McNary Avian Deterrence Conceptual Design Evaluation Final Report

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McNary Avian Deterrence Conceptual Design Evaluation Final Report

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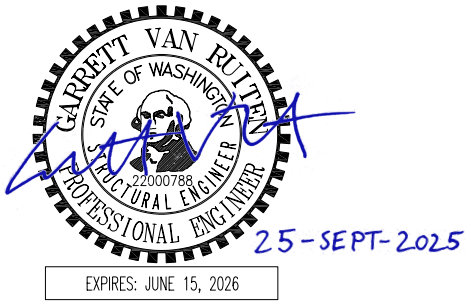

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Acronyms and Abbreviations

APDA	Avian Predation Deterrent Array
APHIS	Animal and Plant Health Inspection Service
BRZ	Boat Restricted Zone
CDW	Concept Design Workshop
FFDRWG	Fish Facility Design Review Work Group
HSS	hollow structural section
JBS	Juvenile Bypass System
LRAD	long-range acoustic device
O&M	operational and maintenance
MNA	McNary Dam
NWW	Walla Walla District
USDA	US Department of Agriculture
UFC	Unified Federal Criteria
USACE	United States Army Corps of Engineers

Executive Summary

Columbia River dams constructed in the 1950s pose challenges for migrating salmonids as they navigate passage through the dams. This circuitous passage through both spillway top spill weirs and juvenile bypass systems makes it easier for predatory birds to feed on the migrating salmonids. McNary Dam (MNA) hosts a large population of these piscivorous birds but lacks an effective and reliable Avian Predation Deterrent Array (APDA) to improve juvenile salmonid survivability.

The objective of this Task Order is to conduct a concept-level Alternatives Evaluation for an APDA located on the tailrace at McNary Dam on the Columbia River, river mile 292, landmark one-mile east of Umatilla, Oregon. Results of this evaluation are expected to lead to construction of an APDA to reduce avian predation rates on passing juvenile salmonids. The design criteria developed by the Jacobs team was based on a combination of various Unified Facilities Criteria (UFC), USACE Walla Walla District (NWW) directed requirements, guidance (including the McNary Dam Avian Predation Deterrent Array Feasibility Report), performance data from the John Day Dam APDA, guidance and recommendations gathered from US Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS), and information collected from the project Concept Design Workshop (CDW), Refined Alternatives Review Meeting and biweekly meetings.

Development of the alternatives considered was conducted as required by the Task Order scope of work. During the CDW, the team validated current design criteria, developed design requirements toward the 15% concept development stage, and discussed the pros and cons of proposed alternatives. The team considered wire array alternatives, in-water array alternatives, and long-range acoustic device (LRAD) systems. Ultimately, two alternative configurations were selected for further development for the aerial APDA. The Jacobs team also proposed an in-water APDA to deter diving bird species. However, the in-water array concept is not based on empirical data or other project design criteria, as Proof-of-Concept for the design either does not exist or is not available. Additionally, an in-water array deployment may include operations, maintenance, and environmental disadvantages. More development is recommended before advancing this concept.

This report outlines the existing conditions found at MNA, describes design criteria including site constraints, presents all alternatives considered during development, and details the recommended alternative and next-best alternative based on cost and selection criteria.

1. Introduction

1.1 Project Authorization

This project is authorized as issued under USACE Walla Walla District Contract W912EF23D0014, Task Order W912EF24F9202 dated 23 September 2024. To date, there are no modifications issued.

1.2 Purpose and Scope

Jacobs is tasked with conducting a concept-level alternatives evaluation that will ultimately lead to a construction project installing an Avian Predation Deterrent Array (APDA). The work under this Task Order includes this report that documents the APDA design alternatives, decisions, discussions, costs, and recommendations. Designs for APDA's McNary Dam will consider factors such as biological effectiveness (improve salmonid survival through deterrence while not adversely impacting fish passage), tailrace access by boats and personnel, operation and maintenance of both the overall dam features and the APDA.

1.3 Report Organization

This report is organized to document the alternatives, decisions, discussions, costs, and recommendations that were part of the concept design evaluation process.

Section 1 introduces the information and background necessary to understand the scope of the report.

Section 2 summarizes relevant existing conditions at McNary Dam and John Day Dam to provide context for alternative selection and conceptual design.

Section 3 details the engineering, biological, constructability, reliability and operational criteria that guided the development of deterrent alternatives.

Section 4 describes the primary alternatives selected for conceptual development based on input from the CDW and Refined Alternatives Review Meeting.

Section 5 presents a comparative analysis of the selected alternatives, including cost estimates, biological effectiveness, constructability, reliability, and operational feasibility. This section also identifies the recommended and next-best alternatives.

Appendices provide supporting documentation including drawings, cost estimates, calculations, meeting notes, and stakeholder review comments.

1.4 General Description of Site

The McNary Dam is a concrete gravity, hydroelectric facility spanning 7,365 feet across the Columbia River, with a structural height of 183 feet. Located approximately one-mile northeast of Umatilla, Oregon, the dam is operated and managed by the 120-employee local team from the Walla Walla District. Completed in 1954, the dam supports multiple functions including hydroelectric power generation, river navigation lock, flood control, and fish passage. Its powerhouse contains 14 turbine units with a total generating capacity of 980 megawatts, capable of producing over 5,000 GWh annually. The dam construction also includes a spillway section that is 1,310 feet long and consists of 22 gate-controlled

spillbays. The spillbays are used to manage river flow and assist in fish passage, particularly during high-flow periods and directing juvenile fish downstream.

The dam includes two fish ladders, one on each shore, to facilitate upstream migration of anadromous fish species. The dam creates Lake Wallula on the east side, which extends 64 miles upstream. The tailrace on the west side leads to Lake Umatilla and allows migrating smolt to continue downstream via the Juvenile Bypass System on the south shore and top spill weirs.

1.5 History of Concept Development

The Avian Predation Deterrent Array McNary Dam Feasibility Report was drafted in 2019 and updated in 2022 to provide specific cost and technology revisions. This conceptual design evaluation considered and validated alternatives presented in the feasibility report. The feasibility report was also used as a reference for relevant technical background and analysis as well as current avian-predation-related requirements. This Task Order followed a structured process involving multiple phases of stakeholder engagement and technical development.

1.5.1 Kickoff Meeting

A virtual kickoff meeting was held to align project objectives, review the scope of work, and establish communication protocols between USACE and Jacobs.

1.5.2 Site Visit

A site visit to John Day and McNary Dams was conducted to assess existing conditions, identify potential anchorage points, and gather input from dam operations staff and biologists. Detailed information about site visit findings can be found in Appendix G.

1.5.3 Concept Design Workshop and Alternatives Selection

A Concept Design Workshop (CDW) was held on December 19, 2024, to develop and screen initial APDA alternatives. The workshop included input from USACE, Jacobs, and US Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) Wildlife Services. See Appendix E for details.

Seventeen alternatives were evaluated - all but two were different configurations of wire arrays. Two alternatives introduced a novel concept of an in-water deterrent system anchored to the Juvenile Bypass System and floated on the surface of the Columbia River. Through motion of the system, it is theorized to deter species of diving birds.

Other avian predation deterrent systems discussed but not further developed included falconry deterrence, the current long-range acoustic device (LRAD) system, and Guardian Soundscape Technology.

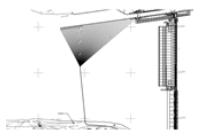
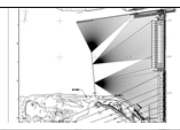
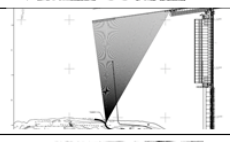
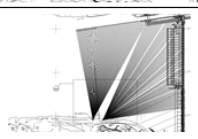
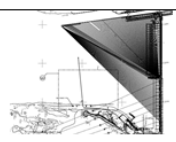
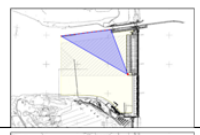
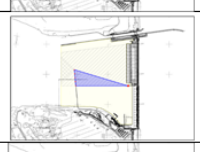
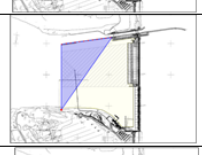
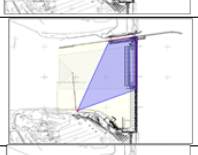
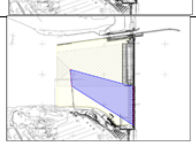
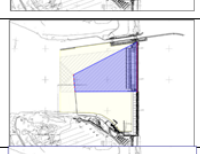
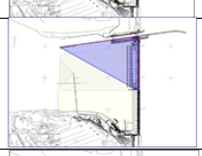
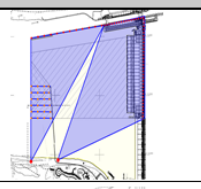
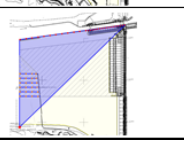
- Falconry is an avian deterrent measure the Walla Walla District evaluates but from an operational standpoint, conflicts with the favored passive wire arrays. NWW will continue to evaluate falconry but will not be considered in conjunction with wire array design development.
- McNary Dam currently uses an LRAD system and is considered minimally to moderately effective. Dam biologists have observed the targeted avian species habituated to the device. Biologists will continue to consider options for LRAD use independently from this effort.
- The Guardian Soundscape Technology is used to deter nearly all avian species and mammals in certain applications. The constant undulating sound disrupts wildlife's ability to communicate according to the

manufacturer. The clear disadvantage of this device is the constant loud sound produced. It was decided this device poses an unacceptable disruption to dam operators and visiting public.

From the wire arrays presented and discussed, two alternatives were selected for refinement based on biological effectiveness and feasibility. See Table 1-1 for a summary of alternatives considered and overall score. Alternatives 16 and 17 were selected to be refined specifically to deter aerial foragers.

Note: Alternative 14 is not further refined in this report because it has not moved past the Proof-of-Concept stage of development. It is intended as a possible in-water deterrent for avian water-based foragers that approach feeding areas by swimming. Alternate 14 is an add-on to Alternatives 16 and 17 if USACE Walla Walla District chooses to develop in the future using computational fluid dynamic modeling and small-scale pilot project.

Table 1-1. Summary of Alternatives Considered

	McNary Dam Avian Deterrent Predation Array Ranking Matrix	Scoring Summary Five is highest ranking score (best) one lowest ranking score (worst)		Walla Walla District Comments
	Alternatives Feasibility Report alternatives designed with "FR" letters preceding the title below	Concept Schematic	Total Accumulated Points (highest score is top preferred)	
1	FR 6.3 JBS Pier to Nav Lock Guidewall - screened out due to added structural load concerns at outfall pier		No score	Cannot secure to end of Juvenile bypass pipe. Covers little area.
2	FR 6.4 JBS Pier to Navigation Lock & Guidewall, Spillway, and Powerhouse - screened out due to added structural load concerns at outfall pier		No score	Cannot secure to Juvenile bypass pipe. Install/maintenance outweighs the effectiveness around powerhouse and spillway coverage. Very few smolts pass through powerhouse and turbulence in tailrace near spillway is extreme during spill season making predation difficult.
3	FR 6.5 Oregon Shoreline to Navigation Lock Guidewall		9	Covers the area of highest predation concentration. Ease of installation, not attached to spillway/powerhouse. Would have little impact on project operations during installation/maintenance.
4	FR 6.6 Shoreline to Navigation Lock & Guidewall, Spillway, and Powerhouse minus powerhouse		8	Covers areas of highest predation concentration. Costly and difficult to install on powerhouse/spillway. Would have major impact on project operations during installation/maintenance. Very few smolts pass through powerhouse and turbulence in tailrace is extreme during spill season making predation difficult.
5	FR 6.7 Powerhouse and Spillway to Navigation Lock and Guidewall		6	Overlaying wires are difficult to install and repair. Would have major impact on project operations during installation/maintenance. Very few smolts pass through powerhouse and turbulence in tailrace is extreme during spill season making predation difficult. Doesn't cover area of major concern at JBS release site.
6	Jacobs Tailrace Pier – Navigation Lock and Guidewall Array		6	Covers little area of concern.
7	Jacobs Tailrace Pier to JBS Outfall Pier - screened out due to structural concern at outfall pier connection points and low biological effectiveness (predation area coverage)		No score	Cannot secure to Juvenile bypass pipe. Installation/maintenance outweighs the effectiveness around the area of coverage. Very few smolts pass through powerhouse and turbulence in tailrace is extreme during spill season making predation difficult.
8	Jacobs Oregon Shore to Navigation Lock Guidewall Array		9	Covers the area of highest predation concentration. Ease of installation, not attached to spillway/powerhouse. Would have little impact on project operations during installation/maintenance.
9	Jacobs Oregon Shore to Navigation Lock and Spillway Array - no powerhouse included		7	Difficult to install on spillway. Would have major impact on project operations during installation/maintenance. Turbulence in tailrace is extreme during spill season making predation difficult.
10	Jacobs JBS Outfall Pier to Powerhouse Array - screened out due to structural concern at outfall pier connection points, low biological effectiveness and installation complexity		No score	Cannot secure to Juvenile bypass pipe. Install/maintenance outweighs the effectiveness around powerhouse coverage. Very few smolts pass through powerhouse during spill season.
11	Jacobs JBS Outfall Pier to Spillway Array - screened out due to structural concern at outfall piers' connection points and installation complexity		No score	Cannot secure to Juvenile bypass pipe. Covers little predation area of interest.
12	Jacobs Navigation Lock Guidewall to Spillway Array		6	Installation concerns. Covers little predation area during high spill.
13	Jacobs Navigation Lock Guidewall to Spillway and Powerhouse Array - screened out due to installation challenges and lack of coverage at JBS outfall		No score	Installation concerns. Covers little predation area during high spill.
14	Jacobs In-Water Floating Array		5	Installation difficulty. Continuous maintenance with in-water array collecting debris.
15	Jacobs In-Water Floating Array with Modified Outfall Location - screened out because moving the outfall would defeat earlier design intent for discharge location		No score	Cannot move outfall.
Alternatives added after Concept Design Workshop				
16	Jacobs 8, 9 (wire array) and 14 (in-water array) combined		8	Covers the area of highest predation concentration. Multi-method approach (effective against multiple avian species?). Would have impact on project operations during installation/maintenance. Very few smolts pass through powerhouse and turbulence in tailrace is extreme during spill season making predation difficult.
17	Jacobs 8 extended to Spillway Deck and 14 combined		9	Covers the area of highest predation concentration. Multi-method approach (effective against multiple avian species?). Would have little impact on project operations during installation/maintenance.

1.5.4 Develop and Present Refined Alternatives Review Meeting

Refined alternatives were developed and presented at a review meeting on April 10, 2025. Feedback from the Fish Facility Design Review Work Group (FFDRWG) and other stakeholders was incorporated into the final evaluation. Further, costs of various alternatives were introduced, including costs for different wire sizes and number of towers required to support the proposed wire array alternatives. The Refined Alternatives and Review Meeting concluded with the understanding Walla Walla District would evaluate current code governing wire size versus similar APDAs on the Columbia River that use a smaller diameter wire size.

Alternatives 16 and 17, noted from Table 1-1 and in Section 1.5.3, were renumbered at this stage. Alternative 16 was renumbered Alternative 1A. Alternative 17 was renumbered Alternative 1B. Both alternatives considered a designed wire size that was consistent with criteria developed in the CDW. Detailed information about this meeting can be found in Appendix F.

1.5.5 Draft Conceptual Design Evaluation Report

A Draft version of this report was prepared to document the refined alternatives, design criteria, and preliminary cost estimates.

A code compliant alternative with two variants was added at this stage. With the added alternative, the alternatives in the Draft report changed and use the following format:

Alternative 1

The wire array is designed in alignment with applicable codes and relevant criteria as outlined in Section 3. This alternative includes two variants:

- Variant A addresses the entire area identified as having the highest levels of avian predation within the tailrace spillway zone that extends to the BRZ.
- Variant B targets a smaller portion of the area covered by Variant A and provides a more cost-effective solution.

Alternative 2

Formerly Alternate 1, this wire array is designed using criteria developed in the CDW and varies from code as outlined in Section 3. This alternative also includes the same two area-of-coverage variants below the tailrace spillway.

Alternative 3

The in-water concept, named Alternative 14 in Section 1.5.3, was changed to Alternative 3. Alternative 3 is considered an optional add-on as previously discussed and is not compared to Alternatives 1 and 2 anywhere in this report.

1.5.6 Draft Conceptual Design Evaluation Report Review Meeting

The Draft Conceptual Design Review Meeting was held 04 September 2025, to discuss overall review, comments and other feedback regarding the Draft. Detailed information about this meeting can be found in Appendix I.

1.5.7 Prepare Final Conceptual Design Evaluation Report

Submitted with this report.

1.5.8 Prepare Final Conceptual Design Evaluation Cost Estimate

Submitted with this report.

2. Existing Conditions

2.1 John Day Dam

John Day Dam is a major hydroelectric facility on the Columbia River, located between Washington and Oregon. Operated by the U.S. Army Corps of Engineers Portland District, the facility includes a concrete gravity dam, earthen embankments, navigation lock, and a powerhouse with 16 turbine-generator units capable of producing more than 2,000 megawatts of electricity. The electrical systems include high-voltage switchyards and transmission infrastructure that connect to the Pacific Northwest power grid. The dam also features systems for turbine operation, spillway gate control, and fish passage. The APDA at John Day Dam includes a passive line array.

The following sections summarize existing conditions as observed and discussed by the Jacobs team during the site visit to John Day Dam on October 22, 2024.

2.1.1 Structural

The existing avian deterrent system at John Day Dam consists of a passive line array supported by five towers on the Oregon shore, three towers on the Washington shore, and anchor points at the navigation lock and spillway. Constructed in 2010, the array includes approximately 125 lines, with spans reaching up to 3,000 feet. Although the original design specified synthetic rope, several lines have been replaced with 3/16-inch stainless-steel wire, which is preferred for its durability, inhospitable avian perch and lower cost.

Two types of tower structures support the array. One type is constructed from welded triangular steel pipe columns anchored to individual concrete pad footings, each approximately 20 feet by 20 feet in size. The remaining towers consist of single circular steel posts mounted on base plates and supported by similar footings. Multiple wires are attached to the top of each tower, with additional steel carry cables spanning between adjacent towers to support more lines. On the dam side, lines are anchored using various systems, including embedded hooks and steel posts connected to the concrete structure using post-installed epoxy threaded rods and steel bearing plates.

The system includes dampeners at connection points to reduce wind-induced vibration and noise, which were significant issues during initial installation. Although tensioning devices were installed, they are not used where steel wires are in place, and no system is currently available to measure line tension. Some connections include winches for tensioning, while others do not. Over time, several ropes have broken due to excessive tension or wear and replacing them requires barge access across the river.

As discussed on-site, the current system has several limitations. The avian predation deterrent system requires annual maintenance; however, the John Day Dam maintenance crew cannot service the synthetic lines so a contractor must be engaged for repairs. Birds occasionally become entangled, two or three incidents have occurred over the past five years, and some species, such as pelicans and cormorants, are not effectively deterred. Additionally, birds often fly beneath the array, reducing overall effectiveness. The dam-side lines are adjustable, but the system's performance is constrained by wire spacing. Closer spacing improves deterrence but increases the risk of wires touching, which can reduce system efficiency. During conversations, it was suggested that a grid of wires or net-style configuration may offer improved performance.

2.1.2 Electrical

During the site visit, it was observed that the avian predation deterrent system did not have a lightning protection system. Temporary grounding measures are employed only during maintenance or operational work. The powerhouse at the dam comprises 16 generating units, each with a capacity of 155 MWh. All electrical power is generated in-house with no external sources used to support dam operations.

2.2 McNary Dam

McNary Dam, located on the Columbia River near Umatilla, Oregon, is a hydroelectric and navigation facility operated by the U.S. Army Corps of Engineers, Walla Walla District. Commissioned in 1954, the dam features a concrete gravity structure with a powerhouse containing 14 turbine units, providing a total capacity of approximately 980 megawatts. The electrical infrastructure includes high-voltage switchyards and transmission systems that support regional power distribution. The dam includes a spillway section with gated bays designed to manage river discharge and support fish passage during high-flow conditions. The powerhouse at McNary Dam is also equipped with a Juvenile Bypass System that diverts most juvenile fish away from the turbine and eventually returns them to the river via the outfall pipe. Two fish ladders, located on the north and south shores, facilitate upstream migration of anadromous fish species.

The following sections summarize existing conditions as observed and discussed by the Jacobs team during the site visit to McNary Dam on October 23, 2024.

2.2.1 Structural

While on-site, the team observed the outfall pipe structure as visible from Spillway Park. During spring runoff, it was briefed to the team that water levels can rise more than two feet above the outfall pipe. As discussed on-site, structural attachments, such as wires, are discouraged from being attached to the outfall itself; therefore, any new installations are preferred to be mounted to a dedicated tower, either on shore or in the water.

It was observed that the Boat Restricted Zone (BRZ) extends from the hatch/stripe marked sign at the outfall to the dam. Public boating and fishing are prohibited within this boundary and any cable arrays should be confined within the BRZ markers. Although birds feed in multiple areas, the majority of avian predation activity occurs at the outfall and downstream of the spillway tailrace, with less frequent activity in the powerhouse tailrace. A wire array system over the powerhouse tailrace was not identified as a priority at this time.

2.2.2 Electrical

During the site visit, several key observations were made regarding the facility's electrical infrastructure and operational capabilities. The powerhouse consists of 14 generating units that produce power at 4160 volts, which is then stepped up via transformers and transmitted at a voltage of 125 kV through overhead transmission lines. The facility generates sufficient in-house power to support all operational needs, with no reliance on incoming external power sources. Two of the generating units are designated as black start units, capable of starting independently without external power. Backup systems include a diesel generator dedicated to the spillway gates and an internal battery system. Despite the facility's robust generation capabilities, it does not have lightning protection, and past incidents of lightning strikes have caused operational trips. For the proposed new system, any added towers will require permanent grounding. Avian deterrent wires must be installed at a height sufficient to allow safe passage of

designated boats allowed to operate within the BRZ. Additionally, the designated shipping channel through the navigation lock must remain unobstructed.

3. Design Criteria and Constraints

3.1 Governing Criteria, Codes and Other References

- UFC 1-200-01, DoD Building Code
- UFC 3-201-01, Civil Engineering
- UFC 3-301-01, Structural Engineering
- UFC 3-401-01, Mechanical Engineering
- UFC 3-501-01, Electrical Engineering
- UFC 3-740-05 Construction Cost Estimating
- ER 1110-2-1150 Engineering and Design for Civil Works Projects
- ER 1110-2-1302 Civil Works Cost Engineering
- UFC 3-575-01, Lightning and Static Electricity Protection Systems
- ASCE 7-22 (ASCE 7-10 where noted), Minimum Design Loads and Associated Criteria for Buildings and Other Structures
- AISC 360-22, AISC Specification for Structural Steel Buildings
- ACI 318-19, Building Code Requirements for Structural Concrete
- NFPA 70, National Electrical Code 2023
- McNary Avian Predation Deterrent Array Feasibility Report with FFDRWG comments dated 26 Oct 2022
- John Day Dam Lock and Dam Avian Predation Deterrent Array Phase II dated 20 Nov 2009
- McNary Juvenile Fish Facility Outfall Pipe Relocation FY2011

3.2 General

The design criteria and constraints developed by the Jacobs team was a collaborative effort. Initially, general design requirements were provided by USACE as part of the Statement of Work. Criteria was further developed from current codes and standards, Walla Walla District directed requirements, McNary Dam Avian Predation Deterrent Array Feasibility Report, information collected from John Day Dam APDA and general site conditions at McNary Dam during the site visit, and guidance and recommendations gathered from USDA APHIS. The criteria and constraints were then validated by stakeholders who attended the CDW.

Below is a list of general design criteria and constraints that apply to the selected alternatives:

- According to USDA, the newest wire array at John Day is designed with Kevlar rope and has distinct disadvantages compared to steel wire. The service life for synthetic rope is five years compared to a 20-year service life for steel. Additionally, ice builds up more on larger diameter rope. Finally, synthetic rope is more expensive to install than metal wire.
- Wire arrays support wire from two ends and as a result, the wire sags in the middle. Achieving maximum wire sag is important to create a more three-dimensional deterrent for gulls.

- USDA wire array installation team does not measure tension in the wire. Sag and distance to the water are primary installation requirements for maximum effectiveness.
- Layering or crisscrossing different arrays is not more effective and complicates installation.
- Wire sag closer to the water is most effective but needs to consider mean high water elevation.
- Thin steel gage wire is the most effective for ease of installation, longevity, rigidity, and operation. Thin wires are preferable to minimize avian perching.
- Wire closer to spillways needs to be heavier gage to support potential ice buildup during winter.
- Parallel arrays, using large cable for multiple anchor points, is not recommended. This support configuration makes achieving uniform sag difficult to achieve.

3.3 Biological Effectiveness

By reducing avian predation, the array is anticipated to improve survival rates for vulnerable fish species, contributing to healthier populations and supporting broader conservation goals, particularly for threatened or endangered species. The system is designed to minimize unintended impacts on non-target species and the surrounding ecosystem. Regular monitoring and maintenance will be essential to ensure continued effectiveness and to prevent potential hazards to other wildlife.

The overhead wire array design provides targeted coverage over the spillway tailrace, an area known for high concentrations of piscivorous bird activity. To ensure the biological effectiveness of the APDA, several key design factors were considered:

- Size of wire: steel wire products as small as 0.54mm are used for perch deterrence in smaller applications. The Department of Natural Resources Minnesota recommends a steel wire size of 0.8mm while the Internet Center for Wildlife Damage Management (icfwdm.org) recommends 1.0mm for gull deterrent wire arrays. These wire size recommendations suggest smaller wire sizes deter perching. As the wire size increases to achieve adequate strength or code compliant properties, it also increases the chance of gulls perching allowed by the larger and more stable landing surface thereby decreasing the overall biological effectiveness.
- Spacing and orientation of wires: wide spacing between wires may allow birds to maneuver through the array more easily, diminishing its role as a physical and behavioral deterrent. To ensure biological effectiveness, several key factors are considered in this report. Optimal wire spacing is approximately 18 feet, close enough to prevent birds from flying between wires, yet wide enough to avoid wire collisions and excessive material use. Wires should be oriented horizontally and positioned about 20 feet above the water surface to create a visible barrier that deters diving without obstructing dam operations or maintenance access. Wire arrays are most effective for avian deterrence when oriented perpendicular to prevailing winds.
- Wire array coverage over predation area: while wire array coverage could be biologically effective in all areas known to have predation activity, this approach is not practical or cost effective. This concept evaluation considered the area where it would be most effective and is defined by the tailrace area immediately downstream of the spillway and the area surrounding the JBS outfall. Although the array area limits do not extend downstream of the BRZ, the wire array alternatives are expected to disrupt flight paths and foraging behavior in critical areas.

Adaptive management strategies, such as adding deterrent features or extending coverage may be necessary to maintain or improve biological effectiveness. Regular maintenance and behavioral observations will be essential to assess system performance and guide future improvements. Despite its

limitations, the array contributes to broader goals of reducing avian predation and improving survival rates for vulnerable fish species.

3.4 Structural

The following sections outline the structural design criteria used to develop the concept-level APDA alternatives. Two distinct approaches were considered: one developed in accordance with the governing codes and criteria specified in the Task Order and another that introduces a targeted variance to those criteria to increase biological effectiveness. The latter approach aims to reduce environmental loads from wind and ice by targeting specific structural performance criteria that would be acceptable for an APDA installed at McNary Dam.

3.4.1 Code-Compliant Array Criteria

Alternatives 1A and 1B were developed using the governing criteria and codes as noted in the Task Order for this study.

In collaboration with the USACE team, it was confirmed that the most current version of UFC 3-301-01 with Change 3 dated 3 February 2025, should be used for the concept design. This version of the UFC references ASCE 7-22, which uses ice and wind load design values based on recent environmental data. These ice and wind loads are lower than those required by ASCE 7-16, which was referenced by the previous version of UFC 3-301-01, in effect at the time of Task Order award.

Design Load Parameters

The avian deterrent system is assumed to be Risk Category I, indicating a structure with low risk to human life in the event of failure. Structural design parameters were established based on the codes and standards noted in the previous section and environmental loads specific to the site.

Design load parameters as shown in table below.

Table 3-1. ASCE 7-22, Design Load Parameters

Parameter	Value
Risk Category	I
Basic Wind Speed, V	94 mph
Nominal Ice Thickness	0.52 inch
Concurrent Wind Speed, V_c	46 mph

3.4.2 Code Variance Array Criteria

Alternatives 2A and 2B were designed using criteria based on a proposed code variance. The criteria were developed through discussions between USACE and Jacobs, which concluded that strict adherence to the current code would result in wire sizes being too large to effectively deter avian species. Larger wires may enable birds to perch on or dive beneath the array and reduce its effectiveness. The team reviewed previous installations at John Day Dam and The Dalles Dam, both of which utilized 3/16-inch diameter stainless-steel wires. Based on these precedents and the longer span of approximately 3,300 feet at

McNary Dam, the team agreed that a slightly larger 1/4-inch wire would be more appropriate for this location.

The following design code modifications were developed to support the use of 1/4-inch wire and achieve structural performance objectives for an unoccupied wire array type structure at McNary Dam.

- Ice and wind loads calculated using ASCE 7-10.
- Wind load to be calculated using the 25-year MRI wind speed.
- Consider Dead/Wind and Dead/Ice load combinations.
- Dead/Wind/Ice concurrently does not need to be considered.
- Wire utilization to be calculated based on minimum cable breaking strength values, without applying a reduction factor or safety factor.

Design Load Parameters

The avian deterrent system is assumed to be Risk Category I, indicating a structure with low risk to human life in the event of failure. Structural design parameters were established based on the code variance noted in the previous section along with environmental loading at the site.

Design load parameters as shown in table below.

Table 3-2. ASCE 7-10, Design Load Parameters

Parameter	Value
Risk Category	I
25-year MRI Wind Speed	79 mph
Nominal Ice Thickness	0.25 inch
Concurrent Wind Speed, V_c	40 mph
Ice Importance Factor - Thickness, I_i	0.80
Ice Importance Factor – Wind, I_w	1.00

3.4.3 Structural Systems and Materials

Wires

Wires for the avian deterrent array should be stainless-steel wire rope. Based on conversations with stakeholders, stainless-steel is preferred over synthetic rope.

According to the USDA APHIS, the most recent synthetic rope installation at John Day Dam demonstrated several disadvantages compared to stainless-steel, including a reduced service life of approximately five years (versus 20 years for stainless-steel), increased ice accumulation due to larger diameter, and higher installation costs. Synthetic options, such as Plasma Spectra used at John Day, are also prone to creep, which can cause excessive sag leading to contact with debris in the river or adjacent wires. Synthetic rope installations also require helicopter support to span the river, whereas stainless-steel wire can be installed using a customized boat/barge reel operation. Additionally, USDA personnel have the tools and expertise to maintain and repair stainless-steel arrays in-house, while synthetic rope repairs require contracted services.

Stainless-steel Type 304 is recommended for the wire rope due to its high resistance to corrosion in outdoor and aquatic environments. Class 6x19 and 7x19 wire rope were used for calculating wire sizes and forces on the array structural components. These classes of wire rope consist of six to seven strands, each made up of approximately 19 individual wires, offering high flexibility, strength, and excellent fatigue resistance. The table below summarizes the assumed wire properties.

Table 3-3. Code-Compliant Array Wire Properties

Parameter	Value
Wire Diameter	1 ¼ inch
Wire Construction	6x19
Wire Material	Stainless-Steel, Type 304
Nominal Breaking Strength	129,400 lbs
Weight	2.9 lbs / foot

Table 3-4. Code Variance Array Wire Properties

Parameter	Value
Wire Diameter	¼ inch
Wire Construction	7x19
Wire Material	Stainless-Steel, Type 304
Nominal Breaking Strength	6,400 lbs
Weight	0.11 lbs / foot

Towers at Array Origin

At the origin of the wire array, towers will support multiple wires extending out from a common attachment point at the top. These towers are proposed as tubular steel structures, similar to those used for electric transmission lines and the towers previously installed on the north shore of the John Day Dam APDA.

Tubular steel towers are typically fabricated with a hollow circular cross-section and tapered profile. This provides efficient load transfer and resistance to wind, ice, and tension from suspended wires. The closed circular cross-section enhances torsional rigidity and minimizes maintenance by reducing surface exposure to environmental conditions. This geometry also reduces wind-induced loads, vibration, and fatigue. The tapered profile is optimized for material use, concentrating strength and stiffness where it is needed at the base, while reducing weight at the top. The steel towers should also be galvanized to protect against corrosion in the outdoor riverine environment, where exposure to moisture and temperature fluctuations are common.

Foundation type will depend on site-specific geotechnical investigation and recommendations, which will assess subsurface conditions such as soil type, seismic parameters, bearing capacity, groundwater depth, and the presence of bedrock. These findings will inform the structural selection of an appropriate foundation system. To resist the significant overturning forces generated by tensioned wire arrays, towers may require either large spread footings bearing on competent soil or foundations socketed into bedrock.

This approach is consistent with the foundation systems used at the John Day Dam APDA, where similar structural demands and site conditions were present. The final foundation design should be selected to ensure long-term stability, minimize settlement, and accommodate lateral and uplift forces imposed by wire tension and other loads on the towers.

In-water towers were avoided to minimize impacts on fish passage and reduce debris accumulation. The USDA team typically uses a reel truck to install and maintain wire, so tower placement should avoid locations such as the outfall pier or lock guide wall.

Individual Wire Anchorage

To achieve required wire elevation and sag, posts are used to raise wire anchor points above deck level at the navigation guide wall, navigation lock wall, and spillway for the code-compliant arrays and at the navigation guide wall and spillway for the code variance arrays. These posts are attached to the existing concrete structures using large steel bearing plates and post-installed, drill-and-epoxy threaded rods. Anchorage design must account for operational and maintenance (O&M) access, avoiding interference with handrails and light poles and ensuring the posts do not obstruct personnel movement or equipment operation.

For the code variance arrays, additional anchorage along the navigation lock wall consists of individual wire connections using steel anchor plates attached to the concrete wall with drill-and-epoxy threaded rod anchors.

Anchoring wires to large carry cables, which span between the towers and support multiple wire ends, is discouraged due to challenges with achieving uniform sag. Proper sag requires precise tensioning of both the carry cable and each individual wire; however, maintaining this level of control in the field is challenging. Uneven sag can result in inconsistent wire tension, reduced avian deterrence due to larger distances between wires, increased wear at connection points, and contact and abrasion of adjacent wires. Additionally, wires supported by the carry cable are more susceptible to wind-induced oscillations and dynamic loading, which can compromise long-term durability and performance.

Based on lessons learned at John Day Dam, line dampeners are recommended for longer spans to mitigate wind-induced vibration and fatigue, while tensioners are not required due to the low-creep characteristics of stainless-steel wire. Dampeners should be positioned to support safe and efficient inspection and replacement without the need for specialized equipment or confined space entry.

All structural anchor members and connectors must be protected against corrosion using stainless-steel, galvanized steel, or epoxy-coated materials.

3.5 Electrical

In accordance with Unified Facilities Criteria (UFC) 3-575-01, all metallic piping systems, including steel lines, must be grounded to mitigate the risk of static discharge and induced voltages resulting from nearby overhead power transmission lines. Grounding is a critical safety measure intended to protect personnel, equipment, and infrastructure from electrical hazards.

As such, the steel towers supporting the wire arrays must be properly grounded. This grounding requirement ensures compliance with UFC standards and supports the overall electrical safety and reliability of the installation.

3.6 Constructability

Constructability criteria were developed to evaluate the feasibility of installing each alternative within the operational and environmental constraints of McNary Dam. These criteria address the complexity, safety, and efficiency of construction activities, as well as the potential impacts on dam operations during installation. Key considerations include:

- Installation Complexity: Evaluate the number and size of components (e.g., towers, anchorage points, wire spans) and the need for specialized equipment such as high-capacity cranes, barges, or tensioning rigs. Alternatives requiring large-diameter wires or extensive anchorage systems were considered more challenging to construct.
- Access and Work Zone Constraints: Assess the ability to stage equipment and materials on the south shore, navigation lock walls, and spillway deck without interfering with existing infrastructure or navigation. Alternatives requiring work over the spillway or in restricted zones were assigned higher constructability risk.
- Sequencing and Operational Impacts: Determine whether installation activities could disrupt dam operations, including spillway gate access, navigation lock use, or fish passage systems. Alternatives minimizing work in critical areas were favored.
- Foundation and Anchorage Requirements: Evaluate the complexity of installing tower foundations and anchorage systems, including the need for deep foundations, large spread footings, or post-installed anchors in existing concrete structures.
- Safety and Environmental Considerations: Consider worker safety during high-elevation work, over-water operations, and compliance with environmental protection measures.

3.7 Operation and Reliability

Operation and reliability criteria were established to assess the long-term performance, maintainability, and resilience of each alternative under site-specific conditions. These criteria focus on minimizing operational disruptions and ensuring consistent deterrent effectiveness throughout the system's service life. Key considerations include:

- Inspection and Maintenance Requirements: Evaluate the number of components requiring routine inspection (e.g., wires, towers, anchorage points) and the ease of access for maintenance crews. Alternatives with fewer components and simplified layouts were considered more reliable.
- Durability and Service Life: Assess material selection (e.g., stainless-steel wire vs. synthetic rope), corrosion resistance, and susceptibility to environmental factors such as ice accumulation, wind loading, and debris impact. Wire systems with longer service life and lower maintenance demands are preferred.
- Operational Impacts: Determine whether maintenance activities could interfere with dam operations, navigation, or fish passage. Alternatives avoiding spillway anchorage or critical infrastructure were rated higher.
- System Resilience: Consider the ability of the system to withstand extreme weather events, seasonal ice, and high-flow conditions without significant damage or loss of function. Systems with lower susceptibility to damage during these events were deemed more reliable.

4. Analysis of Selected Alternatives

This section describes and evaluates the alternatives selected for continued development at the end of the CDW. It discusses these alternatives in greater detail and summarizes the evaluation of biological effectiveness, concept design by engineering discipline, constructability, operation and reliability, and cost.

4.1 Alternative 1A

4.1.1 Description

Alternative 1A consists of a large APDA originating from towers at the Oregon shoreline. Wires fan out across the river, anchoring along the navigation guide wall, navigation lock wall, and spillway deck. This alternative was developed using the governing criteria and codes noted in the Task Order.

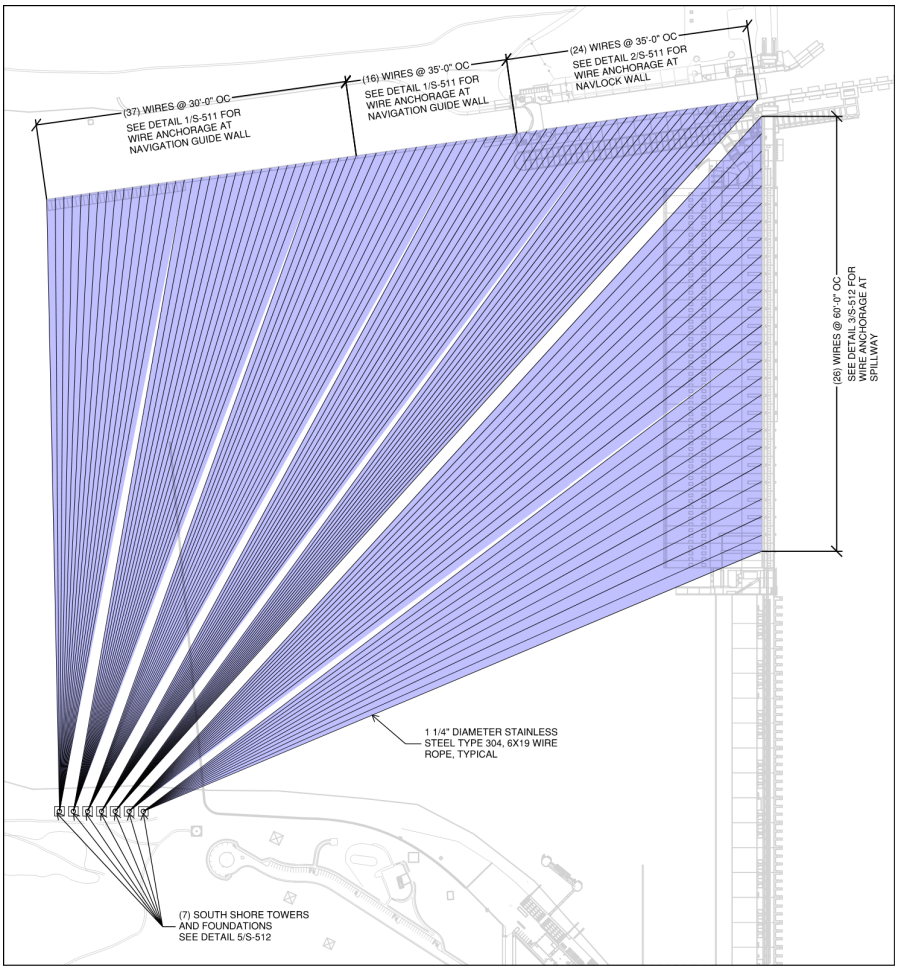


Figure 4-1. Alternative 1A - Wire Array Plan

4.1.2 Biological Effectiveness Evaluation

Alternative 1A uses 1¼-inch wires and has wider horizontal spacing at the spillway as compared to Alternative 2A. While code compliant, this configuration reduces biological effectiveness by increasing opportunities for perching by gulls and other large-bodied birds and allowing easier maneuvering around wires. Coverage is limited to the BRZ, providing reasonable protection of the primary zone but minimal disruption to flight paths further downstream. The wire array forms a physical barrier that restricts bird access to the water surface, reducing predation opportunities and improving juvenile salmonid survival.

4.1.3 Structural Evaluation

The array originates from seven tubular steel towers on the Oregon shoreline and spans the river with approximately 103 stainless-steel 6x19 wire ropes (1 1/4-inch diameter), anchored at the navigation guide wall, navigation lock wall, and spillway. Wire spans across the river range from 2,100 to 3,300 feet.

Alternative 1A was developed using the governing criteria and codes noted in the Task Order. Due to ice and wind loading specified in ASCE 7-22, design wire sizes are significantly larger than those in existing APDAs at John Day and the Dalles. The larger wires and higher ice and wind loads result in wire tension forces approximately six to seven times larger than at the existing ADPAs. Transferring the wire loads into the foundations and supporting dam structures requires significant anchor plates, anchor rods, and/or post-installed concrete connections.

South shore towers are tapered tubular steel structures as described in Section 3.4.3, with a 9-foot base diameter and 3-inch wall thickness. Alternative 1A has the most towers compared to Alternatives 1B, 2A, and 2B. The additional towers also necessitate more extensive foundation work, including the potential for deep foundations or large spread footings to resist higher overturning moments from the increased number of wire spans.

Anchorages at the guide wall, navigation lock wall, and spillway consist of elevated built-up plate columns mounted to existing concrete using steel bearing plates and post-installed threaded rods. Anchorage design must avoid interference with handrails, light poles, equipment, and O&M access routes.

The total number of anchorage points in Alternative 1A is higher than in Alternatives 1B and 2B, increasing both the initial installation effort and the long-term inspection and maintenance burden. Due to larger wire size, individual anchor plates and connections are significantly larger for Alternatives 1A and 1B when compared to Alternatives 2A and 2B.

Alternative 1A offers expansive coverage within the tailrace area; however, the necessary wire sizes reduce its biological effectiveness. This alternative also requires increased structural material, installation complexity, and construction cost. Attachment to the spillway structure may also reduce accessibility for maintenance.

4.1.4 Electrical Evaluation

Each steel tower installation must include a complete grounding system to ensure electrical safety and compliance with applicable standards. A grounding conductor must be installed on each south shore tower by connecting a grounding wire from the avian protection wires using split-bolt connectors. A #6 AWG XHHW copper conductor must be routed internally through the anchor pipe and connected to the external grounding wires via a cord connector.

At the base of the tower, the #6 XHHW conductor must transition into a ¾-inch Schedule 40 PVC conduit and terminate within a concrete valve box located adjacent to the tower base. Additionally, a #4 AWG bare copper grounding conductor must be embedded in the concrete at the base of the tower to provide a low-impedance path to ground. A grounding rod must be installed inside the concrete valve box, and all grounding conductors must be securely terminated at this point.

Grounding is not required on the anchorage side of the wires. For detailed layout and installation specifications, refer to Drawing E-501 in Appendix A.

4.1.5 Constructability Evaluation

Alternative 1A introduces greater construction complexity and installation demands. The inclusion of spillway anchorage increases the number of wire terminations from 77 in Alternative 1B to 103 in Alternative 1A and requires wire installation across the spillway. Installation in this zone could impact dam operations.

Installing the 1 1/4-inch diameter wire ropes across the river presents notable constructability challenges compared to smaller diameter systems. While 1/4-inch wires can be efficiently transported and tensioned using barges, the increased weight, stiffness, and handling requirements of the larger wires necessitate enhanced installation procedures. Specialized equipment, including high-capacity winches, tensioning rigs, and floating platforms, may be required to manage the wire deployment and maintain alignment across spans ranging from 2,100 to 3,300 feet. The larger wire diameter also increases the difficulty of achieving uniform sag and tension, particularly under variable wind and thermal conditions. Coordination with marine operations and careful sequencing will be essential to ensure safe installation. Compared to alternatives with smaller wires, Alternative 1A requires more robust constructability planning, increased labor effort, and longer installation durations.

In addition to the challenges associated with wire installation, anchorage construction for Alternative 1A requires substantial effort due to the increased size and quantity of components. Anchor plates are approximately 14 feet by 16 feet, representing a significant increase in area compared to those used in Alternatives 2A and 2B. This scale necessitates a corresponding increase in the number of post-installed, drill-and-epoxy threaded rod anchors to achieve adequate load transfer into the dam structure. Where wires terminate at the dam, built-up steel columns measuring approximately 32 inches by 16 inches and fabricated from 1-inch-thick plate are required to support the elevated anchor assemblies. These components are heavy and difficult to position, requiring specialized lifting equipment, precision rigging, and coordinated access planning. Installation must also account for spatial constraints and avoid interference with existing infrastructure such as handrails, lighting, and operational access routes. The complexity and scale of the anchorage system contribute to longer installation durations and increased construction cost relative to alternatives with smaller wires and fewer anchorage points.

Erection of the steel towers on the south shore requires high-capacity cranes and stable access pads to safely lift and position each structure. With a maximum 9-foot diameter and 3-inch-thick walls at the base, the towers are heavy and must be aligned within specified tolerances. The on-grade location allows more flexibility than wire anchorage to the dam, but still requires careful planning for equipment staging, lifting operations, and access coordination.

4.1.6 Operation and Reliability Evaluation

Alternative 1A presents increased O&M requirements due to the larger size of wires and anchorage. The higher number of towers, wires, and anchorage points also may result in more components requiring

routine inspection, tension monitoring, and periodic repair. Wires terminating at the spillway may be more difficult to access and could impact dam operations during maintenance activities.

Repairing a damaged wire would require removing the damaged section and installing a replacement segment using tensioning equipment and access platforms. This work would likely require barge-mounted cranes or floating work platforms, along with specialized rigging to manage the weight and stiffness of the 1¼-inch-diameter stainless-steel wire. Re-tensioning must be carefully controlled to maintain uniform sag and alignment with adjacent spans

Grounding systems installed at each tower must also be maintained to ensure continued electrical safety and compliance with applicable standards.

4.1.7 Cost Estimate

This alternative requires the greatest number of wires and a total of seven towers, resulting in the highest construction costs and the longest estimated construction period. Estimated cost for this alternative given the preliminary concept design and assumptions is $51.696M. The full cost summary can be found in Figure 5-1, McNary Dam Avian Deterrence Alternative Estimate Summary.

4.2 Alternative 1B

4.2.1 Description

Alternative 1B consists of a large APDA originating from towers at the Oregon shoreline. Wires fan out across the river, anchoring at the navigation lock guide wall and navigation lock wall. The layout is similar to Alternative 1A but does not include wires that attach to the spillway portion of the dam, therefore reducing the coverage of the tailrace area. This alternative was developed using the governing criteria and codes noted in the Task Order.

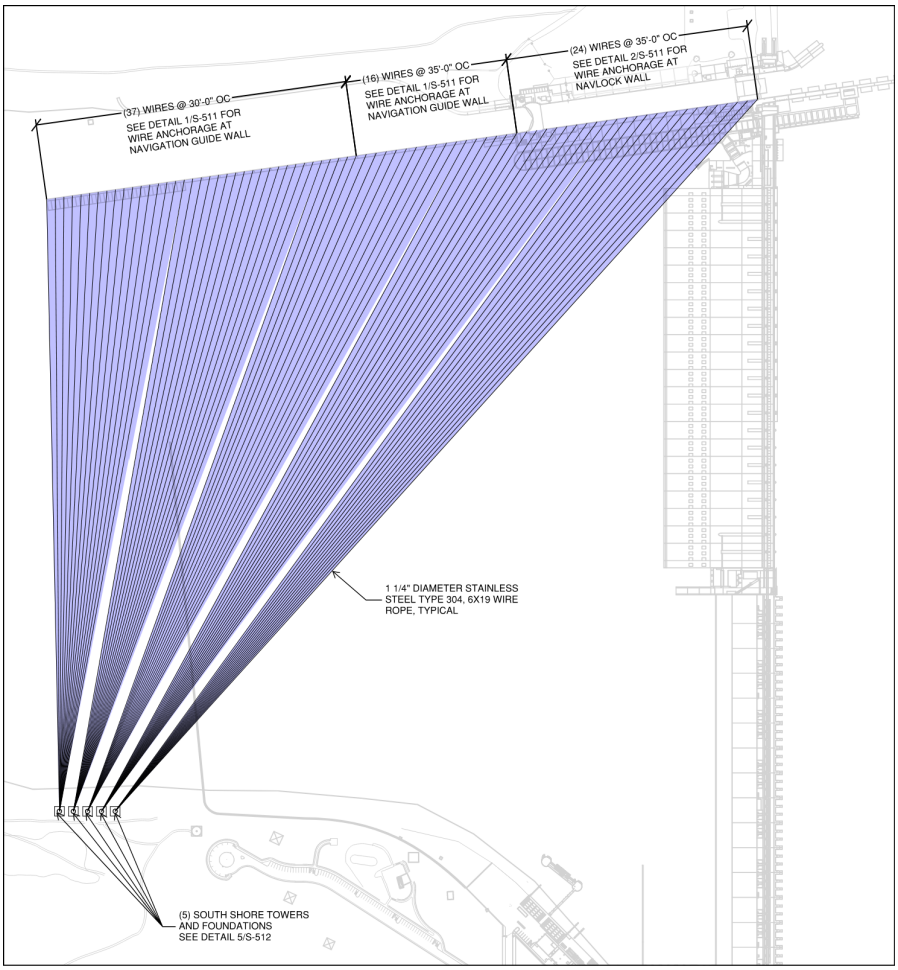


Figure 4-2. Alternative 1B - Wire Array Plan

4.2.2 Biological Effectiveness Evaluation

Alternative 1B is similar to 1A but omits spillway anchorage, focusing on areas with the highest observed concentrations of piscivorous bird activity. It does not cover the tailrace immediately below the spillway and remains within the BRZ, leaving downstream predation unaddressed and potentially limiting protection for salmonids exiting the JBS outfall. Although less effective than 1A, Alternative 1B still

provides reasonable coverage of the primary predation zone. Similar to 1A, the array is expected to reduce predation pressure and enhance the survivability of the fish populations by creating a physical barrier that limits bird access to the water.

4.2.3 Structural Evaluation

The array originates from five tubular steel towers on the Oregon shoreline and spans the river with approximately 77 stainless-steel 6x19 wire ropes (1 1/4-inch diameter), anchored at the navigation guide wall and navigation lock wall. This layout is structurally similar to Alternative 1A but omits wires anchored at the spillway, resulting in a reduced total number of wires and structural components.

Alternative 1B follows the same code-compliant design approach as Alternative 1A, resulting in similar wire size and anchorage requirements. The elimination of spillway anchorage reduces the overall array size. With fewer wires, cumulative tension loads on towers are lower and only five south shore towers are required. The shorter total wire length also reduces the number of line dampeners and anchorage connections required.

South shore towers are the same size as those in Alternative 1A; however, the use of only five towers reduces material quantities, fabrication effort, and erection time. Fewer towers also translate to reduced foundation quantities. This simplification is expected to lower construction cost and shorten installation duration compared to Alternative 1A.

Anchorage at the navigation lock guide wall and navigation lock wall is consistent with the approach used in Alternative 1A, built-up plate columns mounted to existing concrete using steel bearing plates and post-installed threaded rods. However, the reduced number of anchorage points in Alternative 1B decreases the complexity of installation and minimizes potential conflicts with existing infrastructure such as handrails, light poles, equipment, and O&M access routes at the spillway.

4.2.4 Electrical Evaluation

Grounding will be similar to the description in Alternative 1A.

Each steel tower installation must include a complete grounding system to ensure electrical safety and compliance with applicable standards. A grounding conductor must be installed on each south shore tower by connecting a grounding wire from the avian protection wires using split-bolt connectors. A #6 AWG XHHW copper conductor must be routed internally through the anchor pipe and connected to the external grounding wires via a cord connector.

At the base of the tower, the #6 XHHW conductor must transition into a ¾-inch Schedule 40 PVC conduit and terminate within a concrete valve box located adjacent to the anchor pipe base. Additionally, a #4 AWG bare copper grounding conductor must be embedded in the concrete at the base of the tower to provide a low-impedance path to ground. A grounding rod must be installed inside the concrete valve box, and all grounding conductors must be securely terminated at this point.

Grounding is not required on the anchorage side of the wires. For detailed layout and installation specifications, refer to Drawing E-501 in Appendix A.

4.2.5 Constructability Evaluation

Alternative 1B reduces installation complexity relative to Alternative 1A by eliminating spillway anchorage and associated wire spans. Using 77 wires for Alternative 1B compared to 102 for Alternative 1A simplifies

installation sequencing and avoids work directly above the spillway structure, thereby reducing potential impacts to dam operations and improving access for construction crews.

Although the same 1¼-inch-diameter wire ropes are used, the reduced array size in Alternative 1B lowers the total cable length and cumulative tension loads. Installation procedures remain similar, requiring specialized equipment to manage the weight and stiffness of the larger wires across spans ranging from 2,100 to 3,300 feet. However, the absence of spillway anchorage allows for more streamlined deployment and tensioning, particularly in areas with fewer spatial constraints.

Anchorage construction is also simplified in Alternative 1B. While anchor plates and built-up steel columns remain substantial in size, the reduced number of wire terminations results in fewer post-installed threaded rod anchors and less overall installation effort. This reduction in anchorage points decreases the time required for layout, drilling, epoxy installation, and final assembly, contributing to improved constructability and lower installation cost compared to Alternative 1A.

Erection of the south shore towers is similarly less demanding. With only five towers required, crane operations, access preparation, and foundation work are reduced in scope. The towers retain the same structural configuration as those in Alternative 1A, but the smaller quantity shortens the overall construction schedule and reduces material handling requirements.

4.2.6 Operation and Reliability Evaluation

Alternative 1B presents reduced O&M requirements compared to Alternative 1A due to its smaller array and elimination of spillway anchorage. With fewer towers, wires, and anchorage points, the total number of components requiring inspection, tension monitoring, and repair is lower. The absence of spillway-mounted wires also improves accessibility and eliminates potential operational impacts associated with maintenance activities near critical dam infrastructure. Repairing a broken wire in Alternative 1B would follow similar procedures to those described for Alternative 1A.

During winter, mist generated at the base of the spillways can cause localized ice accumulation on the wires. Because this alternative is located farther downstream, it is less exposed to spillway mist and therefore less prone to ice buildup, reducing the likelihood of wire breakage.

Grounding systems installed at each tower remain consistent with Alternative 1A and must be maintained to ensure electrical safety and compliance.

Overall, the reduced system footprint and simplified layout of Alternative 1B contribute to lower O&M demands and improved long-term reliability.

4.2.7 Cost Estimate

This alternative uses less wires as compared to 1A and a total of five towers, resulting in 2nd highest construction cost and 2nd longest estimated construction period. Estimated cost for this alternative given the preliminary concept design and assumptions is $39.727M. The full cost summary can be found in Figure 5-1, McNary Dam Avian Deterrence Alternative Estimate Summary.

4.3 Alternative 2A

4.3.1 Description

Alternative 2A consists of a large APDA originating from towers at the Oregon shoreline. Wires fan out across the river, anchoring along the navigation guide wall, navigation lock wall, and spillway deck. Alternative 2A was designed using criteria based on a proposed code variance.

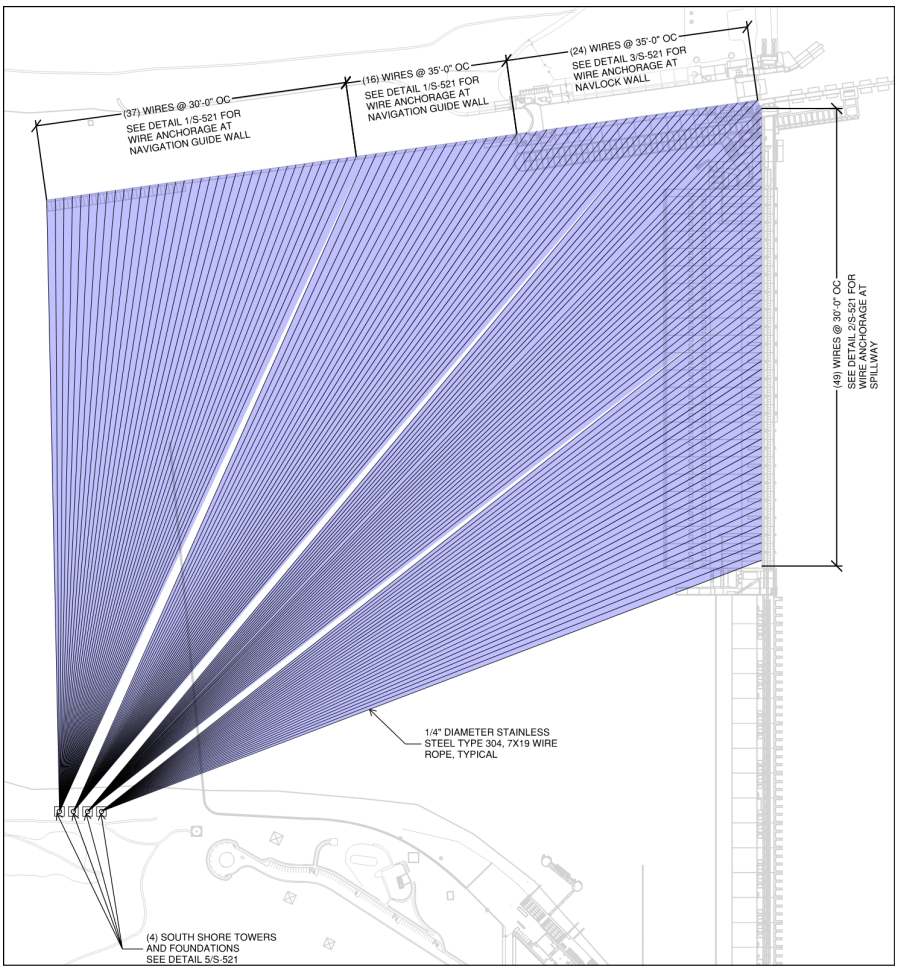


Figure 4-3. Alternative 2A - Wire Array Plan

4.3.2 Biological Effectiveness Evaluation

Alternative 2A uses ¼-inch wires and has smaller horizontal spacing at the spillway compared to Alternative 1A, improving biological effectiveness by reducing opportunities for perching and maneuvering. This configuration provides the most extensive spillway tailrace coverage within the BRZ, targeting areas with the highest observed bird activity. Similar to other alternatives, it leaves downstream predation unaddressed and potentially limits protection for salmonids exiting the JBS outfall. With the highest biological effectiveness and coverage of the alternatives, this array reduces avian predation by creating an effective physical barrier that disrupts flight paths and foraging behavior, causing birds to avoid the area. This is expected to improve juvenile salmonid survival.

4.3.3 Structural Evaluation

The array originates from four tubular steel towers on the Oregon shoreline and spans the river with approximately 126 stainless-steel 7x19 wire ropes (1/4-inch diameter), anchored at the navigation guide wall, navigation lock wall, and spillway deck. Wire spans across the river range from 2,100 to 3,300 feet.

Alternative 2A was developed under a proposed code variance to allow smaller wire sizes, reducing perching potential and improving biological effectiveness. Wire loads are significantly lower than in Alternatives 1A and 1B, lowering the cumulative tension load on the towers. As a result, south shore towers have a smaller 6.5-foot base diameter and 2-inch wall thickness and foundation size will be proportionally reduced.

Anchorage at the guide wall and spillway consists of elevated hollow structural section (HSS) posts mounted to existing concrete using steel bearing plates and post-installed threaded rods. Anchorage design must avoid interference with handrails, light poles, equipment, and O&M access routes. Additional anchorage at the navigation lock wall includes individual wire terminations connecting to a fabricated steel plate assembly fastened to the wall using post-installed threaded rods. Since the total number of anchorage points in Alternative 2A is similar to 1A and higher than Alternatives 1B and 2B, both the initial installation effort and the long-term inspection and maintenance burden will be increased. Anchorage steel and connections to concrete will be significantly smaller for Alternative 2A compared to Alternatives 1A and 2B due to the reduce force in each wire.

While Alternative 2A offers the greatest potential for reducing avian predation within the tailrace area due to its expansive coverage, it does so at the cost of increased structural material, higher installation complexity, and reduced accessibility for maintenance when compared to Alternative 2B.

4.3.4 Electrical Evaluation

Each steel tower installation must include a complete grounding system to ensure electrical safety and compliance with applicable standards. A grounding conductor must be installed on each south shore tower by connecting a grounding wire from the avian protection wires using split-bolt connectors. A #6 AWG XHHW copper conductor must be routed internally through the tower and connected to the external grounding wires via a cord connector.

At the base of the tower, the #6 XHHW conductor must transition into a ¾-inch Schedule 40 PVC conduit and terminate within a concrete valve box located adjacent to the tower base. Additionally, a #4 AWG bare copper grounding conductor must be embedded in the concrete at the base of the pipe to provide a low-impedance path to ground. A grounding rod must be installed inside the concrete valve box, and all grounding conductors must be securely terminated at this point.

For detailed layout and installation specifications, refer to Drawing E-501 in Appendix A. Grounding is not required on the anchorage side of the wires.

4.3.5 Constructability Evaluation

From a constructability standpoint, Alternative 2A introduces greater complexity and installation demands. The inclusion of spillway anchorage increases the number of wire terminations from 77 in Alternative 2B to 126 in Alternative 2A and requires wire installation across the spillway. Installation in this zone could impact dam operations.

4.3.6 Operation and Reliability Evaluation

Alternative 2A presents additional O&M requirements compared to 2B due to its larger scale and inclusion of spillway anchorage. The increased number of towers, wires, and anchorage points results in more components to be inspected and repaired. Maintenance activities at wires attaching to the spillway may also have operational impacts.

4.3.7 Cost Estimate

This alternative uses a large number of wires similar to Alternative 1A, a much smaller diameter wire, and a total of four towers, resulting in lessor construction costs and a shorter estimated construction period. Estimated cost for this alternative given the preliminary concept design and assumptions is $18.210M. The full cost summary can be found in Figure 5-1, McNary Dam Avian Deterrence Alternative Estimate Summary.

4.4 Alternative 2B

4.4.1 Description

Alternative 2B consists of a large APDA originating from towers at the Oregon shoreline. Wires fan out across the river, anchoring at the navigation lock guide wall and navigation lock wall. The layout is similar to Alternative 2A but does not include wires that attach to the spillway portion of the dam, thereby reducing the coverage of the tailrace area. Alternative 2B was designed using criteria based on a proposed code variance.

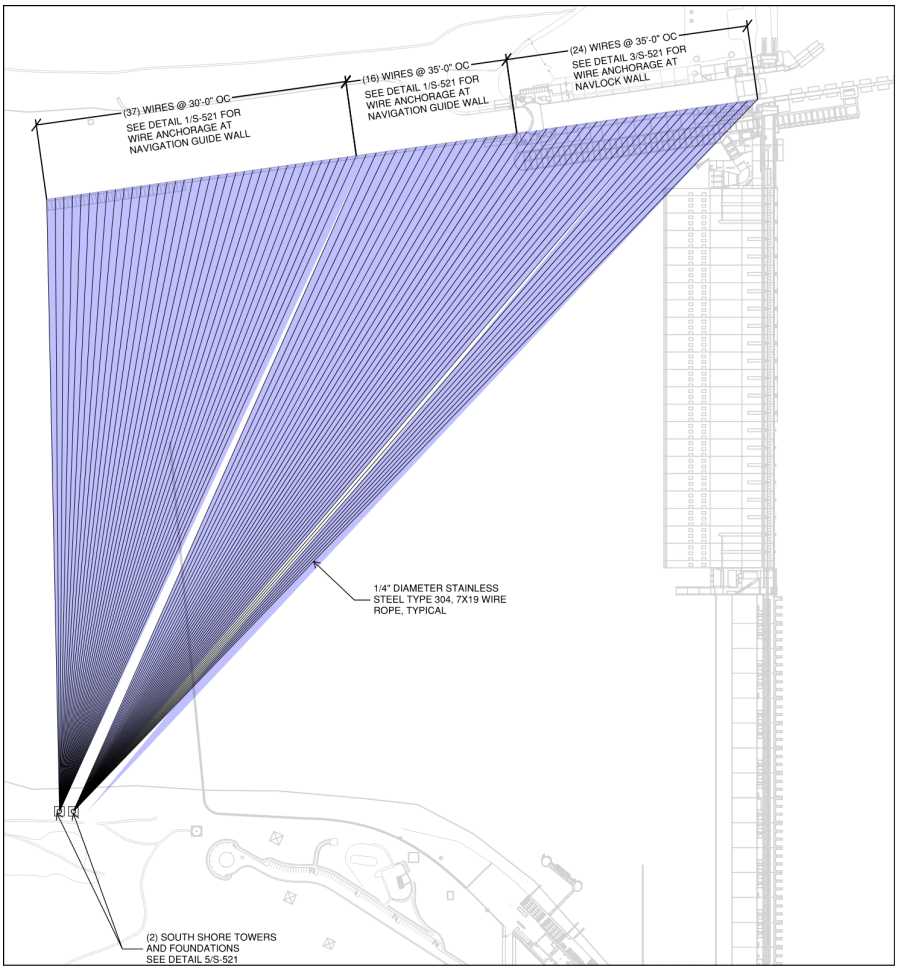


Figure 4-4. Alternative 2B - Wire Array Plan

4.4.2 Biological Effectiveness Evaluation

Alternative 2B is similar to 2A but omits spillway anchorage, focusing on areas with the highest observed concentrations of piscivorous bird activity. Like other alternatives, it remains within the BRZ and does not address downstream predation. Although slightly less effective than 2A due to array coverage near the spillway, Alternative 2B offers targeted coverage of the highest known predation area. It is also more biologically effective than Alternatives 1A and 1B due to the smaller wires. The wire array creates a

physical barrier that limits bird access to the water surface, reducing predation pressure and enhancing juvenile salmonid survival.

4.4.3 Structural Evaluation

The array originates from two tubular steel towers on the Oregon shoreline and spans the river with approximately 77 stainless-steel 7x19 wire ropes (1/4-inch diameter), anchored at the navigation lock guide wall and navigation lock wall. This layout is structurally similar to Alternative 2A but omits wires anchored at the spillway, resulting in a reduced total number of wires and structural components.

The elimination of spillway anchorage simplifies the structural system. With fewer wires, cumulative tension loads on towers are fewer and only two south shore towers are required. The shorter total wire length also reduces the number of line dampeners required and anchorage connections.

The use of only two south shore towers reduces material quantities, fabrication effort, and erection time. Fewer towers also translate to reduced foundation quantities. This simplification is expected to lower construction costs and shorten installation duration compared to alternatives with more extensive tower infrastructure.

Anchorage at the navigation lock guide wall and navigation lock wall is consistent with the approach used in Alternative 2A, utilizing HSS posts and drop-in expansion anchors. However, the reduced number of anchorage points in Alternative 2B decreases the complexity of installation and minimizes potential conflicts with existing infrastructure such as handrails, light poles, equipment, and O&M access routes at the spillway deck.

4.4.4 Electrical Evaluation

Grounding will be similar to the description in Alternative 2A.

Each steel tower installation must include a complete grounding system to ensure electrical safety and compliance with applicable standards. A grounding conductor must be installed on each south shore tower by connecting a grounding wire from the avian protection wires using split-bolt connectors. A #6 AWG XHHW copper conductor must be routed internally through the tower and connected to the external grounding wires via a cord connector.

At the base of the tower, the #6 XHHW conductor must transition into a ¾-inch Schedule 40 PVC conduit and terminate within a concrete valve box located adjacent to the tower base. Additionally, a #4 AWG bare copper grounding conductor must be embedded in the concrete at the base of the tower to provide a low-impedance path to ground. A grounding rod must be installed inside the concrete valve box, and all grounding conductors must be securely terminated at this point.

For detailed layout and installation specifications, refer to Drawing E-501 in Appendix A. Grounding is not required on the anchorage side of the wires.

4.4.5 Constructability Evaluation

From a constructability standpoint, Alternative 2B presents a simplified installation approach with reduced complexity. By eliminating spillway anchorage, this alternative reduces the number of wire terminations from 126 in Alternative 2A to 77 in Alternative 2B. All structural work is confined to the navigation lock guide wall and navigation lock wall, which are more accessible and present fewer operational constraints.

This streamlined layout minimizes construction risks, shortens installation duration, and reduces the likelihood of interference with dam operations.

4.4.6 Operation and Reliability Evaluation

Alternative 2B offers a more streamlined and accessible system for operations and maintenance. By eliminating spillway anchorage, the array reduces the total number of structural components requiring inspection and repairs and less impact on dam operations.

During winter, mist generated at the base of the spillways can cause localized ice accumulation on the wires. Because this alternative is located farther downstream, it is less exposed to spillway mist and therefore less prone to ice buildup, reducing the likelihood of wire breakage.

4.4.7 Cost Estimate

This alternative uses the least number of wires and a total of two towers, resulting in the least construction cost and least estimated construction period. Estimated cost for this alternative given the preliminary concept design and assumptions is $15.975M. The full cost summary can be found in Figure 5-1, McNary Dam Avian Deterrence Alternative Estimate Summary.

4.5 Alternative 3

4.5.1 Description

The bird species discussed in this report prey on salmonids both at the water's surface and underwater. Gulls are effectively deterred by wire arrays, as they typically hunt while in flight and then dive toward their prey that are on the water surface. The wire arrays proposed as Alternatives 1A, 1B, 2A, and 2B are specifically designed to deter such aerial foragers. In contrast, cormorants and pelicans approach feeding areas by swimming and tend to avoid wire arrays by landing on open water and then swimming to forage. The concept behind Alternative 3 is intended to deter species that are less affected by aerial deterrents and instead forage at or just below the water surface.

The proposed system consists of a series of stainless-steel cables suspended at the water surface by regularly spaced buoy floats. These cables are arranged in a linear array trailing downstream from the JBS outfall pier, covering the area where juvenile salmonids are most vulnerable after exiting the bypass system. The floats maintain the cables at the surface, where they can most effectively disrupt avian predation behavior.

The cables are free-floating and designed to move laterally with river current and wave action, creating an undulating surface disturbance that deters birds from landing or diving. The system is seasonally deployed during the spring and summer months, aligning with the salmonid migration period.

At the time of writing this report, there are no commercial off-the-shelf solutions for this alternative. If this alternative is selected for further design development, it is recommended to conduct computational fluid dynamics modeling and small in-water trials to observe avian deterrent behavior as a Proof-of-Concept before designing and constructing a full-scale array.

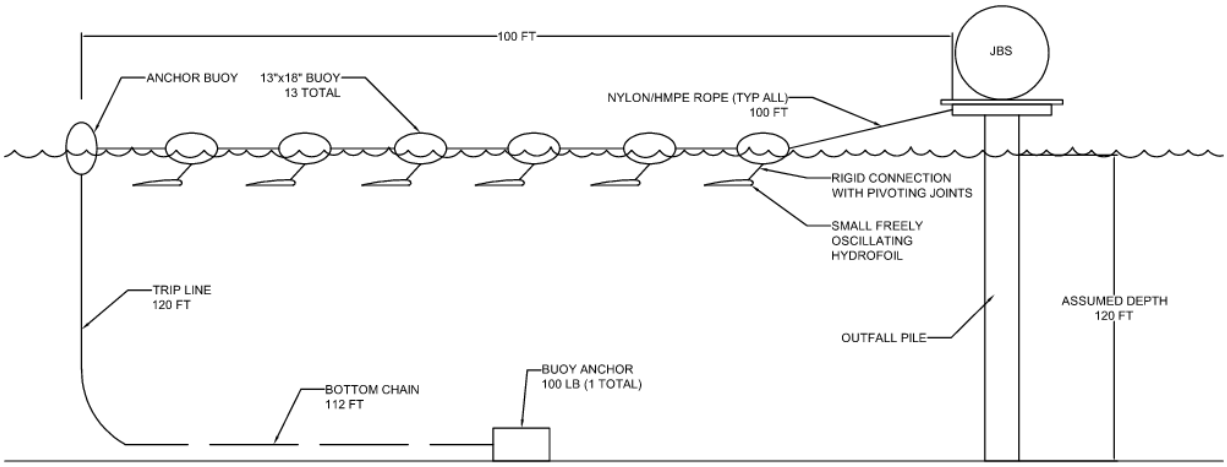


Figure 4-5. Cable Buoy Array Section View

4.5.2 Biological Effectiveness

The proposed system of using cables or chains with floats arranged in parallel with the riverbank presents a potentially promising approach to deterring avian predators at dams. This method targets the areas where ESA-listed smolts are most vulnerable by creating a physical barrier that prevents birds from accessing concentrated prey.

To reduce predation, the cables will be tethered to vertical bars and extend over the BRZ and will rise and fall with the water to create a dynamic barrier. This undulating motion, enhanced by rudders or other mechanical devices, is designed to effectively deter birds from approaching the area. By preventing birds from accessing smolts, the system reduces predation pressure, thereby protecting fish populations.

While beneficial for birds like pelicans and cormorants, the presence of abundant prey can lead to population growth and higher nesting densities near the outfall. By dispersing predation pressure downstream to areas with a greater diversity of fish species, the system encourages birds to move away from concentrated smolt populations. This helps manage avian populations and prevents the formation of large predator colonies.

The design works to minimize debris and other objects from getting caught in the cables, maintaining the system's effectiveness and minimizing environmental effects. The use of durable, weather-resistant materials for the floating balls ensures long-term functionality and reduces maintenance needs.

Although deterrents do not completely eliminate predation, the proposed system is expected to reduce it to a manageable level. By protecting vulnerable smolts and encouraging predators to disperse, the system supports ecosystem management and contributes to the conservation of these endangered fish species.

In summary, the proposed floating bird deterrent system offers a potentially biologically effective solution to reducing avian predation at the dam. By minimizing bird predation, this system should benefit fish populations. Furthermore, the reduction in avian predation pressure can lead to a more balanced and healthier ecosystem overall. While the concept appears promising, it will be important to conduct thorough field studies to validate its effectiveness and ensure that it does not inadvertently disrupt other

aspects of the ecosystem. If successful, this innovative approach could serve as a model for similar conservation efforts in other regions facing avian predation challenges.

4.5.3 Structural Evaluation

The in-water cable and buoy array will be structurally attached to the existing concrete pylons of the JBS outfall pier. The system is designed for seasonal deployment and removal, and its structural configuration is intended to balance ease of installation, biological effectiveness, and adaptability to site conditions. Three mounting strategies are currently under consideration, each offering distinct advantages depending on the desired layout and operational flexibility.

The first option involves attaching individual cables directly to the first five pier pylons extending toward the center of the river. These pylons are spaced 50 feet apart, resulting in a corresponding 50-foot interval between each deterrent cable. This approach takes advantage of existing structural elements, minimizing the need for additional infrastructure. It also simplifies installation and removal. However, the fixed spacing may not align with the most effective deterrent pattern, and it offers limited flexibility for future adjustments or refinements.

The second option proposes the installation of a localized steel mounting beam along the final 100 feet of the outfall pier. This beam would span between the last pylons and serve as a continuous mounting surface for the array cables. By allowing attachment points at custom intervals, this configuration enables more precise control over cable spacing based on biological and hydraulic design criteria. It also improves alignment and consistency in the most critical zone near the JBS outfall. While this option introduces additional fabrication and structural integration requirements, it offers greater adaptability and performance potential. It may also introduce localized loading that would need to be evaluated during detailed design.

The third option involves extending the reach of the deterrent system further into the river by installing a cantilevered beam at the end of the JBS outfall pier. This beam would project approximately 20 feet beyond the pier's edge, allowing cables to be anchored closer to the center of the river where smolts emerge after plunging into the water from the JBS. Two variants of this design are considered: a fixed extension that remains in place year-round, and a retractable version that can fold, slide, or telescope back into the pier structure for off-season storage. This retractable design supports seasonal operation while reducing exposure to debris and environmental wear. However, it would require a custom mechanical design and structural analysis to ensure stability under cantilevered loading and may involve more complex installation and maintenance procedures.

Each of these structural options offers a viable path forward, and the final selection will depend on a combination of biological performance goals, constructability, and long-term operational considerations.

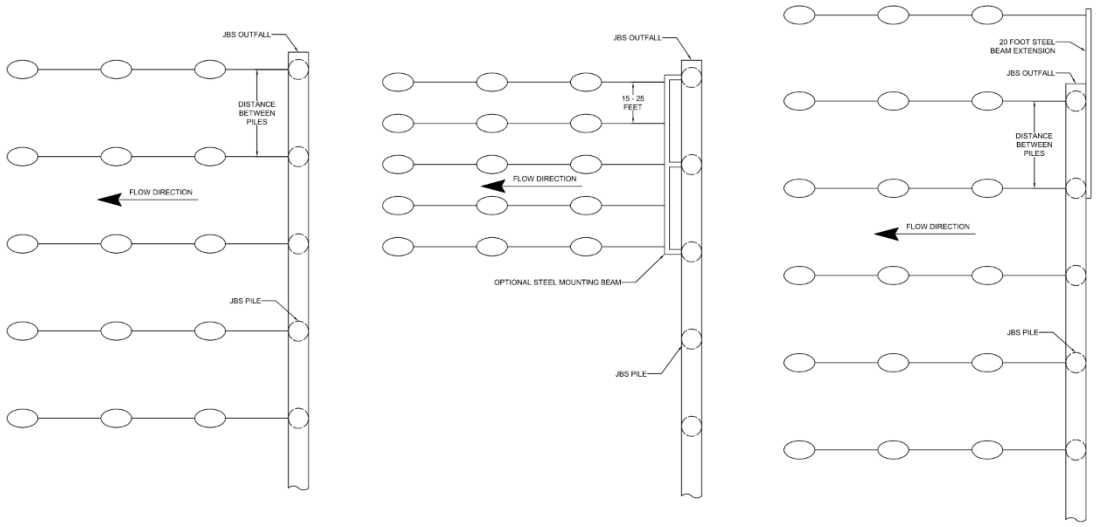


Figure 4-5.1. Three Configuration Options Plan View

4.5.4 Mechanical Evaluation

The in-water cable and buoy array is a passive deterrent system designed to operate at the water's surface, where it disrupts avian predation through dynamic, unpredictable motion. This system is deployed seasonally, typically during the spring and summer months, to coincide with the downstream migration of juvenile fish.

The system consists of a series of marine-grade stainless-steel cables, each trailing freely behind the JBS outfall pier. These cables are not tensioned; instead, they float naturally with the river current. Their movement is supported by a series of buoyant floats, spaced evenly along each cable at intervals of approximately 6 to10 feet. The buoys, made from UV-resistant polyethylene or closed-cell foam, ensure that the cables remain near the water surface, where they are most effective at deterring birds.

Each cable is anchored to the JBS pier using fixed mounting points or optional extension beams. These anchor points are equipped with quick-connect hardware, such as clevis pins or carabiner-style latches, to allow for fast, tool-free installation and removal. This modular design supports the system's seasonal operation, enabling it to be deployed quickly at the start of the migration season and retrieved just as easily at the end. Once removed, the components can be bundled and stored compactly for reuse in subsequent years.

The deterrent effect of the system is driven by its motion. As river currents, wind, and wave action interact with the floating cables, they induce a natural side-to-side undulation. Mounted beneath each buoy is a small underwater hydrofoil, designed to freely oscillate in response to the flow of water. As the current passes over the hydrofoil, it generates lift forces that cause the buoy to shift laterally. This motion is transferred to the cable, amplifying the undulating pattern. The result is a constantly shifting surface and subsurface disturbance that birds find visually and physically disruptive, discouraging them from landing or diving in the area.

Because the cables are not tensioned and free-floating, the system avoids the need for mechanical tensioners or rigid supports. The buoy distribution is carefully designed to maintain surface contact while allowing the cables to flex and follow wave motion. Additionally, the system is engineered to minimize drag and flow resistance, ensuring that it remains stable and effective even under varying river conditions.

From a maintenance perspective, the system is designed for simplicity and durability. In-season maintenance is minimal, with only occasional inspections recommended to check for wear, biofouling, or damage. The materials used are selected for long-term exposure to freshwater environments, ensuring resistance to corrosion and UV degradation.

Importantly, the system poses no entrapment risk to juvenile fish due to its open, flexible design. It is also positioned to avoid interference with river navigation and is capable of flexing or submerging temporarily in response to floating debris, reducing the risk of damage or obstruction.

4.5.5 Electrical Evaluation

Grounding is not anticipated to be required for this alternative.

4.5.6 Constructability Evaluation

The in-water cable and buoy array is considered for seasonal deployment and removal, with a modular configuration that supports installation using standard equipment and access methods. The system is intended to integrate with existing infrastructure and accommodate site-specific conditions.

Installation is scheduled to occur at the beginning of the juvenile fish migration season. Cables and buoys can be preassembled in segments and transported to the site by boat or from the pier. Once on-site, the cables are connected to pre-installed anchor points on the JBS outfall pier or to one of the proposed mounting structures, such as the localized steel beam or extendable pier-end beam. Quick-connect hardware (e.g., clevis pins or carabiner-style latches) is used to reduce installation time and limit the need for specialized tools.

The buoy and cable segments are modular and lightweight, allowing for deployment in sections. The free-floating design eliminates the need for tensioning or precise alignment. This configuration allows for adjustments to be made during installation based on river conditions or biological monitoring data.

At the end of the migration season, the system is retrieved and stored. Components are disconnected, coiled, and stored for reuse. Permanent anchor points and mounting hardware remain in place to support future seasonal deployments.

The system is configured to accommodate variable water levels, debris flow, and limited access. Its passive design allows it to respond to changing river conditions without requiring active adjustment. The installation process does not require significant modification to the existing pier structure when using the pylon-mounted or beam-based attachment options.

4.5.7 Operation and Reliability Evaluation

The in-water cable and buoy array is considered for seasonal operation, aligning with the smolt migration period, typically during spring and summer. Its passive design and modular construction contribute to a low-maintenance, repeatable deployment cycle that supports long-term reliability.

The system operates without active mechanical or electrical components. Once deployed, the cables and buoys function autonomously, relying on river current, wind, and wave action to generate lateral undulation. This motion serves as the primary deterrent mechanism against avian predators.

Deployment and retrieval are conducted seasonally. Installation occurs at the start of the migration season, and the system is removed and stored at the end of the season. The use of quick-connect hardware and modular components allows for efficient handling by small crews using standard

equipment. The system is designed to be installed from the pier or by boat, depending on-site access and flow conditions.

The system's reliability is supported by its simplicity and the use of durable materials. Marine-grade stainless-steel cables and UV-resistant buoys are selected for their resistance to corrosion, ultraviolet degradation, and biofouling. These materials are expected to perform consistently over multiple seasons with minimal degradation.

The passive nature of the system eliminates the risk of mechanical failure associated with moving parts or powered components. The free-floating design allows the system to adapt to varying river conditions, including changes in flow rate, water level, and surface turbulence.

Periodic inspections are recommended during the deployment period to check for wear, damage, or entanglement with debris. However, the system is not expected to require frequent maintenance. At the end of each season, components should be inspected, cleaned, and stored in a dry, protected environment to extend service life.

The system is considered to avoid interference with fish passage, navigation, and debris flow. Its flexible, open structure poses no entrapment risk to juvenile fish. In the event of high debris loads or extreme flow conditions, the cables and buoys are capable of flexing or submerging temporarily, reducing the likelihood of structural damage or obstruction.

Overall, the system is expected to provide consistent seasonal performance with low operational complexity and high reliability, assuming proper handling, inspection, and storage protocols are followed. Modeling and in-water small scale trials would be beneficial to further develop specifications and measure/ensure biological effectiveness (deterrence of cormorants and pelicans).

4.5.8 Cost Estimate

The estimated cost for the in-water cable and buoy array system (Alternative 3) is based on a per-line analysis and scaled to reflect a six-line deployment, which is the proposed configuration for this alternative. Based on the preliminary concept design and assumptions, the total estimated cost for the full six-line system is $1,076,989. This figure includes all direct and indirect costs associated with fabrication, deployment, and contingency planning. To reflect early-stage design uncertainty, a Class 3 order-of-magnitude feasibility range is applied. The resulting estimate spans from $679,274 (–30%) to $1,164,470 (+20%), accounting for variability in material pricing, labor, and site-specific installation conditions. The full cost summary can be found in Figure 5-1, McNary Dam Avian Deterrence Alternative Estimate Summary.

5. Summary of Recommendations

5.1 Alternative Analysis

5.1.1 General

Alternatives 1 and 2 – considering both A and B options - offer the same avian deterrent coverage configurations. As described in the report, the clear distinction between the two alternatives is Alternative 1 satisfies referenced codes, whereas Alternative 2 concept characteristics more closely align with other APDAs located downstream from McNary Dam at John Day and The Dalles Dams, as well as conform to preferences obtained at the site visit and CDW.

Alternative 1 concept increases wire size by five times compared to Alternative 2 to achieve compliance with codes, but the increased weight and size depreciate the intrinsic values of the APDA to a point that it becomes ineffective. The biological effectiveness, operation and maintenance and constructability all become more adversely complex when considering Alternative 1.

Alternative 2 concept is anticipated to be more effective in each of the factors considered but does not follow codes as required by this Task Order.

When analyzing variants A and B and taking into consideration the input received at the site visit and CDW, the variant providing the greatest benefit and least disadvantages is B, the wire array configuration that does not span across the top of the spillway. Variant B covers the highest expected area of predation at a smaller construction cost.

5.1.2 Biological Effectiveness Analysis

Alternative 2B is recommended as the most biologically effective option, balancing deterrence performance, spatial coverage, and adaptability. Alternative 2A is the next-best option, offering broader coverage but with slightly reduced layout optimization. Alternatives 1A and 1B are structurally compliant but biologically less effective. Alternative 3 may serve as a supplemental deterrent for diving birds but requires further validation.

Table 5-1. Comparative Summary of Biological Effectiveness

Alternative	Compliance	Coverage Area	Wire Design	Deterrence Potential	Biological Effectiveness
1A	Code-based	Extended coverage	Large wire, wide gaps near spillway	Moderate disruption with wider coverage, perching & avoidance risk	√√
1B	Code-based	Enhanced	Large wire, refined layout	Moderate disruption, perching risk	√√√
2A	Code variance	Extended coverage	Smaller wire, reduced gaps near spillway	Strong disruption with wider coverage, minimal perching/maneuverability	√√√√

Alternative	Compliance	Coverage Area	Wire Design	Deterrence Potential	Biological Effectiveness
2B	Code variance	Enhanced	Smaller wire, refined layout	Strong disruption, minimal perching/maneuverability	√√√√
3	Non-wire	Variable	Non-wire deterrents	Varies by method, less flexible	√√ to √√√

5.2 Cost Evaluation

The following figure summarizes the estimated cost of the different alternatives with associated ranges given in a Class 3 estimate.

Figure 5-1 McNary Dam Avian Deterrence Alternative Estimate Summary

McNary Dam Avian Deterrence Alternatives Estimate Summary

			Alternative 1A (1-1/4" SS) 7 Towers w/ Dam Wall Plate		Alternative 1B (1-1/4" SS) 5 Towers w/out Dam Wall Plate		Alternative 2A (1/4" SS) 4 Towers w/ Dam Wall Plate		Alternative 2B (1/4" SS) 2 Towers w/out Dam Wall Plate		Alternative 3 In-Water Array	
Level	Description	UOM	Quantity	Contract	Quantity	Contract	Quantity	Contract	Quantity	Contract	Quantity	Contract
Level 0	04 McNary Dam Avian Deterrence Alternatives											
Level 1	0401 Alternative Stainless Steel Wire Array Area	SF	4,649,605	$ 44,243,318	2,838,565	$ 33,999,507	4,886,108	$ 15,684,206	3,143,837	$ 13,759,514	6	$ 933,697
Level 2	040199 Associated General Items	LS	1	$ 44,243,318	1	$ 33,999,507	1	$ 15,684,206	1	$ 13,759,514	1	$ 933,697
Level 3	04019901 Barge Costs	MO	10	$ 5,040,637	8	$ 4,165,576	6	$ 1,708,385	4	$ 1,179,019	1.5	$ 675,440
Level 3	04019902 Foundations for Towers	EA	7	$ 2,915,359	5	$ 2,161,156	4	$ 887,213	2	$ 487,871		
Level 3	04019903 Structural Steel	LS	1	$ 24,649,513	1	$ 18,947,972	1	$ 11,490,635	1	$ 11,147,126		
Level 3	04019904 Stainless Steel Wire	LF	271,155	$ 11,621,530	198,693	$ 8,712,734	328,269	$ 1,587,668	199,320	$ 940,165		
Level 3	04019916 Grounding	EA	7	$ 16,280	5	$ 12,069	4	$ 10,305	2	$ 5,334		
Level 3	04019902 In-Water Array Anchors	EA									6	$ 258,257
	Total Contract			$ 44,243,318		$ 33,999,507		$ 15,684,206		$ 13,759,514		$ 933,697
	Escalation			$ 2,336,047		$ 1,795,174		$ 723,042		$ 634,314		$ 36,694
	Total Contract Escalated			$46,579,365		$35,794,681		$16,407,248		$14,393,828		$970,392
	Contingency			$2,328,968		$1,789,734		$820,362		$719,691		$48,520
	SIOH			$2,787,775		$2,142,312		$981,974		$861,471		$58,078
	Total Project Cost			$51,696,108		$39,726,727		$18,209,584		$15,974,990		$1,076,989
	CLASS 3 Expected Accuracy	-30%		$32,605,555		$25,056,277		$11,485,074		$10,075,680		$679,274
		20%		$55,895,238		$42,953,617		$19,688,698		$17,272,593		$1,164,470

Figure 5-2 McNary Dam Avian Deterrence Alternative Cost Benefit Analysis

McNary Dam Avian Deterrence Alternative Cost Benefit Analysis

	Alternative 1A (1-1/4" SS) 7 Towers w/ Spillway Anchorage	Alternative 1B (1-1/4" SS) 5 Towers w/out Spillway Anchorage	Alternative 2A (1/4" SS) 4 Towers w/ Spillway Anchorage	Alternative 2B (1/4" SS) 2 Towers w/out Spillway Anchorage	Alternative 3 In-Water Array
Reliability	√√√√	√√√√√	√√	√√√	√√
Biological Effectiveness	√√√	√√√	√√√√	√√√√	√√ to √√√
Constructability	√	√√	√√√	√√√√	√√√√
Ease of Routine Maintenance	√√	√√√	√√√√	√√√√√	√√√√
Total Project Cost	$51,696,108	$39,726,727	$18,209,584	$15,974,990	$1,076,989
Total SF	4,649,605	2,838,565	4,868,108	3,143,837	n/a
Cost/SF	$11.12	$14.00	$3.74	$5.08	n/a

The Cost Benefit Analysis figure illustrates Alternative 2B offers the highest score in ease of maintenance, constructability, biological effectiveness, and a moderate score for reliability. These scores, coupled with the reasonable cost/SF makes Alternative 2B the best value among the wire array alternatives.

5.3 Recommended Alternative

If strict compliance with code is a major factor in making a recommendation, Alternative 1B offers the best value considering all criteria used to evaluate the alternatives.

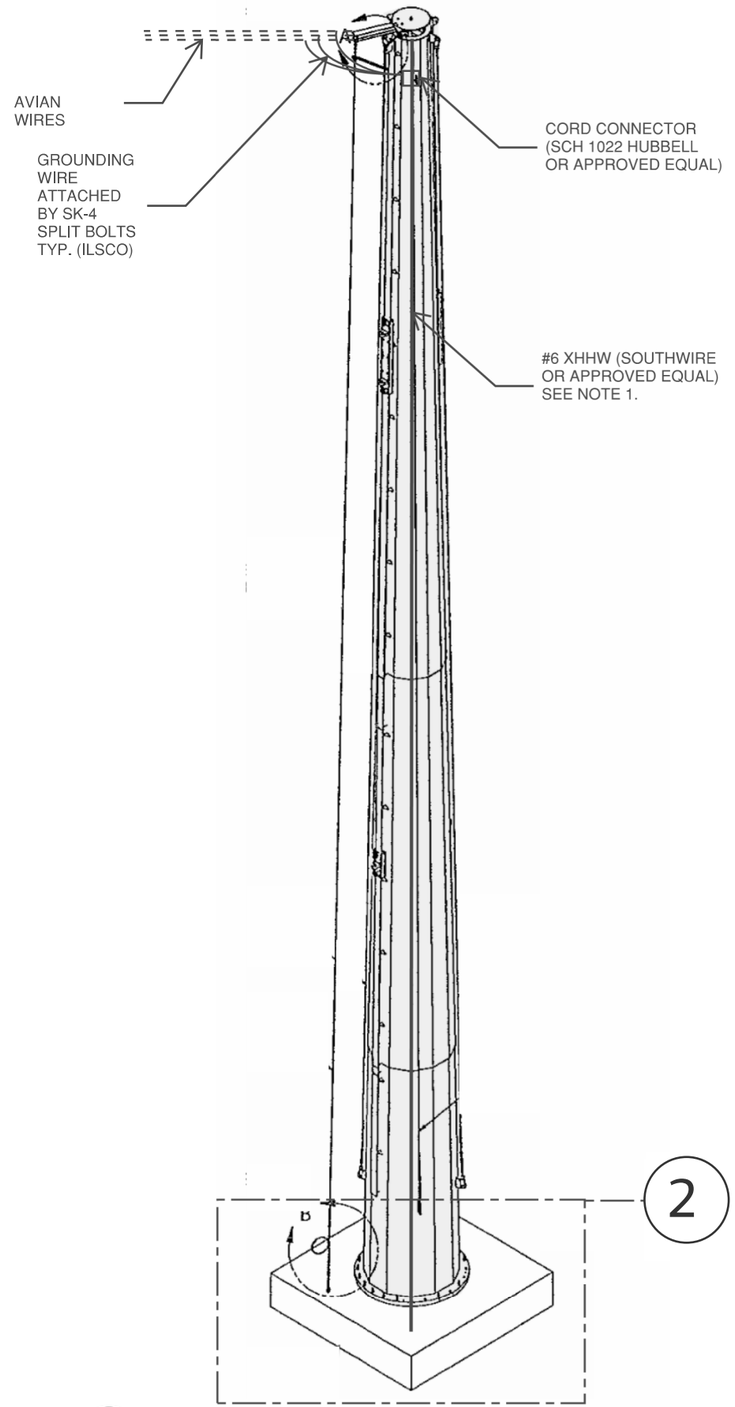
If a variance from code is considered for further development, Alternative 2B is thought to be the best value overall, especially when cost is a driver.

5.4 Next-Best Alternative

If strict compliance with code is a major factor in making a next-best recommendation, Alternative 1A provides the best coverage across the predation zone but comes with trade-offs that include increased cost, anchorage points that extend across the spillway deck, and potential impact to dam operations with construction and occasional maintenance on the dam deck.

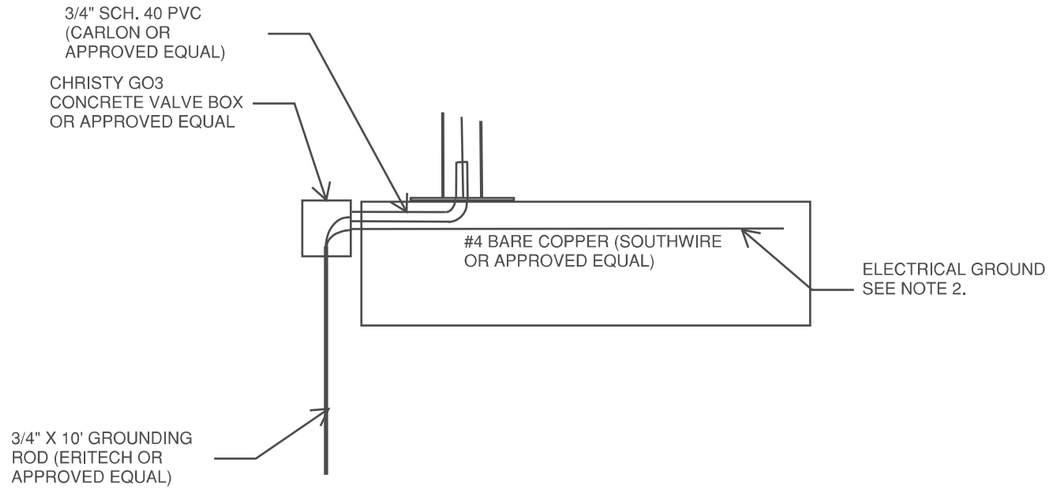
The next-best recommendation for an alternative, if code compliance is not factor, is Alternative 2A. Alternative 2A provides full coverage across the predation area, has a smaller diameter wire, and significantly lower cost. Similar to the code compliant variant Alternative 1A, disadvantages include increased cost, anchorage points that extend across the spillway deck, and potential impact to dam operations with construction and occasional maintenance on the dam deck.

Appendix A. Drawings



1 STEEL TOWER GROUNDING DETAIL - ELEVATION

NTS



2 BASE OF STEEL TOWER - SECTION VIEW

NTS

GENERAL NOTES:

1. PROVIDE GROUNDING SYSTEM AS SHOWN ON ALL TOWERS, TYPICAL.

SHEET NOTES:

1. AVIAN WIRE ELECTRICAL GROUNDING WIRE ON THE STEEL TOWER.
2. GROUNDING WIRE EMBEDDED IN CONCRETE AND CONNECTED TO REBAR MAT WITH GROUND ROD CLIP.

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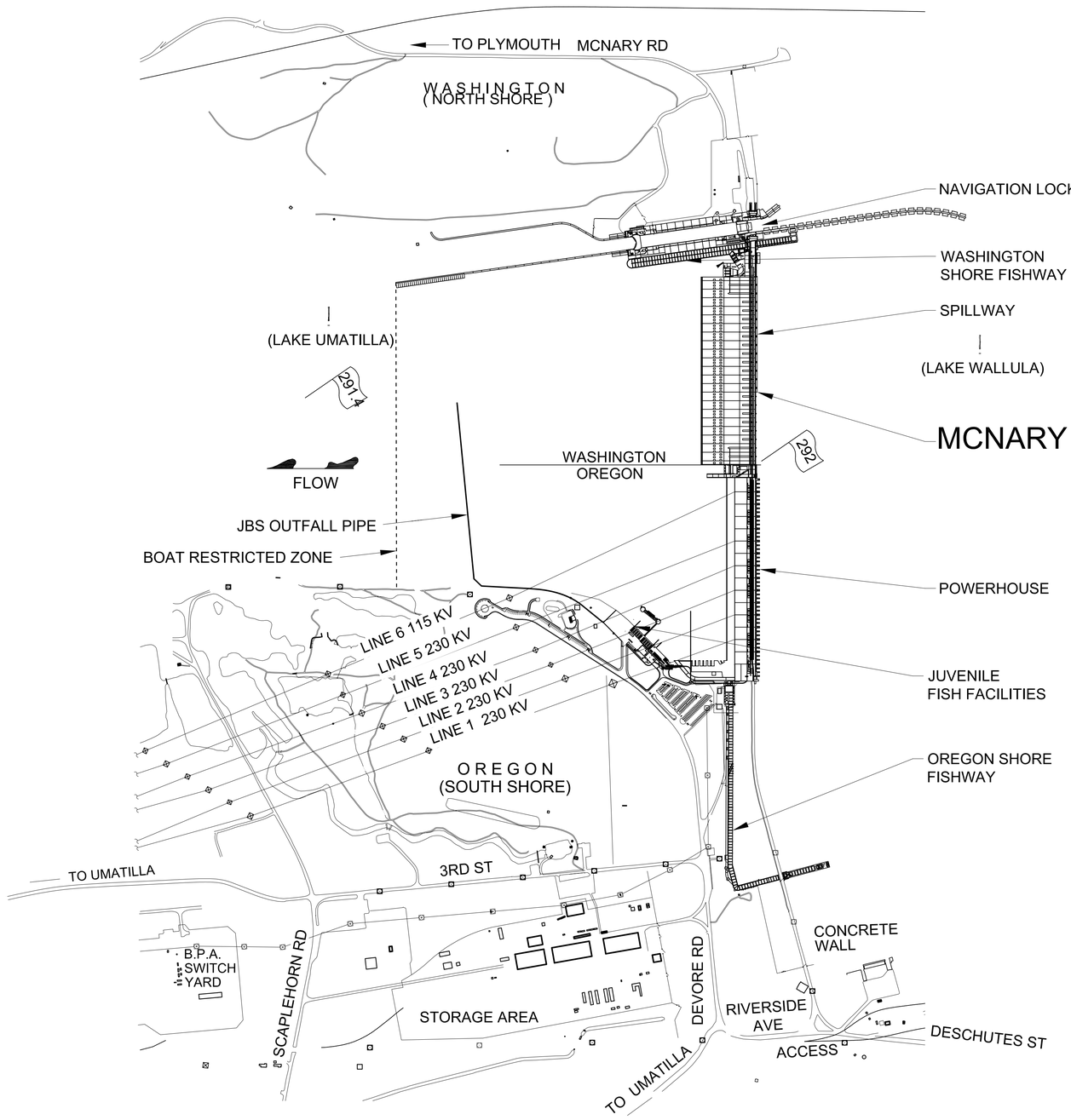
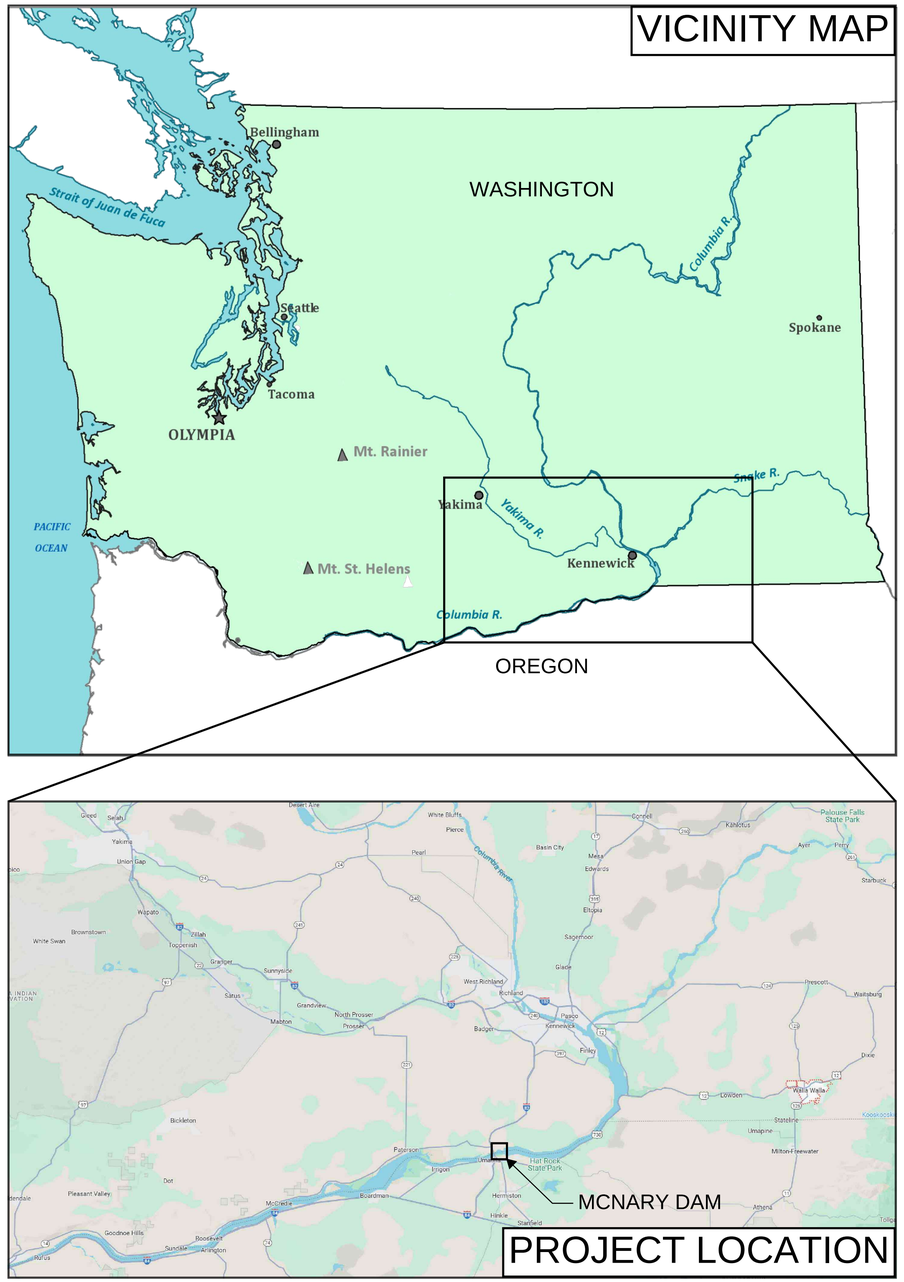
WALLA WALLA DISTRICT
MCNARY AVIAN PREDATION DETERRENT ARRAY CONCEPT EVALUATION

SHEET NUMBER:	E-501
SHEET NAME:	ELECTRICAL DETAILS



PROJECT SITE MAP

NOT TO SCALE



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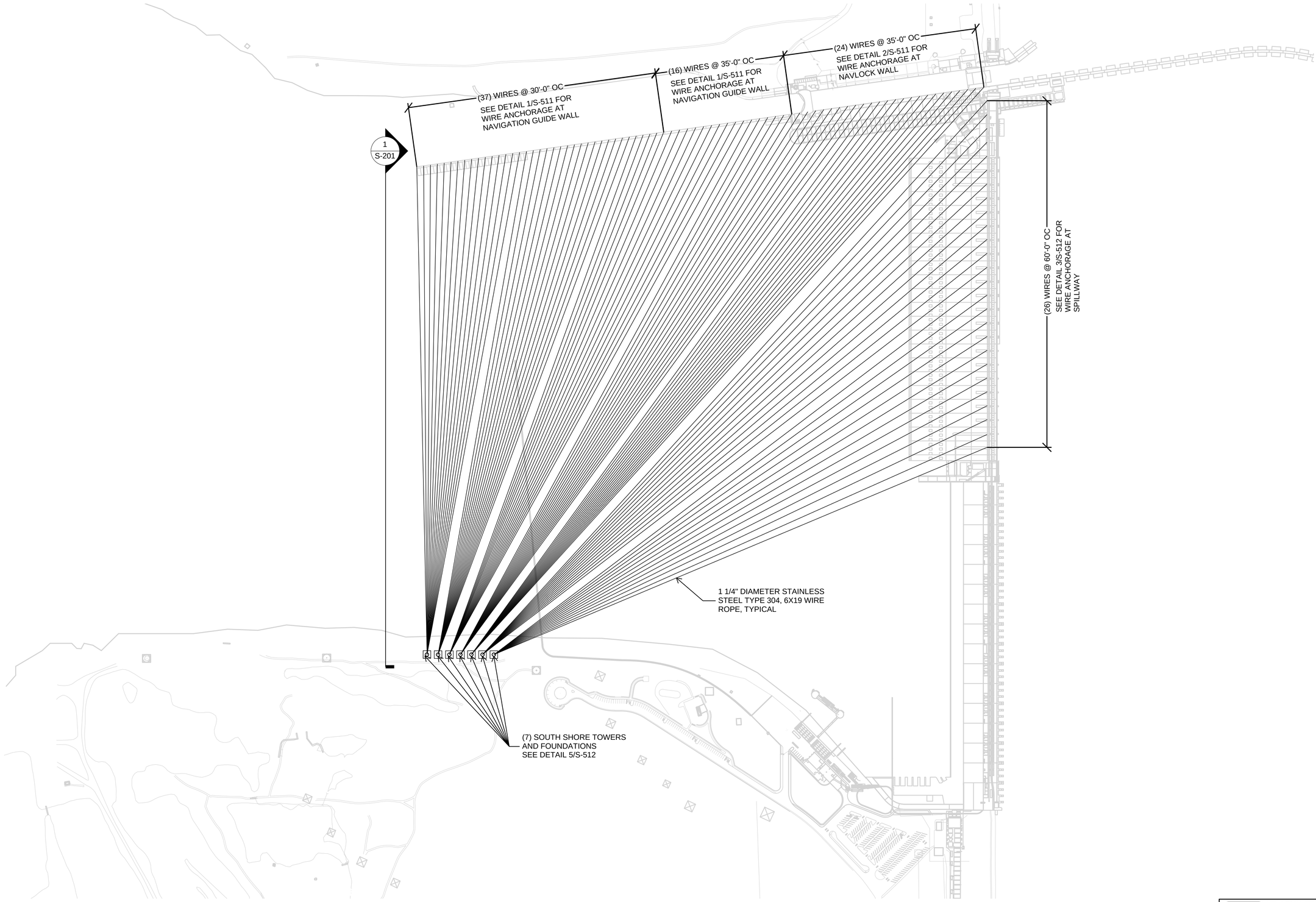
WALLA WALLA DISTRICT
MCNARY AVIAN PREDATION DETERRENT
ARRAY CONCEPT EVALUATION

SHEET NUMBER:	G-101
SHEET NAME:	PROJECT VICINITY, LOCATION, AND SITE MAPS



ALTERNATIVE 1A - OVERALL WIRE PLAN

SCALE: 1' = 200'

JACOBS

US ARMY CORPS OF ENGINEERS WALLA WALLA DISTRICT MCNARY AVIAN PREDATION DETERRENT ARRAY CONCEPT EVALUATION	
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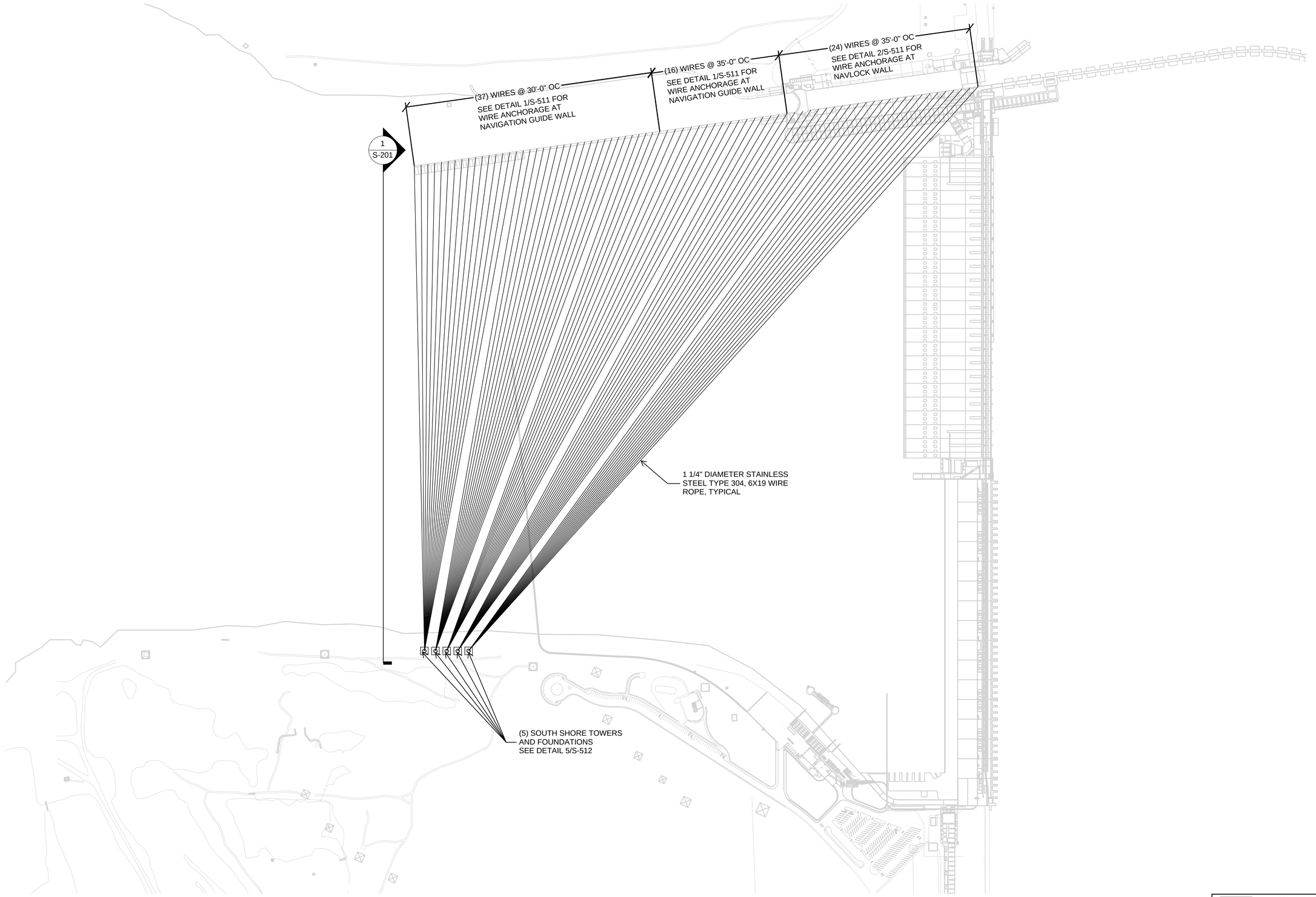
SHEET NAME:	OVERALL WIRE PLAN ALTERNATIVE 1A



ALTERNATIVE 1B - OVERALL WIRE PLAN

SCALE: 1' = 200'

JACOBS

US ARMY CORPS OF ENGINEERS WALLA WALLA DISTRICT MCNARY AVIAN PREDATION DETERRENT ARRAY CONCEPT EVALUATION	
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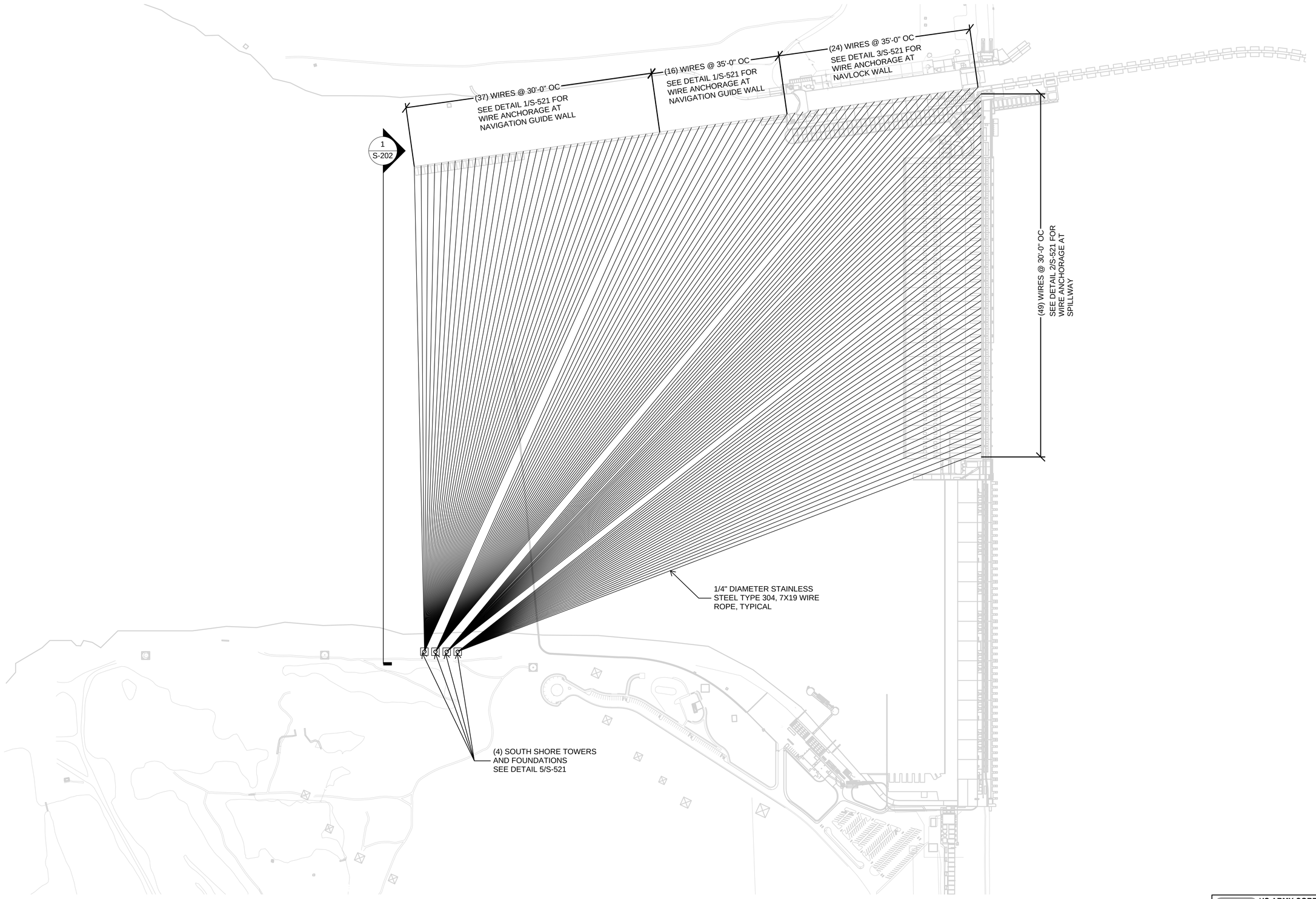

ALTERNATIVE 2A - OVERALL WIRE PLAN

SCALE: 1' = 200'

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US ARMY CORPS OF ENGINEERS
WALLA WALLA DISTRICT
MCNARY AVIAN PREDATION DETERRENT
ARRAY CONCEPT EVALUATION

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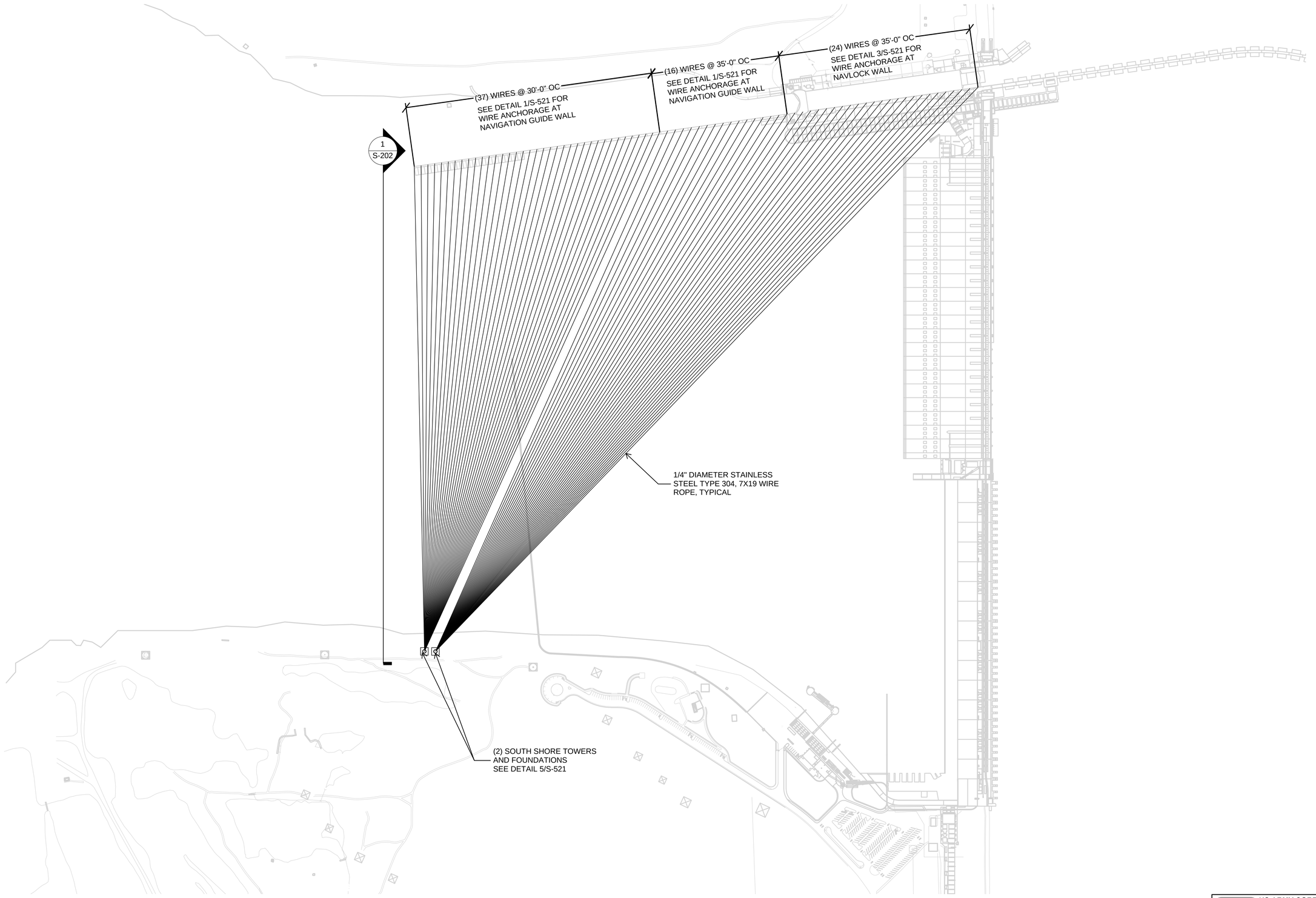
SHEET NAME:	OVERALL WIRE PLAN ALTERNATIVE 2A



ALTERNATIVE 2B - OVERALL WIRE PLAN

SCALE: 1' = 200'

JACOBS

US ARMY CORPS OF ENGINEERS WALLA WALLA DISTRICT MCNARY AVIAN PREDATION DETERRENT ARRAY CONCEPT EVALUATION	
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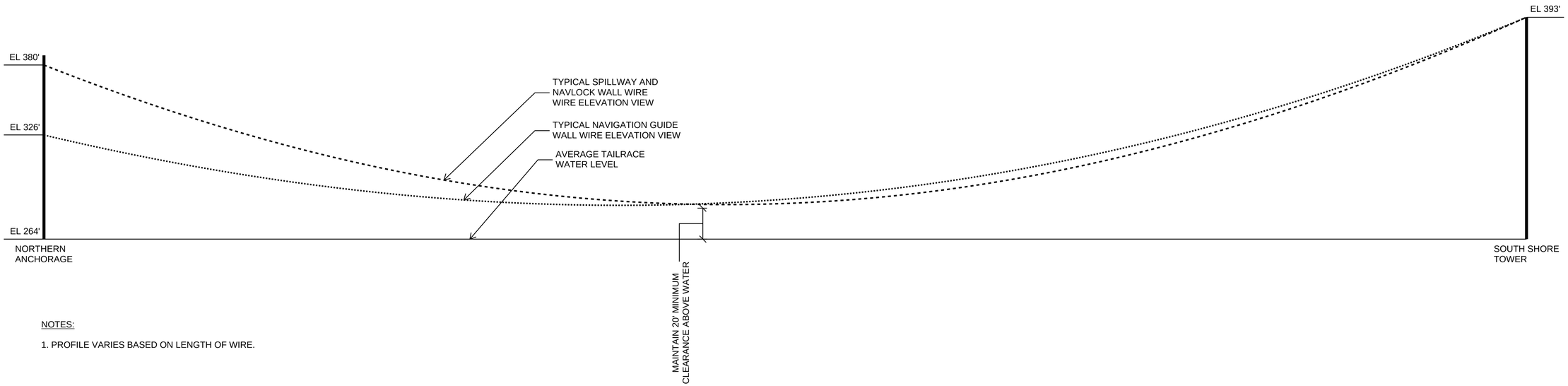
SHEET NAME:	OVERALL WIRE PLAN ALTERNATIVE 2B



NOTES:

1. PROFILE VARIES BASED ON LENGTH OF WIRE.

1 AVIAN WIRE ELEVATIONS - ALTERNATIVES 1A & 1B

NTS

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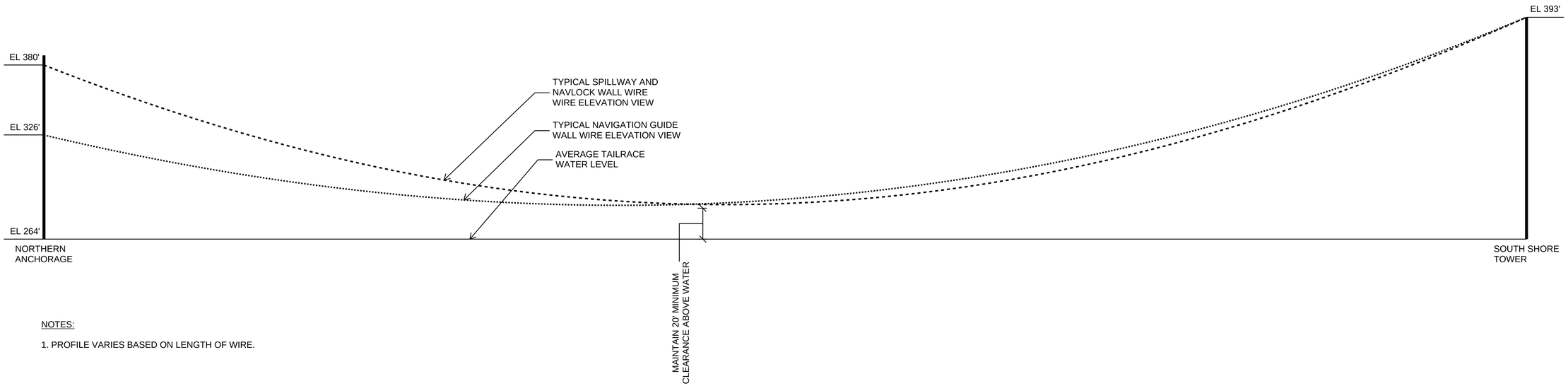
WALLA WALLA DISTRICT
MCNARY AVIAN PREDATION DETERRENT
ARRAY CONCEPT EVALUATION

SHEET NUMBER:	S-201
SHEET NAME:	WIRE ELEVATIONS ALTERNATIVES 1A & 1B



NOTES:

1. PROFILE VARIES BASED ON LENGTH OF WIRE.

1 AVIAN WIRE ELEVATIONS - ALTERNATIVES 1A & 1B

NTS

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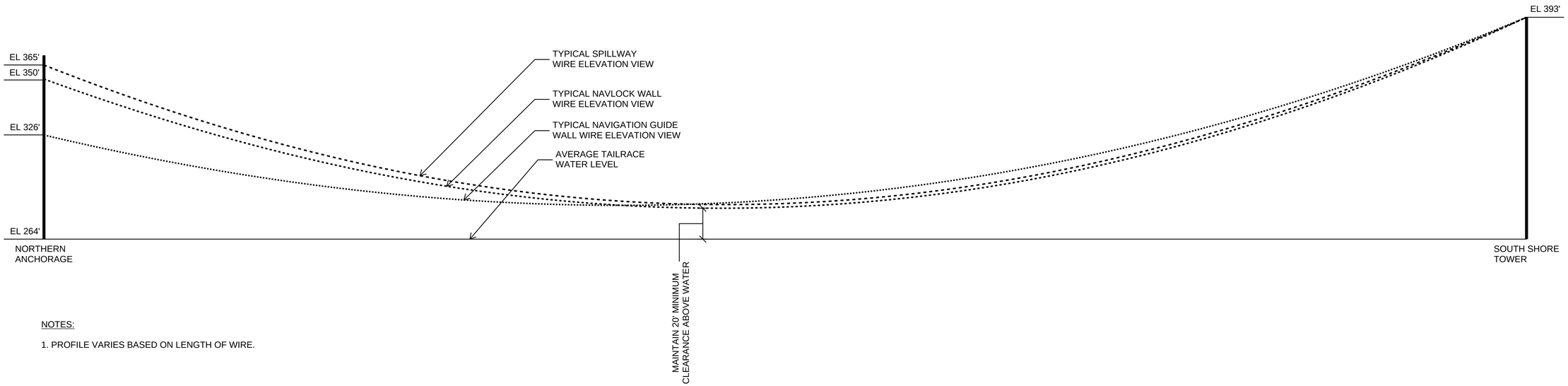
WALLA WALLA DISTRICT
MCNARY AVIAN PREDATION DETERRENT
ARRAY CONCEPT EVALUATION

SHEET NUMBER:	S-201
SHEET NAME:	WIRE ELEVATIONS ALTERNATIVES 1A & 1B



NOTES:

1. PROFILE VARIES BASED ON LENGTH OF WIRE.

1 AVIAN WIRE ELEVATIONS - ALTERNATIVES 2A & 2B

NTS

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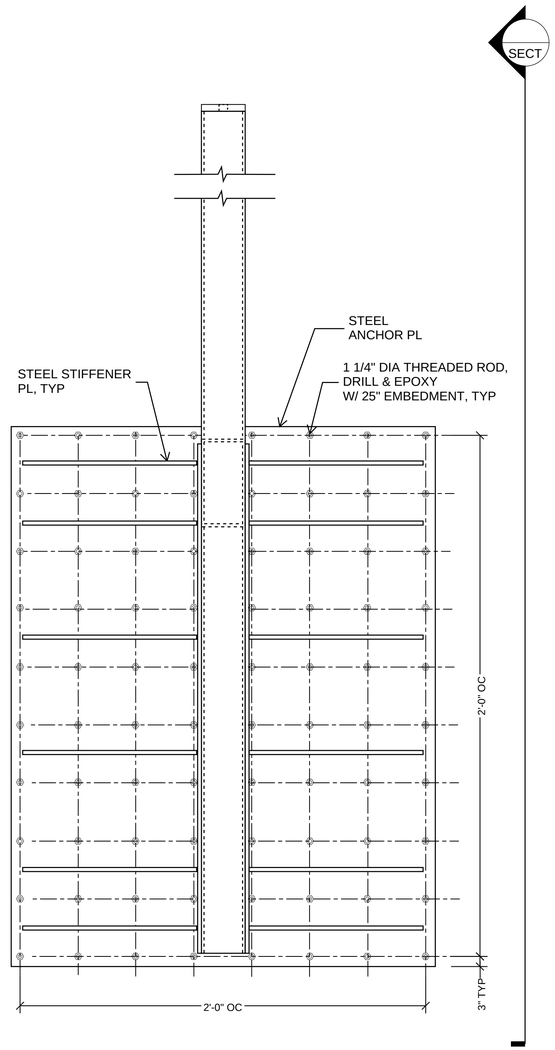
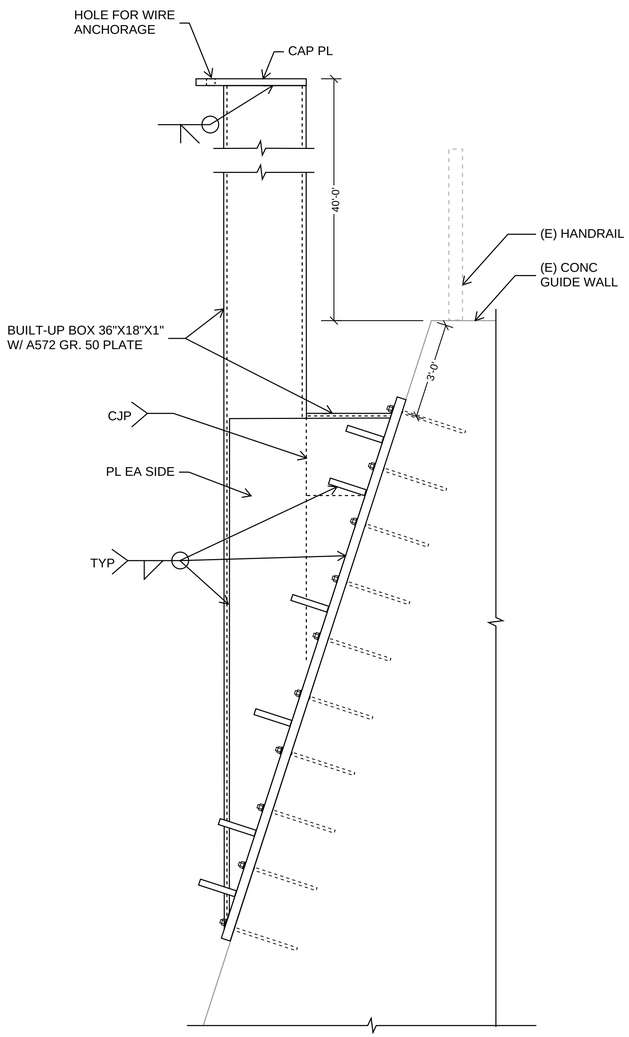
US ARMY CORPS OF ENGINEERS
WALLA WALLA DISTRICT
MCNARY AVIAN PREDATION DETERRENT
ARRAY CONCEPT EVALUATION

SHEET NUMBER:	S-202
SHEET NAME:	WIRE ELEVATIONS ALTERNATIVES 2A & 2B



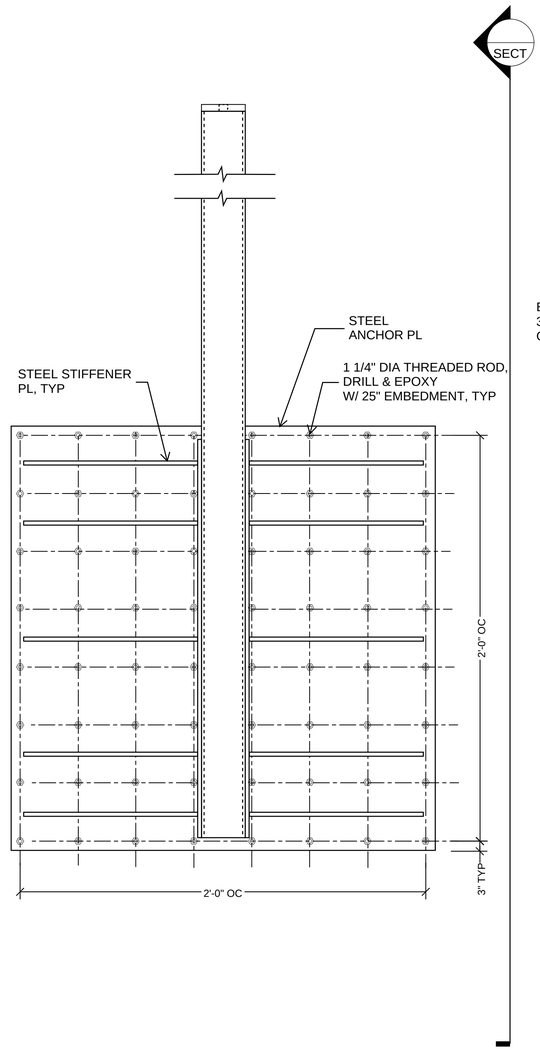
ELEVATION



SECTION

1 AVIAN WIRE TO NAVIGATION GUIDE WALL ANCHOR

NTS



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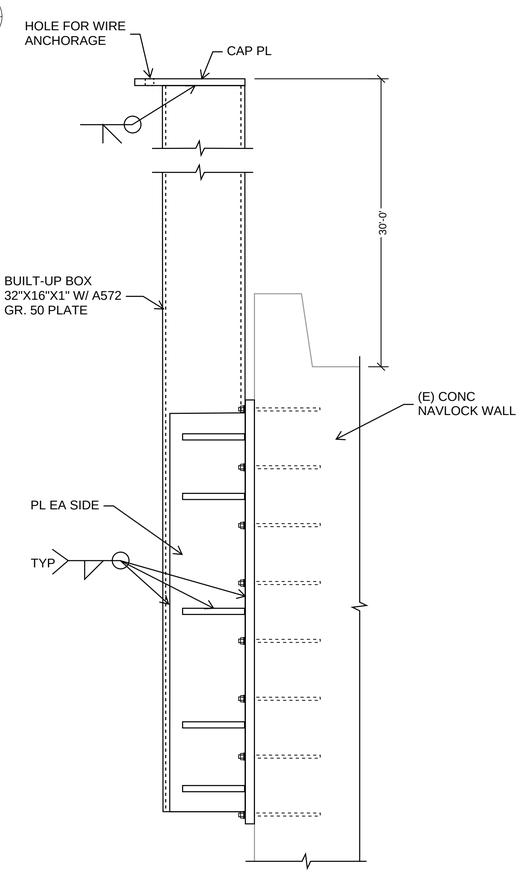

SECTION

2 AVIAN WIRE TO NAVLOCK WALL ANCHOR

NTS

JACOBS

US ARMY CORPS OF ENGINEERS WALLA WALLA DISTRICT MCNARY AVIAN PREDATION DETERRENT ARRAY CONCEPT EVALUATION	
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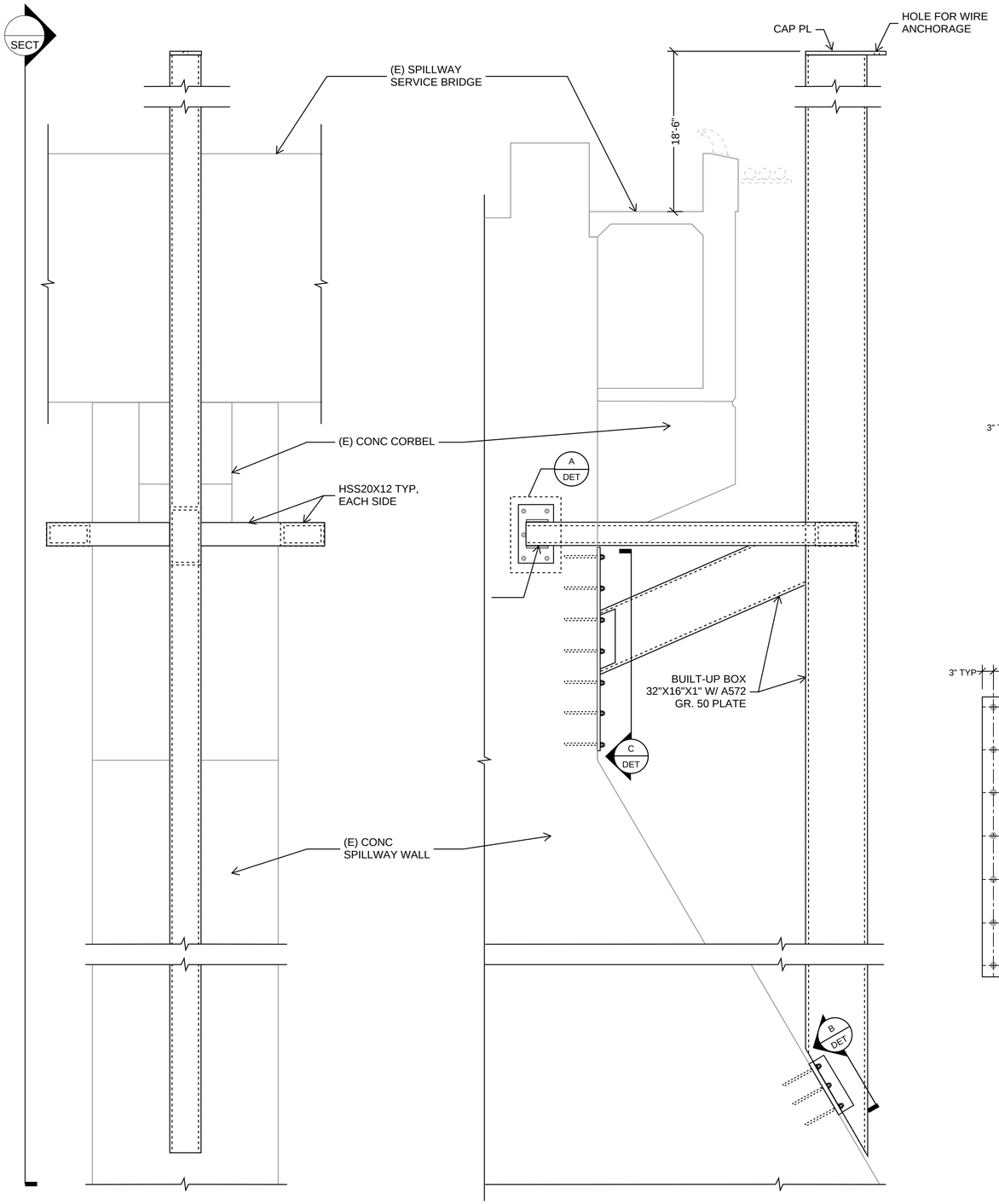
SHEET NAME:	ANCHOR DETAILS ALTERNATIVES 1A & 1B

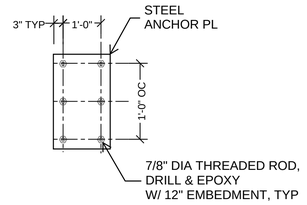


ELEVATION

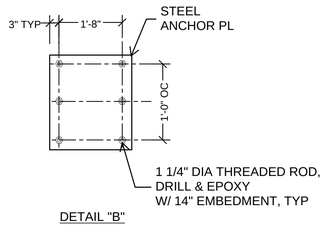
SECTION

3 AVIAN WIRE TO SPILLWAY ANCHOR

NTS



DETAIL "A"



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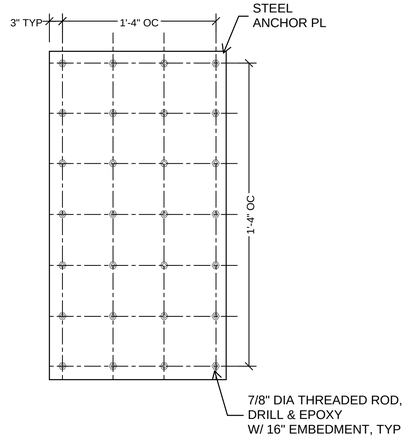

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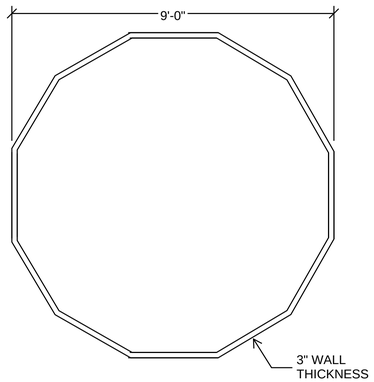
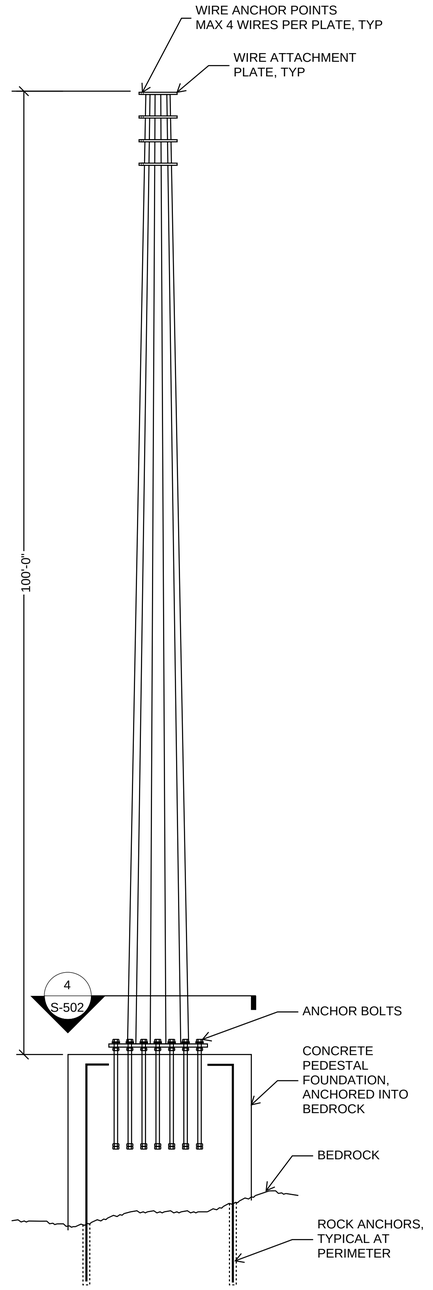


4 SOUTH SHORE TOWER SECTION

NTS



NOTES:

1. FOUNDATION REINFORCING NOT SHOWN.

5 SOUTH SHORE TOWER

NTS

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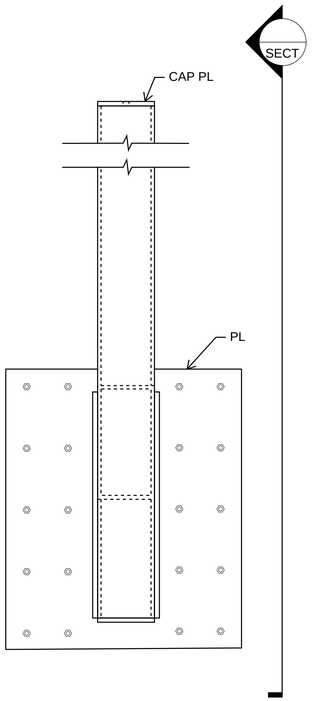
WALLA WALLA DISTRICT
MCNARY AVIAN PREDATION DETERRENT ARRAY CONCEPT EVALUATION

SHEET NUMBER:	S-512
SHEET NAME:	ANCHOR DETAILS ALTERNATIVES 1A & 1B



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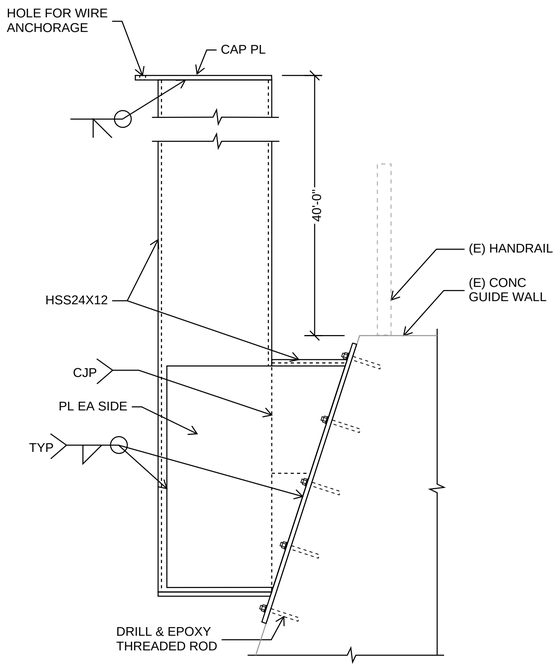
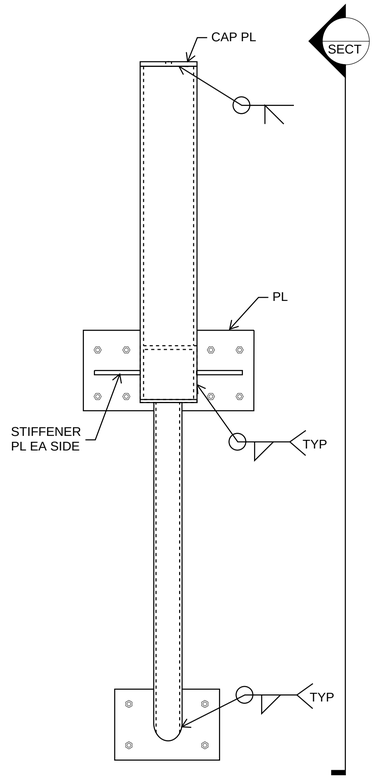


SECTION

1 AVIAN WIRE TO NAVIGATION GUIDE WALL ANCHOR

NTS



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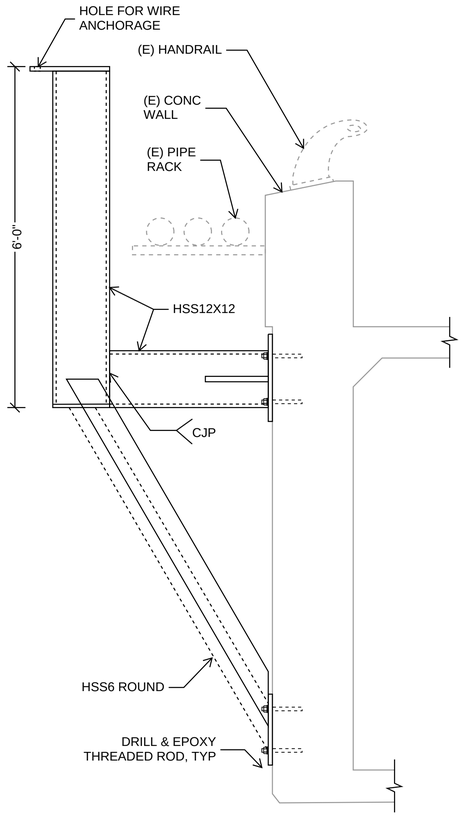

SECTION

2 AVIAN WIRE TO SPILLWAY ANCHOR

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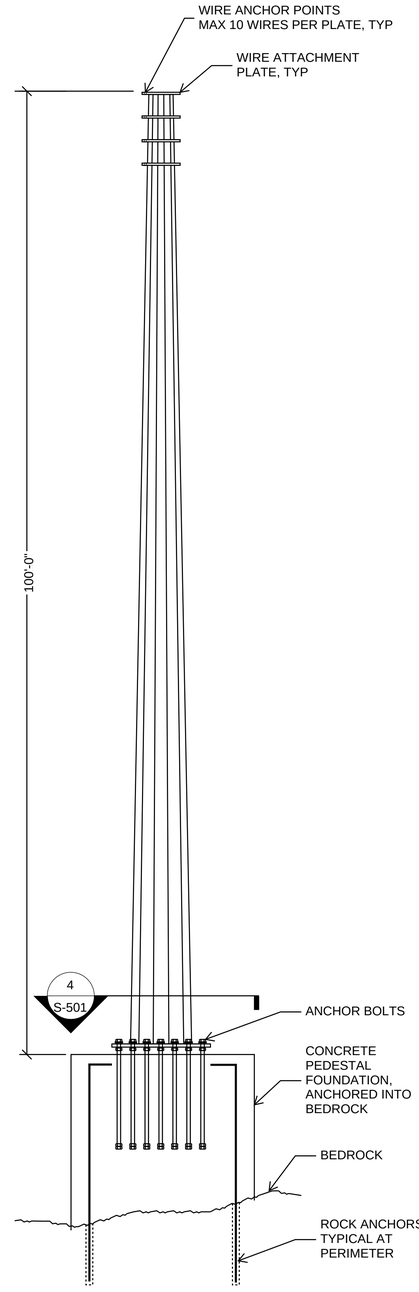


NOTES:

1. FOUNDATION REINFORCING NOT SHOWN.

ALTERNATIVE 1A		
LOCATION	QUANTITY	DETAIL REFERENCE
NAVIGATION GUIDE WALL	53	1/S-511
NAVLOCK WALL	24	2/S-511
SPILLWAY	26	3/S-512
SOUTH SHORE TOWERS	7	5/S-512

ALTERNATIVE 1B		
LOCATION	QUANTITY	DETAIL REFERENCE
NAVIGATION GUIDE WALL	53	1/S-511
NAVLOCK WALL	24	2/S-511
SPILLWAY	-	-
SOUTH SHORE TOWERS	5	5/S-512

ALT 1A/1B ANCHOR QUANTITY TABLES

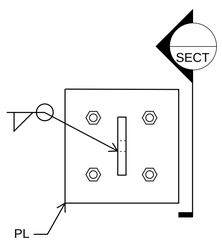
NTS

ALTERNATIVE 2A		
LOCATION	QUANTITY	DETAIL REFERENCE
NAVIGATION GUIDE WALL	53	1/S-521
NAVLOCK WALL	24	3/S-521
SPILLWAY	49	2/S-521
SOUTH SHORE TOWERS	4	5/S-521

ALTERNATIVE 2B		
LOCATION	QUANTITY	DETAIL REFERENCE
NAVIGATION GUIDE WALL	53	1/S-521
NAVLOCK WALL	24	3/S-521
SPILLWAY	-	-
SOUTH SHORE TOWERS	2	5/S-521

ALT 2A/2B ANCHOR QUANTITY TABLES

NTS



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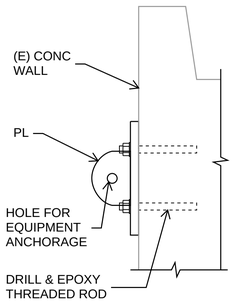
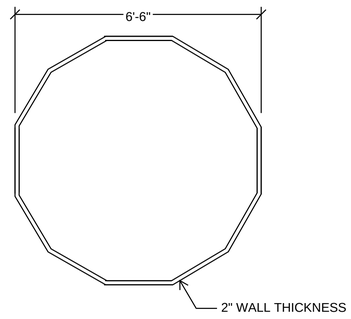


SECTION

3 AVIAN WIRE TO NAVLOCK WALL ANCHOR

NTS



4 SOUTH SHORE TOWER SECTION

NTS

5 SOUTH SHORE TOWER

NTS

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US ARMY CORPS OF ENGINEERS
WALLA WALLA DISTRICT
MCNARY AVIAN PREDATION DETERRENT ARRAY CONCEPT EVALUATION

SHEET NUMBER:	S-521
SHEET NAME:	ANCHOR DETAILS ALTERNATIVES 2A & 2B

Appendix B. Product Data and Cut Sheets - NOT USED

Appendix C. Cost Estimates

Basis of Estimate

McNary Avian Deterrence Alternatives
30% Preliminary Design

McNary Dam, Columbia River
Umatilla, OR

PREPARED FOR:

US Army Corps of Engineers
Walla Walla District
201 N 3rd Ave
Walla Walla, WA 99362

PREPARED BY:

Legis Consultancy, Inc.
9 Dunwoody Park, Ste. 131
Atlanta, GA 30338

Submitted: September 15, 2025

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4. Regulations and Guidance 4
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a. Alternatives 1A and 1B 7
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Abbreviations

Abbreviations

Appendices

Appendix A: MCACES MII Estimate
Appendix B: Estimate Support

Abbreviations

AACEI	Association for the Advancement of Cost Engineering, International	JOOH	Job Office Overhead
APDA	Avian Predation Deterrent Array	KW	Kilowatts
APHIS	Animal and Plant Health Inspection Service	LB	Pounds
BOE	Basis of Estimate	LF	Linear Feet
CCP	Certified Cost Professional	LS	Lump Sum
CCT	Certified Cost Technician	MBA	Master of Business Administration
CDW	Concept Design Workshop	MII	Micro-Computer Aided Cost Estimating System Second Generation
CEP	Certified Estimating Professional	MNA	McNary Dam
CF	Cubic Feet	NFS	Non-Federal Sponsor
CFS	Cubic Feet per Second	NTP	Notice To Proceed
CST	Certified Scheduling Technician	NWW	USACE Walla Walla District
CWCCIS	Civil Works Construction Cost Index System	O&M	Operations & Maintenance
CY	Cubic Yards	P.E.	Professional Engineer
DC	Direct Costs	PDT	Project Delivery Team
DIA	Diameter	Ph.D	Doctor of Philosophy
DOR	Designer of Record	PM	Project Manager
ECI	Early Contractor Involvement	PSP	Planning & Scheduling Professional
F.AACE	Fellow - Association for the Advancement of Cost Engineering, International	QA	Quality Assurance
F.ASCE	Fellow - American Society of Civil Engineers	QC	Quality Control
G&A	General & Administrative Expenses	QTO	Quantity Takeoff
GIS	Geographic Information Systems	SC	Substantial Completion
GPM	Gallons per Minute	SCADA	Supervisory Control and Data Acquisition
H&H	Hydrology & Hydraulics	SF	Square Feet
HOOH	Home Office Overhead	SOW	Scope of Work / Statement of Work
HP	Horsepower	TN	Tons
HTRW	Hazardous, Toxic, and Radioactive Waste	USACE	U.S. Army Corps of Engineers
I&C	Instrumentation & Control	USDA	U.S. Department of Agriculture

A. Executive Summary

1. Project Description

This Estimate addresses the subset of features of work anticipated for concept-level evaluation and alternatives evaluation in advance of a construction project to install an Avian Predation Deterrent Array (APDA) on the tailrace at McNary Dam on the Columbia River, river mile 292, landmark one-mile east of Umatilla, Oregon. The construction of Columbia River dams, including McNary Dam (MNA), led to challenges for migrating salmonids as they navigate passage through the dams. The passage through both spillway top spill weirs and juvenile bypass systems makes it easier for predatory birds to feed on the migrating salmonids. MNA hosts a large population of these piscivorous birds but lacks an effective and reliable APDA to improve salmonid survivability.

This Estimate includes cost development for the following design Alternatives:

- Alternative 1A: Large APDA originating from towers on the Oregon shoreline; 1 ¼" SS wires fan out across the river, anchoring at the navigation lock guide wall, navigation lock wall, and spillway.
- Alternative 1B: Large APDA originating from towers on the Oregon shoreline; 1 ¼" SS wires fan out across the river, anchoring at the navigation lock guide wall and navigation lock wall; excludes wires attached at the spillway.
- Alternative 2A: Similar design to Alternative 1A, with additional design based on a proposed code variance. (Large APDA originating from towers at the Oregon shoreline. ¼" SS wires fans out across the river, anchoring along the navigation guide wall, navigation lock wall, and spillway deck.)
- Alternative 2B: Similar design to Alternative 1B, with additional design based on a proposed code variance. (Large APDA originating from towers on the Oregon shoreline; ¼" SS wires fan out across the river, anchoring at the navigation lock guide wall and navigation lock wall; excludes wires attached at the spillway.)
- Alternative 3: In-water array composed of a series of stainless-steel cables suspended at the water surface by regularly spaced buoy floats; cables are arranged in a linear array trailing downstream from the outfall pier.

(The wire arrays proposed as Alternatives 1A, 1B, 2A, and 2B are specifically designed to deter aerial foragers, while Alternative 3 is designed to deter water-based foragers, which approach feeding areas by swimming.)

Costs include the following key items:

- Mobilization/Demobilization
- Barge Operations
- Tower Foundations
- Structural Steel (Towers and Columns)
- Stainless Steel Wire (gauge varies by Alternative)
- Grounding

2. Probable Cost of Construction

The Probable Cost of Construction for each Alternative is presented in Figure 1. These costs represent the project team's best understanding and knowledge of the requirements for the McNary Dam Avian Predation Deterrent Array (APDA) project. The Estimate meets the requirements of the Association for the Advancement of Cost Engineering, International (AACE) Class 3 standards and carries an expected accuracy range of -30% / +20%.

	Direct Cost	Prime Contractor Cost	Contract Cost	Project Cost
	Labor, Equipment, Materials, and Subcontracts, plus Sales Tax and Adjusted Productivity	Direct Cost, plus Subcontractor Markups	Contractor Cost, plus Job Office Overhead (JOOH), Home Office Overhead (HOOH), Bond, Insurance, Mob/Demob, and Profit	Contract Cost, plus Escalation (SIOH and 15% Contingency)
Alternative 1A	23,520,507	31,305,795	44,243,317	51,696,108
Alternative 1B	17,666,291	23,513,834	33,999,507	39,726,727
Alternative 2A	7,730,448	10,289,227	15,684,206	18,209,584
Alternative 2B	6,953,797	9,255,504	13,759,514	15,974,990
Alternative 3	463,128	616,424	933,697	1,076,989

Figure 1: *Breakdown of Project Costs*

B. Scope of Services

1. Subcontract Scope of Work

On October 14, 2024, Legis Consultancy, Inc. ("Legis") entered into Professional Services Agreement (PSA) Number 148059531 with Jacobs Engineering Group, Inc. ("Jacobs" or "A-E Team") under its USACE Walla Walla District Contract W912EF23D0014, Task Order W912EF24F9202. The PSA provided for a Notice to Proceed on October 16, 2024. Legis agreed to provide services detailed in a Statement of Work Dated August 23, 2024 (MSA Appendix A). This contract engaged Jacobs to provide a concept-level evaluation and alternatives evaluation in anticipation of a construction project to install an Avian Predation Deterrent Array (APDA).

The Statement of Work (SOW) provided for Legis to provide Cost Engineering Services including support for CDW meeting and Refined Alternatives Review Meeting, initial ROM cost Estimates for two alternatives, follow-up refined ROM cost Estimates for Concept Level Design, cost benefit analyses, final Conceptual Design Evaluation Report Cost Estimate, and a Class 3 budgetary cost Estimate for the recommended alternative and the next best alternative. All work was to be completed on or before September 30, 2025. Scheduling services were not included as part of the SOW.

The Class 3 Estimate is to be prepared in accordance with ER 1110-2-1302 Civil Works Cost Engineering. Based on Association for the Advancement of Cost Engineering, International (AACE), Class 3 Estimates carry an expected accuracy range of -30% / + 20%.

C. Estimate Definition

1. Project Information

Estimator:		Legis Consultancy, Inc.
Designer of Record:		Jacobs Engineering Group, Inc
Subcontract/Task Order:		W912EF24F9202
Owner:		US Army Corps of Engineers – Walla Walla District
Project Location:		Columbia River, Umatilla, OR
Design Documents Receipt:		April 2 – September 8, 2025
Estimate Class/Methodology:		AACE Class 3 Estimate
Processing Software:		MCACES MII ver 4.4.2
Cost Books and Libraries:		Costbook CB24EN: 2024 MII English Cost Book
Equipment:		EP24R08 MII Equipment 2024 Region 08
Project Number:		D3815201

Figure 2: *Project Definition Information*

2. Site Visits

Legis did not participate in site visits for the Pre-Construction Services Pile Load Test sites.

3. Design Documents

Item	Date	Source
2198_CT_TL_019_1123_Vectran_12S_and_12x12_tech_sheet_hres_20250402.pdf	4/2/2025	Van Ruiten email
2198_JD Avian Wire Plans_20250401.pdf	4/2/2025	Sharepoint download
2198_JD Avian in-water Plans_J Teeter email_20250403.pdf	4/2/2025	Teeter email
2198_Anchor Kit Description_20250403.pdf	4/2/2025	Teeter email
2198_In-Water Array_Anchor Layout_20250403.pdf	4/2/2025	Teeter email
2198_McNary synthetic wire_Van Ruiten email_20250402.pdf	4/2/2025	Van Ruiten email
2198_McNary Wire Array - Structural Concept Set_DRAFT 4-2-2025.pdf	4/3/2025	Van Ruiten email
2198_SS v Vectran wire_G VanRuiten email_20250403.pdf	4/3/2025	Van Ruiten email
2198_McNary Avian Deterrence_Tower Foundation Estimated Sizes_Jacobs_2025-09-08	9/8/2025	Van Ruiten email

Figure 3: *Design Documents*

4. Regulations and Guidance

This Cost Estimate has been prepared in accordance with the requirements of:

- ER 1110-2-1302, Civil Works Cost Engineering
- 17R-97: Cost Estimate Classification System, AACEI

5. Estimating Team

Resource Name	Group	Assigned Role
Melissa Marion-Landais, MBA	PM	Project Manager
Juan C. Rojas, CCP	CE	Lead Cost Estimator
Adam Stephens, CCT, CST	QC	Staff Cost Estimator
Patrick Ray, JD, CCP, PMP	QC	Quality Control
Laura Lancaster	PM	Documentation Specialist
Michele Huff	PM	Contract Administration

Figure 4: *Project Estimating Team*

D. Estimate Detail

- Estimate Quantity Development: Tower foundation quantities provided by JV; additional quantities and costs developed by Estimating team (See BOE Appendix B).

- Planned Contract Duration: Notice to Proceed for all Alternatives was provided as 2Q2027 (assumed as January 3, 2027). A construction schedule was not included in the Estimating scope; expected durations were based on estimator judgment and consultation with the Design Team, as follows:
  - Alternative 1A: 12 months
  - Alternative 1B: 10 months
  - Alternative 2A: 8 months
  - Alternative 2B: 6 months
  - Alternative 3: 1.5 months

- Prime Contractor: Regional contractor capable of project requirements include barge-based construction.

- Contractor Markups: Profit Markup was defined as a running 10%. Prime and Subcontractor Markups are based on Estimating Team experience. Markups vary by Alternative. (See BOE Appendix B 2.0 for Markup Report detail.)

- Escalation: Costbook escalation from 1Q2024 to date of Estimate was calculated at 5.3% based on the Bureau of Labor Statistics Inflation Calculator.

  Estimate escalation to midpoint has been calculated using the CWCCIS March 2025 CWBS 12 NAVIGATION PORTS & HARBORS Index. Construction durations range from 1.5 to 12 months, with escalation ranging from 3.93% to 5.28%. (See BOE Appendix B 12.0)

- Contingency: Based on guidance from Design Team, contingency was included at 15%.

- Labor Rates: Based on General Decision Number: OR20250077 for Umatilla County in Oregon and Department of Labor Statistics for the State of Oregon. For roles included in the Estimate, Davis-Bacon base and taxable fringe rates were compared to the most recent Department of Labor corresponding rates to provide the most updated labor rate information. The greater between D-B and DOL was selected for the applicable job roles. Where D-B did not provide a current applicable job role, the DOL rate was applied. (See BOE Appendix B 11.0 for labor rate development.)

- Fuel: Fuel cost for Equipment is based on Gas Buddy - Umatilla current available market pricing for Umatilla, OR. Marine fuel is based on Columbia River Club. Estimating team reduced on-road diesel pricing by $0.10 for off-road diesel cost.

- Productivity: Productivity has been assumed at 70% for Alternatives 1 and 2 and at 80% for Alternative 3.

- Weather Inefficiency: Weather averages in Umatilla, OR are based on www.usclimatedata.com/climate/umatilla
  Average annual low temperature is reported at 43 degrees F.
  Average annual high temperature is reported at 64 degrees F.
  Average annual rainfall is reported at 8.93 inches.

• Site Access	Access to the work site has been assumed to be adequate.
• Site Parking	Adequate Site Parking has been assumed.
• Item Costs	Material costs are based on the MII costbook; where updating pricing has been acquired, it has been noted on relevant cost line items. Additional cost calculations by the Estimating Team are provided in BOE Appendix B 8.0 and 9.0.
• Sales & Use Tax	Sales Tax is excluded from the Estimate.
• Government Furnished Materials	No Government Furnished Materials are included.
• Construction Methodology	Standard Construction Practices and Methodology are assumed, including some marine barge-based construction.
• Environmental Concerns	The Estimate does not address any costs or impacts for Hazardous, Toxic, and Radioactive Waste remediation.
• Cultural/ Archeological Concerns	No cultural/archeological concerns are anticipated as the project site has already been developed.
• Contract Quality Management	Issues found during the Quality Review have been corrected prior to Estimate submittal.
• Estimate Submittal Files	2198_McNary_Preliminary 30%_BOE Compiled 20250915.pdf 2198_McNary_Preliminary 30%_Estimate 20250915.pdf

E. Estimate Narrative

1. Overview

The McNary Dam (MNA) Avian Predation Deterrent Array (APDA) project is conceived to install an APDA on the tailrace at McNary Dam on the Columbia River, river mile 292, landmark one-mile east of Umatilla, Oregon. The goal of the APDA is to reduce predation of migrating salmonids as they navigate passage through the dam. In the absence of an APDA, predatory birds can readily feed on the migrating salmonids as they pass through both spillway top spill weirs and juvenile bypass systems. MNA hosts a large population of piscivorous birds and currently lacks an effective and reliable APDA to improve salmonid survivability.

The Estimate includes separate cost folders representing four main design Alternatives to deter predators with aerial hunting approaches. Additionally, the Estimate includes a fifth Alternative which may be considered in conjunction with any of the four main Alternatives; this fifth option is designed to provide additional deterrence of predators with a water-based hunting approach. The Alternatives are summarized as:

- Alternative 1A: Large APDA originating from towers on the Oregon shoreline; 1 ¼" SS wires fan out across the river, anchoring at the navigation lock guide wall, navigation lock wall, and spillway.
- Alternative 1B: Large APDA originating from towers on the Oregon shoreline; 1 ¼" SS wires fan out across the river, anchoring at the navigation lock guide wall and navigation lock wall; excludes wires attached at the spillway.
- Alternative 2A: Similar design to Alternative 1A, with additional design based on a proposed code variance. (Large APDA originating from towers at the Oregon shoreline. ¼" SS wires fans out across the river, anchoring along the navigation guide wall, navigation lock wall, and spillway deck.)
- Alternative 2B: Similar design to Alternative 1B, with additional design based on a proposed code variance. (Large APDA originating from towers on the Oregon shoreline; ¼" SS wires fan out across the river, anchoring at the navigation lock guide wall and navigation lock wall; excludes wires attached at the spillway.)
- Alternative 3: In-water array composed of a series of stainless-steel cables suspended at the water surface by regularly spaced buoy floats; cables are arranged in a linear array trailing downstream from the outfall pier.

a. Alternatives 1A and 1B

The design for these options relies on the concept of large towers located on the shore, with additional 40' and 30' steel columns attached to the concrete dam and spillway structures. 1 ¼" SS wire will be strung between the steel columns and the towers to create a wire pattern over the water in order to disrupt the aerial approach of predators.

Generally, construction will begin with foundation work of the large towers from a land-based crew. These towers will be supported on piling foundations to be installed after clearing and excavation. Subsequently, reinforced concrete will be installed for the mat foundations. Once the foundation is complete, the tower can be erected. At the same time, a barge crew will work from the water to construct the structural steel 40' and 30' columns. Once all columns and towers are complete, a marine-based crew will install the SS wire pulled between the columns and towers; to alleviate stress on the towers during this operation, a crew will support the wire from the water during installation.

These options vary only by the number of main towers: 1A has 7 towers, while 1B has 5 towers.

b. Alternatives 2A and 2B

The design for these options relies on the concept of large towers located on the shore, with additional 40' and 30' steel columns attached to the concrete dam and spillway structures. A smaller gauge ¼" SS wire will be strung between the steel columns and the towers to create a wire pattern over the water in order to disrupt the aerial approach of predators.

Generally, construction will begin with foundation work of the large towers from a land-based crew. These towers will be supported on piling foundations to be installed after clearing and excavation. Subsequently, reinforced concrete will be installed for the mat foundations. Once the foundation is complete, the tower can be erected. At the same time, a barge crew will work from the water to construct the structural steel 40' and 30' columns on the spillway, and steel plates on the dam structure. These options avoid towers on the dam structure and replace them instead with steel plates which can support the lighter weight of the ¼" wire. Once all columns, towers, and plates are installed, a marine-based crew will install the SS wire pulled between the columns, towers, and plates; to alleviate stress on the towers during this operation, a crew will support the wire from the water during installation.

These options vary only by the number of main towers: 2A has 4 towers and wall plates, while 2B has 2 towers and no plates.

c. Alternative 3

The Estimate includes costs for the assumed design of Alternative 3, an in-water array composed of a series of stainless-steel cables suspended at the water surface by regularly spaced buoy floats; cables are arranged in a linear array trailing downstream from the outfall pier. Based on Design Team guidance, a series of six wire arrays has been assumed. Alternative 3 might be best considered a potential add-on to provide additional deterrence measures for predators which have a water-based hunting approach.

F. Assumptions

Contracting

1. Standard contracting practices are assumed.
2. For construction purposes, weather days will be made up on weekends.
3. Government holidays are assumed at 11 per year. (See BOE Appendix B 1.0)

Quantities

4. Tower foundation quantities provided by Design Team; additional quantities and costs developed by Estimating team (See BOE Appendix B).

Contractor

5. The Estimate assumes a capable, well-equipped, competent Contractor who is familiar with plans, details, and specifications as they pertain to the site and construction.
6. It is assumed that the Contractor will be a registered Contractor in good standing in the state of Oregon.
7. It is assumed that the Design complies with all relevant criteria and appropriate codes.
8. The Estimate assumes that procurement will be possible within the project design periods.

Markups

9. Escalation to midpoint of construction based on the March CWCCIS 2025 is included in the Estimate. (See BOE Appendix B 12.0). Costbook escalation from 1Q2024 to date of Estimate was calculated at 5.3% based on the Bureau of Labor Statistics Inflation Calculator.
10. SIOH at 5.3% has been included in the Estimate
11. Profit Markup was applied as 10% running.
12. General Contractor and Subcontractor overhead items were assumed based on Estimating Team experience. (See BOE Appendix B 2.0)
13. Productivity has been assumed at 70% for Alternatives 1 and 2 and at 80% for Alternative 3.

Construction

14. The Estimate excludes costs for potential Hazardous, Toxic, and Radioactive Waste remediation; any HTRW concerns can be assessed in future Estimates.
15. The Estimate assumes that the sites are free of human remains and/or historical artifacts; discovery of such items may result in additional costs.
16. Unforeseen obstructions, buried objects, underground utilities, underground pipelines, or other similar conditions have been excluded.
17. Spoil areas are not assumed to be necessary and have not been identified.
18. The Estimate assumes that adequate staging areas sites are available.

G. Certification of Estimate

This Estimate, as completed, reflects the status of the deliverable. The deliverable meets all the Client's contract requirements and Legis Consultancy, Inc. internal requirements, except as noted in the deliverable. The shortfall(s) are not material or, if material, are adequately explained in the deliverable. Any material shortfall(s) have been discussed with Legis senior management, which has authorized the release of the deliverable.

Patrick Ray, JD, CCP, PMP
President
Legis Consultancy, Inc.

September 15, 2025
Date

Melissa Marion-Landais
Director of Project Delivery
Legis Consultancy, Inc.

September 15, 2025
Date

APPENDIX A

MCACES MII Estimate

Estimated by Legis Consultancy
Designed by JACOBS
Prepared by Juan C Rojas, CCC

Preparation Date 9/12/2025
Effective Date of Pricing 7/4/2027
Estimated Construction Time 365 Days

Library Properties i
Project Notes iii
a. Alternatives 1A and 1B v
b. Alternatives 2A and 2B vi
c. Alternative 3 vi
Markup Properties vii
Project Cost Summary Report - Lvl 3 1
04 McNary Dam Avian Deterrence Alternatives 1
Contract Cost Summary Report - Lvl 3 2
04 McNary Dam Avian Deterrence Alternatives 2
Project Direct Costs Report 3
04 McNary Dam Avian Deterrence Alternatives 3
0401 ALTERNATIVE 1A - 1-1/4" Stainless Steel Wire 3
0401 ALTERNATIVE 1B - 1-1/4" Stainless Steel Wire 6
0401 ALTERNATIVE 2A - 1/4" Stainless Steel Wire 9
0401 ALTERNATIVE 2B - 1/4" Stainless Steel Wire 12
0401 ALTERNATIVE 3 - In-Water Array Anchors 16
Job Office Overhead Direct Cost Report 18
Prime Option 1A 18
Prime Option 1B 18
Prime Option 2A 18
Prime Option 2B 18
Labor Direct Cost Summary 22

Designed by
JACOBS
Estimated by
Legis Consultancy
Prepared by
Juan C Rojas, CCC

Design Document
Document Date 9/9/2025
District
Contact Melissa Marion-Landais 770-393-8766
Budget Year 2027
UOM System Original

Direct Costs
LaborCost
EQCost
MatlCost
SubBidCost

Timeline/Currency
Preparation Date 9/12/2025
Escalation Date 3/31/2025
Eff. Pricing Date 7/4/2027
Estimated Duration 365 Day(s)

Currency US dollars
Exchange Rate 1.000000

Costbook CB24EN: 2024 MII English Costbook

Labor : McNary Labor Rates 2025
Note: Based on General Decision Number: OR20250077 for Umatilla County in Oregon and Department of Labor Statistics for the State of Oregon. For roles included in the Estimate, Davis-Bacon base and taxable fringe rates were compared to the most recent Department of Labor corresponding rates to provide the most updated labor rate information. The greater between D-B and DOL was selected for the applicable job roles. Where D-B did not provide a current applicable job role, the DOL rate was applied. See BOE Appendix B 11.0 for detail.

Labor Rates
LaborCost1
LaborCost2
LaborCost3
LaborCost4

Equipment EP24R08: MII Equipment 2024 Region 08
Note: Fuel cost for Equipment is based on Gas Buddy - Umatilla (https://www.gasbuddy.com/gasprices/oregon/umatilla) current available market pricing for Umatilla, OR. Marine fuel is based on Columbia River Club (https://www.cryc.com/fuel-prices).

Region 08 - NORTHWEST, (2024)
Sales Tax 0.00

Fuel
Electricity 0.101

Shipping Rates
Over 0 CWT 81.11

Working Hours per Year	1,480
Labor Adjustment Factor	1.06
Cost of Money	4.63
Cost of Money Discount	25.00
Tire Recap Cost Factor	1.50
Tire Recap Wear Factor	1.80
Tire Repair Factor	0.15
Equipment Cost Factor	1.00
Standby Depreciation Factor	0.50

Gas	3.850
Diesel Off-Road	4.450
Diesel On-Road	3.740

Over 240 CWT	57.53
Over 300 CWT	47.09
Over 400 CWT	40.74
Over 500 CWT	37.18
Over 700 CWT	31.86
Over 800 CWT	10.93

Date	Author	Note

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This Estimate addresses the subset of features of work anticipated for concept-level evaluation and alternatives evaluation in advance of a construction project to install an Avian Predation Deterrent Array (APDA) on the tailrace at McNary Dam on the Columbia River, river mile 292, landmark one-mile east of Umatilla, Oregon. The construction of Columbia River dams, including McNary Dam (MNA), led to challenges for migrating salmonids as they navigate passage through the dams. The passage through both spillway top spill weirs and juvenile bypass systems makes it easier for predatory birds to feed on the migrating salmonids. MNA hosts a large population of these piscivorous birds but lacks an effective and reliable APDA to improve salmonid survivability.

This Estimate includes cost development for the following design Alternatives:

- Alternative 1A: Large APDA originating from towers on the Oregon shoreline; wires fan out across the river, anchoring at the navigation lock guide wall, navigation lock wall, and spillway.
- Alternative 1B: Large APDA originating from towers on the Oregon shoreline; wires fan out across the river, anchoring at the navigation lock guide wall and navigation lock wall; excludes wires attached at the spillway.
- Alternative 2A: Similar design to Alternative 1A, with additional design based on a proposed code variance. (Large APDA originating from towers at the Oregon shoreline. Wires fans out across the river, anchoring along the navigation guide wall, navigation lock wall, and spillway deck.)
- Alternative 2B: Similar design to Alternative 1B, with additional design based on a proposed code variance. (Large APDA originating from towers on the Oregon shoreline; wires fan out across the river, anchoring at the navigation lock guide wall and navigation lock wall; excludes wires attached at the spillway.)
- Alternative 3: A series of stainless-steel cables suspended at the water surface by regularly spaced buoy floats; cables are arranged in a linear array trailing downstream from the outfall pier.

(The wire arrays proposed as Alternatives 1A, 1B, 2A, and 2B are specifically designed to deter aerial foragers, while Alternative 3 is designed to deter water-based foragers, which approach feeding areas by swimming.)

Costs include the following key items:

- Mobilization/Demobilization
- Barge Operations
- Tower Foundations
- Structural Steel (Towers and Columns)
- Stainless Steel Wire (gauge varies by Alternative)
- Lightning Protection

Date	Author	Note

9/10/2025 11:42:15 PM
Notice to Proceed for all Alternatives was provided as 2Q2027 (assumed as January 3, 2027). A construction schedule was not included in the Estimating scope; expected durations were based on estimator judgment and consultation with the Design Team, as follows:

- Alternative 1A: 12 months
- Alternative 1B: 10 months
- Alternative 2A: 8 months
- Alternative 2B: 6 months
- Alternative 3: 1.5 months

9/10/2025
11:43:23
PM
Costbook escalation from 1Q2024 to date of estimate was calculated at 5.3% based on the Bureau of Labor Statistics Inflation Calculator.
Estimate escalation to midpoint has been calculated using the CWCCIS March 2025 CWBS 12 NAVIGATION PORTS & HARBORS Index. Construction durations range from 1.5 to 12 months, with escalation ranging from 3.93% to 5.28%. (See BOE Appendix B 12.0)

9/10/2025
11:44:34
PM
Based on General Decision Number: OR20250077 for Umatilla County in Oregon and Department of Labor Statistics for the State of Oregon. For roles included in the Estimate, Davis-Bacon base and taxable fringe rates were compared to the most recent Department of Labor corresponding rates to provide the most updated labor rate information. The greater between D-B and DOL was selected for the applicable job roles. Where D-B did not provide a current applicable job role, the DOL rate was applied. (See BOE Appendix B 11.0 for labor rate development.)

9/10/2025
11:44:55
PM
Productivity has been assumed at 70% for Alternatives 1 and 2 and at 80% for Alternative 3.

9/10/2025
11:51:10
PM
Contracting

Date	Author	Note

1. Standard contracting practices are assumed.
2. For construction purposes, weather days will be made up on weekends.
3. Government holidays are assumed at 11 per year. (See BOE Appendix B 1.0)

Quantities

4. Tower foundation quantities provided by Design Team; additional quantities and costs developed by Estimating team (See BOE Appendix B).

Contractor

5. The Estimate assumes a capable, well-equipped, competent Contractor who is familiar with plans, details, and specifications as they pertain to the site and construction.
6. It is assumed that the Contractor will be a registered Contractor in good standing in the state of Oregon.
7. It is assumed that the Design complies with all relevant criteria and appropriate codes.
8. The Estimate assumes that procurement will be possible within the project design periods.

Markups

9. Escalation to midpoint of construction based on the March CWCCIS 2025 is included in the Estimate. (See BOE Appendix B 12.0). Costbook escalation from 1Q2024 to date of estimate was calculated at 5.3% based on the Bureau of Labor Statistics Inflation Calculator.
10. SIOH at 5.3% has been included in the Estimate
11. Profit Markup was applied as 10% running.
12. General Contractor and Subcontractor overhead items were assumed based on Estimating Team experience. (See BOE Appendix B 2.0)
13. Productivity has been assumed at 70% for Alternatives 1 and 2 and at 80% for Alternative 3.

Construction

14. The Estimate excludes costs for potential Hazardous, Toxic, and Radioactive Waste remediation; any HTRW concerns can be assessed in future estimates.
15. The Estimate assumes that the sites are free of human remains and/or historical artifacts; discovery of such items may result in additional costs.
16. Unforeseen obstructions, buried objects, underground utilities, underground pipelines, or other similar conditions have been excluded.
17. Spoil areas are not assumed to be necessary and have not been identified.
18. The Estimate assumes that adequate staging areas sites are available.

9/10/2025
11:51:32
PM

a. Alternatives 1A and 1B

The design for these options relies on the concept of large towers located on the shore, with additional 40’ and 30’ steel columns attached to the concrete dam and spillway structures. 1 ¼” SS wire will be strung between the steel columns and the towers to create a wire pattern over the water in order to disrupt the aerial approach of predators.

Date Author Note

Generally, construction will begin with foundation work of the large towers from a land-based crew. These towers will be supported on piling foundations to be installed after clearing and excavation. Subsequently, reinforced concrete will be installed for the mat foundations. Once the foundation is complete, the tower can be erected. At the same time, a barge crew will work from the water to construct the structural steel 40' and 30' columns. Once all columns and towers are complete, a marine-based crew will install the SS wire pulled between the columns and towers; to alleviate stress on the towers during this operation, a crew will support the wire from the water during installation.

These options vary only by the number of main towers: 1A has 7 towers, while 1B has 5 towers.

b. Alternatives 2A and 2B

The design for these options relies on the concept of large towers located on the shore, with additional 40' and 30' steel columns attached to the concrete dam and spillway structures. A smaller gauge ¼" SS wire will be strung between the steel columns and the towers to create a wire pattern over the water in order to disrupt the aerial approach of predators.

Generally, construction will begin with foundation work of the large towers from a land-based crew. These towers will be supported on piling foundations to be installed after clearing and excavation. Subsequently, reinforced concrete will be installed for the mat foundations. Once the foundation is complete, the tower can be erected. At the same time, a barge crew will work from the water to construct the structural steel 40' and 30' columns on the spillway, and steel plates on the dam structure. These options avoid towers on the dam structure and replace them instead with steel plates which can support the lighter weight of the ¼" wire. Once all columns, towers, and plates are installed, a marine-based crew will install the SS wire pulled between the columns, towers, and plates; to alleviate stress on the towers during this operation, a crew will support the wire from the water during installation.

These options vary only by the number of main towers: 2A has 4 towers and wall plates, while 2B has 2 towers and no plates.

c. Alternative 3

The Estimate includes costs for the assumed design of Alternative 3, an in-water array composed of a series of stainless-steel cables suspended at the water surface by regularly spaced buoy floats; cables are arranged in a linear array trailing downstream from the outfall pier. Based on Design Team guidance, a series of six wire arrays has been assumed. Alternative 3 might be best considered a potential add-on to provide additional deterrence measures for predators which have a water-based hunting approach.

Direct Cost Markups	**Category**	**Method**
Productivity	Productivity	Productivity
Overtime	Overtime	Overtime

	Days/Week	*Hours/Shift*	*Shifts/Day*	*1st Shift*	*2nd Shift*	*3rd Shift*
Standard	*5.00*	*8.00*	*1.00*	*8.00*	*0.00*	*0.00*
Actual	*5.00*	*8.00*	*1.00*	*10.00*	*0.00*	*0.00*

Day	*OT Factor*	*Working*	*OT Percent*	*FCCM Percent*
Monday	*1.50*	*Yes*	*10.00*	*(20.00)*
Tuesday	*1.50*	*Yes*		
Wednesday	*1.50*	*Yes*		
Thursday	*1.50*	*Yes*		
Friday	*1.50*	*Yes*		
Saturday	*1.50*	*No*		
Sunday	*2.00*	*No*		

Cost Book Adj.	TaxAdj	Running % on Selected Costs
EQCost		
MatlCost		
Sales Tax	TaxAdj	Running % on Selected Costs
MatlCost		
Estimate Contingency	MiscDirect	Running % on Selected Costs
LaborCost		
EQCost		
MatlCost		
SubBidCost		

Contractor Markups	**Category**	**Method**
Sub JOOH	JOOH	Running %
Sub HOOH	HOOH	Running %
Sub Profit	Profit	Running %
JOOH %	JOOH	Running %
JOOH (Small Tools)	Allowance	% of Labor
JOOH	JOOH	JOOH (Calculated)
HOOH	HOOH	Running %
Profit	Profit	Running %
Bond	Bond	Running %
Excise Tax	Excise	Running %

Owner Markups	Category	Method
Escalation 1A	Escalation	Escalation
StartDate 9/12/2025	*StartIndex* 1,104.12 *EndDate* 7/4/2027	*EndIndex* 1,162.45 *Escalation* 5.28
Escalation 1B	Escalation	Escalation
StartDate 9/12/2025	*StartIndex* 1,104.12 *EndDate* 6/4/2027	*EndIndex* 1,162.45 *Escalation* 5.28
Escalation 2A	Escalation	Escalation
StartDate 9/12/2025	*StartIndex* 1,104.12 *EndDate* 5/4/2027	*EndIndex* 1,154.97 *Escalation* 4.61
Escalation 2B	Escalation	Escalation
StartDate 9/12/2025	*StartIndex* 1,104.12 *EndDate* 4/4/2027	*EndIndex* 1,154.97 *Escalation* 4.61
Escalation 3	Escalation	Escalation
StartDate 9/12/2025	*StartIndex* 1,104.12 *EndDate* 1/25/2027	*EndIndex* 1,147.48 *Escalation* 3.93
Contingency	Contingency	Running %
SIOH	SIOH	Running %

Description	Quantity	UOM	ContractCost	Escalation	ProjectCost
Project Cost Summary Report - Lvl 3			**108,620,242**	**5,525,271**	**126,684,398**
04 McNary Dam Avian Deterrence Alternatives	**1.00**	**LS**	**108,620,242**	**5,525,271**	**126,684,398**
0401 ALTERNATIVE 1A - 1-1/4" Stainless Steel Wire	**4,649,605.00**	**SF**	**44,243,318**	**2,336,047**	**51,696,108**
040199 Associated General Items	**1.00**	**LS**	**44,243,318**	**2,336,047**	**51,696,108**
0401 ALTERNATIVE 1B - 1-1/4" Stainless Steel Wire	**2,838,565.00**	**SF**	**33,999,507**	**1,795,174**	**39,726,727**
040199 Associated General Items	**1.00**	**LS**	**33,999,507**	**1,795,174**	**39,726,727**
0401 ALTERNATIVE 2A - 1/4" Stainless Steel Wire	**4,886,108.00**	**SF**	**15,684,206**	**723,042**	**18,209,584**
040199 Associated General Items	**1.00**	**LS**	**15,684,206**	**723,042**	**18,209,584**
0401 ALTERNATIVE 2B - 1/4" Stainless Steel Wire	**3,143,837.00**	**SF**	**13,759,514**	**634,314**	**15,974,990**
040199 Associated General Items	**1.00**	**LS**	**13,759,514**	**634,314**	**15,974,990**
0401 ALTERNATIVE 3 - In-Water Array Anchors	**6.00**	**EA**	**933,697**	**36,694**	**1,076,989**
040199 Associated General Items	**1.00**	**LS**	**933,697**	**36,694**	**1,076,989**

Description	Quantity	UOM	DirectCost	SubCMU	CostToPrime	PrimeCMU	ContractCost
Contract Cost Summary Report - Lvl 3			**56,334,173**	**18,646,611**	**74,980,784**	**33,639,458**	**108,620,242**
04 McNary Dam Avian Deterrence Alternatives	**1.00**	**LS**	**56,334,173**	**18,646,611**	**74,980,784**	**33,639,458**	**108,620,242**
0401 ALTERNATIVE 1A - 1-1/4" Stainless Steel Wire	**4,649,605.00**	**SF**	**23,520,507**	**7,785,288**	**31,305,795**	**12,937,522**	**44,243,318**
040199 Associated General Items	**1.00**	**LS**	**23,520,507**	**7,785,288**	**31,305,795**	**12,937,522**	**44,243,318**
0401 ALTERNATIVE 1B - 1-1/4" Stainless Steel Wire	**2,838,565.00**	**SF**	**17,666,291**	**5,847,542**	**23,513,834**	**10,485,673**	**33,999,507**
040199 Associated General Items	**1.00**	**LS**	**17,666,291**	**5,847,542**	**23,513,834**	**10,485,673**	**33,999,507**
0401 ALTERNATIVE 2A - 1/4" Stainless Steel Wire	**4,886,108.00**	**SF**	**7,730,448**	**2,558,778**	**10,289,227**	**5,394,979**	**15,684,206**
040199 Associated General Items	**1.00**	**LS**	**7,730,448**	**2,558,778**	**10,289,227**	**5,394,979**	**15,684,206**
0401 ALTERNATIVE 2B - 1/4" Stainless Steel Wire	**3,143,837.00**	**SF**	**6,953,797**	**2,301,707**	**9,255,504**	**4,504,010**	**13,759,514**
040199 Associated General Items	**1.00**	**LS**	**6,953,797**	**2,301,707**	**9,255,504**	**4,504,010**	**13,759,514**
0401 ALTERNATIVE 3 - In-Water Array Anchors	**6.00**	**EA**	**463,128**	**153,296**	**616,424**	**317,273**	**933,697**
040199 Associated General Items	**1.00**	**LS**	**463,128**	**153,296**	**616,424**	**317,273**	**933,697**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
Project Direct Costs Report			**18,964,096**	**3,158,235**	**33,629,941**	**581,900**	**56,334,173**
04 McNary Dam Avian Deterrence Alternatives	**1.00**	**LS**	**18,964,096**	**3,158,235**	**33,629,941**	**581,900**	**56,334,173**
(Note: This Estimate addresses the subset of features of work anticipated for concept-level evaluation and alternatives evaluation in advance of a construction project to install an Avian Predation Deterrent Array (APDA) on the tailrace at McNary Dam on the Columbia River, river mile 292, landmark one-mile east of Umatilla, Oregon. The construction of Columbia River dams, including McNary Dam (MNA), led to challenges for migrating salmonids as they navigate passage through the dams. The passage through both spillway top spill weirs and juvenile bypass systems makes it easier for predatory birds to feed on the migrating salmonids. MNA hosts a large population of these piscivorous birds but lacks an effective and reliable APDA to improve salmonid survivability. The Estimate includes costs for 5 Alternatives.)							
			1.85	*0.27*	*2.91*	*0.03*	*5.06*
0401 ALTERNATIVE 1A - 1-1/4" Stainless Steel Wire	**4,649,605.00**	**SF**	**8,584,706**	**1,276,644**	**13,539,557**	**119,600**	**23,520,507**
(Note: Alternative 1A: Large APDA originating from towers on the Oregon shoreline; 1 ¼" SS wires fan out across the river, anchoring at the navigation lock guide wall, navigation lock wall, and spillway. Assumed construction duration: 12 Months)							
040199 Associated General Items	**1.00**	**LS**	**8,584,706**	**1,276,644**	**13,539,557**	**119,600**	**23,520,507**
(Note: Costs developed for Alternative 1A include Barge, Towers Foundations, Structural Steel for Towers and Columns, SS wire, and Lightning Protection.)							
			198,837.92	*58,780.98*	*0.00*	*10,350.00*	*267,968.90*
04019901 Barge Costs	**10.00**	**MO**	**1,988,379**	**587,810**	**0**	**103,500**	**2,679,689**
(Note: Barge mob/demob and operations for marine-based work. See BOE Appendix B, 3.0.)							
Mobilization of Barge	**1.00**	**LS**	**0**	**0**	**0**	**51,750**	**51,750**
			0.00	*0.00*	*0.00*	*51,750.00*	*51,750.00*
RSM 310660151320 Mobilization, set up and remove, mobilization by water for barge driving rig, maximum	1.00	EA	0	0	0	51,750	51,750
			198,837.92	*58,780.98*	*0.00*	*0.00*	*257,618.90*
Barge Operations	**10.00**	**MO**	**1,988,379**	**587,810**	**0**	**0**	**2,576,189**
			198,837.92	*58,780.98*	*0.00*	*0.00*	*257,618.90*
RSM 061333520360 On-site time for barge driving rig with crew	10.00	MO	1,988,379	587,810	0	0	2,576,189
Demobilization of Barge	**1.00**	**LS**	**0**	**0**	**0**	**51,750**	**51,750**
			0.00	*0.00*	*0.00*	*51,750.00*	*51,750.00*
RSM 310660151320 Demobilization by water for barge driving rig, maximum	1.00	EA	0	0	0	51,750	51,750
			105,764.59	*14,263.99*	*99,079.24*	*2,300.00*	*221,407.82*
04019902 Foundations for Towers	**7.00**	**EA**	**740,352**	**99,848**	**693,555**	**16,100**	**1,549,855**
(Note: Costs have been included for clearing/grubbing, minor excavation, piling for cranes, structural concrete for tower foundation mats, and backfill. Based on A-E guidance, site is assumed to have adequate access and sufficient nearby space for laydown arrea.)							
			4,529.97	*2,692.91*	*0.00*	*0.00*	*7,222.88*
0401990201 Site Prep	**7.00**	**EA**	**31,710**	**18,850**	**0**	**0**	**50,560**
			0.22	*0.22*	*0.00*	*0.00*	*0.44*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
RSM 311110100150 Clearing & grubbing, grub stumps and remove	6,300.00	SF	1,414	1,383	0	0	2,797
			1.35	*1.76*	*0.00*	*0.00*	*3.11*
RSM 311413231460 Topsoil stripping and stockpiling, loam or topsoil, remove and stockpile on site, 200 HP dozer, 6" deep, 500' haul per S.Y.	700.00	SY	945	1,231	0	0	2,177
			11.43	*6.32*	*0.00*	*0.00*	*17.76*
RSM 312316166260 Structural excavation for minor structures, bank measure, for spread and mat footings, elevator pits, and small building foundations, sandy clay or loam, 2 C.Y. bucket, machine excavation, hydraulic backhoe	2,567.00	BCY	29,351	16,236	0	0	45,587
			45.12	*9.16*	*76.29*	*3.59*	*134.16*
0401990202 Piling	**4,480.00**	**VLF**	**202,119**	**41,029**	**341,779**	**16,100**	**601,027**
			32,586.27	*6,614.87*	*0.00*	*0.00*	*39,201.14*
RSM 310660150300 Mobilization, 150 ton, set up and remove crane, with pile leads and pile hammer	1.00	EA	32,586	6,615	0	0	39,201
			0.00	*0.00*	*0.00*	*16,100.00*	*16,100.00*
RSM 310660141050 Piling special costs, testing, any type piles, test load is twice the design load, 50 ton design load, 100 ton test	1.00	EA	0	0	0	16,100	16,100
			37.84	*7.68*	*76.29*	*0.00*	*121.81*
RSM 316223134200 Concrete-filled steel piles, steel, pipe piles, concrete filled, 50' long, 24" diameter, 59 lb./L.F., excludes mobilization or demobilization	4,480.00	VLF	169,533	34,414	341,779	0	545,726
			217.05	*0.92*	*329.38*	*0.00*	*547.35*
0401990203 Mat Foundations for Towers (Note: Q*20*20*10*1.03/27)	**1,068.00**	**CY**	**231,809**	**985**	**351,776**	**0**	**584,571**
			217.05	*0.92*	*329.38*	*0.00*	*547.35*
RSM 033053405950 Structural concrete, in place, pile cap (3000 psi), square or rectangular, over 10 C.Y., includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), placing and finishing	1,068.00	CY	231,809	985	351,776	0	584,571
			39,244.86	*5,568.98*	*0.00*	*0.00*	*44,813.85*
0401990204 Backfill	**7.00**	**EA**	**274,714**	**38,983**	**0**	**0**	**313,697**
			90.28	*0.00*	*0.00*	*0.00*	*90.28*
HNC 312323140022 Backfill, structural, 6" lifts, backfill around foundation, by hand	1,426.00	CY	128,738	0	0	0	128,738
			127.94	*34.17*	*0.00*	*0.00*	*162.10*
HNC 311313110016 Selective clearing, load spoils, wheel and ramp load, includes 2 mile haul to dump	1,141.00	CY	145,976	38,983	0	0	184,959
04019903 Structural Steel (Note: Structural Steel for towers and columns. See BOE Appendix B, 3.0 for QTY and 9.0 for structural tubing cost.)	**1.00**	**LS**	**3,061,928**	**588,986**	**9,453,190**	**0**	**13,104,104**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
			219,690.58	*65,304.25*	*378,335.38*	*0.00*	*663,330.21*
0401990301 Main Towers	**7.00**	**EA**	**1,537,834**	**457,130**	**2,648,348**	**0**	**4,643,311**
			2,373.20	*705.45*	*4,086.96*	*0.00*	*7,165.60*
RSM 337113230640 Steel tower, special steel structure erection	648.00	TON	1,537,834	457,130	2,648,348	0	4,643,311
			16,066.42	*1,356.22*	*72,052.50*	*0.00*	*89,475.15*
0401990302 40' Columns	**53.00**	**EA**	**851,520**	**71,880**	**3,818,783**	**0**	**4,742,183**
			726.01	*139.00*	*3,148.47*	*0.00*	*4,013.48*
HNC 051223232011 Column, structural tubing, 36" x 18" x 1", incl shop primer, cap & base plate, bolts	486.00	TON	352,840	67,554	1,530,156	0	1,950,550
			0.00	*0.00*	*132.25*	*0.00*	*132.25*
RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer (Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate. No Cost Book adjustment added as this item is quoted.)	14,510.00	SF	0	0	1,918,948	0	1,918,948
			117.61	*1.02*	*87.19*	*0.00*	*205.82*
RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	4,240.00	EA	498,681	4,326	369,679	0	872,685
			13,451.47	*1,199.54*	*59,721.19*	*0.00*	*74,372.20*
0401990303 30' Columns	**50.00**	**EA**	**672,574**	**59,977**	**2,986,060**	**0**	**3,718,610**
			726.01	*139.00*	*3,148.47*	*0.00*	*4,013.48*
HNC 051223232011 Column, structural tubing, 32" x 16" x 1", incl shop primer, cap & base plate, bolts	408.00	TON	296,211	56,712	1,284,576	0	1,637,499
			0.00	*0.00*	*132.25*	*0.00*	*132.25*
RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer (Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate. No Cost Book adjustment added as this item is quoted.)	10,756.00	SF	0	0	1,422,481	0	1,422,481
			117.61	*1.02*	*87.19*	*0.00*	*205.82*
RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	3,200.00	EA	376,363	3,265	279,003	0	658,630
			10.28	*0.00*	*12.50*	*0.00*	*22.78*
04019904 Stainless Steel Wire	**271,155.00**	**LF**	**2,788,632**	**0**	**3,389,573**	**0**	**6,178,205**
(Note: SS wire 1 1/4" gauge. See BOE Appendix B, 3.0 for QTY and 8.0 for SS wire cost.No Cost Book adjustment added as the items under this section are quotes.)							
			10.28	*0.00*	*12.50*	*0.00*	*22.78*
1-1/4" Stainless Steel Wire	**271,155.00**	**LF**	**2,788,632**	**0**	**3,389,573**	**0**	**6,178,205**
			10.28	*0.00*	*12.50*	*0.00*	*22.78*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
RSM 051516500590 Steel wire 1-1/4" dia	271,155.00	LF	2,788,632	0	3,389,573	0	6,178,205
(Note: Material quote from https://www.uscargocontrol.com/products/galvanized-wire-rope-eips-iwrc-6x19-class-1-1-4-5000-coil.)							
			773.61	*0.00*	*462.76*	*0.00*	*1,236.37*
04019916 Grounding	**7.00**	**EA**	**5,415**	**0**	**3,239**	**0**	**8,655**
(Note: Grounding for Main Towers.)							
			773.61	*0.00*	*462.76*	*0.00*	*1,236.37*
04019916 Grounding	**7.00**	**EA**	**5,415**	**0**	**3,239**	**0**	**8,655**
			14.69	*0.00*	*9.14*	*0.00*	*23.84*
RSM 264113132100 Cable, copper, 375 lb per thousand feet, over 40' high	350.00	LF	5,143	0	3,200	0	8,343
			272.50	*0.00*	*39.36*	*0.00*	*311.86*
RSM 260526800030 Grounding rod, copper clad, 8' long, 1/2" diameter	1.00	EA	273	0	39	0	312
			2.27	*0.34*	*3.57*	*0.04*	*6.22*
0401 ALTERNATIVE 1B - 1-1/4" Stainless Steel Wire	**2,838,565.00**	**SF**	**6,449,522**	**970,767**	**10,126,402**	**119,600**	**17,666,291**
(Note: Alternative 1B: Large APDA originating from towers on the Oregon shoreline; 1 ¼" SS wires fan out across the river, anchoring at the navigation lock guide wall and navigation lock wall; excludes wires attached at the spillway. Assumed construction duration: 10 months)							
040199 Associated General Items	**1.00**	**LS**	**6,449,522**	**970,767**	**10,126,402**	**119,600**	**17,666,291**
(Note: Costs developed for Alternative 1B include Barge, Towers Foundations, Structural Steel for Towers and Columns, SS wire, and Lightning Protection.)							
			198,837.92	*58,780.98*	*0.00*	*12,937.50*	*270,556.40*
04019901 Barge Costs	**8.00**	**MO**	**1,590,703**	**470,248**	**0**	**103,500**	**2,164,451**
(Note: Barge mob/demob and operations for marine-based work. See BOE Appendix B, 4.0.)							
Mobilization of Barge	**1.00**	**LS**	**0**	**0**	**0**	**51,750**	**51,750**
			0.00	*0.00*	*0.00*	*51,750.00*	*51,750.00*
RSM 310660151320 Mobilization, set up and remove, mobilization by water for barge driving rig, maximum	1.00	EA	0	0	0	51,750	51,750
			198,837.92	*58,780.98*	*0.00*	*0.00*	*257,618.90*
Barge Operations	**8.00**	**MO**	**1,590,703**	**470,248**	**0**	**0**	**2,060,951**
			198,837.92	*58,780.98*	*0.00*	*0.00*	*257,618.90*
RSM 061333520360 On-site time for barge driving rig with crew	8.00	MO	1,590,703	470,248	0	0	2,060,951
Demobilization of Barge	**1.00**	**LS**	**0**	**0**	**0**	**51,750**	**51,750**
			0.00	*0.00*	*0.00*	*51,750.00*	*51,750.00*
RSM 310660151320 Demobilization by water for barge driving rig, maximum	1.00	EA	0	0	0	51,750	51,750
			107,639.30	*14,641.28*	*99,088.65*	*3,220.00*	*224,589.23*
04019902 Foundations for Towers	**5.00**	**EA**	**538,196**	**73,206**	**495,443**	**16,100**	**1,122,946**
(Note: Costs have been included for clearing/grubbing, minor excavation, piling for cranes, structural concrete for tower foundation mats, and backfill. Based on A-E guidance, site is assumed to							

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
have adequate access and sufficient nearby space for laydown arrea.)							
			4,528.67	*2,692.19*	*0.00*	*0.00*	*7,220.85*
0401990201 Site Prep	**5.00**	**EA**	**22,643**	**13,461**	**0**	**0**	**36,104**
			0.22	*0.22*	*0.00*	*0.00*	*0.44*
RSM 311110100150 Clearing & grubbing, grub stumps and remove	4,500.00	SF	1,010	988	0	0	1,998
			1.35	*1.76*	*0.00*	*0.00*	*3.11*
RSM 311413231460 Topsoil stripping and stockpiling, loam or topsoil, remove and stockpile on site, 200 HP dozer, 6" deep, 500' haul per S.Y.	500.00	SY	675	880	0	0	1,555
			11.43	*6.32*	*0.00*	*0.00*	*17.76*
RSM 312316166260 Structural excavation for minor structures, bank measure, for spread and mat footings, elevator pits, and small building foundations, sandy clay or loam, 2 C.Y. bucket, machine excavation, hydraulic backhoe	1,833.00	BCY	20,958	11,594	0	0	32,552
			48.03	*9.75*	*76.29*	*5.03*	*139.10*
0401990202 Piling	**3,200.00**	**VLF**	**153,681**	**31,197**	**244,128**	**16,100**	**445,105**
			32,586.27	*6,614.87*	*0.00*	*0.00*	*39,201.14*
RSM 310660150300 Mobilization, 150 ton, set up and remove crane, with pile leads and pile hammer	1.00	EA	32,586	6,615	0	0	39,201
			0.00	*0.00*	*0.00*	*16,100.00*	*16,100.00*
RSM 310660141050 Piling special costs, testing, any type piles, test load is twice the design load, 50 ton design load, 100 ton test	1.00	EA	0	0	0	16,100	16,100
			37.84	*7.68*	*76.29*	*0.00*	*121.81*
RSM 316223134200 Concrete-filled steel piles, steel, pipe piles, concrete filled, 50' long, 24" diameter, 59 lb./L.F., excludes mobilization or demobilization	3,200.00	VLF	121,095	24,582	244,128	0	389,804
			217.05	*0.92*	*329.38*	*0.00*	*547.35*
0401990203 Mat Foundations for Towers	**763.00**	**CY**	**165,609**	**704**	**251,316**	**0**	**417,629**
(Note: Q*20*20*10*1.03/27)							
			217.05	*0.92*	*329.38*	*0.00*	*547.35*
RSM 033053405950 Structural concrete, in place, pile cap (3000 psi), square or rectangular, over 10 C.Y., includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), placing and finishing	763.00	CY	165,609	704	251,316	0	417,629
			39,252.60	*5,568.98*	*0.00*	*0.00*	*44,821.59*
0401990204 Backfill	**5.00**	**EA**	**196,263**	**27,845**	**0**	**0**	**224,108**
			90.28	*0.00*	*0.00*	*0.00*	*90.28*
HNC 312323140022 Backfill, structural, 6" lifts, backfill around foundation, by hand	1,019.00	CY	91,994	0	0	0	91,994

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
			127.94	*34.17*	*0.00*	*0.00*	*162.10*
HNC 311313110016 Selective clearing, load spoils, wheel and ramp load, includes 2 mile haul to dump	815.00	CY	104,269	27,845	0	0	132,114
04019903 Structural Steel	**1.00**	**LS**	**2,273,264**	**427,313**	**7,144,872**	**0**	**9,845,448**
(Note: Structural Steel for towers and columns. See BOE Appendix B, 4.0 for QTY and 9.0 for structural tubing cost.)							
			219,758.39	*65,324.41*	*378,452.15*	*0.00*	*663,534.95*
0401990301 Main Towers	**5.00**	**EA**	**1,098,792**	**326,622**	**1,892,261**	**0**	**3,317,675**
			2,373.20	*705.45*	*4,086.96*	*0.00*	*7,165.60*
RSM 337113230640 Steel tower, special steel structure erection	463.00	TON	1,098,792	326,622	1,892,261	0	3,317,675
			16,066.42	*1,356.22*	*72,052.50*	*0.00*	*89,475.15*
0401990302 40' Columns	**53.00**	**EA**	**851,520**	**71,880**	**3,818,783**	**0**	**4,742,183**
			726.01	*139.00*	*3,148.47*	*0.00*	*4,013.48*
HNC 051223232011 Column, structural tubing, 36" x 18" x 1", incl shop primer, cap & base plate, bolts	486.00	TON	352,840	67,554	1,530,156	0	1,950,550
			0.00	*0.00*	*132.25*	*0.00*	*132.25*
RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer	14,510.00	SF	0	0	1,918,948	0	1,918,948
(Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate. No Cost Book adjustment added as this item is quoted.)							
			117.61	*1.02*	*87.19*	*0.00*	*205.82*
RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	4,240.00	EA	498,681	4,326	369,679	0	872,685
			13,456.31	*1,200.46*	*59,742.84*	*0.00*	*74,399.62*
0401990303 30' Columns	**24.00**	**EA**	**322,952**	**28,811**	**1,433,828**	**0**	**1,785,591**
			726.01	*139.00*	*3,148.47*	*0.00*	*4,013.48*
HNC 051223232011 Column, structural tubing, 32" x 16" x 1", incl shop primer, cap & base plate, bolts	196.00	TON	142,297	27,244	617,100	0	786,642
			0.00	*0.00*	*132.25*	*0.00*	*132.25*
RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer	5,163.00	SF	0	0	682,807	0	682,807
(Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate. No Cost Book adjustment added as this item is quoted.)							
			117.61	*1.02*	*87.19*	*0.00*	*205.82*
RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	1,536.00	EA	180,654	1,567	133,921	0	316,142
			10.28	*0.00*	*12.50*	*0.00*	*22.78*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
04019904 Stainless Steel Wire	**198,693.00**	**LF**	**2,043,413**	**0**	**2,483,762**	**0**	**4,527,175**
(Note: SS wire 1 1/4" gauge. See BOE Appendix B, 4.0 for QTY and 8.0 for SS wire cost.No Cost Book adjustment added as the items under this section are quotes.)							
			10.28	*0.00*	*12.50*	*0.00*	*22.78*
1-1/4" Stainless Steel Wire	**198,693.00**	**LF**	**2,043,413**	**0**	**2,483,762**	**0**	**4,527,175**
			10.28	*0.00*	*12.50*	*0.00*	*22.78*
RSM 051516500590 Steel wire 1-1/4" dia	198,693.00	LF	2,043,413	0	2,483,762	0	4,527,175
(Note: Material quote from https://www.uscargocontrol.com/products/galvanized-wire-rope-eips-iwrc-6x19-class-1-1-4-5000-coil.)							
			789.18	*0.00*	*465.00*	*0.00*	*1,254.19*
04019916 Grounding	**5.00**	**EA**	**3,946**	**0**	**2,325**	**0**	**6,271**
(Note: Grounding for Main Towers.)							
			789.18	*0.00*	*465.00*	*0.00*	*1,254.19*
04019916 Grounding	**5.00**	**EA**	**3,946**	**0**	**2,325**	**0**	**6,271**
			14.69	*0.00*	*9.14*	*0.00*	*23.84*
RSM 264113132100 Cable, copper, 375 lb per thousand feet, over 40' high	250.00	LF	3,673	0	2,286	0	5,959
			272.50	*0.00*	*39.36*	*0.00*	*311.86*
RSM 260526800030 Grounding rod, copper clad, 8' long, 1/2" diameter	1.00	EA	273	0	39	0	312
			0.43	*0.10*	*1.03*	*0.02*	*1.58*
0401 ALTERNATIVE 2A - 1/4" Stainless Steel Wire	**4,886,108.00**	**SF**	**2,111,609**	**478,211**	**5,021,029**	**119,600**	**7,730,448**
(Note: Alternative 2A: Similar design to Alternative 1A, with additional design based on a proposed code variance. Large APDA originating from towers at the Oregon shoreline. ¼" SS wires fans out across the river, anchoring along the navigation guide wall, navigation lock wall, and spillway deck. Assumed construction duration: 8 Months)							
040199 Associated General Items	**1.00**	**LS**	**2,111,609**	**478,211**	**5,021,029**	**119,600**	**7,730,448**
(Note: Costs developed for Alternative 2A include Barge, Towers Foundations, Structural Steel for Towers and Columns, SS wire, and Lightning Protection.)							
			71,412.35	*51,676.07*	*0.00*	*17,250.00*	*140,338.42*
04019901 Barge Costs	**6.00**	**MO**	**428,474**	**310,056**	**0**	**103,500**	**842,030**
(Note: Barge mob/demob and operations for marine-based work. See BOE Appendix B, 5.0.)							
Mobilization of Barge	**1.00**	**LS**	**0**	**0**	**0**	**51,750**	**51,750**
			0.00	*0.00*	*0.00*	*51,750.00*	*51,750.00*
RSM 310660151320 Mobilization, set up and remove, mobilization by water for barge driving rig, maximum	1.00	EA	0	0	0	51,750	51,750
			71,412.35	*51,676.07*	*0.00*	*0.00*	*123,088.42*
Barge Operations	**6.00**	**MO**	**428,474**	**310,056**	**0**	**0**	**738,530**
			71,412.35	*51,676.07*	*0.00*	*0.00*	*123,088.42*
USR 061333520362 Standby time for barge (Small)	6.00	MO	428,474	310,056	0	0	738,530
Demobilization of Barge	**1.00**	**LS**	**0**	**0**	**0**	**51,750**	**51,750**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
			0.00	*0.00*	*0.00*	*51,750.00*	*51,750.00*
RSM 310660151320 Demobilization by water for barge driving rig, maximum	1.00	EA	0	0	0	51,750	51,750
			52,855.34	*7,767.98*	*44,674.37*	*4,025.00*	*109,322.68*
04019902 Foundations for Towers	**4.00**	**EA**	**211,421**	**31,072**	**178,697**	**16,100**	**437,291**
(Note: Costs have been included for clearing/grubbing, minor excavation, piling for cranes, structural concrete for tower foundation mats, and backfill. Based on A-E guidance, site is assumed to have adequate access and sufficient nearby space for laydown arrea.)							
			2,168.02	*1,319.00*	*0.00*	*0.00*	*3,487.02*
0401990201 Site Prep	**4.00**	**EA**	**8,672**	**5,276**	**0**	**0**	**13,948**
			0.22	*0.22*	*0.00*	*0.00*	*0.44*
RSM 311110100150 Clearing & grubbing, grub stumps and remove	2,304.00	SF	517	506	0	0	1,023
			1.35	*1.76*	*0.00*	*0.00*	*3.11*
RSM 311413231460 Topsoil stripping and stockpiling, loam or topsoil, remove and stockpile on site, 200 HP dozer, 6" deep, 500' haul per S.Y.	256.00	SY	346	450	0	0	796
			11.43	*6.32*	*0.00*	*0.00*	*17.76*
RSM 312316166260 Structural excavation for minor structures, bank measure, for spread and mat footings, elevator pits, and small building foundations, sandy clay or loam, 2 C.Y. bucket, machine excavation, hydraulic backhoe	683.00	BCY	7,809	4,320	0	0	12,129
			60.47	*12.28*	*76.29*	*11.18*	*160.22*
0401990202 Piling	**1,440.00**	**VLF**	**87,079**	**17,677**	**109,857**	**16,100**	**230,713**
			32,586.27	*6,614.87*	*0.00*	*0.00*	*39,201.14*
RSM 310660150300 Mobilization, 150 ton, set up and remove crane, with pile leads and pile hammer	1.00	EA	32,586	6,615	0	0	39,201
			0.00	*0.00*	*0.00*	*16,100.00*	*16,100.00*
RSM 310660141050 Piling special costs, testing, any type piles, test load is twice the design load, 50 ton design load, 100 ton test	1.00	EA	0	0	0	16,100	16,100
			37.84	*7.68*	*76.29*	*0.00*	*121.81*
RSM 316223134200 Concrete-filled steel piles, steel, pipe piles, concrete filled, 50' long, 24" diameter, 59 lb./L.F., excludes mobilization or demobilization	1,440.00	VLF	54,493	11,062	109,857	0	175,412
			217.05	*0.92*	*329.38*	*0.00*	*547.35*
0401990203 Mat Foundations for Towers	**209.00**	**CY**	**45,363**	**193**	**68,840**	**0**	**114,396**
(Note: Q*14*14*7*1.03/27)							
			217.05	*0.92*	*329.38*	*0.00*	*547.35*
RSM 033053405950 Structural concrete, in place, pile cap (3000 psi), square or rectangular, over 10 C.Y., includes forms(4 uses), Grade 60 rebar, concrete (Portland	209.00	CY	45,363	193	68,840	0	114,396

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
cement Type I), placing and finishing							
			17,576.73	*1,981.60*	*0.00*	*0.00*	*19,558.33*
0401990204 Backfill	**4.00**	**EA**	**70,307**	**7,926**	**0**	**0**	**78,233**
			90.28	*0.00*	*0.00*	*0.00*	*90.28*
HNC 312323140022 Backfill, structural, 6" lifts, backfill around foundation, by hand	450.00	CY	40,625	0	0	0	40,625
			127.94	*34.17*	*0.00*	*0.00*	*162.10*
HNC 311313110016 Selective clearing, load spoils, wheel and ramp load, includes 2 mile haul to dump	232.00	CY	29,681	7,926	0	0	37,608
04019903 Structural Steel	**1.00**	**LS**	**1,135,207**	**137,082**	**4,391,227**	**0**	**5,663,517**
(Note: Structural Steel for towers. See BOE Appendix B, 5.0 for QTY and 9.0 for structural tubing cost.)							
			54,583.62	*16,225.28*	*93,999.99*	*0.00*	*164,808.90*
0401990301 Main Towers	**4.00**	**EA**	**218,334**	**64,901**	**376,000**	**0**	**659,236**
			2,373.20	*705.45*	*4,086.96*	*0.00*	*7,165.60*
RSM 337113230640 Steel tower, special steel structure erection	92.00	TON	218,334	64,901	376,000	0	659,236
			13,448.25	*1,198.92*	*59,706.02*	*0.00*	*74,353.19*
0401990303 30' Columns	**45.00**	**EA**	**605,171**	**53,951**	**2,686,771**	**0**	**3,345,894**
			726.01	*139.00*	*3,148.47*	*0.00*	*4,013.48*
HNC 051223232011 Column, structural tubing, 32" x 16" x 1", incl shop primer, cap & base plate, bolts	367.00	TON	266,445	51,013	1,155,488	0	1,472,946
			0.00	*0.00*	*132.25*	*0.00*	*132.25*
RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer	9,680.00	SF	0	0	1,280,180	0	1,280,180
(Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate. No Cost Book adjustment added as this item is quoted.)							
			117.61	*1.02*	*87.19*	*0.00*	*205.82*
RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	2,880.00	EA	338,726	2,938	251,103	0	592,767
			11,066.54	*742.92*	*49,379.13*	*0.00*	*61,188.59*
0401990304 20' Columns	**24.00**	**EA**	**265,597**	**17,830**	**1,185,099**	**0**	**1,468,526**
			726.01	*139.00*	*3,148.47*	*0.00*	*4,013.48*
HNC 051223232011 Column, structural tubing, 32" x 16" x 1", incl shop primer, cap & base plate, bolts	117.00	TON	84,943	16,263	368,371	0	469,577
			0.00	*0.00*	*132.25*	*0.00*	*132.25*
RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer	5,163.00	SF	0	0	682,807	0	682,807

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
(Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate. No Cost Book adjustment added as this item is quoted.)							
			117.61	*1.02*	*87.19*	*0.00*	*205.82*
RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	1,536.00	EA	180,654	1,567	133,921	0	316,142
			940.91	*8.16*	*2,925.66*	*0.00*	*3,874.72*
0401990305 Dam Wall Brackets	**49.00**	**EA**	**46,104**	**400**	**143,357**	**0**	**189,861**
			0.00	*0.00*	*139.26*	*0.00*	*139.26*
RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer (Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate)	784.00	SF	0	0	109,179	0	109,179
			117.61	*1.02*	*87.19*	*0.00*	*205.82*
RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	392.00	EA	46,104	400	34,178	0	80,682
			1.02	*0.00*	*1.37*	*0.00*	*2.38*
04019904 Stainless Steel Wire	**328,269.00**	**LF**	**333,295**	**0**	**449,236**	**0**	**782,531**
(Note: SS wire 1/4" gauge. See BOE Appendix B, 5.0 for QTY and 8.0 for SS wire cost.No Cost Book adjustment added as the items under this section are quotes.)							
			1.02	*0.00*	*1.37*	*0.00*	*2.38*
1/4" Stainless Steel Wire	**328,269.00**	**LF**	**333,295**	**0**	**449,236**	**0**	**782,531**
			1.02	*0.00*	*1.37*	*0.00*	*2.38*
RSM 051516500550 Steel wire, 1/4" dia (Note: https://www.uscargocontrol.com/products/1-4-7x19-type-304-stainless-steel-wire-by-linear-foot)	328,269.00	LF	333,295	0	449,236	0	782,531
			802.81	*0.00*	*466.97*	*0.00*	*1,269.78*
04019916 Grounding	**4.00**	**EA**	**3,211**	**0**	**1,868**	**0**	**5,079**
(Note: Grounding for Main Towers.)							
			802.81	*0.00*	*466.97*	*0.00*	*1,269.78*
04019916 Grounding	**4.00**	**EA**	**3,211**	**0**	**1,868**	**0**	**5,079**
			14.69	*0.00*	*9.14*	*0.00*	*23.84*
RSM 264113132100 Cable, copper, 375 lb per thousand feet, over 40' high	200.00	LF	2,939	0	1,829	0	4,767
			272.50	*0.00*	*39.36*	*0.00*	*311.86*
RSM 260526800030 Grounding rod, copper clad, 8' long, 1/2" diameter	1.00	EA	273	0	39	0	312
			0.53	*0.11*	*1.53*	*0.04*	*2.21*
0401 ALTERNATIVE 2B - 1/4" Stainless Steel Wire	**3,143,837.00**	**SF**	**1,680,337**	**335,720**	**4,818,140**	**119,600**	**6,953,797**
(Note: Alternative 2B: Similar design to Alternative 1B, with additional design based on a proposed code variance. Large APDA originating from towers on the Oregon shoreline; ¼" SS wires fan out across the river, anchoring at the navigation lock guide wall and navigation lock wall; excludes wires attached at the spillway. Assumed construction duration: 6 Months)							

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
040199 Associated General Items	**1.00**	**LS**	**1,680,337**	**335,720**	**4,818,140**	**119,600**	**6,953,797**
(Note: Costs developed for Alternative 2B include Barge, Towers Foundations, Structural Steel for Towers and Columns, SS wire, and Lightning Protection.)							
			71,412.35	*51,676.07*	*0.00*	*25,875.00*	*148,963.42*
04019901 Barge Costs	**4.00**	**MO**	**285,649**	**206,704**	**0**	**103,500**	**595,854**
(Note: Barge mob/demob and operations for marine-based work. See BOE Appendix B, 6.0.)							
Mobilization of Barge	**1.00**	**LS**	**0**	**0**	**0**	**51,750**	**51,750**
			0.00	*0.00*	*0.00*	*51,750.00*	*51,750.00*
RSM 310660151320 Mobilization, set up and remove, mobilization by water for barge driving rig, maximum	1.00	EA	0	0	0	51,750	51,750
			71,412.35	*51,676.07*	*0.00*	*0.00*	*123,088.42*
Barge Operations	**4.00**	**MO**	**285,649**	**206,704**	**0**	**0**	**492,354**
			71,412.35	*51,676.07*	*0.00*	*0.00*	*123,088.42*
USR 061333520362 Standby time for barge (Small)	4.00	MO	285,649	206,704	0	0	492,354
Demobilization of Barge	**1.00**	**LS**	**0**	**0**	**0**	**51,750**	**51,750**
			0.00	*0.00*	*0.00*	*51,750.00*	*51,750.00*
RSM 310660151320 Demobilization by water for barge driving rig, maximum	1.00	EA	0	0	0	51,750	51,750
			61,053.31	*9,420.34*	*44,756.71*	*8,050.00*	*123,280.37*
04019902 Foundations for Towers	**2.00**	**EA**	**122,107**	**18,841**	**89,513**	**16,100**	**246,561**
(Note: Costs have been included for clearing/grubbing, minor excavation, piling for cranes, structural concrete for tower foundation mats, and backfill. Based on A-E guidance, site is assumed to have adequate access and sufficient nearby space for laydown arrea.)							
			2,165.16	*1,317.42*	*0.00*	*0.00*	*3,482.58*
0401990201 Site Prep	**2.00**	**EA**	**4,330**	**2,635**	**0**	**0**	**6,965**
			0.22	*0.22*	*0.00*	*0.00*	*0.44*
RSM 311110100150 Clearing & grubbing, grub stumps and remove	1,152.00	SF	259	253	0	0	511
			1.35	*1.76*	*0.00*	*0.00*	*3.11*
RSM 311413231460 Topsoil stripping and stockpiling, loam or topsoil, remove and stockpile on site, 200 HP dozer, 6" deep, 500' haul per S.Y.	128.00	SY	173	225	0	0	398
			11.43	*6.32*	*0.00*	*0.00*	*17.76*
RSM 312316166260 Structural excavation for minor structures, bank measure, for spread and mat footings, elevator pits, and small building foundations, sandy clay or loam, 2 C.Y. bucket, machine excavation, hydraulic backhoe	341.00	BCY	3,899	2,157	0	0	6,056
			83.10	*16.87*	*76.29*	*22.36*	*198.62*
0401990202 Piling	**720.00**	**VLF**	**59,833**	**12,146**	**54,929**	**16,100**	**143,007**
			32,586.27	*6,614.87*	*0.00*	*0.00*	*39,201.14*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
RSM 310660150300 Mobilization, 150 ton, set up and remove crane, with pile leads and pile hammer	1.00	EA	32,586	6,615	0	0	39,201
			0.00	*0.00*	*0.00*	*16,100.00*	*16,100.00*
RSM 310660141050 Piling special costs, testing, any type piles, test load is twice the design load, 50 ton design load, 100 ton test	1.00	EA	0	0	0	16,100	16,100
			37.84	*7.68*	*76.29*	*0.00*	*121.81*
RSM 316223134200 Concrete-filled steel piles, steel, pipe piles, concrete filled, 50' long, 24" diameter, 59 lb./L.F., excludes mobilization or demobilization	720.00	VLF	27,246	5,531	54,929	0	87,706
			217.05	*0.92*	*329.38*	*0.00*	*547.35*
0401990203 Mat Foundations for Towers (Note: Q*14*14*7*1.03/27)	**105.00**	**CY**	**22,790**	**97**	**34,585**	**0**	**57,472**
			217.05	*0.92*	*329.38*	*0.00*	*547.35*
RSM 033053405950 Structural concrete, in place, pile cap (3000 psi), square or rectangular, over 10 C.Y., includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), placing and finishing	105.00	CY	22,790	97	34,585	0	57,472
			17,576.73	*1,981.60*	*0.00*	*0.00*	*19,558.33*
0401990204 Backfill	**2.00**	**EA**	**35,153**	**3,963**	**0**	**0**	**39,117**
			90.28	*0.00*	*0.00*	*0.00*	*90.28*
HNC 312323140022 Backfill, structural, 6" lifts, backfill around foundation, by hand	225.00	CY	20,313	0	0	0	20,313
			127.94	*34.17*	*0.00*	*0.00*	*162.10*
HNC 311313110016 Selective clearing, load spoils, wheel and ramp load, includes 2 mile haul to dump	116.00	CY	14,841	3,963	0	0	18,804
04019903 Structural Steel (Note: Structural Steel for towers. See BOE Appendix B, 6.0 for QTY and 9.0 for structural tubing cost.)	**1.00**	**LS**	**1,068,468**	**110,175**	**4,454,903**	**0**	**5,633,546**
			54,583.62	*16,225.28*	*93,999.99*	*0.00*	*164,808.90*
0401990301 Main Towers	**2.00**	**EA**	**109,167**	**32,451**	**188,000**	**0**	**329,618**
			2,373.20	*705.45*	*4,086.96*	*0.00*	*7,165.60*
RSM 337113230640 Steel tower, special steel structure erection	46.00	TON	109,167	32,451	188,000	0	329,618
			13,448.25	*1,198.92*	*59,706.02*	*0.00*	*74,353.19*
0401990303 30' Columns	**45.00**	**EA**	**605,171**	**53,951**	**2,686,771**	**0**	**3,345,894**
			726.01	*139.00*	*3,148.47*	*0.00*	*4,013.48*
HNC 051223232011 Column, structural tubing, 32" x 16" x 1", incl shop primer, cap & base plate, bolts	367.00	TON	266,445	51,013	1,155,488	0	1,472,946
			0.00	*0.00*	*132.25*	*0.00*	*132.25*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer (Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate. No Cost Book adjustment added as this item is quoted.)	9,680.00	SF	0	0	1,280,180	0	1,280,180
			117.61	*1.02*	*87.19*	*0.00*	*205.82*
RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	2,880.00	EA	338,726	2,938	251,103	0	592,767
			11,066.54	*742.92*	*49,379.13*	*0.00*	*61,188.59*
0401990304 20' Columns	**32.00**	**EA**	**354,129**	**23,773**	**1,580,132**	**0**	**1,958,035**
			726.01	*139.00*	*3,148.47*	*0.00*	*4,013.48*
HNC 051223232011 Column, structural tubing, 32" x 16" x 1", incl shop primer, cap & base plate, bolts	156.00	TON	113,257	21,684	491,161	0	626,103
			0.00	*0.00*	*132.25*	*0.00*	*132.25*
RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer (Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate. No Cost Book adjustment added as this item is quoted.)	6,884.00	SF	0	0	910,409	0	910,409
			117.61	*1.02*	*87.19*	*0.00*	*205.82*
RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	2,048.00	EA	240,872	2,089	178,562	0	421,523
			1.02	*0.00*	*1.37*	*0.00*	*2.38*
04019904 Stainless Steel Wire (Note: SS wire 1/4" gauge. See BOE Appendix B, 6.0 for QTY and 8.0 for SS wire cost. No Cost Book adjustment added as the items under this section are quotes.)	**199,320.00**	**LF**	**202,372**	**0**	**272,769**	**0**	**475,141**
			1.02	*0.00*	*1.37*	*0.00*	*2.38*
1/4" Stainless Steel Wire	**199,320.00**	**LF**	**202,372**	**0**	**272,769**	**0**	**475,141**
			1.02	*0.00*	*1.37*	*0.00*	*2.38*
RSM 051516500550 Steel wire, 1/4" dia (Note: https://www.uscargocontrol.com/products/1-4-7x19-type-304-stainless-steel-wire-by-linear-foot)	199,320.00	LF	202,372	0	272,769	0	475,141
			870.93	*0.00*	*476.81*	*0.00*	*1,347.74*
04019916 Grounding (Note: Grounding for Main Towers.)	**2.00**	**EA**	**1,742**	**0**	**954**	**0**	**2,695**
			870.93	*0.00*	*476.81*	*0.00*	*1,347.74*
04019916 Grounding	**2.00**	**EA**	**1,742**	**0**	**954**	**0**	**2,695**
			14.69	*0.00*	*9.14*	*0.00*	*23.84*
RSM 264113132100 Cable, copper, 375 lb per thousand feet, over 40' high	100.00	LF	1,469	0	914	0	2,384
			272.50	*0.00*	*39.36*	*0.00*	*311.86*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
RSM 260526800030 Grounding rod, copper clad, 8' long, 1/2" diameter	1.00	EA	273	0	39	0	312
			22,987.04	*16,148.77*	*20,802.26*	*17,250.00*	*77,188.07*
0401 ALTERNATIVE 3 - In-Water Array Anchors	**6.00**	**EA**	**137,922**	**96,893**	**124,814**	**103,500**	**463,128**
(Note: Alternative 3: In-water array composed of a series of six (6) stainless-steel cables suspended at the water surface by regularly spaced buoy floats; cables are arranged in a linear array trailing downstream from the outfall pier. Assumed construction duration: 1.5 Months)							
040199 Associated General Items	**1.00**	**LS**	**137,922**	**96,893**	**124,814**	**103,500**	**463,128**
(Note: Costs developed for Alternative 3 include Barge costs and Array anchors.)							
			89,757.57	*64,595.09*	*0.00*	*69,000.00*	*223,352.65*
04019901 Barge Costs	**1.50**	**MO**	**134,636**	**96,893**	**0**	**103,500**	**335,029**
(Note: Barge mob/demob and operations for marine-based work. See BOE Appendix B, 7.0.)							
0401990101 Mobilization of Barge	**1.00**	**LS**	**0**	**0**	**0**	**51,750**	**51,750**
			0.00	*0.00*	*0.00*	*51,750.00*	*51,750.00*
RSM 310660151320 Mobilization, set up and remove, mobilization by water for barge driving rig, maximum	1.00	EA	0	0	0	51,750	51,750
			89,757.57	*64,595.09*	*0.00*	*0.00*	*154,352.65*
0401990102 Barge Operations	**1.50**	**MO**	**134,636**	**96,893**	**0**	**0**	**231,529**
			89,757.57	*64,595.09*	*0.00*	*0.00*	*154,352.65*
USR 061333520362 Standby time for barge (Small)	1.50	MO	134,636	96,893	0	0	231,529
0401990103 Demobilization of Barge	**1.00**	**LS**	**0**	**0**	**0**	**51,750**	**51,750**
			0.00	*0.00*	*0.00*	*51,750.00*	*51,750.00*
RSM 310660151320 Demobilization by water for barge driving rig, maximum	1.00	EA	0	0	0	51,750	51,750
			547.65	*0.00*	*20,802.26*	*0.00*	*21,349.90*
04019902 In-Water Array Anchors	**6.00**	**EA**	**3,286**	**0**	**124,814**	**0**	**128,099**
(Note: Six (6) In-water arrays. See BOE Appendix B, 7.0 for QTY.)							
			547.65	*0.00*	*20,802.26*	*0.00*	*21,349.90*
0401990201 In-Water Array Anchors	**6.00**	**EA**	**3,286**	**0**	**124,814**	**0**	**128,099**
(Note: . No Cost Book adjustment added as the items under this section are quotes.)							
			0.00	*0.00*	*494.44*	*0.00*	*494.44*
USR 13" X 18" Buoy (Note: https://www.dockgearsupply.com/boat-dock-accessories/pc/13-x-18-Elliptical-Mooring-Buoys-with-Stainless-Steel-Hardware-p1162.htm)	78.00	EA	0	0	38,567	0	38,567
			0.00	*0.00*	*250.57*	*0.00*	*250.57*
USR Anchor Buoy (Note: https://polyformus.com/products/cm-2-mooring-buoy?variant=45343845810314&country=US&currency=USD&utm_medium=product_sync&utm_source=google&utm_content=sag_organic&utm_campaign=sag_organic&gad_source=1&gclid=Cj0KCQjw782_BhDjARIsABTv_JAJP67W5tQE1Vfy62wpdJV15upajVpZf0YkSXNtUqTTh6_OiuCFoLkaAmCFEALw_wcB)	6.00	EA	0	0	1,503	0	1,503

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
			0.00	*0.00*	*115.00*	*0.00*	*115.00*
USR Nylon/HMPE Rope	600.00	LF	0	0	69,000	0	69,000
(Note: https://skydogrigging.com/product/516-blue-hmpe-12-strand-rope-600-spool/?gad_source=1&gclid=Cj0KCQjw782_BhDjARIsABTv_JBEAbYSJ9_n0bojkeMFJ3kv3Va8GbANpTvv6KTP5iRbiTffk36tTy0aAqUmEALw_wcB)							
			0.00	*0.00*	*228.85*	*0.00*	*228.85*
USR 55 LB Weight for Semi Submersion	36.00	EA	0	0	8,239	0	8,239
(Note: https://www.rotometals.com/custom-buoy-weights-50-pounds-for-large-ones/)							
			0.00	*0.00*	*264.50*	*0.00*	*264.50*
USR Buoy Anchor (100 Lb)	6.00	EA	0	0	1,587	0	1,587
(Note: https://boatstore.com/marpac-pyramid-style-mooring-anchor-100-lbs.html?utm_source=googleshopping&utm_medium=cse&srsltid=AfmBOop1ADx9ZKKwsqaGaiL5MGqX13Sbk9lEmGd9eFNSGbo3kO1oOGKza-k)							
			0.00	*0.00*	*0.12*	*0.00*	*0.12*
USR Trip Lines	1,800.00	LF	0	0	207	0	207
(Note: https://www.uline.com/Product/Detail/S-15873/Twine-Rope/Hollow-Braid-Polypropylene-Rope-3-8-x-500?pricode=WB0668&gadtype=pla&id=S-15873&gad_source=4&gclid=Cj0KCQjw782_BhDjARIsABTv_JDvNq4Xnelewrwb1yAwTkuxxw9C9xtLbcKp1gjjGRa5O51GBbmrWosaAnxtEALw_wcB)							
			0.00	*0.00*	*8.50*	*0.00*	*8.50*
USR Bottom Chain	672.00	LF	0	0	5,711	0	5,711
(Note: https://www.grainger.com/product/48RN41?N:N:PS:Paid:GGL:CSM-2295:ZPF8P7:20800401:APZ_1&gad_source=1&gclid=Cj0KCQjw782_BhDjARIsABTv_JDNqwu54XdTzk_hk6DBnwdqwgcBNORv_UOOmo6Vg74joOZe9yx-WtYaAhXTEALw_wcB&gclsrc=aw.ds)							
			547.65	*0.00*	*0.00*	*0.00*	*547.65*
USR In-Water Array Anchors	6.00	HR	3,286	0	0	0	3,286
(Note: Crew composed of 1 foreman, 1 diver, and 2 carpenters)							

Description	UOM	Quantity	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
Job Office Overhead Direct Cost Report							
Prime Option 1A							
			641.59	*330.12*	*0.00*	*0.00*	*971.71*
RSM 015436501400 Demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	EA	100.00	64,159	33,012	0	0	97,171
Prime Option 1B							
			641.59	*330.12*	*0.00*	*0.00*	*971.71*
RSM 015436501400 Demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	EA	100.00	64,159	33,012	0	0	97,171
Prime Option 2A							
			641.59	*330.12*	*0.00*	*0.00*	*971.71*
RSM 015436501400 Demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	EA	100.00	64,159	33,012	0	0	97,171
Prime Option 2B							
			0.00	*16,272.33*	*0.00*	*0.00*	*16,272.33*
USR ST Small Tools	EA	1.00	0	16,272	0	0	16,272
			35,094.47	*0.00*	*0.00*	*0.00*	*35,094.47*
FOP FB-OMANR Project Manager	MO	6.00	210,567	0	0	0	210,567
			36,478.80	*0.00*	*0.00*	*0.00*	*36,478.80*
FOP FA-AGENS General Superintendent	MO	6.00	218,873	0	0	0	218,873
			28,661.20	*0.00*	*0.00*	*0.00*	*28,661.20*
FOP FD-SAENG Safety Engineer	MO	6.00	171,967	0	0	0	171,967
			11,996.64	*0.00*	*0.00*	*0.00*	*11,996.64*
FOP FB-CLTYP Clerks, Typists, Bookkeepers & Receptionis	MO	6.00	71,980	0	0	0	71,980
			28,661.20	*0.00*	*0.00*	*0.00*	*28,661.20*
FOP FA-QAMNGR Quality Control Manager	MO	6.00	171,967	0	0	0	171,967
			0.00	*4,573.04*	*0.00*	*0.00*	*4,573.04*
GEN T50Z0310 TRUCK, HIGHWAY, CONVENTIONAL, 3/4 TON PICKUP, 4X4	MO	12.00	0	54,876	0	0	54,876

Description	UOM	Quantity	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
(2 EA)							
			23,982.57	*0.00*	*0.00*	*0.00*	*23,982.57*
FOP FC-FLDER Field Engineers (2 EA)	MO	12.00	287,791	0	0	0	287,791
			23,982.57	*0.00*	*0.00*	*0.00*	*23,982.57*
FOP 45 Field Shop Drawing Services	MO	6.00	143,895	0	0	0	143,895
			0.00	*0.00*	*0.00*	*5,000.00*	*5,000.00*
USR BEPUSRAB029 Job Photographs / Video (Note: Budget of $5,000 per month based on estimator's judgement.)	MO	6.00	0	0	0	30,000	30,000
			0.00	*0.00*	*80.25*	*0.00*	*80.25*
HTW 019413201504 First aid kits, 36 ingredients	EA	2.00	0	0	160	0	160
			0.00	*0.00*	*0.00*	*0.00*	*0.00*
HTW 019413201102 Eye and body wash stations, emergency body shower and eye wash station	EA	1.00	0	0	0	0	0
			1,002.92	*968.38*	*0.00*	*0.00*	*1,971.30*
RSM 311110100150 Clearing & grubbing, grub stumps and remove	ACR	0.50	501	484	0	0	986
			1.01	*0.93*	*8.25*	*0.00*	*10.19*
RSM 321123230302 Base course drainage layers, aggregate base course for roadways and large paved areas, crushed stone base, compacted, crushed 1-1/2" stone base, to 6" deep (Note: Reduced 206 SY per Amendment dated Sept. 18, 2024)	SY	2,214.00	2,239	2,049	18,266	0	22,554
			3,650.98	*343.95*	*3,050.00*	*0.00*	*7,044.93*
RSM 330526050020 Utility connection, water, sanitary, stormwater, gas, single connection	EA	1.00	3,651	344	3,050	0	7,045
			0.00	*597.02*	*0.00*	*0.00*	*597.02*
GEN G10Z3063 GENERATOR SET, PORTABLE, 5.6 KW, 120/240V, 60 HZ (38 EA)	MO	6.00	0	3,582	0	0	3,582
			0.00	*0.00*	*0.00*	*5,000.00*	*5,000.00*
USR BEPUSRAB032 Temporary Site Lighting (Note: Budget of $5,000 per month for Temporary site lighting based on estimator's judgement)	MO	6.00	0	0	0	30,000	30,000
			3.97	*0.00*	*3.79*	*0.00*	*7.76*
RSM 015626500100 Temporary fencing, chain link, 6' high, 11 ga	LF	2,000.00	7,948	0	7,580	0	15,528
USR BEPUSRAB033 Access Control Points (Note: Budget of $15,000 for Access Control Points based on estimator's judgement)	LS	1.00	0	0	0	15,000	15,000
			0.00	*0.00*	*0.00*	*25,000.00*	*25,000.00*
USR BEPUSRAB034 Dewatering	MO	6.00	0	0	0	150,000	150,000

Description	UOM	Quantity	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
(Note: Budget of $25,000 per month for Dewatering based on estimator's judgement)							
			0.00	*0.00*	*354.00*	*0.00*	*354.00*
RSM 015213200250 Office trailer, furnished, rent per month, 20' x 8', excl. hookups (38 EA)	MO	6.00	0	0	2,124	0	2,124
			0.00	*0.00*	*300.00*	*0.00*	*300.00*
RSM 015113800700 Temporary utilities, temporary construction r bill per month, average (38 Trailers)	MO	6.00	0	0	1,800	0	1,800
(Note: Assume to include all utilities needed for trailer area (Electrical, water, sewer))							
			0.00	*0.00*	*53.50*	*0.00*	*53.50*
RSM 015213200700 Office trailer, excl. hookups, air conditioning, rent per month, add	EA	6.00	0	0	321	0	321
			199.99	*0.00*	*57.50*	*0.00*	*257.49*
RSM 015113500870 Temporary electrical power equipment (pro-rated per job), connections, office trailer, 60 amp	EA	1.00	200	0	58	0	257
			0.00	*0.00*	*91.50*	*0.00*	*91.50*
RSM 015213400120 Field office expense, office supplies, average (38 EA)	MO	6.00	0	0	549	0	549
			0.00	*0.00*	*0.00*	*250.00*	*250.00*
USR BEPUSRAB016 Computing and Copying Equipment (38 EA)	MO	6.00	0	0	0	1,500	1,500
(Note: Budget based on historical data and estimator's judgement)							
			0.00	*0.00*	*0.00*	*250.00*	*250.00*
USR BEPUSRAB017 Computing and Copying Equipment (38 EA)	MO	6.00	0	0	0	1,500	1,500
(Note: Based on the need of 38 licenses. ROM based on historical data and estimator's judgement)							
			0.00	*0.00*	*88.50*	*0.00*	*88.50*
RSM 015213400140 Field office expense, Cell phone bill; average bill/month, incl. long distance (58 EA)	MO	6.00	0	0	531	0	531
			0.00	*0.00*	*0.00*	*1,000.00*	*1,000.00*
USR BEPUSRAB018 Drinking Water	MO	6.00	0	0	0	6,000	6,000
(Note: Budget of $1,000 per month)							
			0.00	*0.00*	*0.00*	*2,000.00*	*2,000.00*
USR BEPUSRAB008 Courier Service	MO	6.00	0	0	0	12,000	12,000
(Note: Budget of $2,000 per month)							
			0.00	*0.00*	*0.00*	*750.00*	*750.00*
USR BEPUSRAB009 Office Supplies	MO	6.00	0	0	0	4,500	4,500
(Note: Budget of $750 per month)							
			0.00	*0.00*	*0.00*	*150.00*	*150.00*

Description	UOM	Quantity	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
HNC 015213201400 Toilet, portable, chemical, rent per month (40 EA)	MO	24.00	0	0	0	3,600	3,600
			0.00	*0.00*	*0.00*	*5,000.00*	*5,000.00*
USR BEPUSRAB026 Fuel Station Equipment (Allow) for Barging (Note: Budget based on estimator's judgement)	MO	6.00	0	0	0	30,000	30,000
USR BEPUSRAB027 Spillage Containment (Note: Budget based on estimator's judgement)	LS	1.00	0	0	0	5,000	5,000
			0.00	*0.00*	*0.00*	*500.00*	*500.00*
RSM 015423802010 Personal protection equipment (Note: Budget based on estimator's judgement)	MO	6.00	0	0	0	3,000	3,000
			0.00	*0.00*	*0.00*	*269.98*	*269.98*
HTW 028110307131 Disposal of waste, transportation loading & stop charges, on-site trailer drops, tanker (daily)	DAY	132.00	0	0	0	35,638	35,638
USR BEPUSRAB041 Job Site Signs incl. Wayfinding (Note: Budget per estimator's judgement)	LS	1.00	0	0	0	20,000	20,000
USR BEPUSRAB042 Safety Cones Barricades, and Barrels (Note: Budget per estimator's judgement)	LS	1.00	0	0	0	30,000	30,000
USR BEPUSRAB013 Builders Risk Insurance Premiums	LS	1.00	0	0	0	200,000	200,000
			641.59	*330.12*	*0.00*	*0.00*	*971.71*
RSM 015436501400 Mobilization or demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	EA	2.00	1,283	660	0	0	1,943
			0.00	*0.00*	*0.00*	*750.00*	*750.00*
USR BEPUSRAB015 Training Cost per Person	EA	20.00	0	0	0	15,000	15,000
			0.00	*0.00*	*0.00*	*200.00*	*200.00*
USR BEPUSRAB043 Badges (Per Person)	EA	20.00	0	0	0	4,000	4,000
			641.59	*330.12*	*0.00*	*0.00*	*971.71*
RSM 015436501400 Demobilization, delivery charge for equipment, hauled on 20-ton capacity towed trailer	EA	100.00	64,159	33,012	0	0	97,171

Description	LaborType	ManHours	BaseWage	Overtime	TaxableFringe	Payroll	WCI	Total
Labor Direct Cost Summary								
Carpenters	Journeyman	1,976	108,253	10,825	39,009	19,378	7,495	184,961
Carpenters	Foreman	334	18,851	1,885	6,600	3,351	1,304	31,991
Cement Finishers	Journeyman	327	17,631	1,763	5,831	3,092	1,221	29,538
Electricians	Journeyman	13,245	851,653	85,165	367,946	160,018	120,179	1,584,962
Electricians	Foreman	2,189	154,850	15,485	60,819	28,335	21,981	281,469
Equip. Operators Crane with Boom Pay	Journeyman	9,565	619,322	61,932	223,147	111,063	67,116	1,082,580
Equip. Operators, Heavy	Journeyman	2,468	140,475	14,048	50,609	25,145	19,907	250,184
Equip. Operators, Medium	Journeyman	24	1,391	139	501	257	89	2,378
Equip. Operators, Oilers / Grade Checker	Journeyman	5,668	287,599	28,760	103,669	51,566	31,560	503,153
Laborers, (Semi-Skilled)	Journeyman	31,783	1,391,790	139,179	541,905	255,464	172,333	2,500,670
Laborers, (Semi-Skilled)	Foreman	1,460	65,376	6,538	24,886	12,215	4,201	113,216
Pile Drivers	Journeyman	17,559	1,136,945	113,695	409,651	203,922	124,763	1,988,975
Pile Drivers	Foreman	3,610	239,507	23,951	84,215	42,721	26,282	416,676
Rodmen, (Reinforcing)	Journeyman	654	33,536	3,354	12,087	6,004	2,323	57,303
Skilled Workers	Journeyman	13,115	718,463	71,846	258,899	128,612	101,986	1,279,806
Structural Steel Workers	Journeyman	32,877	1,723,748	172,375	1,134,919	371,545	244,686	3,647,273
Structural Steel Workers	Foreman	20,577	1,120,010	112,001	710,321	238,091	158,985	2,339,408
Truck Drivers, Heavy	Journeyman	844	40,109	4,011	13,384	7,049	2,577	67,130

APPENDIX B

Estimate Support

McNary Dam Avian Deterrence Alternatives Estimate Summary

Level	Description	UOM	Alternative 1A (1-1/4" SS) 7 Towers w/ Dam Wall Plate		Alternative 1B (1-1/4" SS) 5 Towers w/out Dam Wall Plate		Alternative 2A (1/4" SS) 4 Towers w/ Dam Wall Plate		Alternative 2B (1/4" SS) 2 Towers w/out Dam Wall Plate		Alternative 3 In-Water Array	
			Quantity	Contract	Quantity	Contract	Quantity	Contract	Quantity	Contract	Quantity	Contract
Level 0	04 McNary Dam Avian Deterrence Alternatives											
Level 1	0401 Alternative Stainless Steel Wire Array Area	SF	4,649,605	$ 44,243,318	2,838,565	$ 33,999,507	4,886,108	$ 15,684,206	3,143,837	$ 13,759,514	6	$ 933,697
Level 2	040199 Associated General Items	LS	1	$ 44,243,318	1	$ 33,999,507	1	$ 15,684,206	1	$ 13,759,514	1	$ 933,697
Level 3	04019901 Barge Costs	MO	10	$ 5,040,637	8	$ 4,165,576	6	$ 1,708,385	4	$ 1,179,019	1.5	$ 675,440
Level 3	04019902 Foundations for Towers	EA	7	$ 2,915,359	5	$ 2,161,156	4	$ 887,213	2	$ 487,871		
Level 3	04019903 Structural Steel	LS	1	$ 24,649,513	1	$ 18,947,972	1	$ 11,490,635	1	$ 11,147,126		
Level 3	04019904 Stainless Steel Wire	LF	271,155	$ 11,621,530	198,693	$ 8,712,734	328,269	$ 1,587,668	199,320	$ 940,165		
Level 3	04019916 Grounding	EA	7	$ 16,280	5	$ 12,069	4	$ 10,305	2	$ 5,334		
Level 3	04019902 In-Water Array Anchors	EA									6	$ 258,257
	Total Contract			$ 44,243,318		$ 33,999,507		$ 15,684,206		$ 13,759,514		$ 933,697
	Escalation			$ 2,336,047		$ 1,795,174		$ 723,042		$ 634,314		$ 36,694
	Total Contract Escalated			**$46,579,365**		**$35,794,681**		**$16,407,248**		**$14,393,828**		**$970,392**
	Contingency			$2,328,968		$1,789,734		$820,362		$719,691		$48,520
	SIOH			$2,787,775		$2,142,312		$981,974		$861,471		$58,078
	Total Project Cost			**$51,696,108**		**$39,726,727**		**$18,209,584**		**$15,974,990**		**$1,076,989**
	CLASS 3 Expected Accuracy	-30%		$32,605,555		$25,056,277		$11,485,074		$10,075,680		$679,274
		20%		$55,895,238		$42,953,617		$19,688,698		$17,272,593		$1,164,470

	Option 1A (1-1/4" SS) 7 Towers w/ Dam Wall Plate		Option 1B (1-1/4" SS) 5 Towers w/out Dam Wall Plate		Option 2A 4 Towers w/ Dam Wall Plate		Option 2B 2 Towers w/out Dam Wall Plate		Option 3 In-Water Array
Work from Barge Duration (mos.)	10	12	8	10	6	8	5	6	1.5
Prime JOOH	18.56%		21.25%		27.57%		24.60%		25.00%
Prime HOOH	8%		8%		8%		8%		8%
Prime Profit	10%		10%		10%		10%		10%
Contingency	15%		15%		15%		15%		15%
Area (SF)	4,649,605		2,838,565		4,868,108		3,143,837		n/a
Cost per SF	$11.12		$14.00		$3.74		$5.08		n/a
Wire (LF)	271,155		198,693		328,269		199,320		300

McNary Dam Avian Deterrence 30% Estimate

					A	B	C	D	E=(A+B+C+D)	F	G=(E+F)	H	I=(G+H)	J	K-I+J)	L	M	N=(K+L+M)	
Level	**Description**	**Quantity**	**UOM**	**ManHours**	**Labor**	**Equipment**	**Material**	**Sub Bid**	**Total Direct**	**Sub Markups**	**Cost to Prime**	**Prime Markups**	**Contract**	**Escalation**	**Escalated Contract Cost**	**Contingency**	**SIOH**	**ProjectCost**	**Note**
Level 0	**04 McNary Dam Avian Deterrence Alternatives**																		
Level 1	**0401 ALTERNATIVE 1A - 1-1/4" Stainless Steel Wire**	**4,649,605.00**	**SF**	**70,352.65**	**$ 8,584,706.0**	**$ 1,276,644.2**	**$ 13,539,557.1**	**$ 119,600.0**	**$ 23,520,507.3**	**$ 7,785,287.9**	**$ 31,305,795.3**	**$ 12,937,522.3**	**$ 44,243,317.5**	**$ 2,336,047.2**	**$ 46,579,364.7**	**$ 2,328,968.2**	**$ 2,787,775.0**	**$ 51,696,107.9**	(Note: Alternative 1A: Large APDA originating from towers on the Oregon shoreline; 1 ¼" SS wires fan out across the river, anchoring at the navigation lock guide wall, navigation lock wall, and spillway. Assumed construction duration: 12 Months)
Level 2	**040199 Associated General Items**	**1**	**LS**	**70,352.65**	**$ 8,584,706.0**	**$ 1,276,644.2**	**$ 13,539,557.1**	**$ 119,600.0**	**$ 23,520,507.3**	**$ 7,785,287.9**	**$ 31,305,795.3**	**$ 12,937,522.3**	**$ 44,243,317.5**	**$ 2,336,047.2**	**$ 46,579,364.7**	**$ 2,328,968.2**	**$ 2,787,775.0**	**$ 51,696,107.9**	(Note: Costs developed for Alternative 1A include Barge, Towers Foundations, Structural Steel for Towers and Columns, SS wire, and Grounding.)
Level 3	**04019901 Barge Costs**	**10**	**MO**	**15,600.00**	**$ 1,988,379.2**	**$ 587,809.8**	**$ -**	**$ 103,500.0**	**$ 2,679,689.0**	**$ 886,977.1**	**$ 3,566,666.1**	**$ 1,473,970.6**	**$ 5,040,636.7**	**$ 266,145.6**	**$ 5,306,782.3**	**$ 265,339.1**	**$ 317,610.9**	**$ 5,889,732.4**	(Note: Barge mob/demob and operations for marine-based work. See BOE Appendix B, 3.0.)
Level 4	**Mobilization of Barge**	**1**	**LS**	**-**	**$ -**	**$ -**	**$ -**	**$ 51,750.0**	**$ 51,750.0**	**$ 17,129.3**	**$ 68,879.3**	**$ 28,465.2**	**$ 97,344.5**	**$ 5,139.8**	**$ 102,484.3**	**$ 5,124.2**	**$ 6,133.7**	**$ 113,742.2**	
Line Item	RSM 310660151320 Mobilization, set up and remove, mobilization by water for barge driving rig, maximum	1	EA	-	$ -	$ -	$ -	$ 51,750.0	$ 51,750.0	$ 17,129.3	$ 68,879.3	$ 28,465.2	$ 97,344.5	$ 5,139.8	$ 102,484.3	$ 5,124.2	$ 6,133.7	$ 113,742.2	
Level 4	**Barge Operations**	**10**	**MO**	**15,600.00**	**$ 1,988,379.2**	**$ 587,809.8**	**$ -**	**$ -**	**$ 2,576,189.0**	**$ 852,718.6**	**$ 3,428,907.6**	**$ 1,417,040.1**	**$ 4,845,947.7**	**$ 255,866.0**	**$ 5,101,813.8**	**$ 255,090.7**	**$ 305,343.6**	**$ 5,662,248.0**	
Line Item	RSM 061333520360 On-site time for barge driving rig with crew	10	MO	15,600.00	$ 1,988,379.2	$ 587,809.8	$ -	$ -	$ 2,576,189.0	$ 852,718.6	$ 3,428,907.6	$ 1,417,040.1	$ 4,845,947.7	$ 255,866.0	$ 5,101,813.8	$ 255,090.7	$ 305,343.6	$ 5,662,248.0	
Level 4	**Demobilization of Barge**	**1**	**LS**	**-**	**$ -**	**$ -**	**$ -**	**$ 51,750.0**	**$ 51,750.0**	**$ 17,129.3**	**$ 68,879.3**	**$ 28,465.2**	**$ 97,344.5**	**$ 5,139.8**	**$ 102,484.3**	**$ 5,124.2**	**$ 6,133.7**	**$ 113,742.2**	
Line Item	RSM 310660151320 Demobilization by water for barge driving rig, maximum	1	EA	-	$ -	$ -	$ -	$ 51,750.0	$ 51,750.0	$ 17,129.3	$ 68,879.3	$ 28,465.2	$ 97,344.5	$ 5,139.8	$ 102,484.3	$ 5,124.2	$ 6,133.7	$ 113,742.2	
Level 3	**04019902 Foundations for Towers**	**7**	**EA**	**7,233.77**	**$ 740,352.2**	**$ 99,847.9**	**$ 693,554.7**	**$ 16,100.0**	**$ 1,549,854.7**	**$ 513,001.9**	**$ 2,062,856.6**	**$ 852,502.0**	**$ 2,915,358.7**	**$ 153,930.9**	**$ 3,069,289.6**	**$ 153,464.5**	**$ 183,697.0**	**$ 3,406,451.1**	(Note: Costs have been included for clearing/grubbing, minor excavation, piling for cranes, structural concrete for tower foundation mats, and backfill. Based on A-E guidance, site is assumed to have adequate access and sufficient nearby space for laydown arrea.)
Level 4	**0401990201 Site Prep**	**7**	**EA**	**294.98**	**$ 31,709.8**	**$ 18,850.4**	**$ -**	**$ -**	**$ 50,560.2**	**$ 16,735.4**	**$ 67,295.6**	**$ 27,810.8**	**$ 95,106.4**	**$ 5,021.6**	**$ 100,128.0**	**$ 5,006.4**	**$ 5,992.7**	**$ 111,127.1**	
Line Item	RSM 311110100150 Clearing & grubbing, grub stumps and remove	6,300.00	SF	14.29	$ 1,413.8	$ 1,383.0	$ -	$ -	$ 2,796.8	$ 925.7	$ 3,722.5	$ 1,538.4	$ 5,260.9	$ 277.8	$ 5,538.6	$ 276.9	$ 331.5	$ 6,147.0	
Line Item	RSM 311413231460 Topsoil stripping and stockpiling, loam or topsoil, remove and stockpile on site, 200 HP dozer, 6" deep, 500' haul per S.Y.	700	SY	9.06	$ 945.3	$ 1,231.4	$ -	$ -	$ 2,176.7	$ 720.5	$ 2,897.2	$ 1,197.3	$ 4,094.4	$ 216.2	$ 4,310.6	$ 215.5	$ 258.0	$ 4,784.1	
Line Item	RSM 312316166260 Structural excavation for minor structures, bank measure, for spread and mat footings, elevator pits, and small building foundations, sandy clay or loam, 2 C.Y. bucket, machine excavation, hydraulic backhoe	2,567.00	BCY	271.64	$ 29,350.8	$ 16,236.0	$ -	$ -	$ 45,586.8	$ 15,089.2	$ 60,676.0	$ 25,075.1	$ 85,751.1	$ 4,527.7	$ 90,278.8	$ 4,513.9	$ 5,403.2	$ 100,195.9	
Level 4	**0401990202 Piling**	**4,480.00**	**VLF**	**1,575.26**	**$ 202,119.0**	**$ 41,029.3**	**$ 341,778.5**	**$ 16,100.0**	**$ 601,026.8**	**$ 198,939.9**	**$ 799,966.7**	**$ 330,596.5**	**$ 1,130,563.2**	**$ 59,693.7**	**$ 1,190,256.9**	**$ 59,512.8**	**$ 71,236.9**	**$ 1,321,006.6**	
Line Item	RSM 310660150300 Mobilization, 150 ton, set up and remove crane, with pile leads and pile hammer	1	EA	253.97	$ 32,586.3	$ 6,614.9	$ -	$ -	$ 39,201.1	$ 12,975.6	$ 52,176.7	$ 21,562.7	$ 73,739.4	$ 3,893.4	$ 77,632.9	$ 3,881.6	$ 4,646.3	$ 86,160.8	
Line Item	RSM 310660141050 Piling special costs, testing, any type piles, test load is twice the design load, 50 ton design load, 100 ton test	1	EA	-	$ -	$ -	$ -	$ 16,100.0	$ 16,100.0	$ 5,329.1	$ 21,429.1	$ 8,855.9	$ 30,285.0	$ 1,599.1	$ 31,884.0	$ 1,594.2	$ 1,908.3	$ 35,386.5	
Line Item	RSM 316223134200 Concrete-filled steel piles, steel, pipe piles, concrete filled, 50' long, 24" diameter, 59 lb./L.F., excludes mobilization or demobilization	4,480.00	VLF	1,321.29	$ 169,532.7	$ 34,414.4	$ 341,778.5	$ -	$ 545,725.6	$ 180,635.2	$ 726,360.8	$ 300,178.0	$ 1,026,538.8	$ 54,201.3	$ 1,080,740.0	$ 54,037.0	$ 64,682.3	$ 1,199,459.3	
Level 4	**0401990203 Mat Foundations for Towers**	**1,068.00**	**CY**	**2,278.40**	**$ 231,809.3**	**$ 985.4**	**$ 351,776.1**	**$ -**	**$ 584,570.8**	**$ 193,492.9**	**$ 778,063.8**	**$ 321,544.9**	**$ 1,099,608.6**	**$ 58,059.3**	**$ 1,157,667.9**	**$ 57,883.4**	**$ 69,286.4**	**$ 1,284,837.8**	**(Note: Q*20*20*10*1.03/27)**
Line Item	RSM 033053405950 Structural concrete, in place, pile cap (3000 psi), square or rectangular, over 10 C.Y., includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), placing and finishing	1,068.00	CY	2,278.40	$ 231,809.3	$ 985.4	$ 351,776.1	$ -	$ 584,570.8	$ 193,492.9	$ 778,063.8	$ 321,544.9	$ 1,099,608.6	$ 58,059.3	$ 1,157,667.9	$ 57,883.4	$ 69,286.4	$ 1,284,837.8	
Level 4	**0401990204 Backfill**	**7**	**EA**	**3,085.13**	**$ 274,714.0**	**$ 38,982.9**	**$ -**	**$ -**	**$ 313,696.9**	**$ 103,833.7**	**$ 417,530.6**	**$ 172,549.9**	**$ 590,080.5**	**$ 31,156.3**	**$ 621,236.8**	**$ 31,061.8**	**$ 37,181.0**	**$ 689,479.6**	
Line Item	HNC 312323140022 Backfill, structural, 6" lifts, backfill around foundation, by hand	1,426.00	CY	1,455.13	$ 128,737.6	$ -	$ -	$ -	$ 128,737.6	$ 42,612.1	$ 171,349.7	$ 70,812.5	$ 242,162.2	$ 12,786.2	$ 254,948.3	$ 12,747.4	$ 15,258.7	$ 282,954.4	
Line Item	HNC 311313110016 Selective clearing, load spoils, wheel and ramp load, includes 2 mile haul to dump	1,141.00	CY	1,630.00	$ 145,976.5	$ 38,982.9	$ -	$ -	$ 184,959.4	$ 61,221.6	$ 246,180.9	$ 101,737.4	$ 347,918.3	$ 18,370.1	$ 366,288.4	$ 18,314.4	$ 21,922.4	$ 406,525.2	
Level 3	**04019903 Structural Steel**	**1**	**LS**	**26,105.76**	**$ 3,061,927.8**	**$ 588,986.5**	**$ 9,453,190.0**	**$ -**	**$ 13,104,104.3**	**$ 4,337,458.5**	**$ 17,441,562.8**	**$ 7,207,950.0**	**$ 24,649,512.9**	**$ 1,301,494.3**	**$ 25,951,007.1**	**$ 1,297,550.4**	**$ 1,553,167.8**	**$ 28,801,725.3**	(Note: Structural Steel for towers and columns. See BOE Appendix B, 3.0 for QTY and 9.0 for structural tubing cost.)
Level 4	**0401990301 Main Towers**	**7**	**EA**	**12,494.30**	**$ 1,537,834.1**	**$ 457,129.8**	**$ 2,648,347.7**	**$ -**	**$ 4,643,311.5**	**$ 1,536,936.1**	**$ 6,180,247.6**	**$ 2,554,066.8**	**$ 8,734,314.4**	**$ 461,171.8**	**$ 9,195,486.2**	**$ 459,774.3**	**$ 550,349.9**	**$ 10,205,610.3**	
Line Item	RSM 337113230640 Steel tower, special steel structure erection	648	TON	12,494.30	$ 1,537,834.1	$ 457,129.8	$ 2,648,347.7	$ -	$ 4,643,311.5	$ 1,536,936.1	$ 6,180,247.6	$ 2,554,066.8	$ 8,734,314.4	$ 461,171.8	$ 9,195,486.2	$ 459,774.3	$ 550,349.9	$ 10,205,610.3	
Level 4	**0401990302 40' Columns**	**53**	**EA**	**7,622.87**	**$ 851,520.1**	**$ 71,879.9**	**$ 3,818,782.7**	**$ -**	**$ 4,742,182.7**	**$ 1,569,662.5**	**$ 6,311,845.2**	**$ 2,608,451.1**	**$ 8,920,296.3**	**$ 470,991.6**	**$ 9,391,287.9**	**$ 469,564.4**	**$ 562,068.6**	**$ 10,422,920.9**	
Line Item	HNC 051223232011 Column, structural tubing, 36" x 18" x 1", incl shop primer, cap & base plate, bolts	486	TON	2,777.16	$ 352,839.6	$ 67,554.3	$ 1,530,156.4	$ -	$ 1,950,550.3	$ 645,632.2	$ 2,596,182.4	$ 1,072,905.8	$ 3,669,088.2	$ 193,727.9	$ 3,862,816.1	$ 193,140.8	$ 231,189.5	$ 4,287,146.4	
Line Item	RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer	14,510.00	SF	-	$ -	$ -	$ 1,918,947.5	$ -	$ 1,918,947.5	$ 635,171.6	$ 2,554,119.1	$ 1,055,522.6	$ 3,609,641.7	$ 190,589.1	$ 3,800,230.8	$ 190,011.5	$ 227,443.8	$ 4,217,686.1	(Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate. No Cost Book adjustment added as this item is quoted.)
Line Item	RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	4,240.00	EA	4,845.71	$ 498,680.5	$ 4,325.6	$ 369,678.8	$ -	$ 872,684.9	$ 288,858.7	$ 1,161,543.6	$ 480,022.8	$ 1,641,566.4	$ 86,674.7	$ 1,728,241.1	$ 86,412.1	$ 103,435.2	$ 1,918,088.4	
Level 4	**0401990303 30' Columns**	**50**	**EA**	**5,988.58**	**$ 672,573.7**	**$ 59,976.8**	**$ 2,986,059.6**	**$ -**	**$ 3,718,610.1**	**$ 1,230,860.0**	**$ 4,949,470.1**	**$ 2,045,432.1**	**$ 6,994,902.2**	**$ 369,330.8**	**$ 7,364,233.0**	**$ 368,211.7**	**$ 440,749.4**	**$ 8,173,194.0**	
Line Item	HNC 051223232011 Column, structural tubing, 32" x 16" x 1", incl shop primer, cap & base plate, bolts	408	TON	2,331.44	$ 296,211.0	$ 56,712.3	$ 1,284,575.8	$ -	$ 1,637,499.0	$ 542,012.2	$ 2,179,511.2	$ 900,711.0	$ 3,080,222.2	$ 162,635.7	$ 3,242,857.9	$ 162,142.9	$ 194,085.1	$ 3,599,085.9	
Line Item	RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer	10,756.00	SF	-	$ -	$ -	$ 1,422,481.0	$ -	$ 1,422,481.0	$ 470,841.2	$ 1,893,322.2	$ 782,439.7	$ 2,675,762.0	$ 141,280.2	$ 2,817,042.2	$ 140,852.1	$ 168,600.0	$ 3,126,494.3	(Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate. No Cost Book adjustment added as this item is quoted.)
Line Item	RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	3,200.00	EA	3,657.14	$ 376,362.7	$ 3,264.6	$ 279,002.9	$ -	$ 658,630.1	$ 218,006.6	$ 876,636.7	$ 362,281.4	$ 1,238,918.0	$ 65,414.9	$ 1,304,332.9	$ 65,216.7	$ 78,064.3	$ 1,447,613.9	
Level 3	**04019904 Stainless Steel Wire**	**271,155.00**	**LF**	**21,371.82**	**$ 2,788,631.6**	**$ -**	**$ 3,389,573.1**	**$ -**	**$ 6,178,204.7**	**$ 2,044,985.8**	**$ 8,223,190.5**	**$ 3,398,339.2**	**$ 11,621,529.6**	**$ 613,616.8**	**$ 12,235,146.4**	**$ 611,757.3**	**$ 732,273.5**	**$ 13,579,177.2**	(Note: SS wire 1 1/4" gauge. See BOE Appendix B, 3.0 for QTY and 8.0 for SS wire cost.No Cost Book adjustment added as the items under this section are quotes.)
Level 4	**1-1/4" Stainless Steel Wire**	**271,155.00**	**LF**	**21,371.82**	**$ 2,788,631.6**	**$ -**	**$ 3,389,573.1**	**$ -**	**$ 6,178,204.7**	**$ 2,044,985.8**	**$ 8,223,190.5**	**$ 3,398,339.2**	**$ 11,621,529.6**	**$ 613,616.8**	**$ 12,235,146.4**	**$ 611,757.3**	**$ 732,273.5**	**$ 13,579,177.2**	
Line Item	RSM 051516500590 Steel wire 1-1/4" dia	271,155.00	LF	21,371.82	$ 2,788,631.6	$ -	$ 3,389,573.1	$ -	$ 6,178,204.7	$ 2,044,985.8	$ 8,223,190.5	$ 3,398,339.2	$ 11,621,529.6	$ 613,616.8	$ 12,235,146.4	$ 611,757.3	$ 732,273.5	$ 13,579,177.2	(Note: Material quote from https://www.uscargocontrol.com/products/galvanized-wire-rope-eips-iwrc-6x19-class-1-1-4-5000-coil.)

					A	B	C	D	E=(A+B+C+D)	F	G=(E+F)	H	I=(G+H)	J	K-I+J)	L	M	N=(K+L+M)	
Level	**Description**	**Quantity**	**UOM**	**ManHours**	**Labor**	**Equipment**	**Material**	**Sub Bid**	**Total Direct**	**Sub Markups**	**Cost to Prime**	**Prime Markups**	**Contract**	**Escalation**	**Escalated Contract Cost**	**Contingency**	**SIOH**	**ProjectCost**	**Note**
Level 3	**04019916 Grounding**	**7**	**EA**	**41.29**	**$ 5,415.3**	**$ -**	**$ 3,239.3**	**$ -**	**$ 8,654.6**	**$ 2,864.7**	**$ 11,519.2**	**$ 4,760.5**	**$ 16,279.7**	**$ 859.6**	**$ 17,139.3**	**$ 857.0**	**$ 1,025.8**	**$ 19,022.0**	(Note: Grounding for Main Towers.)
Level 4	**04019916 Grounding**	**7**	**EA**	**41.29**	**$ 5,415.3**	**$ -**	**$ 3,239.3**	**$ -**	**$ 8,654.6**	**$ 2,864.7**	**$ 11,519.2**	**$ 4,760.5**	**$ 16,279.7**	**$ 859.6**	**$ 17,139.3**	**$ 857.0**	**$ 1,025.8**	**$ 19,022.0**	
Line Item	RSM 264113132100 Cable, copper, 375 lb per thousand feet, over 40' high	350	LF	39.22	$ 5,142.8	$ -	$ 3,199.9	$ -	$ 8,342.7	$ 2,761.4	$ 11,104.1	$ 4,588.9	$ 15,693.1	$ 828.6	$ 16,521.7	$ 826.1	$ 988.8	$ 18,336.6	
Line Item	RSM 260526800030 Grounding rod, copper clad, 8' long, 1/2" diameter	1	EA	2.08	$ 272.5	$ -	$ 39.4	$ -	$ 311.9	$ 103.2	$ 415.1	$ 171.5	$ 586.6	$ 31.0	$ 617.6	$ 30.9	$ 37.0	$ 685.4	
Level 1	**0401 ALTERNATIVE 1B - 1-1/4" Stainless Steel Wire**	**2,838,565.00**	**SF**	**52,836.41**	**$ 6,449,522.0**	**$ 970,767.3**	**$ 10,126,401.8**	**$ 119,600.0**	**$ 17,666,291.2**	**$ 5,847,542.4**	**$ 23,513,833.6**	**$ 10,485,673.3**	**$ 33,999,506.9**	**$ 1,795,174.0**	**$ 35,794,680.9**	**$ 1,789,734.0**	**$ 2,142,311.7**	**$ 39,726,726.6**	(Note: Alternative 1B: Large APDA originating from towers on the Oregon shoreline; 1 ¼" SS wires fan out across the river, anchoring at the navigation lock guide wall and navigation lock wall; excludes wires attached at the spillway. Assumed construction duration: 10 months)
Level 2	**040199 Associated General Items**	**1**	**LS**	**52,836.41**	**$ 6,449,522.0**	**$ 970,767.3**	**$ 10,126,401.8**	**$ 119,600.0**	**$ 17,666,291.2**	**$ 5,847,542.4**	**$ 23,513,833.6**	**$ 10,485,673.3**	**$ 33,999,506.9**	**$ 1,795,174.0**	**$ 35,794,680.9**	**$ 1,789,734.0**	**$ 2,142,311.7**	**$ 39,726,726.6**	(Note: Costs developed for Alternative 1B include Barge, Towers Foundations, Structural Steel for Towers and Columns, SS wire, and Grounding.)
Level 3	**04019901 Barge Costs**	**8**	**MO**	**12,480.00**	**$ 1,590,703.4**	**$ 470,247.9**	**$ -**	**$ 103,500.0**	**$ 2,164,451.2**	**$ 716,433.4**	**$ 2,880,884.6**	**$ 1,284,691.2**	**$ 4,165,575.8**	**$ 219,942.4**	**$ 4,385,518.2**	**$ 219,275.9**	**$ 262,473.3**	**$ 4,867,267.3**	(Note: Barge mob/demob and operations for marine-based work. See BOE Appendix B, 4.0.)
Level 4	**Mobilization of Barge**	**1**	**LS**	**-**	**$ -**	**$ -**	**$ -**	**$ 51,750.0**	**$ 51,750.0**	**$ 17,129.3**	**$ 68,879.3**	**$ 30,715.8**	**$ 99,595.0**	**$ 5,258.6**	**$ 104,853.6**	**$ 5,242.7**	**$ 6,275.5**	**$ 116,371.8**	
Line Item	RSM 310660151320 Mobilization, set up and remove, mobilization by water for barge driving rig, maximum	1	EA	-	$ -	$ -	$ -	$ 51,750.0	$ 51,750.0	$ 17,129.3	$ 68,879.3	$ 30,715.8	$ 99,595.0	$ 5,258.6	$ 104,853.6	$ 5,242.7	$ 6,275.5	$ 116,371.8	
Level 4	**Barge Operations**	**8**	**MO**	**12,480.00**	**$ 1,590,703.4**	**$ 470,247.9**	**$ -**	**$ -**	**$ 2,060,951.2**	**$ 682,174.9**	**$ 2,743,126.1**	**$ 1,223,259.7**	**$ 3,966,385.7**	**$ 209,425.2**	**$ 4,175,810.9**	**$ 208,790.5**	**$ 249,922.3**	**$ 4,634,523.7**	
Line Item	RSM 061333520360 On-site time for barge driving rig with crew	8	MO	12,480.00	$ 1,590,703.4	$ 470,247.9	$ -	$ -	$ 2,060,951.2	$ 682,174.9	$ 2,743,126.1	$ 1,223,259.7	$ 3,966,385.7	$ 209,425.2	$ 4,175,810.9	$ 208,790.5	$ 249,922.3	$ 4,634,523.7	
Level 4	**Demobilization of Barge**	**1**	**LS**	**-**	**$ -**	**$ -**	**$ -**	**$ 51,750.0**	**$ 51,750.0**	**$ 17,129.3**	**$ 68,879.3**	**$ 30,715.8**	**$ 99,595.0**	**$ 5,258.6**	**$ 104,853.6**	**$ 5,242.7**	**$ 6,275.5**	**$ 116,371.8**	
Line Item	RSM 310660151320 Demobilization by water for barge driving rig, maximum	1	EA	-	$ -	$ -	$ -	$ 51,750.0	$ 51,750.0	$ 17,129.3	$ 68,879.3	$ 30,715.8	$ 99,595.0	$ 5,258.6	$ 104,853.6	$ 5,242.7	$ 6,275.5	$ 116,371.8	
Level 3	**04019902 Foundations for Towers**	**5**	**EA**	**5,240.22**	**$ 538,196.5**	**$ 73,206.4**	**$ 495,443.2**	**$ 16,100.0**	**$ 1,122,946.2**	**$ 371,695.2**	**$ 1,494,641.3**	**$ 666,514.9**	**$ 2,161,156.2**	**$ 114,109.1**	**$ 2,275,265.3**	**$ 113,763.3**	**$ 136,174.6**	**$ 2,525,203.2**	(Note: Costs have been included for clearing/grubbing, minor excavation, piling for cranes, structural concrete for tower foundation mats, and backfill. Based on A-E guidance, site is assumed to have adequate access and sufficient nearby space for laydown arrea.)
Level 4	**0401990201 Site Prep**	**5**	**EA**	**210.64**	**$ 22,643.3**	**$ 13,460.9**	**$ -**	**$ -**	**$ 36,104.3**	**$ 11,950.5**	**$ 48,054.8**	**$ 21,429.4**	**$ 69,484.2**	**$ 3,668.8**	**$ 73,152.9**	**$ 3,657.7**	**$ 4,378.2**	**$ 81,188.8**	
Line Item	RSM 311110100150 Clearing & grubbing, grub stumps and remove	4,500.00	SF	10.20	$ 1,009.8	$ 987.9	$ -	$ -	$ 1,997.7	$ 661.2	$ 2,658.9	$ 1,185.7	$ 3,844.6	$ 203.0	$ 4,047.6	$ 202.4	$ 242.3	$ 4,492.3	
Line Item	RSM 311413231460 Topsoil stripping and stockpiling, loam or topsoil, remove and stockpile on site, 200 HP dozer, 6" deep, 500' haul per S.Y.	500	SY	6.47	$ 675.2	$ 879.6	$ -	$ -	$ 1,554.8	$ 514.6	$ 2,069.4	$ 922.8	$ 2,992.2	$ 158.0	$ 3,150.2	$ 157.5	$ 188.5	$ 3,496.2	
Line Item	RSM 312316166260 Structural excavation for minor structures, bank measure, for spread and mat footings, elevator pits, and small building foundations, sandy clay or loam, 2 C.Y. bucket, machine excavation, hydraulic backhoe	1,833.00	BCY	193.97	$ 20,958.3	$ 11,593.5	$ -	$ -	$ 32,551.8	$ 10,774.7	$ 43,326.5	$ 19,320.9	$ 62,647.3	$ 3,307.8	$ 65,955.1	$ 3,297.8	$ 3,947.4	$ 73,200.3	
Level 4	**0401990202 Piling**	**3,200.00**	**VLF**	**1,197.75**	**$ 153,681.1**	**$ 31,196.6**	**$ 244,127.5**	**$ 16,100.0**	**$ 445,105.2**	**$ 147,329.8**	**$ 592,435.0**	**$ 264,188.3**	**$ 856,623.3**	**$ 45,229.7**	**$ 901,853.0**	**$ 45,092.7**	**$ 53,975.9**	**$ 1,000,921.6**	
Line Item	RSM 310660150300 Mobilization, 150 ton, set up and remove crane, with pile leads and pile hammer	1	EA	253.97	$ 32,586.3	$ 6,614.9	$ -	$ -	$ 39,201.1	$ 12,975.6	$ 52,176.7	$ 23,267.5	$ 75,444.2	$ 3,983.5	$ 79,427.7	$ 3,971.4	$ 4,753.8	$ 88,152.8	
Line Item	RSM 310660141050 Piling special costs, testing, any type piles, test load is twice the design load, 50 ton design load, 100 ton test	1	EA	-	$ -	$ -	$ -	$ 16,100.0	$ 16,100.0	$ 5,329.1	$ 21,429.1	$ 9,556.0	$ 30,985.1	$ 1,636.0	$ 32,621.1	$ 1,631.1	$ 1,952.4	$ 36,204.6	
Line Item	RSM 316223134200 Concrete-filled steel piles, steel, pipe piles, concrete filled, 50' long, 24" diameter, 59 lb./L.F., excludes mobilization or demobilization	3,200.00	VLF	943.78	$ 121,094.8	$ 24,581.7	$ 244,127.5	$ -	$ 389,804.0	$ 129,025.1	$ 518,829.2	$ 231,364.8	$ 750,194.0	$ 39,610.2	$ 789,804.2	$ 39,490.2	$ 47,269.8	$ 876,564.2	
Level 4	**0401990203 Mat Foundations for Towers**	**763**	**CY**	**1,627.73**	**$ 165,609.1**	**$ 704.0**	**$ 251,315.7**	**$ -**	**$ 417,628.8**	**$ 138,235.1**	**$ 555,863.9**	**$ 247,879.9**	**$ 803,743.8**	**$ 42,437.7**	**$ 846,181.5**	**$ 42,309.1**	**$ 50,644.0**	**$ 939,134.5**	**(Note: Q*20*20*10*1.03/27)**
Line Item	RSM 033053405950 Structural concrete, in place, pile cap (3000 psi), square or rectangular, over 10 C.Y., includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), placing and finishing	763	CY	1,627.73	$ 165,609.1	$ 704.0	$ 251,315.7	$ -	$ 417,628.8	$ 138,235.1	$ 555,863.9	$ 247,879.9	$ 803,743.8	$ 42,437.7	$ 846,181.5	$ 42,309.1	$ 50,644.0	$ 939,134.5	
Level 4	**0401990204 Backfill**	**5**	**EA**	**2,204.10**	**$ 196,263.0**	**$ 27,844.9**	**$ -**	**$ -**	**$ 224,107.9**	**$ 74,179.7**	**$ 298,287.7**	**$ 133,017.3**	**$ 431,305.0**	**$ 22,772.9**	**$ 454,077.9**	**$ 22,703.9**	**$ 27,176.6**	**$ 503,958.3**	
Line Item	HNC 312323140022 Backfill, structural, 6" lifts, backfill around foundation, by hand	1,019.00	CY	1,039.82	$ 91,994.1	$ -	$ -	$ -	$ 91,994.1	$ 30,450.1	$ 122,444.1	$ 54,602.3	$ 177,046.4	$ 9,348.1	$ 186,394.5	$ 9,319.7	$ 11,155.7	$ 206,869.9	
Line Item	HNC 311313110016 Selective clearing, load spoils, wheel and ramp load, includes 2 mile haul to dump	815	CY	1,164.29	$ 104,268.9	$ 27,844.9	$ -	$ -	$ 132,113.8	$ 43,729.7	$ 175,843.5	$ 78,415.0	$ 254,258.5	$ 13,424.9	$ 267,683.4	$ 13,384.2	$ 16,020.9	$ 297,088.4	
Level 3	**04019903 Structural Steel**	**1**	**LS**	**19,425.56**	**$ 2,273,263.5**	**$ 427,313.0**	**$ 7,144,871.7**	**$ -**	**$ 9,845,448.3**	**$ 3,258,843.4**	**$ 13,104,291.7**	**$ 5,843,680.1**	**$ 18,947,971.8**	**$ 1,000,452.9**	**$ 19,948,424.7**	**$ 997,421.2**	**$ 1,193,913.2**	**$ 22,139,759.2**	(Note: Structural Steel for towers and columns. See BOE Appendix B, 4.0 for QTY and 9.0 for structural tubing cost.)
Level 4	**0401990301 Main Towers**	**5**	**EA**	**8,927.26**	**$ 1,098,791.9**	**$ 326,622.0**	**$ 1,892,260.7**	**$ -**	**$ 3,317,674.7**	**$ 1,098,150.3**	**$ 4,415,825.1**	**$ 1,969,177.0**	**$ 6,385,002.0**	**$ 337,128.1**	**$ 6,722,130.1**	**$ 336,106.5**	**$ 402,319.5**	**$ 7,460,556.1**	
Line Item	RSM 337113230640 Steel tower, special steel structure erection	463	TON	8,927.26	$ 1,098,791.9	$ 326,622.0	$ 1,892,260.7	$ -	$ 3,317,674.7	$ 1,098,150.3	$ 4,415,825.1	$ 1,969,177.0	$ 6,385,002.0	$ 337,128.1	$ 6,722,130.1	$ 336,106.5	$ 402,319.5	$ 7,460,556.1	
Level 4	**0401990302 40' Columns**	**53**	**EA**	**7,622.87**	**$ 851,520.1**	**$ 71,879.9**	**$ 3,818,782.7**	**$ -**	**$ 4,742,182.7**	**$ 1,569,662.5**	**$ 6,311,845.2**	**$ 2,814,681.3**	**$ 9,126,526.4**	**$ 481,880.6**	**$ 9,608,407.0**	**$ 480,420.4**	**$ 575,063.2**	**$ 10,663,890.5**	
Line Item	HNC 051223232011 Column, structural tubing, 36" x 18" x 1", incl shop primer, cap & base plate, bolts	486	TON	2,777.16	$ 352,839.6	$ 67,554.3	$ 1,530,156.4	$ -	$ 1,950,550.3	$ 645,632.2	$ 2,596,182.4	$ 1,157,732.2	$ 3,753,914.6	$ 198,206.7	$ 3,952,121.3	$ 197,606.1	$ 236,534.5	$ 4,386,261.8	
Line Item	RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer	14,510.00	SF	-	$ -	$ -	$ 1,918,947.5	$ -	$ 1,918,947.5	$ 635,171.6	$ 2,554,119.1	$ 1,138,974.6	$ 3,693,093.7	$ 194,995.4	$ 3,888,089.1	$ 194,404.5	$ 232,702.1	$ 4,315,195.6	(Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate. No Cost Book adjustment added as this item is quoted.)
Line Item	RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	4,240.00	EA	4,845.71	$ 498,680.5	$ 4,325.6	$ 369,678.8	$ -	$ 872,684.9	$ 288,858.7	$ 1,161,543.6	$ 517,974.5	$ 1,679,518.1	$ 88,678.6	$ 1,768,196.7	$ 88,409.8	$ 105,826.6	$ 1,962,433.1	
Level 4	**0401990303 30' Columns**	**24**	**EA**	**2,875.43**	**$ 322,951.5**	**$ 28,811.1**	**$ 1,433,828.3**	**$ -**	**$ 1,785,590.9**	**$ 591,030.6**	**$ 2,376,621.5**	**$ 1,059,821.9**	**$ 3,436,443.4**	**$ 181,444.2**	**$ 3,617,887.6**	**$ 180,894.4**	**$ 216,530.6**	**$ 4,015,312.6**	
Line Item	HNC 051223232011 Column, structural tubing, 32" x 16" x 1", incl shop primer, cap & base plate, bolts	196	TON	1,120.01	$ 142,297.4	$ 27,244.1	$ 617,100.1	$ -	$ 786,641.7	$ 260,378.4	$ 1,047,020.1	$ 466,904.3	$ 1,513,924.4	$ 79,935.2	$ 1,593,859.6	$ 79,693.0	$ 95,392.5	$ 1,768,945.1	
Line Item	RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer	5,163.00	SF	-	$ -	$ -	$ 682,806.8	$ -	$ 682,806.8	$ 226,009.0	$ 908,815.8	$ 405,274.0	$ 1,314,089.8	$ 69,383.9	$ 1,383,473.7	$ 69,173.7	$ 82,800.9	$ 1,535,448.3	(Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate. No Cost Book adjustment added as this item is quoted.)
Line Item	RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	1,536.00	EA	1,755.43	$ 180,654.1	$ 1,567.0	$ 133,921.4	$ -	$ 316,142.5	$ 104,643.2	$ 420,785.6	$ 187,643.6	$ 608,429.2	$ 32,125.1	$ 640,554.3	$ 32,027.7	$ 38,337.2	$ 710,919.2	
Level 3	**04019904 Stainless Steel Wire**	**198,693.00**	**LF**	**15,660.53**	**$ 2,043,412.8**	**$ -**	**$ 2,483,761.9**	**$ -**	**$ 4,527,174.6**	**$ 1,498,494.8**	**$ 6,025,669.4**	**$ 2,687,065.1**	**$ 8,712,734.5**	**$ 460,032.4**	**$ 9,172,766.8**	**$ 458,638.3**	**$ 548,990.1**	**$ 10,180,395.3**	(Note: SS wire 1 1/4" gauge. See BOE Appendix B, 4.0 for QTY and 8.0 for SS wire cost.No Cost Book adjustment added as the items under this section are quotes.)
Level 4	**1-1/4" Stainless Steel Wire**	**198,693.00**	**LF**	**15,660.53**	**$ 2,043,412.8**	**$ -**	**$ 2,483,761.9**	**$ -**	**$ 4,527,174.6**	**$ 1,498,494.8**	**$ 6,025,669.4**	**$ 2,687,065.1**	**$ 8,712,734.5**	**$ 460,032.4**	**$ 9,172,766.8**	**$ 458,638.3**	**$ 548,990.1**	**$ 10,180,395.3**	

					A	B	C	D	E=(A+B+C+D)	F	G=(E+F)	H	I=(G+H)	J	K-I+J)	L	M	N=(K+L+M)	
Level	**Description**	**Quantity**	**UOM**	**ManHours**	**Labor**	**Equipment**	**Material**	**Sub Bid**	**Total Direct**	**Sub Markups**	**Cost to Prime**	**Prime Markups**	**Contract**	**Escalation**	**Escalated Contract Cost**	**Contingency**	**SIOH**	**ProjectCost**	**Note**
Line Item	RSM 051516500590 Steel wire 1-1/4" dia	198,693.00	LF	15,660.53	$ 2,043,412.8	$ -	$ 2,483,761.9	$ -	$ 4,527,174.6	$ 1,498,494.8	$ 6,025,669.4	$ 2,687,065.1	$ 8,712,734.5	$ 460,032.4	$ 9,172,766.8	$ 458,638.3	$ 548,990.1	$ 10,180,395.3	(Note: Material quote from https://www.uscargocontrol.com/products/galvanized-wire-rope-eips-iwrc-6x19-class-1-1-4-5000-coil.)
Level 3	**04019916 Grounding**	**5**	**EA**	**30.09**	**$ 3,945.9**	**$ -**	**$ 2,325.0**	**$ -**	**$ 6,270.9**	**$ 2,075.7**	**$ 8,346.6**	**$ 3,722.1**	**$ 12,068.7**	**$ 637.2**	**$ 12,705.9**	**$ 635.3**	**$ 760.5**	**$ 14,101.6**	(Note: Grounding for Main Towers.)
Level 4	**04019916 Grounding**	**5**	**EA**	**30.09**	**$ 3,945.9**	**$ -**	**$ 2,325.0**	**$ -**	**$ 6,270.9**	**$ 2,075.7**	**$ 8,346.6**	**$ 3,722.1**	**$ 12,068.7**	**$ 637.2**	**$ 12,705.9**	**$ 635.3**	**$ 760.5**	**$ 14,101.6**	
Line Item	RSM 264113132100 Cable, copper, 375 lb per thousand feet, over 40' high	250	LF	28.01	$ 3,673.4	$ -	$ 2,285.7	$ -	$ 5,959.1	$ 1,972.5	$ 7,931.5	$ 3,537.0	$ 11,468.5	$ 605.5	$ 12,074.0	$ 603.7	$ 722.6	$ 13,400.4	
Line Item	RSM 260526800030 Grounding rod, copper clad, 8' long, 1/2" diameter	1	EA	2.08	$ 272.5	$ -	$ 39.4	$ -	$ 311.9	$ 103.2	$ 415.1	$ 185.1	$ 600.2	$ 31.7	$ 631.9	$ 31.6	$ 37.8	$ 701.3	
Level 1	**0401 ALTERNATIVE 2A - 1/4" Stainless Steel Wire**	**4,886,108.00**	**SF**	**18,779.52**	**$ 2,111,608.9**	**$ 478,210.8**	**$ 5,021,028.8**	**$ 119,600.0**	**$ 7,730,448.4**	**$ 2,558,778.4**	**$ 10,289,226.9**	**$ 5,394,979.2**	**$ 15,684,206.1**	**$ 723,041.9**	**$ 16,407,248.0**	**$ 820,362.4**	**$ 981,973.8**	**$ 18,209,584.2**	(Note: Alternative 2A: Similar design to Alternative 1A, with additional design based on a proposed code variance. Large APDA originating from towers at the Oregon shoreline. ¼" SS wires fans out across the river, anchoring along the navigation guide wall, navigation lock wall, and spillway deck. Assumed construction duration: 8 Months)
Level 2	**040199 Associated General Items**	**1**	**LS**	**18,779.52**	**$ 2,111,608.9**	**$ 478,210.8**	**$ 5,021,028.8**	**$ 119,600.0**	**$ 7,730,448.4**	**$ 2,558,778.4**	**$ 10,289,226.9**	**$ 5,394,979.2**	**$ 15,684,206.1**	**$ 723,041.9**	**$ 16,407,248.0**	**$ 820,362.4**	**$ 981,973.8**	**$ 18,209,584.2**	(Note: Costs developed for Alternative 2A include Barge, Towers Foundations, Structural Steel for Towers and Columns, SS wire, and Grounding.)
Level 3	**04019901 Barge Costs**	**6**	**MO**	**4,160.00**	**$ 428,474.1**	**$ 310,056.4**	**$ -**	**$ 103,500.0**	**$ 842,030.5**	**$ 278,712.1**	**$ 1,120,742.6**	**$ 587,642.1**	**$ 1,708,384.7**	**$ 78,756.5**	**$ 1,787,141.2**	**$ 89,357.1**	**$ 106,960.4**	**$ 1,983,458.7**	(Note: Barge mob/demob and operations for marine-based work. See BOE Appendix B, 5.0.)
Level 4	**Mobilization of Barge**	**1**	**LS**	**-**	**$ -**	**$ -**	**$ -**	**$ 51,750.0**	**$ 51,750.0**	**$ 17,129.3**	**$ 68,879.3**	**$ 36,115.7**	**$ 104,994.9**	**$ 4,840.3**	**$ 109,835.2**	**$ 5,491.8**	**$ 6,573.6**	**$ 121,900.6**	
Line Item	RSM 310660151320 Mobilization, set up and remove, mobilization by water for barge driving rig, maximum	1	EA	-	$ -	$ -	$ -	$ 51,750.0	$ 51,750.0	$ 17,129.3	$ 68,879.3	$ 36,115.7	$ 104,994.9	$ 4,840.3	$ 109,835.2	$ 5,491.8	$ 6,573.6	$ 121,900.6	
Level 4	**Barge Operations**	**6**	**MO**	**4,160.00**	**$ 428,474.1**	**$ 310,056.4**	**$ -**	**$ -**	**$ 738,530.5**	**$ 244,453.6**	**$ 982,984.1**	**$ 515,410.8**	**$ 1,498,394.9**	**$ 69,076.0**	**$ 1,567,470.9**	**$ 78,373.6**	**$ 93,813.1**	**$ 1,739,657.6**	
Line Item	USR 061333520362 Standby time for barge (Small)	6	MO	4,160.00	$ 428,474.1	$ 310,056.4	$ -	$ -	$ 738,530.5	$ 244,453.6	$ 982,984.1	$ 515,410.8	$ 1,498,394.9	$ 69,076.0	$ 1,567,470.9	$ 78,373.6	$ 93,813.1	$ 1,739,657.6	
Level 4	**Demobilization of Barge**	**1**	**LS**	**-**	**$ -**	**$ -**	**$ -**	**$ 51,750.0**	**$ 51,750.0**	**$ 17,129.3**	**$ 68,879.3**	**$ 36,115.7**	**$ 104,994.9**	**$ 4,840.3**	**$ 109,835.2**	**$ 5,491.8**	**$ 6,573.6**	**$ 121,900.6**	
Line Item	RSM 310660151320 Demobilization by water for barge driving rig, maximum	1	EA	-	$ -	$ -	$ -	$ 51,750.0	$ 51,750.0	$ 17,129.3	$ 68,879.3	$ 36,115.7	$ 104,994.9	$ 4,840.3	$ 109,835.2	$ 5,491.8	$ 6,573.6	$ 121,900.6	
Level 3	**04019902 Foundations for Towers**	**4**	**EA**	**1,995.97**	**$ 211,421.4**	**$ 31,071.9**	**$ 178,697.5**	**$ 16,100.0**	**$ 437,290.7**	**$ 144,743.2**	**$ 582,034.0**	**$ 305,179.5**	**$ 887,213.5**	**$ 40,900.5**	**$ 928,114.0**	**$ 46,405.7**	**$ 55,547.6**	**$ 1,030,067.3**	(Note: Costs have been included for clearing/grubbing, minor excavation, piling for cranes, structural concrete for tower foundation mats, and backfill. Based on A-E guidance, site is assumed to have adequate access and sufficient nearby space for laydown arrea.)
Level 4	**0401990201 Site Prep**	**4**	**EA**	**80.81**	**$ 8,672.1**	**$ 5,276.0**	**$ -**	**$ -**	**$ 13,948.1**	**$ 4,616.8**	**$ 18,564.9**	**$ 9,734.2**	**$ 28,299.1**	**$ 1,304.6**	**$ 29,603.7**	**$ 1,480.2**	**$ 1,771.8**	**$ 32,855.7**	
Line Item	RSM 311110100150 Clearing & grubbing, grub stumps and remove	2,304.00	SF	5.22	$ 517.0	$ 505.8	$ -	$ -	$ 1,022.8	$ 338.6	$ 1,361.4	$ 713.8	$ 2,075.2	$ 95.7	$ 2,170.9	$ 108.5	$ 129.9	$ 2,409.3	
Line Item	RSM 311413231460 Topsoil stripping and stockpiling, loam or topsoil, remove and stockpile on site, 200 HP dozer, 6" deep, 500' haul per S.Y.	256	SY	3.31	$ 345.7	$ 450.3	$ -	$ -	$ 796.0	$ 263.5	$ 1,059.5	$ 555.6	$ 1,615.1	$ 74.5	$ 1,689.5	$ 84.5	$ 101.1	$ 1,875.1	
Line Item	RSM 312316166260 Structural excavation for minor structures, bank measure, for spread and mat footings, elevator pits, and small building foundations, sandy clay or loam, 2 C.Y. bucket, machine excavation, hydraulic backhoe	683	BCY	72.28	$ 7,809.3	$ 4,319.9	$ -	$ -	$ 12,129.2	$ 4,014.8	$ 16,144.0	$ 8,464.8	$ 24,608.9	$ 1,134.5	$ 25,743.3	$ 1,287.2	$ 1,540.7	$ 28,571.2	
Level 4	**0401990202 Piling**	**1,440.00**	**VLF**	**678.67**	**$ 87,078.9**	**$ 17,676.7**	**$ 109,857.4**	**$ 16,100.0**	**$ 230,713.0**	**$ 76,366.0**	**$ 307,079.0**	**$ 161,011.6**	**$ 468,090.5**	**$ 21,579.0**	**$ 489,669.5**	**$ 24,483.5**	**$ 29,306.7**	**$ 543,459.7**	
Line Item	RSM 310660150300 Mobilization, 150 ton, set up and remove crane, with pile leads and pile hammer	1	EA	253.97	$ 32,586.3	$ 6,614.9	$ -	$ -	$ 39,201.1	$ 12,975.6	$ 52,176.7	$ 27,358.0	$ 79,534.7	$ 3,666.6	$ 83,201.2	$ 4,160.1	$ 4,979.6	$ 92,340.9	
Line Item	RSM 310660141050 Piling special costs, testing, any type piles, test load is twice the design load, 50 ton design load, 100 ton test	1	EA	-	$ -	$ -	$ -	$ 16,100.0	$ 16,100.0	$ 5,329.1	$ 21,429.1	$ 11,236.0	$ 32,665.1	$ 1,505.9	$ 34,170.9	$ 1,708.6	$ 2,045.1	$ 37,924.6	
Line Item	RSM 316223134200 Concrete-filled steel piles, steel, pipe piles, concrete filled, 50' long, 24" diameter, 59 lb./L.F., excludes mobilization or demobilization	1,440.00	VLF	424.70	$ 54,492.7	$ 11,061.8	$ 109,857.4	$ -	$ 175,411.8	$ 58,061.3	$ 233,473.1	$ 122,417.6	$ 355,890.7	$ 16,406.6	$ 372,297.3	$ 18,614.9	$ 22,282.0	$ 413,194.2	
Level 4	**0401990203 Mat Foundations for Towers**	**209**	**CY**	**445.87**	**$ 45,363.4**	**$ 192.8**	**$ 68,840.1**	**$ -**	**$ 114,396.4**	**$ 37,865.2**	**$ 152,261.5**	**$ 79,835.7**	**$ 232,097.3**	**$ 10,699.7**	**$ 242,796.9**	**$ 12,139.9**	**$ 14,531.4**	**$ 269,468.2**	**(Note: Q*14*14*7*1.03/27)**
Line Item	RSM 033053405950 Structural concrete, in place, pile cap (3000 psi), square or rectangular, over 10 C.Y., includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), placing and finishing	209	CY	445.87	$ 45,363.4	$ 192.8	$ 68,840.1	$ -	$ 114,396.4	$ 37,865.2	$ 152,261.5	$ 79,835.7	$ 232,097.3	$ 10,699.7	$ 242,796.9	$ 12,139.9	$ 14,531.4	$ 269,468.2	
Level 4	**0401990204 Backfill**	**4**	**EA**	**790.62**	**$ 70,306.9**	**$ 7,926.4**	**$ -**	**$ -**	**$ 78,233.3**	**$ 25,895.2**	**$ 104,128.6**	**$ 54,598.0**	**$ 158,726.6**	**$ 7,317.3**	**$ 166,043.9**	**$ 8,302.2**	**$ 9,937.7**	**$ 184,283.8**	
Line Item	HNC 312323140022 Backfill, structural, 6" lifts, backfill around foundation, by hand	450	CY	459.19	$ 40,625.5	$ -	$ -	$ -	$ 40,625.5	$ 13,447.0	$ 54,072.5	$ 28,352.0	$ 82,424.5	$ 3,799.8	$ 86,224.2	$ 4,311.2	$ 5,160.5	$ 95,696.0	
Line Item	HNC 311313110016 Selective clearing, load spoils, wheel and ramp load, includes 2 mile haul to dump	232	CY	331.43	$ 29,681.5	$ 7,926.4	$ -	$ -	$ 37,607.9	$ 12,448.2	$ 50,056.1	$ 26,246.0	$ 76,302.1	$ 3,517.5	$ 79,819.6	$ 3,991.0	$ 4,777.2	$ 88,587.8	
Level 3	**04019903 Structural Steel**	**1**	**LS**	**10,034.47**	**$ 1,135,206.9**	**$ 137,082.5**	**$ 4,391,227.3**	**$ -**	**$ 5,663,516.7**	**$ 1,874,624.0**	**$ 7,538,140.7**	**$ 3,952,494.5**	**$ 11,490,635.1**	**$ 529,718.3**	**$ 12,020,353.4**	**$ 601,017.7**	**$ 719,418.2**	**$ 13,340,789.2**	(Note: Structural Steel for towers. See BOE Appendix B, 5.0 for QTY and 9.0 for structural tubing cost.)
Level 4	**0401990301 Main Towers**	**4**	**EA**	**1,773.88**	**$ 218,334.5**	**$ 64,901.1**	**$ 376,000.0**	**$ -**	**$ 659,235.6**	**$ 218,207.0**	**$ 877,442.6**	**$ 460,071.9**	**$ 1,337,514.5**	**$ 61,659.4**	**$ 1,399,173.9**	**$ 69,958.7**	**$ 83,740.6**	**$ 1,552,873.2**	
Line Item	RSM 337113230640 Steel tower, special steel structure erection	92	TON	1,773.88	$ 218,334.5	$ 64,901.1	$ 376,000.0	$ -	$ 659,235.6	$ 218,207.0	$ 877,442.6	$ 460,071.9	$ 1,337,514.5	$ 61,659.4	$ 1,399,173.9	$ 69,958.7	$ 83,740.6	$ 1,552,873.2	
Level 4	**0401990303 30' Columns**	**45**	**EA**	**5,388.58**	**$ 605,171.1**	**$ 53,951.4**	**$ 2,686,771.1**	**$ -**	**$ 3,345,893.5**	**$ 1,107,490.8**	**$ 4,453,384.3**	**$ 2,335,055.5**	**$ 6,788,439.7**	**$ 312,947.1**	**$ 7,101,386.8**	**$ 355,069.3**	**$ 425,018.0**	**$ 7,881,474.1**	
Line Item	HNC 051223232011 Column, structural tubing, 32" x 16" x 1", incl shop primer, cap & base plate, bolts	367	TON	2,097.15	$ 266,444.7	$ 51,013.2	$ 1,155,488.5	$ -	$ 1,472,946.4	$ 487,545.3	$ 1,960,491.7	$ 1,027,950.1	$ 2,988,441.8	$ 137,767.2	$ 3,126,209.0	$ 156,310.5	$ 187,103.6	$ 3,469,623.0	
Line Item	RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer	9,680.00	SF	-	$ -	$ -	$ 1,280,180.0	$ -	$ 1,280,180.0	$ 423,739.6	$ 1,703,919.6	$ 893,420.9	$ 2,597,340.5	$ 119,737.4	$ 2,717,077.9	$ 135,853.9	$ 162,617.1	$ 3,015,548.9	(Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate. No Cost Book adjustment added as this item is quoted.)
Line Item	RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	2,880.00	EA	3,291.43	$ 338,726.4	$ 2,938.1	$ 251,102.6	$ -	$ 592,767.1	$ 196,205.9	$ 788,973.0	$ 413,684.4	$ 1,202,657.4	$ 55,442.5	$ 1,258,099.9	$ 62,905.0	$ 75,297.3	$ 1,396,302.2	
Level 4	**0401990304 20' Columns**	**24**	**EA**	**2,424.00**	**$ 265,596.9**	**$ 17,830.1**	**$ 1,185,099.1**	**$ -**	**$ 1,468,526.1**	**$ 486,082.2**	**$ 1,954,608.3**	**$ 1,024,865.2**	**$ 2,979,473.5**	**$ 137,353.7**	**$ 3,116,827.2**	**$ 155,841.4**	**$ 186,542.1**	**$ 3,459,210.7**	
Line Item	HNC 051223232011 Column, structural tubing, 32" x 16" x 1", incl shop primer, cap & base plate, bolts	117	TON	668.57	$ 84,942.9	$ 16,263.1	$ 368,371.0	$ -	$ 469,576.9	$ 155,430.0	$ 625,006.9	$ 327,711.6	$ 952,718.5	$ 43,920.3	$ 996,638.8	$ 49,831.9	$ 59,648.8	$ 1,106,119.6	
Line Item	RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer	5,163.00	SF	-	$ -	$ -	$ 682,806.8	$ -	$ 682,806.8	$ 226,009.0	$ 908,815.8	$ 476,521.9	$ 1,385,337.7	$ 63,864.1	$ 1,449,201.8	$ 72,460.1	$ 86,734.7	$ 1,608,396.6	(Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate. No Cost Book adjustment added as this item is quoted.)
Line Item	RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	1,536.00	EA	1,755.43	$ 180,654.1	$ 1,567.0	$ 133,921.4	$ -	$ 316,142.5	$ 104,643.2	$ 420,785.6	$ 220,631.7	$ 641,417.3	$ 29,569.3	$ 670,986.6	$ 33,549.3	$ 40,158.6	$ 744,694.5	
Level 4	**0401990305 Dam Wall Brackets**	**49**	**EA**	**448.00**	**$ 46,104.4**	**$ 399.9**	**$ 143,357.1**	**$ -**	**$ 189,861.4**	**$ 62,844.1**	**$ 252,705.6**	**$ 132,501.8**	**$ 385,207.4**	**$ 17,758.1**	**$ 402,965.5**	**$ 20,148.3**	**$ 24,117.5**	**$ 447,231.2**	
Line Item	RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer	784	SF	-	$ -	$ -	$ 109,179.3	$ -	$ 109,179.3	$ 36,138.3	$ 145,317.6	$ 76,194.8	$ 221,512.4	$ 10,211.7	$ 231,724.1	$ 11,586.2	$ 13,868.7	$ 257,179.0	(Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate)

					A	B	C	D	E=(A+B+C+D)	F	G=(E+F)	H	I=(G+H)	J	K-I+J)	L	M	N=(K+L+M)	
Level	**Description**	**Quantity**	**UOM**	**ManHours**	**Labor**	**Equipment**	**Material**	**Sub Bid**	**Total Direct**	**Sub Markups**	**Cost to Prime**	**Prime Markups**	**Contract**	**Escalation**	**Escalated Contract Cost**	**Contingency**	**SIOH**	**ProjectCost**	**Note**
Line Item	RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	392	EA	448.00	$ 46,104.4	$ 399.9	$ 34,177.9	$ -	$ 80,682.2	$ 26,705.8	$ 107,388.0	$ 56,307.1	$ 163,695.0	$ 7,546.3	$ 171,241.4	$ 8,562.1	$ 10,248.8	$ 190,052.3	
Level 3	**04019904 Stainless Steel Wire**	**328,269.00**	**LF**	**2,564.60**	**$ 333,295.3**	**$ -**	**$ 449,236.1**	**$ -**	**$ 782,531.4**	**$ 259,017.9**	**$ 1,041,549.4**	**$ 546,118.5**	**$ 1,587,667.8**	**$ 73,191.5**	**$ 1,660,859.3**	**$ 83,043.0**	**$ 99,402.4**	**$ 1,843,304.7**	(Note: SS wire 1/4" gauge. See BOE Appendix B, 5.0 for QTY and 8.0 for SS wire cost.No Cost Book adjustment added as the items under this section are quotes.)
Level 4	**1/4" Stainless Steel Wire**	**328,269.00**	**LF**	**2,564.60**	**$ 333,295.3**	**$ -**	**$ 449,236.1**	**$ -**	**$ 782,531.4**	**$ 259,017.9**	**$ 1,041,549.4**	**$ 546,118.5**	**$ 1,587,667.8**	**$ 73,191.5**	**$ 1,660,859.3**	**$ 83,043.0**	**$ 99,402.4**	**$ 1,843,304.7**	
Line Item	RSM 051516500550 Steel wire, 1/4" dia	328,269.00	LF	2,564.60	$ 333,295.3	$ -	$ 449,236.1	$ -	$ 782,531.4	$ 259,017.9	$ 1,041,549.4	$ 546,118.5	$ 1,587,667.8	$ 73,191.5	$ 1,660,859.3	$ 83,043.0	$ 99,402.4	$ 1,843,304.7	(Note: https://www.uscargocontrol.com/products/1-4-7x19-type-304-stainless-steel-wire-by-linear-foot)
Level 3	**04019916 Grounding**	**4**	**EA**	**24.49**	**$ 3,211.2**	**$ -**	**$ 1,867.9**	**$ -**	**$ 5,079.1**	**$ 1,681.2**	**$ 6,760.3**	**$ 3,544.7**	**$ 10,305.0**	**$ 475.1**	**$ 10,780.0**	**$ 539.0**	**$ 645.2**	**$ 11,964.2**	(Note: Grounding for Main Towers.)
Level 4	**04019916 Grounding**	**4**	**EA**	**24.49**	**$ 3,211.2**	**$ -**	**$ 1,867.9**	**$ -**	**$ 5,079.1**	**$ 1,681.2**	**$ 6,760.3**	**$ 3,544.7**	**$ 10,305.0**	**$ 475.1**	**$ 10,780.0**	**$ 539.0**	**$ 645.2**	**$ 11,964.2**	
Line Item	RSM 264113132100 Cable, copper, 375 lb per thousand feet, over 40' high	200	LF	22.41	$ 2,938.7	$ -	$ 1,828.5	$ -	$ 4,767.3	$ 1,578.0	$ 6,345.2	$ 3,327.0	$ 9,672.2	$ 445.9	$ 10,118.1	$ 505.9	$ 605.6	$ 11,229.6	
Line Item	RSM 260526800030 Grounding rod, copper clad, 8' long, 1/2" diameter	1	EA	2.08	$ 272.5	$ -	$ 39.4	$ -	$ 311.9	$ 103.2	$ 415.1	$ 217.6	$ 632.7	$ 29.2	$ 661.9	$ 33.1	$ 39.6	$ 734.6	
Level 1	**0401 ALTERNATIVE 2B - 1/4" Stainless Steel Wire**	**3,143,837.00**	**SF**	**14,977.31**	**$ 1,680,337.3**	**$ 335,720.3**	**$ 4,818,139.7**	**$ 119,600.0**	**$ 6,953,797.3**	**$ 2,301,706.9**	**$ 9,255,504.3**	**$ 4,504,010.0**	**$ 13,759,514.3**	**$ 634,313.6**	**$ 14,393,827.9**	**$ 719,691.4**	**$ 861,470.6**	**$ 15,974,989.9**	(Note: Alternative 2B: Similar design to Alternative 1B, with additional design based on a proposed code variance. Large APDA originating from towers on the Oregon shoreline; ¼" SS wires fan out across the river, anchoring at the navigation lock guide wall and navigation lock wall; excludes wires attached at the spillway. Assumed construction duration: 6 Months)
Level 2	**040199 Associated General Items**	**1**	**LS**	**14,977.31**	**$ 1,680,337.3**	**$ 335,720.3**	**$ 4,818,139.7**	**$ 119,600.0**	**$ 6,953,797.3**	**$ 2,301,706.9**	**$ 9,255,504.3**	**$ 4,504,010.0**	**$ 13,759,514.3**	**$ 634,313.6**	**$ 14,393,827.9**	**$ 719,691.4**	**$ 861,470.6**	**$ 15,974,989.9**	(Note: Costs developed for Alternative 2B include Barge, Towers Foundations, Structural Steel for Towers and Columns, SS wire, and Grounding.)
Level 3	**04019901 Barge Costs**	**4**	**MO**	**2,773.33**	**$ 285,649.4**	**$ 206,704.3**	**$ -**	**$ 103,500.0**	**$ 595,853.7**	**$ 197,227.6**	**$ 793,081.2**	**$ 385,937.5**	**$ 1,179,018.7**	**$ 54,352.8**	**$ 1,233,371.4**	**$ 61,668.6**	**$ 73,817.3**	**$ 1,368,857.3**	(Note: Barge mob/demob and operations for marine-based work. See BOE Appendix B, 6.0.)
Level 4	**Mobilization of Barge**	**1**	**LS**	**-**	**$ -**	**$ -**	**$ -**	**$ 51,750.0**	**$ 51,750.0**	**$ 17,129.3**	**$ 68,879.3**	**$ 33,518.7**	**$ 102,398.0**	**$ 4,720.6**	**$ 107,118.5**	**$ 5,355.9**	**$ 6,411.0**	**$ 118,885.5**	
Line Item	RSM 310660151320 Mobilization, set up and remove, mobilization by water for barge driving rig, maximum	1	EA	-	$ -	$ -	$ -	$ 51,750.0	$ 51,750.0	$ 17,129.3	$ 68,879.3	$ 33,518.7	$ 102,398.0	$ 4,720.6	$ 107,118.5	$ 5,355.9	$ 6,411.0	$ 118,885.5	
Level 4	**Barge Operations**	**4**	**MO**	**2,773.33**	**$ 285,649.4**	**$ 206,704.3**	**$ -**	**$ -**	**$ 492,353.7**	**$ 162,969.1**	**$ 655,322.7**	**$ 318,900.0**	**$ 974,222.7**	**$ 44,911.7**	**$ 1,019,134.4**	**$ 50,956.7**	**$ 60,995.2**	**$ 1,131,086.3**	
Line Item	USR 061333520362 Standby time for barge (Small)	4	MO	2,773.33	$ 285,649.4	$ 206,704.3	$ -	$ -	$ 492,353.7	$ 162,969.1	$ 655,322.7	$ 318,900.0	$ 974,222.7	$ 44,911.7	$ 1,019,134.4	$ 50,956.7	$ 60,995.2	$ 1,131,086.3	
Level 4	**Demobilization of Barge**	**1**	**LS**	**-**	**$ -**	**$ -**	**$ -**	**$ 51,750.0**	**$ 51,750.0**	**$ 17,129.3**	**$ 68,879.3**	**$ 33,518.7**	**$ 102,398.0**	**$ 4,720.6**	**$ 107,118.5**	**$ 5,355.9**	**$ 6,411.0**	**$ 118,885.5**	
Line Item	RSM 310660151320 Demobilization by water for barge driving rig, maximum	1	EA	-	$ -	$ -	$ -	$ 51,750.0	$ 51,750.0	$ 17,129.3	$ 68,879.3	$ 33,518.7	$ 102,398.0	$ 4,720.6	$ 107,118.5	$ 5,355.9	$ 6,411.0	$ 118,885.5	
Level 3	**04019902 Foundations for Towers**	**2**	**EA**	**1,125.98**	**$ 122,106.6**	**$ 18,840.7**	**$ 89,513.4**	**$ 16,100.0**	**$ 246,560.7**	**$ 81,611.6**	**$ 328,172.3**	**$ 159,698.6**	**$ 487,871.0**	**$ 22,490.9**	**$ 510,361.8**	**$ 25,518.1**	**$ 30,545.2**	**$ 566,425.1**	(Note: Costs have been included for clearing/grubbing, minor excavation, piling for cranes, structural concrete for tower foundation mats, and backfill. Based on A-E guidance, site is assumed to have adequate access and sufficient nearby space for laydown arrea.)
Level 4	**0401990201 Site Prep**	**2**	**EA**	**40.35**	**$ 4,330.3**	**$ 2,634.9**	**$ -**	**$ -**	**$ 6,965.2**	**$ 2,305.5**	**$ 9,270.6**	**$ 4,511.4**	**$ 13,782.0**	**$ 635.4**	**$ 14,417.4**	**$ 720.9**	**$ 862.9**	**$ 16,001.1**	
Line Item	RSM 311110100150 Clearing & grubbing, grub stumps and remove	1,152.00	SF	2.61	$ 258.5	$ 252.9	$ -	$ -	$ 511.4	$ 169.3	$ 680.7	$ 331.2	$ 1,011.9	$ 46.7	$ 1,058.6	$ 52.9	$ 63.4	$ 1,174.9	
Line Item	RSM 311413231460 Topsoil stripping and stockpiling, loam or topsoil, remove and stockpile on site, 200 HP dozer, 6" deep, 500' haul per S.Y.	128	SY	1.66	$ 172.9	$ 225.2	$ -	$ -	$ 398.0	$ 131.7	$ 529.8	$ 257.8	$ 787.6	$ 36.3	$ 823.9	$ 41.2	$ 49.3	$ 914.4	
Line Item	RSM 312316166260 Structural excavation for minor structures, bank measure, for spread and mat footings, elevator pits, and small building foundations, sandy clay or loam, 2 C.Y. bucket, machine excavation, hydraulic backhoe	341	BCY	36.08	$ 3,899.0	$ 2,156.8	$ -	$ -	$ 6,055.7	$ 2,004.5	$ 8,060.2	$ 3,922.3	$ 11,982.5	$ 552.4	$ 12,534.9	$ 626.8	$ 750.2	$ 13,911.9	
Level 4	**0401990202 Piling**	**720**	**VLF**	**466.32**	**$ 59,832.6**	**$ 12,145.8**	**$ 54,928.7**	**$ 16,100.0**	**$ 143,007.1**	**$ 47,335.3**	**$ 190,342.4**	**$ 92,626.4**	**$ 282,968.8**	**$ 13,044.9**	**$ 296,013.6**	**$ 14,800.7**	**$ 17,716.4**	**$ 328,530.7**	
Line Item	RSM 310660150300 Mobilization, 150 ton, set up and remove crane, with pile leads and pile hammer	1	EA	253.97	$ 32,586.3	$ 6,614.9	$ -	$ -	$ 39,201.1	$ 12,975.6	$ 52,176.7	$ 25,390.8	$ 77,567.5	$ 3,575.9	$ 81,143.4	$ 4,057.2	$ 4,856.4	$ 90,057.0	
Line Item	RSM 310660141050 Piling special costs, testing, any type piles, test load is twice the design load, 50 ton design load, 100 ton test	1	EA	-	$ -	$ -	$ -	$ 16,100.0	$ 16,100.0	$ 5,329.1	$ 21,429.1	$ 10,428.1	$ 31,857.2	$ 1,468.6	$ 33,325.8	$ 1,666.3	$ 1,994.6	$ 36,986.6	
Line Item	RSM 316223134200 Concrete-filled steel piles, steel, pipe piles, concrete filled, 50' long, 24" diameter, 59 lb./L.F., excludes mobilization or demobilization	720	VLF	212.35	$ 27,246.3	$ 5,530.9	$ 54,928.7	$ -	$ 87,705.9	$ 29,030.7	$ 116,736.6	$ 56,807.6	$ 173,544.1	$ 8,000.4	$ 181,544.5	$ 9,077.2	$ 10,865.4	$ 201,487.2	
Level 4	**0401990203 Mat Foundations for Towers**	**105**	**CY**	**224.00**	**$ 22,790.2**	**$ 96.9**	**$ 34,584.7**	**$ -**	**$ 57,471.9**	**$ 19,023.2**	**$ 76,495.0**	**$ 37,224.8**	**$ 113,719.8**	**$ 5,242.5**	**$ 118,962.3**	**$ 5,948.1**	**$ 7,119.9**	**$ 132,030.3**	**(Note: Q*14*14*7*1.03/27)**
Line Item	RSM 033053405950 Structural concrete, in place, pile cap (3000 psi), square or rectangular, over 10 C.Y., includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), placing and finishing	105	CY	224.00	$ 22,790.2	$ 96.9	$ 34,584.7	$ -	$ 57,471.9	$ 19,023.2	$ 76,495.0	$ 37,224.8	$ 113,719.8	$ 5,242.5	$ 118,962.3	$ 5,948.1	$ 7,119.9	$ 132,030.3	
Level 4	**0401990204 Backfill**	**2**	**EA**	**395.31**	**$ 35,153.5**	**$ 3,963.2**	**$ -**	**$ -**	**$ 39,116.7**	**$ 12,947.6**	**$ 52,064.3**	**$ 25,336.1**	**$ 77,400.3**	**$ 3,568.2**	**$ 80,968.5**	**$ 4,048.4**	**$ 4,846.0**	**$ 89,862.9**	
Line Item	HNC 312323140022 Backfill, structural, 6" lifts, backfill around foundation, by hand	225	CY	229.60	$ 20,312.7	$ -	$ -	$ -	$ 20,312.7	$ 6,723.5	$ 27,036.2	$ 13,156.7	$ 40,192.9	$ 1,852.9	$ 42,045.8	$ 2,102.3	$ 2,516.4	$ 46,664.5	
Line Item	HNC 311313110016 Selective clearing, load spoils, wheel and ramp load, includes 2 mile haul to dump	116	CY	165.71	$ 14,840.7	$ 3,963.2	$ -	$ -	$ 18,803.9	$ 6,224.1	$ 25,028.0	$ 12,179.4	$ 37,207.4	$ 1,715.3	$ 38,922.7	$ 1,946.1	$ 2,329.5	$ 43,198.4	
Level 3	**04019903 Structural Steel**	**1**	**LS**	**9,507.53**	**$ 1,068,467.6**	**$ 110,175.4**	**$ 4,454,903.2**	**$ -**	**$ 5,633,546.1**	**$ 1,864,703.8**	**$ 7,498,249.9**	**$ 3,648,876.6**	**$ 11,147,126.5**	**$ 513,882.5**	**$ 11,661,009.0**	**$ 583,050.5**	**$ 697,911.4**	**$ 12,941,970.9**	(Note: Structural Steel for towers. See BOE Appendix B, 6.0 for QTY and 9.0 for structural tubing cost.)
Level 4	**0401990301 Main Towers**	**2**	**EA**	**886.94**	**$ 109,167.2**	**$ 32,450.6**	**$ 188,000.0**	**$ -**	**$ 329,617.8**	**$ 109,103.5**	**$ 438,721.3**	**$ 213,495.1**	**$ 652,216.4**	**$ 30,067.2**	**$ 682,283.6**	**$ 34,114.2**	**$ 40,834.7**	**$ 757,232.4**	
Line Item	RSM 337113230640 Steel tower, special steel structure erection	46	TON	886.94	$ 109,167.2	$ 32,450.6	$ 188,000.0	$ -	$ 329,617.8	$ 109,103.5	$ 438,721.3	$ 213,495.1	$ 652,216.4	$ 30,067.2	$ 682,283.6	$ 34,114.2	$ 40,834.7	$ 757,232.4	
Level 4	**0401990303 30' Columns**	**45**	**EA**	**5,388.58**	**$ 605,171.1**	**$ 53,951.4**	**$ 2,686,771.1**	**$ -**	**$ 3,345,893.5**	**$ 1,107,490.8**	**$ 4,453,384.3**	**$ 2,167,152.3**	**$ 6,620,536.6**	**$ 305,206.7**	**$ 6,925,743.3**	**$ 346,287.2**	**$ 414,505.7**	**$ 7,686,536.2**	
Line Item	HNC 051223232011 Column, structural tubing, 32" x 16" x 1", incl shop primer, cap & base plate, bolts	367	TON	2,097.15	$ 266,444.7	$ 51,013.2	$ 1,155,488.5	$ -	$ 1,472,946.4	$ 487,545.3	$ 1,960,491.7	$ 954,034.9	$ 2,914,526.6	$ 134,359.7	$ 3,048,886.3	$ 152,444.3	$ 182,475.8	$ 3,383,806.4	
Line Item	RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer	9,680.00	SF	-	$ -	$ -	$ 1,280,180.0	$ -	$ 1,280,180.0	$ 423,739.6	$ 1,703,919.6	$ 829,179.1	$ 2,533,098.7	$ 116,775.9	$ 2,649,874.6	$ 132,493.7	$ 158,595.0	$ 2,940,963.3	(Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate. No Cost Book adjustment added as this item is quoted.)
Line Item	RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	2,880.00	EA	3,291.43	$ 338,726.4	$ 2,938.1	$ 251,102.6	$ -	$ 592,767.1	$ 196,205.9	$ 788,973.0	$ 383,938.3	$ 1,172,911.3	$ 54,071.2	$ 1,226,982.5	$ 61,349.1	$ 73,434.9	$ 1,361,766.5	
Level 4	**0401990304 20' Columns**	**32**	**EA**	**3,232.00**	**$ 354,129.2**	**$ 23,773.4**	**$ 1,580,132.2**	**$ -**	**$ 1,958,034.8**	**$ 648,109.5**	**$ 2,606,144.4**	**$ 1,268,229.2**	**$ 3,874,373.5**	**$ 178,608.6**	**$ 4,052,982.1**	**$ 202,649.1**	**$ 242,571.0**	**$ 4,498,202.2**	
Line Item	HNC 051223232011 Column, structural tubing, 32" x 16" x 1", incl shop primer, cap & base plate, bolts	156	TON	891.43	$ 113,257.2	$ 21,684.1	$ 491,161.3	$ -	$ 626,102.6	$ 207,240.0	$ 833,342.5	$ 405,529.8	$ 1,238,872.3	$ 57,112.0	$ 1,295,984.4	$ 64,799.2	$ 77,564.7	$ 1,438,348.2	
Line Item	RSM 051223650500 Steel plate, structural, for connections & stiffeners, 1.5" T, shop fabricated, incl shop primer	6,884.00	SF	-	$ -	$ -	$ 910,409.0	$ -	$ 910,409.0	$ 301,345.4	$ 1,211,754.4	$ 589,676.6	$ 1,801,430.9	$ 83,046.0	$ 1,884,476.9	$ 94,223.8	$ 112,785.9	$ 2,091,486.7	(Note: https://www.mkmetal.net/hot-rolled-steel-sheet-plate. No Cost Book adjustment added as this item is quoted.)

					A	B	C	D	E=(A+B+C+D)	F	G=(E+F)	H	I=(G+H)	J	K-I+J)	L	M	N=(K+L+M)	
Level	**Description**	**Quantity**	**UOM**	**ManHours**	**Labor**	**Equipment**	**Material**	**Sub Bid**	**Total Direct**	**Sub Markups**	**Cost to Prime**	**Prime Markups**	**Contract**	**Escalation**	**Escalated Contract Cost**	**Contingency**	**SIOH**	**ProjectCost**	**Note**
Line Item	RSM 050519101445 Chemical anchor, 1-3/4" diameter x 25" L, in concrete, brick or stone, incl layout, drilling, threaded rod & epoxy cartridge	2,048.00	EA	2,340.57	$ 240,872.1	$ 2,089.3	$ 178,561.8	$ -	$ 421,523.3	$ 139,524.2	$ 561,047.5	$ 273,022.8	$ 834,070.2	$ 38,450.6	$ 872,520.9	$ 43,626.0	$ 52,220.4	$ 968,367.3	
Level 3	**04019904 Stainless Steel Wire**	**199,320.00**	**LF**	**1,557.19**	**$ 202,371.9**	**$ -**	**$ 272,769.4**	**$ -**	**$ 475,141.3**	**$ 157,271.8**	**$ 632,413.1**	**$ 307,751.5**	**$ 940,164.6**	**$ 43,341.6**	**$ 983,506.2**	**$ 49,175.3**	**$ 58,862.8**	**$ 1,091,544.3**	(Note: SS wire 1/4" gauge. See BOE Appendix B, 6.0 for QTY and 8.0 for SS wire cost. No Cost Book adjustment added as the items under this section are quotes.)
Level 4	**1/4" Stainless Steel Wire**	**199,320.00**	**LF**	**1,557.19**	**$ 202,371.9**	**$ -**	**$ 272,769.4**	**$ -**	**$ 475,141.3**	**$ 157,271.8**	**$ 632,413.1**	**$ 307,751.5**	**$ 940,164.6**	**$ 43,341.6**	**$ 983,506.2**	**$ 49,175.3**	**$ 58,862.8**	**$ 1,091,544.3**	
Line Item	RSM 051516500550 Steel wire, 1/4" dia	199,320.00	LF	1,557.19	$ 202,371.9	$ -	$ 272,769.4	$ -	$ 475,141.3	$ 157,271.8	$ 632,413.1	$ 307,751.5	$ 940,164.6	$ 43,341.6	$ 983,506.2	$ 49,175.3	$ 58,862.8	$ 1,091,544.3	(Note: https://www.uscargocontrol.com/products/1-4-7x19-type-304-stainless-steel-wire-by-linear-foot)
Level 3	**04019916 Grounding**	**2**	**EA**	**13.28**	**$ 1,741.9**	**$ -**	**$ 953.6**	**$ -**	**$ 2,695.5**	**$ 892.2**	**$ 3,587.7**	**$ 1,745.9**	**$ 5,333.6**	**$ 245.9**	**$ 5,579.5**	**$ 279.0**	**$ 333.9**	**$ 6,192.4**	(Note: Grounding for Main Towers.)
Level 4	**04019916 Grounding**	**2**	**EA**	**13.28**	**$ 1,741.9**	**$ -**	**$ 953.6**	**$ -**	**$ 2,695.5**	**$ 892.2**	**$ 3,587.7**	**$ 1,745.9**	**$ 5,333.6**	**$ 245.9**	**$ 5,579.5**	**$ 279.0**	**$ 333.9**	**$ 6,192.4**	
Line Item	RSM 264113132100 Cable, copper, 375 lb per thousand feet, over 40' high	100	LF	11.20	$ 1,469.4	$ -	$ 914.3	$ -	$ 2,383.6	$ 789.0	$ 3,172.6	$ 1,543.9	$ 4,716.5	$ 217.4	$ 4,933.9	$ 246.7	$ 295.3	$ 5,475.9	
Line Item	RSM 260526800030 Grounding rod, copper clad, 8' long, 1/2" diameter	1	EA	2.08	$ 272.5	$ -	$ 39.4	$ -	$ 311.9	$ 103.2	$ 415.1	$ 202.0	$ 617.1	$ 28.5	$ 645.5	$ 32.3	$ 38.6	$ 716.4	
Level 1	**0401 ALTERNATIVE 3 - In-Water Array Anchors**	**6**	**EA**	**1,330.00**	**$ 137,922.2**	**$ 96,892.6**	**$ 124,813.6**	**$ 103,500.0**	**$ 463,128.4**	**$ 153,295.5**	**$ 616,423.9**	**$ 317,273.4**	**$ 933,697.3**	**$ 36,694.3**	**$ 970,391.6**	**$ 48,519.6**	**$ 58,077.9**	**$ 1,076,989.1**	(Note: Alternative 3: In-water array composed of a series of six (6) stainless-steel cables suspended at the water surface by regularly spaced buoy floats; cables are arranged in a linear array trailing downstream from the outfall pier. Assumed construction duration: 1.5 Months)
Level 2	**040199 Associated General Items**	**1**	**LS**	**1,330.00**	**$ 137,922.2**	**$ 96,892.6**	**$ 124,813.6**	**$ 103,500.0**	**$ 463,128.4**	**$ 153,295.5**	**$ 616,423.9**	**$ 317,273.4**	**$ 933,697.3**	**$ 36,694.3**	**$ 970,391.6**	**$ 48,519.6**	**$ 58,077.9**	**$ 1,076,989.1**	(Note: Costs developed for Alternative 3 include Barge costs and Array anchors.)
Level 3	**04019901 Barge Costs**	**1.5**	**MO**	**1,300.00**	**$ 134,636.4**	**$ 96,892.6**	**$ -**	**$ 103,500.0**	**$ 335,029.0**	**$ 110,894.6**	**$ 445,923.6**	**$ 229,516.9**	**$ 675,440.4**	**$ 26,544.8**	**$ 701,985.3**	**$ 35,099.3**	**$ 42,013.8**	**$ 779,098.3**	(Note: Barge mob/demob and operations for marine-based work. See BOE Appendix B, 7.0.)
Level 4	**0401990101 Mobilization of Barge**	**1**	**LS**	**-**	**$ -**	**$ -**	**$ -**	**$ 51,750.0**	**$ 51,750.0**	**$ 17,129.3**	**$ 68,879.3**	**$ 35,452.2**	**$ 104,331.4**	**$ 4,100.2**	**$ 108,431.6**	**$ 5,421.6**	**$ 6,489.6**	**$ 120,342.8**	
Line Item	RSM 310660151320 Mobilization, set up and remove, mobilization by water for barge driving rig, maximum	1	EA	-	$ -	$ -	$ -	$ 51,750.0	$ 51,750.0	$ 17,129.3	$ 68,879.3	$ 35,452.2	$ 104,331.4	$ 4,100.2	$ 108,431.6	$ 5,421.6	$ 6,489.6	$ 120,342.8	
Level 4	**0401990102 Barge Operations**	**1.5**	**MO**	**1,300.00**	**$ 134,636.4**	**$ 96,892.6**	**$ -**	**$ -**	**$ 231,529.0**	**$ 76,636.1**	**$ 308,165.1**	**$ 158,612.6**	**$ 466,777.6**	**$ 18,344.4**	**$ 485,122.0**	**$ 24,256.1**	**$ 29,034.6**	**$ 538,412.7**	
Line Item	USR 061333520362 Standby time for barge (Small)	1.5	MO	1,300.00	$ 134,636.4	$ 96,892.6	$ -	$ -	$ 231,529.0	$ 76,636.1	$ 308,165.1	$ 158,612.6	$ 466,777.6	$ 18,344.4	$ 485,122.0	$ 24,256.1	$ 29,034.6	$ 538,412.7	
Level 4	**0401990103 Demobilization of Barge**	**1**	**LS**	**-**	**$ -**	**$ -**	**$ -**	**$ 51,750.0**	**$ 51,750.0**	**$ 17,129.3**	**$ 68,879.3**	**$ 35,452.2**	**$ 104,331.4**	**$ 4,100.2**	**$ 108,431.6**	**$ 5,421.6**	**$ 6,489.6**	**$ 120,342.8**	
Line Item	RSM 310660151320 Demobilization by water for barge driving rig, maximum	1	EA	-	$ -	$ -	$ -	$ 51,750.0	$ 51,750.0	$ 17,129.3	$ 68,879.3	$ 35,452.2	$ 104,331.4	$ 4,100.2	$ 108,431.6	$ 5,421.6	$ 6,489.6	$ 120,342.8	
Level 3	**04019902 In-Water Array Anchors**	**6**	**EA**	**30.00**	**$ 3,285.9**	**$ -**	**$ 124,813.6**	**$ -**	**$ 128,099.4**	**$ 42,400.9**	**$ 170,500.3**	**$ 87,756.5**	**$ 258,256.9**	**$ 10,149.5**	**$ 268,406.3**	**$ 13,420.3**	**$ 16,064.1**	**$ 297,890.8**	(Note: Six (6) In-water arrays. See BOE Appendix B, 7.0 for QTY.)
Level 4	**0401990201 In-Water Array Anchors**	**6**	**EA**	**30.00**	**$ 3,285.9**	**$ -**	**$ 124,813.6**	**$ -**	**$ 128,099.4**	**$ 42,400.9**	**$ 170,500.3**	**$ 87,756.5**	**$ 258,256.9**	**$ 10,149.5**	**$ 268,406.3**	**$ 13,420.3**	**$ 16,064.1**	**$ 297,890.8**	**(Note: . No Cost Book adjustment added as the items under this section are quotes.)**
Line Item	USR 13" X 18" Buoy	78	EA	-	$ -	$ -	$ 38,566.5	$ -	$ 38,566.5	$ 12,765.5	$ 51,332.0	$ 26,420.6	$ 77,752.6	$ 3,055.7	$ 80,808.3	$ 4,040.4	$ 4,836.4	$ 89,685.1	(Note: https://www.dockgearsupply.com/boat-dock-accessories/pc/13-x-18-Elliptical-Mooring-Buoys-with-Stainless-Steel-Hardware-p1162.htm)
Line Item	USR Anchor Buoy	6	EA	-	$ -	$ -	$ 1,503.4	$ -	$ 1,503.4	$ 497.6	$ 2,001.1	$ 1,030.0	$ 3,031.0	$ 119.1	$ 3,150.2	$ 157.5	$ 188.5	$ 3,496.2	(Note: https://polyformus.com/products/cm-2-mooring-buoy?variant=45343845810314&country=US&currency=USD&utm_medium=product_sync&utm_source=google&utm_content=sag_organic&utm_campaign=sag_organic&gad_source=1&gclid=Cj0KCQjw782_BhDjARIsABTv_JAJP67W5tQE1Vfy62wpdJV15upajVpZf0YkSXNtUqTTh6_OiuCFoLkaAmCFEALw_wcB)
Line Item	USR Nylon/HMPE Rope	600	LF	-	$ -	$ -	$ 69,000.0	$ -	$ 69,000.0	$ 22,839.0	$ 91,839.0	$ 47,269.5	$ 139,108.5	$ 5,467.0	$ 144,575.5	$ 7,228.8	$ 8,652.8	$ 160,457.1	(Note: https://skydogrigging.com/product/516-blue-hmpe-12-strand-rope-600-spool/?gad_source=1&gclid=Cj0KCQjw782_BhDjARIsABTv_JBEAbYSJ9_n0bojkeMFJ3kv3Va8GbANpTvv6KTP5iRbiTffk36tTy0aAqUmEALw_wcB)
Line Item	USR 55 LB Weight for Semi Submersion	36	EA	-	$ -	$ -	$ 8,238.6	$ -	$ 8,238.6	$ 2,727.0	$ 10,965.6	$ 5,644.0	$ 16,609.6	$ 652.8	$ 17,262.3	$ 863.1	$ 1,033.2	$ 19,158.6	(Note: https://www.rotometals.com/custom-buoy-weights-50-pounds-for-large-ones/)
Line Item	USR Buoy Anchor (100 Lb)	6	EA	-	$ -	$ -	$ 1,587.0	$ -	$ 1,587.0	$ 525.3	$ 2,112.3	$ 1,087.2	$ 3,199.5	$ 125.7	$ 3,325.2	$ 166.3	$ 199.0	$ 3,690.5	(Note: https://boatstore.com/marpac-pyramid-style-mooring-anchor-100-lbs.html?utm_source=googleshopping&utm_medium=cse&srsltid=AfmBOop1ADx9ZKKwsqaGaiL5MGqX13Sbk9lEmGd9eFNSGbo3kO1oOGKza-k)
Line Item	USR Trip Lines	1,800.00	LF	-	$ -	$ -	$ 207.0	$ -	$ 207.0	$ 68.5	$ 275.5	$ 141.8	$ 417.3	$ 16.4	$ 433.7	$ 21.7	$ 26.0	$ 481.4	(Note: https://www.uline.com/Product/Detail/S-15873/Twine-Rope/Hollow-Braid-Polypropylene-Rope-3-8-x-500?pricode=WB0668&gadtype=pla&id=S-15873&gad_source=4&gclid=Cj0KCQjw782_BhDjARIsABTv_JDvNq4Xnelewrwb1yAwTkuxxw9C9xtLbcKp1gjjGRa5O51GBbmrWosaAnxtEALw_wcB)
Line Item	USR Bottom Chain	672	LF	-	$ -	$ -	$ 5,711.0	$ -	$ 5,711.0	$ 1,890.3	$ 7,601.3	$ 3,912.4	$ 11,513.7	$ 452.5	$ 11,966.2	$ 598.3	$ 716.2	$ 13,280.7	(Note: https://www.grainger.com/product/48RN41?N:N:PS:Paid:GGL:CSM-2295:ZPF8P7:20800401:APZ_1&gad_source=1&gclid=Cj0KCQjw782_BhDjARIsABTv_JDNqwu54XdTzk_hk6DBnwdqwgcBNORv_UOOmo6Vg74joOZe9yx-WtYaAhXTEALw_wcB&gclsrc=aw.ds)
Line Item	USR In-Water Array Anchors	6	HR	30.00	$ 3,285.9	$ -	$ -	$ -	$ 3,285.9	$ 1,087.6	$ 4,373.5	$ 2,251.0	$ 6,624.5	$ 260.3	$ 6,884.9	$ 344.2	$ 412.1	$ 7,641.2	(Note: Crew composed of 1 foreman, 1 diver, and 2 carpenters)

Appendix D. Calculations

McNary APDA
Conceptual Design Evaluation

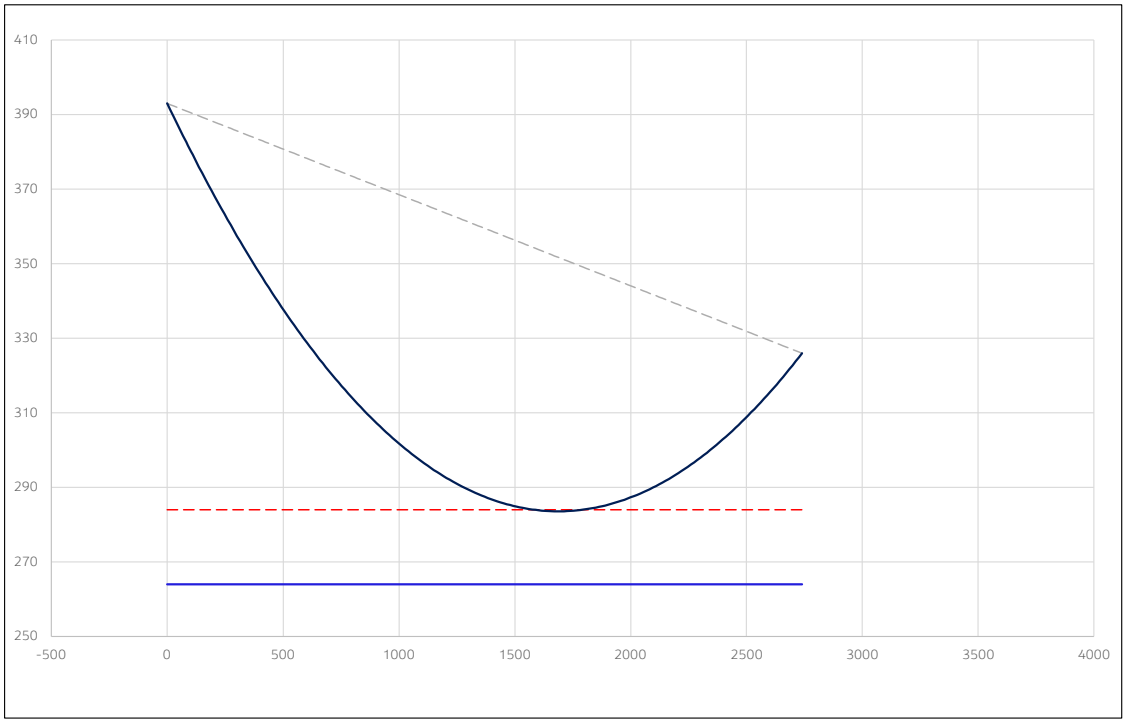
STRUCTURAL CALCULATIONS

STAINLESS STEEL WIRES

ALTERNATIVE 1A/1B
CODE COMPLIANT

Guide Wall Cable - 2740ft (SS)

CABLE PROPERTIES								
Code	ASCE 7-22							
Material	SS 304		Breaking Strength	129400	lbs	h1	105.5	ft
Diameter	1 1/4	in	Reduction Factor	0.5		h2	38.5	ft
Class	6x19		Allowable Tension	64700	lbs	L	2740	ft
Weight, D	2.9	plf						
Wind Gust Speed	94	mph						
Wind Press	23.1	psf						
Wind Load, W	2.4	psf						
Nominal Ice Thickness	0.52	in						
Design Ice Thickness	0.59	in	**South Anchorage**			**North Anchorage**		
Ice Area	3.44	in2	R1	64574	lbs	R2	64265	lbs
Ice Wind Speed	46	mph	R1x	64087	lbs	R1x	64087	lbs
Wind on Ice, Wi	1.12	psf	R1y	7913	lbs	R1y	4780	lbs
Ice Weight, Di	1.34	psf	Theta1	7.04	degrees	Theta1	4.27	degrees
LC 1: D	2.90	psf						
LC 2: D + 0.7*Di	3.84	psf	required strength	129148			128530	
LC 3: D + 0.6*W	4.34	psf						
LC 4: D + 0.7*Di + 0.7*Wi	4.62	psf	DCR	1.00		DCR	0.99	
Max Uniform	4.62	psf						



	Code Variance			Code Compliant		
Code	ASCE 7-10 **			ASCE 7-22		
Basic Wind Speed	V	79	mph	V	94	mph
Nonimal Ice Thickness	t	0.25	in	t	0.52	in
Concurrent Wind Speed	Vc	40	mph	Vc	46	mph
Max Wire Height	z	125.5	ft	z	125.5	ft
Topographic Fator	Kzt	1		Kzt	1	
Importance Factor (RC =1)	I_i	0.8				
Ice Height Factor	fz	1.14		fz	1.14	
Design Ice Thickness	td	0.46	in	td	0.59	in
Ice Density	ρ_{ice}	56	pcf	ρ_{ice}	56	pcf
Wire Diameter	Dc	1 1/4	in	Dc	1 1/4	in
Ice Area	Ai	2.45	in2	Ai	3.44	in2
Ice Weight	Wi	0.95	plf	Wi	1.34	plf

**25 year wind speed used

**Wind on ice load case not considered

ALTERNATIVE 1A/1B
CODE COMPLIANT

Guide Wall Cable - 2740ft (SS)

Utilization Summary (ASD)

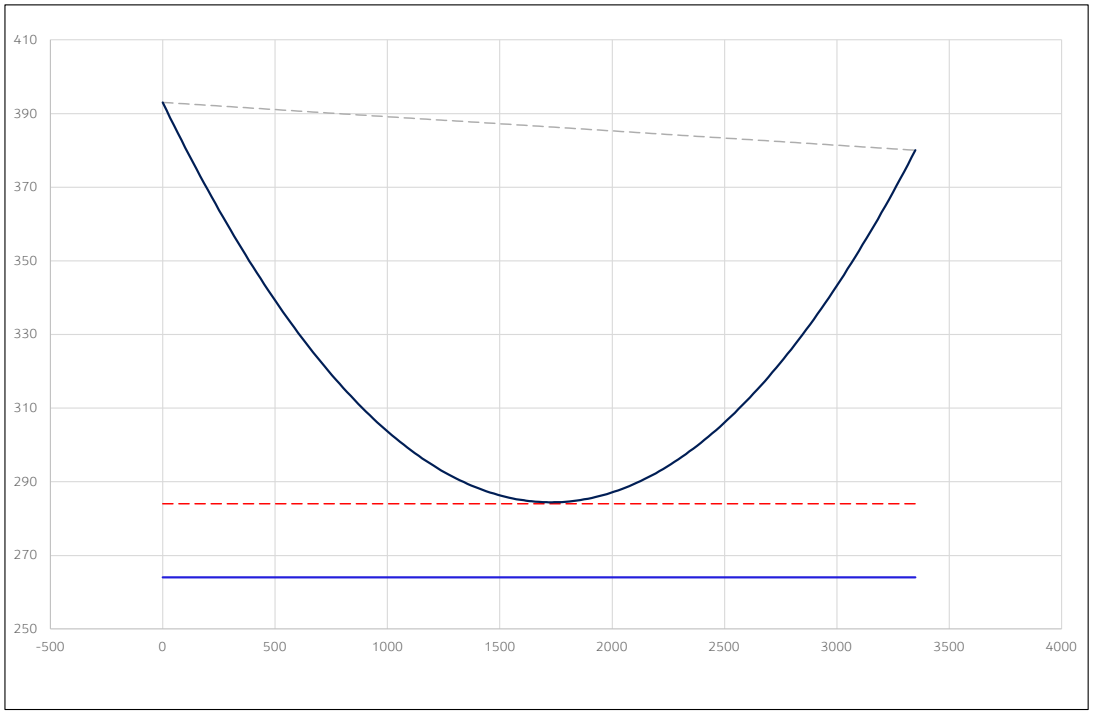
Loads	Load Combination (ASD)	plf	% Max	Max Cable Tension (kip)	Breaking Strength (kip)	% Utilzation
Dead	LC 1: D	2.90	63%	80994	129400	63%
Dead + Wind	LC 2: D + 0.7*Di	3.84	83%	107175	129400	83%
Dead + Ice	LC 3: D + 0.6*W	4.34	94%	121308	129400	94%
Dead + Ice + Wind	LC 4: D + 0.7*Di + 0.7*Wi	4.62	100%	129148	129400	100%

ALTERNATIVE 1A/1B
CODE COMPLIANT

Navlock Cable - 3350ft (SS)

CABLE PROPERTIES

Code	ASCE 7-22							
Material	SS 304		Breaking Strength	129400	lbs	h1	108.5	ft
Diameter	1 1/4	in	Reduction Factor	0.5		h2	95.5	ft
Class	6x19		Allowable Tension	64700	lbs	L	3350	ft
Weight, D	2.9	plf						
Wind Gust Speed	94	mph						
Wind Press	23.1	psf						
Wind Load, W	2.4	psf						
Nominal Ice Thickness	0.52	in						
Design Ice Thickness	0.60	in	**South Anchorage**			**North Anchorage**		
Ice Area	3.45	in2	R1	64332	lbs	R2	64272	lbs
Ice Wind Speed	46	mph	R1x	63831	lbs	R1x	63831	lbs
Wind on Ice, Wi	1.13	psf	R1y	8008	lbs	R1y	7513	lbs
Ice Weight, Di	1.34	psf	Theta1	7.15	degrees	Theta1	6.71	degrees
LC 1: D	2.90	psf						
LC 2: D + 0.7*Di	3.84	psf	required strength	128664			128544	
LC 3: D + 0.6*W	4.34	psf						
LC 4: D + 0.7*Di + 0.7*Wi	4.63	psf	DCR	0.99		DCR	0.99	
Max Uniform	4.63	psf						



		Code Variance			Code Compliant		
		ASCE 7-10 **			ASCE 7-22		
Code							
Basic Wind Speed	V	79	mph		V	94	mph
Nonimal Ice Thickness	t	0.25	in		t	0.52	in
Concurrent Wind Speed	Vc	40	mph		Vc	46	mph
Max Wire Height	z	128.5	ft		z	128.5	ft
Topographic Fator	Kzt	1			Kzt	1	
Importance Factor (RC =1)	I_i	0.8					
Ice Height Factor	fz	1.15			fz	1.15	
Design Ice Thickness	td	0.46	in		td	0.60	in
Ice Density	ρ_{ice}	56	pcf		ρ_{ice}	56	pcf
Wire Diameter	Dc	1 1/4	in		Dc	1 1/4	in
Ice Area	Ai	2.46	in2		Ai	3.45	in2
Ice Weight	Wi	0.96	plf		Wi	1.34	plf

**25 year wind speed used

**Wind on ice load case not considered

ALTERNATIVE 1A/1B
CODE COMPLIANT

Navlock Cable - 3350ft (SS)

Utilization Summary (ASD)

Loads	Load Combination (ASD)	plf	% Max	Max Cable Tension (kip)	Breaking Strength (kip)	% Utilzation
Dead	LC 1: D	2.90	63%	80624	129400	62%
Dead + Wind	LC 2: D + 0.7*Di	3.84	83%	106766	129400	83%
Dead + Ice	LC 3: D + 0.6*W	4.34	94%	120753	129400	93%
Dead + Ice + Wind	LC 4: D + 0.7*Di + 0.7*Wi	4.63	100%	128664	129400	99%

ALTERNATIVE 1A/1B
CODE COMPLIANT

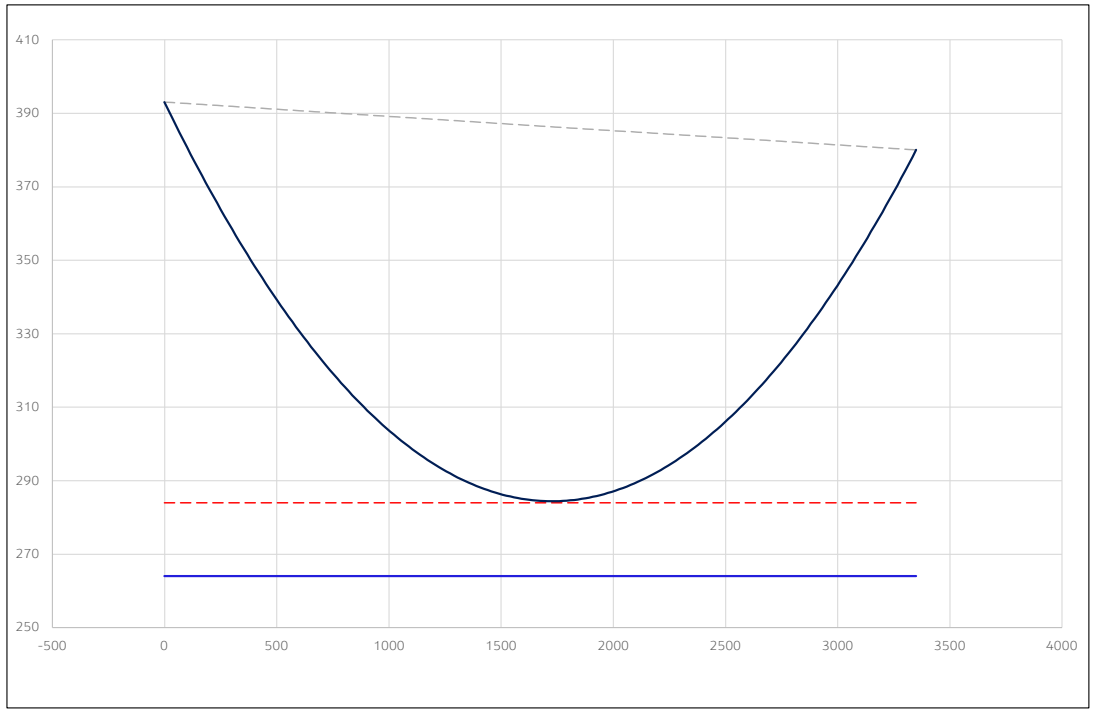
Spillway Cable - 3350ft (SS)

CABLE PROPERTIES								
Code	ASCE 7-22							
Material	SS 304		Breaking Strength	129400	lbs	h1	108.5	ft
Diameter	1 1/4	in	Reduction Factor	0.5		h2	95.5	ft
Class	6x19		Allowable Tension	64700	lbs	L	3350	ft
Weight, D	2.9	plf						
Wind Gust Speed	94	mph						
Wind Press	23.1	psf						
Wind Load, W	2.4	psf						
Nominal Ice Thickness	0.52	in						
Design Ice Thickness	0.60	in	**South Anchorage**			**North Anchorage**		
Ice Area	3.45	in2	R1	64332	lbs	R2	64272	lbs
Ice Wind Speed	46	mph	R1x	63831	lbs	R1x	63831	lbs
Wind on Ice, Wi	1.13	psf	R1y	8008	lbs	R1y	7513	lbs
Ice Weight, Di	1.34	psf	Theta1	7.15	degrees	Theta1	6.71	degrees
LC 1: D	2.90	psf						
LC 2: D + 0.7*Di	3.84	psf	required strength	128664			128544	
LC 3: D + 0.6*W	4.34	psf						
LC 4: D + 0.7*Di + 0.7*Wi	4.63	psf	DCR	0.99		DCR	0.99	
Max Uniform	4.63	psf						

	Code Variance			Code Compliant		
Code	ASCE 7-10 **			ASCE 7-22		
Basic Wind Speed	V	79	mph	V	94	mph
Nonimal Ice Thickness	t	0.25	in	t	0.52	in
Concurrent Wind Speed	Vc	40	mph	Vc	46	mph
Max Wire Height	z	128.5	ft	z	128.5	ft
Topographic Fator	Kzt	1		Kzt	1	
Importance Factor (RC =1)	I	0.8				
Ice Height Factor	fz	1.15		fz	1.15	
Design Ice Thickness	td	0.46	in	td	0.60	in
Ice Density	ρ_{ice}	56	pcf	ρ_{ice}	56	pcf
Wire Diameter	Dc	1 1/4	in	Dc	1 1/4	in
Ice Area	Ai	2.46	in2	Ai	3.45	in2
Ice Weight	Wi	0.96	plf	Wi	1.34	plf

**25 year wind speed used

**Wind on ice load case not considered



ALTERNATIVE 1A/1B
CODE COMPLIANT

Spillway Cable - 3350ft (SS)

Utilization Summary (ASD)

Loads	Load Combination (ASD)	plf	% Max	Max Cable Tension (kip)	Breaking Strength (kip)	% Utilzation
Dead	LC 1: D	2.90	63%	80624	129400	62%
Dead + Wind	LC 2: D + 0.7*Di	3.84	83%	106766	129400	83%
Dead + Ice	LC 3: D + 0.6*W	4.34	94%	120753	129400	93%
Dead + Ice + Wind	LC 4: D + 0.7*Di + 0.7*Wi	4.63	100%	128664	129400	99%

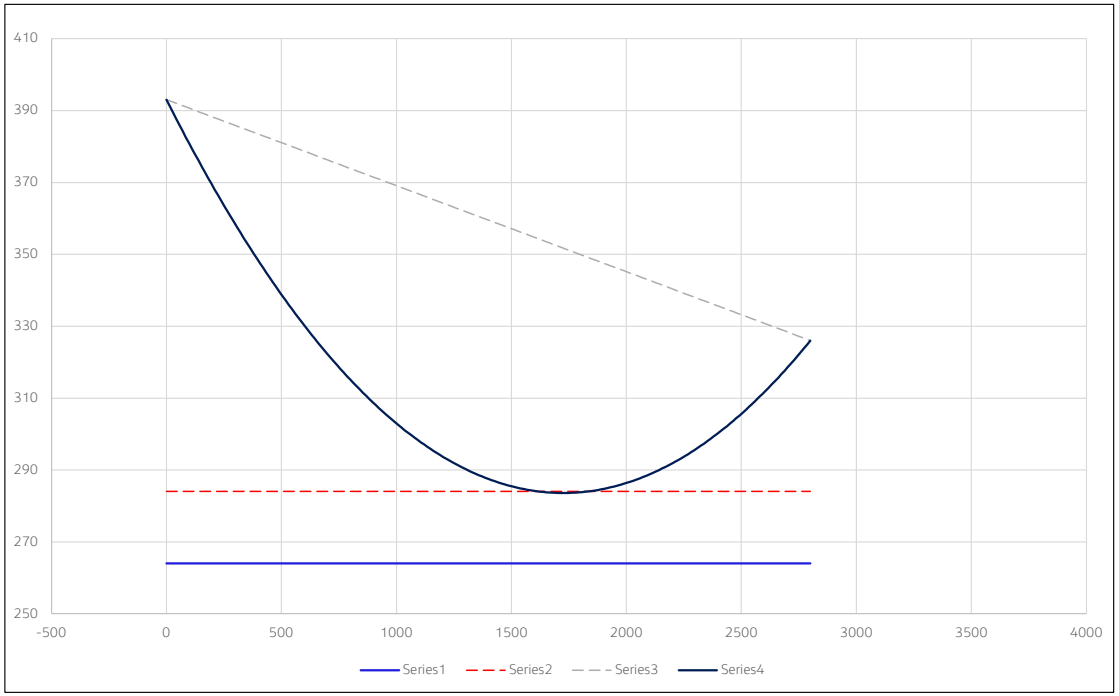
ALTERNATIVE 2A/2B
CODE VARIANCE

Guide Wall Cable - 2800ft (SS)

CABLE PROPERTIES								
Code	ASCE 7-10							
Material	SS 304		Breaking Strength	6400	lbs	h1	105.5	ft
Diameter	1/4	in	Reduction Factor	1	***	h2	38.5	ft
Class	7x19		Allowable Tension	6400	lbs	L	2800	ft
Weight, D	0.11	plf						
Wind Gust Speed	79	mph						
Wind Press	16.3	psf						
Wind Load, W	0.3	psf	https://www.engineeringtoolbox.com/cable-loads-d_1816.html					
Nominal Ice Thickness	0.25	in	*Input values in green cells into "Uniformly Loaded Cables with Inclined Chords" section of websit					
Design Ice Thickness	0.46	in	**South Anchorage**			**North Anchorage**		
Ice Area	1.58	in2	R1	9762	lbs	R2	9717	lbs
Ice Wind Speed	40	mph	R1x	9692	lbs	R1x	9692	lbs
Wind on Ice, Wi	0.41	psf	R1y	1171	lbs	R1y	707	lbs
Ice Weight, Di	0.39	psf	Theta1	6.89	degrees	Theta1	4.17	degrees
LC 1: D	0.11	psf						
LC 2: D + 0.7*Di	0.39	psf	required strength	9762			9717	
LC 3: D + 0.6*W	0.31	psf						
LC 4: D + 0.7*Di + 0.7*Wi	0.67	psf	DCR	1.53		DCR	1.52	
Max Uniform	0.67	psf						

	Code Variance				Code Compliant			
Code		ASCE 7-10	**			ASCE 7-22		
Basic Wind Speed	V	79	mph		V	94	mph	
Nonimal Ice Thickness	t	0.25	in		t	0.52	in	
Concurrent Wind Speed	Vc	40	mph		Vc	46	mph	
Max Wire Height	z	125.5	ft		z	125.5	ft	
Topographic Fator	Kzt	1			Kzt	1		
Importance Factor (RC =1)	I_i	0.8						
Ice Height Factor	fz	1.14			fz	1.14		
Design Ice Thickness	td	0.46	in		td	0.59	in	
Ice Density	ρ_{ice}	56	pcf		ρ_{ice}	56	pcf	
Wire Diameter	Dc	1/4	in		Dc	1/4	in	
Ice Area	Ai	1.02	in2		Ai	1.58	in2	
Ice Weight	Wi	0.39	plf		Wi	0.61	plf	

**25 year wind speed used
**Wind on ice load case not considered
***No reduction or factor of safety applied



ALTERNATIVE 2A/2B
CODE VARIANCE

Guide Wall Cable - 2800ft (SS)

Utilization Summary (ASD)

Loads	Load Combination (ASD)	plf	% Max	Max Cable Tension (kip)	Breaking Strength (kip)	% Utilzation
Dead	LC 1: D	0.11	16%	1601	6400	25%
Dead + Wind	LC 2: D + 0.7*Di	0.39	58%	5627	6400	88%
Dead + Ice	LC 3: D + 0.6*W	0.31	47%	4570	6400	71%
Dead + Ice + Wind	LC 4: D + 0.7*Di + 0.7*Wi	0.67	100%	9762	6400	153%

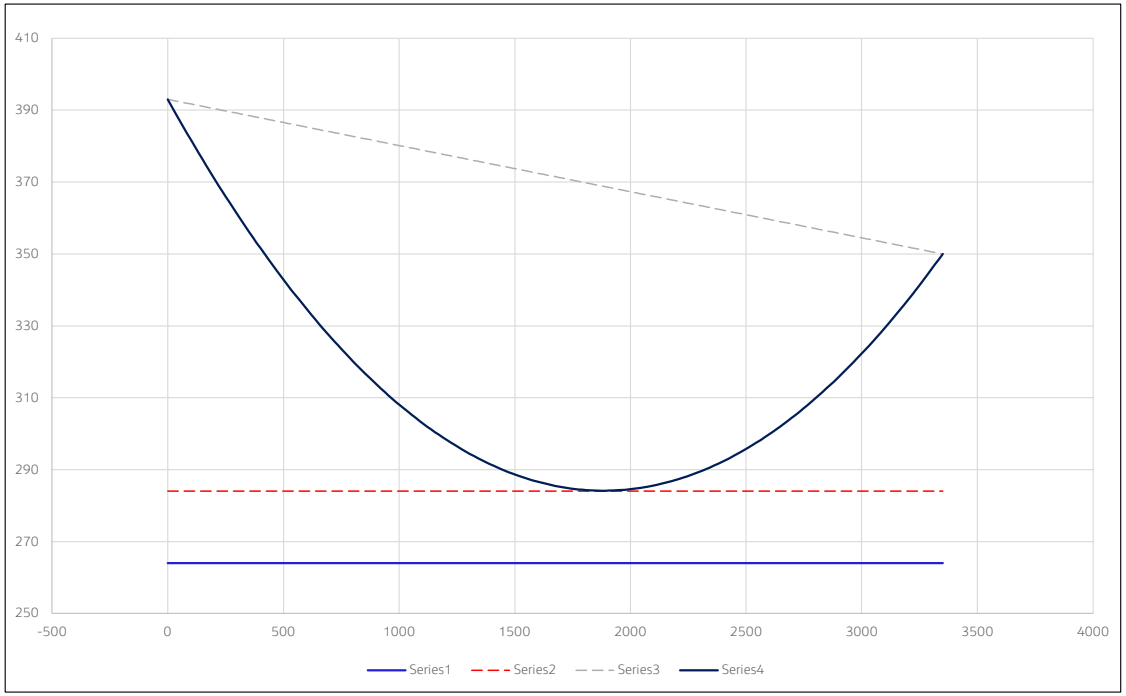
ALTERNATIVE 2A/2B
CODE VARIANCE

Navlock Cable - 3350ft (SS)

CABLE PROPERTIES								
Code	ASCE 7-10							
Material	SS 304		Breaking Strength	6400	lbs	h1	107.5	ft
Diameter	1/4	in	Reduction Factor	1	***	h2	64.5	ft
Class	7x19		Allowable Tension	6400	lbs	L	3350	ft
Weight, D	0.11	plf						
Wind Gust Speed	79	mph						
Wind Press	16.3	psf						
Wind Load, W	0.3	psf	https://www.engineeringtoolbox.com/cable-loads-d_1816.html					
Nominal Ice Thickness	0.25	in	*Input values in green cells into "Uniformly Loaded Cables with Inclined Chords" section of website					
Design Ice Thickness	0.46	in	**South Anchorage**			**North Anchorage**		
Ice Area	1.58	in2	R1	11032	lbs	R2	11004	lbs
Ice Wind Speed	40	mph	R1x	10961	lbs	R1x	10961	lbs
Wind on Ice, Wi	0.41	psf	R1y	1247	lbs	R1y	966	lbs
Ice Weight, Di	0.40	psf	Theta1	6.49	degrees	Theta1	5.04	degrees
LC 1: D	0.11	psf						
LC 2: D + 0.7*Di	0.39	psf	required strength	11032			11004	
LC 3: D + 0.6*W	0.31	psf						
LC 4: D + 0.7*Di + 0.7*Wi	0.67	psf	DCR	1.72		DCR	1.72	
Max Uniform	0.67	psf						

	Code Variance			Code Compliant		
	ASCE 7-10 **			ASCE 7-22		
Code						
Basic Wind Speed	V	79	mph	V	94	mph
Nonimal Ice Thickness	t	0.25	in	t	0.52	in
Concurrent Wind Speed	Vc	40	mph	Vc	46	mph
Max Wire Height	z	127.5	ft	z	127.5	ft
Topographic Fator	Kzt	1		Kzt	1	
Importance Factor (RC =1)	I_i	0.8				
Ice Height Factor	fz	1.14		fz	1.14	
Design Ice Thickness	td	0.46	in	td	0.60	in
Ice Density	ρ_{ice}	56	pcf	ρ_{ice}	56	pcf
Wire Diameter	Dc	1/4	in	Dc	1/4	in
Ice Area	Ai	1.02	in2	Ai	1.58	in2
Ice Weight	Wi	0.40	plf	Wi	0.61	plf

**25 year wind speed used
**Wind on ice load case not considered
***No reduction or factor of safety applied



ALTERNATIVE 2A/2B
CODE VARIANCE

Navlock Cable - 3350ft (SS)

Utilization Summary (ASD)

Loads	Load Combination (ASD)	plf	% Max	Max Cable Tension (kip)	Breaking Strength (kip)	% Utilzation
Dead	LC 1: D	0.11	16%	1807	6400	28%
Dead + Wind	LC 2: D + 0.7*Di	0.39	58%	6360	6400	99%
Dead + Ice	LC 3: D + 0.6*W	0.31	47%	5156	6400	81%
Dead + Ice + Wind	LC 4: D + 0.7*Di + 0.7*Wi	0.67	100%	11032	6400	172%

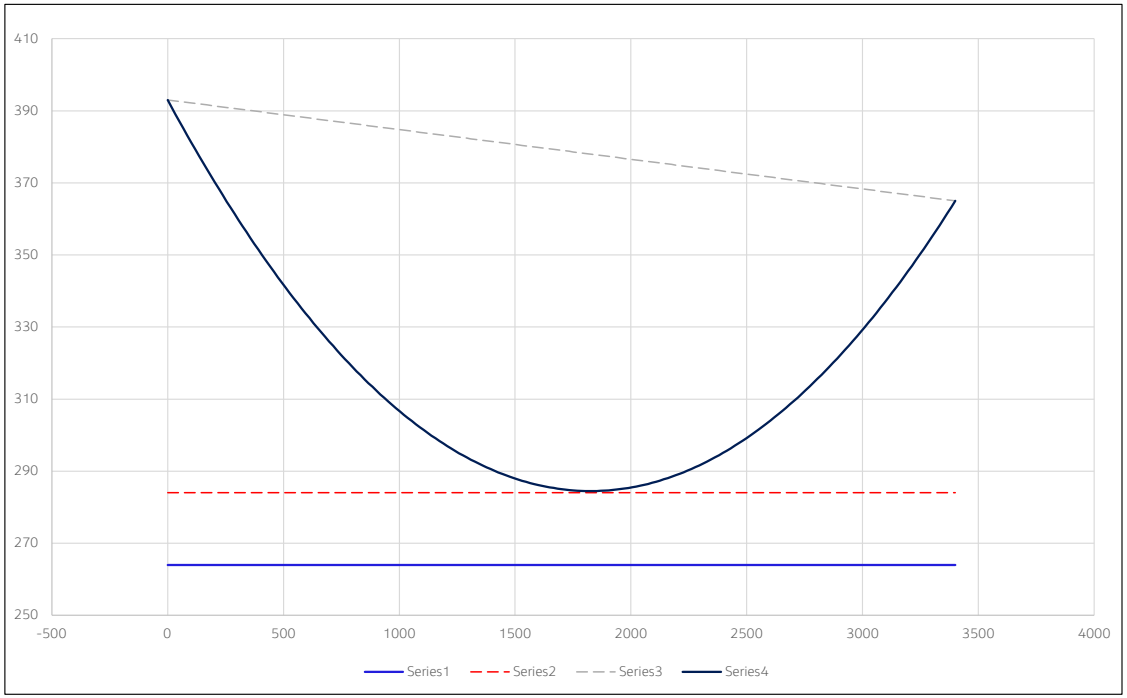
ALTERNATIVE 2A/2B
CODE VARIANCE

Spillway Cable - 3400ft (SS)

CABLE PROPERTIES								
Code	ASCE 7-10							
Material	SS 304		Breaking Strength	6400	lbs	h1	108	ft
Diameter	1/4	in	Reduction Factor	1	***	h2	80	ft
Class	7x19		Allowable Tension	6400	lbs	L	3400	ft
Weight, D	0.11	plf						
Wind Gust Speed	79	mph						
Wind Press	16.3	psf						
Wind Load, W	0.3	psf	https://www.engineeringtoolbox.com/cable-loads-d_1816.html					
Nominal Ice Thickness	0.25	in	*Input values in green cells into "Uniformly Loaded Cables with Inclined Chords" section of websit					
Design Ice Thickness	0.46	in	**South Anchorage**			**North Anchorage**		
Ice Area	1.58	in2	R1	10446	lbs	R2	10428	lbs
Ice Wind Speed	40	mph	R1x	10374	lbs	R1x	10374	lbs
Wind on Ice, Wi	0.41	psf	R1y	1225	lbs	R1y	1055	lbs
Ice Weight, Di	0.40	psf	Theta1	6.74	degrees	Theta1	5.8	degrees
LC 1: D	0.11	psf						
LC 2: D + 0.7*Di	0.39	psf	required strength	10446			10428	
LC 3: D + 0.6*W	0.31	psf						
LC 4: D + 0.7*Di + 0.7*Wi	0.67	psf	DCR	1.63		DCR	1.63	
Max Uniform	0.67	psf						

	Code Variance			Code Compliant		
Code		ASCE 7-10 **			ASCE 7-22	
Basic Wind Speed	V	79	mph	V	94	mph
Nonimal Ice Thickness	t	0.25	in	t	0.52	in
Concurrent Wind Speed	Vc	40	mph	Vc	46	mph
Max Wire Height	z	128	ft	z	128	ft
Topographic Fator	Kzt	1		Kzt	1	
Importance Factor (RC =1)	I_i	0.8				
Ice Height Factor	fz	1.15		fz	1.15	
Design Ice Thickness	td	0.46	in	td	0.60	in
Ice Density	ρ_{ice}	56	pcf	ρ_{ice}	56	pcf
Wire Diameter	Dc	1/4	in	Dc	1/4	in
Ice Area	Ai	1.02	in2	Ai	1.58	in2
Ice Weight	Wi	0.40	plf	Wi	0.62	plf

**25 year wind speed used
**Wind on ice load case not considered
***No reduction or factor of safety applied



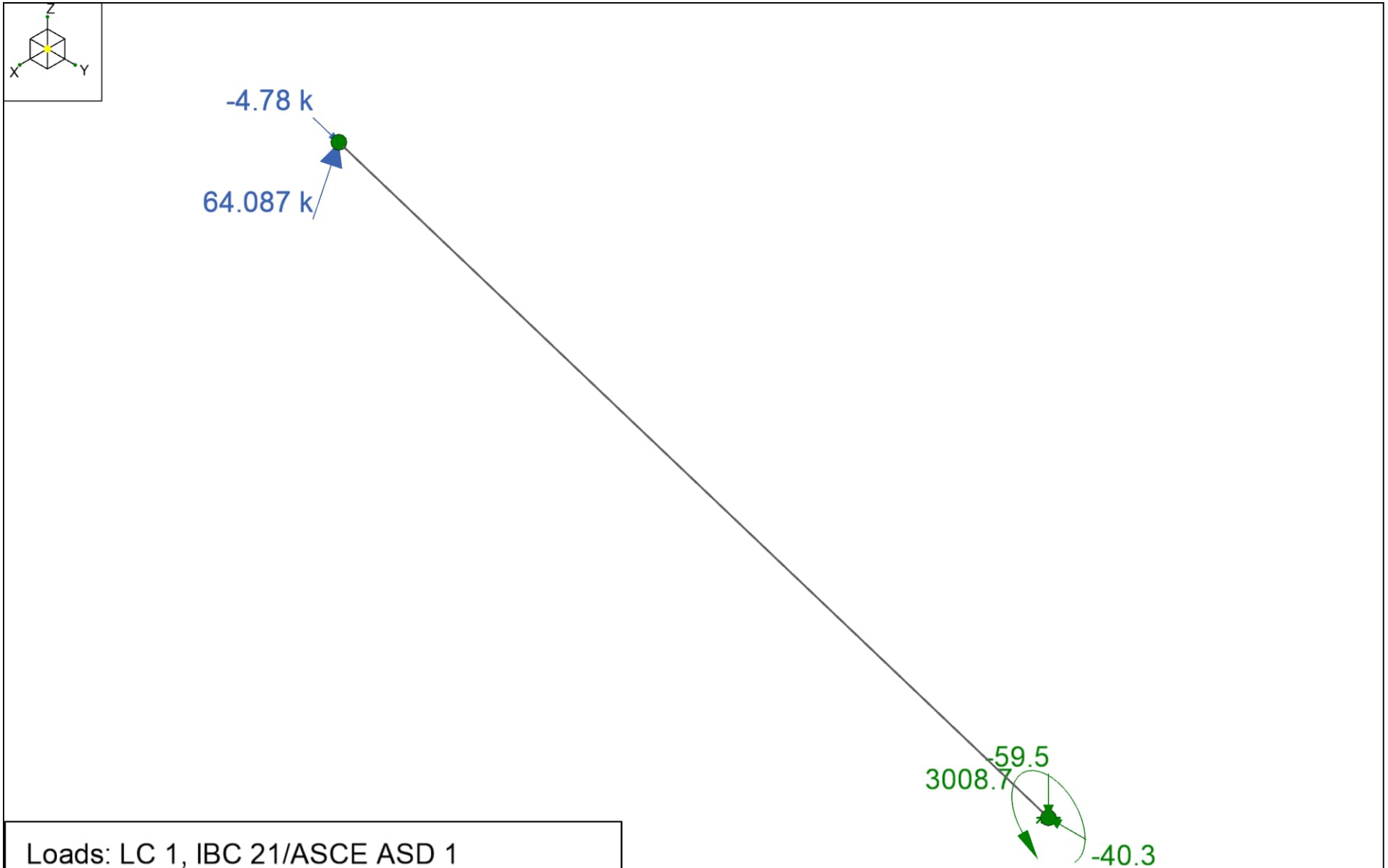
ALTERNATIVE 2A/2B
CODE VARIANCE

Spillway Cable - 3400ft (SS)

Utilization Summary (ASD)

Loads	Load Combination (ASD)	plf	% Max	Max Cable Tension (kip)	Breaking Strength (kip)	% Utilzation
Dead	LC 1: D	0.11	16%	1710	6400	27%
Dead + Wind	LC 2: D + 0.7*Di	0.39	58%	6023	6400	94%
Dead + Ice	LC 3: D + 0.6*W	0.31	47%	4881	6400	76%
Dead + Ice + Wind	LC 4: D + 0.7*Di + 0.7*Wi	0.67	100%	10446	6400	163%

ANCHORAGE DESIGN



Loads: LC 1, IBC 21/ASCE ASD 1
Results for LC 1, IBC 21/ASCE ASD 1
Reaction and Moment Units are kips and kip-ft

RISA A NEMETSCHEK COMPANY	<Licensed Company>		SK-7
	JiangV2		Aug 06, 2025 at 11:27 AM
			Navigation Guide Wall Anchor.r3d

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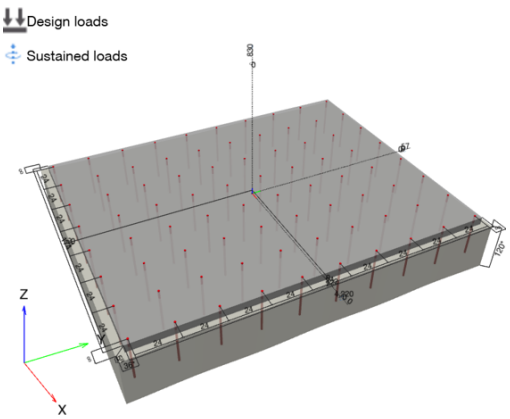
Specifier's comments:

1 Input data

Anchor type and diameter:	**HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) 1 1/4**
Item number:	not available (element) / 2334276 HIT-HY 200-R V3 (adhesive)
Specification text:	Hilti ∅ 1 1/4 in HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) with 23.74 in nominal embedment depth per ICC-ES ESR-4868 , Hammer drill bit installation per MPII,
Effective embedment depth:	$h_{ef,opti}$ = 23.740 in. ($h_{ef,limit}$ = 25.000 in.)
Material:	ASTM F1554 Grade 36
Evaluation Service Report:	ESR-4868
Issued I Valid:	11/1/2024 | 11/1/2026
Proof:	Design Method ACI 318-19 / Chem
Shear edge breakout verification:	Row closest to edge (Case 3 only from ACI 318-19 Fig. R.17.7.2.1b)
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 5.000 in.
Anchor plate[R] :	l_x x l_y x t = 174.000 in. x 222.000 in. x 5.000 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 2500, f_c' = 2,500 psi; h = 120.000 in., Temp. short/long: 32/32 °F
Installation:	**Hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: not present, shear: not present; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar

[R] - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [kip, ft.kip]



Input data and results must be checked for conformity with the existing conditions and for plausibility!
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1.1 Design results

Case	Description	Forces [kip] / Moments [ft.kip]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 83.000; V_x = 0.000; V_y = 57.000; M_x = -4,220.00000; M_y = 0.00000; M_z = 0.00000;	no	100

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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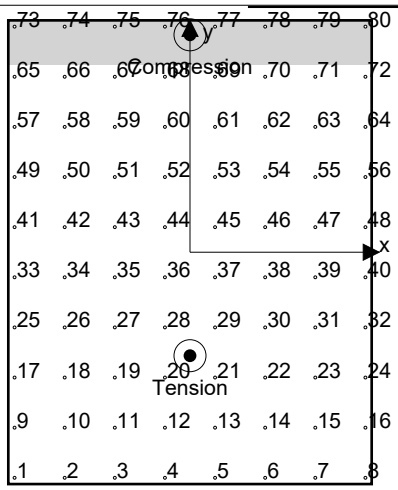
2 Load case/Resulting anchor forces



Anchor reactions [kip]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	10.389	0.713	0.000	0.713
2	10.389	0.713	0.000	0.713
3	10.389	0.713	0.000	0.713
4	10.389	0.713	0.000	0.713
5	10.389	0.713	0.000	0.713
6	10.389	0.713	0.000	0.713
7	10.389	0.713	0.000	0.713
8	10.389	0.713	0.000	0.713
9	9.131	0.713	0.000	0.713
10	9.131	0.713	0.000	0.713
11	9.131	0.713	0.000	0.713
12	9.131	0.713	0.000	0.713
13	9.131	0.713	0.000	0.713
14	9.131	0.713	0.000	0.713
15	9.131	0.713	0.000	0.713
16	9.131	0.713	0.000	0.713
17	7.874	0.713	0.000	0.713
18	7.874	0.713	0.000	0.713
19	7.874	0.713	0.000	0.713
20	7.874	0.713	0.000	0.713
21	7.874	0.713	0.000	0.713
22	7.874	0.713	0.000	0.713
23	7.874	0.713	0.000	0.713
24	7.874	0.713	0.000	0.713
25	6.616	0.713	0.000	0.713
26	6.616	0.713	0.000	0.713
27	6.616	0.713	0.000	0.713
28	6.616	0.713	0.000	0.713
29	6.616	0.713	0.000	0.713
30	6.616	0.713	0.000	0.713
31	6.616	0.713	0.000	0.713
32	6.616	0.713	0.000	0.713
33	5.359	0.713	0.000	0.713
34	5.359	0.713	0.000	0.713
35	5.359	0.713	0.000	0.713
36	5.359	0.713	0.000	0.713
37	5.359	0.713	0.000	0.713
38	5.359	0.713	0.000	0.713

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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Anchor	Tension force	Shear force	Shear force x	Shear force y
39	5.359	0.713	0.000	0.713
40	5.359	0.713	0.000	0.713
41	4.101	0.713	0.000	0.713
42	4.101	0.713	0.000	0.713
43	4.101	0.713	0.000	0.713
44	4.101	0.713	0.000	0.713
45	4.101	0.713	0.000	0.713
46	4.101	0.713	0.000	0.713
47	4.101	0.713	0.000	0.713
48	4.101	0.713	0.000	0.713
49	2.844	0.713	0.000	0.713
50	2.844	0.713	0.000	0.713
51	2.844	0.713	0.000	0.713
52	2.844	0.713	0.000	0.713
53	2.844	0.713	0.000	0.713
54	2.844	0.713	0.000	0.713
55	2.844	0.713	0.000	0.713
56	2.844	0.713	0.000	0.713
57	1.587	0.713	0.000	0.713
58	1.587	0.713	0.000	0.713
59	1.587	0.713	0.000	0.713
60	1.587	0.713	0.000	0.713
61	1.587	0.713	0.000	0.713
62	1.587	0.713	0.000	0.713
63	1.587	0.713	0.000	0.713
64	1.587	0.713	0.000	0.713
65	0.329	0.713	0.000	0.713
66	0.329	0.713	0.000	0.713
67	0.329	0.713	0.000	0.713
68	0.329	0.713	0.000	0.713
69	0.329	0.713	0.000	0.713
70	0.329	0.713	0.000	0.713
71	0.329	0.713	0.000	0.713
72	0.329	0.713	0.000	0.713
73	0.000	0.713	0.000	0.713
74	0.000	0.713	0.000	0.713
75	0.000	0.713	0.000	0.713
76	0.000	0.713	0.000	0.713
77	0.000	0.713	0.000	0.713
78	0.000	0.713	0.000	0.713
79	0.000	0.713	0.000	0.713
80	0.000	0.713	0.000	0.713

Max. concrete compressive strain:	0.04 [‰]
Max. concrete compressive stress:	168 [psi]

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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Resulting tension force in (x/y)=(0.000/-49.543): 385.842 [kip]
Resulting compression force in (x/y)=(0.000/104.094): 302.842 [kip]

Anchor forces are calculated based on the assumption of a rigid anchor plate.

3 Tension load

	Load N_{ua} [kip]	Capacity ϕ N_n [kip]	Utilization $\beta_N = N_{ua}/\phi$ N_n	Status
Steel Strength*	10.389	42.157	25	OK
Bond Strength**	385.842	990.167	39	OK
Sustained Tension Load Bond Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	385.842	386.195	100	OK

* highest loaded anchor **anchor group (anchors in tension)

3.1 Steel Strength

N_{sa} = ESR value refer to ICC-ES ESR-4868
ϕ $N_{sa} \geq N_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.97	58,000

Calculations

N_{sa} [kip]
56.210

Results

N_{sa} [kip]	ϕ_{steel}	ϕ N_{sa} [kip]	N_{ua} [kip]
56.210	0.750	42.157	10.389

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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3.2 Bond Strength

$N_{ag} = \left(\frac{A_{Na}}{A_{Na0}}\right) \psi_{ec1,Na}\ \psi_{ec2,Na}\ \psi_{ed,Na}\ \psi_{cp,Na}\ N_{ba}$ ACI 318-19 Eq. (17.6.5.1b)

$\phi\ N_{ag} \geq N_{ua}$ ACI 318-19 Table 17.5.2

A_{Na} see ACI 318-19, Section 17.6.5.1, Fig. R 17.6.5.1(b)

$A_{Na0} = (2\ c_{Na})^2$ ACI 318-19 Eq. (17.6.5.1.2a)

$c_{Na} = 10\ d_a \sqrt{\frac{\tau_{uncr}}{1100}}$ ACI 318-19 Eq. (17.6.5.1.2b)

$\psi_{ec,Na} = \left(\frac{1}{1 + \frac{e'_N}{c_{Na}}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.5.3.1)

$\psi_{ed,Na} = 0.7 + 0.3 \left(\frac{c_{a,min}}{c_{Na}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.5.4.1b)

$\psi_{cp,Na} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{c_{Na}}{c_{ac}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.5.5.1b)

$N_{ba} = \lambda_a \cdot \tau_{k,c} \cdot \pi \cdot d_a \cdot h_{ef}$ ACI 318-19 Eq. (17.6.5.2.1)

Variables

$\tau_{k,c,uncr}$ [psi]	d_a [in.]	h_{ef} [in.]	$c_{a,min}$ [in.]	$\alpha_{overhead}$	$\tau_{k,c}$ [psi]
2,220	1.250	23.740	36.000	1.000	1,380

$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	c_{ac} [in.]	λ_a
0.000	37.543	36.726	1.000

Calculations

c_{Na} [in.]	A_{Na} [in.^{2}]	A_{Na0} [in.^{2}]	$\psi_{ed,Na}$
17.678	46,233.93	1,250.00	1.000

$\psi_{ec1,Na}$	$\psi_{ec2,Na}$	$\psi_{cp,Na}$	N_{ba} [kip]
1.000	0.320	1.000	128.654

Results

N_{ag} [kip]	ϕ_{bond}	$\phi\ N_{ag}$ [kip]	N_{ua} [kip]
1,523.334	0.650	990.167	385.842

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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3.3 Concrete Breakout Failure

$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b$ — ACI 318-19 Eq. (17.6.2.1b)

$\phi\ N_{cbg} \geq N_{ua}$ — ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ — ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e'_N}{3\ h_{ef}}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.3.1)

$\psi_{ed,N} = 0.7 + 0.3\left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c\ \lambda_a\ \sqrt{f'_c}\ h_{ef}^{1.5}$ — ACI 318-19 Eq. (17.6.2.2.1)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
23.740	0.000	37.543	36.000	1.000

c_{ac} [in.]	k_c	λ_a	f'_c [psi]
36.726	17	1.000	2,500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [kip]
62,967.73	5,072.36	1.000	0.487	1.000	1.000	98.321

Results

N_{cbg} [kip]	$\phi_{concrete}$	$\phi\ N_{cbg}$ [kip]	N_{ua} [kip]
594.146	0.650	386.195	385.842

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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4 Shear load

	Load V_{ua} [kip]	Capacity ϕ V_n [kip]	Utilization $\beta_V = V_{ua}/\phi$ V_n	Status
Steel Strength*	0.713	21.921	4	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength (Concrete Breakout Strength controls)**	57.000	1,864.559	4	OK
Concrete edge failure in direction **	N/A	N/A	N/A	N/A

* highest loaded anchor **anchor group (relevant anchors)

4.1 Steel Strength

V_{sa} = ESR value refer to ICC-ES ESR-4868
ϕ $V_{steel} \geq V_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]
0.97	58,000

Calculations

V_{sa} [kip]
33.725

Results

V_{sa} [kip]	ϕ_{steel}	ϕ V_{sa} [kip]	V_{ua} [kip]
33.725	0.650	21.921	0.713

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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4.2 Pryout Strength (Concrete Breakout Strength controls)

$V_{cpg} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \right]$ ACI 318-19 Eq. (17.7.3.1b)

$\phi V_{cpg} \geq V_{ua}$ ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9 h_{ef}^2$ ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2 e'_N}{3 h_{ef}}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.3.1)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ ACI 318-19 Eq. (17.6.2.2.1)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	23.740	0.000	0.000	36.000

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
1.000	36.726	17	1.000	2,500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [kip]
68,709.02	5,072.36	1.000	1.000	1.000	1.000	98.321

Results

V_{cpg} [kip]	$\phi_{concrete}$	ϕV_{cpg} [kip]	V_{ua} [kip]
2,663.656	0.700	1,864.559	57.000

5 Combined tension and shear loads, per ACI 318-19 section 17.8

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.999	0.033	1.000	86	OK

$\beta_{NV} = (\beta_N + \beta_V) / 1.2 <= 1$

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- Design Strengths of adhesive anchor systems are influenced by the cleaning method. Refer to the INSTRUCTIONS FOR USE given in the Evaluation Service Report for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to https://viewer.joomag.com/profis-design-guide-us-en-summer-2021/0841849001625154758?short&/
- Installation of Hilti adhesive anchor systems shall be performed by personnel trained to install Hilti adhesive anchors. Reference ACI 318-19, Section 26.7.

Fastening meets the design criteria!

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7 Installation data

Profile: no profile

Hole diameter in the fixture: d_f = 1.375 in.

Plate thickness (input): 5.000 in.

Recommended plate thickness: not calculated

Drilling method: Hammer drilled

Cleaning: Compressed air cleaning of the drilled hole according to instructions for use is required

Anchor type and diameter: HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) 1 1/4

Item number: not available (element) / 2334276 HIT-HY 200-R V3 (adhesive)

Maximum installation torque: 0.20000 ft.kip

Hole diameter in the base material: 1.375 in.

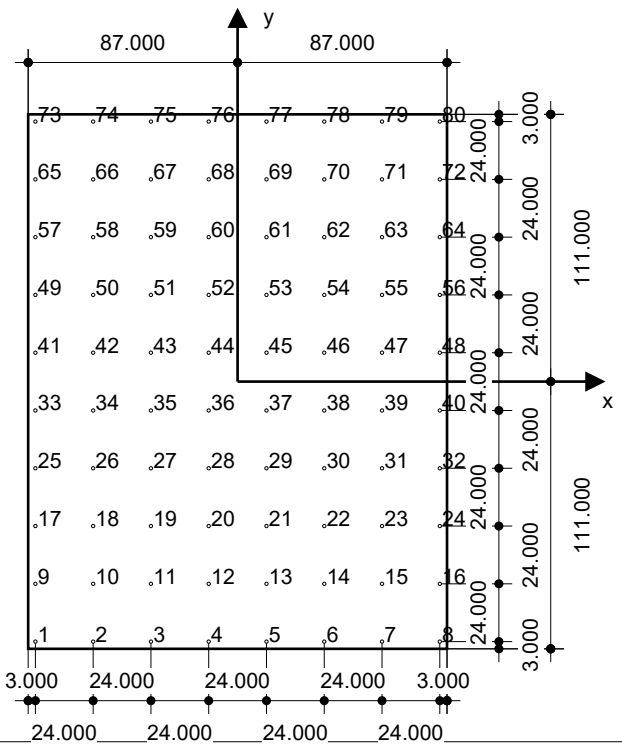
Hole depth in the base material: 23.740 in.

Minimum thickness of the base material: 26.490 in.

Hilti ∅ 1 1/4 in HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) with 23.740157 in nominal embedment depth per ICC-ES ESR-4868 , Hammer drill bit installation per MPII

7.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Compressed air with required accessories to blow from the bottom of the hole • Proper diameter wire brush	• Dispenser including cassette and mixer • Torque wrench



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Design:	LRFD - Nav Guide Anchor	Date:	7/31/2025
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Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-84.000	-108.000	-	-	36.000	-
2	-60.000	-108.000	-	-	36.000	-
3	-36.000	-108.000	-	-	36.000	-
4	-12.000	-108.000	-	-	36.000	-
5	12.000	-108.000	-	-	36.000	-
6	36.000	-108.000	-	-	36.000	-
7	60.000	-108.000	-	-	36.000	-
8	84.000	-108.000	-	-	36.000	-
9	-84.000	-84.000	-	-	60.000	-
10	-60.000	-84.000	-	-	60.000	-
11	-36.000	-84.000	-	-	60.000	-
12	-12.000	-84.000	-	-	60.000	-
13	12.000	-84.000	-	-	60.000	-
14	36.000	-84.000	-	-	60.000	-
15	60.000	-84.000	-	-	60.000	-
16	84.000	-84.000	-	-	60.000	-
17	-84.000	-60.000	-	-	84.000	-
18	-60.000	-60.000	-	-	84.000	-
19	-36.000	-60.000	-	-	84.000	-
20	-12.000	-60.000	-	-	84.000	-
21	12.000	-60.000	-	-	84.000	-
22	36.000	-60.000	-	-	84.000	-
23	60.000	-60.000	-	-	84.000	-
24	84.000	-60.000	-	-	84.000	-
25	-84.000	-36.000	-	-	108.000	-
26	-60.000	-36.000	-	-	108.000	-
27	-36.000	-36.000	-	-	108.000	-
28	-12.000	-36.000	-	-	108.000	-
29	12.000	-36.000	-	-	108.000	-
30	36.000	-36.000	-	-	108.000	-
31	60.000	-36.000	-	-	108.000	-
32	84.000	-36.000	-	-	108.000	-
33	-84.000	-12.000	-	-	132.000	-
34	-60.000	-12.000	-	-	132.000	-
35	-36.000	-12.000	-	-	132.000	-
36	-12.000	-12.000	-	-	132.000	-
37	12.000	-12.000	-	-	132.000	-
38	36.000	-12.000	-	-	132.000	-
39	60.000	-12.000	-	-	132.000	-
40	84.000	-12.000	-	-	132.000	-
41	-84.000	12.000	-	-	156.000	-
42	-60.000	12.000	-	-	156.000	-
43	-36.000	12.000	-	-	156.000	-
44	-12.000	12.000	-	-	156.000	-
45	12.000	12.000	-	-	156.000	-
46	36.000	12.000	-	-	156.000	-
47	60.000	12.000	-	-	156.000	-
48	84.000	12.000	-	-	156.000	-
49	-84.000	36.000	-	-	180.000	-
50	-60.000	36.000	-	-	180.000	-
51	-36.000	36.000	-	-	180.000	-
52	-12.000	36.000	-	-	180.000	-
53	12.000	36.000	-	-	180.000	-
54	36.000	36.000	-	-	180.000	-
55	60.000	36.000	-	-	180.000	-
56	84.000	36.000	-	-	180.000	-
57	-84.000	60.000	-	-	204.000	-
58	-60.000	60.000	-	-	204.000	-
59	-36.000	60.000	-	-	204.000	-
60	-12.000	60.000	-	-	204.000	-
61	12.000	60.000	-	-	204.000	-
62	36.000	60.000	-	-	204.000	-
63	60.000	60.000	-	-	204.000	-
64	84.000	60.000	-	-	204.000	-
65	-84.000	84.000	-	-	228.000	-
66	-60.000	84.000	-	-	228.000	-
67	-36.000	84.000	-	-	228.000	-
68	-12.000	84.000	-	-	228.000	-
69	12.000	84.000	-	-	228.000	-
70	36.000	84.000	-	-	228.000	-
71	60.000	84.000	-	-	228.000	-
72	84.000	84.000	-	-	228.000	-
73	-84.000	108.000	-	-	252.000	-
74	-60.000	108.000	-	-	252.000	-
75	-36.000	108.000	-	-	252.000	-
76	-12.000	108.000	-	-	252.000	-
77	12.000	108.000	-	-	252.000	-
78	36.000	108.000	-	-	252.000	-
79	60.000	108.000	-	-	252.000	-
80	84.000	108.000	-	-	252.000	-

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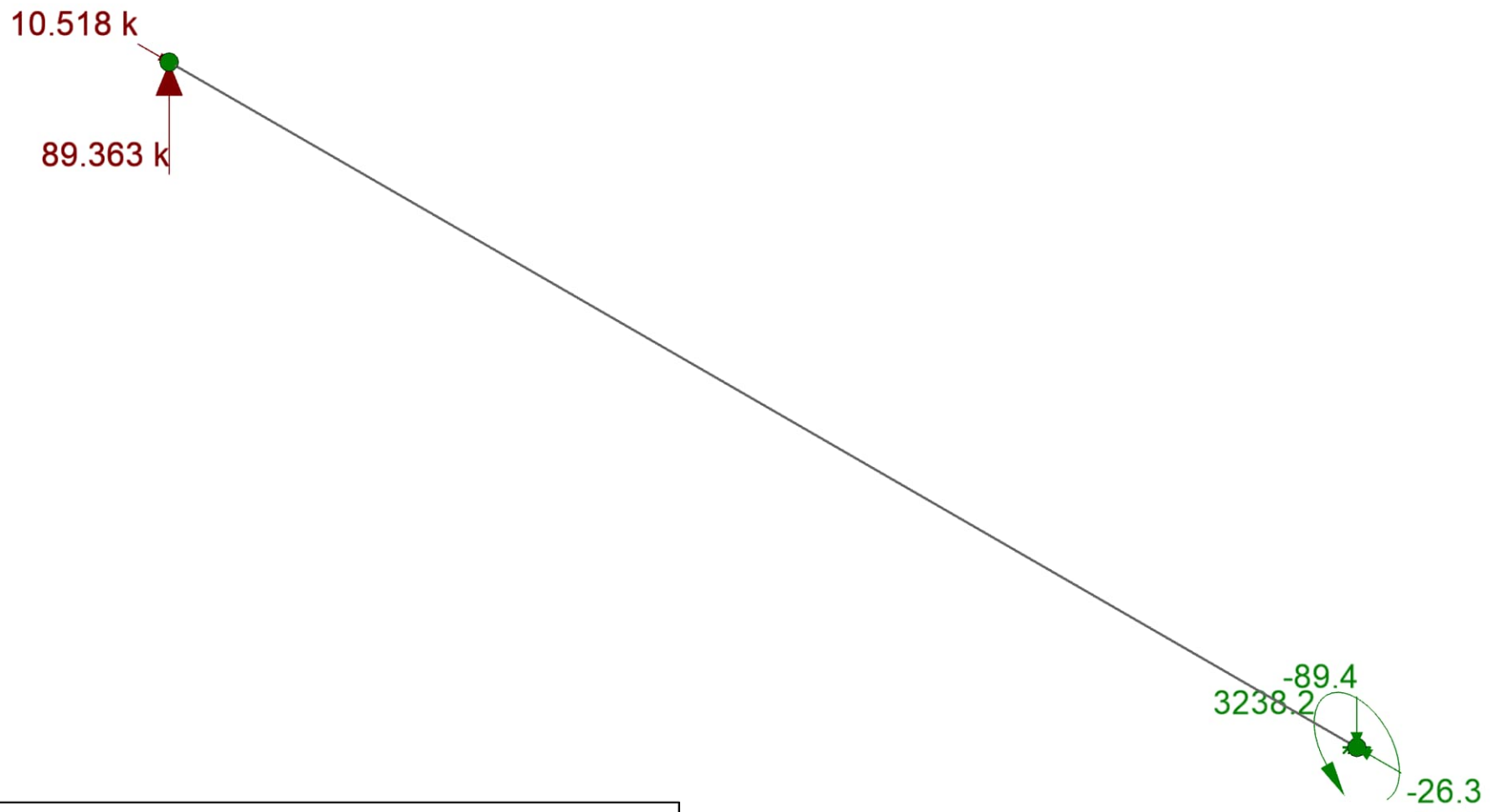

Loads: LC 2, IBC 21/ASCE Strength 1
Results for LC 2, IBC 21/ASCE Strength 1
Reaction and Moment Units are kips and kip-ft

RISA A NEMETSCHEK COMPANY	<Licensed Company>		SK-5
	JiangV2		Aug 06, 2025 at 10:34 AM
			Navigation Lock Wall Anchor.r3d

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Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	LRFD - Nav Lock Anchor	Date:	7/31/2025
Fastening point:			

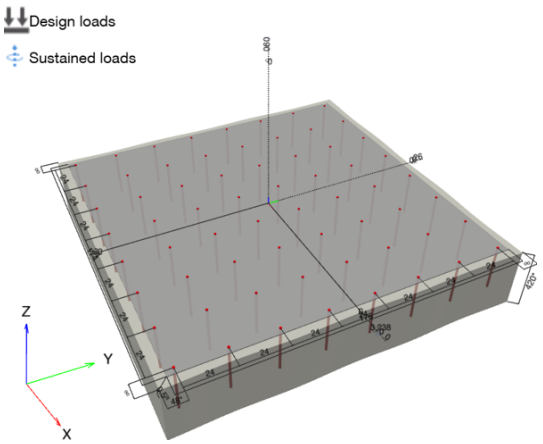
Specifier's comments:

1 Input data

Anchor type and diameter:	**HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) 1 1/4**
Item number:	not available (element) / 2334276 HIT-HY 200-R V3 (adhesive)
Specification text:	Hilti ∅ 1 1/4 in HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) with 25 in nominal embedment depth per ICC-ES ESR-4868 , Hammer drill bit installation per MPII,
Effective embedment depth:	$h_{ef,opti}$ = 25.000 in. ($h_{ef,limit}$ = 25.000 in.)
Material:	ASTM F1554 Grade 36
Evaluation Service Report:	ESR-4868
Issued I Valid:	11/1/2024 | 11/1/2026
Proof:	Design Method ACI 318-19 / Chem
Shear edge breakout verification:	Row closest to edge (Case 3 only from ACI 318-19 Fig. R.17.7.2.1b)
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate[R] :	l_x x l_y x t = 174.000 in. x 176.000 in. x 0.500 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 2500, f_c' = 2,500 psi; h = 420.000 in., Temp. short/long: 32/32 °F
Installation:	**Hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: not present, shear: not present; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar

[R] - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [kip, ft.kip]



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1.1 Design results

Case	Description	Forces [kip] / Moments [ft.kip]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 90.000; V_x = 0.000; V_y = 26.000; M_x = -3,238.00000; M_y = 0.00000; M_z = 0.00000;	no	101

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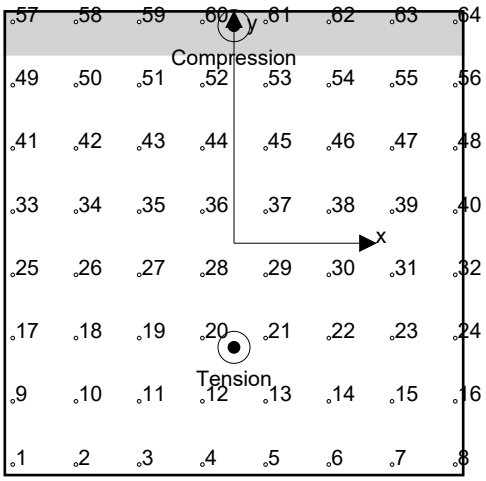
2 Load case/Resulting anchor forces



Anchor reactions [kip]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	12.593	0.406	0.000	0.406
2	12.593	0.406	0.000	0.406
3	12.593	0.406	0.000	0.406
4	12.593	0.406	0.000	0.406
5	12.593	0.406	0.000	0.406
6	12.593	0.406	0.000	0.406
7	12.593	0.406	0.000	0.406
8	12.593	0.406	0.000	0.406
9	10.652	0.406	0.000	0.406
10	10.652	0.406	0.000	0.406
11	10.652	0.406	0.000	0.406
12	10.652	0.406	0.000	0.406
13	10.652	0.406	0.000	0.406
14	10.652	0.406	0.000	0.406
15	10.652	0.406	0.000	0.406
16	10.652	0.406	0.000	0.406
17	8.711	0.406	0.000	0.406
18	8.711	0.406	0.000	0.406
19	8.711	0.406	0.000	0.406
20	8.711	0.406	0.000	0.406
21	8.711	0.406	0.000	0.406
22	8.711	0.406	0.000	0.406
23	8.711	0.406	0.000	0.406
24	8.711	0.406	0.000	0.406
25	6.770	0.406	0.000	0.406
26	6.770	0.406	0.000	0.406
27	6.770	0.406	0.000	0.406
28	6.770	0.406	0.000	0.406
29	6.770	0.406	0.000	0.406
30	6.770	0.406	0.000	0.406
31	6.770	0.406	0.000	0.406
32	6.770	0.406	0.000	0.406
33	4.829	0.406	0.000	0.406
34	4.829	0.406	0.000	0.406
35	4.829	0.406	0.000	0.406
36	4.829	0.406	0.000	0.406
37	4.829	0.406	0.000	0.406
38	4.829	0.406	0.000	0.406

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Anchor	Tension force	Shear force	Shear force x	Shear force y
39	4.829	0.406	0.000	0.406
40	4.829	0.406	0.000	0.406
41	2.888	0.406	0.000	0.406
42	2.888	0.406	0.000	0.406
43	2.888	0.406	0.000	0.406
44	2.888	0.406	0.000	0.406
45	2.888	0.406	0.000	0.406
46	2.888	0.406	0.000	0.406
47	2.888	0.406	0.000	0.406
48	2.888	0.406	0.000	0.406
49	0.947	0.406	0.000	0.406
50	0.947	0.406	0.000	0.406
51	0.947	0.406	0.000	0.406
52	0.947	0.406	0.000	0.406
53	0.947	0.406	0.000	0.406
54	0.947	0.406	0.000	0.406
55	0.947	0.406	0.000	0.406
56	0.947	0.406	0.000	0.406
57	0.000	0.406	0.000	0.406
58	0.000	0.406	0.000	0.406
59	0.000	0.406	0.000	0.406
60	0.000	0.406	0.000	0.406
61	0.000	0.406	0.000	0.406
62	0.000	0.406	0.000	0.406
63	0.000	0.406	0.000	0.406
64	0.000	0.406	0.000	0.406

Max. concrete compressive strain:	0.05 [‰]
Max. concrete compressive stress:	204 [psi]
Resulting tension force in (x/y)=(0.000/-39.525):	379.113 [kip]
Resulting compression force in (x/y)=(0.000/82.569):	289.113 [kip]

Anchor forces are calculated based on the assumption of a rigid anchor plate.

3 Tension load

	Load N_{ua} [kip]	Capacity ϕ N_n [kip]	Utilization $\beta_N = N_{ua}/\phi$ N_n	Status
Steel Strength*	12.593	42.157	30	OK
Bond Strength**	379.113	1,004.888	38	OK
Sustained Tension Load Bond Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	379.113	376.811	101	not recommended

* highest loaded anchor **anchor group (anchors in tension)

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3.1 Steel Strength

N_{sa} = ESR value	refer to ICC-ES ESR-4868
$\phi\ N_{sa} \geq N_{ua}$	ACI 318-19 Table 17.5.2

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.97	58,000

Calculations

N_{sa} [kip]
56.210

Results

N_{sa} [kip]	ϕ_{steel}	$\phi\ N_{sa}$ [kip]	N_{ua} [kip]
56.210	0.750	42.157	12.593

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3.2 Bond Strength

$N_{ag} = \left(\frac{A_{Na}}{A_{Na0}}\right) \psi_{ec1,Na}\ \psi_{ec2,Na}\ \psi_{ed,Na}\ \psi_{cp,Na}\ N_{ba}$ ACI 318-19 Eq. (17.6.5.1b)

$\phi\ N_{ag} \geq N_{ua}$ ACI 318-19 Table 17.5.2

A_{Na} see ACI 318-19, Section 17.6.5.1, Fig. R 17.6.5.1(b)

$A_{Na0} = (2\ c_{Na})^2$ ACI 318-19 Eq. (17.6.5.1.2a)

$c_{Na} = 10\ d_a \sqrt{\frac{\tau_{uncr}}{1100}}$ ACI 318-19 Eq. (17.6.5.1.2b)

$\psi_{ec,Na} = \left(\frac{1}{1 + \frac{e'_N}{c_{Na}}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.5.3.1)

$\psi_{ed,Na} = 0.7 + 0.3 \left(\frac{c_{a,min}}{c_{Na}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.5.4.1b)

$\psi_{cp,Na} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{c_{Na}}{c_{ac}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.5.5.1b)

$N_{ba} = \lambda_a \cdot \tau_{k,c} \cdot \pi \cdot d_a \cdot h_{ef}$ ACI 318-19 Eq. (17.6.5.2.1)

Variables

$\tau_{k,c,uncr}$ [psi]	d_a [in.]	h_{ef} [in.]	$c_{a,min}$ [in.]	$\alpha_{overhead}$	$\tau_{k,c}$ [psi]
2,220	1.250	25.000	48.000	1.000	1,380

$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	c_{ac} [in.]	λ_a
0.000	27.525	39.077	1.000

Calculations

c_{Na} [in.]	A_{Na} [in.^{2}]	A_{Na0} [in.^{2}]	$\psi_{ed,Na}$
17.678	36,472.87	1,250.00	1.000

$\psi_{ec1,Na}$	$\psi_{ec2,Na}$	$\psi_{cp,Na}$	N_{ba} [kip]
1.000	0.391	1.000	135.481

Results

N_{ag} [kip]	ϕ_{bond}	$\phi\ N_{ag}$ [kip]	N_{ua} [kip]
1,545.981	0.650	1,004.888	379.113

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3.3 Concrete Breakout Failure

$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b$ — ACI 318-19 Eq. (17.6.2.1b)

$\phi\ N_{cbg} \geq N_{ua}$ — ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ — ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e'_N}{3\ h_{ef}}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.3.1)

$\psi_{ed,N} = 0.7 + 0.3\left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c\ \lambda_a\ \sqrt{f'_c}\ h_{ef}^{1.5}$ — ACI 318-19 Eq. (17.6.2.2.1)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
25.000	0.000	27.525	48.000	1.000

c_{ac} [in.]	k_c	λ_a	f'_c [psi]
39.077	17	1.000	2,500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [kip]
53,217.00	5,625.00	1.000	0.577	1.000	1.000	106.250

Results

N_{cbg} [kip]	$\phi_{concrete}$	$\phi\ N_{cbg}$ [kip]	N_{ua} [kip]
579.710	0.650	376.811	379.113

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Fastening point:			

4 Shear load

	Load V_{ua} [kip]	Capacity ϕ V_n [kip]	Utilization $\beta_V = V_{ua}/\phi$ V_n	Status
Steel Strength*	0.406	21.921	2	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength (Concrete Breakout Strength controls)**	26.000	1,561.517	2	OK
Concrete edge failure in direction **	N/A	N/A	N/A	N/A

* highest loaded anchor **anchor group (relevant anchors)

4.1 Steel Strength

V_{sa} = ESR value refer to ICC-ES ESR-4868
ϕ $V_{steel} \geq V_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]
0.97	58,000

Calculations

V_{sa} [kip]
33.725

Results

V_{sa} [kip]	ϕ steel	ϕ V_{sa} [kip]	V_{ua} [kip]
33.725	0.650	21.921	0.406

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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4.2 Pryout Strength (Concrete Breakout Strength controls)

$V_{cpg} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \right]$ ACI 318-19 Eq. (17.7.3.1b)

$\phi V_{cpg} \geq V_{ua}$ ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9 h_{ef}^2$ ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2 e'_N}{3 h_{ef}}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.3.1)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ ACI 318-19 Eq. (17.6.2.2.1)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	25.000	0.000	0.000	48.000

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
1.000	39.077	17	1.000	2,500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [kip]
59,049.00	5,625.00	1.000	1.000	1.000	1.000	106.250

Results

V_{cpg} [kip]	$\phi_{concrete}$	ϕV_{cpg} [kip]	V_{ua} [kip]
2,230.739	0.700	1,561.517	26.000

5 Combined tension and shear loads, per ACI 318-19 section 17.8

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
1.006	0.019	1.000	86	OK

$\beta_{NV} = (\beta_N + \beta_V) / 1.2 <= 1$

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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Design:	LRFD - Nav Lock Anchor	Date:	7/31/2025
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6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- Design Strengths of adhesive anchor systems are influenced by the cleaning method. Refer to the INSTRUCTIONS FOR USE given in the Evaluation Service Report for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to https://viewer.joomag.com/profis-design-guide-us-en-summer-2021/0841849001625154758?short&/
- Installation of Hilti adhesive anchor systems shall be performed by personnel trained to install Hilti adhesive anchors. Reference ACI 318-19, Section 26.7.

Fastening does not meet the design criteria!

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7 Installation data

Profile: no profile

Hole diameter in the fixture: d_f = 1.375 in.

Plate thickness (input): 0.500 in.

Recommended plate thickness: not calculated

Drilling method: Hammer drilled

Cleaning: Compressed air cleaning of the drilled hole according to instructions for use is required

Anchor type and diameter: HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) 1 1/4

Item number: not available (element) / 2334276 HIT-HY 200-R V3 (adhesive)

Maximum installation torque: 0.20000 ft.kip

Hole diameter in the base material: 1.375 in.

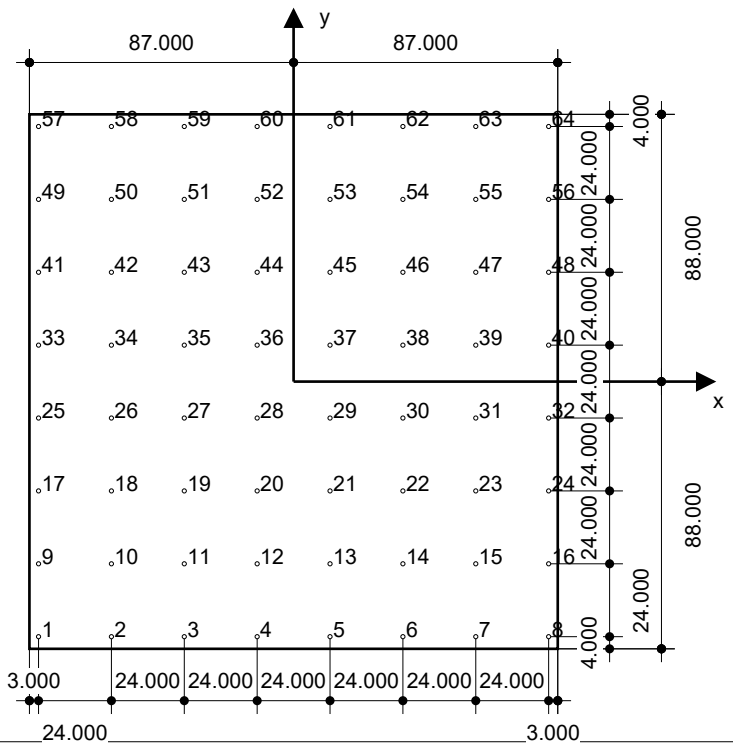
Hole depth in the base material: 25.000 in.

Minimum thickness of the base material: 27.750 in.

Hilti ∅ 1 1/4 in HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) with 25 in nominal embedment depth per ICC-ES ESR-4868 , Hammer drill bit installation per MPII

7.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Compressed air with required accessories to blow from the bottom of the hole • Proper diameter wire brush	• Dispenser including cassette and mixer • Torque wrench



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Design:	LRFD - Nav Lock Anchor	Date:	7/31/2025
Fastening point:			

Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-84.000	-84.000	-	-	48.000	-
2	-60.000	-84.000	-	-	48.000	-
3	-36.000	-84.000	-	-	48.000	-
4	-12.000	-84.000	-	-	48.000	-
5	12.000	-84.000	-	-	48.000	-
6	36.000	-84.000	-	-	48.000	-
7	60.000	-84.000	-	-	48.000	-
8	84.000	-84.000	-	-	48.000	-
9	-84.000	-60.000	-	-	72.000	-
10	-60.000	-60.000	-	-	72.000	-
11	-36.000	-60.000	-	-	72.000	-
12	-12.000	-60.000	-	-	72.000	-
13	12.000	-60.000	-	-	72.000	-
14	36.000	-60.000	-	-	72.000	-
15	60.000	-60.000	-	-	72.000	-
16	84.000	-60.000	-	-	72.000	-
17	-84.000	-36.000	-	-	96.000	-
18	-60.000	-36.000	-	-	96.000	-
19	-36.000	-36.000	-	-	96.000	-
20	-12.000	-36.000	-	-	96.000	-
21	12.000	-36.000	-	-	96.000	-
22	36.000	-36.000	-	-	96.000	-
23	60.000	-36.000	-	-	96.000	-
24	84.000	-36.000	-	-	96.000	-
25	-84.000	-12.000	-	-	120.000	-
26	-60.000	-12.000	-	-	120.000	-
27	-36.000	-12.000	-	-	120.000	-
28	-12.000	-12.000	-	-	120.000	-
29	12.000	-12.000	-	-	120.000	-
30	36.000	-12.000	-	-	120.000	-
31	60.000	-12.000	-	-	120.000	-
32	84.000	-12.000	-	-	120.000	-
33	-84.000	12.000	-	-	144.000	-
34	-60.000	12.000	-	-	144.000	-
35	-36.000	12.000	-	-	144.000	-
36	-12.000	12.000	-	-	144.000	-
37	12.000	12.000	-	-	144.000	-
38	36.000	12.000	-	-	144.000	-
39	60.000	12.000	-	-	144.000	-
40	84.000	12.000	-	-	144.000	-
41	-84.000	36.000	-	-	168.000	-
42	-60.000	36.000	-	-	168.000	-
43	-36.000	36.000	-	-	168.000	-
44	-12.000	36.000	-	-	168.000	-
45	12.000	36.000	-	-	168.000	-
46	36.000	36.000	-	-	168.000	-
47	60.000	36.000	-	-	168.000	-
48	84.000	36.000	-	-	168.000	-
49	-84.000	60.000	-	-	192.000	-
50	-60.000	60.000	-	-	192.000	-
51	-36.000	60.000	-	-	192.000	-
52	-12.000	60.000	-	-	192.000	-
53	12.000	60.000	-	-	192.000	-
54	36.000	60.000	-	-	192.000	-
55	60.000	60.000	-	-	192.000	-
56	84.000	60.000	-	-	192.000	-
57	-84.000	84.000	-	-	216.000	-
58	-60.000	84.000	-	-	216.000	-
59	-36.000	84.000	-	-	216.000	-
60	-12.000	84.000	-	-	216.000	-
61	12.000	84.000	-	-	216.000	-
62	36.000	84.000	-	-	216.000	-
63	60.000	84.000	-	-	216.000	-
64	84.000	84.000	-	-	216.000	-

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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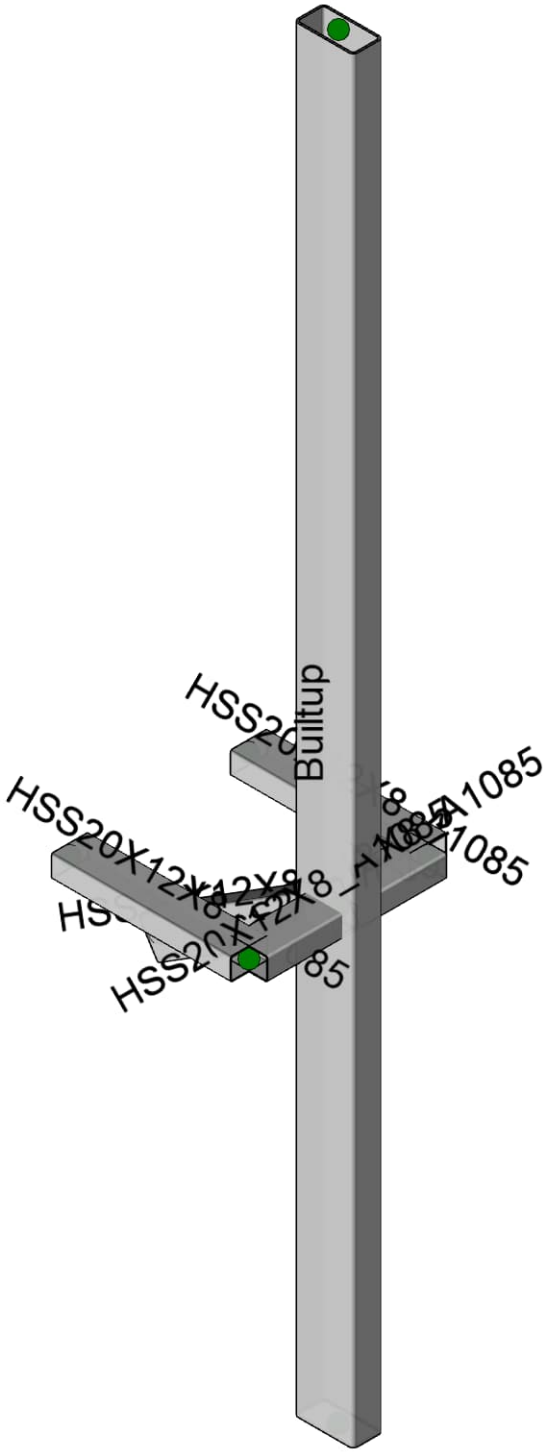
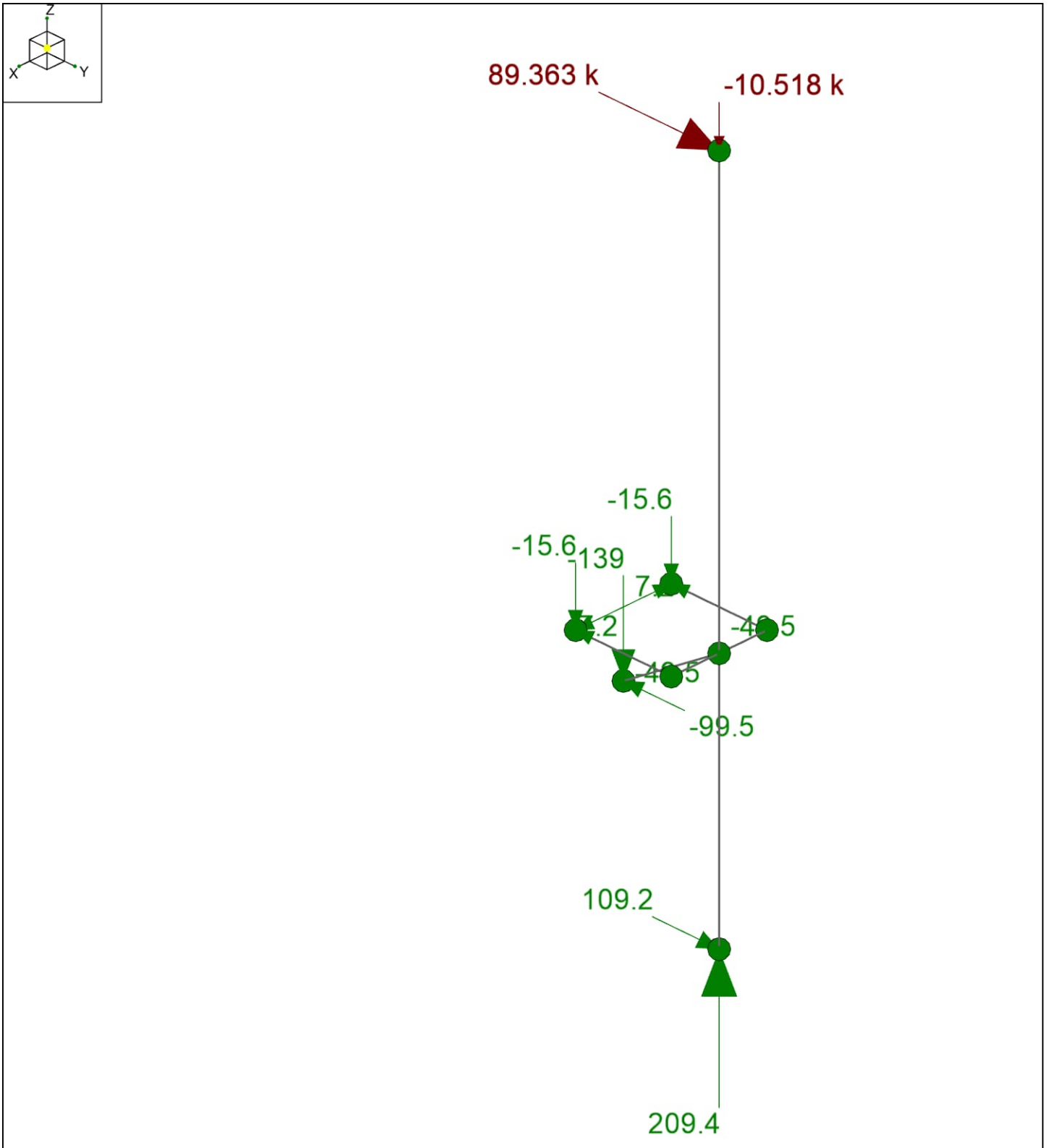
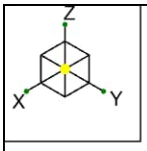


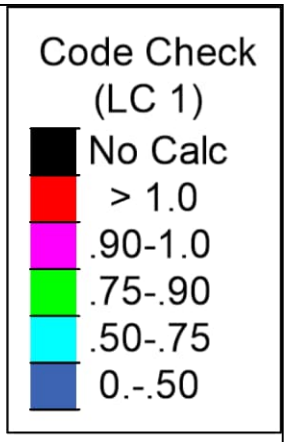
IRISA A NEMETSCHEK COMPANY	<Licensed Company>		SK-3
	JiangV2		Aug 06, 2025 at 10:25 AM
			Navigation Spillway Anchor …

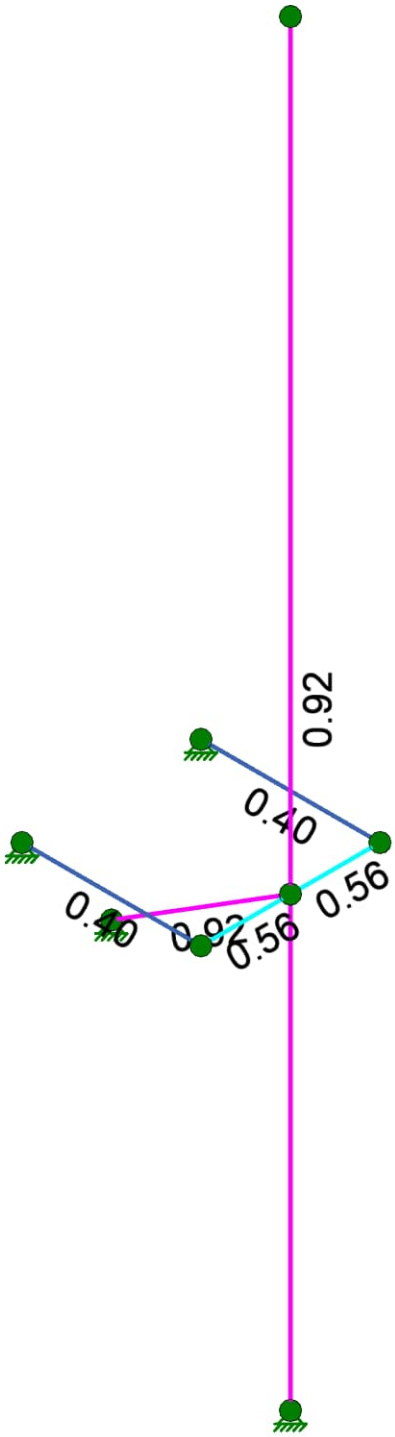


Loads: LC 2, IBC 21/ASCE Strength 1
Results for LC 2, IBC 21/ASCE Strength 1
Reaction and Moment Units are kips and kip-ft

IRISA A NEMETSCHEK COMPANY	<Licensed Company>		SK-2
	JiangV2		Aug 06, 2025 at 10:23 AM
			Navigation Spillway Anchor …







Member Code Checks Displayed
Results for LC 1, IBC 21/ASCE ASD 1

IRISA A NEMETSCHEK COMPANY	<Licensed Company>		SK-4
	JiangV2		Aug 06, 2025 at 10:31 AM
			Navigation Spillway Anchor …

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Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	LRFD - Spillway Anchor Top	Date:	8/5/2025
Fastening point:			

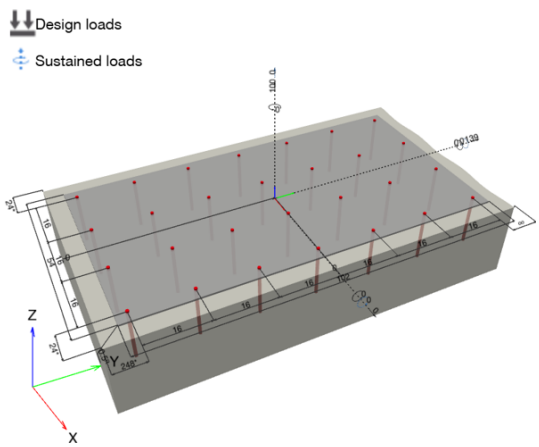
Specifier's comments:

1 Input data

Anchor type and diameter:	**HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) 7/8**
Item number:	not available (element) / 2334276 HIT-HY 200-R V3 (adhesive)
Specification text:	Hilti ∅ 7/8 in HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) with 14.091 in nominal embedment depth per ICC-ES ESR-4868 , Hammer drill bit installation per MPII,
Effective embedment depth:	$h_{ef,opti}$ = 14.091 in. ($h_{ef,limit}$ = 17.500 in.)
Material:	ASTM F1554 Grade 36
Evaluation Service Report:	ESR-4868
Issued I Valid:	11/1/2024 | 11/1/2026
Proof:	Design Method ACI 318-19 / Chem
Shear edge breakout verification:	Row closest to edge (Case 3 only from ACI 318-19 Fig. R.17.7.2.1b)
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate[R] :	l_x x l_y x t = 54.000 in. x 102.000 in. x 0.500 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 2500, f_c' = 2,500 psi; h = 60.000 in., Temp. short/long: 32/32 °F
Installation:	**Hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: not present, shear: not present; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar

[R] - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [kip, ft.kip]



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Design:	LRFD - Spillway Anchor Top	Date:	8/5/2025
Fastening point:			

1.1 Design results

Case	Description	Forces [kip] / Moments [ft.kip]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 100.000; V_x = 0.000; V_y = 139.000; M_x = 0.00000; M_y = 0.00000; M_z = 0.00000;	no	100

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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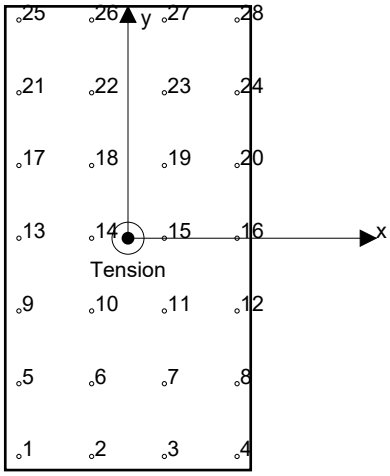
Design:	LRFD - Spillway Anchor Top	Date:	8/5/2025
Fastening point:			

2 Load case/Resulting anchor forces



Anchor reactions [kip]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	3.571	4.964	0.000	4.964
2	3.571	4.964	0.000	4.964
3	3.571	4.964	0.000	4.964
4	3.571	4.964	0.000	4.964
5	3.571	4.964	0.000	4.964
6	3.571	4.964	0.000	4.964
7	3.571	4.964	0.000	4.964
8	3.571	4.964	0.000	4.964
9	3.571	4.964	0.000	4.964
10	3.571	4.964	0.000	4.964
11	3.571	4.964	0.000	4.964
12	3.571	4.964	0.000	4.964
13	3.571	4.964	0.000	4.964
14	3.571	4.964	0.000	4.964
15	3.571	4.964	0.000	4.964
16	3.571	4.964	0.000	4.964
17	3.571	4.964	0.000	4.964
18	3.571	4.964	0.000	4.964
19	3.571	4.964	0.000	4.964
20	3.571	4.964	0.000	4.964
21	3.571	4.964	0.000	4.964
22	3.571	4.964	0.000	4.964
23	3.571	4.964	0.000	4.964
24	3.571	4.964	0.000	4.964
25	3.571	4.964	0.000	4.964
26	3.571	4.964	0.000	4.964
27	3.571	4.964	0.000	4.964
28	3.571	4.964	0.000	4.964

Max. concrete compressive strain: - [‰]
Max. concrete compressive stress: - [psi]
Resulting tension force in (x/y)=(0.000/0.000): 100.000 [kip]
Resulting compression force in (x/y)=(-/-): 0.000 [kip]

Anchor forces are calculated based on the assumption of a rigid anchor plate.

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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Phone I Fax:	|	E-Mail:	
Design:	LRFD - Spillway Anchor Top	Date:	8/5/2025
Fastening point:			

3 Tension load

	Load N_{ua} [kip]	Capacity ϕ N_n [kip]	Utilization $\beta_N = N_{ua}/\phi$ N_n	Status
Steel Strength*	3.571	20.085	18	OK
Bond Strength**	100.000	465.791	22	OK
Sustained Tension Load Bond Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	100.000	204.132	49	OK

* highest loaded anchor **anchor group (anchors in tension)

3.1 Steel Strength

N_{sa} = ESR value refer to ICC-ES ESR-4868
ϕ $N_{sa} \geq N_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.46	58,000

Calculations

N_{sa} [kip]
26.780

Results

N_{sa} [kip]	ϕ_{steel}	ϕ N_{sa} [kip]	N_{ua} [kip]
26.780	0.750	20.085	3.571

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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Design:	LRFD - Spillway Anchor Top	Date:	8/5/2025
Fastening point:			

3.2 Bond Strength

$N_{ag} = \left(\frac{A_{Na}}{A_{Na0}}\right) \psi_{ec1,Na}\ \psi_{ec2,Na}\ \psi_{ed,Na}\ \psi_{cp,Na}\ N_{ba}$ ACI 318-19 Eq. (17.6.5.1b)

$\phi\ N_{ag} \geq N_{ua}$ ACI 318-19 Table 17.5.2

A_{Na} see ACI 318-19, Section 17.6.5.1, Fig. R 17.6.5.1(b)

$A_{Na0} = (2\ c_{Na})^2$ ACI 318-19 Eq. (17.6.5.1.2a)

$c_{Na} = 10\ d_a \sqrt{\frac{\tau_{uncr}}{1100}}$ ACI 318-19 Eq. (17.6.5.1.2b)

$\psi_{ec,Na} = \left(\frac{1}{1 + \frac{e'_N}{c_{Na}}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.5.3.1)

$\psi_{ed,Na} = 0.7 + 0.3 \left(\frac{c_{a,min}}{c_{Na}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.5.4.1b)

$\psi_{cp,Na} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{c_{Na}}{c_{ac}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.5.5.1b)

$N_{ba} = \lambda_a \cdot \tau_{k,c} \cdot \pi \cdot d_a \cdot h_{ef}$ ACI 318-19 Eq. (17.6.5.2.1)

Variables

$\tau_{k,c,uncr}$ [psi]	d_a [in.]	h_{ef} [in.]	$c_{a,min}$ [in.]	$\alpha_{overhead}$	$\tau_{k,c}$ [psi]
2,220	0.875	14.091	24.000	1.000	1,290

$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	c_{ac} [in.]	λ_a
0.000	0.000	22.650	1.000

Calculations

c_{Na} [in.]	A_{Na} [in.^{2}]	A_{Na0} [in.^{2}]	$\psi_{ed,Na}$
12.374	8,784.32	612.50	1.000

$\psi_{ec1,Na}$	$\psi_{ec2,Na}$	$\psi_{cp,Na}$	N_{ba} [kip]
1.000	1.000	1.000	49.966

Results

N_{ag} [kip]	ϕ_{bond}	$\phi\ N_{ag}$ [kip]	N_{ua} [kip]
716.601	0.650	465.791	100.000

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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3.3 Concrete Breakout Failure

$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b$ — ACI 318-19 Eq. (17.6.2.1b)

$\phi\ N_{cbg} \geq N_{ua}$ — ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ — ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e'_N}{3\ h_{ef}}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.3.1)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c\ \lambda_a\ \sqrt{f'_c}\ h_{ef}^{1.5}$ — ACI 318-19 Eq. (17.6.2.2.1)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
14.091	0.000	0.000	24.000	1.000

c_{ac} [in.]	k_c	λ_a	f'_c [psi]
22.650	17	1.000	2,500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [kip]
12,482.01	1,786.89	1.000	1.000	1.000	1.000	44.958

Results

N_{cbg} [kip]	$\phi_{concrete}$	$\phi\ N_{cbg}$ [kip]	N_{ua} [kip]
314.049	0.650	204.132	100.000

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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4 Shear load

	Load V_{ua} [kip]	Capacity ϕ V_n [kip]	Utilization $\beta_V = V_{ua}/\phi$ V_n	Status
Steel Strength*	4.964	10.445	48	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength (Concrete Breakout Strength controls)**	139.000	439.668	32	OK
Concrete edge failure in direction x-**	139.000	172.836	81	OK

* highest loaded anchor **anchor group (relevant anchors)
When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

4.1 Steel Strength

V_{sa} = ESR value refer to ICC-ES ESR-4868
ϕ $V_{steel} \geq V_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]
0.46	58,000

Calculations

V_{sa} [kip]
16.070

Results

V_{sa} [kip]	ϕ_{steel}	ϕ V_{sa} [kip]	V_{ua} [kip]
16.070	0.650	10.445	4.964

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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4.2 Pryout Strength (Concrete Breakout Strength controls)

$V_{cpg} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \right]$ ACI 318-19 Eq. (17.7.3.1b)

$\phi V_{cpg} \geq V_{ua}$ ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9 h_{ef}^2$ ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2 e'_N}{3 h_{ef}}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.3.1)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ ACI 318-19 Eq. (17.6.2.2.1)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	14.091	0.000	0.000	24.000

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
1.000	22.650	17	1.000	2,500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [kip]
12,482.01	1,786.89	1.000	1.000	1.000	1.000	44.958

Results

V_{cpg} [kip]	$\phi_{concrete}$	ϕV_{cpg} [kip]	V_{ua} [kip]
628.097	0.700	439.668	139.000

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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4.3 Concrete edge failure in direction x-

$V_{cbg} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ec,V} \psi_{ed,V} \psi_{c,V} \psi_{h,V} \psi_{parallel,V} V_b$ ACI 318-19 Eq. (17.7.2.1b)

$\phi V_{cbg} \geq V_{ua}$ ACI 318-19 Table 17.5.2

A_{Vc} see ACI 318-19, Section 17.7.2.1, Fig. R 17.7.2.1(b)*

$A_{Vc0} = 4.5 c_{a1}^2$ ACI 318-19 Eq. (17.7.2.1.3)

$\psi_{ec,V} = \left(\frac{1}{1 + \frac{e'_v}{1.5c_{a1}}}\right) \leq 1.0$ ACI 318-19 Eq. (17.7.2.3.1)

$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$ ACI 318-19 Eq. (17.7.2.4.1b)

$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$ ACI 318-19 Eq. (17.7.2.6.1)

$V_b = 9 \lambda_a \sqrt{f'_c} c_{a1}^{1.5}$ ACI 318-19 Eq. (17.7.2.2.1b)

Variables

c_{a1} [in.]	c_{a2} [in.]	e_{cV} [in.]	$\psi_{c,V}$	h_a [in.]
24.000	248.000	0.000	1.000	60.000

l_e [in.]	λ_a	d_a [in.]	f'_c [psi]	$\psi_{parallel,V}$
7.000	1.000	0.875	2,500	2.000

Calculations

A_{Vc} [in.^{2}]	A_{Vc0} [in.^{2}]	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [kip]
6,048.00	2,592.00	1.000	1.000	1.000	52.909

Results

V_{cbg} [kip]	$\phi_{concrete}$	ϕV_{cbg} [kip]	V_{ua} [kip]
246.908	0.700	172.836	139.000

*Anchor row defined by: Anchor 1, 5, 9, 13, 17, 21, 25; Case 3 controls

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

5 Combined tension and shear loads, per ACI 318-19 section 17.8

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.490	0.804	5/3	100	OK

$\beta_{NV} = \beta_N^{\zeta} + \beta_V^{\zeta} <= 1$

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- Design Strengths of adhesive anchor systems are influenced by the cleaning method. Refer to the INSTRUCTIONS FOR USE given in the Evaluation Service Report for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to https://viewer.joomag.com/profis-design-guide-us-en-summer-2021/0841849001625154758?short&/
- Installation of Hilti adhesive anchor systems shall be performed by personnel trained to install Hilti adhesive anchors. Reference ACI 318-19, Section 26.7.

Fastening meets the design criteria!

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7 Installation data

Profile: no profile

Hole diameter in the fixture: d_f = 0.938 in.

Plate thickness (input): 0.500 in.

Recommended plate thickness: not calculated

Drilling method: Hammer drilled

Cleaning: Compressed air cleaning of the drilled hole according to instructions for use is required

Anchor type and diameter: HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) 7/8

Item number: not available (element) / 2334276 HIT-HY 200-R V3 (adhesive)

Maximum installation torque: 0.12500 ft.kip

Hole diameter in the base material: 1.000 in.

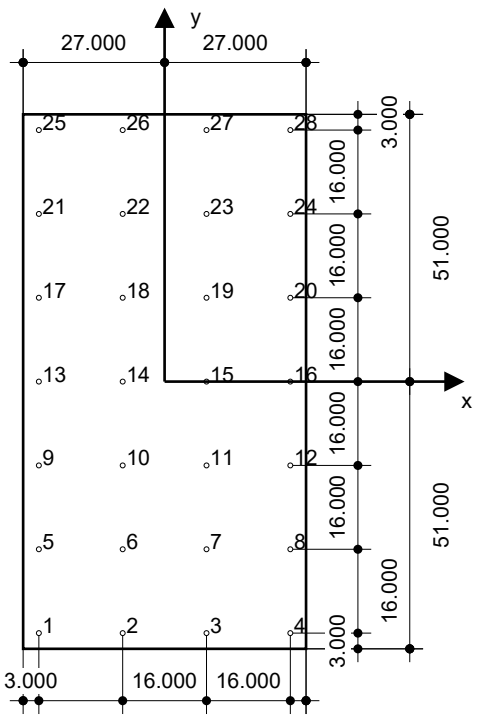
Hole depth in the base material: 14.091 in.

Minimum thickness of the base material: 16.091 in.

Hilti ∅ 7/8 in HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) with 14.090551 in nominal embedment depth per ICC-ES ESR-4868 , Hammer drill bit installation per MPII

7.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Compressed air with required accessories to blow from the bottom of the hole • Proper diameter wire brush	• Dispenser including cassette and mixer • Torque wrench



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Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-24.000	-48.000	24.000	72.000	248.000	-
2	-8.000	-48.000	40.000	56.000	248.000	-
3	8.000	-48.000	56.000	40.000	248.000	-
4	24.000	-48.000	72.000	24.000	248.000	-
5	-24.000	-32.000	24.000	72.000	264.000	-
6	-8.000	-32.000	40.000	56.000	264.000	-
7	8.000	-32.000	56.000	40.000	264.000	-
8	24.000	-32.000	72.000	24.000	264.000	-
9	-24.000	-16.000	24.000	72.000	280.000	-
10	-8.000	-16.000	40.000	56.000	280.000	-
11	8.000	-16.000	56.000	40.000	280.000	-
12	24.000	-16.000	72.000	24.000	280.000	-
13	-24.000	0.000	24.000	72.000	296.000	-
14	-8.000	0.000	40.000	56.000	296.000	-
15	8.000	0.000	56.000	40.000	296.000	-
16	24.000	0.000	72.000	24.000	296.000	-
17	-24.000	16.000	24.000	72.000	312.000	-
18	-8.000	16.000	40.000	56.000	312.000	-
19	8.000	16.000	56.000	40.000	312.000	-
20	24.000	16.000	72.000	24.000	312.000	-
21	-24.000	32.000	24.000	72.000	328.000	-
22	-8.000	32.000	40.000	56.000	328.000	-
23	8.000	32.000	56.000	40.000	328.000	-
24	24.000	32.000	72.000	24.000	328.000	-
25	-24.000	48.000	24.000	72.000	344.000	-
26	-8.000	48.000	40.000	56.000	344.000	-
27	8.000	48.000	56.000	40.000	344.000	-
28	24.000	48.000	72.000	24.000	344.000	-

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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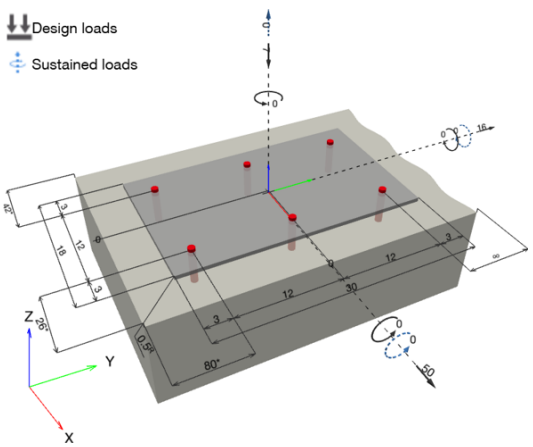
Specifier's comments:

1 Input data

Anchor type and diameter:	**HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) 7/8**
Item number:	not available (element) / 2334276 HIT-HY 200-R V3 (adhesive)
Specification text:	Hilti ∅ 7/8 in HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) with 3.815 in nominal embedment depth per ICC-ES ESR-4868 , Hammer drill bit installation per MPII,
Effective embedment depth:	$h_{ef,opti}$ = 3.815 in. ($h_{ef,limit}$ = 17.500 in.)
Material:	ASTM F1554 Grade 36
Evaluation Service Report:	ESR-4868
Issued I Valid:	11/1/2024 | 11/1/2026
Proof:	Design Method ACI 318-19 / Chem
Shear edge breakout verification:	Row closest to edge (Case 3 only from ACI 318-19 Fig. R.17.7.2.1b)
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate[R] :	l_x x l_y x t = 18.000 in. x 30.000 in. x 0.500 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 2500, f_c' = 2,500 psi; h = 60.000 in., Temp. short/long: 32/32 °F
Installation:	**Hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: not present, shear: not present; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar

[R] - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [kip, ft.kip]



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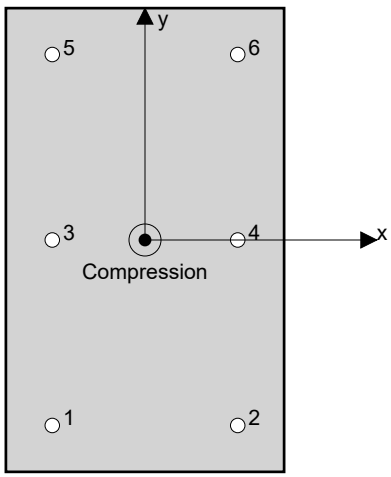
1.1 Design results

Case	Description	Forces [kip] / Moments [ft.kip]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = -7.000; V_x = 50.000; V_y = 16.000; M_x = 0.00000; M_y = 0.00000; M_z = 0.00000;	no	99

2 Load case/Resulting anchor forces



Anchor reactions [kip]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	0.000	8.750	8.333	2.667
2	0.000	8.750	8.333	2.667
3	0.000	8.750	8.333	2.667
4	0.000	8.750	8.333	2.667
5	0.000	8.750	8.333	2.667
6	0.000	8.750	8.333	2.667

Max. concrete compressive strain: 0.00 [‰]
Max. concrete compressive stress: 13 [psi]
Resulting tension force in (x/y)=(-/-): 0.000 [kip]
Resulting compression force in (x/y)=(-0.000/0.000): 7.000 [kip]

Anchor forces are calculated based on the assumption of a rigid anchor plate.

3 Tension load

	Load N_{ua} [kip]	Capacity ϕ N_n [kip]	Utilization $\beta_N = N_{ua}/\phi$ N_n	Status
Steel Strength*	N/A	N/A	N/A	N/A
Bond Strength**	N/A	N/A	N/A	N/A
Sustained Tension Load Bond Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	N/A	N/A	N/A	N/A

* highest loaded anchor **anchor group (anchors in tension)

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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4 Shear load

	Load V_{ua} [kip]	Capacity ϕ V_n [kip]	Utilization $\beta_V = V_{ua}/\phi$ V_n	Status
Steel Strength*	8.750	10.445	84	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength (Concrete Breakout Strength controls)**	52.498	53.203	99	OK
Concrete edge failure in direction x+**	52.498	53.337	99	OK

* highest loaded anchor **anchor group (relevant anchors)
When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

4.1 Steel Strength

V_{sa} = ESR value refer to ICC-ES ESR-4868
ϕ $V_{steel} \geq V_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]
0.46	58,000

Calculations

V_{sa} [kip]
16.070

Results

V_{sa} [kip]	ϕ_{steel}	ϕ V_{sa} [kip]	V_{ua} [kip]
16.070	0.650	10.445	8.750

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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4.2 Pryout Strength (Concrete Breakout Strength controls)

$V_{cpg} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \right]$ ACI 318-19 Eq. (17.7.3.1b)

$\phi V_{cpg} \geq V_{ua}$ ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9 h_{ef}^2$ ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2 e'_N}{3 h_{ef}}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.3.1)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ ACI 318-19 Eq. (17.6.2.2.1)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	3.815	0.000	0.000	26.000

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
1.000	4.722	17	1.000	2,500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [kip]
785.91	130.99	1.000	1.000	1.000	1.000	6.334

Results

V_{cpg} [kip]	$\phi_{concrete}$	ϕV_{cpg} [kip]	V_{ua} [kip]
76.004	0.700	53.203	52.498

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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4.3 Concrete edge failure in direction x+

$V_{cbg} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ec,V}\ \psi_{ed,V}\ \psi_{c,V}\ \psi_{h,V}\ \psi_{parallel,V}\ V_b$ — ACI 318-19 Eq. (17.7.2.1b)

$\phi\ V_{cbg} \geq V_{ua}$ — ACI 318-19 Table 17.5.2

A_{Vc} see ACI 318-19, Section 17.7.2.1, Fig. R 17.7.2.1(b)*

$A_{Vc0} = 4.5\ c_{a1}^2$ — ACI 318-19 Eq. (17.7.2.1.3)

$\psi_{ec,V} = \left(\frac{1}{1 + \frac{e'_v}{1.5c_{a1}}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.7.2.3.1)

$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.7.2.4.1b)

$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$ — ACI 318-19 Eq. (17.7.2.6.1)

$V_b = \left(7\left(\frac{l_e}{d_a}\right)^{0.2}\sqrt{d_a}\right)\lambda_a\sqrt{f'_c}\,c_{a1}^{1.5}$ — ACI 318-19 Eq. (17.7.2.2.1a)

Variables

c_{a1} [in.]	c_{a2} [in.]	e_{cV} [in.]	$\psi_{c,V}$	h_a [in.]
26.000	80.000	0.000	1.000	60.000

l_e [in.]	λ_a	d_a [in.]	f'_c [psi]	$\psi_{parallel,V}$
3.815	1.000	0.875	2,500	1.000

Calculations

A_{Vc} [in.^{2}]	A_{Vc0} [in.^{2}]	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [kip]
3,978.00	3,042.00	1.000	1.000	1.000	58.268

Results

V_{cbg} [kip]	$\phi_{concrete}$	$\phi\ V_{cbg}$ [kip]	V_{ua} [kip]
76.196	0.700	53.337	52.498

*Anchor row defined by: Anchor 2, 4, 6; Case 3 controls

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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5 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- Design Strengths of adhesive anchor systems are influenced by the cleaning method. Refer to the INSTRUCTIONS FOR USE given in the Evaluation Service Report for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to https://viewer.joomag.com/profis-design-guide-us-en-summer-2021/0841849001625154758?short&/
- Installation of Hilti adhesive anchor systems shall be performed by personnel trained to install Hilti adhesive anchors. Reference ACI 318-19, Section 26.7.

Fastening meets the design criteria!

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6 Installation data

Profile: no profile

Hole diameter in the fixture: d_f = 0.938 in.

Plate thickness (input): 0.500 in.

Recommended plate thickness: not calculated

Drilling method: Hammer drilled

Cleaning: Compressed air cleaning of the drilled hole according to instructions for use is required

Anchor type and diameter: HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) 7/8

Item number: not available (element) / 2334276 HIT-HY 200-R V3 (adhesive)

Maximum installation torque: 0.12500 ft.kip

Hole diameter in the base material: 1.000 in.

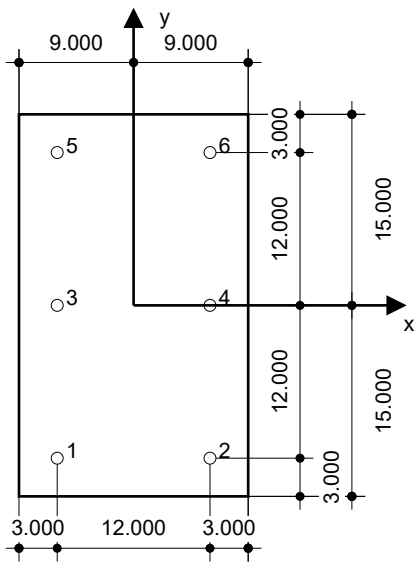
Hole depth in the base material: 3.815 in.

Minimum thickness of the base material: 5.815 in.

Hilti ∅ 7/8 in HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) with 3.814961 in nominal embedment depth per ICC-ES ESR-4868 , Hammer drill bit installation per MPII

6.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Compressed air with required accessories to blow from the bottom of the hole • Proper diameter wire brush	• Dispenser including cassette and mixer • Torque wrench



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-6.000	-12.000	42.000	38.000	80.000	-
2	6.000	-12.000	54.000	26.000	80.000	-
3	-6.000	0.000	42.000	38.000	92.000	-
4	6.000	0.000	54.000	26.000	92.000	-
5	-6.000	12.000	42.000	38.000	104.000	-
6	6.000	12.000	54.000	26.000	104.000	-

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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7 Remarks; Your Cooperation Duties

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- You must take all necessary and reasonable steps to prevent or limit damage caused by the Software. In particular, you must arrange for the regular backup of programs and data and, if applicable, carry out the updates of the Software offered by Hilti on a regular basis. If you do not use the AutoUpdate function of the Software, you must ensure that you are using the current and thus up-to-date version of the Software in each case by carrying out manual updates via the Hilti Website. Hilti will not be liable for consequences, such as the recovery of lost or damaged data or programs, arising from a culpable breach of duty by you.

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Design:	LRFD - Spillway Anchor Bottom	Date:	8/5/2025
Fastening point:			

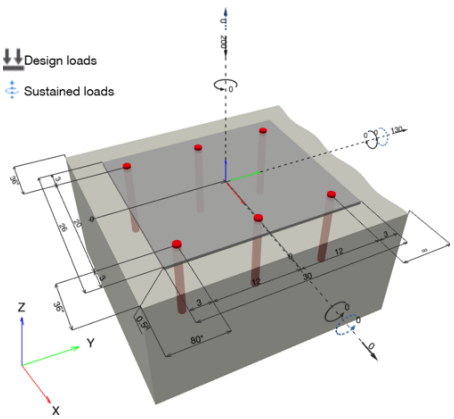
Specifier's comments:

1 Input data

Anchor type and diameter:	**HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) 1 1/4**
Item number:	not available (element) / 2334276 HIT-HY 200-R V3 (adhesive)
Specification text:	Hilti ∅ 1 1/4 in HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) with 12.244 in nominal embedment depth per ICC-ES ESR-4868 , Hammer drill bit installation per MPII,
Effective embedment depth:	$h_{ef,opti}$ = 12.244 in. ($h_{ef,limit}$ = 25.000 in.)
Material:	ASTM F1554 Grade 36
Evaluation Service Report:	ESR-4868
Issued I Valid:	11/1/2024 | 11/1/2026
Proof:	Design Method ACI 318-19 / Chem
Shear edge breakout verification:	Row closest to edge (Case 3 only from ACI 318-19 Fig. R.17.7.2.1b)
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate[R] :	l_x x l_y x t = 26.000 in. x 30.000 in. x 0.500 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 2500, f_c' = 2,500 psi; h = 60.000 in., Temp. short/long: 32/32 °F
Installation:	**Hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: not present, shear: not present; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar

[R] - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [kip, ft.kip]



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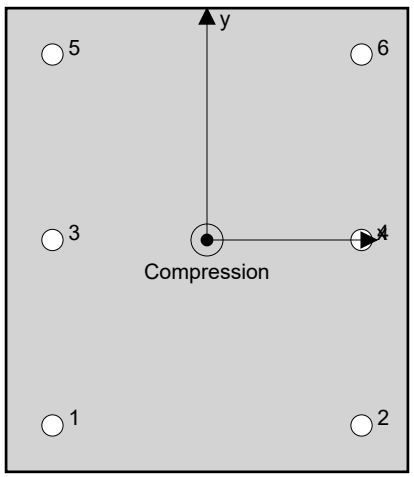
1.1 Design results

Case	Description	Forces [kip] / Moments [ft.kip]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = -200.000; V_x = 0.000; V_y = 130.000; M_x = 0.00000; M_y = 0.00000; M_z = 0.00000;	no	100

2 Load case/Resulting anchor forces



Anchor reactions [kip]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	0.000	21.667	0.000	21.667
2	0.000	21.667	0.000	21.667
3	0.000	21.667	0.000	21.667
4	0.000	21.667	0.000	21.667
5	0.000	21.667	0.000	21.667
6	0.000	21.667	0.000	21.667

Max. concrete compressive strain:	0.06 [‰]
Max. concrete compressive stress:	256 [psi]
Resulting tension force in (x/y)=(-/-):	0.000 [kip]
Resulting compression force in (x/y)=(0.000/-0.000):	200.000 [kip]

Anchor forces are calculated based on the assumption of a rigid anchor plate.

3 Tension load

	Load N_{ua} [kip]	Capacity ϕ N_n [kip]	Utilization $\beta_N = N_{ua}/\phi$ N_n	Status
Steel Strength*	N/A	N/A	N/A	N/A
Bond Strength**	N/A	N/A	N/A	N/A
Sustained Tension Load Bond Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	N/A	N/A	N/A	N/A

* highest loaded anchor **anchor group (anchors in tension)

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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4 Shear load

	Load V_{ua} [kip]	Capacity ϕ V_n [kip]	Utilization $\beta_V = V_{ua}/\phi$ V_n	Status
Steel Strength*	21.667	21.921	99	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength (Concrete Breakout Strength controls)**	130.000	130.194	100	OK
Concrete edge failure in direction x-**	130.000	166.320	79	OK

* highest loaded anchor **anchor group (relevant anchors)
When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

4.1 Steel Strength

V_{sa} = ESR value refer to ICC-ES ESR-4868
ϕ $V_{steel} \geq V_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]
0.97	58,000

Calculations

V_{sa} [kip]
33.725

Results

V_{sa} [kip]	ϕ_{steel}	ϕ V_{sa} [kip]	V_{ua} [kip]
33.725	0.650	21.921	21.667

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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4.2 Pryout Strength (Concrete Breakout Strength controls)

$V_{cpg} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \right]$ ACI 318-19 Eq. (17.7.3.1b)

$\phi V_{cpg} \geq V_{ua}$ ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9 h_{ef}^2$ ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2 e'_N}{3 h_{ef}}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.3.1)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ ACI 318-19 Eq. (17.6.2.2.1)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	12.244	0.000	0.000	36.000

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
1.000	16.592	17	1.000	2,500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [kip]
3,445.48	1,349.26	1.000	1.000	1.000	1.000	36.417

Results

V_{cpg} [kip]	$\phi_{concrete}$	ϕV_{cpg} [kip]	V_{ua} [kip]
185.991	0.700	130.194	130.000

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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4.3 Concrete edge failure in direction x-

$V_{cbg} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ec,V}\ \psi_{ed,V}\ \psi_{c,V}\ \psi_{h,V}\ \psi_{parallel,V}\ V_b$ — ACI 318-19 Eq. (17.7.2.1b)

$\phi\ V_{cbg} \geq V_{ua}$ — ACI 318-19 Table 17.5.2

A_{Vc} see ACI 318-19, Section 17.7.2.1, Fig. R 17.7.2.1(b)*

$A_{Vc0} = 4.5\ c_{a1}^2$ — ACI 318-19 Eq. (17.7.2.1.3)

$\psi_{ec,V} = \left(\frac{1}{1 + \frac{e'_v}{1.5c_{a1}}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.7.2.3.1)

$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.7.2.4.1b)

$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$ — ACI 318-19 Eq. (17.7.2.6.1)

$V_b = 9\ \lambda_a\ \sqrt{f'_c}\ c_{a1}^{1.5}$ — ACI 318-19 Eq. (17.7.2.2.1b)

Variables

c_{a1} [in.]	c_{a2} [in.]	e_{cV} [in.]	$\psi_{c,V}$	h_a [in.]
36.000	80.000	0.000	1.000	60.000

l_e [in.]	λ_a	d_a [in.]	f'_c [psi]	$\psi_{parallel,V}$
10.000	1.000	1.250	2,500	2.000

Calculations

A_{Vc} [in.^{2}]	A_{Vc0} [in.^{2}]	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [kip]
7,128.00	5,832.00	1.000	1.000	1.000	97.200

Results

V_{cbg} [kip]	$\phi_{concrete}$	$\phi\ V_{cbg}$ [kip]	V_{ua} [kip]
237.600	0.700	166.320	130.000

*Anchor row defined by: Anchor 1, 3, 5; Case 3 controls

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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5 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- Design Strengths of adhesive anchor systems are influenced by the cleaning method. Refer to the INSTRUCTIONS FOR USE given in the Evaluation Service Report for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to https://viewer.joomag.com/profis-design-guide-us-en-summer-2021/0841849001625154758?short&/
- Installation of Hilti adhesive anchor systems shall be performed by personnel trained to install Hilti adhesive anchors. Reference ACI 318-19, Section 26.7.

Fastening meets the design criteria!

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6 Installation data

Profile: no profile

Hole diameter in the fixture: d_f = 1.375 in.

Plate thickness (input): 0.500 in.

Recommended plate thickness: not calculated

Drilling method: Hammer drilled

Cleaning: Compressed air cleaning of the drilled hole according to instructions for use is required

Anchor type and diameter: HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) 1 1/4

Item number: not available (element) / 2334276 HIT-HY 200-R V3 (adhesive)

Maximum installation torque: 0.20000 ft.kip

Hole diameter in the base material: 1.375 in.

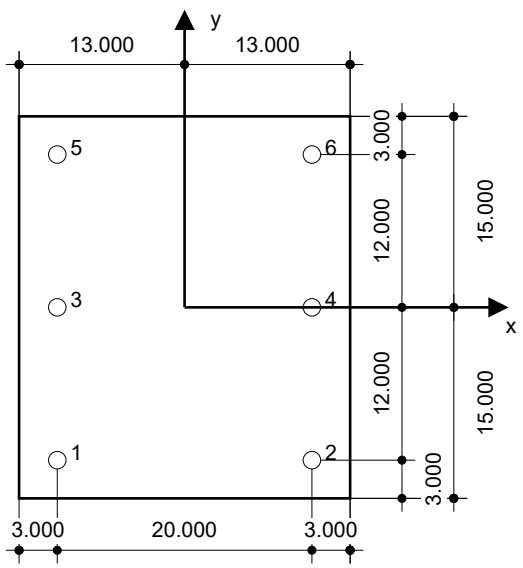
Hole depth in the base material: 12.244 in.

Minimum thickness of the base material: 14.994 in.

Hilti ∅ 1 1/4 in HIT-HY 200 V3 + HAS-V-36 HDG (ASTM F1554 Gr.36) with 12.244094 in nominal embedment depth per ICC-ES ESR-4868 , Hammer drill bit installation per MPII

6.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Compressed air with required accessories to blow from the bottom of the hole • Proper diameter wire brush	• Dispenser including cassette and mixer • Torque wrench



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-10.000	-12.000	36.000	56.000	80.000	-
2	10.000	-12.000	56.000	36.000	80.000	-
3	-10.000	0.000	36.000	56.000	92.000	-
4	10.000	0.000	56.000	36.000	92.000	-
5	-10.000	12.000	36.000	56.000	104.000	-
6	10.000	12.000	56.000	36.000	104.000	-

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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Appendix E. Concept Design Workshop Presentation

Jacobs

Meeting Minutes

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Subject	**Concept Design Workshop**		
Project	USACE Walla Walla District McNary Avian Deterrence Conceptual Design Evaluation		
Project No.	Contract W912EF-23-D0014 Task Order W912EF24F9202	**Report Date**	19 December 2024
Prepared by	Ralph Field	**Phone No.**	360-622-0435
Location	Held virtually on Microsoft Teams	**Meeting Date**	19 December 2024
Attendees	Attachment A		

The following is our understanding of the subject matter covered in this meeting. If this differs from your understanding, please notify us within five (5) business days.

The Concept Design Workshop (CDW) meeting for the Walla Walla District McNary Avian Deterrence Conceptual Design Evaluation was conducted by Ralph Field, Project Manager for Jacobs.

1 Introductions & Safety Moment

Ralph Field began the meeting by initiating introductions for all in attendance.

Culture of Caring Moment: Teamwork – funny cartoon within CDW presentation demonstrates the importance of teamwork. Achieving an objective requires planning and execution as a team.

2 CDW Purpose

Ralph reviewed the problem statement and the APDA objectives for the project, as well as the purpose for the CDW: review and develop concept alternatives, identify criteria and constraints to each alternative, and select two alternatives for refinement and advancement for further design.

3 Wire Array Design Considerations

Ralph led the discussion of the wire array design considerations. The team reviewed the list of preferred characteristics provided by Nick Borchert with USDA Animal and Plant Health Inspection Service (APHIS).

During the discussion, it was noted McNary Dam has no immediate plans to explore falconry. It is something they would like to try, but do not have dedicated funding for yet. The team agreed to move forward with developing a wire array independent of falconry.

Karen Zelch asked if there had been any lessons learned from John Day Dam regarding steel wire and cost of maintenance or safety/risk, for example, needing to make sure all steel is grounded? Ralph stated the impression he got from discussion with Nick was that steel wire requires little to no maintenance. Also, no tensioner – steel has only one tension, not adjustable. It was also discussed advantages of installation and cost for steel wire arrays vs. Kevlar. Tower grounding will be a part of any concept. Regarding maintenance, John Day Dam management alerts APHIS with severed steel wires and they come out to remove the wire. No concerns noted with any issues with steel wire. Ralph noted Nick stated wire array is less expensive

assuming APHIS installs the wire. Also, installing Kevlar rope required use of helicopter and no helicopter would be needed to install wire. APHIS installs the wire from a boat.

Avian Design Considerations

Gary Santolo reviewed avian design considerations for wire array.

Chris Peery confirmed primary avian predation zone of focus as that identified on slide 11. He noted there is less than 2% steelhead juveniles and very few fish passing through the turbines.

Structural Design Considerations

Garrett Van Ruiten reviewed structural design considerations for wire array.

Matt Riegle noted studies showed that18ft (6m) is the optimal wire spacing width. Anything less does not show to be more effective. Increasing space between wires allows more space for bird predation.

Height of towers is not really a concern. Concern would be if they are low enough to get contact with water and debris, but anything above that is not a concern. Wires are typically removed during duration of work where the wires would interfere. APHIS routinely removes them for dams with wire arrays. No concerns were noted with the public being in the area during work.

- Anchor points should not be any lower than 20ft from the water line. Wire sag can be easily adjusted unless anchor points are too low.
- Jared reminded the team that in regard to anchorage, the navigation channel cannot be covered. Must have enough height to allow boats to come through with unrestricted boat height.

Ralph noted that with wire, while no tensioners were needed, but wires do would still need dampeners.

Jared noted that per the ASCE hazard tool online, maximum wind gust speed for McNary Dam was noted as 100mph and 0.72 inches for ice load. Not sure where the lower values noted in the feasibility report came from but pointing out for awareness as the numbers may need to be increased at some point. Jacobs took note and will change the specification for design.

Top of dam lock is about 100ft up from the spillway. That height presents an advantage using the spillway deck height as compared to towers starting near tailrace water level.

Electrical Design Considerations

Kashifa Kabeer noted the only major consideration from an electrical design standpoint is grounding. Per UFC all poles will be grounded.

References and Constraints

2023 Avian Report stated pelicans are becoming a larger percentage of predation by the SWT. Chris Peery clarified that while they are seeing more pelicans, they are not sure what they are actually feeding on but believes their diet could be mostly shad. Diet study is being conducted. Pelicans may not be as high a priority for predation consideration.

Jared noted that additional as-builts were sent to Jacobs today (19 Dec 2024) via email.

Ralph noted that it would be beneficial if the Jacobs' team could get structural calculations on the bypass pier to understand what the piers are actually built to withstand.

- **ACTION ITEM** - Jared to follow-up with Portland for pier calculations and provide to Jacobs before the holidays. [COMPLETE]

April/May is peak for smolts and is the primary time interval to target predator deterrence. July is when adult shad is most prevalent moving upstream leading to increased pelican predation activity. August is usually when McNary Dam experiences sub yearlings moving downstream which initiates increases gull predation.

January/February construction restraint is only for in-water work construction. USACE does not see it being restricted to winter months only for this work. Primarily it would be to avoid the spillways – cannot install tower while they are spilling and would need to work around that. Most restrictive construction work would be in or around the fish ladder.

For cost estimating purposes, they need a notice-to-proceed date to build out from. Knowing project is currently at very early stage, tentatively utilize FY2026 Q3 as a start date to avoid spill season as a start date.

4 APDA Alternative Types Discussion

Karen stated that the intent of alternatives from feasibility report was to have spillway covered and some of the powerhouse tailrace and asked from a bird behavior perspective if not having wires on powerhouse at all would visually cue gulls to use that as an entry point.

- They are not currently seeing a lot of gulls coming from underneath. Birds do not generally like anything (wires) above them – where predators come from. Would likely see more predation along the edges, not from underneath.

Jacobs Developed Alternatives

Garrett noted the Jacobs developed alternatives were made to be a la carte and could be combined to desired preference.

Anthony O-Hare commented: Anything that goes on the trash and ice outfall wall is not an area that can be accessible by truck. No vehicle traffic access. If there is a single point on that wall that needs tension it could not be on that wall. Trash and ice outfall and Nav Lock guidewall are not available for vehicle traffic.

Elevation of Nav Lock wall could allow for direct connection to the structure. Main thing would be to coordinate and avoid equipment on top. Towers were used at John Day just to get enough elevation clearance to avoid equipment.

Matt commented that any option that uses the JBS outfall would be problematic. APHIS installation equipment (wire spools etc. are mounted at the tow hitch of the truck, so access by truck is very important. They would have to access via a boat and that would be extremely hard to keep steady. Barge has never been tried before but would still be hard to keep steady and expensive. Would have to happen each time for unplanned maintenance as well.

Jacobs Alternative 1 – Tailrace Pier – Navigation Lock and Guidewall Array

- Confirmed Tailrace Pier Tower connection point is best at top of spillway. But it could be moved to the top of the dam if needed.
- Would entail approximately 35-45 wires based on length of wall.
- Wires would be perpendicular to the river, which is more optimal.
- One of the factors feeding into cost is max wire span.

Jacobs Alternative 2 – Tailrace Pier to JBS Outfall Pier

- Would need pier calculations of what they were designed for.
- Distributed towers across pier. Updated 2022 Feasibility Report comments suggested the possibility of installing a single large tower onto JBS Outfall Pier, but Jacobs team did not progress with that alternative as they do not consider that feasible for pier to support a single extremely large tower. USACE concurred.

Jacobs Alternative 3 – Oregon Shore to Navigation Lock Guidewall Array

- Based on option from feasibility report.
- Chris Peery confirmed the western half of spillway is primary area of concern. Area nearest to the spillway is so turbulent that the birds typically avoid. The more they spill, the further downstream the birds move for better fishing.
- Distributed towers could be placed on top of lock wall as well if needed to increase coverage.
- Avoid attaching wires to the fish ladder itself.

Jacobs Alternative 4 – Oregon Shore to Navigation Lock and Spillway Array

- Complementary to the Jacobs Alternative 3. Covers the upper spillway area (east side).
- Could be modified to put structural support tower into the water if wanted to consider. Bedrock is not too deep that we could not add it into the water if we want to consider that cost against cost of shorter wire. (same for Alternative 3). Matt noted there was no advantage to moving the pier out into the water. It will increase installation cost to install the pier. They will need to have a barge out there for install and maintenance and is expensive. More length to wire is cheaper than bringing barge out into water.
- If both alternatives 3 and 4 were constructed together it would provide better coverage.

Jacobs Alternative 5 – JBS Outfall Pier to Powerhouse Array

- Does not really cover the predation zone.

Jacobs Alternative 6 – JBS Outfall Pier to Spillway Array

- Wires would be predominantly parallel to the water direction.

Jacobs Alternative 7 – Navigation Lock Guidewall to Spillway

- No comments of note.

Jacobs Alternative 8 – Navigation Lock Guidewall to Spillway and Powerhouse Array

- No comments of note.

Alternative In-water Deterrent System

- Proof of concept option.
- Intent would be to attach to the outfall piers and end piers. Birds do not like things that move around on the water. Would be especially effective for pelicans since they feed just below the water surface it would obstruct their feeding.
- Relies on water current, distance between cables, and rudders to keep it from tangling. Spacing would be important.
- Meant to be seasonally deployed and could be taken out of water when out-of-season.
- Would never be an independent alternative since it would not deter gulls. Would have to be combined with another wire array alternative.

In-Water Floating Array with Modified Outfall Location

- Would leave outfall the same but bring where fish are released closer to the south shore.

Guardian Soundscape Technology

- Feasibility Report mentioned considering other options not noted. Jacobs sharing something they found.
- Soundscape claims that the sound is harder for the birds to habituate to.
- Drawbacks noted are from Jacobs research, not from the Soundscape site.

5 Selection of Preferred Alternatives

Walla Walla District emphasized that project development should review and consider comments provided by FFDRWG in 2022 Feasibility Report.

Ralph shared the ranking matrix. After initial discussion, the group decided to eliminate the following alternatives.

- FR 6.3 – not going to do anything effective, difficult to build.
- FR 6.4 – have seen weight of wires pull the anchors up. Might be too heavy. Removed from consideration due to structural load concerns.
- Jacobs Alternative 2 – does not cover enough area, especially for amount of money and effort it would take, and structural difficulties in installing.
- Jacobs Alternative 5 – only covers powerhouse and we do not need to cover the powerhouse.
- Jacobs Alternative 6 – attachment points will be problematic structurally and would take too much work to make connections work at outfall.
- Jacobs Alternative 8 – same as alternative 7 but with powerhouse coverage which does not need to be covered.

- In-Water Floating Array with Modified Outfall Location – a lot of extra work getting to the outfall as it is.

USACE requested they be given time to review the ranking matrix and complete internally together and send it back to Jacobs.

- Mark Jones noted part of the scope was to have 2 alternatives selected by the end of the CDW, which is what is driving the push to complete now.
- Regarding internal review completion, Karen noted that January is problematic as many people, especially at the dams, are out for the holidays. Would likely not be able to get feedback from all internal stakeholders until early February. Jacobs is not opposed to allow pushing out schedule another month to accommodate but would need to set a deadline.
- USACE to present all options to their internal stakeholders, but for purposes of design and cost, currently identified the following top two alternatives (subject to change pending internal review and feedback):
    - Preferred alternative 1: extend Jacobs Alternative #3 into the spillway.
    - Preferred alternative 2: combine Jacobs Alternatives #3 and #4 with In-water Array alternative.
    - **ACTION ITEM** – Garrett to provide updated alternative graphics to incorporate into ranking matrix. Completed 19 Dec 2024 by Garret Van Ruiten. [COMPLETE]
    - **ACTION ITEM** – Ralph to update ranking matrix per discussion and send to Karen to review and complete internally. [COMPLETE]

6 Schedule

- Schedule to be pushed out a month to accommodate regional stakeholder input for alternative option rankings. USACE tentative deadline of early February for regional stakeholder input.
- Canceled today's (19 Dec 2024) bi-weekly coordination meeting as it is not required.

7 Action Items

- Jared to follow-up with Portland for pier calculations and provide to Jacobs before the holidays. [COMPLETE]
- Garrett to provide updated alternative graphics to incorporate into ranking matrix. Completed 19 Dec 2024 by Garret Van Ruiten. [COMPLETE]
- Jacobs to update Alternatives Ranking Matrix options and send to Karen for distribution to internal and regional stakeholder team for their input. [COMPLETE]
- Jacobs to send meeting minutes.

8 Attendance Roster

Attendee	Company	Position
Karen Zelch	USACE	Project Manager, Walla Walla District
Mark Jones	USACE	Contracting Officer's Representative
Brandon McNeil	USACE	Project Technical Lead; Mechanical

Ryan Ashcroft	USACE	Biologist
Jared Houchin	USACE	Structural Engineering
Phong Pham	USACE	Electrical Engineering
Chris Peery	McNary Dam	Operations
Anthony O'Hare	McNary Dam	Tech Section POC
Matt Riegle	USDA APHIS	Biologist
Ralph Field	Jacobs	Project Manager
Gary Santolo	Jacobs	Avian Scientist
Kashifa Kabeer	Jacobs	Electrical Engineering
James Teeter	Jacobs	Mechanical Engineering
Garrett Van Ruiten	Jacobs	Structural Engineering
Youngsin Joh	Jacobs	Project Coordinator
Melissa Marion-Landais	Legis	Project Manager, Cost Estimating
Juan Rojas	Legis	Lead Cost Estimator
Adam Stephens	Legis	Staff Cost Estimator

END OF MEETING MINUTES

McNary Dam Avian Deterrence Concept Design Evaluation

Concept Design Workshop

19 December 2024

Agenda

Culture of Caring Moment

Introductions

- Walla Walla District
- McNary Dam Team
- Jacobs Team
- USDA Team

Task Order/Project Overview

- Problem Statement
- Project Objectives
- Purpose of Concept Design Workshop

Break

Concept Development for Avian Predation Deterrent Array (APDA) Alternative Types

- Primary wire arrays
- In-water arrays

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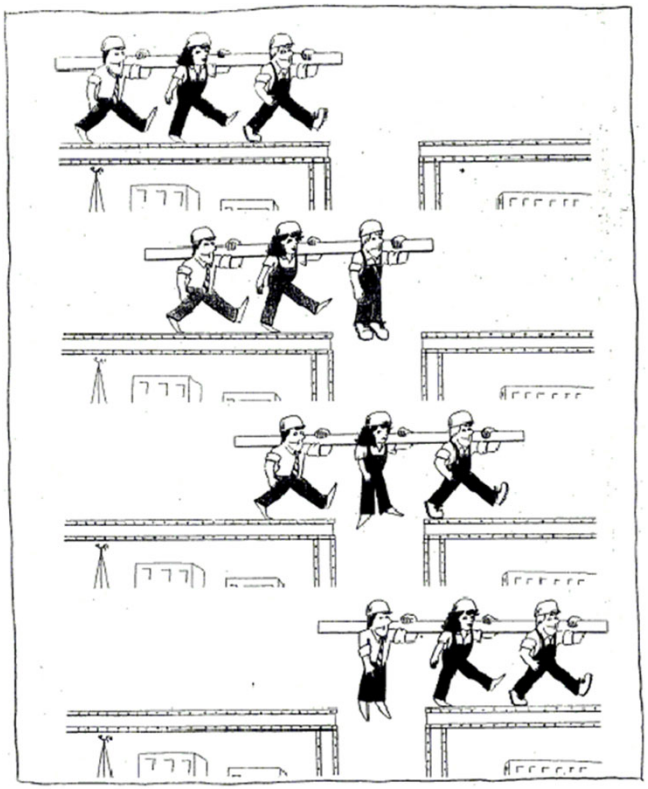
Culture of Caring Moment

- Achieving an objective requires planning and execution as a team
- Teamwork may include risk
- Teamwork requires trust
- Success is not only defined by achieving team objectives, but everyone goes home ***safe***, both mentally and physically



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Problem Statement and APDA Objectives

- Problem Statement
  - Smolts navigating downstream are more vulnerable to avian predators when concentrated in the forebays of mainstem dams and in tailraces if they become injured or temporarily disoriented following passage
  - 13 species of fish listed as threatened or endangered IAW ESA
  - Avian Predation identified as limiting factor in recovery of some ESA-listed salmonid populations in the CRB
- APDA objectives
  - Biological effectiveness
  - Device reliability
  - Ease of routine maintenance
  - Does not adversely impact dam operations
    - Tailrace access by boats and personnel
    - O&M of dam features
  - Identify ROM costs for cost/benefit analysis

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CDW Purpose

- Develop concept alternatives
- For each alternative, identify criteria and constraints
- Present alternative salient characteristics, pros/cons of potential APDA strategies
- Select two alternatives for refinement and advancement

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Wire Array Design Considerations

- General
  - According to USDA, newest wire array at John Day is designed with kevlar rope and has distinct disadvantages compared to steel wire: service life of 5 years vs. 20 years; ice builds up more on larger rope; more expensive to install
  - Achieving maximum wire sag is important to create a more three-dimensional deterrent for gulls
  - Wire array installers like the USDA team do not measure tension in the wire. Sag and distance to the water are primary installation requirements
  - Criss-crossing different arrays is not more effective and complicates installation
  - Sag closer to the water is most effective but needs to consider mean high water elevation
  - Thin steel gage wire is the most effective for ease of installation, longevity, rigidity, operation (no need to adjust tension)
  - Thin wires are preferable to minimize avian perching
  - Wire closer to spillways needs to be heavier gage to support potential ice build-up during winter
  - On parallel arrays using large cable for multiple anchor points, achieving uniform sag is a challenge and not recommended
  - Will wire arrays impact falconry abatement?

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Array Design Considerations (cont.)

- Avian Behavior Priorities
  - Three major predatory species are gulls, cormorants, and pelicans
  - Gulls are responsive to wire arrays
  - Cormorants are diving birds and pelicans forage just below the water surface and may respond to in-water arrays only
  - See predation priorities slide

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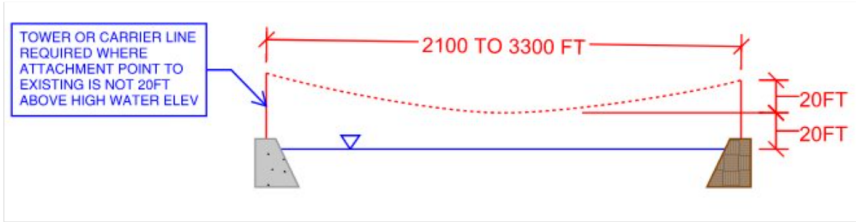
Array Design Considerations (cont.)

- Structural (Includes biological and operational priorities noted in Feasibility Report)
  - Wire spacing is 25-35ft maximum at termination location. Narrower spacing of 10-20ft are likely best for deterring gulls.
  - Avoid wires parallel to wind. Birds tend to fly parallel with wind, so perpendicular or angled orientation is most effective. 45 degrees max angle is preference.
  - Minimum wire height of 20 ft. above normal high tailwater for tailrace access by small boats/work platforms and to avoid entanglement with debris in river. Too high and birds can readily come in from underneath, making the array less effective.
  - Ideally no posts in water but may be acceptable if necessary. If so, avoid high flows areas, such as those associated with TSW outfalls (stay out of spill basin) due to potential fish impacts.
  - Anchorage must stay clear of handrails and light poles while being accessible for O&M purposes.
  - Line tensioners and dampeners are necessary for larger arrays/spans based on lessons learned at JDA.
  - Line tensioners & dampeners should be readily accessible w/o needing specialized equipment by project personnel.

ARRAY WIRE PROFILE

- 20ft minimum cable height above high water elevaton
- 20ft maximum cable sag
- 40ft minimum cable attachment height above high water elevaton



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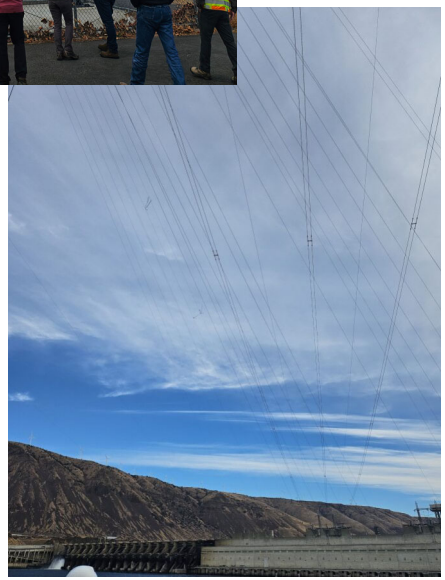
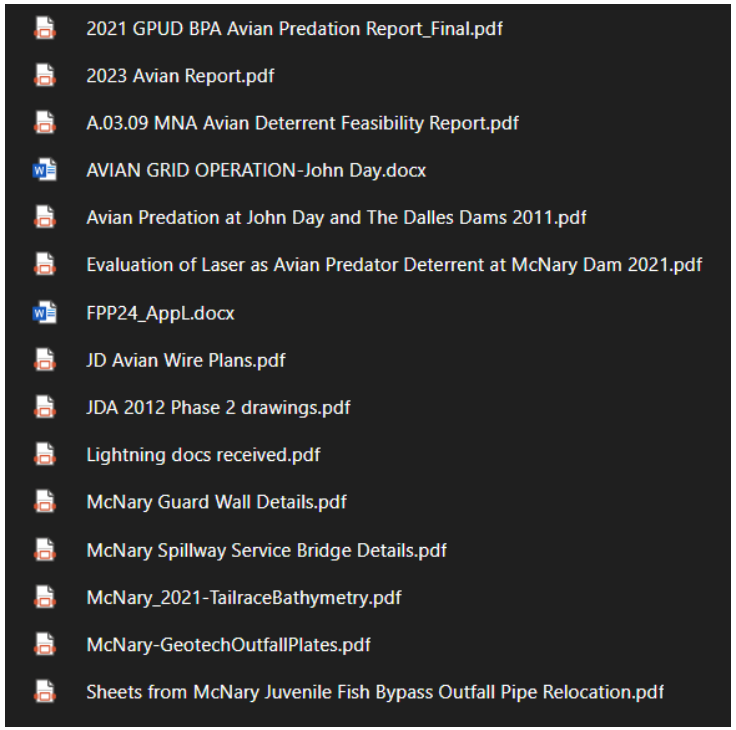
Wire Array Design Considerations (cont.)

- Structural (cont.)
  - Wind Load:
    - Assume 15 mph average wind (for synthetic creep analysis)
    - Able to withstand 72 mph sustained wind, and 85 mph gusts (check)
  - Assume ¼" ice load added to the diameter of the wire rope (check)
  - Temperature Range:
    - Assume Average Max Temp 61 °F, Average Min Temp 38 °F
    - Recorded temperature ranges from -28 °F to 108 °F
    - These ranges will be used for thermal expansion and synthetic creep analysis. JDA has seen significant differences in amount of synthetic line creep between summer and winter periods which must be addressed in design of new APDA's
  - Structural strength limits:
    - 60% of the minimum breaking strength for steel wires
    - 80% of the minimum breaking strength or synthetic wires
- Electrical
  - Per Unified Facilities Criteria (UFC) 3-575-01, all steel lines need to be grounded to prevent static and/or induced charges from the overhead power transmission lines.
  - Grounding is required for safety, protection, and prevention of electrical hazards.
  - The anchor pole for the wire arrays is required to be grounded. See image for a detail from John Day Dam Avian Predation deterrent array drawings (sheet detail B on S-401).



Wire Array Design Considerations (cont.)

- References:
  - Applicable USACE publications per the SOW
  - Governing criteria and codes per Unified Federal Criteria
  - McNary Avian Predation Deterrent Array Feasibility Report with FFDRWG comments_Final_26Oct2022
  - Other documents shared with Jacobs, post award:
    - Will be adding two more files for JBS record drawings
- Constraints:
  - Navigation channel cannot be blocked
  - APDAs cannot be placed west of the BRZ
  - Debris flow during spring
  - Limited construction window?
  - USDA APHIS Team uses reel truck to spool wire. Care should be taken to consider location of tower (not on outfall pier or lock guidewall).



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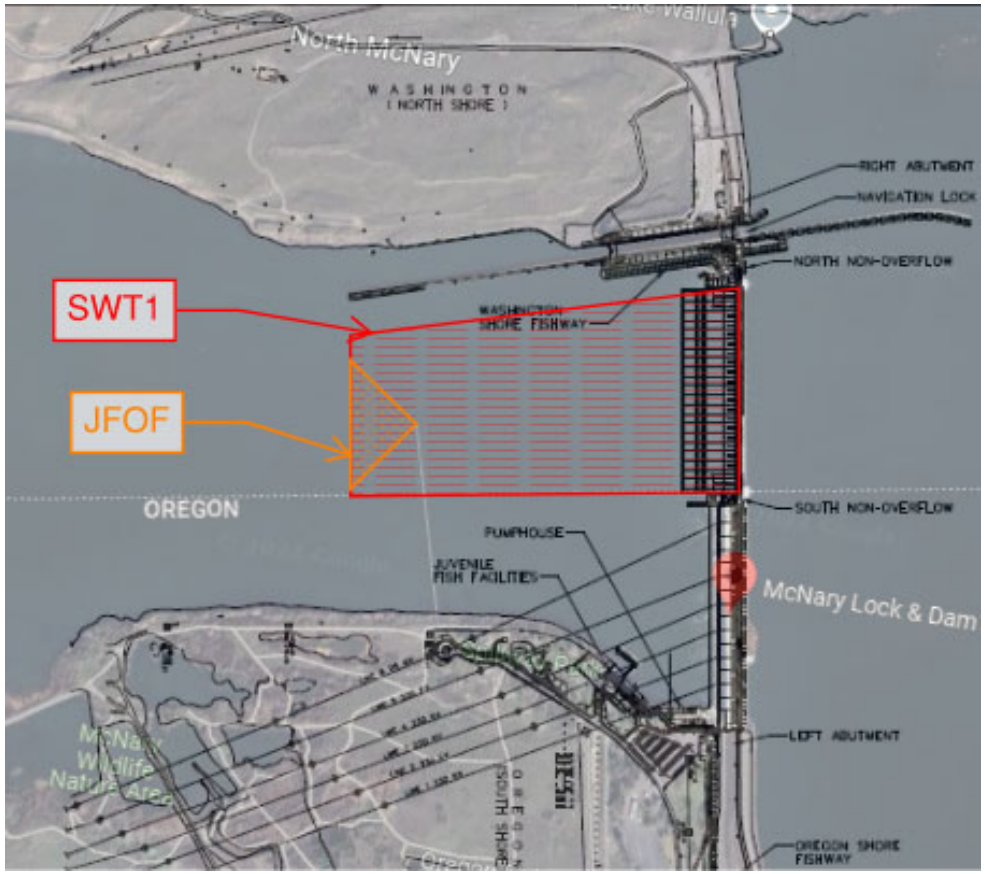
Primary Avian Predation Zones

- Input from Bobby Johnson and Chris Peery during Site Visit
- FFDRWG comments regarding change of dam operations where a majority of juvenile salmonid pass through spillways



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Jump to Whiteboard and review Feasibility Report Alternatives

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10 Minute Break

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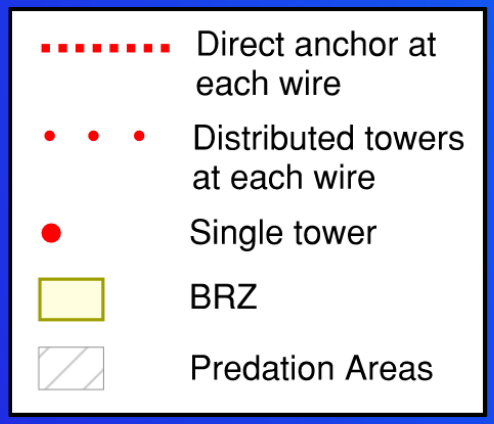
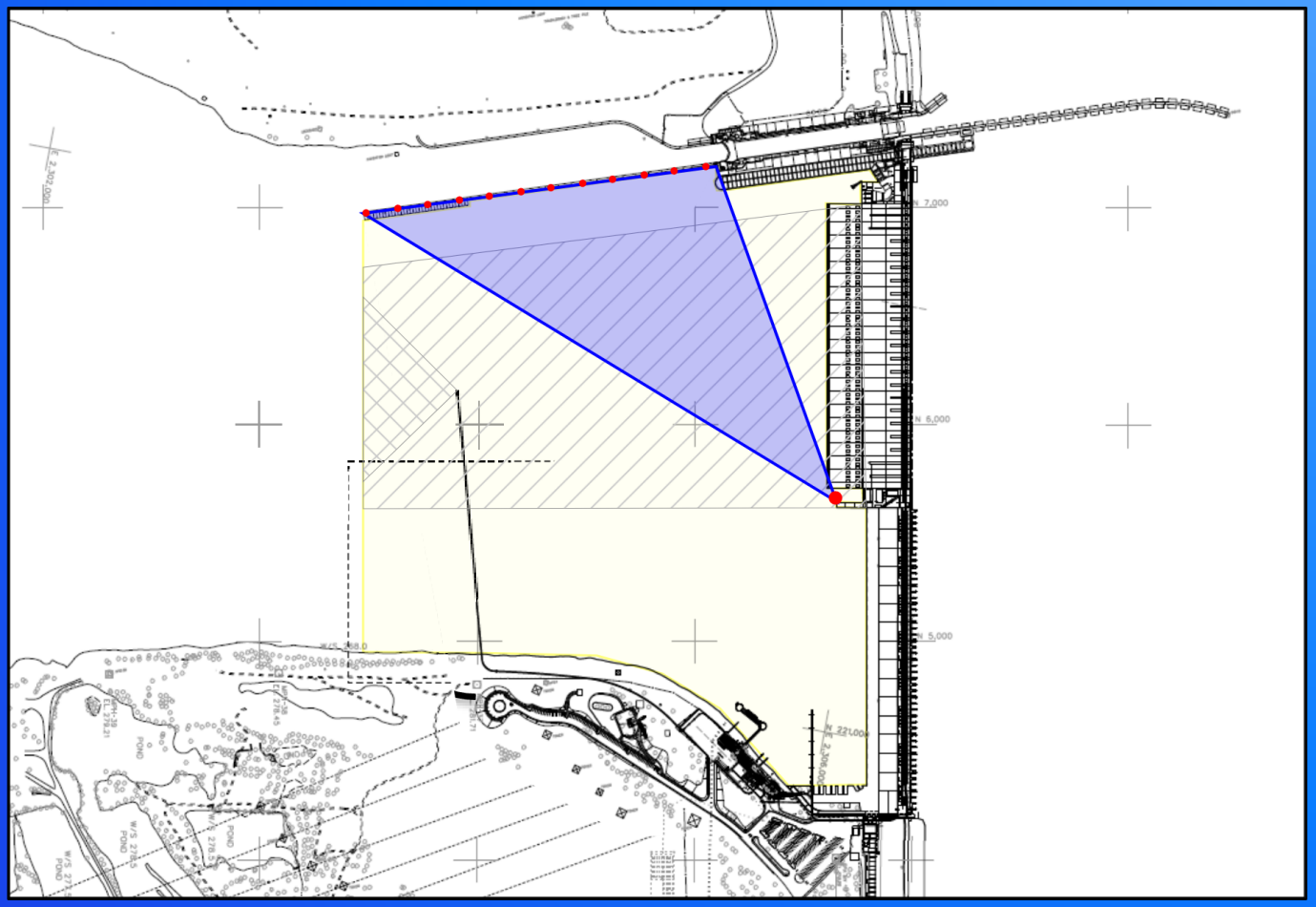
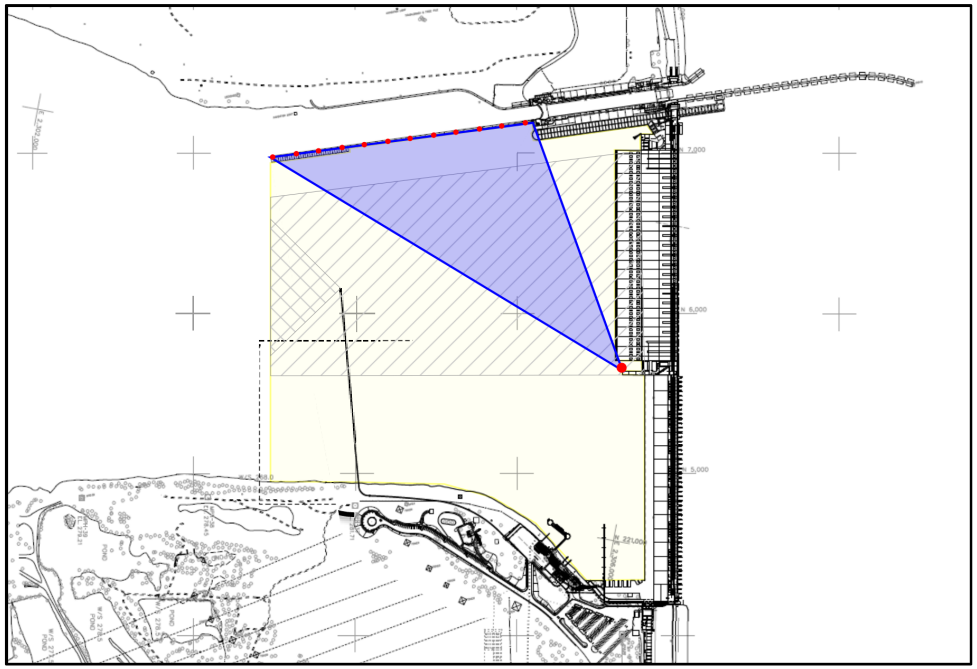
Tailrace Pier – Navigation Lock and Guidewall Array





Tailrace Pier – Navigation Lock and Guidewall Array

- Pros
  - Partial coverage of spillway tailrace
  - No new structural support needed in water
- Cons
  - No coverage at JFOF or downstream tailrace
  - Single or distributed towers needed at all wire attachment points
  - Max wire span about 2,600 ft



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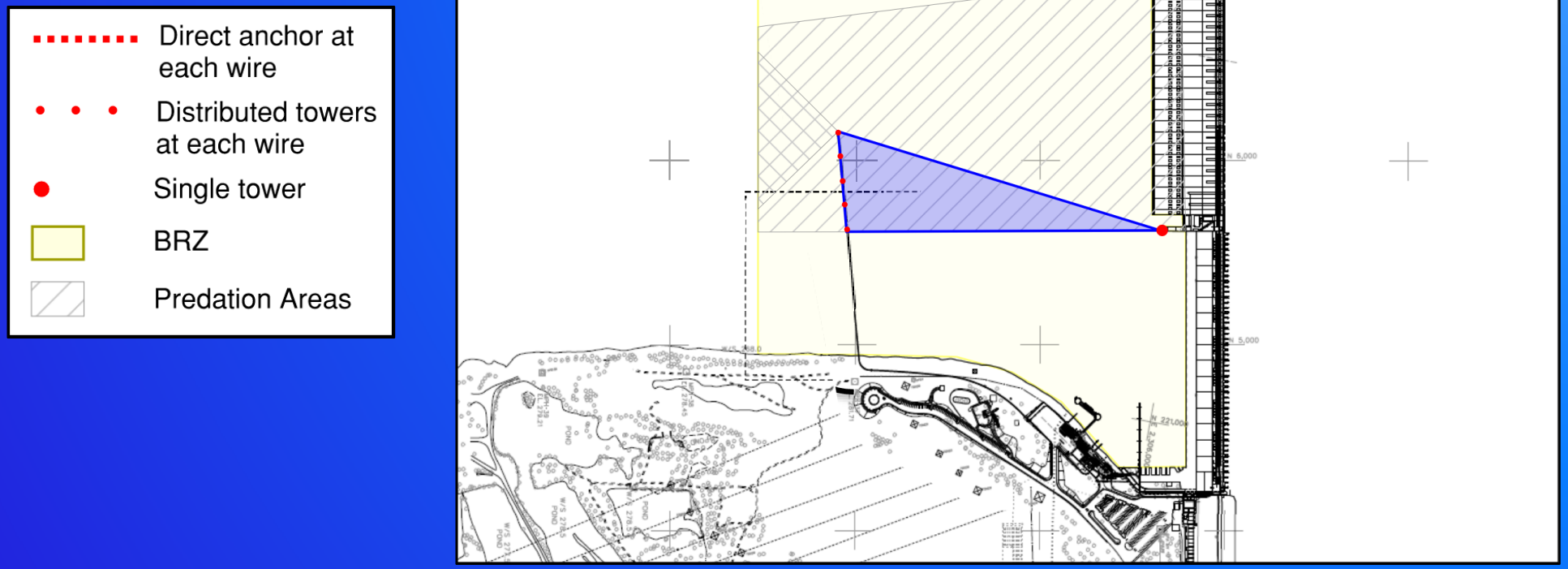
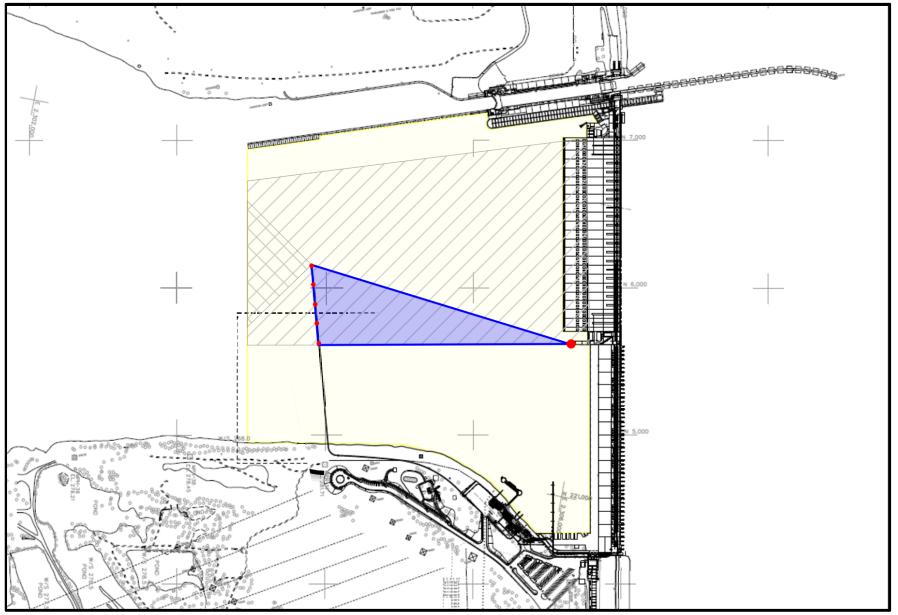
Tailrace Pier to JBS Outfall Pier



Tailrace Pier to JBS Outfall Pier

- Pros
  - Partial coverage of spillway tailrace
  - No new structural support needed in water
  - Max wire span about 1,900 ft
- Cons
  - No coverage at JFOF and limited coverage at north tailrace
  - Single or distributed towers needed at all wire attachment points



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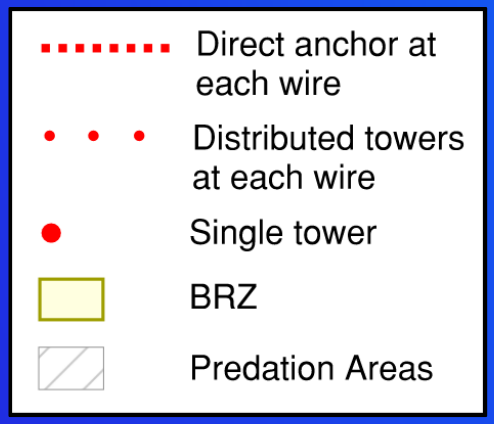
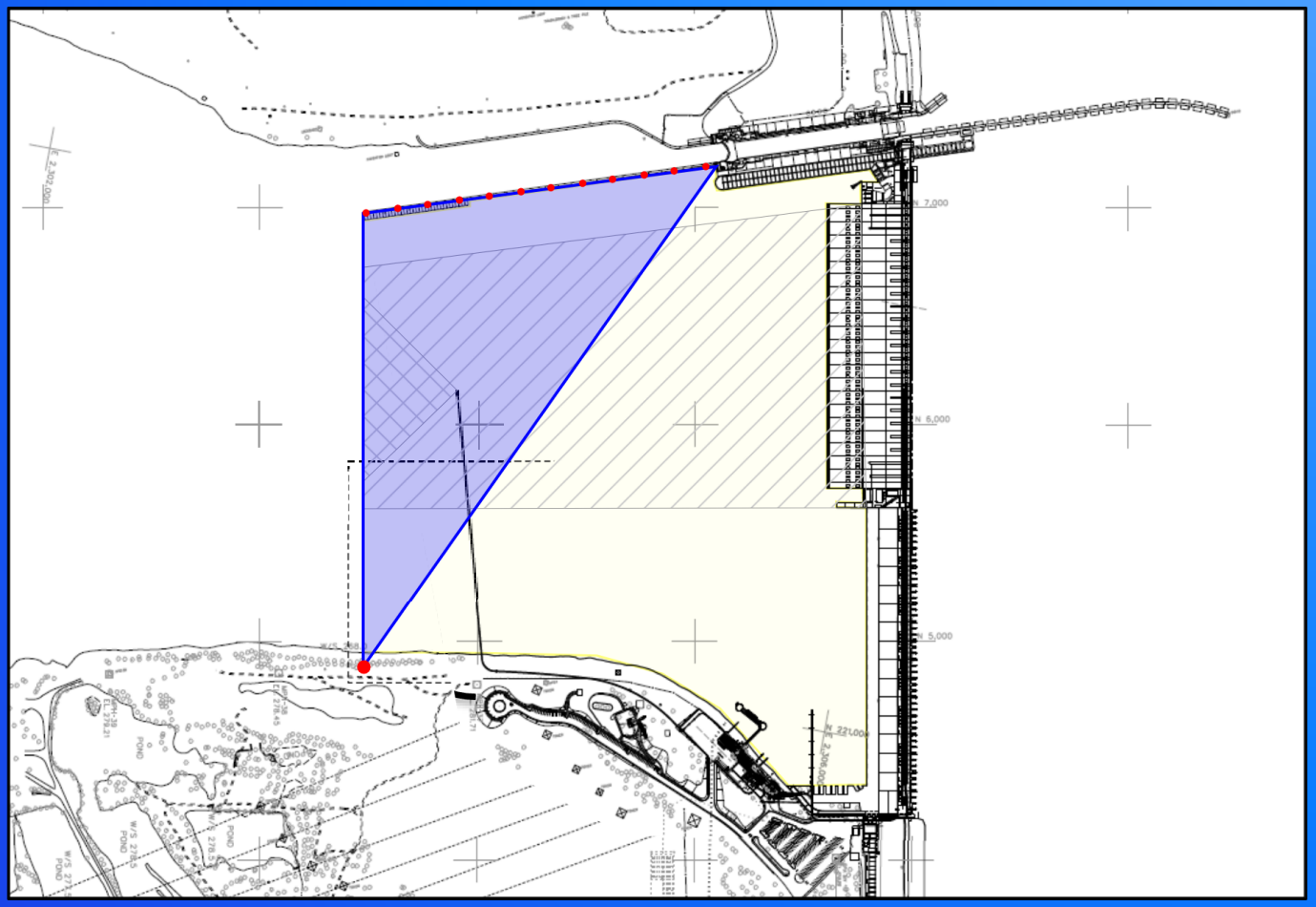
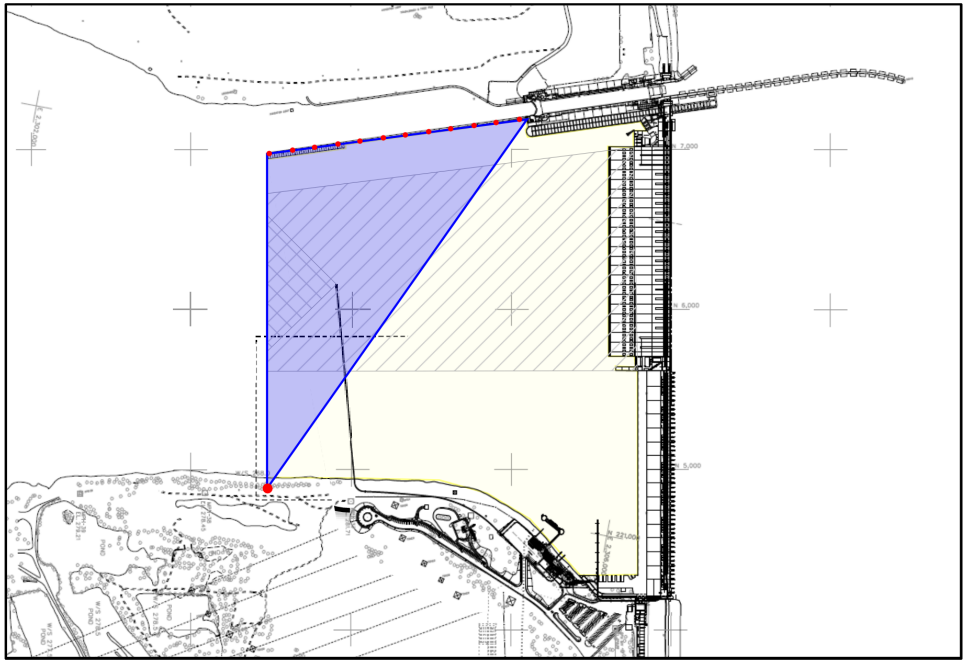
Oregon Shore to Navigation Lock Guidewall Array





Oregon Shore to Navigation Lock Guidewall Array

- Pros
  - Good coverage of JFOF and partial coverage of spillway tailrace
  - No new structural support needed in water
- Cons
  - No coverage at upstream tailrace
  - Single or distributed towers needed at all wire attachment points
  - New tower foundation required at south shore
  - Max wire span about 2,900 ft



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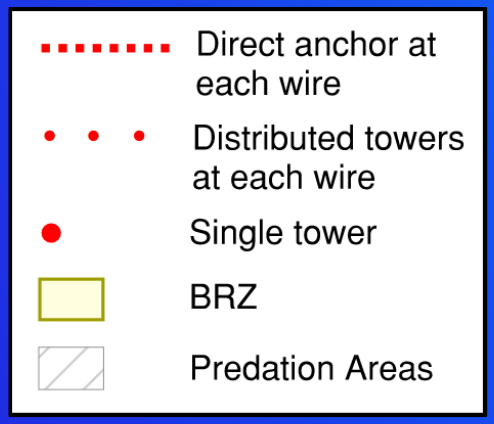
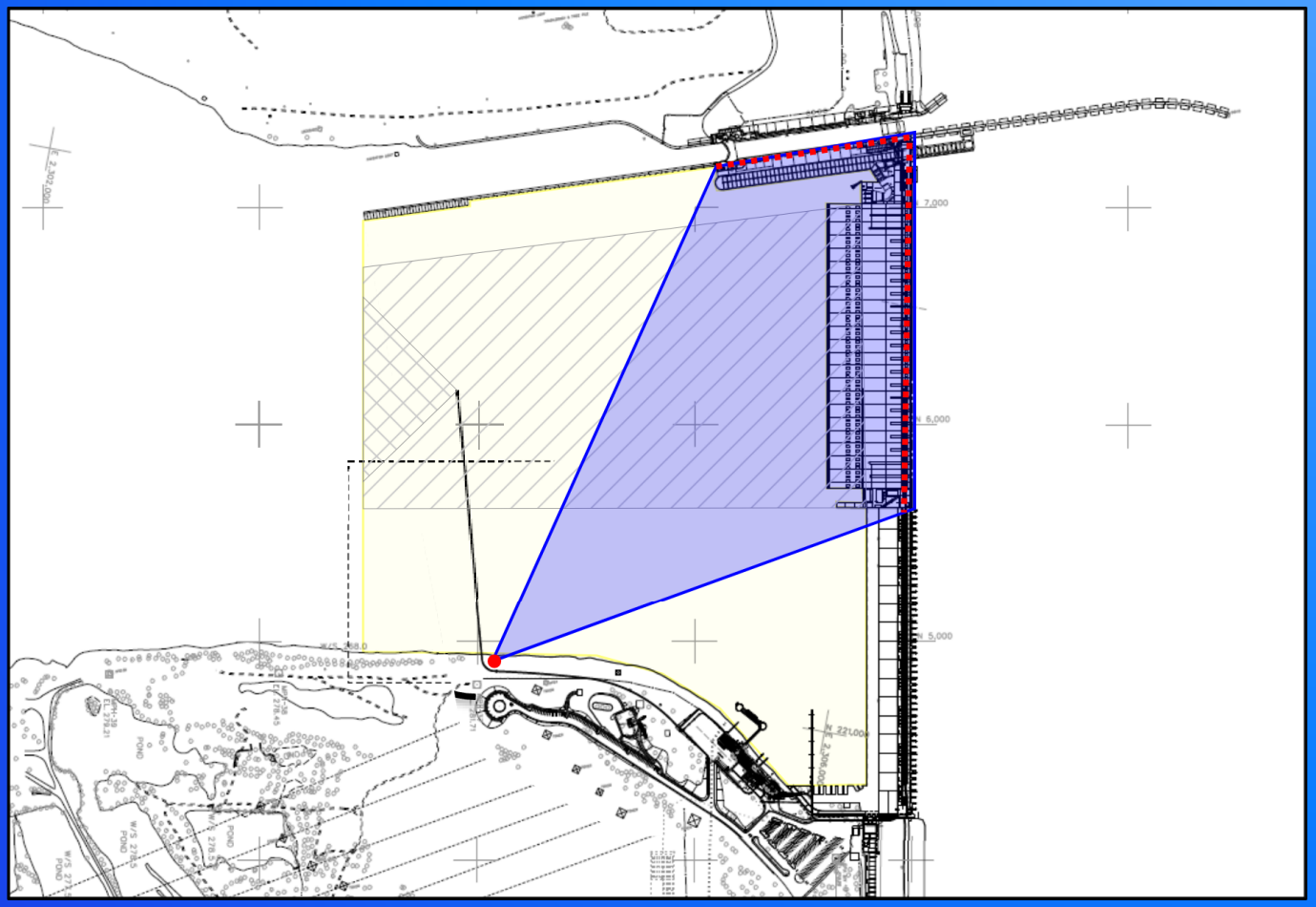
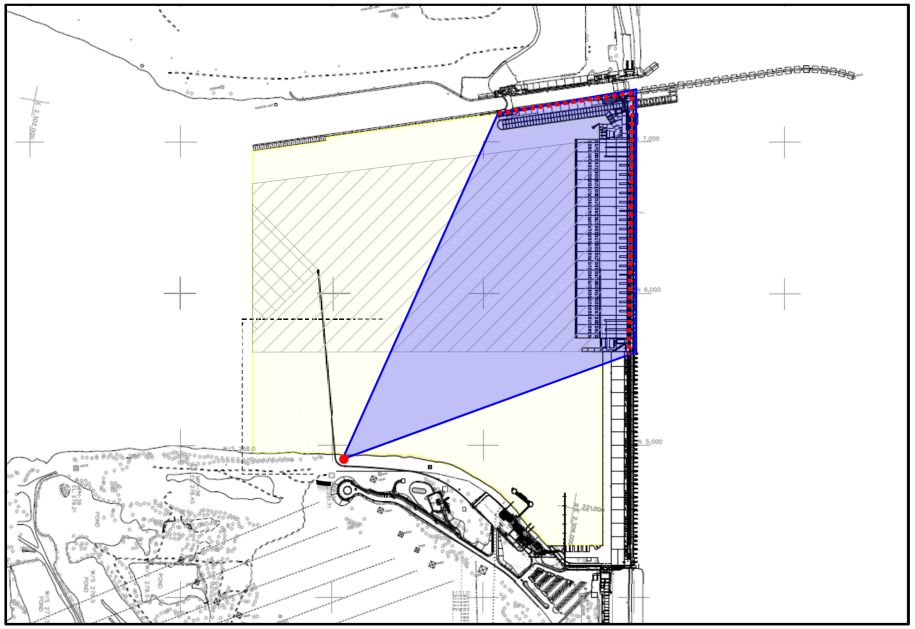
Oregon Shore to Navigation Lock and Spillway Array





Oregon Shore to Navigation Lock and Spillway Array

- Pros
  - Partial coverage of spillway tailrace
  - No new structural support needed in water
- Cons
  - No coverage at JFOF or downstream tailrace.
  - Single tower needed at south shore
  - New tower foundation required at south shore
  - Max wire span about 3,100 ft



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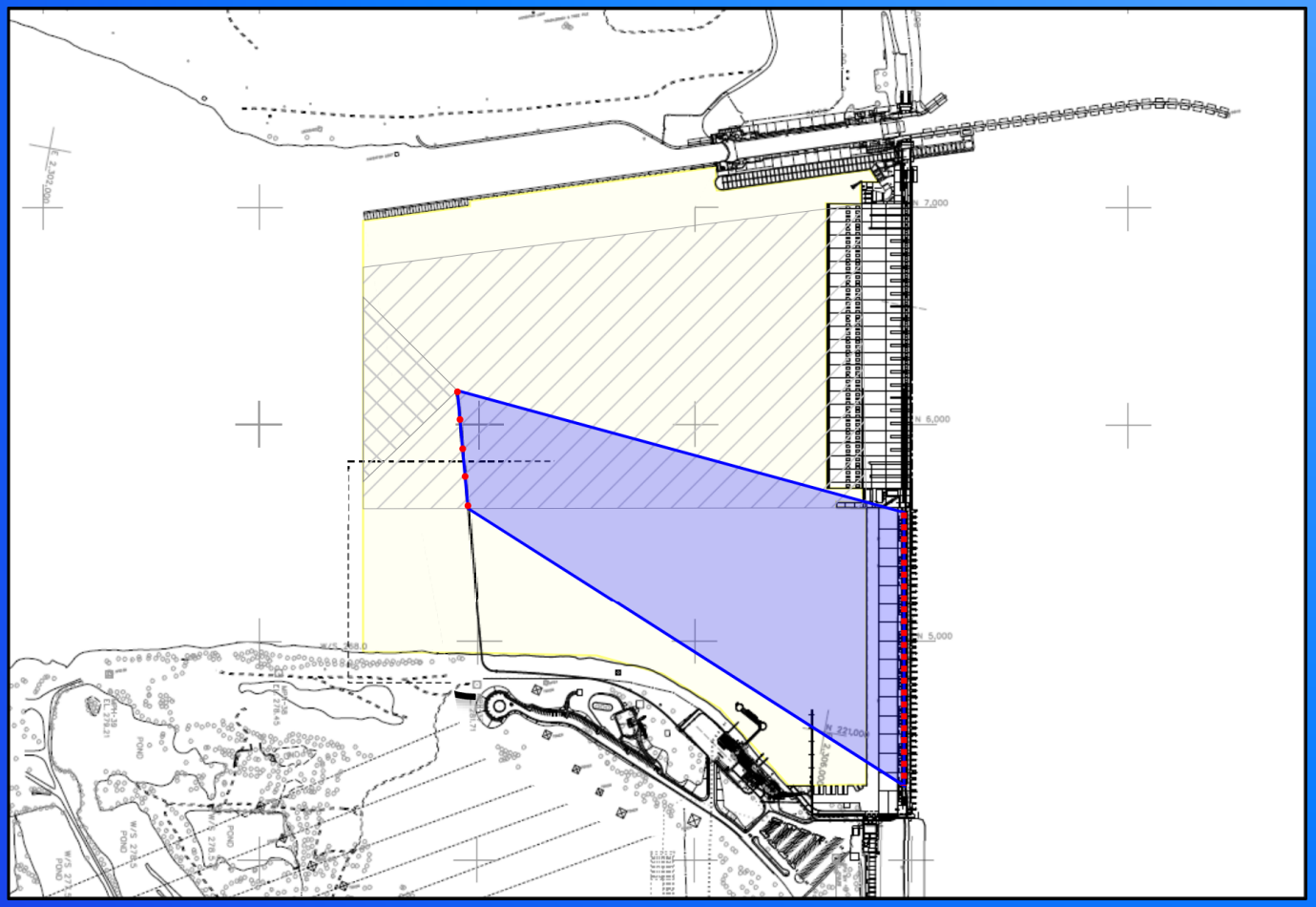
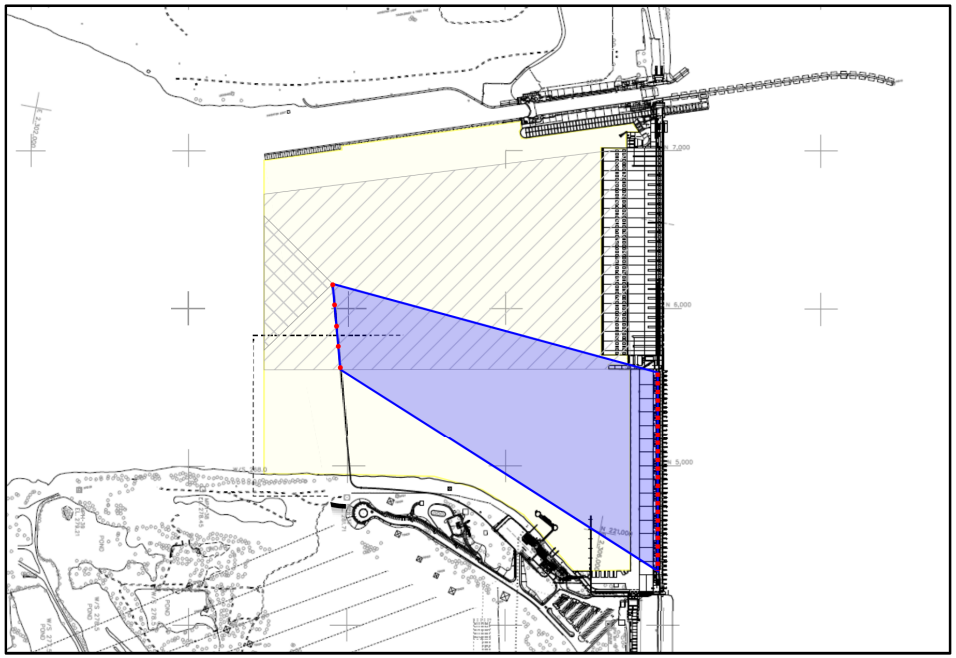
JBS Outfall Pier to Powerhouse Array

- Direct anchor at each wire
- Distributed towers at each wire
- Single tower
- BRZ
- Predation Areas



JBS Outfall Pier to Powerhouse Array

- Pros
  - Good coverage of powerhouse tailrace and partial coverage of spillway tailrace
  - No new structural support needed in water
  - No large single towers needed and distributed towers limited to small portion of outfall pier
- Cons
  - No coverage at JFOF and limited coverage at north tailrace
  - Distributed towers needed at outfall pier attachment points
  - Max wire span about 2,500 ft



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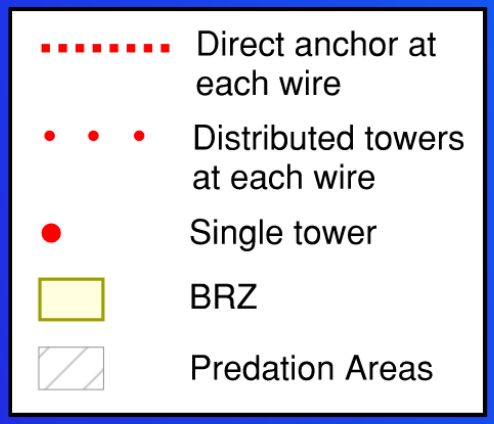
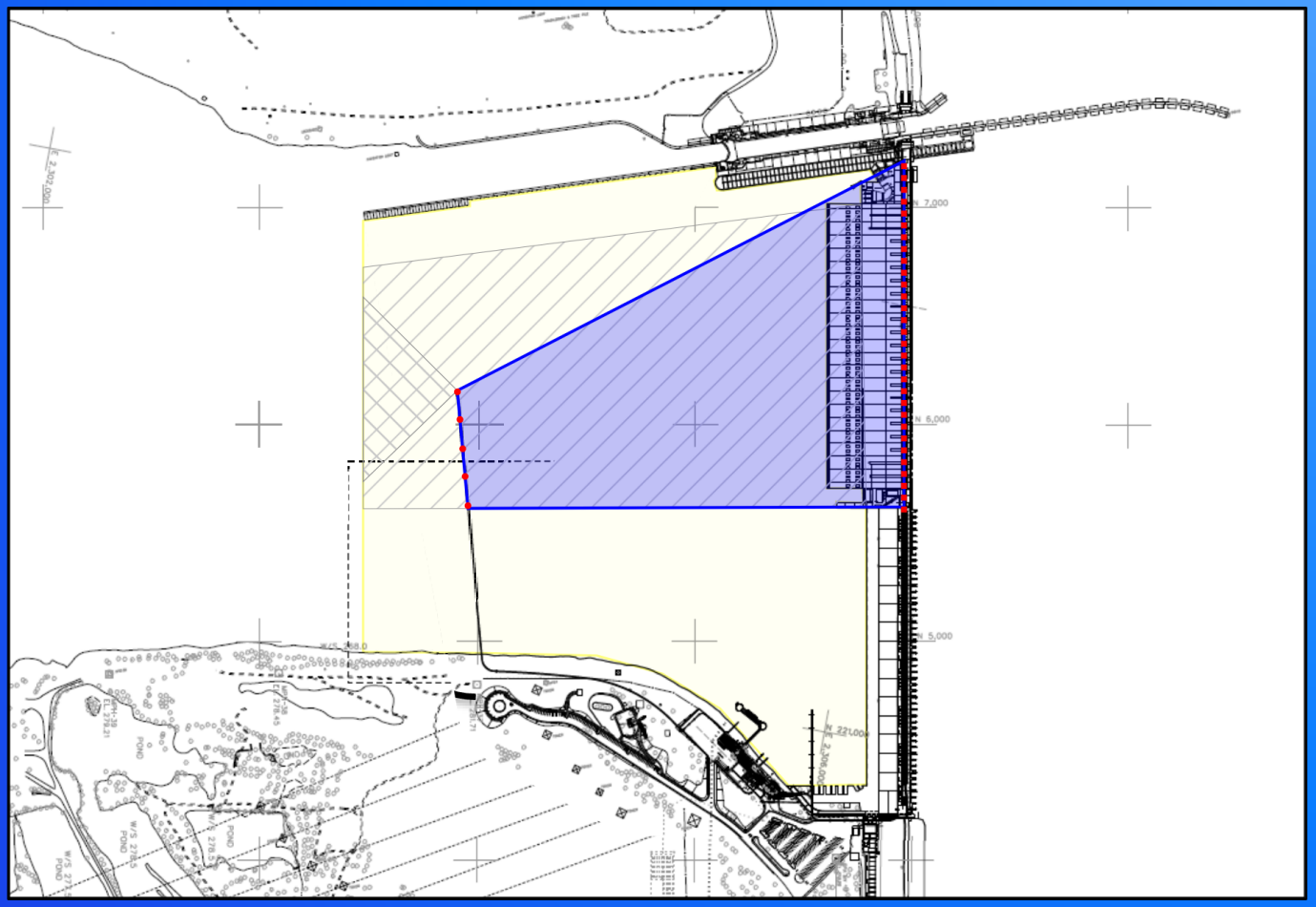
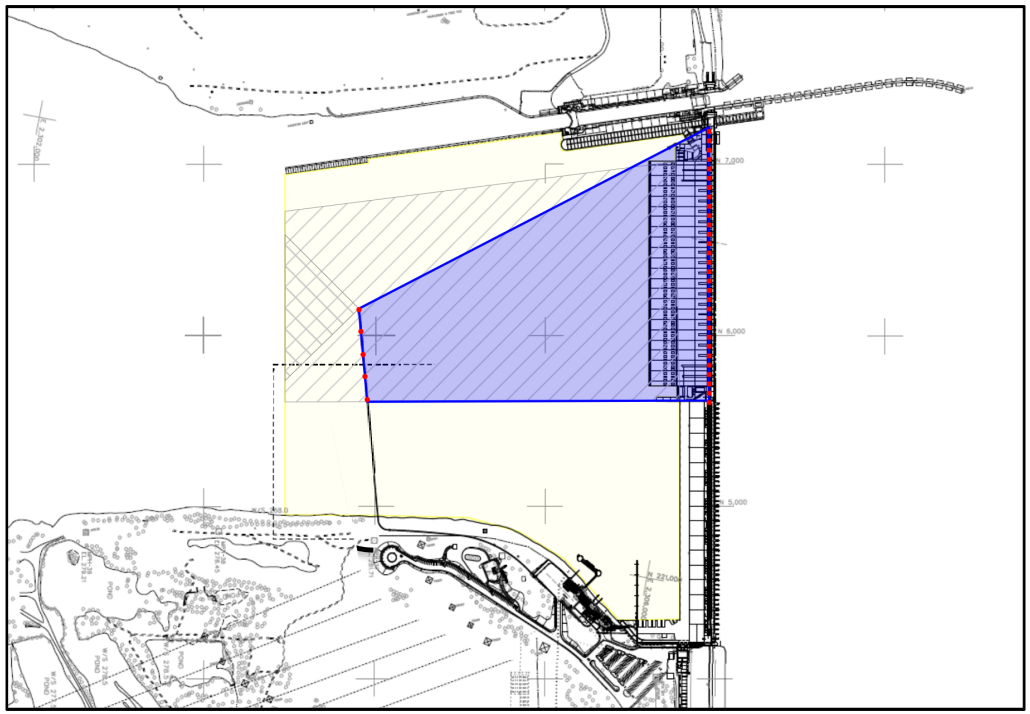
JBS Outfall Pier to Spillway Array





JBS Outfall Pier to Spillway Array

- Pros
  - Good coverage of spillway tailrace
  - No new structural support needed in water
- Cons
  - No coverage at JFOF
  - Distributed towers needed at outfall pier attachment points
  - Max wire span about 2,400 ft



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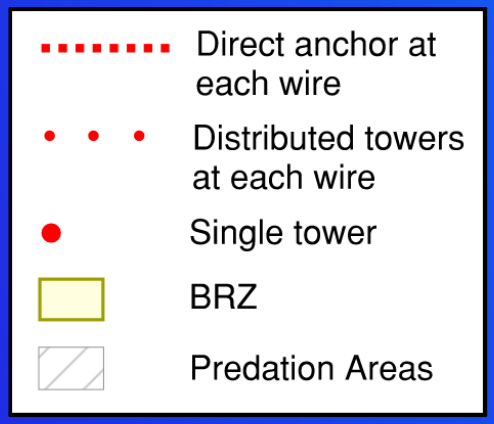
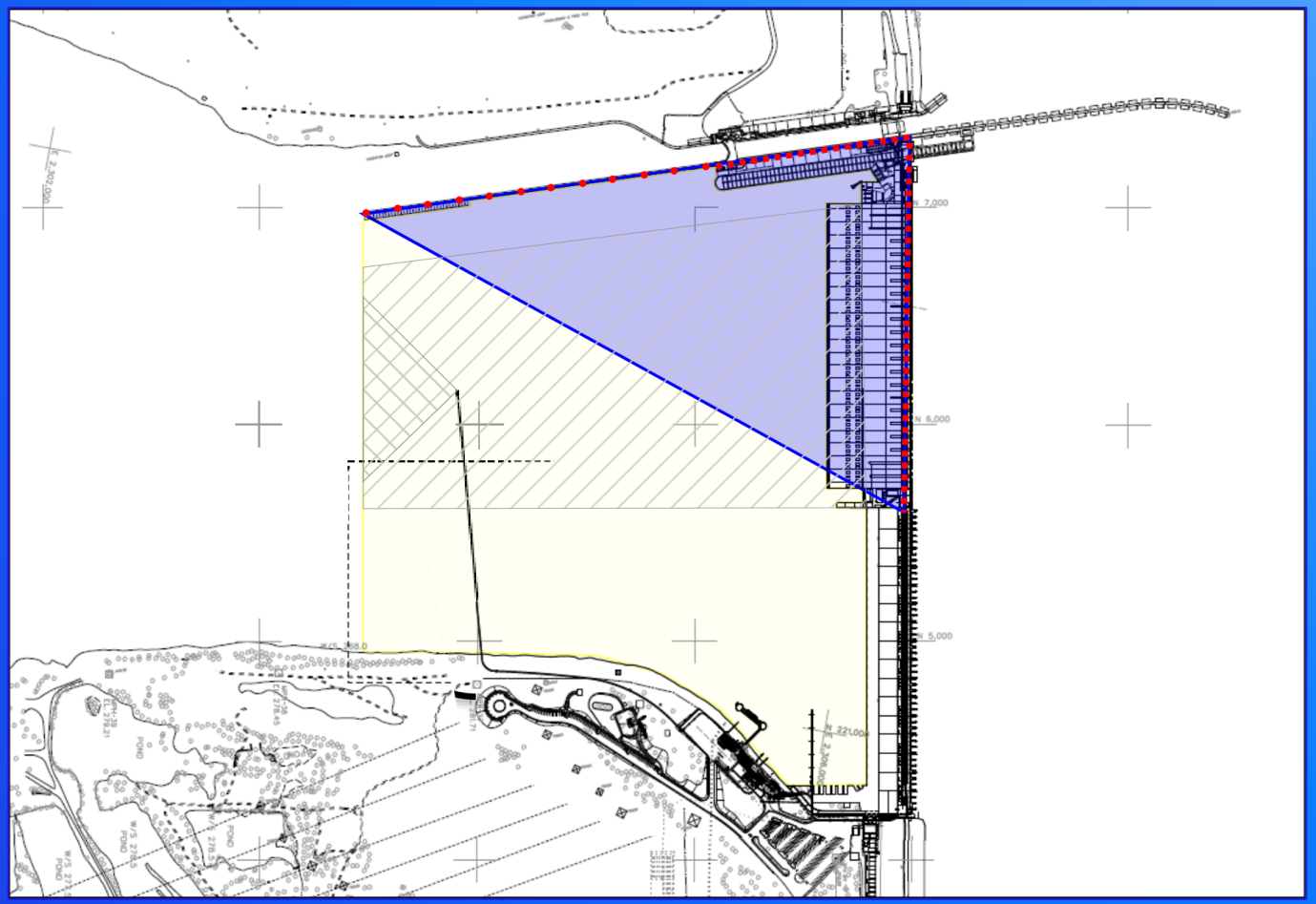
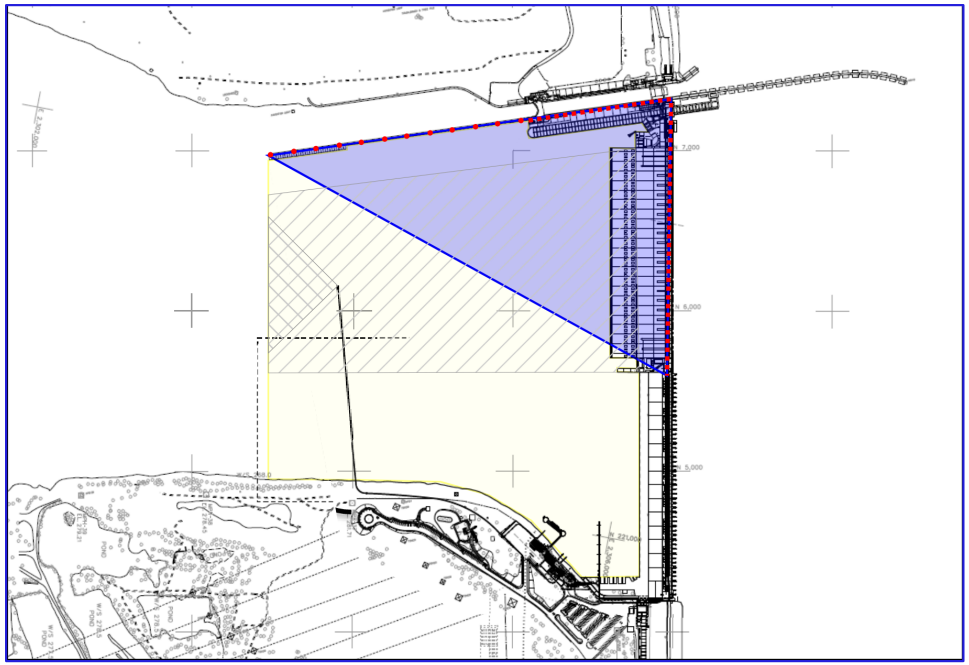
Navigation Lock Guidewall to Spillway





Navigation Lock Guidewall to Spillway Array

- Pros
  - Partial coverage of spillway tailrace
  - No new structural support needed in water
- Cons
  - No coverage at JFOF
  - Distributed towers needed at navigation guide wall attachment points
  - Max wire span about 2,900 ft



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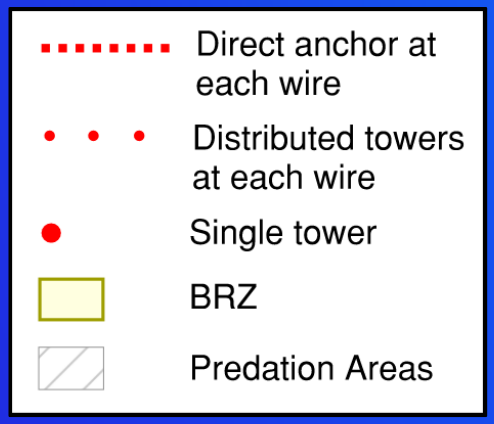
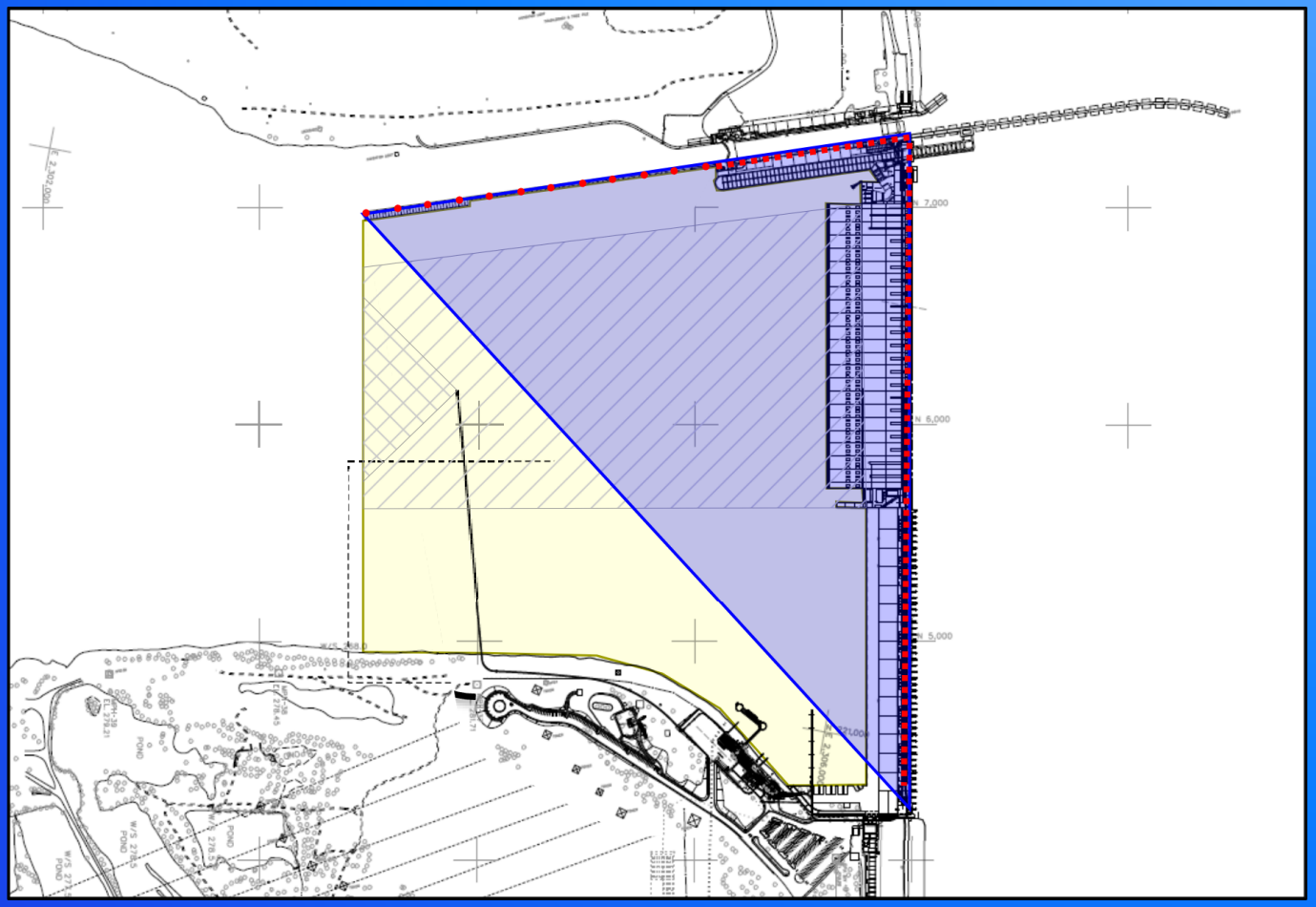
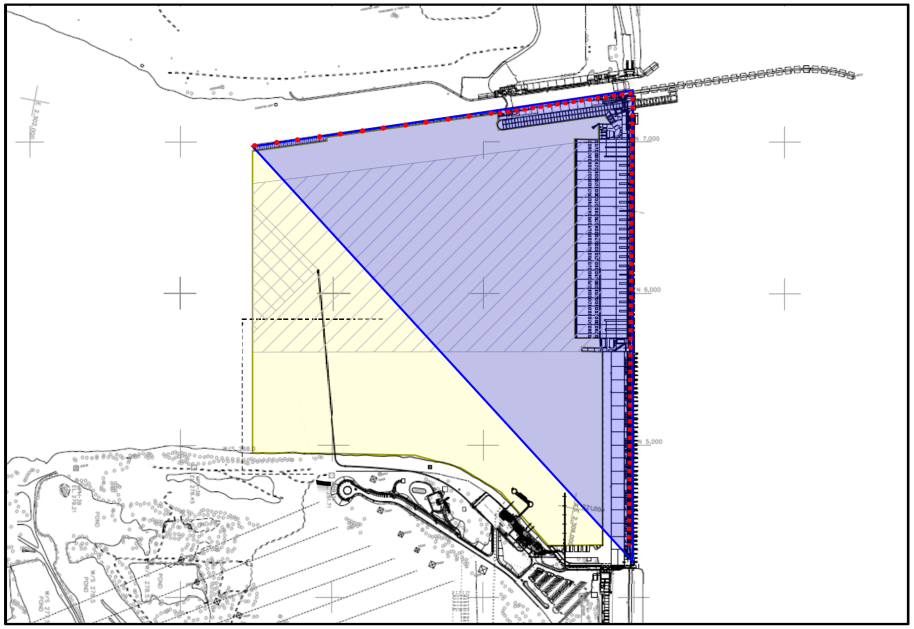
Navigation Lock Guidewall to Spillway and Powerhouse Array





Navigation Lock Guidewall to Spillway and Powerhouse Array

- Pros
  - Partial coverage of powerhouse tailrace and good coverage of spillway tailrace
  - No new structural support needed in water
- Cons
  - No coverage at JFOF or downstream tailrace.
  - Distributed towers needed at navigation guide wall attachment points
  - Max wire span about 3,800 ft



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Alternative In-water Deterrent System

- Aerial arrays are ineffective against pelicans (surface foraging) and cormorants (diving birds)
- Alternative Deterrents
  - Use cables with floats arranged parallel to the riverbank, utilizing the river's current
  - Cables rise and fall with water levels, extending over the boat restrictive zone (BRZ)
  - Rudders attached to cables create undulating motion, deterring birds and preventing debris accumulation
  - Floating balls made from durable, weather-resistant materials cover large areas, reducing predation risk

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Example of Floating In-water Array

- **Debris-Free Design**
  - The floating balls will be arranged in parallel lines with the riverbank, without perpendicular attachments
- **Durable Materials**
  - The floating balls used will be made from durable, weather-resistant materials
- **Self-Cleaning Motion**
  - The use of the river's current to spread the floating balls downstream creates a natural, self-cleaning motion

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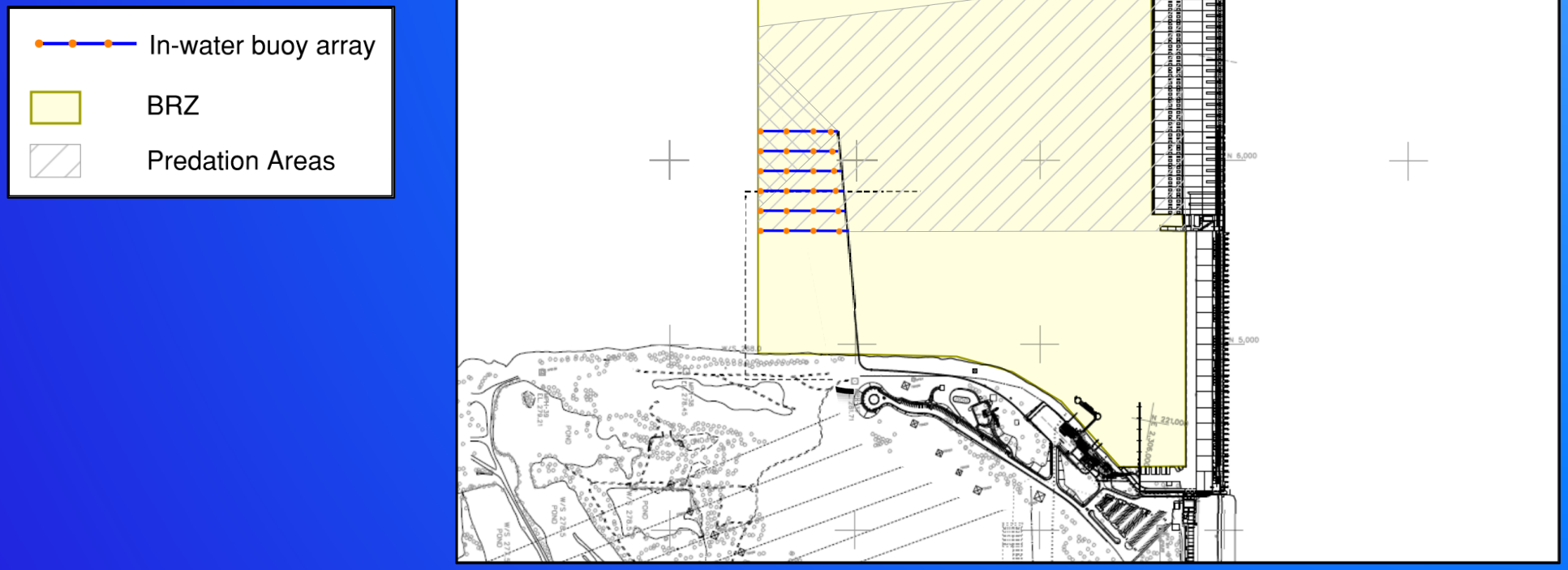
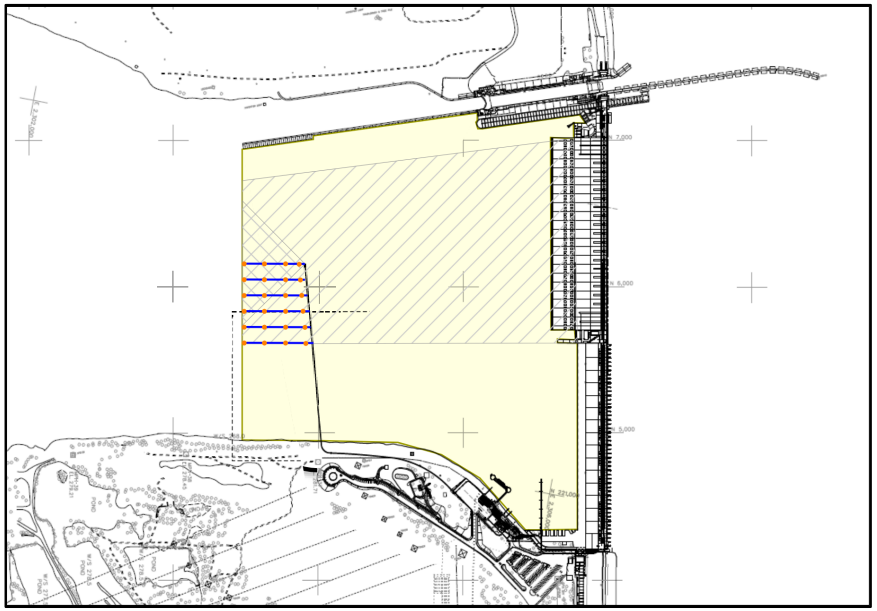
In-Water Floating Array



In-Water Floating Array

- Pros
  - Partial coverage of JFOF
    - No new structural support needed in water
    - No aerial wires and towers
    - Could be a cost-effective proof of concept
- Cons
  - No coverage at tailrace
  - Waterborne debris may impact floating array



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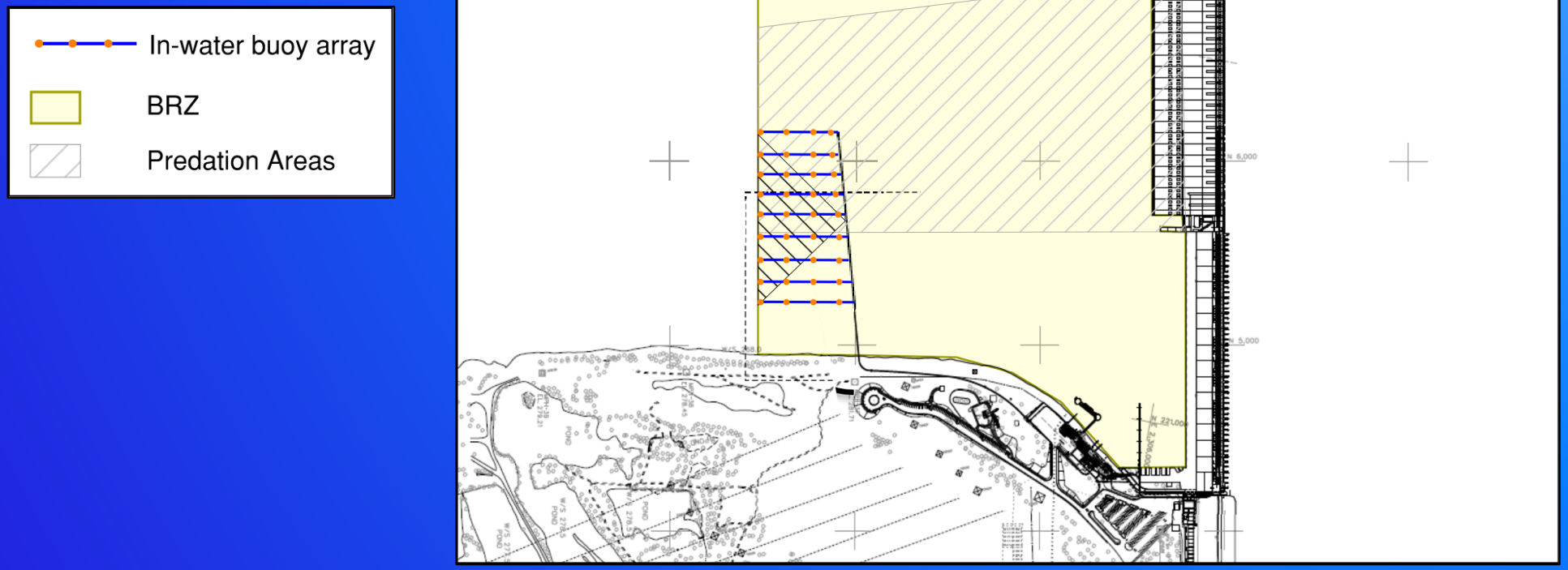
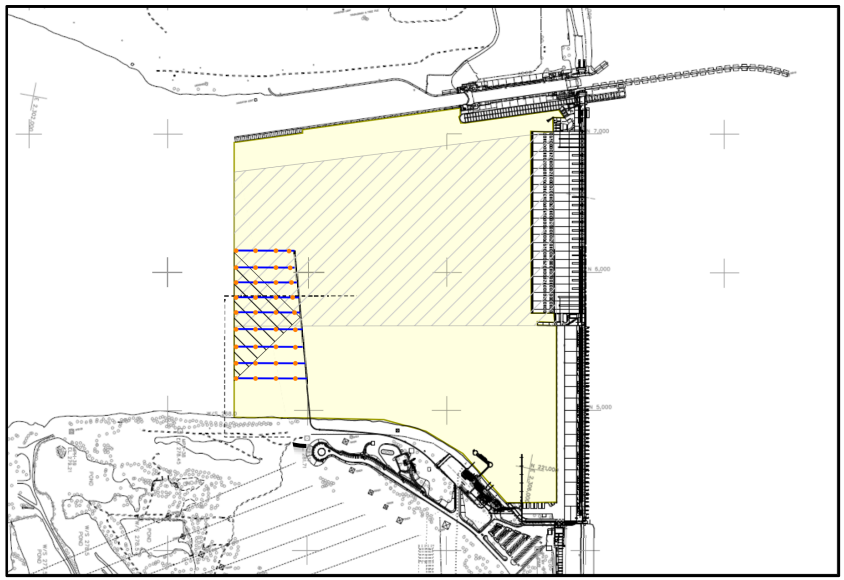
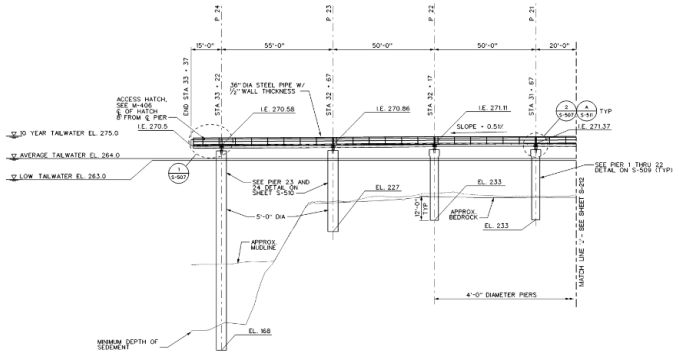
In-Water Floating Array with Modified Outfall Location

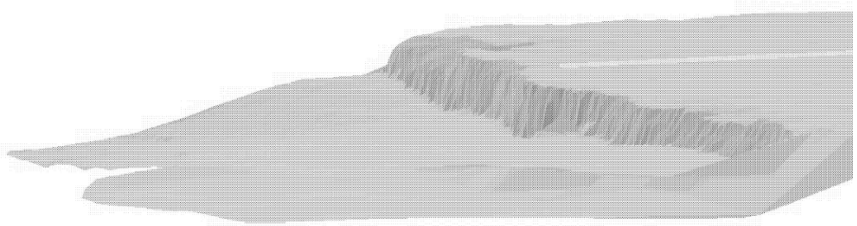


In-Water Floating Array with Modified Outfall Location

- Pros
  - Good coverage of JFOF
  - No new structural support needed in water
  - No wires and towers
- Cons
  - No coverage at tailrace
  - Waterborne debris may impact floating array
  - Modification of outfall location







A 3D RENDERING OF BEDROCK

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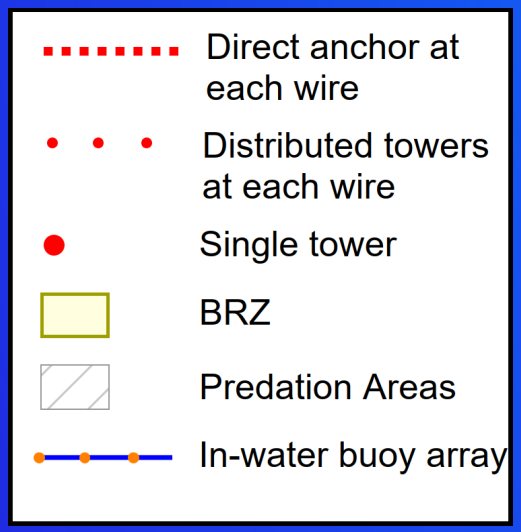
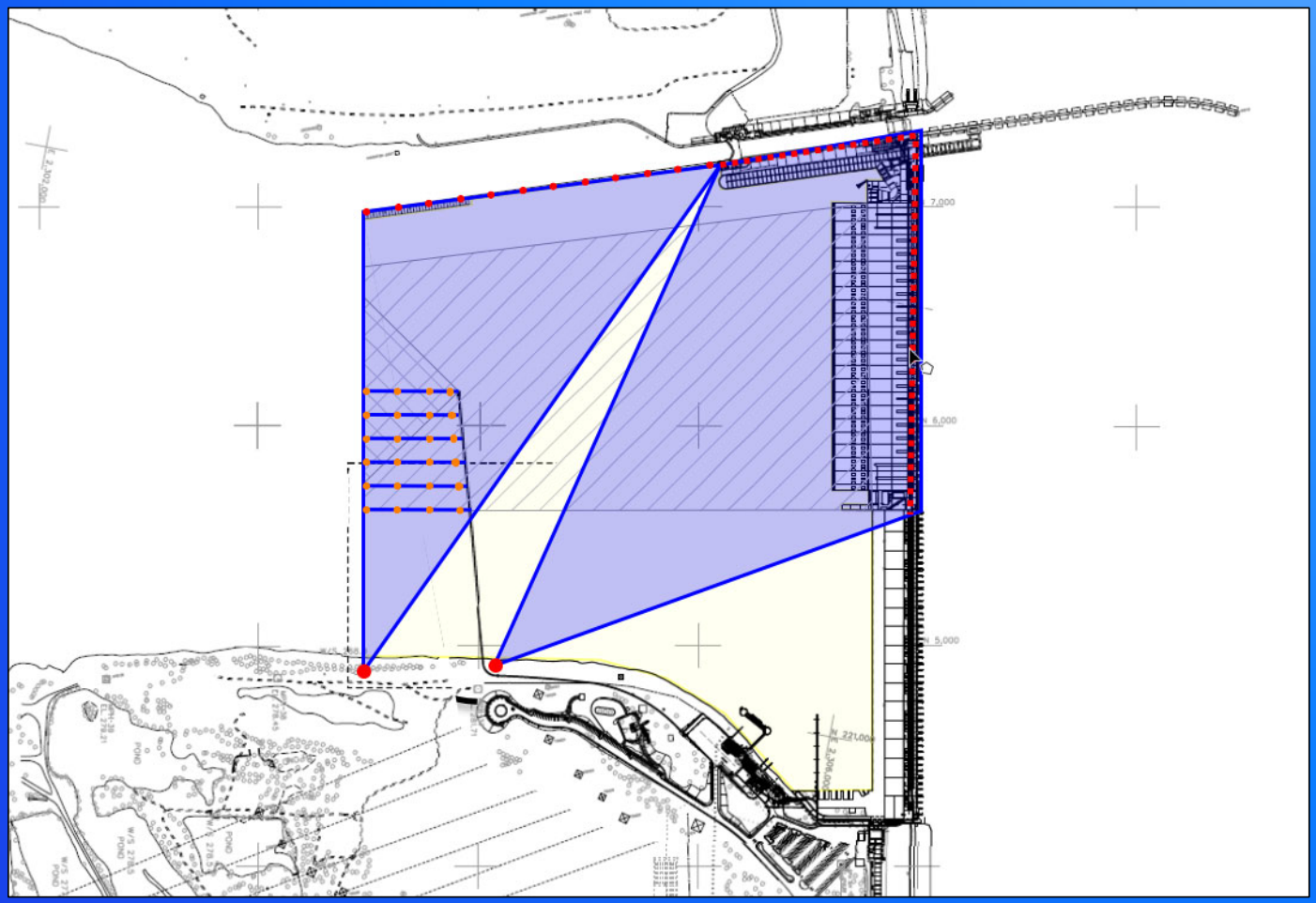
Alternate One: Wire Arrays "Oregon Shoreline to Guidewall" and "Oregon Shoreline to NavLock to Spillway Decks" and In-water Array

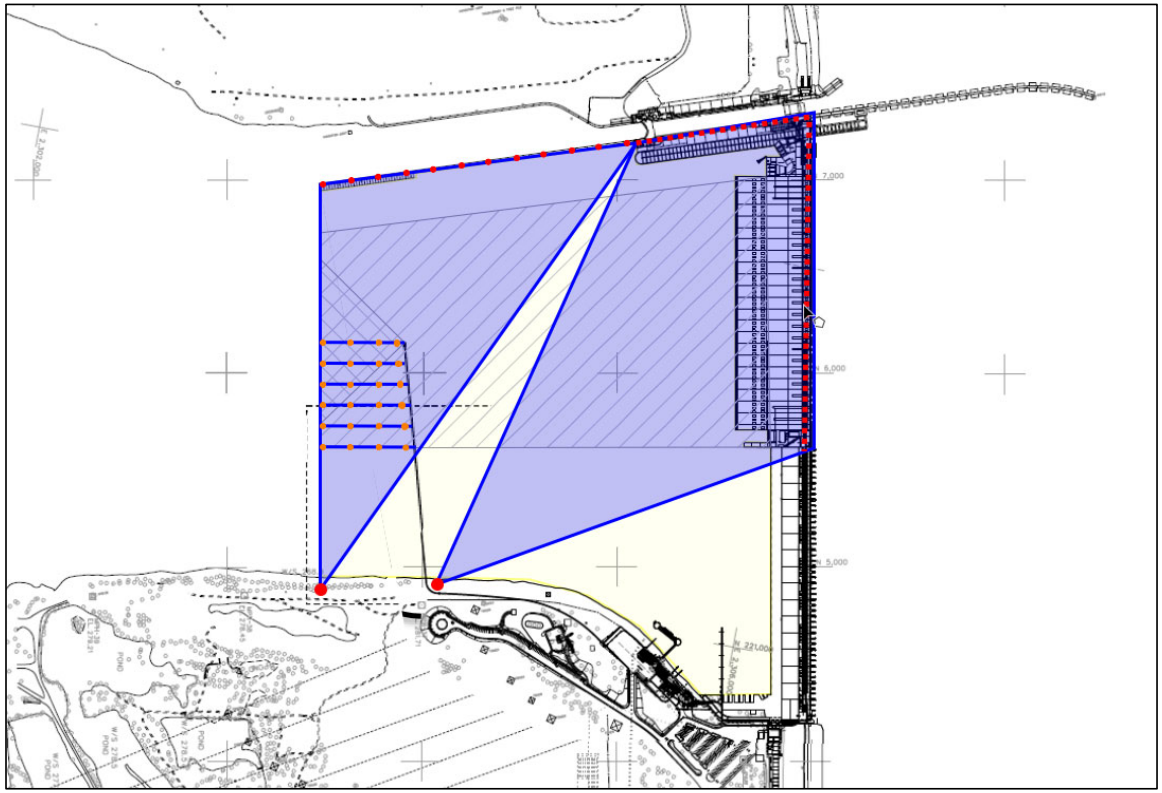




Added after CDW

Alternate One: Wire Arrays "Oregon Shoreline to Guidewall" and "Oregon Shoreline to NavLock to Spillway Decks" and In-water Array

- Pros
  - Excellent coverage of full Predation Priority Area
  - Structural towers on shore
  - Provides protection against gulls, pelicans and cormorants
- Cons
  - More expensive alternative
  - In-water array untested
  - Routine maintenance due to waterborne debris



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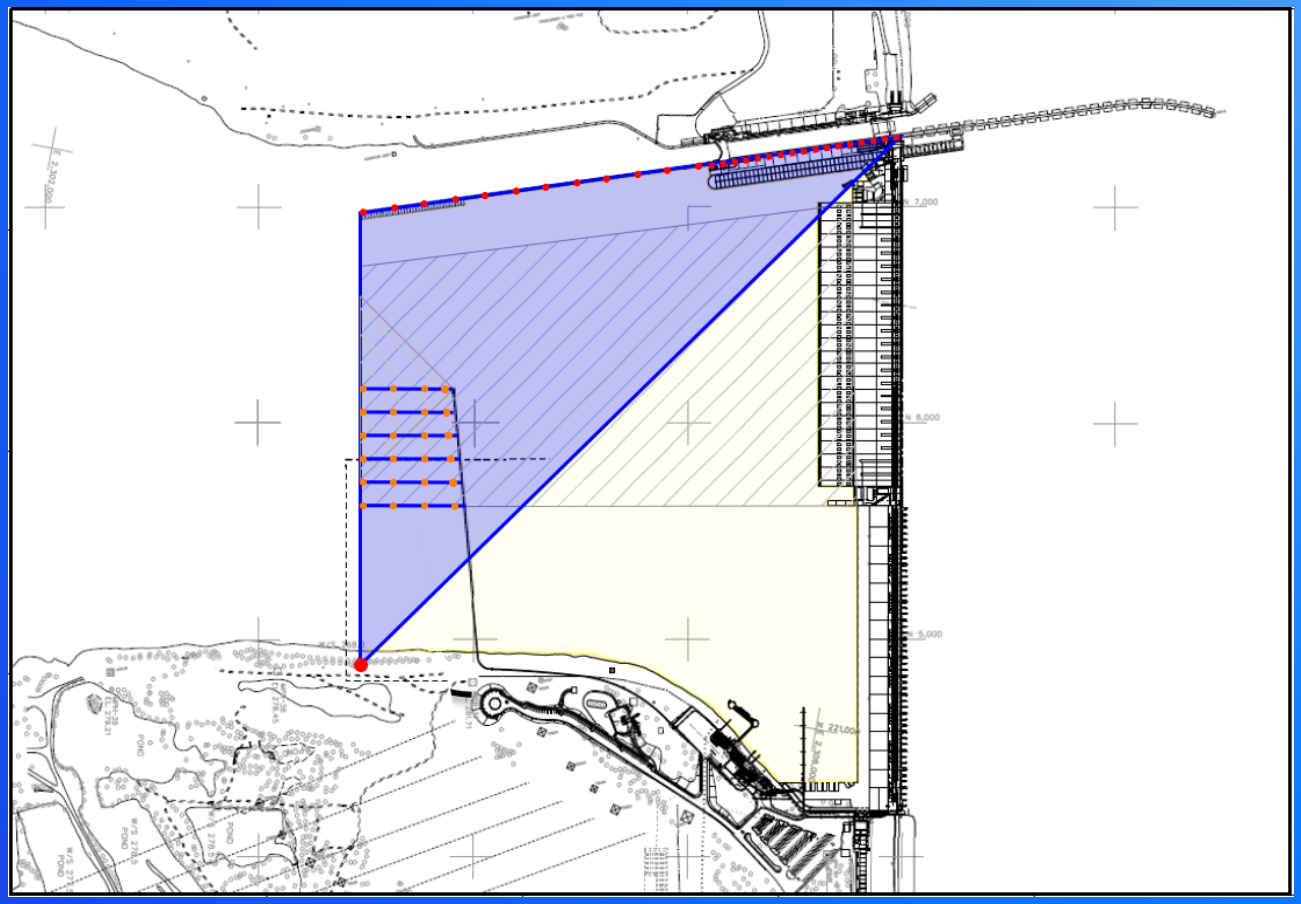
Alternate Two: Wire Array "Oregon Shoreline to Guidewall Expanded to NavLock Deck" and In-water Array

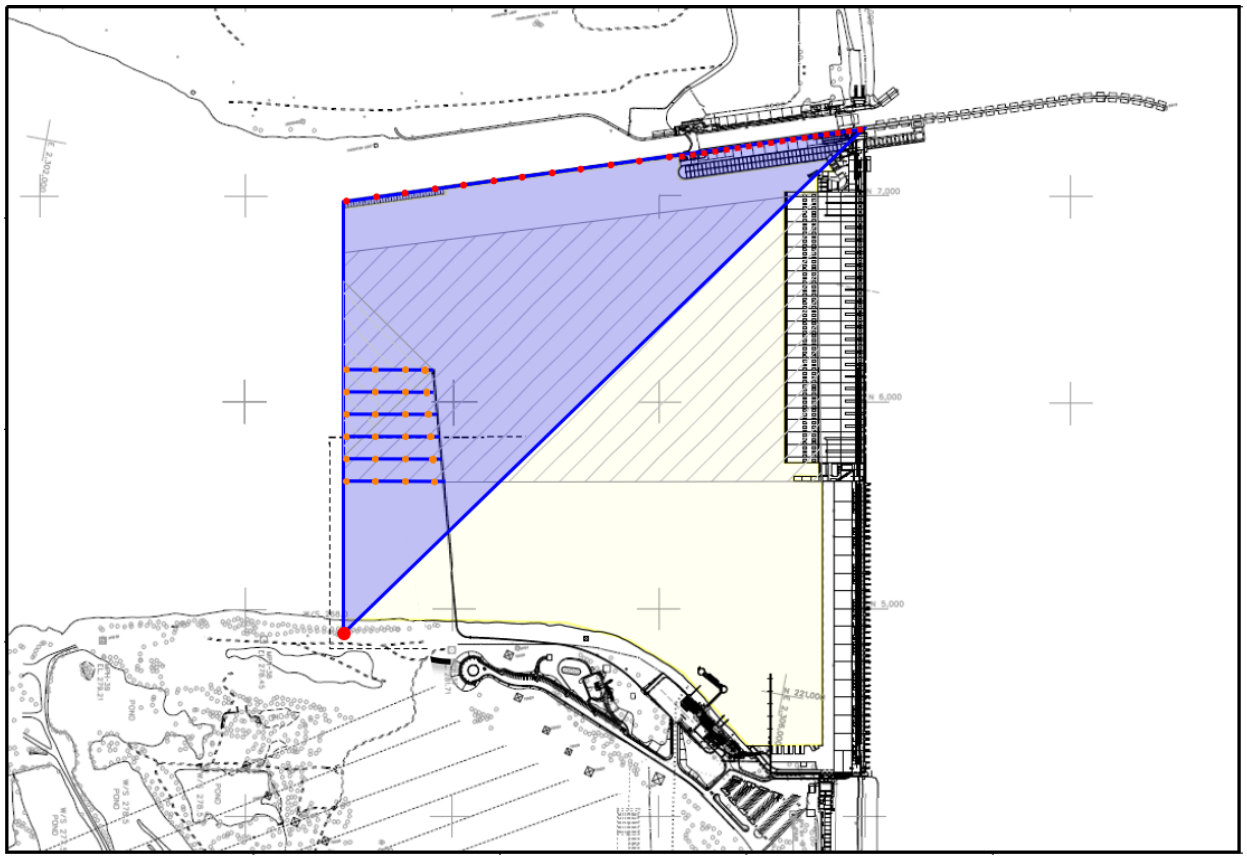
- Direct anchor at each wire
- Distributed towers at each wire
- Single tower
- BRZ
- Predation Areas
- In-water buoy array



Added after CDW

Alternate Two: Wire Array "Oregon Shoreline to Guidewall Expanded to NavLock Deck" and In-water Array

- Pros
  - Sizable coverage of full Predation Priority Area
  - Structural tower on shore
  - Provides protection against gulls, pelicans and cormorants
- Cons
  - Wire array does not cover approx 1/3 of Predation Priority Area
  - In-water array untested
  - Routine maintenance due to waterborne debris



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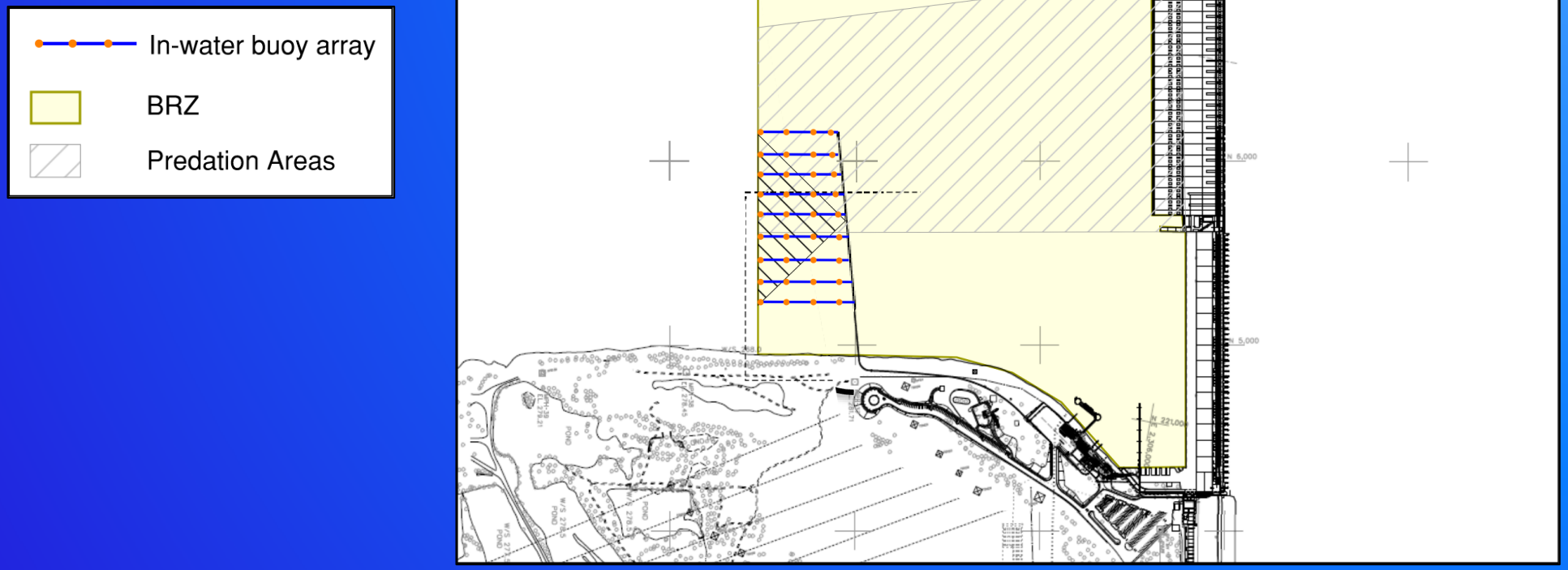
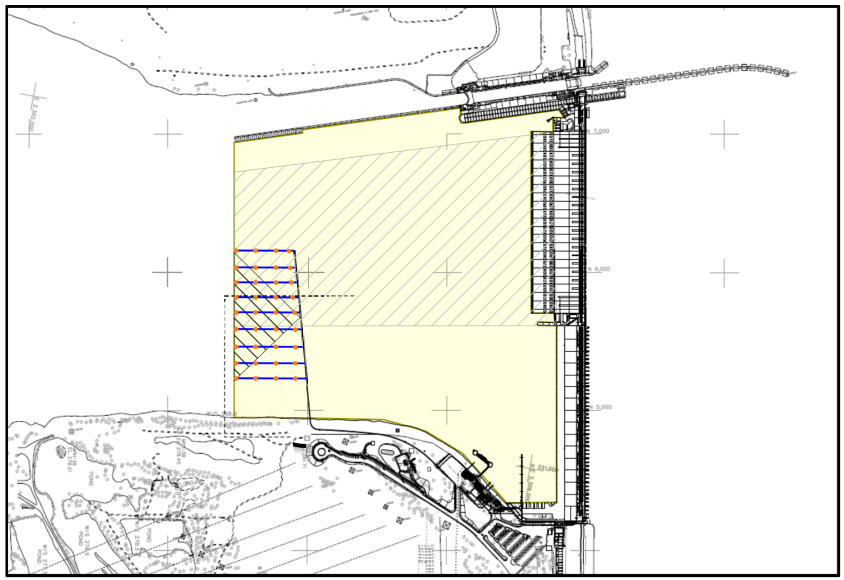
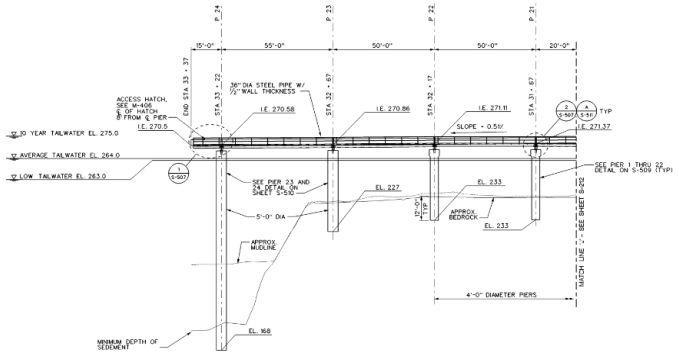
In-Water Floating Array with Modified Outfall Location

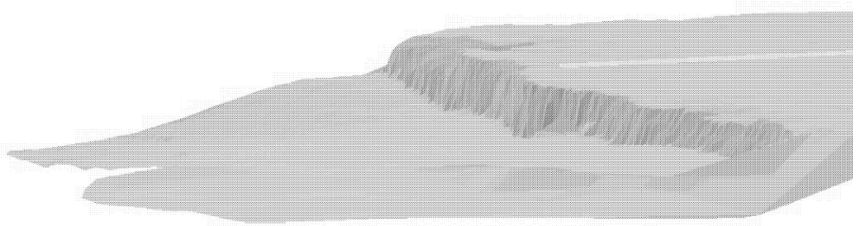


In-Water Floating Array with Modified Outfall Location

- Pros
  - Good coverage of JFOF
  - No new structural support needed in water
  - No wires and towers
- Cons
  - No coverage at tailrace
  - Waterborne debris may impact floating array
  - Modification of outfall location







A 3D RENDERING OF BEDROCK

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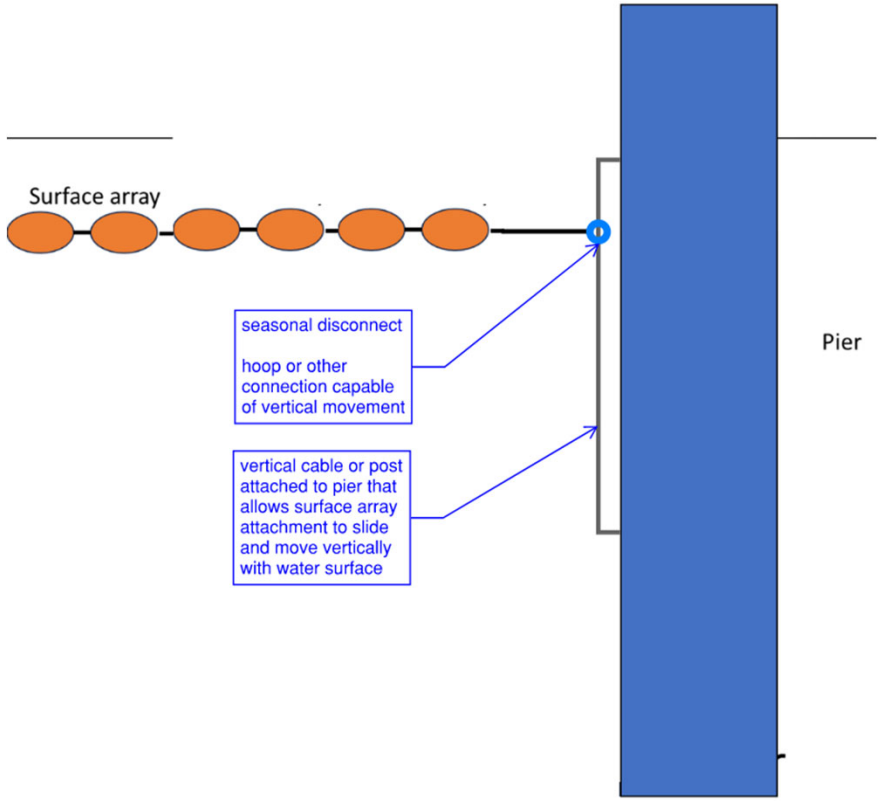
Cables with Floats – Advantages

- Deters diving birds like cormorants and pelicans
- Simple Tethering System
  - Cables tethered to a vertical bar attached to permanent structures like the outfall piers or dam, which are stable, require minimal adjustments, and adapts to changing water levels
  - Less prone to wear and tear, minimizing the need for ongoing maintenance
- Potential to be removed seasonally



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Cables with Floats – Disadvantages

- Installation Complexity
  - Installing cables with floats and rudders may be technically challenging, requiring specialized equipment and skilled labor
- Maintenance Requirements
  - Wear and tear of cables, floats, and attachment points requiring regular inspections and maintenance
  - Ensuring the rudders remain functional and effective in creating undulating motion
- Added Structural Load to Outfall Piers
- Environmental Impact
  - Installation and presence of cables may disrupt local aquatic habitats and affect other wildlife
  - Cables could potentially alter water flow patterns, affecting sediment transport and aquatic vegetation

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Other Potential Disadvantages

- Debris Accumulation
  - Potential for Clogging - risk that floating balls could become clogged with debris, requiring regular cleaning
  - Environmental Debris - natural events like storms could increase debris load, challenging the effectiveness of the array
- Effectiveness Variability
  - Species Adaptation - birds may eventually adapt to the deterrents, reducing their effectiveness over time
  - Behavioral Changes - some bird species might find ways to navigate around or through the deterrents, diminishing their effect
- Aesthetic and Recreational Impact
  - Visual Impact - floating balls or cables may be considered unsightly, affecting the aesthetic value of the river
  - Recreational Use – potentially impacts recreational activities such as boating, fishing, or swimming

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Other Alternatives

- **The Guardian Soundscape Technology**
  - Claims to be proven effective on nearly all species of songbirds, gulls, wading birds, waterfowl, raptors, and birds of prey. As well as on mammals like deer, raccoon, possum and others
  - System can be mounted on poles, rafters, trailers, or walls
  - Speaker array options- 360°, 140°, Directional
  - Power input 120VAC only; or 120VAC / 12VDC selectable
  - Single 360° array covers approximately 8-20+ acres depending on topography of site
  - Constant undulating sound that the manufacturer claims disrupts wildlife's ability to communicate
  - Wildlife does not habituate to the sounds

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Potential Drawbacks to "Soundscape"

- Relies on constant sound
  - Constant disruptive sound may be unsettling or annoying to the dam workers and the public. Some potential risks of human exposure include:
    - Cognitive impairment due to exposure to low frequency sound
    - Physiological, neurological, and biochemical changes
    - Elevated blood pressure, loss of sleep, increased heart rate, cardiovascular constriction, labored breathing, and changes in brain chemistry
    - Increased risk of mental health problems
  - Excessive volume may need to be used at the dam, or it may not be effective near the spillways when they are in operation
  - If it is effective, it would likely drive away all or most wildlife

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Discussion about Selection of Preferred Alternatives

- APDA objectives
  - Biological effectiveness
  - Device reliability
  - Ease of routine maintenance
  - Does not adversely impact dam operations
- Design Considerations which includes constraints and criteria (biological and operational criteria from Feasibility Report)
- Review and consider FFDRWG comments from Feasibility Report
- Jump to Ranking Matrix using
  - Biological effectiveness (predation priorities coverage)
  - Ease of installation and routine maintenance
  - Devise reliability
  - FFDRWG input
  - Cost
  - Other important factor(s)?

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Next Steps

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Backup Slides

McNary Dam Observation Zones with seasonal mean daily bird counts (circa 2013)

- FB1 – Forebay

Common Name	FB1
American White Pelican	0.3
Bald Eagle	0.0
Caspian Tern	0.1
Common Merganser	0.0
Double-crested Cormorant	0.1
Great Blue Heron	0.0
Grebe spp.	**6.2**
Gull spp.	**1.6**
Osprey	0.1

- SWT1 – Spillway Tailrace

Common Name	SWT1
American White Pelican	**3.7**
Bald Eagle	0.0
Caspian Tern	**6.6**
Common Merganser	0.2
Double-crested Cormorant	**1.1**
Great Blue Heron	<0.0
Grebe spp.	0.0
Gull spp.	**17.7**
Osprey	0.0

- PHT1 – Powerhouse Tailrace

Common Name	PHT1
American White Pelican	0.1
Bald Eagle	0.0
Caspian Tern	0.1
Common Merganser	0.0
Double-crested Cormorant	<0.1
Great Blue Heron	0.0
Grebe spp.	0.0
Gull spp.	0.1
Osprey	<0.1

- JFOF – Juvenile Fish Bypass Outfall

Common Name	JFOF
American White Pelican	**1.4**
Bald Eagle	0.0
Caspian Tern	**1.1**
Common Merganser	0.0
Double-crested Cormorant	0.1
Great Blue Heron	0.0
Grebe spp.	0.1
Gull spp.	**4.9**
Osprey	0.0

- BRZ – Boat Restriction Zone

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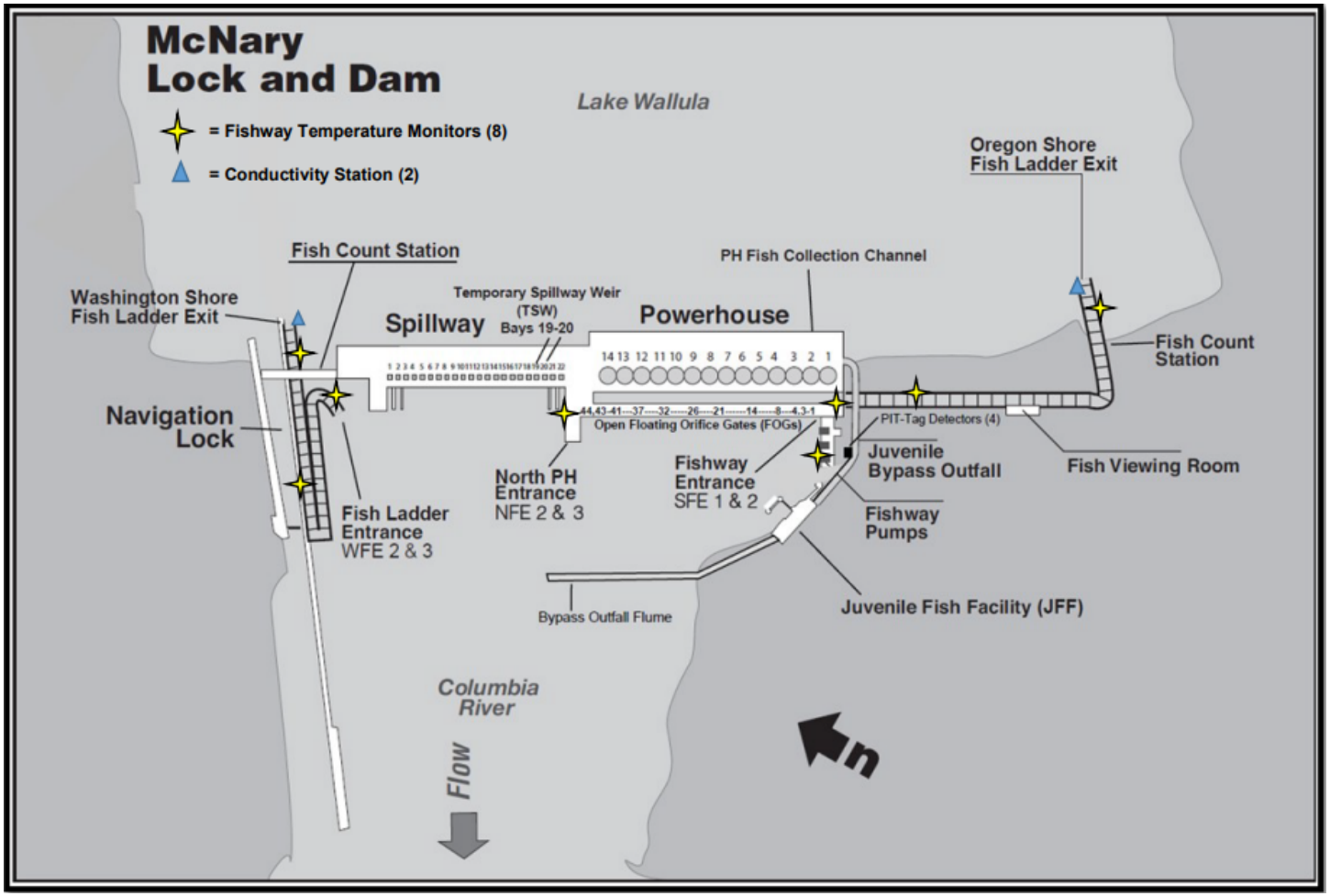

Source: From 2024 Fish Passage Plan

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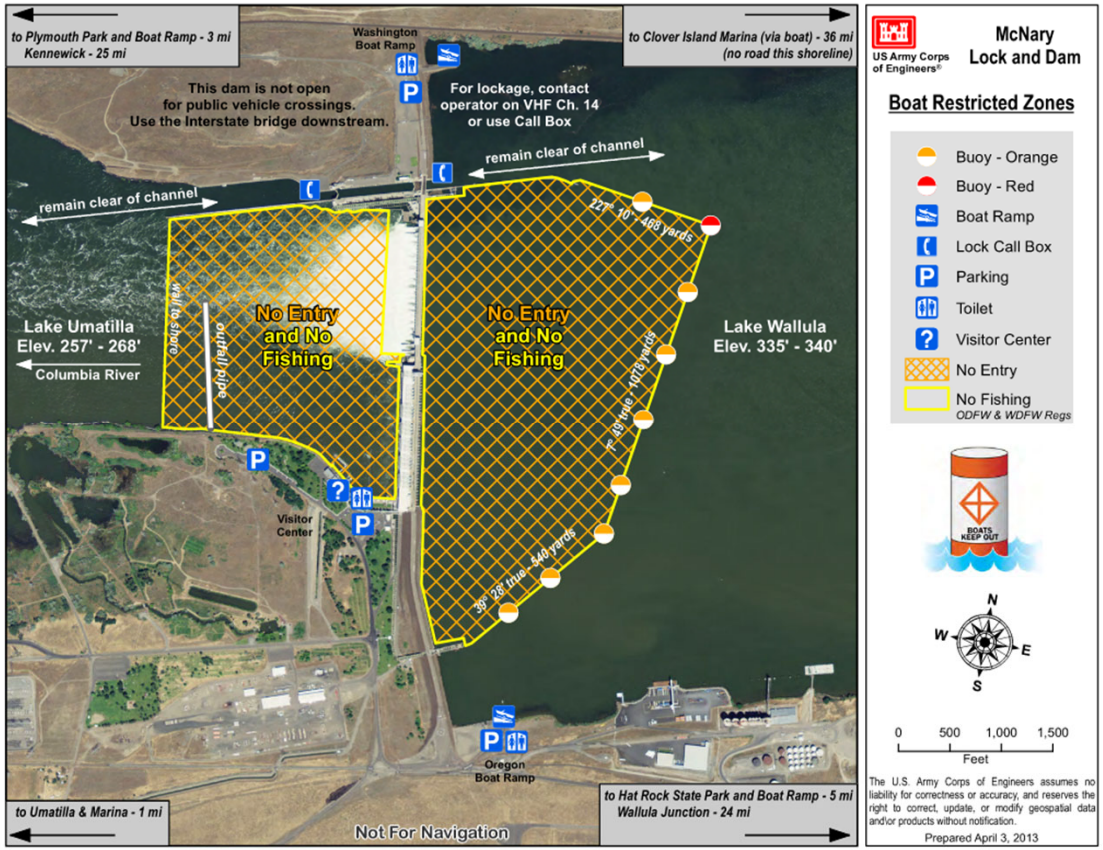
Boat Restricted Zone (BRZ)



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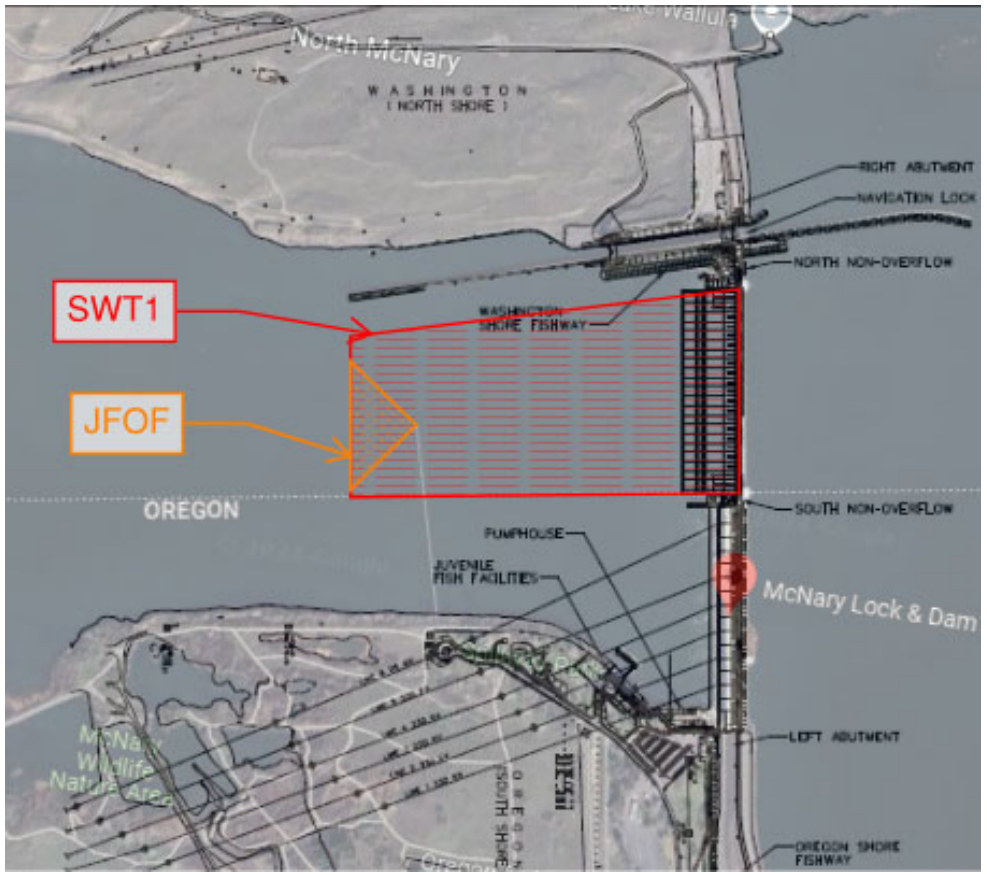
Primary Avian Predation Zones

- Spillway Tailrace (SWT1)
- Juvenile Fish Outfall (JFOF)



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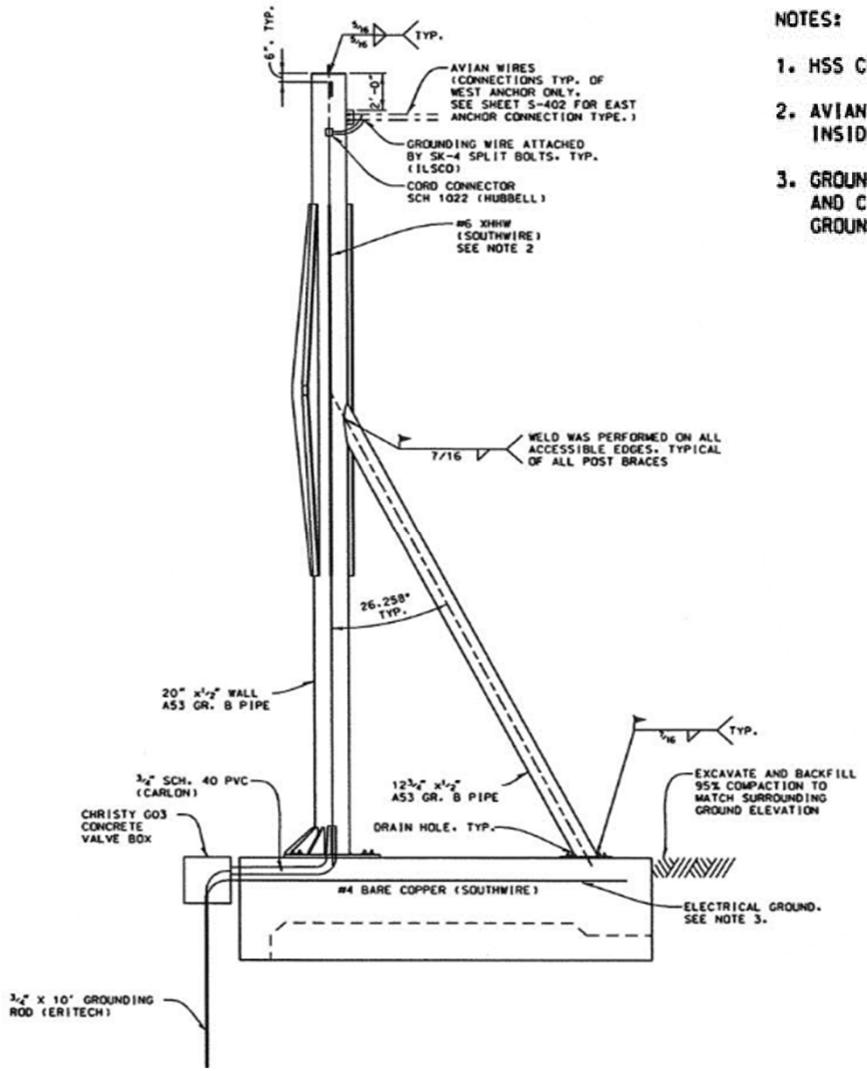
Electrical Grounding

- Grounding is required for safety protection, and prevention of electrical hazards
- The anchor pole for the wire arrays is required to be grounded. See image for a detai from John Day Dam Avian Predation deterrent array drawings (sheet detail B on S-401)



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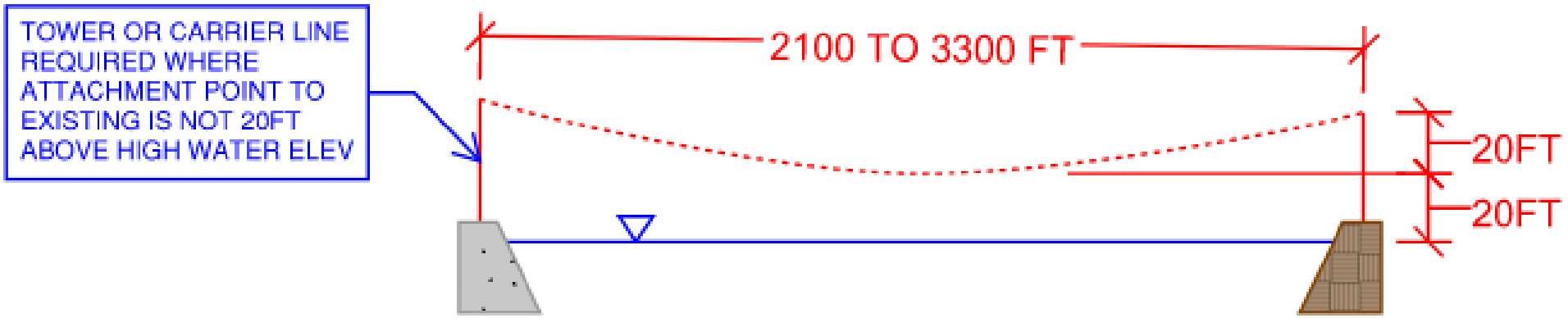
Array Wire Profile

- 20ft minimum cable height above high water elevaton
- 20ft maximum cable sag
- 40ft minimum cable attachment height above high water elevaton



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Appendix F. Refined Alternatives Review Meeting Presentation

Jacobs

Meeting Minutes

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Subject	**McNary Dam Avian Deterrence Concept Design Evaluation – Refined Alternatives Meeting**		
Project	USACE Walla Walla District McNary Avian Deterrence Conceptual Design Evaluation		
Project No.	Contract W912EF-23-D0014 Task Order W912EF24F9202	**Report Date**	20 April 2025
Prepared by	Tiesha Bailey	**Phone No.**	214-920-8041
Location	Held virtually on Microsoft Teams	**Meeting Date**	10 April 2025
Attendees	Attachment A		

The following is our understanding of the subject matter covered in this meeting. If this differs from your understanding, please notify us within five (5) business days.

The Refined Alternatives Review Meeting for the Walla Walla District McNary Avian Deterrence Conceptual Design Evaluation was conducted by Ralph Field, Project Manager for Jacobs.

1 Introductions & Safety Moment

Ralph Field began the meeting with introductions. Those attending the call introduced themselves.

Culture of Caring: Pollen Survival Guide was presented by Ralph Field to begin the meeting. Tips were shared to assist in being aware of pollen counts in our area, as well as protecting yourself and treating allergies related to pollen.

2 Task Order/Project Overview

The McNary Dam Avian Deterrence Concept Design Evaluation project focuses on developing avian predation deterrent arrays to protect smolts navigating downstream at McNary Dam.

- Problem Statement
  - Smolts are vulnerable to avian predators in the forebays of mainstem dams and tailraces.
  - Avian predation is a limiting factor in the recovery of some ESA-listed salmonid populations.
- Project Objectives
  - Ensure biological effectiveness, device reliability, ease of routine maintenance, and no adverse impact on dam operations.
  - Tailrace access by boats and personnel must be maintained.
- Purpose of Refined Alternatives Meeting

- Present system characteristics, components, general layout, schematics, diagrams, rough order of magnitude costs, options, and pros and cons of alternatives
- Seek stakeholder input and concurrence
- Validate alternatives meet constraints

3 Concept Development for Avian Predation Deterrent Array (APDA) Alternative Types

The Jacobs Team recapped the design considerations discussed at the Concept Design Workshop (CDW). Some design considerations and characteristics were emphasized during this meeting to highlight further considerations, such as materials for wire arrays and code changes since the beginning of the project. Notes below are taken from the CDW presentation:

- Primary Wire Arrays

  General
  - According to USDA, newest wire array at John Day is designed with kevlar rope and has distinct disadvantages compared to steel wire: service life of 5 years vs. 20 years
  - Achieving maximum wire sag is important to create a more three-dimensional deterrent for gulls
  - Wire array installers like the USDA team do not measure tension in the wire. Sag and distance to the water are primary installation requirements
  - Criss-crossing different arrays is not more effective and complicates installation
  - Sag closer to the water is most effective but needs to consider mean high water elevation
  - On parallel arrays using large cable for multiple anchor points, achieving uniform sag is a challenge and not recommended
  - Will wire arrays impact falconry abatement?

  Avian Behavior Priorities
  - Three major predatory species are gulls, cormorants, and pelicans
  - Gulls are responsive to wire arrays
  - Cormorants are diving birds and pelicans forage just below the water surface and may respond to in-water arrays only

  Structural
  - The current wire spacing is on the wider side but still within acceptable criteria.
  - There are no posts in the water, satisfying the criteria for wire height and angles.
  - Anchorage is clear of handrails and light poles.

- Tensioners and dampeners are still planned for use.
- Structural criteria related to UFC and ASCE 7-10, notes the ice loading impacts wire diameter.
- Changes in nominal ice thickness across different code cycles (ASCE 7-10: 1/4 inch, 2016 edition: 1 inch, 2022 edition: 3/4 inch).
- Using a steel wire strength allowable of 60% of the ultimate breaking strength, seeking feedback on potential modifications.

Electrical

- Per Unified Facilities Criteria (UFC) 3-575-01, all steel lines need to be grounded to prevent static and/or induced charges from the overhead power transmission lines.
- Grounding is required for safety, protection, and prevention of electrical hazards.
- The anchor pole for the wire arrays is required to be grounded. See image for a detail from John Day Dam Avian Predation deterrent array drawings (sheet detail B on S-401).

References

- Applicable USACE publications per the SOW
- Governing criteria and codes per Unified Federal Criteria
- McNary Avian Predation Deterrent Array Feasibility Report with FFDRWG comments_Final_26Oct2022
- Other documents shared with Jacobs, post award

Constraints

- Navigation channel cannot be blocked
- APDAs cannot be placed west of the BRZ
- Limited construction window
- USDA APHIS Team uses reel truck to spool wire.
    - Care should be taken to consider location of tower (not on outfall pier or lock guidewall).

4 Cost Options Summary

- Cost summaries and key assumptions were shared for each option.
    a. See the presentation slides for more detailed information.

5 Stakeholder Input and Concurrence

- Stakeholders were invited to provide input and validate that the alternatives meet constraints.
- Feedback on wire arrays and in-water arrays was solicited.

6 Action Items

- Coordinate with engineering staff at McNary Dam for feedback on connection points.
- Send the presentation to stakeholders for further review.
- Follow up on specific questions and feedback within the next two weeks.

7 Attachments

- Attachment A: Attendee List
- Attachment B: Refined Alternatives Meeting – Presentation Slides

END OF MEETING MINUTES

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McNary Dam Avian Deterrence Concept Refined Alternatives Sign-In Sheet

Date / Time: April 9, 2025

Project name: McNary Dam Avian Deterrence Concept

Project no: Contract W912EF-23-D0014
Task Order W912EF24F9202

Prepared by: Tiesha Bailey

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Name	Company	Position
1. Ralph Field	Jacobs	Project Manager
2. Pete Helmlinger	Jacobs	Program Manager
3. Kashifa Kabeer	Jacobs	Electrical
4. Karen Zelch	Walla Walla	Project Manager
5. Melissa Marion-Landais	Legis	Cost Estimator
6. Paul Bertschinger	McNary	Fish Biologist
7. Phong Pham	Walla Walla	Electrical
8. Gary Santolo	Jacobs	Scientist
9. James Teeter	Jacobs	Mechanical
10. Garrett Van Ruiten	Jacobs	Structural
11. Juan Rojas	Legis	Cost Estimator
12. Tiesha Bailey	Jacobs	Project Coordinator
13. Mark Jones	Walla Walla	COR and AE Coordinator
14. Ryan Ashcraft	Walla Walla	Fish Biologist
15. Ashley Barnes	Walla Walla	Study Specialist
16. Tiffany Dixon	Walla Walla	Fish Biologist
17. Greg McBride	Walla Walla	Project Manager
18. Brandon McNeil	Walla Walla	Mechanical
19. Jared Houchins	Walla Walla	Structural

McNary Dam Avian Deterrence Concept Design Evaluation

Refined Alternatives Meeting

10 April 2025

Challenging today.
Reinventing tomorrow.

Agenda

Culture of Caring Moment

Introductions

- Walla Walla District
- McNary Dam Team
- Jacobs Team

Task Order/Project Overview

- Problem Statement
- Project Objectives
- Purpose of Refined Alternates Meeting

Concept Development for Avian Predation Deterrent Array (APDA) Alternative Types

- Primary wire arrays
- In-water arrays

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Culture of Caring Moment – Pollen Survival Guide

- Can you really avoid pollen?
- Know your pollen count and check https://www.aaaai.org/Tools-for-the-Public/Check-Pollen-Counts
- Stay indoors when pollen counts are high
- Plan outdoor time wisely
- Protect yourself when you go outside
- Keep pollen from following you
- Treat your pollen allergies
- Take an allergy vacation

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Problem Statement and APDA Objectives

- Problem Statement
  - Smolts navigating downstream are more vulnerable to avian predators when concentrated in the forebays of mainstem dams and in tailraces if they become injured or temporarily disoriented following passage
  - 13 species of fish listed as threatened or endangered IAW ESA
  - Avian Predation identified as limiting factor in recovery of some ESA-listed salmonid populations in the CRB
- APDA objectives
  - Biological effectiveness
  - Device reliability
  - Ease of routine maintenance
  - Does not adversely impact dam operations
    - Tailrace access by boats and personnel
    - O&M of dam features
  - Identify ROM costs for cost/benefit analysis

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Refined Alternatives Review Meeting Purpose

- Present system characteristics, components, general layout, schematics, diagrams, rough order of magnitude costs, options, and pros and cons of alternatives
- Seek stakeholder input and concurrence
- Validate alternatives meet constraints

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Wire Array Design Considerations

- General
  - According to USDA, newest wire array at John Day is designed with kevlar rope and has distinct disadvantages compared to steel wire: service life of 5 years vs. 20 years ☑
  - Achieving maximum wire sag is important to create a more three-dimensional deterrent for gulls ☑
  - Wire array installers like the USDA team do not measure tension in the wire. Sag and distance to the water are primary installation requirements ☑
  - Criss-crossing different arrays is not more effective and complicates installation ☑
  - Sag closer to the water is most effective but needs to consider mean high water elevation ☑
  - **Thin steel gage wire is the most effective for ease of installation, longevity, rigidity, operation (no need to adjust tension)** ☐
  - **Thin wires are preferable to minimize avian perching** ☐
  - **Wire closer to spillways needs to be heavier gage to support potential ice build-up during winter** ☐
  - On parallel arrays using large cable for multiple anchor points, achieving uniform sag is a challenge and not recommended ☑
  - Will wire arrays impact falconry abatement? ☑

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Array Design Considerations (cont.)

- Avian Behavior Priorities ☑
  - Three major predatory species are gulls, cormorants, and pelicans
  - Gulls are responsive to wire arrays
  - Cormorants are diving birds and pelicans forage just below the water surface and may respond to in-water arrays only
  - See predation priorities slide

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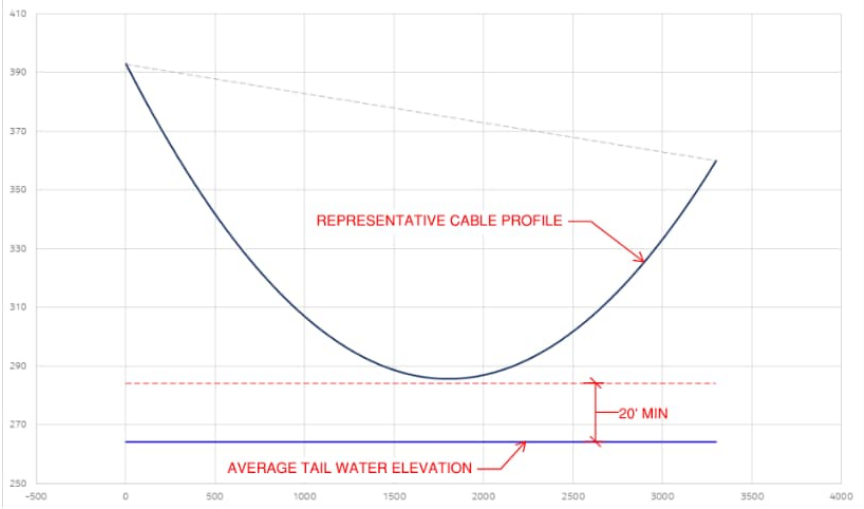
Array Design Considerations (cont.)

- Structural (Includes biological and operational priorities noted in Feasibility Report)
  - Wire spacing is 25-35ft maximum at termination location. Narrower spacing of 10-20ft are likely best for deterring gulls. ☑
  - Avoid wires parallel to wind. Birds tend to fly parallel with wind, so perpendicular or angled orientation is most effective. 45 degrees max angle is preference. ☑
  - Minimum wire height of 20 ft. above normal high tailwater for tailrace access by small boats/work platforms and to avoid entanglement with debris in river. Too high and birds can readily come in from underneath, making the array less effective. ☑
  - Ideally no posts in water but may be acceptable if necessary. If so, avoid high flows areas, such as those associated with TSW outfalls (stay out of spill basin) due to potential fish impacts. ☑
  - Anchorage must stay clear of handrails and light poles while being accessible for O&M purposes. ☑
  - Line tensioners and dampeners are necessary for larger arrays/spans based on lessons learned at JDA. ☑
  - **Line tensioners & dampeners should be readily accessible w/o needing specialized equipment by project personnel.** ☐



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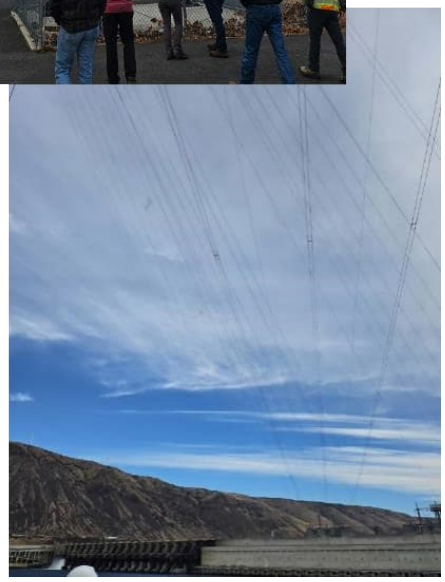
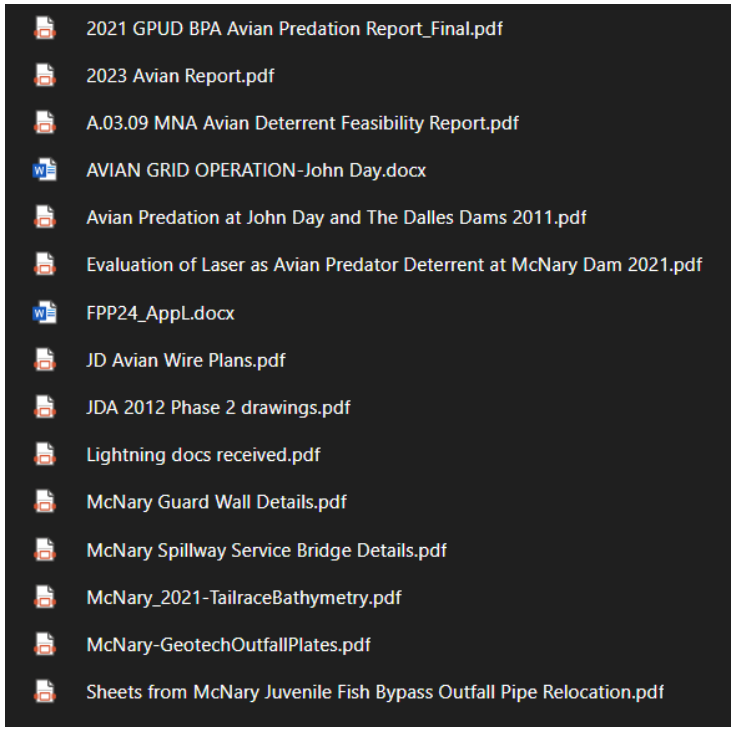
Wire Array Design Considerations (cont.)

- Structural (cont.)
  - **Wind Load:**
    - Assume 15 mph average wind (for synthetic creep analysis) ☐
    - **Able to withstand 72 mph sustained wind, and 85 mph gusts**
  - **Assume ¼" ice load added to the diameter of the wire rope**
  - Temperature Range: ☑
    - Assume Average Max Temp 61 °F, Average Min Temp 38 °F
    - Recorded temperature ranges from -28 °F to 108 °F
    - These ranges will be used for thermal expansion and synthetic creep analysis. JDA has seen significant differences in amount of synthetic line creep between summer and winter periods which must be addressed in design of new APDA's
  - Structural strength limits: ☐
    - **60% of the minimum breaking strength for steel wires**
    - 80% of the minimum breaking strength or synthetic wires
- Electrical
  - Per Unified Facilities Criteria (UFC) 3-575-01, all steel lines need to be grounded to prevent static and/or induced charges from the overhead power transmission lines. ☑
  - Grounding is required for safety, protection, and prevention of electrical hazards. ☑
  - The anchor pole for the wire arrays is required to be grounded. See image for a detail from John Day Dam Avian Predation deterrent array drawings (sheet detail B on S-401). ☑



Wire Array Design Considerations (cont.)

- References: ☑
  - Applicable USACE publications per the SOW
  - Governing criteria and codes per Unified Federal Criteria
  - McNary Avian Predation Deterrent Array Feasibility Report with FFDRWG comments_Final_26Oct2022
  - Other documents shared with Jacobs, post award:
    - Will be adding two more files for JBS record drawings
- Constraints:
  - Navigation channel cannot be blocked ☑
  - APDAs cannot be placed west of the BRZ ☑
  - **Debris flow during spring** ☐
  - Limited construction window? ☑
  - USDA APHIS Team uses reel truck to spool wire. ☑
    Care should be taken to consider location of tower (not on outfall pier or lock guidewall).



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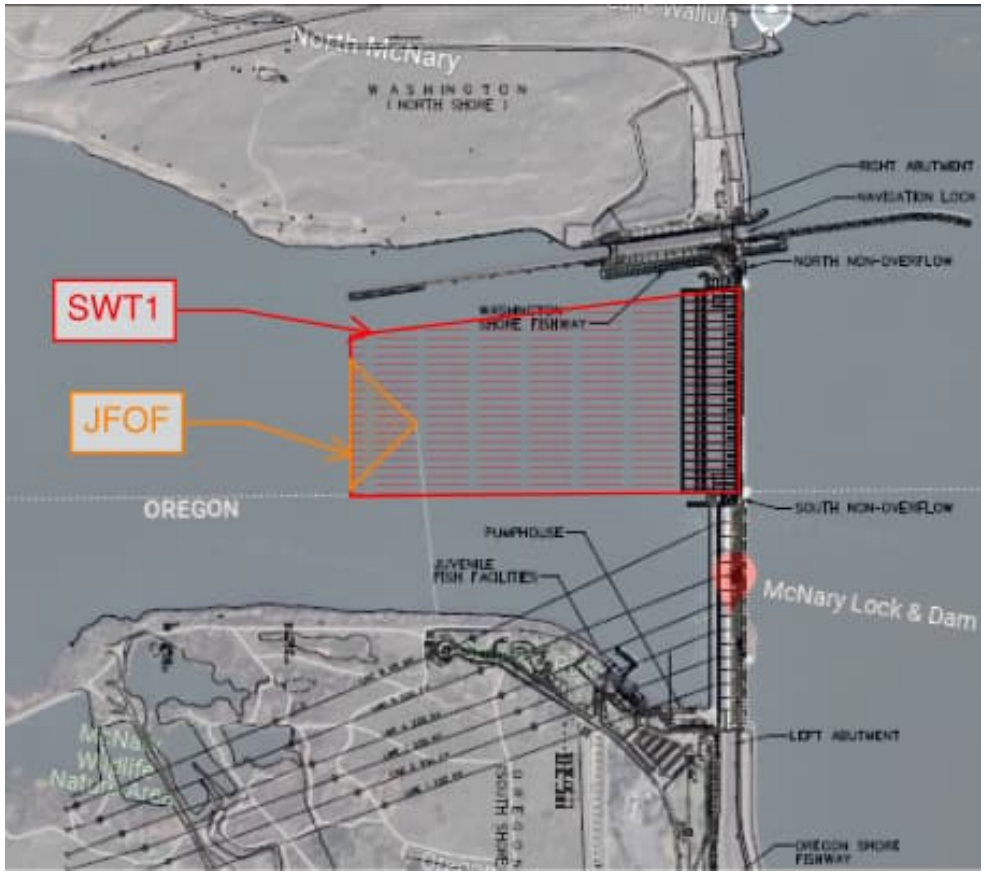
Primary Avian Predation Zones

- Input from Bobby Johnson and Chris Peery during Site Visit
- FFDRWG comments regarding change of dam operations where a majority of juvenile salmonid pass through spillways



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Alternatives Refined - Wire Array

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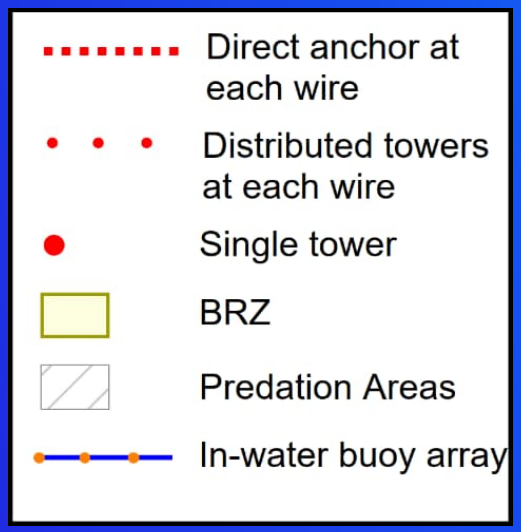
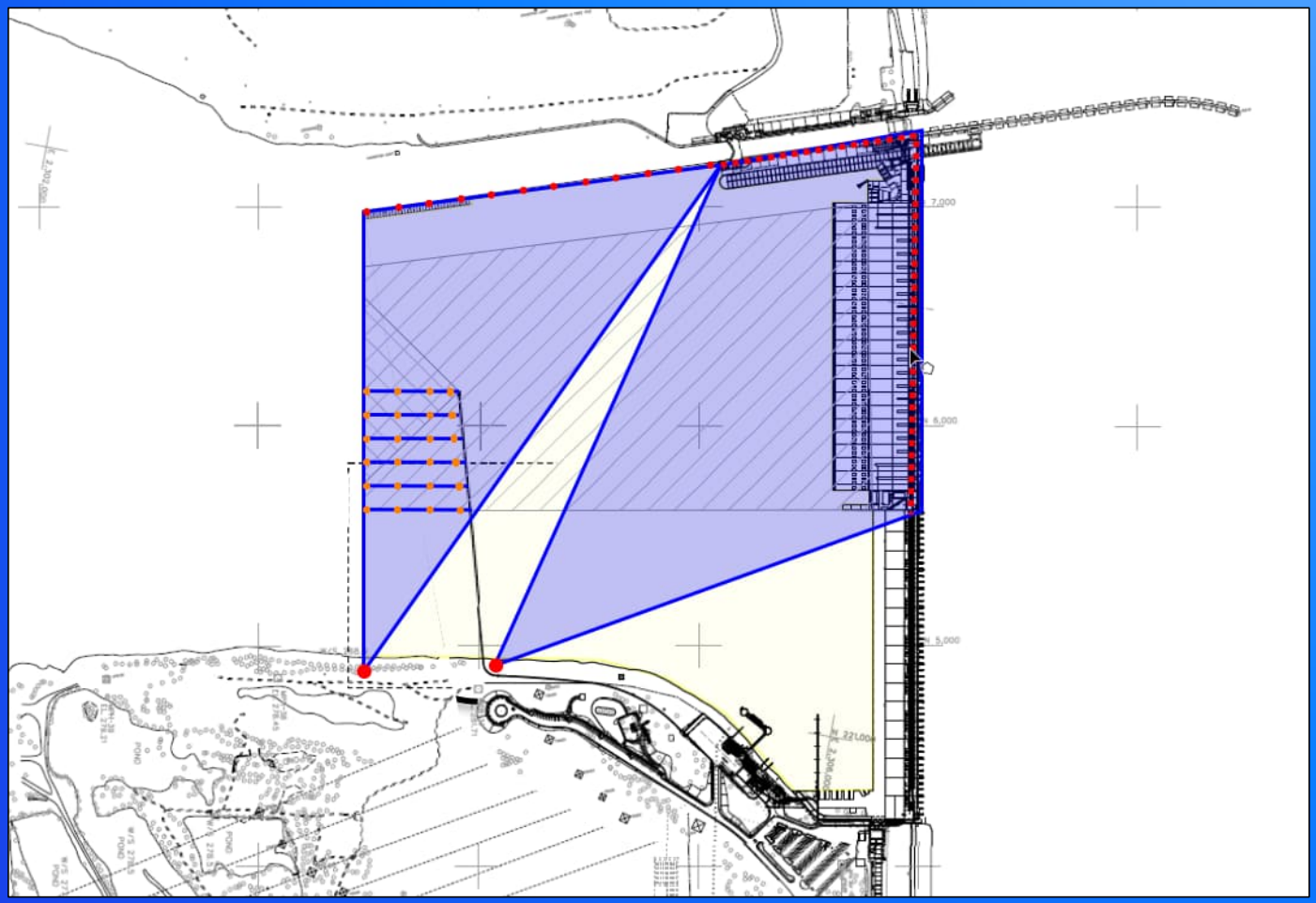
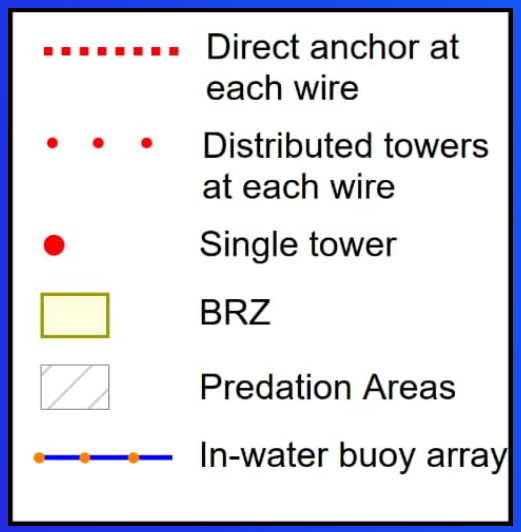
Alternate 1A: Wire Arrays "Oregon Shoreline to Guidewall" and "Oregon Shoreline to NavLock and Spillway Decks" and In-water Array

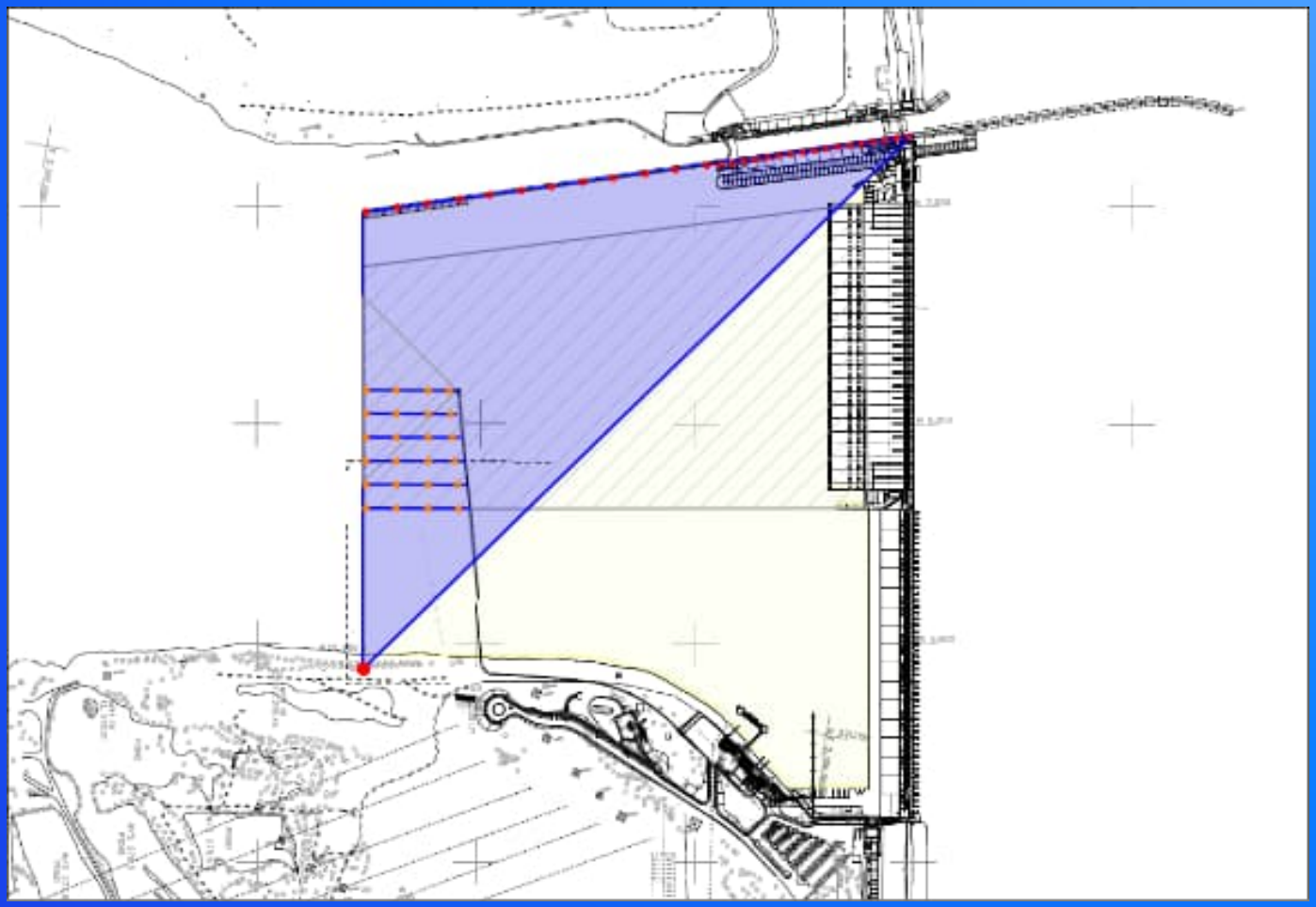




Added after CDW

Alternate 1B: Wire Array "Oregon Shoreline to Guidewall" extended along NavLock and In-water Array





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Cost Section: Options Cost Summary

	Option 1A 4 Towers w/ Dam Wall Plate		Option 1B 3 Towers w/out Dam Wall Plate		Option 2 In-Water Array
	Vectran	SS	Vectran	SS	** per line
Direct Cost (w/ install)	$ 7,813,243	$ 10,070,863	$ 6,108,464	$ 6,849,035	$ 33,794
Mobilization + Barge Crew	$ 512,000	$ 666,000	$ 358,000	$ 435,000	$ 34,250
Subtotal:	**$ 8,325,243**	**$ 10,736,863**	**$ 6,466,464**	**$ 7,284,035**	**$ 68,044**
Markups	$ 4,037,743	$ 5,207,379	$ 3,136,235	$ 3,532,757	$ 33,001
Subtotal:	**$ 12,362,986**	**$ 15,944,242**	**$ 9,602,699**	**$ 10,816,792**	**$ 101,045**
Contingency 15%	$ 1,854,448	$ 2,391,636	$ 1,440,405	$ 1,622,519	$ 15,157
Total	**$ 14,217,434**	**$ 18,335,878**	**$ 11,043,104**	**$ 12,439,311**	**$ 116,202**

CLASS 4 Order of Magnitude - Feasibility Study Range	-20%	$ 9,890,389	$ 12,755,393	$ 7,682,160	$ 8,653,434	$ 80,836
	50%	$ 18,544,480	$ 23,916,362	$ 14,404,049	$ 16,225,189	$ 151,568

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Cost Section (cont.) Key Assumptions/Wire Comparison

	Option 1A 4 Towers w/ Dam Wall Anchor		Option 1B 3 Towers w/out Dam Wall Anchor		Option 2 In-Water Array
Work from Barge Duration (mos.)	6	8	4	5	0.25
JOOH	25%				
HOOH	8%				
Profit	10%				
Contingency	15%				
Wire (LF)	289,961		176,184		300

Vectran 12 Strand & 12X12 Wire		
1/4"	5/16"	3/8"
$ 3.71	$ 3.83	$ 4.19
	Average Cost Per L	3.912857605

Stainless Steel Wire		
1" 304 SS	1/2" SS	7/16" SS
$ 33.36	$ 9.66	$ 6.89

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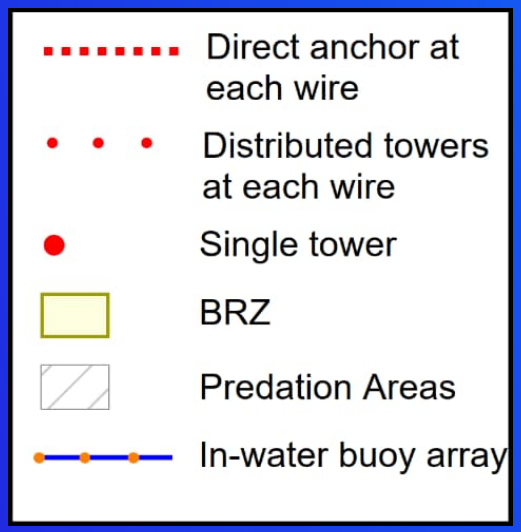
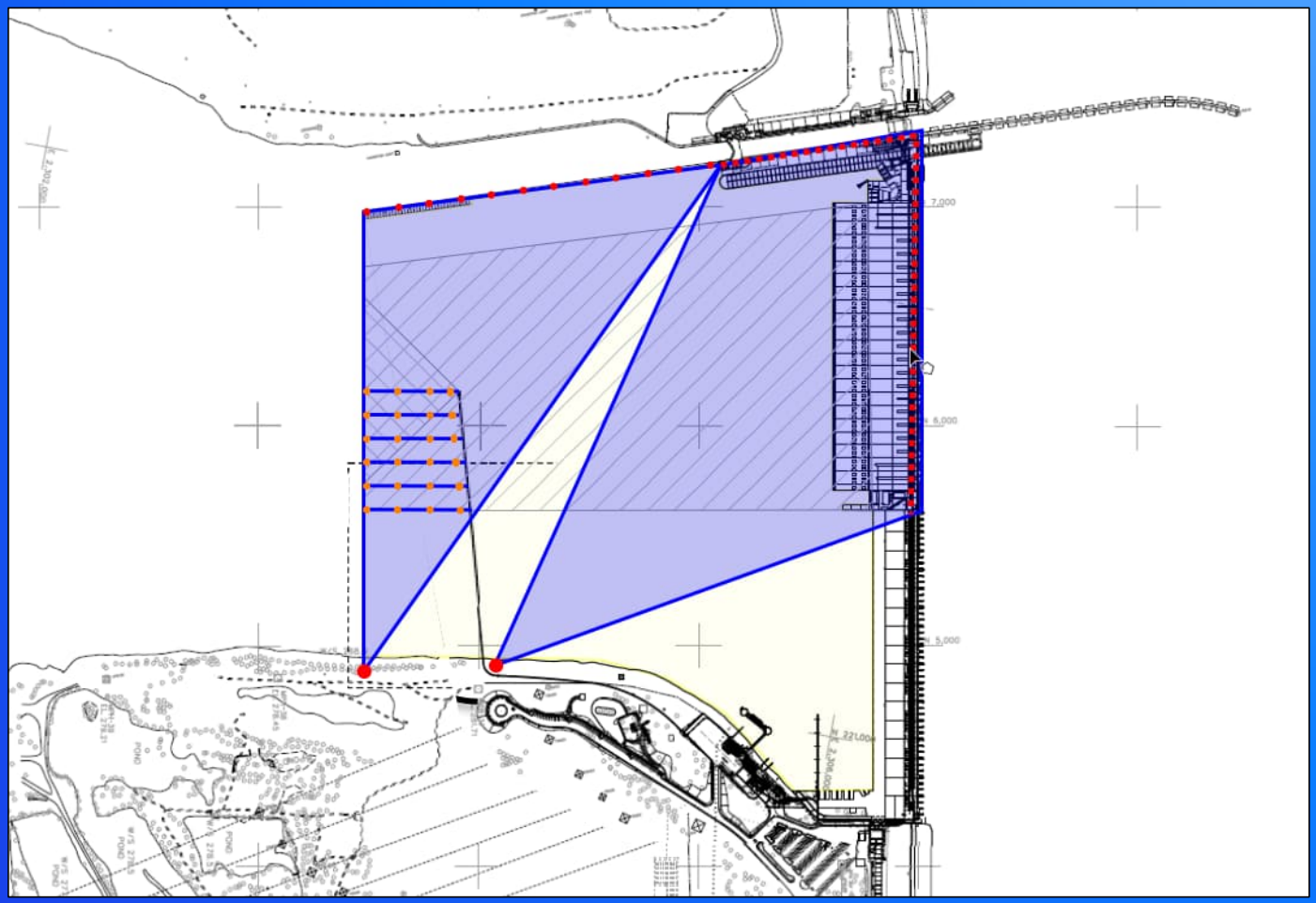
Alternate 1A: Wire Arrays "Oregon Shoreline to Guidewall" and "Oregon Shoreline to NavLock and Spillway Decks" and In-water Array

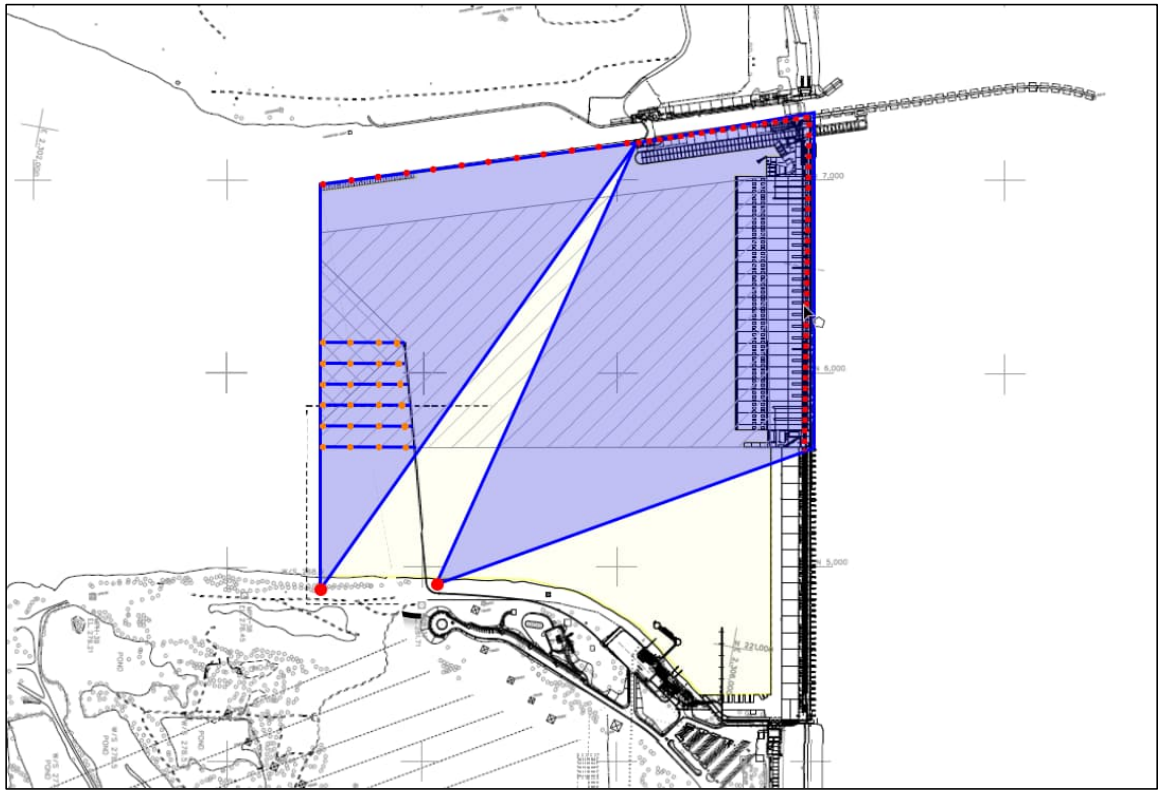




Added after CDW

Alternate 1A: Wire Arrays "Oregon Shoreline to Guidewall" and "Oregon Shoreline to NavLock and Spillway Decks" and In-water Array

- Pros
  - Excellent coverage of full Predation Priority Area
  - Structural towers on shore
  - Provides protection against gulls, pelicans and cormorants
- Cons
  - More expensive alternative
  - In-water array untested
  - Routine maintenance due to waterborne debris



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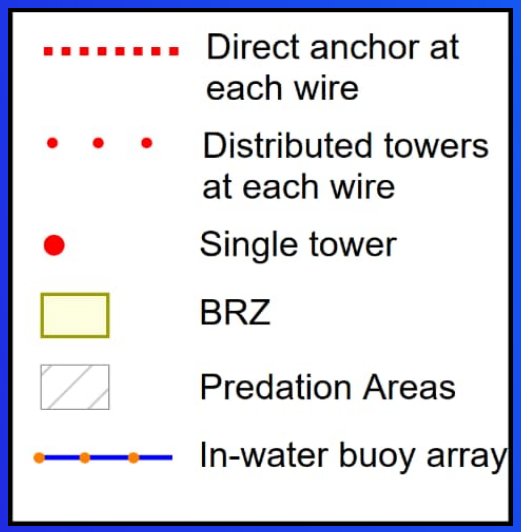
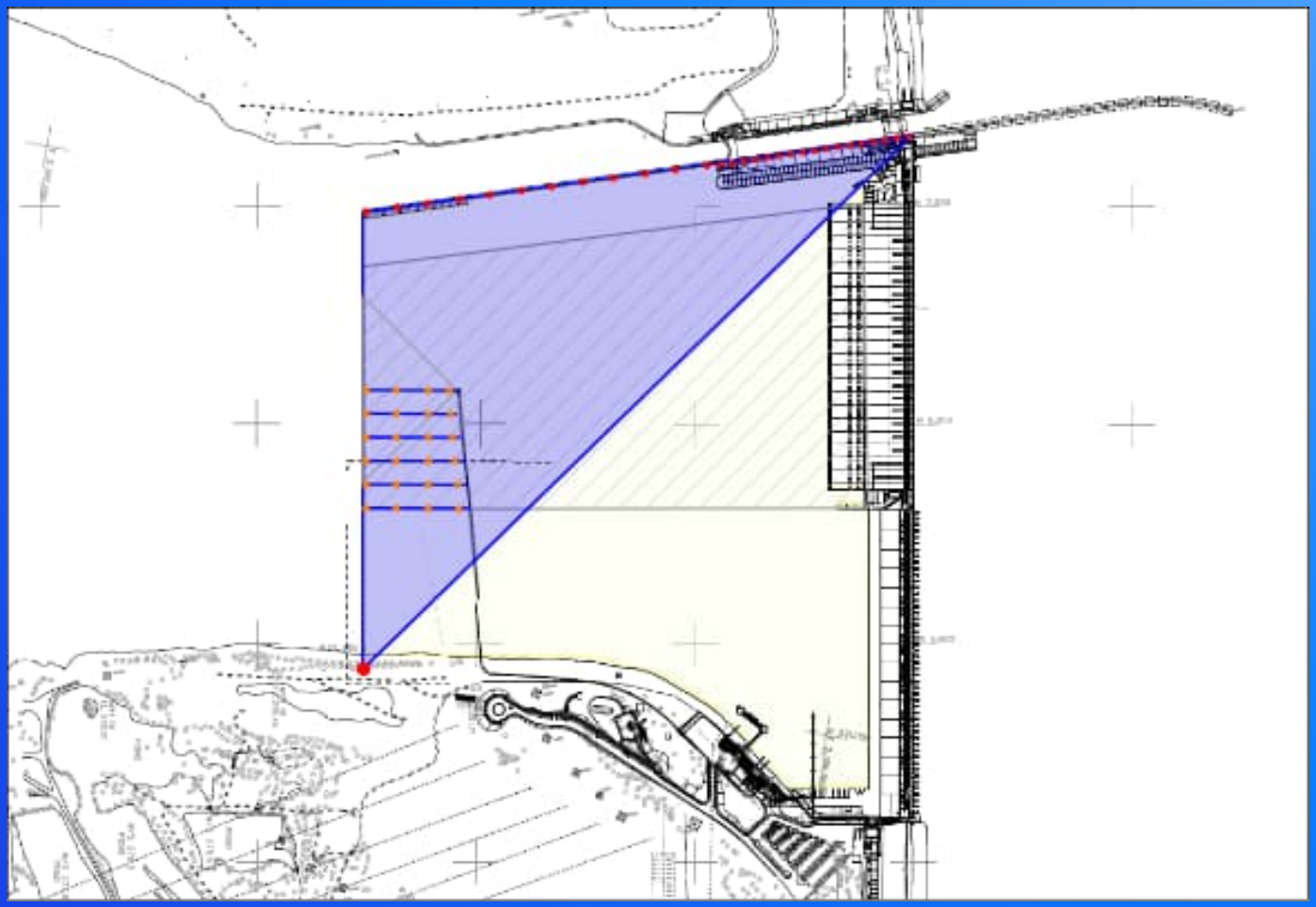
Alternate 1B: Wire Array "Oregon Shoreline to Guidewall" extended along NavLock and In-water Array

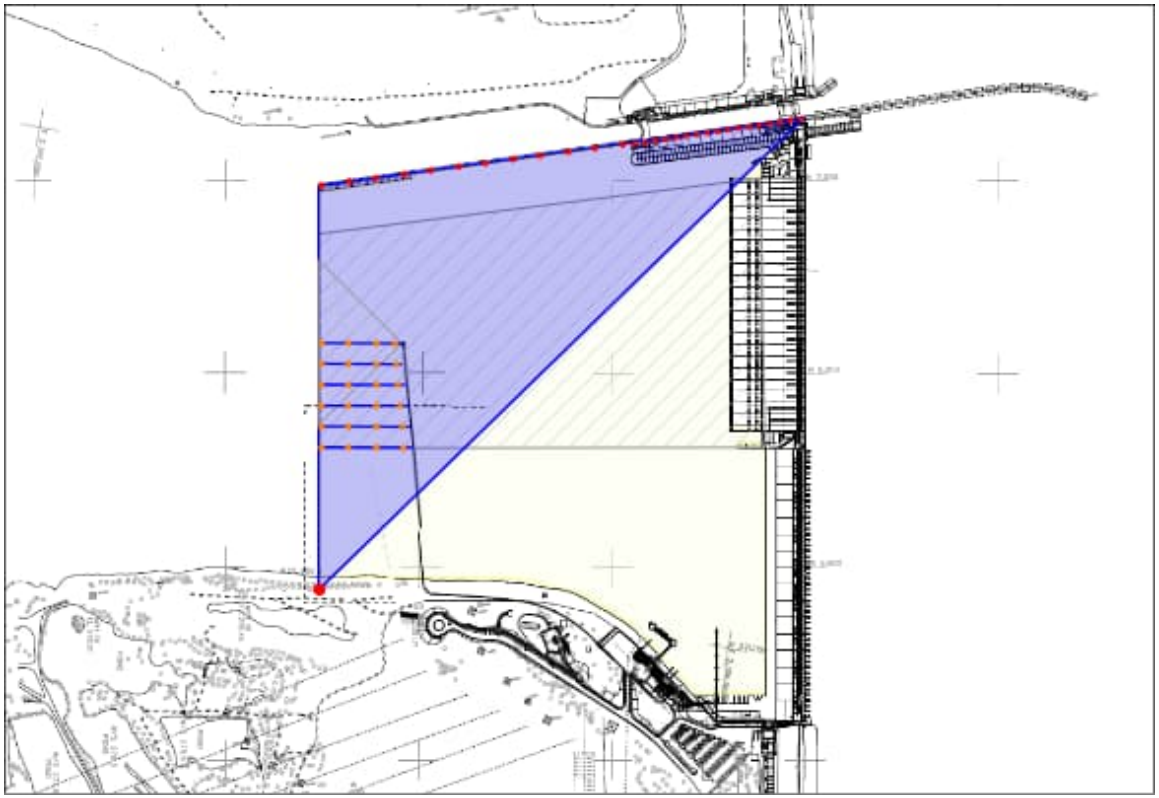




Added after CDW

Alternate 1B: Wire Array "Oregon Shoreline to Guidewall" extended along NavLock and In-water Array

- Pros
  - Good coverage of Predation Priority Area, except near base of spillway
  - Structural towers on shore
  - Provides protection against gulls, pelicans and cormorants
- Cons
  - Less coverage than Alterative 1A
  - In-water array untested
  - Routine maintenance due to waterborne debris



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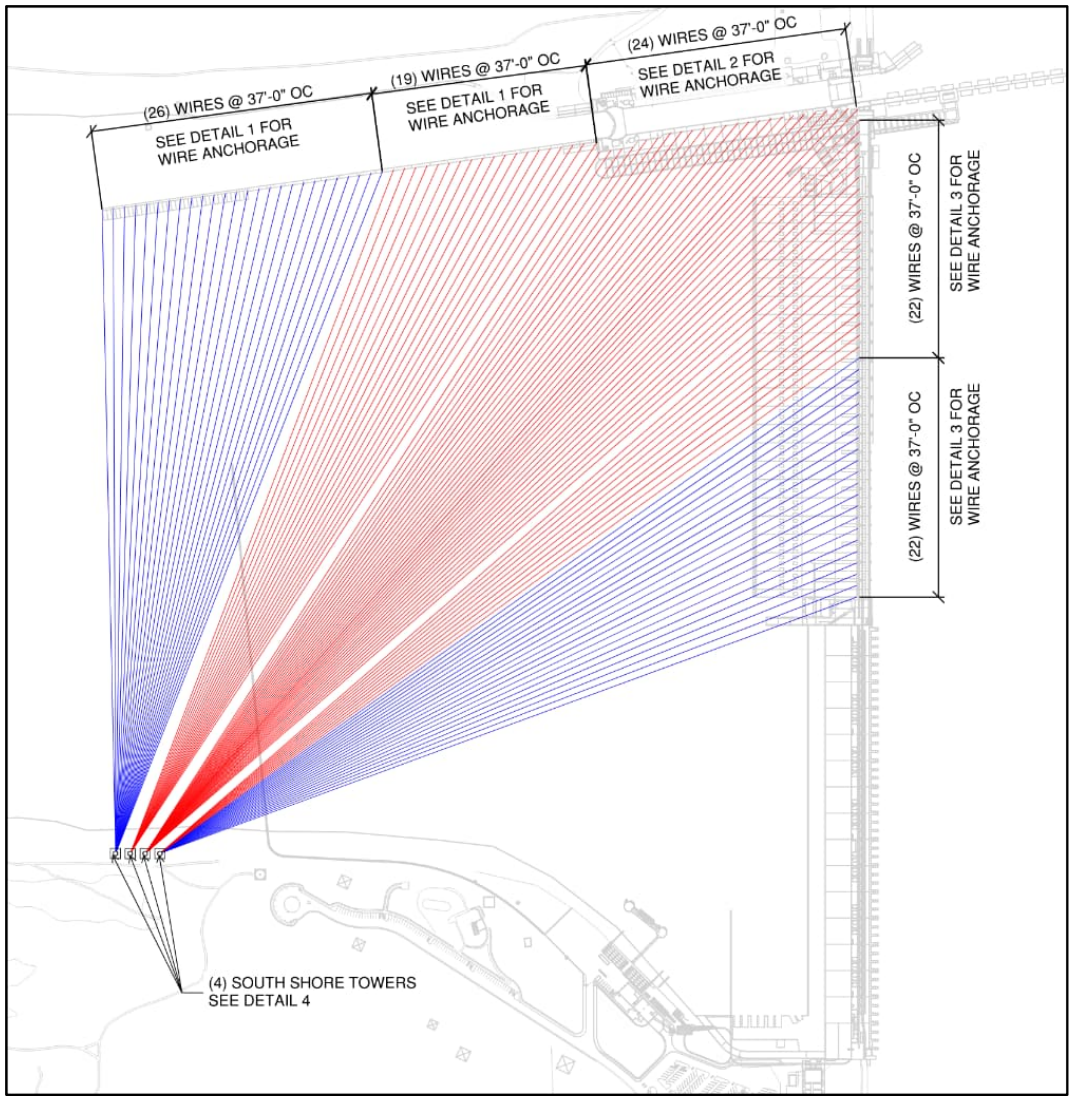
Alternate 1A

Wire sizes based on loads from UFC 3-301-01, with Change 3
(References ASCE 7-22)

	1/2" STAINLESS STEEL 304, 6x19 WIRE ROPE [5/16" VECTRAN 12 STRAND WIRES]
	1" STAINLESS STEEL 304, 6x19 WIRE ROPE [3/8" VECTRAN 12 STRAND WIRES]



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Alternate 1B

Wire sizes based on loads from UFC 3-301-01, with Change 3

(References ASCE 7-22)

	1/2" STAINLESS STEEL 304, 6x19 WIRE ROPE [5/16" VECTRAN 12 STRAND WIRES]
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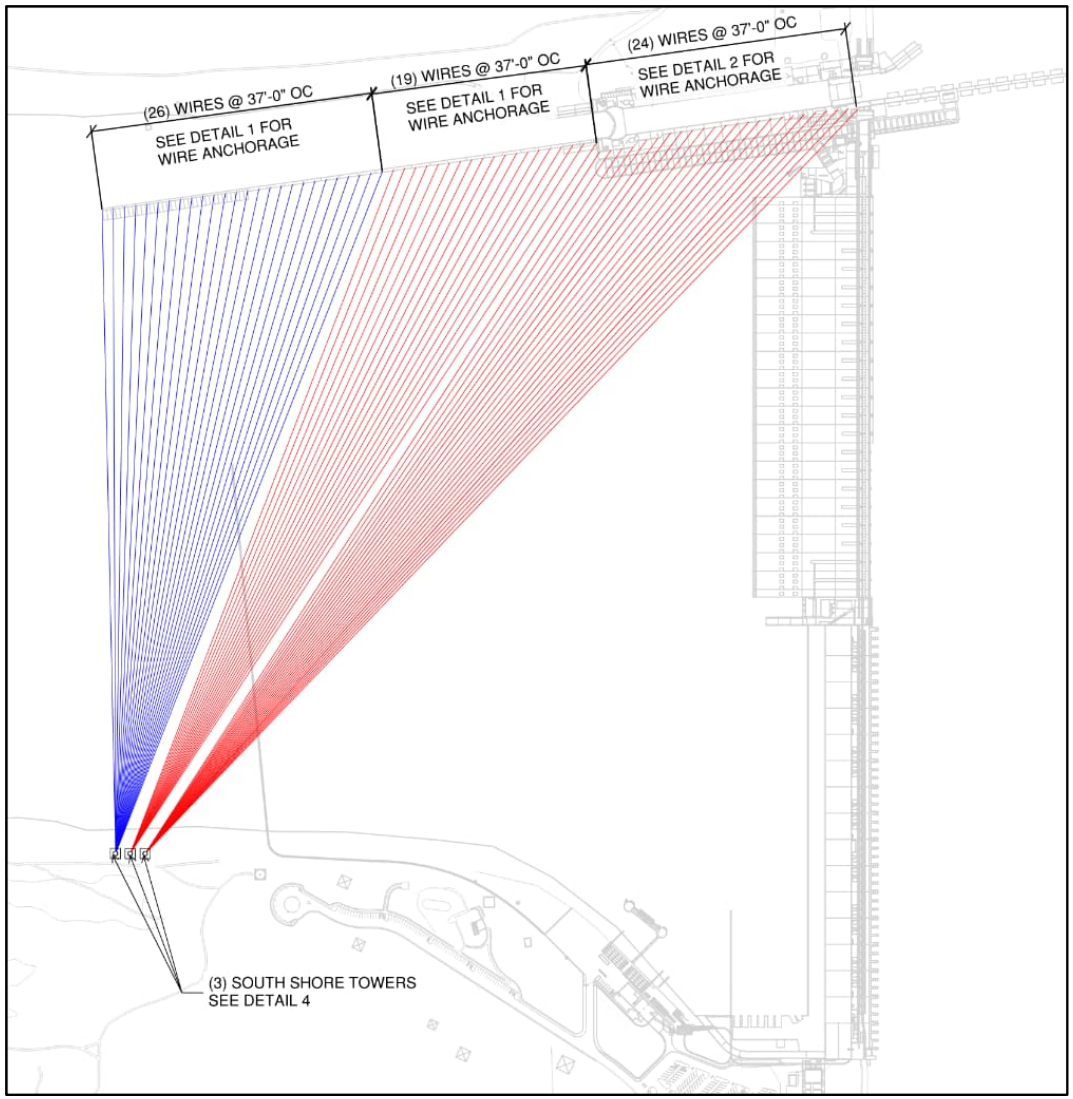

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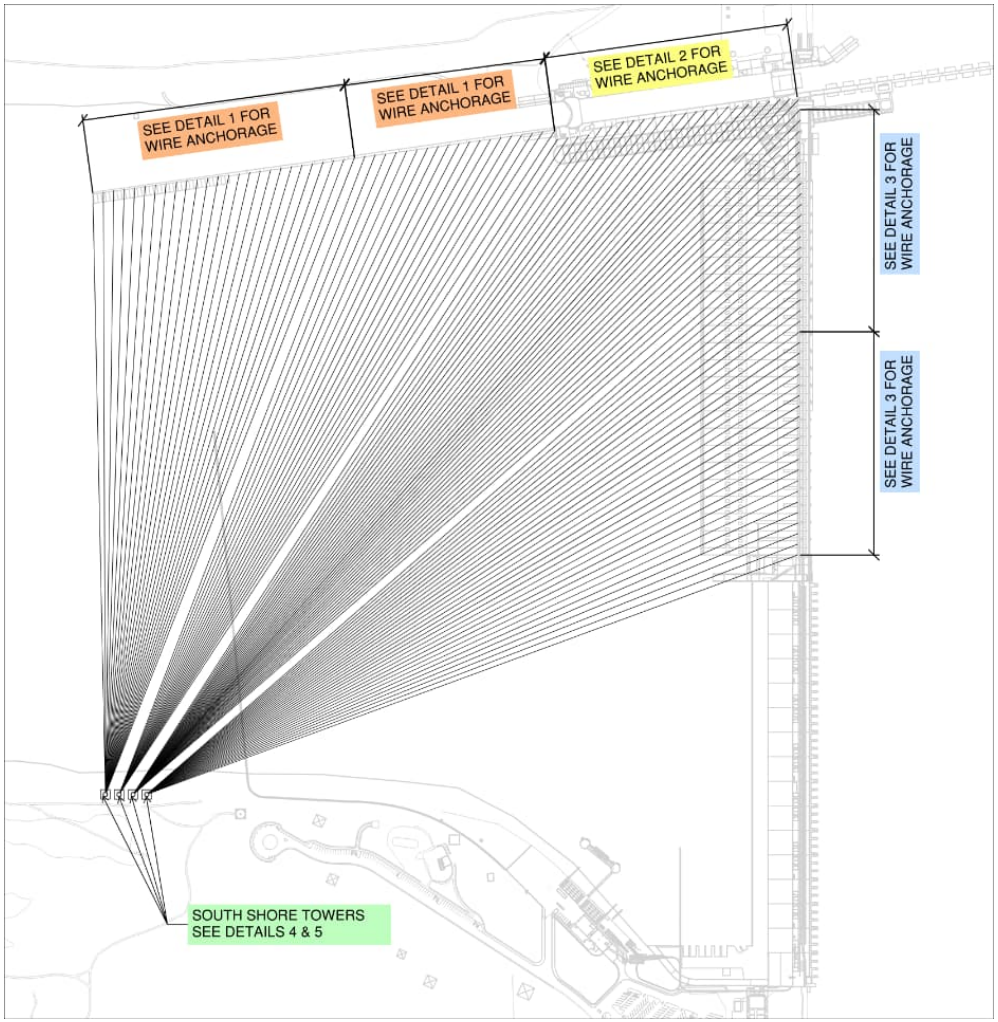
Cable Array Anchorage Concepts

- (4) Primary Anchorage Locations
  - Guide Wall Towers
  - Navigation Lock Wall Eyelets
  - Spillway Posts
  - South Shore Towers and Foundations



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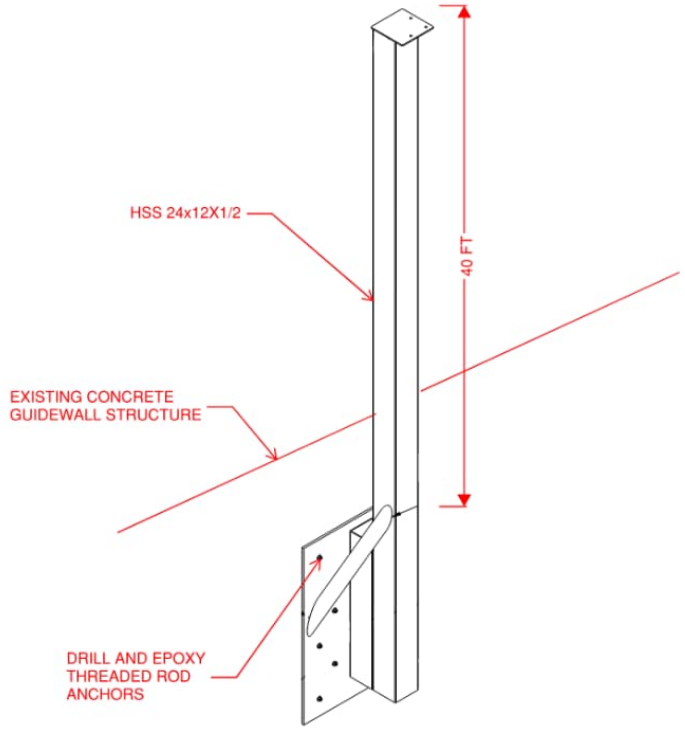
Cable Array Anchorage Concepts

- Guide Wall Towers



DETAIL 1

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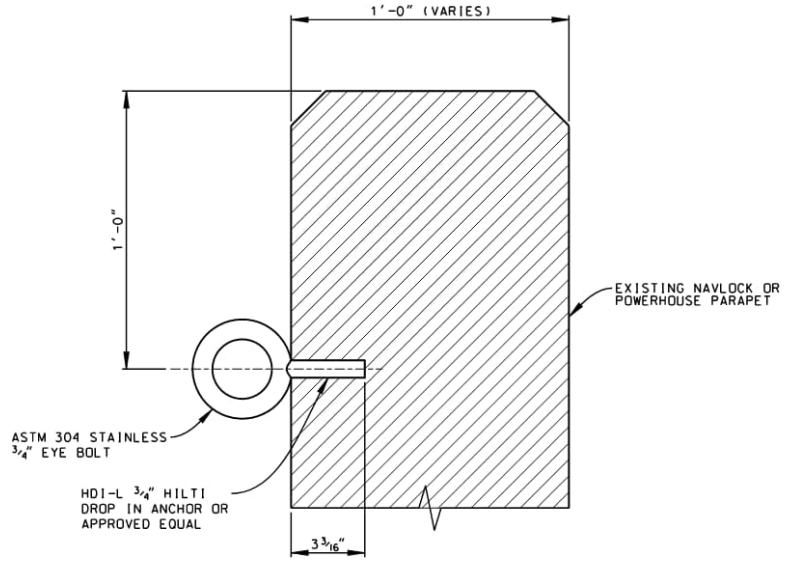
Cable Array Anchorage Concepts

- Navigation Lock Wall Eyelets



DETAIL 3

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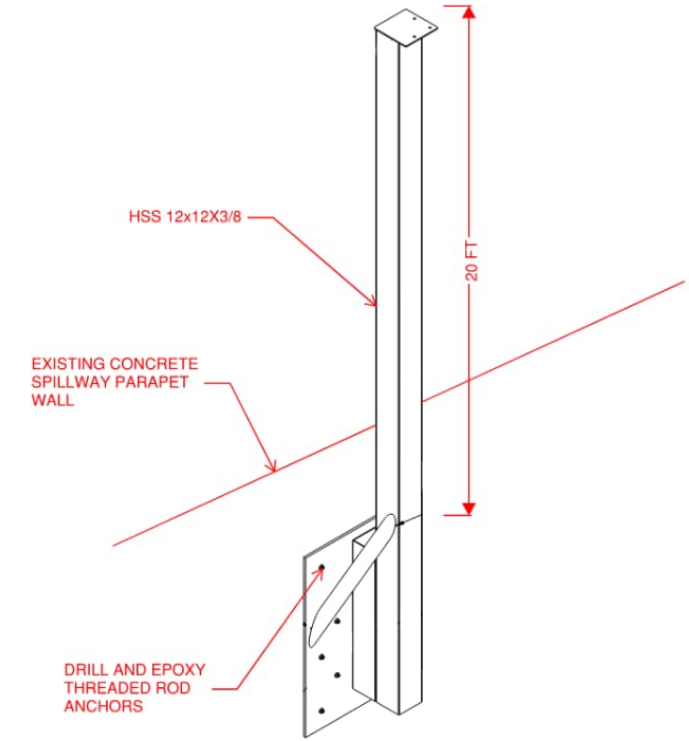
Cable Array Anchorage Concepts

- Spillway Posts



DETAIL 2

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Cable Array Anchorage Concepts

- Proposed location of Spillway Posts are outboard of pipes attached to face of concrete.
- Alternatively, can be placed inboard of handrail, but would encroach on walkway

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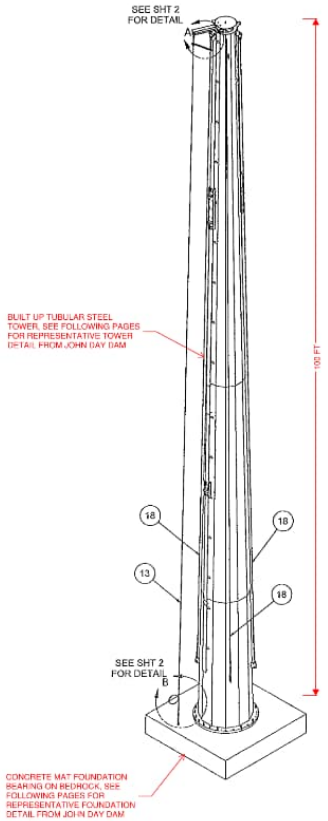
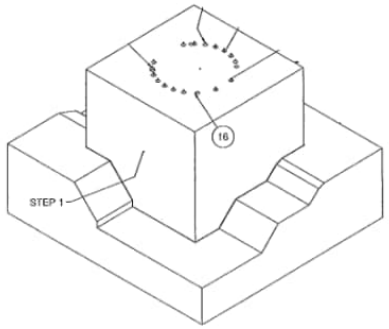
Cable Array Anchorage Concepts

- South Shore Towers and Foundation



DETAIL 4



DETAIL 5

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Alternative In-water Deterrent System

- Aerial arrays are ineffective against pelicans (surface foraging) and cormorants (diving birds)
- Alternative Deterrents
  - Use cables with floats arranged parallel to the riverbank, utilizing the river's current
  - Cables rise and fall with water levels, extending over the boat restrictive zone (BRZ)
  - Rudders attached to cables create undulating motion, deterring birds and preventing debris accumulation
  - Floating balls made from durable, weather-resistant materials cover large areas, reducing predation risk

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Example of Floating In-water Array

- **Debris-Free Design**
  - The floating balls will be arranged in parallel lines with the riverbank, without perpendicular attachments
- **Durable Materials**
  - The floating balls used will be made from durable, weather-resistant materials
- **Self-Cleaning Motion**
  - The use of the river's current to spread the floating balls downstream creates a natural, self-cleaning motion

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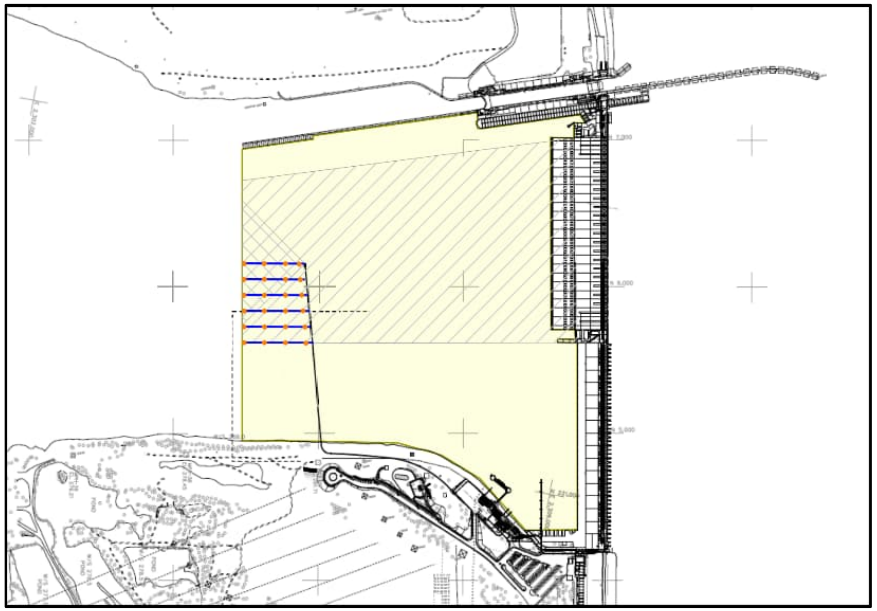
In-Water Floating Array

In-Water Floating Array

- Pros
  - Partial coverage of JFOF
    - No new structural support needed in water
    - No aerial wires and towers
    - Could be a cost-effective proof of concept
- Cons
  - No coverage at tailrace
  - Waterborne debris may impact floating array



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Cables with Floats – Potential Disadvantages

- Installation Complexity
  - Installing cables with floats and rudders may be technically challenging, requiring specialized equipment and skilled labor
- Maintenance Requirements
  - Wear and tear of cables, floats, and attachment points requiring regular inspections and maintenance
  - Ensuring the rudders remain functional and effective in creating undulating motion
- Added Structural Load to Outfall Piers
- Environmental Impact
  - Installation and presence of cables may disrupt local aquatic habitats and affect other wildlife
  - Cables could potentially alter water flow patterns, affecting sediment transport and aquatic vegetation

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Other Potential Disadvantages

- Debris Accumulation
  - Potential for Clogging - risk that floating balls could become clogged with debris, requiring regular cleaning
  - Environmental Debris - natural events like storms could increase debris load, challenging the effectiveness of the array
- Effectiveness Variability
  - Species Adaptation - birds may eventually adapt to the deterrents, reducing their effectiveness over time
  - Behavioral Changes - some bird species might find ways to navigate around or through the deterrents, diminishing their effect
- Aesthetic and Recreational Impact
  - Visual Impact - floating balls or cables may be considered unsightly, affecting the aesthetic value of the river
  - Recreational Use – potentially impacts recreational activities such as boating, fishing, or swimming

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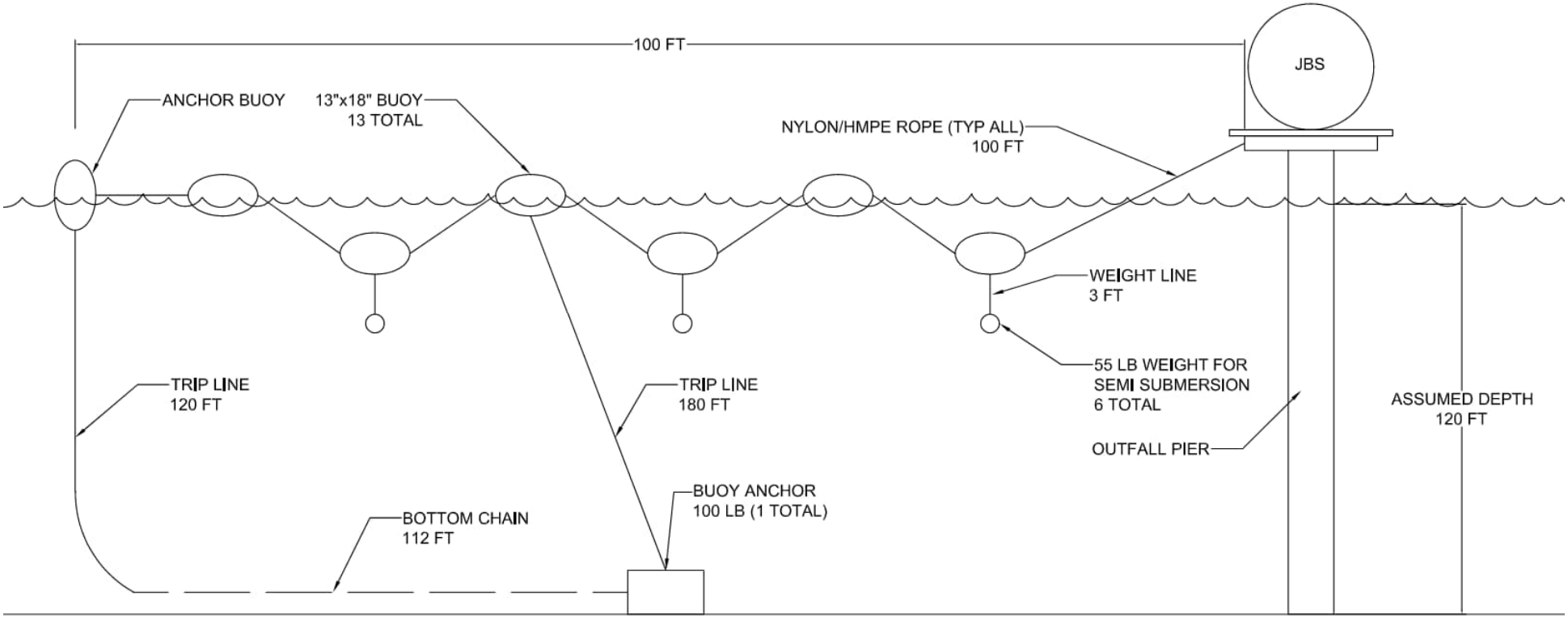
Cables with Floats – Refined Alternative

- Weighted offset buoys with safety anchor provides in-water and on-water deterrence. River currents induce variable motion among buoys of different depths.



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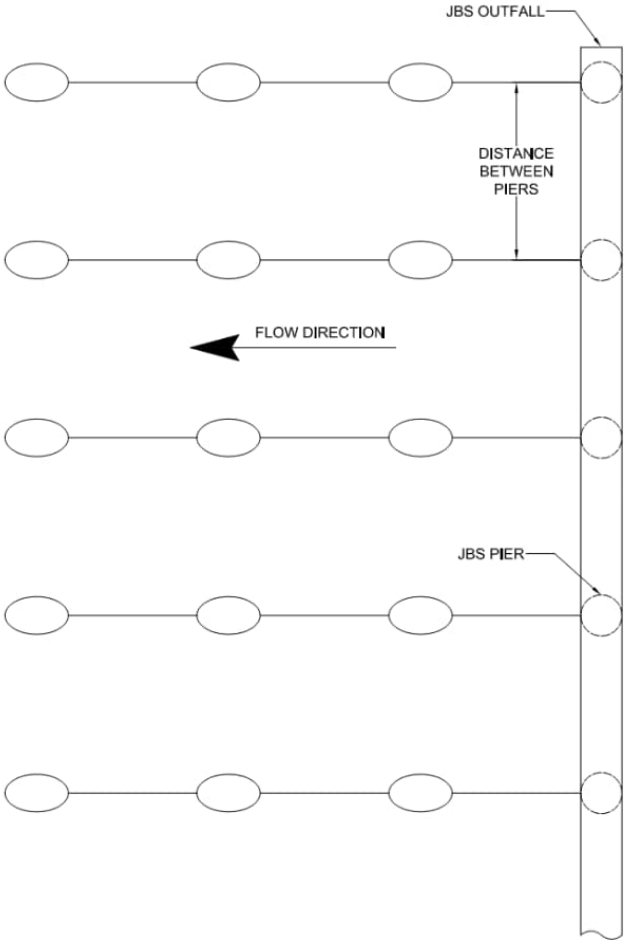
Cables with Floats – Options and Configurations

- Configuration 1 – One float line per pier
- Roughly 50 feet pier to pier



  - Pros:
    - Least amount of drag force per pier.
    - No additional material needed for mounting.
    - Relatively easy install.
  - Cons:
    - Minimal outfall coverage beyond the first line.
    - Additional float lines south of farthest pier may be ineffective.

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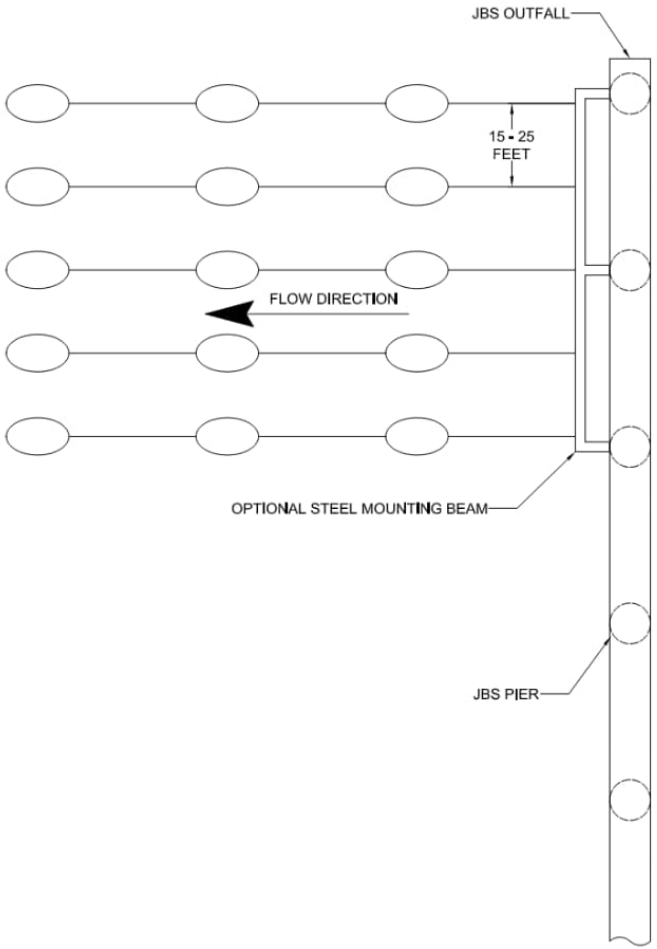
Cables with Floats – Options and Configurations

- Configuration 2 – Pier to pier mounting beam
- Steel beam attached between piers.
  - Pros:
    - Any mounting distance between lines.
    - Easy connect/disconnect for storage.
    - More coverage closer to JBS outfall.
  - Cons:
    - Additional material and construction required.
    - Line drag force distributed between fewer piers.



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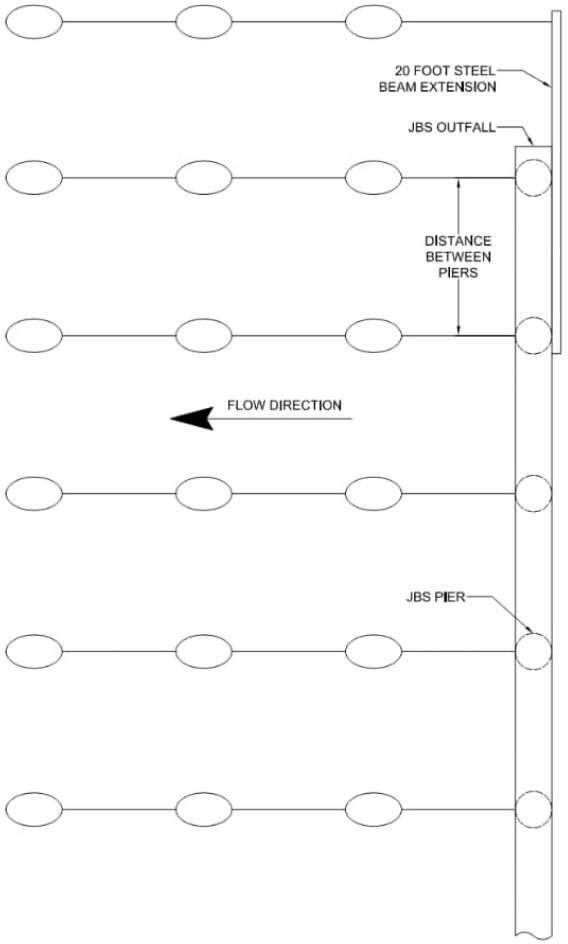
Cables with Floats – Options and Configurations

- Configuration 3 – Outfall beam extension
- Steel beam extension beyond outfall.
  - Pros:
    - Applies to either configuration 1 or configuration 2.
    - Can be designed with retractability for easy storage.
    - Extends coverage beyond JBS outfall.
  - Cons:
    - Additional material and construction required.
    - Additional line drag force applied to end piers.



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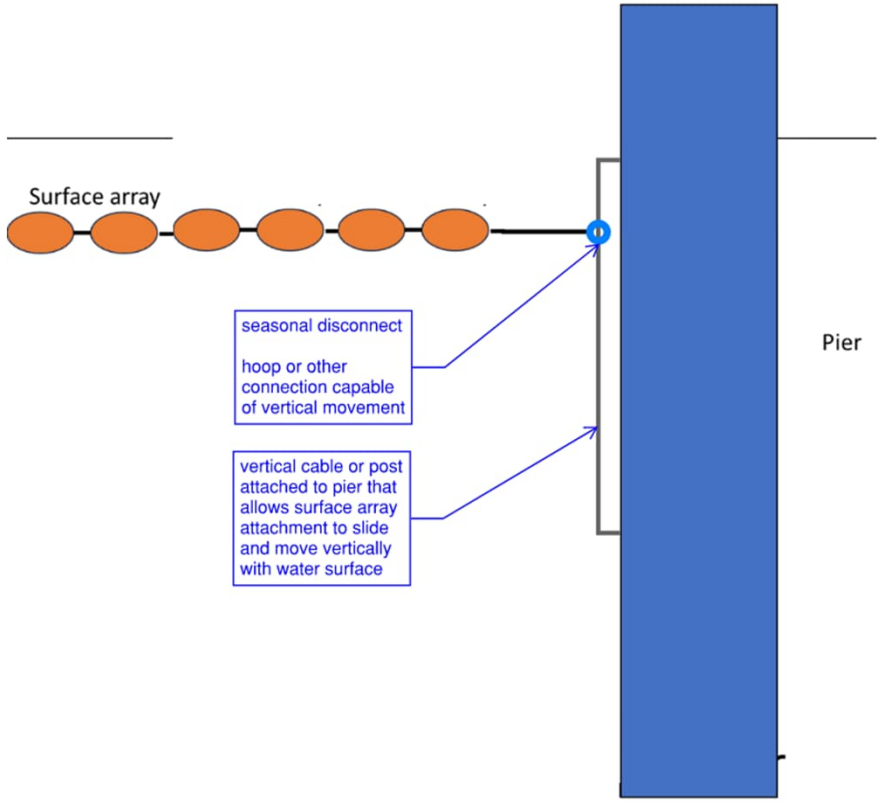
Cables with Floats – Advantages

- Deters diving birds like cormorants and pelicans
- Simple Tethering System
  - Cables tethered to a vertical bar attached to permanent structures like the outfall piers or dam, which are stable, require minimal adjustments, and adapts to changing water levels
  - Less prone to wear and tear, minimizing the need for ongoing maintenance
- Potential to be removed seasonally



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Refined Alternatives Review Meeting Purpose

- Present system characteristics, components, general layout, schematics, diagrams, rough order of magnitude costs, options, and pros and cons of alternatives
- Seek stakeholder input and concurrence
- Validate alternatives meet constraints

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Next Steps

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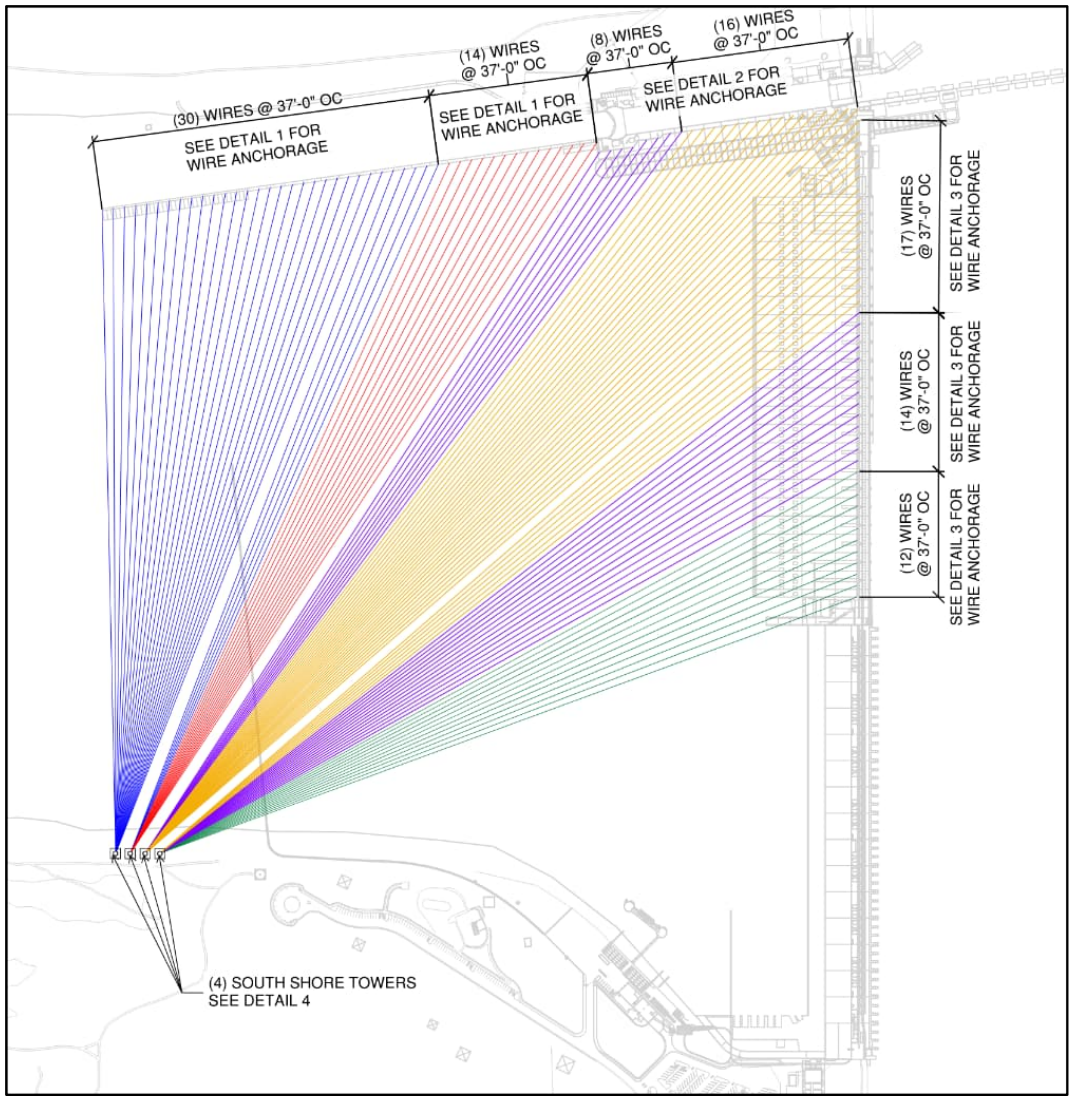
Backup Slides

Alternate 1A

Wire sizes based on
ASCE 7-10

1/2" STAINLESS STEEL 304, 6x19 WIRE ROPE
[5/16" VECTRAN 12 STRAND WIRES]

1" STAINLESS STEEL 304, 6x19 WIRE ROPE
[3/8" VECTRAN 12 STRAND WIRES]



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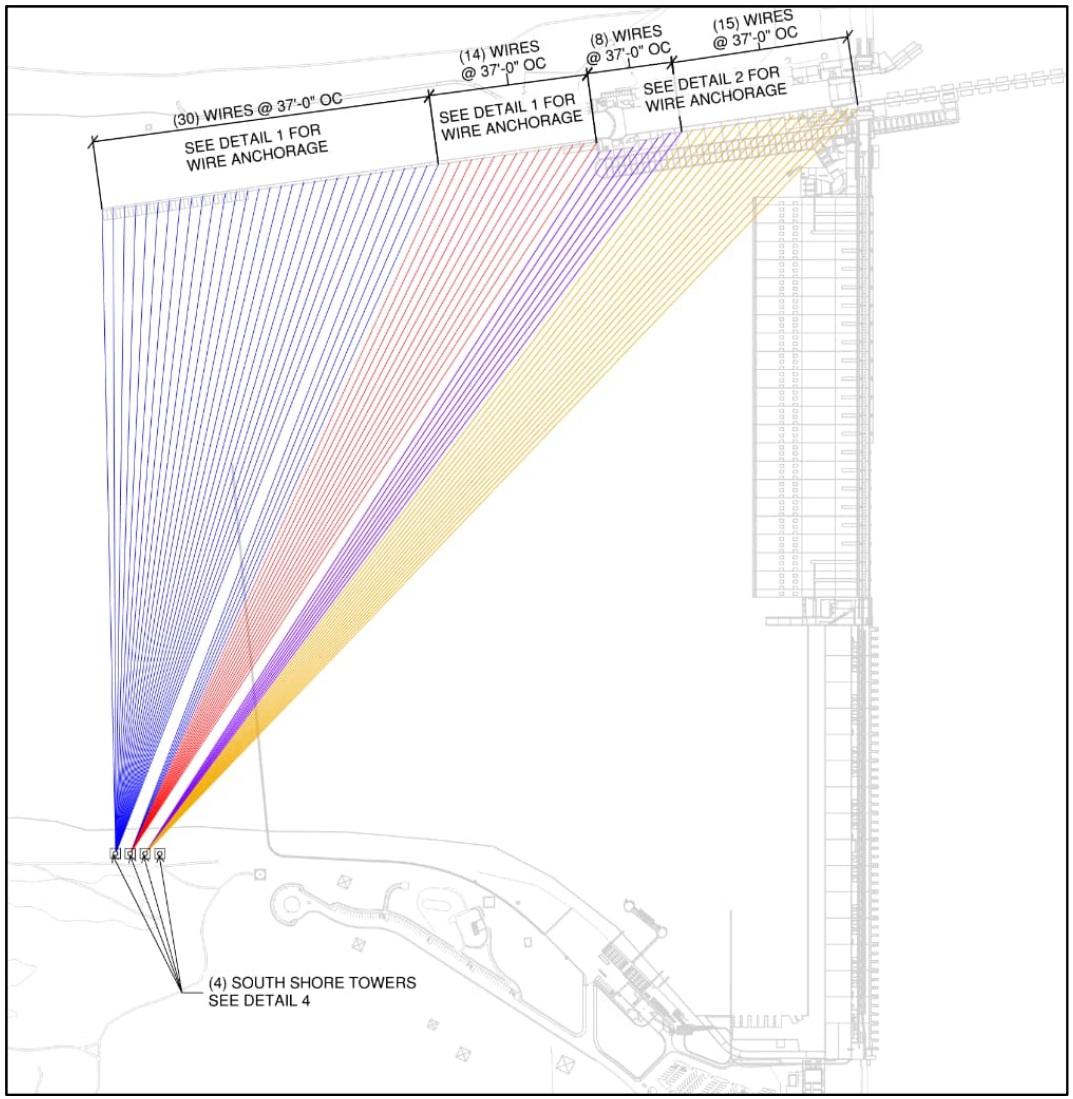
Alternate 1B

Wire sizes based on
ASCE 7-10

- 3/8" STAINLESS STEEL 304, 7x19 WIRE ROPE
- 1/2" STAINLESS STEEL 304, 6x19 WIRE ROPE
- 9/16" STAINLESS STEEL 304, 6x19 WIRE ROPE
- 7/16" STAINLESS STEEL 304, 6x19 WIRE ROPE
- 9/32" STAINLESS STEEL 304, 7x19 WIRE ROPE



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ASCE 7-22 Ice Load Criteria

Ice Details

Thickness	0.52 in.
Concurrent Temperature	15 F
3-s Gust Speed	46 mph

Values provided are equivalent radial ice thicknesses due to freezing rain for 250, 500, 1,000, and 1,400-year mean recurrence intervals along with concurrent 3-s gust speeds and concurrent air temperatures. The shading indicates special icing regions, with elevations above 2,100 ft (640 m) in the east, 6,000 ft (1829 m) in the west, and 1,600 ft (488 m) in Alaska, with sparse weather station data for determining design ice loads. In these regions, as well as in regions with complex terrain causing unusual icing conditions and regions where snow or in-cloud icing results in larger loads, the mapped values should be adjusted based on a combination of local historical records and experience, reanalysis data, and numerical weather prediction systems.

Data Source: Standard ASCE/SEI 7-22, Figs. 10-2 through 10-8

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McNary Dam Observation Zones with seasonal mean daily bird counts (circa 2013)

- FB1 – Forebay

Common Name	FB1
American White Pelican	0.3
Bald Eagle	0.0
Caspian Tern	0.1
Common Merganser	0.0
Double-crested Cormorant	0.1
Great Blue Heron	0.0
Grebe spp.	**6.2**
Gull spp.	**1.6**
Osprey	0.1

- SWT1 – Spillway Tailrace

Common Name	SWT1
American White Pelican	**3.7**
Bald Eagle	0.0
Caspian Tern	**6.6**
Common Merganser	0.2
Double-crested Cormorant	**1.1**
Great Blue Heron	<0.0
Grebe spp.	0.0
Gull spp.	**17.7**
Osprey	0.0

- PHT1 – Powerhouse Tailrace

Common Name	PHT1
American White Pelican	0.1
Bald Eagle	0.0
Caspian Tern	0.1
Common Merganser	0.0
Double-crested Cormorant	<0.1
Great Blue Heron	0.0
Grebe spp.	0.0
Gull spp.	0.1
Osprey	<0.1

- JFOF – Juvenile Fish Bypass Outfall

Common Name	JFOF
American White Pelican	**1.4**
Bald Eagle	0.0
Caspian Tern	**1.1**
Common Merganser	0.0
Double-crested Cormorant	0.1
Great Blue Heron	0.0
Grebe spp.	0.1
Gull spp.	**4.9**
Osprey	0.0

- BRZ – Boat Restriction Zone

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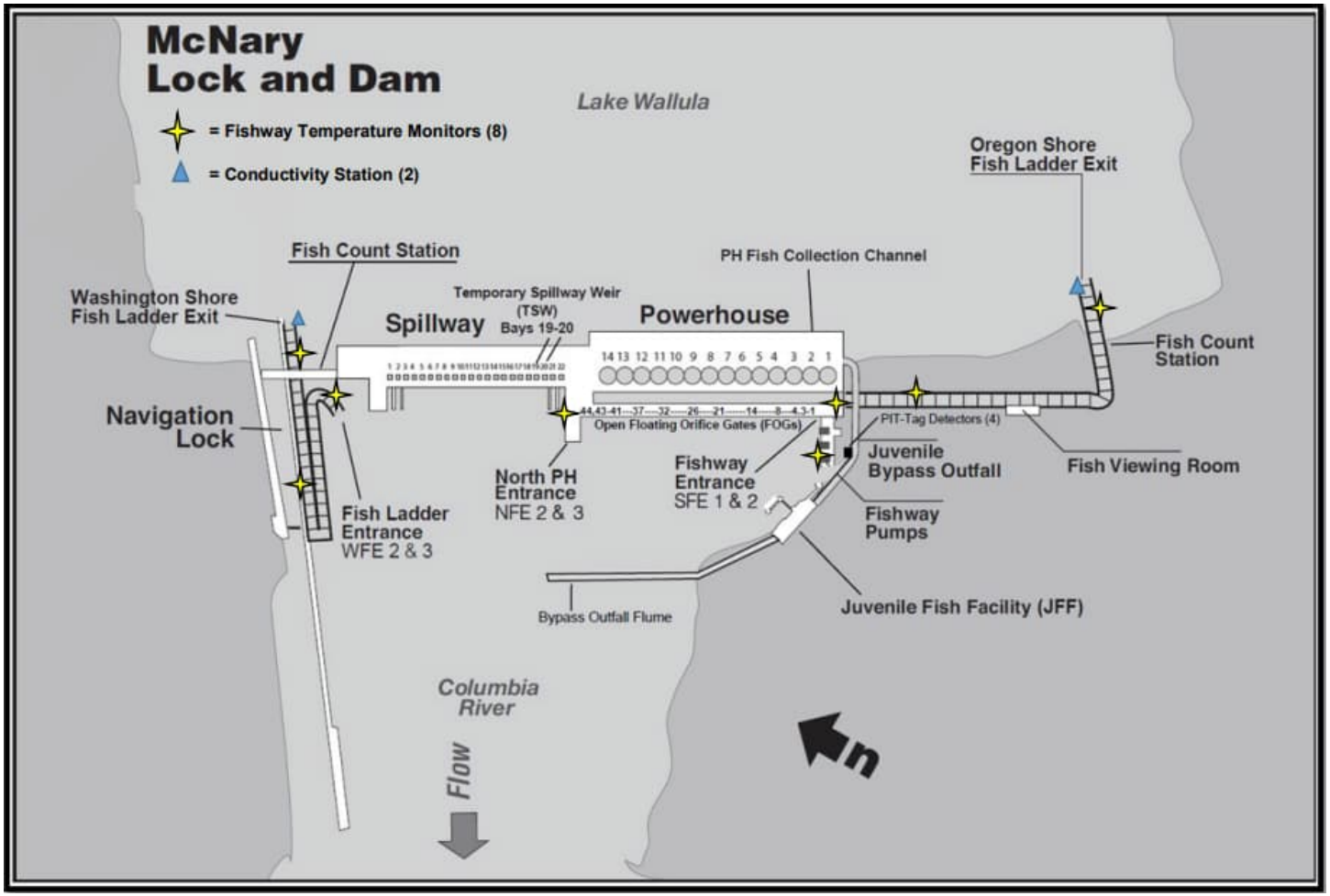

Source: From 2024 Fish Passage Plan

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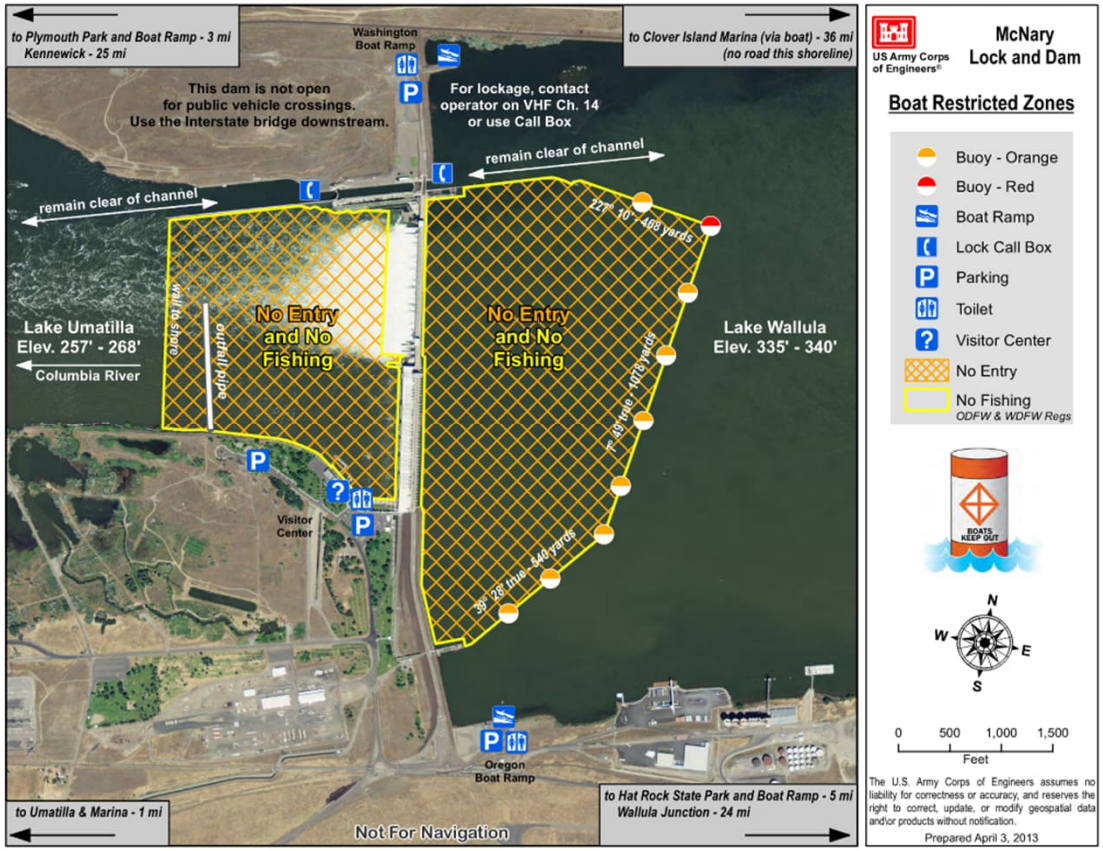
Boat Restricted Zone (BRZ)



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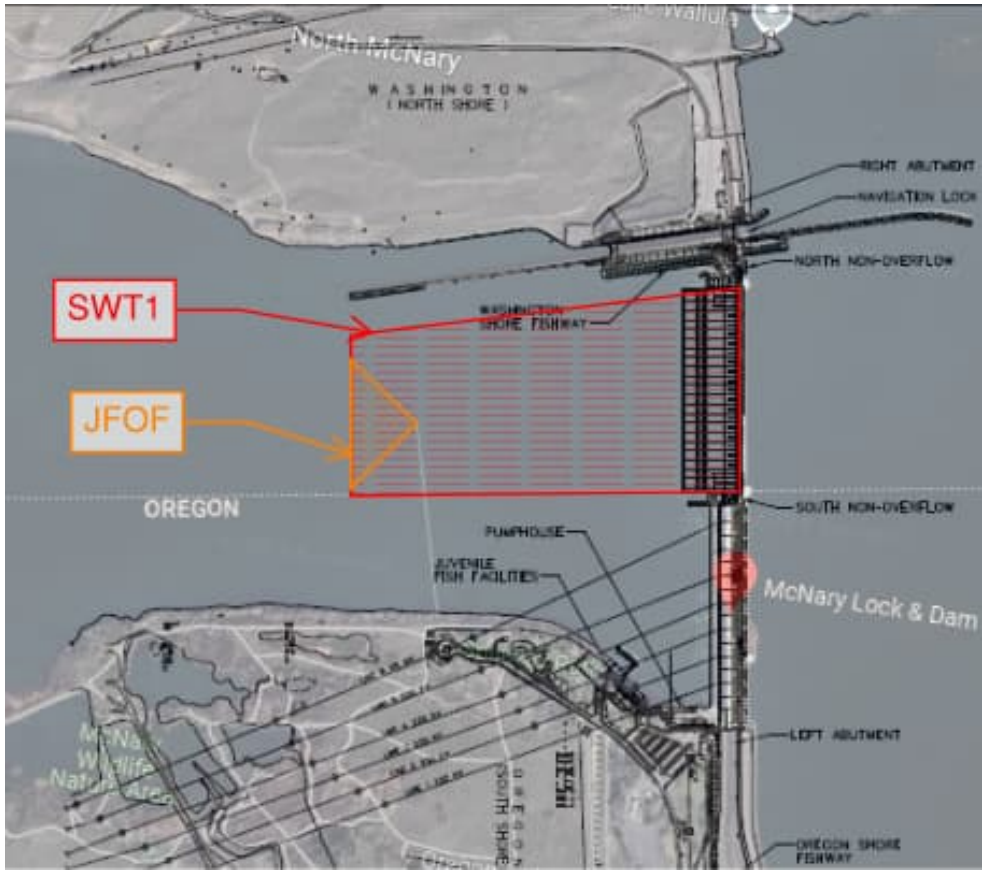
Primary Avian Predation Zones

- Spillway Tailrace (SWT1)
- Juvenile Fish Outfall (JFOF)



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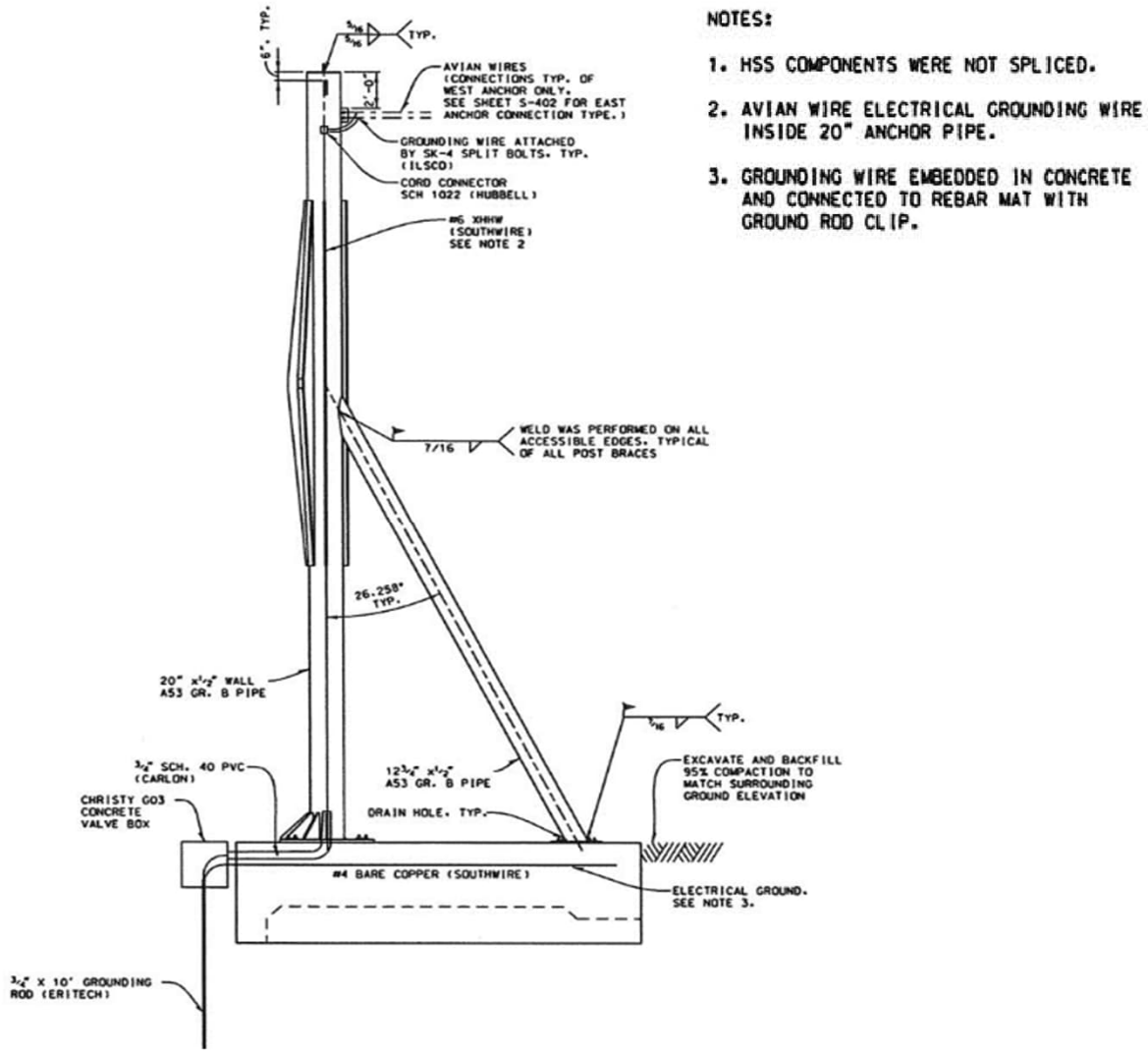
Electrical Grounding

- Grounding is required for safety, protection, and prevention of electrical hazards
- The anchor pole for the wire arrays is required to be grounded. See image for a detail from John Day Dam Avian Predation deterrent array drawings (sheet detail B on S-401)



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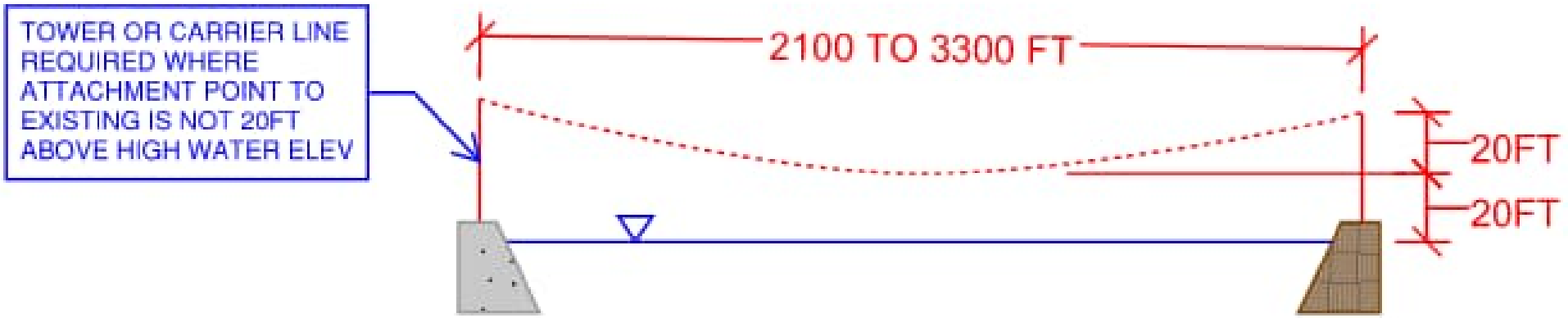
Array Wire Profile

- 20ft minimum cable height above high water elevaton
- 20ft maximum cable sag
- 40ft minimum cable attachment height above high water elevaton



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Appendix G. Site Visit and Meeting Notes

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Site Engineering Investigation Report

McNary Dam Avian Deterrence Concept Design Evaluation Site Visit

USACE Walla Walla District
Contract No.: W912EF23D0014,
Task Order No. W912EF24F9202

October 22, 2024

Site Engineering Investigation Report

Client Name:	USACE Walla Walla District		
Project Name:	McNary Dam Avian Deterrence Concept Design Evaluation Site Visit		
Contract No.:	W912EF23D0014, Task Order No. W912EF24F9202	**Project Manager:**	Ralph Field
Date:	October 22, 2024	**File Name:**	SEI Report_Oct_2024

Document History and Status

Revision	Date	Description	Author	Checked	Reviewed	Approved

Jacobs

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Purpose

Site Investigation to John Day Dam to observe existing Avian Predation Deterrent Array (APDA) and understand existing conditions and alternative design requirements. Day 2 – Site Investigation to McNary Dam to observe existing conditions and how various alternatives will apply at McNary Dam site.

Attendees

Walla Walla District visiting team:

- Mark Jones (project COR)
- Karen Zelch (PM)
- Brandon McNeil (Tech Lead)
- Ryan Ashcraft (Biologist)
- Jared Houchin (Structural)
- Noel Wise (Electrical)
- Chris Peery (Operations)
- Tiffany Stoekig-Dixon (Biologist)

John Day Dam POC:

- Laura Ricketts (Biologist)

McNary Dam POC:

- Bobby Johnson (Biologist)

Jacobs team:

- Ralph Field (PM)
- Gary Santolo (Scientist)
- Kamran Haghighi (Structural)
- Kashifa Kabeer (Electrical)
- James Teeter (Mechanical)

John Day Dam Site Visit
22 October 2024

John Day Dam shore, wire array tower in foreground. John Day Dam powerhouse in background

General

The teams arrived at John Day Dam Fish Operations office approximately 1000. After a brief introduction, the teams moved to the location of the Oregon shore APDA structural towers. Laura Ricketts walked the team through the operation of the two different arrays (synthetic rope and wire), history, installation, and general operation and maintenance. Laura also described an issue they experienced when a maintenance worker was shocked when he was in close proximity of electrical power transmission lines. The site team next moved to the tailrace deck on top of the dam giving the team a unique opportunity to see the entire site, including both south and north fish ladders, APDAs, etc. Another observation point was the north shore Navigation Lock deck which gave the team a view of rope attachment points with tensioners. Finally, all teams met in an office space adjacent to the Nav Lock to discuss what we observed on site and ask any questions. Below are team take-away notes:

- Observed existing avian deterrent system – arrays.
- Arrays are supported by towers (5) and about 125 lines – stainless steel (3/16”), used to have rope before.
- Observed issues with the arrays – fishermen have trouble, birds get caught (2 or 3 in 5 years), they get tangled, birds fly underneath so it is not 100% effective, does not work on pelicans or cormorants.
- Pros of the arrays – works best on gulls.
- Dam side lines are adjustable for sag and tension (see photos).
- Lines need annual maintenance; John Day maintenance crew do not touch the lines, so they need contractor to come and fix anything.
- Longest line is about 3000ft.
- The lines were replaced in 2017, original design was 2009 or 2010.
- They did not want to use drones for installation – expensive and strict protocols.

- Incident in the past – some work was being done at the transmission line and a line fell on the APDA and broke some, no one was hurt.
- There was initial issue with vibration and loud noise because of the wind when lines were installed, so dampeners were installed.
- Other avian deterrent methods: April to July they also do boat hazing, use shotguns, handheld laser.
- Tips to make arrays more effective: height from the water, number of lines and distance between them, instead of going straight may be make them crisscross like a hatch.
- Protection zone extends to 2000 ft downstream of outfall outlet.
- Tension devices installed but not used where steel wires installed.
- Higher density wires would be beneficial.

Electrical Specific

- No lightning protection on towers.
- Temporary grounding is used when work needs to be done.
- Array connection points do not appear to be grounded.
- Powerhouse has 16 units, 155MWh each. All power is generated and transmitted, no incoming power.

Mechanical Specific

- Samples of existing rope lines and steel lines were provided.
- Rope lines tend to snap after storms and need to be replaced every few years.
- Steel lines are still relatively new and seem to be durable.
- Rope lines suspected to experience greater adverse effects of wind and ice loads due to roughness of surface and porousness.

Structural Specifics

John Day Dam Nav Lock Deck Wire Array connections

- The existing ropes are made of synthetic material, which is very expensive. Operations likes to use steel wire which is a fraction of the cost.
- The steel wires are 3/16" diameter.

- There are different types of tower posts. Few are made of welded triangle shape steel pipe columns and supported on individual base plate anchored into a single concrete pad footing. The height of the tower is around 40 feet +/-.
- The newer towers are a single steel post circular shape on a single base plate and supported on a single pad footing.
- Size of footing is roughly 20'x20'.
- Multiple wires attached to top of each tower, additionally steel cable running between two adjacent towers which support more wires/ropes.
- Wires connected to top of dam are attached to the body of the dam through different systems. Some directly to dam and embed hook system. Some are attached to top of a steel post. The steel post is welded to a steel plate which is bolted to the concrete.
- Dampener installed at connection points to reduce the noise and vibrations.
- Some of the connections have winches to tension the ropes and some do not have tensioners. There is no system in place to measure the tension in the ropes.
- Some of the ropes have been broken due to excessive tension or wear and tear. Replacement of the ropes is not easy and requires barge to carry it from one side to the other.
- An effective array includes wires to be spaced apart enough to not touch each other, however, too far apart make it an ineffective system. One of the ways to increase the effective of the system is to somehow create a closer array or create a grid/net system.
- During a Q&A discussion, operators rejected the idea of using drones due to cost and need for control.
- During a Q&A discussion: an idea of feeding the birds to prevent them from predation at dam site is not effective because that method increases the bird population and eventually comes back to the known feeding area (at the dam site) which increases the magnitude of the issue.

McNary Dam Site Visit
23 October 2024

McNary Dam south fish ladder in foreground, dam spillway (middle), and powerhouse (far right).

General

The teams arrived at McNary Dam Fish just outside the security gate at approximately 1000. After a brief introduction, the teams moved to various site observation points on the dam. Bobby Johnson and Chris Peery explained dam operation and witnessed avian predation during various seasons, as well as general operation and maintenance. We then made our way to the south shore where towers may be located. Near the same location, some team members walked out on the Juvenile Bypass System to observe existing conditions and the existing LRAD system. Finally, all teams met in the staff meeting area of the visitor center to discuss what we observed on site and have a question-and-answer period. Below are team take-away notes:

Nav Lock Guidewall on right, JBS Pier coming out from the south shore.

- Shore to shore the dam is about 1.5 miles wide.
- Fish at TSW are in smaller numbers and not considered as important a predation area as the outfall.

- Various avian predation areas are the outfall pipe, the spillway, near the powerhouse, and around the fish ladders.
- The outfall pipe – farthest column holding it is 120ft deep.
- Most juvenile fish move from the forebay to tailrace via the JBS outfall and hazing from a boat and shore is used from about May to August.
- The LRAD system uses audio. Operators have a 24-hour track playing periodically – music, human voices, etc. Other deterrent systems used in the past are laser and water spray/sprinklers but are observed to be mostly ineffective.
- Sprinklers that were used did not deter the pelicans.
- BRZ (boat restricted zone) is from a hatch/stripemark sign downstream of the JBS outfall. Recreational activity is prohibited beyond this virtual boundary to the dam. Only dam employees are permitted to operate boats.
- Can see the outfall pipe at the spillway park.
- Roughly 30% of fish go through turbines.
- Salmonids migrate mostly in the spring/summer.
- Walla Walla District prefers not to have wires attached to the JBS outfall itself. Array towers should be designed either in water or on the shore.
- Sprinkler was largely ineffective.
- Downstream of TSW needs protection from avian predation.
- Ideal priority for APDA is JBS outfall, then TSW. Gulls then cormorants.
- TSW is an issue because this location has a large number of surface fish.
- Cable array should not extend past the BRZ markers.
- Spring runoff can flood 2' over top of outfall pipe.

Electrical Specific

- Powerhouse has 14 units, produces 4160V which is stepped up to high voltage with transformer and transmitted via transmission lines.
- There is sufficient power that is produced in-house for dam operations and to power anything if needed.
- No power comes in from the commercially sourced grid.
- Dam Operations use diesel generators for spillway gates and battery backup in-house.
- Two generator units are black start units, so they do not need power to start.
- Transmission voltage 125kV.
- Lightning has caused trips in the past.
- No lightning protection: the cranes may have lightning protection according to the McNavy Dam POC. Electrical engineer was not available to attend site visit.
- Requirement for new system:
  - Array towers require grounding.
  - Design height of array towers and wire sag must account for dam operation boat clearance.
  - Alternatives can consider APDAs in the water but will likely be scrutinized by regulatory agencies.

- Any alternative considered must not interfere with Navigation Lock operation and river channel.
- Multiple APDA methods at different areas are preferred.

Located on Juvenile Bypass System Pier, Long Range Acoustic Device Behind Brandon McNeil (Project Technical Lead). Far beyond on north shore, Nav Lock Guidewall and Nav Lock Deck.

Appendix H. Review Comments

Comment Report: All Comments
Project: McNary Avian Deterrence
Review: Conceptual Design Report
Displaying 26 comments for the criteria specified in this report.

Id	Discipline	Section/Figure	Page Number	Line Number
11478340	Electrical	n/a	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

I have read through the MNA Avian Deterrence Conceptual Design Evaluation Draft Report and have no comments pertaining to the electrical aspects of the design.

Submitted By: Phong Pham (509.527.7711). Submitted On: Aug 11 2025

1-0 Evaluation **Concurred**
Thank you.

Submitted By: Ralph Field (3606330435) Submitted On: Aug 13 2025

1-1 Backcheck Recommendation **Close Comment**
I have read and reviewed the MNA Avian Deterrence Conceptual Design Evaluation Draft - Final Report, and I have no additional comments.

Submitted By: Phong Pham (509.527.7711) Submitted On: Sep 19 2025
Current Comment Status: **Comment Closed**

11481439	Biology-Ecology	n/a	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

I have no comments on this report.

Submitted By: Bobby Johnson (541-922-2212). Submitted On: Aug 12 2025

1-0 Evaluation **Concurred**
thank you

Submitted By: Mark Jones (509-527-7219) Submitted On: Aug 18 2025

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Mark Jones (509-527-7219) Submitted On: Sep 23 2025
Current Comment Status: **Comment Closed**

11487581	Biology-Ecology	4.1 Alternative 1A	4-1	n/a

Comment Classification: **UNCLASSIFIED (U)**

Biological Effectiveness Evaluation is listed for all alternatives under Alternative 1A heading? Formatting is confusing.

Submitted By: Ryan Ashcraft (509-527-7262). Submitted On: Aug 15 2025

1-0 Evaluation **Concurred**
Format will be corrected for the Final Report

Ralph Field

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ryan Ashcraft (509-527-7262) Submitted On: Sep 22 2025
Current Comment Status: **Comment Closed**

11492368 Biology-Ecology n/a n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

From Tom Lorz (CRITFC): Do we have information that the larger diameter wire has the issues outlined? Is there opportunity for additional review of the different wire diameters?

Submitted By: Ryan Ashcraft (509-527-7262). Submitted On: Aug 19 2025

1-0 Evaluation **For Information Only**
To prevent gulls from perching, wire should be
Ralph Field

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ryan Ashcraft (509-527-7262) Submitted On: Sep 22 2025
Current Comment Status: **Comment Closed**

11492378 Biology-Ecology n/a n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

From Tom Lorz (CRITFC): Was using the pilings of the JBS or placing a tower or two downstream of the JBS considered as an option? Why were they ruled out if they were considered?

Submitted By: Ryan Ashcraft (509-527-7262). Submitted On: Aug 19 2025

1-0 Evaluation **For Information Only**
These options were considered and discussed in the Concept Design Workshop (CDW).

Ralph Field

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
Backcheck not conducted

2-0 Evaluation **Concurred**
Options which considered use of JBS pilings for tower structural support or placing towers downstream were analyzed as alternatives and ruled out. Discussed in the CDW, use of the JBS pier would add structural forces to the JBS that were not anticipated for in the JBS design thereby risking compromise of the JBS pier structural integrity. In-water towers were discussed throughout the development period. It was noted in-water towers were not preferred due to the increased chance of collecting river debris, and unfavorable conditions for tower constructability, wire installation, and operations and maintenance.

Submitted By: Ralph Field (3606330435) Submitted On: Sep 17 2025

2-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Ryan Ashcraft (509-527-7262) Submitted On: Sep 22 2025
Current Comment Status: **Comment Closed**

11507035 Biology-Ecology n/a 4-1 n/a
Comment Classification: **UNCLASSIFIED (U)**

Consider moving the Biological Effectiveness Evaluation for each alternative and the ranking for each alternative to section 5 where the recommendations are summarized. Its seems out of place under alternative 1A

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0 Evaluation **Check and Resolve**
Would it make sense to have the bio evaluations in both places? We are open to formatting the report in a way that supports clear content and recommendations.

Ralph Field

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Final report was better organized and made sense as a reader.

Submitted By: Jared Houchin ((509)527-7624) Submitted On: Sep 23 2025
Current Comment Status: **Comment Closed**

11507037 Structural 4 n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

Consider adding images similar to those used in the refined alternatives review presentation to the alternative analysis sections along with their description. Would help clearly define which alternative is which.

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0 Evaluation **Concurred**
Images will be added to final report.

Garrett Van Ruiten

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Images added

Submitted By: Jared Houchin ((509)527-7624) Submitted On: Sep 23 2025
Current Comment Status: **Comment Closed**

11507041 Structural 4.1.3, 4.3.3 n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

Suggest removing tower description from these sections. The tower is explained in 3.4.3 and seems repetitive to also include in these sections.

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0 Evaluation **Concurred**
Sections will be updated to reduce repetitive descriptions.

Garrett Van Ruiten

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Sections updated

Submitted By: Jared Houchin ((509)527-7624) Submitted On: Sep 23 2025
Current Comment Status: **Comment Closed**

11507045 Structural 4.3.5 n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

Consider changing the quantity of wire termination to the actual amount instead of the amount reduced by. Unsure what the baseline is and how significant a reduction of 45 terminations is.

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0 Evaluation **Concurred**
This will be updated to clarify magnitude of increase.

Garrett Van Ruiten

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Quantities updated. Easier to understand.

Submitted By: Jared Houchin ((509)527-7624) Submitted On: Sep 23 2025
Current Comment Status: **Comment Closed**

11507048 Electrical 4.1.4, 4.2.4, 4.3.4, 4.4.4 n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

Consider rewording the description of the grounding to avoid the word anchor pipe. This could get confused with anchorage to the dam and not anchorage of the towers.

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0 Evaluation **Concurred**
This will be updated.

Kashifa Kabeer

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Section updated and clarity was made.

Submitted By: Jared Houchin ((509)527-7624) Submitted On: Sep 23 2025
Current Comment Status: **Comment Closed**

11507052 Electrical 4.1.4, 4.2.4, 4.3.4, 4.4.4 n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

Is there any grounding requirements required on the anchorage side of the wires? Consider adding clarity that only the tower requires grounding.

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0 Evaluation **Concurred**
This will be updated.

Kashifa Kabeer

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Grounding for anchorage side added

Submitted By: Jared Houchin ((509)527-7624) Submitted On: Sep 23 2025
Current Comment Status: **Comment Closed**

11507059 Cost Engineering 4.2.7, 4.3.7, 4.4.7 n/a n/a
Comment Classification: **UNCLASSIFIED (U)**

Cost estimate description contradicts alternative description. Consider rewording for clarity.

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0 Evaluation **Concurred**
Cost estimate descriptions will be coordinated with the report.

Ralph Field

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Sections updated

Submitted By: Jared Houchin ((509)527-7624) Submitted On: Sep 23 2025
Current Comment Status: **Comment Closed**

11507060 Biology-Ecology 5 n/a n/a
Comment Classification: **UNCLASSIFIED (U)**

Alternative 3 not mentioned in summary of recommendations. Worth mentioning that is can be added with any wire array alternative.

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0 Evaluation **Check and Resolve**
Statement can be added as recommended. The intent was to keep Alternative 3 independent since the alternative could not be further developed due to lack of empirical data.

Ralph Field

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Alternative 3 being added to any alternative was addressed better at the beginning of the report.

Submitted By: Jared Houchin ((509)527-7624) Submitted On: Sep 23 2025
Current Comment Status: **Comment Closed**

11507061 Structural Appendix A n/a n/a
Comment Classification: **UNCLASSIFIED (U)**

Multiple copies of the same drawings included with many seeming to be old and outdated versions of the same drawings

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0 Evaluation **Concurred**
This will be updated so only the final drawing are included.

Garrett Van Ruiten

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Only the final drawings were included with the final report

Submitted By: Jared Houchin ((509)527-7624) Submitted On: Sep 23 2025
Current Comment Status: **Comment Closed**

11507065 Structural Appendix A n/a n/a
Comment Classification: **UNCLASSIFIED (U)**

Recommend adding a table to the anchorage drawings with quantities of each anchorage used. I see that quantities are called out on the layout of each wire array but a table with the anchorages would be a nice summary.

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0 Evaluation **Concurred**
Tables will be added to detail sheets to show quantity of each anchorage.

Garrett Van Ruiten

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Table added to help summarize quantities.

Submitted By: Jared Houchin ((509)527-7624) Submitted On: Sep 23 2025

Current Comment Status: **Comment Closed**

11507069 Structural n/a n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

Comments added in Dr Checks. Markup attached for any clarity needed on sections referenced. Some other small comments are included on the markups that I did not seem fit for their own whole comment.

(Attachment: MNA_APDA_Concept_Evaluation_Report_Draft.pdf)

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0 Evaluation **Concurred**

Comment responses in attachment are 'Concur' unless noted otherwise. Please see attachment for status and response to all comments.

Garrett Van Ruiten

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
(Attachment: Attachment_for_Comment_ID_11507069.pdf)

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Jared Houchin ((509)527-7624) Submitted On: Sep 23 2025

Current Comment Status: **Comment Closed**

11513011 Mechanical n/a n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

Section 1.5.3 (PDF page 10) - Final paragraph is self-contradictory "two alternatives were selected for refinement..." than "Alternatives 14, 16, and 17 were selected to be refined."

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0 Evaluation **Concurred**

Alternatives selected for refinement will be clarified.

Garrett Van Ruiten

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Brandon McNeil (5095277544) Submitted On: Sep 22 2025

Current Comment Status: **Comment Closed**

11513014 Mechanical n/a n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

Section 1.5.4 (PDF page 12) - Recommend noting how alternatives were renumbered. 1A = ? / 1B = ? in reference to table 1-1.

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0 Evaluation **Concurred**
Alternatives selected for refinement will be clarified.

Garrett Van Ruiten

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Brandon McNeil (5095277544) Submitted On: Sep 22 2025
Current Comment Status: **Comment Closed**

11513015 Mechanical n/a n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

Section 1.5.5 (PDF page 12) – Recommend including relationship between alternative from table 1-1 and the evaluated alternatives in this report. Recommend including an update regarding wire size/code and how addressed/included in this report (2A & 2B).

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0 Evaluation **Concurred**
Alternatives selected for refinement will be clarified. Summary of applicable criteria/codes for Alternatives 1A/1B compared to those for Alternatives 2A/2B.

Garrett Van Ruiten

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Brandon McNeil (5095277544) Submitted On: Sep 22 2025
Current Comment Status: **Comment Closed**

11513019 Mechanical n/a n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

Recommend including additional sections: 3.6 describing constructability criteria and 3.7 describing Operation and Reliability criteria.

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0 Evaluation **Concurred**
Will include sections summarizing constructability criteria and Operation and Reliability criteria considered in the report.

Garrett Van Ruiten

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Brandon McNeil (5095277544) Submitted On: Sep 22 2025
Current Comment Status: **Comment Closed**

11513022 Mechanical n/a n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

Section 4 - Recommend including graphics in the description of each alterative (something like on PDF pg. 271). Referencing the corresponding alternative from table 1-1 in the descriptions of each alterative would also be helpful.

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0 Evaluation **Concurred**
Images will be added to final report. Previous sections will be updated to clarify how Table 1-1 alternative numbers correspond to alternative names used in the report.

Garrett Van Ruiten

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Brandon McNeil (5095277544) Submitted On: Sep 22 2025
Current Comment Status: **Comment Closed**

11513023 Mechanical n/a n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

Section 4.1 titled is Alternative 1A. Section 4.1.2 discusses all the alternatives and compares them. This is very useful but does not fit the organization of the report.

Reorganizing as follows might help:
4.1 Alternatives Description (4.1.1-alt 1A, ect). 4.2 Biological Effectiveness Evaluation
4.3 Structural Evaluation
4.4 Electrical Evaluation
4.5 Constructability Evaluation
4.6 Operation and Reliability Evaluation
4.7 Cost Estimate.

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0 Evaluation **Concurred**
Format will be corrected for the Final Report

Ralph Field

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Brandon McNeil (5095277544) Submitted On: Sep 22 2025
Current Comment Status: **Comment Closed**

11513024 Mechanical n/a n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

PDF pages 48-57 appear to be a duplicates.

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0 Evaluation **Concurred**
This will be updated so only the final drawing are included.

Garrett Van Ruiten

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Brandon McNeil (5095277544) Submitted On: Sep 22 2025
Current Comment Status: **Comment Closed**

11513026 Mechanical n/a n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

PDF page 43 & 58 are both titled Alternative 1A but are different. Page 58 appears more consistent with alterative description.

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0 Evaluation **Concurred**
This will be updated so only the final drawing are included.

Garrett Van Ruiten

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Brandon McNeil (5095277544) Submitted On: Sep 22 2025
Current Comment Status: **Comment Closed**

11513027 Mechanical n/a n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

PDF page 44 & 59 are both titled Alternative 1B but are different. Page 59 appears more consistent with alterative description.

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0 Evaluation **Concurred**
This will be updated so only the final drawing are included.

Garrett Van Ruiten

Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Brandon McNeil (5095277544) Submitted On: Sep 22 2025
Current Comment Status: **Comment Closed**

11527479 Mechanical n/a n/a n/a

Comment Classification: **UNCLASSIFIED (U)**

See report markups from Kevin Renshaw, Mechanical Design Section Chief.

(Attachment: MNA_APDA_Concept_Evaluation_Report_Draft_KMR_cmts_9-10-25.pdf)

Submitted By: Mark Jones (509-527-7219). Submitted On: Sep 12 2025

1-0 Evaluation **Concurred**

Concur with all but two markups. Two FIOs are straight forward. Please see individual evaluations in the file attached.

Submitted By: Ralph Field (3606330435) Submitted On: Sep 17 2025 (Attachment: MNA_APDA_Concept_Evaluation_Report_Draft_KMR_cmts_Jacobs_evals.pdf)

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Kevin Renshaw (509 527 7570) Submitted On: Sep 24 2025

Current Comment Status: **Comment Closed**

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Appendix I. Draft Conceptual Design Review Meeting

Jacobs

Meeting Minutes

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Bellevue, WA 98004
United States
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www.jacobs.com

Subject	**McNary Avian Deterrent Concept Comment Review Meeting Minutes**		
Project	USACE Walla Walla District McNary, Avian Deterrent Concept Evaluation		
Project No.	Contract W912EF-23-D0014 Task Order W912EF24F9202		
Prepared by	Ralph Field	**Phone No.**	360-633-0435
Location	Held on Microsoft Teams	**Meeting Date**	04 September 2025
Attendees	See Section **4 Attendance**		

The following is our understanding of the subject matter covered in this meeting. If this differs from your understanding, please notify us within five (5) business days.

1 **Culture of Caring Moment –** Today's air quality is moderate to unhealthy across most of Washington caused by local wildfires as well as wildfires from Oregon and California. If you're one of those who are bothered by poor air quality, recommend staying indoors. Stay safe.

2 Comments Discussed

- 11487581 – Jacobs concurs and will fix in final report. Ryan agreed.
- 11492368 – Jacobs will update report to provide basis. The opportunity to discuss using different wire size is up to Walla Walla District AHJ. Our report provides two alternatives. Ryan agrees with Jacob's response and will let Tom Lorz know.
- 11492378 – Jacobs – Karen and Ryan suggest writing a more detailed evaluation for Tom Lorz. *Ralph concurred.*
- 11507035 – Jacobs will make some formatting changes. Jared suggested to keep the top part of the bio effectiveness in the sections and the ranking would go in Section 5 where it's most effective. Reformatting needed. Jacobs will make changes.
- 11507037 – Jacobs will add images to the final report.
- 11507041 – Jacobs will update sections. Jacobs will refer to the first section and take out the repetition.
- 11507045 –Garrett will give values for each alternative to see comparison.
- 11507048 – Jacobs will change the wording of the description.

- 11507052 – Jacobs concurred and will update.
- 11507059 – Jacobs will update the cost estimate descriptions and will be coordinated in final report.
- 11507060 – Jacobs – It was our understanding the district was not inclined to pursue Alternative 3 from a value standpoint since it could only be developed to a certain level in comparison to the other concepts. Jacobs will add a statement about Alternative 3 being an optional add-on to provide context clarity.
- 11507061 – Jacobs will make corrections in Final.
- 11507065 – Jacobs will add an Excel detailed summary table.
- 11507069 – Jared suggested to avoid white space in plans. Garrett explained why it was presented that way. Jared was OK with the explanation.
- 11513014 – Brandon concurs with Jacobs' response
- 11513023 – Brandon's request for reorganization is just a recommendation.
- *Jacobs will review spelling errors in Table 1-1 and make all corrections.*

3 Schedule

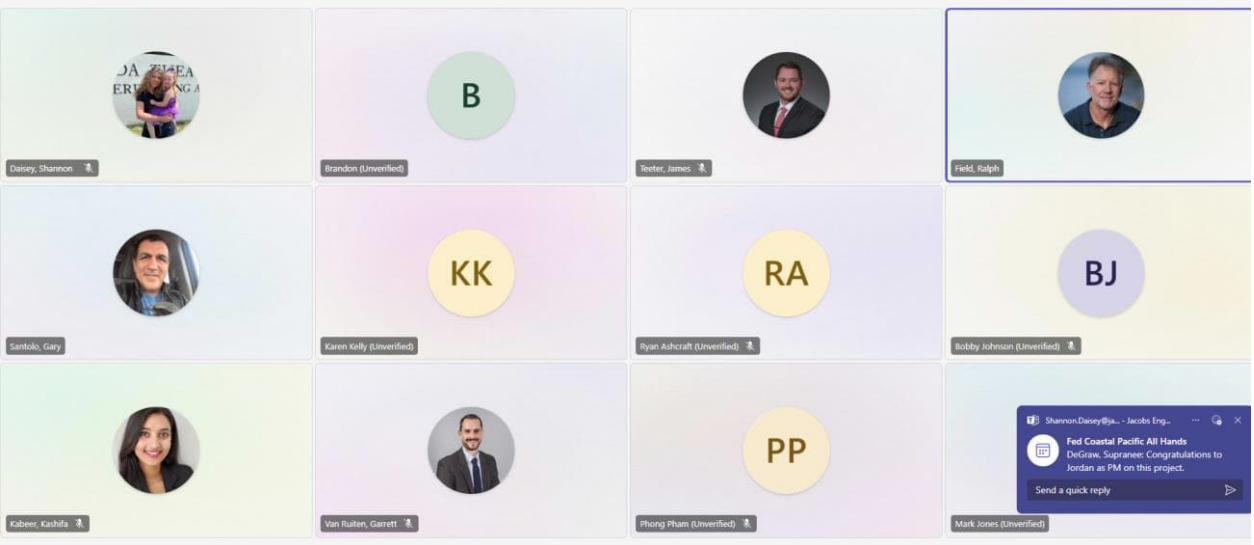
Jacobs will submit the Final on Sept 15, 2025. The Government will then have until Sept 26, 2025, to backcheck comments. If the Government has additional comments, Jacobs will resubmit final on Sept 29, 2025.

4 Attendance

Attendee	Company	Role	Present
Karen Kelly	NWW District	Project Manager	x
Mark Jones	NWW District	COR	x
Brandon McNeil	NWW District	Technical Lead	x
Ryan Ashcraft	NWW District	Fish Biologist	x
Bobby Johnson	NWW District	Fish Biologist	x
Phong Pham	NWW District	Electrical Engineer	x
Jared Houchin	NWW District	Structural Engineer	x
Ralph Field	Jacobs	Project Manager	x
Gary Santolo	Jacobs	Avian Scientist	x
Kashifa Kabeer	Jacobs	Electrical Engineer	x
James Teeter	Jacobs	Mechanical Engineer	x
Garrett Van Ruiten	Jacobs	Structural Engineer	x

Shannon Daisey	Jacobs	Project Coordinator	x

END OF MEETING MINUTES



Comment Report: All Comments
Project: (FY250410) McNary Avian Deterrence Review: Conceptual Design Report
Displaying 25 comments for the criteria specified in this report.
407 ms to run this page

Id	Discipline	Section/Figure	Page Number	Line Number
11478340	Electrical	n/a	n/a	n/a
Comment Classification: **UNCLASSIFIED (U)** I have read through the MNA Avian Deterrence Conceptual Design Evaluation Draft Report and have no comments pertaining to the electrical aspects of the design. Submitted By: Phong Pham (509.527.7711). Submitted On: Aug 11 2025				
1-0	Evaluation **Concurred** Thank you. Submitted By: Ralph Field (3606330435) Submitted On: Aug 13 2025			
	Backcheck not conducted			
	Current Comment Status: **Comment Open**			
11481439	Biology-Ecology	n/a	n/a	n/a
Comment Classification: **UNCLASSIFIED (U)** I have no comments on this report. Submitted By: Bobby Johnson (541-922-2212). Submitted On: Aug 12 2025				
1-0	Evaluation **Concurred** thank you Submitted By: Mark Jones (509-527-7219) Submitted On: Aug 18 2025			
	Backcheck not conducted			
	Current Comment Status: **Comment Open**			
11487581	Biology-Ecology	4.1 Alternative 1A	4-1	n/a
Comment Classification: **UNCLASSIFIED (U)** Biological Effectiveness Evaluation is listed for all alternatives under Alternative 1A heading? Formatting is confusing. Submitted By: Ryan Ashcraft (509-527-7262). Submitted On: Aug 15 2025				
1-0	Evaluation **Concurred** Format will be corrected for the Final Report Ralph Field Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025			
	Backcheck not conducted			
	Current Comment Status: **Comment Open**			
11492368	Biology-Ecology	n/a	n/a	n/a
Comment Classification: **UNCLASSIFIED (U)**				

From Tom Lorz (CRITFC): Do we have information that the larger diameter wire has the issues outlined? Is there opportunity for additional review of the different wire diameters?

Submitted By: Ryan Ashcraft (509-527-7262). Submitted On: Aug 19 2025

1-0	Evaluation **For Information Only** To prevent gulls from perching, wire should be <0.95mm and best if 0.7mm based on the Minnesota DNR. Wire cannot be that small due to many performance factors. Generally, the assumption is, the larger the wire size, the greater the perching. Wire diameters shown are minimum required to support structural loads and smaller wire sizes are not feasible. Opportunities for additional review of wire diameters remain with the AHJ. Ralph Field Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11492378	Biology-Ecology	n/a	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

From Tom Lorz (CRITFC): Was using the pilings of the JBS or placing a tower or two downstream of the JBS considered as an option? Why were they ruled out if they were considered?

Submitted By: Ryan Ashcraft (509-527-7262). Submitted On: Aug 19 2025

1-0	Evaluation **For Information Only** These options were considered and discussed in the Concept Design Workshop (CDW). Ralph Field Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11507035	Biology-Ecology	n/a	4-1	n/a

Comment Classification: **UNCLASSIFIED (U)**

Consider moving the Biological Effectiveness Evaluation for each alternative and the ranking for each alternative to section 5 where the recommendations are summarized. Its seems out of place under alternative 1A

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0	Evaluation **Check and Resolve** Would it make sense to have the bio evaluations in both places? We are open to formatting the report in a way that supports clear content and recommendations. Ralph Field Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11507037	Structural	4	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

Consider adding images similar to those used in the refined alternatives review presentation to the alternative analysis sections along with their description. Would help clearly define which alternative is which.

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0	Evaluation **Concurred** Images will be added to final report. Garrett Van Ruiten Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11507041	Structural	4.1.3, 4.3.3	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

Suggest removing tower description from these sections. The tower is explained in 3.4.3 and seems repetitive to also include in these sections.

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0	Evaluation **Concurred** Sections will be updated to reduce repetitive descriptions. Garrett Van Ruiten Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11507045	Structural	4.3.5	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

Consider changing the quantity of wire termination to the actual amount instead of the amount reduced by. Unsure what the baseline is and how significant a reduction of 45 terminations is.

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0	Evaluation **Concurred** This will be updated to clarify magnitude of increase. Garrett Van Ruiten Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11507048	Electrical	4.1.4, 4.2.4, 4.3.4, 4.4.4	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

Consider rewording the description of the grounding to avoid the word anchor pipe. This could get confused with anchorage to the dam and not anchorage of the towers.

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0	Evaluation **Concurred** This will be updated. Kashifa Kabeer

	Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11507052	Electrical	4.1.4, 4.2.4, 4.3.4, 4.4.4	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

Is there any grounding requirements required on the anchorage side of the wires? Consider adding clarity that only the tower requires grounding.

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0	Evaluation **Concurred** This will be updated. Kashifa Kabeer Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11507059	Cost Engineering	4.2.7, 4.3.7, 4.4.7	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

Cost estimate description contradicts alternative description. Consider rewording for clarity.

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0	Evaluation **Concurred** Cost estimate descriptions will be coordinated with the report. Ralph Field Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11507060	Biology-Ecology	5	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

Alternative 3 not mentioned in summary of recommendations. Worth mentioning that is can be added with any wire array alternative.

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0	Evaluation **Check and Resolve** Statement can be added as recommended. The intent was to keep Alternative 3 independent since the alternative could not be further developed due to lack of empirical data. Ralph Field Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11507061	Structural	Appendix A	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

Multiple copies of the same drawings included with many seeming to be old and outdated versions of the same drawings

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0	Evaluation **Concurred** This will be updated so only the final drawing are included. Garrett Van Ruiten Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11507065	Structural	Appendix A	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

Recommend adding a table to the anchorage drawings with quantities of each anchorage used. I see that quantities are called out on the layout of each wire array but a table with the anchorages would be a nice summary.

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0	Evaluation **Concurred** Tables will be added to detail sheets to show quantity of each anchorage. Garrett Van Ruiten Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11507069	Structural	n/a	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

Comments added in Dr Checks. Markup attached for any clarity needed on sections referenced. Some other small comments are included on the markups that I did not seem fit for their own whole comment.

(Attachment: MNA_APDA_Concept_Evaluation_Report_Draft.pdf)

Submitted By: Jared Houchin ((509)527-7624). Submitted On: Aug 27 2025

1-0	Evaluation **Concurred** Comment responses in attachment are 'Concur' unless noted otherwise. Please see attachment for status and response to all comments. Garrett Van Ruiten Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025 (Attachment: Attachment_for_Comment_ID_11507069.pdf)
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11513011	Mechanical	n/a	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

Section 1.5.3 (PDF page 10) - Final paragraph is self-contradictory "two alternatives were selected for refinement..." than "Alternatives 14, 16, and 17 were selected to be refined."

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0	Evaluation **Concurred** Alternatives selected for refinement will be clarified. Garrett Van Ruiten Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11513014	Mechanical	n/a	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

Section 1.5.4 (PDF page 12) - Recommend noting how alternatives were renumbered. 1A = ? / 1B = ? in reference to table 1-1.

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0	Evaluation **Concurred** Alternatives selected for refinement will be clarified. Garrett Van Ruiten Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11513015	Mechanical	n/a	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

Section 1.5.5 (PDF page 12) – Recommend including relationship between alternative from table 1-1 and the evaluated alternatives in this report. Recommend including an update regarding wire size/code and how addressed/included in this report (2A & 2B).

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0	Evaluation **Concurred** Alternatives selected for refinement will be clarified. Summary of applicable criteria/codes for Alternatives 1A/1B compared to those for Alternatives 2A/2B. Garrett Van Ruiten Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11513019	Mechanical	n/a	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

Recommend including additional sections: 3.6 describing constructability criteria and 3.7 describing Operation and Reliability criteria.

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0	Evaluation **Concurred** Will include sections summarizing constructability criteria and Operation and Reliability criteria considered in the report. Garrett Van Ruiten

	Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11513022	Mechanical	n/a	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

Section 4 - Recommend including graphics in the description of each alterative (something like on PDF pg. 271). Referencing the corresponding alternative from table 1-1 in the descriptions of each alterative would also be helpful.

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0	Evaluation **Concurred** Images will be added to final report. Previous sections will be updated to clarify how Table 1-1 alternative numbers correspond to alternative names used in the report. Garrett Van Ruiten Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11513023	Mechanical	n/a	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

Section 4.1 titled is Alternative 1A. Section 4.1.2 discusses all the alternatives and compares them. This is very useful but does not fit the organization of the report.

Reorganizing as follows might help:
4.1 Alternatives Description (4.1.1-alt 1A, ect). 4.2 Biological Effectiveness Evaluation
4.3 Structural Evaluation
4.4 Electrical Evaluation
4.5 Constructability Evaluation
4.6 Operation and Reliability Evaluation
4.7 Cost Estimate.

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0	Evaluation **Concurred** Format will be corrected for the Final Report Ralph Field Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11513024	Mechanical	n/a	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

PDF pages 48-57 appear to be a duplicates.

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0	Evaluation **Concurred** This will be updated so only the final drawing are included. Garrett Van Ruiten

	Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11513026	Mechanical	n/a	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

PDF page 43 & 58 are both titled Alternative 1A but are different. Page 58 appears more consistent with alterative description.

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0	Evaluation **Concurred** This will be updated so only the final drawing are included. Garrett Van Ruiten Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**

11513027	Mechanical	n/a	n/a	n/a

Comment Classification: **UNCLASSIFIED (U)**

PDF page 44 & 59 are both titled Alternative 1B but are different. Page 59 appears more consistent with alterative description.

Submitted By: Brandon McNeil (5095277544). Submitted On: Sep 02 2025

1-0	Evaluation **Concurred** This will be updated so only the final drawing are included. Garrett Van Ruiten Submitted By: Shannon Daisey (562-619-5127) Submitted On: Sep 03 2025
	Backcheck not conducted
	Current Comment Status: **Comment Open**