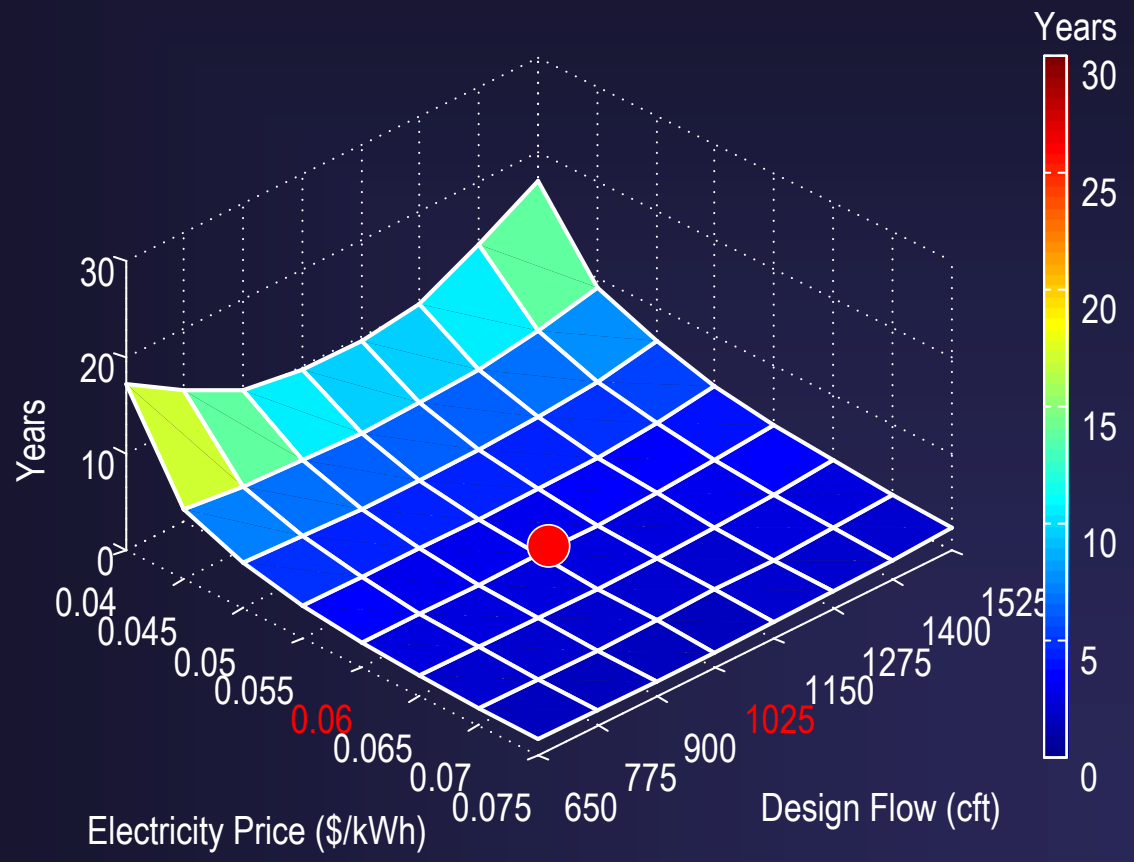
Feasibility Study
Sensitivity Analysis

Year-to-Positive Cash Flow at Elgin Dam



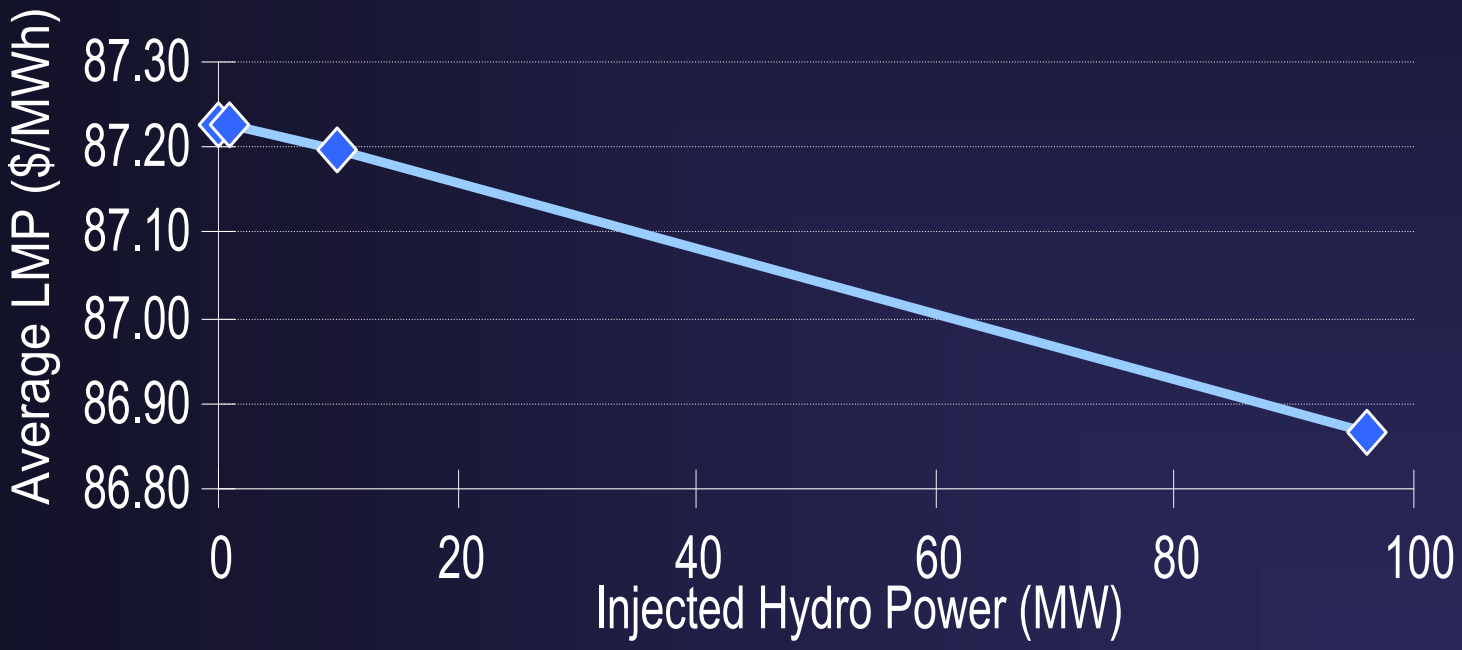
Feasibility Study
Sensitivity Analysis

Year-to-Positive Cash Flow at Stolp Island East Dam



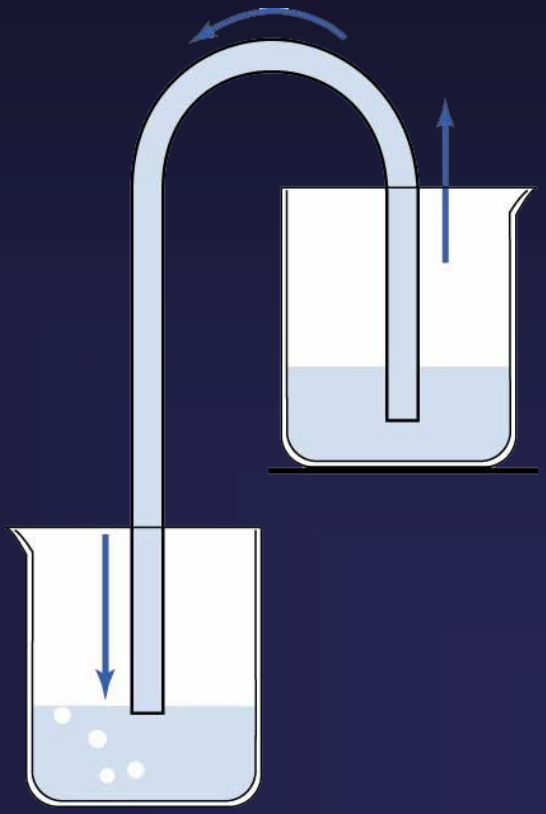
Power Market Impact

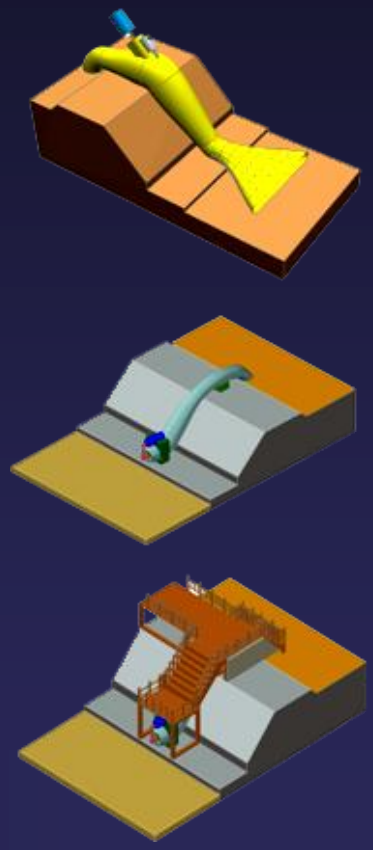
- Tools: Security Constrained Unit Commitment (SCUC)
- Location: TDC-570 bus in the ComEd Power system



Technical Design

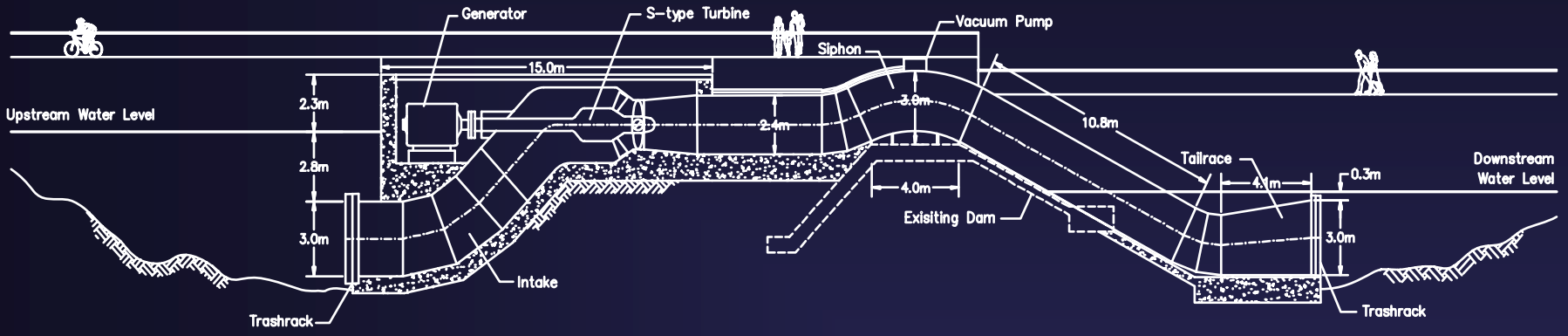
- Siphon Turbine
  - Perfect for Small Hydro
  - Minimum dam modifications
  - Minimum civil work
  - Choice for the Elgin site

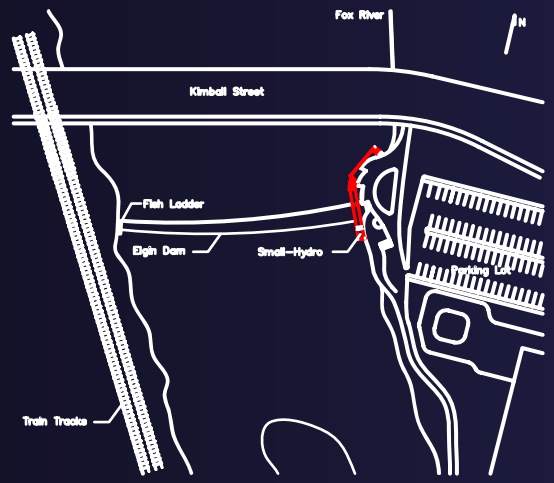




Technical Design

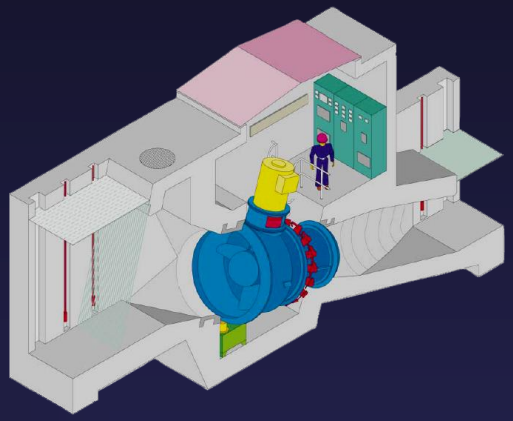
Preliminary Design for Elgin (Siphon Turbine)

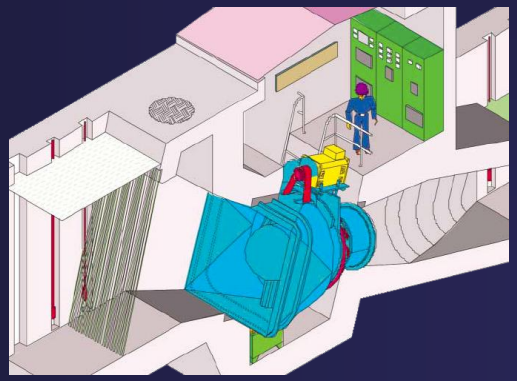




Technical Design

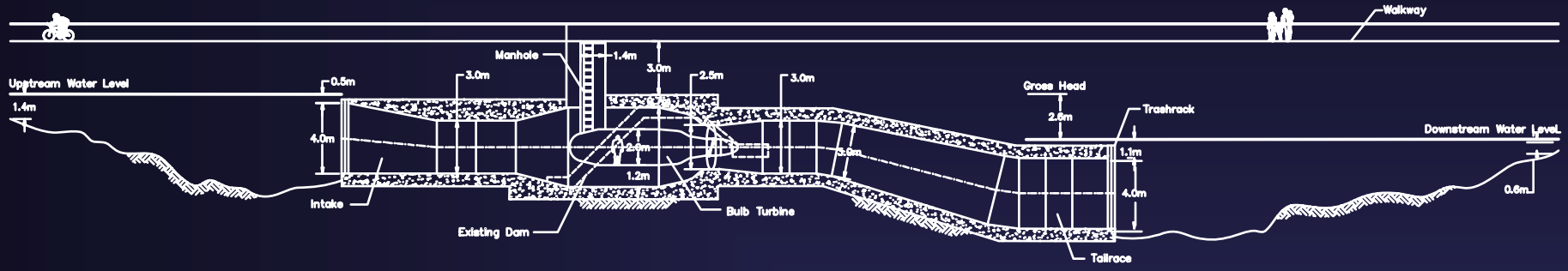
- Compact Bulb Turbine
  - Significant civil work
  - Small and minimum applications
  - Suitable for Aurora site

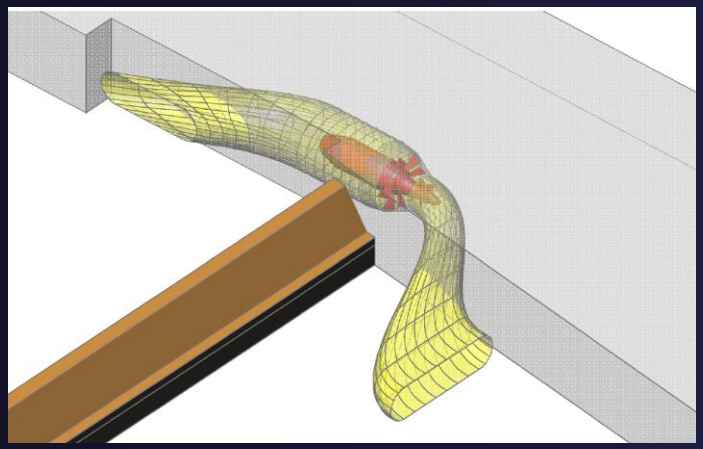


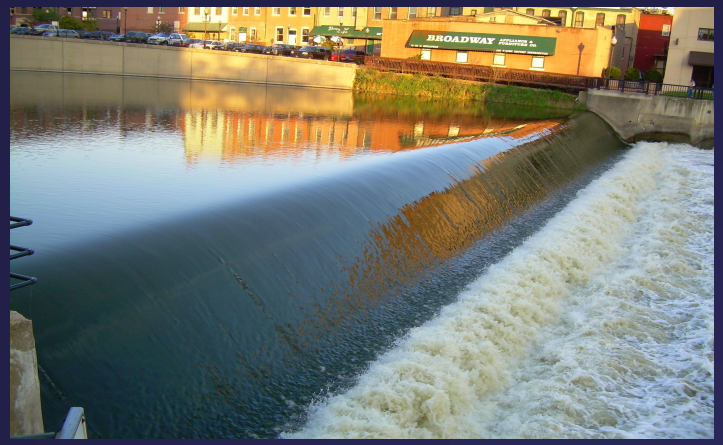


Technical Design

Preliminary Design for Stolp Island East (Bulb Turbine)







Impacts on Water Quality

Impacts on Recreational Activities

Noise Impact at Elgin, IL

Noise Impact at Aurora, IL

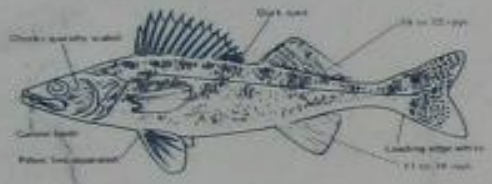
ATTENTION ANGLERS!

FISHING REGULATIONS
FOR THE SPECIAL MANAGEMENT ZONE ON THE FOX RIVER AND TRIBUTARY STREAMS
FROM THE SOUTH ELGIN DAM TO THE NORTH AURORA DAM

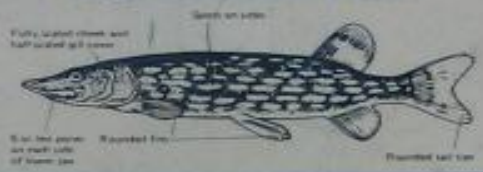
LARGEMOUTH BASS

SMALLMOUTH BASS

WALLEYE



NORTHERN PIKE



SAUGER

DAILY CREEL & SIZE LIMITS:

	CREEL LIMIT	MINIMUM SIZE
LARGEMOUTH OR	Catch and Release Only Fishing	

Fishes on Fox River, IL

Conclusions

- Achievements
  - Designed low-head small hydro at Elgin and Stolp Island East
    - Economically profitable
    - Technically efficient and feasible
    - Environment friendly
      - CO_2: 1,690,000 lbs SO_2: 3,330 lbs
      - NO_x: 1,030 llbs Fuel: 36,000 MBTU
  - Starting point of a massive application of small hydro in Illinois and around the country

Conclusions

- **Future Work**
  - Communicating this project to the general public and seeking political support
  - Learning the permitting process and applying for grants
  - Contacting manufacturers and contractors to obtain more accurate price quotation
  - Obtaining more detailed site dimensions and fine-tuning the technical designs
  - Continuing this project with an EnPRO for actual implementation

Acknowledgments

- Special Thanks to:
  - Dr. Alexander Tseng
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Questions?