



LEAVENWORTH NATIONAL FISH HATCHERY PUMP BACK – PRELIMINARY ASSESSMENT

Prepared for

Chelan County Natural Resources Department

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U.S. Fish and Wildlife Service, Leavenworth National Fish Hatchery

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March 18, 2015

**This technical memorandum was prepared under
the supervision of a registered Professional Engineer.**



March 18, 2015

TECHNICAL MEMORANDUM

To: Dave Irving, U.S. Fish and Wildlife Service
Steve Croci, U.S. Fish and Wildlife Service

Date: March 18, 2015

From: David Rice, P.E., Anchor QEA, LLC
Bob Montgomery, P.E., Anchor QEA, LLC

Project: 140204-02.01

Cc: Mike Kaputa, Chelan County Natural Resources Department
Mary Jo Sanborn, Chelan County Natural Resources Department

Re: Leavenworth National Fish Hatchery Pump Back – Preliminary Assessment

The U.S. Fish and Wildlife Service (USFWS) operates the Leavenworth National Fish Hatchery (LNFH) on Icicle Creek, near the City of Leavenworth, Washington. The USFWS relies on a combination of surface water diversions from Icicle Creek, shallow groundwater wells, and deep groundwater wells to supply water needed for hatchery operations. Competing demands for water in Icicle Creek have limited the USFWS's ability to provide adequate water supply for hatchery operations. This memorandum provides a preliminary assessment of a potential project identified by LNFH personnel that would enable the USFWS to capture and pump "run-through" water from an effluent pipe at the LNFH back into the Hatchery Channel to improve water supply. The LNFH Pump Back project is one of several options being evaluated by LNFH personnel that are intended to reduce reliance on surface water from Icicle Creek and improve overall water supply conditions at the LNFH.

BACKGROUND

The LNFH is one of three hatcheries that form the Leavenworth Fisheries Complex. The Leavenworth Fisheries Complex is operated by the USFWS under an interagency agreement with the U.S. Bureau of Reclamation to mitigate for impacts associated with construction and operation of Grand Coulee Dam. The Leavenworth Fisheries Complex is a critical resource for supporting commercial, recreational, and tribal fisheries in the Mid-Columbia Basin.

The USFWS raises spring Chinook salmon at the LNFH. Spring Chinook salmon are raised at the LNFH during the first 18 months of their lives and are then released into Icicle Creek. Adequate fresh water supply is critical to hatchery operations. Water for hatchery

operations is supplied through a surface water intake on Icicle Creek and through a series of shallow and deep groundwater wells on the LNFH property. In addition to supplying surface water to LNFH, Icicle Creek supports other out-of-stream water needs, including surface water diversions for the Icicle and Peshastin Irrigation Districts, Cascade Orchards Irrigation Company, and the City of Leavenworth. Icicle Creek also provides habitat for non-indigenous hatchery stock Chinook salmon and Endangered Species Act (ESA)-listed bull trout and steelhead. Balancing out-of-stream uses with instream flow needs has become an increasing challenge for resource managers and water users.

Chelan County Natural Resources Department (CCNRD) has been working with the LNFH and other water users to identify projects that will improve management of water resources in the Icicle Creek Sub-basin and restore flows in lower Icicle Creek. CCNRD retained Anchor QEA, LLC, and Aspect Consulting (Aspect) to review options for recirculating run-through water, by pumping and improving the groundwater well supply system. The Anchor QEA/Aspect team met with CCNRD and LNFH personnel in March 2014 to discuss these options. The following background information was provided by LNFH during that meeting:

- The USFWS has surface water rights that allow for diversion of up to 42 cubic feet per second (cfs) from Icicle Creek and groundwater rights that allow for withdrawal of up to 15 cfs to support hatchery operations.
 - The LNFH was designed with two structures, Structures 2 and 5, on Icicle Creek that are critical to the water supply and hatchery activities at LNFH. Structures 2 and 5 were originally designed to rear fish in the former hatchery which is now the historical channel. Structure 2 was designed to control flow into that portion of the hatchery (the historical channel). Today, the structures have been re-purposed to meet current needs, which include brood stock management, aquifer recharge, fish release, facility maintenance and protection (flood control).
 - Structure 2, located at the south end of the LNFH property, controls flow distribution from Icicle Creek between the historic channel and a large excavated channel, referred to as the Hatchery Channel.
 - Water in the Hatchery Channel infiltrates and recharges the shallow groundwater aquifer. That groundwater is withdrawn by the shallow groundwater wells. When the Hatchery Channel has water in it, shallow groundwater levels near the channel increase to help maintain supply from shallow groundwater wells near the channel.
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- The Hatchery Channel has an adverse grade, sloping slightly from the downstream (north) end to the upstream (south) end. An overflow spillway located at the north end of the channel spills water back to Icicle Creek when the channel is full.
- Restrictions have been placed on the operation of Structure 2 and filling the Hatchery Channel to maintain flows in the historic channel. The restrictions allow for the Hatchery Channel to be filled only 2 to 3 weeks out of the year.
- When the channel is emptied, shallow groundwater levels drop quickly, and the capacity of the shallow groundwater wells is reduced.
- Groundwater supplied by the wells is about 44 to 52 °F; cooler in the summer and warmer in the winter than the surface water supply.
- All water diverted from Icicle Creek is used for hatchery production. When the hatchery ponds are brushed clean, the effluent is directed to a pollution abatement pond. All other water returns to Icicle Creek via an effluent line that discharges run-through water (water not used to clean hatchery ponds) below the Hatchery Channel spillway through the fish ladder.

LNFH has been proactive in identifying and evaluating other options for maintaining water supply needed for the hatchery process, while complying with permit conditions, regulations, and instream flow requirements. One potential solution identified by LNFH managers, referred to herein as the LNFH Pump Back project, would involve capturing and pumping the run-through water, or effluent not used for cleaning the hatchery ponds, back into the Hatchery Channel. The water pumped into the Hatchery Channel would keep a portion of the channel wetted and allow for more consistent water supply from the shallow groundwater wells adjacent to the channel.

The LNFH Pump Back project is one of several potential projects currently being evaluated under the direction of the Icicle Work Group (IWG). The IWG was co-convened by CCNRD and the Washington State Department of Ecology (Ecology) to take a comprehensive look at water resource management in the Icicle Creek Sub-basin. The IWG consists of the LNFH; federal, state, and local agencies; irrigation districts; the City of Leavenworth; non-profit organizations; environmental groups; and other stakeholders. The IWG is working to identify and evaluate projects that will improve management of water in the Icicle Creek Sub-basin and improve instream flow conditions in Lower Icicle Creek. This

preliminary assessment of the LNFH Pump Back project was funded under a grant (Grant No. G1400161) from Ecology's Office of the Columbia River. Projects endorsed by the IWG are collectively intended to meet the following nine Guiding Principles:

1. Streamflow that:
 - Provides passage,
 - Provides healthy habitat,
 - Serves channel formation function,
 - Meets aesthetic and water quality objectives,
 - Is resilient to climate change.
2. Sustainable hatchery that:
 - Provides healthy fish in adequate numbers,
 - Is resource efficient,
 - Significantly reduces phosphorus loading,
 - Has appropriately screened diversion(s),
 - Does not impede fish passage.
3. Tribal Treaty and federally-protected fishing/harvest rights are met at all times.
4. Provide additional water to meet municipal and domestic demand.
5. Improve agricultural reliability that:
 - Is operational,
 - Is flexible,
 - Decreases risk of drought impacts,
 - Is economically sustainable.
6. Improve ecosystem health including protection and enhancement of aquatic and terrestrial habitat.
7. Comply with state and federal law.
8. Protect Non-Treaty Harvest
9. Comply with the Wilderness Act of 1964, the Alpine Lakes Wilderness Act of 1976, and the Alpine Lakes Wilderness Management Plan.

The intent of the LNFH Pump Back Project is to meet multiple prongs of the Guiding Principles. This project has the potential to:

- Assist in providing a sustainable hatchery (Guiding Principle No. 2).
- Augment streamflow in Reaches 4 and 5 of Icicle Creek as water not captured by LNFH wells will benefit these reaches (Guiding Principle No. 1).
- Assist LNFH in complying with state and federal law (Guiding Principle No. 7).
- Potentially benefit habitat (Guiding Principle No. 6) and Treaty and Non-Treaty Harvest (Guiding Principles No. 3 and No. 8).

EXISTING FACILITIES

Annual flow monitoring reports are prepared for Clean Water Act Section 401 certification. The report for Water Year 2012 (USFWS 2013), indicated that the LNFH operates the following water supply and delivery facilities (see Figure 1):

- **Surface Water Intake** – LNFH diverts surface water through intake facilities located on the left bank of Icicle Creek (looking downstream) about 1 mile upstream of the LNFH property. Surface water is conveyed from the intake to the LNFH in a buried pipeline. The diversion and first 1,260 feet of pipe are shared with Cascade Orchards Irrigation Company. LNFH is in the process of evaluating upgrades to the intake facilities.
 - **Instream Control Structures** – Structures 2 and 5 were originally designed to rear fish in the former hatchery which is now the historical channel. The structures have been re-purposed to meet current needs, which include brood stock management, aquifer recharge, fish release, facility maintenance and protection (flood control).
 - **Hatchery Channel** – As noted earlier, Structure 2 on Icicle Creek is used to control the division of flow between the historic channel in Icicle Creek and the Hatchery Channel. The Hatchery Channel is filled to maintain water supply to shallow groundwater wells that are installed along the west side of the channel.
 - **Shallow Groundwater Wells (Wells 1, 2, 3, 4, and 7)** – These wells, located along the west side of the Hatchery Channel, deliver water to the hatchery process. The water temperature is about 44 to 52 °F; cooler in the summer and warmer in the winter than the surface water supply. The wells have new motors, pumps, and variable frequency drives (VFDs).
 - **Additional Wells (Wells 5 and 6)** – Wells 5 and 6 are located west of the main LNFH facilities, further from the Hatchery Channel. Well 5 draws water from a
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deep aquifer and is not influenced by surface water in the Hatchery Channel or historic channel. Well 6 draws water from both aquifers.

- **Effluent** – Water from the hatchery process is returned to Icicle Creek at two locations. Fresh run-through water (water not used for cleaning hatchery ponds) is discharged to Icicle Creek, immediately downstream of the Hatchery Channel spillway through a 42-inch pipe. Cleaning water is treated at the pollution abatement pond located at the north end of the site and discharged back to Icicle Creek through an outfall downstream of the Hatchery Channel.

Other facilities at the LNFH include hatchery tanks, raceways, ponds, buildings, power supply, utilities, and other equipment required for the hatchery process.

PROJECT CONCEPT

A preliminary plan (Figure 2) and preliminary plan details (Figure 3) were prepared to illustrate the proposed LNFH Pump Back project and provide a basis for developing a preliminary opinion of probable project costs. The proposed project would likely consist of the following major components:

- A reinforced concrete vault and manholes that would be designed to intercept water flowing in the run-through effluent pipe for recirculation to the Hatchery Channel. The vault would be designed with weir walls and pump forebays to deliver captured water to four vertical turbine pumps. An 18-foot by 18-foot (interior) vault is shown in Figure 3. The vault would be grated and would be approximately 14 feet deep.
 - The existing run-through pipe would be rerouted to the vault at two manholes through a 42-inch-diameter pipe.
 - This vault would be constructed adjacent to the existing run-through pipe and the run-through pipe would continue to operate during vault construction to minimize interruption of its operation.
 - Four vertical turbine pumps, each sized to deliver approximately 6,400 gallons per minute (14.25 cfs), would be installed at the vault. The total pumping capacity would be 57 cfs, which matches the total of the maximum instantaneous water rights from the surface water and groundwater supplies at LNFH. Although the run-through water is typically less than the total water supplied to the hatchery, USFWS suggested
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that the pump back facilities be conservatively sized to convey the total water right amount. The costs and sizes of the actual facilities may be smaller than those identified in this memorandum, when the pumping capacity is optimized.

- The four pumps would discharge to a common, buried, 36-inch-diameter discharge header and pipeline.
- The buried 36-inch discharge pipeline would extend approximately 292 feet from the pump station to a discharge point along the west bank of the Hatchery Channel near the upstream end of the ramp that leads to the Hatchery Channel spillway.
- The pipeline would discharge to a reinforced concrete structure designed to dissipate energy and deliver water to the Hatchery Channel.
- The pumping facilities would require extension of 3-phase power service from the existing 3-phase power drop at the LNFH located on the north side of the maintenance shed (Figure 2).

CONSIDERATIONS

The following is a list of factors that would need to be given additional consideration through a more detailed design analysis and evaluation of this project.

Flow Rates and Operation

The project concept assumes that facilities would be designed to deliver up to 57 cfs to the Hatchery Channel from the run-through pipeline. Opinions of probable cost (Table 1) for facilities needed to deliver the full capacity and half the capacity were developed to estimate the impact on capital and operating costs for a range of potential design flow rates. The LNFH indicated recharge would generally be needed when natural flows result in dewatering of the hatchery channel. This typically happens for extended periods from mid-summer to early spring. The flow required will vary throughout the year. A more thorough evaluation of the magnitude, timing, and duration of flows in the run-through effluent pipeline and flows required to sustain the hatchery process would be needed to help optimize design flow rates for LNFH Pump Back facilities.

Hydraulic Analysis and Pump Selection

A more detailed hydraulic analysis of the proposed project will be needed to optimize the size and configuration of the pump station, discharge pipeline, and delivery to the Hatchery Channel. Results of the hydraulic analysis would need to be reviewed with a pump supplier to verify the number, size, and type of pumps best suited for this application.

Subsurface Geology

Geotechnical exploration would be needed to verify the condition of subsurface soils and develop the design of the pump station vault and pipeline facilities. Excavation and backfill requirements, structural design of the vault, and the alignment and profile of the pipe will be informed by subsurface soil conditions.

Utilities

Additional background information would be needed to verify the location of existing utilities and process piping at the site. LNFH has indicated that there are several buried process lines and other utilities in the vicinity of the proposed facilities. Verification and mapping of those utilities will be needed to ensure success in design and construction.

Cultural Resources

LNFH has indicated that the area immediately south of the conceptual pump station vault was historically a Native American encampment location and is used by the Yakama Nation for cultural purposes. Coordination with the Yakama Nation and a thorough review of cultural resources would be needed to understand potential impacts to siting of the pump station and related facilities.

Power Supply

The power required for pumping up to 57 cfs from the run-through effluent line to the Hatchery Channel was estimated at 200 horsepower (50 horsepower per pump).

Three-phase power service would need to be extended to the pump vault from the power drop on the north side of the maintenance shed. Coordination with the power utility and additional investigation of site constraints will be needed to design the power extension.

Environmental Review and Permitting

A preliminary environmental review and permitting evaluation would need to be completed to determine if there are any fatal flaws related to environmental impacts that would prevent project implementation. The preliminary environmental review would also identify likely permitting requirements and conditions for construction and operation.

OPINION OF PROBABLE PROJECT COSTS

A preliminary opinion of probable implementation costs was developed for the materials and work associated with implementing the LNFH Pump Back project. The costs should be considered order of magnitude, as they are based on limited background information and conceptual design. Table 1 summarizes the opinion of probable cost. A more detailed breakdown of the costs is included as Attachment 1.

The opinion of probable costs includes the following allowances:

- Sales tax of 8.2%
 - A contingency of 30%
 - An allowance for engineering, permitting, and administration of 20%
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Table 1
Summary of Opinion of Probable Project Costs

| Item | 57-cfs System (full capacity) | 28.5-cfs System (half capacity) |
|---|--|--|
| Miscellaneous Site Work | \$102,800 | \$71,400 |
| Earthwork | \$69,000 | \$63,400 |
| Pump Station | \$456,500 | \$263,200 |
| Delivery Pipeline | \$44,200 | \$34,500 |
| Pavement Restoration | \$10,600 | \$9,900 |
| Subtotal¹ | \$683,000 | \$442,000 |
| Sales Tax | \$56,006 | \$36,244 |
| Subtotal – Construction Contract¹ | \$739,000 | \$478,000 |
| Contingencies (30%) | \$221,700 | \$143,400 |
| Engineering, Permitting, Administration (20%) | \$147,800 | \$95,600 |
| Total Project Cost¹ | \$1,109,000 | \$717,000 |

Note:

1. Subtotals and totals are rounded to the nearest \$1,000.

A preliminary estimate of long-term operating costs, including operations and maintenance (O&M) and pumping power costs was developed. The annual O&M cost, in 2014 dollars, was estimated as 1% of the total project implementation cost. The annual pumping cost was estimated based on a total amount of 200 horsepower of pumping, the pumps operating all year, and Chelan Public Utility District's Rate Schedule 2 for General Service, Part B-23. A summary of the annual operating costs is also included as part of Attachment 1. Additional coordination will ultimately be required to verify the applicable rate schedule.

Table 2
Summary of Estimate of Probable Annual Operating Costs

| Item | 57-cfs System (full capacity) | 28.5-cfs System (half capacity) |
|--|----------------------------------|------------------------------------|
| Annual Operations and Maintenance Costs ¹ | \$11,100 | \$7,200 |
| Annual Pumping Power Costs ² | \$35,000 | \$17,700 |
| Total Annual Operating Costs³ | \$46,100 | \$24,900 |

Notes:

1. Annual operations and maintenance costs were estimated at 1% of the project implementation cost, in 2014 dollars.
2. Pumping power costs are based on Chelan Public Utility District's Electrical Rate Schedule 2 for General Service, Part B-23, in 2014 dollars. It was assumed that pumps would operate all year (365 days, 24 hours per day).
3. Subtotals and totals are rounded to the nearest \$100.

SUMMARY AND RECOMMENDATIONS

The proposed LNFH Pump Back project has the potential to provide an alternate source of supply for the LNFH water supply system and enable USFWS to better meet the needs of the hatchery operation. It is recommended that a more detailed appraisal or feasibility-level study of design constraints, flow rates, operations, hydraulic conditions, subsurface geology, on-site utilities, cultural resources, power supply requirements, and environmental impacts and permitting requirements be completed to determine the feasibility and challenges for design and implementation. The project concept appears promising and could offer a complimentary solution to other projects currently being evaluated at the LNFH and within the Icicle Creek Sub-basin.

REFERENCES

Chelan County PUD, 2012. *Electric Rate Schedules 2012*. Accessed: November 14, 2014.

Available from: http://www.chelanpud.org/departments/customerservices/elec_rates_brochure.pdf.

USFWS, 2013. *Leavenworth National Fish Hatchery Annual Flow Monitoring Report, Water Year 2012*. Prepared in accordance with Ecology's Water Quality Program for EPA CQA 401 Certification Order No. 7192.

FIGURES

Q:\Jobs\ChelanCounty_0204\IcicleCreekCompWaterMgtPlan\Maps\2015_03\Location Map - LNFH.mxd ahill 3/19/2015 9:44:19 AM

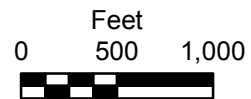
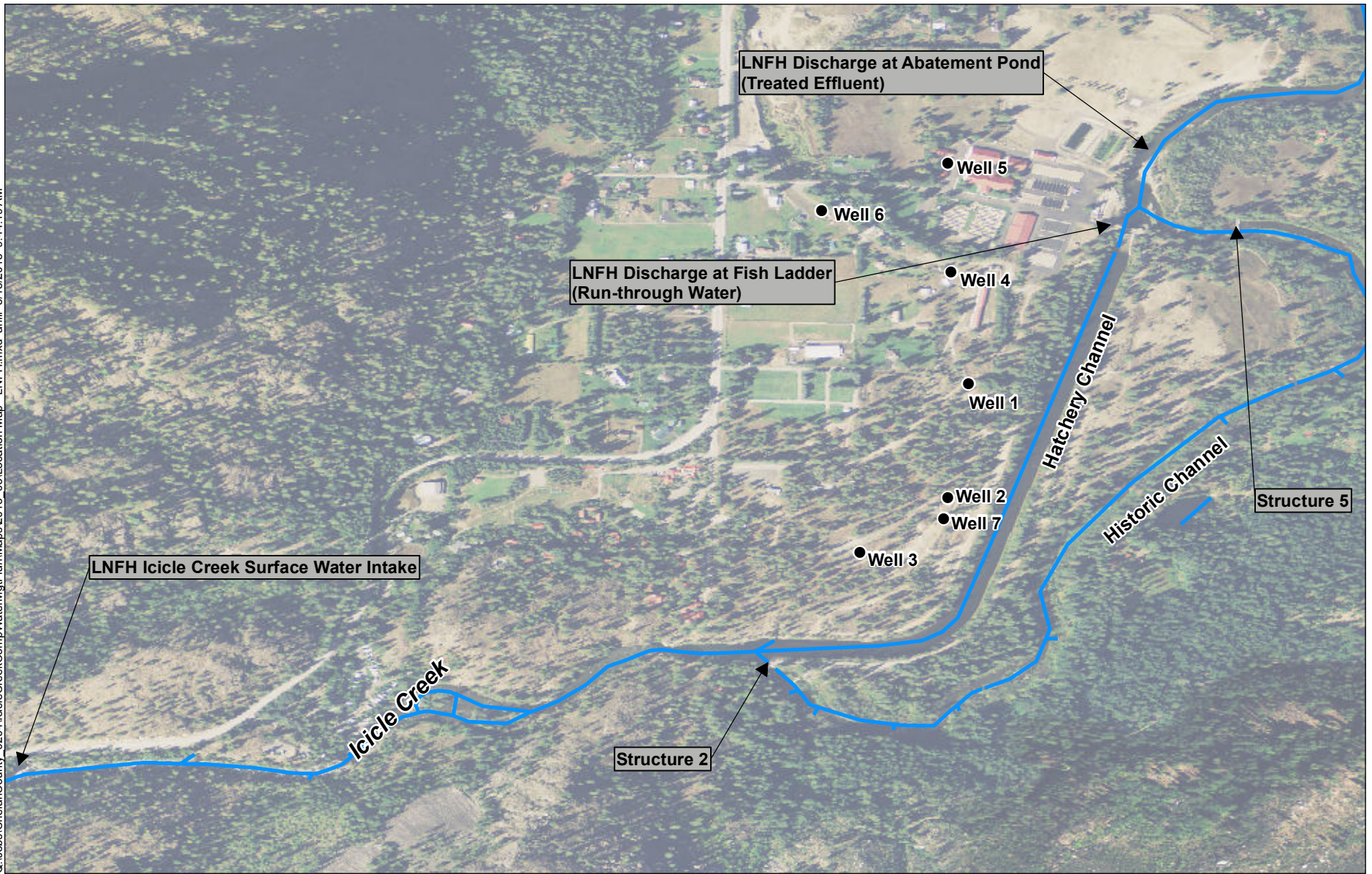
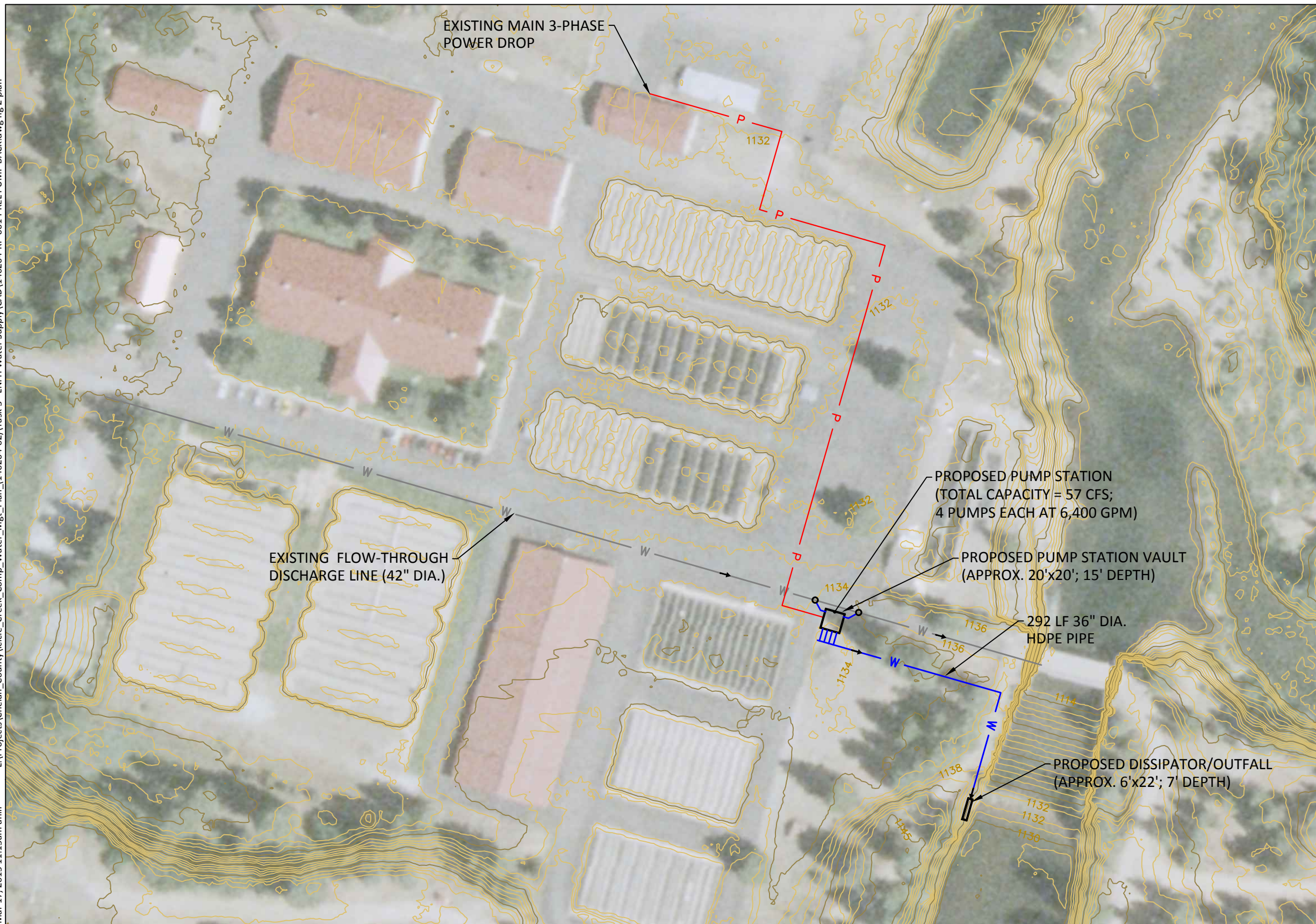


Figure 1
Location Map
Leavenworth National Fish Hatchery
Icicle Creek Watershed Comprehensive Plan

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Mar 17, 2015 11:15am ahill

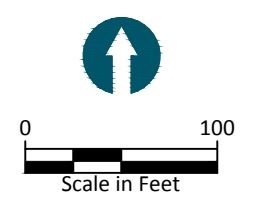


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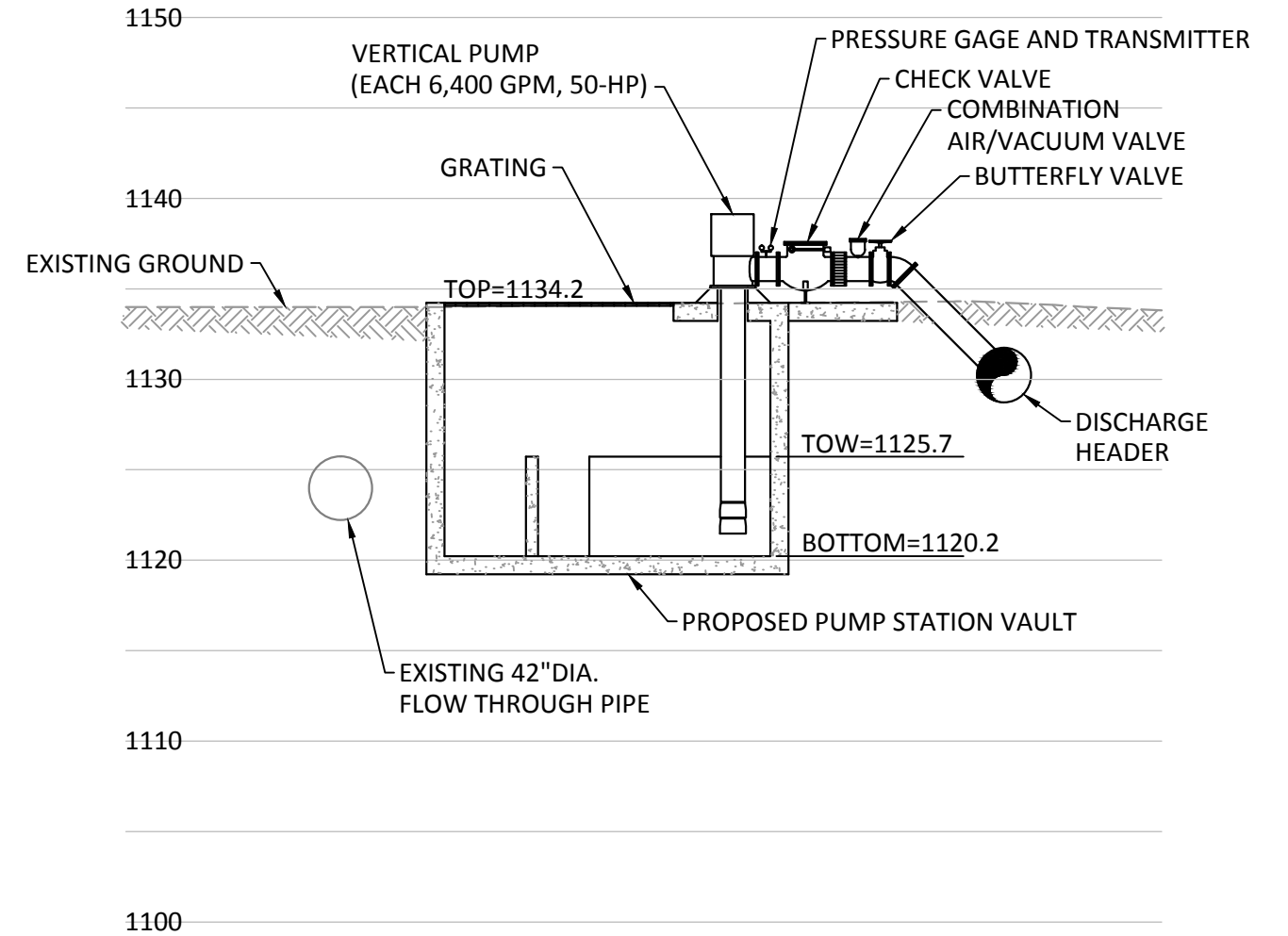
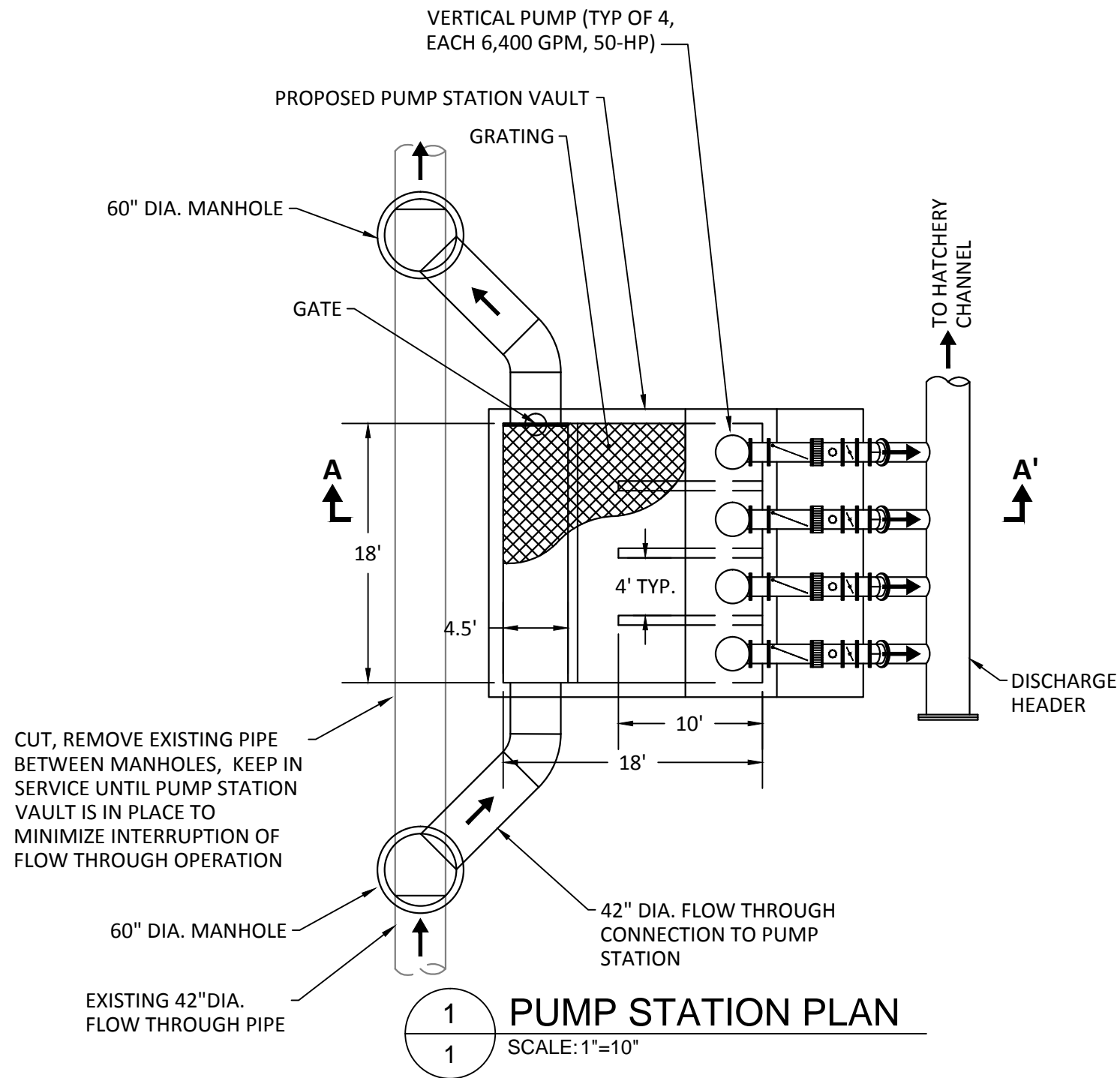
- W— Existing Water Flow-through Line
- W— Proposed Pump Back Discharge Line
- P— Proposed UG Power Service

SOURCE:
Aerial photo: USGS WA 2006
Topography: ERSI LIDAR 2006

DATUM:
Horizontal: Washington State Plane North, NAD 83
Vertical: NAVD 88



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A **SECTION**
 HORIZ. SCALE: 1" = 10'
 VERT. SCALE: 1" = 10'

ATTACHMENT 1
OPINION OF PROBABLE COSTS

**Leavenworth National Fish Hatchery - Pump Back System
Preliminary Opinion of Probable Costs**

| ITEM | UNIT | UNIT COST | 57-CFS SYSTEM | | 28.5-CFS SYSTEM | |
|---|-------|-----------|---------------|--------------------|-----------------|-------------------|
| | | | QTY | COST ¹ | QTY | COST ¹ |
| Miscellaneous Site Work | | | | | | |
| Mobilization / Demobilization (10%) | LS | VARIABLES | 1 | \$68,000 | 1 | \$44,000 |
| Temporary Facilities | DAY | \$150 | 30 | \$4,500 | 30 | \$4,500 |
| Temporary Erosion and Sediment Control (3%) | LS | VARIABLES | 1 | \$20,700 | 1 | \$13,300 |
| Construction Surveying | HR | \$200 | 48 | \$9,600 | 48 | \$9,600 |
| Subtotal - Miscellaneous Site Work | | | | \$102,800 | | \$71,400 |
| Earthwork | | | | | | |
| AC Pavement Sawcutting | LF | \$2 | 2,190 | \$4,380 | 2,170 | \$4,340 |
| AC Pavement Removal | TN | \$50 | 75 | \$3,750 | 70 | \$3,500 |
| Temporary Shoring | SF | \$9 | 5,650 | \$50,850 | 5,380 | \$48,420 |
| Structure Excavation and Stockpile | CY | \$8 | 400 | \$3,200 | 260 | \$2,080 |
| 42" Dia. Pipe Removal and Salvage | LF | \$40 | 50 | \$2,000 | 40 | \$1,600 |
| Pump Vault Foundation Material | TN | \$25 | 22 | \$550 | 12 | \$300 |
| Wall Drain Material | TN | \$25 | 86 | \$2,150 | 71 | \$1,775 |
| Native Material Backfill | CY | \$6 | 113 | \$678 | 90 | \$540 |
| Waste/Disposal of Excess Material | CY | \$5 | 290 | \$1,450 | 175 | \$875 |
| Subtotal - Earthwork | | | | \$69,000 | | \$63,400 |
| Pump Station | | | | | | |
| 42" HDPE DR 32.5 Pipe, Flow Through Connection | LF | \$125 | 16 | \$2,000 | 16 | \$2,000 |
| 60" Manhole | EA | \$6,500 | 2 | \$13,000 | 2 | \$13,000 |
| Reinforced Concrete Vault (18' long x 18' wide, x 14' deep) | CY | \$750 | 59 | \$44,250 | 0 | \$0 |
| Reinforced Concrete Vault (9' long x 18' wide, x 14' deep) | CY | \$750 | 0 | \$0 | 39 | \$29,250 |
| Grating | SF | \$30 | 216 | \$6,480 | 108 | \$3,240 |
| 42-inch Slide Gate | EA | \$4,500 | 1 | \$4,500 | 1 | \$4,500 |
| 3-Phase Power Extension ² | LF | \$35 | 750 | \$26,250 | 750 | \$26,250 |
| Vertical Pump (6,400 gpm, 50-hp) | EA | \$50,000 | 4 | \$200,000 | 2 | \$100,000 |
| Electrical and Controls | LS | VARIABLES | 1 | \$100,000 | 1 | \$55,000 |
| Fittings, Valves, Meter, and Appurtenances | LS | VARIABLES | 1 | \$60,000 | 1 | \$30,000 |
| Subtotal - Pump Station | | | | \$456,500 | | \$263,200 |
| Delivery Pipeline | | | | | | |
| 36" HDPE DR 32.5 Pipe ² | LF | \$105 | 292 | \$30,660 | 0 | \$0 |
| 30" HDPE DR 32.5 Pipe ² | LF | \$90 | 0 | \$0 | 292 | \$26,280 |
| Dissipating Structure at Pipe Outfall | CY | \$750 | 18 | \$13,500 | 11 | \$8,250 |
| Subtotal - Delivery Pipeline | | | | \$44,200 | | \$34,500 |
| Pavement Restoration | | | | | | |
| Base Course | TN | \$25 | 145 | \$3,625 | 135 | \$3,375 |
| AC Asphalt Pavement | TN | \$120 | 58 | \$6,960 | 54 | \$6,480 |
| Subtotal - Pavement Restoration | | | | \$10,600 | | \$9,900 |
| Construction Subtotal¹ | | | | \$683,000 | | \$442,000 |
| Sales Tax | 8.2% | | | \$56,006 | | \$36,244 |
| Subtotal - Construction Contract¹ | | | | \$739,000 | | \$478,000 |
| Contingencies | 30.0% | | | \$221,700 | | \$143,400 |
| Engineering, Permitting, Administration | 20.0% | | | \$147,800 | | \$95,600 |
| Total Project Cost¹ | | | | \$1,109,000 | | \$717,000 |

Notes:

- 1) Subtotals are rounded to the nearest \$100. Construction subtotals and total project cost are rounded to the nearest \$1,000.
- 2) Includes cost of furnishing and installing pipe or conduit and trenching, backfilling, and compaction of bedding and backfill.

**Leavenworth National Fish Hatchery - Pump Back System
Preliminary Opinion of Probable Annual Operating Costs**

| ITEM | UNIT | UNIT COST | 57-CFS SYSTEM | | 28.5-CFS SYSTEM | |
|---|--------|-----------|---------------|-------------------|-----------------|-------------------|
| | | | QTY | COST ¹ | QTY | COST ¹ |
| Annual Operations and Maintenance Cost¹ | | | | \$11,100 | | \$7,200 |
| Pumping Power Costs² | | | | | | |
| Monthly Basic Charge (3-Phase Power) | /EA/MO | \$25.35 | 1 | \$25.35 | 1 | \$25.35 |
| Monthly Demand Charge | /kW/MO | \$2.25 | 149 | \$335.70 | 75 | \$167.85 |
| Energy Charge (Full-year Operation at Full Capacity) | kWH | \$0.0235 | 1,306,992 | \$30,714.31 | 653,496 | \$15,357.16 |
| Total Annual Pumping Costs | | | | \$35,000 | | \$17,700 |
| Total Annual Operating Costs³ | | | | \$46,100 | | \$24,900 |

Notes:

- 1) Annual Operations and Maintenance Costs estimated a 1% of project implementation cost, in 2014 dollars.
- 2) Pumping power costs are based on Chelan PUD Electrical Rate Schedule 2 (General Service), Part B-23, in 2014 dollars.
- 3) Subtotals and totals are rounded to the nearest \$100.