Owyhee River Ecosystem Restoration

Duck Valley Indian Reservation, Idaho and Nevada

Continuing Authorities Program Section 206 Feasibility Report and Integrated Environmental Assessment

APPENDIX B, HABITAT EVALUATION MODELING

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1.0 EXECUTIVE SUMMARY

The USACE has implemented the FACStream model to assess existing and future with- and without project stream and wetland functional capacity within the Owyhee River study area, Elko County, Nevada. This model was used for the following reasons:

- The study area is remote with little scientific data. Field assessment must be a reconnaissance level and be based on information collected in the field over 1 or 2 days.
- There are healthy populations of redband trout and sage-grouse within the larger watershed area and study area. Redband trout occurs in the reach upstream of the China Diversion and sage-grouse within sagebrush habitat and wet meadows within the downstream section of the study area.
- Redband trout habitat requirements would involve small tributaries for spawning, adjacent wetlands/riparian vegetation, cool water temperatures, meandering streams within riffles and pools. Because of the China Diversion, suitable habitat for redband trout currently would be adult habitat, not spawning or juvenile habitat.
- Sage-grouse habitat requirements involve sagebrush adjacent to wet meadows that can contain small woody shrubs such as willow. These wet meadows are feeding grounds for juvenile birds that feed on insects.
- Most of the Owyhee River throughout the study area is severely deteriorated by human induced manipulation for irrigation and agricultural purposes. The stream channel `is not active with its floodplain and entrenched by 15-foot shoreline walls. There are no or very marginal wetland habitat adjacent to the river.
- HEP models were reviewed and found either did not support the targeted habitat conditions (i.e., redwing blackbird or great blue heron marshes, beaver ponds), or needed data that could not be obtained (i.e., water temperature data, dissolved oxygen, pH). There would have been large assumptions and measured parameters may not change drastically because of restoration efforts.

FACStream is a rapid response functional assessment tool that can rate functional condition according to the degree of impairment of wetland and stream functions and values throughout the watershed.

2.0 PROJECT BACKGROUND

The Walla Walla District is undertaking a Continuing Authorities Program Section 206 ecosystem restoration study on the Owyhee River, Duck Valley Indian Reservation in Nevada and Idaho in cooperation with the project Sponsor, the Shoshone-Paiute Tribes.

The Owyhee River watershed provides habitat for sage-grouse and red band trout, both are sensitive species in Idaho and Nevada, as well as culturally significant species highly valued by the Shoshone-Paiute Tribes. The Owyhee River has tremendous cultural significance for the Shoshone-Paiute Tribes as an important fishery, and for the spiritual and physical healing powers ascribed to its waters.

The ecological function and quality of the Owyhee River watershed is impacted by a period of changed climatologic conditions, changes in runoff characteristics, lack of floodplain connectivity, reduced quantity and quality of riparian habitat, and barriers to historic salmonid spawning and rearing habitat. These conditions have negative impacts on species. Opportunities exist to restore riparian quality and function and improve instream habitat complexity and quality (pool frequency and physical and hydraulic features).

Three Planning Objectives were developed to address the degraded habitat condition and cultural interests discussed above.

- Improve aquatic habitat diversity associated with in-stream features for native fish habitat for spawning, rearing, and overwintering.
- Reconnect and restore the historic channel segments and functions to promote a more natural hydrologic connection with improved ecological responses.
- Restore adjacent riparian and wetland habitat, utilizing indigenous knowledge/practices where possible.

The purpose of this study is to restore and enhance aquatic ecosystem structure, function and process of riparian wetlands and stream channel along the Duck Valley Indian Reservation segment of the Owyhee River to benefit fish and wildlife.

The project is needed because the aquatic ecosystem segment of the Owyhee River (River) on the Duck Valley Indian Reservation (Reservation), as well as its adjacent habitats, has been altered by livestock range, ranching, and agricultural practices, and associated irrigation diversions. Much of this segment of the Owyhee River has been channelized and deepened. The relic side channels, and meanders have evaporated or form stagnant pools with degraded wetland habitat that is no longer providing aquatic/river ecosystem functions and processes. Reduced demand for irrigation withdrawals has allowed an opportunity to improve the river's lost riparian and wetland habitat and functions along this segment of river on the Reservation Restoration and enhancement of the aquatic habitat and function of the River on the Reservation and its riparian areas and associated wetlands would benefit many native fish and wildlife species that are dependent on these rare habitats including sage-grouse, waterfowl and native red band trout populations.

1.1 Study Area

The proposed study area is located within the Shoshone-Paiute Tribes' Duck Valley Indian Reservation which spans the Idaho and Nevada border

(

Figure **1**). The largest community on the reservation is Owyhee, Nevada. The Owyhee River and its riparian habitat have been altered over time by land use practices, such as mining activities, range management, agricultural practices, and irrigation diversions

(Shoshone-Paiute and Owyhee Water Council 2004). Within the Duck Valley Indian Reservation, agricultural practices and dewatering for irrigation diversion reduced flows and, in some cases, completely dewatered the river channel. These actions altered the natural flow regime and flooding cycles that would have cut and maintained side channels, deposited sediment to create shallow banks and marshy wetlands that are needed by fledgling sage-grouse for foraging for insects, and established pools with depths red band trout could use as summer refugia. The channelization and dewatering of the Owyhee River have resulted in loss of side channels and meanders, reduced depth and pools, changed sedimentation processes, blocked fish passage, and decreased habitat complexity and diversity. Disconnected side channels and meanders have evaporated and further fragmented the habitat. The river has lost the ecosystem benefits derived from natural cycles.

Figure 1. Study Area.

The Owyhee River is a 280-mile-long tributary of the Snake River, with headwaters originating in the Independent Mountain Range of northern Nevada (Figure 2). The river flows northwest through the Duck Valley Indian Reservation, through Idaho into Oregon to join the Snake River. It flows through the Owyhee Plateau, an arid region of sage shrub-brush environment, for which aquatic and riparian habitats provide critical functions for the survival of fish and wildlife. The Owyhee Plateau has been prioritized by the US Fish and Wildlife Service (USFWS) as the most important sagebrush ecosystem in North America (USFWS 2016), and the loss of wetlands and aquatic habitat has been identified as an important factor in the decline of the ecosystem.

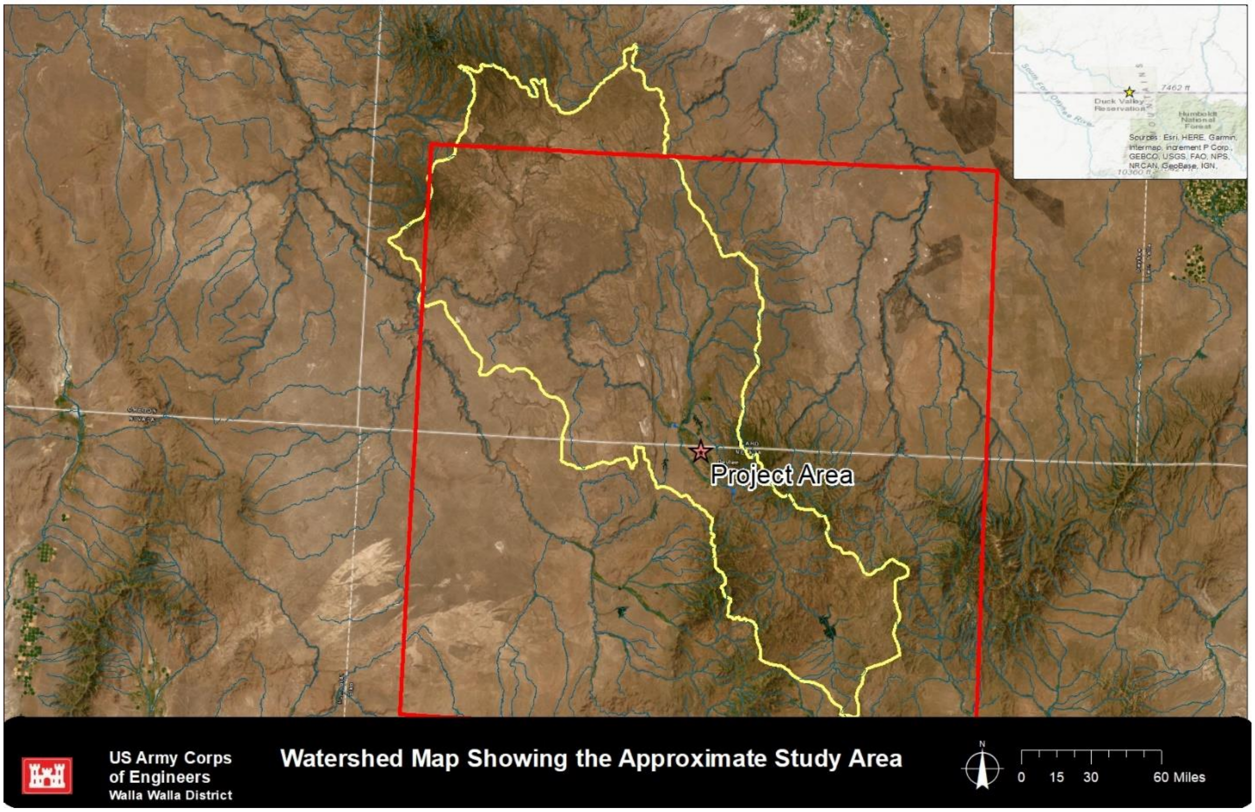


Figure 2. Watershed map showing the approximate study area.

1.2 Historic and Present Habitat Characteristics

Historically, the Owyhee River within the reservation was a network of stream channels, wetlands, and riparian forests and wet meadows over a vast active flood plain near Owyhee, Elko County, Nevada. Seasonal flows would have cut new channels, deposited sediment and debris, and created a complex of oxbows and backwaters that supported a diversity of habitats for fish, wildlife, birds, and other aquatic and riparian species. The river provided instream cover, habitat complexity, and the healthy riparian vegetative community necessary to support the over-summering of native interior red band trout (*Oncorhynchus mykiss*) in a desert environment and rearing of salmon and steelhead species (now extirpated). These wetlands also provided an oasis for arid land wildlife. There was an abundance of wetland and upland plant diversity, including rushes, cattails, willows, wildflowers, camas, and bunchgrasses. The greater sage-grouse (*Centrocercus urophasianus*) uses wetland habitats for brood rearing in late summer months. Sage-grouse rely on the soft leaves of sagebrush year-round, and these wetland areas provided lush forbs for adults and insects for growing juveniles. Sharp-tailed grouse (*Tympanuchus phasianellus*) once thrived in the Owyhee willow riparian areas as well, and historic accounts suggest blue grouse (*Dendragapus* spp.) were summer migrants to the Owyhee River bottomlands. Development, range management, and agricultural practices modified the wetlands, side channels, and small oxbows into drier habitats that now contain degraded, stagnant water.

- The Owyhee River has been channelized for irrigation purposes. The channelized structure of the river does not allow for a typical riffle and pool complex that is important for redband trout habitat.
- The river is entrenched and bordered by steep shorelines that are as high as 20 feet. There is little to no connection to the historic floodplain. As a result, the relic floodplain has converted to upland grasses and sagebrush and lacks wetland functions and services necessary to support Greater sage-grouse and redband trout habitat. Old meanders are found adjacent to the channel as small, isolated depressions with little wetland or stream benefits.
- The demand on the Owyhee River for irrigation has caused the channel to run dry during the summer months most years, causing unsuitable habitat along the Owyhee River during the hotter months.
- China Diversion impedes upstream fish migration, blocking access to suitable habitat located upstream.
- Sediment accumulation and low flows in the disconnected side channel led to ongoing water stagnation, increased shallow-water pools, and low dissolved oxygen levels. Accumulation of sediment adds to increased water temperatures along the river. These pools are typically used as cold water refugia by resident fish during the summer months. This increase in water temperature can exceed 75° F (29° C), which is lethal to trout and salmon.
- Riparian wetlands along the Owyhee River are degraded to only fringe wetlands immediately adjacent to the river’s edge. These wetlands serve minimal functions and values to support aquatic or terrestrial organisms. Riparian wetlands are important for providing seasonal insects that serve as a food for both redband trout and sage-grouse. In addition, the vegetation provides cooler water temperatures in the river and structure in the form of woody debris. Farmers allow cattle to drink from the Owyhee River. This creates shoreline failure that increases the sedimentation load in the Owyhee River.

The aquatic and riparian habitat is fragmented and degraded; and has been lost because of grazing, irrigation, reduced diversity, and encroaching exotics, the destruction of biological crusts, and historic mining. These habitats would have supported fledgling sage-grouse for foraging for insects, and established pools with depths redband trout could use as summer refugia.

1.2.1 Wet Meadows and Active Floodplains

Prior to the settlement of the Owyhee River watershed, the Owyhee River was a braided river with an active floodplain (Figure 3). The riparian vegetation was characterized by seasonally inundated wet meadows flanked by willow and sagebrush along the Owyhee River. Reference wetlands included a variety of willow (*Salix spp.*) and herbaceous meadow species (Figure 4).

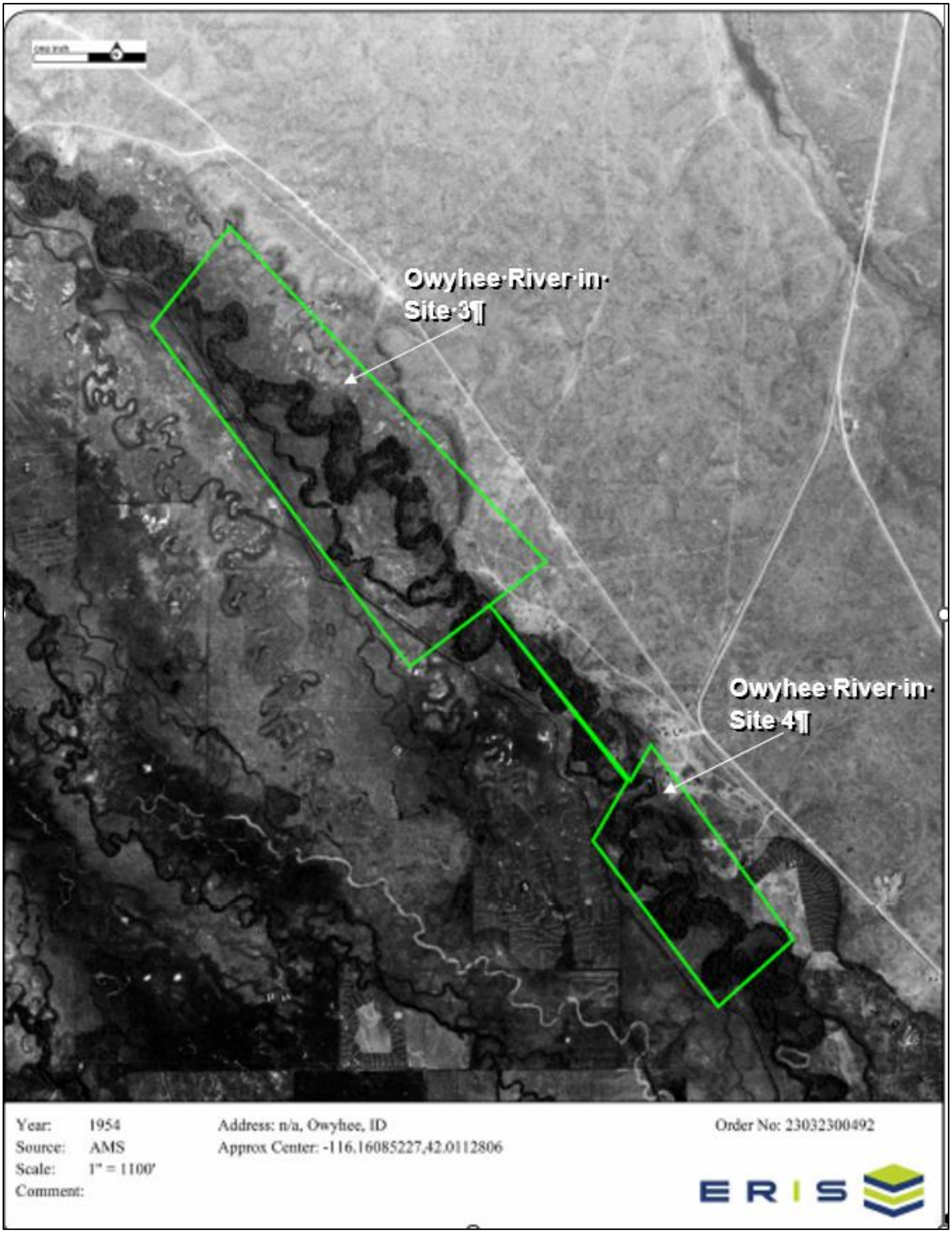


Figure 3. Owyhee River pre-channelization (1954).

Figure 4. Wet Meadow on the Duck Valley Indian Reservation

Floodplain connectivity allowed for sediment and nutrient transport and deposition, shifting islands, forming point bars, and renewing genetic diversity among plant species. The floodplain would filter spring runoff and provide cool summer groundwater inputs and shade.

Around the 1950-1960's, the Bureau of Indian Affairs channelized the Owyhee River to manage the river flow for irrigation of agriculture (Figure 5). The riparian area was disassociated with the floodplain and largely stripped the land of riparian vegetation (Figure 6). The Owyhee River was straightened and confined to a gully. Ultimately, the River would continue to downcut and evolve into an deeply incised channel within a floodplain at the bottom of the gully (Figure 7).

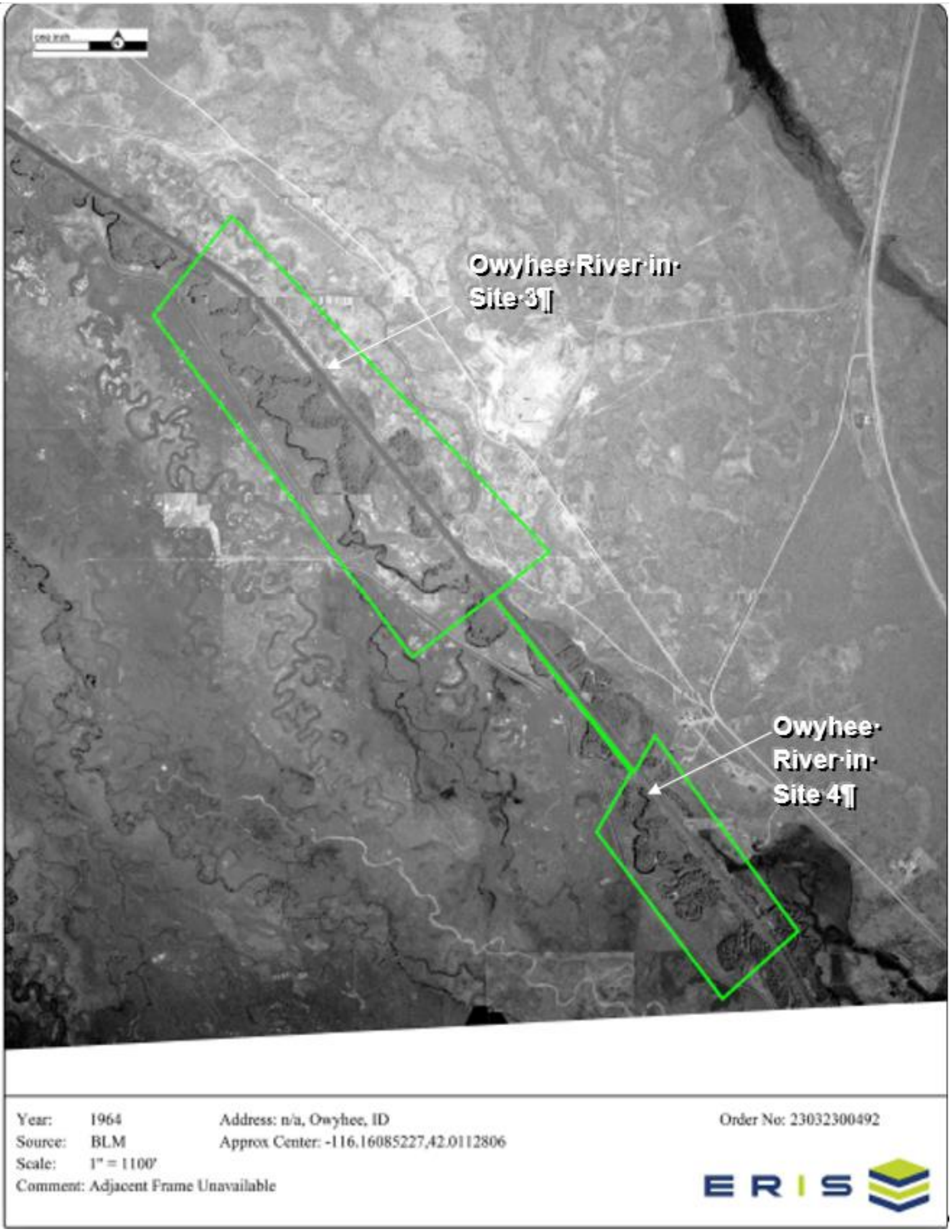


Figure 5. Owyhee River Post channelization (1964).

Figure 6. Owyhee River steep banks, and disconnected floodplain.

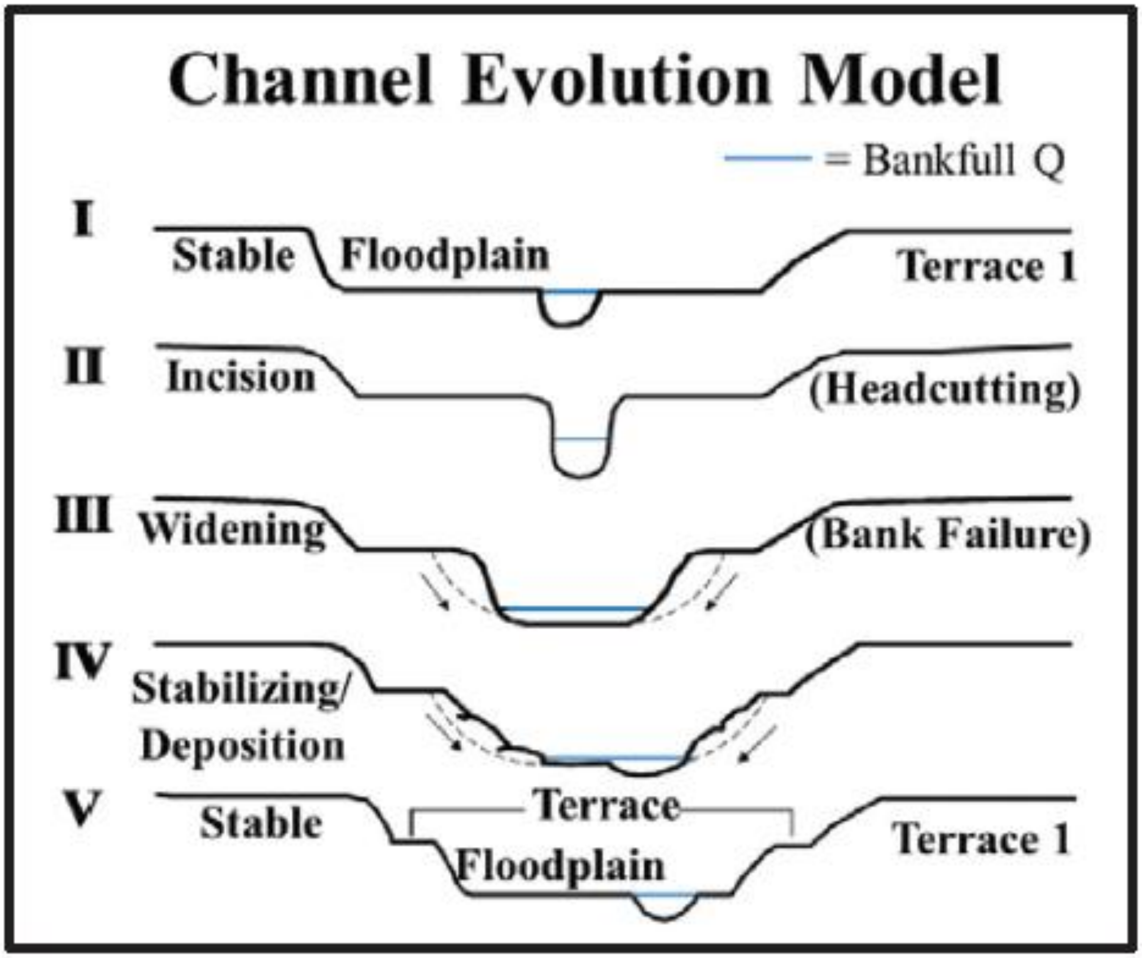


Figure 7. channel evolution model from Schumm et al. 1984.

The area outside of the gully would be drained and become uplands in areas where they may be currently wet meadows or wetland habitat. It could take decades for the completion of this transition. Overall, the process would evolve volumes of shoreline downstream thereby affecting other reaches of the Owyhee River as well as fish habitat.

As the river downcut, the wet meadows along the Owyhee River began to convert to sagebrush (Figure 8 and Figure 9).

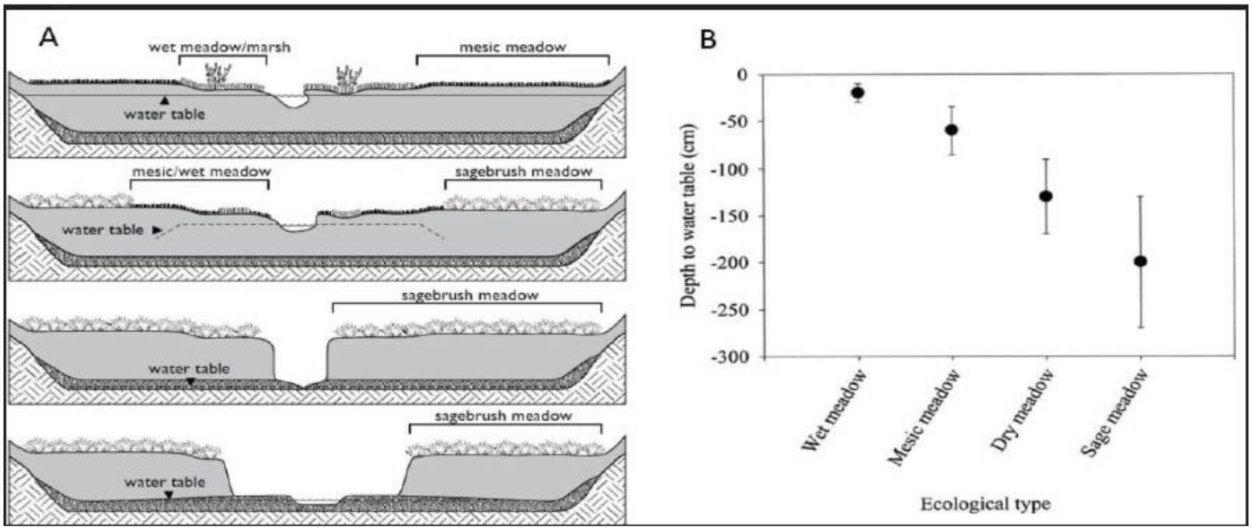


Figure 8. Change in habitat changes with downgrading streambed and water table (adapted from Dickard et al. 2015).

Figure 9. Wet meadows converting to sagebrush habitat.

Presently, the channel migration and functional floodplains are limited to a very few areas. The natural processes are largely nonfunctioning due to push-up berms and embankments causing channel incision and the upstream China Irrigation Diversion Dam starving the Owyhee River of substrate movement and deposition.

The riparian area (floodplain) is limited to an average width of under 20 feet with some exceptions based on recent aerial imagery. There is little evidence of side channels and channel complexity on the Owyhee River. Relic side channels are now isolated wetlands (Figure 10).

Figure 10. Relic oxbows habitat in dry fields.

Specific factors adversely affecting natural ecosystem function within the project area include:

- Loss of habitat complexity due to floodplain manipulation, irrigation diversion, and push-up berms and embankments.
- Loss or degradation of wetland and off-channel habitats due to stream incision and loss of floodplain connectivity.
- Irrigation diversions create fish passage barriers and alter sediment and substrate transport.
- Decreased diversity of culturally significant species of plants and animals.

1.2.2 Instream Habitat

Prior to anthropomorphic changes to the floodplain and hydrograph, channel complexity was likely high and dynamic with point bars, side channels, backwaters, and braided channels throughout the study area (Figure 11).

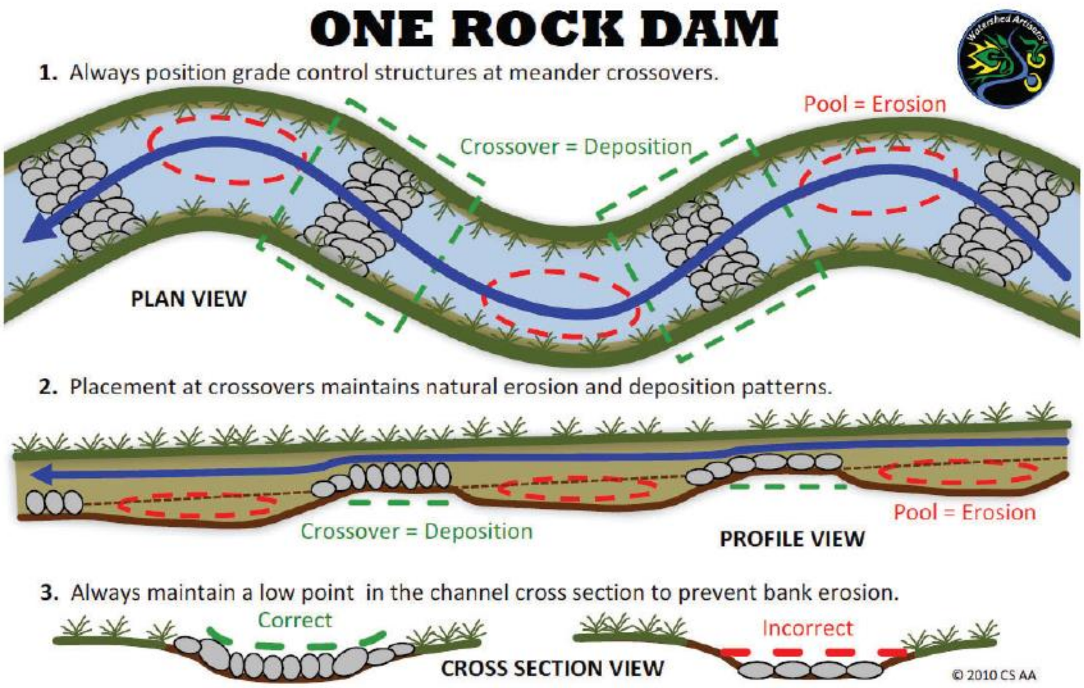


Figure 11. Typical riffle and pool complex and meanders (Sponholtz and Anderson 2013).

Large woody debris provided by the riparian zone would contribute to pool formation and complex cover (Figure 12). Based on aerial imagery, fish spawning habitat would have been greater quality and quantity throughout the reach.

Figure 12. Large woody debris.

Presently, the Owyhee River consists of a deeply incised-straight channel with shorelines consisting of berms that are sparsely vegetated with riparian vegetation. The berms prohibit the river from overbanking into the historic floodplain, active floodplain is greatly reduced and there is little recruitment of large woody debris. Consequently, there is little opportunity for natural processes for the river to meander, form pools and and riffles, and adequately deposit natural sediment transport. The China diversion exacerbates sediment transport impairment. The riffle-run-pool structure of the stream is at risk of being non-functional with long stretches of uniform rifle or run habitat.

Owyhee River supports spawning and rearing redband trout habitat upstream of the China Diversion at Fawn Creek. Anecdotally, juvenile redband trout have been observed upstream of the China Diversion. The habitat within Reach 3 and Reach 4 is degraded by high temperatures above 61 degrees Fahrenheit (16 degrees Celsius).

Given a year-round optimal water temperature, quality and quantity of rearing and residing are limiting factors and can be attributed to the following.

1) A lack of instream habitat complexity, both hydraulic (unbalanced riffle-run-pool sequence, homogenous depth and velocity, little off-channel habitat) and structural (boulders, large wood).

2) A lack of riparian vegetation to shade the river.

3) The lack of large woody debris to provide adequate in-stream structure.

Riffle-run-pool sequencing and coarse physical structure is needed to provide a wider variety of flow, depth, and depositional areas. Depth and velocity variation will provide for adult migrant resting and juvenile rearing habitat that will promote a wide variety of aquatic biota.

1.3 Wet Meadow Habitat Function and Value to Wildlife

A variety of wildlife relies on wet meadow habitats across the western United States. Water sources and humidity are required to produce lush vegetation and insects required for migratory and upland bird species brood rearing. For example, greater sage-grouse require wetland habitats for brood rearing in later summer months. While sage-grouse rely on the soft leaves of sage brush year-round, wetland areas provide lush forbs for adults, and insects for growing juveniles.

The importance of riparian and wetland ecosystems is evident in scientific literature.

- *Importance to the Landscape* (Sparks 1992; Krueper 1993; Malanson 1993; Naiman et al. 1993; Dynesius and Nilsson 1994; Ward et al. 1999; Lytle and Merritt 2004):

- *Importance to bat species for food, water, and roosting* (Hayes and Adam 1996; Swystun et al. 2007): Insectivorous bats rely on appropriate environmental conditions to provide for insect food sources. The humidity and water sources associated with riparian and wetland areas is important for insect production.

- *Importance to small mammals* (Anderson and Ohmart 1977; Pendleton 1984; Golightly Jr. 1997; Melquist 1997): Small mammals, largely mesocarnivores in urban settings, rely on the greenways that river corridors provide for food, shelter and migration. Studies have found as many as 11 rodent species that rely on wetland vegetation and would support mesocarnviores as a food source.

- *Importance to amphibians* (Hecnar and M'Closkey 1998; Houlahan and Findlay 2003): Species richness is positively correlated with wetland area, forest cover, and the amount of wetlands on adjacent lands and negatively correlated with road density and nitrogen levels. While water is necessary for amphibian reproduction, woody vegetation may provide non-breeding food sources and shelter.

- *Importance to waterfowl for food and nesting* (Dugger and Fredrickson 1992; Boavida 1999): Wetlands provide essential nesting and foraging habitat for migratory waterfowl. Spring and summer insect forage for molting, nesting, and brood rearing are critical.

- *Importance to upland and migratory song birds for food, nesting, brood rearing, and resting* (MacArthur 1964; Austin 1970; Carothers et al. 1974; Johnson et al. 1977; Stamp 1978; Sedgewick and Knopf 1986; Sedgewick and Knopf 1990; Croonquist and Brooks 1993; Krueper 1993; Freemark et al. 1995; Skagen et al. 1998; Saab 1999; Faulkner 2004): Many studies have evaluated various aspects of riparian use by migratory song birds in the southwest United States for foraging, migrating, nesting, and brood-rearing.

Riparian ecosystems are among the rarest and most sensitive habitat types in the western United States and are critical for up to 80% of terrestrial vertebrate species, and is especially important in the arid west (Krueper 1993).

In portions of southeastern Oregon and southeastern Wyoming, more than 75% of terrestrial wildlife species are dependent upon riparian areas for at least a portion of their life cycle (Chaney et al. 1990 *as cited in* Krueper 1993).

Riparian areas slow flood flows, filter out sediments, reduce erosion, buffer soil chemistry, enhance biodiversity, protect hydrologic systems from temperature extremes and evaporative loss, and slowly release retained water which extends quality and quantity of water for a variety of consumptive and non-consumptive uses (Carothers 1974, Hubbard 1977, Sands and Howe 1977, Chaney et al. 1990; *as cited in* Krueper 1993).

2.0 FACSTREAM STREAM FUNCTIONAL CAPACITY MODEL

There are reaches within Owyhee River with great restoration potential including floodplain connectivity. Habitat quality that may be realized from restoration would not only provide the proper physical features of stream and riparian habitat for a variety of fish and wildlife species but could also greatly improve stream processes within and downstream of restored reaches. Evaluating stream functional capacity is important for projects that may impair or improve stream function. Therefore, the Functional Assessment of Colorado Streams (FACStream) model was selected to evaluate Project restoration benefits.

Based on the scarcity and importance to fish and wildlife of wet meadows, riparian and instream habitats within the western U.S., and the potential for this Project to benefit the entire ecosystem within a given reach, alternative or combination thereof, the FACStream model is an excellent fit.

Simpler models, such as the Habitat Evaluation Procedures suitability indices could provide relative estimates of existing and future with-project conditions. However, the importance of instream and wet meadow habitat is paramount to the myriad fish and wildlife species including redband trout and sage-grouse, as well as at the landscape level. Therefore, evaluating habitat functions and values holistically with a model like FACStream more appropriately assesses the existing and future conditions, and is applicable to the species discussed in Section 1. Model applicability to these species will be further discussed in Section 2.3.

2.1 Model Use Approval

It is desirable to use existing models approved for National use by the Cops Ecosystem Planning Community of Practice (Eco-PCX). However, new and Corps approved models that have been modified may be pending review and approval by the Corps Eco-PCX. One exception is for CAP projects. Models utilized for CAP projects may be approved at the Division level through the Agency Technical Review process as described in the Director of Civil Works' Policy Memorandum #1, dated 19 January 2011.

The FACStream model has only been approved for single use on several other studies, most recently the Sweetwater Creek Ecosystem Restoration Section 203 in Lapwai, Idaho. While this Project is being executed on the Tribal Partnership Program timeline, the Northwestern Division provided guidance that model approval would be obtained at the Division level, as appropriate for a CAP-level study.

A model use request for approval and justification memorandum was provided to Carrie Bond of Northwestern Division Environmental team, March 3, 2023. Use approval was received March 24, 2023 (Annex A).

2.2 Model Considerations

FACStream is a reach-scale functional assessment tool that rates functional condition according to the degree of impairment of ten ecological forcing factors (State Variables) that each describe a foundational driver of stream health. The scores for these variables are combined as a weighted average to give an overall reach condition score. The functional capacity index (FCI), an index of the degree of aquatic functioning of the reach on a percent scale, is calculated directly from the condition score.

Stream “functions” are processes that drive the physicochemical makeup of a stream and are objective in the sense that they are not tied to plant or animal species or community requirements, rather the opposite is true. Optimizing habitat for a singular species or habitat feature or function may result in diminished suitability for others. Therefore, FACStream is a value-neutral assessment of functioning, meaning it is designed to assess stream functioning, but not the value of the functions performed (Johnson et al. 2015); therefore, evaluating stream, riparian, and watershed-level components holistically.

FACStream incorporates all aspects of stream function to include riparian and floodplain integrity and connectivity, which encompasses habitat benefits to the myriad wildlife that utilize the Owyhee River watershed, and is, therefore, representative of habitat quality and function at the ecosystem level.

A FACStream assessment can incorporate data from any level of effort, be it a remote sensing survey or reconnaissance (EPA Level 1), routine field assessment (EPA Level 2), or intensive field assessment [(EPA Level 3) Johnson et al. 2015]. The reconnaissance level of effort would be used for the Project and is based on professional judgment using the best available information to include web-based tools, aerial imagery, gray- or peer-reviewed literature, and ground-truthed with a site visit. Reconnaissance-level analysis is perfectly applicable to ecosystem restoration as performed under Civil Works, particularly the Continuing Authorities Program and Tribal Partnership Program, primarily to achieve efficiency with an acceptable level of rigor.

Finally, FACStream produces a numerical index output between 0 and 1 that may be directly multiplied by habitat acres to create habitat units (HU). The resulting HUs would then be compared among alternatives to evaluate benefits in the form of lift from the existing condition and would be compatible with a cost-effective/incremental cost analysis to determine the most efficient restoration alternatives.

Key model applicability points are as follows:

- The model is acceptable for use as-is, without adjustments to variable scoring.
- It is a weight-of-evidence approach suited for varied levels of qualitative and quantitative analysis and can be justified with professional judgment.
- It is a value-neutral ecosystem model assessing the function of riparian and aquatic variables applicable to all local fish and wildlife species.
- It is the formalization of an investigative process that seeks to uncover agents impairing the ability of a stream to function in a manner characteristic of its type.
- It provides scientific context to evaluator observations and site information.
- In FACStream, the quality of evidence, analytical uncertainties and data gaps are made explicit and transparent.
- It considers the severity and extent of stressors to gauge the departure of each State Variable from Reference Standard condition.
- It is a tool to aid mitigation planning, design and reporting, and increase the effectiveness of compensatory mitigation.
- It was developed to assess the function of streams in Colorado landforms similar to the Columbia Plateau.

2.2.1 Description of Input and Output Data

Input data are robust and somewhat complex, requiring educated professional judgment. Model population was based largely on-site visit observations and data collected on May 26, 2022, supporting professional judgment.

The model breaks habitat into 10 functional State Variables with multiple sub-variables (Table 1).

Table 1. FACStream State Variables and brief descriptions evaluated against a reference reach

Variables*	Description
V-hyd: Flow Regime	
Total Stream Volume	Considers the total annual volume of water delivered to the reach from its contributing watershed.
Peak Flow	Considers the magnitude and duration of peak flows, or the "high end" of the hydrograph.
Base Flow	Considers the magnitude, and duration of base flows, or the "low end" of the hydrograph.
Flow Variability	Considers the temporal pattern of flows including the characteristic timing of peaks, base flows, and rate of change.
V-sed: Sediment Regime	
Land Erosion	Considers the amount of sediment produced in the watershed via land erosion including both surface erosion and mass erosion.
Channel Erosion	Considers the rate of sediment produced by channel erosion in the contributing watershed.
Sediment Transport	Considers the transport of sediment to and through the reach.
V-chem: Water Quality	
Temperature Regime	Considers temperature as a critical biotic habitat factor.
Organic Nutrient Inputs	Considers organic nutrient supply as foundational to trophic structure.
Inorganic Nutrients/Toxins	Encompasses all of the other physicochemical properties of a reach that are not accounted for in prior variables.
V-con: Floodplain Connectivity	
Saturation Frequency	Considers the access of water to the floodplain and riparian area from the stream channel(s).
Floodplain Width	Assesses the degree to which the lateral extent of the floodplain is decreased from stressors.
Saturation Duration	Considers the amount of time the floodplain is saturated during the vegetation growing season.
V-veg: Riparian Vegetation	
Woody Veg Structure	Considers the physical structure of the woody vegetation layers in the riparian area.
Herbaceous Veg Structure	Considers the physical structure of the herbaceous vegetation layers in the riparian area.
Species Diversity	Considers plant species diversity across all layers.
V-deb: Debris	
Large Woody Debris Supply	Considers the LWD supply to the reach.
Detritus Supply	Considers the detritus supply to the reach.
V-morph: Stream Morphology	
Stream Evolution	Considers gross impacts to stream morphology from stressors.
Stream Planform	Considers gross changes to stream branching, sinuosity patterns, etc.
Stream Dimension	Considers gross changes to stream cross-section, width/depth ratio, etc.
Stream Profile	Considers gross change to stream slope or gradient.
V-stab: Stability/Resilience	
Channel Dynamic Equilibrium	Considers stream deposition, scour and migration as measures of stability.

Table 1 Continued

Variables	Description
Channel Resilience	Considers stream response to disturbance as a measure of stability.
V-str: Physical Structure	
Hydraulic Structure	Considers changes to characteristic distribution of depth and velocity.
Coarse Features (flow, LWD, etc.)	Considers coarse physical structure including bed and bank form.
Fine Features (deposition of detritus, etc.)	Considers fine scale physical structure within the stream channel.
V-bio: Biotic Structure	
Stream Biotic Structure	Considers all taxonomic and trophic groups present.

*Watershed-scale hydrology variables are highlighted blue, reach-scale floodplain variables are highlighted green, and reach-scale physical stream characteristics are highlighted burgundy.

Each State Variable is populated with a letter grade based on the scholastic scale score (Table 2). Letter grades were selected for the existing and future-with project conditions based on data collected and professional judgment of each variable's functional integrity. Letter grades are rolled up to provide an overall index value for each of the 10 factors based on Equation 1.

The FACStream FCI may be directly multiplied by habitat acres to HUs. The resulting HUs are compatible with a cost effective/incremental cost analysis to identify the best array of alternatives.

Table 2. Scholastic grade scale for assigning letter grades to model variables.

Grade	FCI Score	Level of Impairment
A++	100	None (pristine)
A+	98	Negligible
A	95	
A-	92	
B+	88	Mild
B	85	
B-	82	
C+	78	Significant
C	75	
C-	72	
D+	68	Severe
D	65	
D-	62	
F+	58	Profound
F	55	
F-	52	

Equation 1: $FCI = \left(\frac{condition\ score}{50}\right) - 1$

2.2.2 Availability of Input Data

A team of USACE and Shoshoni-Paiute employees collected data across all initial reaches of Owyhee River for all categories except V-Hyd (flow) and V-Chem (water quality). Data collected by the Shoshone-Paiute and H & H discussions and modeling were used to inform these ratings. Both Site 3 and 4 were evaluated and compared to the conditions at two reference reaches. A total of two to four data points were collected within each reach (typically top, middle, and bottom of the reach, depending upon reach length) and averaged to create a single representative FCI value.

2.2.3 Model Limitations

The FACStream model poses no apparent limitations in relevance and ability to capture holistic present and future site conditions, but there are several clear limitations that affect the representation of project-level benefits and quality control.

1) The FACStream model overall sensitivity to minor changes in letter grade are lost among the myriad variables and calculation weighting. While changing the letter grade of subvariables within an overarching category (e.g. V-stab, V-str, etc.) can change the overall category letter grade, minor changes in one or two categories (i.e. moving from a B to B+) do not necessarily change the overall model FCI. This is perfectly acceptable in the context of biological condition and relevance, but plays a more significant role in the cost effective/incremental cost analysis modeling to identify best-buy and cost-effective plans.

   We did not find this to be problematic for this study due to the relatively large reaches and ability to magnify minor benefits across the area via HU calculations. However, this model may not be suitable for smaller projects where extensive earthwork or floodplain connection are not possible. In other words, a project must significantly improve several categories, or provide minor improvement across most categories for benefits to be measurable to a degree that will easily separate alternatives in the CE/ICA model.

2) Watershed-level hydrology variables are difficult to improve with a localized project. While a project may improve all other categories significantly, the project may never pencil out as the team envisions because the lower scores for the watershed-level variables may not allow the model FCI to reflect the significance identified in other categories. Therefore, the lead biologist may need to explain in greater detail each of the categorical and subvariable improvements to further justify significant benefits not apparent in the FCI value. Providing the model spreadsheets for Agency Technical Review (ATR) is critical.

3) The FACStream model is incredibly robust, which makes it a solid choice for ecosystem restoration projects. Conversely, such a robust model entails at minimum seven spreadsheets to capture assumptions and scores for a given alternative and time series. For this project there are over 100 spreadsheets including assumptions and calculations that ATR reviewers will need to review. This effort fits a General Investigation well, but may be too much for smaller CAP studies.

2.2.4 Model Assumptions

FACStream is based on the assumption that natural systems perform optimally until disturbed by humans. For this reason, we compare the model outcome to a reference reach to measure the departure or level of impairment.

At the individual variable level, assumptions may be based on professional judgment for the level 1 rapid assessment or based on data collection and analysis methods for the level 3 intensive assessment. For the purposes of Owyhee River restoration, the team worked across the board regarding data collection and characterization of existing conditions. Future conditions were based solely on professional judgment and expertise in how the project may mature.

Any applicable assumptions for the hydrology variables (Flow Regime, Sediment Regime, Floodplain Connectivity) and geomorphology variables (Stream Morphology, Stability/Resilience) can be found in Appendix B. Model spreadsheets include assumptions for each subvariable as they are scored. General assumptions made by the biologist are provided below.

- *Hydrology Variables:* One assumptions worth noting here is the China diversion is being modified for irrigation activities to be more efficient. This modification would be completed over the next 20 years (or thereabout). The assumption is that hydrology within the Owyhee River would remain like existing conditions, being that irrigation demands are expected to be constant. This is conservative as the condition may be better as there is no expected change in the demand of irrigation and the conditions at the China Diversion would allow for more storage of water. Other assumptions include the assumption that Beaver dam analogs and other detainment features such as step-pool or riffle-pool complex would detain water on the site for extended periods of time. 11 acres of detainment would be approximately an extra month of detainment within the project area.
- *Water Quality Variables:* Ratings were based on field observations, and water quality data collected by the Tribes and Idaho Department of Environmental Quality. It was assumed that data being referenced were accurate and future

water quality improvements resulting from each alternative and time series are reasonable.

- *Floodplain Connectivity Variables:* Floodplain width/percentage intact was estimated using professional judgment on present land use, presence of push-up berms, and topography. Saturation frequency and duration were estimated based on Natural Resource Conservation Service soil survey information, lidar imagery, hydrology model data and professional judgment to interpret said data. It was assumed that educated professional judgment and scoring of variables was reasonable, as well as future conditions resulting from each alternative and time series.
- *Riparian Vegetation Variables:* Given the existing condition was observed in the field, future conditions were forecasted on professional judgment and review of scientific literature (Murray and Harrington 1983, Woods et al. 1996; Moore 2016). Riparian benefits were also based on the professional judgment of measures implemented and their magnitude per reach and alternative. The relative benefit captured in the FACStream model was based on the potential proportion of riparian benefit per alternative. The use of professional judgment for vegetation variable scoring is assumed to be appropriate for the level of effort and detail necessary for this study.
- *Debris Variables:* Similar to riparian variables, the magnitude of debris input benefits were based on professional judgment and experience with tree species maturity like black cottonwood. To remain simple and logical in assigning benefits, large wood transport and inputs coming in from outside reaches was not factored into this variable. It was assumed that professional judgment of debris contribution and associated benefits accurately informed the maturation and scores of these variables.
- *Stream Physical Structure Variables:* Changes to hydraulic, coarse, and fine physical structure are directly estimable with known results. Estimation of proportional improvements throughout each reach from the various boulder, LWD, pools, side channels and backwaters informed professional judgment for capturing the benefits in the model. It was assumed that the benefits forecasted are reasonable for these variables.
- *Biotic Structure Variable:* Biotic structure baseline score was based on data and professional judgment of the Tribes, the Corps biologist, and rapid-field macroinvertebrate data collection. While the full array of aquatic species present was not readily available, the presence of invasive fishes was assumed to be minimal based on observations by the Tribes. Additionally, the cold water in Owyhee River would preclude most warmwater invasive species like largemouth bass from thriving in the river. Therefore, the macroinvertebrate data was the driver for this variable. The Ephemeroptera, Plecoptera, Tricoptera (EPT) taxa

were at low abundance at each reach as was overall diversity. It was assumed that this variable would improve (based on increased species diversity and abundance) over time with additional debris inputs and variation in physical structure and sediment deposition, etc. This was assumed to be a reasonable and accurate approach to scoring this variable for this project.

2.3 Model Applicability to Owyhee River Fish and Wildlife Species

The FACStream model applicability to evaluating fish and wildlife habitat value is presented below.

2.3.1 Fishes

The redband trout represents the type of fish species targeted for the restoration effort. It is a subspecies of rainbow trout native to high desert basins of the western US and is renowned for its persistence in harsh desert conditions (Benke, 1992). The species is designated as a sensitive species by Idaho and Nevada BLM and is a Species of Greatest Conservation Need in Idaho. The redband trout in desert environments have twice been petitioned for listing under the Endangered Species Act but listing was found to be not warranted in either case (USFWS 1995; 2000).

The best population near the reservation is upstream of the China Diversion along Fawn Creek which is “fair condition” redband trout habitat. Redband trout do spill into the reservation from the China Diversion but are lost in the system due to the poor river downstream. There is no fish passage at the diversion.

The success of this fish is dependent on appropriate flows during key life stages; resident fish species are adapted to the flashy, desert flows. Summer and early fall low flows and high flows that may occur only every few years are integral to the maintenance of pool depths and channel diversity.

Stream temperature and riparian vegetation have been shown to be important to redband trout distribution and abundance previously (Zoellick et al. 2006; Meyer et al. 2010). BLM collected stream temperature data from 2010 to 2012 from data loggers to predict temperatures for the Owyhee Basin (Feseneyer K and Dan Dauwalter, 2015) (Figure 13). Based on that data, it could be predicted that the study area could reach 17.1-24° C during the month of August most years. This temperature is within the tolerance range for the fish species. Redband trout can survive in streams with maximum daily temperatures as high as 28-29° C (Benke 1992; Zoelick 1999).

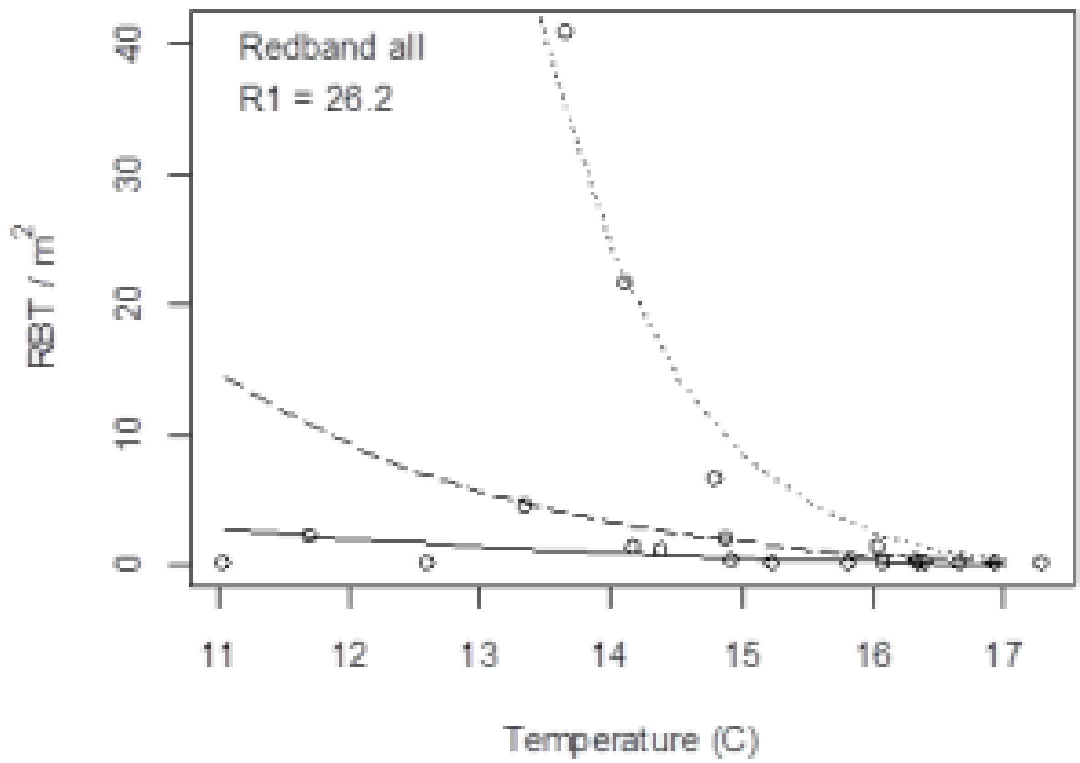


Figure 13. Redband trout abundance measured against stream temperature.

Redband trout distribution and abundance has been linked to stream temperature and woody riparian vegetation measured in the field (Zoellick et al. 2006; Meyer et al. 2013) (Figure 14). Redband trout abundance has been observed to be as high as 130 redband trout/100m2 in desert streams (Zoellick et al. 2006) and is typically higher in colder streams that are more shaded (Zoellick 2004; Zoellick and Cade 2006). Abundance has also been shown to be lower in stream with higher concentrations of silty substrate and in the presence of piscivorous fish, particularly northern pikeminnow (*Ptychocheilus oregonensis*) and smallmouth bass (Meyer et al. 2013).

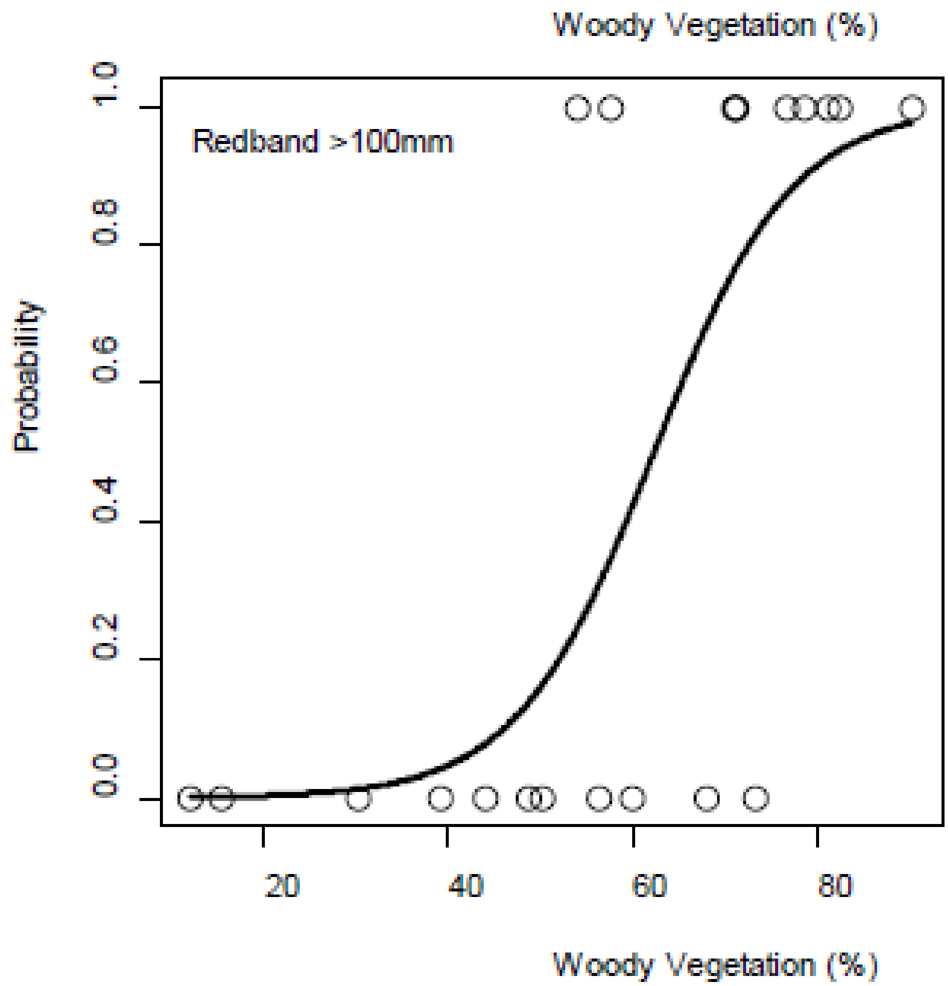


Figure 14. Probability of redband trout based on woody vegetation cover.

Table 3 provides the specifics of how the model applies to redband trout, specifically. While a complete account of the fishes in the Owyhee River is not presented, it can be assumed that all other species native to Owyhee River would benefit from this project as natural cohabitants of cold, headwater streams.

Table 3. FACStream State Variables and how they apply to redband trout habitat

Variables*	Application to Salmonid Habitat
V-hyd: Flow Regime	
Total Stream Volume	Migration, spawning and rearing.
Peak Flow	Migration, spawning and rearing.
Base Flow	Migration, spawning and rearing.
Flow Variability	Migration, spawning and rearing.
V-sed: Sediment Regime	
Land Erosion	Spawning and rearing substrates.
Channel Erosion	Spawning and rearing substrates.
Sediment Transport	Spawning and rearing substrates.
V-chem: Water Quality	
Temperature Regime	All trout life-history requirements.
Organic Nutrient Inputs	Food sources for rearing trout.
Inorganic Nutrients/Toxins	Food sources for rearing trout.
V-con: Floodplain Connectivity	
Saturation Frequency	Organic energy inputs and off-channel rearing habitat availability.
Floodplain Width	Organic energy inputs and off-channel rearing habitat availability.
Saturation Duration	Length of time off-channel rearing habitat.
V-veg: Riparian Vegetation	
Woody Veg Structure	Riparian wildlife food and cover, detritus inputs, bank stability and cover.
V-veg: Riparian Vegetation	
Herbaceous Veg Structure	Riparian wildlife food and cover, detritus inputs, bank stability and cover.
Species Diversity	Riparian wildlife food and cover, detritus inputs, bank stability and cover, plants of cultural significance.
V-deb: Debris	
Large Woody Debris Supply	Food, rearing habitat, riffle-run-pool sequencing, resting.
Detritus Supply	Food sources for rearing trout.
V-morph: Stream Morphology	
Stream Evolution	
Stream Planform	Sinuosity, riffle-run-pool sequencing for migration, spawning, rearing, and resting.
Stream Dimension	W/D ratio, riffle-run-pool sequencing for migration, spawning, rearing, and resting.
Stream Profile	Riffle-run-pool sequencing for migration, spawning, rearing, and resting.
V-stab: Stability/Resilience	
Channel Dynamic Equilibrium	
Channel Resilience	
V-str: Physical Structure	
Hydraulic Structure	Migration (depth distribution and channel shape) and rearing
Coarse Features (flow, LWD, etc.)	Spawning, rearing, and resting for trout.
Fine Features (deposition of detritus, etc.)	Spawning, rearing, and resting for trout.
V-bio: Biotic Structure	
Stream Biotic Structure	Food sources for and predation on rearing trout.

* Watershed-scale hydrology variables are highlighted blue, reach-scale floodplain variables are highlighted green, and reach-scale physical stream characteristics are highlighted burgundy.

2.3.2 Insects

Redband trout diet consists of a variety of macroinvertebrates including water fleas (*Daphnia*), midges (*Diptera*) and mayflies (*Ephemeroptera*). The higher the diversity in insect population, the more variable the available diet for the trout. *Variables V-hyd, V-sed, V-chem* inform the difference between midges (*Diptera)* and EPT taxa presence, for example. Diptera are found in slower, warmer, slackwater aquatic environments with low dissolved oxygen and higher sediment deposition. Higher flows, colder water, and higher gravel content with little sediment deposition suggest that EPT taxa will remain dominant in the Owyhee River in riffle environments. Water temperature will remain cold and faster flow in the river. Cobble would remain common features in faster water environments and sand and silt will remain common features that preclude slower water.

V-con, V-veg, and V-deb variables inform the potential abundance and diversity of insects based on available foods. The presence of vegetation parts including leaves, stems, and fruits would indicate a higher presence of shredder type insects such as stoneflies (Plecoptera), caddisflies (*Trichoptera*), and craneflies (Tipuloidea). Decomposers or filters depend on detritus. These insects would include midges, caddisflies and blackflies (*Simuliidae*). Diversity is also captured here by V-con (floodplain connectivity). Floodplain connectivity leads to wetland presence and function. Midges are the dominant insect in wetland environments and can provide food for predator insects such as dragonflies when wetlands are flooded.

Insect productivity is very high in forested wetland and riparian areas because aqueous nutrients from floodwaters and forest leaf litter enrich forested floodplains (as cited in Batzer and Wissinger 1996).

V-morph and V-str represent sinuosity, riffle-run-pool sequencing, and the types of structures and depositional opportunities present in the reach. A balanced riffle-run-pool sequence and greater diversity of the physical and hydraulic structure of a reach increases the potential for inspect species diversity via varied substrates, velocity, and depths.

2.3.3 Amphibians

The Idaho Department of Fish and Game (IDFG) has identified 4 native amphibian species within Owyhee County. Columbia Spotted Frog (*Rana luteiventris*), Western Toad (*Anaxyrus boreas*), Woodhouse's toad (*Anaxyrus woodhousii*) and the Northern Leopard Frog (*Rana pipiens*) are listed as Species of Greatest Conservation Need (SGCN).

Amphibians are sensitive to water availability, sediments, and water chemistry. Variables V-hyd, V-sed, V-chem include parameters like temperature, dissolved oxygen, and chemical contaminants, which are critical to amphibians. Amphibians are especially susceptible to contaminant uptake through their moist skin. Changes in dissolved oxygen and temperature can reduce reproduction success, food source availability, and overall organism survival.

Connection to floodplain would benefit the amphibians as the breeding areas for these animals typically is prolonged standing water with no fish and no dominant invasive weeds. Breeding areas are typically ditches, ponds, pools, lakes. Most amphibians can reach adult stage in approximately five to eight weeks.

V-con, V-veg, and V-deb are important for amphibians in forested riparian wetlands where shade moderates temperature and contributes a more humid environment. This affects the overall environmental suitability for amphibians. While water is necessary for amphibian reproduction, forested areas may provide non-breeding food sources and shelter (Houlahan and Findlay 2003).

2.3.4 Bats

The IDFG has identified five bat species that are listed as SGCN and may occupy the study area. These are Townsend's big-eared bat (*Corynorhinus townsendii*), silver-haired bat (*Lasionycteris noctivagans*), hoary bat (*Lasiurus cinereus*), western small-footed myotis (*Myotis ciliolabrum*), and little brown myotis (*Myotis lucifugus*).

Variables V-hyd, V-sed and V-chem are critical for providing adequate food sources for bats. Appropriate riparian wetland hydrology provides water sources for drinking and greater insect productivity compared to drier habitats. Water-born midges tend to dominate wetland habitats (Batzer and Wissinger 1996) serving as a significant food source for bats. Other important food sources consist of aquatic insects found in riparian and stream environments including mayflies, mosquitoes, and caddisflies.

V-con, V-veg, and V-deb are important for bat roosting. In semi-arid regions on the prairies of North America, tree cavities in riparian forests, particularly black cottonwood, often provide the primary source of natural roosts for cavity roosting bats (Swaytsun et al. 2007). Cavities provide protection from predators and inclement weather and has been argued that the availability of suitable roost sites is the most important limiting resource for bat populations (Humphrey 1975; Kunz 1982 *as cited in* Swystun et al. 2007).

2.3.5 Mammals

The IDFG has identified six mammal species (excluding bats) that may occupy the study area listed as a SGCN. They are pygmy rabbit (*Brachylagus idahoensis*), Bighorn sheep (*Ovis canadensis*), dark kangaroo mouse (*Microdipodops megacephalus*), Columbia Plateau Ground Squirrel (*Urocitellus canus*), Wyoming Ground Squirrel (*Urocitellus elegans novadensis*), and Southern Idaho Ground Squirrel (*Urocitellus endemicus*) however, none of these species would benefit from creation of riparian or wetland habitat.

Use of riparian wetlands for foraging is likely by mink, raccoon (*Procyon lotor*), and other small mammals in the rodent family as these species are feeding generalists that will seek crustaceans, insects, other small mammals, and vegetation, and utilize terrestrial habitats, whereas species like otters are piscivorous and utilize riverine habitats largely (Melquist 1997).

These variables are important to small mammal use of riparian wetlands. Studies have trapped up to 11 small mammal species suggesting that mouse and shrew use of wetland habitats in South Dakota were stratified by soil moisture content and correlated positively or negatively with percent herbaceous cover (Pendleton 1984). This correlates directly with floodplain connectivity and saturation duration and frequency.

Mouse, shrew, and vole species forage on a variety of vegetation types to include tree bark, herbaceous vegetation, and tree fruit or mast. Trees are important to mustelids as large woody debris can be used as cover and forage habitat (Melquist 1997). Mustelids may also seek shelter in tree cavities.

Coyotes may seek shelter in large, hollow logs of fallen black cottonwood. They are also food generalists that will seek vegetation, fruit, and mast when necessary, as well as small mammals. Vegetation that supports rodents would do well to support coyotes as well.

The red fox (*Vulpes vulpes*) may share a similar use of riparian wetland habitats, barring competition with coyote in the study area.

White-tailed deer (*Odocoileus virginianus*) and mule deer (*Odocoileus hemionus*) seek riparian and wetland habitats for shelter, water, browse and travel corridors. These habitats often offer summer refugia in the form of shade and cool bedding areas during summer. Thicker riparian habitat and wetlands may serve as preferred fawning areas. Diverse vegetation offers a variety of food sources and nutrition, serving an additional benefit during fawning periods.

Variables V-hyd, V-sed and V-chem are important to small mammal use of riparian wetlands. Studies have trapped up to 11 small mammal species suggesting that mouse and shrew use of wetland habitats in South Dakota were stratified by soil moisture content and correlated positively or negatively with percent herbaceous cover (Pendleton 1984). This correlates directly with floodplain connectivity and saturation duration and frequency.

Use of wetlands for foraging is likely by mink, raccoon (*Procyon lotor*), and small rodents that are generalists that seek crustaceans, insects, other small mammals, and vegetation, and utilize terrestrial habitats, whereas species like otters are piscivorous and utilize riverine habitats largely (Melquist 1997).

V-con, V-veg, and V-deb are critical to mustelids such as river otters (*Lontra canadensis*) and mink (*Vison vison*). Mink occupy a home range on average between 1.5 and 3.5 miles (2.2 – 5.5 kilometers) long, while river otters occupy home ranges from 5-92 miles (8 – 148 kilometers) in length in montane river corridor habitats. This is dependent on food abundance and habitat suitability, which relies on quality riparian habitats. Habitat connectivity is significantly important for small mammals (mesocarnivores) but may be less important for small rodents not requiring extensive home ranges.

2.3.6 Migratory and Upland Birds

The IDFG has identified 187 bird species to include 26 raptors and 7 upland bird species that may occupy the study area, 14 of which are identified as SGCN (Table 4).

Table 4. Bird Species of Greatest Conservation Need in Owyhee County

Common Name	Latin Name
Greater Sage-Grouse	*Centrocercus urophasianus*
Ferruginous Hawk	*Buteo regalis*
Golden Eagle	*Aquila chrysaetos*
Yellow-billed Cuckoo	*Coccyzus americanus*
Burrowing Owl	*Athene cunicularia*
Short-eared Owl	*Asio flammeus*
Common Nighthawk	*Chordieles minor*
Sage Thrasher	*Oreoscoptes montanus*
Burrowing Owl	*Athene cunicularia*
Sagebrush Sparrow	*Artemisiospiza novedensis*
Grasshopper Sparrow	*Ammodramus savannarum*
Common Nighthawk	*Chordieles minor*
Sage Thrasher	*Oreoscoptes montanus*
Sagebrush Sparrow	*Artemisiospiza novedensis*

Migrating birds depend on suitable stopover sites, often riparian and other wetland habitats. Long-distance en-route migrants may base their selection of stopover sites on factors extrinsic to rather than intrinsic to the sites, including meteorological conditions, physiological condition, and landscape-level attributes of the available stopover sites such as patch size and shape, degree of isolation or contagion and connectivity, patch orientation, and interception probabilities (Hutto 1985a; Gutzwiller and Anderson 1992 *as cited in* Skagen et al. 1998). Patch size is a key feature of breeding habitat for western yellow-billed cuckoo populations, with larger, wider areas of habitat strongly preferred (Wiles and Kalasz 2017).

Finally, agriculture and residential development adjacent to natural habitat can encourage nest parasites (Saab 1999).

These variables also play a major role in migratory bird nesting, food and cover sources. Breeding bird populations are significantly higher among habitats with perennial compared to ephemeral water sources (MacArthur 1964). In the western U.S., insectivorous landbirds migrating in spring prefer riparian habitats for refueling (Johnson et al. 1977; Stevens et al. 1977; Emmerich & Vohs 1982; *as cited in* Skagen et al. 1998). Therefore, insectivorous migratory birds may experience greater food availability with intact water supply and hydrology.

Twedt and Portwood (1997) suggest that three-dimensional vegetation structure may be more important than specific plant species. Western clematis (*Clematis ligusticifolia*), shrub densities, willow density, and canopy are all indicators of quality habitat. Diversity of bird species has been correlated with diversity of foliage height in riparian habitats of the southwestern United States such as desert riparian, mesquite shrub, sycamore-cottonwood, and mixed deciduous habitats (Austin 1970, MacArthur 1964, Carothers et al. 1974).

Homogenous cottonwood plots with permanent water sources (e.g., streamside stands) have shown the greatest migratory bird species diversity and the greatest population densities of nesting birds relative to other habitat types (MacArthur 1964).

Yellow-billed cuckoo are riparian forest obligates, making forested riparian and wetland habitats critical to their persistence; however, there is some debate over their preferred vegetation structure. Buffington et al. (1997) suggest they prefer mid- and late-successional stands over early-successional, while Hughes (1999) directly and completely contradicts this, stating that yellow-billed cuckoo prefer early-successional stands. One point of consistency is that in the western U.S., yellow-billed cuckoo nesting is strongly associated with large [usually exceeding 98 ac (40 hectares) in size], wide [over 328 feet (100 meters)] patches of low to mid-elevation riparian habitat dominated by cottonwoods, willows, and a mix of other species (Wiles and Kalasz 2017).

Variables V-hyd, V-sed, V-chem will define which type of birds would be utilizing the wetland areas. The longer the duration of saturation or inundation would define the type of foods available for these avian species, especially those that eat insects, such as yellow billed cuckoo, grasshopper sparrow, and common nighthawk. Others that eat rodents could also be affected by the hydrology. Typically, these animals will prefer areas that are moist or seasonally wet, not fully inundated by large bodies of standing water (i.e., marshes).

V-con, V-veg, and V-deb are critical to migratory bird species. Because riparian habitats in arid lands have unique features among forests (i.e., long, narrow shapes with large amounts of edge), adjacent landscape patterns might be particularly important to avian community structure (Saab 1999). Modeling results reported by Saab (1999) suggest that cottonwood stand area, proximity to other cottonwood stands, and natural adjacent landscape are among the main predictors of high species richness.

2.3.7 Sage-Grouse

The Duck Valley Indian Reservation contains areas identified as Key Sage-Grouse Habitat. These areas consist of generally intact sagebrush that provide sage-grouse habitat during some portion of the year. Most sage-grouse nests occur in and are more successful under sagebrush (Patterson 1952 and Connelly et al. 1991). If sagebrush is eliminated from a large area, or severely fragmented into small units, the area will not support strong sage-grouse populations because nest success and/or juvenile survival would be reduced.

The Duck Valley Indian Reservation maintains a healthy sage-grouse population; however, the population strongly depends on the quality and quantity of brood-rearing habitat for sage-grouse chick survival. Typically, early June to mid-July brood-rearing areas are in the vicinity of nest site, and good habitat contains an abundance of forbs as well as sagebrush cover (Connelly et al. 2000 and Apa 1998). During the mid-late summer, brood use shifts to more mesic habitats where forbs are mor abundant.

Herbaceous cover should be managed to ensure that it provides the height and cover necessary for sage-grouse nesting habitat. Connelly et al. (2000) recommended that, when possible, herbaceous understory vegetation in sage-grouse breeding habitat should be more than 7 inches height and more than 15% cover. However, most research on nesting habitat reports values that represent herbaceous nesting cover following hatching (late May and early June) when measurements could be made without disturbances to nesting hens. Data regarding herbaceous cover values present during nest site selection are unavailable. Research is currently ongoing in southern Idaho by IDFG to refine the understanding of herbaceous understory requirements for nesting sage-grouse (Connelly and Musil 2007).

Areas classified as excellent nesting habitat support 15-25% big sagebrush canopy cover and a healthy native bunchgrass understory. Areas with 6-15% big sagebrush canopy cover are rated as fair if composition of the understory vegetation is greater than 40% native plants and poor, if not. Areas seeded with non-native grasses are designated as fair or poor sage-grouse habitat, depending on the extent of sagebrush cover present. In general, seeded areas, particularly those at lower elevations that are dominated by species such as crested or intermediate wheatgrass typically are lacking in forb diversity and would not have the same potential or desirability as native rangelands, regardless of shrub cover. The classification of nesting habitat quality also reflects the condition of early brood habitat since early brood-rearing habitats are generally in the vicinity of nest sites.

Table 5 provides the specifics of how the model applies to sage-grouse, specifically. While a complete account of the birds in the Owyhee River is not presented, it can be assumed that all other species native to Owyhee River would benefit from this project as natural riparian dependent cohabitants.

Table 5. FACStream State Variables and how they apply to sage-grouse habitat

Variables*	Application to Sage-grouse Habitat
V-hyd: Flow Regime	
Total Stream Volume	Source of water for the restoration of wet meadows
Peak Flow	Source of water for the restoration of wet meadows
Base Flow	Source of water for the restoration of wet meadows
Flow Variability	Source of water for the restoration of wet meadows.
V-sed: Sediment Regime	
Land Erosion	Riparian habitat stability
Channel Erosion	Insect availability, detritus for insect foods, stable riparian habitat
Sediment Transport	Types of insects available for food
V-chem: Water Quality	
Temperature Regime	Not Applicable.
Organic Nutrient Inputs	Food sources for insects.
Inorganic Nutrients/Toxins	Food sources for insects.
V-con: Floodplain Connectivity	
Saturation Frequency	Riparian wildlife food and cover, detritus inputs, bank stability
Floodplain Width	Riparian wildlife food and cover, detritus inputs, bank stability
Saturation Duration	Riparian wildlife food and cover, bank stability and cover.
V-veg: Riparian Vegetation	
Woody Veg Structure	Riparian wildlife food and cover, detritus inputs, bank stability.
V-veg: Riparian Vegetation	
Herbaceous Veg Structure	Riparian wildlife food and cover, detritus inputs, bank stability and cover.
Species Diversity	Riparian wildlife food and cover, detritus inputs, bank stability and cover, plants of cultural significance.
V-deb: Debris	
Large Woody Debris Supply	Food availability
Detritus Supply	Food sources for rearing juveniles.
V-morph: Stream Morphology	
Stream Evolution	
Stream Planform	Frequency of flooding, duration of saturation for wetlands
Stream Dimension	Frequency of flooding, duration of saturation for wetlands.
Stream Profile	Frequency of flooding, duration of saturation of wetlands
V-stab: Stability/Resilience	
Channel Dynamic Equilibrium	
Channel Resilience	
V-str: Physical Structure	
Hydraulic Structure	Frequency of flooding, duration of saturation of wetlands
Coarse Features (flow, LWD, etc.)	Types of available food sources
Fine Features (deposition of detritus, etc.)	Types of available food sources

V-bio: Biotic Structure	
Stream Biotic Structure	Food sources

* Watershed-scale hydrology variables are highlighted blue, reach-scale floodplain variables are highlighted green, and reach-scale physical stream characteristics are highlighted burgundy.

2.3.7 Waterfowl and Shorebirds

The IDFG has identified 93 waterfowl species that may occupy the study area, 11 of which are identified as SGCN (Table 6).

Table 6. Waterfowl SGCN within the study area

Common Name	Latin Name
American White Pelican	*Pelecanus erythrorhynchos*
Black Tern	*Chlidonias niger*
California Gull	*Larus californicus*
Caspian Tern	*Hydroprogne caspia*
Clark's Grebe	*Aechmophorus clarkii*
American Bittern	*Botaurus lentiginosus*
Long-billed Curlew	*Numenius americanus*
Ring-billed Gull	*Larus delawarensis*
Sandhill Crane	*Grus canadensis*
Western Grebe	*Aechmophorus occidentalis*
White-faced Ibis	*Plegadis chihi*

Distance between resting and feeding areas and patch size and quality are important for migrants. The surrounding landscape can affect the suitability of wetland habitats for nesting and brood rearing. Waterfowl (non-piscivorous) rely largely on vegetation over winter, but like upland and migratory birds, insect forage becomes an important diet component during spring and summer for molting, egg production, and brood rearing. Live forest and shallow, emergent wetland vegetation are important diet components for wood ducks (Dugger and Fredrickson 1992).

Vegetation structure and complexity are critical for waterfowl and shorebirds. Mature trees provide the largest proportion of trees with cavities suitable for nesting. A mix of tree, shrub, and herbaceous species is preferred. It is assumed that the Idaho native cottonwood gallery forest vegetation and species structure would be suitable for wood duck as they naturally occur in the area.

V-hyd, V-con, V-veg, and V-deb are critical for waterfowl and shorebirds. Distance between resting and feeding areas and patch size and quality are important for migrants and can be captured by floodplain connectivity and saturation duration and frequency, as well as base flow. The surrounding landscape can affect the suitability of wet meadows and wetland habitats for nesting and brood rearing. Some species, like bitterns and curlews would prefer more mesic habitats whereas others such as pelicans and gulls would require deeper water habitats.

3.0 ALTERNATIVES DEVELOPMENT

Given the large study area, the Owyhee River was broken into five reaches. Through the Planning process, we eliminated all reaches except Site 3 and Site 4 due to constraints.

Four measures were carried forward as presented in Table 6. Detailed measure descriptions are available in Section 3 of the main report. Measures were combined into standalone “site plans” within each reach [Table 7 (See Appendix X for complete site plan descriptions)]. Overall, three alternatives were developed from standalone measures or measure combinations. Three alternatives, Alternative 5, 6 and 8 were evaluated individually with the FACStream model. Existing condition and alternative benefits assumptions are presented below.

Table 7. Measures carried forward for analysis

Measure	Measure Name	Measure Techniques	Aquatic	Riparian	Both Riparian and Aquatic
A	Wetland/Riparian Habitat	• Planting • Fencing • Invasive Species control		X	
B	Side channel connection/Main Channel Diversion	• Grading relic channel to create a meandering channel with riffle-pool complex	X	X	X
C	Instream habitat improvement	• Beaver Dam Analogs • Boulders for side channels • Adding large woody debris • Detainment structures to allow storage of water in the floodplain	X		
D	Floodplain Connection	• Notch berm and or		X	

		excavation to reconnect historic floodplain			
E	Fencing for livestock	• Exclude cattle from grazing in riparian planting areas		X	

3.1 Reach and Alternative Assumptions

Below are assumptions of the existing condition of each reach and each alternative. Estimates of the improvements that may be realized by the implementation of each of the Alternatives are in Table 7. For each Alternative, modeling combined both Site 3 and Site 4 activities to create the AAHU's.

Reach 1 (Reference)

Existing Condition – Reach 1 is approximately 2,000 linear feet and is upstream of the China Diversion Dam on the Owyhee River. The channel consists of riffle and pool complex that is gravel substrate (Figure 15). There are no embankments or other barriers within this reach. The reach has meanders and an active floodplain (Figure 16). There are multiple side channels. The river is not deeply incised. The riparian corridor is thick and wide. The riparian vegetation is protected by fencing to prevent cattle from grazing in riparian areas (Figure 17).

Figure 15. Representative photo of riffle at Reach 1 looking downstream

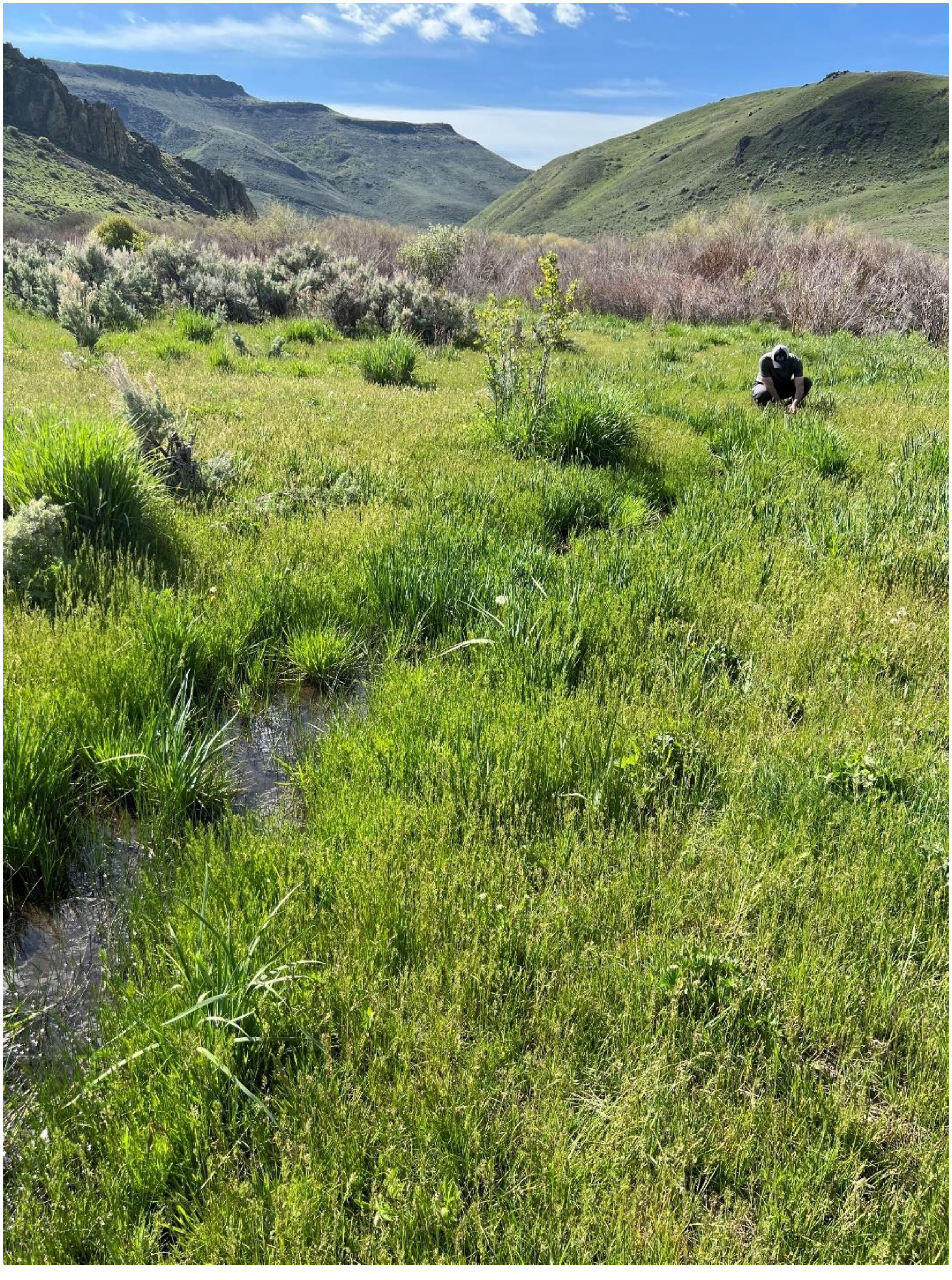


Figure 16. Active floodplain at Reach 1.

Figure 17. Fencing to protect shrub-riparian vegetation from grazing cattle.

This is a reference reach in which no improvements are needed. The area supports large wood on the outer bends, boulders, floodplain connectivity and contains approximately 23 acres of wetlands along the reach. Wet meadows and active riffle pool complex exist within this reach.

Reach 3

Existing Condition – Reach 3 is a 3,800 linear foot section of the Owyhee River. It is prime opportunity for floodplain connectivity, riparian restoration, and reactivation of side channels. The Owyhee River is channelized and disconnected from its floodplain by a series of berms (Figure 18 and Figure 19). The berms along the shoreline that prevent overbanking onto the historic floodplain. There is a beaver dam analog within this reach that was installed to detain water within this reach (Figure 20). The present riparian corridor is a narrow strip adjacent to grazing fields used for raising cattle. Cattle graze within the adjacent lands and cause erosion in areas where they drink from the river. Additionally, areas of the adjacent lands are converting to sagebrush because of dryer conditions than the surrounding wetland areas. There are relic side channels that are now isolated wetlands (Figure 21).

Figure 18. Representative photo of Reach 3.

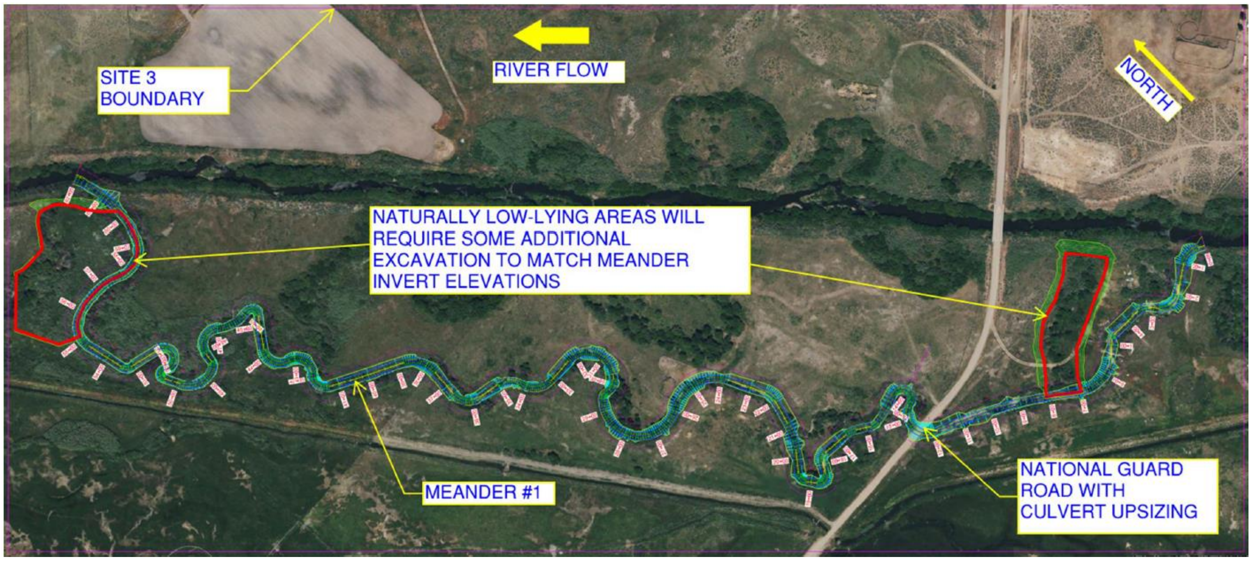
Figure 19. Berms that disconnect the Owyhee River from its adjacent floodplain.

Figure 20. Use of Beaver Dam Analogs in the Owyhee River.

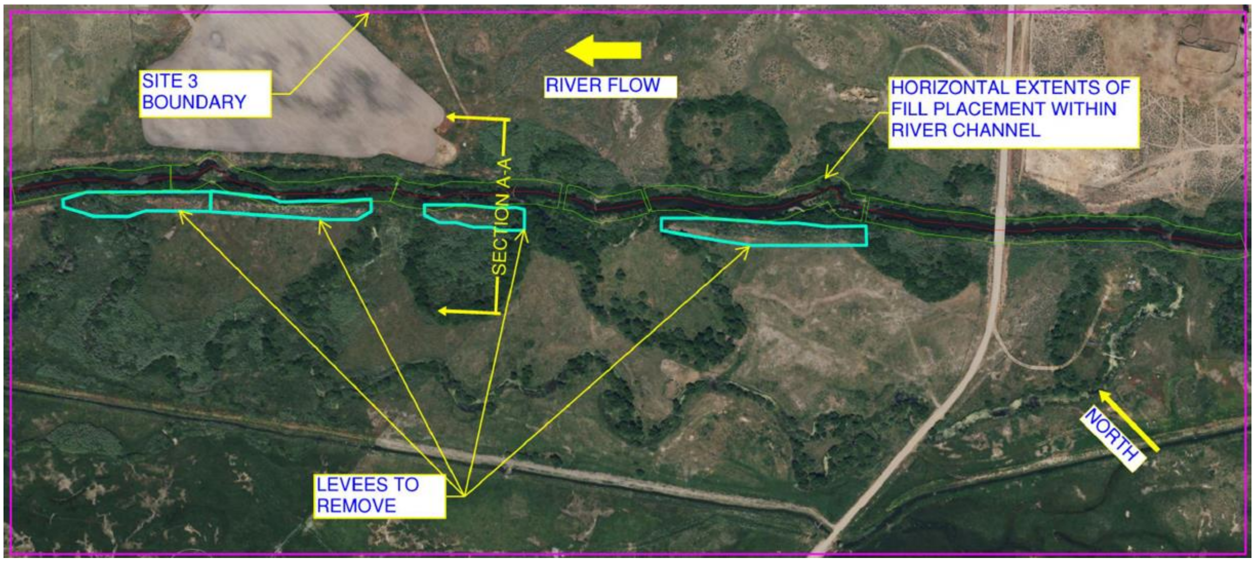
Figure 21. Relic side channels that are isolated wetlands.

Site 3-Alternative 5 – This alternative includes excavation of a 20-foot wide side channel and construction of beaver dam analogs to allow for normal flows of the Owyhee River to flow through the site. Side channel realignment would create sinuosity, the development of backwaters and lateral pools. Approximately 15 acres of area would be planted with riparian vegetation to create riparian habitat with regularly connected spring stream habitat and nutrient inputs, boulder placement and log jams. The beaver dam analogs would be used to detain water on site for extended periods of time to allow for water retention and groundwater recharge. This alternative would create approximately

6,400 linear feet of side channel for juvenile and adult redband trout foraging habitat and create approximately four acres of juvenile sage-grouse habitat at Site 3.



Site 3-Alternative 6 – This alternative excavates notches in the berms along the Owhyee River to allow for the river to overbank onto the historic floodplain. Notches would also be created to redirect the flow of the Owyhee River into historic meanders to reactivate a side channel. The fill material from the notched berms would be placed in the Owyhee River to cause water to backflow and overbank into the historic floodplain. Beaver dam analogs or other detainment structures may be implemented to allow for water retention and groundwater recharge over extended periods of time. Approximately 50 acres of wet meadows for juvenile sage-grouse would be created by overbank flooding. The side channel would consist of approximately 6,400 linear feet of side channel that could be used by foraging juvenile and adult red band trout at Site 3.



Site 3-Alternative 8 – This alternative excavates 5,300 linear feet,40-foot-wide side channel within the historic floodplain large enough to contain all flows of the Owyhee River (floodwater and normal). The channel would be capable to accommodate floodwater events and an earth embankment diversion structure would be placed in the Owyhee River to divert the flows into the new channel. The channel would be armored with rip rap and boulders along the outside meanders to provide channel stability. Detainment structures may be needed to allow for water to be detained on site for extended periods of time. This alternative would plant approximately 15 acres of riparian habitat and 40 acres of wet meadows at Site 3.

Reach 4

Existing Condition – Reach 4 is a 2,200 linear foot reach of the Owyhee River that is entrenched by as much as a 20-foot-deep embankment. However, some portions are lower enough that minor excavation of the berms could reactivate floodplain. The riparian area is a very narrow strip of willows at the top of the ravine bank (Figure 18 and 19). The adjacent land has converted from wetland areas to sagebrush habitat because of excessive drying of the land by the entrench (Figure 20). The upstream section of the reach is constrained by a bridge, that can back flood water up along the road, causing erosion in areas of the shoreline. There is a culvert under the National Guard Road that is in a relic meander. Relic channels are throughout the adjacent lands (Figure 21).

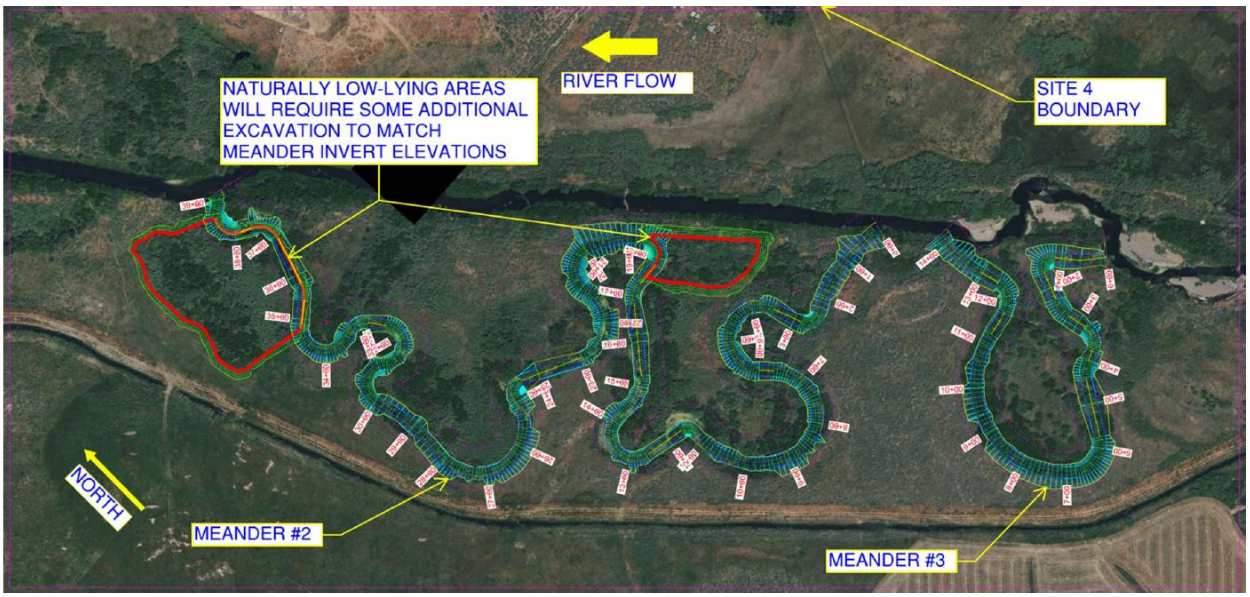
Figure 22. Representative picture of Site 4.

Figure 23. Inactive floodplain at Reach 4.

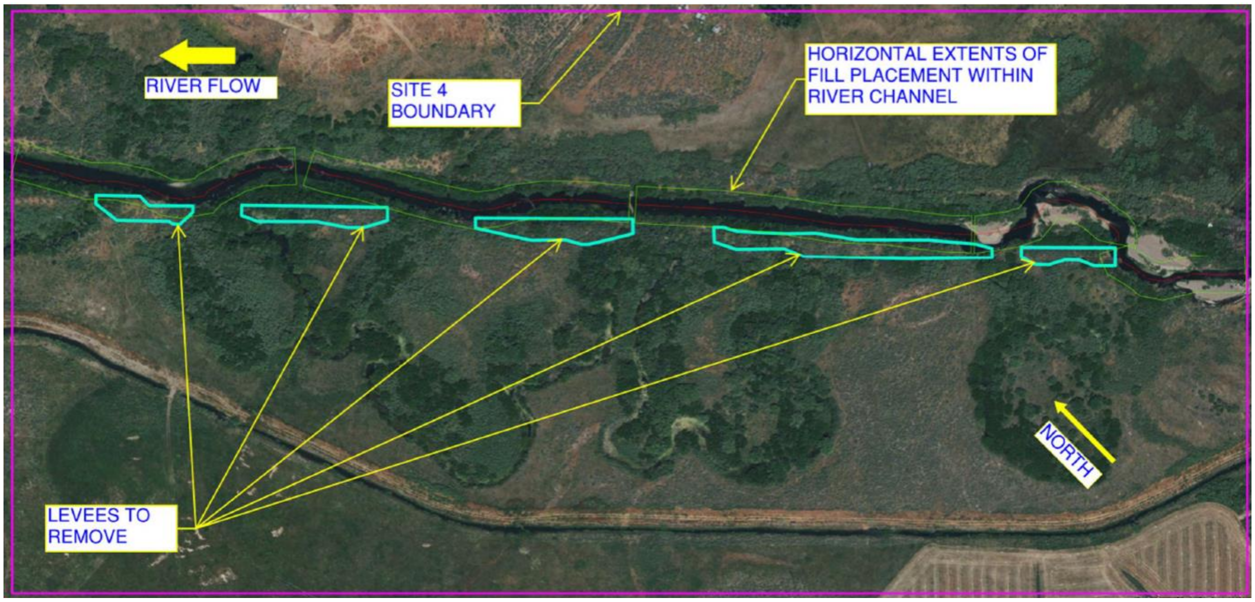
Figure 24. Conversion of wetlands to sagebrush habitat.

Figure 25. Inactive Meander sidechannels and relic oxbows.

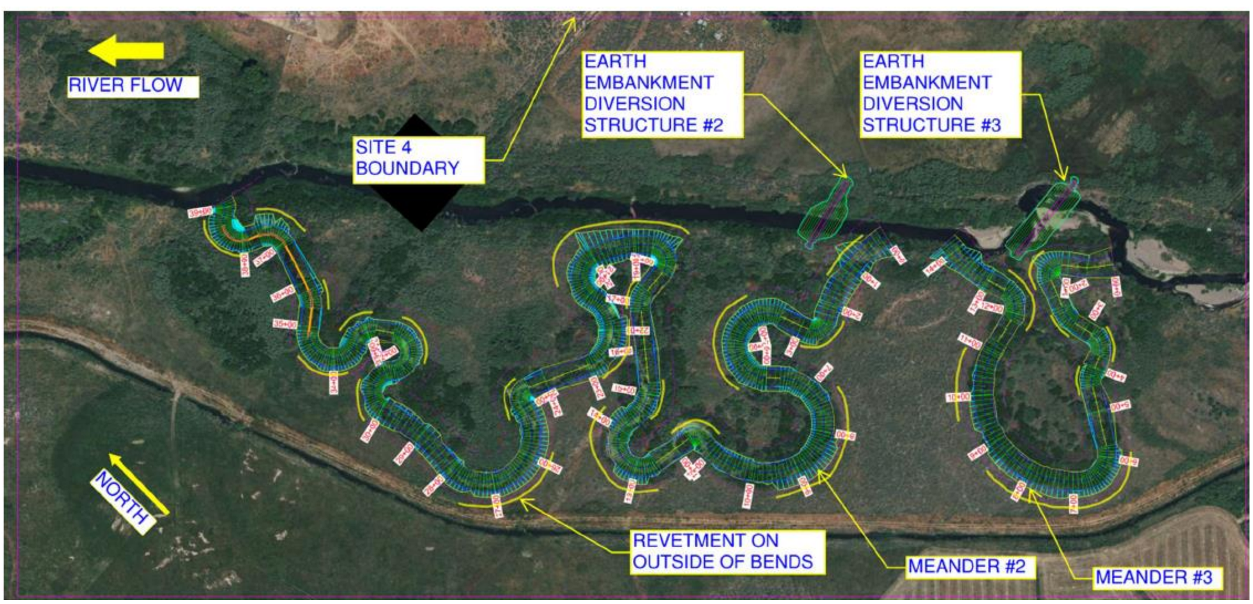
Site 4-Alternative 5 –This alternative includes excavation of a 20 foot wide side channel and construction of beaver dam analogs to allow for normal flows of the owyhee River to flow through the floodplain. Side channel realignment would create sinuosity, the development of backwaters, and lateral pools, and the planting of 13 acres of riparian habitat with regularly connected spring stream habitat and nutrient inputs, bolder placement and log jams. The beaver dam analogs would be used to detain water on site for extended periods of time to allow for water retention and groundwater recharge. This alternative would create approximately 5,400 linear feet of stream channel for juvenile and adult redband trout foraging habitat and create approximately 9 acres of sage-grouse habitat at Site 4.



Site 4-Alternative 6 – This alternative excavates notches in the berms along the Owhyee River to allow for the river to overbank onto the historic floodplain. Notches would also be created to redirect the flow of the Owyhee River into historic meanders to reactivate a side channel. The fill material from the notched berms would be placed in the Owyhee River to cause water to backflow and overbank into the historic floodplain. Beaver dam analogs or other detainment structures may be implemented to allow for water retention and groundwater recharge over extended periods of time. Approximately 5 acres of wet meadows for juvenile sage-grouse would be created by overbank flooding. Additionally, an estimated 5,000 linear feet of side channel would be reactivated that could be used by foraging juvenile and adult red band trout at Site 4.



Site 4-Alternative 8 – This alternative excavates 5,400 linear feet,40-foot-wide side channel within the historic floodplain large enough to contain all flows of the Owyhee River (floodwater and normal). The channel would be capable to accommodate floodwater events and an earth embankment diversion structure would be placed in the Owyhee River to divert the flows into the new channel. The channel would be armored with rip rap and boulders along the outside meanders to provide channel stability. Detainment structures may be needed to allow for water to be detained on site for extended periods of time. This alternative would plant approximately 13 acres of riparian habitat and six acres of wet meadows at Site 4.



Reach 5 (Reference Site)

Existing Condition – Similar to Reach 1, there is much greater floodplain and active side channels in this reach. This is an approximately 2,100 linear foot reach of the Owyhee River that is constricted by a bridge (BIA 903). The floodplain supports a variety of willows, red osier dogwood along the riverbank and wet meadows adjacent to the riparian vegetation. The present riparian area is better than the other sites and the Owyhee River has more natural meanders even given the constraints of the bridge crossing (Figure 8). No action is planned at this reach, and it is only used as reference.

Figure 26. Representative photo of Reach 5 (Reference site).

Figure 27. Representative photo of Reach 5 wet meadows and active floodplain.

4.0 ANALYSIS AND RESULTS

4.1 FACStream Scoring and Alternatives Analysis

To be clear on assumptions for each model variable and to remain transparent and consistent with the assumed benefits or condition for each site plan, a time-series workbook was set up for each reach site plan. Assumptions and letter grades were documented for each subvariable at maturation years 0, 5, 10, 20 and 50 and based on assumptions of the benefits each site plan would provide relative to the existing condition.

Existing condition and site plan benefits assumptions are presented below for each reach.

As discussed in Section 2.2, letter grades were assigned for each subvariable across site plans and maturation time steps. The FACStream model then provided the subvariable score roll-up (Figure 10) to include the overall FCI value for each site plan.

The overall FCI was then multiplied by the maximum Project area within each reach to estimate Habitat Units (HU).

HUs for each site plan and maturation time step were calculated into Average Annual Habitat Units (AAHU) which inform the benefit of a given site plan or alternative relative to the existing and future without-project conditions for Cost-Effectiveness/Incremental Cost Analysis (CE/ICA) modeling.

Reference Reach Downstream	River/Stream	Date	5/26/2022
Owyhee River	Site/Reach ID	Evaluators	Kristen Shacochis-Brown, Kat Herzog, Jaimie Johnson
	Project ID		
3835 + 6026	Reach length (feet)	Affiliation	VWD, PWS

Variable score	Variable	Metric score	Metric
F	V_{hyd}	F	V_{hyd}1: Total Volume
M	Confidence	F	V_{hyd}2: Peak Flows
		F	V_{hyd}3: Base Flows
		D	V_{hyd}4: Flow Variability
B	V_{sed}	B	V_{sed}1: Land Erosion
M	Confidence	B-	V_{hyd}2: Channel Erosion
		B	V_{hyd}3: Transport
B	V_{chem}	B	V_{chem}1: Temperature Regim
M	Confidence	B	V_{chem}2: Organics/Nutrients
		B	V_{chem}3: Inorganics/Toxins
B+	V_{con}	A-	V_{con}1: Saturation Frequenc
M	Confidence	A	V_{con}2: Floodplain Width
		B	V_{con}3: Saturation Duration
C+	V_{veg}	C	V_{veg}1: Woody Veg. Structur
H	Confidence	C	V_{veg}2: Herbaceous Veg. Str
		A	V_{veg}3: Species Diversity
D	V_{deb}	A	V_{deb}1: LWD
H	Confidence	F	V_{deb}2: Detritus
A	V_{morph}	A	V_{morph}1: Stream Evolution
H	Confidence	A	V_{morph}2: Planform
		A	V_{morph}3: Dimension
		A	V_{morph}4: Profile
C	V_{stab}	C	V_{stab}1: Dynamic Eq.
H	Confidence	C	V_{stab}2: Resilience
C	V_{str}	C	V_{str}1: Hydraulic Structure
H	Confidence	C	V_{str}2: Coarse Scale
		C	V_{str}3: Fine Scale
D	V_{bio}	D	V_{bio}1: Biotic Structure
H	Confidence		
C	Reach Condition Score		

Process Domain

Physographic Region	hern Basin and R
Hydrologic Region	wyhee River Bas
Ecoregion	Semiarid Uplands
Strahler Order	6
Valley Confinement	PC
Valley Slope	VL
Riparian Reference	Scrub-Shrub

Morphology

Stream Type	Rosgen	SEM
Existing	F	3
Reference	E	7

Biology Functions FCI	0.44
Physicochemical Functions FCI	0.48
Geomorphology Functions FCI	0.52
Hydraulic Functions FCI	0.50
Overall FCI	0.48

Figure 28. Example FACStream model roll-up.

4.2 FACStream Results

The three unique Alternatives yielded 19 FACStream model runs to include existing and future without-project (FWOP) conditions and five maturation time steps (years 0, 5, 10, 20, 50). Annex B provides scoring and assumptions across reaches and time series and Annex C provides the FACStream model roll-up score sheets. Net AAHUs for standalone site plans ranged from 0 for FWOP (combined Site 3 and 4) to 62 for Alternative 6 (Table 8).

Table 8. AAHU Calculations for each alternative across the time series modeled

Alternative	Gross AAHU	Net AAHU
No Action	15.2	0
Alternative 5	25.7	10.5
Alternative 6	42.1	27.0
Alternative 7	24.3	9.2

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Annex A

FACStream Single Use Model Approval for the Owyhee River Ecosystem Restoration Section 206

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NORTHWESTERN DIVISION
PO BOX 2870
PORTLAND, OR 97208-2870

CENWD-PDD (1105-2-10b2)

MEMORANDUM FOR Commander, Walla Walla District (CENWW-ZA/LTC KingSlack)

SUBJECT: Owyhee River, Elko County, Nevada, Section 206 Project Review Plan Approval

1. References:

   a. ER 1165-2-217 Review Policy for Civil Works, 1 February 2021.

   b. Owyhee River Ecosystem Restoration, Elko County, Nevada Section 206 Project Review Plan, 30 January 2023.

2. Per the process and requirements outlined in reference a, Walla Walla District (NWW) has submitted a Review Plan (RP) (reference b) for the subject study.

3. Appropriate Northwestern Division (NWD) staff have reviewed the RP and all comments have been addressed. While model approval is not required for Continuing Authorities Program studies, appropriateness of habitat model use for the study has been coordinated with NWD.

4. The RP is hereby approved. The RP must be posted on the NWW internet site and made available for public comment.

5. Please contact Rachel Wooten at 503-894-0682 or rachel.c.wooten@usace.army.mil if you have further questions regarding this matter.

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FRANCES E. COFFEY, SES
Director, Programs

Annex B

FACStream Model Scoring and Assumptions

(Provided Electronically)

Annex C

FACStream Model Roll-up Scoring Sheets

(Provided Electronically)