US Army Corps of Engineers®
Seattle District

Planning and Environmental & Cultural Resources Branch

February 2026

Puget Sound & Adjacent Waters Restoration (PSAWR)

Spencer Island Ecosystem Restoration Snohomish County, WA

Appendix C – Economics

Photo Credit: Sydney Kerkhove-Peltier, USACE

Figures and Tables

Figures

Tables

Unit Conversion Factors

Multiply	By	To Obtain
acres	4,046.873	square meters
feet	0.3048	meters

Appendix C

C.1 Introduction

This report documents the evaluation and comparison of the Final Array of Alternatives for the Spencer Island Ecosystem Restoration project. Section C.2 covers the study authority, purpose, and background. Section C.3 covers the evaluation and comparison of the focused array of alternatives and the identification of the Recommended Plan. Section C.4 covers the comprehensive benefits analysis of the final array of alternatives, and Section C.5 concludes with a summary of the Recommended Plan.

C.2 National Ecosystem Restoration

Federal interest in ecosystem restoration is established in many laws and executive orders for the protection, restoration, conservation, and management of environmental resources (USACE, 2000).

C.2.1 Study Authority

This project is authorized under Puget Sound and Adjacent Waters Restoration, WA (PSAWR), Sec 544 of the Water Resources Development Act of 2000 (Public Law 106-51) (Sec 544), which implements restoration projects with immediate ecosystem benefits by using existing plans to the maximum extent practical. The Spencer Island project was specifically selected for implementation through the Puget Sound Nearshore Ecosystem Restoration Program (PSNERP) General Investigation as documented in the 2016 FR/EIS, Chief's Report, and Record of Decision signed January 19, 2017.

The United States Congress' explanatory statement accompanying its fiscal year 2022 appropriations act specifies funding for this project. It encourages USACE to proceed with the tiered implementation strategy developed with the PSNERP study using all existing authorities, and it directs USACE to recognize the PSNERP study as the feasibility component for the purposes of Sec 544.

C.2.2 Purpose

The purpose of the feasibility study is to evaluate degradation of significant aquatic ecosystem at Spencer Island and analyze measures to reasonably maximize national ecosystem restoration, consistent with restoring ecosystem process, structure, and function of the natural environment.

C.2.3 Study Area

The study area is within the Whidbey Subbasin of Puget Sound in western Washington. Spencer Island is in the Snohomish River Estuary, the second largest estuary in Puget Sound. The site is at approximately river mile 3.8 between Union and Steamboat Sloughs near Everett, Washington. The project area is about 350 acres within the total 426 acres of Spencer Island.

C.2.4 Assumptions

This section of the report presents the assumptions used in computing average annual equivalent costs for the focused array of alternatives:

- The cost effectiveness analysis employs the FY2026 federal discount rate of 3.25% (USACE, 2025).
- All dollar figures are stated in constant FY2026 dollars for the Focused Array of Alternatives.

C.2.5 Existing Condition

Spencer Island was diked and drained in the early 1900s. The system of dikes, tidegates, and drainage ditches precluded tidal inundation and river flooding, and thereby allowed the island to support grazing lands. In 1989, Snohomish County and the Washington Department of Fish and Wildlife (WDFW) purchased the island to support recreational activities.

Past restoration on Spencer Island has occurred through active and passive restoration efforts, creating three dike breaches that have restored tidal action to about 80 acres of tidal marsh habitat in the southern part of the island. A series of designed breaches in the 1990s and the construction of a cross dike allowed tidal inundation to restore estuarine processes in the southern part of the island. In 2005, an accidental breach occurred in the northeastern part of the island, restoring tidal action to a small area. Since the breach in 2005, mudflat sedimentation and vegetation colonization are occurring within the site. However, the preexisting field drain system appears to have captured tidal flows, precluding the development of a dendritic channel network.

The current condition on Spencer Island is diked freshwater and estuarine intertidal wetlands with altered hydrology. Land use consists of pedestrian paths typically used for waterfowl hunting in the northern portion of the site, and birdwatching and dog-walking around the southern portion.

C.2.6 Study Alternatives – Focused Array

The study team identified four management measures for potential implementation to achieve the project objectives (Spencer Island IFR-EA, Section 3.1 Management

Measures). The study team combined these management measures in varying degrees to formulate an initial array of eleven alternative plans, including the No Action alternative, to meet the planning objectives (Spencer Island IFR-EA, Section 3.2.1). To screen the initial array of alternative plans, the study team presented the alternatives to the two public entities that own the project lands, WDFW (the non-federal sponsor) and Snohomish County. The two landowners conducted public outreach to assess stakeholders' views of the range of alternatives. They also considered the construction and maintenance history of the Union Slough dike on Spencer Island. Outreach results indicated a balanced interest in recreation and restoration. The screening process to arrive at a focused array of alternatives is detailed in the Main Report (Spencer Island IFR-EA, Section 3.2.2 Focused Array of Alternative Plans). Further screening of the following focused array of alternatives and the evaluation of the final array of alternatives are described in this appendix:

- **Alternative 1:** No Action
- **Alternative 2:** Minimum Restoration
- **Alternative 4a:** Interior Channel Restoration
- **Alternative 5a:** Partial South Cross Dike Lowering Restoration
- **Alternative 8:** High Restoration

Detailed descriptions of alternatives can be found in the main study report in Section 3.2.2, Focused Array of Alternative Plans.

C.3 Evaluation of Focused Array of Alternative Plans

The study team evaluated alternatives based on the Spencer Island planning objectives of improving fish access, improving tidal hydrology to support tidal channel formation and maintenance, and improving nearshore ecosystem processes (sedimentation, erosion, and detritus recruitment) at Spencer Island for the 50-year period of analysis beginning in 2028. A planning consideration of the Spencer Island project is to avoid or minimize impacts to recreational access for activities such as walking, wildlife viewing, and hunting to the extent practicable. The study team evaluated the extent to which recreational access is maintained or improved under each alternative.

The following sections describe the economic evaluation of the focused array of alternatives, including the development of the ecosystem outputs for each alternative, the input (cost) for each alternative, and the model used to evaluate ecosystem outputs in relation to cost. This section concludes with an evaluation of the impacts to recreation under each alternative.

C.3.1 Habitat Modeling Description

To estimate the ecosystem benefits that would be provided by each alternative, the study team utilized an ecosystem benefit model developed for Puget Sound river delta ecosystem restoration projects, "Ecosystem Output Calculator for CAP[1] and CAP-like River Delta Ecosystem Restoration in Puget Sound" (USACE, 2023).

Ecosystem output (EO) is measured in habitat units (HUs), which are used as a numerical estimate of the benefits provided by each alternative. The EO under the future-with-project condition minus the EO under the future-without-project condition represents each action alternatives' net benefits.

For a given alternative, a habitat quality score (HQS) is multiplied by the number of acres impacted by the alternative, with the resulting number being the EO, given in HUs. The general formula is as follows:

Ecosystem Output (in HUs) = Quality (the HQS) x Quantity (# of Acres)

The HQS is indexed on a scale from 0-1 (0-100%), with a score of 1 indicating optimal habitat quality and 0 indicating minimal habitat quality.

The calculator uses three metrics to quantify habitat quality, each of which applies to the area of site wetted at a particular tide level associated with that metric. Detailed descriptions of each metric, the H&H analysis conducted to determine HQSs for each metric, and the GIS data used to support the analysis, can be found in the report, "Technical Memorandum; Subject: Updated Hydraulic Analysis of Spencer Island Ecosystem Restoration Feasibility Study Alternatives" (Corum, 2024). The Metrics are as follows:

1. Metric 1 (M1): Tidal Channel Connectivity
    a. This metric relates to aquatic species access within the tidal marsh channel network. It informs the degree to which the natural process of exchange of aquatic organism is restored.
    b. The M1 HQS if the average frequency in time during which water velocities would be lower than an impairment threshold of 1.5 feet per second (ft/s) during the spring tide weeks of June. Alternatives that reduce the frequency of excessive velocities have higher HQSs (maximum of 1, or 100% of the time) than those that do not.

---

[1] Continuing Authorities Program

   c. The HEC-RAS 2D hydraulic model provides velocity output data to estimate this HQS.

2. Metric 2 (M2): Marsh Connectivity
   a. The M2 HQS is the ratio of the number of existing and new connections (dike breaches) between the tidal marsh to be restored and adjacent distributary channels, and the best available Puget Sound science-based regression prediction for Spencer Island (Hood 2015).
   b. Habitat quality for this metric increases as the number of opening approaches the optimal number, as determined by the regression predictor.
   c. The number of openings directly informs the degree to which the following processes are restored: tidal flow, tidal channel formation and maintenance, sediment input, sediment transport, and erosion and accretion of sediments. These processes are essential to creating and sustaining deltaic marshlands and associated aquatic and riparian habitat for many valued species, including ESA-listed salmonids.
3. Metric 3 (M3): Floodplain Connectivity
   a. GIS and digital elevation models of existing and proposes conditions are used to estimate this HQS.
   b. The M3 HQS is the length of shoreline relative to the total shoreline length where the ground elevation is below a frequent fluvial/coastal floor elevation and physical processes associated with flooding are unimpaired.
   c. This metric addresses the degree to which the diked site is connected to distributary channels and adjacent restoration sites during floods. It also informs the degree to which the following processes are restored: tidal flow, detritus import and export, sediment input, sediment transport, and erosion and accretion of sediments. These processes are critical to forming and sustaining native habitat structure (e.g., sediment distribution, large wood, and nutrient distribution), which supports many valued species including ESA-listed salmonids.

Metric 3 (floodplain connectivity) is the largest driver of increases in habitat units, followed by Metric 2 (marsh connectivity) and Metric 1 (tidal channel connectivity). Separately, actions to increase each of these metrics are beneficial, however removing dikes without also adding new connections to distributary channels would perpetuate degraded conditions within the march channel network and unnecessarily delay (or hinder) restoration (Corum, 2024).

The arithmetic mean of the three HQSs is used for the “quality” component of the calculation. For the “quantity” portion of the calculation, the largest applicable area is used. In other words, the largest of the three wetted areas (corresponding to the three Metrics), is used as the quantity of restored habitat. As the three areas correspond to tide levels, the largest area necessarily includes the two smaller areas. The resulting total combined EO score for the site has a maximum score equal to the total acreage of the areas to be restored.

In accordance with USACE policy, alternative plans must be evaluated for the benefits they would accrue over the period of analysis (USACE, 2000). After a site is restored, ecosystem processes take time to reestablish native site conditions and reach the dynamic equilibrium optimal for supportive habitat. In order to account for this, the study team estimated a benefit accrual rate, given in Average Annual Habitat Units (AAHUs) over the 50-year period of analysis beginning in 2028 using the method in the model approved by the Office of Water Project Review for use by the Puget Sound Nearshore Ecosystem Restoration (PSNER) project (USACE, 2013).

Based on this method, the study team assigned a Benefit-Accrual Curve, Benefit Curve 3, to each alternative based on the management measures associated with that alternative. The Benefit Curve 3 is a Polynomial Curve that represents how benefits accrue steadily, but at a faster rate than a linear curve over the 50-year period of analysis. Benefit Curve 3 is associated with an Average Annual Benefits Factor of 0.65 (or 65%). This Average Annual Benefits Factor was multiplied by each action alternative’s net benefits to calculate the annualized benefits for each action alternative, given in AAHUs.

More information on the ecosystem output calculator used to estimate ecosystem restoration benefits at Spencer Island can be found in the report, “Ecosystem Output Calculator for CAP and CAP-like River Delta Ecosystem Restoration in Puget Sound” (USACE, 2023).

All alternatives in the focused array would provide ecosystem benefits, increasing in magnitude from Alterative 1, the no action alternative, through Alternative 8.

The future condition under Alternative 1, the no action alternative, is equivalent to the “future-without-project” condition. The EO under the future-with-project condition minus the EO under the future-without-project condition represents each action alternatives’ net benefits. Each action alternatives’ net benefits are annualized to get Average Annual Habitat Units for each action alternative. Ecosystem outputs are presented in Table 2-1.

Table 2-1 Alternatives Summary of Ecosystem Outputs*

Alt.	Impacted Area (Acres)	Habitat Quality Score (0-1)	Ecosystem Output (HUs)	ΔEcosystem Output (△HUs)	Average Annual Habitat Units (AAHUs)
1	391.70	0.500	196	0	0
2	402.70	0.597	240	44	29
4a	403.00	0.750	302	106	69
5a	407.20	0.827	337	141	91
8	408.30	0.850	347	151	98

Sources: (1) Ecosystem Output Calculator for CAP and CAP-like River Delta Ecosystem Restoration in Puget Sound (USACE, 2023); (2) Technical Memorandum: Updated Hydraulic Analysis of Spencer Island Ecosystem Restoration Feasibility Study Alternatives (Corum, 2024).

**Note: The figures reported in this table for ecosystem output may slightly differ from those in the original Excel file due to rounding to the nearest whole number.*

Both the quality (HQS) and the quantity (impacted area) of habitat increase from Alternative 1 through Alternative 8. For each alternative the Metric 3 wetted area is the largest area of impact. Thus, the Metric 3 wetted area is used as the impacted area, or quantity of habitat, under each alternative.

Under the No-Action Alternative, the impacted area is about 391.7 acres. The habitat quality score assigned to the no action alternative is 0.500. Under the No-Action Alternative, Spencer Island will experience an ecological lift of 196 habitat units.

Alternative 2 will impact about 402.7 acres of habitat in the project area. This habitat under alternative 2 received a quality score of 0.597. Over the 50-year period of analysis, restoration activities associated with Alternative 2 produce about 240 habitat units, about 44 habitat units greater than Alternative 1, the no-action alternative. Alternative 2 produces 28.88 average annual habitat units (AAHUs) over the No-Action Alternative.

Alternative 4a produces about 302 habitat units over the 50-year period of analysis, about 106 habitat units greater than Alternative 1, the no action alternative. The impacted area under Alternative 4a, 403 acres, is comparable to that of Alternative 2. The greater ecosystem output under Alternative 4a is attributable to greater tidal channel, marsh, and floodplain connectivity under Alternative 4a, than under Alternative 2, which is represented by a higher habitat quality score of 0.750. From an annual perspective, Alternative 4a produces 69.19 average annual habitat units over the No-Action Alternative.

The impacted area under Alternative 5a is 407.2 acres, and the habitat received a HQS of 0.827. Alternative 5a produces about 337 habitat units over the 50-year period of analysis, about 141 habitat units greater than Alternative 1, the No-Action Alternative. From an annual perspective, Alternative 5a produces 91.50 AAHUs over the No-Action Alternative.

Alternative 8 has an impact on a comparable quantity of habitat, 408.3 acres, to Alternative 5a. The habitat quality score assigned to the habitat under Alternative 8 is 0.850. All Metric HQSs under Alternative 8 are higher than under Alternative 5a. The greatest difference in Metric HQSs between Alternative 8 and Alternative 5a is for Metric 1 (tidal channel connectivity). Alternative 8 produces a total of about 347 habitat units over the 50-year period of analysis, about 151 habitat units greater than Alternative 1. Alternative 8 produces 98.28 average annual habitat units over the No-Action Alternative.

The next section covers how these ecosystem outputs, along with the costs of each alternative, are employed in an input-output model to determine the cost-effectiveness of each alternative.

C.3.2 IWR Planning Suite II – Plan Inputs

The IWR Planning Suite II is a software developed by the U.S. Army Corps of Engineers (USACE) Institute for Water Resources (IWR). While initially created to assist with the formulation, evaluation, and comparison of plans for ecosystem restoration and watershed planning, its use has since expanded to a wide variety of USACE planning studies, particularly those involving both monetary costs and non-monetary benefits. The software is a key tool for conducting Cost Effectiveness & Incremental Cost Analysis (CE/ICA) required for environmental restoration plans. For this study, the team used the suite’s built-in Annualization tool to determine the annualized cost of each alternative. These results were then used to perform the CE/ICA on the focused array of alternatives.

Total Project Cost Summary (TPCS) was prepared for each alternative in the focused array of alternatives. The TPCS includes the costs for lands, easements, relocations, and rights of way, and disposal areas (LERRD), pre-construction, engineering, and design (PED), construction, construction management, and contingency. These costs are escalated in order to calculate the Project First Cost and the Total Project Cost. The Project First Cost is used to calculate the Average Annual Cost, which is the input for Cost Effectiveness Analysis.

The project first cost breakdown and construction duration for the focused array of alternatives are displayed in Table 2-2. Additional cost details are available in Appendix I, Cost.

Table 2-2 Alternatives Summary of Total Project First Cost Breakdown ($ ’000)*

Alt.	Construction	PED	Constr. Mngmt.	LERRD	Project First Cost	Construction Duration
1	-	-	-	-	-	0 Months
2	6,429	1,534	566	3,320	11,850	5 Months
4a	6,819	1,279	667	3,320	12,086	7 Months
5a	5,838	1,257	740	3,320	11,156	7 Months
8	7,795	1,367	685	3,320	13,167	6 Months

Source: CAP 544 Spencer Island TPCS 20251212.xlsx

**Note: FY26 Oct 2025 Price Level.*

Interest during construction (IDC) is an estimate of the opportunity cost of money spent to build the project during the construction period. In other words, it is the cost of not investing the money elsewhere during that time. Uniform monthly payments were calculated for each alternative by dividing the Project First Cost by the Construction Duration (Table 2-2). The IWR Planning Suite Annualization Tool was used to determine the IDC for each alternative based on the construction durations and uniform monthly payments. IDC was calculated at a FY26 price level and a discount rate of 3.25% (USACE, 2025). The Total Project Investment Cost is then calculated using the following formula:

Total Project Investment Cost = Project First Cost + IDC

This cost was then annualized using the IWR Planning Suite II’s Annualization Tool to determine the Average Annual Equivalent (AAEQ) Cost. The calculation was performed at the FY26 price level over the 50-year period of analysis beginning in 2028, using a 3.25% discount rate. Detailed calculation procedures for this process are outlined in the IWR Planning Suite II User’s Guide (USACE, IWR, 2017).

The resulting AAEQ Cost is then used to determine the project's total Average Annual Cost (AAC). The AAC is the sum of AAEQ Cost and any Annual Operations and Maintenance (O&M) costs.

AAC = AAEQ Cost + Annual O&M Costs

Because the study team does not anticipate this ecosystem restoration project will require additional maintenance, O&M costs are zero, making the Average Annual Cost equal to the Average Annual Equivalent Cost.

The annualized benefits for this ecosystem restoration project are the ecosystem outputs, given in Average Annual Habitat Units (AAHUs). This output is used to calculate the Average Annual Cost per AAHU, which is determined by dividing the Average Annual Cost by the total AAHUs, providing a clear cost per unit of output.

Average Annual Cost per AAHU = AAC / AAHU

A summary of these annualized costs and benefits is presented in Table 2-3. For clarity in the table, AAHUs are rounded to the nearest whole number, while Average Cost is rounded to one decimal place to better display the difference in the cost per habitat unit.

Table 2-3 Alternatives Summary of Annualized Costs and Benefits ($ '000)*

Alt.	IDC	Total Project Investment Cost	AAEQ Cost	Annual O&M	Average Annual Cost	Output (AAHUs)	Average Annual Cost per AAHU
1	-	-	-	-	-	0	-
2	79	11,929	486	-	486	29	16.8
4a	113	12,199	497	-	497	69	7.2
5a	105	11,261	459	-	459	91	5.0
8	106	13,273	541	-	541	98	5.5

Source: IWR Planning Suite II: Annualization Calculator. Accessed desktop application in October 2024.

**Note: FY26 Oct 2025 Price Level and 3.25 Percent Federal Discount Rate*

C.3.3 NER Plan Identification from Cost Effectiveness and Incremental Cost Analysis

Cost-effectiveness and incremental cost analysis (CE/ICA) was conducted for the focused array of alternatives, with Average Annual Cost (AAC), FY26 dollars, as the input and Average Annual Habitat Units (AAHUs) as the output for each alternative.

A cost-effectiveness analysis was performed to identify the plans that provide the greatest environmental output for the lowest cost. An alternative is considered cost-effective if no other plan offers a higher level of output for the same or a lower cost. Based on this principle, Alternatives 2 and 4a were identified as inefficient and therefore screened out as not cost-effective. Specifically, as shown in in Table 2-4 and Figure 2.1, Alternative 5a produces a significantly higher output (91 AAHUs) at a lower annual cost ($459,000), than both Alternative 2 (29 AAHUs at $486,000) and Alternative 4a (69 AAHUs at $497,000). Alternative 8 produces the greatest level of environmental output (98 AAHUs). Although Alternative 8 is the most expensive alternative, no other plans yield a greater level of output. Therefore, the set of cost-effective plans that are carried forward for further analysis includes Alternative 1 (No Action), Alternative 5a (Partial South Cross Dike Lowering Restoration), and Alternative 8 (High Restoration).

Table 2-4 Cost Effectiveness Analysis – Focused Array of Alternatives

Alternative	Output (AAHUs)	Cost AAC ($ ’000)*	Cost Effective?	Best Buy?
1	0	-	Yes	Yes
2	29	486	No	No
4a	69	497	No	No
5a	91	459	Yes	Yes
8	98	541	Yes	Yes

Source: IWR Planning Suite II: CEICA

**Note: FY26 Oct 2025 Price Level and 3.25 Percent Federal Discount Rate*

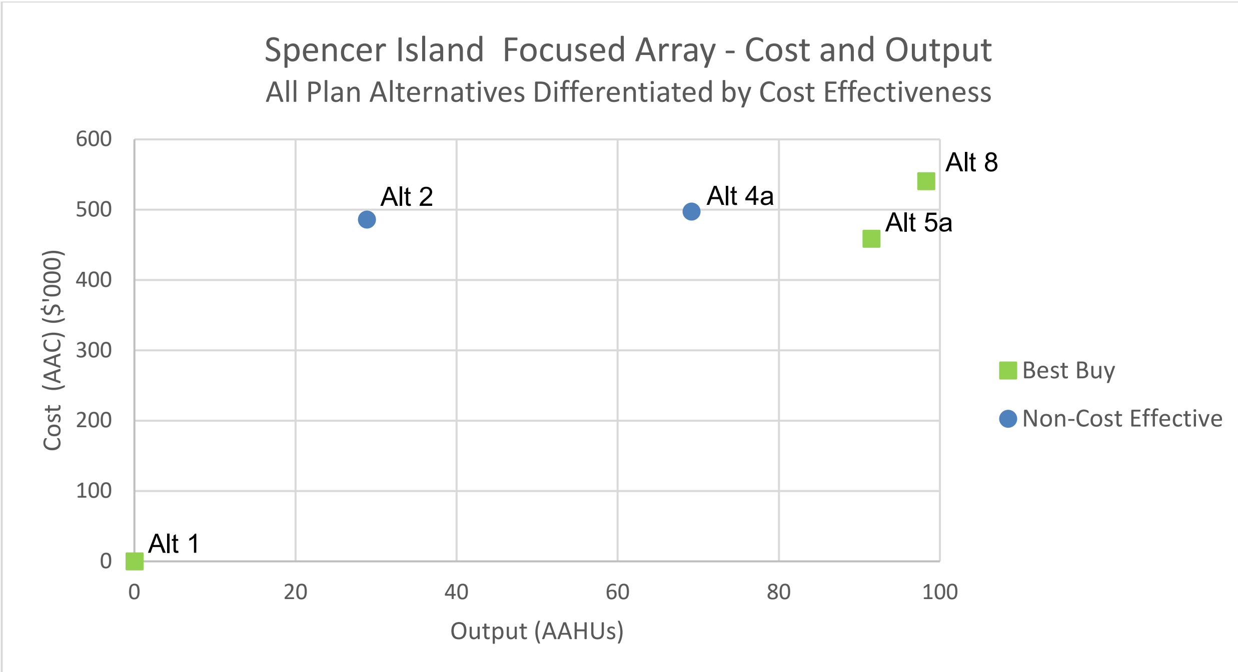

Figure 2.1. Cost Effectiveness Analysis – Focused Array of Alternatives

**Note: FY26 Oct 2025 Price Level and 3.25 Percent Federal Discount Rate*

The findings in Table 2-4 are visually supported by the data presented in Figure 2.1. Alternatives 2 and 4a are inefficient and therefore not cost-effective, so these alternatives were removed from further consideration. The final focused array of alternatives is shown in Table 2-5, each of which is a cost-effective or least cost alternative for the corresponding level of output.

Table 2-5 Cost Effectiveness Analysis – Cost-Effective Alternatives

Alternative	Output (AAHUs)	Cost AAC ($ '000)*	Average Cost ($ '000/AAHU)	Cost Effective?	Least Cost?
1	0	-	-	Yes	No
5a	91	459	5.0	Yes	Yes
8	98	541	5.5	Yes	Yes

**Note: FY26 Oct 2025 Price Level and 3.25 Percent Federal Discount Rate*

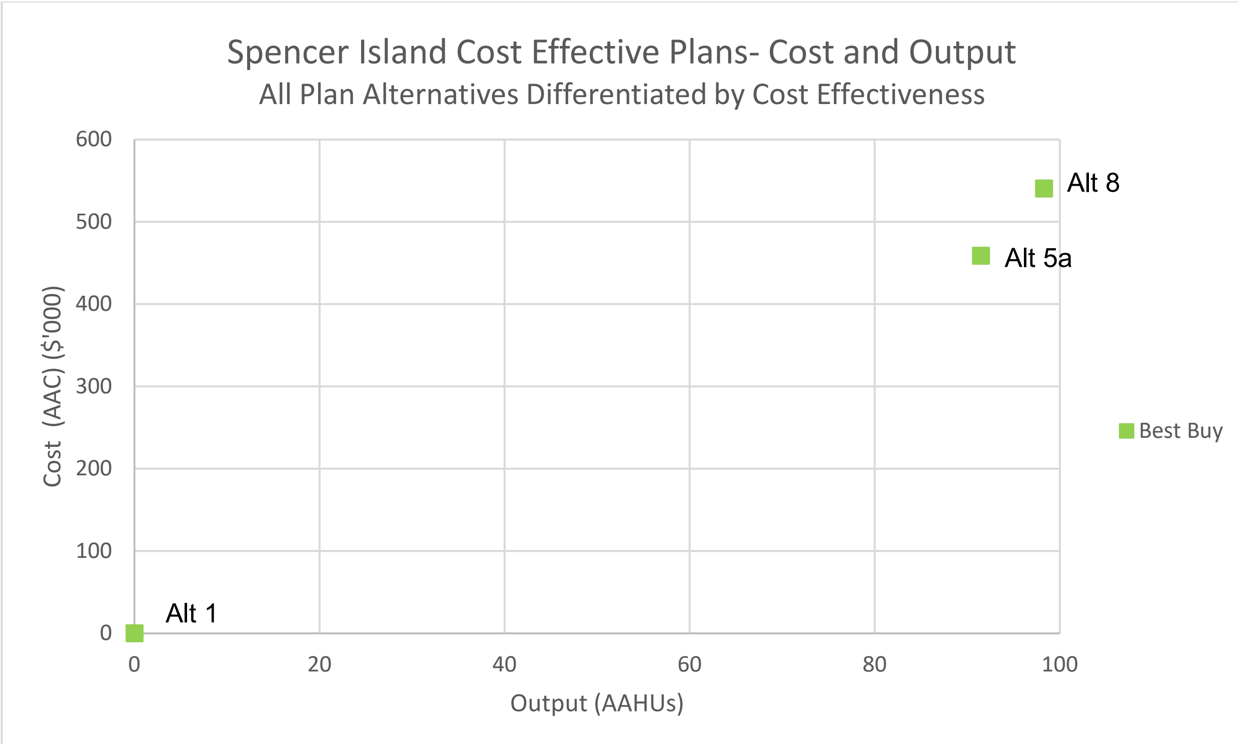

Figure 2.2. Cost Effectiveness Analysis - Cost Effective Alternatives

**Note: FY26 Oct 2025 Price Level and 3.25 Percent Federal Discount Rate*

Average cost per output can facilitate the comparison of production efficiencies across the alternatives by placing each alternative plan in a common metric: dollars per unit of output (USACE, IWR, 1994). Based on the ecosystem model and CEICA results, Alternative 5a is the most productively efficient alternative, with the least average cost per output of $5.0 thousand or $5,000. Although Alternative 8 is not the most productively efficient alternative, Alternative 8 proceeds to the next step of analysis with Alternative 1 and Alternative 5a as it produces a greater level of output (98 AAHUs) than Alternative 5a (91 AAHUs).

An Incremental Cost Analysis (ICA) was performed to determine if the most cost-effective options, Alternative 1 (No Action), Alternative 5a (Partial South Cross Dike Lowering Restoration), and Alternative 8 (High Restoration) were also the “best-buy” plans. A best-buy plan is one that provides the greatest environmental benefit for the lowest additional cost. Put another way, they are the most efficient alternatives for which the incremental cost per unit is lowest for a particular level of output.

The ICA process begins with the No-Action Alternative, and the incremental cost and incremental benefit beyond the No-Action Alternative are calculated for all other cost-effective alternatives. These values are then used to calculate the incremental cost per incremental benefit for each cost-effective alternative. The alternative with the lowest incremental cost per unit of benefit is identified as the first best-buy option. The ICA process then involves recalculating this ratio (i.e., slope) between that first best-buy alternative and the remaining options, selecting the alternative with the next lowest incremental cost per unit of benefit as the subsequent best-buy. This stepwise comparison continues until all alternatives are ranked, with the final entry typically being the “kitchen sink” alternative, which incorporates all management measure under review. Following identification of the best-buy alternatives, incremental costs and outputs are compared across best-buy alternatives to determine if each incremental cost is justified by the associated increase of ecosystem output. The results of the incremental cost analysis are reported in Tables 2-6 and 2-7, and displayed in Figure 2.3.

Table 2-6. Incremental Cost Analysis – Final Array of Alternatives ($ ’000)*

Alternative	Cost (AAC)	Output (AAHUs)	Incremental Cost	Incremental Output (AAHUs)	Incremental Cost/ Incremental Output**	Best-Buy
1	-	0	-	0	-	First Best-Buy
5a	459	91	459	91	5.0	Second Best-Buy
8	541	98	541	98	5.5	

**Note: FY26 Oct 2025 Price Level and 3.25 Percent Federal Discount Rate*

***Note: Figures reported in this table may slightly differ from those in the original Excel file due to rounding to one decimal place.*

The results of the ICA confirm that the three cost-effective alternatives (Alternatives 1, 5a, and 8) are also the best-buy alternatives (Table 2-6 and Table 2-7). Alternative 1 (No Action) was identified as the first best-buy plan. Next, the ratio of incremental costs to incremental benefits of the remaining alternatives was calculated against Alternative 1 (Table 2-6). From this, Alternative 5a was identified as the next best-buy alternative, as it has the lowest in incremental cost per incremental output. Finally, as shown in Table 2-7, the same process was repeated by considering Alternative 5a as the point of reference, which established Alternative 8 as the third and final best-buy alternative.

Alternative 5a has an incremental increase in average annual cost from the No-Action Alternative of about $459,000 which is associated with approximately 91 additional

AAHUs. Alternative 8 has an incremental increase in average annual cost from Alternative 5a of approximately $82,000 which is associated with an incremental increase in output from Alternative 5a of about 7 AAHUs. The incremental cost per incremental output for alternatives 5a and 8 are approximately $5,000 (Table 2-6) and $12,100 (Table 2-7), respectively.

Table 2-7. Incremental Cost Analysis – Alternative 5a & Alternative 8 ($ '000)*

Alternative	Cost (AAC)	Output (AAHUs)	Incremental Cost	Incremental Output (AAHUs)	Incremental Cost/ Incremental Output**	Best-Buy
5a	459	91	0	0	0.0	
8	541	98	82	7	12.1	Third Best-Buy

**Note: FY26 Oct 2025 Price Level and 3.25 Percent Federal Discount Rate*

***Note: Figures reported in this table may slightly differ from those in the original Excel file due to rounding to one decimal place.*

The results of the ICA are shown graphically in Figure 2-3. The figure evaluates the change in annualized costs for each additional unit of annualized ecological output, measured in Average Annual Habitat Units (AAHUs), to identify the sequence of best-buy plans. In the figure, the horizontal axis shows environmental output in AAHUs, while the vertical axis shows incremental costs per additional AAHU. The dark green band, representing the move from Alternative 1 to Alternative 5a, shows that achieving the first 91 AAHUs of environmental benefit costs an additional $5,000 for each unit. However, the light blue band, representing the move from Alternative 5a to Alternative 8, shows that the cost to achieve the final increment of habitat (from 91 to 98 AAHUs) increases, rising to $12,100 per additional AAHU.

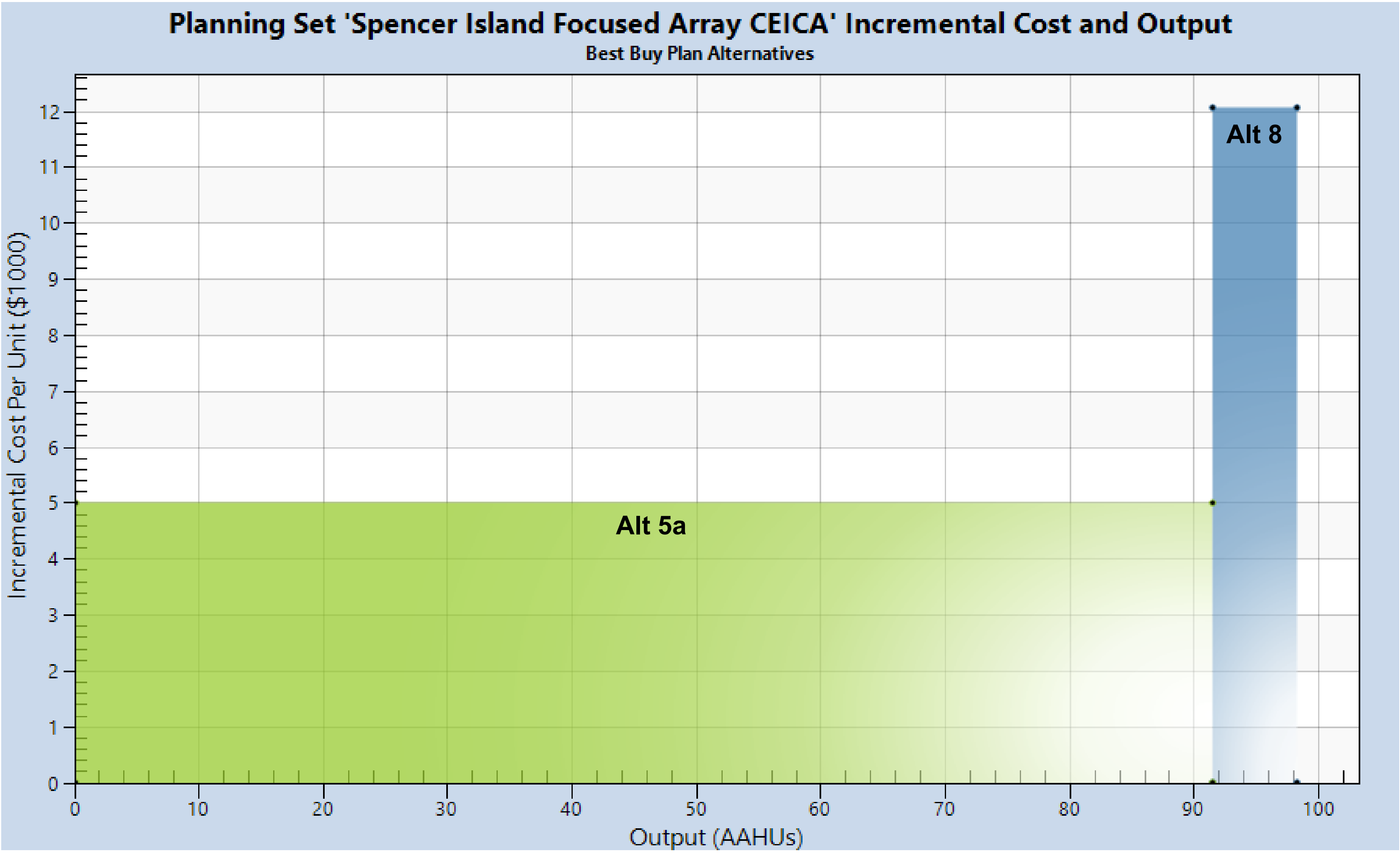

Figure 2.3. Incremental Cost Analysis - Best Buy Alternatives

Alternative 5a is the most productively efficient alternative as determined by the model. Implementation of alternative 5a would involve a moderate level of channel connectivity, a medium level of levee breaching, and a medium level of levee lowering to achieve the first increment of 91 AAHUs. To achieve the final increment of habitat benefits, implementation of alternative 8 involves additional management measures for maximum channel connectivity, maximum levee breaching, and maximum levee lowering. Specifically, creating 4 additional channels and filling 19 ditches, adding one more levee breach, and lowering an additional levee. Alternative 8 creates more assurance of channel connectivity than Alternative 5a, via drainage ditch filling. Through discussions with stakeholders and lessons learned from other ecosystem restoration projects in the Snohomish Delta, the study team identified that if drainage ditches are not filled, tidal flows will continue to follow the drainage ditches, which are not suitable habitat for salmonids and other species in the Snohomish Delta. Discussion on the additional ecological lift, not captured in the model, and associated with the ditch filling under Alternative 8 can be found in the main report in the ‘Channel Network Improvement’ paragraph of Section 3.4. Although alternative 8 has a higher incremental cost per incremental benefit than alternative 5a, the study team determined the incremental environmental benefits associated with alternative 8 are worth the additional investment due to the greater assurance of increased channel connectivity, a significant aspect of restoring suitable aquatic habitat in the Snohomish Delta.

C.3.4 Recreation Evaluation

For ecosystem restoration projects, it is important that proposed recreation features are appropriate in scope and scale to the opportunity provided by the project, and that the recreational development and anticipated use be compatible with the ecosystem restoration purpose of the project. The recreation potential may be satisfied only to the extent that recreation does not significantly diminish the ecosystem outputs that justify the ecosystem restoration project (USACE 2000).

The following sections describe the existing recreational condition on Spencer Island, the future without-project (FWOP) condition, and the future with project (FWP) condition under each alternative. The metrics used to evaluate recreation are displayed for each alternative, and the impacts to recreation under alternatives 5a and 8, the best buy action alternatives, are described in further detail.

C.3.4.1 Existing Condition

Spencer Island is a popular location for three primary user groups: waterfowl hunters who enter on foot and by small watercraft, birdwatchers who walk the established trails and may make excursions off trail, and dogwalkers who primarily use the south end perimeter loop trail. Snohomish County owns the southern half of the island, and WDFW owns the northern half.

Snohomish County has several key recreational features on Spencer Island. The current recreational features at Spencer Island include a trail network and 4 wooden bridges that continue the trails over dike breaches (Figure 2.4). The County installed the three wooden bridges in 1994 as part of their initial restoration effort. All the original bridges were constructed with wood pilings and were installed by the same contractor that built the cross-dike and excavated the breaches. The original bridge over the Steamboat breach broke apart during a high-water event and was rebuilt by the county. The County constructed an additional bridge after the cross-dike was naturally breached in 2005. In addition to the loop trail bridges, Snohomish County installed two boardwalks over the marsh as part of the early 1990s restoration and trails project. The northernmost boardwalk is approximately 126 feet long, and the southern boardwalk approximately 246 feet long. Because the boardwalks were installed prior to the unplanned breach in 2005 they are submerged during high water conditions.

Ducks Unlimited executed a smaller restoration project at Spencer Island, completed in the winter of 2007-2008. The project involved breaching some of the perimeter berm and expanding the breach at the north end of the Island on

Union Slough. This project also added some recreational features such as a trail from the perimeter berm on Union Slough out to the marsh as a waterfowl hunting vantage point.

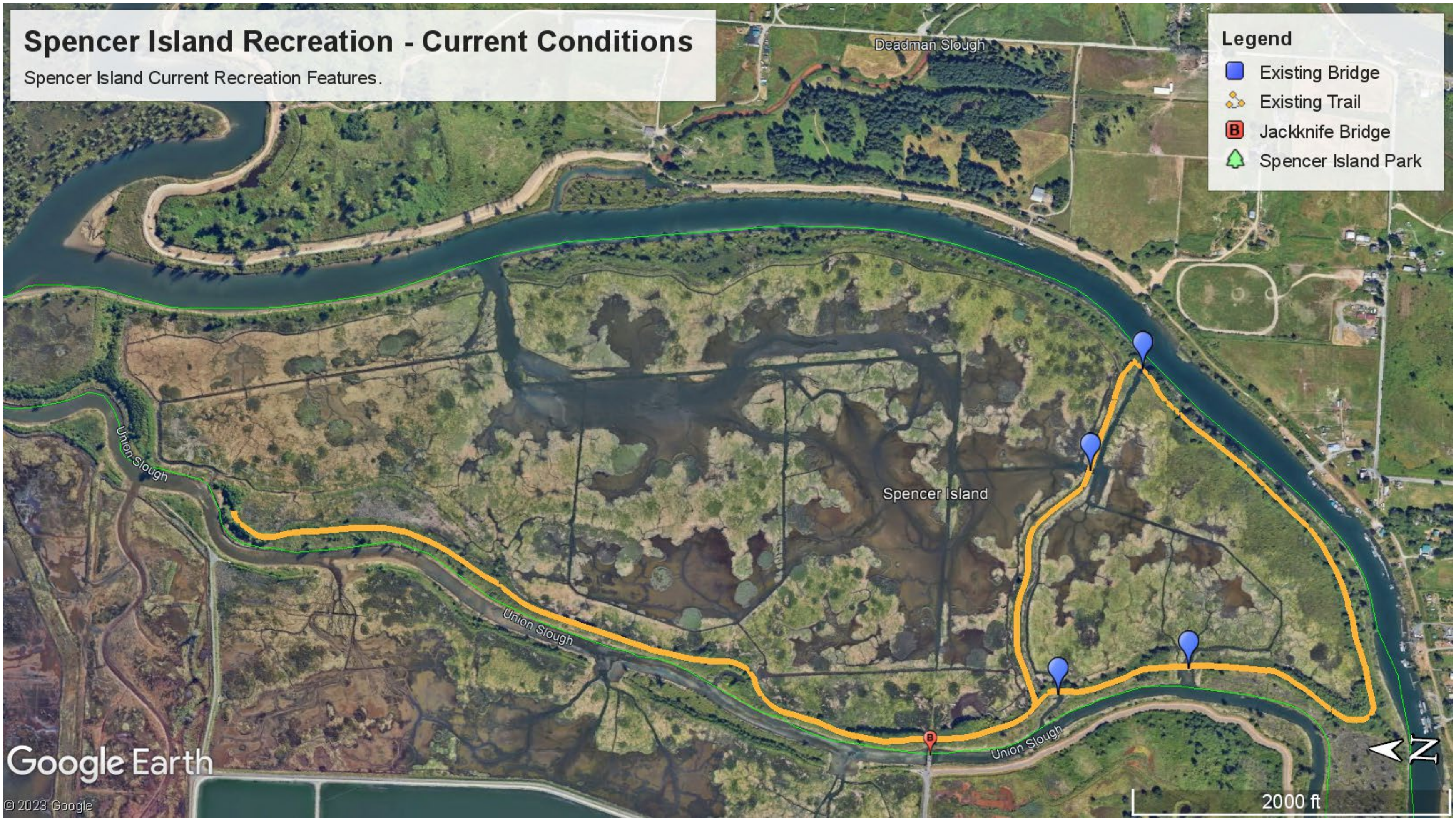

Figure 2.4. Spencer Island Recreation Features - Current Conditions

The Jackknife bridge from Smith Island over Union Slough to the entrance of Spencer Island is owned by Snohomish County Parks Department. The bridge was installed in 1993 to replace a wooden bridge that was destroyed in the 1990 floods. Upon installation, the bridge was intended for pedestrian use as well as for emergency and maintenance vehicles.

Spencer Island currently provides the following recreation features:

- Dike-Loop Trail across the south cross-dike and around the southern portion of Spencer Island. This trail includes the cross-dike bridge and the three loop trail bridges.
- Dike-Top Trail from Jackknife Bridge north along Union Slough to the breach at the NW portion of the perimeter dike.
- Trail from Jackknife Bridge south along Union Slough to the cross-dike.

The North cross dike is heavily overgrown with no current access due to multiple dike breaches. The trail along Union Slough is narrow and overgrown, which lowers the quality and ease of recreation access. The existing trail length at Spencer Island is approximately 8,160 feet (Table 2-7). This existing trail length reported here does not include the southern loop trail as it is owned by Snohomish County and not included in the scope of this project.

C.3.4.2 *Future Conditions*

The study team evaluated impacts to recreation based on changes from the existing condition. Under each action alternative, trails are *improved* as an artifact of grading and clearing for construction access. In order to facilitate mobilization of construction equipment, undersized trails will be widened, vegetation will be cleared, and the trails will be topped with gravel. This work will also facilitate future work by others to add boardwalks; WDFW intends to add pedestrian boardwalks to the north end of the island along Union Slough at a later date as part of a separate action. Trails that are not widened for construction access would be widened at the end of construction for pedestrian access, disturbed upland areas would be revegetated, and interpretive signs would be installed. In alternative evaluation, trails with access improved as a byproduct of construction access are qualified as “Improved Trail.”

Some trails at higher elevations are not likely to significantly degrade from tidal action over the 50-year period of analysis and are left as they currently are. In alternative evaluation, trails left as they currently are qualified as “Unimproved Trail.”

Under some action alternatives additional features including a hand-powered boat launch and earthen elevated viewing areas are included to maintain recreational access. Although the study team did not formulate for recreation benefits, mitigating loss to recreation access was included as a project consideration, and alternatives were formulated taking this into account.

The study team evaluated impacts to recreation based on length of trail *improved,* length of trail *unimproved,* and additional features added. This evaluation does not quantify the impacts to recreation associated with improved ecosystem resources, however it can be assumed that improved habitat may lead to a higher success rate of wildlife dependent recreational activities.

Under Alternative 2, *all* of the existing trail system would remain, and about 70% of these trails would be improved. Under Alternative 4a, a little over 50% of the existing trail system would remain, and about 45% of these remaining trails would be improved. Additionally, the project would have one hand-powered boat launch and two earthen elevated viewing platforms under Alternative 4a. In comparison to the FWOP condition, alternatives 2 and 4a will have moderate beneficial impacts to recreation. Discussed in further detail below, alternatives 5a and 8 will have minor beneficial impacts to recreation. A summary of recreation access under each action alternative is given in Table 2-7.

Table 2-8. Alternatives Summary of Recreation Access

Alt.	Existing Condition - Trail Length (ft)	FWP - Improved Trail (ft)	FWP - Unimproved Trail (ft)	FWP - Trail Lost (ft)	FWP - Boat Launch	FWP - Viewing Platforms
1	8160	0	<8160	-	-	-
2	8160	5850	2310	-	-	-
4a	8160	2000	2310	3850	1	2
5a	8160	2000	1400	4760	1	2
8	8160	2000	1600	4560	1	2

Source: Google Earth Pro. Accessed online September 2024.

Alternative 1: No-Action Alternative

Compared to the existing condition, minor negative impacts to recreational resources would occur under the No-Action alternative.

The dike-top trail and cross-dike breach would continue to degrade due to tidal action. The southern cross-dike bridge and the Steamboat Slough bridge are expected to cause ongoing repair and maintenance concerns for WDFW. It is possible these bridges would continue to fail as they have in the past, in which case access to the southern loop-trail would be partially lost. The trail from Jackknife bridge to the northern portion of the Island will continue narrowing, and the hole in the cross-dike will continue to grow. These trails could become inaccessible under the No-Action alternative. The southern loop trail managed by Snohomish County sits at a higher elevation than the northern trails and will not likely be impacted by tidal flows. The quality and capacity of recreation access will continue to decline into the future without project condition.

Alternative 5a: Partial South Cross Dike Lowering Restoration

With implementation of any of the action alternatives, recreational opportunities would be temporarily lost in the immediate vicinity of the construction footprint while construction related activities are underway. During construction periods, recreationists may experience an increase in noise from operation of equipment that could impact their ability to seek solitude or may reduce the success of wildlife dependent recreation activities. During this temporary reduction, similar recreation opportunities would remain available on adjacent lands. Recreation would resume in a manner similar to the existing condition after construction is complete.

Under Alternative 5a, the project will provide the following recreational features:

- Southern cross-dike trail ending with a 0.3-acre earthen elevated viewing platform.
- Southern dike-top trails and bridges.
- Dike-top trail from Jackknife Bridge north along Union Slough to the end of the dike with a 0.4-acre gravel viewing pad.
- Trail connecting northern viewing pad to a hand-carried boat launch.
- Trail from Jackknife Bridge south along Union Slough to the southern cross-dike.

The final configuration to the trail network under Alternative 5a is shown in Figure 2.5. More information on recreational features under Alternative 5a can be found in Appendix B, Engineering, Section 1.6.8.

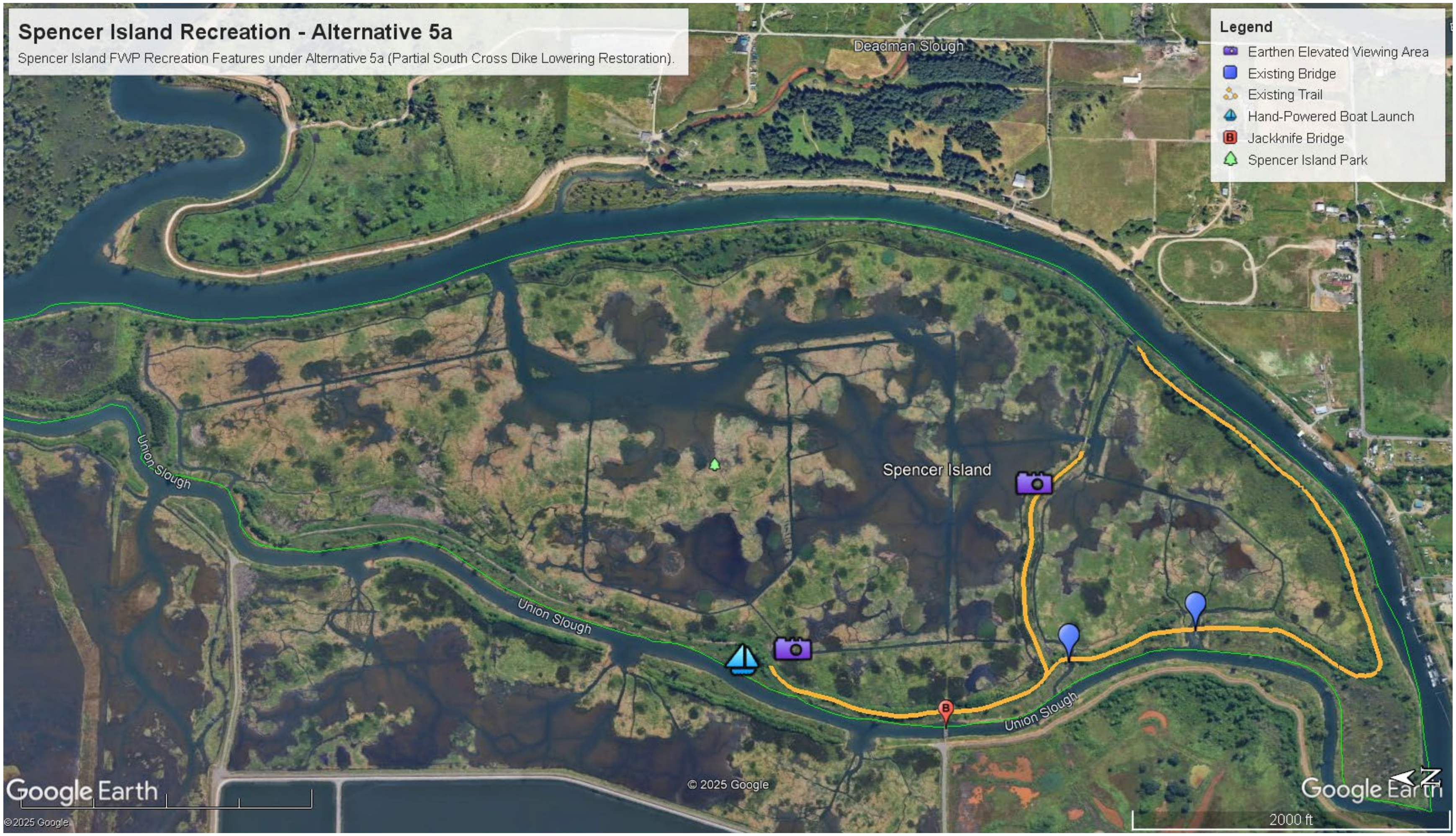

Figure 2.5. Spencer Island FWP Recreation Features - Alternative 5a

Under Alternative 5a, approximately 40% of the existing trail system would remain. Of the remaining trail network under Alternative 5a, approximately 2000 feet, or about 60%, would be improved, and the rest would remain as is. Additionally, the project would have one hand-powered boat launch and two earthen elevated viewing platforms to compensate for the loss of about 4760 feet of the existing trail network to dike lowering.

To compensate for the loss in some of the southern trail network, one elevated earthen viewing platform will be installed at the east end of the restored South Cross Dike. This viewing area will be at the same elevation as the existing bridge and will provide a larger area for people to gather. The oblong pad will be unobstructed and provide panoramic bird watching opportunities.

To compensate for the loss of trail along Union Slough, a large viewing area will be created at the dike termination point where there is an existing breach. This viewing pad will be connected by a short path to a hand-carried boat launch. This boat launch will be located at the location of the existing tide gate, which will be removed as part of this project. This will provide improved opportunities for the public to formally access both Union Slough and the restored Spencer Island tidal marsh.

Under Alternative 5a, there will be minor beneficial impacts to recreation. Alternative 5a includes improved access to remaining trails, improved viewsheds, and formal access to Union Slough. Access to Spencer Island will be maintained, and the current recreational uses, birdwatching, hunting, and dog walking, will still occur.

Alternative 8: High Restoration (Preferred Alternative)

As in Alternative 5a, with implementation of the Preferred Alternative recreational opportunities would be temporarily lost in the immediate vicinity of the construction footprint while construction related activities are underway. During construction periods, recreationists may experience an increase in noise from operation of equipment that could impact their ability to seek solitude or may reduce the success of wildlife dependent recreation activities. During this temporary reduction, similar recreation opportunities would remain available on adjacent lands. Recreation would resume in a manner similar to the existing condition after construction is complete.

The project will provide the following recreational features under Alternative 8:

- Southern cross-dike trail ending with a 0.3-acre earthen elevated viewing platform.

- Southern dike-top trails and bridges.
- Dike-top trail from Jackknife Bridge north along Union Slough to the end of the dike with a 0.4-acre gravel viewing pad.
- Trail connecting northern viewing pad to a hand-carried boat launch.
- Trail from Jackknife Bridge south along Union Slough to the southern cross-dike.

The final configuration to the trail network is shown in Figure 2.6. More information on recreational features under Alternative 8 can be found in Appendix B, Engineering, Section 1.6.8.

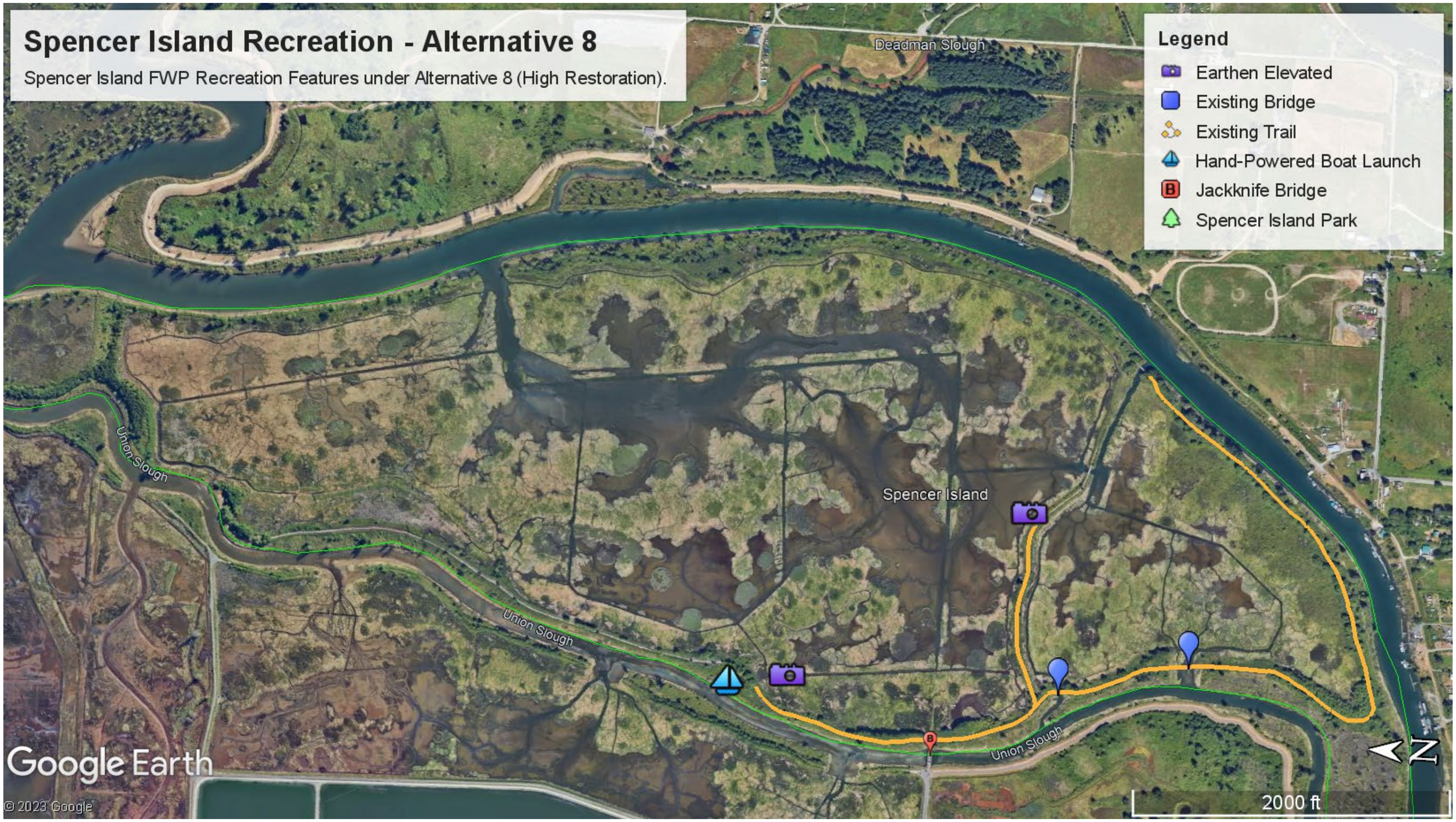

Figure 2.6. Spencer Island FWP Recreation Features - Alternative 8

Under Alternative 8, approximately 45% of the existing trail system would remain. Of the remaining trail network under Alternative 8, approximately 2000 feet, or about 60%, would be improved, and the rest would remain as is. Additionally, the project would have one hand-powered boat launch and two earthen elevated viewing platforms to compensate for the loss of about 4560 feet of the existing trail network to dike lowering.

Alternative 8 includes a designed breach of the western perimeter dike along Union Slough. The trail adjacent to the breach will be widened to create a viewing area for birdwatchers, and the trail from Jackknife Bridge north along Union Slough will end at this viewing area. Shortening this trail will remove pedestrian access to the northern portion of the island. The loss of this portion of the trail will not greatly impact waterfowl hunting use, as access to the Island for this type of recreation is primarily by boat. This viewing pad will be connected by a short path to a hand-carried boat launch. This boat launch will be located at the location of the existing tide gate, which will be removed as part of this project. The viewing platform and boat launch will provide improved opportunities for the public to formally access both Union Slough and the restored Spencer Island tidal marsh.

Another viewing area will be created mid-way along the cross-dike before the location of the existing cross-dike bridge. The cross-dike trail will travel east along the cross-dike and end at the viewing area. Existing non-native vegetation around the viewing platform will be cleared to improve sightlines.

The cross-dike bridge and loop-trail bridge along Steamboat will be removed. Pedestrian access to most of the southern dike-loop trail will be maintained, however the trail will not connect in a loop across the cross-dike. The dike-top trail from Jackknife bridge to the cross-dike will be widened and flattened to improve the ease of access to the cross-dike and southern trails. This viewing area will be at the same elevation as the existing bridge and will provide a larger area for people to gather. The oblong pad will be unobstructed and provide panoramic views of the improved habitat for wildlife viewers and birdwatchers with greater capacity for recreational users.

Although both the northern and southern trails will be shortened, actions to widen the trails, create wildlife viewing areas, and improve habitat quality would result in recreational use similar to that of that existing condition.

Under Alternative 8, there will be minor beneficial impacts to recreation. Alternative 8 includes improved access to remaining trails, improved viewsheds, and formal access to Union Slough. Access to Spencer Island will be maintained, and the current recreational uses, birdwatching, hunting, and dog walking, will still occur.

C.4 Comprehensive Benefits Analysis

The focused array of four action-alternatives and one no-action alternative were evaluated to select the final array of alternatives. The final array of alternatives was selected by analyzing the incremental cost per output compared to the output in AAHUs and management of recreation access. Three best-buy plans, including the no-action plan were selected as the final array of alternatives. This final array, Alternative 1 (No Action), Alternative 5a (Partial South Cross Dike Lowering Restoration), and Alternative 8 (High Restoration), was then analyzed using criteria set by USACE planning policy and a comprehensive benefit assessment, to determine the Recommended Plan, which is also the National Ecosystem Restoration (NER) Plan. Alternative 1 is a best-buy plan, but it does not meet the study objectives. The no action plan is used as a basis on which to compare the FWP conditions under each alternative to.

In accordance with the ASA(CW) Memorandum for the Commanding General, USACE, dated 5 January 2021, the study team is instructed to identify the plan that maximizes net total benefits across all benefit categories – economic, social, and environmental (ASA(CW), 2021). This section documents the evaluation conducted to deduce the plan which maximizes benefits across the four USACE planning accounts.

C.4.1 RED Impacts

The Regional Economic Development (RED) account measures changes in the distribution of regional economic activity that would result from implementation of each alternative plan. Evaluations of regional effects are measured using nationally consistent projections of income, employment, output, and population (USACE, IWR, 2011). The study team used an input-output regional economic model to estimate the impacts from USACE expenditure on local and regional economic activity.

C.4.1.1 RECONS Methodology

The study team used a regional economic impact modeling tool, RECONS (Regional Economic System), developed by the USACE Institute for Water Resources, Louis Berger, and Michigan State University to estimate local and regional economic impacts associated with the construction expenditures for the implementation of Alternatives 5a and 8. RECONS provides estimates of jobs and other economic measures such as labor income, value added, and sales that are supported by USACE programs, projects, and activities. This modeling tool allows the study team to evaluate the regional economic impact and contribution associated with USACE expenditures, activities, and infrastructure.

Regional economic impacts are typically classified into one of three categories, direct effects, indirect effects, and induced effects. Direct effects represent the impacts the new federal expenditures have on industries which directly support the new project. Labor and construction materials can be considered direct components to the project. Indirect effects represent changes to secondary industries that support the direct industries. Rock quarries used in making cement or fuel for dredgers could be considered indirect pieces of the project. Induced effects are changes in consumer spending patterns caused by the change in employment income within the ‘direct’ and ‘indirect’ industries. The additional income workers receive via a project may be spent on clothing, groceries, dining out, and other items in the local/regional area.

Inputs for RECONS model are expenditures entered by business line work activity, each of which have their own production function. These expenditures are specifically the Project First Cost, which includes costs for Construction, PED, Construction Management, and Real Estate. (Table 2-2).

Assumptions

The Input-Output analysis rests on the following assumptions. The production functions of industries have constant returns to scale, so if inputs are to increase, output will increase in the same proportion. Industries face no supply constraints; they have access to all the materials they can use. Industries have a fixed commodity input structure; they will not substitute any commodities or services used in the production of output in response to price changes. Industries produce their commodities in fixed proportions, so an industry will not increase production of a commodity without increasing production in every commodity it produces. It is assumed that industries use the same technology to produce all its commodities. Because the model is static, it is assumed that the economic conditions of 2025, the year of the socioeconomic data in the RECONS model database, will prevail during the year(s) of the construction process.

Description of Metrics

Output is the total sum of transactions that take place as a result of the project construction, including both value added and intermediate goods purchased in the economy. Labor income includes all forms of employment income, including employee compensation (wages and benefits) and proprietor income. Gross Regional Product (GRP) or “value added” captures all final goods and services produced in the study area because of the project's existence. It differs from output in the sense that one dollar of a final good or service may have multiple transitions associated with it. "Jobs" is the estimated worker-years of labor required in full time equivalent units to build the project.

C.4.1.2 *RECONS Results*

This section discusses the estimated regional economic impacts associated with construction expenditures for Alternative 5a (Partial South Cross Dike Lowering Restoration) and Alternative 8 (High Restoration). The regional economic impacts were estimated for the Local Area, Snohomish County, and the State of Washington. Regional Economic Development (RED) impacts of alternatives 5a and 8 are summarized in Table 2-8.

Alternative 5a – Partial South Cross Dike Lowering Restoration

The construction expenditures associated with Alternative 5a are estimated to be $11,156,000. Of this total expenditure $10,323,000 will be captured within the local impact area, Snohomish County. The remainder of the expenditure will be captured within the state of Washington and the nation. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in the following tables.

The regional economic effects are shown for the local impact area and the state impact area. The Civil Works expenditures of $11,156,000 support a total of 107 full-time equivalent jobs, $9,642,000 in labor income, $10,053,000 in the gross regional product, and $15,206,000 in economic output in the local impact area, Snohomish County. More broadly, these expenditures support 152 full-time equivalent jobs, $12,088,000 in labor income, $13,845,000 in the gross regional product, and $21,669,000 in economic output in the state of Washington. These regional impacts are limited to the construction period for job creation and additional spending.

Alt 8 – High Restoration (Preferred Alternative)

The construction expenditures associated with Alternative 8 are estimated to be $13,167,000. Of this total expenditure $12,184,000 will be captured within the local impact area, Snohomish County. The remainder of the expenditure will be captured within the state of Washington and the nation. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in the following tables.

The regional economic effects are shown for the local impact area and the state impact area. The Civil Works expenditures of $13,167,000 support a total of 127 full-time equivalent jobs, $11,380,000 in labor income, $11,865,000 in the gross regional product, and $17,947,000 in economic output in the local impact area, Snohomish County. More broadly, these expenditures support 180 full-time equivalent jobs, $14,266,000 in labor income, $16,341,000 in the gross regional product, and $25,576,000 in economic output in the state of Washington. These regional impacts are limited to the construction period for job creation and additional spending.

Table 2-9. RED Impacts of Alternative 5a and Alternative 8 ($ ‘000)*

	Alternative 5a		Alternative 8	
RED Impacts	**Local Area**	**State of Washington**	**Local Area**	**State of Washington**
First Cost***	11,156	11,156	13,167	13,167
Direct Impact				
Output	10,323	10,649	12,184	12,568
Jobs**	80	105	94	124
Labor Income	8,065	8,478	9,518	10,007
GRP or Value Added	6,961	7,226	8,216	8,528
Secondary impact				
Output	4,883	11,021	5,764	13,007
Jobs**	27	47	32	56
Labor Income	1,557	3,609	1,861	4,260
GRP or Value Added	3,092	6,619	3,649	7,813
Total Impact (Direct + Secondary)				
Output	15,206	21,669	17,947	25,576
Jobs**	107	152	127	180
Labor Income	9,642	12,088	11,380	14,266
GRP or Value Added	10,053	13,845	11,865	16,341

Source: Analysis conducted using the on-line Economic Impact Model Developed by the US Army Corps of Engineers, Louis Berger Group, Michigan State University. 2025-12-15. US Army Corps of Engineers Regional Economic System (RECONS), Generic Analysis – CW Budget Data and Work Activities.

**Note: FY26 Oct 2025 Price Level*

***Note: Jobs are presented in full-time equivalence (FTE) and are short-term resulting from construction spending.*

The greater construction expenditures under Alternative 8 over Alternative 5a are primarily associated with ditch filling and channel creation activities. There is also more dike lowering work on the southern cross-dike under Alternative 8. The additional earthwork required under Alternative 8 leads to additional construction expenditures. In turn, these additional construction expenditures lead to a proportionally greater impact on the regional economy. For example, under Alternative 5a, the construction expenditures of $11,156 thousand support an estimated total of 107 jobs (FTE) in Snohomish County and 152 jobs (FTE) in the State of Washington. In comparison, under Alternative 8 the construction expenditures of $13,167 thousand support an estimated total of 127 jobs (FTE) in Snohomish County and 180 jobs (FTE) in the state of Washington.

Implementation of Alternative 5a would result in regional economic impacts similar to those of Alternative 8, at a smaller magnitude proportional to construction expenditures. Alternative 1, no action, would not provide any regional economic benefits via construction expenditures to the local economy.

While both alternatives produce proportional direct, secondary, and total regional economic benefits, Alternative 8 demonstrates greater overall output. For instance, Alternative 5a generates a total output of $15,206 thousand in the local area and $21,669 thousand in the state of Washington. In comparison, Alternative 8 generates $17,947 thousand in the local area and $25,576 thousand in the state of Washington. Thus, from the regional economic development perspective, Alternative 8 is preferred over Alternative 5a due to its higher total output at both the local and state levels.

C.4.2 Other Social Effects Impacts

C.4.2.1 *Demographics*

Spencer Island is located in Snohomish County, WA in the City of Everett. The study team defined the “project area” as the area contained within a 2-mile ring around the project’s center (47.996634, -122.157324).

The City of Everett and Snohomish County have both experienced population growth since 2010, with increases in population of 9 percent and 19 percent, respectively (Table 2-9). Snohomish County comprises approximately 2.2% of the Washington’s 2022 statewide population. The project area contains a population of 18,207 in an area of 12.56 square miles.

Table 2-10 Everett, WA and Snohomish County Demographics

Location	Population 2010	Population 2022	Increase Since 2010
City of Everett	101,667	110,847	9%
Snohomish County, WA	694,219	828,337	19%
State of Washington	6,561,297	7,688,549	17%

Source: U.S. Census Bureau 2022 ACS 5-year Estimate.

C.4.2.2 *Other Social Effects impacts of the alternatives*

As defined in the Planning Guidance Notebook, the Other Social Effects account includes plan effects on social aspects such as community impacts, life, health and safety factors, displacement, energy conservation, and others (USACE, 2000). In ecosystem restoration projects, the improvement of ecosystem resources can have direct and indirect social value, primarily associated with recreational enjoyment of improved resources to the project.

In the Institute for Water Resource manual “Applying Other Social Effects In Alternatives Analysis,” Other Social Effects are categorized into 7 social factors: Health and Safety; Economic Vitality (having a stable or growing base with access to good jobs); Social Connectedness (sustaining a sense of connection to the community and neighborliness); Identity (feeling pride in the community); Social Vulnerability and Resiliency (ensuring that the requirement of special needs populations in the community are adequately addressed); Participation (feeling that one’s participation is valued and recognized in community decision making); Leisure and Recreation (having access to healthy and safe outdoor recreation); and Public Safety (USACE, IWR, 2013). The social factors associated with project implementation will vary from project to project. For the Spencer Island Ecosystem Restoration Project, the primary applicable social factors are Participation, and Leisure and Recreation.

Using the social factors describes above the study team evaluated the social impacts of each alternative, and the extent to which each action alternative will incorporate the needs and considerations of all at risk communities in the project area defined in Section C.4.2.1.

The Spencer Island project area is located in census tract #53061052104. The lands of the Tulalip Tribe (Federally Recognized Tribe) encompass less than 1% of this tract. Although only 1% of the census tract is covered by the lands of the Tulalip Tribe, Spencer Island and the Snohomish River delta are a part of the Tulalip Tribe’s historic usual and accustom area. The study team is collaborating with the Tulalip Tribes throughout this project to incorporate project elements so that their valued resources and community can benefit from this proposed action.

Alternative 1 – No Action

Implementation of Alternative 1, the no action alternative, will have negative impacts on Leisure & Recreation. Under the no-action alternative, recreational access and opportunities will decline in the FWOP condition. As trails continue to erode from tidal action, the existing breaches will continue to widen, and the bridges over existing breaches would likely fail as they have in the past. If the bridges were to fail, access to the southern perimeter loop trail and the northern portion of the island would be lost. The degree of access lost under the no action alternative is uncertain. Under the no action alternative, ecosystem functions (nutrient cycling, carbon sequestration, fish habitat, etc.) of wetlands will not be reestablished, and current conditions will persist. Thus, the no action alternative will have negative impacts on Leisure & Recreation due to the decline in quality of and access to recreational opportunities.

Alternative 5a (Partial South Cross Dike Lowering Restoration) & Alternative 8 (High Restoration)

Social impacts under Alternative 5a and Alternative 8 are primarily driven by the improved access to recreation and higher success rates of wild-life dependent activities associated with both of these alternatives.

The participation social factor reflects the degree to which the community feels their participation matters in decision making and has trust in public officials and public interest in the community. The study team collaborated with the public, including various recreation groups, the Tulalip Tribes, and others throughout plan formulation. Alternative 8 incorporates specific design considerations brought to the study team by the Tulalip Tribe.

Implementation of Alternative 8 would display to the community that their knowledge and preferences were fully incorporated into the design, which could improve public participation in the FWP condition. The study team continues to collaborate with the Tulalip Tribes on project design to ensure that elements of the project are incorporated so that their resources of interest can benefit from the proposed action.

There will be minor beneficial impacts to recreation access under alternatives 5a and 8, compared to the FWOP condition (C.3.4.2). The increase in environmental output associated with these alternatives will have indirect benefits to Leisure and Recreation. The action alternatives would all provide greater access for migratory species to increased habitat in comparison to the no action alternative and because increased habitat access yields greater abundance of migratory species, the strengthened biodiversity will provide increased opportunities for birdwatching and other wild-life related activities. Put in another way, the improved habitat under alternatives 5a and 8 will likely improve the success of wild-life dependent activities. Additionally, increased Leisure and Recreation opportunities in the area provide increased benefits for mental and physical health. The degree to which social impacts will differ between the action alternatives was not measured – it is assumed that social effects under Alternative 5a and Alternative 8 will be of the same magnitude.

C.4.3 Environmental Quality Impacts

The environmental quality account considers non-monetary effects on ecological, cultural, and aesthetic resources. Under this account, plans are evaluated with regards to their impacts to the environment, both positive and negative. Ecosystem restoration projects are evaluated to determine the degree of ecosystem benefits they provide. As with all project types, they are also evaluated regarding the degree to which they avoid or minimize negative environmental impacts in the study area to the extent practicable considering other criteria and planning objectives.

As this project is being conducted under an ecosystem restoration authority (Sec 544), alternatives are developed specifically to generate ecosystem benefits. Those benefits (and the costs to provide them) differentiate the alternatives significantly more than the other alternative comparison parameters. To estimate the ecosystem benefits that would be provided by each alternative for the purpose of evaluating cost-effectiveness, the study team utilized an ecosystem benefit model developed for Puget Sound river delta ecosystem restoration projects, "Ecosystem Output Calculator for CAP and CAP-like River Delta Ecosystem Restoration in Puget Sound" (USACE, 2023). This model scores each alternative based on physical parameters related to how tidal and riverine flows enter and transit the site. Alternatives that result in conditions closer to those found in a comparable, unimpaired site in Puget Sound score best. The hydraulic factors that drive alternative scores also directly influence the ecosystem processes that correspond to the study planning objectives. All alternatives in the focused array would provide benefits, increasing in magnitude from Alterative 2 through Alternative 8. Ecosystem outputs, quantified as "habitat units", are presented in section C.3.1 and compared to costs in section C.3.3. Negative environmental impacts resulting from the alternatives are limited to construction impacts such as those stemming from construction equipment emissions; these negative impacts would be negligible and would vary in proportion to the scale of the alternatives.

C.4.4 National Economic Development (NED) Impacts

For water resources projects intended to generate economic benefits, USACE evaluates alternatives under the NED account by considering net economic benefits and the benefit-cost ratio in dollars. Traditionally, NED benefits are associated with flood risk management and navigation studies where costs and benefits of implementing an alternative are assessed relative to flood damage, and transport of commodities. Recreation Benefits are also included in NED. For this ecosystem restoration project, focused on nonmonetary ecosystem benefits, the NED account was considered qualitatively. An evaluation of the impacts to recreation under each alternative can be found in Section C.3.4.2.

The restoration of Spencer Island enhances a recreational opportunity in the nation that provides NED benefits to recreators, especially boaters, hunters, and birdwatchers. There would be a benefit to recreators through the implementation of any of the action alternatives. Under the no action alternative, there will be a minor decrease in recreational benefits from the current condition due to a decrease in quality of and access to recreational opportunities. There will be similar minor recreational benefits under Alternatives 5a and 8, with increased quality of recreational opportunities and access maintained.

Construction expenditures in the local area would not be considered a net benefit to the nation, as they are associated with regional transfers, and are evaluated in the Regional Economic Development Section, C.4.1.

C.5 Recommended Plan

Alternative 8 is the recommended option over Alternative 5a for several key reasons that have been outlined in this report. Looking at the social effects of the project, alternative 8 better incorporates important community input by integrating design considerations from the Tulalip Tribe, which helps build trust. From a recreational perspective, Alternative 8 not only preserves a larger portion of the existing trail system (45% versus 40%) but also includes upgrades like wider trails with viewing areas, cleared vegetation for better views, and a flatter main trail for easier access. Environmentally, Alternative 8, the “High Restoration” option, produces the greatest level of ecological benefits. In comparison to alternative 5a, alternative 8 is expected to produce greater ecological benefits, as it provides more assurance of increased channel connectivity, a significant aspect of restoring suitable aquatic habitat in the Snohomish Delta.

The Recommended Plan is Alternative 8, high restoration with access maintained. Alternative 8 includes the following measures:

- Dike lowering and dike breaching.
- Re-excavating historic channels across portions of Spencer Island and adding sinuosity to existing interior channels.
- Removing undersized culvert or bridge opening and adding large wood to channels.
- Planting and/or seeding native species that typically occur in the ecological setting being restored.

The Recommended Plan includes dike breaching, dike lowering, excavation of channels, and filling of historic drainage ditches to restore estuarine processes and seasonal riverine flooding to the interior of Spencer Island. The plan also includes trail improvements, removal of an existing tide gate and two existing 60-foot bridges, new marsh/upland planting benches, two new permanent viewing areas, and a new hand-carried boat launch.

For a total project investment cost of $13,273 thousand (FY26, 3.25% discount rate), an average annual cost of $541 thousand, the Recommended Plan, produces a total of 347 habitat units over the 50-year period of analysis beginning in 2028, 151 habitat units greater than in the FWOP condition. The Recommended Plan provides a net benefit of 98.28 AAHUs and achieves the ecosystem restoration project objectives of improving fish access, improving tidal hydrology to support channel formation and maintenance, and improving nearshore ecosystem processes at Spencer Island for the 50-year period of analysis beginning in 2028. The Recommended Plan restores degraded habitat and prevents further habitat degradation, while avoiding impacts to recreational access to the extent practicable.

2 References

ASA (CW). 2021. “Memorandum for the Commanding General, U.S. Army Corps of Engineers, Subject: Policy Directive – Comprehensive Documentation of Benefits in Decision Document.”

Z. Corum, P.E. 2024. SUBJECT: Updated Hydraulic Analysis of Spencer Island Ecosystem Restoration Feasibility Study Alternatives (Technical Memorandum).

Department of the Army, 2016. SUBJECT: Puget Sound Nearshore Ecosystem Restoration, Washington (Chief’s Report).

U.S. Census Bureau. 2022. ACS 5-Year Estimate Data Profiles. Accessed September 2024 online at: https://data.census.gov/table/ACSDP5Y2022.DP05?q=DP05:%20ACS%20Demographic%20and%20Housing%20Estimates&g=050XX00US53061. Tables: DP05. GEOs: Snohomish County, Washington.

U.S. Water Resources Council. 1983. Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (Principles and Guidelines).

US Army Corps of Engineers, Louis Berger Group, Michigan State University. 2024-09-25. US Army Corps of Engineers Regional Economic System (RECONS), Generic Analysis – CW Budget Data and Work Activities. Access online September 2024.

USACE. 1999-2. Civil Works Ecosystem Restoration Policy (Engineer Regulation 1165-2-501).

USACE. 2000. Planning Guidance Notebook (Engineer Regulation 1105-2-100).

USACE. 2013. Puget Sound Nearshore Ecosystem Restoration Project: Ecosystem Output Model.

USACE. 2016. Puget Sound Nearshore Ecosystem Restoration Final Integrated Feasibility Report and Environmental Impact Statement

USACE. 2023. Ecosystem Output Calculator for CAP and CAP-like River Delta Ecosystem Restoration in Puget Sound.

USACE. 2025. Federal Interest Rates for Corps of Engineers Projects for Fiscal Year 2026. (Economic Guidance Memorandum 26-01).

USACE, IWR (Institute for Water Resources). 1994. Cost Effectiveness Analysis for Environmental Planning: Nine Easy Steps (IWR Report 94-PS-2).

USACE, IWR (Institute for Water Resources). 1995. Evaluation of Environmental Investments Procedures Manual – Interim: Cost Effectiveness and Incremental Cost Analysis (IWR Report 95-R-1).

USACE, IWR (Institute for Water Resources). 2011. Regional Economic Development (RED) Procedures Handbook (IWR Report 2011-RPT-01).

USACE, IWR (Institute for Water Resources). 2013. Applying Other Social Effects in Alternatives Analysis (IWR Report 2013-R-03).

USACE, IWR (Institute for Water Resources). 2017. IWR Planning Suite II User's Guide.