Naselle Fish Hatchery A/E Final Design Services – Phase II Project Design

Washington Department of Fish and Wildlife

Naselle Fish Hatchery Exclusion Barrier: Backwater Analysis Report

Revision No. #1

McMillen

January 26, 2023

This page intentionally left blank.

Table of Contents

EXECUTIVE SUMMARY .... **iv**

1.0 INTRODUCTION **1**
- 1.1 Purpose 1
- 1.2 Background 1
- 1.3 Report Organization 2

2.0 DESIGN CRITERIA **3**
- 2.1 Exclusion Barrier Design Criteria 3
- 2.2 Juvenile/Resident Fish Ladder Design Criteria 4

3.0 DESIGN AND OPERATIONS **5**
- 3.1 Exclusion Barrier Design Description 5
- 3.2 Exclusion Barrier Operations 6
- 3.3 Juvenile/Resident Fish Ladder Design Description 7
- 3.4 Juvenile/Resident Fish Ladder Operations 9
- 3.5 Operational Summary 10

4.0 BACKWATER ANALYSIS METHODOLOGY **12**
- 4.1 Data Sources 12
- 4.2 Model Version 12
- 4.3 Geometry Development 13
- 4.4 Boundary and Initial Conditions 15

5.0 BACKWATER ANALYSIS RESULTS **16**

6.0 IMPACTS AND MITIGATION ANALYSIS **25**
- 6.1 Temporary Construction Impacts 25
- 6.2 Long-Term Impacts and Mitigation 26

7.0 REFERENCES **29**

List of Tables

Table 1-1. Design Documentation Report Outline 2

Table 2-1. Exclusion Barrier Design Criteria (McMillen Jacobs 2020)..3

Table 2-2. Juvenile/Resident Fish Ladder Design Criteria (McMillen Jacobs 2020)....................................4

Table 3-1. Juvenile/Resident Fish Ladder Operational Performance 10

Table 4-1. Hydraulic Model Data Sources 12

Table 6-1. Intake Pumping Rates, River Flows and Water Surface Elevations by Month 27

List of Figures

Figure 3-1. Section View of the Current Exclusion Barrier Design Showing the Weir in Both the "Up" and "Down" Positions 5

Figure 3-2. Plan View of the Current Exclusion Barrier, Resident Ladder and Intake Design 6

Figure 3-3. Elevation View from Downstream of the Juvenile/Resident Fish Ladder in the Closed Position (All Stoplogs In) 8

Figure 3-4. Section View through the Juvenile/Resident Fish Ladder from Upstream (Left) to Downstream (Right) 9

Figure 4-1. Plan View of the Model Domain Showing Cross Sections Built from Topobathymetry and LiDAR Datasets..13

Figure 4-2. Aerial View of the Naselle River Reach, Showing Uniformity of Bank Lines and Straightness of the Overall Reach 14

Figure 4-3. Example Cross Section with Overlapping LiDAR and Topobathymetric Data.........................15

Figure 5-1. Hydraulic Profile for Baseline and Alternative 1 (Proposed) Conditions for the Mean Daily Flow and the 100-Year Flood with the Obermeyer in the "Down" Position 18

Figure 5-2. Water Surface Elevation Results for Cross Section 06+85 for Both Baseline and Alternative 1 (Proposed) Conditions 19

Figure 5-3. Water Surface Elevation Results for Cross Section 12+85 for Both Baseline and Alternative 1 (Proposed) Conditions 20

Figure 5-4. Water Surface Elevation Results for Cross Section 21+85 for Both Baseline and Alternative 1 (Proposed) Conditions 21

Figure 5-5. Water Surface Elevation for Cross Section 27+85 for Both Baseline and Alternative 1 (Proposed) Conditions 22

Figure 5-6. Plan View of Model Flood Extents Overlain on Aerial Photo of the Area (Mean Daily Flow) ...23

Figure 5-7. Plan View of Model Flood Extents Overlain on Aerial Photo of the Area (100-Year Flood).....24

Distribution

To:	Robert Lund, P.E. Environmental Engineer – CAMP Washington Department of Fish & Wildlife
	Gina Carr, P.E. Environmental Engineer – CAMP Washington Department of Fish & Wildlife
	Robert Allan Region 6 Hatchery Operations Manager Washington Department of Fish & Wildlife
From:	Kevin Jensen, P.E. McMillen
Prepared By:	Kevin Jensen, P.E. McMillen
	Seth Eisele, EIT McMillen
Reviewed By:	Joy Terry, P.E. McMillen

Revision Log

Revision No.	Date	Revision Description
0	December 29, 2022	Draft for WDFW Review
1	January 26, 2023	WDFW Review Incorporated

EXECUTIVE SUMMARY

As part of the Washington Department of Fish and Wildlife's (WDFW's) Naselle Hatchery Renovation Project, McMillen, Inc (McMillen). has designed a fish exclusion barrier to a 90% level of completion. The barrier is proposed to replace the existing weir that is currently located at the Naselle Hatchery intake on the Naselle River in southwest Washington State. The new exclusion barrier is intended to help guide migrating fish into the hatchery facility for sorting during the trapping season and to facilitate upstream and downstream passage of fish during the non-trapping season. The exclusion barrier would consist of an Obermeyer-style inflatable bladder weir that can be automatically raised and lowered remotely to improve worker safety and to minimize maintenance requirements associated with debris.

To maximize trapping efficiency associated with the new barrier, Washington State will follow the National Marine Fisheries Service guidance on exclusion barrier criteria, which prescribe the overall static drop across the weir, the slope and drop across the downstream apron, and the final drop into the maximum tailwater. These criteria have placed constraints on the elevations associated with the new exclusion barrier, requiring that the bottom sill be elevated approximately 1 foot above the existing sill elevation. The net result of this modification mean that, with the Obermeyer weir in the "down" position, the static water level at the weir location would be 1 foot higher than it is today, provided that the new juvenile ladder and intake sluice channel are both closed off and not passing water. In addition, during the trapping season, the new Obermeyer weir would be raised approximately 3.5 feet above the new sill elevation, effectively raising the water level at the barrier by 4.5 feet. These increases in water level are expected to taper off in the downstream direction.

After developing the 90% design package for the renovation project, WDFW has subsequently received important stakeholder input form the local community and other state and local agencies. Some of this input has included concerns related to the backwater impact of the proposed Obermeyer weir. More specifically, there is concern that upstream private property may be negatively impacted by the Obermeyer weir, potentially inducing additional flooding that could damage property improvements or otherwise impact raw land. Because of these concerns, WDFW and McMillen developed a hydraulic model of the Naselle River to investigate both baseline (current, pre-project) conditions and proposed (with project) conditions to better understand the extent of the backwater effect of the proposed barrier.

The model was built using the Hydrologic Engineering Center's River Analysis System (HEC-RAS) and Light Detection and Range (LiDAR) topographic data combined with project-specific site survey data. Hydrologic inputs were borrowed from analyses conducted separately or the project, and the model geometry was manipulated to reflect future proposed conditions at the barrier.

As expected, the vertical rise in water level is greatest near the weir and tapers to near zero in the upstream direction. Approximately 2,500 feet upstream of the weir, at a location just upstream of the bridge crossing of the Naselle River, the change in water level between existing and proposed conditions during the mean daily flow event is +0.5 inches. At the same location, the change in water level between existing and proposed conditions during the 100-year flow event is +1.7 inches. Due to the relatively steep banks within the Naselle River, these small vertical rises in water level equate to a very limited additional lateral spread into the upland area. In the worst case, at Station 06+85, the edge of water during the 100-year flood event moves inland approximately 8 feet under proposed conditions, compared with existing. Based on an assessment of upstream building structures, the 100-year flood flow does not encroach within about 35 feet of any existing buildings, both under existing an proposed conditions.

In addition to the modeling effort, a standard operating procedure for the proposed Obermeyer barrier was developed and outlined. The procedure indicates when the Obermeyer will be in the “up” position (generally July through February) and how it will be operated during flow that would otherwise approach the ordinary high water mark (OHWM). Specifically, as the water level behind the barrier approaches the OHWM during extreme event, the Obermeyer weir will be incrementally lowered to maintain the water level behind the weir. This will happen until the weir is completely lowered, as needed. The result of this operational protocol is that the OHWM will not change under proposed conditions. This will help maintain the long-term morphology of the reach upstream of the barrier. In addition, upstream erosion due to the operation of the barrier is not expected and scour downstream will be avoided through the design of downstream scour protection features.

1.0 INTRODUCTION

1.1 Purpose

The purpose of this Backwater Analysis Report (Report) is to provide a description of the design criteria, the overall design and operations, and the potential impacts associated with the juvenile/resident fish ladder and exclusion barrier for the Naselle Hatchery Project (Project), as well as to present potential mitigation options to address those impacts and to propose a design and operational configuration to carry forward into final engineering design and construction implementation.

1.2 Background

The Project involves architectural and engineering (A/E) design services for the Washington Department of Fish and Wildlife (WDFW) Naselle Fish Hatchery located on the Naselle River, a tributary of Willapa Bay, near the town of Naselle in southwest Washington. The original facility was constructed in 1978 and includes salmon and steelhead adult trapping, holding and spawning facilities as well as incubation and juvenile rearing infrastructure. The program currently raises fall-run Chinook Salmon (*Oncorhynchus tshawytscha*), Coho Salmon (*Oncorhynchus kisutch*), Chum Salmon (*Oncorhynchus keta*) and steelhead trout (*Oncorhynchus mykiss*). All fish stocks and species (including salmonids and all game and non-game fish) within the Naselle watershed are currently unlisted under the U.S. Endangered Species Act and no Tribal agreements are currently in place to regulate hatchery operations.

A hatchery Predesign Study was conducted in 2016 and identified major renovations required to address critical infrastructure deficiencies at the site. A redesign of the hatchery facility has been ongoing since 2018, with redesign implementation broken into three separate phases spread out over a number of years:

- Phase 1 of the redesign included new sedimentation basins for the two main hatchery water sources (Naselle River and Crusher Creek), a new distribution box to route water from the new sedimentation basins to a variety of destinations throughout the hatchery facility, and a new pipeline along North Valley Road connecting the facility with the intake along Crusher Creek. Phase 1 was successfully implemented in 2020 and has been in operation since.

- Phase 2 of the redesign will include a new Naselle River exclusion barrier, a new intake building and pump station with actively cleaned fish screens, a new juvenile/resident fish ladder to pass species of all life stages upstream of the exclusion barrier, and a new adult fish ladder to pass upstream migrants to a trapping and sorting facility where hatchery fish can be directed to holding ponds and wild fish and resident fish can be safely conveyed back to the river upstream of the facility. The Phase 2 design effort is currently at a 90% level of completion, with final permits and contract documents anticipated in the spring of 2023.

- Phase 3 of the redesign will include the adult trap and crowding system, the sorting facility, a number of ponds for holding and rearing, a new incubation building, and a small re-use pump station for re-using effluent water during periods of critical water shortage. Phase 3 design is anticipated to begin later in 2023.

Project design elements associated with Phase 2 include, among others, the construction of an adjustable velocity-type exclusion barrier in the Naselle River, a new juvenile/resident fish ladder in the Naselle River (hereafter referred to as the "resident ladder"), and modifications to an existing intake structure that screens fish from pumped hatchery supply water. Due to the location of these facility components in-river, their interaction with each other, and the potential impacts to upstream landowners from raising weir and backwatering upstream, the overall design, operations, and potential impacts of these structures is of interest to environmental compliance, regulatory, and community stakeholders.

1.3 Report Organization

The Report is organized according to the nine separate sections listed in Table 1-1.

Table 1-1. Design Documentation Report Outline

Section	Description	Content
1.0	Introduction	Provides a description of the Report purpose, the Project background, and report organization.
2.0	Design Criteria	Presents the design criteria specific to the fish passage facilities on the Naselle River.
3.0	Design and Operations	Presents the current Phase 2 design elements located on the Naselle River, their anticipated operations, and their specific interactions.
4.0	Backwater Analysis Methodology	Presents the analytical methods employed to investigate the backwater effects of the exclusion barrier and other facility components.
5.0	Backwater Analysis Results	Summarizes the results of the backwater analysis, with reference to a series of model output graphs and tables.
6.0	Impacts and Mitigation Analysis	Summarizes the anticipated impacts of the facility components to stakeholders in terms of backwater effects and presents mitigation measures to alleviate or eliminate those impacts.
7.0	References	Lists the literature referenced in the Report.

2.0 DESIGN CRITERIA

The following section presents the design criteria used to help design both the exclusion barrier and the resident ladder. Similar criteria have been adopted in the design of the adult fish ladder, which is not discussed further in this Report.

2.1 Exclusion Barrier Design Criteria

Exclusion barrier design criteria are presented in Table 2-1.

Table 2-1. Exclusion Barrier Design Criteria (McMillen Jacobs 2020)

Criteria	Units	Value	Comments
5% Exceedance Flow in the Naselle River	cfs	1,851	During the migration window for resident and anadromous species, which is taken to be year-round. This is used as the NMFS high flow.
95% Exceedance Flow in the Naselle River	cfs	29	During the migration window for resident and anadromous species, which is taken to be year-round. This is used as the NMFS low flow.
Weir height	ft	3.5	The minimum weir height relative to the maximum apron elevation is 3.5 feet.
Apron length	ft	16	The minimum apron length (extending downstream from base of weir) is 16 feet.
Apron slope	H:V	16:1	The minimum apron downstream slope is 16:1 (horizontal:vertical)
Weir head	-	-	Specifies a maximum head over the weir crest of 2 feet. However, given river conditions at Naselle, this maximum depth cannot be achieved. The maximum weir head is 3.68 ft at the 5% exceedance flow during the migratory period.
Downstream apron elevation	-	-	The elevation of the downstream end of the apron must be greater than the tailrace water surface elevation corresponding to the high design flow.
Flow ventilation	-	-	The flow over the weir must be fully and continuously vented along the entire weir length, to allow a fully aerated flow nappe to develop between the weir crest and the apron. Full aeration of the flow nappe prevents an increase in water surface behind the nappe, which may allow fish to stage and jump the weir.

Note from Table 2-1 that the exclusion barrier must be 3.5 feet higher than the maximum apron elevation during operation to effectively exclude fish. Therefore, when the exclusion barrier is in operation and is acting as a fish barrier, water will be impounded at least 3.5 feet above the weir sill elevation.

2.2 Juvenile/Resident Fish Ladder Design Criteria

Juvenile/resident fish ladder design criteria are presented in Table 2-2.

Table 2-2. Juvenile/Resident Fish Ladder Design Criteria (McMillen Jacobs 2020)

Criteria	Units	Value	Comments
5% Exceedance Flow in the Naselle River	cfs	1,707	Year-round. This is used as the NMFS high flow. See Appendix A.
95% Exceedance Flow in the Naselle River	cfs	27	Year-round. This will be used as the NMFS low flow. See Appendix A.
5% Exceedance Tailwater Elevation	ft	28.41	
95% Exceedance Tailwater Elevation	ft	24.09	
Min Instream Flow	cfs	2	Assumed
Fishway Entrance			
Hydraulic Head Drop	ft	0.33	Per NMFS criteria
Approach Conditions	-	See Comment	Similar to ambient depth, velocity, flow direction, and turbulence. Bell, 1991.
Fish Ladder			
Hydraulic drop between fish ladder pools	ft	0.50	The juvenile/resident fish ladder near the intake shall have hydraulic drops between pools no greater than 6 inches.
Min Pool Length	ft	3.5	NMFS 4.5.3.3 specifies a minimum of 8 feet; however, 3.5 feet is adequate to achieve target EDF values.
Pool Width	ft	7.0	NMFS 4.5.3.3 requires a minimum of 6.0 feet.
Max Energy Dissipation Factor	ft-lb/s	3.0	Modified NMFS 4.5.3.5 based on discussions with WDFW
Fish Ladder Pool Freeboard	ft	3.0	Minimum of 3 feet at high design flow. NMFS 4.5.3.6.
Lighting	-	See comments	Ambient lighting is preferred. Abrupt lighting changes must be avoided. NMFS 4.5.3.8.
Fishway Exit			
Max Hydraulic Drop	ft	0.33	Per NMFS criteria
Coarse Trashrack Velocity	-	1.5	Velocity through the gross area of the coarse trashrack. NMFS 4.8.2.1.
Coarse Trashrack Depth	ft	See comments	NMFS 4.8.2.2. Equal to the pool depth in the fishway
Coarse Trashrack Slope	H:V	1:5 max	NMFS 4.8.2.3.
Coarse Trashrack Bar Spacing	in	10 min	NMFS 4.8.2.5.
Coarse Trashrack Orientation	degree	At or greater than 45° relative to the fishway flow	NMFS 4.8.2.6.

3.0 DESIGN AND OPERATIONS

The section provides a description of the design and anticipated standard operation of both the exclusion barrier and the juvenile/resident fish ladder.

3.1 Exclusion Barrier Design Description

The exclusion barrier design includes an inflatable bladder weir (e.g. Obermeyer, hereafter used interchangeably with “exclusion barrier”) that is configured to act like a National Marine Fisheries Service (NMFS) compliant velocity barrier per the design criteria specified above. The Obermeyer weir would be constructed in a recessed area of a sloping concrete apron. When in the fully down position, the weir panel would lie flush with the apron slab in order to minimize the potential for fish catching or scraping on otherwise exposed portions of the weir. To raise the weir, a small air compressor located inside the intake building would inflate the bladder, thereby raising the weir plate at an angle to the slab. The weir would be designed to raise at least 3.5 feet above the crest of the slab to work as a velocity barrier. See Figure 3-1.

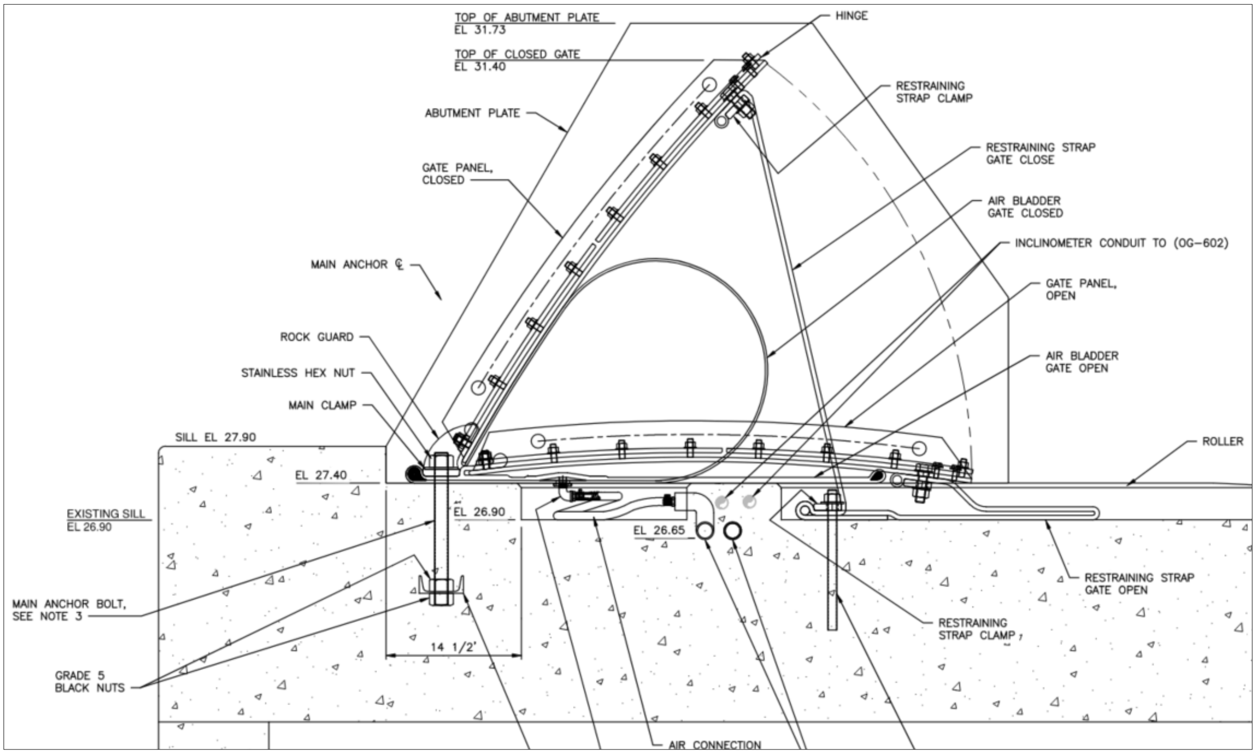

Figure 3-1. Section View of the Current Exclusion Barrier Design Showing the Weir in Both the “Up” and “Down” Positions

The exclusion barrier would be approximately 70 feet wide and would extend from the juvenile/resident fish ladder across the Naselle River to an abutment on river left (see Figure 3-2). The left abutment would be located within an existing WDFW parcel easement. The Obermeyer weir would likely come in several sections and could be plumbed to operate multiple sections simultaneously, while operating others inde pendently. In this way, hatchery operations personnel could balance system flexibility with operational simplicity.

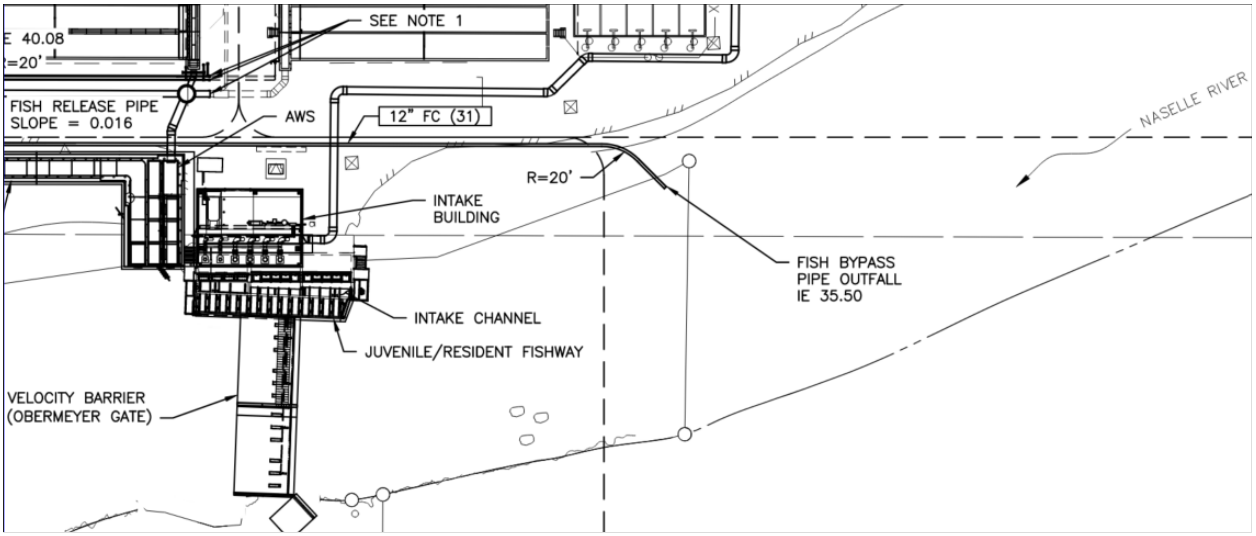

Figure 3-2. Plan View of the Current Exclusion Barrier, Resident Ladder and Intake Design

The exclusion barrier slab would slope downward in the downstream direction at a slope of 1:16. At sixteen feet long, this would put the downstream extents of the apron 1 foot below the upstream extents at the base of the Obermeyer. The 16-foot apron would be shorter than the existing apron at the same location. Therefore, the existing apron would be demolished during construction. At those locations where there is no new barrier, the demolished area would be filled to a limited extent with a layer of cobble and boulder material to act as an energy dissipator and scour protection at the toe of the apron so that the risk of undercutting the footing at the downstream end of the apron is minimized. This area would not extend outside the footprint of the existing barrier apron, however, and would likely occupy an area smaller than the existing barrier. There would also not be a need for additional streambank armoring beyond the exclusion barrier. The total area of the existing barrier, which includes concrete curbing and a concrete mass slab, is approximately 2,325 square feet. By comparison, the new exclusion barrier and concrete apron will have a total area of approximately 1,320 square feet. Beyond the apron, scour protection is expected to extend approximately 10 feet in the downstream direction, with an associated area of about 800 square feet. The total footprint of the exclusion barrier and its in-channel features is therefore roughly 2,120 square feet. The remaining 205 square feet of reclaimed area (2,325 – 2,120 = 205) will be restored to natural river conditions.

3.2 Exclusion Barrier Operations

The exclusion barrier would be operated from July through February to coincide with the timing of upstream anadromous fish migration. With the Obermeyer weir in the “up” position (i.e., with the weir crest 3.5 feet above the apron elevation) across the range of design flows, migratory and resident fish would be naturally guided to the entrance to the adult fish ladder due to the slightly slanted orientation of the exclusion barrier with respect to overall river flow in plan-view. With 9-inch drops across pools in the adult ladder, many of the adult resident fish will be able to ascend the adult ladder and enter the adult trap and sorting facility. From the sorting facility, resident and wild anadromous fish will be separated from target hatchery fish and will be passed back to the river through a NMFS-compliant bypass pipe and outfall. The bypass pipe will extend from the sorting facility in the upstream direction approximately 350 feet, with the outfall located sufficiently upstream of the exclusion barrier that the potential for fallback will be minimized. The anaesthetization, sorting, recovery, and bypass operation will minimize fish handling and reduce overall stress on the fish compared with existing operations.

When the exclusion barrier is in the fully down position (normally from March through June), debris and accumulated sediment stored behind the barrier over the previous migratory period will be readily flushed upon lowering. Should debris get caught on the structure at any point during the migration window, hatchery personnel may choose to lower the barrier temporarily to quickly flush the debris, and then restore the barrier to the "up" position.

The exclusion barrier is expected to be operated manually using the custom controls that are shipped with the inflatable bladder weir. However, operations will also include an automated emergency override that utilizes remote sensing equipment to trigger a lowering of the barrier during an unanticipated extreme high flow event. This emergency response will ensure that upstream flooding during high flow events does not occur. In addition, the sluice gate along river right adjacent to the intake screens may also be opened manually during high flow events to allow excess flows pass through the facility and further reduce back-watering.

Operation of the exclusion barrier will also be closely coordinated with the operation of the juvenile/resident fish ladder in order to maintain the hydraulic drops and velocities through the ladder. For example, during the fish passage (i.e., trapping) window, the crest of the Obermeyer weir gates is expected to modulate between an elevation of 30.9 and 31.4 feet to maintain the hydraulics within the juvenile/resident fish ladder to satisfy the criteria listed in Table 2-2. Raising or lowering the crest beyond these limits may induce hydraulic changes that result in non-compliant conditions for fish passage. See Section 3.4 for further discussion.

3.3 Juvenile/Resident Fish Ladder Design Description

The juvenile/resident fish ladder consists of a series of fourteen stoplog weirs in a linear configuration from upstream to downstream and separated by a series of thirteen pools. The stoplog weirs are attached on both sides to a concrete side wall, each of which is attached at 90 degrees to the main juvenile/resident fish ladder walls. At a width of 3.0 feet, the stoplog weirs are narrower than the pools, which are 7.0 feet wide. The greater pool width allows for better energy dissipation. Each of the side walls also includes a chamfered 1-foot by 1-foot orifice at the base of the wall for lamprey passage. The orifices also provide additional mixing in a rotational direction that is opposite to streaming flow rotational direction. This will further enhance mixing in the pool. And finally, the orifices are located at the outer edge of the channel, whereas the weirs are located in the middle of the channel. This will induce complex eddies within pool that will further enhance mixing to better accommodate juveniles.

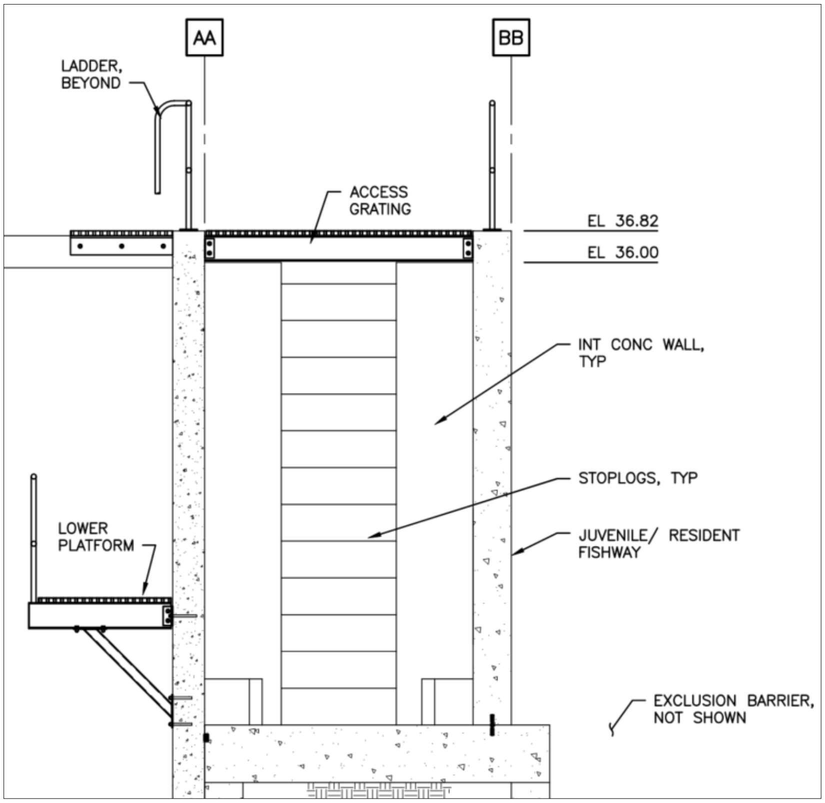

Figure 3-3. Elevation View from Downstream of the Juvenile/Resident Fish Ladder in the Closed Position (All Stoplogs In)

The floor of the ladder slopes downward in the downstream direction at approximately 7.8%. The pools of the ladder are 7.0 feet wide and 3.5 feet long. The fishway includes embedded wall slots on either wall for placing picket panels and/or stoplogs. Picket panels would have a 1-inch clear bar spacing, in accordance with NMFS guidelines. Access to the area above the fishway is provided by a combination of embedded rung ladder and removable grating. Direct access to the fish ladder pools would require placement of a removable pool ladder. Just upstream of the fish ladder exit, a coarse trashrack would be placed across the ladder exit and at an angle to pass debris over to the exclusion barrier where it will freely pass downstream without getting caught up in the fish ladder.

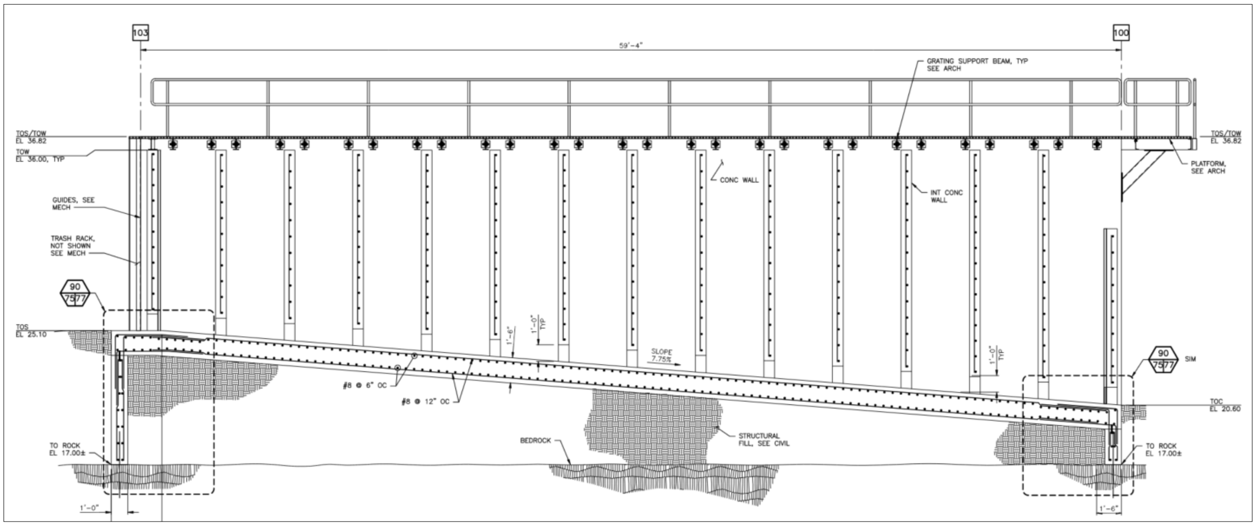

Figure 3-4. Section View through the Juvenile/Resident Fish Ladder from Upstream (Left) to Downstream (Right)

The fish ladder is designed to provide 6-inch hydraulic drops across each of the pools, allowing resident and juvenile fish to ascend the ladder. Peak velocities over the weirs are estimated at 3.7 ft/s and in the pools at 0.24 ft/s. Ladder design flows range from 12.2 cfs to 16.6 cfs, which correspond with the ladder portion of the river’s 95% and 5% exceedance flows, respectively.

3.4 Juvenile/Resident Fish Ladder Operations

Normal operations of the juvenile/resident fish ladder would take place from March through June of each year and would coincide with the lowering of the exclusion barrier. Prior to this period hatchery personnel would remove the picket panels from the upstream and downstream extents of the ladder to allow fish to migrate freely through the ladder. Periodically, or on an as-needed basis, stoplogs could be lowered into the picket panel slots embedded in the walls of the fishway to dewater the ladder and provide enhanced access for personnel to clean and maintain the ladder. At the start of the anadromous migration window in early July, picket panels would be placed again. When the exclusion barrier is in the “up” position during the migratory period for anadromous species (July through February) and upstream migrants are being guided to the adult ladder, the juvenile/resident fish ladder is closed off by picket panels at both the downstream and upstream ends of the ladder. The picket panel at the downstream terminus of the juvenile/resident fish ladder prevents adult anadromous fish from migrating past the facility, while the upstream picket panel prevents downstream migrants from getting trapped in the ladder and instead shunts them to the side where they can safely pass over the exclusion barrier or migrate past the intake screens to continue downstream. Also, from July through February, the auxiliary water supply that would otherwise diffuse into the adult ladder is instead passed through the AWS chamber and back into the river near the entrance to the juvenile/resident fish ladder, thereby enhancing attraction flow to this location.

Juvenile/resident fish ladder performance, including depths, velocities and energy dissipation factors (EDFs), are provided by pool in Table 3-1.

Table 3-1. Juvenile/Resident Fish Ladder Operational Performance

	5% Exceedance Flow					95% Exceedance Flow				
Pool	WSEL (ft)	Depth (ft)	Pool Volume (cf)	EDF (ft-lb/cf)	Weir Velocity (ft/s)	WSEL (ft)	Depth (ft)	Pool Volume (cf)	EDF (ft-lb/cf)	Weir Velocity (ft/s)
HW	35.08					31.06				
14	34.75	9.65	236.5	1.27	3.27	30.73	5.63	137.9	1.19	2.67
13	34.25	9.65	236.5	1.27	3.68	30.23	5.63	137.9	1.19	3.39
12	33.75	9.65	236.5	1.27	3.68	29.73	5.63	137.9	1.19	3.39
11	33.25	9.65	236.5	1.27	3.68	29.23	5.63	137.9	1.19	3.39
10	32.75	9.65	236.5	1.27	3.68	28.73	5.63	137.9	1.19	3.39
9	32.25	9.65	236.5	1.27	3.68	28.23	5.63	137.9	1.19	3.39
8	31.75	9.65	236.5	1.27	3.68	27.73	5.63	137.9	1.19	3.39
7	31.25	9.65	236.5	1.27	3.68	27.23	5.63	137.9	1.19	3.39
6	30.75	9.65	236.5	1.27	3.68	26.73	5.63	137.9	1.19	3.39
5	30.25	9.65	236.5	1.27	3.68	26.23	5.63	137.9	1.19	3.39
4	29.75	9.15	224.2	1.34	3.68	25.73	5.13	125.6	1.31	3.39
3	29.25	8.65	212.0	1.42	3.68	25.23	4.63	113.4	1.45	3.39
2	28.75	8.15	199.7	1.51	3.68	24.73	4.13	101.1	1.63	3.39
1	28.41	7.81	191.4	1.57	3.30	24.23	3.63	88.9	1.85	3.39
TW	28.41					24.09				

3.5 Operational Summary

The following list of activities summarizes the operational protocol for the exclusion barrier and juvenile/resident fish ladder facility according to total river flow:

- **0 cfs to 26 cfs:** During this low-flow condition, neither the exclusion barrier nor the juvenile/resident fish ladder are required to meet fish passage criteria because the river flow is below the low fish passage design flow for both facility components. Therefore, the juvenile/resident fish ladder may be completely closed off with stoplogs and the exclusion barrier may be in the fully "up" position such that no water is passing over the exclusion barrier and all river water is being routed through the intake channel. This will help ensure that water is "checked up" on the intake pumps, should the hatchery need to pump process water. This pumping will be subject to the instream flow lower limit noted in Table 2-2.

- **27 cfs to 1,707 cfs:** Both the juvenile/resident fish ladder and the exclusion barrier will be operating within criteria in this river flow range, typically in the March through June timeframe. To ensure that the hydraulics within the ladder are appropriate, operational curves for the ladder will be developed during commissioning that will instruct facility operators of the acceptable Obermeyer weir crest and juvenile/resident fish ladder stoplog settings for any given tailwater elevation. It is expected that operations will be compliant with as few as two to three separate gate and stoplog settings. The range of stoplogs heights within the ladder is between 5.3 and 9.0

feet and the range of Obermeyer weir crest elevations is between 30.9 and 31.4 feet for the 95% and 5% exceedance flows, respectively.

- **1,708 cfs to 1,851 cfs:** During this high-flow condition, the juvenile/resident fish ladder would not be required to meet fish passage criteria, but the exclusion barrier would. In this case, the juvenile/resident fish ladder could either be closed off or left open and operational (but potentially out of criteria), while the exclusion barrier remains in the “up” position.

- **1,852 cfs and above:** During this high-flow condition, neither the exclusion barrier nor the juvenile/resident fish ladder are required to meet fish passage criteria because the river flow is above the high fish passage design flow for both facility components. Therefore, the juvenile/resident fish ladder would be completely closed off with stoplogs and the Obermeyer gates would be in the “down” position. The reasons the juvenile ladder would be closed off are: 1) it will reduce the maintenance requirements within the ladder, particularly as debris may otherwise tend to accumulate in the ladder at these high flows, and 2) resident passage has either ceased or, in the case of adult residents who are good swimmers, passage may continue over the lowered exclusion barrier.

- **Non-trapping**: If the hatchery facility is not trapping fish, despite the fact that the river flows are between the 5% and 95% exceedance flows, the juvenile/resident fish ladder would be completely closed off with stoplogs and the Obermeyer gates would be in the “down” position to provide unimpeded access to the river above and below for all species and life stages.

4.0 BACKWATER ANALYSIS METHODOLOGY

A backwater analysis was conducted by developing a one-dimensional hydraulic model of the Naselle River near the facility and extending upstream approximately 2,500 feet to the bridge crossing of the river that connects North Valley Road with Upper Naselle Road. The following section describes the methodology adopted to develop the hydraulic model.

4.1 Data Sources

The primary data sources for the hydraulic model are provided in

Table 4-1. Hydraulic Model Data Sources

Data	Data Source	Comments
Topobathymetric Survey	Wilson Engineering, 2018	Ground and stream survey data collected in 2018 and used as the basis for the overall facility design; dataset extends upstream of the existing weir approximately 550 feet.
LiDAR Ground Survey	U.S. Geological Survey, 2017	This Light Detection and Ranging (LiDAR) dataset was collected by Quantum Spatial under contract with USGS and downloaded from the National Map. The data is not water-penetrating, such that areas where water was present during the survey indicate approximate water surface elevations rather than channel elevations. The dataset meets the 3DEP Quality Level 1 (QL1 LiDAR), with a target point density of ≥8.0 points/m^2 (0.74 points/ft^2), vertical accuracy of 10 cm (RMSEz), and a digital elevation model cell size of 0.5 m.
Hydrologic Boundary Conditions	Design Documentation Report (DDR), McMillen Jacobs Associates, 2021 TM004, McMillen Jacobs Associates, 2021	The DDR provides several hydrologic flow events, including the 100-year flow, which was developed using the Army Corps of Engineers'' HEC-SSP software program and the methods of Bulletin 17B. TM004 was developed to provide preliminary information about the juvenile/resident fish ladder and the exclusion barrier operations. Part of the effort in developing the memo included the calculation of the fish passage design flows, both for the exclusion barrier and for the juvenile/resident fish ladder.
Proposed Exclusion Barrier and Juvenile/Resident Fish Ladder Geometry	90% Construction Documents, McMillen Jacobs Associates, 2021	The design drawings submitted at a 90% level of completion in December, 2021 were used as the basis for determining the proposed weir and juvenile/resident fish ladder geometry (Alternative 1).

4.2 Model Version

The hydraulic model was developed using the Army Corps of Engineers' Hydrologic Engineering Center River Analysis System (HEC-RAS) version 6.2, released March 2022. The model was set up as a one-dimensional model due to the one-dimensional nature of flow in the reach of interest. Because the planform of the river near the facility has very little sinuosity and is considered a straight reach, and because no substantial tributaries enter the river between the facility and the upstream extents of the model, the hydraulics within the reach are expected to be primarily one-dimensional without the influence of largescale eddies, ineffective flow area, lateral inflow sources, and other features that would contribute to a lateral component of velocity.

4.3 Geometry Development

The HEC-RAS model geometry was developed using AutoCAD Civil3D software to place cross sections with a variable spacing depending on location within the reach. For areas close to the weir where the in-river structures needed to be captured, cross sections were placed between 15 and 30 feet apart, whereas in areas upstream covered by fairly uniform stretches of river with no in-river structures, cross sections were placed up to 300 feet apart. Channel cross sections were then "cut" from the cross-section alignments using the topobathymetric and LiDAR surfaces as a base. Additional cross sections were then added every 50 feet within the model using the interpolation tool native to HEC-RAS. As noted above, the topobathymetric surface only extended upstream of the existing weir approximately 550 feet, whereas the model domain extends approximately 2,500 feet upstream of the weir (Figure 4-1; interpolated cross sections not shown for clarity). For this reason, LiDAR data would need to be used for the upstream cross sections. However, that data would need to be revised because it is not water-penetrating and therefore does not capture the channel geometry. In these cases, the topobathymetric data was used to extrapolate a channel into the LiDAR dataset, as discussed below.

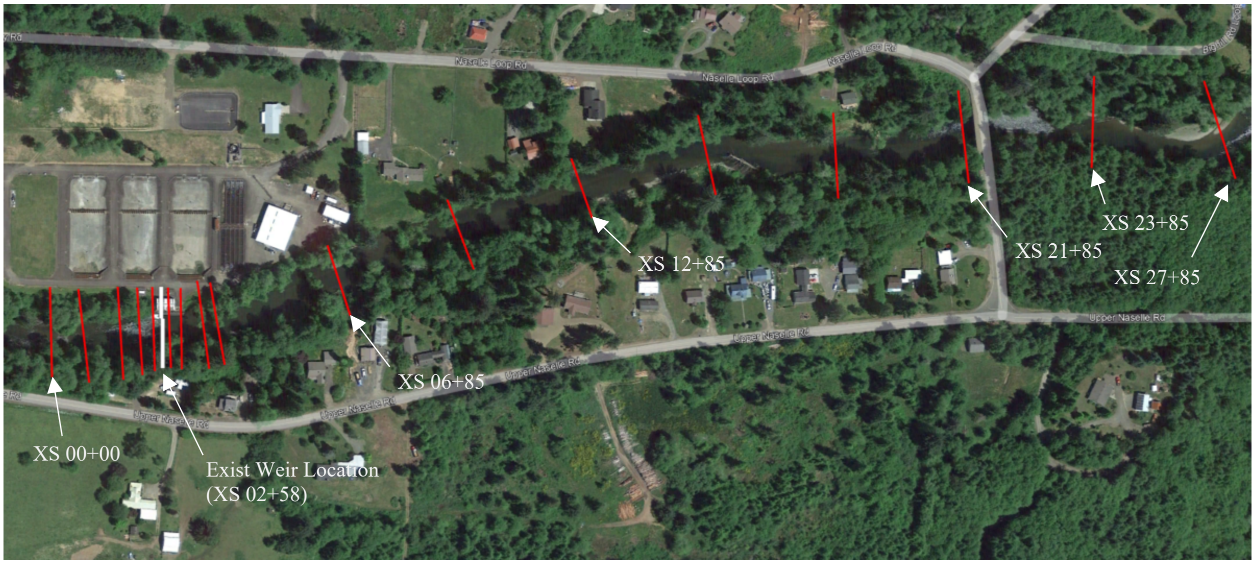

Figure 4-1. Plan View of the Model Domain Showing Cross Sections Built from Topobathymetry and LiDAR Datasets

The friction slope represents the slope of the energy grade line, and if it is held constant, then the unit head loss remains the same from one cross section to the next, resulting in a water surface with a relatively constant slope in the longitudinal direction. A constant friction slope may come about when the hydraulic geometry is more or less the same from one cross section to the next. For instance, when the flow area is uniform, when the top and bottom widths are uniform, and when the channel slope is uniform, then the hydraulic geometry will stay more or less the same from one cross section to the next.

In addition, straight reaches do not have the losses associated with channel form in meandering rivers. This is the situation in the Naselle River within the reach of interest, as evidenced by Figure 4-2, which shows how straight the reach above the facility is and how uniform the bank lines (i.e., top-of-channel width) is within the model domain.

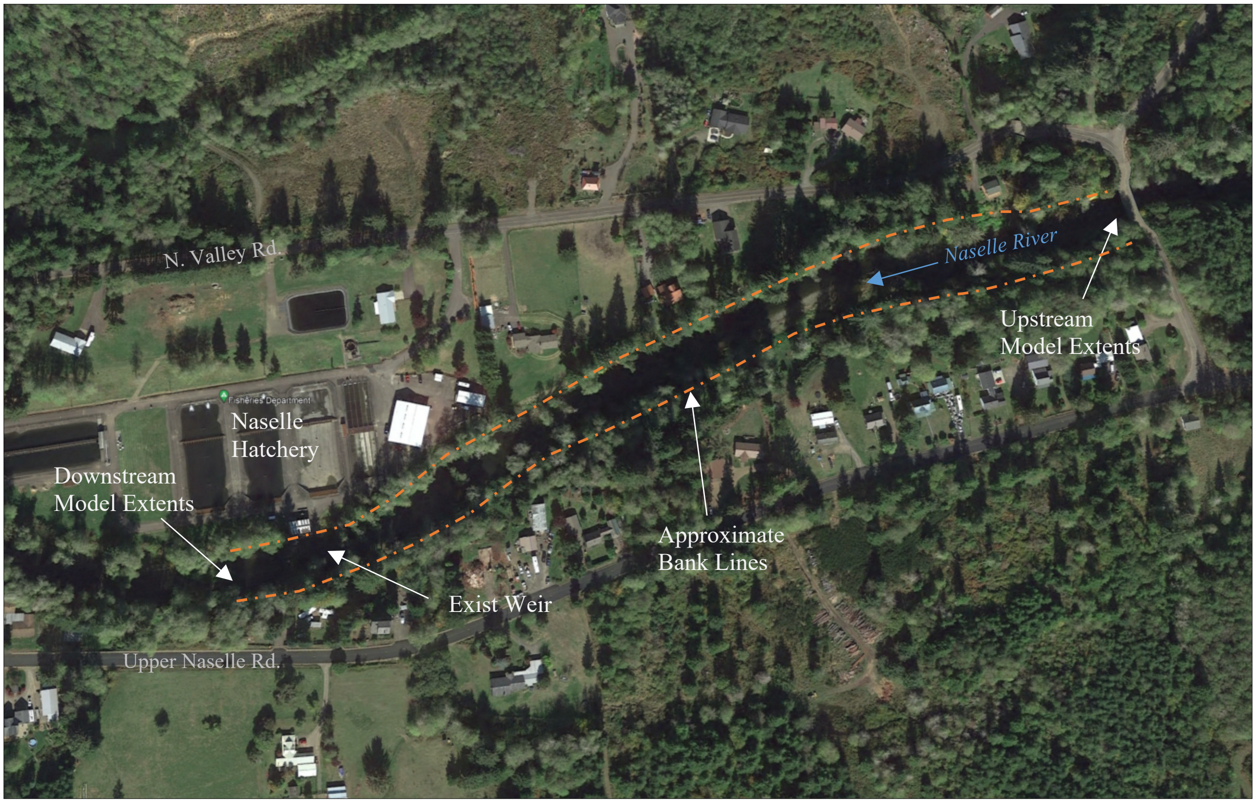

Figure 4-2. Aerial View of the Naselle River Reach, Showing Uniformity of Bank Lines and Straightness of the Overall Reach

For the reasons noted above, the LiDAR data, which indicates a constant water surface slope within the reach, can be used with the topobathymetric data to approximate the elevation and slope of the channel bottom even in areas where no bathymetric data is available. This was done for the model domain by identifying cross sections that overlap in both the LiDAR and topobathymetric datasets and using the difference in area at the bottom of the cross sections to "carve out" a channel bottom in the cross sections for which only LiDAR data was available. This difference in area can be seen in the example cross section shown in Figure 4-3. From the figure, the two datasets match up very well (e.g., the bottom and top of channel widths are very close, suggesting good agreement between the datasets), except where water is present. In those areas, a channel bottom in the LiDAR-only cross sections was extruded using this area as a template and by adjusting the channel bottom elevation upward from one cross section to the next according to the slope of the water surface derived from the LiDAR data.

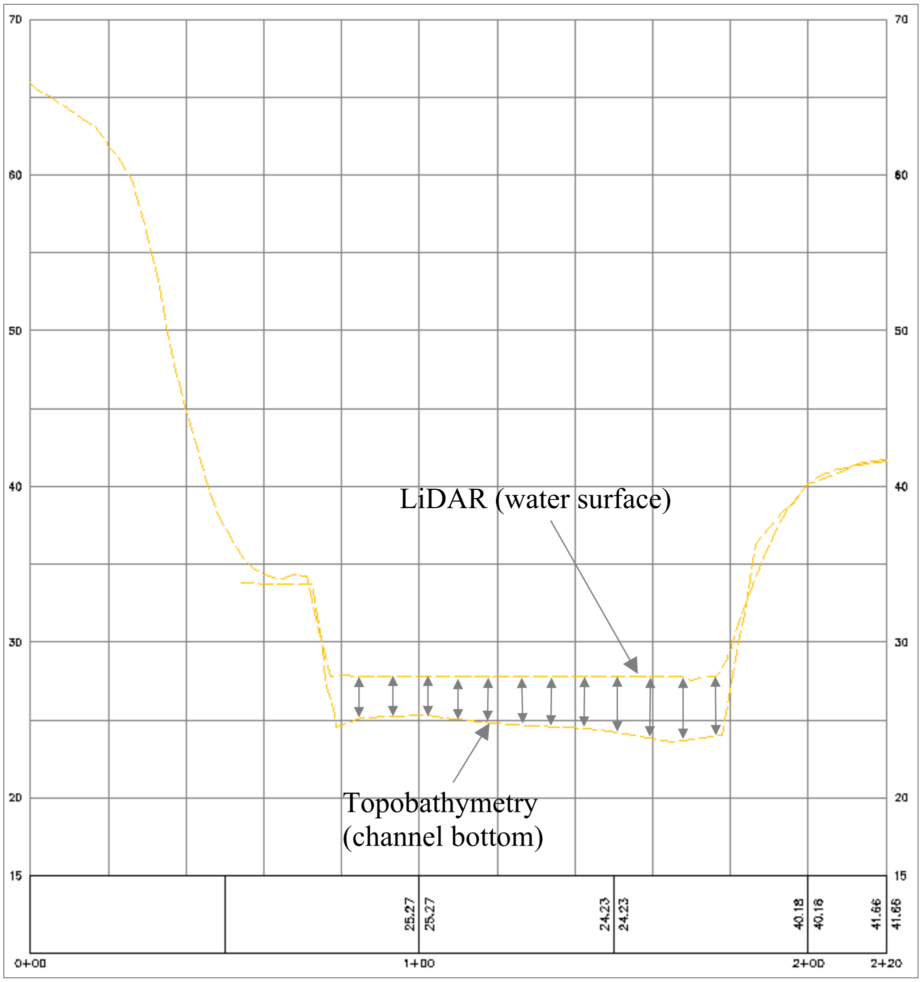

Figure 4-3. Example Cross Section with Overlapping LiDAR and Topobathymetric Data

4.4 Boundary and Initial Conditions

The model was set up to run as a quasi-steady state model in mixed flow regime in order to better capture the backwater effects of the weir and to better represent any hydraulic jumps and transitions through critical flow that might be present within the model domain. For this reason, boundary conditions were non-uniform and the model inputs required initial conditions. An inflow hydrograph was assigned to the furthest upstream cross section for two separate scenarios, considered to “book-end” the problem: the 95% exceedance flow for the exclusion barrier (29 cfs) and the 100-year flow (12,539 cfs). Initial conditions were simply set to the 95% exceedance flow for the exclusion barrier, and the hydrograph was shaped by increasing inflows by 1 cfs every minute. Downstream boundary conditions were set to friction slope at normal depth, which was approximated using the slope of the channel bottom near the downstream boundary and was set to 0.00262.

The model was parameterized using values of Manning’s roughness coefficient for the main channel (0.04) and the overbank areas (0.06).

5.0 BACKWATER ANALYSIS RESULTS

Backwater analysis results are presented in this section in a series of figures with the following commentary:

- Figure 5-1: The figure shows the hydraulic profile in the longitudinal direction during the 100-year flood within the reach of interest, starting with the existing weir location at Station 02+58 and continuing upstream past the bridge crossing of the river until Station 27+85. The figure shows a slightly elevated water surface elevation near the weir under proposed conditions. The rise in water level gradually tapers out in the upstream direction, however, until the difference in water levels is only 1.7 inches at the upstream extents of the model. This is effectively little to no difference due to the limitations in model accuracy.

  The figure also shows the hydraulic profile in the longitudinal direction during the mean daily flow event within the reach of interest, again starting with the existing weir location and continuing upstream past the bridge crossing of the river. The mean daily flow profile shows a more pronounced rise in water surface elevation (from the baseline) near the weir under proposed conditions, compared with the relative rise in water surface elevation during the 100-year event. This stands to reason because the relative “roughness” of the weir will have a greater influence on the change in water level at lower flow than it will at higher flow. At higher flow, the weir itself becomes increasingly submerged (i.e., the downstream water level is higher than the weir crest), so that the control on upstream water levels is more influenced by tailwater levels than it is by the weir crest height. As with the 100-year flood profile, the difference in water levels also tapers in the upstream direction, and ultimately converges with baseline conditions near the bridge, where there is effectively no difference (0.5 inches) under a mean daily flow regime.
- Figure 5-2: The figure shows the water surface elevation results for cross section 06+85, which is located near the upstream extent of the Naselle Hatchery. The figure shows both the 100-year flood level and the mean daily flow level for both Baseline and Alternative 1 (Proposed) conditions. From the figure, the cross-section is moderately entrenched, insofar as the 100-year flood flow does not overtop the channel banks at this location. As a consequence, the additional flooding during the 100-year flow extends only an additional 8 feet laterally into the upland along the right bank. Modeled water surface elevations are as follows:
  - Baseline, 100-Year: 38.53 ft
  - Alternative 1, 100-Year: 38.99 ft
  - Baseline, Mean Daily Flow: 28.10 ft
  - Alternative 1, Mean Daily Flow: 29.78 ft
- Figure 5-3: The figure shows the water surface elevation results for cross section 12+85, which is located roughly midway along the reach of interest and abutted on either side by private property. The figure shows both the 100-year flood level and the mean daily flow level for both Baseline and Alternative 1 (Proposed) conditions. From the figure, the cross-section is highly entrenched (i.e., the floodplain is inaccessible to all but the most extreme flood flows) along river right (looking downstream) and moderately so along river left, where conditions are similar to those

shown in Figure 5-2 along river right. Again, the increase in lateral flooding is quite modest, whereby perhaps two additional feet would be flooded along river left during the 100-year flood and perhaps five feet during the mean daily flow. Modeled water surface elevations are as follows:

  - Baseline, 100-Year: 39.61 ft
  - Alternative 1, 100-Year: 39.94 ft
  - Baseline, Mean Daily Flow: 28.34 ft
  - Alternative 1, Mean Daily Flow: 29.83 ft

- Figure 5-4: The figure shows the water surface elevation results for cross section 21+85, which is located just downstream of the bridge crossing of the Naselle River near Crusher Creek. The figure shows both the 100-year flood level and the mean daily flow level for both Baseline and Alternative 1 (Proposed) conditions. From the figure, the cross-section is highly entrenched along both river right and river left, leading to very little (i.e., less than one foot) increase in lateral flooding between proposed and baseline conditions. Modeled water surface elevations are as follows:
  - Baseline, 100-Year: 41.26 ft
  - Alternative 1, 100-Year: 41.46 ft
  - Baseline, Mean Daily Flow: 29.81 ft
  - Alternative 1, Mean Daily Flow: 30.22 ft
- Figure 5-5: The figure shows the water surface elevation results for cross section 27+85, which represents the upstream extents of the model domain and is located just downstream of a meander bend and a presumed inflection point in the long profile, beyond which the channel form changes to a more sinuous shape with active floodplains. The figure shows both the 100-year flood level and the mean daily flow level for both Baseline and Alternative 1 (Proposed) conditions. From the figure, the cross-section is somewhat compound, with a very steep and tall left bank and an active floodplain along river right, followed by a steep and tall outer bank. Although the 100-year flood flow happens to intersect the steep and tall portion of the right bank, leading to very little increase in lateral flooding, intermediate flows would, by inspection, intersect the active floodplain portion of the cross section. This would lead to larger increases in lateral flooding; however, at this location upstream, the increase in water level is very little, thereby substantially muting any increases in lateral flooding extent. Modeled water surface elevations are as follows:
  - Baseline, 100-Year: 42.84 ft
  - Alternative 1, 100-Year: 42.97 ft
  - Baseline, Mean Daily Flow: 31.19 ft
  - Alternative 1, Mean Daily Flow: 31.23 ft
- Figure 5-6 and Figure 5-7: The figures show in plan view the modeled flood extents of the existing and proposed mean daily flow and 100-year flood, respectively. From the figures, very little flooding is attributable to the exclusion barrier.

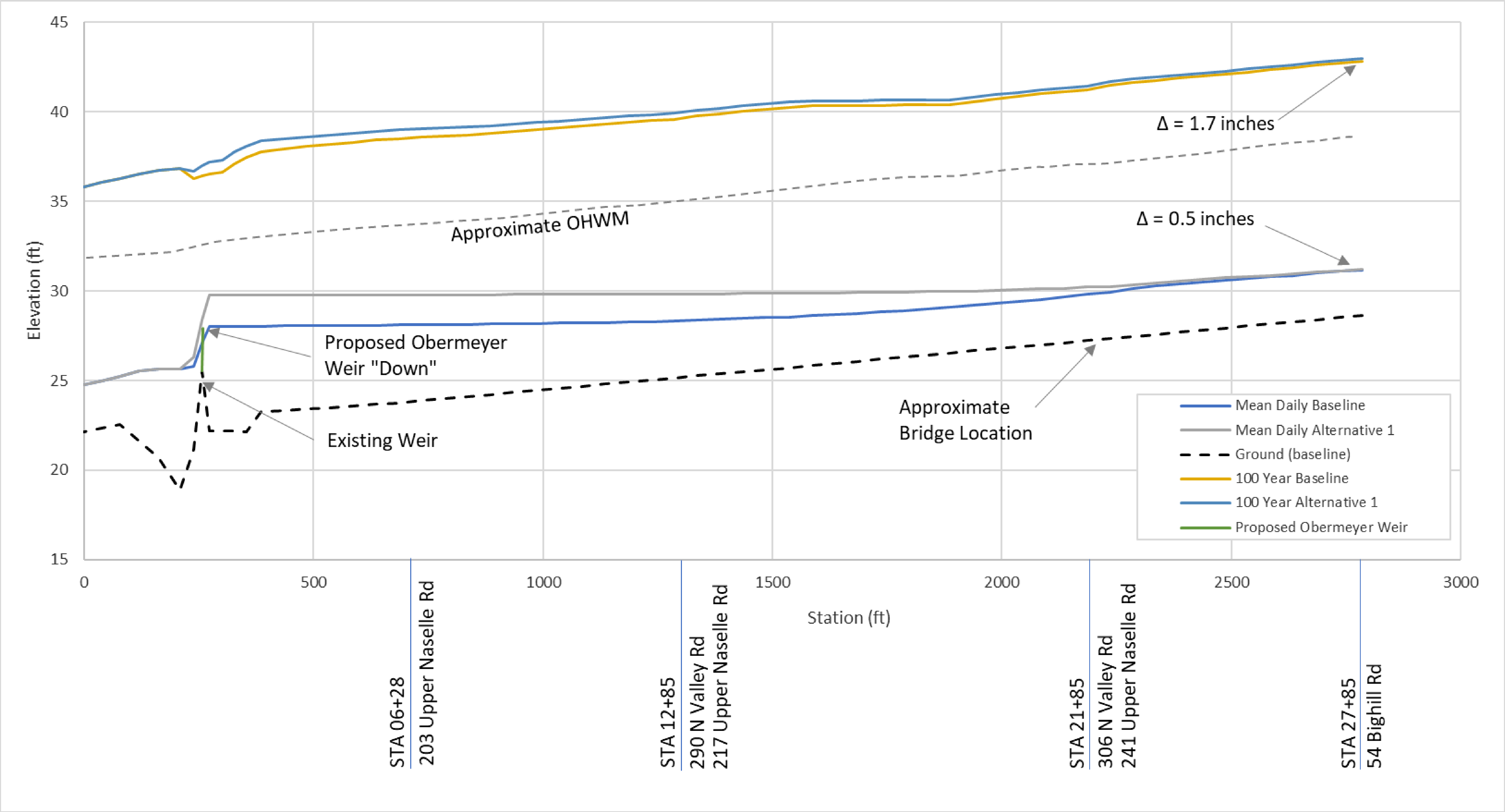

Figure 5-1. Hydraulic Profile for Baseline and Alternative 1 (Proposed) Conditions for the Mean Daily Flow and the 100-Year Flood with the Obermeyer in the "Down" Position

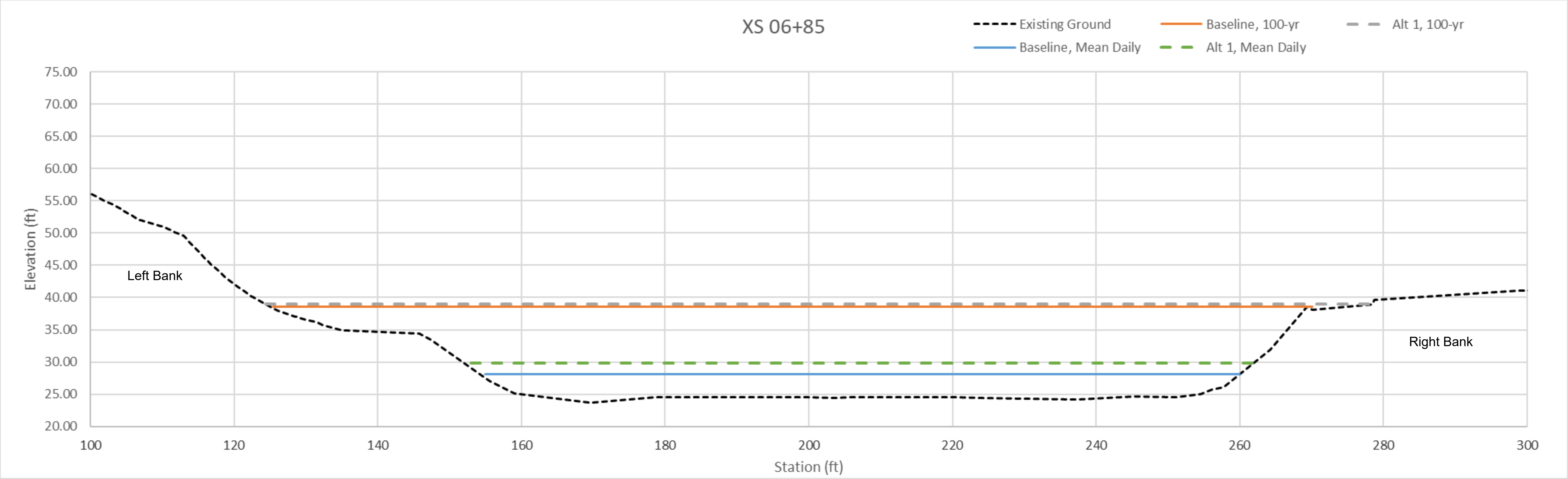

Figure 5-2. Water Surface Elevation Results for Cross Section 06+85 for Both Baseline and Alternative 1 (Proposed) Conditions

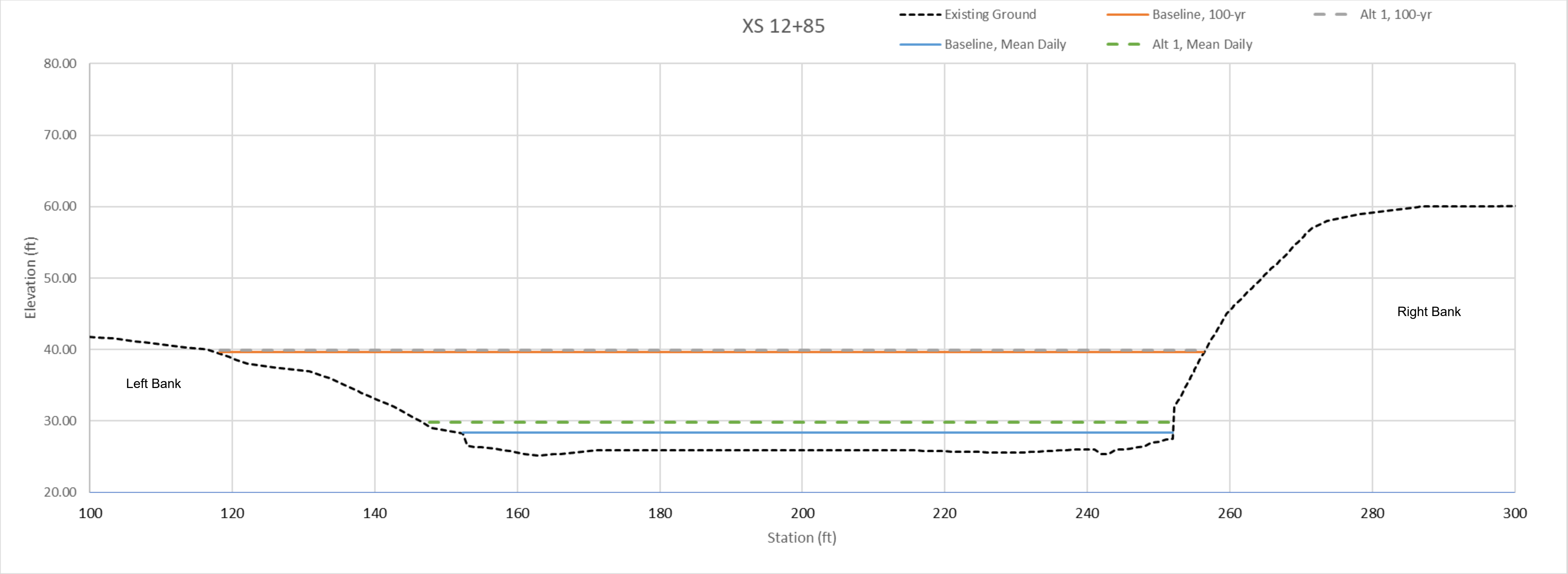

Figure 5-3. Water Surface Elevation Results for Cross Section 12+85 for Both Baseline and Alternative 1 (Proposed) Conditions

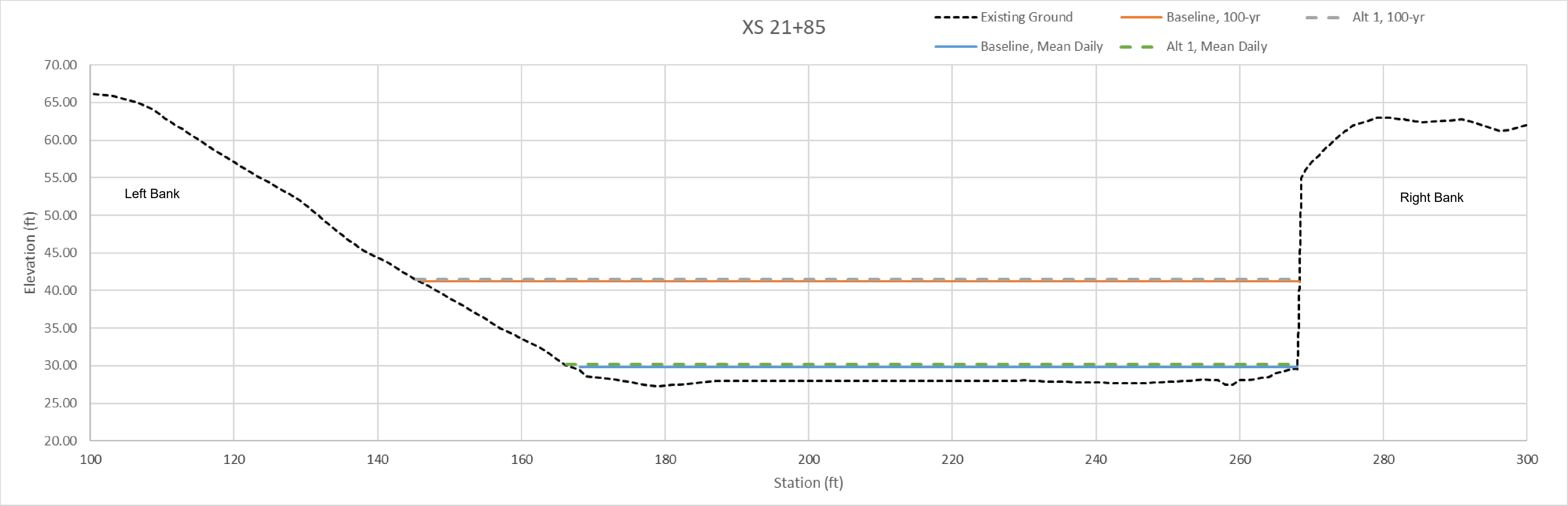

Figure 5-4. Water Surface Elevation Results for Cross Section 21+85 for Both Baseline and Alternative 1 (Proposed) Conditions

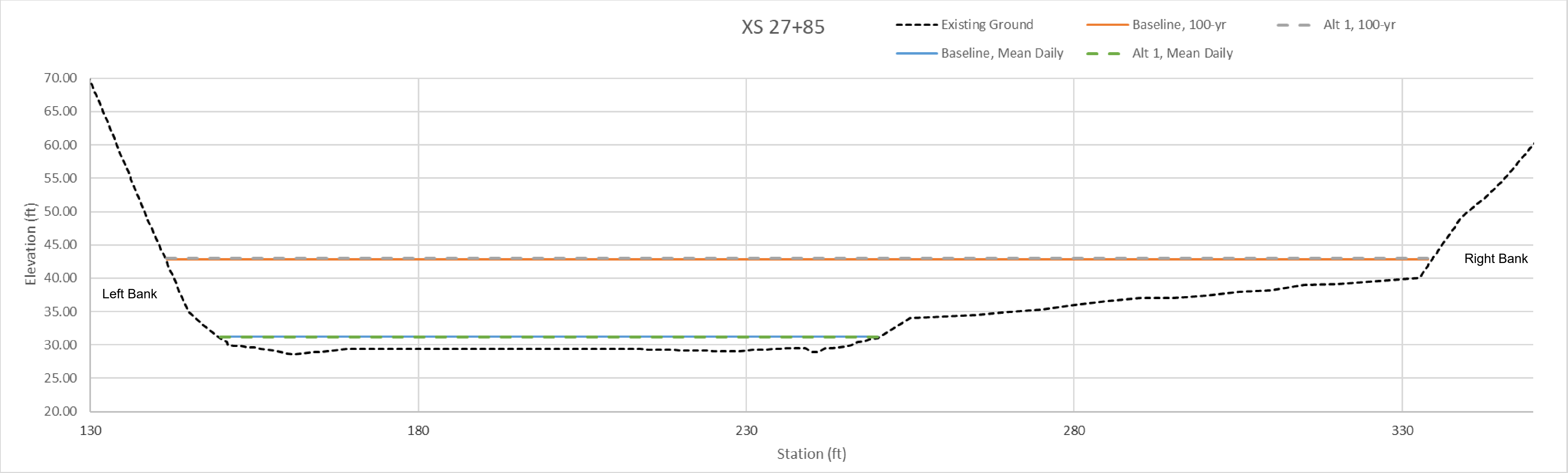

Figure 5-5. Water Surface Elevation for Cross Section 27+85 for Both Baseline and Alternative 1 (Proposed) Conditions

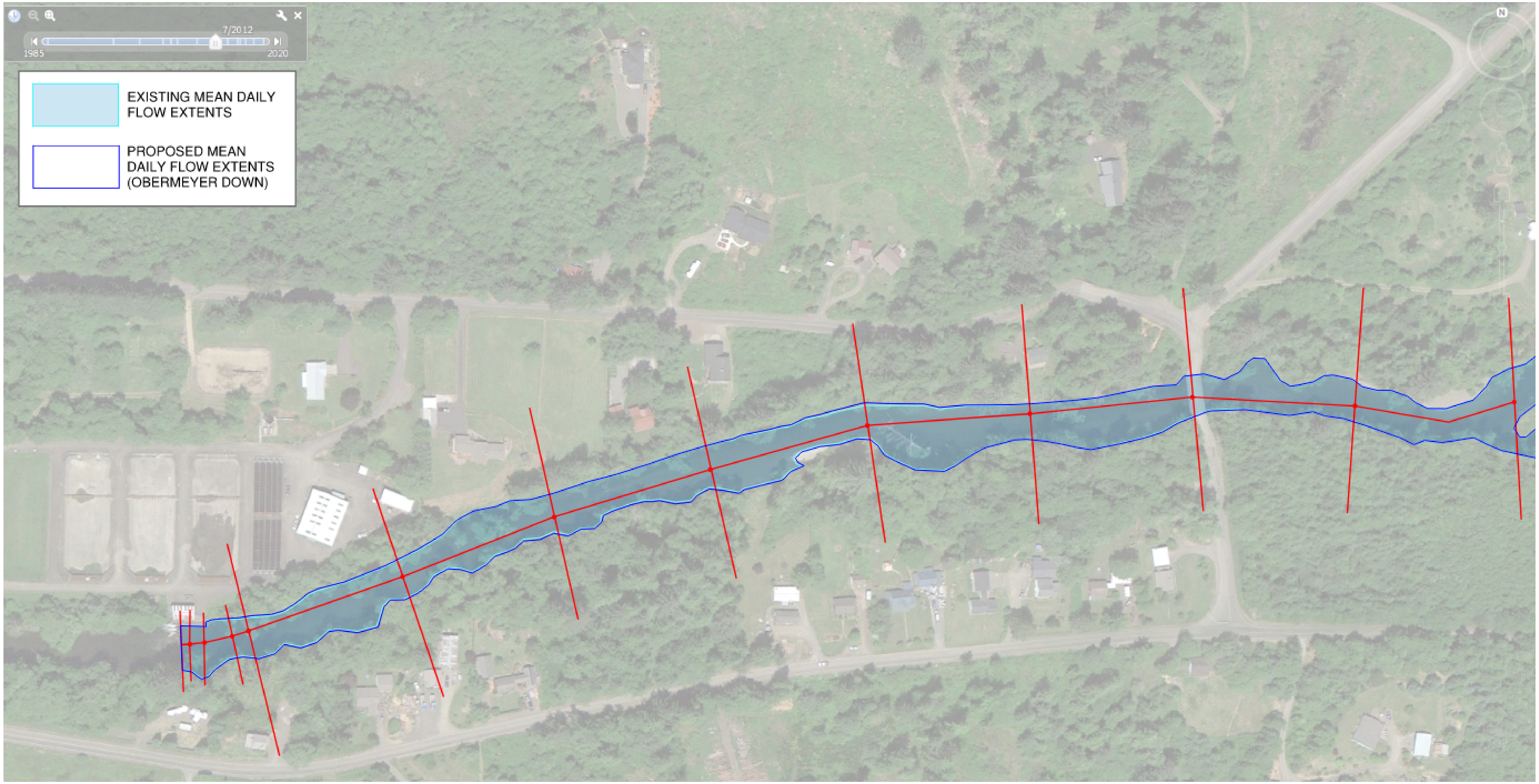

Figure 5-6. Plan View of Model Flood Extents Overlain on Aerial Photo of the Area (Mean Daily Flow)

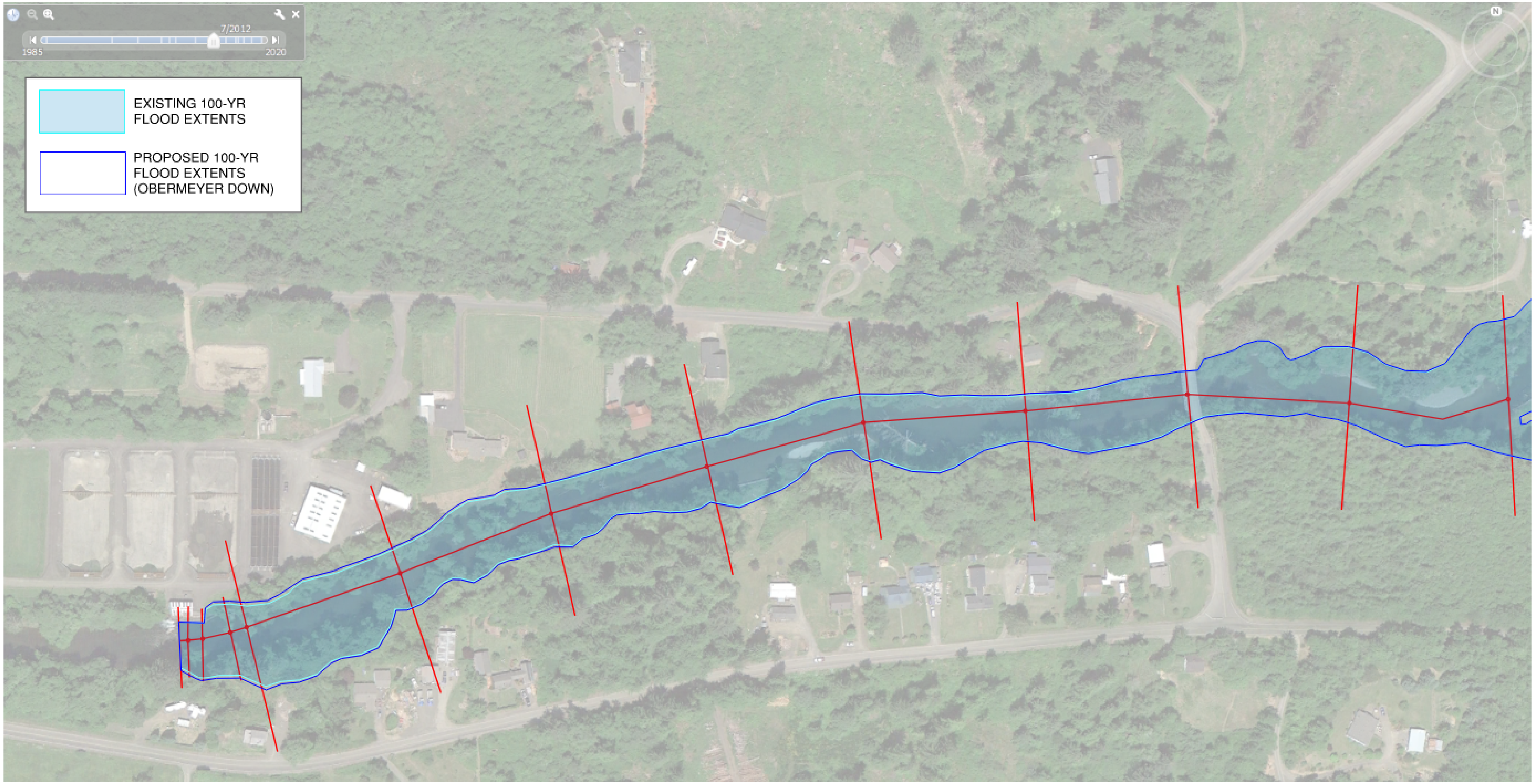

Figure 5-7. Plan View of Model Flood Extents Overlain on Aerial Photo of the Area (100-Year Flood)

6.0 IMPACTS AND MITIGATION ANALYSIS

Potential impacts attributable to the exclusion barrier can be separated into temporary construction impacts and anticipated long-term impacts. Each of these is discussed in the sub-sections that follow.

6.1 Temporary Construction Impacts

Construction of the exclusion barrier will require in-water work. In-water work will take place between May 1 and August 31. Dewatering and in-water work may be conducted in a variety of ways and will depend largely on the construction means and methods employed by the contractor. One such method is described here, however, as a baseline. Should the contractor develop a method that is safer, more affordable, and/or has less environmental impact, they would be encouraged to describe that plan in detail in an In-Water Work Plan.

One method that could be used to construct the exclusion barrier is a phased dewatering approach, whereby part of the stream is fully dewatered while the remainder is left open and flowing. For initial access for equipment and labor to install dewatering features, the contractor may choose to install a simple bridge deck that spans the low-flow portion of the river near the right bank. The deck could be placed on a temporary abutment on the right bank and lowered onto the existing concrete stemwall and apron that forms the downstream portion of the existing exclusion barrier. The deck would need not be longer than about 30 to 40 feet and would be about 10 to 15 feet wide to provide access for smaller equipment loadings.

Once access to the left bank of the river is secured, the contractor would be able to install silt curtains or similar approved features across the width of the channel to control increases in downstream turbidity. The contractor may then choose to install a cofferdam in a "U" shape that isolates the construction area on the left bank. Within the isolated area the contractor could then complete all work designated for that area, including partial apron demolition, gravel/cobble/boulder bed augmentation, and partial exclusion barrier installation. Obermeyer weirs may be installed in sections, so the optimal length of each section will be determined that best suits the needs of both construction installation and long-term operational simplicity and flexibility. During construction and installation, nuisance water could be pumped using portable utility pumps to baker tanks along river right that would then settle solids and gravity discharge water back to the stream a short distance downstream of the cofferdam. Because in-water work is envisioned over two construction seasons, the first portion of the installation would likely occur during the low-flow period of the first season. Installation of roughly half of the exclusion barrier would allow the contractor to leave the stream for high flows during the fall, winter and spring months to safely pass over the remaining portion of the existing exclusion barrier and the installed portion of the new barrier in the down position. During the second in-water work window, the cofferdam would be re-installed, except "flipped" to isolate the remaining area along the right bank and existing intake facility. The primary initial focus here may be on completion of the exclusion barrier so that the remaining in-water work on the juvenile/resident fish ladder could be completed during higher flows, should the schedule require it.

The contractor will be required to employ Best Management Practices (BMPs) for pollution prevention and to minimize temporary impacts during the construction window. The contractor will also be required to restore any areas of incidental disturbance to their original state and at their own expense prior to demobilizing from the job site. This includes bank disturbances, clearing, grubbing, or any other activities that may negatively impact bank stability. Other requirements will be built into the construction contract to ensure that potential impacts due to construction activities are either avoided or minimized.

Impacts associated with temporary construction may include slightly elevated suspended sediment concentrations. However, as noted above, sedimentation basins (e.g. baker tanks) will be installed and BMPs practiced, to help avoid or minimize water quality impacts due to construction. Additionally, in-water work will restrict the river's conveyance capacity due to the fact that roughly half of the river will be dewatered while work is under way. However, because the in-water work window runs from May 1 through August 15 when river flows are diminished or quite low, the restricted conveyance capacity is not expected to induce upstream flooding.

6.2 Long-Term Impacts and Mitigation

Potential long-term impacts associated with the exclusion barrier are presented below, along with elements of the design included to mitigate against, or altogether avoid those impacts.

The velocity exclusion barrier will increase localized velocities and could initiate localized scour and erosion downstream of the structure. As part of the design, however, the area immediately downstream and upstream of the exclusion barrier apron will be protected with a layer of cobble and possibly boulder to prohibit erosion and provide energy dissipation. Beyond this point, shear stresses in the river will converge with what is presently there at the site. Furthermore, the footprint of the cobble/boulder energy dissipator will be restricted approximately to the footprint of the existing exclusion barrier apron, and in all likelihood will be smaller. The remainder of the existing footprint that is not occupied by the new barrier and energy dissipator will be restored to natural conditions using appropriately sized gravel as needed, thereby increasing the net benefit to the river system.

The velocity exclusion barrier may trap sediment and debris on the upstream side over time, thereby potentially impacting the functional height of the barrier, increasing the upstream channel width, and reducing the supply of sediment to downstream reaches. However, because the exclusion barrier is designed to have an adjustable crest elevation, normal operations will involve completely lowering the exclusion barrier until it is flush with the apron at least once per year for several months. Because this lowering coincides with higher flow months, any accumulated sediment and debris is expected to be flushed from upstream of the barrier. These features help ensure sediment continuity between the reaches upstream and downstream of the barrier, limiting the scope and timeframe of impacts on an annual basis.

The velocity exclusion barrier will impact upstream water depths. During the migration window when the Obermeyer is in the "up" position, water will be elevated 3.5 feet above the apron and will backwater a distance upstream dictated by the channel slope. The ordinary high-water mark (OHWM) at the existing intake and weir has been measured at an elevation of 32.5 feet (WDFW, pers. comm. 2023). Water surface elevations for normal operations are provided in Table 6-1 below, assuming average monthly flows. From the table, it is clear that on an average monthly basis, the Obermeyer weir operation does not increase water levels above the OHWM. Instead, water levels are at least 0.7 feet below the OHWM when the Obermeyer is in the "up" position.

At the 5% exceedance flow for the exclusion barrier (1,851 cfs), with the Obermeyer weir in the fully "up" position, the water level would be approximately 32.3 feet, which is about 0.2 feet below the OHWM. This is the most extreme condition with the Obermeyer in the "up" condition, which underscores that the exclusion barrier will not contribute to flooding during normal operations. Again, when daily flows exceed the 5% exceedance flow of 1,851 cfs, the Obermeyer would be operated to maintain the water level below the OHWM. With the Obermeyer weir in the fully "up" position, water levels are not expected to reach the OHWM until the total river flow is approximately 2,239 cfs.

For those shorter time periods during which the water level may otherwise rise above the OHWM due to high river flow rates, standard operating procedure for the Obermeyer weir will require the lowering of the weir as needed when the water levels begin to approach the OHWM (see discussion in Section 3.0). Operating the weir above this minimum when water levels begin to approach the OHWM will prevent unnecessary flooding while continuing to ensure that the barrier remains in compliance for fish exclusion. Therefore, the barrier is not expected to exacerbate upstream flooding.

Table 6-1. Intake Pumping Rates, River Flows and Water Surface Elevations by Month

Month	Pumped Flow (cfs)	Avg Monthly River Flow (cfs) [1]	Water Depth at Weir (ft)	Existing Water Surface Elevation (ft) [2]	Proposed Water Surface Elevation (ft) [2]	Barrier Up?
January	29.4	883	2.1	27.6	31.8	Yes
February	39.4	760	1.9	27.5	31.8	Yes
March	49.7	624	1.6	27.3	28.5	No
April	49.7	404	1.1	27.1	28.4	No
May	20.1	209	0.7	26.9	27.9	No
June	6.7	137	0.6	26.4	27.7	No
July	8.9	75	0.3	26.1	27.1	Yes
August	8.9	50	0.2	26.0	27.1	Yes
September	20.1	82	0.3	26.2	27.2	Yes
October	25.4	289	0.9	27.0	29.3	Yes
November	26.3	746	1.9	27.5	31.8	Yes
December	26.3	910	2.1	27.6	31.8	Yes

[1] From USGS Gage 12010000 NASELLE RIVER NEAR NASELLE, WA

[2] Taken at Cross Section 02+74 located at the existing and proposed weir crest

Finally, when riverbanks are submerged for long periods of time, the seepage conditions within the bank will likely have reached a steady-state. If it is necessary to lower the water levels on the bank quickly, for example by dropping the Obermeyer weir, the pore-water pressures within the riverbank may remain relatively high while the stabilizing effect of the weight of the river's water column along the bank is removed. This process can cause instability of the bank, leading to erosion on the face of the bank. To minimize the possibility of any bank erosion due to operation of the weir, the standard operating procedure the Obermeyer will include lower the weir in increments over a two-day period when transitioning from the trapping to the non-trapping period. Note that the potential for this type of erosion only exists when transitioning from trapping to non-trapping. When transitioning from non-trapping to trapping, the Obermeyer is raised and a portion of the bank is wetted, which will raise the phreatic surface in the bank until equilibrium is achieved. This is not an unstable condition. Also, when flood flows are occurring and it becomes necessary to incrementally lower the Obermeyer to maintain the water level at or below the OHWM, the water surface elevation does not change, and therefore no instability due to wetting and drying would occur.

7.0 REFERENCES

NMFS (National Marine Fisheries Service). 2022. NOAA Fisheries West Coast Region Anadromous Salmonid Passage Design Manual, NMFS, WCR, Portland, Oregon.

McMillen Jacobs Associates (McMillen Jacobs), 2019. Technical Memo 001: Biological Design Criteria, Naselle Fish Hatchery Design.

McMillen Jacobs Associates (McMillen Jacobs), 2020. Technical Memo 002: Hydraulic and Fish Passage Design Criteria, Naselle Fish Hatchery Design.