Priest River
Cold Water Augmentation Concept

Alternatives Assessment

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Lakes Commission Presentation
June 19, 2019

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PROJECT BACKGROUND

- **Project Background**
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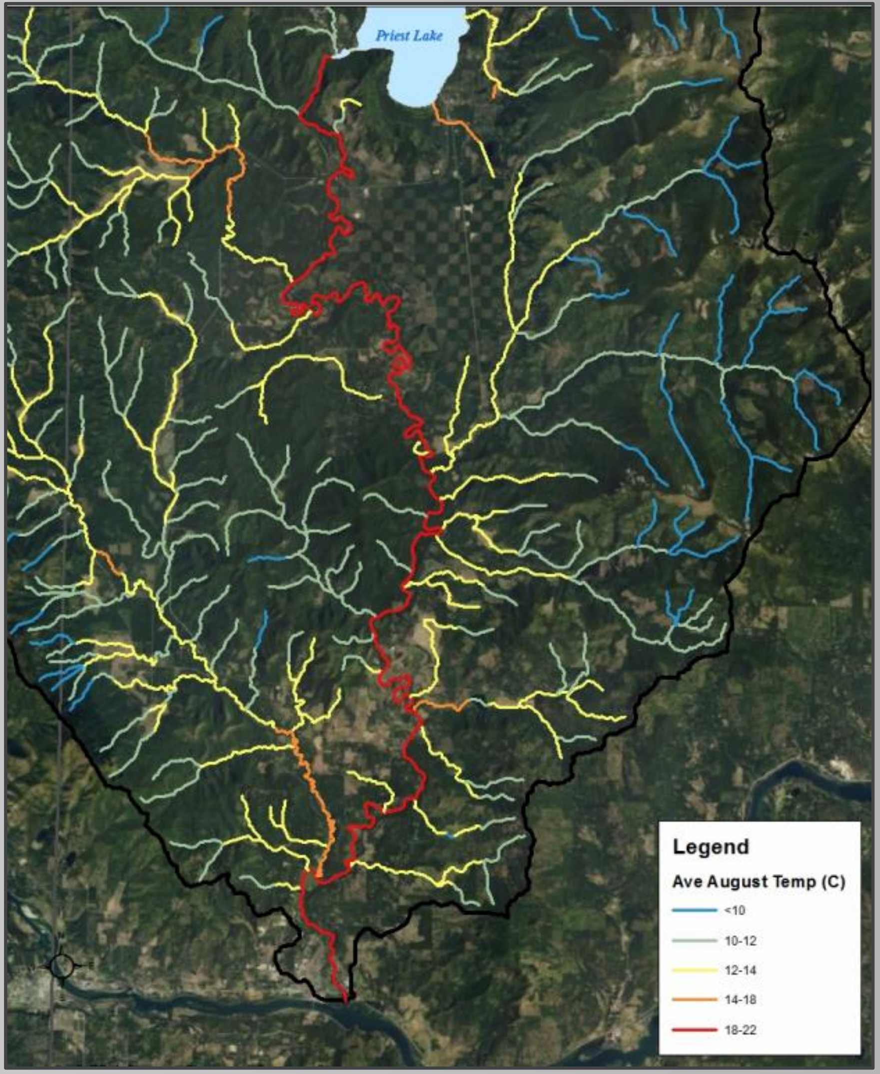
- Design Constraints
- Water Supply Alternatives
- Assessment
- Future Research
- Questions

PROJECT INTRODUCTION

- The Lower Priest River currently exceeds the IDEQ cold water aquatic life temperature criterion of **19°C** (66°F) in the late summer months.

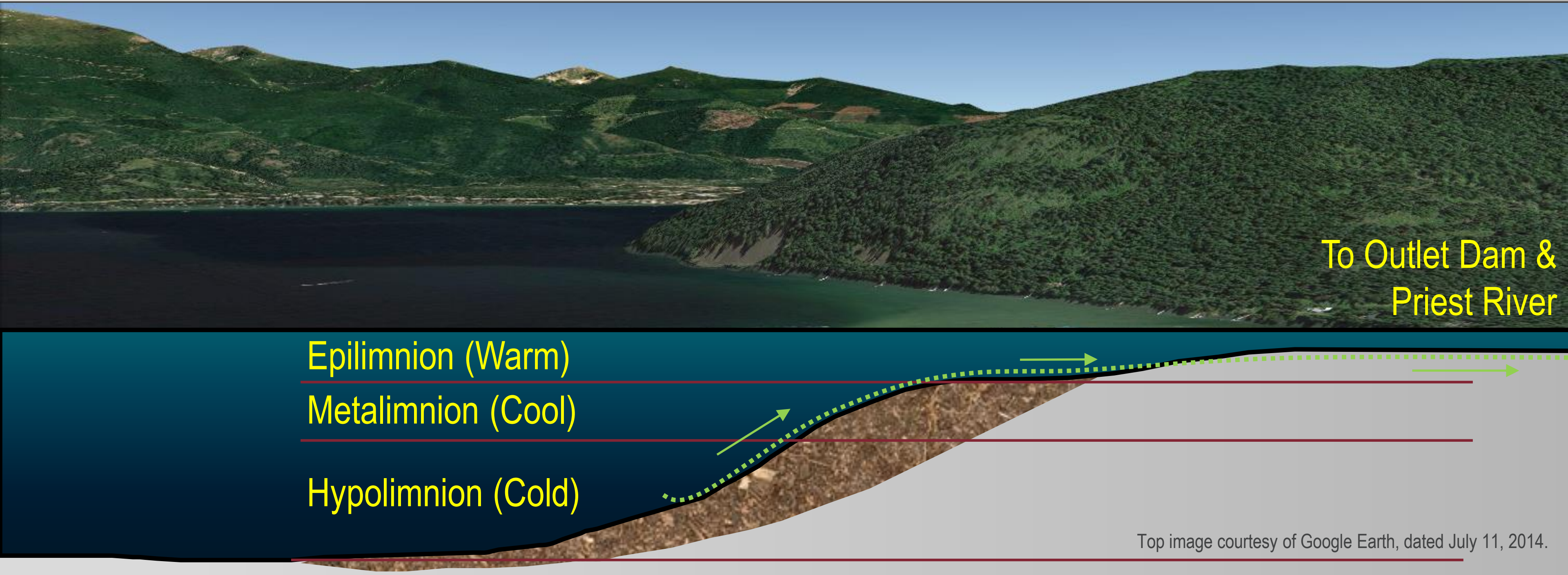
- High temperatures negatively impact life-cycles of migratory and resident fish, including native bull and cutthroat trout, as well as the ability to provide fishing opportunities in Priest River downstream.

Bull trout (top) courtesy of the Hook & Hackle Company, www.hookhack.com
Cutthroat trout (bottom) courtesy of Hook & Hackle Company, www.hookhack.com



PROJECT INTRODUCTION

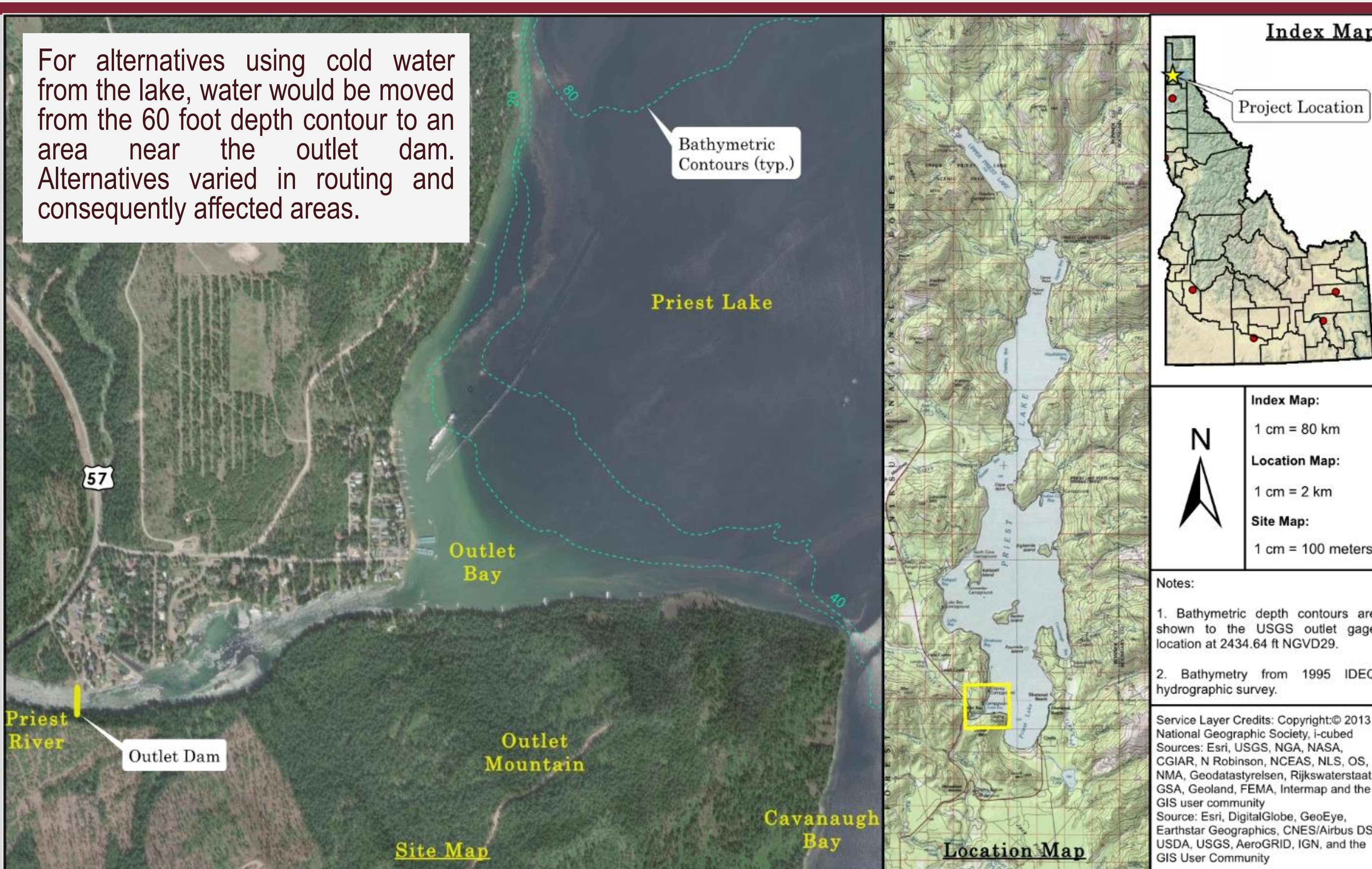
- Ample cold water is available in the lower strata (hypolimnion) of Priest Lake.
- A concept has been proposed to supply the Lower Priest River with cold water from Priest Lake to improve water temperatures for cold water biota, and to improve fishing opportunities in Lower Priest River.
- An alternatives assessment was performed with the purpose of determining costs of preliminary alternatives and assessing engineering feasibility.



Top image courtesy of Google Earth, dated July 11, 2014.

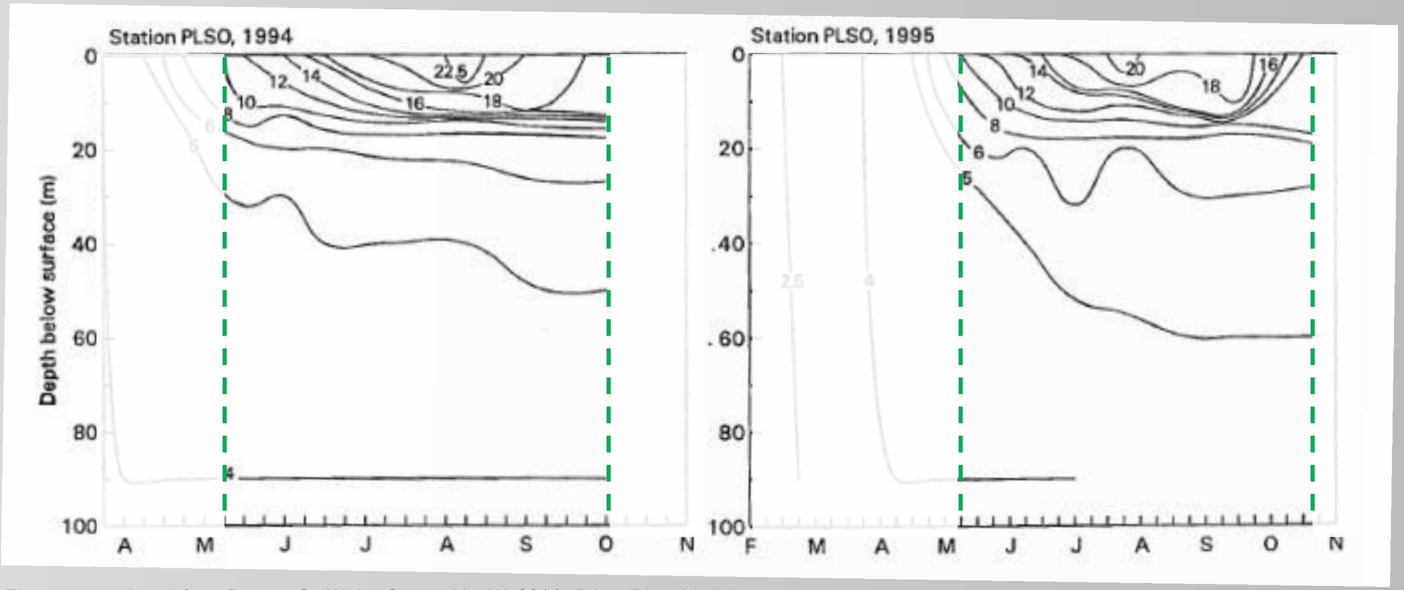
PROJECT LOCATION

For alternatives using cold water from the lake, water would be moved from the 60 foot depth contour to an area near the outlet dam. Alternatives varied in routing and consequently affected areas.



PREVIOUS WORK

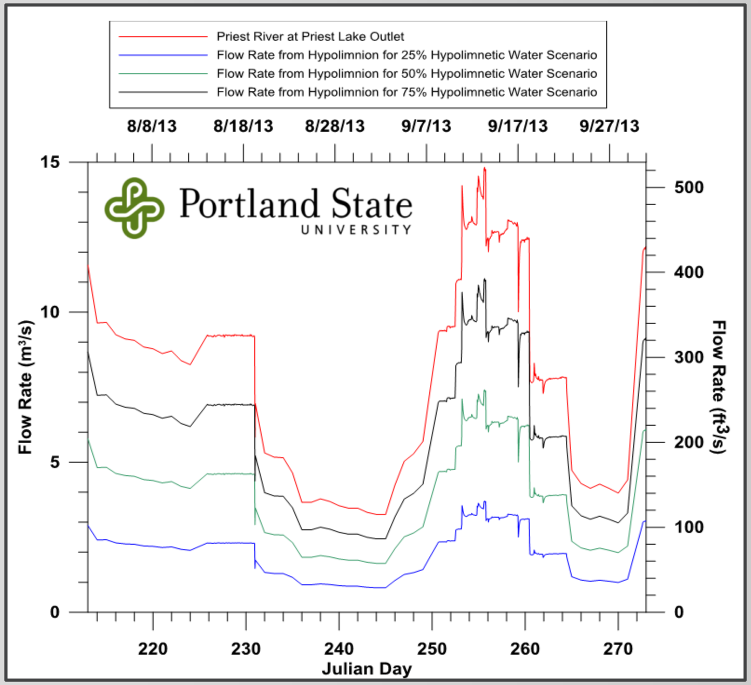
- 1994/1995 – Idaho Department of Environmental Quality (IDEQ) performed measurements and developed profiles of water temperature in Priest Lake

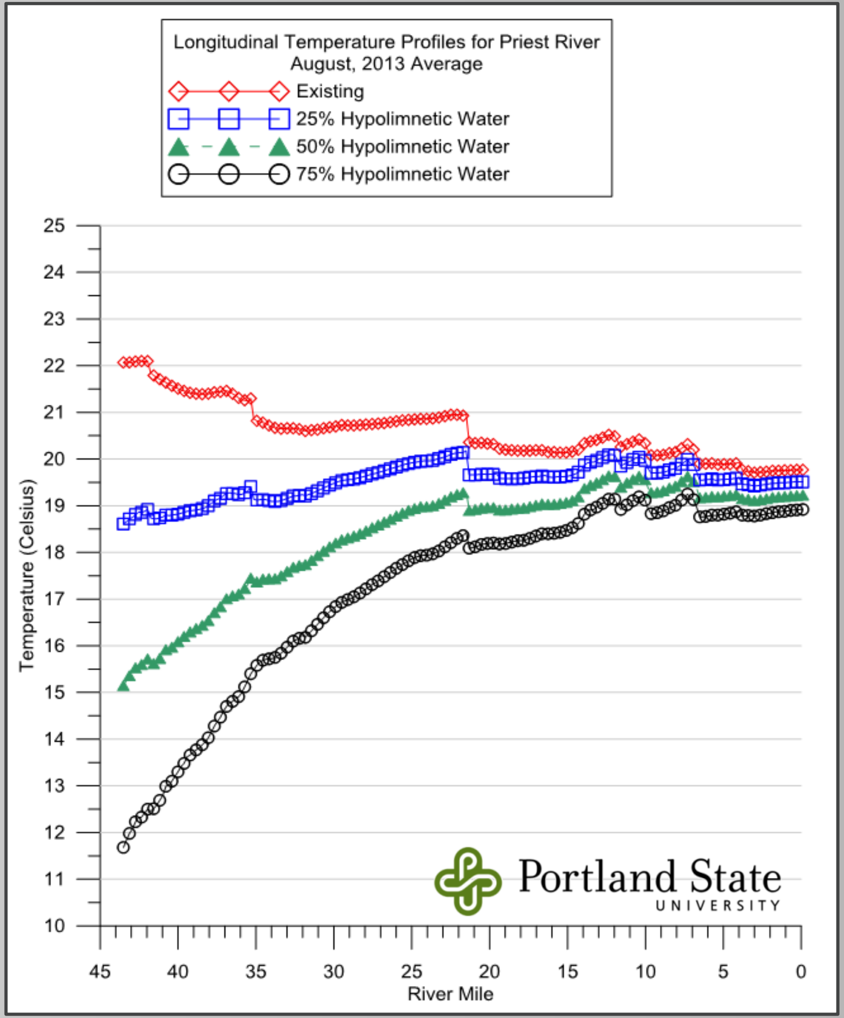


Figures reproduced from Berger, C., Wells, S., and Xu, W. 2014. *Priest River Model: Model Development, Calibration and Scenarios Report. Prepared for the Kalispel Tribe. Portland State University, July 2014.*

PREVIOUS WORK

- 2014 – Portland State University performed water quality modeling to determine feasibility of achieving temperature goals using hypolimnetic water
- It was found that the cold water goals were achievable using 75% hypolimnetic water



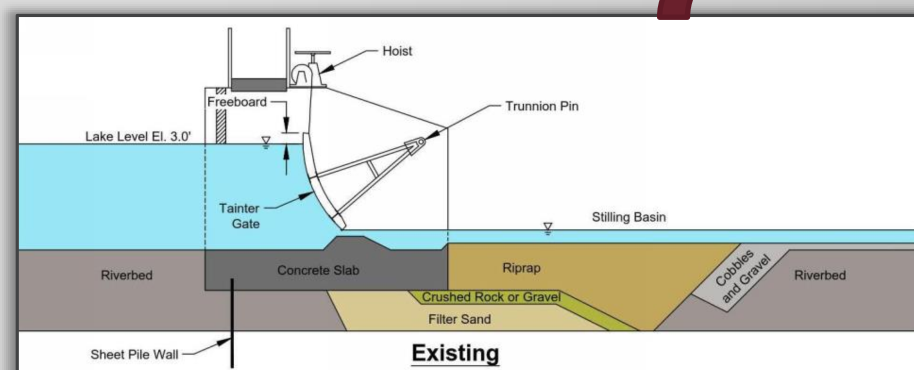


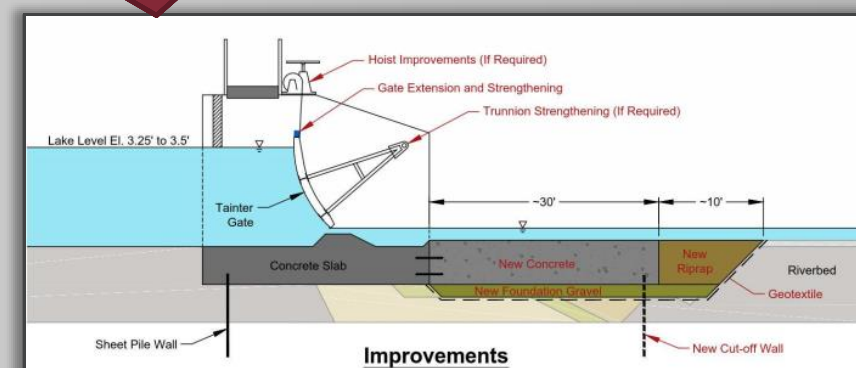
Figures reproduced from Berger, C., Wells, S., and Xu, W. 2014. *Priest River Model: Model Development, Calibration and Scenarios Report. Prepared for the Kalispel Tribe. Portland State University, July 2014.*

CONCURRENT WORK

- Improvements to the existing outlet dam and water operations are proposed to better maintain the recreational water levels in the lake during low water years.

- Implementation of a cold water augmentation project would be compatible with these changes.





Figures reproduced from Mott MacDonald, 2018. *Priest Lake Water Management Study Report*, prepared for the Idaho Water Resource Board, February 2018.

DESIGN CONSTRAINTS

- Project Background
- **Design Constraints**
- Water Supply Alternatives
- Assessment
- Questions
- Future Research
- Questions

DESIGN CONSTRAINTS

Among the most significant design constraints were the following:

Criterion	Units	Value	Comments
Aesthetics	N/A	N/A	Aesthetic impact is to be minimized by the selected alternative
Lake Level	ft	3.0	Maintain 3-ft lake level at outlet gage
Instream Flow	ft^3/s	60	Minimum discharge flow; junior to lake level criterion
Navigation	N/A	N/A	No change to existing navigation conditions
Target Maximum Daily Average Temperature	°C	19	For cold-water aquatic life
Minimum Augmentation Flow	ft^3/s	45-71	Per thermal requirements
Minimum Intake Depth	ft	60	11-ft factor of safety on thermocline
Screen Approach Velocity	ft/s	0.5	US Fish and Wildlife Service
Operational Window	N/A	Summer; Year-round	Summer season is critical for temperature; year-round considered for operational flexibility

WATER SUPPLY ALTERNATIVES

- Project Background
- Design Constraints
- **Water Supply Alternatives**
  - Gravity Fed System
  - Siphon System
  - Groundwater Well System
  - Pump System
- Assessment
- Future Research
- Questions

WATER SUPPLY ALTERNATIVES

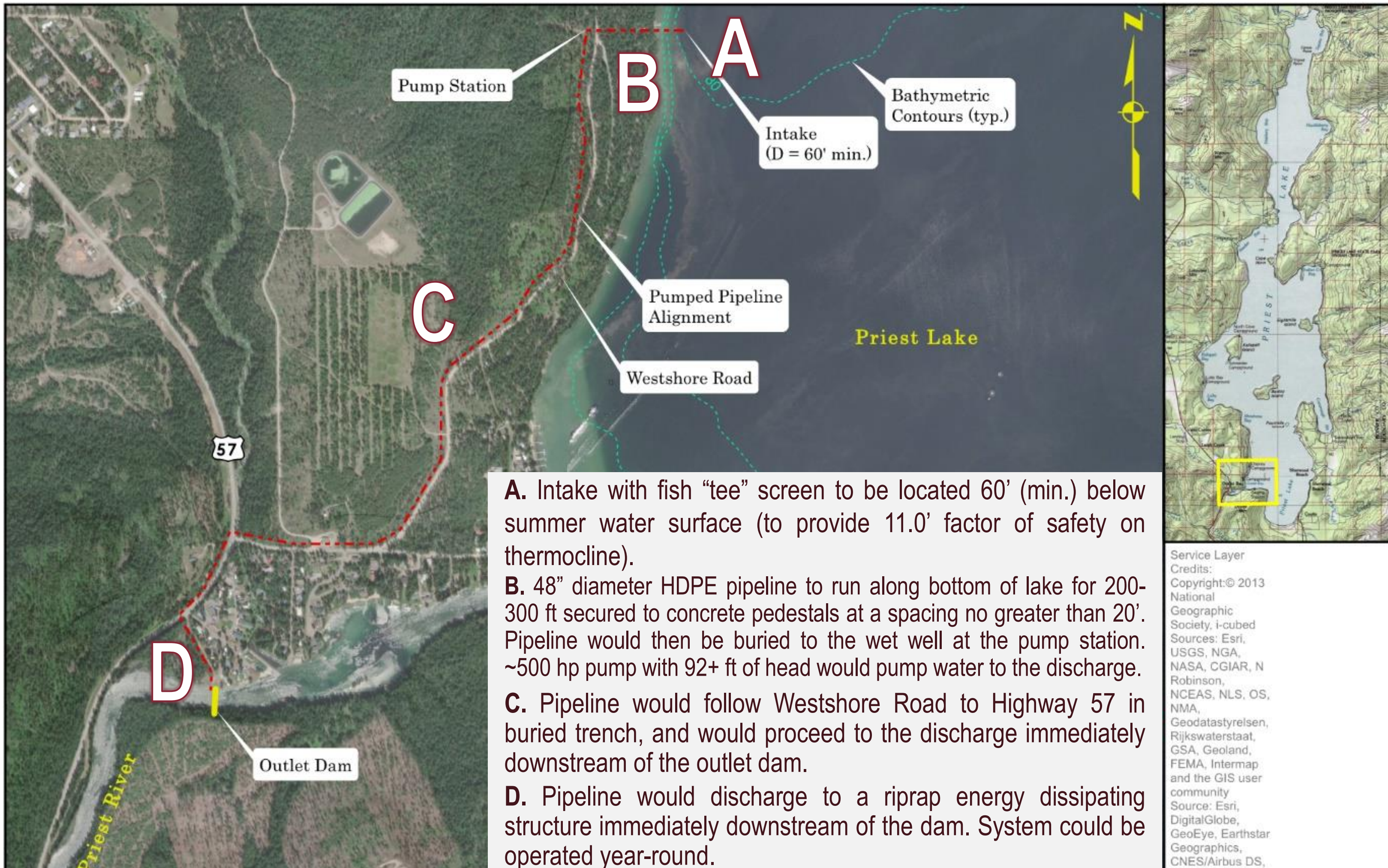
11 Alternatives were considered and were screened down to **4** Alternatives to advance to further stages of evaluation.

- Gravity Fed System
- Siphon System
- Groundwater Well System
- Pump System
- Ranney Well System
- Groundwater Well with Recharge
- Tree Shading
- Vortex Tube System
- Passively Induced Upwelling
- Trap and Haul System
- Mechanical Chiller System

→

- Pump System
- Siphon System
- Gravity Fed System
- Groundwater Well System

PUMP SYSTEM



A. Intake with fish "tee" screen to be located 60' (min.) below summer water surface (to provide 11.0' factor of safety on thermocline).

B. 48" diameter HDPE pipeline to run along bottom of lake for 200-300 ft secured to concrete pedestals at a spacing no greater than 20'. Pipeline would then be buried to the wet well at the pump station. ~500 hp pump with 92+ ft of head would pump water to the discharge.

C. Pipeline would follow Westshore Road to Highway 57 in buried trench, and would proceed to the discharge immediately downstream of the outlet dam.

D. Pipeline would discharge to a riprap energy dissipating structure immediately downstream of the dam. System could be operated year-round.

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PUMP SYSTEM

- This alternative would consist of:
  - Approx. 9,750 feet of 48” dia. HDPE pipeline
  - Approx. 10 concrete pipe pedestals
  - ~500 hp pump
  - Prefabricated metal building
  - Valving
  - Controls
  - 3-phase electricity

- Could be operated year-round, and while the pumping power required would vary with the head differential at the outlet dam, this alternative could encompass a range of head differentials.

- Pipe would run in buried trench from lake bottom to wet well at the pumping facility.

- Pumped pipeline would require trenching and construction through town to the discharge point downstream of the dam. Pipeline would follow Westshore Rd. and Highway 57.

Photograph courtesy of Idaho Department of Commerce – Tourism Development, 2019. *Priest Lake.* Accessed at https://visitidaho.org/things-to-do/natural-attractions/priest-lake-2/, March 2019.

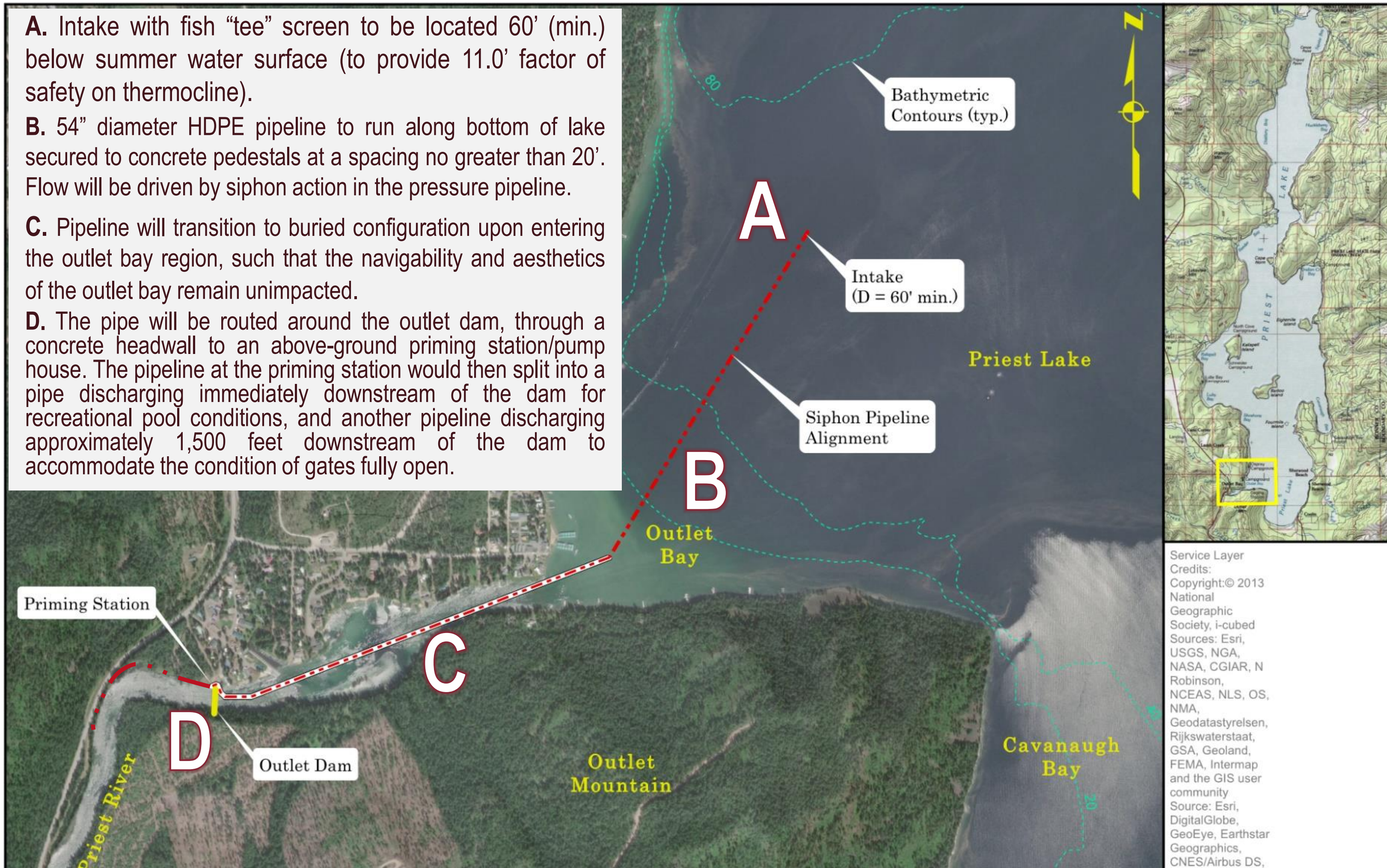
SIPHON SYSTEM

A. Intake with fish “tee” screen to be located 60’ (min.) below summer water surface (to provide 11.0’ factor of safety on thermocline).

B. 54” diameter HDPE pipeline to run along bottom of lake secured to concrete pedestals at a spacing no greater than 20’. Flow will be driven by siphon action in the pressure pipeline.

C. Pipeline will transition to buried configuration upon entering the outlet bay region, such that the navigability and aesthetics of the outlet bay remain unimpacted.

D. The pipe will be routed around the outlet dam, through a concrete headwall to an above-ground priming station/pump house. The pipeline at the priming station would then split into a pipe discharging immediately downstream of the dam for recreational pool conditions, and another pipeline discharging approximately 1,500 feet downstream of the dam to accommodate the condition of gates fully open.



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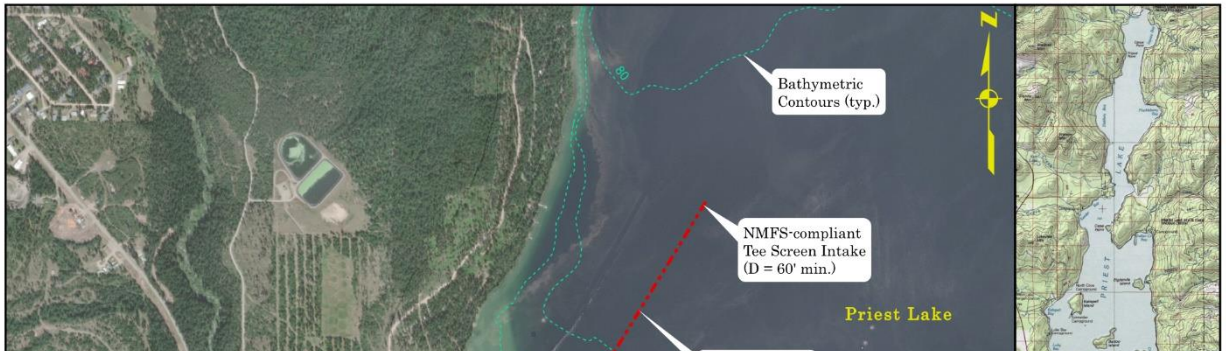
SIPHON SYSTEM



Outfall 1 – for

Image from Intake Screens Inc. 2019. Accessed at http://intakescreensinc.com/projects/priest-rapids-dam/

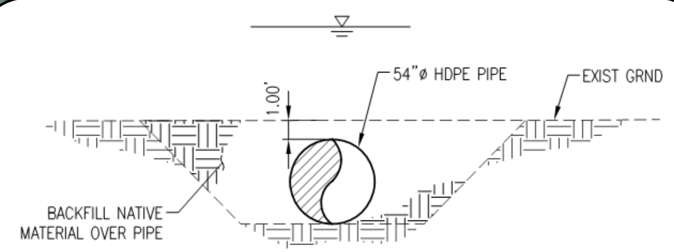
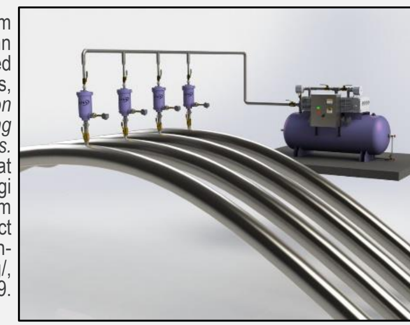
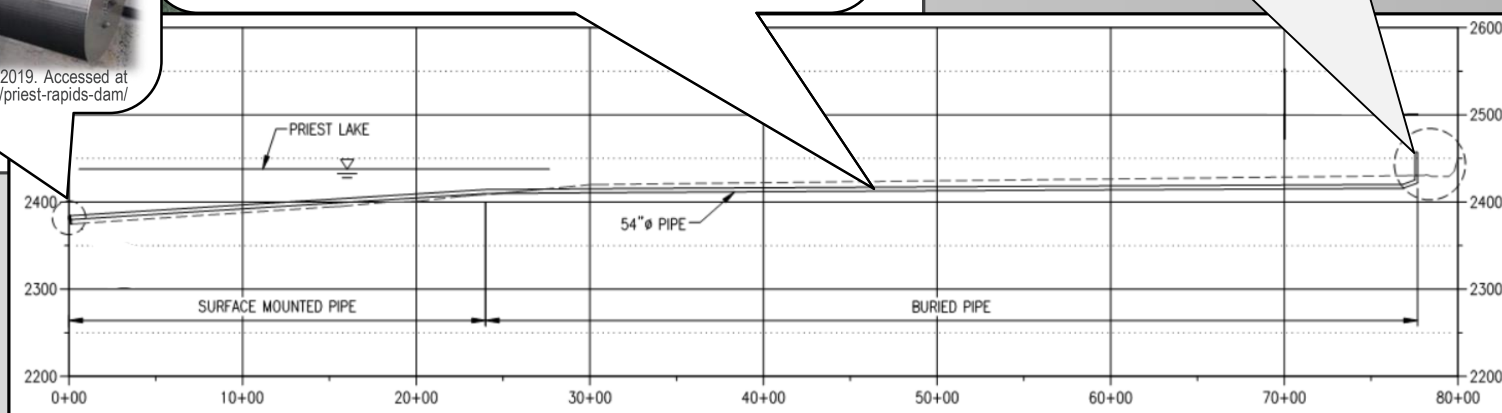


Image from Lynn Engineered Systems, 2019. *Siphon Priming Systems.* Accessed at http://lynnengineeredsystems.com/products/siphon-priming/, March 2019.





SIPHON SYSTEM

- This alternative would consist of:
  - Approx. 7,900 ft of 54” dia. HDPE pipeline
  - Approx. 1,600 ft of 54” dia. steel pipeline
  - Approx. 120 concrete pedestals
  - Fish screen
  - Priming station/pump house
  - Valving
  - Controls
  - Prefabricated metal building
  - Single-phase power

- Head differential across the outlet dam sufficient during the recreational season to outlet immediately downstream of dam.

- When outlet dam gates are fully open, discharge point will be approximately 1,500 ft downstream of the dam.

Photographs reproduced from Mott MacDonald, 2018. *Priest Lake Water Management Study Report*, prepared for the Idaho Water Resource Board, February 2018.

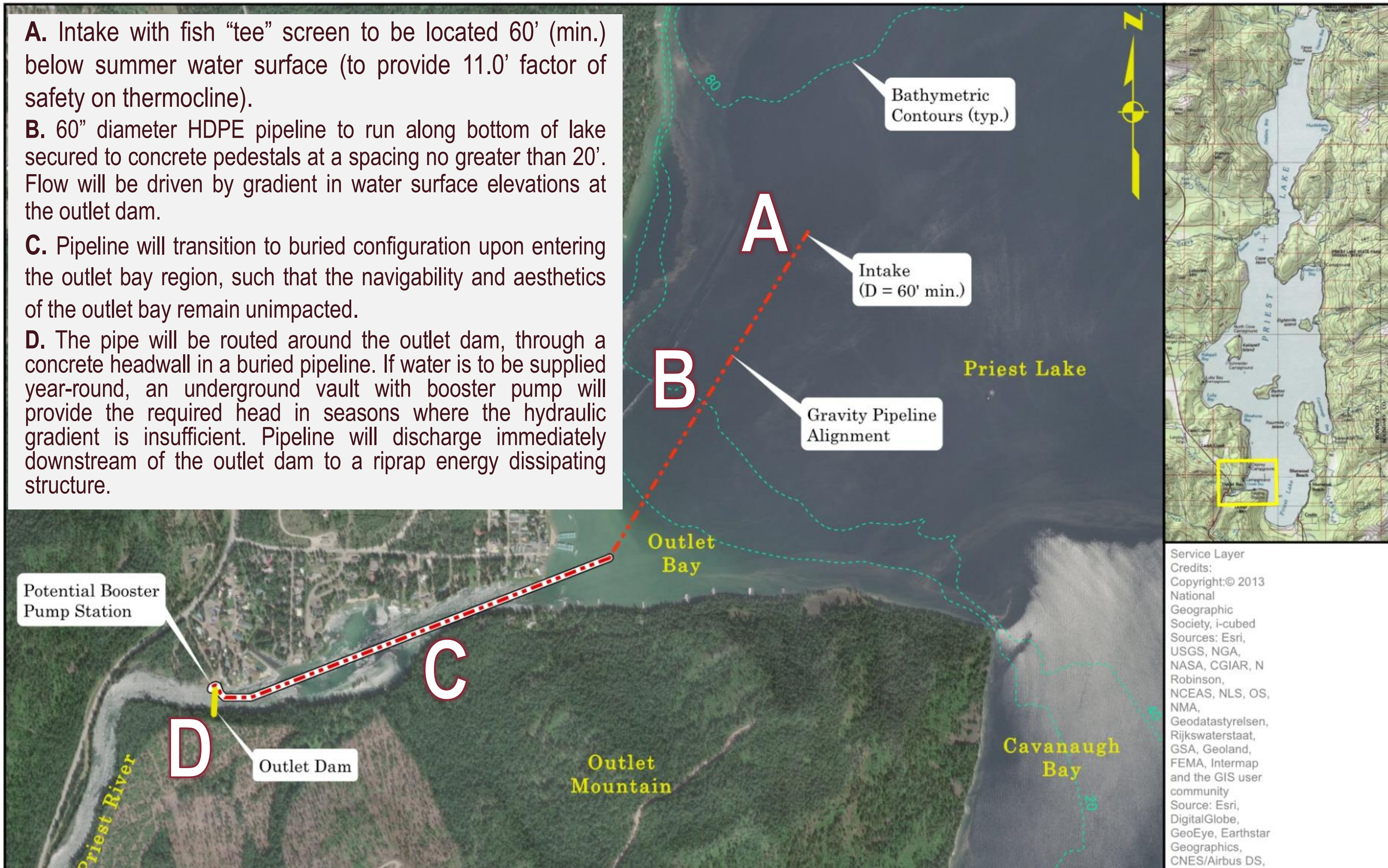
GRAVITY FED SYSTEM

A. Intake with fish “tee” screen to be located 60’ (min.) below summer water surface (to provide 11.0’ factor of safety on thermocline).

B. 60” diameter HDPE pipeline to run along bottom of lake secured to concrete pedestals at a spacing no greater than 20’. Flow will be driven by gradient in water surface elevations at the outlet dam.

C. Pipeline will transition to buried configuration upon entering the outlet bay region, such that the navigability and aesthetics of the outlet bay remain unimpacted.

D. The pipe will be routed around the outlet dam, through a concrete headwall in a buried pipeline. If water is to be supplied year-round, an underground vault with booster pump will provide the required head in seasons where the hydraulic gradient is insufficient. Pipeline will discharge immediately downstream of the outlet dam to a riprap energy dissipating structure.



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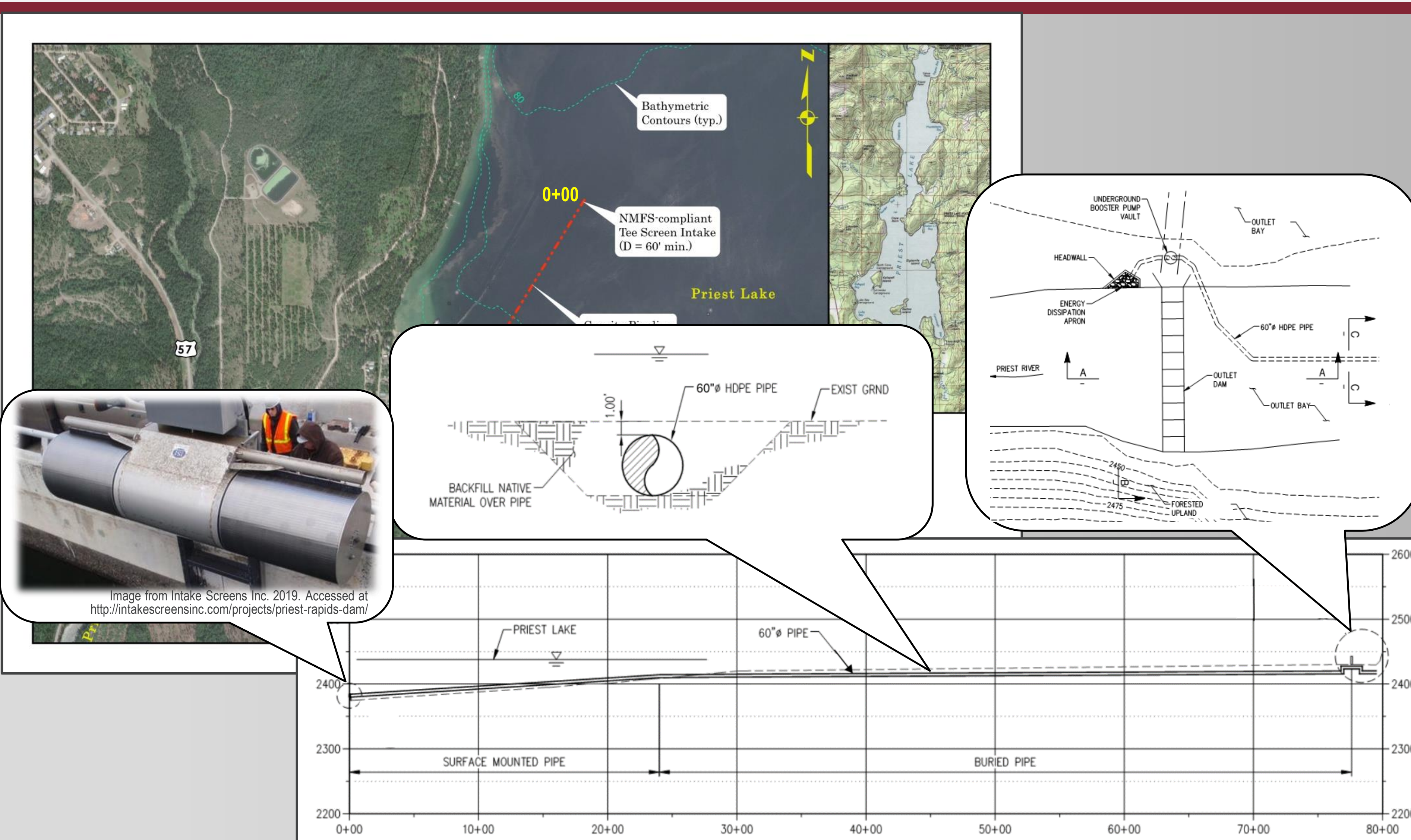
GRAVITY FED SYSTEM



GRAVITY FED SYSTEM

- This alternative would consist of:
  - Approx. 8,000 ft of 60" dia. HDPE pipeline
  - Approx. 120 concrete pedestals
  - Fish screen
  - Contingency booster pump station
  - Valving
  - Controls
  - Booster pump vault
  - 3-phase power

- Hydraulic head during the recreational season is sufficient to drive water through the pipeline to the Priest River. If this alternative were to be operated year-round, however, a booster pump would be required to drive the 45-71 cfs downstream.

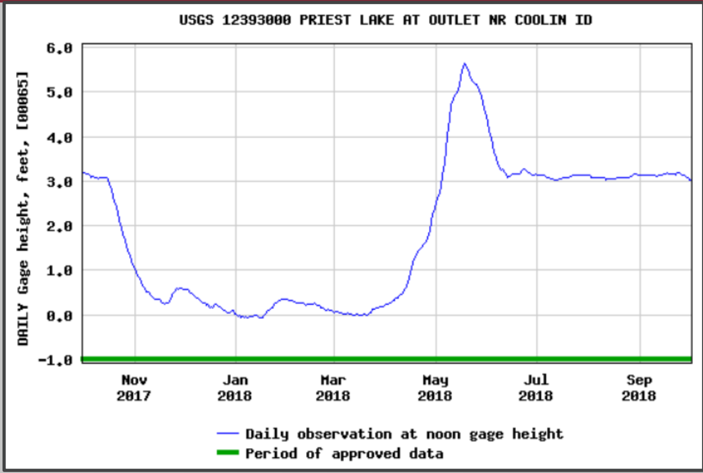


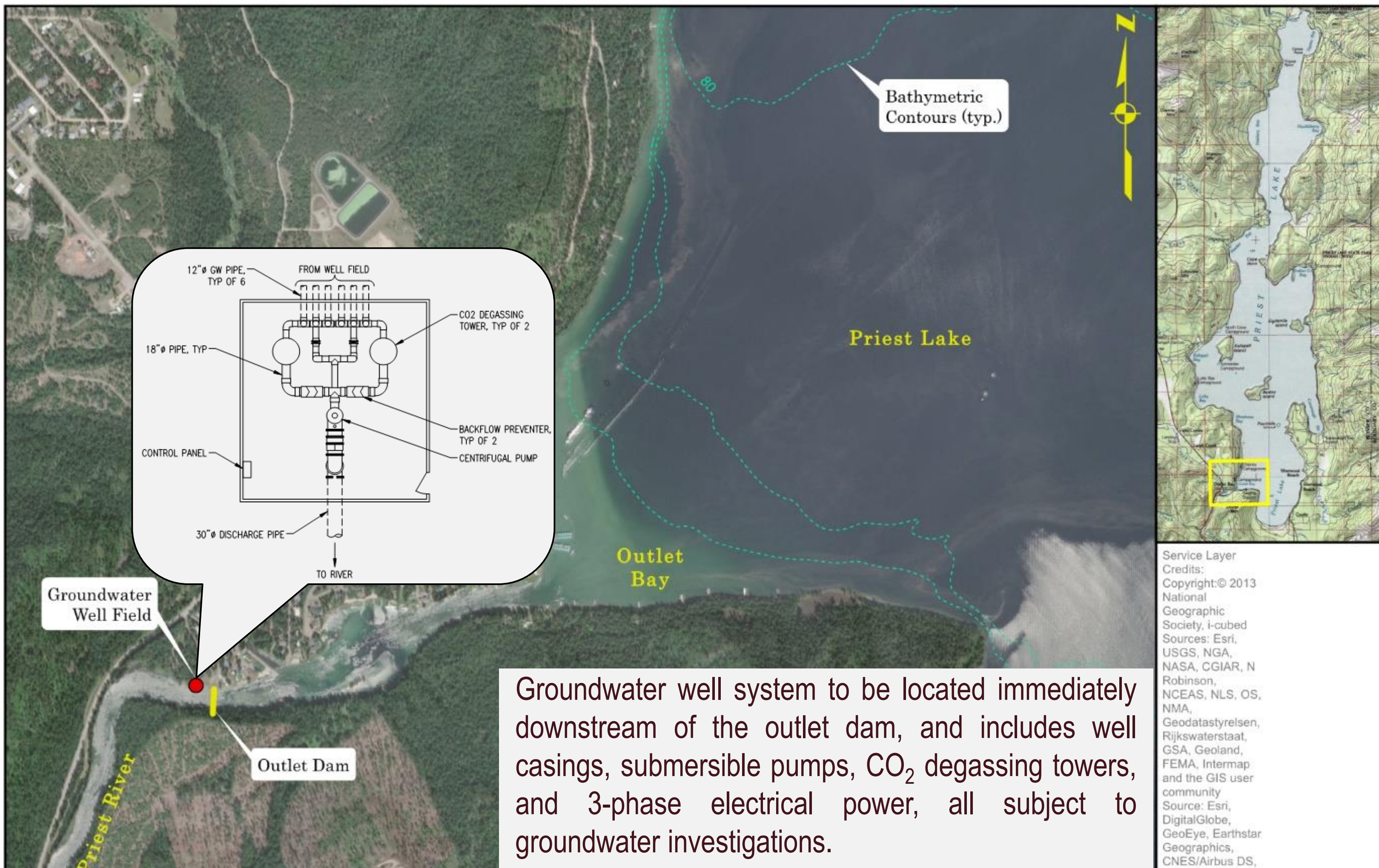
Image (above) from USGS gage station 12393000 data, accessed at https://waterdata.usgs.gov.

Image (below) from Mott MacDonald, 2018. *Priest Lake Water Management Study Report*, prepared for the Idaho Water Resource Board, February 2018.

GRAVITY FED SYSTEM

Siphon	Gravity Fed
✓ Requires priming pumps for both summer flows and year-round	✓ Requires booster pumps only for off-season flows when dam gates are open
✓ Requires two outlets: one for recreational lake conditions, one for gates fully open	✓ Requires only one outlet, immediately downstream of the outlet dam
✓ Subject to loss of prime and will require stringent monitoring	✓ Reliable mechanism with a booster pump contingency

GROUNDWATER WELL SYSTEM



Groundwater well system to be located immediately downstream of the outlet dam, and includes well casings, submersible pumps, CO_2 degassing towers, and 3-phase electrical power, all subject to groundwater investigations.

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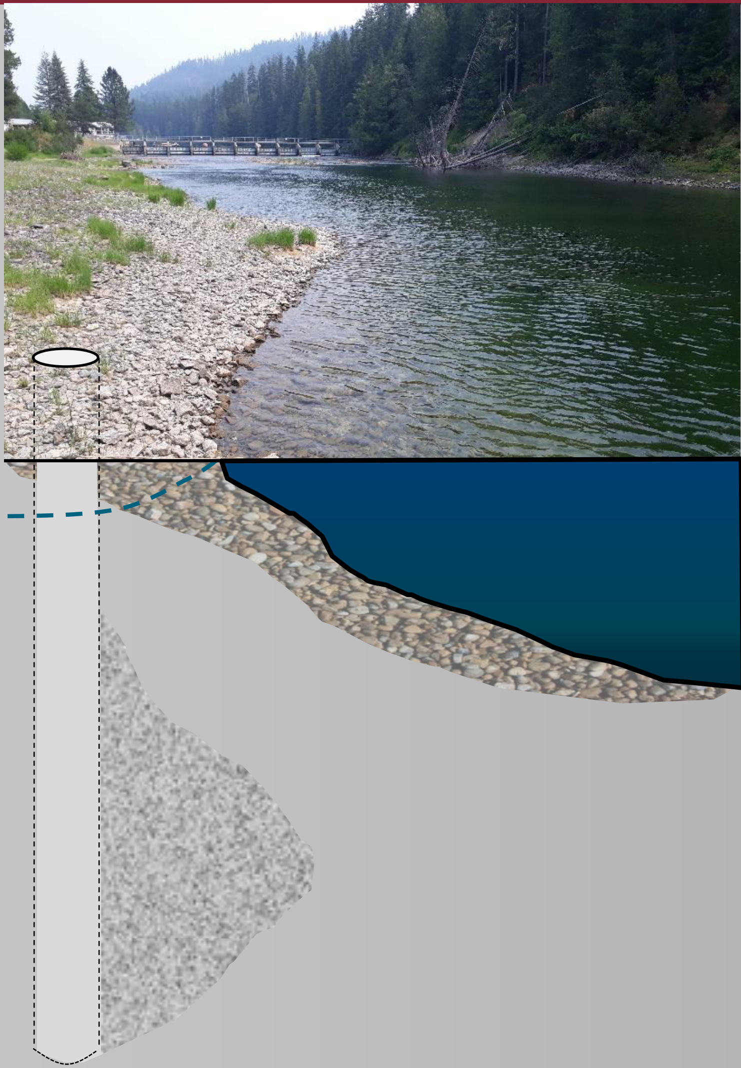
GROUNDWATER WELL SYSTEM

- This alternative would consist of:
  - Approximately 800 ft of 12” dia. steel well casing
  - 6 x 150 hp groundwater pumps
  - 300 ft of 12” dia. HDPE pipe
  - Control house
  - Degassing towers
  - Valving
  - Controls
  - 1 low head booster pump
  - 3-phase power
- Could be operated year-round and would not be dependent upon the head differential across the outlet dam.
- Currently the water availability and temperature are not well understood and would require further steps to establish the feasibility of this alternative.
- Would require obtaining additional water rights for pumping of groundwater.



ASSESSMENT

- Project Background
- Design Constraints
- Water Supply Alternatives
- **Assessment**
- Future Research
- Questions

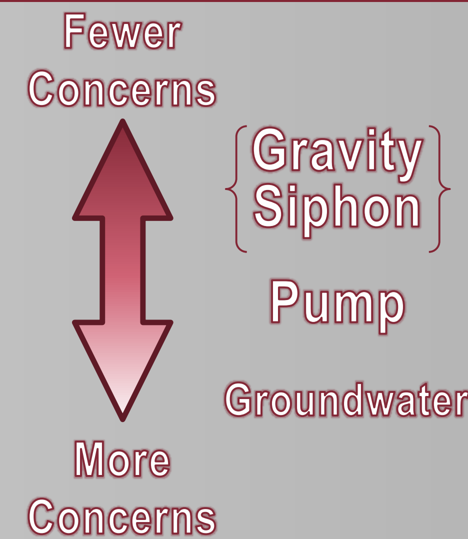
ASSESSMENT

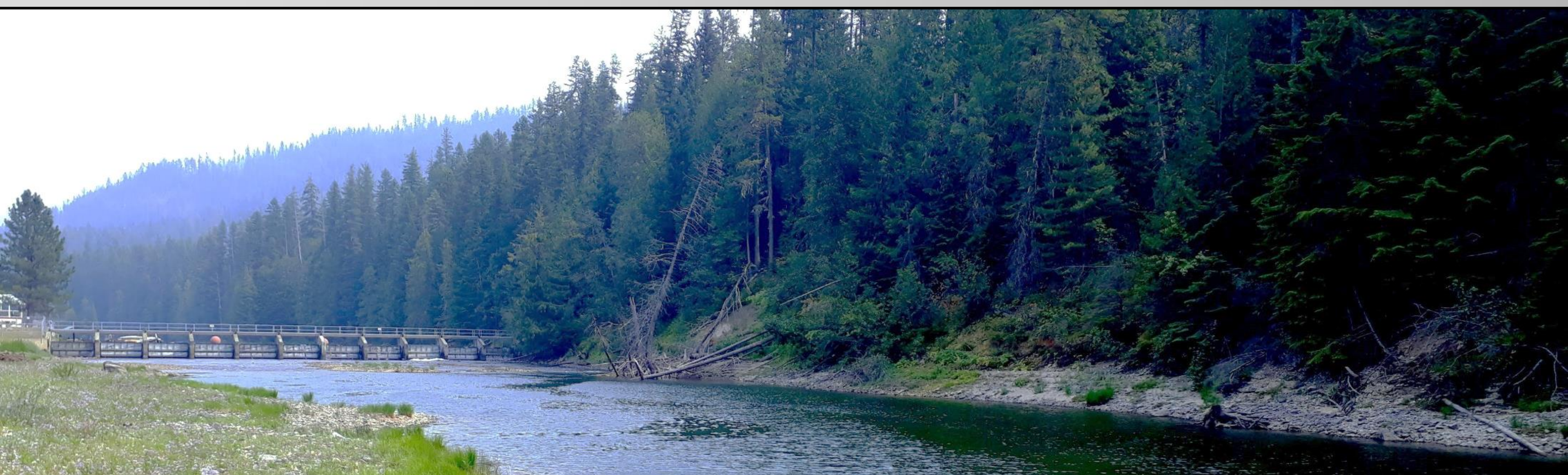
Alternatives were assessed on the following set of criteria:

1	**Public Concerns**	e.g. public safety, navigability, recreational impact, aesthetics, etc.
2	**Biological Efficiency**	Ability to meet temperature criterion for both the season of interest, or year-round
3	**Constructability**	Challenges to constructing the alternative
4	**Environmental Considerations**	For both construction and operations e.g. effects to riparian areas and wildlife, water rights, noise, etc.
5	**Operation**	Ease of implementation, monitoring, and maintenance
6	**Design Approach**	Complexity of the system and demonstrated effectiveness
7	**Cost**	Including both capital costs and ongoing operations and maintenance

PUBLIC CONCERNS

- No impacts to public safety, navigability, or recreation are expected for any of the alternatives
- Aesthetic impact would be limited, and would vary by alternative:
  - Gravity-fed and pump station alternatives would be hidden from view
  - Siphon system would entail an above ground structure for priming
  - Groundwater wells would include degassing towers and a housing structure

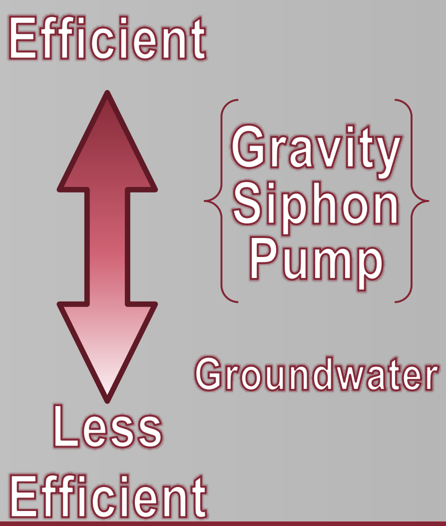




BIOLOGICAL EFFICIENCY

- The gravity-fed, siphon, and pump alternatives are all able to provide 45 cfs from the hypolimnion to the discharge points in the Lower Priest River throughout the year.
- The effectiveness of the groundwater well system would require further studies to determine the productivity and temperature of the aquifer.

Photographs reproduced from Mott MacDonald, 2018. *Priest Lake Water Management Study Report*, prepared for the Idaho Water Resource Board, February 2018.



CONSTRUCTABILITY

- The groundwater well system construction would be confined to one area, and performed in the dry.
- The remaining three alternatives would require in-water work, most likely performed from a barge.
- The siphon system is the only alternative that would not require 3-phase power to the site.
- The pump system would require significant lengths of pipe trench along Westshore Road and Highway 57.

Simple

Groundwater

Siphon

Gravity

Pump

Complex

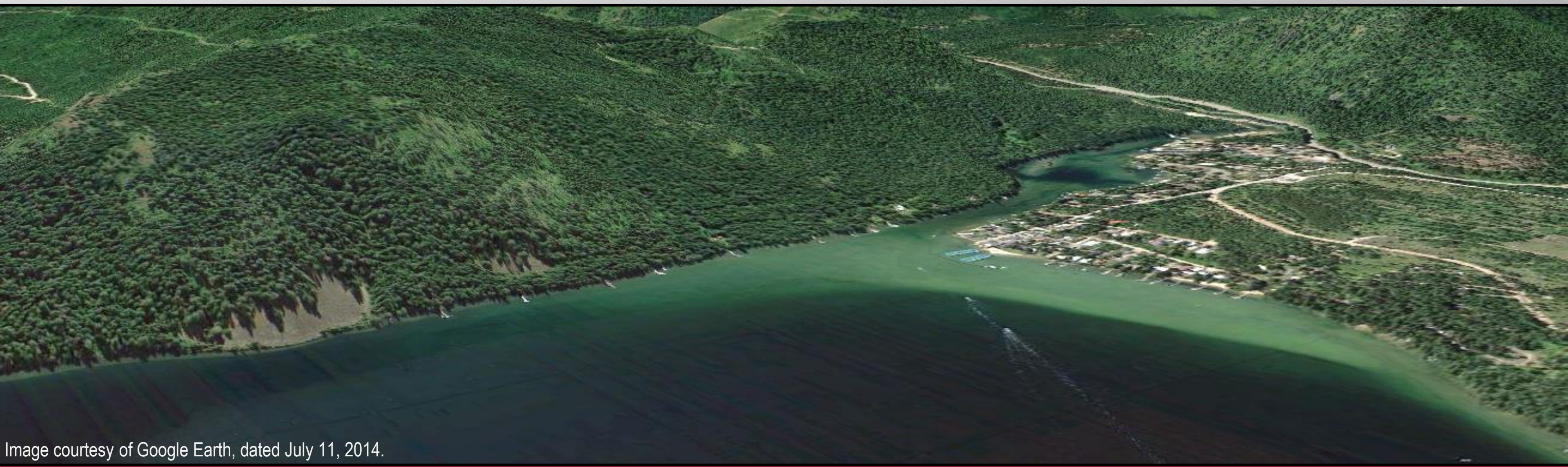
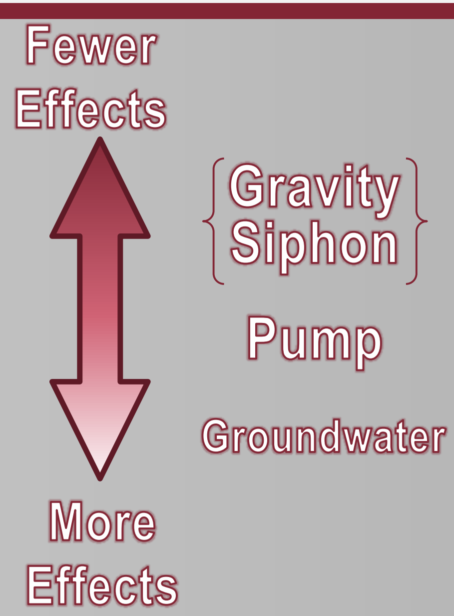


Image courtesy of Google Earth, dated July 11, 2014.

ENVIRONMENTAL CONSIDERATIONS

- Environmental impacts are expected to be limited, and occur primarily during the construction phase. Some of the effects identified were:
  - Temporary re-suspension of fine material during construction of the in-water pipeline for the gravity, siphon, and pump alternatives.
  - Potential for limited noise pollution under the pump alternative.
  - Significant groundwater rights would need to be acquired for the groundwater well alternative.



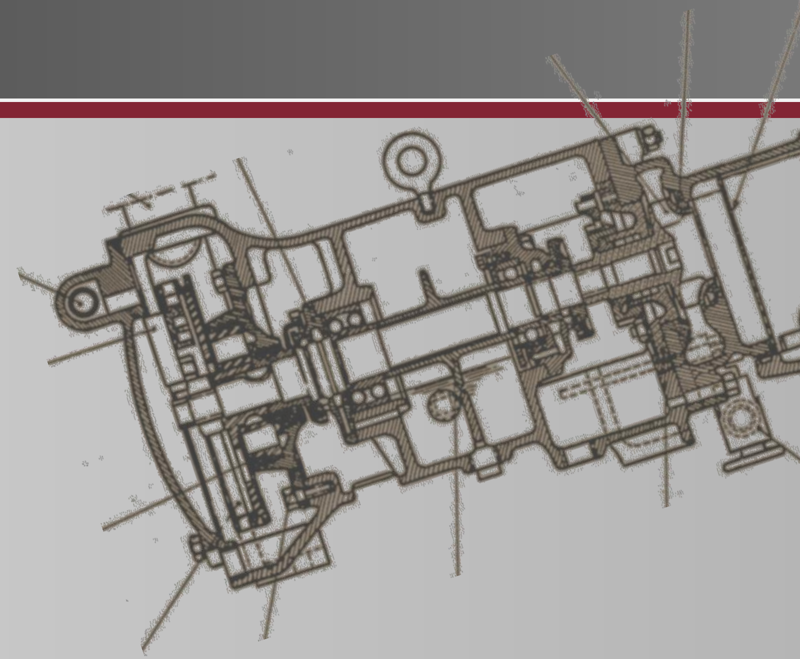
OPERATION

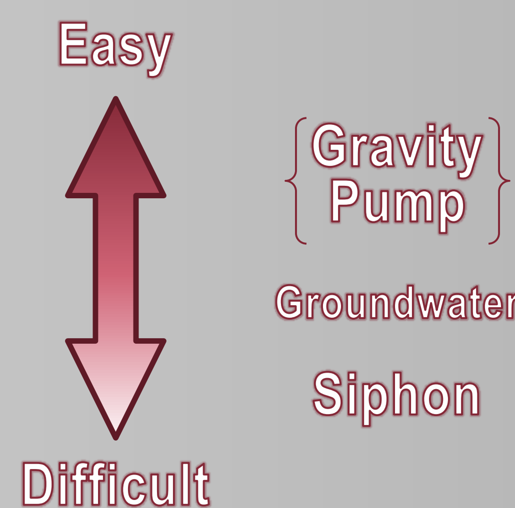
- The gravity system would only require pumping during the non-recreational period, and therefore maintenance and operation would be minimal.

- The pumping system would pump for longer periods, but any maintenance to the pipeline would be much more accessible.

- The amount of pumps and variety of equipment required for the groundwater well system could require significant maintenance.

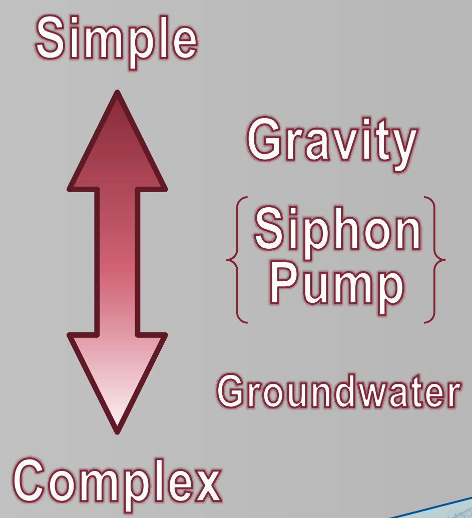
- The siphon system would require significant monitoring and maintenance, as these systems are notorious for losing their prime.





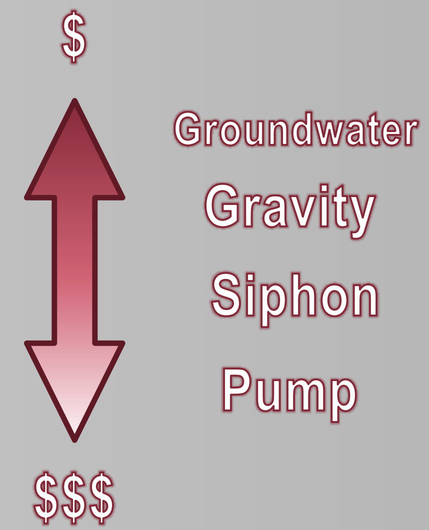
DESIGN APPROACH

- Most of the alternatives were found to be able to meet the project objectives while meeting NMFS fish screen design criteria.
- The gravity and siphon alternatives would additionally benefit from the proposed outlet dam improvements of raising the water pool by 6-inches.
- The siphon and groundwater alternatives introduce additional measures of complexity that provide more opportunities for failure of critical components.



COST

- A life cycle analysis was performed on the four alternatives over a 20-year project life, and all costs are reported in present-value
- It was found that while the groundwater system has the highest estimated O&M costs, it has the lowest life cycle cost
- The pump station has both a high construction cost and ongoing O&M costs



Line Item	Alternative 1 Gravity System	Alternative 2 Siphon System	Alternative 3 Groundwater Well System	Alternative 4 Pump Station
Construction Cost	$3,815,000	$4,523,000	$684,000	$4,689,000
Summer O&M Costs, Present Value (20-year)	$30,355	$46,053	$2,370,516	$1,302,619
Life Cycle Cost	**$3,845,355**	**$4,569,053**	**$3,054,516**	**$5,991,619**

ENGINEER RECOMMENDATIONS

- Two of the four alternatives are recommended for further investigation:

Gravity

- ✓ Lowest O&M costs
- ✓ 2nd lowest life cycle costs
- ✓ Limited aesthetic impact
- ✓ Simplest system
- ✓ Proven effectiveness
- ✓ Ability to meet criteria year-round
- ✓ Benefits from proposed outlet improvements

Groundwater

- ✓ Lowest life cycle cost
- ✓ Lowest capital costs
- ✓ Limited construction impacts
- ✓ Easily constructible
- ✓ Not dependent on lake levels
- × Will require further hydrogeological study to ensure ability to meet criteria

FUTURE RESEARCH

- Project Background
- Design Constraints
- Water Supply Alternatives
- Assessment
- **Future Research**
- Questions

FUTURE RESEARCH

- Additional studies and research will be required:
  - Water Quality/Limnology
  - Groundwater Analysis
  - Pipeline Geotechnical Analysis
  - Erosion Potential as it relates to pipe corridor
  - Construction Practices and Sequencing
  - Economic/Financial Assessment Evaluation

QUESTIONS ?