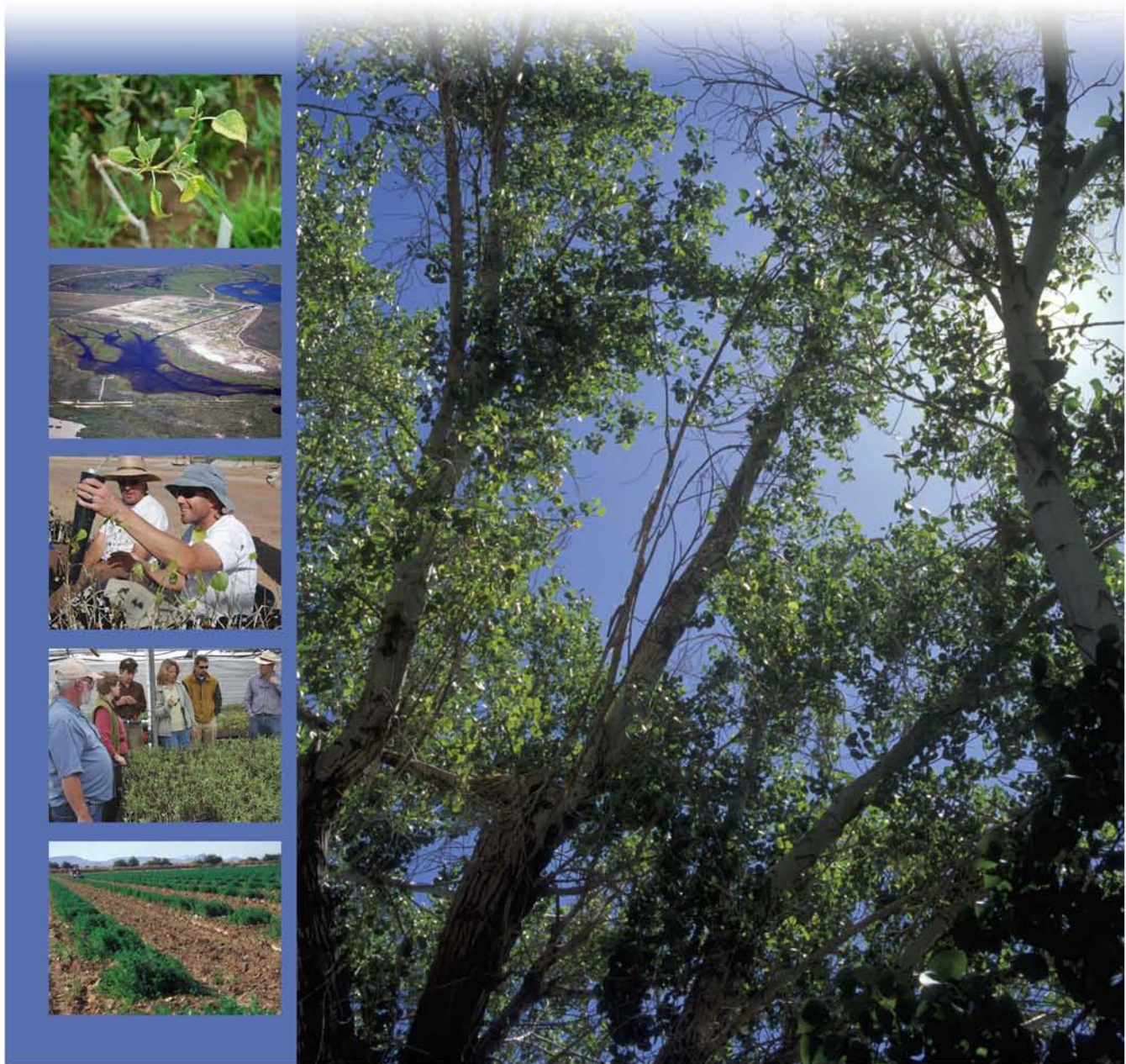




# Lower Colorado River Multi-Species Conservation Program

*Balancing Resource Needs*

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



August 10, 2006

# **Lower Colorado River Multi-Species Conservation Program Implementation Steering Committee Members**

## **Federal Participant Group**

Bureau of Reclamation  
Fish and Wildlife Service  
National Park Service  
Bureau of Land Management  
Bureau of Indian Affairs  
Western Area Power Administration

## **Arizona Participant Group**

Arizona Department of Water Resources  
Arizona Electric Power Cooperative, Inc.  
Arizona Game and Fish Department  
Arizona Power Authority  
Central Arizona Water Conservation District  
Cibola Valley Irrigation and Drainage District  
City of Bullhead City  
City of Lake Havasu City  
City of Mesa  
City of Somerton  
City of Yuma  
Electrical District No. 3, Pinal County, Arizona  
Golden Shores Water Conservation District  
Mohave County Water Authority  
Mohave Valley Irrigation and Drainage District  
Mohave Water Conservation District  
North Gila Valley Irrigation and Drainage District  
Town of Fredonia  
Town of Thatcher  
Town of Wickenburg  
Salt River Project Agricultural Improvement and Power District  
Unit "B" Irrigation and Drainage District  
Wellton-Mohawk Irrigation and Drainage District  
Yuma County Water Users' Association  
Yuma Irrigation District  
Yuma Mesa Irrigation and Drainage District

## **Other Interested Parties Participant Group**

QuadState County Government Coalition  
Desert Wildlife Unlimited

## **California Participant Group**

California Department of Fish and Game  
City of Needles  
Coachella Valley Water District  
Colorado River Board of California  
Bard Water District  
Imperial Irrigation District  
Los Angeles Department of Water and Power  
Palo Verde Irrigation District  
San Diego County Water Authority  
Southern California Edison Company  
Southern California Public Power Authority  
The Metropolitan Water District of Southern California

## **Nevada Participant Group**

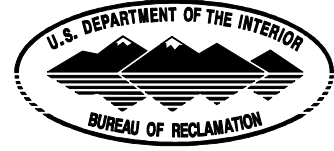
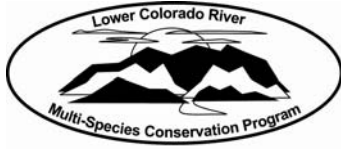
Colorado River Commission of Nevada  
Nevada Department of Wildlife  
Southern Nevada Water Authority  
Colorado River Commission Power Users  
Basic Water Company

## **Native American Participant Group**

Hualapai Tribe  
Colorado River Indian Tribes  
The Cocopah Indian Tribe

## **Conservation Participant Group**

Ducks Unlimited  
Lower Colorado River RC&D Area, Inc.



# **Lower Colorado River Multi-Species Conservation Program**

**Draft Final**

## **Guidelines for the Screening and Evaluation of Potential Conservation Areas**

**Lower Colorado River  
Multi-Species Conservation Program Office  
Bureau of Reclamation  
Lower Colorado Region  
Boulder City, Nevada  
<http://www.usbr.gov/lc/lcrmscp>**

**August 10, 2006**

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

## 9 Chapter 1. Introduction

10 The Lower Colorado River Multi-Species Conservation Program (LCR MSCP) is a multi-  
11 stakeholder Federal and non-Federal partnership responding to the need to balance the use of  
12 lower Colorado River (LCR) water resources and the conservation of native species and their  
13 habitats in compliance with the Endangered Species Act. This is a long-term (50-year) plan to  
14 conserve at least 26 species along the LCR from Lake Mead to the Southerly International  
15 Boundary with Mexico through the implementation of a Habitat Conservation Plan (LCR MSCP  
16 2004). Most of the covered species are state and/or Federally listed special status species. The  
17 Bureau of Reclamation (Reclamation) is the entity responsible for implementing the LCR MSCP  
18 over the 50-year term of the program. A Steering Committee, currently consisting of 54 entities,  
19 has been formed as described in the *LCR MSCP Funding and Management Agreement (FMA)*<sup>1</sup>,  
20 to provide input and oversight functions to support of LCR MSCP implementation.

21 The LCR MSCP Habitat Conservation Plan (HCP) (LCR MSCP 2004) provides for a habitat-  
22 based approach to conservation and includes measures to provide for the creation and  
23 management of 8,132 acres of habitat for LCR MSCP covered species. These created habitats  
24 provide mitigation for impacts of LCR MSCP covered activities evaluated in the HCP and  
25 compliance with Federal Endangered Species Act and California Endangered Species Act permit  
26 requirements (California parties only). Reclamation will create these habitats within the LCR  
27 MSCP planning area or at locations along the lower reaches of the Muddy River/Moapa Valley,  
28 Virgin River, Bill Williams River, and lower Gila River Valley (Department of the Interior  
29 2005). These habitats will be created on LCR MSCP conservation areas that are comprised of  
30 lands secured for this purpose by Reclamation. Reclamation intends to work with willing  
31 partners to secure an interest in land and water sufficient to create and maintain LCR MSCP  
32 habitats. Habitats will be created through the establishment and management of land cover types  
33 (i.e., cottonwood-willow, honey mesquite, marsh, or backwater) such that they provide the  
34 elements of each covered species habitat. It is anticipated that willing landowners will enter into

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<sup>1</sup> Provided in Exhibit A of the LCR MSCP HCP.

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

## 6 **Purpose**

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

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

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

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

---

<sup>2</sup> Lands on which habitats are created to replace permanent loss of covered species habitats would be maintained as habitat in perpetuity.



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

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

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

- 10 • the 30 COAs;
- 11 • available agricultural lands; and
- 12 • other undeveloped lands.

13 HCP Section 5.5.2 additionally states:

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

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

## 25 **Created Land Cover Types**

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

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

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

2

### 3 **Screening and Evaluation Processes**

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

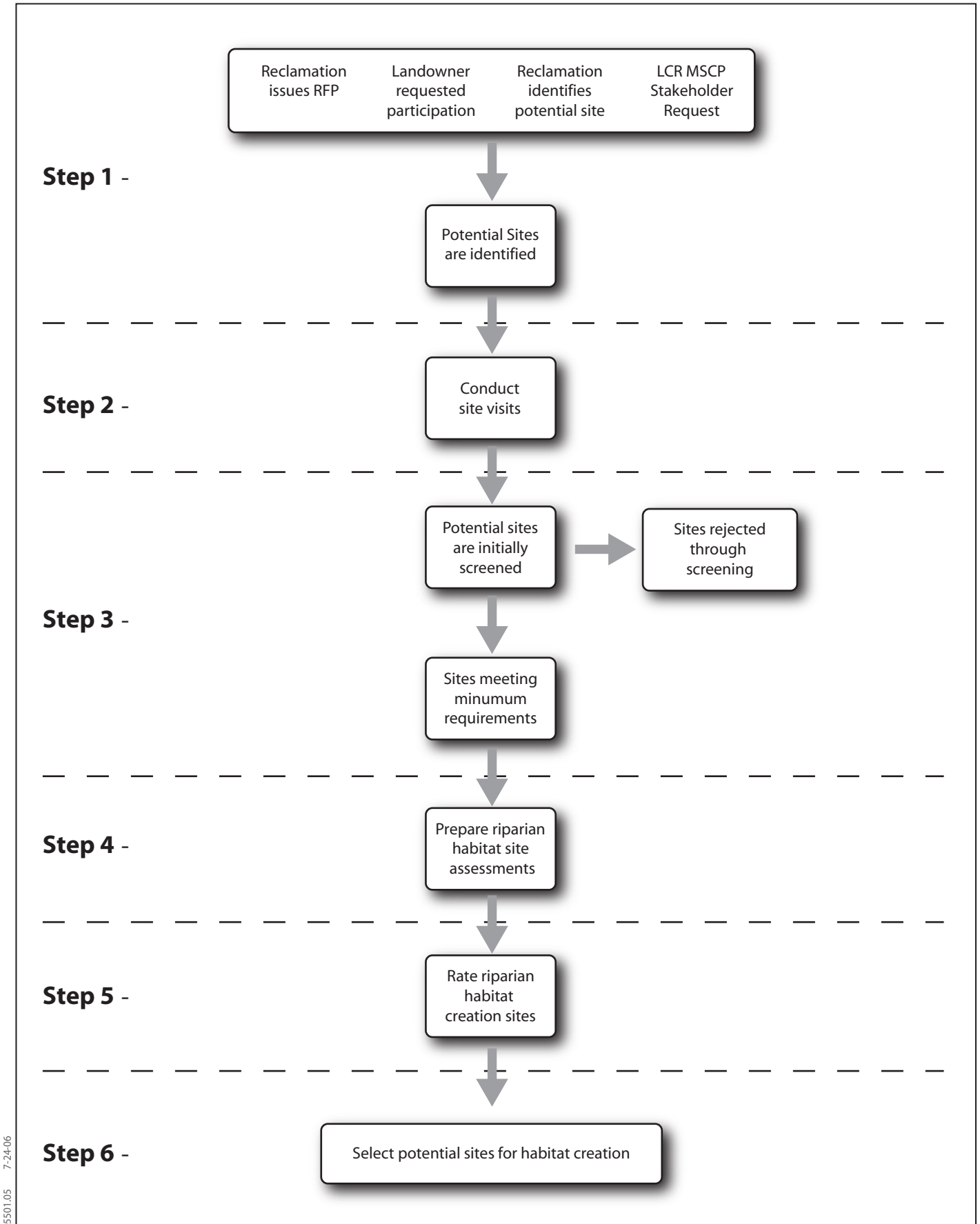
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<sup>3</sup> Riparian habitat as used in these guidelines is defined as cottonwood-willow, honey mesquite, and marsh land cover types that will be created and managed by Reclamation to provide habitat for covered species.

## 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.



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

## 1 **Step 1: Identification of Sites for Screening and Evaluation**

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

- 5 • **Landowner Request:** Landowners who wish to make their lands available for use as CAs  
6 may contact Reclamation to request that their lands be evaluated to determine their  
7 suitability for use as a conservation area. Under this process, Reclamation would provide  
8 guidance and assistance to the landowner on the requirements for submitting a proposal  
9 to Reclamation.
- 10 • **Reclamation Identified:** Reclamation may identify sites that may be suitable for creating  
11 riparian habitats, based on Reclamation's understanding of the potential availability of  
12 lands and likely suitability to meet HCP requirements for habitat creation. Under this  
13 process, Reclamation would develop, in cooperation with willing landowners, the  
14 information necessary to evaluate the suitability of sites.
- 15 • **LCR MSCP Stakeholder Request:** Stakeholders may identify to Reclamation sites that  
16 may be suitable for creating riparian habitats. Under this process, Reclamation would  
17 develop in coordination with the stakeholders identifying the sites, the information  
18 necessary to evaluate the suitability of sites.
- 19 • **Request for Proposals (RFP):** Depending on the availability of lands for use as  
20 conservation areas relative to the LCR MSCP implementation schedule, Reclamation  
21 may release a RFP for sites to be used for the establishment of CAs. Under this process,  
22 parties would submit a proposal to Reclamation in response to the RFP that provides the  
23 information requested in the solicitation. The submitted proposal would provide the  
24 initial basis from which Reclamation would evaluate the suitability of the offered lands  
25 for use as a conservation area.

## 26 **Step 2: Conduct Site Visits**

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

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

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

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

### 25 **Step 3: Initial Screening**

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

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

- 1 3. No deed, easement, or other legal restrictions are attached to the site that could limit the  
2 ability of Reclamation to create and manage habitats over the term of the LCR MSCP.
- 3 4. Sites offered for the establishment of riparian habitats must be large enough to  
4 accommodate the establishment of a minimum acreage of habitat (10, 25, or 50 acres for  
5 cottonwood-willow, depending on habitat creation requirements<sup>4</sup>; 10 contiguous acres for  
6 honey mesquite; 5 contiguous acres for marsh) and any additional area required for use as  
7 buffer land, infrastructure (e.g., roads, canals), and other features required to support the  
8 created habitat.
- 9 5. The site is *not* located where levels of human activity are sufficiently high that it is  
10 unlikely that created land cover types can fully function as covered species habitat.
- 11 6. The site must support conditions that will allow for the practicable creation of habitats.  
12 This determination will be made based on the reconnaissance-level information collected  
13 during site visits under Step 2.
- 14 7. Based on information provided by the landowner in Steps 1 and 2, no hazardous  
15 materials are present on the site of a type or in quantities that would preclude the  
16 efficacious establishment, future management, or value of habitats created on the site.
- 17 8. The site must be located such that habitats created at the site will contribute towards  
18 achieving the distribution of habitats by the river reaches suggested in the HCP.

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

## 26 **Step 4: Site Assessments**

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

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<sup>4</sup> 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.

1 **Assess Site Conditions**

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

- 7 • water availability,
- 8 • soil conditions,
- 9 • site location,
- 10 • habitat development potential, and
- 11 • site constraints.

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

<i>Water Availability</i>
<ul style="list-style-type: none"> <li>• the details of the water right, including the priority, type, and quantity;</li> <li>• description of water quality; and</li> <li>• if available, any information related to depth to groundwater.</li> </ul>
<i>Soil Conditions<sup>a</sup></i>
<ul style="list-style-type: none"> <li>• the soils present on the site based on the best available information;</li> <li>• a description of the habitats and extent of habitat that could be established and maintained on site soils; and</li> <li>• soil-related limitations to the establishment of cottonwood-willow, honey mesquite, and marsh habitats.</li> </ul>
<i>Other Relevant Information</i>
<ul style="list-style-type: none"> <li>• description of existing habitats;</li> <li>• description of existing infrastructure;</li> <li>• proximity to nearby habitats;</li> <li>• extent of site feasible for creating habitats;</li> <li>• suitability of marsh creation sites for the use of fire as a management tool;</li> <li>• long-term management likely to be required to maintain created habitats; and</li> <li>• any other available information relevant for assessing site suitability.</li> </ul>
<p><sup>a</sup> 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.</p>

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



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

### 5 ***Water Availability***

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

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

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

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

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

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

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

### 3 **Soil Condition**

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

- 7 • Soil texture: considerations include the suitability of the soil to support dominant land  
8 cover type plant species and, depending on the habitat type, water retention or drainage  
9 requirements.
- 10 • Soil salinity: considerations include whether or not soil salinity is within the tolerance  
11 range of the dominant land cover type plant species.

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

### 18 **Site Location**

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

- 20 • proximity to the LCR;
- 21 • proximity to occupied habitats for species specified in the HCP (i.e., western red bat and  
22 western yellow bat roost sites and Colorado River cotton rat, Yuma hispid cotton rat,  
23 California black rail, western least bittern, and MacNeill's sootywing skipper habitat)<sup>5</sup>;  
24 and
- 25 • improve connectivity among existing covered species habitats along the LCR<sup>6</sup>.

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

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<sup>5</sup> 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.

<sup>6</sup> 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.

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

### 3 ***Habitat Development Potential***

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

### 12 ***Long-Term Management Considerations***

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

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

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

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<sup>7</sup> 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.

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

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

### 17 ***Costs to Secure an Interest in Land and Water***

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

### 23 ***Infrastructure Improvement Costs***

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

- 29 • roads;
- 30 • irrigation and drainage system, including pumps and diversions;

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<sup>8</sup> 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.

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

4 **Site Preparation Costs**

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

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

11 **Habitat Restoration Costs**

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

14 **Operation and Maintenance Costs**

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

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

27 **Regulatory Compliance Costs**

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

1 Environmental Quality Act (CEQA). HCP habitat creation and management activities were  
2 evaluated in the LCR MSCP programmatic environmental impact statement (EIS)/environmental  
3 impact report (EIR) (LCR MSCP 2004) and covered under the record of decision (LCR MSCP  
4 2005). Project-specific NEPA and CEQA (for sites developed in California) compliance would  
5 be tiered from the programmatic EIS/EIR.

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

## 14 **Step 5: Assign Habitat Creation Opportunity Ratings**

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

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

## 28 **Step 6: Identify Sites for Securement through the Annual Work 29 Plan Process**

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

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

4 Following ranking of the sites, the Program Manager, depending on the habitat creation  
5 schedule, may select one or more of the highest ranked sites for securement through the Annual  
6 Work Plan process. During this process, Reclamation will develop detailed site information,  
7 habitat creation design plans, and cost estimates and initiate negotiations with landowners to  
8 secure interests in land and water. Consequently, sites could be eliminated from further  
9 consideration during this process based on newly developed technical information, inability to  
10 negotiate agreements with landowners, or other factors that may be identified by the Program  
11 Manager. If sites are dropped from further consideration, the Program Manager may identify  
12 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.<sup>9</sup> 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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<sup>9</sup> 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.

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

## 11      **Step 1: Identification of Backwaters for Screening and Evaluation**

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

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

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

**Step 1 -**

Conduct Backwaters Inventory



Initially Screen Backwaters



Backwaters rejected through screening

**Step 2 -**

Conduct site visits



Rate Backwater Habitat Creation Sites



Sites not Selected for Further Evaluation in Current Planning Cycle

**Step 3 -**

Select Sites for Further Evaluation



Conduct Backwater Habitat Site Assessments



Select Sites for Potential Habitat Creation

**Step 4 -**

**Step 5 -**

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

## 1 **Step 2: Conduct Site Visits**

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

- 8 • water quality,
- 9 • cover,
- 10 • depth,
- 11 • gravel substrate,
- 12 • larval forage base, and
- 13 • bio-indicators.

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

## 19 **Step 3: Rate Identified Backwaters for Further Evaluation**

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

## 29 **Rating Potential Backwater Habitat Creation Sites**

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

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

4 **Biological Suitability**

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

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

<i>Habitat Creation Opportunity Rating</i>	<i>Numerical Biological Suitability Criteria Score<sup>a</sup></i>	<i>Rationale</i>
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.

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

18 **Backwater Size**

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

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

9 Two categories were designated for rating backwaters based on size (Table 4). Support for the  
 10 5-acre lower bound in the high category is provided by Cibola High Levee Pond which has been  
 11 highly successful in supporting native fishes and is approximately 5 acres in size (Mueller et. al.  
 12 2004). The upper bound of 40 acres in the high category represents professional judgment  
 13 regarding when habitats would be too large to be efficiently managed. Reclamation (2005)  
 14 proposed designing ponds as large as 17 acres, but this was within a confined area (Imperial  
 15 NWR) and those designs focused on multiple small ponds rather than an individual large pond.  
 16 This type of design may be very effective when possible to implement because multiple small  
 17 ponds that are created or restored in a relatively small area may require less effort to manage  
 18 than a single large pond. During implementation of early projects, these size bounds may be  
 19 adjusted as more information is collected from early successes and failures.

20 **Table 4. Guidelines for Evaluating Backwater Size**

<i>Habitat Creation Opportunity Rating</i>	<i>Backwater Size</i>
High	5-40 acres
Low	1-4 acres and greater than 40 acres

21 ***Long-Term Management Considerations***

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

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

### 3 **Step 4: Backwater Site Assessments**

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

### 13 **Seasonal Site Monitoring**

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

### 21 **Conceptual Habitat Creation Plan**

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

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

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

#### 4 **Preliminary Cost Assessment**

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

12 Preliminary costs will be assessed for:

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

#### 19 ***Costs to Secure an Interest in Land and Water***

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

#### 25 ***Infrastructure Improvement Costs***

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

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



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

#### 4 ***Habitat Restoration Costs***

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

#### 8 ***Operation and Maintenance Costs***

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

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

#### 22 ***Regulatory Compliance Costs***

23 Reclamation will estimate costs that may be required for compliance with environmental laws  
24 and regulations that could be associated with site development, including any environmental  
25 review required under the National Environmental Policy Act (NEPA) and California  
26 Environmental Quality Act (CEQA). HCP habitat creation and management activities were  
27 evaluated in the LCR MSCP programmatic environmental impact statement (EIS)/environmental  
28 impact report (EIR) (LCR MSCP 2004) and covered under the record of decision (LCR MSCP  
29 2005). Project-specific NEPA and CEQA (for sites developed in California) compliance would  
30 be tiered from the programmatic EIS/EIR.

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

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

## 6 **Step 5: Select Potential Backwaters for Habitat Creation**

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

## 1   **References**

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

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

<i>Element</i>	<i>Habitat Creation Opportunity Rating</i>			
	EXCELLENT	IGH	ODERATE	OW
<b>Water Availability Criteria</b>				
Water entitlement <sup>a</sup>	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.  M	Water entitlement is sufficient to allow for the establishment and management of created habitats on most of the developable portions of the site.  L	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.
<b>Soil Conditions Criteria<sup>b</sup></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**

<i>Element</i>	<i>Habitat Creation Opportunity Rating</i>			
	EXCELLENT	IGH	ODERATE	OW
Honey Mesquite	<p>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).</p> <p style="text-align: center;">H</p>	<p>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.</p> <p style="text-align: center;">M</p>	<p>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 &gt;4 dS/m.</p>	<p>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 &gt;4 dS/m.</p>
Marsh <sup>c</sup>	<p>Site is dominated by clayey soils with very low to low permeability.</p>	<p>Site is dominated by clayey to loamy soils with low to medium permeability.</p>	<p>Site is relatively even mix of clayey, loamy and sandy soils with medium to high permeability.</p>	<p>Site is dominated by sandy and loamy soils with high permeability.</p>
<b>Site Location Criteria</b>				
Proximity to occupied covered species habitat	<p>The site is in close proximity to occupied habitat for two or more covered species for which habitat can be created</p>	<p>The site is in close proximity to occupied habitat for one covered species for which habitat can be created</p>	<p>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</p>	<p>The site is not in close proximity to occupied covered species habitats</p>
Proximity to the LCR	<p>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).<sup>d</sup></p>	<p>None.</p>	<p>None.</p>	<p>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).<sup>d</sup></p>

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

<i>Element</i>	<i>Habitat Creation Opportunity Rating</i>			
	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.
<b>Habitat Development Potential Criteria</b>				
	<b>H</b>	<b>M</b>	<b>L</b>	
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.
<b>Guidelines for Evaluating Long-term Management Considerations Criteria</b>				
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**

<i>Element</i>	<i>Habitat Creation Opportunity Rating</i>			
	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.

<sup>a</sup> 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.

<sup>b</sup> 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.)

<sup>c</sup> 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.

<sup>d</sup> 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

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

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

#### 14 **Flannelmouth Sucker (Connected, In-Channel Habitats)**

15 Although not Federally listed, this species is being monitored with special concern (USFWS  
16 1994), especially below Davis Dam where the population of flannelmouth suckers represents the  
17 only known, successful reintroduction of a native fish to the mainstem of the Colorado River  
18 (Mueller and Marsh 2002, Mueller and Wydoski 2004). Few details are available regarding  
19 habitat requirements of early flannelmouth sucker life stages, particularly in the LCR, and little is  
20 known about why this population below Davis Dam has been successfully reintroduced.  
21 However, a review of all known literature for the species (BIO-WEST 2005) indicates that  
22 flannelmouth sucker populations are larger in areas with heterogeneous habitat characteristics  
23 where cobble-gravel substrates are abundant and populations are smaller in areas where sandy  
24 substrates dominate (BIO-WEST 2005). It was also determined that flannelmouth suckers,  
25 particularly in the adult and later juvenile life stages, are highly riverine-dependent. For this  
26 reason, habitat to be created for flannelmouth sucker under the LCR MSCP must be connected to  
27 the mainstem LCR. These habitats will not exclude use by razorback sucker or bonytail, but will  
28 remain accessible to non-native fishes and have physical habitat conditions that are more specific  
29 to the needs of flannelmouth suckers and may not be preferred by the other two species.

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

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<sup>1</sup> 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.

1 **Permanence**

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

9 **Current Use**

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

20 **Landowner/Land Manager Interest**

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

26 **Accessibility**

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

1 **Step 2: Conduct Site Visits**

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

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

26 **Table B-1. Biological Suitability Criteria**

<i>Criterion</i>	<i>Razorback Sucker/Bonytail</i>	<i>Flannelmouth Sucker</i>
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 Pimental (1983) speculate, based on temperature avoidance trials, that an upper limit for razorback sucker in the LCR may

1 exist at approximately 32 degrees Celsius. Bradford and Vlach (1995) reported that historic  
2 water temperatures on the Colorado River ranged from 0-32 degrees Celsius. Reclamation  
3 (2004) measured temperatures between 11.2 and 30 degrees Celsius in an isolated backwater  
4 habitat in Imperial NWF (Butler Lake). The highest LCR measurement in the vicinity of Butler  
5 Lake was approximately 29 degrees Celsius. By combining historical temperature information  
6 with laboratory-derived tolerances, it is suggested that razorback suckers may actively seek  
7 and/or avoid habitats based on temperature, as other conditions permit.

8 Temperature will be measured as the average maximum hypolimnetic temperature (degrees  
9 Celsius) of a backwater. Measurements will be taken in the same locations as dissolved oxygen.  
10 In addition, three temperature profiles will be taken in each backwater at intervals of 0.5m.  
11 Based on the information presented above, the lowest suitability for temperature in isolated  
12 backwaters was chosen to be those that have a maximum hypolimnetic temperature that exceeds  
13 32 degrees Celsius. In contrast, backwaters that maintain a maximum hypolimnetic temperature  
14 below 27 degrees Celsius are considered the highest suitability for temperature. Those  
15 backwaters with maximum temperature values that fall between these ranges will be categorized  
16 as having intermediate suitability for temperature.

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

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

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



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

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

9 *pH* pH is a measure of the concentration of hydrogen ions in water and indicates its acidity or  
10 alkalinity. Information on pH preferences specific to razorback sucker were not found, but  
11 warm-water fishes generally survive well within a pH range of 6.5-9.0 (Boyd 1979, Piper et al.  
12 1982). The majority of backwaters investigated for razorback sucker habitat usage by Slaughter  
13 et al. (2002) ranged between a pH of 8-9, within these suggested limits for warm-water fishes. In  
14 Lake Mohave grow-out ponds, pH levels also fell within the range suggested by Boyd (1979)  
15 and Piper et al. (1982).

16 The pH value for a backwater will be the average hypolimnetic value and taken in the same  
17 locations as dissolved oxygen, temperature, and conductivity measurements. A pH range of 6.0-  
18 9.0 was selected for those sites with the highest suitability for the covered species while those  
19 sites falling outside of this range will be considered to have the lowest suitability.

20 *Selenium* High selenium levels can be a concern along the LCR. Prieto (1998) found that  
21 selenium levels in connected backwaters virtually track levels in the mainstem. Selenium levels  
22 average, and at times exceed, 2 ppb in the mainstem LCR (Marr and Velasco 2005). When  
23 selenium in water exceeds 2 ppb, there is increased potential for food chain bioaccumulation and  
24 subsequent reproductive impairments in fish and aquatic birds (Lemly 1996). Marr and Velasco  
25 (2005) indicated that selenium concentrations in crayfish should not exceed 4-5 ppm dry weight  
26 and concentrations in fish eggs should not exceed 10-20 ppm dry weight.

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

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

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

1 <50 µg/L and sites above this level will be categorized as having the lowest suitability. Sites  
2 with <50% composition of cyanobacteria will be rated as high suitability and sites above this  
3 level will be categorized as having the lowest suitability.

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

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

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

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

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

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

4 The lack of specific information on appropriate types of vegetative cover and their densities  
5 indicate that the criterion should be based on information for fishes in general. Holden et al.  
6 (1986) suggest that moderate amounts (10-70%) of emergent vegetation supported higher  
7 densities of fishes in LCR backwaters than either low (<10%) or high (>70%) amounts of  
8 emergent vegetation. These numbers are closely aligned with observations of vegetative  
9 abundance in CHLP where up to 60% submergent vegetation was observed in the summer  
10 (Mueller 2004). Thus, the highest suitability will be assigned to backwaters with either emergent  
11 or submergent vegetation (submergent vegetation presumably supplies similar cover attributes as  
12 emergent vegetation) that covers 10-60% of the surface area and the lowest suitability category  
13 assigned to those backwaters with <10% or >60%. The percent coverage also may include  
14 riparian or other woody debris (e.g., beaver dams, standing tree trunks, etc.) that are contained  
15 within the backwater's surface area.

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

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

27 *Turbidity* Turbid water reduces the predation risk of early life stages from predaceous fish (if  
28 present) or birds. Turbid water has been associated with increased survival of young life stages  
29 of razorback sucker and is an important component in the overall sustainability of populations  
30 along the LCR. Razorback sucker recruitment on Lake Mead has been linked to unique  
31 combinations of turbidity and vegetative cover, which presumably offer protection to early life  
32 stage razorback sucker from non-native fish predation (Holden et al. 1997, 1999, 2000a, 2000b,  
33 2001; Abate et al. 2002; Golden and Holden 2003; Welker and Holden 2003; Welker and Holden  
34 2004; Albrecht and Holden 2005; BIO-WEST 2005). Turbidity was measured in documented  
35 razorback sucker recruitment areas within Lake Mead and ranged between 2-85 nephelometric  
36 turbidity units (NTUs) (Golden and Holden 2003). Turbidity readings in known spawning areas  
37 ranged between 20-80 NTUs. In isolated backwater habitats, turbidity values tend to have large  
38 ranges. Turbidity readings in Butler Lake on the Imperial NWR in 2005 were approximately 125  
39 NTUs whereas on McAlister Lake on the same NWR, readings were approximately 25 NTUs  
40 (Walker 2006).

1 Johnson and Hines (1999) reported that young razorback suckers preferred clearer water over  
2 water samples containing higher turbidity. However, as turbidity increased, razorback sucker  
3 predator avoidance improved under laboratory conditions, while predators became less effective  
4 at capturing prey (Johnson and Hines 1999). These researchers tested turbidity concentrations of  
5 0, 250, and 2000 mg/L (or approximately 0.1, 6,751, and 54,001 NTUs, respectively) in an  
6 attempt to approximate the clear conditions of Lake Mohave and Colorado River turbidity levels  
7 at normal versus high run-off scenarios.

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

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

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

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

1 Although there appears to be no clear pattern of fish survival or ability to reproduce in isolated  
2 ponds relative to water depth, broad guidelines can be established for determining the biological  
3 suitability of this criterion. Because of the range of depths used by these species, a high quality  
4 backwater should have a range of depths which would theoretically provide a greater diversity of  
5 habitat complexity available to each life stage during different times of the year (Reclamation  
6 2005). For permanent, isolated backwaters, Reclamation (2005) recommended pond depths with  
7 a range of 0-3.7 meters (0-12 feet) and suggested that the majority of each pond (60%) have a  
8 1.5-3.0 meter (5-10 feet) contour. The advisory group suggested that 20% of a permanent pond  
9 be less than 1.5 meters (5 feet) and 20% greater than 3.0-3.7 meters (10-12 feet). The latter  
10 recommendation is important because sufficient depths are also necessary to ensure that refuge  
11 areas exist from high temperature and low dissolved oxygen levels. Bulkley and Pimental  
12 (1983) reported that razorback sucker avoided elevated temperatures, if provided the  
13 opportunity. Permanently deep backwaters of at least 1.5 meters (5 feet) in depth were found to  
14 be generally beneficial to all fishes in the Holden et al. (1986) LCR backwater classification  
15 system.

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

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

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

1 **Razorback Sucker and Bonytail Criterion 5: Forage Base** A detailed literature review of  
2 razorback sucker and bonytail (BIO-WEST 2005) indicated that these species are generalists in  
3 their diet habits. Early life history studies have reported threshold densities of food items  
4 necessary for larval survival. Papoulias and Minckley (1990) found yolk absorption to occur  
5 approximately 8 days post-hatching and that the majority of larval mortality occurred within 20-  
6 30 days of hatching. These authors found that this was the result of starvation or delayed feeding  
7 after hatching. Papoulias and Minckley (1992) reared larval razorback sucker with a range of  
8 food densities and demonstrated that increased growth was positively related to invertebrate  
9 (e.g., zooplankton) densities. This research indicates the importance of maintaining a standing  
10 crop of forage sufficient to allow survival of the early life stages. Papoulias and Minckley  
11 (1990) demonstrated that larval mortality is minimized when the forage base (e.g., zooplankters)  
12 occur within the range of 50-1000 organisms/L. Marsh and Langhorst (1988) indicated that  
13 larval razorback sucker preferred food items less than 0.3mm in length. Macroinvertebrates are  
14 likely important to the survival and growth of juvenile and adult razorback sucker and bonytail,  
15 but little is known about the requirements (macroinvertebrate density or taxa) for these other life  
16 stages.

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

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

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

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

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

1 (Prieto 1998). Isolated backwaters with no means of surface water exchange are subject to  
2 excessive evaporation, increased salinity concentrations, and high water temperatures.  
3 Historically, flood events temporarily reconnected isolated backwaters, preventing excess  
4 accumulation of salts. Pseudo-seeps have water quality measurements similar to the mainstem,  
5 particularly in terms of salinity, pH, temperature, and turbidity, but do not have a visible surface  
6 connection to the river and instead are connected to the river through sub-surface flow (Prieto  
7 1998).

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

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

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

### 27 ***Flannelmouth Sucker Biological Suitability Criteria***

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

33 Various habitat types have been reported to be important for adult, juvenile, and early life-history  
34 stages of flannelmouth sucker (Holden 1973, Holden and Stalnaker 1975, McAda 1977, Holden  
35 1999, BIO-WEST 2005). Brandenburg et al. (2005) found that larval flannelmouth suckers in  
36 the San Juan River are typically associated with shoreline backwaters, embayments, and other  
37 low-velocity habitats. Gido et al. (1997) suggest that secondary channels may also be important  
38 to young flannelmouth sucker in the San Juan River. Larval and juvenile flannelmouth suckers  
39 reside in these habitats for the initial 2-3 months after hatching. Backwater habitats on the San  
40 Juan River differ from those on the LCR in that they are almost all relatively small (less than 1

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

7 As mentioned above, flannelmouth suckers are typically only found in backwater habitats for the  
8 initial 2-3 months of their life-history; backwater habitats become less important for juveniles  
9 and adults. Consequently, since these backwater habitats are used only by early life stages, the  
10 size of these habitats is probably not as critical as other habitat components (e.g., the complexity  
11 of habitat conditions in the adjacent main channel). After juveniles move out of backwaters, it is  
12 assumed that they move into areas of greater velocity, such as runs and edges of riffles (Holden  
13 1999). These larger juveniles and adult flannelmouth suckers are not found in backwater  
14 habitats, but may use these areas as refuge during high water events (BIO-WEST 2005). Since  
15 adult flannelmouth suckers are not found in lentic (still water) backwaters or reservoirs, it is  
16 unlikely that they would persist in isolated refugia habitats such as those proposed for habitat  
17 creation for razorback sucker and bonytail. This suggests that the flannelmouth sucker has an  
18 affinity for swifter, mainstem conditions (Holden 1999, BIO-WEST 2005). Cross (1975) made  
19 similar observations of in-channel cover use by flannelmouth suckers in the Virgin River. He  
20 observed that flannelmouth suckers had an affinity for rubble-cobble, boulders, overhanging  
21 trees, or undercut banks.

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

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

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



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

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

22 **Flannelmouth Sucker Criterion 3: Depth** Young flannelmouth suckers can occupy relatively  
23 shallow depths (BIO-WEST 2005). Larval and early juvenile stage flannelmouth suckers have  
24 been observed in relatively shallow backwater habitats that range in depth from 0.3-1.0 meters  
25 (1-3 feet) in the San Juan River (M. Golden, BIO-WEST, personal observation). Although little  
26 is known about the depths used by adults, it is assumed that, similar to the habitat for razorback  
27 sucker and bonytail, a range of depths provides a greater diversity of habitat availability during  
28 different times of the year and to be used by different life stages (BIO-WEST 2005). Relatively  
29 shallow depths may allow for slightly elevated temperatures during critical times of the year,  
30 something that may be limiting below Davis Dam (see previous temperature section for more  
31 information). Depth will also be important relative to the backwater entrance and anticipated  
32 larval entrainment. Also important to consider with depth is the potential establishment of non-  
33 native fishes in deeper habitats. Deeper backwaters would likely be more persistent in nature  
34 allowing for residual populations of predatory non-native fishes to predominate. Ideally,  
35 backwaters for flannelmouth suckers should exist at depths to facilitate larval entrainment during  
36 high flows, persist for 3-4 months, and would then become desiccated during the remainder of  
37 the year (concepts from Modde 2005a).

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

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

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

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

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

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

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

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

1 backwater habitat creation. Robinson et al. (1998) found that young flannelmouth sucker do not  
2 exhibit diel drift periodicity indicating that larval fish have similar drift rates throughout the day.  
3 Mueller and Wydoski (2004) report that spawning fish were found in relatively swift currents  
4 (0.5-1.0 meters/s) within the mainstem LCR. Using this information along with egg incubation  
5 times, water temperature, and discharge information may provide some insight regarding where,  
6 and at what elevation newly created backwater habitats may provide maximum benefit for larval  
7 flannelmouth sucker.

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

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

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

### 27 **Step 3: Screen and Rate Identified Backwaters for Further Evaluation**

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

### 36 **Step 4: Backwater Site Assessments**

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

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

### 3 ***Seasonal Site Monitoring***

4 Reclamation will conduct additional site visits, initially conducted during the summer months,  
5 during the other seasons of the year for prospective backwaters in Step 4. This will include a fall  
6 sample (anticipated to occur during October-November), a winter sample (anticipated between  
7 December and February), and a spring sample (anticipated between March and May). The goal  
8 of these additional visits is to document seasonal variation of habitat suitability over an annual  
9 cycle. Certain characteristics may only be observed during particular times (e.g., senescence of  
10 large quantities of plant material in the fall leading to oxygen depletion). The site visits will  
11 follow the same format as the original visits including the use of the same scoring worksheet  
12 (Attachment A). One exception will be that bathymetry surveys will not be necessary after the  
13 original depth evaluation. Instead, the water surface elevation of each backwater will be used to  
14 evaluate the water depths relative to the original survey. Reclamation will generate a biological  
15 suitability score and associated habitat creation opportunity rating (see Guidelines, Table 3) for  
16 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

8	Dissolved Oxygen	(1) >5 (mg/L)	5		
		(2) 2-5	3	_____	_____
		(3) <2	1		
11	Temperature	(1) <27 (degrees Celsius)	5		
		(2) 27-31	3	_____	_____
		(3) >32	1		
14	Salinity	(1) <5000 (uS/cm)	5		
		(2) >5000	1	_____	_____
16	pH	(1) 6-9	5		
		(2) outside 6-9	1	_____	_____
18	Selenium	(1) <5 (ppm dry weight)	5		
		(2) >5	1	_____	_____
20	Chlorophyll a	(1) <50 (mg/L)	5		
		(2) >50	1	_____	_____
22	Cyanobacteria	(1) <50% composition	5		
		(2) >50% composition	1	_____	_____

Average Water Quality Score: \_\_\_\_\_ / 7 =

## COVER:

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

1 Turbidity (1) 10-100 (NTU) 5  
 2 (2) 0-10 3 \_\_\_\_\_  
 3 (3) >100 1 \_\_\_\_\_

4 Rip-Rap (1) Present 5  
 5 (2) Absent 1 \_\_\_\_\_

Average Cover Score: \_\_\_\_\_/3 =

**DEPTH:**

8 Depth >10feet (1) 15-25% (of pond) 5  
 9 (2) >25% 3 \_\_\_\_\_  
 10 (3) <15% 1 \_\_\_\_\_

11 Depth <5feet (1) <30% 5  
 12 (2) >30% 1 \_\_\_\_\_

Average Depth Score: \_\_\_\_\_/2 =

14 **GRAVEL SUBSTRATE:** (1) >5% (pond's perimeter) 5   
 15 (2) <5% 1

16 **LARVAL FORAGE BASE:** (1) >50 (zooplankton/L) 5   
 17 (2) <50 1

18 **BIO-INDICATORS:** (1) Fish present (any species) 5   
 19 (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

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

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

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

10 Selenium is measured as ppm dry weight of crayfish. Please refer to Marr and Velasco  
11 (2005) for collection and analysis details.

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

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

### 17 **COVER**

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

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

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

### 28 **DEPTH**

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

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

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

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

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

7 **ADDITIONAL NOTES**

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

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

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