Riparian Buffer Design Guidelines

For Water Quality and Wildlife Habitat Functions on Agricultural Landscapes in the Intermountain West

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Case Study

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Contents

Case Study

This hypothetical case study illustrates how the riparian buffer planning protocol described in the RB handbook is used to plan a buffer for both water quality and wildlife conservation on a specific project site. The case study site includes riparian buffer characteristics typical of the study area-variable topography and soils, flood plain wetlands, seeps, springs, fringe riparian vegetation, grazed and ungrazed shrub-steppe, and row crop agriculture.

The case study highlights the sequential preparation of maps used to illustrate buffer width recommendations that respond to various site attributes based on dimensions obtained from buffer width keys and matrices in the protocol for water quality and wildlife habitat. The mapping sequence results in two final riparian buffer maps. One map depicts optimum buffer widths and land use zones with accompanying land use and restrictions for water quality functions. The second map depicts an optimum buffer configuration and land use zones with accompanying general habitat management recommendations for wildlife conservation tiered to levels of landowner willingness/ability to participate in wildlife conservation.

The hypothetical buffer case study site, 2,100 ft in length, is located on a first order stream in a sub-watershed dominated by farming and ranching land uses. There are no dams or diversions up stream of the project site. A healthy population of brown trout persists in the stream reach bounded by the project site. It is an important recreation resource for local anglers and tourists. The landowner cultivates a field devoted to small grain production within 300 ft of the stream. Pre-emergent herbicides are applied and the field is fertilized annually. Insecticides are also applied if needed. A segment of the proposed buffer is grazed and cattle access the river to drink. Surface erosion and bank sloughing occur in several cattle access locations. A large patch of shrub-steppe upland, which hasn't been grazed in 30 years, is within the proposed buffer boundary. Invasive exotic plant species have established themselves in patches of varying sizes across the project site.

Riparian/wetland vegetation is confined to a narrow fringe along the stream edge and landward along a spring that flows into the river. Although narrow, age class diversity of native riparian woody vegetation is high and plants are healthy, matching adjacent undisturbed reference sites. The ratio of expected to observed riparian obligate and dependant breeding land birds that inhabit the site during the breeding season was estimated at 75 percent.

The site is also used as a migration corridor by passive birds that nest at higher elevations. Moose and mule deer use the buffer in early spring and late fall as a migration corridor connecting summer and winter ranges. There are no T or E species or State listed species of concern that inhabit or use the site in any significant way.

The landowner's primary objective for the riparian buffer is to improve the quality of water leaving the property and entering the stream. However, the landowner also wants to improve habitat quality within the buffer for a diversity of riparian obligate and dependant species (Level 2 participation).

Section A: Water Quality Protocol

Presented below are a series of bullet points that summarize the previous water quality protocol discussion. The bullet points are illustrated on case study maps that follow.

- Watershed context map (fig. CS-1).
- Existing landscapes features map (fig. CS-2).
- Delineate project boundaries and buffer units (fig. CS-3).
- Gather and map primary buffer attribute data (figs. CS-4 and CS-5).
- Gather and map secondary site attribute data (fig. CS-6).
- Determine the unadjusted optimum buffer width for each buffer unit using the buffer width key.
- Adjust the width generated from the key for each buffer unit according to additional factors (secondary attributes) affecting buffer function (fig. CS-7).
- Map a continuous optimum buffer width line (Zone 2) over the entire project site (all buffer units). Map unstable stream banks, which have been caused by human disturbance (fig. CS-8).

The optimum riparian buffer configuration designed for water quality functions for the entire project site will be delineated when the evaluator has completed the seven steps described above.

Section B: Wildlife Habitat Protocol

Presented below are a series of bullet points that summarize the previous wildlife habitat protocol discussion. The bullet points are illustrated on the maps that follow. The optimum riparian buffer configuration designed for water quality functions as described above serves as the basic footprint for the inventory, analysis, and design of the buffer for wildlife habitat.

- Use the optimum water quality buffer configuration as the base map for wildlife habitat planning (fig. CS-9).
- Use the same baseline and discrete buffer units used for water quality buffer planning to prepare the wildlife habitat plan (fig. CS-9)
- Delineate the riparian/wetland and upland plant communities in each buffer unit on the base map (fig. CS-9).
- Determine the level of landowner willingness/ability to participate in a wildlife conservation project.
- Determine whether or not T or E species or State listed species of concern inhabit or make substantial use of the project site.
- Inventory and rate primary wildlife habitat buffer functional attribute data for both upland and riparian/wetland plant communities for each buffer unit by working through the protocol matrices.
- Estimate plant community vigor.
- Estimate level of human induced disturbance/fragmentation.
- Estimate relative abundance of invasive exotic plants.
- Calculate ratio of expected riparian obligate and dependent breeding land birds to birds observed.
- Rate project scale attribute, stand age diversity for woody riparian/wetland vegetation. Note: *The project scale attribute may be used to modify functional condition ratings only to the riparian/wetland plant community and only when the length of the riparian buffer project site is greater than 1200 ft in length*.
- Use the riparian and upland Ecological Function Condition Rating Keys to produce an Unadjusted Ecological Functional Condition Rating Map (fig. CS-10).

- Rate habitat suitability for target specie(s) by comparing existing riparian/wetland and/or upland plant community functional condition with habitat parameters for the target species. Record specific management recommendations for the target species in the comments section. Note: *This rating only applies to projects where the landowner has identified habitat for a target specie(s) as a project objective.*
- Using the Functional Condition Adjustment Key produce the Ecological Functional Condition Map (fig. CS-11).
- Using the Wildlife Habitat Management and Land Use Zone key, produce a map showing wildlife habitat management recommendations and land use zones tiered to landowner willingness/ability to participate in wildlife conservation (figs. CS-12 and CS-13).
- Determine species specific management recommendations if landowner has a target specie(s) as a project objective. Note: *Consultation with NRCS or state DWR biologists is recommended when developing species specific habitat management plans. A list of important habitat characteristics to inventory and analyze when preparing a specific habitat management plan can be found in Appendix B-3.*

The optimum riparian buffer width for both water quality and wildlife habitat for Levels 1 and 2 will be delineated when the evaluator has completed the mapping or rating steps described above. It is beyond the scope of this handbook to describe the patch, corridor, and matrix principles required to effectively expand and connect riparian buffer habitat to adjacent habitats necessary to meet Level 3 landowner objectives. However, the NRCS publication "Conservation Corridor Planning at the Landscape Level: Managing for Wildlife Habitat" covers these topics in great detail.

Describing habitat enhancement, rehabilitation, reclamation, or restoration techniques is also beyond the scope of this document. Listed below are several excellent references specific to the study area that cover these topics. In addition, consulting with NRCS, state DWR biologists, and habitat specialists within NGO's such as Nature Conservancy, Audubon, Ducks Unlimited, Pheasants Forever, and others can be very useful.

Riparian and Shrub-Steppe Restoration Reference List

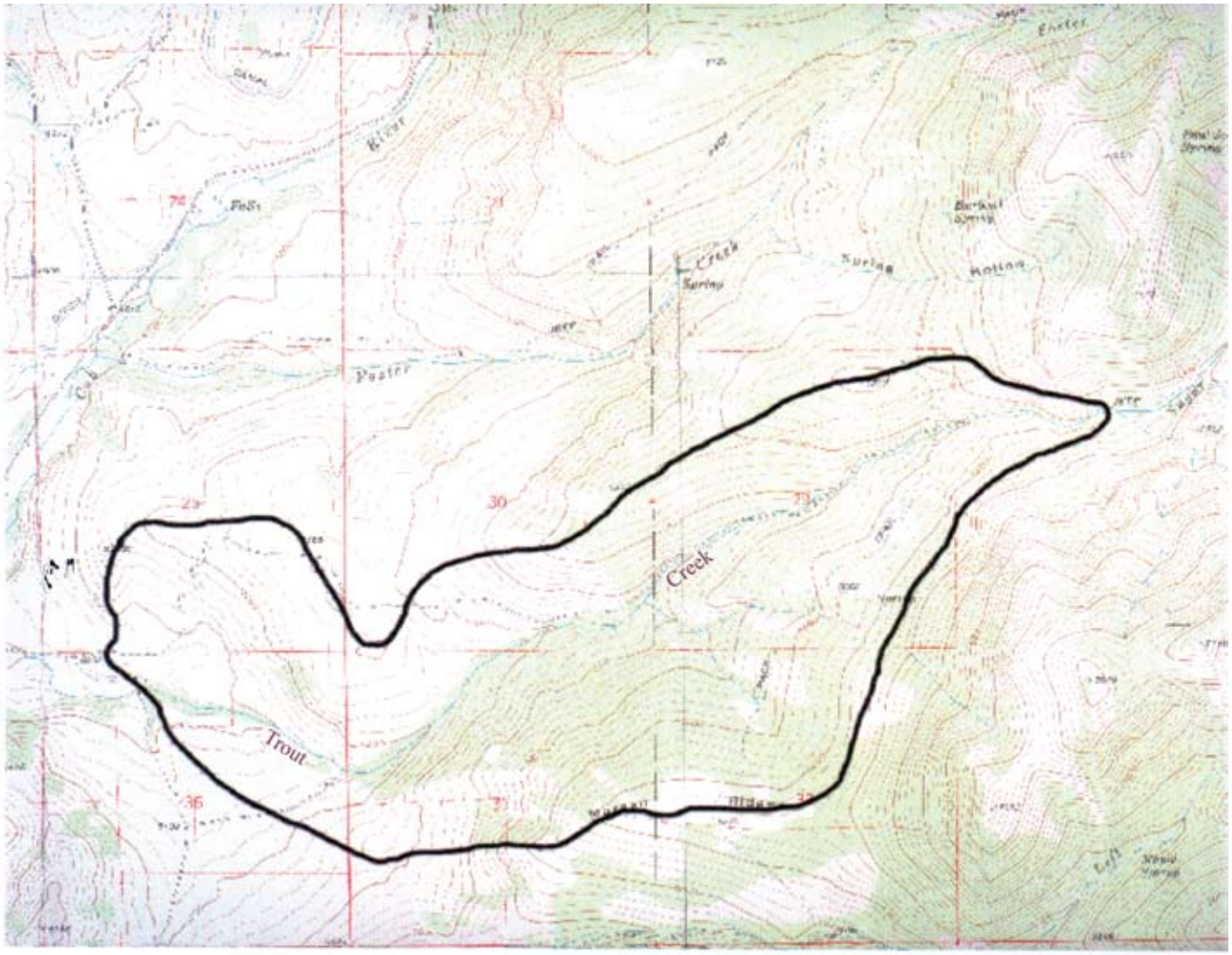
Bentrup, G.; Hoag, C. 1998. The practical streambank bioengineering guide: users guide for natural streambank stabilization in the arid and semi-arid Great Basin and Intermountain West. Aberdeen, ID: USDA Natural Resources Conservation Service Plant Materials Center. 165 p.

Federal Interagency Stream Restoration Working Group. 1998. Stream corridor restoration: principles, processes, and practices. GPO Item No. 0120-A. Washington, DC.

Gardner, P.A.; Stevens, R.; Howe, F.P. 1999. A handbook of riparian restoration and revegetation for the conservation of land birds in Utah with emphasis on habitat types in middle and lower elevations. Pub. 99-83. Salt Lake City, UT: Utah Division of Wildlife Resources. 48 p.

Paige, C.; Ritter, S.A. 1999. Birds in a sagebrush sea: managing sagebrush habitats for bird communities. Boise, ID: Partners in Flight Western Working Group. 52 p.

Figure CS-1. Watershed context map.



WATERSHED DELINEATION

TROUT CREEK
RIPARIAN BUFFER PROJECT

Figure CS-2. Existing landscapes features map.

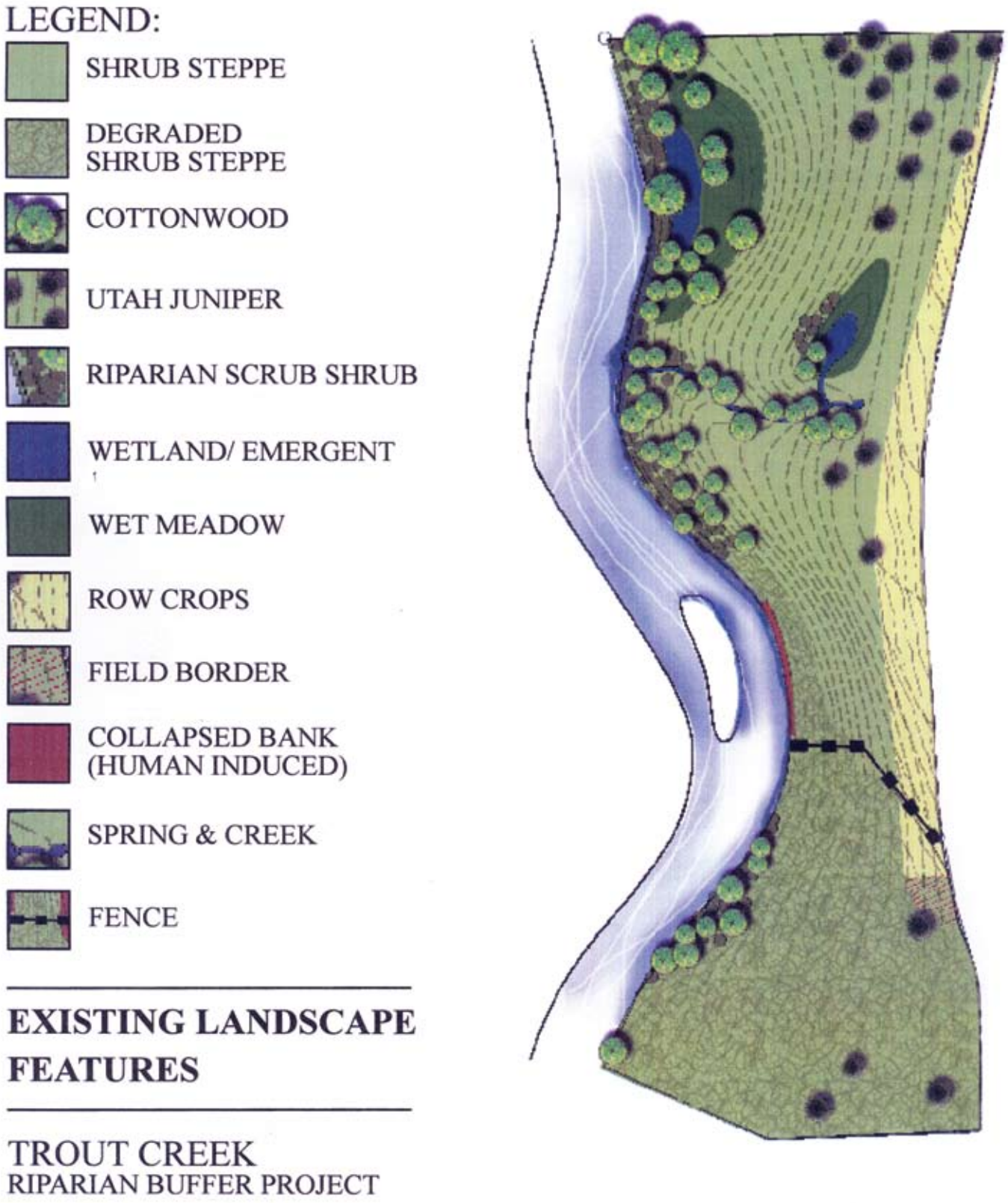


Figure CS-3. Delineate project boundaries and buffer units.

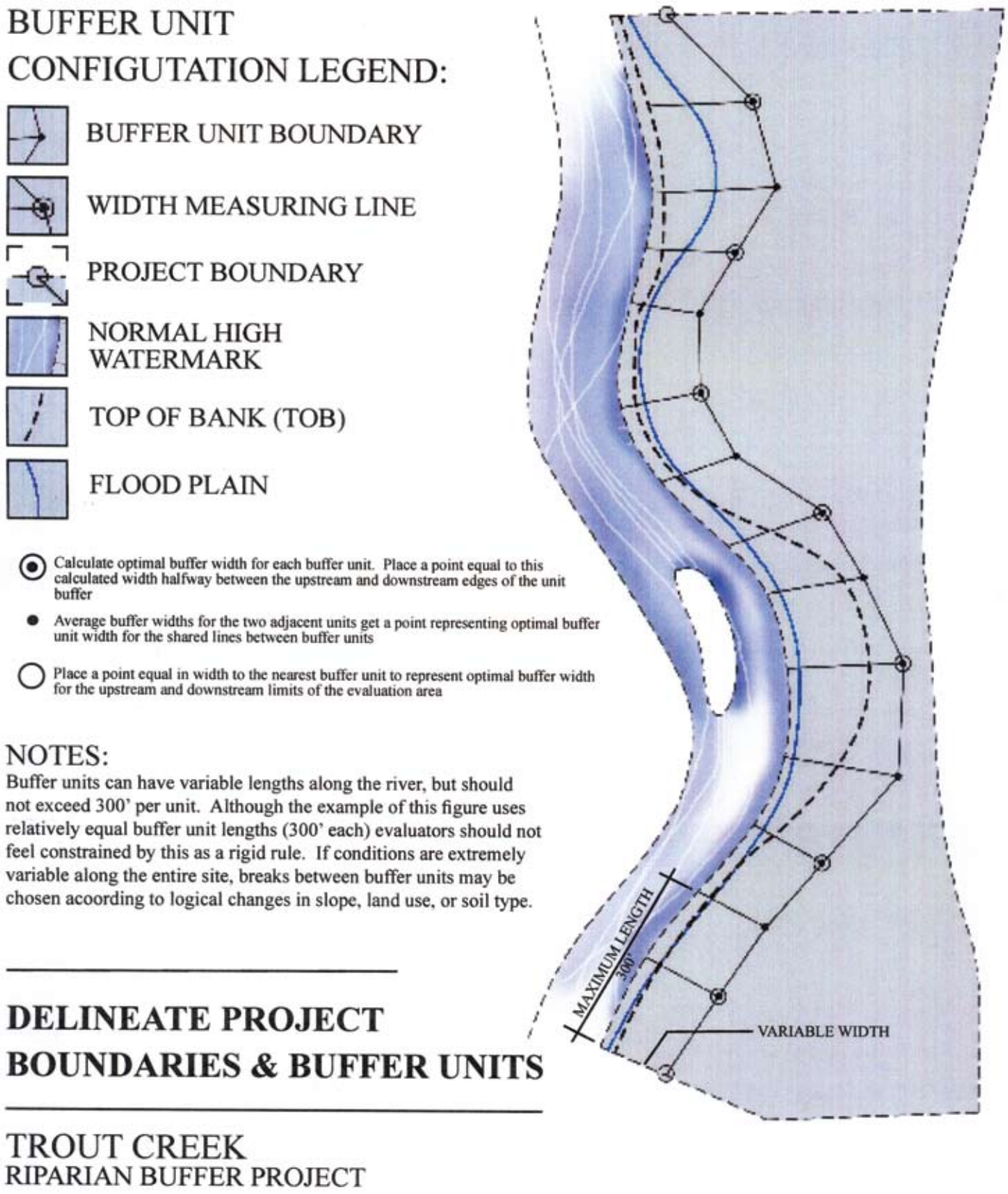


Figure CS-4. Existing slopes on project site.

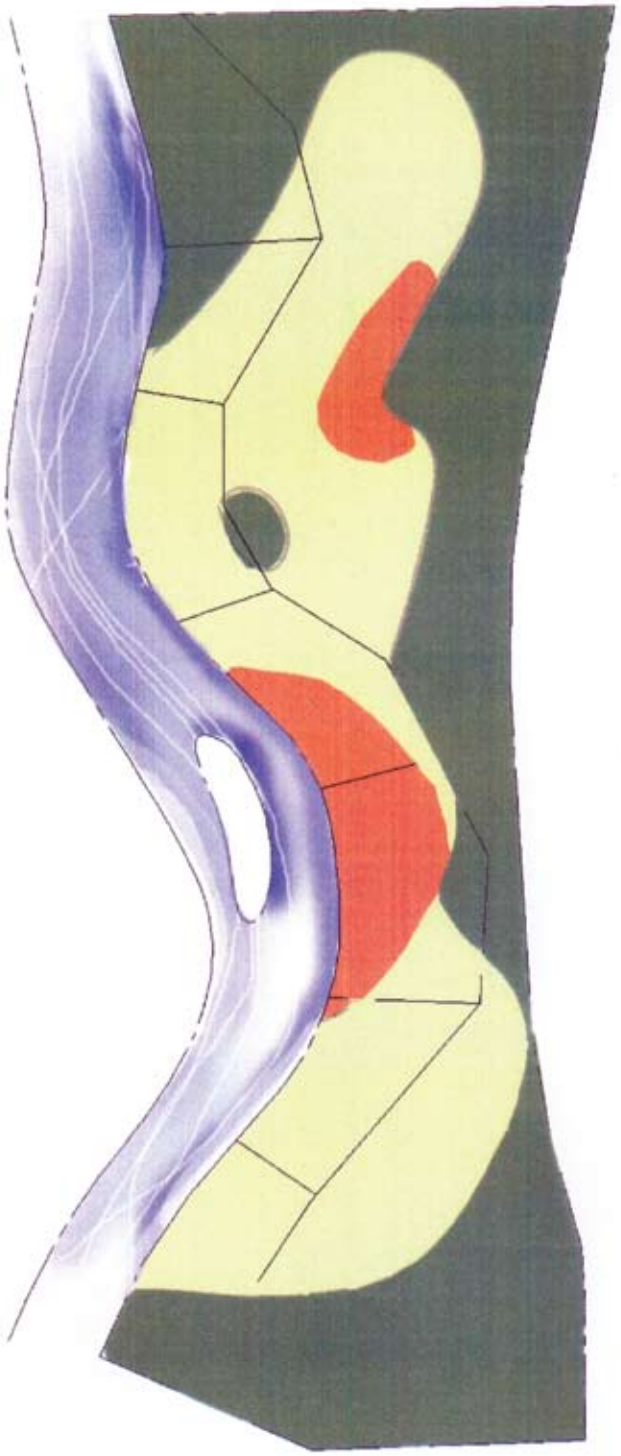
PERCENT SLOPE
LEGEND:

0-5%

5-15%

15-25%

NOTES:
This drawing shows resource information outside buffer boundaries for illustrative purposes. Evauators collect and analyze data only within the buffer boundaries except for some secondary attributes which may occur landward of the buffer boundary.



EXISTING SLOPES ON PROJECT SITE

TROUT CREEK
RIPARIAN BUFFER PROJECT

Figure CS-5. Average slope per buffer unit.

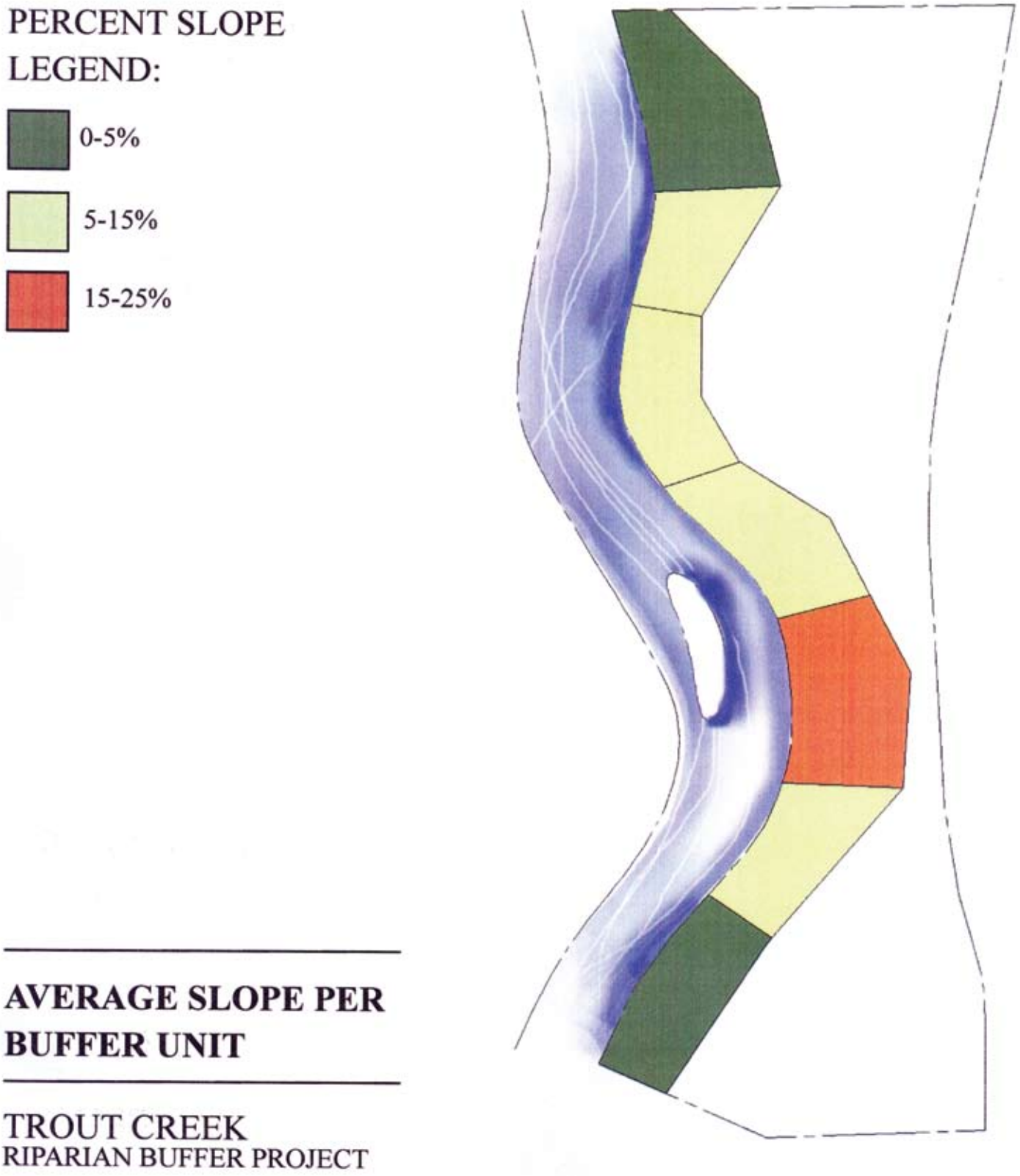


Figure CS-6. Existing soil hydrologic group on project site.

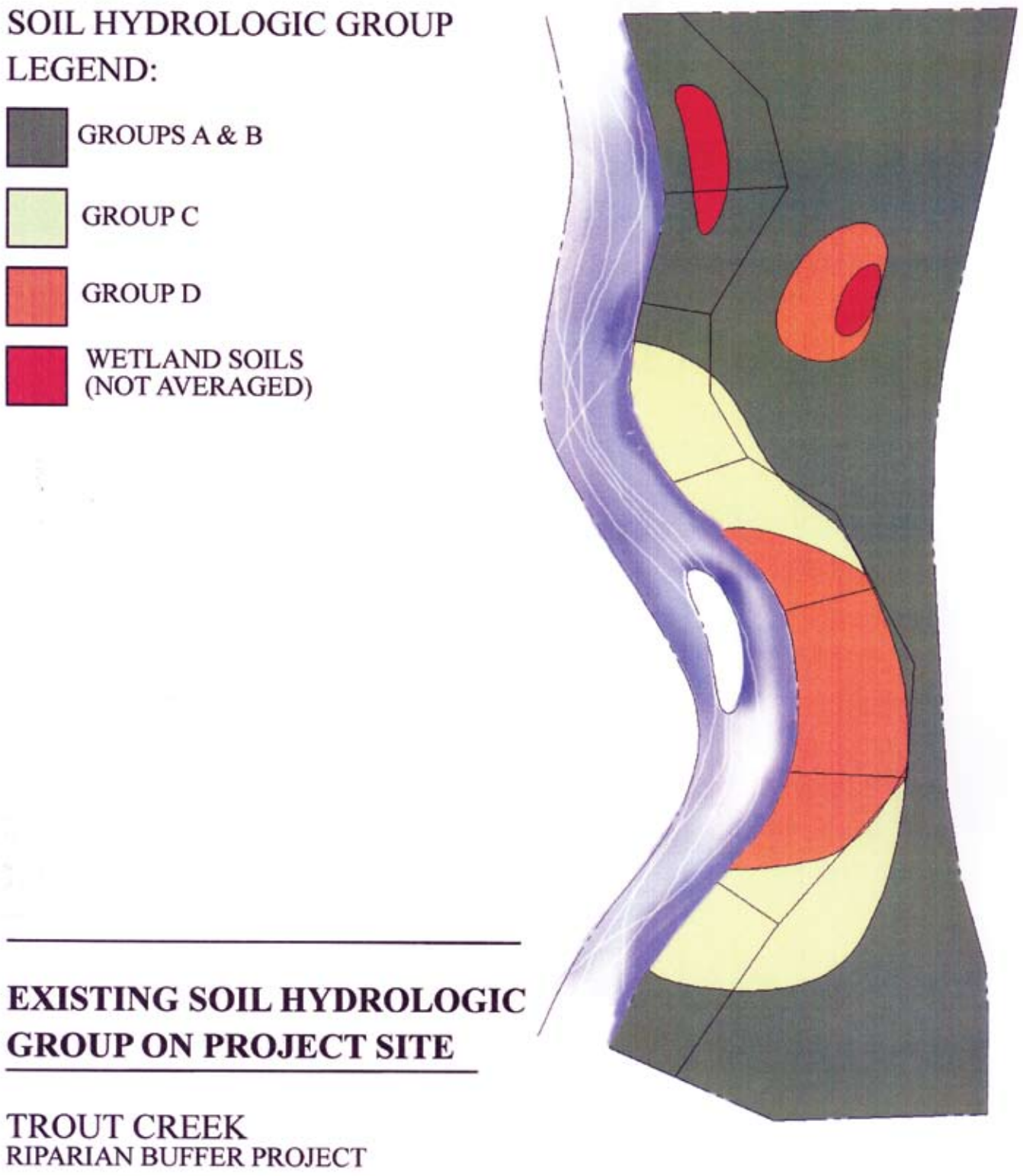


Figure CS-7. Average soil group per buffer unit.

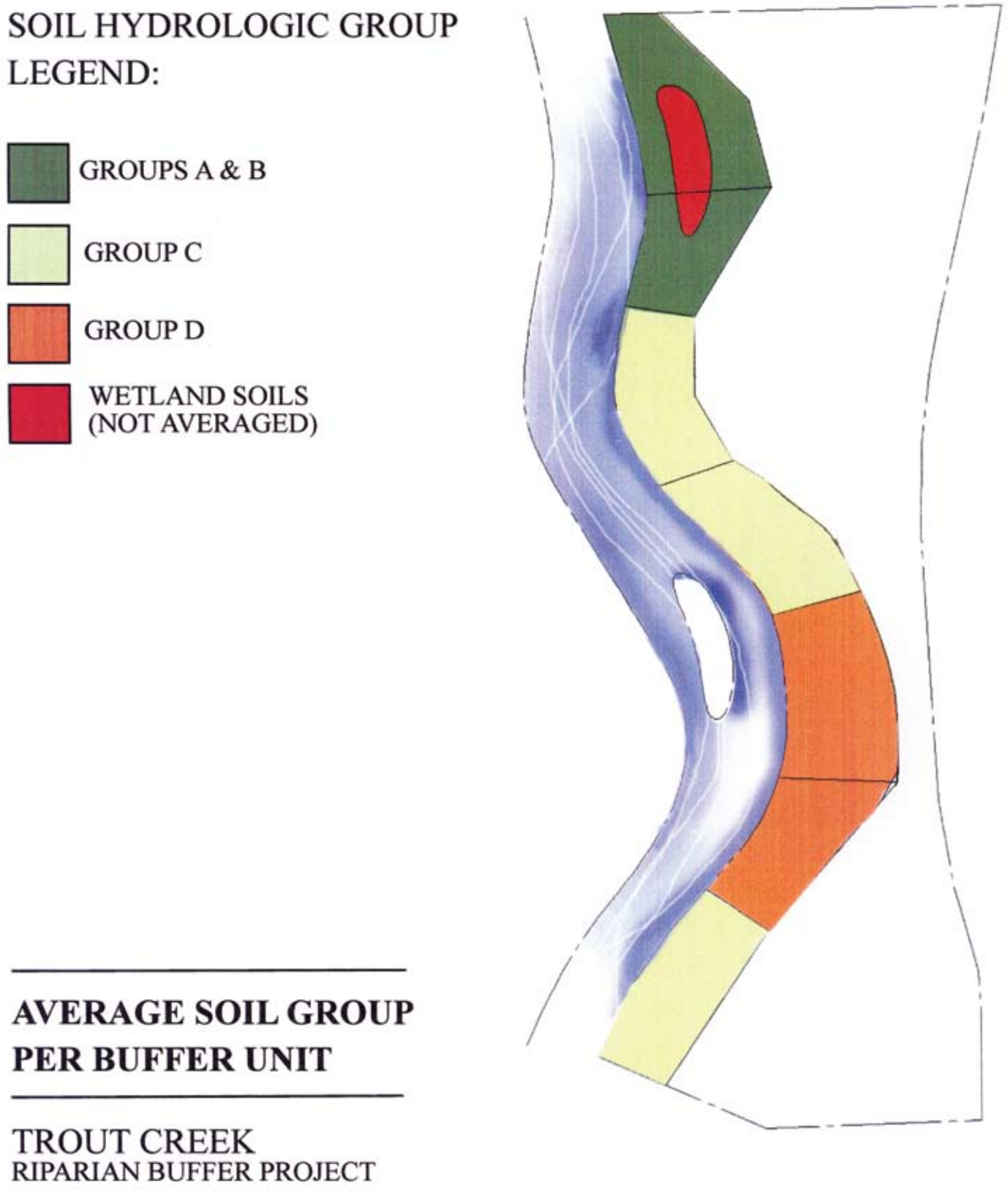


Figure CS-8. Existing surface roughness.

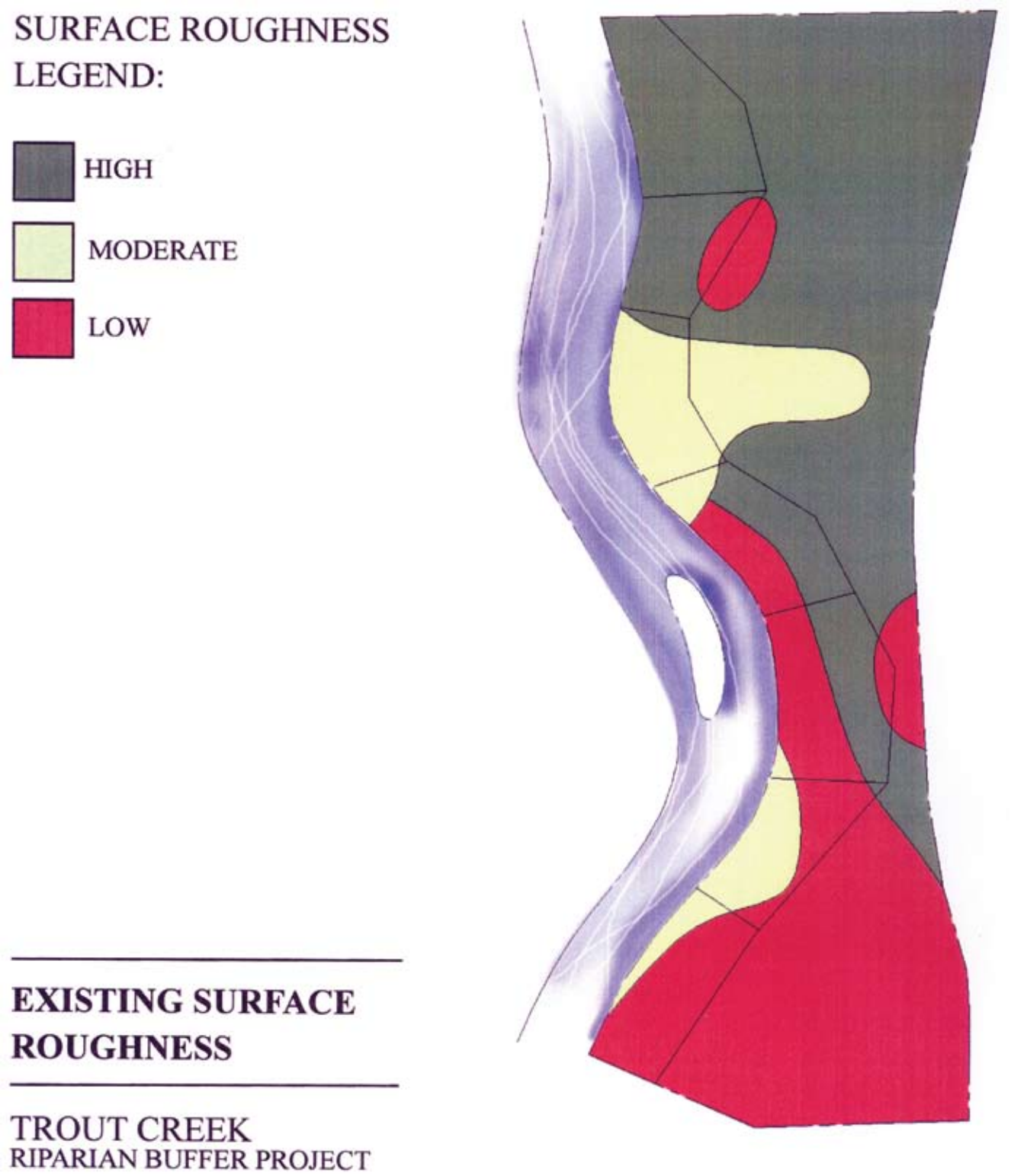


Figure CS-9. Averaged surface roughness per buffer unit.

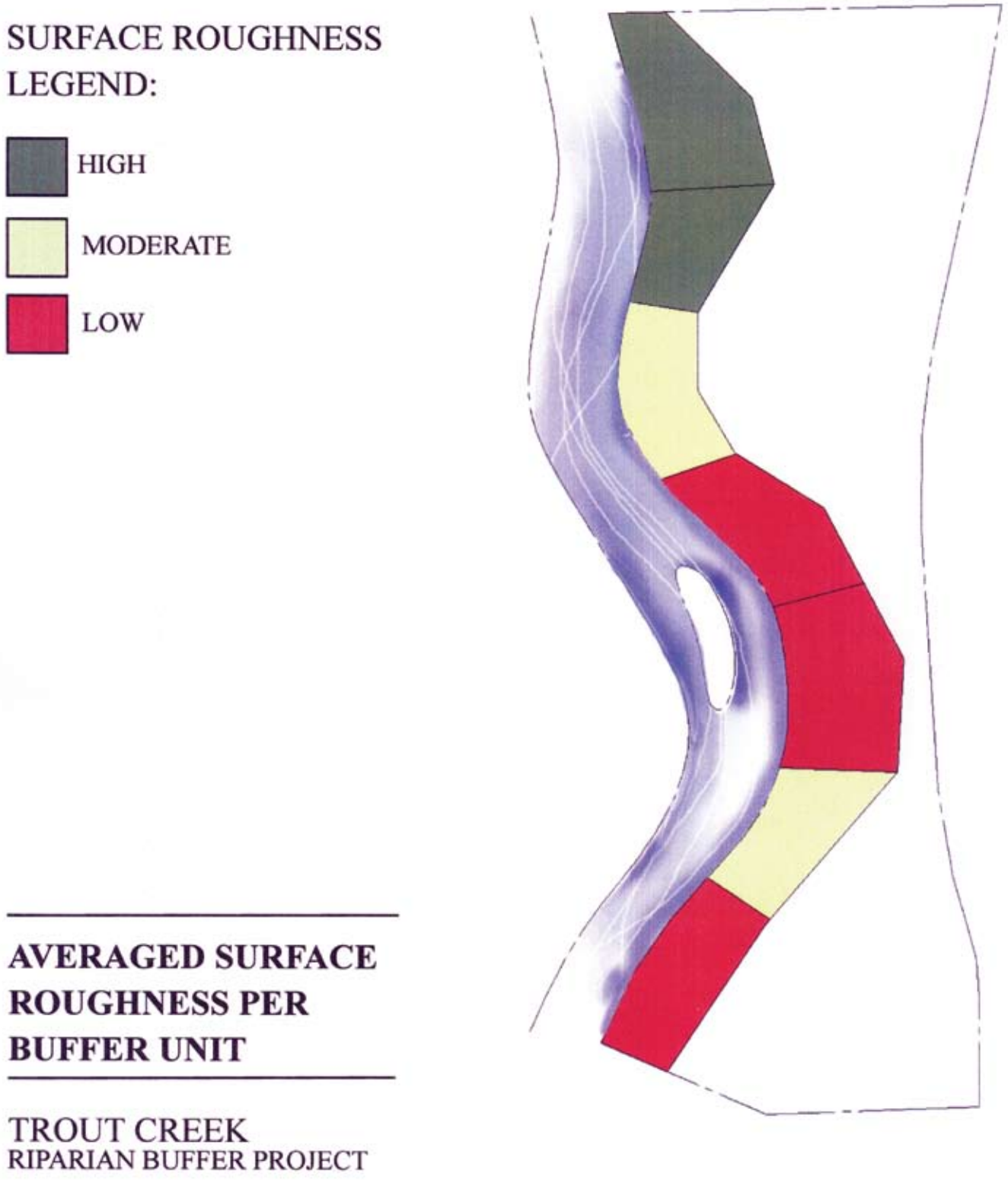


Figure CS-10. Existing secondary site attributes on project site.

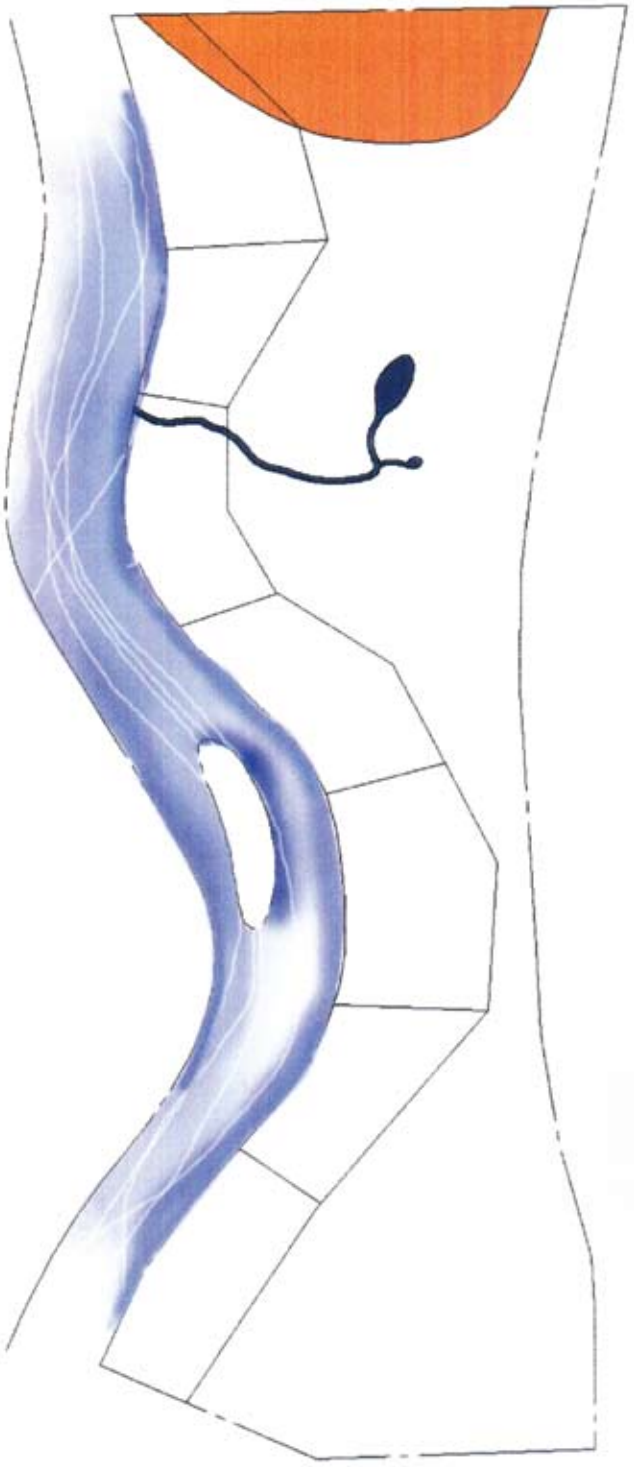
SECONDARY SITE ATTRIBUTES LEGEND:

SAND & GRAVEL AQUIFER

PERCHED WETLAND

SPRING AND OUTLET

NOTE:
The evaluator evaluates the site attibutes outside the Primary Planning Area that may effect buffer function; in this example a spring head perched wetland and sand and gravel aquifer.



EXISTING SECONDARY SITE ATTRIBUTES ON PROJECT SITE

TROUT CREEK
RIPARIAN BUFFER PROJECT

Figure CS-11. Buffer adjustments made based on secondary site attributes.

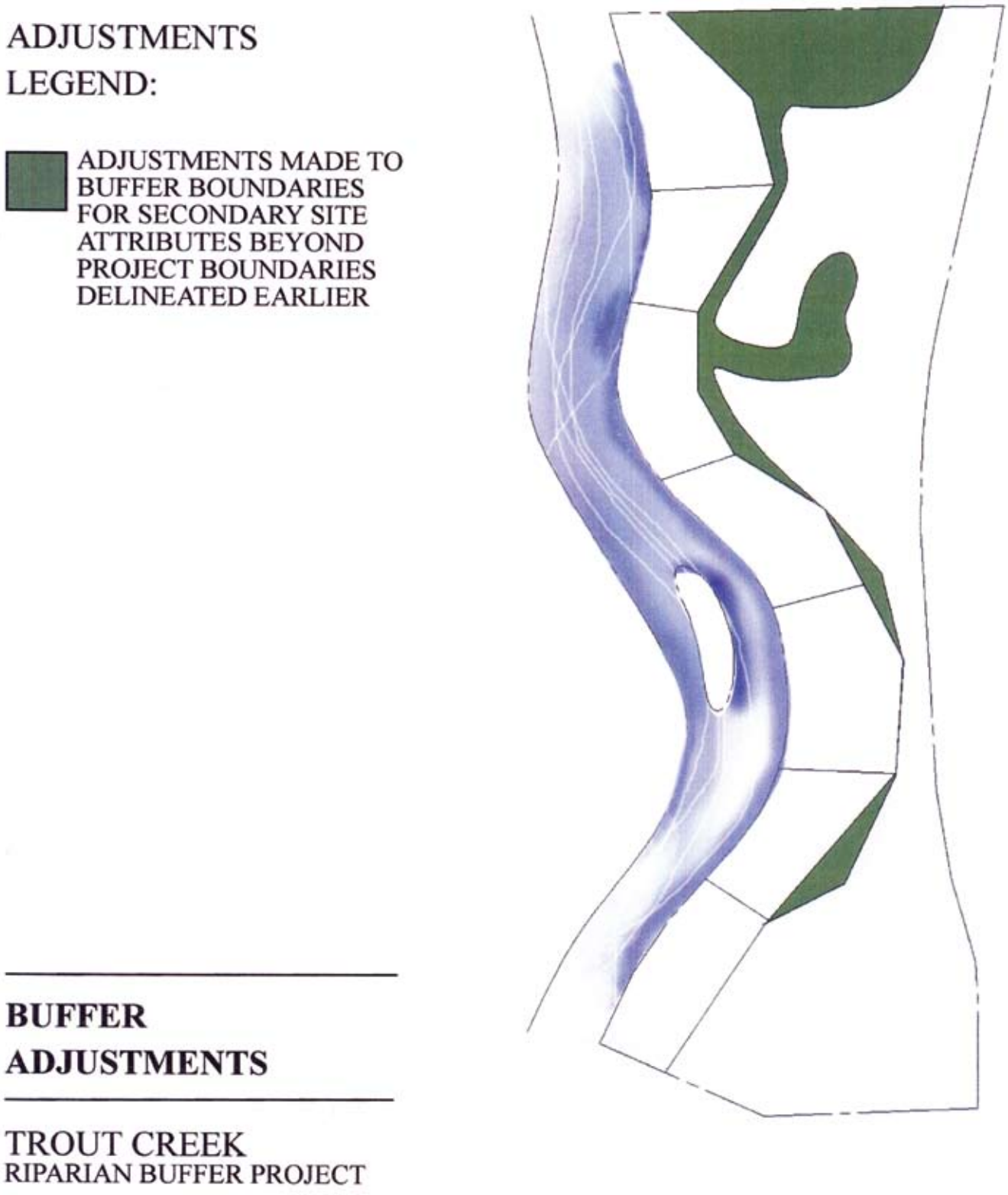


Figure CS-12. Land use and management zones.

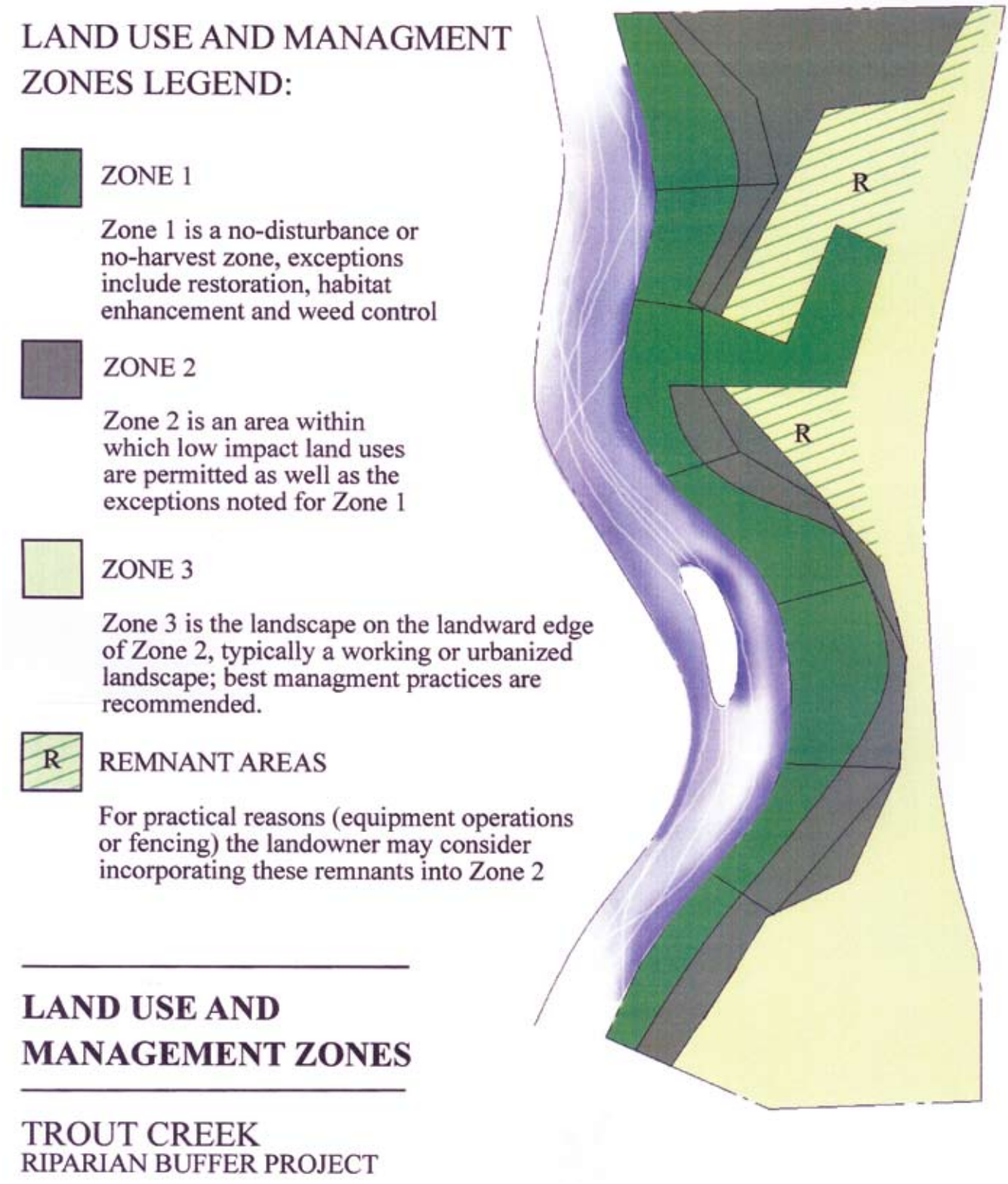


Figure CS-13. Wildlife habitat planning base map.

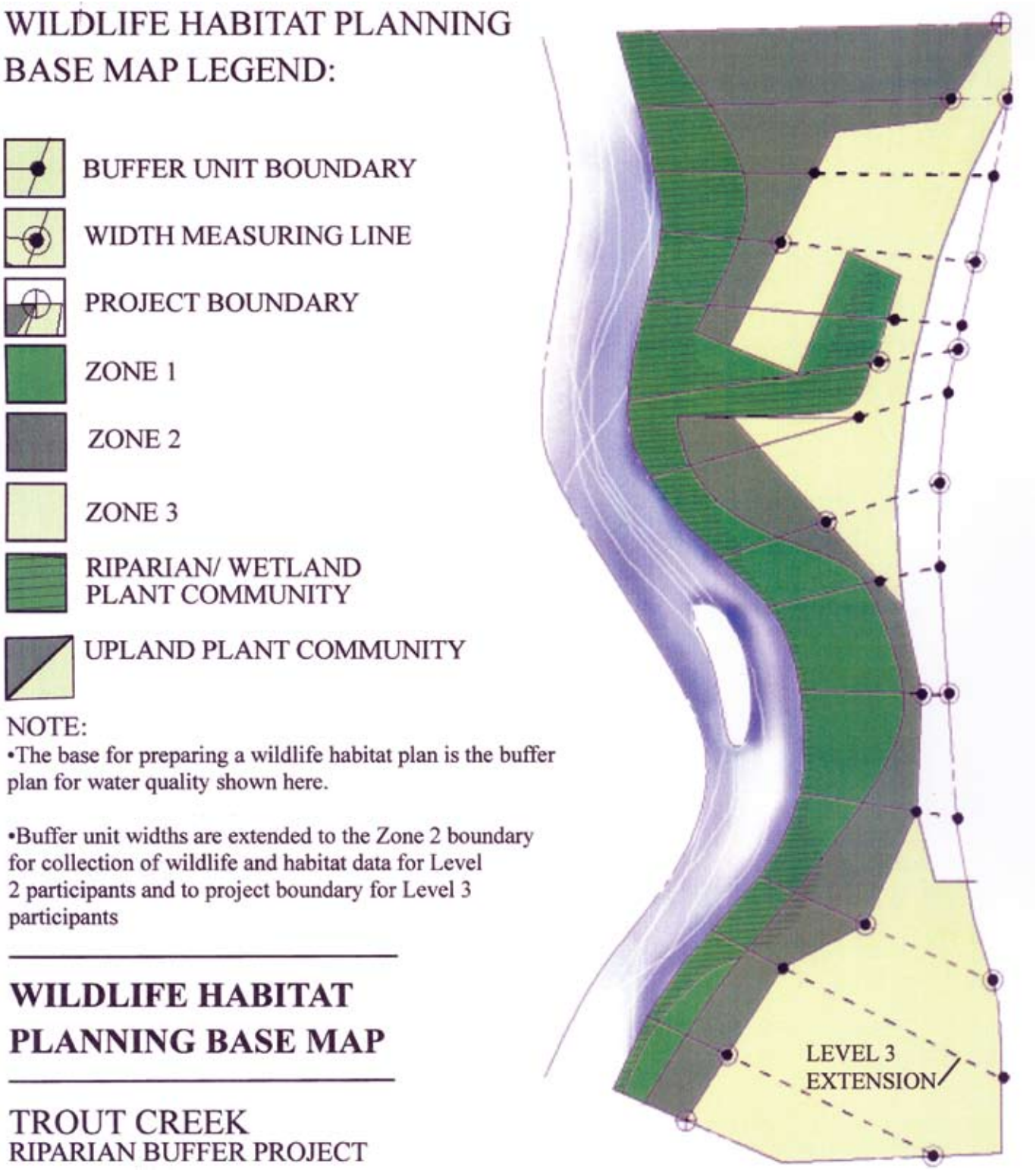


Figure CS-14. Unadjusted functional condition map.

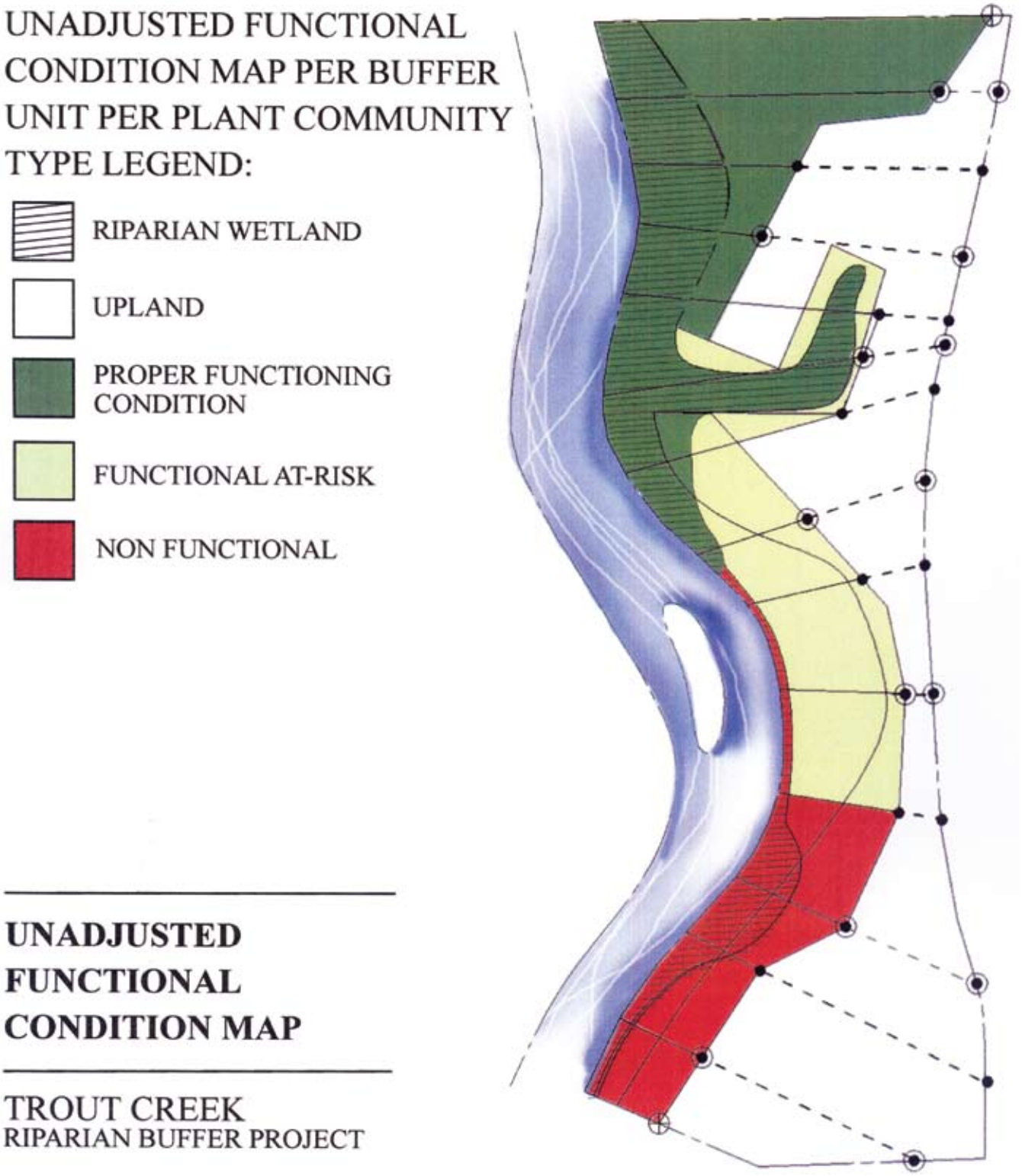


Figure CS-15. Adjusted functional condition map.

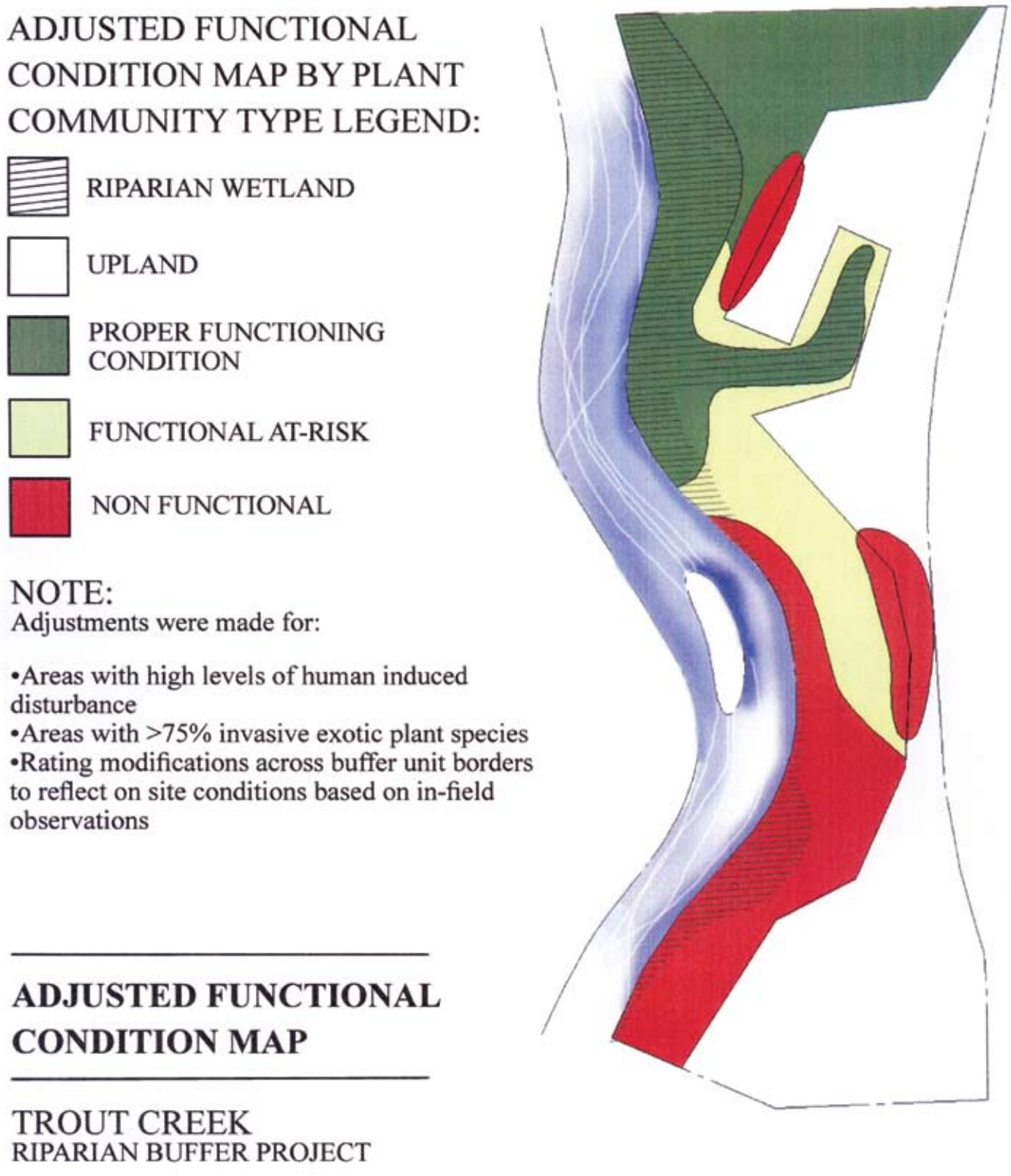


Figure CS-16. Level 1 and 2 habitat management specifications and land use zones.

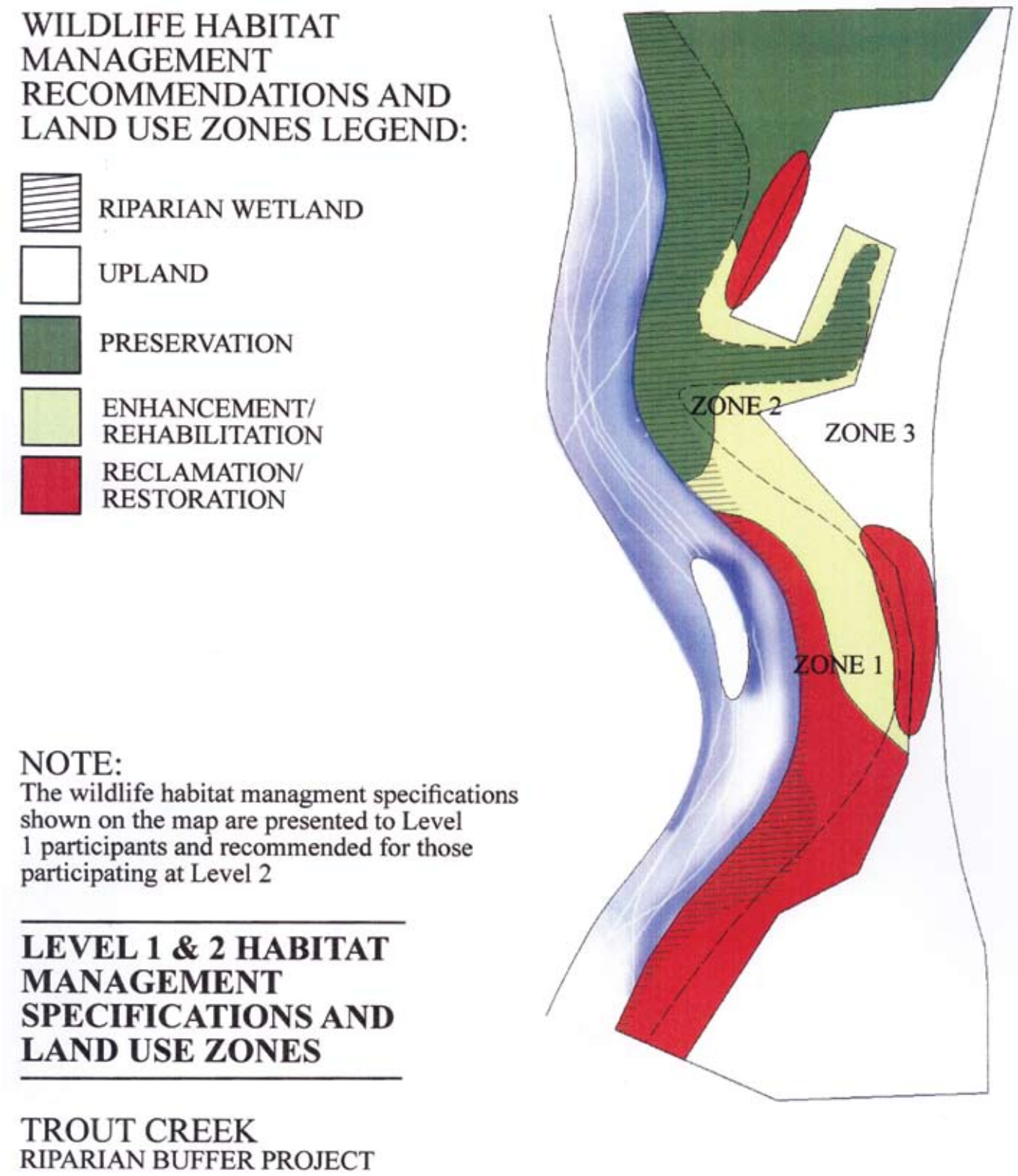
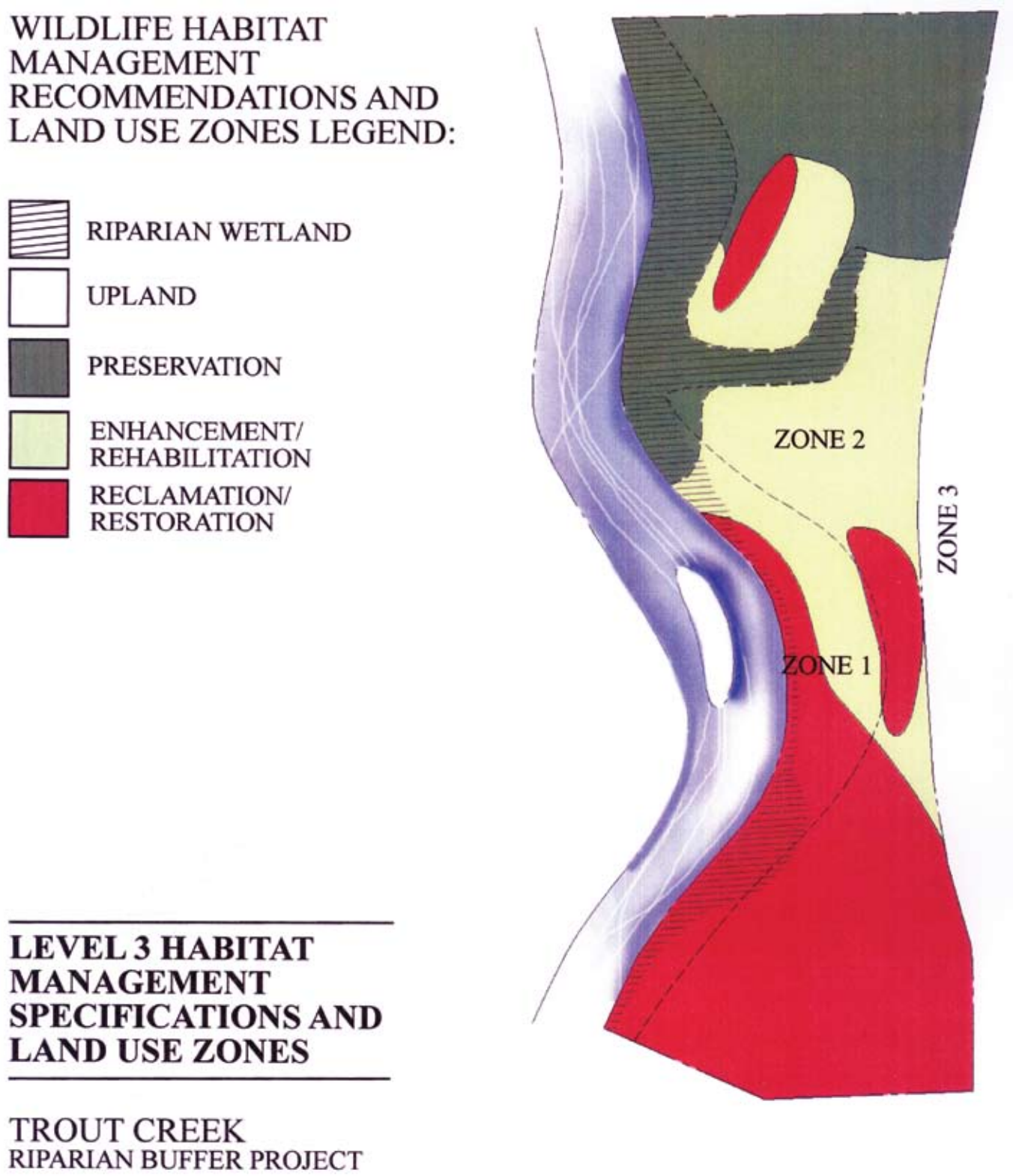


Figure CS-17. Level 3 habitat management specifications and land use zones.



Appendix A-1: Water Quality Buffer Data Form

Date: _____

Surveyed by:_____

Landowner address: (mailing)

USGS quad:_____

_____

Stream name:_____

_____

Buffer Unit #: _____

Data for Determining the Baseline for Water Quality Buffers

High Watermark: Identify the mean high watermark on the stream bank. This will be the starting point for all measurements except where floodplains or wetlands are involved.

Floodplains and Adjacent Open Wetlands: Identify the landward edge of all floodplains and open wetlands (in other words, slope, depression, and riverine wetlands) adjacent to the stream. These features are considered part of the stream zone being protected rather than part of the buffer. Begin buffer measurements at the landward edge of these features. Check applicable items(s) below.

Neither floodplains nor open wetlands occur immediately adjacent to the stream _____
Slope, depression, and/or riverine wetland identified adjacent to stream _____
Floodplain identified adjacent to stream_____

Top of Stream Bank (TOB): Identify the upslope landward line along which the gradient of the stream bank changes to a different (generally lesser) percent gradient. This line will be used as a reference base line in later planning steps.

Data for Use with Buffer Width Key (Primary Attributes)

Slope: 0 to 5 percent _____
>5 to 15 percent _____
>15 to 25 percent _____
>25 percent_____

source _____

Soils: hydrologic soils group A _____
hydrologic soils group B _____
hydrologic soils group C _____
hydrologic soils group D _____

source _____

Surface Roughness: (check one)

Typical or Moderate degree of surface roughness: _____
High degree of surface roughness: _____
Low degree of surface roughness: _____

source _____

Note: Refer to Appendix A-6 and A-7 (Surface roughness guidelines and Estimating vegetative ground cover percentage). Surface roughness features include: woody vegetation, emergent wetland vegetation, stout stemmed grasses and forbs, coarse woody debris (> 1 inch), rotten stumps or logs, boulders or rocks 12 inch in diameter, and undulating micro-topography, a portion of the land surface slopes away from the stream; and intact duff layer (surface organic horizon)/lack of exposed mineral soils.

Surface Roughness: (continued)

Buffer does not have exposed mineral soils as a result of human activity: _____
(Typical or high degree of surface roughness; no change or subtract 25 ft)
Buffer has exposed mineral soils (in other words, duff layer or cryptogamic crust not intact) as a result of human activity: ____
(Automatically low degree of surface roughness; add 25 ft to Zone 2)
If exposed mineral soils, note cause (if known) _____

Additional Data Used to Adjust Buffer Width (Secondary Attributes)

Surface Water Features: (check all that apply)

No surface water features located in the buffer: _____
(No adjustment to buffer width)
Surface water feature located in the buffer _____ check type(s) below:
intermittent stream: _____
perennial stream: _____
drainage ditch or swale: _____
irrigation canal or ditch: _____
other: _____
(Add 50 ft to Zone 2; in addition, maintain a 35 ft no-disturbance strip adjacent to perennial surface water features or irrigation canal or ditch in Zone 2)
Exception: If the surface water feature is not connected to the in-stream habitat being protected by means of surface drainage, no adjustment is made (for example, isolated pond).

Note: Surface water feature as defined here include rivers, streams or creeks in addition to constructed ditches and swales that carry stormwater drainage or return irrigation water to the in-stream habitat being protected.

source_____
_____

Note: If surface water features are identified in the field but are not indicated on available map resources, locations should be shown on map.

Groundwater Seepage or Spring: (check one)

Springs/groundwater seepage not present in buffer _____
Could not determine if spring/seepage present or not _____ (in some cases it will not be possible to positively identify springs/groundwater seepage based on field observations) (no adjustment to buffer width)
Spring(s)/groundwater seepage present in buffer (note # and approx. locations):_____

_____
(add 25 ft to Zone 2)

source _____

Note: A field indicator of springs is a relatively constant discharge of cool water to the surface. Typically, there is not surface water inflow, yet water trickles/seeps out. Often, there is a seepage wetland or small spring-fed stream associated with these groundwater discharge features. Perched or shallow subsurface drainage seeps not directly connected to the underlying aquifer should not be counted (groundwater discharge in areas of highly permeable fluvial deposits should be assumed to be connected to the underlying aquifer). Springs/seeps often occur on lower portions of side-slopes adjacent to streams.

Sand and Gravel Aquifers: (check one)

Mapped Significant Sand and Gravel Aquifer does not occur in buffer _____
(No adjustment to buffer width)
Mapped Significant Sand and Gravel Aquifer (or any portion of such a feature) occurs in buffer _____
(Include entire portion of the aquifer)

source _____

Wetlands: (check all that apply)

No wetlands located in the buffer _____
(No adjustment to buffer width)
Isolated wetland (not connected to stream by surface drainage) occurs in buffer _____
Wetland directly connected to stream by surface drainage occurs in buffer _____
(Add 25 ft to Zone 2 for the presence of any wetland regardless of whether it is isolated or connected. Further expand Zone 2 to encompass the entire wetland for any wetland that is at least partly in the buffer and is connected to the stream being protected by means of surface flows)

source _____

Very Steep Slopes (>25 percent): Note all areas in the buffer that have very steep slopes (check one).
Very steep slopes not located in buffer area _____
(No adjustment to buffer width)
Very steep slopes identified in buffer area _____
(Expand Zone 2 as necessary to encompass the entire area of very steep slopes plus 35 ft beyond break of grade

source _____

Additional Data

Streambank Condition

Streambank is stable, abundance of plants with binding root mass or presence of rock outcropping or boulders, no evidence of erosion_____
Streambank is unstable, severely degraded or undercut and sloughing into the stream _____

source _____

Note: This data does not result in additional adjustments to buffer width, but is helpful in identifying streambank locations that require further hydrological evaluation and, potentially, future restoration.

Soils Series and Surficial Geology:

Superficial geologic material(s) in buffer_____

source _____

Note: This data does not result specific additional adjustments to the buffer width, but this information may help identify soil characteristics, aspects of water movement through the buffer, and areas sensitive to potential groundwater contamination.

Identifiable Land Uses:

Type of land use	location/coverage	source
1._____	_____	_____
2._____	_____	_____
3._____	_____	_____

Note: Land uses affect buffer attributes such as percent canopy cover, surface roughness, and soil hydrologic group (infiltration capacity). These, in turn, affect optimal buffer width. But additional buffer width adjustments are not made as a result of specific land use practices historically occurring in the buffer. There are recommended land use restrictions in the buffer zone (Zone 1 and Zone 2); however, in many cases, it is impractical to eliminate historical uses in these zones. Best management practices to protect soils and water quality and provide shading should be employed to the maximum extent possible within the two zones of the buffer. Best management practices are also recommended in Zone 3 (typical crop, pasture or range uses).

Note any differences between actual field conditions and desktop data collected (field data should generally take precedent over desktop data):

_____

_____

_____

_____

_____

Other Notes:

_____

_____

_____

_____

_____

_____

Appendix A-2: Water Quality Buffer Unit Worksheet

Buffer Unit #: _____

1. Length of buffer unit along baseline/stream*: _____

2. Width of buffer unit used to measure/determine buffer attributes (in other words, not the same as optimal buffer width-use A-4): _____

3. Unadjusted buffer width from key: _____

4. Adjust number from the key to account for those factors that result in specific increases or decreases in buffer width:

Adjustment for surface water features	_____	=	_____
Adjustment for groundwater seepage/springs:	_____	=	_____
Adjustment for significant sand & gravel aquifers	_____	=	_____
Adjustment for wetlands:	_____	=	_____

Adjusted Buffer Width: _____

5. Finally, expand the buffer width as necessary to include:
   a. all areas of very steep (>25 percent) slopes that are at least partially within the adjusted buffer width (as determined in Step 2) plus 35 ft beyond break in grade, and
   b. all wetlands connected to the stream by surface drainage that are at least partially within the adjusted buffer width (as determined in Step 2)

   Describe adjustments made, if any, for very steep slopes: _____
   _____

   Describe adjustments made, if any, for connected wetlands: _____
   _____

   * The length of buffer units should be no more than 300 ft along the baseline of the stream reach being protected (the baseline is parallel to the normal high water mark of the stream or, if there are adjacent floodplains or open wetlands, the baseline is parallel to the landward edge of these features). Evaluators should not be constrained by this number; however, you may choose smaller lengths so that breaks between buffer units coincide with logical changes in buffer attributes, such as abrupt changes in slope, soils, percent vegetative cover, or wetlands.

Appendix A-3: Table to Determine Portion of Buffer to Measure Attributes

To determine the portion of the riparian buffer for which attributes data is gathered, start by determining the slope in the area between 0 and 100 ft and proceed as necessary through the table presented below:

If slope is:	Then measure buffer attributes in this portion of buffer:
<5 percent in the area between mean high watermark (0) or edge of floodplain or open wetland and the next 70 ft landward,	Mean high watermark to top of bank (TOB) + 35 ft or 70 ft, whichever is greater.
5 to 15 percent in the area between mean high watermark (0) or edge of floodplain or open wetlands and the next 70 ft, but <5 percent in area between 0 and 150 ft,	Mean high watermark to TOB + 35 ft or 125 ft, whichever is greater.
5 to 15 percent in the area between mean high watermark (0) or edge of floodplain or open wetland and the next 70 ft, and 5 to 15 percent in the area between 0 and 150 ft,	Mean high watermark to TOB + 35 ft or 150 ft, whichever is greater.
>15 percent in the area between mean high watermark or edge of floodplain or open wetlands and the next 70 ft, but <15 percent in the area between 0 and 200 ft,	Mean high watermark to TOB + 35 ft or 175 ft, whichever is greater.
>15 percent in the area between or the edge of floodplain or open wetlands and the next 100 ft, and >15 percent in the area between TOB or edge of floodplain or open wetlands 0 and 200 ft,	Mean high water mark to TOB + 35 ft or 200 ft, whichever is greater.

Appendix A-4: Optimal Buffer Width Key: Unadjusted Width*

1. Slopes 0 to 5 percent
    2. hydrologic **group A and B** soils
        3. high surface roughness 70 ft
        3. moderate surface roughness 80 ft
        3. low surface roughness 90 ft
    2. hydrologic **group C** soils
        3. high surface roughness 90 ft
        3. moderate surface roughness 100 ft
        3. low surface roughness 110 ft
    2. hydrologic **group D** soils
        3. high surface roughness 110 ft
        3. moderate surface roughness 120 ft
        3. low surface roughness 130 ft
1. Slopes 5 to 15 percent
    2. hydrologic **group A and B** soils
        3. high surface roughness 100 ft
        3. moderate surface roughness 110 ft
        3. low surface roughness 120 ft
    2. hydrologic **group C** soils
        3. high surface roughness 120 ft
        3. moderate surface roughness 130 ft
        3. low surface roughness 140 ft
    2. hydrologic **group D** soils
        3. high surface roughness 140 ft
        3. moderate surface roughness 150 ft
        3. low surface roughness 160 ft
1. Slopes 15 to 25 percent
    2. hydrologic **group A and B** soils
        3. high surface roughness 130 ft
        3. moderate surface roughness 140 ft
        3. low surface roughness 150 ft
    2. hydrologic **group C** soils
        3. high surface roughness 150 ft
        3. moderate surface roughness 160 ft
        3. low surface roughness 170 ft
    2. hydrologic **group D** soils
        3. high surface roughness 170 ft
        3. moderate surface roughness 180 ft
        3. low surface roughness 190 ft
1. Slopes >25 percent
    2. hydrologic **group A and B** soils
        3. high surface roughness 160 ft
        3. moderate surface roughness 170 ft
        3. low surface roughness 180 ft
    2. hydrologic **group C** soils
        3. high surface roughness 180 ft
        3. moderate surface roughness 190 ft
        3. low surface roughness 200 ft
    2. hydrologic **group D** soils
        3. high surface roughness 200 ft
        3. moderate surface roughness 210 ft
        3. low surface roughness 220 ft

Or, top of bank or landward edge of floodplain or wetland plus 35 ft, whichever is greater.

* This key yields unadjusted optimal buffer widths that are subsequently adjusted to account for the presence of other buffer variables such as wetlands, surface water features, springs, significant sand and gravel aquifers, and very steep slopes.

Appendix A-5: Adjustment Factors Key

The following table lists additional buffer attributes not included in the optimal buffer width key and specifies buffer adjustments for each of these variables.

Buffer Attributes	Adjustment to Buffer Width
Surface Water Features (for example, stream, canals, ditches, gullies, and ponds)	If surface water features, whether perennial or intermittent, are present in the buffer and are connected to the in-stream habitat being protected by surface drainage, increase the buffer width by 50 ft.
Groundwater Seepage/Springs (includes discharge spring water, and canal leakage)	If groundwater seepage or springs or leaking canals are present in the buffers that are directly connected to the underlying aquifer increase the buffer width by 25 ft.
Sand and Gravel Aquifers	If significant sand and gravel aquifers are present in the buffer, increase the buffer width by 25 ft.
Floodplains	Floodplains, no matter how wide, are considered part of the stream resource being protected rather than part of the buffer zone. Therefore, establish the baseline (start point) for buffer width measurement at the landward edge of floodplain plus 35 ft (and also non-forested wetlands as detailed below).
Wetlands	If wetlands or portions of wetlands occur in the buffer, increase the buffer width by 25 ft regardless of whether the wetland is isolated or connected. In addition, if these wetlands or portions of wetlands are hydrologically connected to the in-stream resource being protected by surface (including seasonal or intermittent) drainage, expand the buffer as necessary to encompass the entire area of wetlands. Open wetlands (riverine, lacustrine, depressional and slope wetlands) immediately adjacent to the stream are considered part of the stream resource being protected rather than part of the buffer zone. Therefore, establish the baseline (start point) for buffer width measurement at the landward edge of adjacent open wetlands plus 35 ft.
Very Steep Slopes (> 25 percent)	If very steep slopes occur in the buffer, expand the buffer as necessary to encompass the entire area of very steep slopes and add 35 ft landward from the break in grade.
Stream Order	Buffers adjacent to first and second order streams, no matter how narrow are afforded the same calculated optimal riparian buffer widths as larger streams (in other words, there is no downward adjustment for narrower, smaller order streams).

Appendix A-6: Surface Roughness Guidelines and Photos

High Degree of Surface Roughness

Buffer units with a high degree of surface roughness have the following characteristics:

- The microtopography is complex. Often there is undulating topography resulting from previous geologic and hydrologic events so that a portion of the land slopes away from the stream. The land surface does not slope smoothly and consistently toward the stream.
- The buffer unit is forested or covered with dense stands of riparian scrub or shrub-steppe vegetation or dense rush/sedge vegetation. Non-forested or sparsely populated riparian/wetland or shrub-steppe buffers have either a typical or a low degree of surface roughness. Non-forested or sparsely vegetated, rush/sedge, or shrub buffers allow greater quantities of runoff to reach the stream and are more susceptible to concentrated flow patterns.
- The surface organic horizon (duff layer) is intact throughout the buffer unit. If exposed, mineral soil related to human impacts (for example, over grazing, dirt roads, and recreation trails where the surface organic horizon has been removed down to mineral material) occurs anywhere in the buffer units and automatically, there is a low degree of surface roughness. Areas of exposed mineral soil often become concentrated flow paths for runoff. Natural occurrences of mineral soils, such as tip-ups (trees that fall over bringing the root crown and attached mineral soils to the soil surface), may be present. **In natural shrub-steppe plant communities, 35 percent exposed mineral soil is common and undisturbed sites may be covered with cryptogamic crust.**
- In forested areas, dead-and-down wood and rotting logs and stumps are common. Specifically, coarse woody debris (>1 inch) is scattered about and older woody debris is being incorporated into the organic horizon.
- Often, there is a well-developed grass forb layer. However, in shaded riparian woodlands this will not always be the case. A dense grass/forb layer is not necessary, although it remains important for a high degree of surface roughness as long as other factors are present.
- Often, boulders and exposed bedrock are common and, where present, add microtopographical complexity. This feature is not required and may not be present in some cases.
- Greater than 65 percent of the land surface contains surface roughness features. Surface roughness features include: coarse-woody debris, woody and herbaceous vegetation, emergent wetland vegetation, rotten stumps and logs, litter, boulders, rock outcroppings, and land that slopes away from the stream (see Appendix A-7 for estimating percent coverage).

Typical (or Moderate) Degree of Surface Roughness

Buffers with a typical degree of surface roughness have the following characteristics:

- Between 35 and 65 percent of the land surface contains surface roughness features (see above for surface roughness features).
- For an open (non-forested) system, such as shrub-steppe or wet meadow, it must not be intensively grazed, mowed, hayed, or intensively managed (for example, row crop agriculture or winter feed lot) and vegetation must be rough and dense. Usually, there will be clumps of woody vegetation establishing due to lack of mowing or reduced or eliminated grazing. Also, there must be surface roughness features other than herbaceous vegetation, such as woody debris, boulders, or hummocky topography, over at least 5 percent of the land surface by aerial coverage.
- The surface organic horizon (duff layer) is intact throughout the buffer unit.

Low Degree of Surface Roughness

Buffers with a low degree of surface roughness have the following characteristics:

- Less than 35 percent of the land surface contains surface roughness features.
- Buffer units with exposed mineral soils as a result of human use automatically have a low degree of surface roughness, as do managed areas (for example, areas that are intensively grazed, mowed, or used for agriculture).

Low Surface Roughness

Photos by Susan Buffler.

Surface Roughness Features include:

- wet meadow
- emergent wetland
- deep rooted woody and/or herbaceous vegetation, and for riverine and lacustrine wetlands, may also include coarse woody debris, litter, boulders, and micro-topography

Low Surface Roughness

Less than 35 percent of the land surface contains surface roughness features.

Moderate Surface Roughness

Photo by Susan Buffler.

Photo by Craig Johnson.

Photo by Craig Johnson.

Surface Roughness Features include:

- wet meadow
- emergent wetland
- deep rooted woody and/or herbaceous vegetation, and for riverine and lacustrine wetlands, may also include coarse woody debris, litter, boulders, and micro-topography

Moderate Surface Roughness

Between 35 and 65 percent of the land surface contains surface roughness features.

High Surface Roughness

Photo by Craig Johnson.

Photo by Susan Buffler.

Photo by Susan Buffler.

Photo by Craig Johnson.

Surface Roughness Features include:

- wet meadow
- emergent wetland
- deep rooted woody and/or herbaceous vegetation, and for riverine and lacustrine wetlands, may also include coarse woody debris, litter, boulders, and micro-topography

High Surface Roughness

Greater than 65 percent of the land surface contains surface roughness features.

Appendix A-7: Estimating Vegetative Ground Cover Percentage

Note: To estimate percentages >50 percent, use white portions instead of black (for example, to get an idea of what 75 percent looks like, look at 25 percent and use the white instead of the black). Each fourth of any one square has the same amount of black.

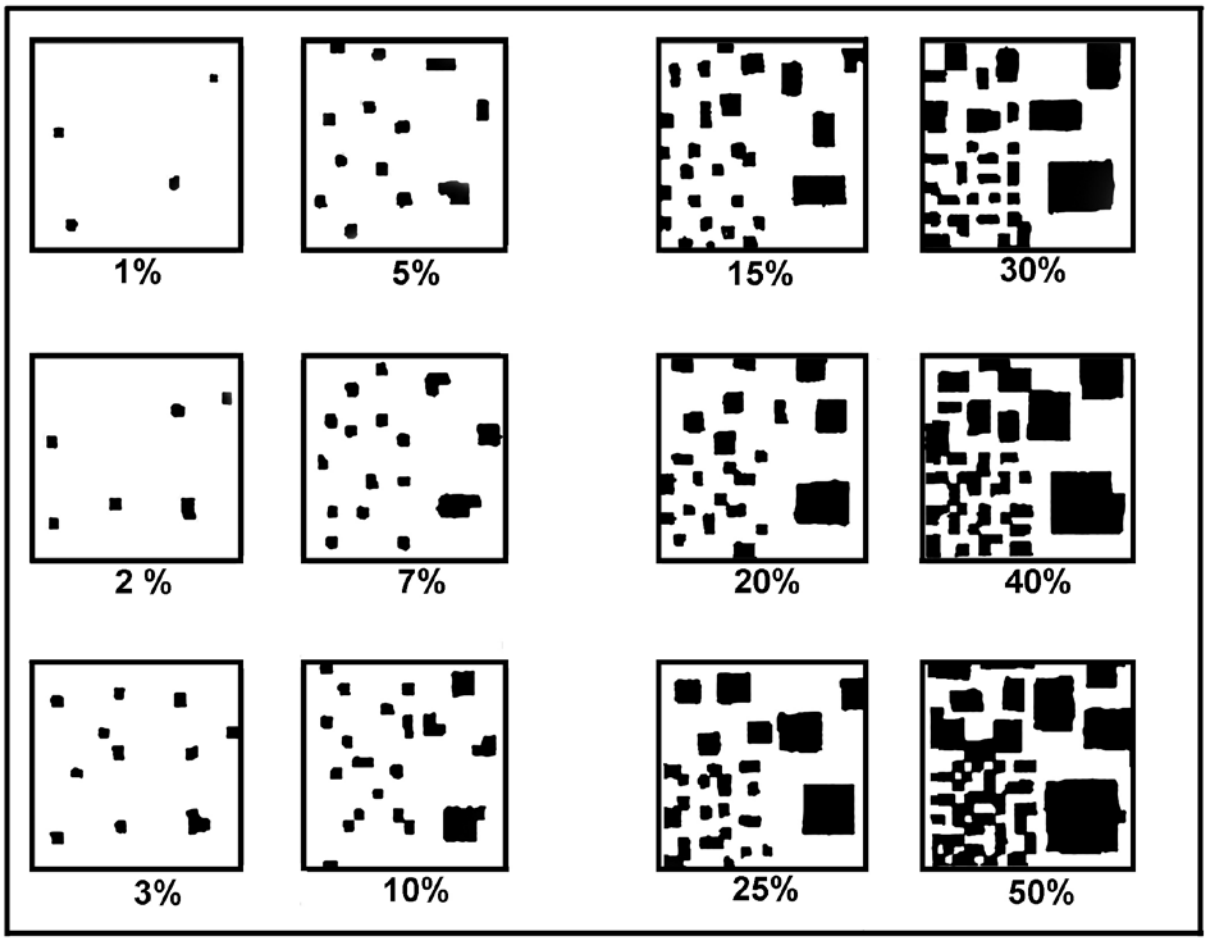


Diagram for estimating vegetative ground cover percentage.

Appendix A-8: Land Use Specifications

Land Use Specifications for Zone 1 and Zone 2 and Recommendations for Zone 3

Zone 1

Zone 1 includes land from the normal high watermark of the stream landward to the top of bank plus 35 or 70 ft, whichever is greater. Or, in the case of floodplains and wetlands, 35 ft landward from the normal high watermark or where these features abut slopes >25 percent, extend buffer Zone 1 to TOB +35 ft. Zone 1 is a no-disturbance or no-harvest zone where land uses that involve disturbance to soils or vegetation should be avoided. Many of the intended Zone 1 functions, such as bank stabilization and shading, will not operate optimally if tree or shrub removal or other land uses occur in this area.

Permitted exceptions to these recommendations include site disturbances associated with streambank, wetland, or shrub-steppe reclamation/restoration; wildlife habitat enhancement; and chemical use (spot spraying) to control invasive exotic vegetation. In addition, drift boat launch sites may be permitted, but design and specifications should be reviewed before approval to proceed.

Zone 2

Zone 2 begins at the landward edge of Zone 1 and extends landward variable distances depending on primary and secondary site landscape attributes in the buffer. There are low-impact uses that can take place in Zone 2 that do not compromise the desired functions of this zone (as noted below). Uses that result in impervious surfaces; removal of the organic soil horizon; use of fertilizer or chemicals; significant alterations to the infiltration capacity of the soils; or removal of trees or shrubs sufficient to jeopardize wind-firm conditions or bank stability should be avoided in this variable-width zone. Uses that would compromise the desired functions of Zone 2 include, but are not necessarily limited to, residential and commercial development, septic disposal systems, roads, row crop agriculture on slopes >5 percent, and unregulated grazing.

Low-impact tree harvesting, seasonal, short duration grazing, and agriculture (forage production) on slopes <5 percent are practices that may occur in this zone without compromising the desired function. Literature indicates that carefully managed vegetation removal in this zone serves as a mechanism to remove stored nutrients and chemical pollutants sequestered in the boles and large branches of trees, shrubs, and forage and enhance vigorous new growth (Welsch 1991; Chase and others 1997). Literature also indicates that controlled tree removal can take place without significantly affecting the infiltration capacity of the soils (Welsch 1991; Chase and others 1997). However, there is also abundant literature to suggest that forestry operations, row crop agriculture, and unmanaged grazing can result in significant sedimentation and other impacts if not properly controlled (Davies and Sowles 1997) and thus precipitates the need for the limitations placed on forestry, grazing, and agriculture operations in Zone 2 (outlined below). Permitted exceptions include those described in Zone 1.

The objectives for vegetation management operations in Zone 2 are as follows:

- To establish and maintain wind-firm, well-distributed, uneven-aged, or multi-aged forest stands where they historically existed.
- To establish and maintain diverse, vigorous, uneven-aged, or multi-aged shrub-steppe and riparian scrub vegetative stands where they historically existed.
- To maintain sustainable forage production or grazing on areas in buffers committed to this land, use on lands <5 percent slope.

Therefore,

- Water quality Best Management Practices (BMPs) should be observed at all times.
- New roads and borrow pits should not be developed in buffer areas.

No more than 40 percent of the volume of timber over 6 inches in DBH should be removed in any 10-year period from Zone 2 buffer areas.

- A 35-ft no-harvest strip should be maintained adjacent to all perennial surface water features (in other words, perennial streams, ponds) in Zone 2 that are directly connected by surface flow to the in-stream resource being protected.
- Harvesting operations in Zone 2 buffers should be curtailed when harvesting equipment creates significant soil disturbance (for example, mineral soils are exposed or sheet and rill erosion is evidenced). Operations should be limited to periods when the soils are frozen solid.
- Agriculture should be limited to the production of sod forming grasses or alfalfa on slopes <5 percent.
- All grazing in Zone 2 should be seasonal, of short duration, and observe best range management practices. Cattle watering facilities should be located outside Zone 2. If impractical, river access should be fenced and armored at the stream bank edge.
- If significant soil disturbance should occur, remediation should be undertaken immediately with logging slash and other appropriate materials. Remediation should accomplish restoring conditions to the point where they are functionally similar to the predisturbance condition.

If these guidelines are followed, tree harvesting, grazing, and agricultural operations may be conducted without adversely affecting buffer function or causing harm to in-stream habitats. Other land uses that would not compromise intended Zone 2 functions include light recreation such as hunting, walking trails, picnic tables, and low-impact camp sites.

Land uses affect buffer attributes such as percent canopy cover, surface roughness, and infiltration capacity (soil hydrologic group). These, in turn, affect optimal buffer width. Therefore, buffers that contain agricultural uses or development will, all else being equal, cause wider optimal buffer width determinations. There are recommended land use restrictions in each buffer zone (Zone 1 and Zone 2); however, in many cases, it is impractical to eliminate historical uses, such as residential development, already in these zones. To the extent that such uses can be discontinued and the non-conforming portions of the buffer can be allowed to revert to naturally vegetated buffer, buffer effectiveness will be maximized. The calculated optimal buffer width will decrease as succession allows abandoned lands to revert to forested riparian scrub or shrub-steppe systems (for example, due to greater percent canopy, shrub-steppe, or riparian scrub coverage and higher degrees of surface roughness).

Where it is impractical to remove/abandon prior uses, best management practices to protect soils and water quality and provide shading should be employed to the maximum extent possible within the two zones of the buffer. It is beyond the scope of this handbook to review buffer best management practices in detail. Where possible, however,

the establishment of native woody vegetation (by planting or natural succession) within the managed portion of the buffer is recommended. In addition, channelization of run-off should be prevented/minimized and adherence to storm water BMPs, particularly on-site retention of storm water, should be employed.

Zone 3 Optional Recommendations

Zone 3 is the landscape on the landward edge of Zone 2. Irrigated and non-irrigated crops, grazing, and increasing exurban residential development are predominant uses. Research has shown that implementation of BMP (field borders, buffer strips, filter strips, grassed waterways, storm water management, and other NRCS practices) can significantly reduce sediments and pollutants originating with these land uses (Schnepf and Cox 2006). Thus, BMPs are recommended for Zone 3 to protect long-term buffer functional efficiency.

Appendix A-9: Websites for State Sources of GIS Data

IDAHO

Interactive Numeric and Spatial Information Data Engine with links to Federal, Idaho, Oregon, Montana, Nevada, Utah, Washington, Wyoming, and other sites
http://inside.uidaho.edu/default.htm

MONTANA

Montana State Library—Montana Natural Resource Information System—Geographic Information
http://nris.state.mt.us/gis/default.htm

OREGON

University of Oregon Libraries—Map and Aerial Photography Collection Maps and GIS Resources: United States, by State
http://libweb.uoregon.edu/map/map_section/map_Statedatasets.html

UTAH

Utah Division of Wildlife Resources
Index of Available GIS Data
http://dwrcdc.nr.utah.gov/ucdc/DownloadGIS/disclaim.htm
USGS—List of Spatial Data Sets for Water (Water quality and hydrologic data by county for Utah—bottom of page)
http://water.usgs.gov/lookup/getgislist

WASHINGTON

Washington Access—Official State Government Website Department of Ecology GIS
http://www.ecy.wa.gov/services/gis/data/data.htm

WYOMING

Wyoming Geographic Information Advisory Council—Wyoming Spatial Data Clearinghouse
http://wgiac2.state.wy.us/html/wsdc_index.asp

GENERAL

Natural Resource Conservation Service—NRCS GIS and Data Sites
http://www.nrcs.usda.gov/technical/land/nrcsdata.html

Environmental Protection Agency—EPA Region 8—GIS and Spatial Data (Montana, North Dakota, South Dakota, Utah, Wyoming, and Colorado)
http://www.epa.gov/region08/gis/gislinks.html

U.S. Fish & Wildlife Service—Geographic Information Systems and Spatial Data (Links to all states)
http://www.fws.gov/data/gishome.html

Appendix A-10: Illustrations of Project Boundary Delineation and Buffer Units

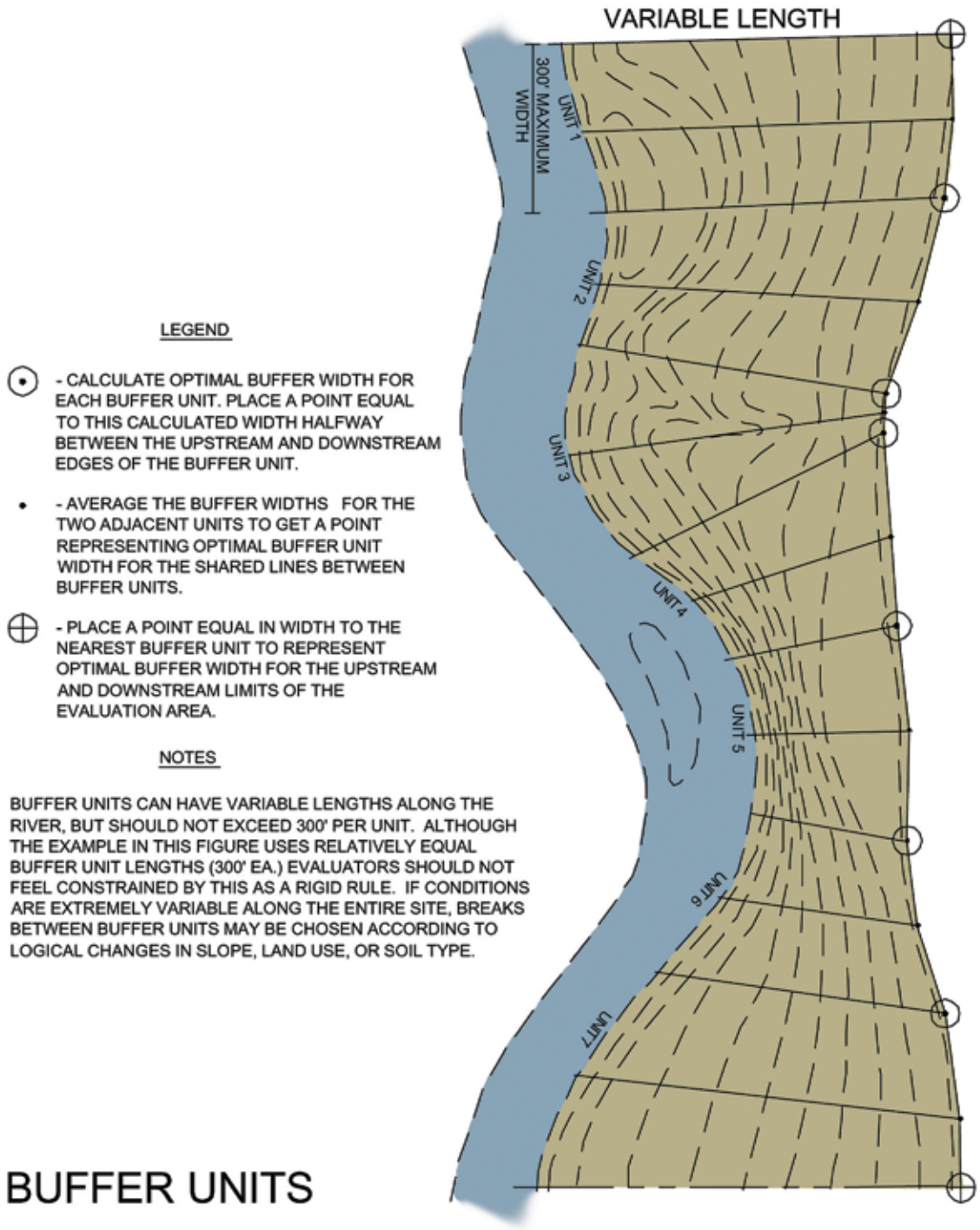


Illustration of project boundary delineation and buffer units.

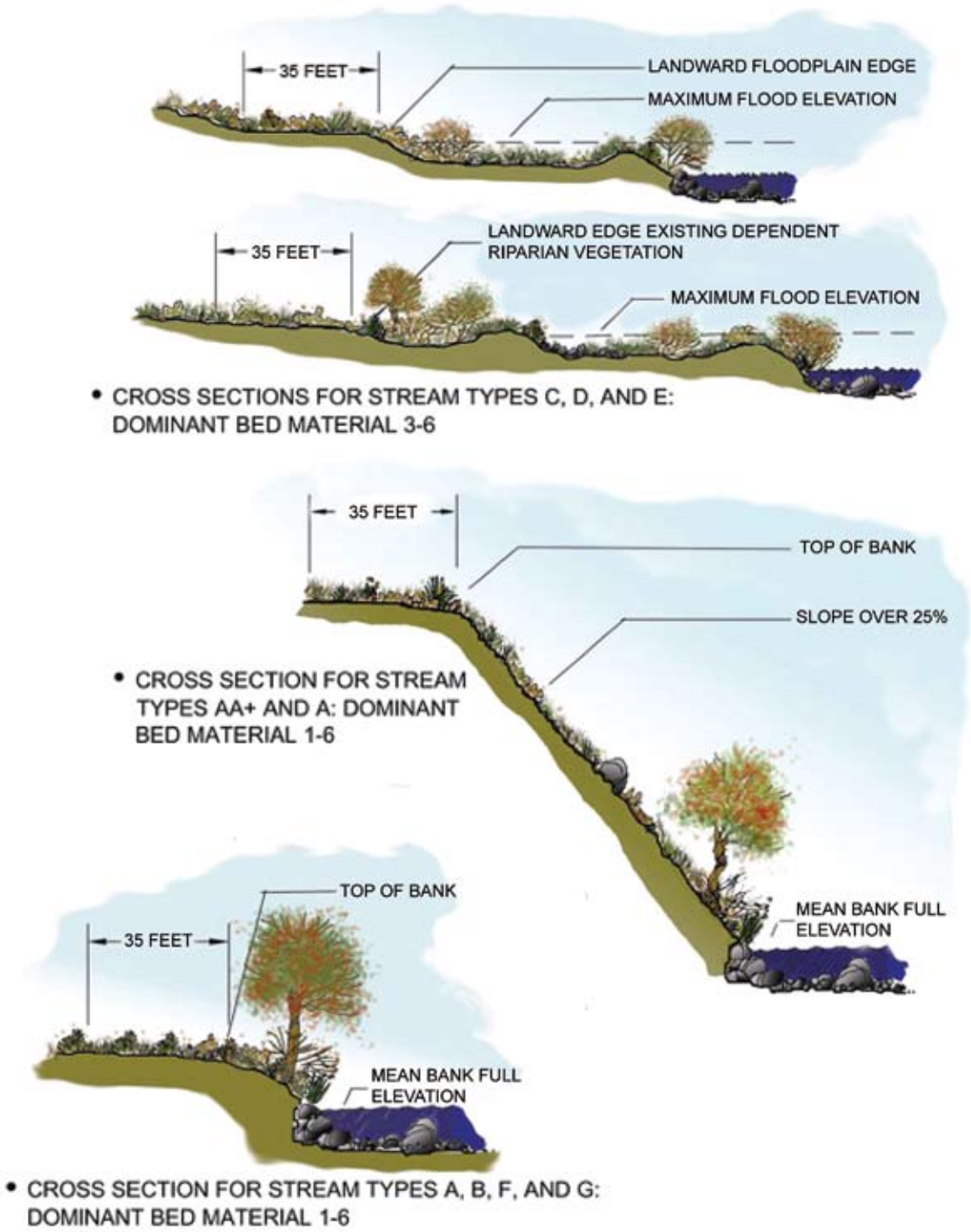
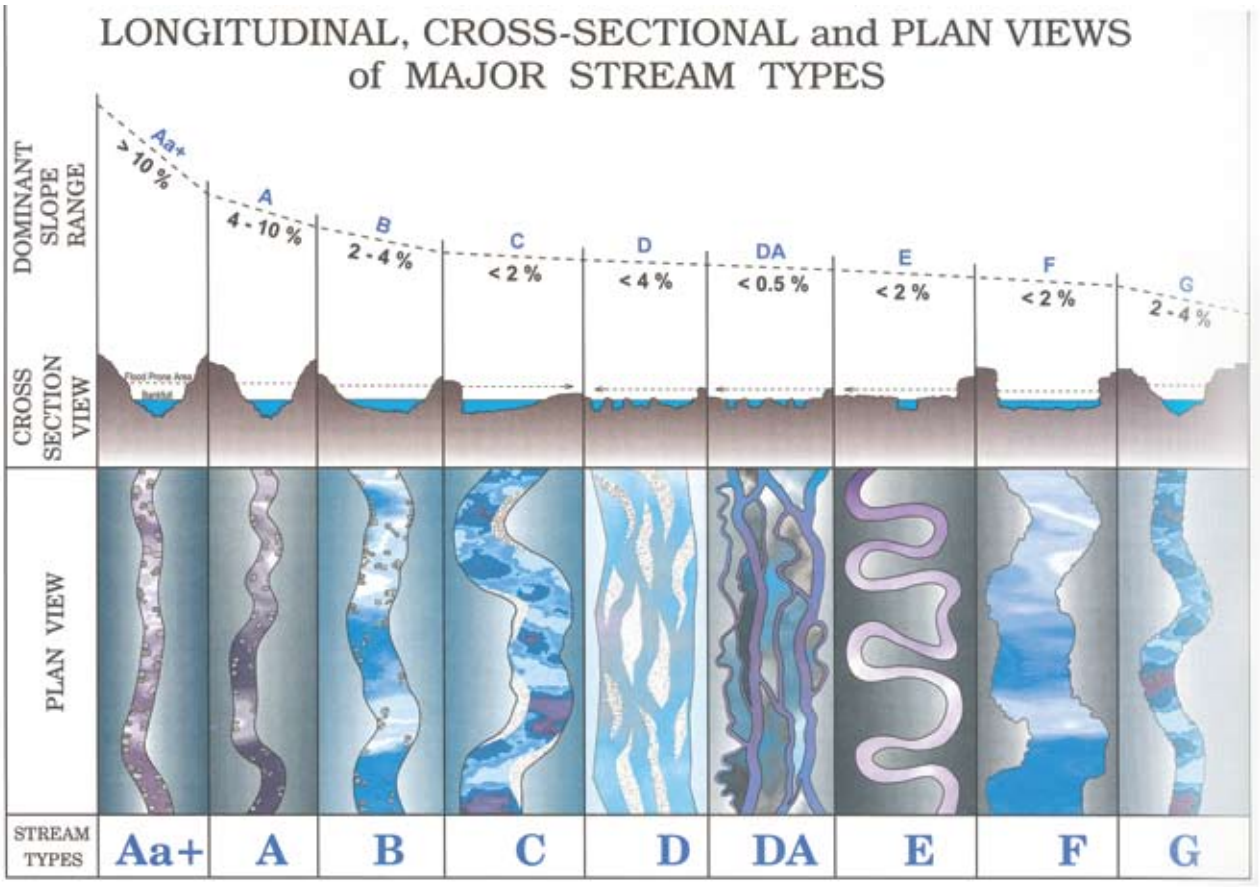


Illustration of buffer unit cross sections.

Appendix A-11: Rosgen Stream Classification Diagrams



Rosgen Stream Classification Diagrams. Source: Rosgen, D.L (1996). Used with permission.

Stream Type	General Description	Entrenchment Ratio	W/D Ratio	Sinuosity	Slope	Landform/ Soils/Features
Aa+	Very steep, deeply entrenched, debris transport, torrent streams.	<1.4	<12	1.0 to 1.1	>.10	Very high relief. Erosional, bedrock or depositional features; debris flow potential. Deeply entrenched streams. Vertical steps with deep scour pools; waterfalls.
A	Steep, entrenched, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock or boulder dominated channel.	<1.4	<12	1.0 to 1.2	.04 to .10	High relief. Erosional or depositional and bedrock forms. Entrenched and confined streams with cascading reaches. Frequently spaced, deep pools in associated step/pool bed morphology.
B	Moderately entrenched, moderate gradient, riffle dominated channel, with infrequently spaced pools. Very stable plan and profile. Stable banks.	1.4 to 2.2	>12	>1.2	.02 to .039	Moderate relief, colluvial deposition, and/or structural. Moderate entrenchment and W/D ratio. Narrow, gently sloping valleys. Rapids predominate w/scour pools.
C	Low gradient, meandering, point-bar, riffle/pool, alluvial channels with broad, well defined floodplains.	>2.2	>12	>1.4	<.02	Broad valleys w/terraces, in association with floodplains, alluvial soils. Slightly entrenched with well-defined meandering channels. Riffle/pool bed morphology.
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks.	n/a	>40	n/a	<.04	Broad valleys with alluvium, steeper fans. Glacial debris and depositional features. Active lateral adjustment, w/abundance of sediment supply. Convergence/divergence bed features, aggradational processes, high bedload and bank erosion.
DA	Anastomosing (multiple channels) narrow and deep with extensive, well vegetated floodplains and associated wetlands. Very gentle relief with highly variable sinuosities and width/depth ratios. Very stable streambanks.	>2.2	Highly variable	Highly variable	<.005	Broad, low-gradient valleys with fine alluvium and/or lacustrine soils. Anastomosed (multiple channel) geologic control creating fine deposition w/well-vegetated bars that are laterally stable with broad wetland floodplains. Very low bedload, high wash load sediment.
E	Low gradient, meandering riffle/pool stream with low width/depth ratio and little deposition. Very efficient and stable. High meander width ratio.	>2.2	<12	>1.5	<.02	Broad valley/meadows. Alluvial materials with floodplains. Highly sinuous with stable, well-vegetated banks. Riffle/pool morphology with very low width/depth ratios.
F	Entrenched meandering riffle/pool channel on low gradients with high width/depth ratio.	<1.4	>12	>1.4	<.02	Entrenched in highly weathered material. Gentle gradients, with a high width/depth ratio. Meandering, laterally unstable with high bank erosion rates. Riffle/pool morphology.
G	Entrenched "gully" step/pool and low width/depth ratio on moderate gradients.	<1.4	<12	>1.2	.02 to .039	Gullies, step/pool morphology w/moderate slopes and low width/depth ratio. Narrow valleys, or deeply incised in alluvial or colluvial materials, i.e., fans or deltas. Unstable, with grade control problems and high bank erosion rates.

Rosgen Stream Classification Table. Source: Rosgen, D.L (1996). Used with permission.

Appendix B-1: Wildlife Habitat Buffer Data Form and Worksheet

Date:_____ Surveyed by:_____

USGS quad:_____

Landowner address (mailing):

_____ Stream name:_____

_____

Buffer Unit #:_____

Data for Determining the Baseline for Wildlife Buffers: Use the buffer delineated for water quality as a starting point.

Data for use in Habitat Management Recommendations and Zones of Use Keys: Check the appropriate boxes in response to the questions and matrices that follow.

A. Attribute: Level of landowner willingness/ability to participate in wildlife conservation
Check the appropriate answer. **Level 1**_____ **Level 2**_____ **Level 3**_____

source _____

B. Attribute: Federally Listed Species
Check the appropriate answer below.

The presence of habitat for federally listed or proposed threatened or endangered (T or E) plants or wildlife within the project site may require special planning procedures to meet requirements of the species of concern. Formal consultations with the US Fish and Wildlife Service may be required. Riparian buffer configuration, its structural characteristics, and permitted uses within the buffer may be affected to protect the species of concern.

Threatened or endangered species listed or proposed are present on the project site Y____ N ____

species_____ source _____

C. Attribute: State Listed Species
Check the appropriate answer below.

Some riparian buffer sites may be inhabited by State listed species of concern. These species do not receive the same level of protection afforded Federally listed T and E species, however, the riparian buffer plan should give special consideration to conservation of State listed species. Consultation with state wildlife agencies is recommended. Riparian buffer configuration, its structural characteristics, and permitted uses within the buffer may be affected to protect the species of concern.

State listed species of concern are present on the project site Y ____ N ____

species_____ source _____

PRIMARY BUFFER ATTRIBUTES

D. Attribute: Plant Community Vigor Inventory
Use matrix below to determine resource presence or absence and estimate percent of native species.
Circle the appropriate answers in the matrix below (H=High, M=Moderate, or L=Low; Y=Yes, N=No, or na=not applicable).

	RIPARIAN			UPLAND		
Criteria						
Hydrological processes that operate across the site are sufficient to sustain riparian/wetland vegetation (1).	Y	N	na			
Plant horizontal and vertical structure normally associated with plant community type is present (2).	Y	N	na	Y	N	na
Native plant species normally associated with plant community type are present. Reported as percent of native species (3).	≥90%	75-90%	<75%	≥90%	75-90%	<75%
Rating based on percentage and professional judgment (3).	H	M	L	H	M	L
Range of age classes of dominant tree and or shrub species is present in the buffer unit (4).	Y	N	na			

Adapted from: BLM (1998), Berglund (1999), Keate (2004)

Comments:

source/calculation method _____

1. Indicators of natural hydrological processes sufficient to sustain riparian/wetland vegetation include but are not limited to: absence of upstream or on-site human made dams or diversions, over-bank flow across the active flood plain at least once every 2 to 3 years, channel alignment, cross section and gradient in balance with the geomorphic setting or mean depth to water table in the riparian zone is < 20 inches.

2. Estimate by comparing project site to reference site, literature descriptions, or historical reference. See Appendix B-4 for plant list.

3. Calculate the ratio of native to non-native species of the most dominant trees, shrubs, and herbaceous species based on the point sampling procedure detailed in Appendix B-5. Refer to Appendix B-4 for a general plant list. The plant list may require modification to reflect sub-regional characteristics. Select final rating (H, M, or L). This rating may be lowered based on professional judgment if an expected plant community component is missing.

4. Estimate by comparing project site to reference site, literature descriptions, or historical references. In the study area, age stands are not uniformly distributed along the stream channel. Typically, greatest stand age diversity occurs on point bars and transition areas between pools and riffles. In multiple channel or braided streams, recruitment is high on in-stream bars and islands. Mature and senescent plants are most prevalent along straight reaches and abandoned channels.

Stand age class diversity for woody species in the riparian plant community should be estimated for the entire project area by comparing the length of project site reach with similar length of reach in the reference area. The estimate is recorded in Step I.

E. Attribute: Plant Community Vigor Rating - Riparian Plant Community
Use the matrix below with circled responses from Step D to estimate plant community vigor. Circle the appropriate answers in the boxes below (H=High, M=Moderate, or L=Low; Y=Yes or N=No).

Criteria												
Hydrological processes are present to sustain riparian/wetland vegetation (from Step D)	Y						N					
Plant community horizontal and vertical structure normally associated with the plant community type is present (from Step D)	Y			N			Y			N		
Native plant species normally associated with the plant community type are present (use H, M, or L from Step D)	H	M	L	H	M	L	H	M	L	H	M	L
Rating calculated (circle rating)	H	H	L	H	M	L	M	M	L	M	L	L
Actual functional points (record points in rating box below)	1.0	0.9	0.4	0.8	0.7	0.3	0.6	0.5	0.2	0.4	0.2	0.1

Adapted from: BLM (1998), Berglund (1998), Keate (2004)

RATING	**High**	**Moderate**	**Low**
Score - report the functional point score from matrix above			

Comments:

source/calculation method _____

E. Attribute: Plant Community Vigor Rating - Upland Plant Community
Use the matrix below with circled responses from Step D to estimate plant community vigor. Circle the appropriate answers in the boxes below (H=High, M=Moderate, or L=Low; Y=Yes or N=No).

Criteria						
Plant Community horizontal and vertical structure normally associated with the plant community type is present (from Step D)	Y			N		
Native plant species normally associated with the plant community type are present (use H, M or L from Step D)	H	M	L	H	M	L
Rating calculated (circle rating)	H	M	L	M	L	L
Actual functional points (record points in rating box below)	1.0	0.7	0.4	0.6	0.3	0.1

Adapted from: Mee and others (2003), Paige and Ritter (1999)

RATING	**High**	**Moderate**	**Low**
Score - report the functional point score from matrix above			

Comments:

source/calculation method_____

F. Attribute: Level of Human-induced Distrubance or Fragmentation in the Buffer Unit
Use the matrix below to estimate the level of human induced disturbance/fragmentation in the buffer unit and adjacent area. Circle the appropriate answer in the matrix below and record the score in the rating box below (H=High, M=Moderate, or L=Low).

Criteria	Conditions adjacent to buffer unit (within 600 ft of the project boundary)		
Conditions within buffer unit	Land occurs and is managed in predominately natural state; is not grazed, hayed, logged; or otherwise converted; does not contain buildings	Land not cultivated, but moderately grazed or hayed or selectively logged; or has been subject to minor clearing; contains few roads or buildings	Land cultivated or heavily grazed or logged; subject to substantial fill placement, grading, clearing, or hydrological alteration; high road or building density
Buffer unit occurs and is managed in predominately natural state; is not grazed, hayed, logged; or otherwise converted; does not contain roads or occupied buildings	1.0 (L)	0.9 (L)	0.7 (M)
Buffer unit not cultivated, but moderately grazed or hayed or selectively logged; or otherwise converted; does not contain roads or occupied buildings	0.7 (M)	0.5 (M)	0.3 (H)
Cultivated or heavily grazed or logged; subject to relatively substantial fill placement, grading, clearing or hydrological alteration; high road or building density	0.5 (H)	0.2 (H)	0.1 (H)

RATING Adapted from: Bergland (1998) and Johnson and others(2004) **RATING**	**High**	**Moderate**	**Low**
Score - report the functional point score from matrix above			

Comments: Note types of disturbance, intensity, and season.

Mapping: Outline on the base map any areas >300 sq ft with high levels of disturbance in the buffer unit. (Map overlay #1)

source/calculation method_____

G. Atrribute: Relative Abundance of Exotic Invasive Vegetation - Riparian Plant Community
Use the matrix below to determine relative abundance of invasive exotic vegetation. Circle the appropriate answer in the matrix and record the score in the rating box (H=High, M=Moderate, or L=Low).

Criteria	H	M	L
>25 pecent of the area of the riparian plant community in the buffer unit is occupied by invasive exotic plant species	0.3		
Between 10 and 25 percent of the area of the riparian plant community in the buffer unit is occupied by invasive exotic plant species		0.7	
<10 percent of the area of the riparian plant community in the buffer unit is occupied by invasive exotic plant species			1.0

Adapted from: Keate (2004), Johnson and others (2004)

RATING	High	Moderate	Low
Score - report the functional point score from matrix above			

Comments:

Mapping: On the base map, outline grass and forb areas (>300 sq ft), shrub areas (>600 sq ft) and treed areas (>900 sq ft) with greater than 75 percent invasive exotic vegetation (Map overlay #2).

source/calculation method_____

G. Atrribute: Relative Abundance of Exotic Invasive Vegetation - Upland Plant Community
Use the matrix below to determine relative abundance of invasive exotic vegetation. Circle the appropriate answer in the matrix and record the score in the rating box (H=High, M=Moderate, or L=Low).

Criteria	H	M	L
>25 percent of the area of the upland plant community in the buffer unit is occupied by invasive exotic plant species	0.3		
Between 10 and 25 percent of the area of the upland plant community in the buffer unit is occupied by invasive exotic plant species		0.7	
<10 percent of the area of the upland plant community in the buffer unit is occupied by invasive exotic plant species			1.0

Adapted from: Keate (2004), Johnson and others (2004)

RATING	High	Moderate	Low
Score - report the functional point score from matrix above			

Comments:

Mapping: On the base map, outline grass and forb areas (>300 sq ft), shrub areas (>600 sq ft) and treed areas (>900 sq ft) with greater than 75 percent invasive exotic vegetation (Map overlay #2).

source/calculation method_____

H. Attribute: Habitat Suitability Rating for Riparian Breeding Birds
Use the bird survey protocol described in Appendix B-6 to estimate the habitat suitability of existing vegetation for riparian obligate or dependent breeding land birds. See Appendix B-5 for a list of riparian land bird species. Circle the appropriate answer in the matrix and record score in rating box (H=High, M=Moderate, or L=Low).

Criteria	H	M	L
>80 percent of the species expected to be present were observed	1.0		
60 to 80 percent of the species expected to be present were observed		0.7	
<60 percent of the species expected to be present were observed			0.3

Adapted from: Rich (2002)

RATING	High	Moderate	Low
Score - report the functional point score from matrix above			

Calculation: number of observed species ÷ number of expected species x 100
Comments:

source/calculation method_____

I. Project Scale Attribute: Range of Age Classes
Range of age classes of dominant native riparian tree and or shrub species for all buffer units combined (applies only to buffer projects with a stream length ≥1200 ft (Johnson and others 2004; Keate 2004).

Use the answer key below to estimate the range of age classes for the project site.

1. The stream bank length in the project site is ≥1200 ft Y ___ N ___
If the answer is NO, circle na in the rating box below and proceed to the next step; if the answer is YES answer question #2.

2. The riparian plant community in the buffer unit has the diversity of age classes of dominant native trees and or shrubs typical of riparian zones in this stream class Y ___ N ___ Enter your response in the buffer unit rating box below.

If, after evaluating all buffer units, the conclusion is that the project site does not have the expected level of stand age diversity circle -0.2 in the project site rating box. Then proceed to Step J, subtract 0.2 from the percent functional points and enter the new score in the modified percent total functional points box in Step J.

Buffer Unit Rating Box		Y	N	na
Project Site Rating Box	Adjust the buffer unit score as described above. The adjusted score is recorded in the modified percent total functional points rating box in Step J.		-0.2	

Optional Step: Habitat Suitability Rating for Target Species

Conduct this step if the landowner or planning group has selected a target species. Compare the condition of existing habitat with the target species habitat model. The levels of target species habitat suitability below provide guidelines for evaluation. Circle the appropriate rating in the rating box below.

High: The buffer unit contains most of the food cover, water, space, reproductive sites, security, special features, and other life requisites necessary to sustain the target species.

Moderate: The buffer unit contains most of the food, cover, water, space, reproductive sites, security, special features, and other life requisites necessary to sustain the target species but one or more of the life requisites is limited in quality, quantity, or availability.

Low: The buffer unit contains few or none of the food, cover, water, space, reproductive sites, security, special features, and other life requisites necessary to sustain the target species.

Target species name:_____

RATING BOX	High	Moderate	Low

Comments:

Target species name:_____

RATING BOX	High	Moderate	Low

Comments:

source/calculation method_____

Note: Target species habitat suitability ratings are not used for estimating the functional condition of plant communities in the buffer unit. However, they will be useful in developing specific habitat management plans for the species.

J. Riparian Plant Community Ecological Functional Condition Rating Form: Unadjusted
Enter the general evaluation ratings (H, M, or L) and actual functional points (0 to 1) from the previous sections. Add up the actual functional points.

Function variables (primary site attributes)	General evaluation H-M-L	Actual functional points	Possible functional points
Plant community vigor Step E			1.0
Levels of human-induced disturbance or fragmentation Step F			1.0
Relative abundance of invasive exotic plant species Step G			1.0
Habitat for riparian obligate and dependent land breeding birds Step H			1.0
Totals			4.0

Modified Rating
If the answer to the question in Step I (Project Scale Attribute) is NO, subtract 0.2 from the unadjusted habitat quality rating (percent total functional points) and enter the new modified habitat quality rating score in the rating box below. If a modification is made as described above, use the modified score to estimate the Function Condition Category for the buffer unit, otherwise use the unadjusted score.

Unadjusted Habitat Quality Rating - Riparian (percent functional points = actual functional points ÷ possible functional points x 100		percent of total functional points
Modified Habitat Quality Rating - Riparian Y____N____		Modified percent of total functional points

J. Upland Plant Community Ecological Functional Condition Rating Form: Unadjusted
Enter the general evaluation ratings (H, M, or L) and actual functional points (0 to 1) from the previously rated primary site attributes. Add up the actual functional points.

Function variables (primary site attributes)	General evaluation H-M-L	Actual functional points	Possible functional points
Plant community vigor Step E			1.0
Levels of human-induced disturbance or fragmentation Step F			1.0
Relative abundance of invasive exotic plant species Step G			1.0
Totals			3.0

Unadjusted Habitat Quality Rating - Upland _____
(percent functional points = actual functional points ÷ possible functional points x 100)

Overall Unadjusted Functional Condition Rating and Management Recommendation
Circle the appropriate functional condition in the rating box for the riparian/wetland and upland plant communities using the criteria below.

Proper Functioning Condition (PFC)
Riparian/wetland • A score of High for habitat suitability for riparian/wetland obligate or dependent and breeding birds or score ≥80 pecent (0.8) of the possible functional points. **Upland** • A score of ≥80 percent (0.8) of the possible functional points. Proper functioning condition plant communities are high quality habitats with numerous niches for a diversity of species. They are generally uncommon in the study area. These high quality remnants are critical to the persistence of biodiversity in the study area.
Management Recommendation: Preservation

Functional-At Risk (FAR)
Riparian/wetland • A score of Moderate for habitat suitability for riparian/wetland obligate or dependent land breeding birds or a score of <80 percent (0.8) but >60 percent (0.6) of the possible functional points. **Upland** • Score <80 percent (0.8) but >60 percent (0.6) of the possible functional points. Functional-At Risk plant communities are moderate quality habitat for some species but typically have fewer niches and do not support the diversity of species associated with plant communities rated PFC. FAR plant communities are more common than PFC communities; they are less stable and thus susceptible to further degradation.
Management Recommendation: Enhancement/Rehabilitation

Nonfunctional (NF)
Riparian/wetland • Does not meet the scoring criteria described above. **Upland** • Does not meet the scoring criteria described above. Nonfunctional plant communities are typically low quality habitat for most wildlife species; they have few niches and wildlife species diversity is low. The condition will persist if the causes of dysfunction are not addressed.
Management Recommendation: Reclamation/Restoration

RATING

	Riparian	PFC	FAR	NF
	Upland	PFC	FAR	NF

K. Functional Condition Rating Adjustment Key

Make functional condition rating adjustments (if necessary) to segments within the buffer unit using the specific single attribute criteria below. Make adjustments across buffer unit boundaries (including single attribute adjustments) when preparing the final project scale functional condition map using the criteria below.

Adjustment 1 - Specific Single Attribute	
	Adjustment
Areas >300 sq ft with high levels of human-induced disturbance (reference Map Overlay #1 from Step F)	Reduce the Unadjusted Ecological Functional Condition by one level in areas outlined as having high levels of human-induced disturbance on Map Overlay #1. (for example, PRC=FAR, FAR=NF, NF=NF)
Grass and forb areas (>300 sq ft), shrub areas (>600 sq ft) and treed areas (>900 sq ft) with greater than 75 percent invasive exotic vegetation (reference Map Overlay #2 from Step G)	Reduce the Unadjusted Ecological Functional Condition by one level in areas outlined as having >75 percent invasive exotic plant species on Map Overlay #2. (for example, PFC=FAR, FAR=NF, NF=NF)
Adjustment 2 –Across Buffer Unit Boundaries	
Modify the boundaries of the functional condition rating across buffer units to more accurately reflect on the ground conditions based on additional information and best professional judgment.	
Mapping – Final Adjusted Ecological Functional Condition Map	
Record the adjustments on a copy of the base map and redraw the map based on the adjustments. The redrawn map is the final Adjusted Ecological Functional Condition Map. This map is used to determine final habitat management recommendations and land use zones for the entire project site.	

L. Habitat Management and Land Use Zone Key for Plant Communities by Level of Participation

Level 1
For Level 1, the configuration of the riparian buffer for wildlife is the same as the buffer delineated for water quality. All management and land use recommendations occur inside the buffer. Level 1 landowners do not have wildlife conservation as a project objective. However, the buffer unit evaluation may identify areas within the buffer unit that are functional at-risk or non-functional. In these cases, the landowner should be encouraged to implement appropriate restoration or reclamation techniques to stabilize the problem areas.

Level 2
For Level 2, the configuration of the riparian buffer for wildlife conservation is the same as the buffer delineated for water quality. All management and land use recommendations occur inside the buffer.

Level 2: Management Recommendations and Land Use Zone Key		
Functional Conditions from Step J/K	Management Recommendations	Land Use Zones & Specifications
Proper Functioning Condition	Preservation	Zone 1
Functioning at-Risk	Enhancement/Rehabilitation	
Nonfunctional	Reclamation/Restoration	

Comments:

See Appendix A-8 for Land Use Zones and Specifications.

Mapping: Record on the base map the functional condition rating, management recommendation and land use zone derived from the matrix above for both plant communities inside the buffer in the buffer unit.

Level 2: Target Species Habitat Management Recommendation Key		
	Habitat Rating from Step J/K	Management Recommendations
Species Name:	High	Preservation
	Moderate	Enhancement/Rehabilitation
	Low	Reclamation/Restoration
Species Name:	High	Preservation
	Moderate	Enhancement/Rehabilitation
	Low	Reclamation/Restoration

Comments:

See Appendix A-8 for Land Use Zones and Specifications.

Mapping: Record on a separate base map the management recommendations for target species derived from the matrix above for both plant communities in the buffer unit.

Level 3
For Level 3, the riparian buffer delineated for water quality is the core of the buffer for wildlife conservation. The buffer may be expanded to increase habitat value for wildlife or to enhance habitat functions (for example, widening the buffer to accommodate seasonal migration or connecting the buffer to other habitat patches).

Level 3: Management Recommendations and Land Use Zone Key		
Functional Conditions from Step J/K	Management Recommendations	Land Use Zones & Specifications
Proper Functioning Condition	Preservation	Zone 1
Functioning at-Risk	Enhancement/Rehabilitation	
NonFunctional	Reclamation/Restoration	

Comments:

See Appendix A-8 for Land Use Zones and Specifications.

Mapping: Record on the base map the functional condition rating, management recommendation and land use zone derived from the matrix above for both plant communities inside the project site boundary.

Level 3: Target Species Habitat Management Recommendation Key		
	Habitat Rating from Step J/K	Management Recommendations
Species Name:	High	Preservation
	Moderate	Enhancement/Rehabilitation
	Low	Reclamation/Restoration
Species Name:	High	Preservation
	Moderate	Enhancement/Rehabilitation
	Low	Reclamation/Restoration

Comments:

See Appendix A-8 for Land Use Zones and Specifications.

Mapping: Record on the base map the functional condition rating, management recommendation and land use zone derived from the matrix above for both plant communities inside the project site boundary.

Mapping: Record on a separate base map the management recommendations for target species derived from the matrix above for both plant communities in the buffer unit.

Appendix B-2: Wildlife Species Habitat Model—Example

Shorebird Habitat Model

Willet Scolopacidae Catoptrophorus semipalmatus inornatus

Model by Jenn Elliot

General Habitat Description

During the spring and fall, willets can be found along the edges of lakes and ponds; along streams, rivers, and canals; in irrigated agricultural areas; in rush/bulrush/sedge/cattail type marshes; and in aquatic basins, sandbars, mudflats, and playas. Willets prefer shallow water with little or no emergent vegetation. Habitat also consists of desert riparian deciduous woodland that provides a narrow band of trees (especially cottonwoods) and shrubs along the margins of streams and rivers. The willet favors ephemeral, temporary, seasonal, and alkali wetlands over semi-permanent and permanent wetlands. They also occupy areas that are open with lightly vegetated cover. They tend to avoid tilled land, but will use cultivated fields (Lowther and others 2001).

Food

The willet is a generalist (Lowther and others 2001). Overall, the general food habits of the willet are not well known. Both juvenile and adult willets eat the seeds, fruits, and cones of vascular plants as well as worms, mollusks, crustaceans, aquatic insects, and insect larvae. Mollusca and insecta are especially important food sources. Adults and juveniles feed in the mud or silt, fresh water, and saline marshes. Willets forge by probing in moist substrates. They also forage in the ground on their upland nesting sites and where there is sparse vegetation.

Water

Willets require wetlands with water depths ranging from dry mud to 4 inches deep (NatureServe 2006). As mentioned in the general habitat description, willets also prefer to have other water sources nearby (Lowther and others 2001).

Reproduction Cover

Willets breed and lay their eggs in fresh water marshes that consist of dry grasses, forbs, sedges, and rushes. They nest on alkaline grass on the edge of a body of water. Their gestation and incubation period is 3 to 4 weeks (NatureServe 2006). Breeding occurs from late April through late June for Cache County, Utah (Lowther and others 2001). Nesting sites are located in open areas up to several hundred yards from the water's edge (Stokes and Stokes 1996). Nests are usually found near a piece of driftwood, dried cattle dung, or rocks. In areas with few or no wetland basins, median distance of a nest site to any water feature is generally 1/2 mile (Lowther and others 2001). In the U.S. Great Basin, willets often nest at edges of sagebrush near ponds.

Home Range-Territory Size

Willet's are both nocturnal and diurnal. They migrate during the night. The average size of a willet's territory is 110 acres (NatureServe 2006). Willets are territorial during the breeding season, but little intraspecific hostility is observed following the hatch (Lowther and others 2001). There is little information available regarding a willet's

home range size. It is fair to assume that the size of a willet's home range is at least the size of its territory. They often use the same places to roost and forage. The distance between roosting and feeding is often around 1/2 mile (Lowther and others 2001).

Interspersion of Habitat Elements In Home Range

Willets require a mosaic of wetland types, from ephemeral to semi-permanent, interspersed with short to moderate height grasslands for nesting and brood rearing. No information was found on preferred distance between these features. As wetlands flood or dry up, willets, along with their chicks, have been known to move to the next shallow water source, often a mile or more away (Lowther and others 2001).

Patch Size and Configuration

No specific information can be found in the literature concerning patch size. Based on a willet's territory and home range size, any patch that is smaller than 110 acres may not be adequate (Lowther and others 2001).

Factors Adversely Affecting the Species

Wetland availability and drought create unpredictable food resources. Neighborhood dogs can potentially disturb roosting birds. Heavy machinery and vehicles, including all terrain vehicles, apparently do not cause any disturbances to nesting willets (Lowther and others 2001). There are potential effects on adults and young from insecticides such as carbaryl, chlorpyrifos, deltamethrin, dimethoate, and malathion, which are primarily used for grasshopper control. These effects and the extent to which they cause harm have not been fully researched. Insecticides may also have an indirect effect on the willet's food resources. Willets have occasionally been hit by cars and have been known to run into power lines, particularly during aerial territorial and sexual chases (Lowther and others 2001).

Management Options

Recommendations include:

- Protect contiguous blocks of native grassland >250 acres containing diverse complex of wetland types including temporary ponds (NatureServe 2006);
- Bury power lines or avoid putting lines through wetlands;
- Maintain shallow-water ponds with little or no emergent vegetation for pre- and post-breeding flocks and maintain shallow-water ponds with margins of emergent vegetation for broods (Lowther and others 2001); and
- Use rotational grazing to maintain preferred habitat of shorter, sparser vegetation (avoid grazing until early to later June) (Lowther and others 2001).

Site Specific Recommendations

Water depths should be kept shallow at a maximum of 4 inches, but kept stable during nesting and brood care (April through June) (NatureServe 2006). Water should be in wetland complexes so that in drought years wetlands and playas will have water. Berms should be used to hide architecture and parking lots adjacent to the willet's habitat. Berms should have a gradual (not steep) slope and be vegetated with native grassland species. Buildings near willet habitat should also have low profiles. No reflective effects should radiate from buildings. Power, telephone, and other utilities traditionally placed above ground should be buried. Insecticide use should be minimized or eliminated.

Willets should be provided with continuous corridors with suitable wetland/grassland habitat to connect blocks of native grassland. When searching for habitat patches,

look for pasturelands that are over 100 acres. Low growing crops can make an effective buffer and can be used for food sources, but habitat should include native grassland for successful nesting sites. Cropland used for buffers should not be left tilled, but replanted with a rotating crop (Lowther and others 2001). Nesting locations range between 900 ft and 1/2 mile. Edges should be planted with the following playa plant species at a minimum distance of 300 ft from the water (Stokes and Stokes 1996).

Playa Plant Species List

Plants found in playas that are used by willets.

Common Name	Scientific Name
pickleweed	*Salicornia europaea variety rubra*
iodine bush	*Allenrolfea occidentalis*
greasewood	*Sarcobatus vermiculatus*
salt grass	*Distichlis spicata* var. *stricta*
knotweed	*Polygonum* spp.
mouse barley	*Hordeum murinum*
pepper grass	*Lepidium perfoliatum*
Gardner's salt bush	*Atriplex gardneri*
squirrel tail	*Sitanion hystrix*

Appendix B-3: List of Wildlife and Wildlife Habitat Data Needs

The following lists should be added to the water quality inventory list when planning for wildlife in the riparian buffer. The information and mapped data will be used to identify areas requiring reclamation/restoration or other management functions to improve wildlife habitat.

Wildlife Species Data Needs

- List of species observed or whose presence is inferred from indirect evidence on the site
- List of federal or state listed threatened or endangered species or state species of concern (if any)
- List of species breeding on the site
- List of potential breeding species (species associated with plant community types on the site), but not observed or inferred
- List of nuisance species (if any)
- Estimate of species abundance

Wildlife Habitat Data Needs

Existing Vegetation Map Layer

- Grass plant community type
- Grass/shrub community type
- Riparian wooded plant community type
- Riparian shrub plant community type
- Riparian grass plant community type
- Upland wooded plant community type (natural)
- Upland wooded plant community type (introduced)
- Wetland type
- Invasive exotic vegetation

Existing Vegetation Stand Characteristics

- Percent native species
- Vegetative structure (layers)
- Range of age classes (woody vegetation)

Land Use or Cover Type Map Layer

- Cropland
- Pastureland
- Rangeland
- Conservation Reserve (indicate type)

- Park/open space
- Urban
- Other (specify)

Disturbance Map Layer

- Natural disturbance regimes are present every 2 to 3 years in the riparian zone (overbank flooding)
- Natural disturbance regimes are present in upland habitat
- Recreational use (intensity)
- Bare spots
- Active erosion, for example, rills, gullies, and slumps
- Sloughing banks (caused by induced activity)
- Overgrazing, logged, or chained lands
- Agriculture
- Roads, dams, and diversions (mapped in Section A)
- Other (specify)

Habitat Features Maps

Special Patches

- Large remnant riparian patches
- Large remnant upland patches
- Large introduced patches
- Special Corridors
- Migration and dispersal corridors

Special Areas

- Patches or corridors inhabited by threatened and endangered species, state species of concern, or vulnerable populations
- Lek or other breeding sites (rookeries)
- Calving or birthing sites
- Winter range and cover
- Summer range
- Thermal cover
- Irreplaceable sources of food or water
- Other (specify)

Special Features

- Snags
- Dens and burrows
- Talus or rock poles
- Cliffs
- Caves and abandoned mines
- Other (specify)

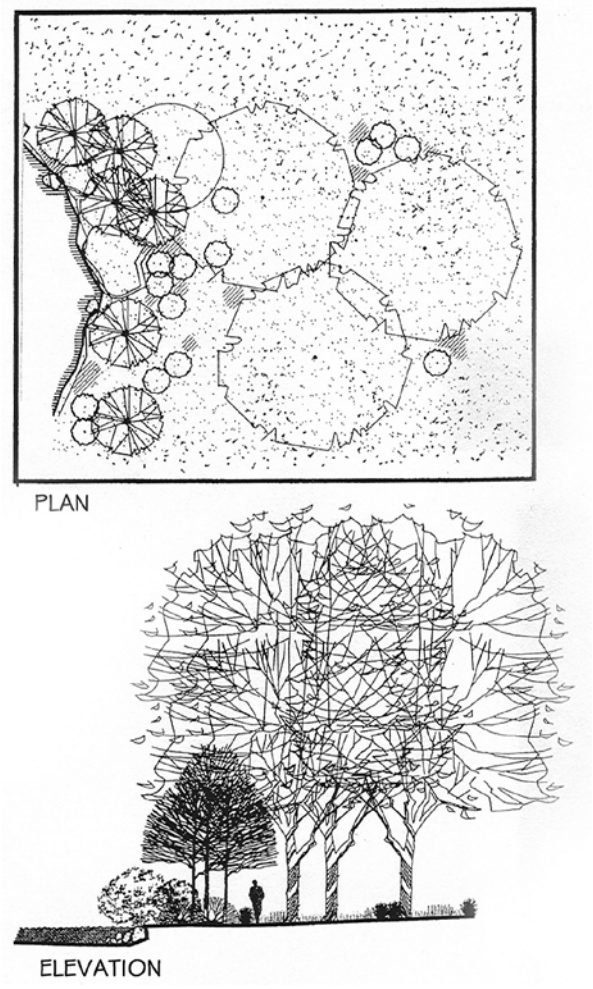
Appendix B-4: List of Dominant Shrub-Steppe and Riparian Plant Species

The list below contains dominant plants in the shrub-steppe study area. Typical shrub-steppe landscapes include annual precipitation 10 to 12 inches, elevation range 3,500 to 6,000 ft, and deep and fertile soil. Shrub-steppe habitat varies from semi-arid grass dominated landscapes with a scattering of sagebrush to sagebrush dominated landscapes with few grasses or forbs. Modify the plant list below as necessary to reflect sub-regional and project site characteristics.

Common Name	Scientific Name
Trees	
Rocky mountain juniper	*Juniperus osteosperma*
Utah juniper	*Juniperus scopulorum*
Shrubs	
serviceberry	*Amelanchier* spp.
sagebrush	*Artemesia* spp.
shadscale	*Atriplex confertifolia*
rabbitbrush	*Chrysothamnus* spp.
bitterbrush	*Purshia tridentate*
sumac	*Rhus glabra* var. *cismontane*
chokecherry	*Prunus* spp.
snowberry	*Symphoricarpus* spp.
Forbs	
common yarrow	*Achillea millefolium*
locoweed	*Astragalus* spp.
balsamroot	*Balsamorrhiza* spp.
Indian paintbrush	*Castilleja* spp.
larkspur	*Delphineum* spp.
daisies	*Erigeron* spp.
buckwheat	*Eriogonum* spp.
blue flax	*Linum lewisii*
lupine	*Lupinus* spp.
phlox	*Phlox* spp.
penstemon	*Penstemon* spp.
globemallow	*Sphaeralcea* spp.
Grasses	
Indian ricegrass	*Achnatherum hymenoides*
blue grama	*Boutaloua gracilis*
mountain brome	*Bromus marginatus*
rabbitbrush squirreltail	*Elymus elymoides*
Idaho fescue	*Festuca idahoensis*
needle and thread grass	*Hesperostipa comata*
Great Basin wildrye	*Koeleria macrantha*
junegrass	*Leymus cinereus*
western wheatgrass	*Pascopyrum smithii*
sandberg bluegrass	*Poa secunda*
bluebunch wheatgrass	*Pseudoroegneria spicata*

Dominant Native Riverine and Lacustrine Plants Organized by Life Form and Elevation 2500 to 5000 ft

Photo by Susan Buffler.

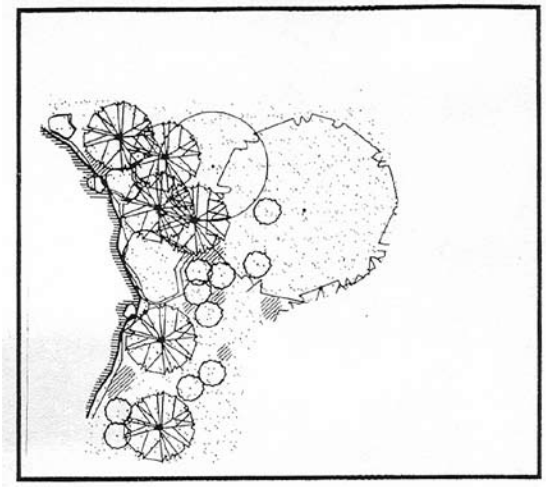


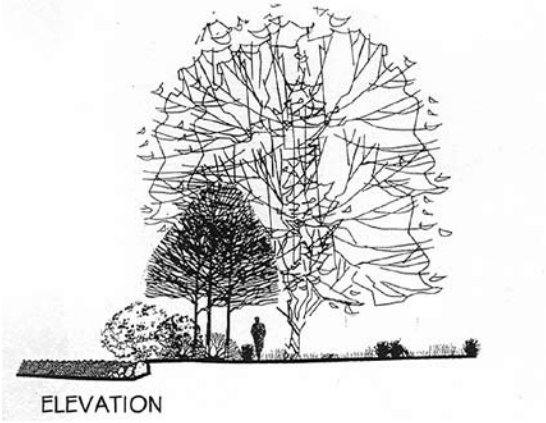
Riverine and Lacustrine Plant Community—Elevation 2500 to 5000 ft.

Common Name	Scientific Name
Trees	
boxelder	*Acer negundo*
water birch	*Betula occidentalis*
black hawthorn	*Crataegus douglasii*
lanceleaf cottonwood	*Populus acuminata*
Fremont cottonwood	*Populus fremontii*
chokecherry	*Prunus virginiana*
Shrubs	
redoiser dogwood	*Cornus sericea*
golden currant	*Ribes aureum*
Wood's rose	*Rosa woodsi*
willow	*Salix* spp.
Grasses, rushes, sedges and forbs	
sedge	*Carex* spp.
saltgrass	*Distichlis spicata*
spikerush	*Eleocharis* spp.
scouring rush	*Equisetum* spp.
rush	*Juncus* spp.

Dominant Native Riverine and Lacustrine Plants Organized by Life Form and Elevation 5000 to 8200 ft

Photo by Susan Buffler.



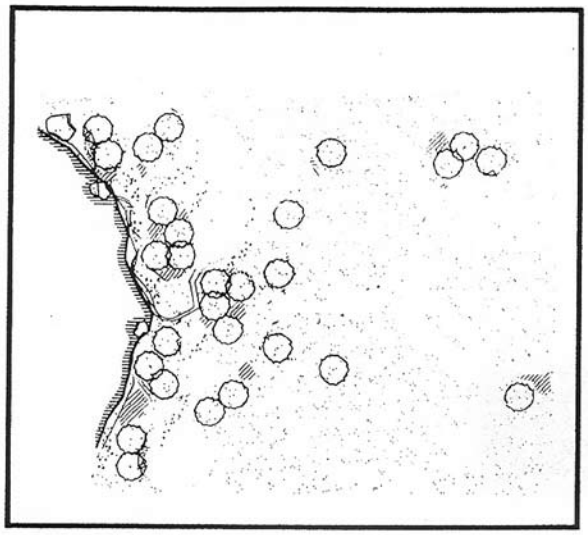


Riverine and Lacustrine Plant Community—Elevation 5000 to 8200 ft.

Common Name	Scientific Name
Trees	
boxelder	*Acer negundo*
gray alder	*Alnus incana*
water birch	*Betula occidentalis*
lanceleaf cottonwood	*Populus acuminata*
narrowleaf cottonwood	*Populus angustifolia*
Shrubs	
redoiser dogwood	*Cornus sericea*
shrubby cinquefoil	*Potentilla fruiticosa*
chokecherry	*Prunus virginiana*
willow	*Salix* spp.
silver buffaloberry	*Shepherdia argentea*
Grasses, rushes, sedges, and forbs	
reedgrass	*Calamgrostis* spp.
sedge	*Carex* spp.
tufted hairgrass	*Deschampsia cespitosa*
spikerush	*Elecocharis* spp.
scouring rush	*Equisetem* spp.
rush	*Juncus* spp.

Dominant Native Riverine and Lacustrine Plants Organized by Life Form and Elevation 8200 to 11000 ft

Photo by Craig Johnson.



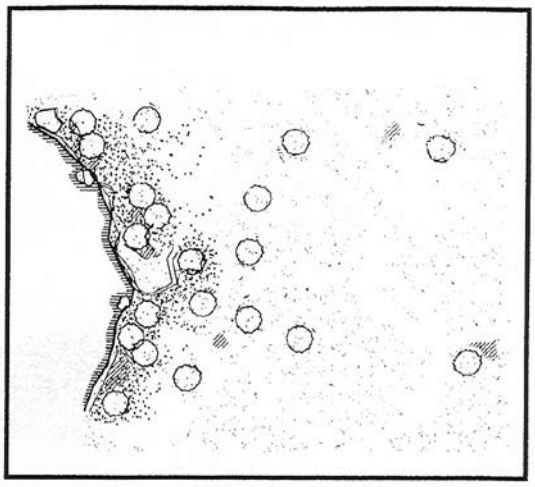
Common Name	Scientific Name
Trees	
gray alder	*Alnus incana*
water birch	*Betula occidentalis*
Shrubs	
silver sage	*Artemisia cana*
redoiser dogwood	*Cornus sericea*
shrubby cinquefoil	*Potentilla fruiticosa*
willow	*Salix* spp.
Grasses, rushes, sedges and forbs	
sedge	*Carex* spp.
tufted hairgrass	*Deschampsia cespitosa*

Riverine and Lacustrine Plant Community—Elevation 8200 to 11000 ft.

Dominant Native Riverine and Lacustrine Plants Organized by Life Form and Elevation >11000 ft

Photo by Craig Johnson.

Common Name	Scientific Name
Shrubs	
willow	*Salix* spp.
Grasses, rushes, sedges and forbs	
sedge	*Carex* spp.
tufted hairgrass	*Deshampsia cespitosa*



Riverine and Lacustrine Plant Community—Elevation >11000 ft.

Appendix B-5: Plant Survey Point Sampling Protocol

Adapted from: Mitchell, W.A.; Hughes, H.G. 1995. Point Sampling: Section 6.2.1. U.S. Army Corps of Engineers Wildlife Resources Management Manual, Technical Report EL-95-25. Vicksburg, MS: U.S. Army Engineer Waterways Experiment Station. 37 p.

Note: Some modifications have been made to adjust the protocol to the specific intent of the RB Handbook. Refer to Mitchell and Hughes (1995) for original documentation.

Study Design

The study design below is not unique to point sampling, but is a general design that may be used with other vegetation sampling techniques. It is a combination of random and systematic sampling and may be altered to fit project needs.

Site Selection

Aerial photographs should be studied and a ground reconnaissance conducted to determine the size and characteristics (for example, terrain heterogeneity) of the study area. The sites to be sampled should be selected and located on a map of the study area prior to data collection. If the area is large and homogeneous, sites may be randomly selected by using a numbered grid and random number selection. However, if the study area consists of diverse habitats, it may be preferable to select sites representative of the vegetation types in proportion to the amount of area occupied by each.

Transects

Although points may be randomly located across a site, it is logistically easier to establish randomly located transects and to sample at regular intervals along each transect. The random location of transect meets the statistical assumptions of sampling unit independence and systematic sampling along each transect facilitates rapid sampling. Transects may be of predetermined or indefinite length and sample points may be continuous or located at stations equally spaced along the transects. If statistical tests are not needed, it may be appropriate to use a grid design in which sampling units are evenly distributed over the entire area.

Sampling Design

At each site, data are collected at 20 stations that are located at constant intervals along the transects. The distance between stations will be determined by the size of the study area and should be great enough to distribute points over the area. At each station, 10 points of data are collected at 2-m intervals (approximately a man's pace length) along the transect. If other data are being collected along the transect, the points may be located on a line parallel to the main transect and one pace to the right or left of it. This procedure may be used with any single-point sampling design.

Sample Size

Sample size is extremely important in habitat studies and should be determined by specific research objectives and the types of habitat sampled. The number of sampling points should be based on the approximate acreage to be included in the study area; at least 20 (preferably 20) samples per unit should be taken. Using 100 points per acre for sampling rangeland vegetation with the step-point method is recommended. Use the following guide for determining the number of sample points:

- 0 to 40 acres (0 to 16 ha) = 1 point/acre (0.5 ha)
- 41 to 80 acres (16 to 32 ha) = 1 point/2 acres (1 ha)
- 81 to 200 acres (32 to 80 ha) = 1 point/4 acres (1.6 ha)
- >200 acres (80 ha) = 1 point/10 acres (4 ha)

Sample size can be calculated if data are separated by points. A formula used to calculate sample size is:

$$N = \frac{s^2 t^2}{d^2}$$

where N = number of sample points required

s = standard deviation

t = t value with n - 1 degree of freedom

d = allowable error (arithmetic mean of the sample total times the designated percent accuracy)

If a study encompasses many vegetation types, sample size should be determined for each type (for example, old field, shrub-steppe, or riparian forest) rather than for the total acreage of the study area. Sample size may be modified by increasing or decreasing the number of sites or the number of samples collected at each site. The latter may be achieved by altering the number or length of transects or by changing the number of points sampled at each station.

Preparation

Users should be proficient with point sampling before data collection begins because results may be biased if the technique is learned during the study. The observer should use a compass to pace straight transect lines and practice consistent pacing between points. Consistent pacing is essential for preventing over- or underestimation of vegetative cover. It ensures that intervals between stations and among sample points are consistent throughout the study, thus providing reliable data for statistical analysis. Transect lines and sampling points can be recorded using GPS.

The sampling procedure should be practiced so users gain confidence with the technique before actual data collection begins. It is recommended that field personnel gain experience with point sampling by conducting trial runs in the type(s) of vegetation that will be sampled in the study. Practice sites should be randomly located in a variety of vegetation types to familiarize personnel with using the technique in habitat conditions.

Cover Categories

Three categories of vegetative cover are herbaceous vegetation, shrubs, and trees. These categories are defined as follows:

1. Herbaceous vegetation: grasses, grass-like plants such as sedges and rushes, and forbs (broadleaved flowering plants).
2. Shrubs: woody plants, branched at or near the base and usually less than 15 ft (4.6m) in height; woody vines may be classed as shrubs or placed in a separate category.
3. Trees: woody plants with a main stem (trunk), numerous branches, and a height of 20 ft (6.1 m) or more. A tree may be placed in the shrub category if it is less than 10 ft tall. Criteria for trees and shrubs will be determined by study objectives.

Step Point

Equipment

The only equipment needed is the observer's boot with an indicator to define the sampling point. The tip of one boot should be marked with a small V-shaped notch or narrow permanent line. The marker is placed at the boot tip to provide a consistent sampling point and to minimize disturbance to the vegetation before sampling. The notch or line should be as narrow as possible to avoid overestimation of cover.

Data Collection

The procedure for collecting data at each point along the transect is given below.

1. Pace to the sample point.
2. Examine the vegetation at the tip of your boot.
3. Record the presence (hit) or absence (miss) of each cover category, with 1=hit and 0=miss (see data recording). If sampling is conducted in non-forested vegetation types, data will be collected for the herbaceous vegetation and shrub categories.
    a. Herbaceous vegetation: Record a hit if the mark or notch on your boot tip is touching a grass or forb. Identify and record the species as a hit. If it is not touching herbaceous vegetation, record a miss (if the herbaceous vegetation is growing under a shrub canopy, move aside the shrub limbs and foliage to sample the herbs).
    b. Shrub: Record a hit if the marker on your boot is touching a shrub or is under its canopy.
    c. Tree: Look directly overhead. Record a hit if you are under the canopy of a tree. Identify and record the species as a hit. If not, record a miss.
4. Visually estimate the percent ground cover of native vegetation along the transect.

Data Recording and Analysis

5. Compile a complete list of all species identified in all transects. Separate the list into native and non-native species present using the following equation:

Number of native species / total number of species in the sample.

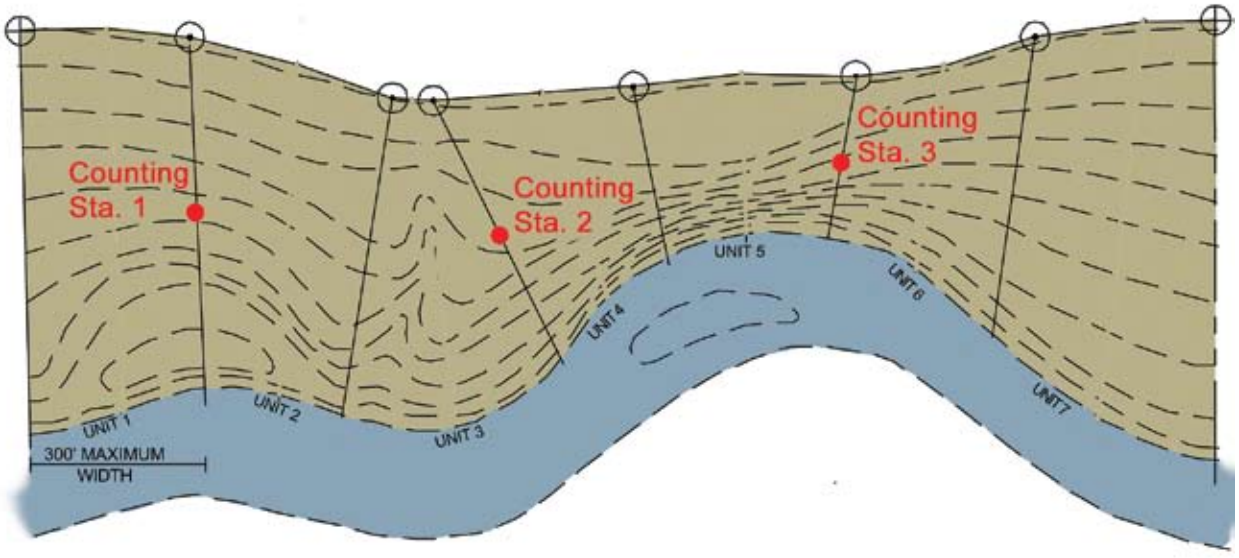
Appendix B-6: Breeding Land Bird Sampling Protocol

The following is a survey protocol for estimating presence/absence of riparian obligate and dependent land birds. It is modified from methods described in:

Ratti, J.T.; Rocklage, A.M.; Giudice, J.H.; Garton, E.O.; Golner, D.R. 2001. Comparison of avian communities on restored and natural wetlands in North and South Dakota. Journal of Wildlife Management. 65(4):676-684.

Rich, T.D. 2002. Using breeding birds in the assessment of western riparian systems. Wildlife Society Bulletin. 30(4):1128-1138.

- Establish counting stations at 600ft intervals through the center of the riparian plant community beginning at the boundary between the first and second buffer unit (see accompanying diagram below).
- Identify and count all birds detected by sight or sound within 150 ft of the counting station. Do not identify or count birds flying overhead.
- Visit the survey route twice, from mid-May to mid-June, separating the visits by at least 7 days.
- Use trained observers or wildlife professionals to conduct the survey.
- Surveys should be conducted between sunrise and 10:00 am.
- Surveys should not be conducted during inclement weather.
- Compile a list of all species and the number of species detected during the two survey periods for each counting station.
- Compare the list of species detected during the surveys with the list of expected riparian obligate and dependent species (see Appendix B-7).
- Calculate the percent of species present (number of species detected/number of species expected), and using the following categories, High (H) ≥80 percent, Moderate (M) ≥60 to 80 percent, and Low (L) <60 percent, assign a rating to the buffer units on either side of the counting station.
- Record the rating of the Wildlife Habitat Data Form for the two buffer units.
- Repeat the procedure for each counting station.



Bird counting stations.

Appendix B-7: List of Riparian Land Birds

Note: All species on the list are riparian obligate or dependent and as noted in references, abundant (species is very numerous), common (certain to be seen in suitable habitat), or uncommon (present but not seen).

Common Name	Scientific Name	Obligate or Dependent	Vegetation Layer Used
American dipper	*Pipilo aberti*	Obl.	U
American goldfinch	*Carduelis tristis*	Dep.	U, M, C
belted kingfisher	*Ceryle alcyon*	Obl.	U, M
black-capped chickadee	*Poecile atricapilla*	Dep.	M
black-chinned hummingbird	*Archilochus alexandri*	Dep.	U, M
black-headed grosbeak	*Pheucticus melanocephalus*	Dep.	M, C
Bullock's oriole	*Icterus bullockii*	Dep.	M, C
common yellowthroat	*Geothlypis trichas*	Obl.	U
Eastern kingbird	*Tyrannus tyrannus*	Dep.	M, C
fox sparrow	*Passerella iliaca*	Obl.	U
house wren	*Troglodytes aedon*	Dep.	U, M
Lewis's woodpecker	*Melanerpes lewis*	Dep.	M, C
MacGillivray's warbler	*Oporornis tolmiei*	Dep.	U, M
orange-crowned warbler	*Vermivora celata*	Dep.	U, M, C
song sparrow	*Melospiza melodia*	Obl.	U
tree swallow	*Tachycineta bicolor*	Dep.	M, C
Western wood-pewee	*Contopus sordidulus*	Obl.	U, M
willow flycatcher	*Empidonax traillii*	Obl.	U, M
yellow warbler	*Dendroica petechia*	Obl.	M, C
yellow-breasted chat	*Icteria virens*	Obl.	U, M, C

U- understory
M- midstory
C- canopy

This species list was adapted for the study area from a master list of riparian obligate or dependent breeding land birds for the western United States presented in Rich (2002). The list was refined for the study area using the following references:

Bridgerland Audubon Society. 2002. The checklist of birds of Cache County, UT.

Gardner, P.A.; Stevens, R.; Howe, F.P. 1999. A handbook of riparian restoration and revegetation for the conservation of land birds in Utah with emphasis on habitat types in middle and lower elevations. Pub. 99-83. Salt Lake City, UT: Utah Division of Wildlife Resources. 48 p.

Idaho Department of Fish and Game (IDFG). 1999. Long range management plan: Sand Creek wildlife management area. Boise, ID: Idaho Department of Fish and Game.

Appendix B-8: Websites for Threatened and Endangered Species

Location	Listing	International	Federal	National Park	National Forest	Ecoregion	State	Indian Reservation	County	Website
United States 1		X	X				X			http://endangered.fws.gov/wildlife.html
United States 2							X		X	http://cfpub.epa.gov/npdes/stormwater/esa.cfm#estable
Idaho 3									X	http://idahoes.fws.gov/IdahoT&E.html
Idaho 4			X				X		X	http://fishandgame.idaho.gov/cms/tech/CDC/t&e.cfm
Montana 5				X	X		X	X	X	http://montanafieldoffice.fws.gov/
Oregon 6						X	X		X	http://oregonstate.edu/ornhic/tebook.pdf
Utah 7									X	http://extension.usu.edu/files/factsheets/FactSheet13.pdf
Utah 8							X			http://extension.usu.edu/files/natrpubs/endgspec.pdf
Washington 9			X				X			http://wdfw.wa.gov/wildlife.htm
Colorado, Montana, Utah, Wyoming 10							X		X	http://mountain-prairie.fws.gov/

1 U.S. Fish and Wildlife Service

2 EPA Endangered Species Act Review Procedures

3 U.S. Fish and Wildlife Service—Pacific Region (Snake River Fish and Wildlife Office)

4 Idaho Fish and Game

5 U.S. Fish and Wildlife—Montana Ecological Services Field Office

6 Oregon Natural Heritage Program. February 2001. Rare, Threatened and Endangered Plants and Animals of Oregon

7 Endangered Species Protection Program—Utah State University Extension, Logan, UT (1) Quinney Professorship for Wildlife Conflict Management, Jack H. Berryman Institute—U.S. Fish and Wildlife Service—Utah Department of Natural Resources—Division of Wildlife Resources—Utah State University Extension Service

8 Endangered and Threatened Animals of Utah

9 Washington Department of Fish and Wildlife—Endangered, Threatened and Candidate Species

10 U.S. Fish and Wildlife—Mountain Prairie Region—Listings for Colorado, Kansas, Montana, Nebraska, North Dakota, South Dakota, Utah, and Wyoming