Ice Harbor Lock and Dam

Design Documentation Report
Initial Review

Adult Fish Ladder Weir Gate Hoist Machinery Replacement

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Prepared By:

USACE NWW

February 2026

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PREVIOUS REPORTS AND STUDIES

Ice Harbor Fish Ladder Gate Hoist Phase 1a - Final	

ACRONYMS

Acronym	Definition
HLD	Ice Harbor Lock and Dam

1 INTRODUCTION

This report has been prepared in accordance with ER 1110-2-1150 to record design decisions, assumptions and methods after the Feasibility Report for this project.

1.1 BACKGROUND

Ice Harbor Lock and Dam is located 7.1 miles upstream from the mouth of the Snake River. It is the first dam on the Snake River that adult salmon approach on their journey upstream to their spawning territory. There are six fishway attraction channel weirs that are raised and lowered by dedicated hoist machinery for regulating the flow, two at each of three fish ladder entrances. Reliable adjustment of the weirs is critical to maintaining the criterion for salmon of at least 8 feet of water depth over the weir and 1 to 2 feet of head across the weirs. In recent years, failures of this equipment have become more frequent, requiring unplanned disruption for maintenance and repairs.

The existing fish ladder entrance weir gate hoist equipment at Ice Harbor Dam was installed in the 1960s and is experiencing increased failures despite elevated maintenance. Maintenance data indicate (see **Error! Reference source not found.**) that the gate systems fail and require repair on average almost three times per year (17 failures in six years). This is in addition to major failures in 2011 and 2012 which required divers to repair the failed gates.

The equipment is worn and unreliable, and replacement parts are generally not available. The telescoping weirs get stuck in locations requiring operations to modify operational procedures to free them. There are three weir gate hoist locations: (1) south fish ladder entrance, (2) center entrance at the north end of the powerhouse tailrace deck, and (3) the north entrance at north fish ladder by the navigation lock. Each location has a pair of gate hoists, for a total of six hoists. Each location has two gates, two single-drum hoists, associated motor controllers, programmable logic controller (PLC), as well as ultrasonic water level and resistance water level sensors.

The sheave beam assemblies, chains, and weir gate leaves were all replaced by Contract 99-D-04. The beam sheaves are worn and will be replaced within the scope of this proposal. The chains and weir gate leaves are not included in the scope of this proposal.

This project is to remove and replace the fish ladder entrance weir gate hoist equipment at Ice Harbor Dam so the National Marine Fisheries Service (NMFS) fish migration criteria can be met and maintained. The fish ladder weir gates regulate the attraction flow head and elevations at the downstream entrance to the fish ladder. **The recommended alternative replaces the single drum, single wire rope hoist systems with a single drum, dual wire rope hoist systems. This would include new motors, controls, and water level sensors. Safety and control features will be added to measure and report gate height and slack rope condition**. These improvements will increase reliability and enhance the capability to meet NMFS fish migration criteria throughout a larger range of river flow fluctuations.

1.2 PROJECT DELIVERY TEAM (PDT)

Table 1 contains the members of the PDT for this DDR.

Table 1. Participants and Roles

Name	Title/Role
Greg Linklater	Project Manager
Mike Mclean	Mechanical (TL)
Eric Hedine	Electrical
Beth Milligan	Specifier
Bennett Moore	Ice Harbor POC
Ben Mcarthur	Ice Harbor Fish Biologist

1.3 TECHNICAL REVIEW DOCUMENTATION

Table 2. Reviews

Review Name	Estimated Date	Date Completed
Initial Review	MARCH 2026	
Interim Review	JUNE 2026	
Final Review	SEPT 2026	
BCOES Backcheck	NOV 2026	

2 MECHANICAL DESIGN

2.1 GENERAL

The Mechanical scope of this project includes the replacement of the Weir Gate lift system from the chain pick points on the gate and up, including the Lift Beam, Wire Rope, Sheaves, Drum, Hoist Drive Train, and Motor.

2.2 REFERENCES

- EM 1110-2-2610 Mechanical and Electrical Design for Lock and Dam Operating Equipment (2025)
- EM 1110-2-3200 Wire Rope for Civil Works Structures
- CMAA Specification No. 70 – 2020 Multiple Girder Cranes

2.3 NEW HOIST, SHEAVE, AND LIFT BEAM DESIGN

The Phase 1a design recommended a dual wire drum hoist configuration to replace the existing single wire and lift beam configuration. Both the hoist and lift beam will be redesigned as a part of this effort. After initial consideration a sheave and reeving configuration as shown in Fig. X was determined to be the configuration to move forward with. The x2 far sheaves are required to create the proper fleet angle of ½ deg to 2 degs MIN and MAX. The lift beam will be remade in order to create a reeving ratio of 2:1. This takes half of the load off of the hoist and also creates a point where a load cell can be easily implemented in order to create the slack line indication as was requested by the Phase 1a document.

2.4 NEW DRUM AND DRIVE TRAIN DESIGN

The new drum and drive train will be designed as a complete skid mounted unit that can be essentially copied x6 times for all of the relevant Weir Gates. The drum will have opposed helically grooved areas on either end of the drum. The space between the two grooved sections provides the necessary geometry to maintain the fleet angle requirements for the sheaves and the drum as outlined by EM 1110-2-3200 and CMAA 70. The Drum will be driven by an off the shelf right angle gear box and driven by a 2-3 HP electric motor attached by a NEMA C Face mount and coupling directly to the gear box. This motor will have an integral brake. The Gearbox low speed shaft will be coupled to the drum utilizing a barrel coupling creating a spherical bearing connection that doesn't axially fix the drum to the gear box shaft. On the other end of the drum a stub shaft will extend and a fixed pillow block spherical bearing will secure the other end to the new base plate as shown. A radial limit switch will then be driven by the end of the non driven side shaft connected by a 1:1 timing belt pulley arrangement. This limit switch will be directly connected to the power input for the motor not allowing the motor to overtravel past it's limits.

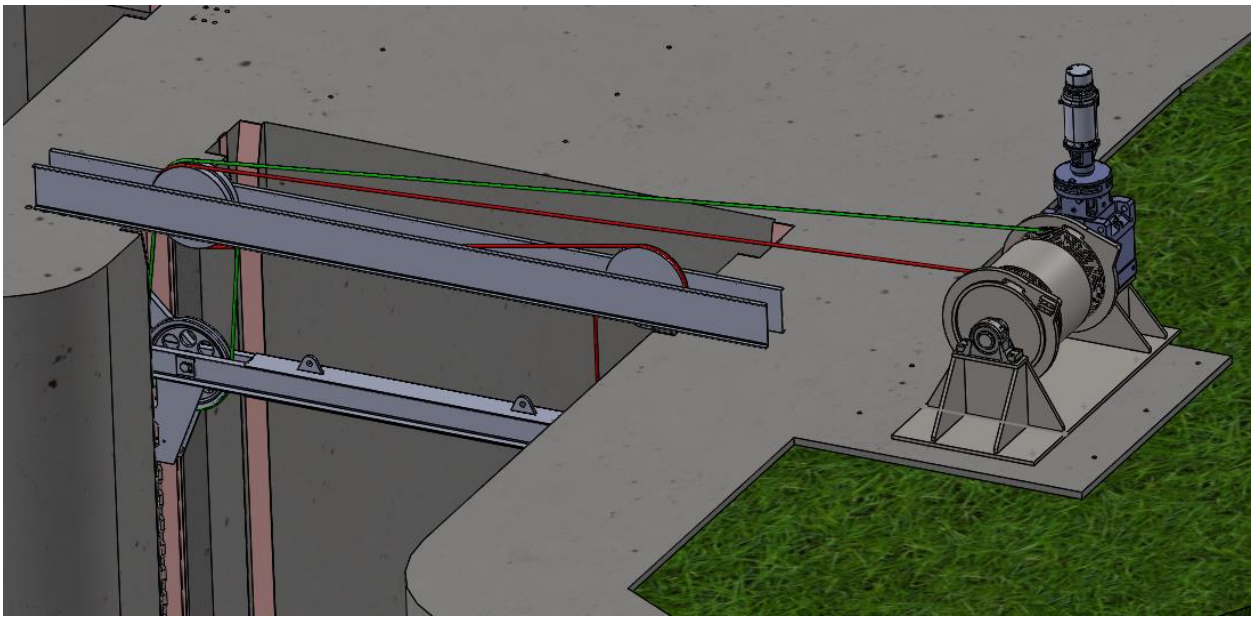

Figure X – Proposed wire rope configuration for the new dual wire drum hoist.

2.5 SLACK LINK INDICATION

Figure X – Strainsert SPA series load cell. Replaces the pin on a standard wire rope spelter socket.

The Phase 1a document recommends the addition of a slack line indication system to ensure the gate is not jammed, or skewed in the guide slots and loads up one side unevenly. This will be accomplished by using a load cell that is designed to replace the pin in a spelter socket connection installed onto the terminating end of the wire ropes where they attach to the new bridge structure. This will send back a force measurement in a 4-20 mA signal that can be used by the PLC to determine if the difference between the two tensions is large enough to throw an error. Fig. X shows an example of this in the Strainsert SPA series loadcells.

2.6 GAUGE WELLS

This project includes replacing the level indicators that are currently installed to monitor the difference in water level. The levels of interest are the level in the Collection Channel, and the level in the Tailrace. There are existing gauge wells that were included with the original construction of the dam. These have since been abandoned, some of them with equipment still in place. These wells will be reused by clearing out the existing equipment and replacing them with modern sonar or laser level indication equipment. The covers for these wells will also be replaced in order to properly protect the new level indicators. The level indicators will be connected to the PLC as well as a local readout display close to the entrance weir locations.

2.7 UHMW GATE SLIDES

The Phase 1a document recommended including the addition of UHMW gate slides to the scope of this project. They indicated that one gate already had a system like this installed. Upon investigation we couldn't find a case onsite of post installed UHMW guides. These will be further researched and developed in later design reviews.

2.8 NEW HOIST MOTOR AND INSTRUMENTATION

The new hoist motor will be an AC Induction motor with an electrically actuated motor brake. The motor will be operated with a VFD. The VFD can be used to limit over torquing. There will also be a rotary limit switch/encoder installed onto the non-drive side of the hoist drum. This encoder will be connected to the PLC and will also have a local readout in the same panel as the load indication and level sensor readouts.

3 ELECTRICAL DESIGN

3.1 GENERAL

The electrical scope of work includes the complete replacement of the PLC control system and the original 1960's MCCs (FCQ1, FCQ2, & FCQ4). All loads fed by the new MCCs will have new conductors installed up to the first point of termination. The only loads being completely replaced are the Fish Entrance Weir Gates. There are three entrances, North Fishway Entrance (NFE), Central Fishway Entrance (CFE), and South Fishway Entrance (SFE). Each entrance contains two weir gates that regulate attraction flow and water levels within the fish ladders. Each of the fishway entrances will receive new local and remote controls. Remote operation will be controlled via an HMI in the control room where the operators can monitor and control.

3.2 REFERENCES

- UFC 4-010-06, CYBERSECURITY OF FACILITY-RELATED CONTROL SYSTEMS (FRCS)
- NFPA 70, National Electrical Code 2023
- EM-1110-2-3006, Mechanical and Electrical Design of Hydroelectric Power Plants

3.3 PREVIOUS REPORTS

A scoping document report (SDR) was completed in 2013. The electrical recommendations of this SDR included reprograming existing PLCs and replacing the local weir gate hoist equipment and associated motors, motor control centers, motor controls, and sensors. The motor control centers (MCCs) related to the fishway weirs are FCQ1, FCQ2, and FCQ4. FCQ1 and FCQ2 serve the Powerhouse south and central shore respectively. MCC FCQ4 serving the north shore weir gate hoist motors is housed in a metal shed that is exhibiting signs of corrosion. The MCC within the shed is original to the installation and beyond its useful life. This MCC should be replaced. Finding existing equipment that will fit in the original enclosures or modifying the enclosures could prove difficult and expensive. The new FCQ4 should be installed in either a NEMA 4X rated enclosure that can withstand the conditions on the deck, including water spray and high humidity.

A Phase 1a report was completed in 2023. This report recommended the same upgrades as mentioned in the SDR. The only difference is the Phase 1a report also recommended a full PLC replacement. This decision was made due to the lack of documentation on the existing PLC system and due to the mixture of different PLCs used. This report also recommended installing central instrument panel for each gate assembly with displays for instrumentation.

3.4 EXISTING ELECTRICAL DISTRIBUTION

The current system is made up of three MCCs; FCQ1 FCQ2, and FCQ4. FCQ1 and FCQ2 are fed from FSQ1 which is located near each other in the Fishway Cable Gallery. FCQ4 is fed from DCQ1 which is in the Upstream Wall Gallery.

New equipment standards have changed since the original MCCs were installed. To make new devices fit in old MCC buckets it would require modifying the bucket which could prove difficult and expensive. Most

buckets in both FCQs would need to be modified or replaced regardless, making a full replacement timelier and more cost effective.

FSQ1 and FCQ1 will require custom work to make the new feeder breakers fit. A entire replacement of these switchgear is out of scope for this project due to wide range of loads they serve and the cost associated with switchgear replacement.

3.4.1 Fishway South and Central Entrance Power (FCQ1 & FCQ2)

Both motor control centers FCQ1 and FCQ2 are fed by switchgear FSQ1. The main MCC feeder conductors will be demolished back to FSQ1. FCQ1 powers the south entrance weir gates (SFE-1 & SFE-2). FCQ2 powers the central entrance weir gates (CFE1 & CFE-2). The central fishway entrances were formally called the north entrance. Existing drawings call it this and label them NFE1 & NFE2.

FCQ1, FCQ2 and their associated gate hoisting equipment will be demolished. The remaining loads on FCQ1 and FCQ2 include lighting panels, heating panels, sluice gates will have their conductors demolished from the MCCs to the first point of termination.

The following loads will be demolished and not replaced as the project indicated they are no longer used.

- FCQ1 Loads:
    - FC-1, COLLECTION CHANNEL WING GATE
    - SFE-1 SOUTH FISH ENTRANCE WING GATE
    - FISHWAY SYSTEM CONTROL (FSC) SWITCHBOARD 480 VAC SUPPLY
- FCQ2 Loads:
    - FC-2, COLLECTION CHANNEL WING GATE

3.4.2 Fishway North Entrance Power (FCQ4)

The motor control center FCQ4 is fed by switchgear DCQ1. FCQ4's main feeder conductors will be demolished. FCQ4 powers the north entrance weir gates (NFE-1 & NFE-2). FCQ4 and its gate hoisting equipment will be demolished. The remaining loads on FCQ4 includes 480VAC receptacle circuits, diffuser valves, a distribution panel for heater loads and control circuits. Conductors for these loads will be demolished from FCQ4 to the first point of termination.

FCQ4 is housed in a metal shed that is exhibiting signs of corrosion. The MCC within the shed is original to the installation and beyond its useful life. This MCC and its enclosure will be demolished.

3.5 EXISTING CONTROL SYSTEM

There are three fishway entrances South, Central, and North. Each fishway entrances are made up of two weir gates. See Table 3: Fishway Entrance Naming Conventions for naming conventions and see Figure 2: Fishway Entrance Locations for general locations. Each fishway entrance utilizes ultrasonic sensors to monitor the tailwater and water head across each weir gate. The objective of the weir gate hoist system is to maintain the fish passage criteria which includes providing a velocity of 8 feet per second at the entrance with a one-foot drop across the weir.

The existing control system has been modified and there is no documentation. The PDT has scheduled an as-building effort with the project in March/April. So far, the PDT has sketched out as much as we can with the information received during site visits and based on older drawings. A possible option for how this system is functioning is sketched below. This is an educated guess as to how the system is connected and will be verified during as-building effort. See Figure 1: Existing Controls Block Diagram Sketch.

The PDT is uncertain if the South and Central weir gate PLCs are still being used. They had power during our site visit, but we could not determine if they were part of the control scheme. All fishway weir gate related PLCs are beyond their normal life expectancy (15 years).

Name	Definition
SFE1	South Fishway Entrance One
SFE2	South Fishway Entrance Two
CFE1	Center Fishway Entrance One
CFE2	Center Fishway Entrance Two
NFE1	North Fishway Entrance One
NFE2	North Fishway Entrance Two

Table 3: Fishway Entrance Naming Conventions

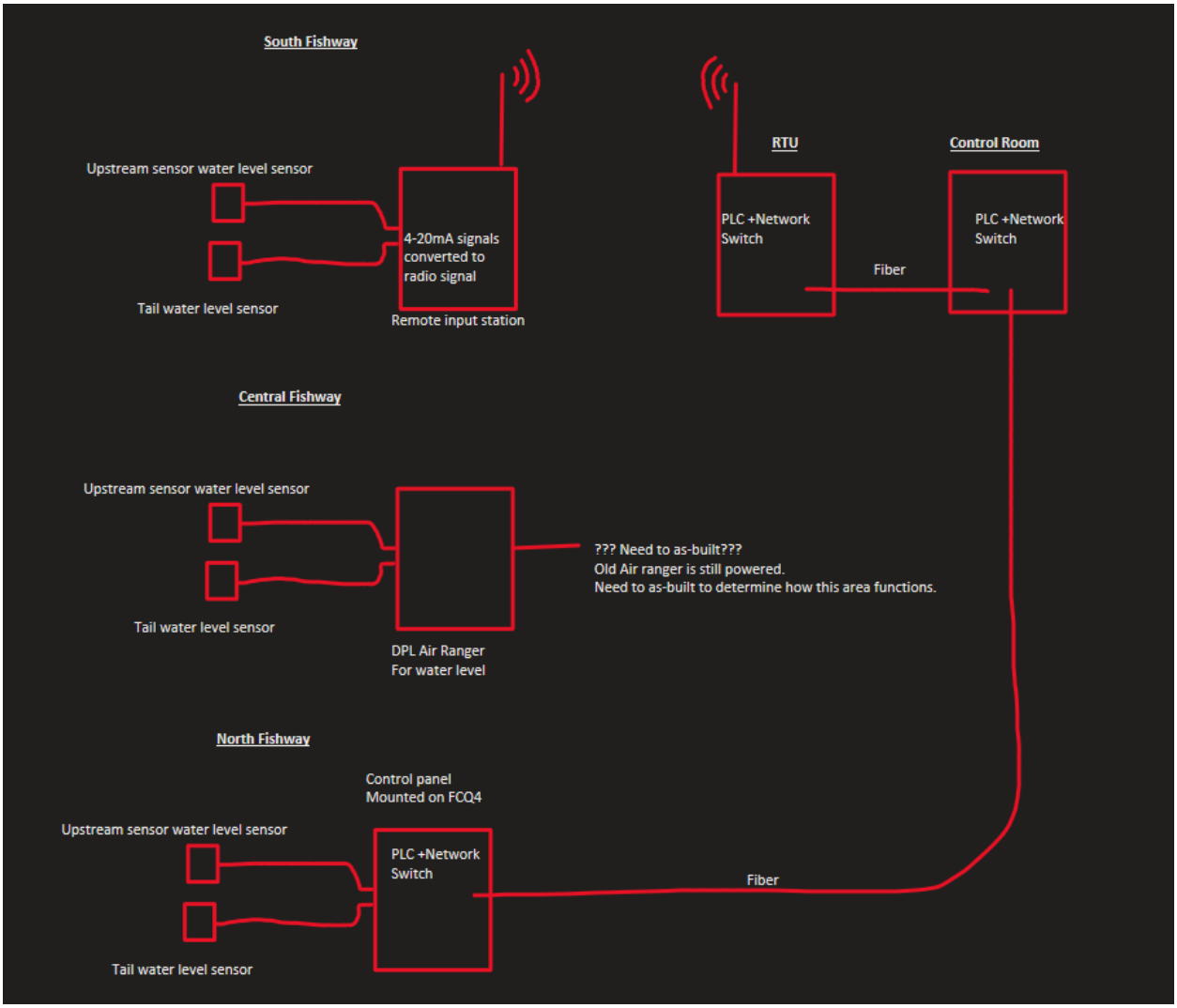

Figure 1: Existing Controls Block Diagram Sketch

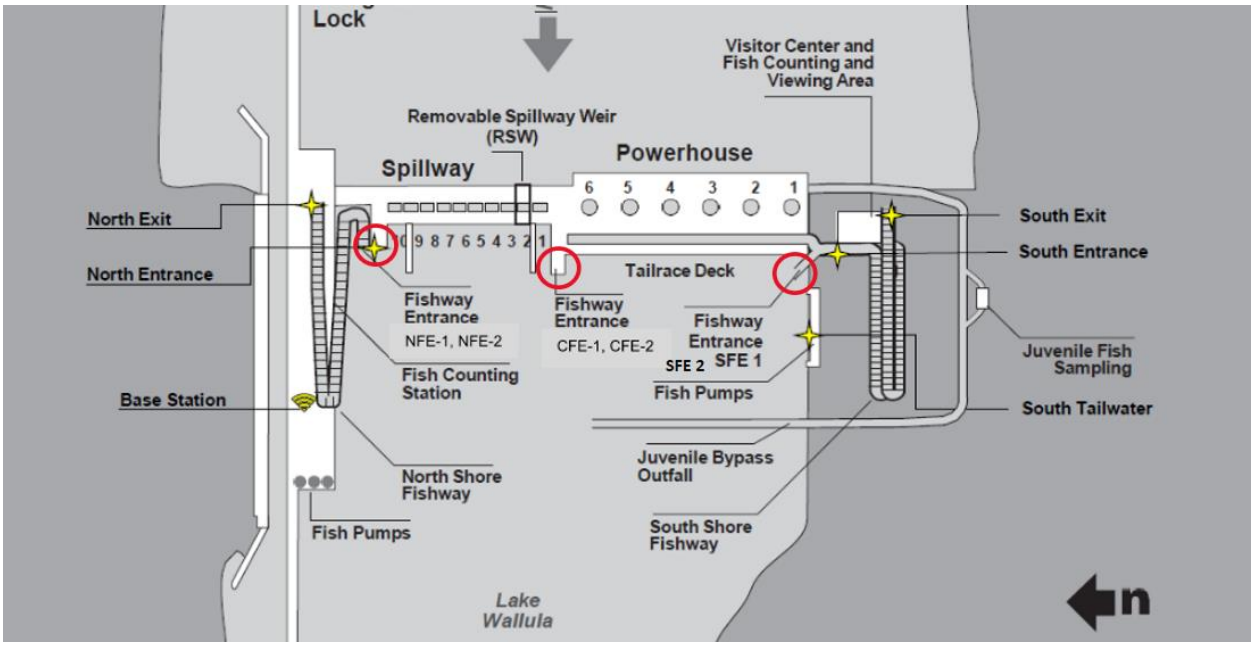

Figure 2: Fishway Entrance Locations

3.5.1 South Fishway Entrance

For the south entrance the downstream ultrasonic sensor mounted near the gate is no longer functional. See Figure 4: SFE1 & 2 Original Tailwater Sensor .Instead, a nearby tailwater ultrasonic sensor is used to acquire the water level. See Figure 4. During a site visit a J-grade electrician mentioned the upstream ultrasonic didn't work either. See Figure 3. Instead they use the remote sensor panel located on the top deck of the powerhouse that monitors the forebay water level. PDT will need to verify if this is the case during as-building effort in February.

Additionally, there are abandoned conduits and stilling wells that used to be used as part of the control system. See Figure 6. This area will be as-built as well to verify they are abandoned. All abandoned devices will be demolished. The hoisting equipment SFE1 and SFE2 will be demolished as well. See Figure 7. Routing is mostly embedded back to the Fishway Gallery. Existing embedded conduits must be re-used.

Figure 3: SFE Upstream Sensors

Figure 4: SFE1 & 2 Original Tailwater Sensor

Figure 5: Tail Water Level Sensors

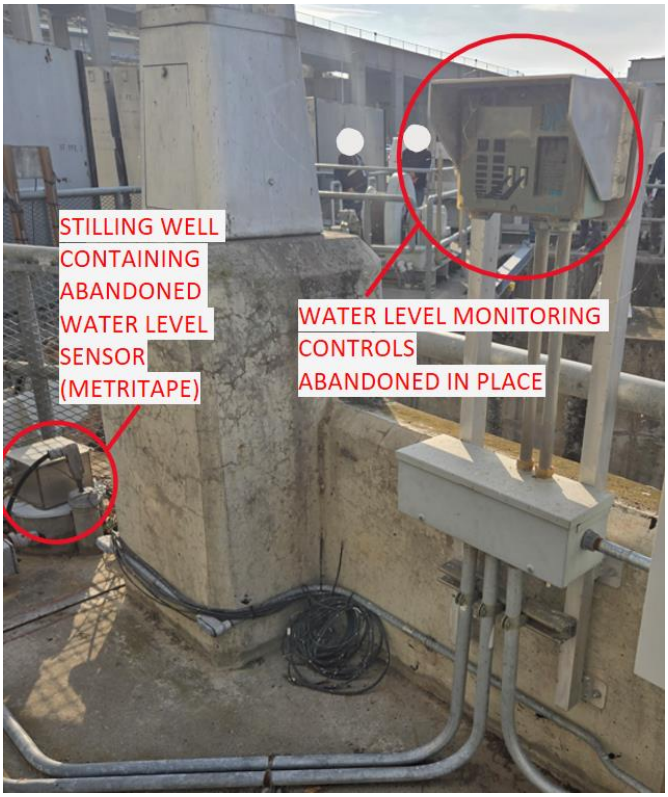

Figure 6: Stilling Well & Abandoned Devices

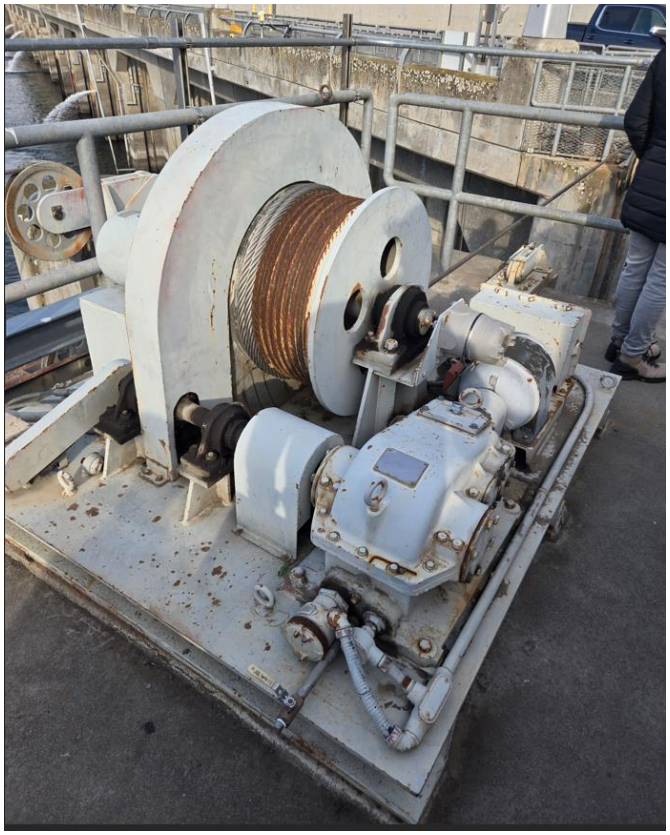

Figure 7: SFE1 Hoist Equipment (Typical for all locations)

3.5.2 Central Fishway Entrance

The central fishway has one tailrace level sensor that connects to a remote input radio station. See Figure 8. As of the initial review it is unclear if this sensor is used for the weir gate controls. Two additional and older ultrasonic sensors are installed and feed their signals into a device called DPL Airranger. See Figure 8 and Figure 9. One ultrasonic sensor is installed just upstream of the gate, and the other is installed just downstream of the gate. This portion of the control system will also need to be as-built to verify how the system works. For the initial review it's unclear how this system is communication back to the control room.

In the stilling well there is a metritape water level sensor that appears to be abandoned in place. See Figure 10Figure 10: Stilling Well – Water level Sensor Metritape. All original controls and abandoned devices will be demolished.

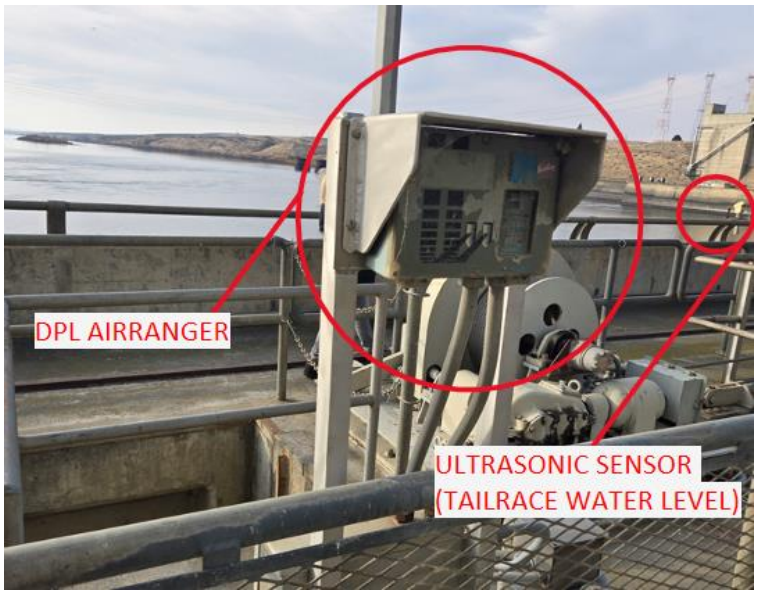

Figure 8: Central Weir Gate Sensor & Devices

Figure 9: Central Weir Gate Ultrasonic Sensors

Figure 10: Stilling Well – Water level Sensor Metritape

3.5.3 North Fishway Entrance

The north fishway control system consists of an HMI located in the FCQ4 shack as shown in Figure 14, two ultrasonic sensors as shown in Figure 11 and Figure 12 and network switches. This system connects back to the PLC in the control room via fiber. Exact routing is TBD as of initial review. In the stilling well there is a metritape water level sensor. All north weir gate controls will be demolished.

Figure 11: North Fishway Tailrace Ultrasonic Sensor

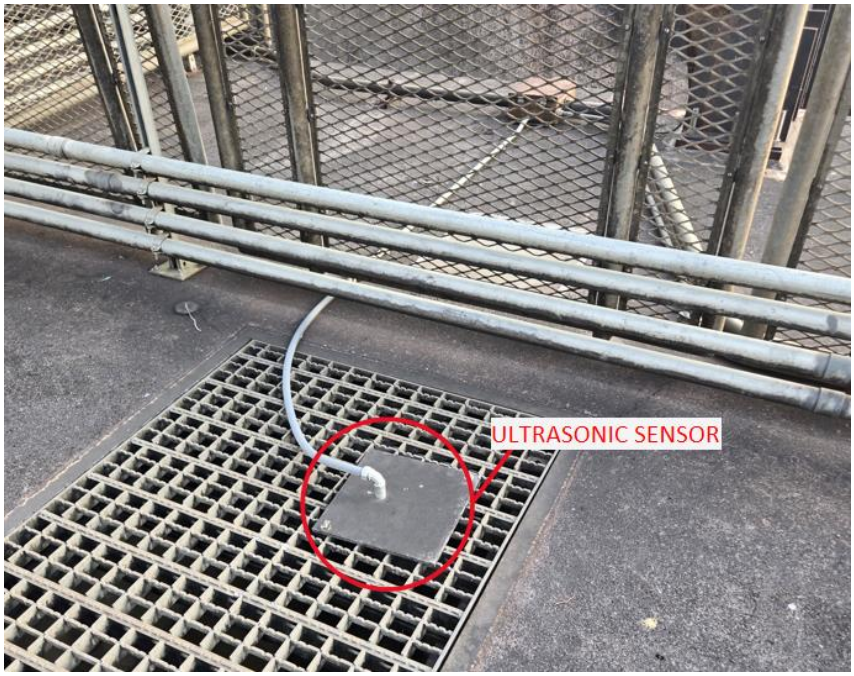

Figure 12: North Fishway Ultrasonic Sensor

Figure 13: Stilling Well – Water level Sensor Metritape

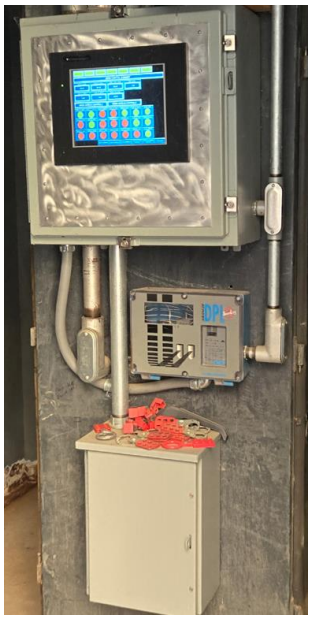

Figure 14: North Fishway HMI/PLC Cabinet In FCQ4 Shack

3.5.4 FSC

The Fishway Control Center (FSC) is in the Fishway Cable Gallery between FSQ1 and FCQ1, see Figure 15. It was the original method for remote control and position feedback for the south and central fishway entrance gates. This equipment is not used and the project personnel indicated they would like it removed and not replaced.

Figure 15: FSC

3.5.5 Control Room

All gate annunciation and remote controls are networked into the control room where the data is interpreted by a PLC located in the SO switchboard, cabinet SOR5. See Figure 16 .The data is displayed on an HMI in the operator's control desk. See Figure 17 .The PLC, network switches, and HMI will be demolished. PDT will need to acquire a copy of the program to verify any additional systems that might be handled by this PLC.

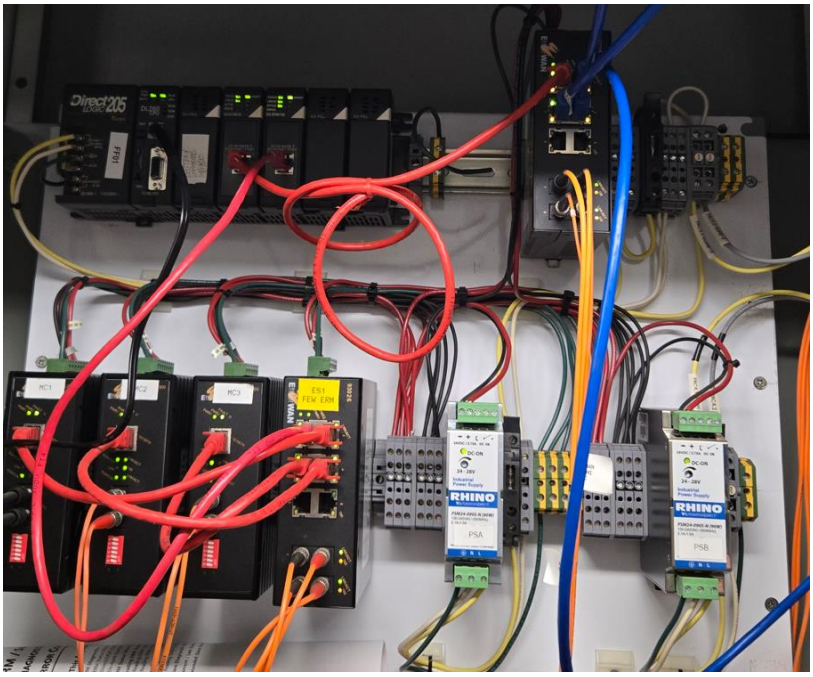

Figure 16: Control Room PLC & Network Switches

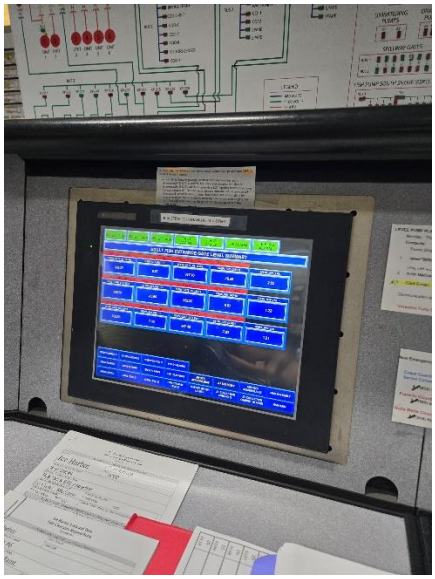

Figure 17: Control Room Fishway HMI

3.6 New Electrical Distribution

EM 1110-2-3006 recommends the feeders should be sized based on maximum expected load, with proper allowance made for voltage drop, motor starting inrush, and to withstand short-circuit currents.

3.6.1 Motor Control Centers

MCCs provide a convenient grouping of motor starters and controls within the power distribution equipment, which allows less clutter and hazards at the utilization equipment where space is often at a premium. According to EM 1110-2-3006 NEMA 1 enclosure are suitable for clean and controlled environments. NEMA 12 is recommended for dirty and/or oily environments or where temperature is not well controlled. Such environments should require enclosure strip heaters to help reduce condensation. This project will utilize NEMA 12 enclosures for FCQ1 and FCQ2. FCQ4 will be installed in its own prefabricated container and will have a NEMA 4X rating.

3.6.1.1 MCC House Keeping Pads

The MCCs will be elevated up to 3 inches on housekeeping concrete pads. This will prevent any liquids from entering the bottom of the MCC or its embedded conduits. The existing embedded conduits will need to be extended to account for the new pad.

3.6.1.2 Weir Gate Motor Starting

The traditional across-the-line starting of the motors will be utilized. The weir gate motors are only two horsepower. The inrush would be around 3.4 Amps.

3.6.2 Load Flow Study

The load study confirms whether the designed power system can supply the various loads. It confirms whether services, feeders, and equipment are sized properly, or they are overloaded. See Appendix F for detailed load calculations and screen shots of the load flow study.

The loads are not being increased for this project but it's still important to verify instead of blindly copying original documentation. Wing gates and the FSC panel were not included in the load flow as they will be demolished and not re-installed.

In summary, the load flow study completed in ETAP resulted in load current values similar to what was calculated. The only outliers were control panels which drew less current than what was calculated. This difference is due to the calculation being based off of the transformer VA rating while ETAP uses the entered KVA for the load to determine what the load current is. For this design I'm basing transformer secondary protection and feeder sized based off of NFPA which uses the transformer VA.

3.6.3 Voltage Drop Study

See Appendix F. (Not complete as of initial design)

3.7 NEW CONTROL SYSTEM

The fishway weir gates will receive a new control system that will allow the project to stay in compliance with the fish passage plan which includes all applicable criteria. This system will have an automatic mode and a manual mode. Additionally, local hardwired controls will be implemented for maintenance, and to serve as an emergency backup if the fishway entrance gate control network goes down.
Simple raise, lower, and stop commands will be utilized for each Gate. Automatic mode will utilize gate position (tracked via an encoder) and compare that against water levels (tracked with radar sensors) just

upstream and downstream of the gate. This will allow the gates to stay in compliance with regulations automatically. Alarms and remote controls will be visible in the control room where the operator can adjust the weir gates from a new HMI. The new control system will utilize fiber only. All radio signals will no longer be associated with fishway weir gate position controls.

3.7.1 Fishway Passage Plan Requirements

The annual Fish Passage Plan (FPP) is developed by the U.S. Army Corps of Engineers in coordination with the Bonneville Power Administration (BPA), regional Federal, State, and Tribal fish agencies, and other partners through the Fish Passage Operations & Maintenance (FPOM) coordination team. The FPP describes year-round operations and maintenance (O&M) actions scheduled to occur each year from March 1 through the end of February to provide fish passage and protection at the eight Corps hydropower projects on the lower Columbia and lower Snake rivers The fish passage plans are posted at this location: https://pweb.crohms.org/tmt/documents/fpp/

FPP requires fishways to maintain water velocities in the range of 1.5 - 4.0 feet per second (fps). Ice Harbor monitors water velocity at the junction pool in the lower south fish ladder. This is controlled via fish ladder water pumps

Head is measured at the north, central, and south fishway entrances. The water depth over fishway ladder weirs must be kept between 1.0’ and 1.3’. The water head on all fishway entrances must be kept between 1’ and 2’. This is controlled by adjusting the weir gate height or manually adjusting the fish ladder water pumps.

3.7.1.1 South Fishway Entrance

Fish Passage plan requirements:

1. The control system should operate the entrance closest to powerhouse (SFE-1). SFE-2 will only be operated for adult salmonid passage.
2. Elevation of top of SFE-1 gate on sill = 332.25’. Elevation of top of SFE-2 gate on sill = 333.25’ with the installation of the lamprey passage structure.
3. At tailwater lower than elevation 340.25’ for SFE-1 and 341.25’ for SFE-2, weirs should be on sill.
4. From July 1 to October 1, operate entrance furthest from powerhouse (SFE-2) for adult lamprey passage.

3.7.1.2 Central Fishway Entrance

Fish Passage plan requirements:

1. Operate one downstream gate.
2. Elevation at top of gate on sill = 332.25’.
3. Weir depth ≥ 8’ below tailwater. At tailwater lower than elevation 340.25', weirs should be on sill. [Note: At low tailwater, weirs will bottom out and will be less than 8' below tailwater.]

3.7.1.3 North Fishway Entrance

Fish Passage plan requirements:

1. Operate downstream gate closest to shore (NFE-1).
2. NFE-2 will only be operated for adult salmonid passage if NFE-1 gate is not functioning properly to maintain criteria.
3. Elevation at top of gate on sill = 332.25’.
4. Weir depth 8' or greater below tailwater. At tailwaters less than 340.25’, weirs should be on sill. Note that at low flow and tailwater, some of the diffusers are above tailwater and the project may only be able to maintain a 6’ weir depth.

3.7.2 PLCs

Ice Harbor personnel indicated the preferred PLC for this application is the Allen Bradley Micro800 controllers. Due to the limited inputs at each weir gate and its ability to connect to an HMI the Micro820 will be utilized. Design currently has an existing five-year Justification and Approval (J&A) for the use of all Allen Bradley products. The 800 series utilize connected components workbench (CCW) for its programming language.

Each fishway entrance will have its own PLC. Specifically the micro 820 which includes inputs and outputs on the main unit and includes two expansion slots. Both expansion slots will be taken by the encoders, one for each gate.

The main inputs and outputs are:
Inputs:

- Whisker limit switches (alarms if cable unspools)
- Motor overloads
- Power loss
- Radar sensors for water level
- Encoders used for gate position

Outputs:

- Gates raise and lower control
- PLC power loss

3.7.2.1 Encoders

The expansion slots will be utilized by the 2080-MOT-HSC high speed counter cards which are used as inputs for the gate position encoders. While the two high speed counter cards do take up the rest of the available slots, there are still available inputs and outputs on the main unit for future expansion. Using the HSC module in conjunction with a traditional encoder was chosen over two 4-20mA encoders because it is more accurate in position and direction, cheaper, and more suitable for rugged conditions. The HSC module also has improved noise immunity. Additionally, while the 4-20mA encoder would be easier to program logically and test using a multimeter, the HSC module and Allen Bradley already have the programming blocks on their website library making it easy to program. A negative to utilizing an encoder with ABZ signals is it would require an oscilloscope to test and troubleshoot.

3.7.2.2 Radar Water Level Sensors

All fishway entrances have stilling wells that will be used to house new radar water level sensors. Radar water level sensors will also be mounted just beyond the gates to capture the tailrace water level. Sensor placement was not only based on the single most representative position, but also the placement for ease of installation and maintenance.

Two radar sensors will be installed to monitor the inlet water level. Standard ultrasonic sensors struggle with buildup from condensation, spider webs or other contamination sources. This influences the reliability of the measurement signal and increases the dead zone. Thanks to optimized signal processing, radar sensors can suppress interference caused by buildup on the antenna system.

Due to their physical measuring principle, ultrasonic sensors are exposed to considerable influences because the sound running time changes with temperature, e.g. due to solar radiation and gas

composition. Even in heavy fog, wind or rain, the sound waves are additionally attenuated, and the measuring range further restricted. Radar sensors are unaffected by temperature, pressure or vacuum and provide correct readings under all environmental conditions.

Radar sensors can also be used in confined spaces and installations such as the stilling wells. Due to the high focus of the 80 GHz technology, the radar beam can be aligned almost precisely to the medium to be measured. This means that there are no interference signals even with installations such as pipes or pumps, in narrow shafts or with deposits on walls. Compared to ultrasonic sensors, no interference signal suppression is necessary. Radar sensors also avoid the maintenance associated with silt which can build up in underwater pressure sensors. Radar sensors utilize a two wire 4-20mA signal.

3.7.2.3 PLC Control Network

The micro 820 includes an ethernet port which will be utilized to connect to a cisco network switch. The selected switch is the Cisco C9200CX-12T-2X2G. It was chosen for its compact size, reliability, and small number of ports as this network is not complicated. This switch is on the Defense Information Systems Agency (DISA) approved list meaning it meets cybersecurity requirements.

Each weir gate PLC will connect to its own network switch. The network switches will utilize fiber-optic cable and route back to the control room where they land on a new network switch and PLC mounted in the SO board. Specifically, the internal side of SOR5. The new control room PLC will receive the gate data and display it on an HMI located in the Operator's desk.

3.7.2.4 PLC Ladder Logic Considerations

Ladder logic is developed at the early stages of construction. NWW Electrical design will be programing this system with operations review. PDT will have one week during the outage to commission the PLC control system. At initial review, the exact expectations are TBD… (Full PLC replacement at once vs replacing one at a time and updating the existing plc/network switches to accommodate connection to new PLCs).

3.7.3 Control Modes

3.7.3.1 Hand-Mode (Local only)

Each weir gate will be capable of switching to hand mode which implements simple relay logic controls to either open, close or stop the gate manually. Limit switches will prevent the gate from moving beyond its allowable range. A local HMI will be utilized to display gate position, water levels above and below the gate, and the differential between the water levels. Additionally, gate related alarms such as overtravel, wire spooling, and motor overload status will be displayed on the HMI.

3.7.3.2 Auto-Mode

Each fishway weir gate will be capable of automatically adjusting to maintain fish passage criteria. Automatic mode relies on local PLCs which take in water levels just above and below the gate. The gate position itself is tracked via an encoder.

3.7.3.3 Remote-Mode

Operators will be able to remote control any of the fishway weir gates from the new HMI in the control room. The project indicated they wanted the new fishway entrance HMI to have a display similar to what is used at MNA. See Figure 18 below for a screen shot from MNA's fishway entrance HMI.

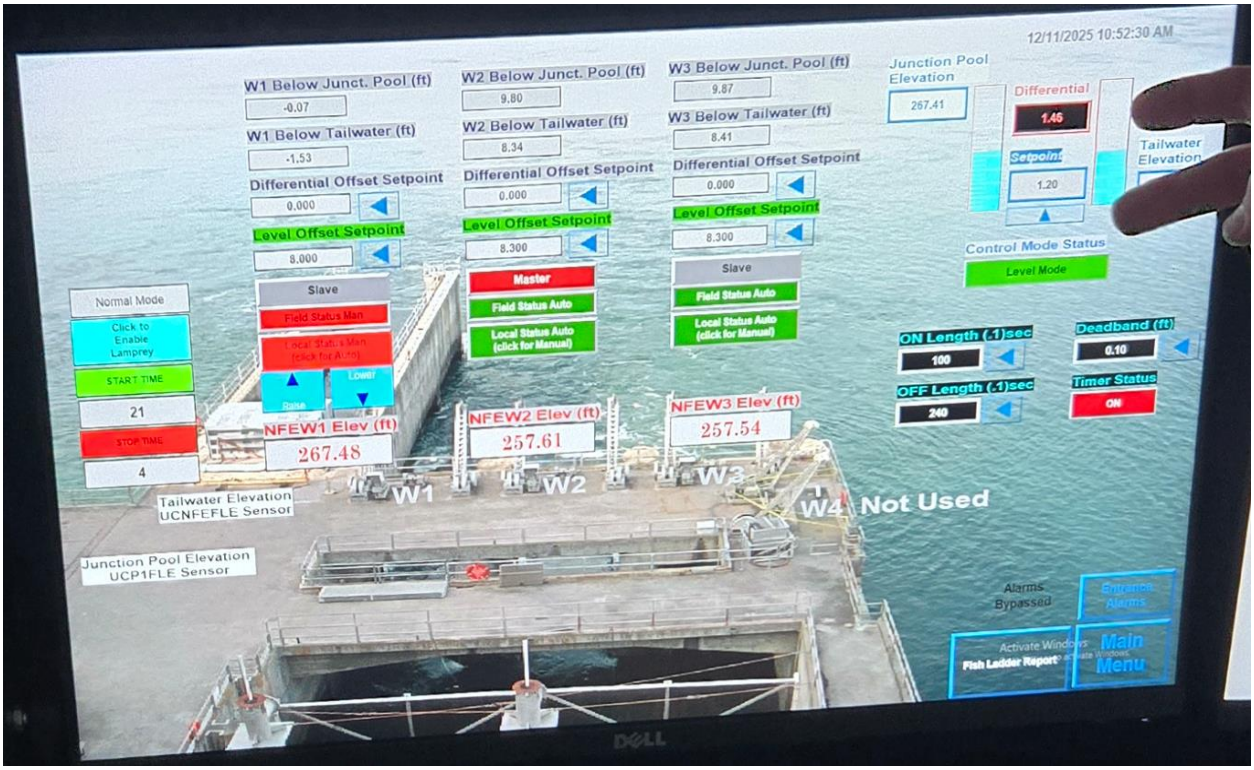

Figure 18: MNA HMI Weir Gate Control Example

3.8 CYBERSECURITY

UFC 4-010-06 applies to all design and construction of new and existing facilities which include a control system with a network regardless of funding source and regardless of network type. This UFC defines a process for identification of cybersecurity requirements based on the Risk Management Framework (RMF) suitable for control systems of any impact rating and provides specific guidance suitable for control systems assigned LOW or MODERATE impact level.

Before the new control system can be turned over to the project it must receive an Authority to Operate (ATO). To receive an ATO the Authorizing Official (AO) evaluates the risk and either accepts the risk or denies it. This PDT is working closely with NWW's assigned Information System Security officer (ISSO), Lidia Thomas and USACE Critical Infrastructure Cybersecurity (UCIC) Regional Information System Security Managers.

Network components have been selected from the DISA approved product list. The chosen network switch for this project is the Cisco C9200CX-12T-2X2G.

3.9 ANTICIPATED DRAWINGS

E-001	Legend
ED101	Overall site plan demo
ED102	North weir gate plan view demo
ED103	Central weir gate plan view demo
ED104	South weir gate plan view demo
ED105	FCQ1 plan view demo
ED106	FCQ2 plan view demo
ED107	FCQ4 plan view demo
ED108	Control room plan view demo
ED301	Section view demo MCCs
ED302	Section view demo remote PLC panels
ED303	Sensor section views demo
ED501	Demo detail drawing
ED601	South and Central schematics demo
ED602	North schematics demo
ED603	Demo one lines (FSQ1 & DCQ1)
ED604	Demo one lines (FCQ1, FCQ2, FCQ4)
ED605	Demo network drawing
E-101	Overall site plan install
E-102	North weir gate plan view install
E-103	Central weir gate plan view install
E-104	South weir gate plan view install
E-105	FCQ1 plan view install
E-106	FCQ2 plan view install
E-107	FCQ4 plan view install
E-108	Control room plan view install
E-301	Section view install MCCs
E-302	Section view install PLCs
E-303	Sensor section view install
E-501	Install detail drawing
E-601	South and Central schematics install
E-602	North schematics install
E-603	Install one line (FSQ1 & FCQ2)
E-604	Install one lines (FCQ1, FCQ2, FCQ3)
E-605	Install network diagram
ED606	Demo cable and conduit schedule
ED607	Demo cable and conduit schedule
E-606	Install cable and conduit schedule
E-607	Install cable and conduit schedule

3.10 RESOURCE DRAWINGS

File Number/Drawing number	Description
IHF-1-6-5/8	Entrance Weirs power and control (FCQ4)
IHF-1-6-5/9	FCQ4 to 120/240VAC panel FR5, three line diagram
IHF-1-6-5/10	FCQ4 to entrance weirs 1 and 2, connection diagram
IHF-1-6-5/11	FCQ4 conduit stub up detail/North Shore Fishway Entrance Plan view
IHF-1-6-5/14.1	FCQ4 Switchgear Wiring Diagram
IHF-1-6-5/16	FCQ4 - weirs 1&2 hardwired control & Weir gates alarm circuit
IHF-1-6-5/18	North Shore Fish Ladder - Entrance weirs 1,2,3 connection diagram
IHF-1-6-5/19	FCQ4 plan view
IHF-1-6-5/20	FCQ4 arrangement and details
1HP-1.1-3-2/10	Fish Collection System Weir Gate Operating Machinery
144A2565 SH 1	Fishway Power Distribution and control
144A2565 SH 5A	Adult Fish entrance weir gate hoist control (South)
144A2565 SH 5B	Adult Fish entrance weir gate hoist control (Central)
144A2565 SH 6	South Fishway Annunciator
144A2565 SH 9	Fishway Material List
144A2565 SH 10	(FCQ4) North Fishway One line- weir gates 1,2,3
144A2565 SH 13	Fishway entrance weir #1 and 2 control schematic (North)
144A2565 SH 15	Sylsyns removed in 2000
144A2565 SH 26	Lighting Panel - "logic power" for entrance weir gate control
144A2565 SH 80	FCQ4 control center views
144A2565 SH 81	FSC board
144A2565 SH 81	FSC board
6010-E-1 SH 1	Ultrasonic Level Sensing Controller (Airanger) Central Entrance
6010-E-1 SH 2	Ultrasonic Level Sensing Controller (Airanger) South Entrance
6010-E-1 SH 3	Tail water and channel level metritape

6010-E-1 SH 4	Ultrasonic Level Sensing Controller (Airanger) North Entrance
IHP-1-6-IC2/2	FCQ1 and FCQ2 MCC front views
IHP-1.1-6-IC21/1	FSP1-FSQ1-FCQ1 and FCQ2 one-line
IHP-1.1-6-IC21/2	FCQ1 one line
IHP-1.1-6-IC21/3	FCQ2 one line
IHP-1.1-6-9C9/1	South Shore Fish facilities Cable tray diagram
IHP-1.1-6-9C9/2	South Shore Fish facilities Cable tray diagram
IHP-1.1-6-9C9/3	South Shore Fish facilities Cable tray diagram
IHP-1.1-6-9C24/1	South Shore Fish facilities Auto control diagram (1960s)
IHP-1.1-6-9C24/1	South Shore Fish facilities Motor control (1960s)
IHP-1.1-6-9C51/1	South Shore Fish Facilities Gate Machinery Wiring diagram (UPDATED 2008)
IHP-1.1-6-9C51/3	South shore FCQ1 FCQ2 terminal block arrangement
IHP-1.1-6-9C52/1	FSC SWBD External wiring (Goes to FCQ1, FCQ2
IHP1.1-6-9C0/1	FSC location and mounting
IHP-1-6-9C40/1	Central and south large site plan view
IHP-1.1-6-7A0/1	Grounding System (Shows connections to FCQ1, FCQ2)
IHP-1.2-6-7A21/1	Grounding System Riser
IHP-9-6-9A40/1	Control Room Switchgear Location
IHN-1-6-14/4	DCQ1-FCQ4
IHD-1-6-13/9	Central Fishway Entrance (CFE1, CFE2) plan views embedded conduits
IHD-1-6-13/41.1	DCQ1 Wiring Diagram
IHD-1-6-13/45	DCQ1 Cable & Conduit Schedule (DCQ1-q1-FCQ4)
IHD-1-6-13/45	DCQ1 one-line and panel arrangement
IHP-1-6-1F/5	Fishway Gallery Plan - Conduit (bays 4,5 & 6)
IHP-1-6-1E/5	Fishway Gallery Plan - Conduit (bays 1,2 & 3)
IHP-1-6-1D/2	Tailrace Deck and service bay (FCQ1 conduits)
IHP-1-6-1D/3	Tailrace Deck and Erection Bay (FCQ1 conduits)
IHP-1-6-1D/4	Fishway Gallery and Erection Bay (FCQ1 and FSC conduits)
IHD-1-6-13/45	DCQ1 CCS

IHP-9-6-13-87	FCQ1 CCS part 1
IHP-9-6-13-88	FCQ1 CCS part 2
IHP-9-6-13-89	FCQ1 CCS part 3
IHP-9-6-13-90	FCQ1 CCS part 4
IHP-9-6-13-91	FCQ2 & FSC CCS
IHP-9-6-13-92	FCQ2 CCS part 1
IHP-9-6-13-93	FCQ2 CCS part 2
IHP-9-6-13-94	FCQ2 CCS part 3
IHP-9-6-13-95	FCQ2 CCS part 4
IHP-9-6-13-20	FCQ1 & FSC CCS
IHP-9-6-13-85	FSQ1 CCS

3.11 Anticipated Electrical Specifications

- 25 05 11.00 Cybersecurity
- 26 05 19.00 10 Insulated Wire and Cable
- 26 28 00.00 10, Motor Control Centers
- 40 60 00, Process Control

3.12 Construction Considerations

According to the FPP, Winter maintenance is from January 1st till the end of February. The FPP also states that construction will not be conducted within 100’ of any fishway entrance or exit, within 50’ of any other part of the adult fishway, or directly in, above, or adjacent to any fishway, unless coordinated with FPOM or FFDRWG by the Project, District Operations and/or Planning or Construction office. These distances are approximate and will be updated after data are collected and analyzed to determine the threshold for adverse impacts to adult fish behavior. Alternate actions will be considered by District and Project biologists in conjunction with the regional fish agencies on a case-by-case basis.

4 Environmental and Cultural Resources

4.1 General

Insert Text.