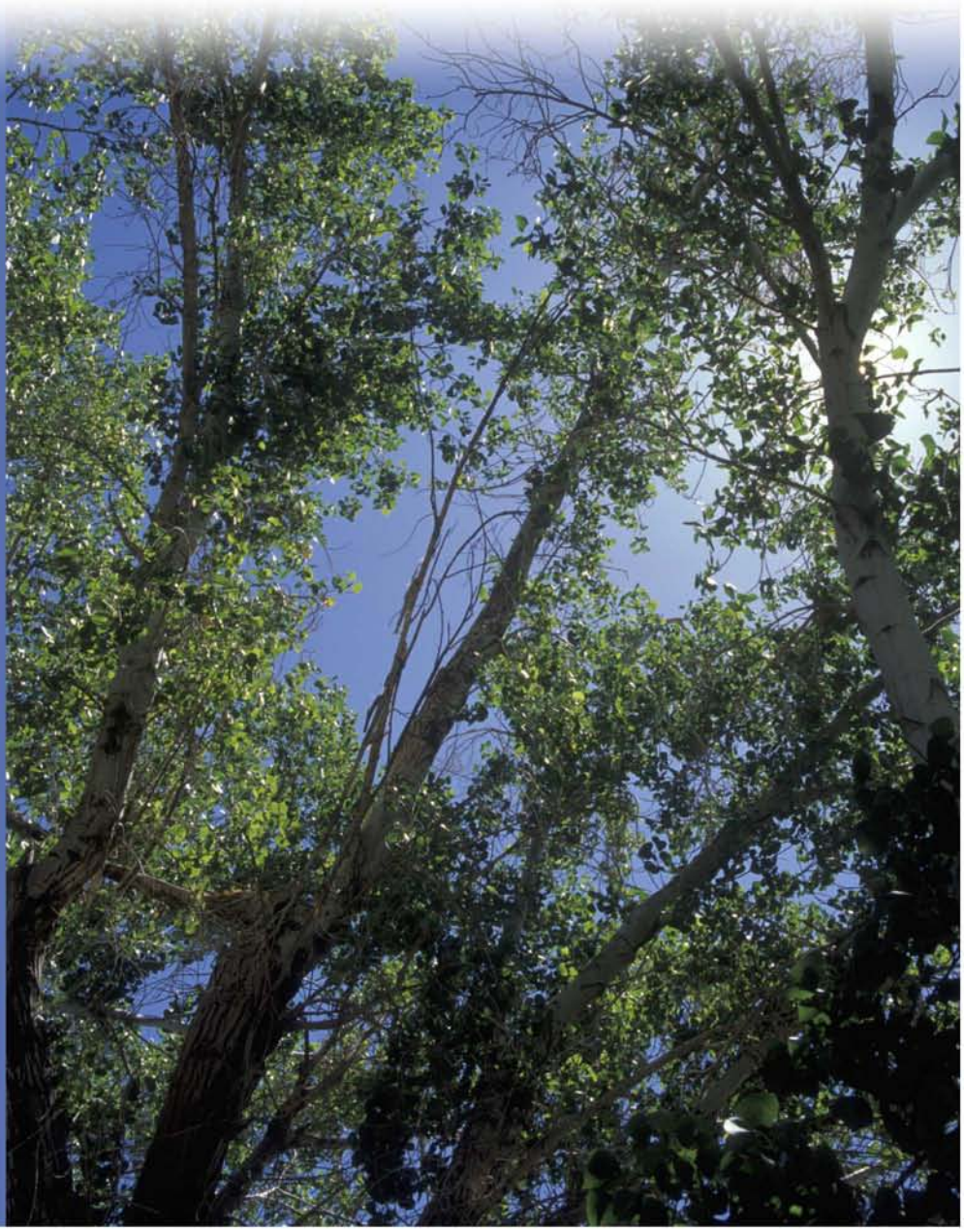
Lower Colorado River Multi-Species Conservation Program

Balancing Resource Needs

Draft Final Guidelines for the Screening and Evaluation of Potential Conservation Areas



U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

August 10, 2006

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National Park Service
Bureau of Land Management
Bureau of Indian Affairs
Western Area Power Administration

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Lower Colorado River
Multi-Species Conservation Program

Draft Final
Guidelines for the Screening and Evaluation of Potential Conservation Areas

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August 10, 2006

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Note to Reviewers: These final draft guidelines will be in effect until at least one riparian habitat creation site and one backwater habitat creation site have been evaluated using the final draft guidelines and are proposed for securement through Reclamation's Annual Work Plan process. This will enable Reclamation to validate and test the effectiveness of the guidelines for screening and evaluating potential riparian and backwater habitat creation sites. Following completion of this initial cycle of site securement, Reclamation will revise these guidelines, as appropriate, to improve their effectiveness and adopt final guidelines.

Chapter 1. Introduction

The Lower Colorado River Multi-Species Conservation Program (LCR MSCP) is a multi-stakeholder Federal and non-Federal partnership responding to the need to balance the use of lower Colorado River (LCR) water resources and the conservation of native species and their habitats in compliance with the Endangered Species Act. This is a long-term (50-year) plan to conserve at least 26 species along the LCR from Lake Mead to the Southerly International Boundary with Mexico through the implementation of a Habitat Conservation Plan (LCR MSCP 2004). Most of the covered species are state and/or Federally listed special status species. The Bureau of Reclamation (Reclamation) is the entity responsible for implementing the LCR MSCP over the 50-year term of the program. A Steering Committee, currently consisting of 54 entities, has been formed as described in the *LCR MSCP Funding and Management Agreement* (FMA)[1], to provide input and oversight functions to support of LCR MSCP implementation.

The LCR MSCP Habitat Conservation Plan (HCP) (LCR MSCP 2004) provides for a habitat-based approach to conservation and includes measures to provide for the creation and management of 8,132 acres of habitat for LCR MSCP covered species. These created habitats provide mitigation for impacts of LCR MSCP covered activities evaluated in the HCP and compliance with Federal Endangered Species Act and California Endangered Species Act permit requirements (California parties only). Reclamation will create these habitats within the LCR MSCP planning area or at locations along the lower reaches of the Muddy River/Moapa Valley, Virgin River, Bill Williams River, and lower Gila River Valley (Department of the Interior 2005). These habitats will be created on LCR MSCP conservation areas that are comprised of lands secured for this purpose by Reclamation. Reclamation intends to work with willing partners to secure an interest in land and water sufficient to create and maintain LCR MSCP habitats. Habitats will be created through the establishment and management of land cover types (i.e., cottonwood-willow, honey mesquite, marsh, or backwater) such that they provide the elements of each covered species habitat. It is anticipated that willing landowners will enter into

[1] Provided in Exhibit A of the LCR MSCP HCP.

some type of long-term agreement that secures an interest in the land and water through the 50-year term of the LCR MSCP or in perpetuity, depending on HCP requirements[2]. Lands secured for use as conservation areas that are not retained by the current landowner could transfer to management by a state or Federal resource agency (e.g., Arizona, California, and Nevada fish and wildlife agencies; U.S. Fish and Wildlife Service; Bureau of Land Management).

Purpose

The purpose of these guidelines is to provide Reclamation with a method for screening and evaluating the suitability of lands that are made available to Reclamation for use as conservation areas. This document is intended to:

- provide guidance to interested parties on the process and site requirements for lands that may be considered by Reclamation for the establishment of conservation areas, and
- describe the process and criteria that will be used by Reclamation to evaluate and screen the suitability of lands (hereafter referred to as "sites") available for use as conservation areas.

The criteria used to evaluate sites described in these guidelines is consistent with relevant programmatic guidance for selecting conservation areas as described in the HCP. Criteria identified in HCP Section 5.5.1 that should be considered in selecting conservation areas include:

- presence of and proximity to existing occupied covered species habitats;
- suitability of site conditions for creating habitat for specific species (e.g., appropriate soils, availability of water for irrigation);
- available requisite infrastructure (e.g., access roads, irrigation-related infrastructure);
- suitability for achieving multiple creation objectives through an integrated mosaic of habitat types;
- likelihood for mosquitoes produced on a site to become a vector control or nuisance problem based on proximity to urban areas and mosquito production potential;
- cost of securing an interest in land (e.g., fee title, conservation easement, lease, etc.);
- cost of implementing and maintaining created habitat;
- availability and cost of water to meet creation and maintenance requirements;

[2] Lands on which habitats are created to replace permanent loss of covered species habitats would be maintained as habitat in perpetuity.

- timing of land availability relative to the need for implementing habitat creation measures; and
- consideration of zoning and general plan designations.

Section 5.5 also provides additional guidance for selecting habitat creation sites. To prepare the HCP, the LCR MSCP identified and evaluated 30 conservation opportunity areas (COAs) encompassing approximately 37,500 acres that may be suitable for habitat creation (see HCP Section 5.5.1).

Based on this assessment, HCP Section 5.5.1 allows for selecting habitat creation sites from among the following:

- the 30 COAs;
- available agricultural lands; and
- other undeveloped lands.

HCP Section 5.5.2 additionally states:

> To the extent consistent with the conservation area site-selection criteria, preference will be accorded to locating created habitat on Federal, state, and tribal lands. If suitable public lands are not available, private land will be considered on the principle of willing seller or lessor. Preference will also be given to the acquisition of large tracts to facilitate the creation of large patches of habitat.

These guidelines are intended to screen and evaluate potential sites based on their likely ability to provide for the successful establishment and maintenance of high value covered species habitats and implementation cost efficiency. Based on new information (e.g., results of habitat monitoring and research may indicate additions or deletions of evaluation criteria) developed through the LCR MSCP adaptive management process, Reclamation may periodically revise these guidelines to improve their efficacy.

Created Land Cover Types

To implement the LCR MSCP, Reclamation will create 8,132 acres of cottonwood-willow, honey mesquite, marsh, and backwater land cover types (see Table 1), including 3,048 acres prioritized for creation in California. Habitats will be created through the establishment and management of land cover types such that they provide the elements of each covered species habitat. The term “habitat” is used hereafter to refer to land cover types and the habitat conditions they provide for covered species.

Table 1. Extent of Habitats to be Created Under the LCR MSCP (acres)

Habitat	*Total to be Created*	*Prioritized within California*
Cottonwood-willow	5,940	1,566
Honey mesquite	1,320	1,048
Marsh	512	240
Backwater	360	194
Total	8,132	3,048

Screening and Evaluation Processes

These guidelines provide separate processes for screening and evaluating sites for the creation of riparian habitats[3] (i.e., cottonwood-willow, honey mesquite, and marsh) (see Chapter 2) and backwater habitat (see Chapter 3). Separate processes are identified because riparian habitats may be created on sites supporting a wide variety of conditions (e.g., agricultural lands, sites dominated by saltcedar) and land ownership whereas Reclamation anticipates that backwater habitat will be created by improving or restoring existing backwaters located on lands primarily managed by Federal resource agencies.

[3] Riparian habitat as used in these guidelines is defined as cottonwood-willow, honey mesquite, and marsh land cover types that will be created and managed by Reclamation to provide habitat for covered species.

Chapter 2. Riparian Habitat Site Screening and Evaluation Process

The process for screening and evaluating sites for the creation of riparian habitats is illustrated in Figure 1. Steps in the process include:

- Step 1: identifying sites to be screened and evaluated;
- Step 2: conducting site visits to document existing site conditions, determine the interests and commitment of landowners for creating habitats over the 50-year term of the LCR MSCP or in perpetuity, gather existing information from landowners (e.g., water rights, area of available land, existing land uses), and identify preliminary habitat creation opportunities.
- Step 3: initially screening sites to determine if they qualify for creating habitats under the HCP;
- Step 4: assessing the suitability of sites that are qualified under Step 3 for creating riparian habitats based on site attributes and preliminary estimated costs of securing an interest in land and water and developing and managing habitats over the term of the LCR MSCP;
- Step 5: assigning an overall riparian habitat creation opportunity rating of sites evaluated in Step 4 based on their suitability for the creation and maintenance of habitat and cost effectiveness.
- Step 6: selecting sites from among those evaluated in Step 5 that will be pursued for securement through Reclamation's Annual Work Plan process.

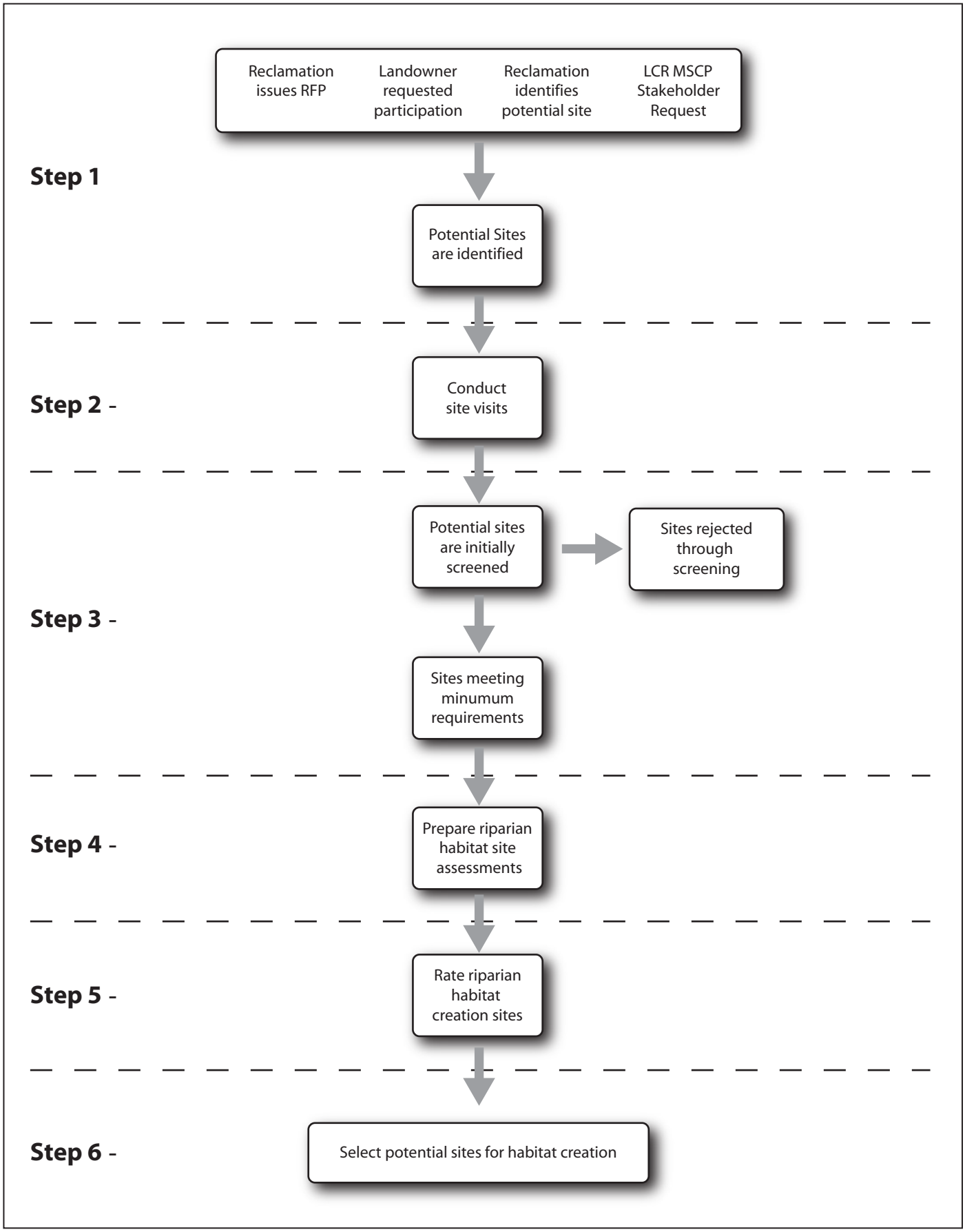

Figure 1 -
Potential Riparian Habitat Creation -
Site Screening and Evaluation Process -

Step 1: Identification of Sites for Screening and Evaluation

Step 1 is the process whereby sites are identified to Reclamation that may be used to create riparian habitats. Reclamation anticipates that riparian habitat creation sites may be identified in three ways:

- Landowner Request: Landowners who wish to make their lands available for use as CAs may contact Reclamation to request that their lands be evaluated to determine their suitability for use as a conservation area. Under this process, Reclamation would provide guidance and assistance to the landowner on the requirements for submitting a proposal to Reclamation.

- Reclamation Identified: Reclamation may identify sites that may be suitable for creating riparian habitats, based on Reclamation's understanding of the potential availability of lands and likely suitability to meet HCP requirements for habitat creation. Under this process, Reclamation would develop, in cooperation with willing landowners, the information necessary to evaluate the suitability of sites.

- LCR MSCP Stakeholder Request: Stakeholders may identify to Reclamation sites that may be suitable for creating riparian habitats. Under this process, Reclamation would develop in coordination with the stakeholders identifying the sites, the information necessary to evaluate the suitability of sites.

- Request for Proposals (RFP): Depending on the availability of lands for use as conservation areas relative to the LCR MSCP implementation schedule, Reclamation may release a RFP for sites to be used for the establishment of CAs. Under this process, parties would submit a proposal to Reclamation in response to the RFP that provides the information requested in the solicitation. The submitted proposal would provide the initial basis from which Reclamation would evaluate the suitability of the offered lands for use as a conservation area.

Step 2: Conduct Site Visits

Following the initial identification of potential riparian habitat creation sites under Step 1, Reclamation will conduct reconnaissance-level site visits to collect information necessary to further assess the suitability of sites for creation of habitats.

Site visits will be conducted by an interdisciplinary team assembled by Reclamation for this purpose. The team will document existing site conditions, including site location, existing habitats, existing infrastructure, and land and water availability. This documentation is anticipated to include information provided by the landowner that may be further verified in subsequent steps of the screening and evaluation process (e.g., confirmation of water right, area

of available land, condition of infrastructure). Reclamation will meet with site landowners to determine their habitat creation interests and interest in committing their lands for creation of habitats over the 50-year term of the LCR MSCP or in perpetuity. If site conditions are present that could provide for creating riparian habitats (e.g., presence of an onsite or offsite source of irrigation water), the team will identify preliminary habitat creation concepts for the site (e.g., a description of the types and extents of habitats that could be created) and identify potential issues related to creating habitats based on results of the site visit. Habitat creation concepts will be consistent with the requirements of the HCP and the presence of existing habitats will be considered in development of the concepts. Results of site visits and identified habitat creation options and issues will be documented in site visit reports. Information anticipated to be provided in reports may include the following:

- water right and priority;
- location map, showing the property location in context to nearby roads, towns, and other local features;
- property map showing location of fences, buildings, roads, agricultural fields, drains, canals, pumps, and other infrastructure as appropriate;
- land use description (e.g., if the site is farmed, the types of crops that are grown; undeveloped);
- land cover map showing dominant vegetation types and acreage (e.g., farmed fields, saltcedar stands);
- description of infrastructure condition;
- description of preliminary habitat creation concepts for developing the site; and
- a description of potential issues related to the establishment and management of created habitats.

Step 3: Initial Screening

Following completion of site visits under Step 2, potential riparian habitat creation sites will be initially screened to identify the best candidates for habitat creation. This initial screening is intended to result in a mutual understanding of the LCR MSCP requirements and commitments between Reclamation, the landowner, and participating parties. Reclamation will initially screen each site to determine if they meet the following minimum requirements.

1. The landowner must demonstrate clear title to the land and water.
2. The site must be made available for establishing created habitats over the term of the LCR MSCP (i.e., through April 30, 2055) or in perpetuity.

3. No deed, easement, or other legal restrictions are attached to the site that could limit the ability of Reclamation to create and manage habitats over the term of the LCR MSCP.

4. Sites offered for the establishment of riparian habitats must be large enough to accommodate the establishment of a minimum acreage of habitat (10, 25, or 50 acres for cottonwood-willow, depending on habitat creation requirements[4]; 10 contiguous acres for honey mesquite; 5 contiguous acres for marsh) and any additional area required for use as buffer land, infrastructure (e.g., roads, canals), and other features required to support the created habitat.

5. The site is *not* located where levels of human activity are sufficiently high that it is unlikely that created land cover types can fully function as covered species habitat.

6. The site must support conditions that will allow for the practicable creation of habitats. This determination will be made based on the reconnaissance-level information collected during site visits under Step 2.

7. Based on information provided by the landowner in Steps 1 and 2, no hazardous materials are present on the site of a type or in quantities that would preclude the efficacious establishment, future management, or value of habitats created on the site.

8. The site must be located such that habitats created at the site will contribute towards achieving the distribution of habitats by the river reaches suggested in the HCP.

Sites will be rejected from further consideration for creating riparian habitats if they do not meet these minimum site requirements. Rejected sites, however, may be reconsidered for use in the future if the offering party(ies) undertakes actions that enable the site to meet these minimum requirements (e.g., removing deed restrictions that hinder creation of habitats). It is anticipated that information necessary to conduct Step 3 will be collected during site visits and provided by the landowner either as a requirement of RFPs or at the request of Reclamation and through public information available to Reclamation.

Step 4: Site Assessments

Step 4 encompasses 1) assessing the suitability of potential riparian habitat creation sites for the establishment and management of created habitats based on site conditions and 2) preparing preliminary cost estimates that could be associated with securing the resource (land and water) and developing and managing the created riparian habitats. To initiate Step 4, Reclamation may request a letter of intent to participate in the LCR MSCP from landowners. The riparian habitat site suitability assessment and cost estimates will be conducted concurrently through an iterative process, but are described separately below.

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[4] The HCP requires that at least 1,702 acres of cottonwood-willow habitat is created in patches of at least 50 acres, 2,348 acres are created in patches of at least 25 acres, and that 1,890 acres are created in patches of at least 10 acres.

Assess Site Conditions

Reclamation may gather information for potential riparian habitat creation sites that have been approved for further consideration under Step 3. This information may be gathered through additional site visits or from existing sources of information, including public sources and information provided to Reclamation by landowners. The types of information that may be gathered are shown in Table 2. Riparian habitat site evaluation and screening criteria include:

- water availability,
- soil conditions,
- site location,
- habitat development potential, and
- site constraints.

Table 2. Information to be Developed for Use in Screening and Evaluating Potential Riparian Habitat Creation Sites

Water Availability
• the details of the water right, including the priority, type, and quantity; • description of water quality; and • if available, any information related to depth to groundwater.
Soil Conditions[a]
• the soils present on the site based on the best available information; • a description of the habitats and extent of habitat that could be established and maintained on site soils; and • soil-related limitations to the establishment of cottonwood-willow, honey mesquite, and marsh habitats.
Other Relevant Information
• description of existing habitats; • description of existing infrastructure; • proximity to nearby habitats; • extent of site feasible for creating habitats; • suitability of marsh creation sites for the use of fire as a management tool; • long-term management likely to be required to maintain created habitats; and • any other available information relevant for assessing site suitability.
[a] Available soils information may include soils survey maps or information previously developed for the site (e.g., soils tests prepared by the landowner, Natural Resources Conservation Service soil survey information). In the absence of mapped soils, an assessment of soil conditions may be developed based on observable soils conditions (e.g., high salinity may be inferred by the presence of salt on the soil surface) and, for agricultural lands, cropping history.

Reclamation will evaluate and rate each site criterion and, based on the collective criteria ratings, will assign an overall habitat creation opportunity rating for the site. Site ratings may be

adjusted higher if Reclamation identifies opportunities for implementing "low-cost" corrective actions that will improve the site conditions addressed by the criterion (e.g., although soils on a site may be highly saline, the site could be rated higher than otherwise if sufficient water is available to flush salts from the soil).

Water Availability

The water availability criterion evaluates the suitability of a site's water supply to provide for:

- the establishment of riparian habitats, including moist surface soil conditions in cottonwood-willow to provide habitat for the southwestern willow flycatcher and in honey mesquite to provide habitat for the MacNeill's sootywing skipper;
- the ability to ensure ongoing irrigation of created habitats to maintain habitat values over the term of the LCR MSCP;
- water sufficient to maintain water depths required by marsh-associated covered species, including water provided through surface or subsurface connection with the LCR; and
- sufficient flow through created marshes to maintain water quality necessary to maintain habitat conditions for covered species.

Elements of the water availability that will be evaluated under this criterion include:

- Water entitlement: considerations include the certainty of water supply and the extent and types of habitat that can be created and maintained on a site based on the quantity of water available to the site.
- Water quality: considerations include potential contribution of selenium, salts, and other contaminants at levels that could affect biotic communities, including dominant vegetation in created covered species habitats based on the quality of the available water.

The evaluation of the water availability criterion will take into consideration the likely effects of conditions present on each site that may affect water usage, including the water to create and maintain habitats. Conditions that can affect water requirements include:

- soil permeability (e.g., sandier soils may require more water than less sandy soils);
- soil salinity (e.g., highly saline soils may require additional water to maintain soil salinity at levels that will sustain established vegetation);
- site factors that may result in water loss (e.g., unlined water delivery canals and ditches); and
- groundwater elevations during the growing season (e.g., sites where groundwater elevations within the rooting depth of honey mesquite may not require water for supplemental irrigation after plants are established, presence of high groundwater elevations maintained by LCR flows may reduce water requirements for the establishment and maintenance of marsh and cottonwood-willow habitats).

The water availability criterion will be rated based on an assessment of the combined ratings for each of the criterion elements using the guidelines presented in Appendix A.

Soil Condition

The soil condition criterion evaluates the suitability of a site's soils to provide for the establishment and sustainment of habitats. Elements of soil conditions that will be evaluated under this criterion include:

- Soil texture: considerations include the suitability of the soil to support dominant land cover type plant species and, depending on the habitat type, water retention or drainage requirements.

- Soil salinity: considerations include whether or not soil salinity is within the tolerance range of the dominant land cover type plant species.

Soil texture and salinity conditions at each site will be identified from Natural Resource Conservation Service soil survey reports and any additional information provided by the landowner/manager. The soil condition criterion will be rated based on an assessment of the combined ratings for each of the criterion elements using the guidelines presented in Appendix A. The evaluation will take into consideration the quantity of water available to mitigate effects of salinity on sites with low to moderate salinity ratings.

Site Location

The site location criterion evaluates the suitability of sites to meet the following conditions:

- proximity to the LCR;
- proximity to occupied habitats for species specified in the HCP (i.e., western red bat and western yellow bat roost sites and Colorado River cotton rat, Yuma hispid cotton rat, California black rail, western least bittern, and MacNeill's sootywing skipper habitat)[5]; and
- improve connectivity among existing covered species habitats along the LCR[6].

The site location criterion will be rated based on an assessment of the combined ratings for each of the criterion elements using the guidelines presented in Appendix A. In addition, Reclamation

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[5] The HCP indicates that created habitats for these species should be located near existing occupied habitat to facilitate the likelihood that the created habitats will be used by these species.

[6] Reclamation will evaluate the location of sites relative to the location of other patches of existing habitat along the LCR to determine the likelihood that creation of habitats on the site will improve connectivity among existing habitats (i.e., reduce the distance between habitat areas). A site's ability to improve connectivity among habitats is considered an important attribute because it will facilitate the movement (e.g., migration, dispersal of juveniles) of wildlife along the LCR by creating patches of habitat that serve as "stepping stones" for movement along the river.

will consider the ability of sites located in California to help achieve the establishment of at least 2,854 acres of riparian habitat prioritized for creation in California (encompasses Reaches 3-6).

Habitat Development Potential

The habitat development potential criterion evaluates the extent of habitat that can be created on a site and the extent to which creating habitat on the site can improve the value of existing nearby habitats.[7] Sites that can accommodate creation of habitat in patches larger than the minimum patch sizes required to provide habitat (see *Step 3: Initial Screening*) can support a greater abundance of covered species and larger sites increase the opportunity to create mosaics of habitat that more closely approximate habitat conditions historically present along the LCR. Attributes that can generally be expected to be associated with the extent of habitat that can be created on a site are presented in Appendix A.

Long-Term Management Considerations

The long-term management considerations criterion qualitatively evaluates each site based on other factors that may affect the ability of Reclamation to effectively establish, manage, and maintain created habitats over the term of the LCR MSCP. Site constraints most likely to be associated with evaluated sites are anticipated to be those associated with human activity and adjacent land uses. A major consideration in rating these site constraints is the degree to which habitats established on sites are buffered from the potential adverse effects of human activity and adjacent land uses. Buffers are defined as barriers that reduce potential adverse effects of human activity and adjacent land uses on created habitats and covered species. Additional considerations include evaluating whether or not site specific conditions (e.g., soils) are such that water management activities could adversely affect water quality on or off-site and whether or not controlled burning can be used as a tool for the creation and management of marsh habitats. Other types of site constraints that could be associated with individual sites will also be considered in site evaluations, as appropriate, by Reclamation. The long-term management considerations criterion will be rated based on an assessment of the combined ratings for each of the criterion elements using the guidelines presented in Appendix A.

Human Activity The proximity of sites to human populations and high use areas (e.g., recreational areas) will be evaluated by Reclamation for the likelihood that:

- the risk for trespass and vandalism of equipment and other property and loss of habitat as a result of human-caused wildfire would be evaluated relative to other locations in the LCR MSCP planning area;
- the value of created habitats for covered species could be substantially diminished by human disturbances associated with recreation and other activities, including harassment and mortality of wildlife by domesticated pets; and

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[7] For example, creating habitat near a patch of existing habitat effectively enlarges the total habitat area, thus increasing the number of individuals that can be supported on the site. Creating habitat near existing patches of other habitat types also improves the local habitat diversity and helps meet the LCR MSCP objective of establishing mosaics of habitat.

- levels of mosquito production that could be associated with created backwaters, marsh, and habitats which require maintenance of moist soil surface or ponded water conditions during the breeding season (i.e., southwestern willow flycatcher and MacNeill's sootywing skipper habitat) would create a nuisance in nearby populated areas.

Reclamation will also evaluate the potential effects of these management considerations that could be associated with future development of nearby lands based on the available information (e.g., zoning designations, approved development plans).

Adjacent Land Uses Reclamation will evaluate adjacent land uses to assess their compatibility with conservation area management objectives. Reclamation will also consider the potential that habitat creation and management activities could adversely affect adjacent land uses.

Other Management Considerations Reclamation will consider other types of management considerations as they may apply to specific sites under consideration (e.g., the cultural importance of a site). As more knowledge is obtained through implementation of initial habitat creation projects and results of LCR MSCP research, other types of management consideration that will be used to evaluate and screen sites may be identified in the future.

Conduct Preliminary Cost Assessment

Reclamation will develop preliminary assessments of potential costs associated with securing an interest in land and water and development and maintenance of created habitats over the term of the LCR MSCP. Assessments will be prepared using the best readily available source for implementation and maintenance costs and will provide the basis for determining whether or not costs associated with securing, developing, and maintaining a site are cost effective and within the available LCR MSCP funding levels. Preliminary costs will be assessed for:

- securing an interest in land and water,
- site access,
- infrastructure improvement, construction, or installation,
- site preparation,
- habitat restoration,
- operation and maintenance (O&M),
- regulatory compliance, and
- and other cost categories as appropriate for each site.

Preliminary cost estimates will be prepared based on a conceptual habitat creation plan developed for each site[8]. Depending on how a site is identified (see *Step 1: Identification of Sites for Screening and Evaluation* above), Reclamation, the landowner, or both working cooperatively will refine the conceptual habitat creation plan based on habitat creation opportunities that are identified through review of information developed in Steps 2 and 4. Conceptual habitat creation plans are expected to be developed through an iterative process of progressive reassessments of how habitats may be developed most efficaciously based on site attributes and likely costs. The conceptual habitat creation plan provides the basis for assessing site development and maintenance costs and should include the following information:

- extent of each created habitat type;
- site access improvements (e.g., construction of access roads);
- activities that will need to be undertaken to prepare potential conservation area lands for establishing created habitats (e.g., grading, grubbing);
- water management requirements;
- infrastructure repair and new infrastructure requirements; and
- other information that may be required by Reclamation to apply the cost criteria.

Costs to Secure an Interest in Land and Water

Reclamation will estimate costs for securing land and water associated with the site based on recent market valuations that are available for similar properties. Land and water costs for sites that may be secured through lease or conservation easement will be determined for the period from which an interest is secured in the land and water through the permitted 50-year term of the LCR MSCP.

Infrastructure Improvement Costs

Reclamation will evaluate the suitability of existing infrastructure and condition for creating the habitats identified in the conceptual habitat creation plan, including access roads and other off-site infrastructure required to support the site. Based on this evaluation, Reclamation will estimate costs that could be associated with the repair of existing infrastructure or the construction or installation of new infrastructure necessary to develop the site, including:

- roads;
- irrigation and drainage system, including pumps and diversions;

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[8] Conceptual habitat creation plans will describe site development requirements at a level of detail necessary to conduct the preliminary cost assessment for each of the cost categories. Reclamation anticipates that this level of detail will correspond to an approximate 20-30% level of design.

- support infrastructure (e.g., buildings, electric power supply, domestic water supply);
- site security enhancements (e.g., fences, firebreaks, signage); and
- other relevant items that may be identified by the Program Manager (PM).

Site Preparation Costs

Reclamation will develop cost estimates for the preparation of habitat creation sites based on the conceptual plan. Items for which cost estimates may be developed include:

- removal of existing vegetation and debris,
- site grading, excavation, and disposal of overburden,
- application of soil amendments, and
- other relevant site preparation activities that may be identified by Reclamation.

Habitat Restoration Costs

Reclamation will develop cost estimates for the procurement, installation, and initial maintenance of planted or seeded plant materials (e.g., cottonwood-seedlings).

Operation and Maintenance Costs

Reclamation will develop cost estimates for O&M activities. These costs may include energy costs associated with irrigation, recurring infrastructure replacement costs, and offsite maintenance costs. Offsite maintenance costs are associated with maintaining infrastructure located outside of the conservation area (e.g., roads, drains, and canals that are located outside of the conservation area but would need to be maintained by Reclamation to provide access to and drainage and water delivery for the conservation area). Items for which cost estimates may be developed include:

- electricity and/or fuel costs for irrigation;
- pump and other infrastructure replacement costs anticipated to be incurred throughout the term of the LCR MSCP;
- offsite infrastructure maintenance costs (e.g., road grading, drain maintenance); and
- other relevant O&M costs that may be identified by Reclamation.

Regulatory Compliance Costs

Reclamation will estimate costs that may be required for compliance with environmental laws and regulations that could be associated with site development, including any environmental review required under the National Environmental Policy Act (NEPA) and California

Environmental Quality Act (CEQA). HCP habitat creation and management activities were evaluated in the LCR MSCP programmatic environmental impact statement (EIS)/environmental impact report (EIR) (LCR MSCP 2004) and covered under the record of decision (LCR MSCP 2005). Project-specific NEPA and CEQA (for sites developed in California) compliance would be tiered from the programmatic EIS/EIR.

Reclamation may review existing available information about or conduct reconnaissance-level surveys of sites to determine if regulated resources are present and their extent and location. If present, Reclamation will assess the likelihood for and extent of adverse effects on sensitive resources based on the conceptual habitat creation plan and, if regulatory compliance may be required, estimate costs for compliance. Sensitive resources for which regulatory cost estimates may be required include cultural resources regulated under Section 106 of the National Historic Preservation Act and wetlands and waters that are regulated under Section 404 of the Clean Water Act.

Step 5: Assign Habitat Creation Opportunity Ratings

Reclamation will assign, based on results of the technical evaluations and cost assessments conducted under Step 4, an overall habitat creation opportunity rating of high, moderate, or low for each potential riparian habitat creation site. These rated sites represent a pool of potential sites that may be investigated further for possible securement by Reclamation. These ratings would be assigned based on the relative ability of a site to achieve overall objectives of the LCR MSCP HCP and the likely costs associated with securing, developing, and managing a site. Generally, sites rated high will be those that:

- are available to Reclamation on a schedule that will be most likely to meet the overall LCR MSCP habitat creation schedule;
- are the most cost effective to implement;
- achieve multiple LCR MSCP habitat objectives and commitments; and
- support site conditions that are the most conducive to the successful establishment of high value habitat.

Step 6: Identify Sites for Securement through the Annual Work Plan Process

Under Step 6, the LCR MSCP Program Manager, will evaluate and rank sites from among those rated in Step 5 to move forward for securement through Reclamation's Annual Work Plan process. The Program Manager will rank sites based on their habitat opportunity ratings and other factors at the discretion of the Program Manager. These other factors may include consideration for projected riparian habitat creation budgets and considerations for the interests

of Stakeholders, cooperating state and Federal agencies, local governments, and other organizations. The Program Manager may periodically revise the site rankings in future years as new sites are screened and evaluated under Steps 1-5.

Following ranking of the sites, the Program Manager, depending on the habitat creation schedule, may select one or more of the highest ranked sites for securement through the Annual Work Plan process. During this process, Reclamation will develop detailed site information, habitat creation design plans, and cost estimates and initiate negotiations with landowners to secure interests in land and water. Consequently, sites could be eliminated from further consideration during this process based on newly developed technical information, inability to negotiate agreements with landowners, or other factors that may be identified by the Program Manager. If sites are dropped from further consideration, the Program Manager may identify replacement sites for securement from among the remaining ranked sites.

Chapter 3. Backwater Habitat Site Screening and Evaluation Process

The HCP describes a commitment to provide 360 acres of backwaters habitat that contain the physical, chemical, and biological conditions required to support native fishes of the lower Colorado River (LCR) in a healthy condition. Over 400 backwaters exist along the LCR and selecting potential backwaters for habitat development requires the application of a systematic, repeatable approach. This approach follows a similar format as that for selecting riparian habitat creation sites. In generating the screening and evaluation process for backwaters, a comprehensive review of the best currently available information was conducted. Data gaps exist pertaining to the factors important to the survival of native LCR fishes (Appendix B). The site attribute criteria used to evaluate sites, including the biological suitability criteria, were developed from a compilation of the best existing literature, stocking sites data, the conference report of a workgroup of fisheries professionals from various Federal and non-Federal agencies (Reclamation 2005), and anecdotal field information obtained from local fisheries biologists.

Backwaters along the LCR are differentiated between those that maintain a direct connection to the LCR and those that remain isolated for the purposes of this site evaluation and rating process.[9] Because of their dependency on riverine habitat, any backwater habitats used by flannelmouth sucker must be connected to the LCR (described in more detail in Appendix B). Although early life stages of this species may use backwater habitats, there is limited information available on their requirements for habitat conditions within these backwaters. The evaluation criteria used in Step 3 of the process (described below) will be different for the flannelmouth sucker than for razorback sucker and bonytail because flannelmouth sucker backwater habitat requirements differ from these species. Backwater habitat requirements are sufficiently known for razorback sucker and bonytail to evaluate potential backwater habitat creation sites. This information, however, is lacking for the early life stages of flannelmouth sucker. Consequently, the site selection process will initially focus on isolated backwater habitats (or connected sites that may be manually separated from the river). Although the criteria used for evaluating backwaters for creating flannelmouth sucker habitat will differ from those used for razorback sucker and bonytail habitat in Step 3, the process described below for evaluating backwaters in Steps 1-5 is the same for all three species. The process for screening and evaluating backwaters for the creation of backwater habitats is illustrated in Figure 2. Because the attributes of isolated and connected backwaters differ substantially (e.g., water quality), they will be evaluated and rated separately. Steps in the process include:

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[9] Connected backwaters are defined as backwaters that maintain a seasonal or year long surface water connection to the LCR. Isolated backwaters are backwaters that do not have a surface water connection with the LCR.

- Step 1: inventorying backwaters and initially screening backwaters to identify those for further screening and evaluation;
- Step 2: conducting site visits to collect technical data necessary to rate backwaters under Step 3;
- Step 3: rating the suitability of backwaters for habitat creation based on data collected in Step 2 and selecting backwaters based on those ratings for evaluation under Step 4.
- Step 4: assessing the technical feasibility and potential costs for creating habitat at backwaters selected in Step 3; and
- Step 5: select backwaters that will be pursued for habitat creation through Reclamation's Annual Work Plan process.

Step 1: Identification of Backwaters for Screening and Evaluation

During Step 1, Reclamation will conduct an initial inventory of existing backwaters within the LCR MSCP planning area and screen these backwaters using criteria that can be evaluated without visiting a site to identify those that are the most suitable for further evaluation as potential backwater habitat creation sites.

Reclamation has identified the location and physical characteristics of the more than 400 backwaters that currently exist along the LCR in recent years. Reviewing information obtained during these efforts, a comprehensive inventory of these backwaters will be developed. The data to be evaluated will include all currently available and relevant data covering the LCR backwaters (e.g., existing aerial photography, video footage archives, and existing maps). The inventory will review the characteristics of the backwaters including, but not limited to: location/reach, size, connection to river, distance from river, presence of water year round, and percent emergent vegetation. To verify the permanence of water in backwaters where this may be questionable, a helicopter survey will be performed in the winter during seasonal low flows. Step 1 will be conducted in three phases using manageable geographic ranges with one third of the LCR being surveyed during each of the three phases.

Following completion of each survey phase, Reclamation will screen these backwaters to select the most likely candidate sites for further evaluation. The screening criteria includes backwater size, connection to the LCR, permanence of surface water, landowner interest in participating in the LCR MSCP, and compatibility of onsite and nearby land uses for creating and managing backwater habitat (Appendix B). Reclamation will also review Federal, state, and local land use records, and interview landowners to obtain the information necessary to screen potential backwater habitat creation sites under this step.

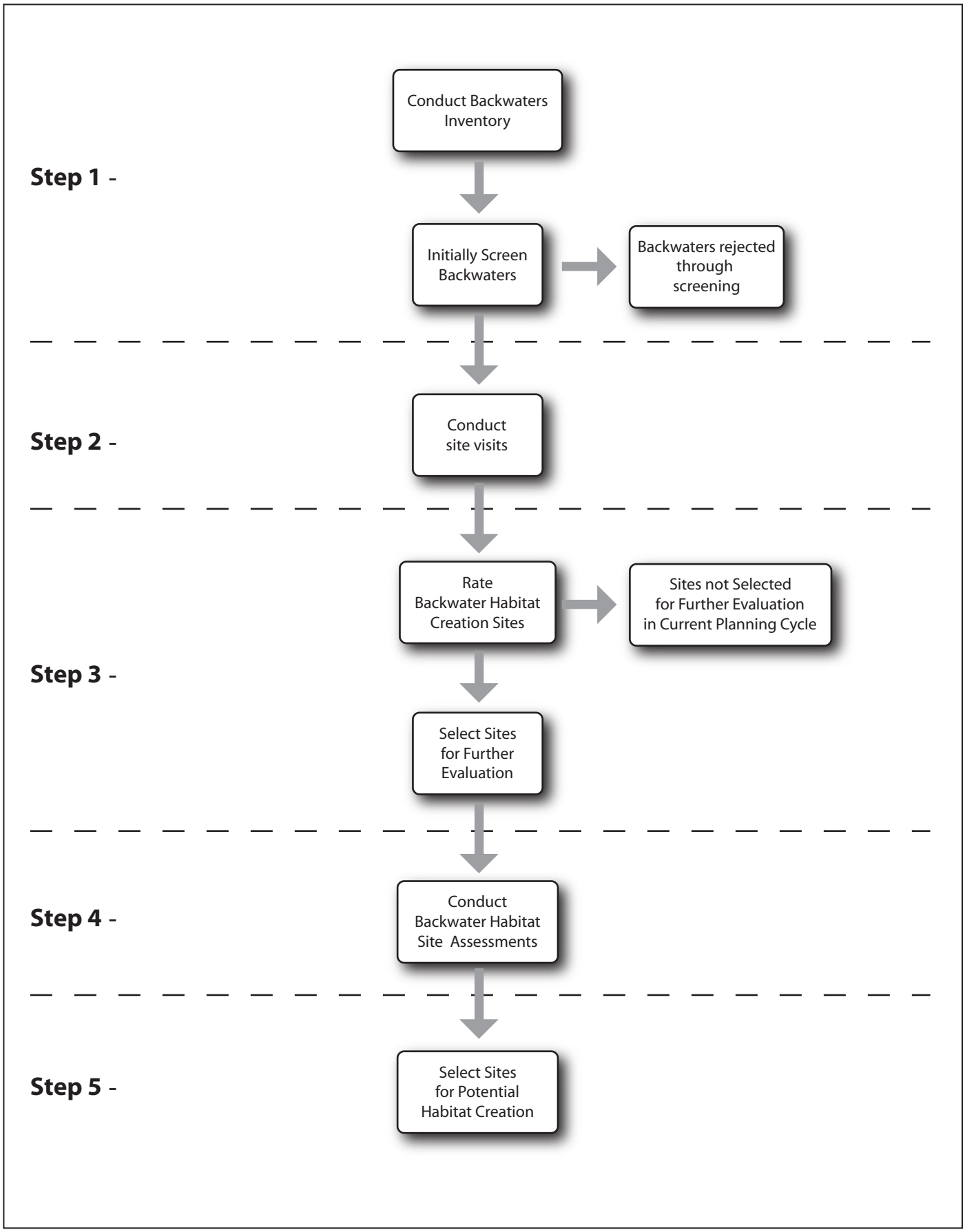

Figure 2 -
Potential Backwater Habitat Creation -
Site Screening and Evaluation Process -

Step 2: Conduct Site Visits

Of the sites that remain after the initial screening in Step 1, Reclamation will visit a limited number of these sites (to be determined based on total area of remaining backwaters, availability of funding, etc.) to assess the current biological suitability of a site. Site visits will be conducted during the peak of summer when environmental conditions are likely to be the most stressful to fish and therefore provide a worst-case scenario. Key variables that were identified to determine their suitability to provide habitat for the covered fish species include:

- water quality,
- cover,
- depth,
- gravel substrate,
- larval forage base, and
- bio-indicators.

These criteria and the methods that will be used to collect the information necessary to apply the criteria are described in detail in Appendix B. The information collected during the site visits will yield rating values for individual parameters that can be summed for an overall biological suitability score for the site (Appendix B). This information will be documented in a Trip Report for each site.

Step 3: Rate Identified Backwaters for Further Evaluation

Under Step 3, Reclamation will rate backwaters based on the information developed under Step 2. The Program Manager will then use these ratings to assist in selecting backwaters for which site assessments will be prepared under Step 4. Ratings for each connected backwater will only be compared to those of other connected backwaters and ratings for isolated backwaters will only be compared to those of other isolated backwaters. Selected sites may include both connected and isolated backwaters. Reclamation, however, will give preference to selection of isolated backwaters for creation of razorback sucker and bonytail habitat. The number of sites selected for additional evaluation will depend upon available funding. Some sites may not be selected for proceeding to Step 4 initially, but will remain candidate sites for future efforts.

Rating Potential Backwater Habitat Creation Sites

Backwaters will be assigned habitat creation opportunity ratings (high, moderate, or low) in three areas—their biological suitability score, backwater size, and long-term management

considerations. Sites with high habitat creation opportunity ratings in all three categories and no other major concerns to indicate a questionable probability of success (identified by the Program Manager) are anticipated to be selected for further evaluation under Step 4.

Biological Suitability

The biological suitability criterion quantitatively evaluates the suitability of sites to support covered fish species based on the key variables described in Step 2. The biological suitability score developed for backwaters in Step 2 indicates the current condition of each backwater as habitat for razorback sucker and bonytail. Higher scores have more parameters within the range of conditions that are preferred or suitable for the species (Table 3). Sites with lower scores would presumably require more effort to restore to a condition that would be suitable for introduction and survival of these fish species. The range of possible scores has been divided into habitat creation opportunity ratings based on anticipated quality of habitat for sites with those scores. In addition to the low, moderate, and high ratings, an excellent category was identified for backwaters that have minimal deficiencies in current habitat conditions for razorback sucker and bonytail.

Table 3. Habitat Creation Opportunity Ratings Based on Backwater Biological Suitability Criteria Scores

Habitat Creation Opportunity Rating	***Numerical Biological Suitability Criteria Score[a]***	***Rationale***
Excellent	19-30	Existing backwater conditions provide the highest probability for establishment of habitat.
High	14-18.9	Existing backwater conditions provide a high probability for establishment of habitat, but the effort required to establish habitat is likely to be more complex than for higher scoring sites.
Moderate	9-13.9	Backwaters score low in at least three biological parameters indicating that actions required to establish and maintain habitat are likely to be more complex and costly than for higher scoring sites.
Low	5-8.9	Backwaters with scores of 5-8.9 have multiple deficiencies as habitat and would likely require substantial effort to establish habitat relative to scoring rated sites.

[a] Methods for assigning numerical biological suitability criteria scores to evaluated backwaters are described in Appendix B, *Backwater Evaluation and Rating Criteria*.

Backwater Size

The backwater size criterion evaluates the spatial suitability of backwaters to provide habitat for covered fish species. Backwater size was not included as a biological suitability criterion because there is not enough information to indicate what size range would provide suitable

habitat conditions for the covered fish species. However, backwater size has implications for both biological suitability and management concerns. From a biological perspective, small isolated backwaters may not provide adequate water quality conditions and may limit the habitat diversity necessary to support all life stages of these species. In contrast, larger sites require more effort to create habitat and implement subsequent management actions to maintain the physical and biological conditions necessary to support covered fish species in a healthy condition over the term of the LCR MSCP. For example, if non-native fish are introduced into backwaters, the likelihood for their successful removal is greater in smaller backwaters.

Two categories were designated for rating backwaters based on size (Table 4). Support for the 5-acre lower bound in the high category is provided by Cibola High Levee Pond which has been highly successful in supporting native fishes and is approximately 5 acres in size (Mueller et. al. 2004). The upper bound of 40 acres in the high category represents professional judgment regarding when habitats would be too large to be efficiently managed. Reclamation (2005) proposed designing ponds as large as 17 acres, but this was within a confined area (Imperial NWR) and those designs focused on multiple small ponds rather than an individual large pond. This type of design may be very effective when possible to implement because multiple small ponds that are created or restored in a relatively small area may require less effort to manage than a single large pond. During implementation of early projects, these size bounds may be adjusted as more information is collected from early successes and failures.

Table 4. Guidelines for Evaluating Backwater Size

Habitat Creation Opportunity Rating	***Backwater Size***
High	5-40 acres
Low	1-4 acres and greater than 40 acres

Long-Term Management Considerations

The long-term management considerations criterion evaluates each site based on other factors that may affect the ability of Reclamation to effectively establish, manage, and maintain backwater habitats over the term of the LCR MSCP. Reclamation will rate each site as having a high, moderate, or low habitat creation opportunity based on other factors that may affect the ability of Reclamation to effectively establish, manage, and maintain created backwater habitat over the term of the LCR MSCP. The site constraint most likely to be associated with backwaters is the accessibility of the site as it relates to the potential likelihood for and frequency of introductions of non-native fish into created backwaters. Other types of site constraints that could be associated with individual sites (e.g., compatibility of adjacent land uses with maintaining site objectives, the cultural importance of a site) will also be considered in site evaluations, as appropriate, by Reclamation. As more knowledge is obtained through implementation of initial habitat creation projects and results of LCR MSCP research, other

types of management consideration that will be used to evaluate and screen sites may be identified in the future.

Step 4: Backwater Site Assessments

Step 4 includes a more extensive evaluation of the biological suitability of the backwaters than that conducted under Step 2 and will result in a Site Assessment Report. The site visit conducted in Step 2 will be augmented with seasonal site visits over the course of one annual cycle to determine which habitat parameters will require restoration and how much effort will be required to correct these degraded parameters. The Site Assessment Report will also include a conceptual habitat creation plan and preliminary cost assessment to provide some preliminary detail on the level of effort required and allow sites to be prioritized based on funding availability. To initiate Step 4, Reclamation may require a letter of intent to participate in the LCR MSCP from landowners.

Seasonal Site Monitoring

Reclamation will expand upon the site information gathered during the summer under Step 2 by conducting quarterly samples in the fall, winter and spring. This information will be gathered through additional site visits and will include the same protocol as data collection efforts during the summer (except that additional bathymetry surveys will not be necessary). Reclamation will generate a biological suitability score (Appendix B) and associated habitat creation opportunity rating (Table 3) for each season at each site to determine whether habitat suitability is consistent across seasons.

Conceptual Habitat Creation Plan

A conceptual habitat creation plan will be developed for each site in Step 4 by Reclamation independently or in cooperation with the landowner/land manager. Conceptual habitat creation plans are expected to be developed through an iterative process of progressive reassessments of how habitats may be developed most effectively based on site attributes and likely costs. The conceptual habitat creation plan provides the basis for assessing site development and maintenance costs and should include the following information:

- surface area of the backwater habitat;
- necessary site access and other infrastructure improvements (e.g., construction of access roads);
- biological suitability criteria that need to be improved and equipment and level of effort required for each (e.g. dredging to increase water depth or aeration for improving dissolved oxygen concentration);
- how non-native fish removal will be undertaken and probability of future reintroductions;

- preliminary maintenance and management plan for ensuring habitat suitability over life of permit; and
- other information that may be required by Reclamation to apply the cost criteria.

Preliminary Cost Assessment

Step 4 will also include development of preliminary cost estimates that will include any cost associated with securing land and water as well as development and management of created backwater habitats over the term of the LCR MSCP. Preliminary cost estimates will be prepared based on the conceptual habitat creation plan developed for each site. Cost assessments will be based on the best readily available source for implementation and maintenance costs and will provide the basis for determining whether or not costs associated with securing, developing, and maintaining a site are cost effective and within the available LCR MSCP funding levels. Preliminary costs will be assessed for:

- securing an interest in land and water,
- infrastructure improvement, construction, or installation,
- habitat restoration,
- operation and maintenance (O&M), and
- regulatory compliance
- other cost categories as appropriate.

Costs to Secure an Interest in Land and Water

Reclamation will estimate costs for securing land and water associated with the site based on recent market valuations that are available for similar properties. Land and water costs for sites that may be secured through lease or conservation easement will be determined for the period from which an interest is secured in the land and water through the permitted 50-year term of the LCR MSCP.

Infrastructure Improvement Costs

Reclamation will evaluate the suitability of existing site infrastructure, including access roads and site security enhancements. Based on this evaluation, Reclamation will estimate costs that could be associated with the repair of existing infrastructure or the construction or installation of new infrastructure necessary to develop the site, including:

- site access (e.g., roads),
- water source and delivery infrastructure,

- barriers to exclude movement of fish into connected backwaters,
- site security enhancements (e.g., fences, signage), and
- other relevant items that may be identified by the Program Manager (PM).

Habitat Restoration Costs

Reclamation will develop cost estimates for the restoration of degraded biological suitability criteria to meet the LCR MSCP requirements. In addition, the cost of renovation efforts necessary to remove non-native fish species from a site will also be determined.

Operation and Maintenance Costs

Reclamation will develop cost estimates for O&M activities. These costs may include monitoring for water quality suitability and for non-native fish introductions. In addition, the probability of degradation of water quality or of non-native fish introductions will provide an indication of the frequency with which renovation efforts may be necessary over the 50-year term of the LCR MSCP. Additional O&M costs could include maintaining infrastructure located outside of the site (e.g., roads that would need to be maintained by Reclamation to provide access to the site). Items for which cost estimates may be developed include:

- labor and equipment costs for monitoring and maintenance efforts;
- piscicide and labor costs for periodic renovation of a backwater compromised with non-native fish introductions;
- maintenance of fish barriers;
- offsite infrastructure maintenance costs (e.g., road grading); and
- other relevant O&M costs that may be identified by Reclamation.

Regulatory Compliance Costs

Reclamation will estimate costs that may be required for compliance with environmental laws and regulations that could be associated with site development, including any environmental review required under the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA). HCP habitat creation and management activities were evaluated in the LCR MSCP programmatic environmental impact statement (EIS)/environmental impact report (EIR) (LCR MSCP 2004) and covered under the record of decision (LCR MSCP 2005). Project-specific NEPA and CEQA (for sites developed in California) compliance would be tiered from the programmatic EIS/EIR.

Reclamation may review existing available information about or conduct reconnaissance-level surveys of sites to determine if regulated resources are present and their extent and location. If present, Reclamation will assess the likelihood for and extent of adverse effects on sensitive

resources based on the conceptual habitat creation plan and, if regulatory compliance may be required, estimate costs for compliance. Sensitive resources for which regulatory cost estimates may be required include cultural resources regulated under Section 106 of the National Historic Preservation Act and wetlands and waters that are regulated under Section 404 of the Clean Water Act.

Step 5: Select Potential Backwaters for Habitat Creation

Based on the habitat creation opportunity ratings assigned to backwater sites and cost estimates developed under Step 4, the Program Manager will select sites to pursue for securement through the Annual Work Plan process as described above under Step 6 for riparian habitat site evaluations.

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Appendix A. Rating Guidelines for the Riparian Habitat Site Screening Criteria

Table A. Rating Guidelines for the Riparian Habitat Site Screening Criteria

Element	***Habitat Creation Opportunity Rating***			
	EXCELLENT	IGH	ODERATE	OW
Water Availability Criteria				
Water entitlement[a]	Water entitlement is sufficient for the establishment and management of created habitats on all developable portions of the site. Sufficient additional water is available to address unanticipated increases in water use that could occur in the future.	Water entitlement is sufficient for the establishment and management of created habitats on all developable portions of the site.	Water entitlement is sufficient to allow for the establishment and management of created habitats on most of the developable portions of the site.	Water entitlement is sufficient to allow for the establishment and management of habitat on a small proportion of the developable portions of the site.
Water quality	Unlikely to affect value of created habitats.	May affect created habitat values, but effects would likely be minor and may require infrequent minor management interventions over the term of the LCR MSCP to maintain habitat values.	Likely to affect created habitat values sufficiently to warrant infrequent major management interventions over the term of the LCR MSCP to maintain habitat values.	Likely to affect created habitat values sufficiently to warrant frequent major management interventions over the term of the LCR MSCP to maintain habitat values.
Soil Conditions Criteria[b]				
Cottonwood-Willow	Large contiguous areas (e.g., ≥85% of the site) with loamy and clayey soil textures. High available water capacity. At least 80% of the site is well below salinity tolerance ranges of cottonwood-willow and associated riparian understory species (0-1 dS/m).	Large contiguous areas (e.g., 70-84% of the site) with loamy and clayey soil textures with limited inclusions of sandy soils. High-medium available water capacity. At least 70% of the site is below or within salinity tolerance ranges of cottonwood-willow, and associated riparian understory species (0-2 dS/m) and at least 20% is approaching the salinity ranges (2-3 dS/m). Soil texture supports amelioration activities to decrease salinity levels, if necessary.	Site is a relatively even mix of loamy, clay, and sandy soil textures. Medium available water capacity. Approximately 30-60% of the site is approaching the salinity tolerance ranges of cottonwood-willow and associated riparian understory species (2-3 dS/m) and less than 50% of the site is outside the salinity tolerance ranges (≥3 dS/m). Soil texture supports amelioration activities to effectively decrease salinity levels on at least 70% of the site with salinity >2 dS/m.	Large contiguous areas with sandy or clay soils (e.g., ≥50% of the site). Low available water capacity. Approximately 50% or more of the site is outside the salinity tolerance range of cottonwood-willow and associated riparian understory species (≥3 dS/m). Soil texture does not support amelioration activities to decrease salinity levels on at least 70% of the site with salinity >2 dS/m.

Table A. Rating Guidelines for the Riparian Habitat Site Screening Criteria

Element	***Habitat Creation Opportunity Rating***			
	EXCELLENT	IGH	ODERATE	OW
Honey Mesquite	Large contiguous areas (e.g., ≥85% of the site) with loamy and clayey soil textures. High available water capacity. At least 80% of the site is well below salinity tolerance ranges of honey mesquite (0-3 dS/m).	Large contiguous areas (e.g., 70-84% of the site) with loamy and clayey soil textures with limited inclusions of sandy soils. High-medium available water capacity. At least 70% of the site is within salinity tolerance ranges of honey mesquite (3-4 dS/m) and at least 20% is approaching the salinity ranges (6-8 dS/m). Soil texture supports amelioration activities to decrease salinity levels, if necessary.	Site is a relatively even mix of loamy, clay, and sandy soil textures. Medium available water capacity. Approximately 30-60% of the site is approaching the upper end of salinity tolerance ranges of honey mesquite (6-8 dS/m) and less than 50% of the site is outside the salinity tolerance ranges(≥8 dS/m). Soil texture supports amelioration activities to effectively decrease salinity levels on at least 70% of the site with salinity >4 dS/m.	Large contiguous areas with sandy or clay soils (e.g., ≥50% of the site). Low available water capacity. Approximately 50% or more of the site is outside the salinity tolerance range of honey mesquite (≥8 dS/m). Soil texture does not support amelioration activities to decrease salinity levels on at least 70% of the site with salinity >4 dS/m.
Marsh[c]	Site is dominated by clayey soils with very low to low permeability.	Site is dominated by clayey to loamy soils with low to medium permeability.	Site is relatively even mix of clayey, loamy and sandy soils with medium to high permeability.	Site is dominated by sandy and loamy soils with high permeability.
Site Location Criteria				
Proximity to occupied covered species habitat	The site is in close proximity to occupied habitat for two or more covered species for which habitat can be created	The site is in close proximity to occupied habitat for one covered species for which habitat can be created	The site is not in close proximity to occupied habitat, but is within the known dispersal distance of one or more covered species for which habitat can be created	The site is not in close proximity to occupied covered species habitats
Proximity to the LCR	The site is located within the LCR MSCP planning area or at other locations approved in the LCR MSCP Record of Decision (Department of Interior 2005).[d]	None.	None.	The site is located outside the LCR MSCP planning area and other locations approved in the LCR MSCP Record of Decision (Department of Interior 2005).[d]

Table A. Rating Guidelines for the Riparian Habitat Site Screening Criteria

Element	***Habitat Creation Opportunity Rating***			
	EXCELLENT	IGH	ODERATE	OW
Connectivity	Creation of habitat on the site will effectively fill gaps between existing habitat areas and is likely to substantially improve the LCR as a corridor for migration and dispersal of wildlife.	Creation of habitat on the site will effectively fill gaps between existing habitat areas and is likely to improve the LCR as a corridor for migration and dispersal of wildlife.	Creation of habitat on the site will fill local gaps between existing habitat areas and is likely to improve conditions for local dispersal and movement of wildlife.	Site is located such that it will not effectively fill gaps between existing habitat areas and will not likely be effective in improving conditions along the LCR for wildlife migration and dispersal.
Habitat Development Potential Criteria	H	M	L	
Site size	Site is greater than 500 acres. Sites of this size maximize the opportunity to create large patches of cottonwood-willow forest and honey mesquite bosques and to create large habitat mosaics based on minimum habitat patch size requirements for covered species.	Site is 200-500 acres. Sites of this size meet the minimum patch size requirements (see Step 3) for all species, allow for creation of large patches of cottonwood-willow forest, and creation of moderately large habitat mosaics based on minimum habitat patch size requirements for covered species.	Site is 50-199 acres. Sites of this size meet the minimum patch size requirements for all species (see Step 3) but is not optimal size for the yellow-billed cuckoo. The ability to create large habitat mosaics based on minimum habitat patch size requirements for covered species is limited for these sites.	Site is less than 50 acres. Sites of this size are less than the minimum patch size requirement for creation of Gila woodpecker habitat and are likely too small to allow for the creation of habitat mosaics based on minimum habitat patch size requirements for covered species.
Guidelines for Evaluating Long-term Management Considerations Criteria				
Potential for human-related disturbance of covered species and habitats		Site is located in a low use area and site is sufficiently buffered by vegetation or intervening lands without public access (e.g., agricultural fields) to minimize likely effects of human-related noise, visual, and pet-related disturbances and the risk of substantial trespass, vandalism, and human-caused wildfire is considered low.	Site is partially buffered by vegetation or intervening lands without public access (e.g., agricultural fields) such that the likely effects of human-related noise, visual, and pet-related disturbances are reduced and the site may be subject to infrequent incidences of trespass and vandalism.	Site is located in a high use area and wildlife using created habitats would likely be subjected to substantial human-related noise, visual, and pet-related disturbances and/or the potential for substantial trespass, vandalism, and human-caused wildfire is considered high.

Table A. Rating Guidelines for the Riparian Habitat Site Screening Criteria

Element	***Habitat Creation Opportunity Rating***			
	EXCELLENT	IGH	ODERATE	OW
Mosquito production		Site is located outside the typical flight distances of mosquito from high-density residential areas.	Site is located away from high-density residential areas, but high density residential areas are within the potential flight distances of mosquitoes that could be produced in created habitats.	Site is located in close proximity to high-density residential areas and the created habitats are likely to result in production of large numbers of mosquitoes.
Adjacent land uses	H	Site is surrounded by natural lands in low-intensity uses or is sufficiently buffered such that visual- and noise-related disturbances and potential for introduction of contaminants associated with the adjacent land uses are minimal.	Site is partially buffered from potential effects of adjacent land uses such that potential effects on created habitats and wildlife are reduced.	Site is surrounded by agricultural lands on which pesticides are regularly applied by aircraft and the risk of pesticide drift onto created habitats is considered high. Site is located near an industrial park or other facility where operation of machinery and other equipment, and visual disturbances (e.g., night lighting that illuminates created habitats) such that use of habitats by covered species and other wildlife would likely be substantially diminished.

Notes:

dS/m = decisiemens per meter. dS/m is equivalent to millimhos per centimeter (mmhos/cm) and gives the same numerical value.

[a] Water entitlement requirements are based on diversion quantities and may be adjusted in the future based on measured water quantities required to establish and maintain created habitats.

[b] Based in part on information presented in Anderson (1995), Brady (1984), and Dreesen et al. (2002). (See *Guidelines for the Screening and Evaluation of Potential Conservation Areas* for full references.)

[c] These guidelines apply to sites that currently do not support marsh hydrology. Sites that currently support marsh hydrology are assumed to support suitable soils for the establishment of marsh habitats.

[d] Other approved locations for creating habitat include the lower reaches of the Muddy River/Moapa Valley, Virgin River, Bill Williams River, and the lower Gila River Valley.

Riparian Habitat Creation Site Screening Criteria Worksheet

Site Number: _____ **Location/Reach:** _____

Site Reviewer(s): _____ **Date:** _____

Overall Ranking (circle one): Excellent High Moderate Low

Water Availability Rating (circle one)[a]	**Rationale for Rating (attach additional information if necessary)**
Excellent Moderate High Low	
Soil Conditions Rating (circle one)	**Rationale for Rating (attach additional information if necessary)**
Excellent Moderate High Low	
Site Location Rating (circle one)[a]	**Rationale for Rating (attach additional information if necessary)**
Excellent Moderate High Low	
Long-Term Management Considerations Rating (circle one)[a]	**Rationale for Rating (attach additional information if necessary)**
High Low Moderate	
Habitat Development Potential[a]	**Rationale for Rating (attach additional information if necessary)**
Excellent Moderate High Low	
Overall Rating	**Rationale for Rating (attach additional information if necessary)**
Excellent Moderate High Low	

[a] Based on guidelines presented in Table A.

Appendix B. Backwater Evaluation and Rating Criteria

This appendix provides information in support of the evaluation and rating criteria that apply to backwaters in the Guidelines for the Screening and Evaluation of Potential Conservation Areas (hereafter referred to as the Guidelines).

Backwater Evaluation Criteria

In order to determine which LCR backwaters currently provide the greatest opportunity to restore habitat for the LCR MSCP covered fish species a systematic, repeatable approach for identifying the current conditions of these sites is necessary. Despite data gaps pertaining to the factors important to the survival of native LCR fishes, a rating system was developed for site attribute criteria that appear to be most important to these species based on existing data. The site attribute criteria presented here, including the biological suitability criteria, were developed from a compilation of the best existing literature, stocking sites data, the conference report of a workgroup of fisheries professionals from various Federal and non-Federal agencies (Reclamation 2005), and anecdotal field information obtained from local fisheries biologists.

Covered Fish Species

The LCR MSCP covers four fish species that are endemic to the LCR—razorback sucker (*Xyrauchen texanus* [Abbott]), bonytail (*Gila elegans*), flannelmouth sucker (*Catostomus latipinnis* [Baird and Girard]) and humpback chub (*Gila cypha*). The LCR MSCP includes conservation measures to create specified amounts of habitat for the razorback sucker, bonytail, and flannelmouth sucker. Razorback sucker and bonytail are currently listed as endangered under the Endangered Species Act (U.S. Fish and Wildlife Service 1980, U.S. Fish and Wildlife Service 1991). Flannelmouth sucker are not listed, but are rare in the LCR due in part to the presence of non-native species and habitat alterations (BIO-WEST 2005). This is a collaborative and cooperative effort among several resource agencies to address threats to these species throughout their respective ranges.

Razorback Sucker and Bonytail (Isolated Refugia Habitats)

Although backwaters that have a direct connection to the mainstem river may be preferred by razorback sucker and bonytail (Bradford et al. 1998, Prieto 1998, Bradford and Gurtin 2000, Slaughter et al. 2002, BIO-WEST 2005) such habitats are highly vulnerable to invasion by non-native fish predators. Therefore, the HCP provides that preference should be given to using isolated backwaters for creating habitat for these two species due to the sensitivity of each to

non-native fishes. This may include habitats that are currently isolated or those that are manually separated from the river. These isolated refugia habitats[1] will deviate from conditions present in mainstem habitats, but there is information in both peer-reviewed literature and unpublished reports that indicate which habitat parameters are likely to be important for the successful maintenance of a population of each of these species (discussed in detail in steps 1 and 2 below). In general, more specific information exists regarding the habitat needs of razorback sucker than bonytail, but there have been instances in which razorback sucker and bonytail have co-existed in isolated backwater habitats (e.g., Cibola High Levee Pond (CHLP) [Mueller et al. 2004]). Because the limited information for bonytail indicate that this species may have similar habitat requirements as the razorback sucker, or at least that the two species can coexist, the more extensive data for the latter species will be used to assess the suitability of a habitat for both species. As more species-specific information is acquired, modifications to these criteria may be warranted, as determined by the LCR MSCP adaptive management process.

Flannelmouth Sucker (Connected, In-Channel Habitats)

Although not Federally listed, this species is being monitored with special concern (USFWS 1994), especially below Davis Dam where the population of flannelmouth suckers represents the only known, successful reintroduction of a native fish to the mainstem of the Colorado River (Mueller and Marsh 2002, Mueller and Wydoski 2004). Few details are available regarding habitat requirements of early flannelmouth sucker life stages, particularly in the LCR, and little is known about why this population below Davis Dam has been successfully reintroduced. However, a review of all known literature for the species (BIO-WEST 2005) indicates that flannelmouth sucker populations are larger in areas with heterogeneous habitat characteristics where cobble-gravel substrates are abundant and populations are smaller in areas where sandy substrates dominate (BIO-WEST 2005). It was also determined that flannelmouth suckers, particularly in the adult and later juvenile life stages, are highly riverine-dependent. For this reason, habitat to be created for flannelmouth sucker under the LCR MSCP must be connected to the mainstem LCR. These habitats will not exclude use by razorback sucker or bonytail, but will remain accessible to non-native fishes and have physical habitat conditions that are more specific to the needs of flannelmouth suckers and may not be preferred by the other two species.

Because of the lack of information on habitat requirements of the early life history stages of flannelmouth sucker, the site selection process will not identify specific criteria under Step 3 for rating sites for this species. Instead, important biological suitability criteria have been identified that should be considered in creating habitat for this species (Step 2). No ranges of suitability could be identified for these parameters from existing data, thus it is not possible to rate the relative suitability of backwaters for this species and proceed through the remaining evaluation steps. As more information is obtained regarding habitat requirements of the early life stages of flannelmouth sucker, appropriate criteria for rating sites may be developed.

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[1] Isolated refugia habitat is defined as isolated backwaters that provide habitat for covered fish species and that are not accessible for colonization by non-native fish present in the LCR.

Supplemental Information in Support of Guideline Steps for Screening and Evaluation of Potential Backwater Habitat Creation Sites for Razorback Sucker and Bonytail

Step 1: Identification of Backwaters for Screening and Evaluation

During Step 1, Reclamation will conduct an initial inventory of existing backwaters within the LCR MSCP planning area and screen these backwaters using criteria that can be evaluated without visiting a site to identify those that are the most suitable for further evaluation as potential backwater habitat creation sites. Anticipated screening criteria for this step are presented below.

Location/Reach

The location of a backwater provides basic information about its characteristics because backwaters located within one reach tend to have much different riverine environments, hydrologic attributes, geologic conditions, and anthropogenic influences in general, than backwaters located in another reach (Holden et al. 1986). In addition, backwaters created for the LCR MSCP must be within Reaches 3-6 and 194 of the 360 acres of the created backwaters for bonytail and razorback sucker are prioritized for establishment in California.

Size

Backwater size influences biological suitability and ease of creation and future manageability. At this stage in the screening process, a minimum size of one acre will be used for backwaters to reduce the number of sites that are evaluated in future steps. Habitat creation in these small backwaters would not substantially increase the total habitat available to the species relative to the effort required to create the habitat. In addition, water quality issues, particularly temperature, would probably limit the usefulness of these sites for long-term sustenance of native fish populations.

Connection to LCR

In accordance with the HCP (see HCP Section 5.4.3.4), Reclamation will give preference to using isolated backwaters for creation of razorback sucker and bonytail habitat. Consequently, the connectivity of the backwaters will be identified and used to screen backwaters in this first step. Because backwaters that are currently connected could be isolated, this screening factor does not necessarily screen out connected sites from further consideration. However, the screening and evaluation process for connected and isolated backwaters will be conducted separately since sites will be evaluated based on their *relative* suitability and certain characteristics will be universally different between the two backwater types.

Permanence

Permanence refers to the maintenance of water year round in an isolated backwater, even during periods of low flows. With no direct connection to the LCR, isolated backwater habitats for razorback sucker and bonytail must be maintained with water year-round to support suitable water quality conditions for these species. The initial screening step will limit the selection of backwaters to those that already maintain water year round. In the event that an insufficient number of sites remain after this screening step, additional sites that may be relatively easily dredged (e.g., easily accessed with dredging equipment) may be considered.

Current Use

1. Current use of backwater sites can influence their suitability as sites for creating LCR MSCP backwater habitats. For example, backwaters that are regularly used for sport fishing may be unsuitable because of their importance for recreation. Sites that have high value for other fish and wildlife uses may also be unsuitable for restoration efforts. In addition, backwaters located adjacent to agricultural runoff would likely be unsuitable because surface flows into these backwaters would likely contain fertilizers and other contaminants. Sites in developed areas will have to be reviewed because most will likely have high public access and may be recreationally important. However, backwaters in highly developed areas have been used successfully in the past (e.g., golf course ponds, public wetland demonstration projects, etc.).

Landowner/Land Manager Interest

Reclamation will interview landowners/land managers of backwater sites that are determined to be suitable for further evaluation based on size, land use, and permanence to determine their interest in creating backwater habitat under the LCR MSCP. Backwaters for which landowners indicate a willingness to participate in the LCR MSCP will proceed for further evaluation under Step 2.

Accessibility

Site access will influence the ability to conduct site visits and restoration efforts in a backwater. A restoration site must be accessible to the equipment necessary to modify the site conditions to meet the physical habitat needs of the species. Because any site can be accessed with appropriate equipment and sufficient effort, no sites will be screened out, but accessibility will be used as a consideration in selecting those that initially proceed to Step 2 in the evaluation process. To identify the relative difficulty of access among sites, the distance to the nearest existing road should be determined. Based on the distances, the most accessible sites that also meet the other Step 1 screening criteria should be considered first for further evaluation in Step 2. In addition, sites that are accessible by boat (i.e., isolated habitats that are within walking distance of the shoreline of the LCR) should also be considered relative to the terrain and difficulty of carrying the necessary supplies for site visits and potential restoration efforts.

Step 2: Conduct Site Visits

Field visits to each site in Step 2 will occur during the summer and include applying the criteria described below. A scoring worksheet was prepared for use during these site visits (Attachment A) that uses a repeatable, quantifiable process to assist in documenting the biological site attributes of an isolated backwater. Details on the number and location of samples as well as equipment to be used to collect samples are presented in the sampling protocol developed separately from this document (Reclamation, in press). The scoring system assigns a value to each category within a criterion based on the relative suitability of the existing conditions. The value from each criterion can then be used to generate a sum total (score) for comparing overall biological suitability among sites. Criteria with sub-components will use an average value for all sub-criteria in the final summation. This score should indicate which sites currently provide the highest habitat quality for these fish species and provide an indication of how much effort would be required to restore degraded habitats.

Key biological suitability criteria have been identified that determine the current suitability of a backwater to provide habitat for the covered fish species. These criteria and the species to which they apply are presented in Table B-1. Two or three categories were identified for each criterion that may be used for rating the current suitability of a site for the LCR MSCP covered fish species. In many cases, the available literature does not allow a precise determination of the range of conditions within a criterion that would provide the most favorable habitat conditions for the covered species. However, the proposed categories are based on information known about the habitat requirements of warm water fishes of the LCR and will provide a means for discriminating those habitats that provide relatively high quality habitat from those that are deficient in many areas. In the section for each criterion below, the ranges of each category are presented along with its relative suitability (highest, intermediate, lowest) for the covered fish species.

Table B-1. Biological Suitability Criteria

Criterion	***Razorback Sucker/Bonytail***	***Flannelmouth Sucker***
Water Quality	x	x
Cover	x	x
Depth	x	x
Substrate	x	x
Forage base	x	x
Bio-Indicators	x	x
Water Exchange	x	x
Shoreline Development Index	x	
Timing		x

Razorback Sucker and Bonytail Biological Suitability Criteria

Razorback Sucker and Bonytail Biological Criterion 1: Water Quality Water quality is a primary concern for the successful creation of isolated backwaters to support populations of razorback sucker and bonytail. There are many parameters associated with water quality and these are correlated with many other factors, including many of the criteria outlined in Table B-1. The water quality parameters selected for evaluation include dissolved oxygen, temperature, salinity, pH, selenium, and primary productivity.

Dissolved Oxygen Critical levels of dissolved oxygen have been relatively well defined for razorback sucker (BIO-WEST 2005). Boyd (1979) and Piper et al. (1982) suggest that growth in warm water fish species may become hindered when dissolved oxygen concentrations drop below 6.0 mg/L. However, razorback sucker may have greater tolerances. Early life stages of razorback sucker have been reported utilizing backwater habitats with dissolved oxygen levels of about 2.0 mg/L in Upper Basin floodplains. Juveniles and subadult razorback sucker are typically found in areas with dissolved oxygen concentrations greater than 5.0 mg/L (Modde 1996, Modde et al. 2001). Bonar et al. (2002) suggests that a dissolved oxygen level of 2.0 mg/L appears to be a critical cut-off for razorback sucker survival. Low dissolved oxygen levels, coupled with elevated summer temperatures, appear to be one of the largest hindrances to successfully maintaining native fishes in isolated backwaters of the LCR (C. Minckley, USFWS, personal communication).

Dissolved oxygen will be measured as the average minimum hypolimnetic dissolved oxygen value for a given backwater, measured in mg/L. These measurements will be distributed throughout the backwater in accordance with the sampling protocol (Reclamation, in press). To reduce the influence of organic sediments, measurements will be taken approximately 0.5m above the substrate. In addition, three dissolved oxygen profile will be taken in each backwater at intervals of 0.5m. Based on the information presented above, the lowest suitability for dissolved oxygen in isolated backwaters was chosen to be those that have an average hypolimnetic dissolved oxygen value that drops below 2 mg/L at any time. In contrast, backwaters that have an average hypolimnetic dissolved oxygen value that remains above 5 mg/L are considered to have the highest suitability for dissolved oxygen. Those backwaters with values that fall between these ranges will be categorized as having intermediate suitability for dissolved oxygen.

Temperature Bulkley and Pimental (1983) estimated the thermal preference for adult razorback sucker to be within the range of 22-25 degrees Celsius and also found that they avoided temperatures from 27.4-31.6 degrees Celsius during laboratory experimentation. Modde (1996) and Modde et al. (2001) describe that juvenile razorback sucker in the Green River prefer floodplains where maximum surface water temperatures do not exceed 26.6 degrees Celsius, but their data suggest that razorback sucker can survive periodic temperature increases to greater than 30 degrees Celsius for short durations. Bozek et al. (1990) demonstrated successful incubation of razorback sucker eggs in Lake Mohave between 9.5-15.0 degrees Celsius. The upper temperature thresholds are less well known but Bulkley and Pimentel (1983) speculate, based on temperature avoidance trials, that an upper limit for razorback sucker in the LCR may

exist at approximately 32 degrees Celsius. Bradford and Vlach (1995) reported that historic water temperatures on the Colorado River ranged from 0-32 degrees Celsius. Reclamation (2004) measured temperatures between 11.2 and 30 degrees Celsius in an isolated backwater habitat in Imperial NWF (Butler Lake). The highest LCR measurement in the vicinity of Butler Lake was approximately 29 degrees Celsius. By combining historical temperature information with laboratory-derived tolerances, it is suggested that razorback suckers may actively seek and/or avoid habitats based on temperature, as other conditions permit.

Temperature will be measured as the average maximum hypolimnetic temperature (degrees Celsius) of a backwater. Measurements will be taken in the same locations as dissolved oxygen. In addition, three temperature profiles will be taken in each backwater at intervals of 0.5m. Based on the information presented above, the lowest suitability for temperature in isolated backwaters was chosen to be those that have a maximum hypolimnetic temperature that exceeds 32 degrees Celsius. In contrast, backwaters that maintain a maximum hypolimnetic temperature below 27 degrees Celsius are considered the highest suitability for temperature. Those backwaters with maximum temperature values that fall between these ranges will be categorized as having intermediate suitability for temperature.

Salinity In permanently isolated backwater habitats, salinity levels often become elevated over time. Evaporation, saline water sources, and lack of surface flow contribute to escalating salinity levels, which can create osmoregulatory problems for freshwater fishes. In most cases, the salinity concentration of water is measured indirectly using electrical conductivity (conductivity) as a surrogate. Water conducts electricity more readily when dissolved salts are present. Over most ranges, the amount of conductivity is directly proportional to the amount of dissolved salts in the water.

At the present time, specific critical salinity limits and salinity effects on native Colorado River fishes remains largely unknown (BIO-WEST 2005), but one laboratory study provides some guidance. Pimental and Bulkely (1983) exposed bonytail and two other native fish, Colorado pikeminnow (*Ptychocheilus lucius*) and humpback chub (*Gila cypha*) to a total dissolved solids (TDS; another surrogate measure associated with salinity) gradient to determine specific concentrations that each species preferred or avoided. Bonytail selected concentrations that were four times higher than the rest of the fishes, with a preferred range of 4,100-4,700 mg/L TDS (i.e., conductivity of approximately 7,000-8,000 uS/cm). Bonytail avoided concentrations less than 560 mg/L TDS (i.e., conductivity of approximately 1,000 uS/cm) and greater than 6,600 mg/L TDS (i.e., conductivity of approximately 11,000 uS/cm).

In the wild, a range of conductivity levels have been recorded in areas where these species have been observed. Golden and Holden (2003) recorded conductivity levels from 500-1,300 uS/cm at known razorback spawning areas in Lake Mead. Unpublished conductivity readings from Lake Mohave grow-out ponds range from approximately 1,000-1,700 uS/cm (Reclamation unpublished data). Conductivity readings from rearing ponds near Page, Arizona, ranged from about 1,000-1,400 uS/cm (Mueller and Wick 1998). Similar readings have been recorded at CHLP (Mueller et al. 2004). Conductivity levels as high as 5,500 uS/cm have been recorded on occasion in ponds that have been used to rear razorback sucker at Dexter National Fish Hatchery

(M. Ulibarri, USFWS, personal communication). In Butler Lake on the Imperial NWR, readings are typically between 4,000 and 6,000 uS/cm while readings in the LCR adjacent to this site range from 1,000 to 1,200 uS/cm (Reclamation 2004).

Salinity will be measured as the average hypolimnetic conductivity value (in uS/cm) and taken in the same locations as dissolved oxygen and temperature. Sites with an average conductivity value of 5,000 uS/cm or lower will be categorized as the highest suitability for this criterion, and values above this level will be categorized as the lowest suitability. As more information becomes available through research and project implementation this attribute should be revisited.

pH pH is a measure of the concentration of hydrogen ions in water and indicates its acidity or alkalinity. Information on pH preferences specific to razorback sucker were not found, but warm-water fishes generally survive well within a pH range of 6.5-9.0 (Boyd 1979, Piper et al. 1982). The majority of backwaters investigated for razorback sucker habitat usage by Slaughter et al. (2002) ranged between a pH of 8-9, within these suggested limits for warm-water fishes. In Lake Mohave grow-out ponds, pH levels also fell within the range suggested by Boyd (1979) and Piper et al. (1982).

The pH value for a backwater will be the average hypolimnetic value and taken in the same locations as dissolved oxygen, temperature, and conductivity measurements. A pH range of 6.0-9.0 was selected for those sites with the highest suitability for the covered species while those sites falling outside of this range will be considered to have the lowest suitability.

Selenium High selenium levels can be a concern along the LCR. Prieto (1998) found that selenium levels in connected backwaters virtually track levels in the mainstem. Selenium levels average, and at times exceed, 2 ppb in the mainstem LCR (Marr and Velasco 2005). When selenium in water exceeds 2 ppb, there is increased potential for food chain bioaccumulation and subsequent reproductive impairments in fish and aquatic birds (Lemly 1996). Marr and Velasco (2005) indicated that selenium concentrations in crayfish should not exceed 4-5 ppm dry weight and concentrations in fish eggs should not exceed 10-20 ppm dry weight.

Selenium in backwaters will be measured as ppm dry weight of crayfish according to the protocol documented in Reclamation (in press). A value of 5ppm or higher dry weight will yield a rating of low suitability while backwaters with values below this threshold will be categorized in the highest suitability for this factor. In the event that no crayfish are present at a site or insufficient numbers are collected to analyze selenium content, this parameter will not be included in the calculation of the overall biological suitability score for the site.

Productivity This sub-criterion was selected to screen hypereutrophic systems which are prone to excessive algal production and periods of hypoxia corresponding to seasonal algal die-off. Cyanobacteria have been shown to be indicators of an impaired system. Levels of chlorophyll a concentrations greater than 50 μg/L and over 50% composition of cyanobacteria have been found to be detrimental to overall backwater habitat health. (ADEQ, in press).

Productivity will be measured as chlorophyll a concentration and proportion of cyanobacteria within a single grab sample in each site. Sites with high suitability for chlorophyll a will have

<50 μg/L and sites above this level will be categorized as having the lowest suitability. Sites with <50% composition of cyanobacteria will be rated as high suitability and sites above this level will be categorized as having the lowest suitability.

Razorback Sucker and Bonytail Criterion 2: Cover Various types and percentages of cover are important for adult, juvenile, and early life-history stages of razorback sucker and bonytail (Holden et al. 1986, Mueller et al. 2004, BIO-WEST 2005). Cover is considered an important enough factor that a workgroup of professionals from various agencies with extensive experience with LCR native fishes identified it as one of the important parameters that should be included in construction/restoration efforts of isolated backwaters in Imperial National Wildlife Refuge (Reclamation 2005). Although the focus of the group was limited to the refuge, the recommendations are transferable to other sites on the LCR and can be used as guidance for determining suitability of other isolated backwaters for these fishes. Three sub-criteria of cover are presented below: vegetation, rip-rap, and turbidity. Observations related to the use of various cover types have occurred in both lentic and lotic environments, with varying degrees of detail and relation to the natural environment historically occupied by these native fish species. As more species-specific information is acquired, modifications to this criterion may be warranted, as determined by the LCR MSCP adaptive management process.

Vegetation Vegetation is an important component of cover for razorback sucker and bonytail. Vegetation provides protection from predators and solar radiation and supports a diversity of diet items. A mix of seasonally and permanently available vegetative cover should provide a diverse range of habitat conditions for native fishes (Mueller et al. 2004).

In Lake Mohave repatriation efforts, stocking sites have been selected with high densities of aquatic vegetative cover to deter avian predation. Information obtained from years of trials has indicated that even large (up to 400 mm) adult razorback suckers display nocturnal tendencies and show extensive utilization of vegetative cover during daylight hours. Presumably, this behavior and affinity for cover acts to minimize predation risk (T. Burke, Reclamation, personal communication).

Additional information on vegetative cover has been obtained from CHLP, which is one of the most successful, isolated backwater habitats for native fishes along the LCR. Although no direct relationship was established between vegetative cover and survival, abundance, or some other population characteristic of the native fish in the backwater, there are many benefits that aquatic vegetation provide. Mueller et al. (2002, 2003, 2004) indicate that submergent vegetation in CHLP varies seasonally; with winter plant biomass occupying <10% of the pond's volume, while in the summer, submergent vegetation at peak growth may encompass nearly 60% of the volume of the pond. Types of submergent vegetation in CHLP include sago pondweed (*Potamogeton pectinatus*), coontail (*Myriophyllum spicatum*), and spiny naiad (*Najas marina*) (Marsh 2000). Emergent aquatic vegetation in CHLP consists of cattail (*Typha domingensis*), with various native and non-native plants providing shoreline cover (Marsh 2000).

While submerged vegetation provides valuable cover to fishes, an overabundance can cause problems. When there is great seasonal variation in plant abundance, a large quantity of plant

matter may senesce simultaneously leading to hypoxic conditions in the water column from its decomposition. In addition, daily variation in dissolved oxygen concentrations and pH can be associated with extensive vegetative cover.

The lack of specific information on appropriate types of vegetative cover and their densities indicate that the criterion should be based on information for fishes in general. Holden et al. (1986) suggest that moderate amounts (10-70%) of emergent vegetation supported higher densities of fishes in LCR backwaters than either low (<10%) or high (>70%) amounts of emergent vegetation. These numbers are closely aligned with observations of vegetative abundance in CHLP where up to 60% submergent vegetation was observed in the summer (Mueller 2004). Thus, the highest suitability will be assigned to backwaters with either emergent or submergent vegetation (submergent vegetation presumably supplies similar cover attributes as emergent vegetation) that covers 10-60% of the surface area and the lowest suitability category assigned to those backwaters with <10% or >60%. The percent coverage also may include riparian or other woody debris (e.g., beaver dams, standing tree trunks, etc.) that are contained within the backwater's surface area.

Rip-Rap Similar to vegetation, large cobble- to boulder-sized substrate provides protection from predators and solar radiation. Mueller et al. (2004) reported the importance of large rip-rap materials to bonytail at CHLP for avoiding predation and sunlight. The rip-rap covers approximately 40% of the shoreline area of CHLP. Large rip-rap materials may simulate historical boulder fields thought to have been common in certain sections of the Colorado River. In addition, the advisory workgroup (Reclamation 2005) indicated that steep rip-rap areas (i.e., at a 1.5:1 slope) may provide greater cover opportunities for bonytail. Some backwaters may also contain a naturally occurring substrate of sizes similar to rip-rap.

The presence or absence of rip-rap or similar sized substrate (large cobble to boulder size) will be noted for each backwater. Sites with the presence of rip-rap will be assigned a higher suitability rating than those without rip-rap.

Turbidity Turbid water reduces the predation risk of early life stages from predaceous fish (if present) or birds. Turbid water has been associated with increased survival of young life stages of razorback sucker and is an important component in the overall sustainability of populations along the LCR. Razorback sucker recruitment on Lake Mead has been linked to unique combinations of turbidity and vegetative cover, which presumably offer protection to early life stage razorback sucker from non-native fish predation (Holden et al. 1997, 1999, 2000a, 2000b, 2001; Abate et al. 2002; Golden and Holden 2003; Welker and Holden 2003; Welker and Holden 2004; Albrecht and Holden 2005; BIO-WEST 2005). Turbidity was measured in documented razorback sucker recruitment areas within Lake Mead and ranged between 2-85 nephelometric turbidity units (NTUs) (Golden and Holden 2003). Turbidity readings in known spawning areas ranged between 20-80 NTUs. In isolated backwater habitats, turbidity values tend to have large ranges. Turbidity readings in Butler Lake on the Imperial NWR in 2005 were approximately 125 NTUs whereas on McAlister Lake on the same NWR, readings were approximately 25 NTUs (Walker 2006).

Johnson and Hines (1999) reported that young razorback suckers preferred clearer water over water samples containing higher turbidity. However, as turbidity increased, razorback sucker predator avoidance improved under laboratory conditions, while predators became less effective at capturing prey (Johnson and Hines 1999). These researchers tested turbidity concentrations of 0, 250, and 2000 mg/L (or approximately 0.1, 6,751, and 54,001 NTUs, respectively) in an attempt to approximate the clear conditions of Lake Mohave and Colorado River turbidity levels at normal versus high run-off scenarios.

Historically, the water in certain backwaters along the LCR may have been relatively clear compared to the mainstem, particularly in connected backwaters (Prieto 1998). It is likely that razorback sucker were able to move out of the connected backwaters into the more turbid waters of the mainstem when predation pressures became acute. Problems associated with avian predation may be more prevalent in these lower turbidity environments. For example, avian predation on Lake Mohave rearing ponds has compromised successful rearing in past years (T. Burke, Reclamation, personal communication).

Although turbidity is generally associated with higher cover value to native fishes, there are negative consequences associated with excessive turbidity. One problem is associated water quality problems such as eutrophication. Eutrophication and ecological succession in isolated backwaters may lead to problems with pond longevity and other water quality parameters. In addition, excessive turbidity also reduces respiratory efficacy in fish.

The standard measurement of water turbidity will be the NTU. Turbidity in isolated backwaters will be rated such that sites with conditions that range from 10-100 NTU will be considered the highest category for suitability, with the anticipation that this category may change as additional information is collected. Backwaters with very low turbidity (0-10 NTU) should be considered moderately suitable due to an increased avian predation risk and those backwaters with high turbidity (>100 NTU) be considered the least suitable for this criterion.

Razorback Sucker and Bonytail Criterion 3: Depth Historically, native riverine Colorado River fishes occupied a wide range of depths depending upon the time of year, species of concern, and life stage (BIO-WEST 2005). There are wide ranging data on depth conditions in various habitats used by razorback sucker and bonytail, including from isolated ponds. In isolated Lake Mohave rearing ponds for razorback sucker and bonytail, the range in depth is 0.5 meters (1.6 feet) to greater than 2.5 meters (8.2 feet) at maximum depth. No clear pattern in native fish survival associated with depth variance has been observed in these ponds (Reclamation, unpublished data). CHLP, where survival has been high and successful reproduction has occurred, has maximum depths greater than 3 meters (9.8 feet). Successful grow-out ponds in Page, Arizona, were approximately 2 meters (6.5 feet) in depth (Mueller and Wick 1998). Rock Tank, a southern Arizona pond that experiences extreme summertime temperatures, ranges between 1-2 meters (3-6 feet) in depth, and has supported limited razorback sucker recruitment (Bonar et al. 2002). In the Upper and Lower Basins, razorback sucker have been documented at various depths within the mainstem.

Although there appears to be no clear pattern of fish survival or ability to reproduce in isolated ponds relative to water depth, broad guidelines can be established for determining the biological suitability of this criterion. Because of the range of depths used by these species, a high quality backwater should have a range of depths which would theoretically provide a greater diversity of habitat complexity available to each life stage during different times of the year (Reclamation 2005). For permanent, isolated backwaters, Reclamation (2005) recommended pond depths with a range of 0-3.7 meters (0-12 feet) and suggested that the majority of each pond (60%) have a 1.5-3.0 meter (5-10 feet) contour. The advisory group suggested that 20% of a permanent pond be less than 1.5 meters (5 feet) and 20% greater than 3.0-3.7 meters (10-12 feet). The latter recommendation is important because sufficient depths are also necessary to ensure that refuge areas exist from high temperature and low dissolved oxygen levels. Bulkley and Pimental (1983) reported that razorback sucker avoided elevated temperatures, if provided the opportunity. Permanently deep backwaters of at least 1.5 meters (5 feet) in depth were found to be generally beneficial to all fishes in the Holden et al. (1986) LCR backwater classification system.

Suitability categories for depth are based on two important depth contours, greater than 10-ft (desirable) and less than 5-ft (undesirable). Any backwater with more than 25% of its total area having greater than 10-ft depths should be considered the highest category for that attribute. A backwater with less than 15% of its total area having depths greater than 10-ft should be considered the least suitable and those with 16%-25% considered moderately suitable. A backwater with less than 30% of its total area having depths less than 5-ft should be considered the highest suitability with all others considered the lowest suitability.

Razorback Sucker and Bonytail Criterion 4: Substrate Historically, substrate use by the native fishes of the LCR has included virtually all types of substrate found in both riverine and lentic situations, ranging from silt and sandy materials to various sizes of gravel and cobble (BIO-WEST 2005). However, substrates used for spawning include a narrower size range. For example, Rock Tank, a location where razorback successfully spawned and recruited, displayed gravel and pebble dominated substrates ranging from 2-63 mm (0.078-2.5 inches) in diameter (Bonar et al. 2002). Similar substrates were reported by razorback sucker and bonytail spawning in CHLP and in areas of Lake Mead (Mueller et al. 2003, Welker and Holden 2003, Welker and Holden 2004, Albrecht and Holden 2005). Reclamation (2005) suggested that razorback sucker and bonytail spawning gravels should consist of large gravel to cobble-sized substrates 13-76 mm (0.5-3 inches) in diameter and should encompass approximately 5% of the acreage of a pond, while being positioned at depths less than 10 feet (Reclamation 2005, Mueller et al. 2004).

Since other available information supports the Reclamation (2005) recommendation for spawning gravels, that threshold value will be used for this evaluation. Existing backwaters with a minimum of 5% of spawning gravels (measured around their perimeters) will be considered to have the highest suitability for this criterion. Backwaters with less than 5% will be categorized as having a lower suitability.

Razorback Sucker and Bonytail Criterion 5: Forage Base A detailed literature review of razorback sucker and bonytail (BIO-WEST 2005) indicated that these species are generalists in their diet habits. Early life history studies have reported threshold densities of food items necessary for larval survival. Papoulias and Minckley (1990) found yolk absorption to occur approximately 8 days post-hatching and that the majority of larval mortality occurred within 20-30 days of hatching. These authors found that this was the result of starvation or delayed feeding after hatching. Papoulias and Minckley (1992) reared larval razorback sucker with a range of food densities and demonstrated that increased growth was positively related to invertebrate (e.g., zooplankton) densities. This research indicates the importance of maintaining a standing crop of forage sufficient to allow survival of the early life stages. Papoulias and Minckley (1990) demonstrated that larval mortality is minimized when the forage base (e.g., zooplankters) occur within the range of 50-1000 organisms/L. Marsh and Langhorst (1988) indicated that larval razorback sucker preferred food items less than 0.3mm in length. Macroinvertebrates are likely important to the survival and growth of juvenile and adult razorback sucker and bonytail, but little is known about the requirements (macroinvertebrate density or taxa) for these other life stages.

Based on the available information, the forage base in existing backwaters habitats will be evaluated for early life stages of the native fishes. Sites with more than 50 zooplankters per liter will be categorized as having the highest suitability for this criterion, while all others have a lower suitability.

Razorback Sucker and Bonytail Criterion 6: Bio-Indicators The suitability of a backwater for native fishes may be determined, in part, by the presence and health of organisms currently using the habitat. The presence of fish in isolated backwaters is an indicator that water quality conditions are suitable for fish in general, though native fish may have more restrictive needs than some non-native fishes. The absence of fish in an isolated backwater is not necessarily indicative that water quality is insufficient to support native fish, but since most backwaters have been colonized by non-native fish (that are generally more tolerant of poor habitat quality), this would raise concerns over the environmental health of the habitat.

This criterion will be evaluated by presence (high suitability) or absence (low suitability) of fish of any species.

Other Considerations Other factors that may be considered by Reclamation in evaluating the biological suitability of backwaters include water exchange, shoreline development, and timing of backwater availability. These factors will not be assigned a numerical score in the rating process, but observations will be noted in the field and incorporated into the Trip Report.

Water Exchange Water exchange is an important factor influencing water quality in backwater habitats (Holden et al. 1986). Prieto (1998) identified three wetland types along the LCR (connected lakes, pseudo-seeps [connected backwaters], and true seeps [isolated backwaters]), which all have recharge supplied by the Colorado River, but have different water exchange characteristics. The water quality measurements of connected backwaters are virtually identical to those of the mainstem whereas true seeps exhibited high evaporation rates, high temperatures, elevated electrical conductivity, relatively high turbidity levels, and low dissolved oxygen levels

(Prieto 1998). Isolated backwaters with no means of surface water exchange are subject to excessive evaporation, increased salinity concentrations, and high water temperatures. Historically, flood events temporarily reconnected isolated backwaters, preventing excess accumulation of salts. Pseudo-seeps have water quality measurements similar to the mainstem, particularly in terms of salinity, pH, temperature, and turbidity, but do not have a visible surface connection to the river and instead are connected to the river through sub-surface flow (Prieto 1998).

Although water exchange is an important parameter that influences the suitability of a site for native species, this is a difficult parameter to measure and no screening parameters were selected for the evaluation process. However, any observation on water influx, whether through seepage or from groundwater will be noted and considered in the overall assessment of project viability.

Shoreline Development Index The shoreline development index provides a descriptive measure of the shape of a backwater as an indication of deviation from a circle. It is useful in determining and describing potential habitat diversity. It provides a method of relative differentiation between relatively round and irregularly shaped shorelines. A high shoreline development index is indicative of a very diverse, desirable habitat. Such habitats typically contain an abundance of microhabitats, which promotes an organismal response and contributes to the success of the various life stages of the fishes. Holden et al. (1986) found that backwaters with a more complex shoreline appeared to be more beneficial to general fish communities than were those with simple shapes.

Although the shoreline development index value may not give a direct indication of the suitability of a backwater for the LCR MSCP fish species, it does provide valuable information on the ecological condition of the habitat. Therefore, backwaters will not be assigned a suitability value for this criterion, but a shoreline development index value will be calculated for sites considered in Step 2 from existing aerial photography and evaluated in the overall assessment of project viability.

Flannelmouth Sucker Biological Suitability Criteria

Most information on flannelmouth sucker has been collected in the upper basin of the Colorado River where the species is more common than in the LCR. Although the species may behave differently or associate with different habitat features in the Lower Colorado River, these data provide useful background information on what may be anticipated by the species in this section of the river.

Various habitat types have been reported to be important for adult, juvenile, and early life-history stages of flannelmouth sucker (Holden 1973, Holden and Stalnaker 1975, McAda 1977, Holden 1999, BIO-WEST 2005). Brandenberg et al. (2005) found that larval flannelmouth suckers in the San Juan River are typically associated with shoreline backwaters, embayments, and other low-velocity habitats. Gido et al. (1997) suggest that secondary channels may also be important to young flannelmouth sucker in the San Juan River. Larval and juvenile flannelmouth suckers reside in these habitats for the initial 2-3 months after hatching. Backwater habitats on the San Juan River differ from those on the LCR in that they are almost all relatively small (less than 1

acre) (M. Golden, BIO-WEST, personal observation), but it is unclear whether smaller backwaters may provide higher quality habitat or if larger backwaters in the LCR provide the same function for these early life stages. The section of the LCR below Davis Dam (the only section in which flannelmouth sucker are currently found) appears to be the most similar to habitats in other systems; this is the only area in the LCR with habitat complexity in the form of cobble substrate (G. Gould, Reclamation, personal communication).

As mentioned above, flannelmouth suckers are typically only found in backwater habitats for the initial 2-3 months of their life-history; backwater habitats become less important for juveniles and adults. Consequently, since these backwater habitats are used only by early life stages, the size of these habitats is probably not as critical as other habitat components (e.g., the complexity of habitat conditions in the adjacent main channel). After juveniles move out of backwaters, it is assumed that they move into areas of greater velocity, such as runs and edges of riffles (Holden 1999). These larger juveniles and adult flannelmouth suckers are not found in backwater habitats, but may use these areas as refuge during high water events (BIO-WEST 2005). Since adult flannelmouth suckers are not found in lentic (still water) backwaters or reservoirs, it is unlikely that they would persist in isolated refugia habitats such as those proposed for habitat creation for razorback sucker and bonytail. This suggests that the flannelmouth sucker has an affinity for swifter, mainstem conditions (Holden 1999, BIO-WEST 2005). Cross (1975) made similar observations of in-channel cover use by flannelmouth suckers in the Virgin River. He observed that flannelmouth suckers had an affinity for rubble-cobble, boulders, overhanging trees, or undercut banks.

There are many data gaps regarding the life history and habitat requirements of flannelmouth sucker, particularly in the LCR. The following criteria were selected as those that are most likely to be important to the species and should be considered when evaluating sites for habitat creation. Because of the importance of main channel habitat features, adjacent main channel conditions will receive significant consideration during evaluation of backwater habitat creation sites. A review of available literature for each criterion is presented, but no suitability categories were developed due to lack of specific information. As more species-specific information is acquired, a more detailed rating and evaluation process may be developed for flannelmouth sucker as determined by the LCR MSCP adaptive management process.

Flannelmouth Sucker Criterion 1: Water Quality Prieto (1998) suggested that water quality measurements in connected backwaters fluctuate with and are virtually identical to those measured in the mainstem. Flannelmouth sucker habitat is dominated by riverine conditions and connected backwaters, therefore water quality is a less important variable for this species' habitats than species in isolated backwaters. However, temperature is one water quality parameter that may fluctuate more in a backwater than the adjacent mainstem habitat.

Temperature Flannelmouth sucker have one of the highest tolerances to temperature of any of the native fishes of the Colorado River and are commonly captured in areas with water temperatures ranging from 10- 35 degrees Celsius (Cross 1975). Deacon et al. (1987) found the final thermal preferendum of flannelmouth sucker (average of 150 mm TL) is 25.9 degrees Celsius (+/- 0.5 degrees Celsius). Deacon et al. (1987) also suggested that the upper temperature

threshold determining habitat usage is highly dependant upon acclimation temperatures and that flannelmouth sucker have one of the highest tolerances to temperature of any of the native fishes of the Colorado River. Ward et al. (2002) found that fatigue velocities in young flannelmouth sucker increased with fish size and water temperature, suggesting that warmer temperatures may be important for flannelmouth recruitment and survival. A combination of low-velocity habitats with slightly elevated temperatures may provide improved conditions (e.g., increased food sources and higher metabolic rates) for increased growth rates. Since the current known range of flannelmouth sucker in the LCR is below Davis Dam, cold water releases may affect larval recruitment and water temperature may be an important variable to evaluate in selecting and designing habitat creations areas.

Flannelmouth Sucker Criterion 2: Cover At the present time, few specifics on larval and juvenile flannelmouth sucker cover preferences have been documented. However, flannelmouth suckers do persist in several systems other than the LCR where backwaters are not dominant habitat features. In those systems, habitat complexity provided by depth variations and in-channel features (e.g., woody debris piles, boulders, undercut banks) provide beneficial cover (M. Golden, BIO-WEST, personal observation). The findings of the studies on those systems may provide insight applicable to the LCR (Gido et al. 1997, Golden and Holden 2004, Golden and Holden 2005). Emergent and submerged vegetation, such as the vegetation found in backwaters, are not likely to be critical habitat components for the persistence of this species. Turbidity and overhead cover (e.g., riparian vegetation) probably provide a desirable form of cover for young-of-year and juvenile flannelmouth suckers.

Flannelmouth Sucker Criterion 3: Depth Young flannelmouth suckers can occupy relatively shallow depths (BIO-WEST 2005). Larval and early juvenile stage flannelmouth suckers have been observed in relatively shallow backwater habitats that range in depth from 0.3-1.0 meters (1-3 feet) in the San Juan River (M. Golden, BIO-WEST, personal observation). Although little is known about the depths used by adults, it is assumed that, similar to the habitat for razorback sucker and bonytail, a range of depths provides a greater diversity of habitat availability during different times of the year and to be used by different life stages (BIO-WEST 2005). Relatively shallow depths may allow for slightly elevated temperatures during critical times of the year, something that may be limiting below Davis Dam (see previous temperature section for more information). Depth will also be important relative to the backwater entrance and anticipated larval entrainment. Also important to consider with depth is the potential establishment of non-native fishes in deeper habitats. Deeper backwaters would likely be more persistent in nature allowing for residual populations of predatory non-native fishes to predominate. Ideally, backwaters for flannelmouth suckers should exist at depths to facilitate larval entrainment during high flows, persist for 3-4 months, and would then become desiccated during the remainder of the year (concepts from Modde 2005a).

Flannelmouth Sucker Criterion 4: Substrate Much of the available information pertaining to substrate usage by flannelmouth sucker is conflicting (BIO-WEST 2005), which indicates that flannelmouth sucker use a wide variety of substrate types. Information exists on substrate usage for foraging and spawning, as well as for cover, particularly within mainstem habitats. However,

cobble-gravel substrates may be preferred by flannelmouth sucker within mainstem habitats (BIO-WEST 2005).

Flannelmouth Sucker Criterion 5: Forage Base BIO-WEST (2005) provides a review of flannelmouth sucker diet components suggesting that the species is omnivorous. Overall, the food habits of the flannelmouth sucker are highly dependent upon the availability of food items, with more common items dominating the diet. Threshold densities of diet items have not been identified for flannelmouth sucker as they have with razorback sucker.

Unlike the isolated habitats proposed for razorback sucker, habitats created for flannelmouth sucker will be connected to the river, which should be a source of invertebrates, diatoms and other food items. If newly constructed backwaters are designed to entrain fish larvae, then it is logical that they may entrain other drift items including zooplankton exported from Lake Mohave and provide sufficient forage for the larval fish.

Flannelmouth Sucker Criterion 6: Timing This is a unique criterion to flannelmouth sucker and relates to the seasonal availability, persistence, and flow related access to connected backwater habitats. Populations of flannelmouth sucker typically tend to congregate for spawning activities during April and May in the LCR (Mueller and Marsh 2002). Since early life stages of flannelmouth sucker utilize backwater habitats for the initial two to three months of their life history sites should be located in areas that permit seasonal inundation during March to August to permit larval entrainment and subsequent rearing.

A management concept used in the Upper Basin allows for increased native fish recruitment through an annual "resetting" of nursery conditions (BIO-WEST 2005 and references contained therein) and may provide some guidance for habitat creation sites on the LCR. Native fish are able to exist at similar sizes to their non-native predators, theoretically minimizing any competitive and predatory advantages that non-native fishes might otherwise possess in a more permanent backwater environment (Modde 2005a). Since flannelmouth suckers are thought to spawn in April and May in the LCR (Mueller and Marsh 2002) the critical timeframe during which flows should be evaluated for entraining larvae and maintaining inundated backwaters is March to August. In instances where connected backwaters in the LCR may be dry during the remainder of the year, or at least during a period of time preceding the spawning period, conditions may prevent establishment of localized populations of predatory fishes.

In addition to having favorable conditions related to seasonal availability, another aspect of location that is important for selecting suitable habitat creation sites is location of current spawning areas. Mueller and Wydowski (2004) indicate that virtually all of their study's contacts with flannelmouth sucker were within 40 km downstream from Davis Dam. More specifically, two large spawning congregations were located, one that was adjacent to Laughlin Lagoon (15 km downstream from Davis Dam) and another near the Fort Mohave Ruins (25 km downstream from Davis Dam). Flannelmouth suckers do not appear to recruit in Lake Havasu (located nearly 80 km downstream of Davis Dam) suggesting that the best habitat creation opportunities are upstream of this impoundment.

Correlating flow information from below Davis Dam with information on drift rates to develop some initial concepts about the suitable distances downstream of these spawning locations for

backwater habitat creation. Robinson et al. (1998) found that young flannelmouth sucker do not exhibit diel drift periodicity indicating that larval fish have similar drift rates throughout the day. Mueller and Wydoski (2004) report that spawning fish were found in relatively swift currents (0.5-1.0 meters/s) within the mainstem LCR. Using this information along with egg incubation times, water temperature, and discharge information may provide some insight regarding where, and at what elevation newly created backwater habitats may provide maximum benefit for larval flannelmouth sucker.

Other Considerations Other factors that may be considered by Reclamation in evaluating the biological suitability of backwaters include water exchange, shoreline development, and timing of backwater availability.

Water Exchange Backwaters for flannelmouth sucker will be directly open to the mainstem LCR so water quality conditions will be similar to that of the river. However, too much exchange of water could potentially result in decreased temperatures in newly constructed in-channel habitats potentially compromising the effectiveness of nursery habitats to young flannelmouth sucker, if a temperature limitation exists. Care should be taken to review the amount of water exchange and influence on water temperature in these connected backwaters.

Size Because backwaters for flannelmouth sucker are not anticipated to be heavily utilized by adult life stages and only used during a short period in the life history, larger backwaters are not likely to provide additional benefits. Larger habitat features, such as large wetland backwaters, are not typically utilized by flannelmouth sucker populations (T. Modde, USFWS, personal communication), and may be more susceptible to establishment and persistence of non-natives. In contrast, small, within-river habitats may be highly important for larval and juvenile flannelmouth suckers. Also important may be the size and orientation of the connection to the mainstem in regards to entrainment of larval fish from known spawning sites. The distance to the nearest upstream spawning location may also be very important so as to maximize their potential value to this unique species during early life stages.

Step 3: Screen and Rate Identified Backwaters for Further Evaluation

As described in the Guidelines, Reclamation will rate backwaters in Step 3 based upon the information within the Trip Report developed in Step 2. Isolated backwaters will be assigned habitat creation opportunity ratings (high, moderate, or low) in three areas, their biological suitability score, the backwater size, and long-term management considerations. The LCR MSCP Program Manager will then use these ratings to assist in selecting which sites will be evaluated further with a Site Assessment in Step 4. Connected backwaters being evaluated for flannelmouth sucker habitat will not have habitat creation opportunity ratings assigned and will be evaluated on a case-by-case basis using information presented in the Trip Report.

Step 4: Backwater Site Assessments

The Site Assessment Report to be generated for Step 4 includes a more extensive evaluation of the biological suitability of the backwaters (seasonal site visits over the course of one annual

cycle), a conceptual habitat creation plan, and preliminary cost assessment. Additional detail on the seasonal site visit is presented below to supplement the Guidelines.

Seasonal Site Monitoring

Reclamation will conduct additional site visits, initially conducted during the summer months, during the other seasons of the year for prospective backwaters in Step 4. This will include a fall sample (anticipated to occur during October-November), a winter sample (anticipated between December and February), and a spring sample (anticipated between March and May). The goal of these additional visits is to document seasonal variation of habitat suitability over an annual cycle. Certain characteristics may only be observed during particular times (e.g., senescence of large quantities of plant material in the fall leading to oxygen depletion). The site visits will follow the same format as the original visits including the use of the same scoring worksheet (Attachment A). One exception will be that bathymetry surveys will not be necessary after the original depth evaluation. Instead, the water surface elevation of each backwater will be used to evaluate the water depths relative to the original survey. Reclamation will generate a biological suitability score and associated habitat creation opportunity rating (see Guidelines, Table 3) for each season at each site to determine whether habitat suitability is consistent across seasons.

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Attachment A: Biological Suitability Criteria Worksheet

Backwater Number: _____ Location/Reach: _____

Channel Formation Type: _____

Backwater Type (circle one): Connected Isolated

Observer(s):_____ Date: _____

Shoreline Development Index Value: _____ Backwater Size _____

WATER QUALITY:			**Measured Value**	**Score**
Dissolved Oxygen	(1) >5 (mg/L)	5		
	(2) 2-5	3	_____	_____
	(3) <2	1		
Temperature	(1) <27 (degrees Celsius)	5		
	(2) 27-31	3	_____	_____
	(3) >32	1		
Salinity	(1) <5000 (uS/cm)	5		
	(2) >5000	1	_____	_____
pH	(1) 6-9	5		
	(2) outside 6-9	1	_____	_____
Selenium	(1) <5 (ppm dry weight)	5		
	(2) >5	1	_____	_____
Chlorophyll a	(1) <50 (mg/L)	5		
	(2) >50	1	_____	_____
Cyanobacteria	(1) <50% composition	5		
	(2) >50% composition	1	_____	_____

Average Water Quality Score: _____/ 7 = ☐

COVER:

Vegetation	(1) 10-60% (pond's area)	5		
	(2) <10%	1	_____	_____
	(3) >60%	1		

Turbidity	(1) 10-100 (NTU)	5		
	(2) 0-10	3	_____	_____
	(3) >100	1		
Rip-Rap	(1) Present	5		
	(2) Absent	1	_____	_____

Average Cover Score: _____/3 = ☐

DEPTH:

Depth >10feet	(1) 15-25% (of pond)	5		
	(2) >25%	3	_____	_____
	(3) <15%	1		
Depth <5feet	(1) <30%	5		
	(2) >30%	1	_____	_____

Average Depth Score: _____/2 = ☐

GRAVEL SUBSTRATE:	(1) >5% (pond's perimeter)	5	☐
	(2) <5%	1	
LARVAL FORAGE BASE:	(1) >50 (zooplankton/L)	5	☐
	(2) <50	1	
BIO-INDICATORS:	(1) Fish present (any species)	5	☐
	(2) Fish absent	1	

Total Score (sum of boldfaced line items) ☐

Additional Notes:

Evidence of water exchange: _____

Unique cover features (beaver dam, standing tree trunks, undercut banks, etc.):

_____

Other observations:

_____

_____

_____

Narrative for Classification and Rating Worksheet

Informational attributes

These items position a site in relationship to other sites and help to describe the formation of the backwater for future reference.

Backwater number follows the description presented in Holden et al. (1986) and includes an initial letter to denote the state where the backwater is located (e.g., N=Nevada, C=California, A=Arizona). A number corresponding to the river mile (nearest) is also to be included.

Location/Reach refers to the particular river section/management reach in which the backwater is located as described in the LCR MSCP. The LCR is divided into seven reaches encompassing habitats from Grand Canyon to Mexico.

Channel Formation Type refers to the historical river feature that a given backwater most closely represents (or mimics). Some of these types include, but are not limited to oxbows, flood plain depressions, old river channels, and developed depressions.

Shoreline Development Index Value refers to the shape of the backwater as an indication of deviation from a circle. This metric will be determined from aerial photographs in the office, but should be noted on the field data sheet.

Biological Criteria

These criteria form the rating system that is based on currently available, species-based information. Because it is difficult to determine the relative value of each of the following criteria, each is given an equivalent range of suitability values (low=1, intermediate=3, high=5). For criteria that have sub-criteria (water quality, cover, and depth) the values of the sub-criteria are averaged for a single score.

Criteria should be added, deleted, or refined as more information is obtained through research or implementation of early projects. The original Holden et al. (1986) rating system had the benefit of being based/modified as field data were collected and analyzed. At the writing of this document, no such field validation has taken place and it is strongly suggested that the rating system be modified if/when deemed applicable.

WATER QUALITY

Dissolved oxygen is measured in mg/L and refers to the average minimum hypolimnetic dissolved oxygen value for a given backwater. This average value will include several hypolimnetic dissolved oxygen measurements from various locations throughout a backwater (detailed in Reclamation protocol [in press]).

Temperature is measured in degrees Celsius and refers to the average maximum hypolimnetic temperature of a backwater. This average value will include several

hypolimnetic temperature measurements from various locations throughout a backwater (in the same locations as dissolved oxygen measurements described above).

Salinity is measured as water conductivity (uS/cm) and refers to the average maximum hypolimnetic salinity of a backwater. This average value will include several hypolimnetic salinity measurements from various locations throughout a backwater (in the same locations as dissolved oxygen measurements described above).

pH refers to the average maximum hypolimnetic pH of a backwater. This average value will include several hypolimnetic pH measurements from various locations throughout a backwater (in the same locations as dissolved oxygen measurements described above).

Selenium is measured as ppm dry weight of crayfish. Please refer to Marr and Velasco (2005) for collection and analysis details.

Chlorophyll a is measured as mg/L. One grab sample will be collected and shipped to a laboratory for analysis according to Reclamation sample protocol (in press).

Cyanobacteria are measured as percent composition. One algal grab sample will be collected and shipped to a laboratory for counting according to Reclamation sample protocol (in press).

COVER

Vegetation refers to the percentage of the surface area of a backwater that contains emergent and/or submergent vegetation. This attribute also may include riparian or other woody debris (e.g., beaver dams, etc.) that may be contained within the backwater's surface area.

Turbidity is measured as NTU and refers to the average turbidity of all measurements. Turbidity will be measured at each hypolimnetic sample point (where dissolved oxygen, etc. point measurements are made) and in a profile (0.5m intervals).

Rip-rap will be noted as presence/absence. Substrate will be considered rip-rap if size is approximately large cobble (128mm diameter) or larger. Any smaller-sized substrate materials placed on site will be noted.

DEPTH

Depth > 10feet refers to the percentage of a backwater greater than 10-feet in depth.

Depth < 5feet refers to the percentage of a backwater less than 5-feet in depth.

GRAVEL SUBSTRATE will be measured as a percentage of the pond's perimeter with gravel-sized substrate (approximately 4mm – 64mm in diameter).

LARVAL FORAGE BASE refers to the number of zooplankton/L. Collection of zooplankton will include towing a plankton net in a circle around the center of a backwater. Samples will be preserved and returned to the laboratory for processing.

BIO-INDICATORS indicate the presence of any fish species in the backwater site. Fish sampling will vary between sites and may involve visual observations, trammel netting, seining, or other trap device for verification.

ADDITIONAL NOTES

Evidence of water exchange: Although difficult to observe in the field, the connectivity of an isolated backwater with the river and groundwater is important in providing suitable water quality. Wherever possible, observation on water influx, whether from seepage or groundwater should be noted.

Unique cover features may influence the suitability of a site beyond the rating categories provided and should be noted for possible distinction of sites that may otherwise be very similar. Features such as beaver dams, standing tree trunks, undercut banks or other features may be very important in providing cover to the MSCP-covered fish species.

Other observations may include waterfowl, high crayfish or bullfrog abundance, extensive riparian habitat or any other potentially important observation that may be important in selection of a site for restoration, but is not covered within the rating categories.