Jocko River Master Plan: Section 3

A guide to ecological restoration activities in the lower main stem Jocko River corridor

Section 3: Restoration Process: Planning, Design & Strategies

CONFEDERATED SALISH AND KOOTENAI TRIBES

Prepared by the CSKT Fish, Wildlife, Conservation, and Wildland Recreation Program

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Jocko River Master Plan: A Guide to Ecological Restoration Activities in the Lower Mainstem Jocko River Corridor: Section 3

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Contributors:

Confederated Salish and Kootenai Tribes
Les A. Evarts
Craig A. Barfoot
Steven K. Klotezel
Seth V. Makepeace
Russel S. Sydnor

Geum Environmental Consulting, Inc
Sarah E. Flynn
Thomas G. Parker
Amy M. Sacry

River Design Group, Inc.
Andrew T. Belski
Troy M. Brandt
Mathew S. Daniels
John M. Muhlfeld

WestWater Consultants, Inc.
Garret T. Decker

Document Preparation:

CW Consulting
David Rockwell

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3.0 Restoration Process: Planning, Design & Strategies

3.1 Introduction

Previous sections describe the diverse ecological components of the lower main-stem Jocko River and its floodplain, its historical condition, the history of use that has led to the existing condition, and the concept of a "desired future condition." This section includes: (1) a discussion about how natural processes, disturbances, and the concept of site potential influence our approach to restoration; (2) a description of the interdisciplinary restoration planning process; and (3) a discussion of restoration strategies and techniques that will be applied to restoration sites within the project area. The Master Plan Team is an interdisciplinary group with expertise in hydrology, geomorphology, fisheries, botany, wildlife management, wetlands, engineering, soils and geology. Members of the team have integrated information from their various disciplines to identify restoration priorities and goals for the lower main-stem Jocko River and its floodplain.

The desired future condition for the lower main stem, in general terms, is the integration of ecological processes that result in an acceptable range of conditions related to river morphology and aquatic/terrestrial habitat. Subsection 2.1 provides a more specific summary of the desired future condition for each ecological component of the lower main stem. Throughout this document, we define ecological (or natural) processes as the physical, chemical and biological actions or events that drive and sustain ecosystems. Examples of ecological processes include competition, decomposition, migration, predation, herbivory, erosion, plant succession and flooding.

A subset of these ecological processes, referred to as disturbance, leads to the alteration of the structure and/or composition of ecosystems. Disturbances, such as flooding (and other associated processes), are especially crucial to the proper functioning of riverine ecosystems. These associated processes, or disturbances, including erosion (scour and deposition of soil and channel bed substrate) and recruitment of large woody debris can drastically modify riverine ecosystems, but at the same time promote additional processes such as plant succession and the exchange of nutrients between terrestrial and aquatic environments that maintain a mosaic of habitat for a wide variety of aquatic and terrestrial life forms.

Because stream flows are critically important as we seek to understand the system and plan for its restoration, we developed an ecological hydrograph as a way to quantify flows necessary to maintain natural riverine processes (Subsection 2.10). In general, with a few exceptions related to an extraordinary series of drought years and other cumulative effects, the desired hydrograph is the existing hydrograph even though it has been permanently altered by operation of the irrigation system and shifts in valley-floor land uses. Under the existing hydrograph, flood flows are still adequate to support bar development and floodplain-scale processes, but average peak flows (bankfull flows) have diminished, resulting in an atrophied channel (see Subsection 2.10 for a discussion of this process). Reference channel reaches reflect this stabilized atrophied state and the river has adjusted to the new hydrograph in each of the Master Plan reaches. The ecological hydrograph, as described in Subsection 2.10, ties together many resource components and is one result of our interdisciplinary work.

Restoring conditions that will support natural processes requires a careful balance of passive and active restoration. **Passive restoration** is defined as changing land management and then allowing the floodplain and river to recover over time. **Active restoration** is defined as physically changing the system; for example, planting shrubs or changing the channel's location or shape. Our planning process is centered on deciding how to balance passive and active restoration. We do this by collecting and analyzing data within each project site and then estimating whether there are any factors that would limit the site's ability to recover to the desired future condition on its own within ten or twenty years. A ten or twenty year timeframe is acceptable based on the agreements that govern this restoration program such as the Consent Decree.

We also evaluate risk. Active restoration may be justified if it would substantially limit the risk that a nearby reach will degrade. For example, if a river channel is constrained by levees or it has become entrenched, normal variations in stream flow may result in excessive bank erosion and sediment input. To address the resulting risk to downstream reaches and fish populations, significant channel re-shaping (active restoration) may be necessary before floods can benefit the system by creating point bars, recharging the floodplain, and stimulating cottonwood regeneration. Another way to think about active restoration techniques is that they temporarily stand in for natural processes. Structures such as log vanes and vegetated soil lifts are not intended to be permanent; rather, they provide a missing ecological or hydraulic function while other components of the system recover. For example, vegetated soil lifts hold streambank soil in place while trees or shrubs with deep binding roots establish and grow, eventually holding the soil in place after the vegetated soil lift degrades.

Passive restoration is preferable where natural processes are relatively intact. In less-degraded reaches of the river, floods may cause channels to adjust laterally, but if the channels are connected to their floodplain, some erosion can be beneficial. Channels that move laterally will develop alluvial bars, and allow healthy cottonwood and willow communities to become established.

The planning process is aimed at choosing the best approach to restore the conditions that will support natural processes. Planning steps include site assessment, feasibility/risk analysis, conceptual restoration design and final restoration design. During the assessment phase, the interdisciplinary team collects data about a site. These data are analyzed during the feasibility/risk analysis phase, resulting in a set of measurable objectives. Different alternatives and associated trade-offs are usually evaluated during the feasibility/risk analysis phase. Once objectives have been determined, a conceptual restoration plan is developed as a tool to support permit applications, grant applications, and public education. Final restoration designs are based on the conceptual designs and include enough detail to support logistics and project implementation.

Monitoring is tightly integrated with the planning process and is described further in Section 4. Because many of the projects will require a phased approach, monitoring of early phases will influence later phases. Similarly, monitoring results from one site may be used to refine designs and objectives at other restoration sites. Monitoring begins during project planning and continues long after projects have been completed. Measurable objectives selected during the planning process determine which monitoring methods and metrics will be used. For example, if one objective is to modify the channel to match a reference condition, monitoring may include measuring channel cross-sections, hydraulic forces and meander geometry to determine if the post-project channel is similar to the desired conditions. From these data, metrics such as channel width-to-depth ratio and bed material size might be selected to compare change over time.

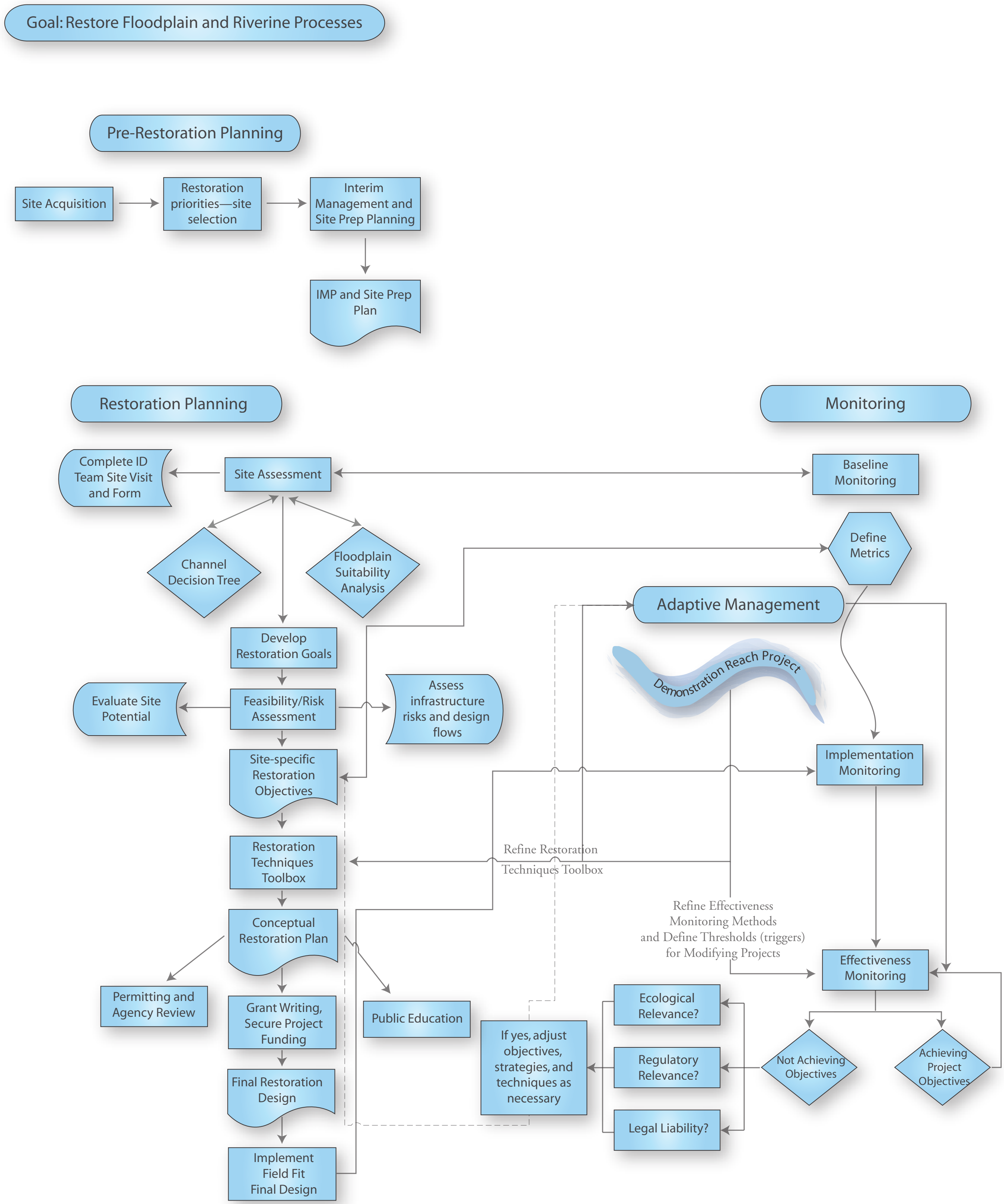

Figure 3.1-1.
Restoration planning process flow chart.

3.2 Natural Processes as a Model for Restoration

3.2.2 Understanding Floodplain and River Processes in a Planning Context

At the broadest scale, riverine ecosystems are each unique, based on their position within a watershed, their surrounding geology and their geomorphic history. At a more local scale, riverine ecosystems develop in response to the hydrologic regime and sediment loads. These environments are further modified by plant communities along the channel and throughout the floodplain. Water, flowing at different volumes during different seasons and years, forms and modifies the channel and floodplain environment, the vegetative communities and the instream aquatic habitat. On the lower main stem, surface and ground water interactions are also an integral natural process and are directly embedded into the hydrologic regime. Because river flows integrate all the other processes, maintaining current flows as a desired future condition is necessary to insure our investment in restoration. In other words, the natural processes we are restoring depend on the current flow regime.

The desired future condition for Jocko River restoration sites is a condition that will support natural processes, and natural processes are driven by disturbances. A disturbance is, "a relatively discrete event in time that disrupts an ecosystem, community, or population structure and changes the resources, substrate availability, or physical environment (White and Pickett 1985)." Natural, periodic disturbance helps sustain natural processes and a site's potential to sustain a specific suite of plant communities or a specific type of river channel. For example, riparian cottonwood systems rely on periodic flooding to produce an open alluvial surface where cottonwood seed can germinate and establish. Reduced flood frequency or magnitude can diminish conditions that support cottonwood community regeneration. Understanding how historical land management has interrupted natural disturbances and the natural processes that result from them helps provide a basis for determining which passive and active restoration strategies are appropriate for a site. Natural systems are dynamic, and disturbance should be incorporated into restoration plans, or at least accepted as part of the restoration process.

The Relationship of Site Potential to Restoration

Disturbance is important because it creates specific environmental conditions that are variable among different locations and over time. These resulting conditions can be thought of as the **ecological legacy** of past disturbance at a site (Swanson and Franklin 1992). To support our restoration planning efforts, we are using the term site potential to describe the combination of water, light, nutrients, soil texture, organic matter, soil compaction, microtopography, soil micro-organisms and fluvial processes that determine the range of possible plant communities that can colonize and occupy a floodplain site. For example, we use a locally accepted plant community classification system (Hansen et al. 1995) that uses key indicator plant species, soils, and hydrology to identify a site's potential natural community. Defining site potential does not lead us to predict a single, best-restored condition; rather it allows us to use data and local knowledge to identify a range of possible outcomes that would indicate functioning natural processes. For example, a point bar could either develop into a cottonwood stand or a willow stand depending upon which seed arrives first. In this case, the restoration goal would be to create conditions that will support point bar formation; exactly what develops on the point bar is less important, as long as it is a native plant community adapted to the site.

The idea of site potential also applies to the river channel. Leopold (1994) describes a similar concept as a river's most probable state. This concept recognizes that two tendencies of a river system—minimize total work and evenly distribute flow power—cannot occur simultaneously. As a result, flow patterns and channel form reflect a compromise. Numerous authors, for example Williams (1979), have developed empirical relations to predict stable channel form based on measurable parameters such as bankfull discharge. Work summarized above has focused on stable channel form, both in cross section and longitudinally. In our effort in the Jocko Watershed, we are attempting to understand both stable channel form, and the processes that promote morphological diversity and rich riparian ecosystems.

Trush et al. (2000) identify a set of alluvial river attributes, which if achieved, are capable of maintaining morphologically diverse channel form and high quality, diverse biological habitat. At a strategic planning scale, when we understand how these alluvial river attributes are functioning and how they have been impacted at specific sites, we are close to understanding the site's potential, and we are in a position to develop restoration implementation plans and implement specific restoration techniques.

3.3 River and Floodplain Processes Tied to Restoration Strategies and Techniques

3.3.1 Natural Channel Design Approach

Natural Channel Design (NCD) seeks to create conditions that will support natural riverine processes. This is accomplished by restoring channel dimension, pattern, and profile; floodplain connectivity; and a riparian community appropriate for the geomorphic setting and stream type (Schmetterling and Pierce 1999, Rosgen 1993, Rosgen 1996). The NCD process incorporates a suite of data collection and analysis techniques to develop design criteria for restored channels. Analyses are based on regional and local data that keys into channel features associated with the bankfull discharge for a specific, stable stream type (Rosgen 1998). Refer to Subsection 2.3.2 for more information on bankfull discharge determination. A reference reach, measured in an area with conditions that support functioning natural processes, provides the "pattern" for a given stream type within a particular geomorphic setting (refer to Subsection 2.4.5 for more information on reference reaches). Observed patterns are compared to the earliest available aerial photos to determine if major changes have occurred over time in the reference reaches. Data from reference reaches are also compared to databases that contain numerous reference-reach data sets from similar streams in similar geomorphic settings. All proposed channel dimensions and features are also validated with analytical hydraulic and sediment transport models.

Natural channel design requires constructing a two-stage channel to accommodate fluctuating stream flow. A two-stage channel includes a bankfull channel to convey the average annual flood and sediment (bankfull flow), and a floodplain that is consistent with the geomorphic setting. Structures placed along banks and within the channel bed are intended to function in the short term until the channel bed stabilizes, wood accumulates in the channel, and vegetation grows so that roots begin to provide bank and floodplain stability.

3.3.2 Stream Channel Restoration Strategies

Streams fall into two general categories:

- Category I—Streams that are not entrenched or artificially confined and that are connected to their floodplain, but do not have the pattern, dimension, profile or habitat appropriate for the stream type. The category includes streams with impaired processes such as accelerated bank erosion, lateral extension, channel displacement, aggradation, braiding, and habitat alteration.

- Category II—Streams that are entrenched or incised within the floodplain to the extent that the floodplain is limited or less than appropriate for the stream type. The category includes streams that have been straightened, channelized, bermed and levied, or that have incised into the floodplain.

Channel widening is a characteristic process that affects Category I streams in response to riparian vegetation removal, an increase in watershed yield, or direct channel modifications that reduce lateral bank stability. Channel widening transitions low width-to-depth ratio E and C stream types to over-widened, high width-to-depth ratio C and D stream types (Rosgen 1996). Over time, the stream erodes through the outside bend of one or several meanders, a process referred to as an "avulsion." When it occurs, stream length is decreased, and the resulting channel becomes steeper than the original E stream type. The over-steepened bed profile (or energy grade line) increases the slope, hydraulic radius and channel depth, which together increase the conveyance and shear stress applied to the channel perimeter. The resulting acceleration of bank erosion contributes excess sediment to the channel and exacerbates in-channel sediment deposition, which causes further bank erosion and channel widening. The result is an over-widened channel, characterized by excessive sediment, impaired riparian and aquatic habitats, shallower depths, and warmer water temperatures.

Channel incision is a characteristic process that affects Category II streams. Channel incision is defined by the loss of vertical channel stability, a lowering of the channel bed's elevation and the channel's isolation from the adjacent floodplain. Lateral confinement by constructed levees or berms can initiate incision into the streambed. Incision starts because the streambed is no longer able to resist the erosive shear stress of the river created by the increased energy gradient. This condition may occur as a result of natural processes or it can be caused by human-induced disturbances such as straightening of the channel. When channel incision occurs over a long reach of stream, the process is termed "degradation." In addition to increased sediment supply and aquatic habitat impairment, streambed degradation lowers the local water table and impacts land productivity due to the loss of the hydrologic connection between the channel and the floodplain. A change in vegetation types from mesic riparian communities to drier, xeric community types decreases bank stability because drier, upland species have poorer rooting characteristics or the roots simply do not extend down low enough in the bank to provide stability. Consequently, during successive flood events, increased energy accelerates lateral erosion rates and vertical incision. Over time, the incised, low width-to-depth ratio G stream type widens to a high width-to-depth ratio, high sediment supply, entrenched F stream type.

Restoring channel-floodplain systems with that are impaired because of either lateral instability or channel incision (Category I or II impairments, respectively) requires active restoration techniques, which are described below. Subsection 3.6.2 describes channel restoration strategies in more detail and Figure 3.6.2-1 shows a channel restoration decision tree that helps guide channel restoration actions.

Category I

Strategies to treat Category I impairments are highly variable and depend on specific site conditions and recovery trends. Category I treatments are recommended for streams impaired by a number of or combination of disturbances including:

- Channel straightening without incision or lateral confinement;
- Channel widening due to direct and indirect modifications;
- Habitat loss due to loss of stability, vegetation conversion and large woody debris removal;
- Accelerated bank erosion and lateral migration due to loss of bank stability or other direct disturbances;

- Loss of woody vegetation along the streambanks;
- Sediment deposition from all causes.

Strategies to address the impairments must focus on the source rather than symptoms of the impairment. Listed below are sources of impairment with their appropriate restoration strategies:

- When the existing stream pattern is not appropriate for the stream type or similar to historical conditions, abandoned meanders can be reactivated;
- When channel dimensions are not appropriate for the stream type or reference conditions (width-to-depth ratios are excessive, braiding due to sediment deposition, etc.), channels can be shaped or reconstructed;
- When patterns are appropriate but accelerated erosion rates are occurring, banks can be stabilized;
- When conditions do not meet objectives or are not similar to reference conditions, aquatic habitats can be enhanced;
- When conditions do not meet objectives or are not similar to reference conditions, riparian zones can be revegetated or enhanced.

Category II

Restoring incised streams is typically complicated by the period of incision, channel and floodplain size, adjacent infrastructure and project costs. Four alternative treatments provide options for restoration. They include:

Treatment 1

Convert G and/or F stream types to C or E stream types at the historical floodplain elevation and convert existing G and/or F stream types to a series of discontinuous wetlands or ponds (Rosgen 1997). Treatment 1 provides the greatest benefits to the stream, riparian community and local water table.

Treatment 2

Convert G and/or F stream types to C or E stream types at the existing elevation by building a floodplain inside of the G and/or F stream type (Rosgen 1997). Treatment 2 provides fewer benefits but reduces sediment inputs into the stream and improves channel-floodplain connectivity and habitat. The local water table remains depressed because the channel elevation has not changed substantially.

Treatment 3

Convert the existing G and/or F stream type to a B or Bc stream type with an available flood-prone area but without an extensive floodplain. This option disturbs less land but is more expensive because bank stabilization and grade control structures are necessary to maintain channel stability in a high-energy stream environment.

Treatment 4

Stabilize the channel in place. This treatment does not include building a floodplain or flood-prone area. Construction is typically expensive because extensive stabilization is required to reduce mass bank failures and continued degradation. Periodic maintenance needs are also high due to the number of structures necessary and the high scour potential created by confining all flows within the channel.

Treatment selection is based on the desired future condition, the natural evolutionary endpoint and limitations related to land ownership, infrastructure and public comment. All four treatments are viable but the costs and benefits vary widely. If complete restoration of the river to the most dynamically stable and productive potential is the goal Treatment 1 is the preferred option. It is usually the most costly choice but the benefits of restoring the riverine system to its historical floodplain elevation are also much greater.

3.3.3 Stream Channel Restoration Strategies in Relation to Reach Succession Processes

The following paragraphs explain how channel restoration strategies can accelerate stream type succession processes to speed stream and floodplain recovery. Reach Succession Scenarios are discussed in more detail in Appendix F where there are also conceptual cross-section diagrams that illustrate the probable stream type succession stages. Subsection 2.4 includes descriptions that relate the Reach Succession Scenarios to the historical, existing and desired future condition of the channel in each of the eight lower main-stem Reaches.

All of the reach succession scenarios below fall within the list of Category II restoration strategies except 2 and possibly 8, which fall under Category I.

Reach Succession Scenario 1

E stream type degradation typically occurs on low-gradient, meandering streams that have been straightened or modified by land uses ranging from agriculture to road construction. Depending on the sequence of processes taking place the E channel may first over-widen and then incise. Or the channel may incise first in response to a downstream channel disturbance that has created an upstream, migrating headcut. The increased channel gradient creates higher water velocities that exceed the channel's resistance to bed scour and incision ensues. E channel spring creeks in the Jocko River Valley are most likely to display Reach Succession Scenario 1. Treatment 1 or 2 strategy would be used to reestablish the narrow, sinuous E channel from its over-widened and/or incised condition.

Reach Succession Scenario 2

Several techniques can accelerate the progression of the over-widened D stream type to a narrow, sinuous C stream type endpoint. Because the channel is vertically stable and connected to the floodplain, the focus is on reducing the channel width-to-depth ratio. Habitat features are deepened to the appropriate design dimensions through channel excavation. Excavated materials are used to fill the secondary braided channels and to extend the floodplain into the over-widened channel. Sediment is excavated from the filled pools to reinstate the riffle-run-pool channel geometry and profile. Woody debris and vane-bank structures can stabilize the newly constructed banks until vegetation colonizes them.

Because the armored pavement layer of the channel substrate is disrupted during channel construction, grade control structures are usually necessary to ensure short-term channel stability until the bed armoring is reestablished. Structures typically used to maintain channel stability and bank integrity include straight and J-hook vanes, cross-vanes, cobble tailouts and large-woody-debris jams. Rootwad composites can also be placed in concert with other structures to diversify fish habitat and provide local bank protection.

Revegetation is key to maintaining constructed channel and floodplain stability, aquatic and riparian habitat and long-term water quality. Revegetation techniques include: (1) transplanting sod and woody vegetation extracted from floodplain areas at a distance from the construction zone, (2) planting willow cuttings and containerized stock and (3) broadcast seeding. Because the area of disturbance is often large, a comprehensive noxious weed control program can speed plant growth and maintain riparian community diversity. Subsections 2.5 and 3.3 discuss revegetation further.

Accelerating stream succession has substantial benefits for channel stability and the aquatic biological community. The D stream type is the result of channel over-widening and a loss of stream competency (stream competency is defined as the maximum size particle that a stream can carry, dependent upon water velocity and gradient.). As the channel aggrades and continues to widen through lateral migration vegetative cover is lost and water temperatures increase. The aggraded channel consists of homogenous riffle and glide habitats instead of the undulating riffle-pool morphology that characterized the historical C stream type. Speeding the recovery of the C stream type will improve aquatic habitat, stream temperatures and water quality as bank erosion and related sediment inputs are mitigated.

Reach Succession Scenario 3

Several techniques can accelerate the progression of an over-widened F stream type in Stage 4 to a narrow, sinuous C stream type endpoint. Because the F stream type has a confined channel without a floodplain, establishing a floodplain is critical to move to the C stream type endpoint (Treatment 2). The establishment of a floodplain is usually accomplished by excavating the terrace to the bankfull floodplain elevation or by filling a portion of the over-widened F stream type channel to develop an inset floodplain. While the first option results in a less confined channel, it costs more and generates a large volume of excavated material. In addition, noxious weeds are more likely to invade because of the size of the disturbance. The second option is typically less expensive because the cut and fills balance and because the area that is disturbed is smaller. Depending on site conditions, a combination of the two methods may be necessary.

Once a floodplain is established similar techniques and structures can improve aquatic habitat and channel stability. To reinstate the riffle-run-pool channel geometry and profile that characterizes the C stream type, habitat features are deepened to the appropriate design dimensions through channel excavation. Excavated materials can then be used to create the floodplain or can be hauled away. As in other scenarios, project revegetation and grade control are necessary.

The F stream type is the result of vertical and lateral channel instability. Advancing the stream to a C stream type increases channel stability and reduces the volume of sediment introduced to the stream as the F channel establishes a floodplain. Reducing the channel width-to-depth ratio has channel stability and aquatic habitat benefits. The narrower, deeper channel maintains greater stream competency and sediment transport. The water temperature regime is decreased as vegetation colonizes the constructed floodplain and shades the channel. Fish habitat also improves with the diversified channel morphology and fish habitat structures.

Reach Succession Scenario 4a

The approach used to speed the progression of an over-widened F stream type to a Bc stream type is similar to that of Reach Succession Scenario 3. Under certain conditions and site constraints, constructing a Bc stream type is preferable to a C stream type. Typically F stream types are converted to Bc stream types when the F channel width is too narrow to construct a channel and floodplain capable of conveying the bankfull and 100-year flood flow events. The constructed Bc stream type channel is constructed as a low-sinuosity, moderately entrenched channel with grade control, bank stabilization and fish habitat structures. Grade control structures are used to provide vertical energy dissipation because the narrow belt width of the F stream type channel does not provide enough lateral energy dissipation.

The type of grade control and fish habitat structures usually deployed to stabilize Bc stream types include log and rock cross vanes, w-weirs, J-hook vanes, and straight vanes. They provide vertical and lateral channel stability until the channel establishes an armored pavement layer. The structures are designed to reduce stream energy, maintain sediment transport and provide fish habitat and the kind of step-pool morphology typical of B stream types. Revegetating the sloped channel margins is key to stabilizing the established side slopes and narrow floodplain.

The F stream type is a result of vertical and lateral channel instability. Advancing the stream to a Bc stream type increases channel stability and reduces the volume of sediment introduced to the stream as the F channel establishes a narrow floodplain.

Reach Succession Scenario 4b

The approach used to speed the progression of an over-widened F stream type to a B stream type is similar to that of Reach Succession Scenario 4a. Constructing a B stream type, as opposed to a Bc stream type, is necessary when the valley gradient is steeper or the confinement of the F stream type does not allow the kind of channel meandering that would otherwise reduce the channel gradient. The B stream type channel is constructed as a low sinuosity, confined channel with grade control, bank stabilization and fish habitat structures. Prescribed grade control structures are situated to provide vertical energy dissipation because the lateral energy dissipation that would be provided by stream meandering is not possible due to the narrow belt width of the F stream type channel. Grade control, bank stabilization and fish habitat structures are similar to those described for Reach Succession Scenario 4a. Site revegetation is key to increasing woody debris inputs and improving the long-term stability and habitat maintenance processes of the channel.

Reach Succession Scenario 6

The approach used to speed the progression of an over-widened F stream type to a B stream type is similar to those of Reach Succession Scenario 4b. Typically F stream types are converted to B stream types when the F channel width is too narrow to construct a channel and floodplain capable of conveying the bankfull and 100-year-flood flow events. The B stream type channel is constructed as a low sinuosity, confined channel with grade control, bank stabilization, and fish habitat structures similar to those outlined in preceding subsections.

Succession Scenario 8

The approach used to speed Reach Succession Scenario 8 to the C stream type depends on the successional stage of the existing type. Typically, a Reach Succession Scenario 8 channel is a D stream type confined within an F stream type. To advance the channel to the desired C stream type endpoint, the braided channels characterizing the D stream type have to be filled to create a single-thread channel using techniques similar to those described for Reach Succession Scenario 2. The constructed floodplain provides an area for floodwater absorption and fine sediment deposition. With the channel and floodplain reconnected, the channel becomes more stable and capable of forming and maintaining channel habitat features (see Reach Succession Scenario 2).

The D stream type is a result of channel over-widening and loss of stream competency (ability of the stream to transport its sediment load). Sediment delivery to the channel is elevated as the channel widens the confining F stream type valley walls or banks. Channel instability limits vegetation colonization and thus hampers the formation of riparian communities that stabilize the channel naturally. Filling secondary channel braids and forming a stable floodplain creates a surface for planting vegetation. As the vegetation becomes established and the channel stabilizes, its competency increases, habitat units stabilize and the aquatic environment diversifies. Stream shading and woody debris contributions to the channel increase as the riparian community expands vertically and laterally from the channel.

Reach Succession Scenario 9

The approach used to speed the progression of Reach Succession Scenario 9 to a C stream type is similar to that of Reach Succession Scenario 3. Because the F stream type is characterized by a confined channel without a floodplain, establishing a floodplain is critical to advance to the C stream type endpoint. Typically, a floodplain is established by excavating the terrace to the bankfull floodplain elevation or by filling a portion of the over-widened F channel to develop an inset floodplain.

3.3.4 Floodplain and Riparian Plant Community Restoration Approach

Subsection 2.5 and 2.6 include detailed descriptions of the floodplain vegetation communities and wetland resources on the lower main stem. We describe vegetation communities based on habitat and community types defined in Hansen et al. (1995) and organize land cover types according the Hydrogeomorphic Approach (HGM) (Hauer et al. 2002). Both methodologies provide a starting point for developing floodplain restoration strategies by allowing the Master Plan Team to assess riverine wetland functions (HGM) and plant community development (Hansen et al.) for the Jocko River floodplain relative to similar floodplain-associated ecosystems in the northern Rocky Mountains. Once we determine what functions and plant communities we wish to restore, the challenge becomes how to create an environment that will favor and perpetuate them.

The concept of site potential (introduced in Section 3.2.2) is a useful way to integrate information regarding floodplain functions (i.e. groundwater storage, nutrient cycling, wildlife habitat) and plant communities (i.e. species composition, structure, successional status) that exist on a given site. In other words, the plant community that results from the integration of ecological processes strongly influences the functions or "services" the floodplain provides. In referring to a site's potential, it is understood that a range of possible vegetation community types are possible on a site, and these often occur together to create a mosaic. Changes in site potential are acceptable, as long as the floodplain is providing desirable functions. Problems arise, however, when site potential is altered so drastically that the floodplain no longer provides desirable functions.

Agricultural practices, fire suppression, river channelization and levee construction and transportation right-of-way corridors have contributed to drastic shifts in site potential throughout the lower main stem, especially in floodplain environments. The removal or diminishment of riparian forests and wetland plant communities for agricultural production has probably had the biggest impact on site potential, and presents the greatest challenge for restoration. Ceasing agricultural activities does not, by itself, shift site potential back to one that will support natural floodplain communities. The routine "disturbances" in an agricultural setting—irrigation, tilling, seeding and weed control—maintain the agricultural site potential by keeping crop species alive and thriving while prohibiting undesired species from establishing. If the regular disturbance regime of irrigation, tilling, seeding and herbicide application is not maintained, the site potential often shifts to one that supports weedy, non-native species adapted to abundant light, readily available nutrients, and relatively dry conditions.

Because of altered light, nutrient and moisture regimes, in addition to uniform topography, it may not be possible to restore the vegetation community in a disturbed area by simply planting or seeding native species. The disturbed site may be missing many components needed to sustain diverse native plant communities. The restoration planning process needs to account for all factors that make up site potential (water, light, nutrients, soil texture, organic matter, soil compaction, microtopography, soil micro-organisms and fluvial processes) and determine which are limiting restoration of natural processes.

The process of shifting site potential and ultimately restoring native riparian and wetland plant communities in the lower maintain will involve the implementation of three broad restoration strategies. The Master Plan Team will not necessarily implement these strategies in a sequential manner, nor is one strategy a precursor for another. Each strategy, however, can enhance the effectiveness of the other strategies. An explanation of each restoration strategy is included below:

- Eliminate or modify the land management practices leading to the degradation of native plant communities. The Master Plan Team often needs to implement this strategy at the beginning of the restoration process. Land management practices such as season-long or high intensity grazing in riparian/wetland areas, diversion of surface water for irrigation, draining of groundwater to dry out floodplain soils and logging in riparian areas have occurred in the past on many of the properties now protected under the ARCO settlement. These practices are not always inherently detrimental to native plant communities, but often the intensity and length of time in which these practices occurred is what has led to plant community degradation. The Master Plan Team will eliminate or modify damaging land management practices upon acquisition and protection of properties and document these changes through an Interim Management Plan. Depending on the severity of plant community degradation, the Master Plan Team will allow natural processes to promote the recovery of native plants to the greatest extent possible.
- Create a new set of ecological conditions to promote the recovery of native plant communities. Inappropriate land management practices in riparian/wetland areas often degrade native plant communities to a point beyond which natural processes are able to recover. This next strategy is fairly broad and complex in that we now must implement passive and active restoration measures to "jumpstart" or supplement ecological processes to address the legacy of past management practices. Examples of the measures the Master Plan Team will consider under this strategy, include (among others): 1) controlling or eradicating (where possible) noxious weed populations; 2) enhancing soil organic matter levels through the addition of compost or wood mulch; 3) reintroducing fire (i.e., prescribed burning) to those plant communities dependent upon fire; or 4) recreating floodplain microtopography in areas where tillage practices or sedimentation have simplified the soil surface. We may also need to utilize stream channel restoration techniques to restore fluvial processes necessary to establish and maintain native plant communities. The Master Plan Team will prescribe the various techniques necessary under this strategy through Site Preparation Management Plans and/or Restoration Plans.
- Supplement native plant communities through active revegetation techniques. The implementation of the first two strategies may not always be sufficient to promote the recovery of native plant communities. This is especially true if past management practices have severely depleted the source of native plant seed or other propagules (root and/or stem pieces capable of generating new plants) present in nearby, remnant native plant communities or the soil seed bank. Also, some of the techniques used to restore stream channel morphology or address floodplain encroachment may lead to extensive soil disturbance due to excavation and regrading of soil materials or construction of erosion control and bioengineering structures. In these cases, it is necessary for the Master Plan Team to prescribe revegetation techniques such as installation of container-grown native plants or cuttings, application of native seed mixtures, or salvage of on-site native plant materials to supplement or recreate native plant communities. The Master Plan Team will address the use of these revegetation techniques through Site Preparation Management Plans or Restoration Plans.

3.3.5 Integrated Channel and Floodplain Restoration Strategies

We propose to create conditions that will support native plant communities and natural floodplain processes by shifting site potential through an array of restoration strategies and techniques. Table 3.3.5-1 lists processes we seek to restore, either directly or indirectly.

Table 3.3.5-1.

Existing versus desired conditions within the Jocko River floodplain expressed as components of ecological site potential (table continued on next page). Descriptions of all the techniques are included in Appendix A.

Process that has been disrupted	Desired Future Condition	Strategy to restore the process	Techniques
Channel has lost connection with its floodplain	Channel is connected to floodplain and groundwater/ surface water interaction is restored.	Reconstructing an appropriate stream type at the original floodplain elevation; Reconstructing an appropriate stream type and floodplain at the existing channel elevation; Reconstructing a less desirable stream type at the existing channel elevation and; Simply stabilizing the existing channel.	Fill, grade control, channel realignment
Channel pattern, profile and dimension	Balanced pattern/ profile and dimension	Restoring the pattern, dimension, and profile of the channel system; Reactivating abandoned meanders; Bank stabilization; and aquatic and riparian habitat enhancement to meet desired future conditions.	Fill, grade control, channel realignment
Sediment transport out of balance	Balanced sediment transport	Restore channel plan, pattern and profile Reduce sediment sources to reference conditions (generally bank stabilization)	Channel realignment and re-shaping, in-channel structures, streambank bioengineering, floodplain revegetation
Plant community succession interrupted	Complex matrix of plant communities represented by all age classes.	Restore site potential to support native vegetation communities	Site preparation, seed bank development, weed management, reconnect river and floodplain
Large wood recruitment	Tree communities present	Restore woody plants and ability of river to recruit wood	Site prep, planting, log vanes (temporarily stand in for the process)
Frequent, moderate (to intense) disturbance (cultivation, year round grazing)	Periodic, intense disturbance (flooding, fire)	Remove human-caused disturbance and restore natural disturbance cycles.	Grazing management, prescribed fire, stream channel restoration
Low species richness, short life cycles, simplified plant community structure	High species richness, complex structure, multiple life forms with varying life cycles	Control weeds and invasive species; restore native plant communities.	Noxious weed management, integrated pest management, seeding, soil seed bank enhancement, native plant installation

Table 3.3.5-1 (cont.).

Process that has been disrupted	Desired Future Condition	Strategy to restore the process	Techniques
High nutrient availability, rapid cycling	Slower nutrient cycling	Modify the soil food web.	Woody debris addition
Soil organic matter derived from mostly herbaceous vegetation with a lower carbon to nitrogen ratio (C:N); readily decomposed	Organic matter derived from herbaceous and woody plants; overall higher C:N that is more resistant to decomposition	Convert simple, agricultural plant communities to complex, native plant communities	Woody debris addition, seeding, native plant installation, soil seed bank enhancement
Soil microbial populations less diverse due to simplified plant community and agricultural practices	Complex microbial populations due to more diverse plant community	Modify the soil food web.	Compost application, woody debris addition, seeding, native plant installation, soil seed bank enhancement
Soil seed bank dominated by non-native and noxious weed species	Diverse seed bank composed of native herbaceous and woody plant species	Exhaust the non-native seed bank; replace with native seed.	Integrated pest management, soil seed bank enhancement
Soils wetted primarily from top down (i.e., irrigation or precipitation)	Soils receive water inputs from groundwater, flood events, upslope storage (as well as from precipitation)	Reconnect river and floodplain to restore surface water/groundwater interaction.	Stream channel restoration, drainage structure modification
Flat, uniform microtopography on soil surface	Complex microtopography	Restore floodplain roughness and structural complexity	Stream channel restoration, microtopographic enhancement, woody debris addition
High, consistent light	Variable light and shade	Restore a multi-structured native woody plant community as part of the floodplain plant community matrix.	Woody debris addition, plant salvage
Extreme variation in wind and temperature	Moderate wind and temperatures	Restore a complex, multi-layered plant community.	Woody debris addition, plant salvage
Few herbivory barriers	Many herbivory barriers	Restore a complex, multi-structured plant community with limited wildlife movement corridors.	Integrated pest management, woody debris addition
Accelerated erosion	Erosion present, but infrequent and episodic	Restore perennial vegetation and duff layer	Microtopographic enhancement, compost application, woody debris addition, seeding, erosion control

3.4 How Restoration Projects are Chosen

3.4.1 Land Acquisition

The procedure for ranking properties under consideration for protection is to apply:

1. The general land acquisition guidelines followed by the Tribes;
2. The specific habitat acquisition guidelines outlined in section III of the Habitat Acquisition Criteria (HAC, CSKT 2002) and summarized below;
3. The habitat acquisition ranking criteria, weighting methodology, and final ecological scoring detailed in sections IV, V, and VI of the HAC, respectively; and
4. The ecological value (potential pricing) for protection.

Criteria used to evaluate habitat acquisition priority from the HAC:

1. Length of Jocko River main-stem channel occurring on the property;
2. Extent of the ecological floodplain;
3. Whether the acquisition is adjacent to protected fish and wildlife habitat or whether it complements the fish and wildlife habitat management activities of adjacent lands;
4. Whether acquisition of the property will protect habitat for populations of listed threatened, endangered or sensitive (TES) species, including species designated as sensitive by the Tribal Fish and Wildlife Management Programs or culturally sensitive by the Tribal Preservation Department;
5. Whether the parcel includes existing healthy, native wetland and riparian habitat features;
6. Potential for riparian and wetland acreage as determined by historic and recent aerial photos, field reconnaissance exercises, and or hydric soils/NWI coverages;
7. Potential to restore significant native wetland and riparian habitat as determined by historical research and biotic and abiotic indicators (soils, hydrology, vegetation);
8. Amount of existing woody debris in and adjacent to the river, as well as the woody debris recruitment potential;
9. Presence of unique or rare habitat types;
10. Potential of a site to enhance ecosystem connectivity with other adjacent protected habitats or fish and wildlife corridors;
11. Presence of known archaeological sites or historic/prehistoric cultural sites;
12. Ratio of existing and restorable wetland and riparian acreage to upland acreage on the property;
13. Presence of shallow groundwater, groundwater upwelling and/or springs on the parcel;
14. Relative costs of habitat restoration for the parcel; and
15. Infrastructure that would need to be removed from the site in order to restore lost functions.

3.4.2 Restoration Priorities

Once properties are protected, priorities are set for restoring them based on several criteria. The priority of the treatment refers to the most logical order for projects within a specific reach. The priority of treatment generally proceed from upstream to downstream, unless some specific action needs to take place before upstream work can be implemented. By completing the restoration on the upstream portions first, the temporary increased sediment yields caused by construction of the project will affect downstream sections that have not yet been treated. In addition, the upstream projects can remedy the excessive (artificial) sediment sources that currently exist in some reaches. In turn, this will reduce the risk that a downstream restoration project will be harmed by upstream sediment releases. This is not to say that a downstream project could not be done prior to completing all upstream work. However, doing so increases the risk that the already completed downstream projects would need maintenance or adjustments after a major runoff event.

A number of treatments are not time-sensitive. They include implementing habitat improvements and riparian planting on sites where the channel will remain in place, removing levees, some bridge crossing and highway treatments and some floodplain treatments.

The primary resources utilized to determine restoration opportunities included:

1. 1937 aerial photographs, with the woody riparian extent outlined as GIS polygons and any other available historical photographs;
2. 2002 or more recent aerial photographs as they become available;
3. HGM vegetative cover types, also delineated as GIS polygons over 2002 aerial photographs;

4. Ecological floodplain, as defined in the Vegetation Section (Subsection 2.5), in GIS format using the 2002 aerial photographs;
5. Hydric soils map in GIS format;
6. NWI maps in GIS format;
7. Channel encroachment features in GIS format;
8. Analysis of channel reference reach data; and
9. Analysis of fish habitat assessment data.

We use these resources, as well as site-specific assessments to evaluate the degree to which alluvial river attributes and biological processes are functioning, and to determine where, within imposed constraints such as ownership and infrastructure, there is opportunity to restore or enhance dynamic river processes and attributes.

Restoration opportunities along the lower main stem consist of natural channel design, instream control and habitat structures, floodplain restoration activities, and where appropriate, passive measures. Several restoration actions are appropriate throughout the lower main stem. They include:

- Adjusting channel cross-sections and alignments based on natural reach succession scenarios described in Subsection 2.3. Lower main-stem Jocko River reaches should be returned to Rosgen C or B stream types, while most Spring Creeks within the project area should be restored to either Rosgen E or C stream types.
- Eliminating or improving management of livestock grazing to allow for natural recovery. Livestock management methods can include changing stocking rates, carefully planning season and duration of use, developing off-stream water sources, and herding cattle out of riparian areas.
- Implementing riparian fencing to protect existing and newly installed riparian vegetation.
- Controlling noxious weeds and invasive species to increase native plant species diversity in both wetland and upland areas within the floodplain matrix.
- Using setback levees to protect structures that remain in or near the floodplain.
- Removing constructed levees immediately adjacent to the stream channel as feasible throughout the floodplain.
- Restoring spring-related channels, river side channels, or oxbow features to restore microtopography (most agricultural fields have been graded, tilled or drained). In addition, microtopography can be increased by adding large woody debris on the surface. In drained areas, filling drainage ditches can raise the water table.
- Converting many agricultural and developed lands (HGM cover types 10 and 11 respectively) to native plant communities through either passive or active revegetation methods.
- Depending upon their condition, maintaining or enhancing all cover types representing native plant communities (Cover Types 1 through 6).

Projects are selected using the following restoration criteria in order of importance:
1. Restore channel processes in reaches that will result in channel equilibrium and balanced sediment transport throughout the whole river system;
2. Reconnect the channel and floodplain locally;
3. Restore floodplain complexity by reestablishing woody plant communities, microtopography, off-channel wetlands and other aquatic features

3.5 Interim Management Plan

Following the acquisition of a property, the Master Plan Team often needs to change land management practices, remove or rebuild infrastructure and address initial weed population issues. To complete these tasks we develop and implement an Interim Management Plan.

The Master Plan Team develops an Interim Management Plan (IMP) following the protection of each acquired property. The IMP describes the immediate and interim management actions necessary, in the short-term, to protect and prepare each protected site for restoration. Depending on the property, actions may include:

- Demolition and salvage of all structures (houses, barns, corrals, etc.) that may impede future restoration activities;
- Removal of unnecessary fences (usually interior cross fences) and/or construction of new fence to prevent access from trespass livestock, unauthorized vehicular traffic, etc.;
- Initial control of noxious weed species;
- Interim revegetation of disturbed sites;
- Construction of recreational access and parking areas;
- Removal of unnecessary roads and ditches; and
- Other actions deemed necessary to prepare properties for restoration.

The IMP will take the form of a parcel-specific checklist with a brief narrative that details necessary management actions. The Master Plan Team takes the overall lead in developing an IMP, but works with other Tribal departments, such as Tribal Lands and Tribal Preservation, to determine the status of property access, water rights, and other legal and cultural issues that may limit future restoration actions. Once developed, the Team works closely with the Tribal Lands Department (TLD) to implement the on the ground management actions specified in the IMP. In general, IMPs are structured to take up to one year to complete. During the implementation process, the Master Plan Team and TLD meet, at a minimum, on a quarterly basis to update the status of all on-going IMPs.

3.6 The Restoration Planning Process

Each restoration site is unique; however, the restoration planning approach generally proceeds as follows:

1. **Site Assessment.** Review existing data and conduct a site visit with the interdisciplinary team to determine the natural processes that are out of balance, identify the disturbances that caused the imbalances, and develop project goals based on site potential (desired future condition);
2. **Feasibility/Risk Assessment.** Conduct a feasibility/risk analysis that includes additional data collection and addresses questions raised during step 1;
3. **Conceptual Restoration Design.** Refine goals and objectives and develop a conceptual plan for the site to support the public process, grant writing and permitting;
4. **Final Restoration Design.** Develop a final design for the site to guide project implementation.

Goals and Objectives

Goals *are broad statements in the context of the larger river system, for example, "restore sedimentation to pre-disturbance levels to reduce channel aggradation in downstream reaches."*

Objectives *are measurable and more specific ways of stating the goals, for example, "replace 80 percent of agricultural cover types with either shrub or forested cover types within 15 years."*

3.6.1 Site Assessment

The purpose of the site assessment is to initiate the interdisciplinary process. Site assessment begins when the Master Plan Team visits the site to collect information that will set the stage for the planning process, coordinate data collection efforts, and identify broad goals and limitations at the project site.

Sources for information and decision tools include:

- Section 2 in the Master Plan
- Other related Jocko River data, including HGM Assessments, USGS data, soil survey data, groundwater and surface water records, and other long-term data sets (which are paraphrased within Section 2)
- Documented Interdisciplinary Team site visit
- Specific data collected by Interdisciplinary Team members—note: these data become baseline data and are an essential component of the monitoring plan for each site.
- Channel restoration decision tree (Subsection 3.6.2 and Figure 3.6.2-1)
- Floodplain suitability analysis (Subsection 3.6.3)

Interdisciplinary Team Site Visit

We approach interdisciplinary design by completing an exercise in the field with each member of the interdisciplinary team present. This is a broad, interdisciplinary approach to understand the hydrograph, the river's dynamic nature, and how vegetation influences river channel morphology. The resulting restoration plan integrates the expertise of each member of the team creating an ecological meshing of as many relevant disciplines as possible, focused to address the challenges of each specific site.

See the *Sample Site Team Visit* (opposite) for an example of the results of one such exercise.

Sample Team Site Visit

Nicholson-Squeque ID Team Site Planning Form

Date of Site Visit: April 3, 2006

Team Members Present:
Les Evarts, Seth Makepeace, Craig Barfoot, Rusty Sydnor, Gary Decker, Tom Parker, Sarah Flynn

Project Goals:
- Correct floodplain constrictions - remove cars
- Reduce sediment inputs
- Protect infrastructure at the downstream end of the project reach near the 90-degree meander bend
- Restore spring creek functions
- Re-establish proper plan, profile and channel dimensions

Project Objectives:
- Remove all cars from the streambanks
- Re-align approximately 1082 feet of the Jocko River channel at the 90-degree bend
- Re-align ## feet of the Jocko River channel the floodplain constriction (car riprap)
- Establish woody vegetation along ## feet of bare, unstable bank
- Revegetate ## acres of the Jocko River floodplain with woody vegetation

Sources of Existing Information:
- Groundwater well data
- Cross-sections (Seth's and USGS)
- Floodplain constrictions (GIS layer)
- HGM data
- Old channel traces (GIS layers)
- 2002 Aerial photos
- 2005 aerial flood photos
- Fish data?

Constraints
- Fish structures on the east side of the Jocko River may influence flows and water temperatures
- Most of the fish species are introduced
- The downstream end of the project may be limited to only one bank of the river

Sample Team Site Visit (cont.)

Site Potential and Site Prep Needs

- On-going weed control
- Interim plan for the Nicholson alfalfa field (hay for 2006)

Desired Project Timing and Duration
Phases/Priorities:

1. Re-align channel at the 90-degree bend (downstream), stabilize banks
2. Revegetate high risk, eroding, bare banks on the left side of the Jocko River (middle)
3. Remove cars from the streambank in the middle of the project reach and stabilize and/or re-align the channel (middle)
4. Restore Squeque Creek
5. Restore floodplain at the fish ponds on the east side of the river (upstream)
6. Restore Jocko Spring Creek
7. Restore floodplain wetlands and upland buffers on both sides of the Jocko River
8. Improve riparian habitat and function in Ravalli Canyon

Additional Data Collection Needs:

- LIDAR or photogrammetry to develop fine topography
- Determine costs of these two options
- Re-survey cross-sections (both USGS and Seth's)
- Survey Jocko River profile
- Current aerial photos
- Measure water temperatures in the western fish ponds
- Review Seth's collection of data
- Excavate floodplain holes to look for evidence of historic woody vegetation in the floodplain
- Determine property boundaries through Ravalli Canyon (one or both sides of the river)
- Compare data with reference reach data

Suggested Tools and Strategies:

1. Re-align channel at the 90-degree bend (stablize banks)
   a. Two channel alignment options

b. Move the channel out the transportation rights-of-way

2. Revegetated high risk, bare, eroding banks
   a. Transplant larger plant material from stable areas of the floodplain to create a stable bank for the channel to encounter
3. Remove cars and stabilize the channel in the middle of the reach
   a. Remove cars and stabilize the channel in place using structures to encourage deposition and bar formation
   b. Re-align the channel west of the existing, behind the car berm and use berm material (without cars) to partially fill/plug old channel
   c. Re-align the channel east of the existing and remove/regrade eastern berm

4. Restore Squeque Creek
    a. Re-align the channel to enter Jocko upstream of existing and plug old channel
    b. Re-align channel to enter Jocko downstream of existing (increase channel length and correct grade)
5. Restore floodplain at western fish ponds
    a. Remove berms around ponds
    b. Create an emergent bench around ponds for amphibian habitat
    c. Add fish barrier to prevent non-native species from using the ponds?
6. Restore Jocko Spring Creek
    a. Restore/Revegetate banks to correct entrenchment
    b. Re-align the channel out of transportation rights-of-way
    c. Remove the farm access road
7. Restore floodplain wetland and upland buffers
    a. On-going weed control
    b. Regrade floodplain to lower higher elevations to wetland elevations and use material to fill floodplain ditches
    c. Plant containerized shrubs and trees to increase floodplain water storage
    d. Willow staking
8. Improve riparian habitat and function in Ravalli Canyon
    a. Rock vanes tied into the railroad riprap to improve instream habitat and function and reduce conflict with the railroad right-of-way.

Potential Trade-offs:
Interim increased sediment inputs with unstable banks using a setback revegetation approach while transplanted vegetation establishes and the streambank erodes to the vegetation.

Interim channel instability/sediment transport while the system restores on its own if a less active approach is taken.

Necessary Changes to Interim Management Plan to Support Restoration:
Evaluate fencing?

Other Notes

3.6.2 Channel Restoration Decision Tree

Figure 3.6.2-1 is a decision tree that shows the existing channel condition relative to what it was historically. Its purpose is to provide a means of evaluating the degree of channel-floodplain connectivity characterizing the focus reach. Once a connectivity determination has been made, the user proceeds to determine the appropriate way to address the channel condition. If it is incised, the user goes to the right side, or side "II" of the decision tree. If the channel remains connected to its floodplain, the user proceeds to the left side, or side "I" of the tree. The user then moves down the tree answering a series of yes or no questions. Ultimately, the responses lead the user to recommended treatments. Two examples of how to use the decision tree follow Figure 3.6.2-1.

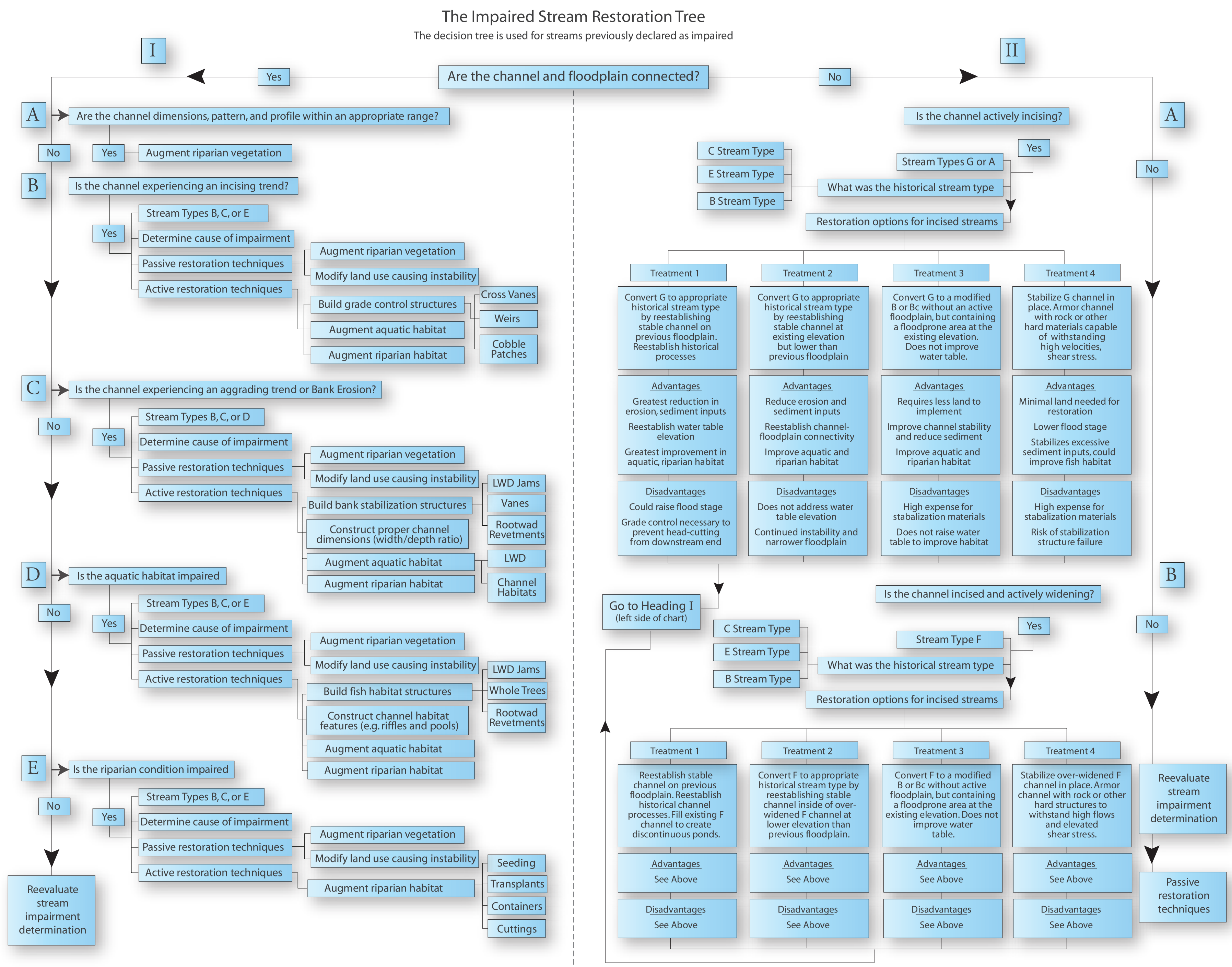

Figure 3.6.2-1.
Channel restoration decision tree.

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Decision Tree Example 1

Refer to Table 3.6.2-1, Reach One, Treatment 1-1. For Reach One, the first channel segment is approximately 2,700 feet long and spans from the confluence with the Flathead River to the lower-most BNSF Railroad Bridge crossing (Station 0+00 to 28+50). This reach is not entrenched or incising, but it is probably aggrading due to an increasing channel width (see Subsection 2.3.5). Because the channel segment remains connected to its floodplain and the channel is not incised, the user selects the left side or side I of the decision tree in Figure 3.6.2-1. The channel dimensions are not within the appropriate range (question A) and the channel is not currently incising (question B). These two negative answers lead the user to question C. Because the channel is experiencing aggradation and accelerated bank erosion, the answer to C is yes. A list of restoration treatments designed to achieve a user-defined desired condition for Reach One is summarized. In this case, Table 3.6.2-1 shows two proposed alternative restoration strategies or prescriptions:

- **Alternative 1:** convert the aggraded, over-widened C4/D4 channel into a stable C4 channel by reactivating historical meanders to the north of the existing channel; or
- **Alternative 2:** shape and stabilize the existing channel in place.

Because the answers to questions C, D and E on the Decision Tree are all yes, a list of specific treatments are proposed depending on the selected restoration alternative. Passive restoration treatments include modifying the land uses that are causing the instability. Active restoration strategies include channel shaping, channel construction, bank stabilization, aggressive revegetation and habitat enhancement with large woody debris. Figure 3.6.2-2 illustrates one conceptual channel alignment (Treatment 1-1, Alternative 1) that was developed using historical photos and design dimensions. The conceptual channel alignment proposed in Alternative 1 is only one of several that would be considered. Additional field data collection and analysis, landowner consent, and public scoping would be necessary prior to finalizing any channel realignment plans.

Figure 3.6.2-2.
Illustration of a conceptual channel alignment along the lower main stem.

Treatment 1-1, Alternative 2 is not illustrated because the treatments are too site-specific to be shown at the scale of the aerial photographs. Instead, specific treatments would be designed during the next phase of the planning effort.

Decision Tree Example 2

The second example focuses on evaluating a portion of Reach Three-e (Station 130+00 to 180+00) (Table 3.6.2-1). Here, the Jocko River is no longer connected to its historical floodplain. Because the channel is entrenched, the user proceeds to the right side of the decision tree, or side II. The answer to question A is no because the channel does not appear to be actively incising. The answer to question B is yes because it does appear to be actively widening or migrating laterally. The dominant historical stream type was most likely a C4, with short reaches of B4 stream type (Reach Three-b and Reach Three-c). Based on the existing conditions and desired conditions discussed in Section 2, the restoration strategies for this incised segment include:

- **Alternative 1:** restore the historical stream type at the historical floodplain elevation by reactivating historical meanders to the south of the existing channel (Treatment II-B-1), or;
- **Alternative 2:** convert the channel from a F4 stream type to a B4c channel at the existing floodplain elevation and in the current channel alignment (Treatment II-B-3).

The advantages and disadvantages of the two alternatives are briefly described in Table 3.6.2-1. Figure 3.6.2-3 illustrates one conceptual channel alignment (Treatment 3-4, Alternative 1) that was developed using historical photos and design dimensions. This proposed alignment is considered conceptual; other alignments would be considered after the completion of additional assessments and scoping. Treatment 3-4, Alternative 2 is not illustrated because the treatments are too site-specific to be illustrated at the scale of the aerial photograph.

Once the major restoration strategy has been selected, the channel restoration decision tree directs the user to the left side of the chart to go through the same series of questions discussed in the first example. Restoration treatments I-C, I-D and I-E would be recommended under either alternative.

Figure 3.6.2-3.
Illustration of an conceptual channel alignment along the lower main stem.

Decision Tree Example 2 (cont.)

Table 3.6.2-1.
Treatment alternatives for two example sections of the main stem.

Map ID Number	Down-stream Station	Upstream Station	Alternative	Entrenched	Currently Incising	Currently Aggrading	Prescription	Treatments	Additional Special Structures	Priority	Feasibility/ Probabilty
1-1	0	27	1	No	No	Yes	Over-widened C4 to C4	I-C, I-D, I-E		H	H
1-1	0	27	2	No	No	Yes	Stabilize in place	I-C, I-D, I-E		M/L	H
3-4	130	180	1	Yes	No	No	F4 to C4	Relocate to historical floodplain and reactivate historical meanders, II-B-1, remove levees where present, I-C, I-D, I-E	W-weir at RR Bridge #3	M	M/H
3-4	130	180	2	Yes	No	No	F4 to B4c	Stabilize and shape in place, II-B-3, remove levees where present, I-C, I-D, I-E	W-weir at RR Bridge #3	M	H

3.6.3 Suitability Analysis of Floodplain Restoration Potential

The Master Plan Team used a suitability analysis approach to identify areas with high potential for restoring native riparian and wetland plant communities along the lower main stem. *Suitability analysis* is a process where specific data attributes from different geographic information layers are combined according to a set of decision rules.

Suitability Analysis Methods

We used four main geographic variables to determine suitability classes for native plant community restoration: soil texture in the surface layer, hydric soil status, presence of woody vegetation in 1937, and HGM cover type. These variables came from two public data sources and two proprietary Confederated Salish and Kootenai Tribes (CSKT) data sources. The public sources were the Lake County Soil survey (1998) and the Montana list of hydric soils (USDA NRCS 2002a, 2002b); the proprietary sources were GIS-based digitized 1937 woody vegetation extent and digitized 2002 HGM cover types. These variables and data sources were selected because they are the best available information for predicting restoration potential across the entire ecological floodplain area. While fine-resolution topographic data would be useful for this analysis, that information is not yet available. As better topographic data becomes available, this analysis should be refined to include elevation classes relative to known hydrologic features.

We grouped soil texture into three major classes (abbreviations follow the National Soil Survey Handbook (NRCS 2003):

- Fine-textured soils, which have a high potential for supporting water storage and other functions typical of a riverine floodplain system, include silt loam (SIL), silty clay loam (SICL), loam (L) and fine sandy loam (FSL);
- Coarse-textured soils which include gravelly loam (GR-L), very gravelly loam (GRV-L), cobbly loam (CB-L), and stony loam (ST-L); and
- Typic, Aquic and Xerofluvents, for which surface textures are undefined.

The hydric soils and historic vegetation attributes are defined as either present or absent; the HGM classes are lumped into agricultural and developed land (Cover Types 10 and 11), existing emergent wetland (Cover Type 6) and other native vegetation or water surface features (Cover Types 1, 2, 3, 4, 5, 7 and 9).

Suitability Analysis Results

Based on the analysis, we identified four main suitability classes that indicate high restoration potential:

- Suitability Class 1: Fine-textured soils that are mapped as hydric, that historically supported woody vegetation and that are currently either agricultural or developed land. These areas probably have the highest potential for restoring riverine floodplain functions.
- Suitability Classes 2, 7, 8, 13 and 14: These areas are currently either agricultural

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Suitability Analysis Methods (cont.)

or developed that formerly supported woody vegetation communities. They should be examined on a case-by-case basis to determine if they still have the potential to support native riparian plant communities.

- Suitability Classes 4, 5, 10, 11, 16 and 17: These areas are currently emergent wetland that formerly supported woody vegetation communities. They are areas where changing livestock management, controlling invasive plant species or noxious weeds, or actively planting native woody plant species could result in conversion from emergent to higher-functioning woody plant communities.
- Suitability Class 22: Fine-textured soils with hydric soils that are currently either agricultural or developed land that did not have woody vegetation in 1937. Emergent wetlands may have historically occurred in these locations. They occupy a landform position that is probably suitable for wetland or riparian restoration.

Other suitability classes may have restoration potential and should be assessed on a case-by-case basis.

Feasibility/Risk Analysis

The feasibility/risk analysis assesses whether a project or alternative can be implemented based on technical considerations or given the constraints posed by land ownership or infrastructure. Each potential project may have several alternative approaches that should be analyzed to determine whether the benefits are enough to justify the potential risk of failure that may result in damage to infrastructure, future costly repair work, or future constraints on the natural system.

Examples of risks that might need to be considered include:

- Removing berms or raising the channel elevation may increase flooding risks or impact irrigation infrastructure;
- Using softer channel bed and bank stabilization approaches may result in a need to repair a project if a large flood event occurs before the channel bed has armored itself or before vegetation has matured enough to stabilize bank materials; and
- Using rigid channel structures or revegetation techniques that fully cover the soil surface may limit the system's ability to respond to natural disturbances.

In addition to assessing feasibility and risk, this planning phase is also the appropriate time to quantitatively evaluate trade-offs among contradictory objectives. In some cases, temporarily stabilizing a channel will reduce its rate of lateral movement. Lateral channel movement results in new depositional features (point bars) that are necessary for cottonwood and willow seedlings to become established. In this situation, the Master Plan Team may need to collect and evaluate more data to determine how to maximize overall ecological benefits to the riverine system. Once the Master Plan Team has evaluated feasibility, risks and trade-offs, it can produce a set of objectives that flow logically from their analysis. These objectives then form the basis for the conceptual restoration design.

3.6.4 Conceptual Restoration Design

The conceptual design process includes identifying the strategies and techniques that will be used to achieve restoration objectives. Using the tools described in Subsections 3.6.1, 3.6.2 and 3.6.3 (Interdisciplinary Team Site Assessment, Channel Decision Tree, Floodplain Suitability Analysis), the conceptual plan should provide a clear link between each process that is out of balance and the strategies and techniques that will be used to restore it (Table 3.3.5-1, Subsection 3.3.5).

The conceptual restoration design may be used to support either permitting or grant applications and should provide enough detail to develop cost estimates suitable for project budgeting. Site preparation activities, included in the conceptual restoration plan, are some of the first steps in restoring a site and are intended to prepare a site for more successful implementation of active restoration measures.

The Conceptual Restoration Plan outline includes:

- Introduction
- Purpose and need
- Plan Development Methods
  - Description of Information Sources
  - Results of Interdisciplinary Team Site Visit
  - Decision Tree results
  - Suitability Analysis Results
  - Discussion of Feasibility/Risk Assessment
- Existing Condition
  - Site Description (addressing processes)
  - Channel
  - Riparian Vegetation
  - Surface water and groundwater
  - Fish
- Desired Future Condition
  - Goals and Objectives
  - Table linking Processes, DFC, Strategies, Techniques
- Restoration Strategies
- Restoration Techniques
- Best Management Practices
- Project Maintenance
- Project Phasing
- Cost Estimate
- Monitoring and Adaptive Management
- Conceptual plan sheets and typical details

Site Preparation (Pre-restoration)

Many of the properties along the lower Jocko River that are currently protected, or that may be acquired in the future, are lands formally or currently managed for agricultural (primarily grazing) purposes. Many are infested with noxious weeds. In addition, several aggressive, non-native plant species have been introduced in the lower watershed as a consequence of converting former riparian/wetland areas to agricultural land. Following the protection of these sites and the relaxation or elimination of grazing, mowing, tilling and irrigation, noxious weeds and other non-native plant populations often expand. Disturbance regimes and site potential for riparian vegetation communities are discussed in more detail in Subsection 3.3.4.

Unless they are brought under control, efforts to restore fully functioning floodplain plant communities will (at best) be hindered or (at worst) fail. Recognizing this, the Master Plan Team includes site preparation strategies and techniques in the restoration plan for each protected property. These strategies address weed management needs prior to full-scale restoration activities. Successfully managing weed populations in the long-term, require a shift in site potential, especially on lands that have been managed for agriculture over a long period of time. Aggressive techniques are often required to control weed populations on these and other lands to jump start the ecological processes that will lead to the recovery of native riparian and wetland communities.

The site preparation strategies and techniques included in the conceptual restoration plan are developed during the site assessment and as part of the IMP implementation phase. The weed management activities associated with site preparation are intended to direct weed management actions over a longer time period than what the IMP addresses (a minimum of two to three years, or longer).

An additional distinction between site preparation strategies and techniques and the IMP, is that the IMP relies heavily on the application of herbicides to initially control noxious and other non-native plant species, whereas site preparation strategies focus on a more integrated approach (see discussion on Integrated Pest Management in Appendix A) that utilizes non-chemical as well as chemical approaches to manage weed populations over the long-term.

Site preparation strategies and techniques will address other opportunities, beyond weed management, to begin the process of site potential conversion. The assumption is that the site potential conversion process will concomitantly lead to a significant decline in, and thus long-term management of, noxious and other non-native plant species. Thus, site preparation activities may include the implementation of some or all of the following techniques (each technique is described in more detail in Appendix A):

- Prescribed Fire
- Microtopographic Enhancement
- Woody Debris Addition
- Soil Amendment
- Soil Seed Bank Enhancement
- Plant Salvage
- Plant Installation

3.6.5 Final Design

The final restoration plan is the conceptual restoration plan modified to include any changes made necessary by permitting requirements, public process, or other factors. In addition, the final design includes construction plan sheets, detailed costs and materials lists, detailed project schedule and a final implementation plan indicating who is responsible for completing which aspects of the project. These are included as appendices to the narrative plan.

The final design includes enough detail to support project implementation in the field. At times, it will be necessary to delay some decisions, such as exact structure locations and planting locations, until early phases of the project are completed. But the final design should include enough information about the location of these structures and planting areas so that early phases of the project do not inhibit later phases by eliminating access or result in equipment staging areas being located within planting areas.

3.7 Maintenance

3.7.1 Maintenance, Monitoring, and Adaptive Management

Ecological restoration, as discussed above, is a phased process rather than a one-time construction event. Because of this, maintenance is an integral part of restoration. Maintenance is not only necessary when project components fail, but must be included as part of the restoration plan and included in restoration project budgets. The project specific goals should address the target ranges for metrics to evaluate the effectiveness during monitoring phase. When metrics fall outside the target range, it will trigger an interdisciplinary assessment of the project to determine if maintenance is needed (refer to Figure 3.1-1) and for what purpose (regulatory, ecological or legal).

While native plants are genetically adapted to their locale, individual plants need time to adapt to a particular site. Deep watering for two growing seasons (if needed based on soil moisture monitoring) allows the root systems to develop sufficiently to support the plant without watering. Deep watering encourages the development of a deep lateral root system; light, overhead watering encourages only surface roots.

Plant communities cannot be constructed as a single-entry project. Changing site potential to one that is self-sustaining will take years on many sites. In addition, invasive plant species are a perpetual management challenge that will need to be controlled until a self-sustaining, native plant community has reestablished.

3.8 Conclusion

This section discusses how natural processes, disturbances, and the concept of site potential influence our approach to restoration, the interdisciplinary restoration planning process, and the restoration strategies and techniques that will be applied to restoration sites within the project area.

The Jocko Master Plan Team, an interdisciplinary team, uses and integrates information from their various disciplines to identify restoration priorities and goals for the lower main-stem Jocko River and its floodplain.

The desired future condition for the lower main stem, in general terms, is the integration of ecological processes that result in an acceptable range of conditions related to river morphology and aquatic/terrestrial habitat. Restoring conditions that will support natural processes requires a careful balance of passive and active restoration.

The restoration planning process is aimed at choosing the best approach to restore the conditions that will support natural processes. Planning steps include site assessment, feasibility/risk analysis, conceptual restoration design and final restoration design. Maintenance, monitoring and adaptive management are also important steps in the restoration planning process that inform future decisions in multi-phase projects based on the success or failure of implementing various techniques. Section 4 discusses monitoring in more detail.

3.9 Literature Cited

For references to this section, go to the Literature Cited Section.