Ecological Integrity Assessment for Colorado Wetlands

Field Manual, Version 1.0 – REVIEW DRAFT

May 2013

Ecological Integrity Assesment (EIA) for Colorado Wetlands Field Manual, Version 1.0 – REVIEW DRAFT

Joanna Lemly and Laurie Gilligan
Colorado Natural Heritage Program
Colorado State University
Fort Collins, Co 80523

Based on NatureServe's Ecological Integrity Assessment Framework.

Funding provided by U.S. Environmental Protection Agency, Region 8 Wetland Program Development Grants.

Matching funds from Colorado Parks and Wildlife.

Version date: May 19, 2013.

TABLE OF CONTENTS

TABLE OF CONTENTS I

LIST OF FIGUERS II

LIST OF TABLES IV

SECTION 1: INTRODUCTION 1

1.1 Ecological Integrity Assessment (EIA) for Colorado Wetlands 1
1.2 Background and Development of Colorado's EIA Method 5
1.3 Structure of Colorado's EIA Method 8

SECTION 2: APPLYING COLORADO'S EIA METHOD 11

2.1 Study Design Considerations 11
2.2 Defining an Assessment Area (AA) 12
2.3 Describing the Assessment Area (AA) 19
2.4 Vegetation Sampling Protocols 24
2.5 Soil Profile Descriptions and Water Chemistry Sampling 33

SECTION 3: EIA METRIC DESCRIPTIONS AND RATINGS 35

3.1 Landscape Context Metrics 35
Key Ecological Attribute: Landscape Connectivity 35
Key Ecological Attribute: Wetland Buffer 38
3.2 Vegetation Condition Metrics 44
Key Ecological Attribute: Vegetation Composition 44
Key Ecological Attribute: Vegetation Structure 48
3.3 Hydrologic Condition Metrics 54
Key Ecological Attribute: Hydrology 54
3.4 Physiochemical Condition Metrics 60
Key Ecological Attribute: Water Quality 60
Key Ecological Attribute: Substrate / Soils 62
3.5 Size Metrics 64
Key Ecological Attribute: Size 64
3.6 Optional Riverine Hydrology Metrics 66

REFERENCES 70

APPENDICES 72

APPENDIX A: Field Key to Wetland and Riparian Ecological Systems of Colorado 73
APPENDIX B National Wetland Inventory Classification 81
APPENDIX C: Field Key to the Hydrogeomorphic (HGM) Classes of Wetlands in the Rocky Mountains 83
APPENDIX E: Soil Texture Flowchart 85
APPENDIX F: Notes on Hydric Soil Indicators for the Mountain West 87
APPENDIX D: Colorado Noxious Weed List 91

LIST OF FIGUERS

Figure 1. Schematic representation of the top-down and bottom-up approaches used in assessment. Biotic or ecological condition assessments use biological response to infer impacts to basic physical drivers. Functional assessments do just the opposite. Figure from Lemly et al. (2013). 4
Figure 2. Graphical illustration of the Level 1-2-3 Framework. 6
Figure 3. Field map showing a standard 40-m radius circle AA layout centered on the target point. The inner yellow circle is the AA and the outer yellow circle is a 100 m envelope. The yellow point is the original target point and the red points are the AA-center and AA-perimeter points taken in the field. 14
Figure 4. Field map showing a standard 40-m radius circle AA layout shifted from the original target point. The yellow point is the original target point and the yellow circle is the potential AA, which crossed a road. The red circle represents the shifted AA polygon sampled in the field and the red points are the AA-center and AA-perimeter points. 15
Figure 5. Field map showing a rectangular AA delineated during field sampling. The yellow point is the original target point and the yellow circle is the potential AA, which included unsampleable upland area. The red polygon represents the 5000 m^2 rectangular AA delineated in the field and the red point is the center of the sampled AA. 16
Figure 6. Example of a freeform AA delineated during field sampling. The yellow point and circle represent the original target point and potential AA, which included water too deep to sample. The red polygon represents the 5000 m^2 freeform AA delineated in the field and the red point is the center of the sampled AA. 17
Figure 7. Example AA photos. Note placement of photo placard in corner and information written on placard. 18
Figure 8. Example of a confined valley setting. Figure 9. Example of an unconfined valley setting.... 22
Figure 10. Graphical illustration of bankfull width and the topographic floodplain. 22
Figure 11. Standard Level 3 Veg Plot Layout. Vegetation Plots are located at specified distances from the AA center. Figure from EPA (2011). 24
Figure 12. Examples of Wetland Boundary Veg Plot Layout. Plots are laid out as close to the standard layout as possible, but may be placed wherever they fit within small or unusually shaped AAs. Figures from EPA (2011). 25
Figure 13. Examples of Wide Polygon Veg Plot Layouts. Veg plots are laid out along both axis as close to the standard layout as possible. Figures from EPA (2011). 26
Figure 14. Examples of Narrow Polygon Veg Plot Layouts. Veg plots are laid out along one axis of the AA, spaced as evenly as possible. Figures from EPA (2011). 26
Figure 15. Examples of percent cover estimate. 31
Figure 16. Examples of percent cover estimate. 32
Figure 17. Orange lines follow the boundary of contiguous land cover in the 500m radius envelope surrounding the AA boundary. This AA is embedded in an unfragmented, natural landscape block in the 20–60% of the 500m envelope category. In this example, dirt roads, buildings, and urban areas/yards break the unfragmented block, but small shallow ditches do not. 36

Figure 18. Orange buffer lines begin at the AA perimeter, continue up to 200m outside the AA, but stop upon reaching non-buffer land cover. The lines are used to determine average buffer width. This wetland has an average buffer width between 100-200m. 40
Figure 19. Potential states of Horizontal Interspersion. 52
Figure 20. Elements of calculating entrenchment ration. Illustration from Collins *et al.* 2008. California Rapid Assessment Method for Wetlands v 5.0.2 69

LIST OF TABLES

Table 1. Overall EIA scores and ranks and associated definitions. 2
Table 2. Comparison of ecological condition assessments and functional condition assessments. 5
Table 3. C-value ranges and associated interpretation. 8
Table 4. Hierarchical structure of the Colorado EIA method. 8
Table 5. Scope and ratings for all stressor categories. The scale of the scope and whether it applies to the landscape or only the AA depends on the stressor category. 9
Table 6. Example EIA Scorecard. Example site is an herbaceous, non-riverine wetland for which size was not considered as a scoring factor. 10
Table 7. Rating for Landscape Fragmentation 36
Table 8. Land covers that are included and excluded from unfragmented blocks and wetland buffers. 37
Table 9. Rating for Riparian Corridor Continuity 38
Table 10. Rating for Buffer Extent 39
Table 11. Rating for Buffer Width 40
Table 12. Rating for Buffer Condition 41
Table 13. Rating for Natural Cover 42
Table 14. Landscape stressors 43
Table 15. Rating for Percent Cover Native Species 45
Table 16. Rating for Noxious Weeds 45
Table 17. Rating for Aggressive Natives 46
Table 18. Rating for Mean C 47
Table 19. Rating for Regeneration of Native Woody Species 48
Table 20. Rating for Buffer Width 49
Table 21. Rating for Buffer Width. 50
Table 22. Descriptions of physical patch types potentially found within the AA. 51
Table 23. Rating for Horizontal Interspersion. 53
Table 24. Vegetation stressors 53
Table 25. Potential water source checklist. Natural sources are on the left; non-natural sources are on the right. 55
Table 26. Rating for Water Source. 55
Table 27. Rating for Hydroperiod. 57
Table 28. Rating for Hydrologic Connectivity. 58
Table 29. Hydrology stressors 59
Table 30. Rating for Surface Water Turbidity/Pollutants. 60
Table 31. Rating for Algal Gowth. 61
Table 32. Rating for Buffer Width 62
Table 33. Physiochemical stressors 63
Table 34. Rating for Relative Size. 64
Table 35. Rating for Absolute Size by Ecological System. 65
Table 36. Field indicators of channel equilibrium, aggradation or degradation. 67
Table 37. Rating for Channel/Bank Stability 68

Table 38. Steps for estimating entrenchment ratio. 68
Table 39. Rating for Entrenchment Ratio. 69

SECTION 1: INTRODUCTION

1.1 Ecological Integrity Assessment (EIA) for Colorado Wetlands

Ecological Integrity Assessment (EIA) for Colorado wetlands is an assessment method that measures overall wetland condition with an emphasis on biological integrity. The method combines quantitative vegetation metrics with qualitative metrics that evaluate landscape context, hydrology, water quality, and soils into a multi-metric index. Final EIA scores rank a wetland's condition on a four-tiered scale (excellent/good/fair/poor), as compared to unaltered wetlands of the same type.

Purpose of Colorado's EIA Method

Colorado's EIA method can be used for a variety of purposes. For the past five years, the EIA method has primarily been used in a series of river basin-scale assessments that document the current range of wetland condition across each major basin (Lemly et al. 2011; Lemly and Gilligan 2012; Lemly and Gilligan *in prep)*. These studies are intended to inform management, restoration and conservation goals within the target basins, specifically for Colorado Parks and Wildlife (CPW)'s Wetlands Wildlife Conservation Program[1] but also for other conservation and management partners. These studies have also been used by the Colorado Department of Public Health and Environment (CDPHE)'s Water Quality Control Division to describe the condition of wetlands as an aquatic resource in their 2012 Integrated Water Quality Monitoring and Assessment Report (WQCD 2012), submitted to U.S. Environmental Protection Agency (EPA) pursuant to Section 303d and 305b of the Federal Clean Water Act (CWA). For the basinwide assessments, results from EIA sampling are not intended to be used as site-specific information. Instead, each survey point represents a portion of the larger wetland resource in the basin, but no single point is the focus of the study.

Beyond the river basin-scale assessments, however, the EIA method has much wider applicability. The process laid out in the EIA provides land and resource managers with a tool to measure the ecological integrity of wetlands under their jurisdiction. When carried out on a suite of wetlands, it could be used to target sites for restoration (those with lower scores) or further protection (those with higher scores). By focusing on biological integrity, the EIA method could be used to track change in species composition and structure over time after restoration projects have been conducted. Through its use of stressor checklist, it could also be used to identify the most pressing stressors faced by wetlands in a given area, helping managers pinpoint and address the stressors under their control.

The EIA could also be used in wetland mitigation planning, though it does differ from the primary assessment method endorsed for use in mitigation, the Functional Assessment of Colorado Wetlands (FACWet: Johnson et al. 2013).[2] FACWet is currently required for all wetland impact permits and mitigation plans submitted to the U.S. Army Corps of Engineers under Section 404 of the CWA. The EIA, however, with its more rigorous vegetation data collection protocols, could be used to establish mitigation performance standards and be incorporated in post-project monitoring of mitigation sites.

---

[1] See the CPW Wetlands Program website for more information: (http://wildlife.state.co.us/LandWater/WetlandsProgram/).
[2] For up-to-date information on FACWet, see the webstie: http://rydberg.biology.colostate.edu/FACWet.

Definition of Ecological Integrity and Ecological Integrity Assessments

Building on the related concepts of biological integrity and ecological health, ecological integrity is a broad and useful endpoint for ecological assessment and reporting (Harwell et al. 1999). "Integrity" is the quality of being unimpaired, sound or complete. To have integrity, an ecosystem should be relatively unimpaired across a range of characteristics and spatial and temporal scales. Ecological integrity can be defined as "the structure, composition and function of an ecosystem operating within the bounds of natural or historic disturbance regimes" (adapted from Lindenmayer and Franklin 2002; Young and Sanzone 2002; Parrish et al. 2003). Ecological integrity has also been defined as "the summation of chemical, physical, and biological integrity" or the ability of an ecosystem to support and maintain a full suite of organisms with species composition, diversity, and function comparable to similar systems in an undisturbed state (Karr and Dudley 1981). High ecological integrity is generally regarded as an ecosystem property where expected structural components are complete and all ecological processes are functioning optimally (Campbell 2000). Ecological integrity assessments, therefore, can be defined as a means of assessing the degree to which, under current conditions, a system matches reference characteristics of similar systems with high ecological integrity.

Reference Condition

The Colorado EIA method, like most ecological integrity assessments, is a reference-based approach. Metrics are rated according to deviation from the natural range of variability (i.e., reference standard) expressed in wetlands over the past ~200–300 years (prior to European settlement). Reference standard is specific to wetland type, meaning metrics are rated using thresholds developed for wetlands of the same type. Reference standard is ideally determined using the range of variability observed in wetlands with no or minimal human disturbance (i.e., reference wetlands) that exist on the landscape today. Where field data are lacking or no reference condition wetlands remain, information from the literature is also used to define reference standard.

Natural variability is defined based on the best current understanding of how ecological systems "work" under reference (no or minimal human impact) conditions. An understanding of how each metric responds to increasing human disturbance is necessary in order to establish thresholds. The farther a metric moves away from its natural range of variability the lower the rating it receives. The EIAs use four basic rating categories to describe the status of each metric relative to its natural variability (Table 1). There are two important thresholds associated with these ranks. The B-C threshold indicates the level below which conditions are not considered acceptable for sustaining ecological integrity. The C-D threshold indicates a level below which system integrity has been drastically compromised and is unlikely to be restorable.

Table 1. Overall EIA scores and ranks and associated definitions.

Rank	*Condition Category*	*Interpretation*
A	**Excellent / Reference Condition** **(No or Minimal Human Impact)**	Wetland functions within the bounds of natural disturbance regimes. The surrounding landscape contains natural habitats that are essentially unfragmented with little to no stressors; vegetation structure and composition are within the natural range of variation, nonnative species are essentially absent, and a comprehensive set of key species are present; soil properties and hydrological functions are intact. Management should focus on preservation and protection.

B	**Good / Slight Deviation from Reference**	Wetland predominantly functions within the bounds of natural disturbance regimes. The surrounding landscape contains largely natural habitats that are minimally fragmented with few stressors; vegetation structure and composition deviate slightly from the natural range of variation, nonnative species and noxious weeds are present in minor amounts, and most key species are present; soils properties and hydrology are only slightly altered. Management should focus on the prevention of further alteration.
C	**Fair / Moderate Deviation from Reference**	Wetland has a number of unfavorable characteristics. The surrounding landscape is moderately fragmented with several stressors; the vegetation structure and composition is somewhat outside the natural range of variation, nonnative species and noxious weeds may have a sizeable presence or moderately negative impacts, and many key species are absent; soil properties and hydrology are altered. Management would be needed to maintain or restore certain ecological attributes.
D	**Poor / Significant Deviation from Reference**	Wetland has severely altered characteristics. The surrounding landscape contains little natural habitat and is very fragmented; the vegetation structure and composition are well beyond their natural range of variation, nonnative species and noxious weeds exert a strong negative impact, and most key species are absent; soil properties and hydrology are severely altered. There may be little long term conservation value without restoration, and such restoration may be difficult or uncertain.

Wetland Classification

Successfully developing indicators of wetland ecological integrity depends on providing a classification framework for distinguishing wetland types, accompanied by a set of keys to identify the types in the field. Classifications help wetland managers to better cope with natural variability within and among types, so that differences between occurrences with good integrity and poor integrity can be more clearly recognized. For over fifteen years, NatureServe and the Network of Natural Heritage Programs have provided international leadership in standardized ecological classification through development of the International Vegetation Classification System (Grossman et al. 1998, NatureServe 2004, Faber-Langendoen et al. 2009) and "Ecological Systems" throughout the United States (Comer et al. 2003).

Ecological Systems provide a finer scale of resolution than traditional wetland classification systems such as the U. S. Fish and Wildlife Service's Cowardin classification (Cowardin et al. 1979) and the hydrogeomorphic (HGM) classification system (Brinson 1993). The Ecological System approach uses both biotic (structure and floristics) and abiotic (hydrogeomorphic template, elevation, soil chemistry, etc.) criteria to define units. These finer classes allow for greater specificity in developing conceptual models of the natural variability and stressors of an ecological system and the thresholds that relate to impacts of stressors.

The Colorado EIA method is built based on the Ecological Systems classification system. A key to wetland and riparian Ecological Systems of Colorado is provided in Appendix A. Several metrics, particularly within the Vegetation Condition category, are specific to Ecological System or refer to typical characteristics of the Ecological System. The unit for assessing condition with the EIA method (the assessment area) is generally constrained to one Ecological System to reduce variability. However, the HGM classification is also used in the EIA method to evaluate Hydrologic Condition metrics, as the HGM classification more tightly controls for variation expected in hydrologic characteristics. Many Ecological Systems are specific to one HGM class, but not all are. Some Ecological Systems can occur in more than one HGM class.

Assessing Ecological Integrity vs. Functional Condition vs. Functional Capacity

There are two main approaches to wetland condition assessment: ecologically based assessments and functionally based assessments. The difference between the two is largely based on the purpose and intended use of the method. Ecological assessments focus on the ecological or biotic response to cumulative stressors over many years. While some stressors may be evident to an observer, others may not. Even when past impacts are not immediately evident, the biota within a wetland often reflects the long term cumulative effect of all stressors and can serve as indicators of its overall health. Ecologically based condition assessments aim to "evaluate a wetland's ability to support and maintain a balanced, adaptive community or organism having a species composition, diversity, and functional organization comparable with that of minimally disturbed wetlands within a region" (EPA 1998). They are typically carried out by measuring or quantifying certain aspects of wetland assemblages (i.e., plant, invertebrate, or faunal communities) along with associated wetland attributes.

The defining characteristic of the ecological/biotic assessment paradigm is that they use plants (or other taxa) as "phytometers" that reflect the quality of the local environment. Vegetative health, as reflected by composition and structure, integrates the myriad of environmental effects into one tangible aspect of the wetland. Ecologically based approaches have the advantage that vegetation health reflects overall wetland health, and vegetation structure and composition respond to factors to which the evaluator may be oblivious. Ecologically based assessment methods can be thought of as being "top down" in perspective (Figure 1), in which a higher-order feature of the wetland is used as an indicator of impairment of basic elements of the wetland, such as hydrology or water chemistry.

Functional assessments focus on physical drivers or processes, such as hydrology and geomorphology. They aim to evaluate the current ability of a wetland to perform certain understood functions typical of a wetland in its class. They are often used to quantify the potential change in functional capacity if certain actions are carried out, such as impacts by development, restoration activities, or changes in hydrologic regime. Functional assessments are carried out by measuring, estimating or otherwise quantifying variables associated with one or more ecosystem functions. Functions normally fall into one of three major categories: 1) hydrologic (e.g., storage of surface water), 2) biogeochemical (e.g., removal of elements and compounds), and 3) physical habitat (e.g., topography, depth of water, number and size of trees) (EPA 1998).

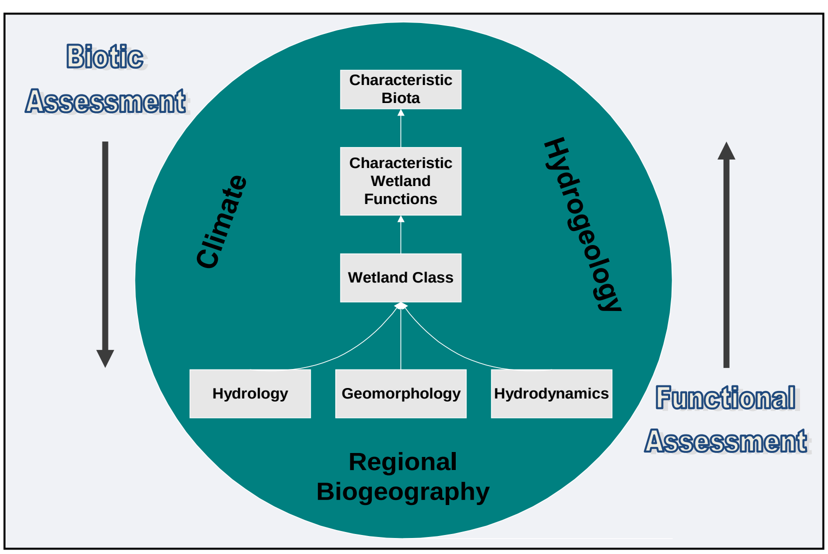


Figure 1. Schematic representation of the top-down and bottom-up approaches used in assessment. Biotic or ecological condition assessments use biological response to infer impacts to basic physical drivers. Functional assessments do just the opposite. Figure from Lemly et al. (2013).

Functionally-based evaluation methods can be considered to be "bottom up" (Figure 1). These methods focus on aspects of the wetland that create higher order functions, including the maintenance of characteristic vegetation. Highlighting the causes of (rather than state of) environmental degradation is the focus of functional methods, while the specific ramifications of impacts, such as changes in species composition, are assumed. This confers the advantage of relieving the evaluator of the need for a high level of taxonomic proficiency, opening them up to a broader audience, but limiting the interpretation of the end state of degradation expressed through vegetation.

The most pure form of functional assessments consider functioning in absolute terms, such as the volume of water stored or the rate of some processes performed. However, these assessments differ from condition assessments in that they evaluate the level or capacity of wetland functions while condition assessments evaluate the condition of key ecological factors or driving ecological processes to indicate ecological integrity. Many functional assessments simply are concerned with the level or capacity of each function regardless of how or whether it relates to ecological integrity (Table 1).

Table 2. Comparison of ecological condition assessments and functional condition assessments.

	Ecological Condition Assessment	***Functional Condition Assessment***
Purpose	Estimate current ecological integrity	Estimate societal value of ecological functions
"Currency"	Condition of key ecological factors	Level of functions and ecological services
Approach	Holistic: ecological integrity = "integrating super function"	Compartmental: each function assessed individually
Method	Combines indicators into conceptual model of key ecological factors	Combines indicators into conceptual model of ecological functions and values
Application	Mitigation, monitoring, state water quality standards, and Heritage Network	Mitigation and monitoring

1.2 Background and Development of Colorado's EIA Method

Level 1-2-3 Framework for Wetland Assessment

Acknowledging that it is impossible to visit every wetland across a landscape to determine the range of condition, EPA developed the three-tiered approach to wetland assessment (Figure 2). [3] Within EPA's Level 1-2-3 Framework, Level 1 assessments are broad in geographic scope and used to characterize resources across an entire landscape. They generally rely on information available digitally in a GIS format or through remote sensing. Goals of Level 1 assessments may include summarizing the extent and distribution of a resource (such as wetland mapping from air photography) or modeling the condition of wetlands based on anthropogenic stressors such as roads, land use, resource extraction, etc. Level 1 assessments can be applied

[3] For more information, see http://www.epa.gov/owow/wetlands/pdf/techfram.pdf.

across a large area and can summarize general patterns, but may not accurately represent the condition of a specific wetland on the ground.

Level 2 assessments are rapid, field-based assessments that evaluate the general condition of wetlands using a suite of easily collected and interpreted metrics. The metrics are often qualitative or narrative multiple choice questions that refer to the condition of various attributes (e.g., buffers, hydrology, vegetation, soil surface disruption) based on stressors present on site. Rapid assessments should be conducted within 1–2 hours of field time and are often used to assess a large number of wetlands on the ground to make an overall estimate of condition or evaluate which sites deserve more intensive monitoring.

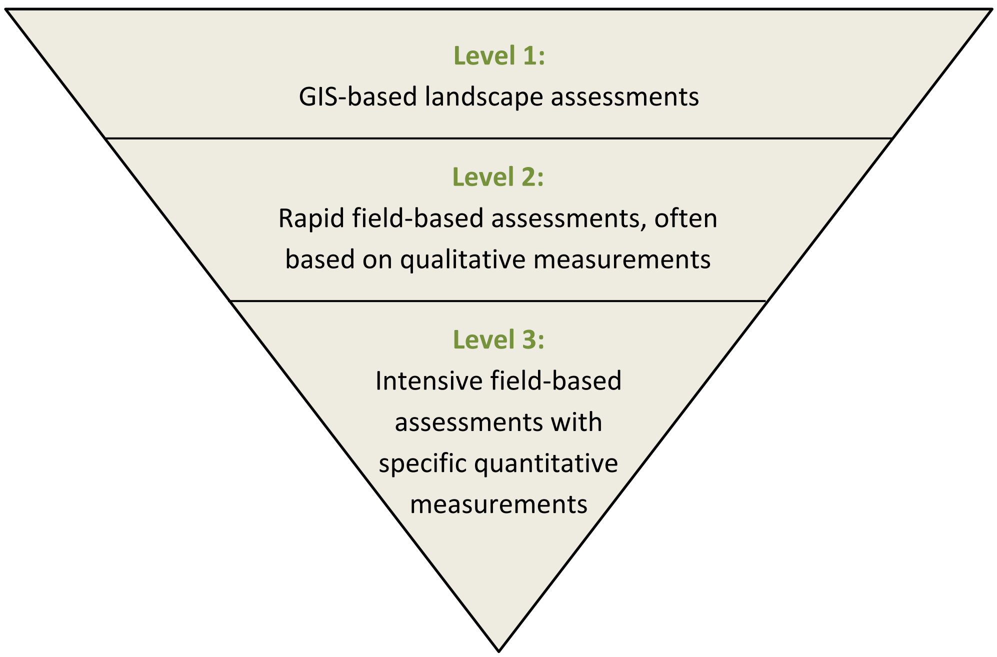


Figure 2. Graphical illustration of the Level 1-2-3 Framework.

Level 3 assessments involve the most intensive, field-based protocols and are considered the most accurate measure of wetland condition. These assessments are based on quantitative data collection and the establishment of data-driven thresholds. They require skilled practitioners to carry out sampling and can take numerous hours for every site. Level 3 protocols are generally developed separately for different wetland attributes, such as vegetation, macro-invertebrates, water chemistry, or hydrology. In some cases, repeat sampling may be necessary to fully capture a wetland's condition.

Within the Level 1-2-3 Framework, data from more detailed levels can be used to calibrate and validate levels above. Level 3 surveys can inform the narrative ratings of Level 2 assessments, and both can help refine Level 1 GIS models. Over time and with sufficient data, coarser level assessments can provide a fairly accurate overview of wetland health across a broad area. However, detailed Level 3 assessments will always provide the most accurate measure of site-specific condition. Many states around the nation are developing wetland assessment tools that fit within EPA's Level 1-2-3 Framework. The EIA method can be used at varying levels of intensity, as described in later sections.

NatureServe's Ecological Integrity Assessment Framework

Development of the Ecological Integrity Assessment (EIA) Framework began in 2004 when NatureServe, the umbrella organization over all Natural Heritage Programs, formed the Ecological Integrity Assessment Workgroup. Members of this group included ecologists for the Arkansas, Colorado, Idaho, and North Carolina Natural Heritage Programs as well as ecologists from NatureServe and The Nature Conservancy. Since the original workgroup was formed, several other states have engaged in developing EIA methods tailored to their states. Additional states include Maine, Montana, New Mexico, New Hampshire, New Jersey, New York, and Washington. In addition, NatureServe has continued to develop their own guidance on EIA methods and have applied those methods in Alaska, Michigan, and Indiana. Two major reports have been published by NatureServe on the EIA Framework (Faber-Langendoen et al 2008; 2013). In addition, NatureServe, along with several partner Natural Heritage Programs, was recently awarded a National EPA Wetland Program Development Grant to compare variations of the EIA methods across several states. Colorado will be part of that project.

The Colorado EIA methods are a direct descendant from the original EIA Framework developed by NatureServe and many of the metrics included in this manual are also included in the two NatureServe reports. However, specific protocols have been modified, and in some case metrics added or dropped, to make the EIA Framework work best in for wetland in the mountains and plains of Colorado.

Colorado Method Development

Ecologists from the Colorado Natural Heritage Program (CNHP) were part of the original NatureServe EIA Workgroup from the very beginning. Concurrently with participation on the NatureServe Workgroup, CNHP began to develop EIA protocols specific to wetland types in Colorado with funding from EPA Region 8 and CPW. The first products developed were conceptual EIA protocols for seven wetland types in the Southern Rocky Mountain Ecoregion (Rocchio 2006a-g). Each report detailed characteristics of the system and identified a range of variables that could be measured to assess ecological integrity, including many at the Level 3 intensive sampling level. With additional funding, CNHP selected protocols from one of the seven systems (Subalpine-Montane Riparian Shrubland) and field tested the protocols as a Level 2 rapid assessment (Lemly and Rocchio 2009a). Through two completed river basin-scale wetland assessment project (Rio Grande Headwaters: Lemly et al. 2011; North Platte: Lemly and Gilligan 2012) and one currently underway (Lower South Platte: Lemly and Gilligan, *in prep*), the conceptual Colorado EIA protocols have been consolidated from seven different documents to one set of metrics that apply to varying degrees to all wetlands found in Colorado. Metrics and scoring procedures have been refined over the years and will likely continue to evolve as more sites are evaluated and input is incorporated form outside partners.

Floristic Quality Assessment (FQA)

At the same time that the Colorado EIA protocols were being developed, CNHP also developed a Floristic Quality Assessment (FQA) tool for use in Colorado. The FQA approach to assessing ecological communities is based on the concept of species conservatism. The core of the FQA method is the use of "coefficients of conservatism" (C-values), which are assigned to all native species in a flora following the methods described by Swink and Wilhelm (1994) and Wilhelm and Masters (1996). C-values range from 0 to 10 and represent an estimated probability that a plant is likely to occur in a landscape relatively unaltered from pre-European settlement conditions (Table 3). High C-values are assigned to species which are obligate to high-quality natural areas and cannot tolerate habitat degradation, while low C-values are assigned to species with a wide tolerance to human disturbance. Generally, C-values of 0 are reserved for non-native species. The proportion of conservative plants in a plant community provides a powerful and relatively easy assessment of the integrity of both biotic and abiotic processes and is indicative of the ecological integrity of a site (Wilhelm and Ladd 1988). The most basic FQA index is a simple average of C-values for a given site, generally called the Mean C, though more complex indices can be calculated. C-values for Colorado species were assigned by a panel of botanical experts in 2006 (Rocchio 2007a). FQA indices are included as a component of the Colorado EIA protocols, but they can also be used as stand-alone measures of biotic condition.

Table 3. C-value ranges and associated interpretation.

C-Values	*Interpretation*
0	Non-native species. Very prevalent in new ground or non-natural areas.
1-3	Commonly found in non-natural areas.
4-6	Equally found in natural and non-natural areas.
7-9	Obligate to natural areas but can sustain some habitat degradation.
10	Obligate to high quality natural areas (relatively unaltered from pre-European settlement).

1.3 Structure of Colorado's EIA Method

Categories, Attributes and Metrics

The EIA method is based on a three-tiered hierarchical structure. At the highest level, the EIA divides wetland condition into five major **categories**. Within each of those categories, the EIA identifies one or more **key ecological attributes** integral to wetland condition that are feasible to monitor**.** For each of the key ecological attributes, one or more individual **metrics** are selected to be measure in the field (Table 4).

Table 4. Hierarchical structure of the Colorado EIA method.

<table>
<tr><th>Ecological Categories</th><th>Key Ecological Attributes</th><th>Metrics</th></tr>
<tr><td rowspan="2">Landscape Context</td><td>Landscape Connectivity</td><td>Landscape Fragmentation
Riparian Corridor Continuity[1]</td></tr>
<tr><td>Buffer</td><td>Buffer Extent
Buffer Width
Buffer Condition</td></tr>
<tr><td rowspan="2">Vegetation Condition</td><td>Species Composition</td><td>Relative Cover Native Plant Species
Absolute Cover Noxious Weeds
Absolute Cover Aggressive Native Species
Mean C</td></tr>
<tr><td>Community Structure</td><td>Regeneration of Native Woody Species[2]
Coarse and Fine Woody Debris[2]
Litter Accumulation
Horizontal Interspersion / Complexity</td></tr>
</table>

Ecological Categories	*Key Ecological Attributes*	*Metrics*
Hydrologic Condition	Hydrology	Water Source Alteration to Hydroperiod Hydrologic Connectivity Bank Stability[1]
Physiochemical Condition	Water Quality	Turbidity / Pollutants Algal Growth
	Substrate / Soils	Substrate / Soil Disturbance
Size	Size	Relative Size Absolute Size

[1] Metric recorded in Riverine HGM wetlands only.
[2] Only applied to sites where woody species are naturally common.

Stressor Checklists

In addition to the condition metrics, the EIA protocol involves collecting data on stressor within each of the major categories (except size). Each stressor is designated with a scope rating, indicating the percent of the AA or landscape that it affects (Table 5). This information allows for correlations between wetland condition and potential stressors. Combining stressor checklists from a suite of wetlands in a given study area will indicate the most pressing stressors observed in the study area. Stressor checklist from a single site can help managers evaluate which stressors they can manage for (and potentially improve wetland condition) and which are beyond their control.

Table 5. Scope and ratings for all stressor categories. The scale of the scope and whether it applies to the landscape or only the AA depends on the stressor category.

Scope of Disturbances	
0	Nil – Little or no observed effect (<1%) on the landscape or AA.
1	Small – Affects a small (1–10%) portion of the landscape or AA.
2	Restricted – Affects some (>10–25%) of the landscape or AA.
3	Moderate – Affects much (>25–50%) of the landscape or AA.
4	Large – Affects most (>50–75%) of the landscape or AA.
5	Pervasive – Affects nearly all (>75%) of the landscape or AA.

Scorecard Reporting

Once EIA metrics have been scores, category and overall ecological integrity scores are calculated based on a set weighting system in a scorecard format (Table 6). Weights are fully explained in Appendix XX.

Table 6. Example EIA Scorecard. Example site is an herbaceous, non-riverine wetland for which size was not considered as a scoring factor.

CATEGORY	Metric			Category			Overall Ecological Integrity	
Metric	**Rank**	**Score**	**Weight**	**Rank**	**Score**	**Weight**	**Rank**	**Score**
LANDSCPE CONTEXT				**C**	**3.4**	**0.2**		
Landscape Fragmentation	C	3	0.4					
Buffer Extent	B	5	0.6[1]					
Buffer Width	C	3						
Buffer Condition	B	4						
VEGETATION CONDITION				**B**	**3.8**	**0.4**		
Relative Cover Native Plant Species	C	3	0.2					
Absolute Cover Noxious Weeds	B	4	0.2[2]					
Absolute Cover Aggressive Native Species	A	5						
Mean C	B	4	0.4					
Coarse and Fine Woody Debris	AB	5	0.05					
Litter Accumulation	AB	5	0.05					
Horizontal Interspersion / Complexity	C	3	0.1					
HYDROLOGIC CONDITION				**B**	**4.4**	**0.3**		
Water Source	A	5	0.2					
Alteration to Hydroperiod	B	4	0.6					
Hydrologic Connectivity	A	5	0.2					
PHYSIOCHEMICAL CONDITION				**B**	**4.2**	**0.1**		
Turbidity / Pollutants	A	5	0.25					
Algal Growth	B	4	0.25					
Substrate / Soil Disturbance	B	4	0.5					
SIZE				**--**	**--**	**--**		
Relative Size	A	5	--					
Absolute Size	C	3	--					
							B	**3.9**

[1]The three buffer metrics are combined into a Buffer Index: (Buffer Condition * (Buffer Extent * Buffer Width)$^{1/2}$)$^{1/2}$.

[2]The lowest score between Absolute Cover of Noxious Weeds and Absolute Cover Aggressive Native Species is used in scoring.

SECTION 2: APPLYING COLORADO'S EIA METHOD

2.1 Study Design Considerations

The EIA method can be applied in a variety of different circumstances with varying study design approaches. It is beyond the scope of this manual to fully outline study design options, but a couple main points will be mentioned.

There two major types of study designs, **random sampling** and **targeted sampling**. Random sampling involves sampling a randomly selected, statistically representative set of sites out of a much larger population. The benefit of a random design is that it provides the ability to make statistically defensible statements about the overall condition of wetlands across the population. If the goal of your study is to assess wetland condition across a large area (entire U.S. Forest Service management unit or entire watershed), then a random design is preferable. CNHP has used the EIA method is several large-scale condition assessment projects using random sample study designs and can provide details on the specifics of these designs upon request. Targeted sampling, on the other hand, involves selecting a specific set of site to sample without the need to make estimates about a larger population. Targeted sampling is most appropriate when there is a discrete number of wetlands you wish to assess.

For either type of study design, it is important to identify **available data sources** to help locate your population of interest. These data sources may be U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) maps, U.S. Geologic Survey (USGS) topographic maps, Natural Resource Conservation Service (NRCS) soil maps, local vegetation maps that depict wetlands, or aerial photography. There is an abundance of god data sources available online today that can help both identify potential sample sites and assess landscape scale metrics.

The last important consideration is how to define your **target population**. If you are conducting random sampling, understanding the limits of the target population is crucial for setting up an assessment area. If you are conducting a targeted assessment, it is just as important to know when the wetland ends and the upland begins.

There are two primary definitions of wetland to consider using for your target population. The first is the USFWS definition used for NWI mapping (Cowardin et al. 1979):

> *"Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year."*

The USFWS definition is different than the definition of wetland used by the ACOE and the EPA for regulatory purposes under Section 404 of the Federal Clean Water Act (ACOE 1987):

> *"[Wetlands are] those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."*

The primary difference between the two definitions is that the Clean Water Act definition requires positive identification of all three wetland parameters (hydrology, vegetation, and soils) while the USFWS definition requires only one to be present. It is important to decide which definition you will use, as the decision has ramification for defining the boundary of your assessment area. In either case, standard wetland identification and delineation techniques can be used to determine inclusion in the target population. Materials produced by the ACOE and the NRCS, such as the *Interim Regional Supplements to the Corps of Engineers Wetland Delineation Manual* (e.g., ACOE 2008) and the *Indicators of Hydric Soils in the United States* (NRCS 2010) are very helpful. However, if using the USFWS definition of wetland, positive identification of only one or two parameters is needed, not all three.

2.2 *Defining an Assessment Area (AA)*

Establishing the Assessment Area

Assessment Areas for Targeted Sampling

The basis of the carrying out the EIA method is identifying and establishing an assessment area (AA) in which data collection is concentrated. For targeted sampling, the AA can be of variable size and shape and can be bound by the entire wetland itself, if so desired. Detailed guidance on defining an AA for non-random targeted sampling will be developed in future iterations of this manual. The remaining discussion will focus on defining AAs for random, point-based sampling.

Assessment Areas for Random Sampling

For random sample designs, it is often preferable to define the AA as a standard area around a fixed point. Because wetlands are so variable in size, random sampling often employs what is called an area-based design. Each AA represents a specific area of wetland and, therefore, a specific proportion of the wetland resource under investigation. The recommended standard AA is a 40-m radius circle (0.5 ha or 5000 m^2) centered on the target random point. However, there can be considerable flexibility in establishing an AA depending on wetland size and shape.

Proper placement of the AA is crucial because it defines the area for most of the data collection. Before heading into the field, users should examine aerial photos of the point and should strategize the most likely placement of the AA based on observed wetland features surrounding the point. Once in the field and the area surrounding the point has been identified to be suitable for sampling, the user will establish the AA to bound further sampling. The AA must be located in the closest possible suitable sample area from the original point. The user should always document the process used to move vegetation plots when the original center point and standard AA are not used.

General Principles

The following are general principles to consider when establishing an AA:

1) The AA should be established in *only one* Ecological System. (Make sure to follow size criteria within the Ecological System Key. Small patches of herbaceous or shrubby vegetation do not necessarily mean multiple Ecological Systems. Changes in dominant soil type or hydrology however, can mean multiple Ecological Systems.)
2) The AA should always be 0.5 ha (5000 m^2) where possible, but can be as small as 0.1 ha (1000 m^2) if necessary.
3) The maximum AA length is 200 m, regardless of shape. The minimum AA width is 10 m, regardless of shape.

4) The AA should contain no more than 10% water > 1 m deep. This includes water in a stream channel. The AA can cross and contain a stream channel that is < 1 m deep (or the depth considered safe to wade by the field user, which may be different for different users and at different stream velocities). The AA *should not* cross streams that are too deep to wade. When sampling a pond fringe with deep water in the center, the AA drawing should specifically indicate the AA edge where water is > 1 m.
5) The AA should contain no more than 10% upland inclusions.
6) Proximity to the original random point generally takes higher priority over retaining a standard 40-m circle AA shape. When there are > 1 wetlands near the original point, but the closest sampleable wetland is smaller than one farther away, the closer wetland should still be sampled. However, do not worry unnecessarily about the exactness of these priorities. If the difference between two potential sites is minimal and one would make that a standard AA is possible, pick the most straightforward sample location. Simply use best professional judgment in the field to survey the original wetland point, in the most standardized way possible, realizing that the goal is to survey the wetland that the random point represents, but that many situations arise in the field that require slight modifications.

AA Layout Protocol in Brief

1) Determine AA shape. This will be a 40-m radius circle, unless size and shape constraints require an alternative shape.
2) For standard circular AAs, take a GPS point the center and record the waypoint number, UTMs and error on the datasheet as the 'AA-Center'. Record elevation, slope, and aspect at the center.
3) For non-standard AAs, you do not need to take a GPS point in the center, as it will be easier to determine in GIS based on the AA polygon. Record elevation, slope, and aspect in a representative area of the AA.
4) Flag AA boundary. For standard circular AAs, flag at least the cardinal directions. For freeform AAs, track boundary using the GPS and flag as often as needed to visualize the AA.
5) Take GPS points and photos at four standard locations on the edge of the AA looking in, either at the cardinal directions for standard AAs or at four logical locations on the edge for freeform AAs. Record the waypoint numbers, UTMs, errors, and photo number on the datasheet.
6) If the site is selected for Level 3 vegetation sampling, layout and flag vegetation plot corners (details to follow in Section 2.4).
7) When AA boundaries are set, draw the AA shape on the color aerial photo. First draw in pencil then trace with a sharpie marker.

Standard AA Layout – 40-m radius circle

The standard AA perimeter is a 40-m radius circle surrounding a center point (Figure 3). Standard AAs may be shifted so the edge of the AA is up to 60 m from the original target point, meaning the center point of a shifted AA can be up to 100 m from the original point (Figure 4).

The perimeter of the AA should be flagged and this process may vary depending on thickness of vegetation. Use judgment to maximize layout efficiency. Further details on flagging the perimeter in open vs. dense vegetation are provided below. In Level 3 plots, veg plots will be flagged simultaneously as the AA boundary is flagged. Site photos can be taken as the AA is flagged (more common in open vegetation) or can be taken after AA is flagged (more common in dense vegetation that is difficult to traverse). Flagging options include biodegradable forestry flagging in visible colors such as pink or orange (easiest in tall vegetation and woody areas) or pin flags (easiest in short vegetation and open water). If it is not possible to stand on the cardinal azimuth of each AA edge (as in deep water), take the reference point UTMs and photos as close as possible to the target position, and note in comments how the reference point(s) are offset.

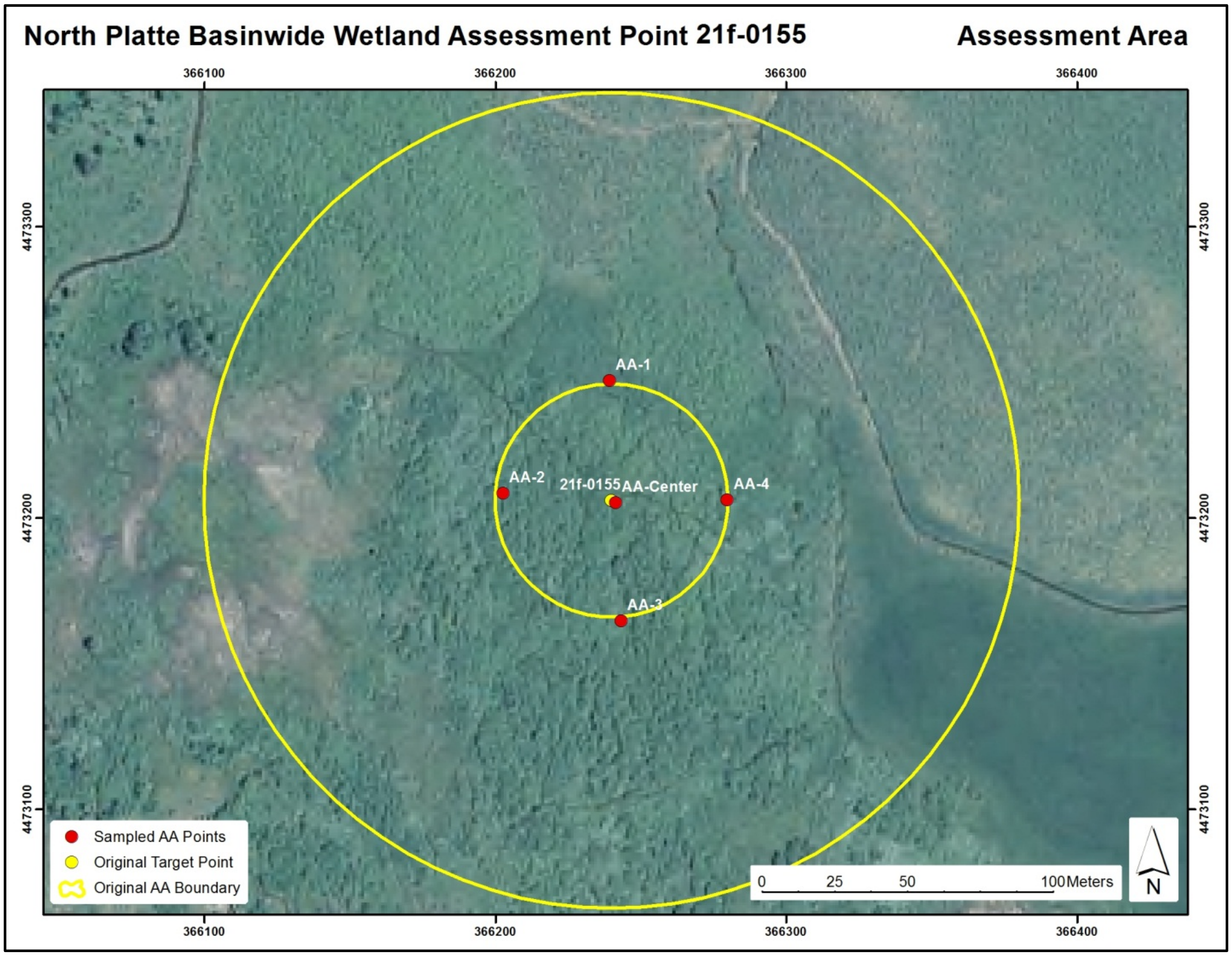


Figure 3. Field map showing a standard 40-m radius circle AA layout centered on the target point. The inner yellow circle is the AA and the outer yellow circle is a 100 m envelope. The yellow point is the original target point and the red points are the AA-center and AA-perimeter points taken in the field.

In open vegetation, a 50-m tape is used to lay out the AA perimeter. One person will stand at the center of the AA holding the end of a 50-m tape, and the other person will walk north from the center of the AA carrying the 50-m tape spool on the left side of their body until they reach 40 m. Use a compass to correct the azimuth to a cardinal direction, looking back at the center point. Once the cardinal direction is flagged, a site photo and waypoint can be taken. For Level 3 plots, vegetation plot corners can be flagged along the tapeline. Then the person at the AA perimeter will walk in a circle, flagging the boundary of the AA with either pin flags or flagging tape until reaching the next cardinal direction. At least four flags should be marked on the AA perimeter, one at each of the cardinal directions (N, E, S, W). In open vegetation, additional perimeter flags can be placed at each of the ordinal directions (NE, SE, SW, NW). More points along the boundary may be marked to aid in visualizing the boundary of the AA, as the user deems appropriate.

If vegetation is dense or difficult to walk through with a 50-m tape, the GPS unit can be a helpful tool to assist with delineating the AA. Mark the center with the GPS, then use the "GO TO" function to measure a 40-m distance from center in a cardinal direction. In Level 2 AAs, the GPS "GO TO" function can be used to delineate each cardinal edge without use of the tape. In Level 3 AAs however, vegetation plots will need to be established at specific distances from center, so it still necessary to use the measuring tape. In these cases, users may need to run the tape at shorter intervals until reaching each veg plot corner. The GPS should not be used to lay out vegetation plots because the GPS accuracy is not good enough to locate veg plot corners separated by only 10 m. Once the last vegetation plot is laid out, the "GO TO" function on the GPS unit can be an easier way to measure the 40 m distance from the plot center the AA edge.

Figure 4. Field map showing a standard 40-m radius circle AA layout shifted from the original target point. The yellow point is the original target point and the yellow circle is the potential AA, which crossed a road. The red circle represents the shifted AA polygon sampled in the field and the red points are the AA-center and AA-perimeter points.

Alternate AA Layout 1 – Rectangle

If a 40-m radius circle does not fit within the wetland area, users may use a rectangular shape to mark out the AA (Figure 5). Compared to free-form AAs, rectangular AAs are easy to layout because the layout is more standardized and the perimeter does not need to be tracked with the GPS. First estimate the required dimensions to reach ~5000 m^2. For example, a square AA should be 70.5 m on each side (70.5 x 70.5 = 4970). If the wetland is 50 m wide, the rectangle should be 50 x 100 m. AAs less than 10-m in width are too narrow to establish vegetation plots, and the feature may no longer confidently qualify as a discrete wetland.

Rectangular AAs may be centered on the point or their edges may be up to 60 m from the point, depending on the wetland area. However, rectangular AAs should only be used where the wetland area is generally straight and the size of the AA is not compromised by bends in the wetland boundary. For this reason, rectangular AAs are not common. GPS waypoints and photos should be taken at each of the four corners of rectangular AAs looking diagonally into the AA.

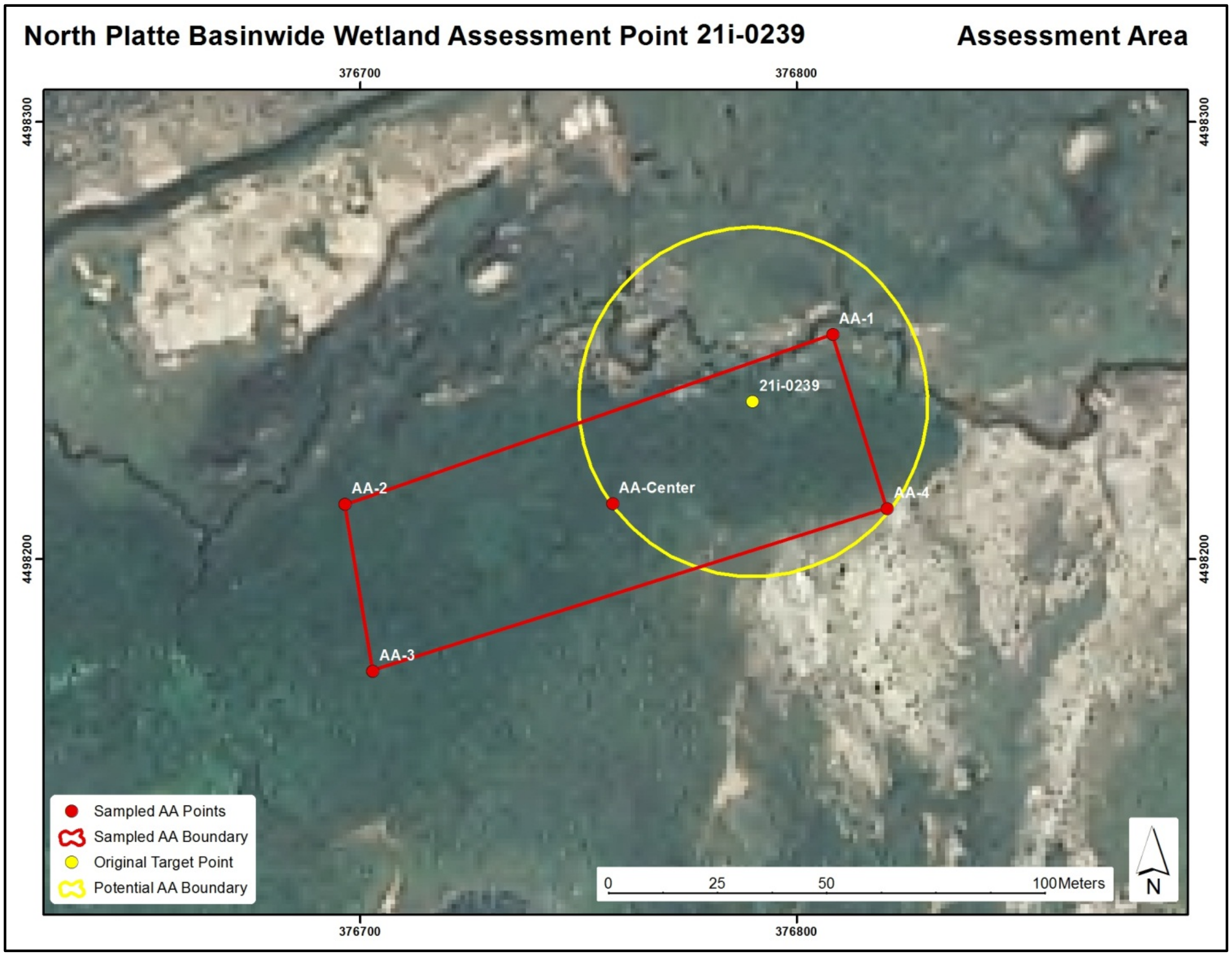


Figure 5. Field map showing a rectangular AA delineated during field sampling. The yellow point is the original target point and the yellow circle is the potential AA, which included unsampleable upland area. The red polygon represents the 5000 m^2 rectangular AA delineated in the field and the red point is the center of the sampled AA.

Alternate AA Layout 2 – Freeform shape

When is not possible to lay out a standard or rectangular AA in 5000 m^2, the AA perimeter is usually confined by 1) the size or shape of the wetland, 2) by Ecological System boundaries, or 3) by deep water. This is considered a freeform AA shape (Figure 6). If the wetland or Ecological System occurrence is small, the entire wetland will become the AA. If the wetland is larger but oddly shaped, the user must first estimate the general dimensions of the wetland using the aerial photos provided and strategize about the best way to lay out a 0.5 ha (5000 m^2) AA. Based on this estimate, the user will walk the perimeter of the AA with the GPS in TRACK mode, flagging the edges as they walk. It is important to visualize the AA layout before walking it out. Once visualized, one crew member leads and flags the AA perimeter while the second crew member follows with the GPS in TRACK mode. This keeps track edges smooth. Before walking the AA track, clear tracks (this action will not clear previously saved tracks). When finished, switch out of track mode, use GPS Area Calculation function to determine AA track size, and record area in m^2. If the AA perimeter ends up significantly larger than 5000 m^2 (~5500 m^2 or larger), the user must determine which portions to exclude to ensure the AA is comparable to others in the study. The GPS track will be saved on the GPS unit and named by the point code.

In cases of wetlands along a pond fringe where the water gets deep (>1m) or substrate becomes dangerously soft towards the center, a donut- or boomerang-shaped free-form AA may be necessary. In some cases, the deepest boundary of the wetland may not be wadeable in areas, and instead of a complete track, the AA is delineated by a partial track, with 2 to 4 extra waypoints along the deep boundary that are also noted on the AA drawing. The AA drawing should also clearly indicate the wetland perimeter, and should describe the portion of the edge that has track data and the portion to edit in office. These resources will be referenced in office to clip any non-target area out of the AA track in GIS.

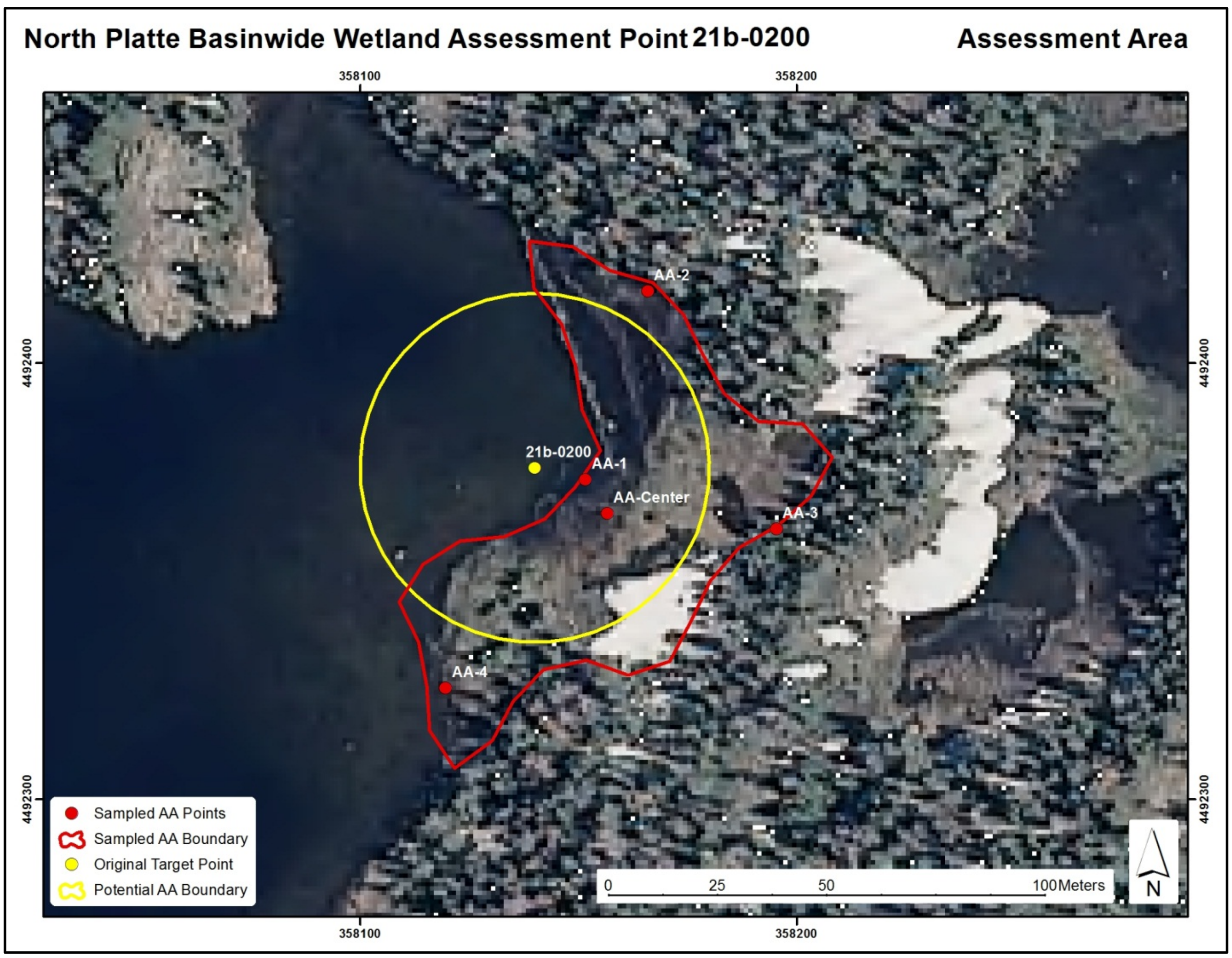


Figure 6. Example of a freeform AA delineated during field sampling. The yellow point and circle represent the original target point and potential AA, which included water too deep to sample. The red polygon represents the 5000 m^2 freeform AA delineated in the field and the red point is the center of the sampled AA.

Photos of the Assessment Area

The aim of AA photos is to represent the AA in photographs—as they say, a photo is worth 1000 words. There are various standard photos that must be taken in each AA, with the photo numbers recorded:

1) The four standard AA positions (record photo number on page 1),
2) Vegetation plots, if site is selected for Level 3 sampling (record photo number on page 4)
3) Soil pit photos (record photo number on soil pit page),
4) Unknown plant photos (record photo range on vegetation plot species table page),
5) Photos of anything notable. When possible, it is helpful to have photos looking down at the entire wetland. Photo numbers should always be recorded when photo is taken outside the AA. When there are questions on how to record data, take photos and record their numbers to represent the issue in question. Otherwise, not all photos within AAs must be labeled if they fall within the AA photo range and are not standard photo (record photo number, photo type, and range on 'Additional AA Photos and Comments,' page 1).

The **photo number** is visible on the camera's screen when it is placed in view or playback mode and when data about the photos are shown. *Remember that the photo number is NOT the sequential number based on the count of photos taken since the camera was last erased. The photo number often starts with a three digit number, a dash, and then a four or five digit number. Only the last four or five digit number is necessary to write down on the form. If sequential numbers are written on the field form, this data will be meaningless, as they are lost when uploading photos.*

A **photo placard** will be held in all four of the standard AA photos (Figure 7). Photo placards will be placed in the very corner of the photo, taking up only a small portion of the frame, with as little arm or body visible as possible. The camera should be tilted to represent as much of the AA as possible, and photos should be reviewed for clarity before moving on. In dense vegetation, one may want to hold the camera higher and move branches directly in front of the camera out of the way. The point code should be written on in full on the first line of the placard (e.g., 21i-191). The second line of the placard will contain the aspect that the photo is facing and the location of the photo (e.g., 140°/AA-4; 300°/AA-1; 90°/AA-1). Aspect should be rounded to the nearest 5 degrees in all photo points. *Make sure to set the declination of your compass.* Date should be written as month / day / 2013 (e.g., 7/7/2013; 6/24/2013). The standard photos can be taken while walking the perimeter of the AA, or after the AA perimeter is flagged. It is essential that two people participate in taking the placard photographs.

Figure 7. Example AA photos. Note placement of photo placard in corner and information written on placard.

2.3 Describing the Assessment Area (AA)

Location and General Information

The first page of the **2013 Colorado Ecological Integrity Assessment Field Form** contains general information about the site. This information can be filled out once the user determines that a target sample area is located at or near the sample point. The following guidance will assist in filling out this section of the form.

Point Code: The code of the original sample point. For CNHP projects, this code starts with a two to three digit code for the Level 4 Ecoregion. The second part of the point code is three-digit number for the point itself. As an example, a point code might be 25c-0032. This code could be anything project specific.

Site Name: This is a name given to the site by the field user. This name can be anything the user wants and should reflect the location of something memorable that happened or was observed during sampling. The name could be something like Spring Creek Shrubland or could be Dizzy Cloud Fen. It is helpful to include the Ecological System at the end of the name. Landowners may request copies of the data sheets so site names (and all notes) should be appropriately professional for landowner review.

Level 2 or Level 3: These check boxes indicate whether the site was sampled with Level 2 rapid protocols or Level 3 intensive protocols. Each site will be designated as Level 2 or Level 3. The primary differences between these two protocols in 2013 surveys is that for Level 3 surveys, vegetation plots are laid out and detailed species and structure data are taken in each plot, while for Level 2 surveys, there are no vegetation plots and the same data is taken at the AA scale.

Date: Date of sampling, written as month, day, year (e.g., July 12, 2013 or 7/12/2013).

Surveyors: The first initial and last name of field user members sampling the site (e.g., J. Lemly, L. Gilligan).

General Location: A brief phrase describing the general location of the site, usually a creek name or other landmark from the USGS topo map (e.g., Spring Creek, Mt Emmons, Beaver Meadows).

County: The county in which the wetland occurs.

General Ownership: A general description of the land ownership, using the following short abbreviations and others where applicable:

- USFS = U.S. Forest Service
- BLM = Bureau of Land Management
- NPS = National Park Service
- SLB = State Land Board
- Private = Privately owned lands

Specific Ownership: A more specific description of the land ownership, such as Rio Grande National Forest, Mt Zirkel Wilderness, Glacier National Park, or landowner name.

Directions to Point: Directions should specify a starting point, either "From Fort Collins" or "From Highway 14 heading N" or "From the 'x' trailhead in Kiowa." Include route taken, approximate mileage traveled on dirt roads, trails, and off trail navigation, and parking location used.

Access Comments: Can be blank, but record any information that would be helpful if one were to revisit the site. Indicate any access restrictions to visiting site such as parking limitations, keys needed, gate codes, or entry facilitation by agency person or landowner. Also indicate if permit is needed, or if challenging structures/vegetation require an indirect approach.

Dimensions of AA: Circle AAs are the 40-m radius standard AA. Rectangular AAs are rectangular. Other dimensions indicate a free-form AA, adjusted to the shape of the wetland/target area boundary.

Elevation: Record elevation at AA center in meters. For all GPS points, when >1 UTM Zone occurs in the study area, users should note the UTM Zone of all GPS points.

Slope: Record slope at AA center in degrees, averaging slope of wetland within AA between uphill and downhill. Depressional wetlands generally do not slope in one direction, so in those slope is N/A. If there are two general slopes (e.g., for a riparian area, the wetland might slope down to the river channel and might also slope with the general gradient and direction of the river), the larger slope outside of the AA can be noted in the comments. Slope is measured either with a clinometer or a compass.

Aspect: Visualize the direction that water would flow downhill, along a scale comparable to the AA size, and take a compass reading of that direction (degrees). Record N-facing aspects as zero, not as 360. If the aspect within the AA is obviously different than the azimuth across a larger land area, record a second aspect and note which one is which. In depressional wetlands, even when depression is larger than AA, aspect is generally N/A. *Make sure to set the declination on your compass.*

AA-Center: If AA is a standard 40-m radius circle, record the center waypoint number and UTMs. To record error, use averaging device on GPS until error appears to stabilize. Optimally, error is < 5m, but that is not always possible. In non-standard AAs, the center point is not needed.

AA-1 through AA-4: These are the reference waypoints, UTMs, and error recorded at four standard locations on the AA perimeter, along with associated photos. It does not matter which directions are labeled AA-1 through AA-4 or what sequence they are taken in. In standard AAs waypoints are recorded at the cardinal directions, facing the AA center. In rectangular AAs, waypoints are taken on the four corners, looking in towards center. In other non-standard AAs, these waypoints and photographs are better taken along the long and short midpoints of AA vertices, facing into the AA towards the center. In long linear or sinuous AAs, the two midpoints along the long vertices may not be directly across from each other, may instead may face the opposite bank, but the two midpoints along the short vertices should still face into the AA towards the center.

The user should make any notes necessary to describe how the AA was established and the reasoning behind the AA shape in the box for **AA Placement and Dimensions Comments**. This will address whether the AA boundary was not standard because the wetland was too small, or whether non-standard because target area was shaped in a way that could not be assessed by a circular AA (such as a linear feature).

Environmental Description and Classification of the Assessment Area

The top of the second page of the field form contains environmental descriptors and classification information. Guidance is given below. For any environmental descriptor or classification where there is doubt, ambiguity, or further explanation is necessary, use the comments sections below the data fields.

Non-target Inclusions: Estimate the percent of the AA occupied by non-target inclusions of water > 1 m deep and upland areas. Non-target inclusions should be limited to < 10% each.

Wetland Origin: Note whether the wetland is a) a natural feature with minimal disturbance, b) a natural feature altered or augmented by human modification that affects hydrology, or c) a non-natural feature created by human management action (creation can be intentional such as created wetland for mitigation, or an unintentially created wetland because of impoundment or irrigation seepage). Use topographic map and aerial photography to interpret possible natural sources of hydrology, such as ponded water from precipitation, old channels, or a high water table due to groundwater exposure at a break in slope. A high water table from irrigation ditch seepage above AA is not considered natural; however, some wetlands could have seeps or springs. When in doubt, use best professional judgment and note thought process.

Ecological System: Use the key provided in **Appendix A** and select the Ecological System targeted in the survey. Circle High, Med, or Low to denote how well classification fits key, and explain in the comments section below when confidence is medium or low.

Cowardin Classification: Record the appropriate Cowardin classification codes, using the definitions provided in **Appendix B**. The Cowardin classification should be applied to patches 0.1 ha (1000 m^2) or larger. The final total of percentages should equal 100% of the AA. Designate affinity to key as above.

HGM Class: Select the appropriate HGM Class using the key provided in **Appendix C.** Try to pick only one dominant HGM Class. Designate affinity to key as above. If it seems there is >1 dominant HGM, reconsider if AA spans over more than one Ecological System (AA should only have one Ecological System). *Note that additional classification and metrics apply to AAs in the Riverine HGM Class.*

Riverine Specific Classification of the Assessment Area

Specific classification is applied to AAs in the Riverine HGM class. Some Riverine Class AAs will include the channel or be located adjacent to a channel. Others may be in a floodplain, but not located near the channel. Answer all questions possible based on available evidence in and surrounding the AA. These questions should be answered based on best professional judgment and do not require exact measurements.

Confined vs. Unconfined Valley Setting: Streams in confined (Figure 8) and unconfined (Figure 9) settings behave very differently. Confinement can result from hard geomorphic barriers such as a rock wall that impedes flow, not to incised banks. Confined wetlands that meet the minimum width requirements for sampling are uncommon. There are two pieces of information necessary to determine whether a stream is in a confined or unconfined setting. This first is bankfull width, the second is valley width. It is not necessary to measure either one precisely in order to make a determination about confined or unconfined status of a stream. Estimate these widths as precisely as is necessary to determine whether the valley width is greater or less than 2x the bankfull width. **Bankfull width** is the width of a stream channel at the point where over-bank flow begins during a flood event. Bankfull indicators may include: the lower limit of perennial vegetation, stain lines, moss or lichen, a change in particle size, etc. **Valley width** is the width of the topographic floodplain, the extent of the area where water could easily flood. In confined valley setting, valley width is less than 2x bankfull width. In unconfined valley settings, valley width is greater than 2x bankfull width. See Figure 10 for a graphical illustration of these components.

Proximity to Channel: Note whether the AA includes the channel and both banks, is adjacent to the channel and includes one bank, or is far from the channel and the banks were not evaluated.

Wadable vs. Non-wadable stream: Note whether the AA is located on both sides of a wadable stream (< 1 m deep), on one side of a non-wadable stream, or is located on one side of a stream but not adjacent to the channel.

Figure 8. Example of a confined valley setting.

Figure 9. Example of an unconfined valley setting.

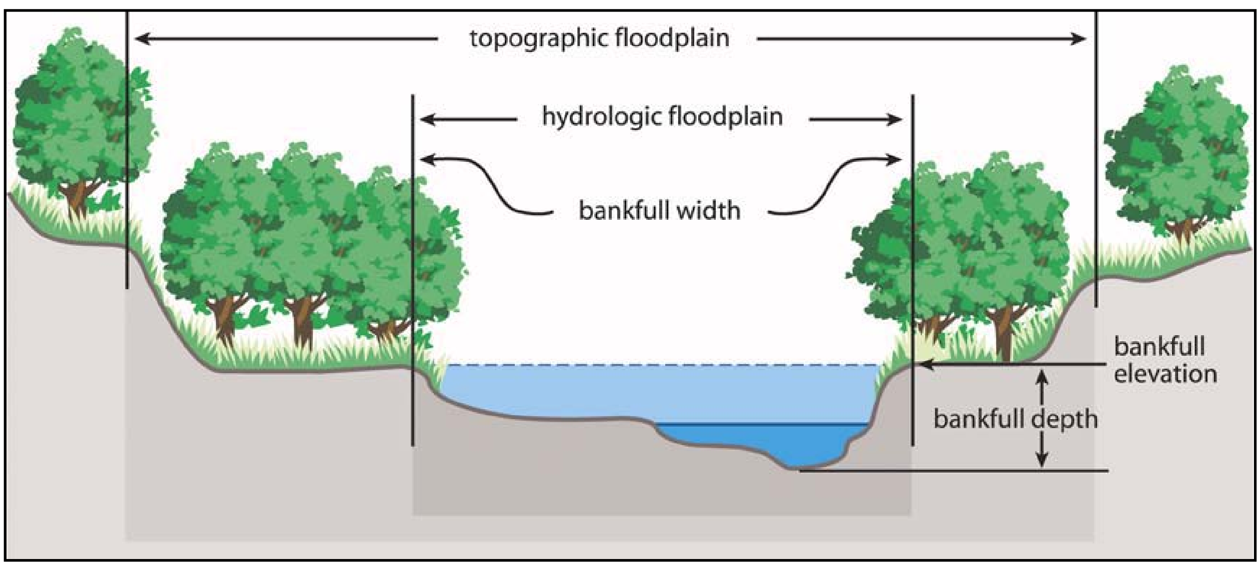


Figure 10. Graphical illustration of bankfull width and the topographic floodplain.

Major Zones within the Assessment Area

Identify and describe the major zones within the AA, which may be vegetation zone or may be physical patches such as open water or bare soil. Vegetation zones often consist of more than one plant species, but some zones can be mono-specific. A vegetation zone should be described if it meets the following rules:

1a. The plant zone is dominated by a physiognomic class distinctly different from other plant zones; OR
1b. The plant zone is dominated by the same physiognomic class as other plant zones, BUT each plant zone is dominated by different species AND the average height of the dominant species differs by > 1 m (e.g., *Typha latifolia* vs. *Juncus balticus*).
2. The plant zone makes up more than 5% of the AA (e.g., 250 m^2 for an AA of 0.5 ha).
3. Each individual patch of the plant zone is greater than 10 m^2.

For each zone identified, note the physiognomy of the dominant stratum, the dominant species (e.g., *Salix monticola/Calamagrostis canadensis*), and the percent of the AA that the zone occupies. Percentages of these zones should total 100% of the AA. Use the following major physiognomic classes:

- **Forest/Woodland** (trees or shrubs > 5 m tall occupy > 30% cover within a patch)
- **Shrubland** (shrubs < 5 m tall occupy > 30% cover within a patch)
- **Herbaceous** (graminoides, forbs, or ferns dominate)
- **Nonvascular** (bryophytes, cryptogrammic crusts dominate)
- **Submerged / Floating** (rooted or floating aquatics dominant, this does not include emergent veg)
- **Sparsely Vegetated** (vegetation cover < 5 %)
- **Open Water** (unvegetated)
- **Bare Ground / Rock** (unvegetated)

Assessment Area Drawing and Description

Provide a drawing of the assessment area illustrating the AA shape and boundary, including major vegetation zones, direction of drainage into and out of wetland, soil pit placement, and vegetation plot placement. Anthropogenic features like culverts, berms, or impoundments should also be included in the sketch. Also, indicate any major vegetation zones on the aerial photo of the AA. Include a north arrow. The AA drawing can be done once the AA is established or it can be done after all sampling is complete, if you have a better understanding of the site.

For the assessment area description and comments, describe the wetland type, dominant vegetation, soils, and hydrology. Also include abiotic zones, habitat features present, general location, and any notable feature about the wetland that may not have been captured in the classification or other information on the first two pages. Also note surrounding vegetation and land use. This is the best place to sum up the major characteristics of the site in paragraph form.

AA Representativeness: Note if AA is typical of surrounding wetland area, or not, and note if AA is the entire wetland.

Wildlife Species: I wildlife species are encountered, they can be listed at the bottom of this page (not required, something to consider if landowners have issues with wildlife observations). Photographs are useful for verification when possible.

2.4 Vegetation Sampling Protocols

Level 2 vs. Level 3 Vegetation Sampling

CNHP recommends one of two vegetation sampling protocols to address metrics in the vegetation condition category of the EIA.

For Level 2 Assessments, walk through the AA and identify as many plant species as possible within one hour. Attempt to identify all common species in the AA during this time, and scan the array of microhabitats in the AA for new plants (e.g., in shade vs. sun, depressional swales, above and below hummocks, away from water vs. in the water). Skip the vegetation plot set up and spend *no more* than 1 hour compiling the species list. Once the species list is compiled, use the first plot column on the form to estimate cover for the entire AA. In addition to the vegetation survey, ground cover estimates should also be made following the same guidance given below for the Level 3 protocol, except that the estimate should be for the entire AA. Data should be entered in the first plot column on the datasheet.

Level 3 Assessments, carry out the full vegetation plot as explained below. It is often advisable that the user lay out and sample the vegetation plot before filling out the EIA metrics. Many of the questions will be easier to answer once the vegetation plot has been carried out.

Determining Placement of the Vegetation Plot

Intensive assessments (Level 3) involve the collection of plant species cover and composition data. The vegetation plot recommended by CNHP is adapted from the EPA's National Wetlands Condition Assessment (NWCA) flexible-plot method (EPA 2011). Five 10 m x 10 m plots (100 m^2 = 0.01 ha) are placed along pre-set locations within the AA (Figure 11). Plot 1 is located 2 m south of the center point on the southern axis. Plot 2 is located 10 m beyond Plot 1, also on the southern axis. Plot 3 is located 15 m from the center point on the western axis. Plot 4 is located 15 m from the center point on the northern axis. Plot 5 is located 20 m from the center point on the eastern axis.

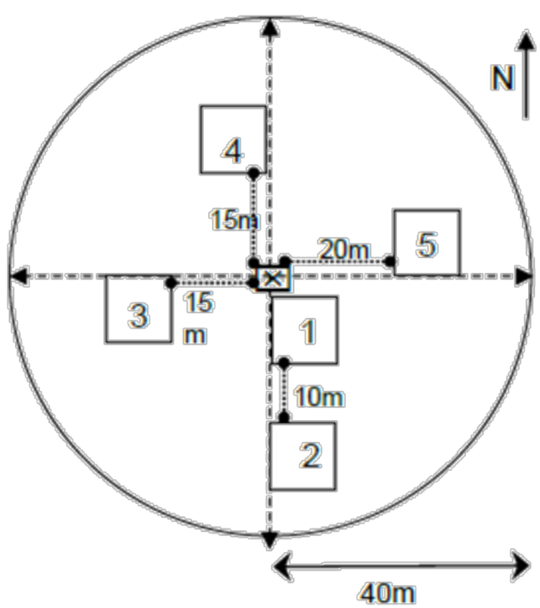


Figure 11. Standard Level 3 Veg Plot Layout. Vegetation Plots are located at specified distances from the AA center. Figure from EPA (2011).

When a non-standard AA layout is used, placement of vegetation plots follows the protocol below:

1a) AA is a 0.5 ha polygon .... Go to 2
1b) AA is <0.5 ha, but >0.1 ha, equaling the wetland boundary........ Wetland Boundary Veg Plot Layout (Fig. 12)

2a) AA width and length >30m .... Wide Polygon Veg Plot layout (Fig. 13)
2b) AA is ≤ 30m wide .... Narrow Polygon Veg Plot Layout (Fig. 14)

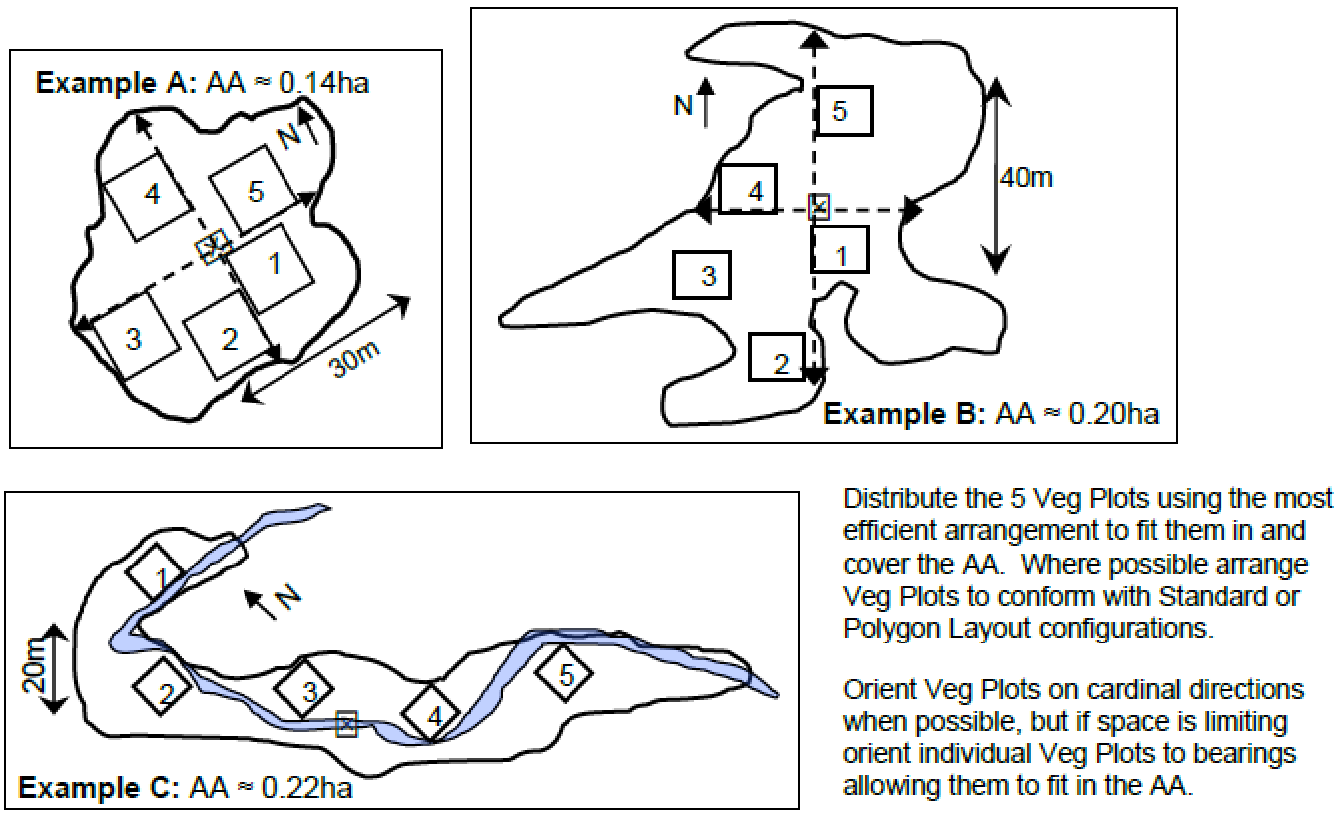


Figure 12. Examples of Wetland Boundary Veg Plot Layout. Plots are laid out as close to the standard layout as possible, but may be placed wherever they fit within small or unusually shaped AAs. Figures from EPA (2011).

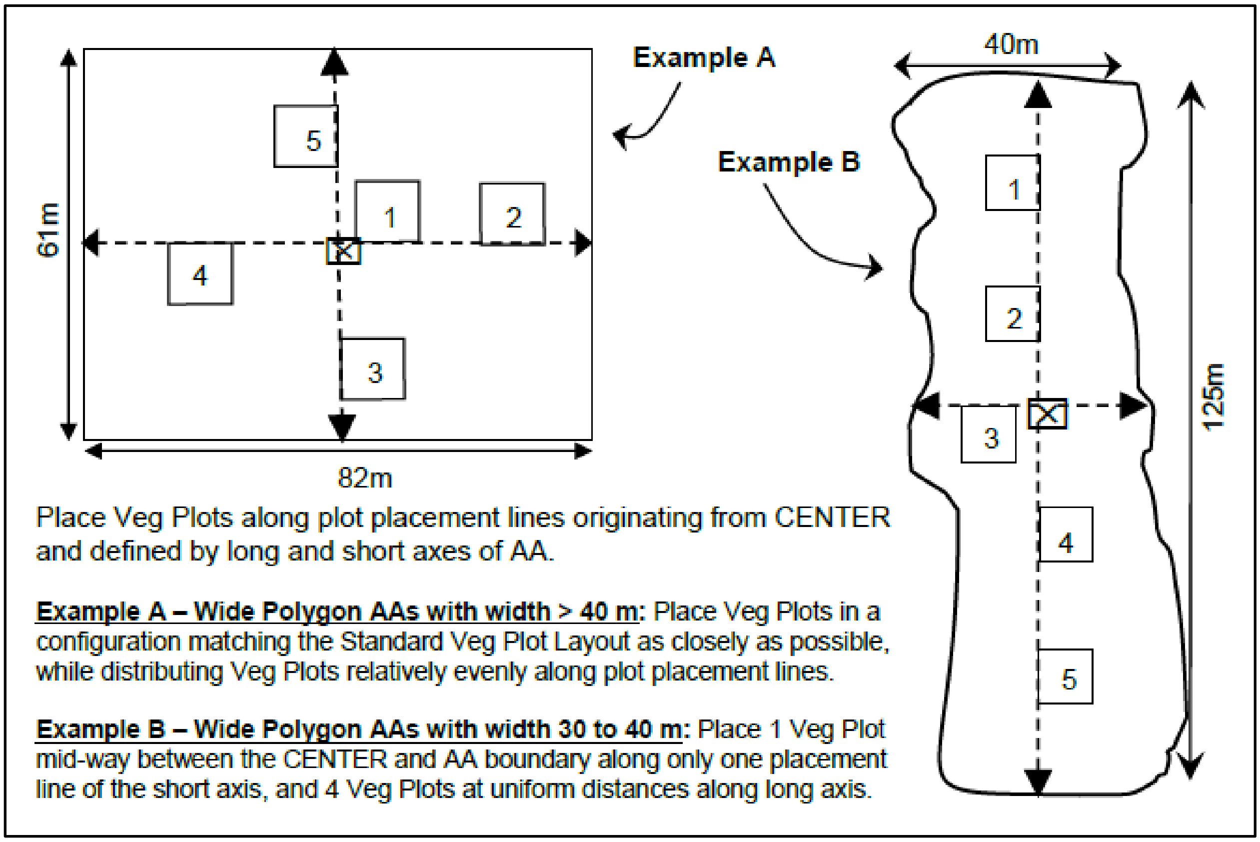


Figure 13. Examples of Wide Polygon Veg Plot Layouts. Veg plots are laid out along both axis as close to the standard layout as possible. Figures from EPA (2011).

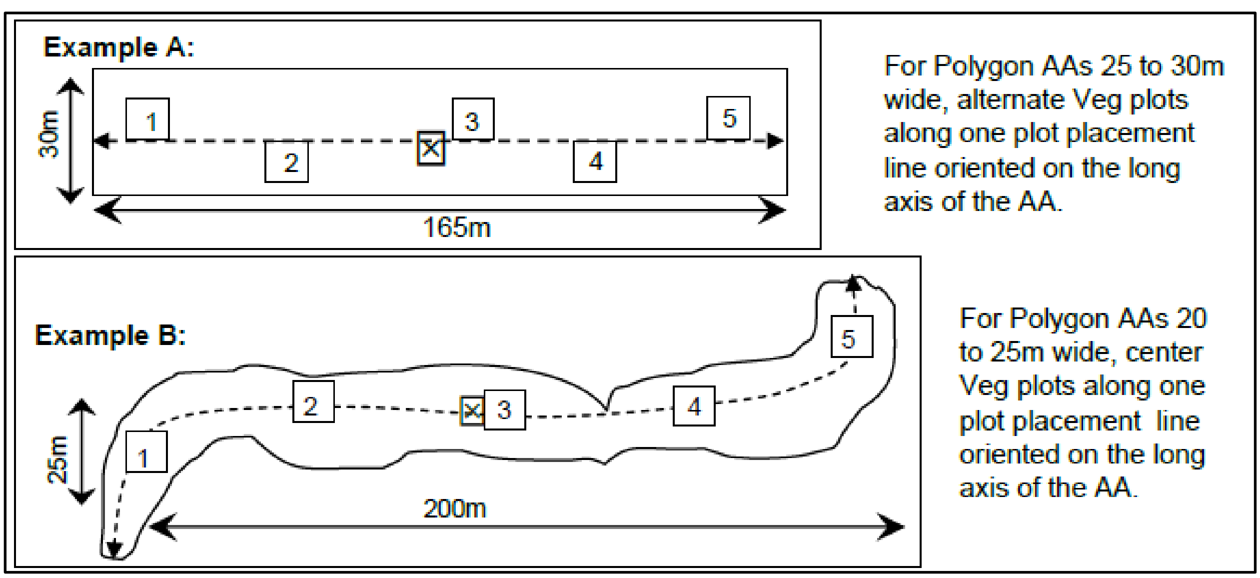


Figure 14. Examples of Narrow Polygon Veg Plot Layouts. Veg plots are laid out along one axis of the AA, spaced as evenly as possible. Figures from EPA (2011).

Laying Out and Documenting the Vegetation Plot

CNHP's Level 3 vegetation protocols are very similar to the NWCA, but are deviate slightly in the interest of sampling efficiency. We set up all five plots, as in the NWCA protocol, but only collect intensive vegetation data in four of the plots. The last plot is designated as a residual plot where only additional species not found in other plots are recorded. The residual plot should be the least noteworthy or unique of the five vegetation plots.

Once the AA corners along the tape are flagged, the 10-m rope will be used to mark out the plots. One crew member should hold the end of the 10-m rope at a plot corner along the tape while the other walks out perpendicular to the tape, so the plot is counterclockwise to the tape. The direction of this 10-m line should be checked by the crew member along the tape line with a compass. Pin flags or flagging tape should be used both along the center line and along the outside edge to mark the plots. After one side of the plot is laid out, the crew then walks back towards the beginning, laying out the second side of the plot. Veg plots are always on the counterclockwise side of each cardinal AA radius. A trick to remembering this is "plots are out in left field", so as you walk out away from the center, plots are to the left.

Before surveying vegetation plots, GPS waypoints and photos should be taken of each plot on their SW corner, facing NE. These photos and waypoints should be taken in a manner consistent with the AA photographs (see Figure 7).

Crew members should note any pertinent information about the plot layout on the form, including whether the vegetation plot layout was standard, or the specifics of the alternative configuration used can be described. Lastly, users should document in the comments if the vegetation plots were not representative of the vegetation within the AA.

Vegetation Plot Species Table

Floristic measurements including presence/absence and abundance (i.e., cover) of all vascular plant species will be made within four intensive veg plots. Sampling will begin in one 1-m^2 corner of the plot to focus the field user's search. Once all species in that corner have been identified, the user can move to a larger area, about 3 m^2. Then user continues throughout the entire plot and each species identified will receive a P to indicate it is present in the plot. Another significant different between CNHP's protocols and the NWCA protocol is that we do not establish the nested quadrats for data collection. We have found that we can identify as many species without the nested quadrats and eliminating them saves valuable field time.

Nomenclature for all plant species should follow the Weber and Wittmann 3rd edition (Weber and Wittmann 2001a, b). C-values from the FQA for Colorado wetlands were determined based on the nomenclature in these floras and data analysis tools reply on these names. When other floras are used to key a species, the key path and species name should be checked in Weber. All species will be recorded on the field form using the fully spelled out scientific name.

Any **unknown species** will be entered on the field form with a descriptive name. If the genus of the species is known, the descriptive name should include the genus name (e.g., Carex 1 sp. or Aster 2 sp). The descriptive name should also include some identifiable characteristics to distinguish multiple unknown species from the same genus (Carex sp. elongate back head or Carex sp. clustered brown head). If the genus is not known, the descriptive name should include any descriptors necessary (fuzzy round basal leaves or purple united corolla). All unknown species will be collected by the field user either when the species is encountered or at the end of the vegetation plot. If the species is not collected until the end of the plot, a marker or pin flag should be left to mark the spot of the unknown species for later collection. Even if the species appears to be unidentifiable, the user should default by collecting unless they are sure the species could not be discerned from other similar species by a botanist's gestault when aware of habitat and growing location. The user may find the same species further developed at a later site and can compare the further developed specimen with the earlier voucher. *The only species the user should not collect are those identified as or suspected to be **federally or state listed species.*** All users should be aware of the listed species in their State and should document occurrences with **multiple clear photographs** and document the photo numbers in the Photos column. It is also useful to photograph plants that the user expects will change substantially after collecting, such as very small or large plants (shrubs, tiny annuals), and aquatics.

All collected unknown species will receive a **collection number**, which will be a running sequential series of numbers that starts at every site. This collection number will be written on the field form in the column "Coll #". When users encounter species that look alike, their bases should be taped with masking tape, and the collection number can be written on the tape with a sharpie. All unknown species should be properly collected for later identification and should include portions of the roots, stems, leaves, flowers, and fruits to the full extent possible. The collector should note whether the plant is rhizomatous or cespitose. Users should always review field keys of unknown species to ensure they record pertinent information. Proper collection technique will be demonstrated in field training.

When all species within a plot have been identified, cover will be visually estimated for the plot using the following cover classes (Peet *et al*. 1998). The visual aid provided in Figures 15 and 16 for estimating cover can be helpful in the field.

1 =	trace (one or two individuals)	6 =	>10–25%
2 =	0–1%	7 =	>25–50%
3 =	>1–2%	8 =	>50–75%
4 =	>2–5%	9 =	>75–95%
5 =	>5–10%	10 =	>95%

Though noting presence in the first plot may seem redundant (every species on the list will be within the plot), this column will be increasingly important as the user moves on to the second, third, and forth plots. Starting with the second plot, the user will record each of the species from the first plot that they encounter in the second plot by placing a P in the "Presence" column. The user may also add to the species list if additional species are encountered in the second plot. This will also receive a "P" in the "Presence" column. Once the user feels confident that all species have been identified, the marks in this column will give the user a list to use when estimating cover for the plot.

Residual plot: After sampling each of the intensive plots, the last (i.e. residual) plot will be walked through to document presence of any species not recorded in the intensive plots. Percent cover of these species will be estimated over the entire AA. In a 5000-m^2 AA, 1% cover is approximately 7x7 m^2. It is ok to also note any observed species from in the AA not in the veg plots in the residual, as long as they are not in an upland inclusion. This is uncommon to do, and the user should not search for any additional species outside the vegetation plots. Rather, when the user notices a very common species in the AA that is not represented in the veg plots or residual, they can add it to the residual plot.

Vegetation Plot Ground Cover and Vertical Strata

Within each of the four intensive plots, in-depth information on the ground cover and vertical vegetation strata will be recorded. The residual plot (the least notable plot) is surveyed last, and only new species or new ground/vertical strata data are recorded when not observed in previous plots. This page comes before the species table within the field form, but is easier to fill out after the plot has been searched for species. The reason it is presented first is so the two pages of the species table are facing each other, which is much easier for use in the field. In each plot, document any attributes observed for the ground cover and vertical strata page. Guidance is provided below.

Cover of standing water of any depth, vegetated or not: This field is for any and all water within the plot, whether it is 0.5 cm or 70 cm deep. Using the cover classes provided at the top of the form, estimate total cover of water.

Minimum depth of standing water: Estimate the minimum depth of standing water that is at least 1 cm. Walk through the plot to make sure you identify the minimum depth.

Maximum depth of standing water: Estimate the maximum depth of standing water. It is likely that this will be < 1 m, since AAs are limited to areas with < 1 m of water. Walk through the plot to make sure you identify the maximum depth.

Predominant depth of standing water: Estimate the predominant depth of standing water. Walk through the plot to get a sense of the range of depths and estimate the most typical depth in the plot.

Cover of bare ground: Cover of bare ground will be estimated using cover classes for three separate categories of bare ground: 1) soil, sand, or sediment; 2) gravel or cobble ~2–250 mm in diameter; and 3) bedrock, rock, or boulders > 250 mm in diameter. Similarly to above, these particle sizes do not overlap, so choose the dominant size.

Cover of litter: Cover of litter will be estimated using cover classes. This includes litter that is hidden beneath vegetation or water. In cases where dense herbaceous vegetation covers the plot, this can be difficult to determine, as this year's herbaceous vegetation can intermix with litter from previous years. Litter can also include standing dead herbaceous vegetation, particularly annual vegetation or dead attached leaves from the previous year, which would become litter once it fell over.

Depth of litter: This is an average of the depth (in cm) of litter at the four plot corners. If those corners have no litter but there is litter in the plot, choose a depth representative of the average. The measured litter height should not be trampled, but should reflect the height at which it occurs naturally.

Predominant litter type: Select the predominant litter type (C = coniferous, E = broadleaf evergreen, D = deciduous, S = sod/thatch, F = forb). Sod/thatch is used for graminoid litter.

Cover of standing and downed woody debris: The cover of woody debris is estimated based on whether it is standing or downed, and the diameter either at breast height or the average diameter of the debris. To differentiate down debris from standing debris, use the 45° rule. If a tree is leaning more than 45° from upright, it is considered downed woody debris. If it is leaning less that 45° from upright, it is considered a standing dead tree or snag.

Cover of nonvascular species: The cover of non-vascular species (eg: moss, liverworts) will be estimated using the cover classes. For each species group, make sure to look underneath vegetation. The cover of these species groups is often underestimated because people do not look for them hiding among the leaves of graminoids or under shrubs.

Vertical vegetation strata: The overall cover and average height class of each vertical stratum will be estimated for the plot. Each vertical stratum has a corresponding height class noted on the data sheet.. Any given stratum can have up to 100% cover, but the overlapping species within the stratum are ignored. Note that the height classes are more specific in the vegetation plots than the height classes in the habitat data.

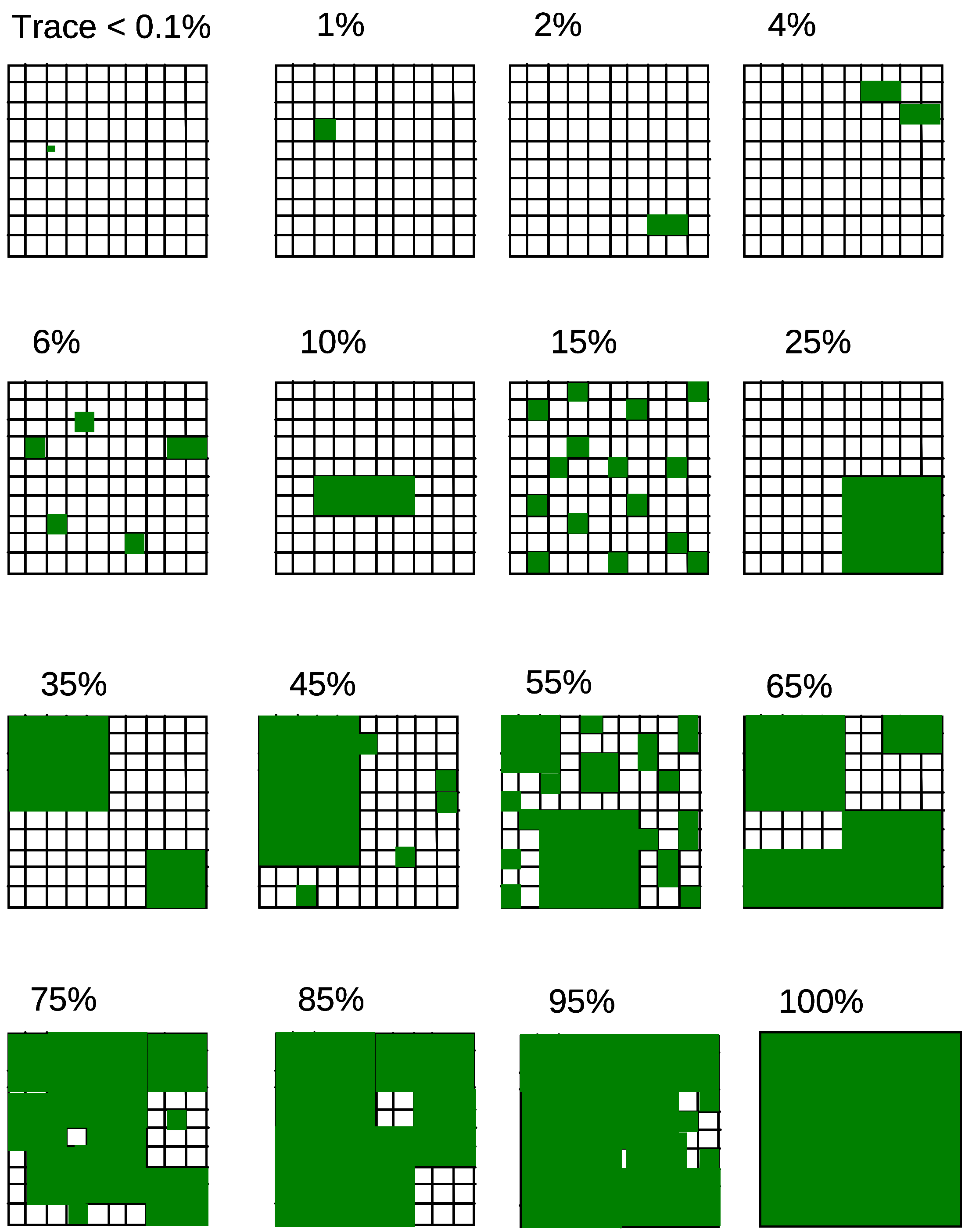


Chart 1. Examples of Percent Cover Estimates. Each large square = 100 m^2 module, grid squares = 1 m^2 (i.e., one grid square = 1% cover in a module), shaded areas represent cover of a vegetation stratum or of an individual species.

Figure 15. Examples of percent cover estimate.

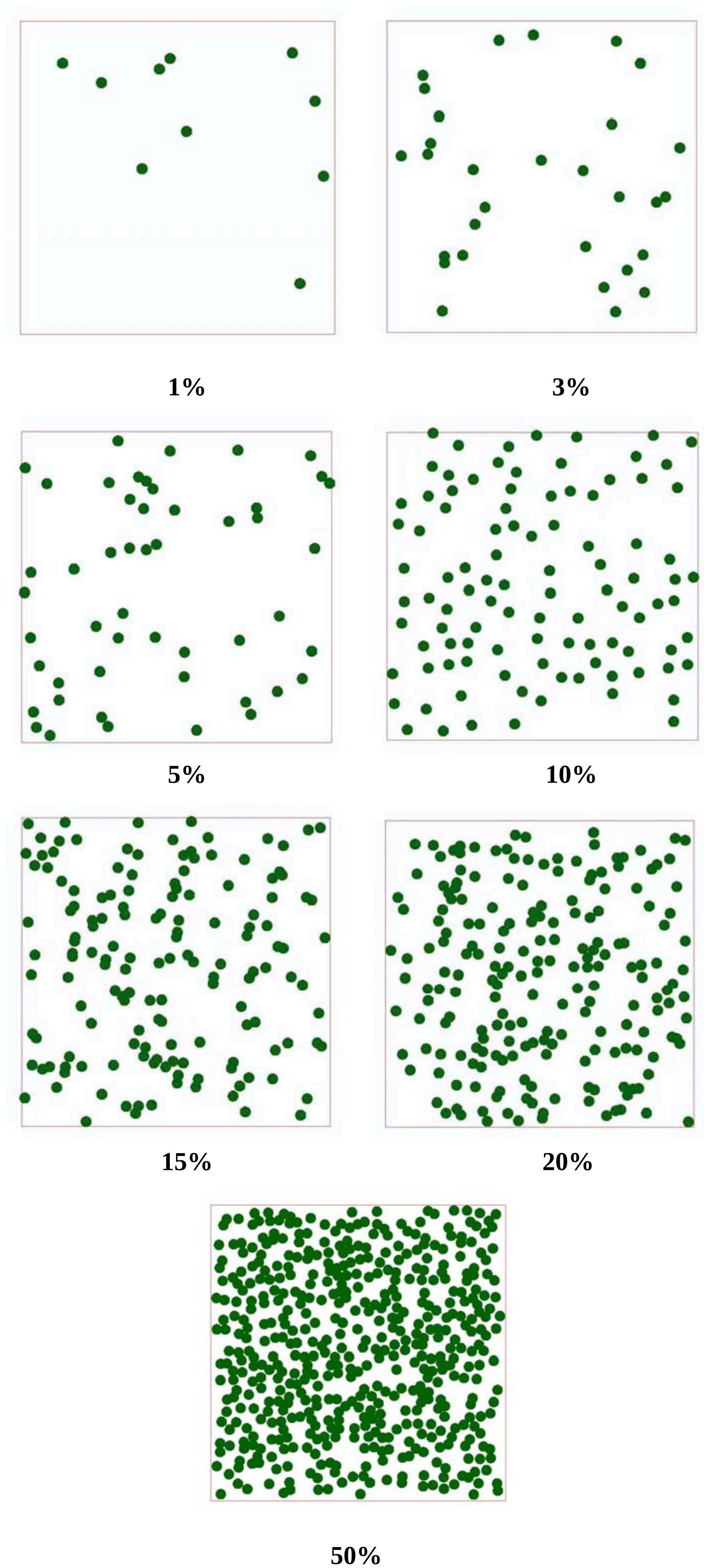


Figure 16. Examples of percent cover estimate.

2.5 Soil Profile Descriptions and Water Chemistry Sampling

Location of soil and water sampling will be determined while laying out the AA. Care should be made not to trample the vegetation plots or water sampling locations while laying out the AA. Shortly after plot layout is complete, water quality data should be taken to minimize mucking of water. In the same vein, vegetation plots should be laid out as soon as possible to flag areas that should not be trampled. When soil pits are dug next to vegetation plots, avoid trampling plots if the pits are dug before vegetation identification.

Soil: At least two soil pits will be dug within the AA. The pits can be dug before or after the vegetation plot is conducted depending on the flow of the sampling day. Pits should be placed in vegetation communities characteristic of the AA. If the vegetation and soil surface appears relatively homogenous, only two pits are necessary. If there is variability within the vegetation and soil, at least three and up to four soil pits should be dug to capture the range of variation within the site. When soil pits are variable, mark which pit best represents the AA. Because digging soil pits is difficult in standing water, it is advisable to pick a location on the edge of deep water, if possible. For all soil pits, take a GPS waypoint and record the waypoint number on the field form. Take photographs, if possible, of the pit and the soil profile one laid out. Mark all soil pits on the site drawing.

Soil pits should be dug with a 40-cm sharp shooter shovel. The pit should be only slightly larger than the width of the soil on all sides to minimize disturbance to the ground surface. Pits will be dug to at least one shovel length depth (35 to 40 cm) when possible. The core removed should be set down next to the pit, taking care to keep all horizons intact and in order. A bucket auger can be used to examine the soil deeper in the profile if needed to find hydric soil indicators. It is difficult to dig soil pits in areas with deep standing water. Concentrate on areas near the water's edge if standing water is a significant part of the AA.

Following guidance in the *ACOE Regional Supplement* and the National Resources Conservation Service (NRCS) Field Indicators of Hydric Soils in the United States (NRCS 2010), identify and describe each distinct layer in the soil pit. It is not necessary to name the layers with horizon designations unless you feel comfortable with soil taxonomy. Measure and record the depth of each distinct layer. For each layer, record the following information: 1) color (based on a Munsell Soil Color Chart) of the matrix and any redoximorphic concentrations (mottles and oxidized root channels) and depletions; 2) the soil texture (using Appendix D); and 3) any specifics about the concentration of roots, the presence of gravel or cobble, or any usual features to the soil. Based on the characteristics, identify which, if any, of the hydric soil indicators occur at the pit. See Appendix E for notes on hydric soil indicators commonly found in the Rocky Mountain region. If soil survey information is known for the assessment area, write down the soil survey unit name and note whether the pit matched the soil survey description.

Water Table: The water table will be measures in soil pits where groundwater is visible. Allow the pit to sit at least 15 minutes and up to one hour before measuring depth to saturation and depth to free water. Once the pit has equilibrated as much as possible, measure the distance to saturated soil and to free water. Saturated soil can be identified by a sheen on the soil surface or water seeping an oozing into the pit. Free water is an approximation of the groundwater table, but in some cases may not represent the true groundwater table because it can take many hours for the water table to equilibrate. If free water is not observed, note whether the pit is dry or if it appears to be slowly filling.

Water Chemistry: Basic field measurements of water chemistry (pH, EC and temperature) can be taken reading using a handheld meter in a variety of locations in the AA depending on the purpose. To characterize groundwater-fed system (fens, seeps or springs), it is best to take water chemistry measurements in soil pits where groundwater is evident. For monitoring water chemistry parameters for amphibians, it is best to take water chemistry measurements in surface water. For all water chemistry sampling, take a GPS waypoint and mark on the field form whether the sample was taken in 1) surface or groundwater, 2) standing or flowing water, 3) shallow or deep water, and 4) clear or turbid water. It is important to recognize that surface water parameters fluctuate widely during the day, throughout the season, and with varying water levels. A single measurement is only a snapshot. To make more rigorous conclusions about water chemistry and water quality, a more intensive sampling regime would be needed.

For the handheld meter, be sure to calibrate the meter daily, log each calibration, and keep the electrode clean at all times. A small squirt bottle is helpful to carry in the field to keep the electrode clean before and after using it.

SECTION 3: EIA METRIC DESCRIPTIONS AND RATINGS

3.1 Landscape Context Metrics

Landscape context metrics evaluate the condition of the landscape surrounding the wetland AA. Anthropogenic impacts to the surrounding watershed can have a significant impact on wetland processes. These metrics focus on 1) the degree of natural connectivity in the landscape, as measured by landscape fragmentation and, for riverine wetlands, by the continuity of the riparian corridor; and 2) the extent, width and condition of the wetland buffer.

Key Ecological Attribute: Landscape Connectivity

Landscape connectivity measures the degree to which the wetland AA is still connected to natural land covers and larger-scale natural process occurring within the surrounding landscape. For all wetlands, fragmentation within the entire surrounding landscape is evaluated. For riverine wetlands, special emphasis is given to the riparian corridor.

Metric 1a: Landscape Fragmentation

Definition and Background: This metric measures the percent of the landscape within 500 meters of the AA that is contiguous with the AA itself, meaning there is an unfragmented connection to the AA. The intensity of human activity in the landscape often has a proportionate impact on the ecological processes of natural systems. The percentage of natural land covers vs. altered land covers (i.e., development or agriculture) provides an estimate of connectivity among natural ecological systems. Fragmentation can dramatically impact natural processes such as seed dispersal, animal movement, and genetic diversity (Lindenmayer and Fischer 2006).

Metric Level: Level 1 (remote sensing) with Level 2 (rapid assessment) verification.

Metric Application: Use for all wetlands, regardless of classification.

Measurement Protocol: To assess this metric, examine land use patterns within a 500 m envelope of the AA. This is best done using the most recent aerial photography available. GIS layers of land use or land cover can also be used, but may not be as accurate as interpretation of aerial photography. When possible, walk through portions of the 500 m envelop to ground truth the photo. Identify the largest unfragmented block *that contains the AA* and estimate its percentage of the total area within the 500 m envelope (Figure 17). This percent of unfragmentated landscape can have small fragmentation inclusions (e.g., individual houses in a forested landscape, etc.) that are subtracted from the percent unfragmented area, but roads that bisect the landscape form a hard boundary on the unfragmented block. Well-traveled dirt roads and major canals count as fragmentation, but hiking trails, non-tilled hayfields, open fences, and small lateral ditches can be included in unfragmented blocks (Table 8). For larger roads, such as highways where road fill and trash borders the road, the zone of the road's influence should also be considered as fragmentation.

NOTE: If you define the AA as an entire wetland, the landscape with 500 m of the AA will be variable in size. The larger the wetland, the larger the landscape under consideration. If your study uses an area-based design with a fixed AA size (i.e., 01–0.5 ha), the landscape will be a more or less standard in size. In this case, the AA may be embedded within a larger wetland complex and some of the landscape under consideration may be continuous wetland area.

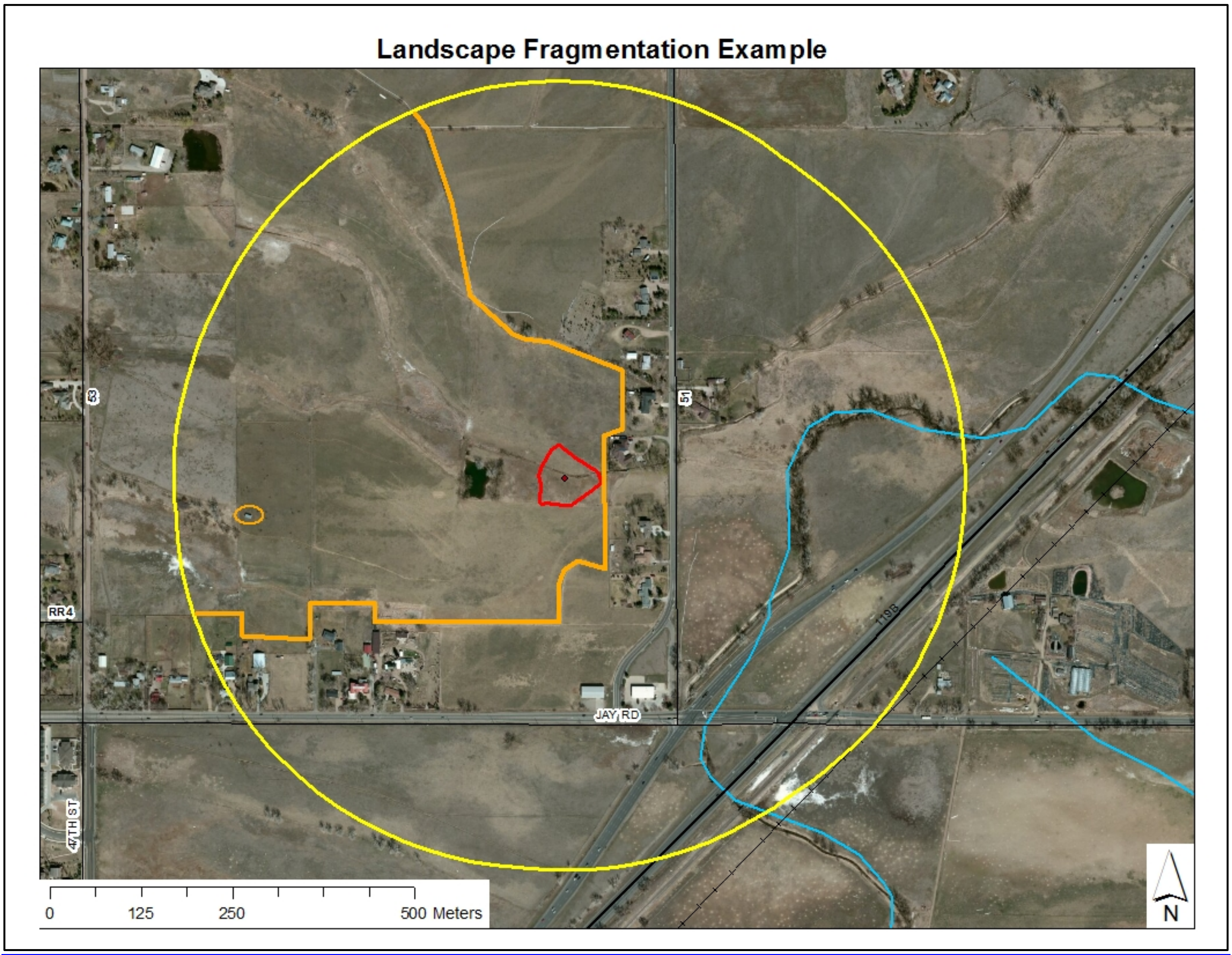


Figure 17. Orange lines follow the boundary of contiguous land cover in the 500m radius envelope surrounding the AA boundary. This AA is embedded in an unfragmented, natural landscape block in the 20–60% of the 500m envelope category. In this example, dirt roads, buildings, and urban areas/yards break the unfragmented block, but small shallow ditches do not.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 7.

Table 7. Rating for Landscape Fragmentation

Rank	*Score*	*State*
Excellent (A)	5	Intact: AA embedded in >90–100% unfragmented, natural landscape.
Good (B)	4	Variegated: AA embedded in >60–90% unfragmented, natural landscape.
Fair (C)	3	Fragmented: AA embedded in >20–60% unfragmented, natural landscape.
Poor (D)	1	Relictual: AA embedded in ≤20% unfragmented, natural landscape.

Table 8. Land covers that are included and excluded from unfragmented blocks and wetland buffers.

Examples of Land Covers Included in Unfragmented Blocks or Buffers	***Examples of Land Covers Excluded from Unfragmented Blocks or Buffers***
o Additional wetland/riparian area o Natural upland habitats o Nature or wildland parks o Bike trails o Foot trails o Horse trails o Low or open fences o Small power lines o Open rangeland with light grazing o Swales and ditches with natural substrate o Open water o Vegetated levees o Non-tilled hay fields	o Commercial developments o Residential developments o Paved roads o Dirt roads o Railroads o Parking lots o Lawns/non-native landscaping o Golf courses o Sports fields o Urbanized parks with active recreation o Paved or heavily used pedestrian/bike trails (frequent traffic) o Sound walls or high, solid fences that interfere with wildlife movements o Major power transmission lines o Wind farms, oil and gas wells o Ditches with hard substrate (concrete) o Intensive agriculture (tilled row crops, orchards, vineyards) o Dryland farming o Intensive livestock areas (horse paddocks, animal feedlots, poultry ranches) o Rangeland with intensive grazing

Metric References: Metric concept and thresholds adapted from Rondeau (2001), Rocchio (2006), and Faber-Langendoen et al. (2008).

Metric 1b: Riparian Corridor Continuity

Definition and Background: This metric measures the degree to which the riverine corridor/floodplain above and below the AA exhibits connectivity with adjacent natural systems. For Riverine HGM Class wetlands, the continuity of the riparian corridor is a particularly important aspect of landscape connectivity. Of special concern is the ability of wildlife to enter the riparian area at any place within 500 m of the AA and to move easily through adequate cover along the riparian corridor from either upstream or downstream. Continuity of the floodplain also allows for overbank flow, which replenished floodplain aquifers and transports sediments and nutrients.

Metric Level: Level 1 (remote sensing) with Level 2 (rapid assessment) verification.

Metric Application: Use for all wetlands in the Riverine HGM class.

Measurement Protocol: To assess this metric, examine land cover within the riparian corridor 500 m upstream and 500 m downstream. Estimate the percent of anthropogenic, non-buffer patches within the corridor. The riparian corridor is defined as the width of the natural geomorphic floodplain, which may be extensive on the plains and mountain parks or may be narrow where the landscape or hydrology naturally limits floodplain development. In general, assume that the riparian corridor upstream and downstream is similar to what it is in the AA, unless it is obviously different to due geomorphology (i.e., the valley naturally widens or narrows). Anthropogenic patches include roads, bridges, urban/industrial development, tilled agriculture fields, etc. (land uses listed in Table 8). Look for patches that cross the corridor, enter it, or run along its length, but are obviously within the geomorphic floodplain and interrupting the continuity. For extensive, wide floodplains, it can be hard to tell if land use adjacent to the riparian corridor is in the historicalnatural floodplain or on its edge. The purpose of this metric is to assess linear movement up and down the riparian corridor. As a rule of thumb, if 1) it is difficult to tell if a land use patch is in the geomorphic floodplain, 2) the land use is at least 100 m from the channel, and 3) the floodplain is otherwise uninterrupted, then the land use can be ignored.

NOTE: If you are assessing a wetland AA on the floodplain of a very large, unwadable river, only consider the riparian corridor on the side of the channel where the wetland AA is located.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 9.

Table 9. Rating for Riparian Corridor Continuity

Rank	*Score*	*State*
Excellent (A)	5	Intact: >95–100% natural habitat within the riparian corridor both upstream and downstream.
Good (B)	4	Variegated: >80–95% natural within the riparian corridor both upstream and downstream.
Fair (C)	3	Fragmented: >50–80% natural habitat within the riparian corridor both upstream and downstream.
Poor (D)	1	Relictual: ≤50% natural habitat within the riparian corridor both upstream and downstream.

Metric References: Metric and thresholds adapted from Rocchio (2006), Collins et al (2008; 2013), Faber-Langendoen et al. (2008), and Muldavin et al. (2011).

Key Ecological Attribute: Wetland Buffer

This attribute is evaluates the overall area and condition of the buffer immediately surrounding the AA using three measures: percent of buffer land cover surrounding the AA, average buffer width (up to 200m from the AA), and buffer condition. Wetland buffers are vegetated, natural (non-anthropogenic) areas that surround a wetland (see Table 8 for buffer land covers). These include forest, grasslands, shrublands, lakes, ponds, streams, or other wetlands. Some low impact land uses can be included in the buffer, such as light recreation and light grazing. Non-tilled, irrigated hay meadows can be counted as part of the buffer if they are not intensively managed or frequently harvested. Buffers serve to protect critical wetland functions, such as wildlife habitat and water quality, by limiting the invasion of non-native species, filtering nutrients and pollutants, and reducing erosion and sedimentation (ELI 2008).

NOTE: If you define the AA as an entire wetland, the buffer metrics will evaluate the actual buffer around the wetland edge. However, if your study uses an area-based design with a fixed AA size (i.e., 01–0.5 ha), the AA may be embedded within a larger wetland complex and some of the buffer under consideration may be continuous wetland area.

Metric 1c: Buffer Extent

Definition and Background: Wetland buffers that fully surround a wetland offer greater protection than those that cover only part of the wetland. Exposed wetland edges are at greater risk of invasion and pollutant loading.

Metric Level: Level 1 (remote sensing) with Level 2 (rapid assessment) verification.

Metric Application: Use for all wetlands, regardless of classification.

Measurement Protocol: This metric can be assessed first using the aerial photography, but must be verified with field observation. Visually estimate the total percentage of the AA perimeter with adjacent land covers that provide buffer functions (Table 8). To be considered as a buffer, a suitable land cover must be at least 5 m wide extending out from the AA edge and continue for at least 10 m in length around the AA perimeter.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 10.

Table 10. Rating for Buffer Extent

Rank	*Score*	*State*
Excellent (A)	5	Buffer land covers surround 100% of the AA.
Very Good (A-)	4.5	Buffer land covers surround >75–99% of the AA.
Good (B)	4	Buffer land covers surround >50–75% of the AA.
Fair (C)	3	Buffer land covers surround >25–50% of the AA.
Poor (D)	1	Buffer land covers surround ≤25% of the AA.

Metric References: Metric and thresholds adapted from Collins et al (2008; 2013), Faber-Langendoen et al. (2008; 2012), and Muldavin et al. (2011).

Metric 1d: Buffer Width

Definition and Background: Like extent, the wider the buffer, the more effective it is at protecting wetland function. Through a synthesis of research on buffer, ELI (2008) report that buffers must be at least ~30 m (100 ft.) to effectively filter all three major water quality stressor of sediment, phosphorus and nitrogen. Wider buffers are even more effective for the removal of nitrogen. The effectiveness of buffer for wildlife habitat depends on the species, but should also be at least 30 m and likely up to 100 m or more to protect a range of native species.

Metric Level: Level 1 (remote sensing) with Level 2 (rapid assessment) verification.

Metric Application: Use for all wetlands, regardless of classification.

Measurement Protocol: This metric can be assessed first using aerial photography but must be verified with field observation. Use an aerial photo, either on a field map or in GIS, to draw eight lines radiating away from the edge of the AA along the cardinal and ordinal directions (N, NE, E, SE, S, SW, W, NW) , up to 200m from the AA perimeter. End each line when it encounters a non-buffer land cover, as they do in Figure 18 below at the railroad. (Note that the buffer lines do cross a minor canal, but they would end at the canal if it was cement lined or a more major conveyance structure. These calls must be verified in the field.) Visually estimate the average distance between the edge of the AA and the edge of the buffer for each of these lines. Enter the length of each line in the table on the field form, calculate the average, and select the narrative description that matches the average.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 11.

Table 11. Rating for Buffer Width

Rank	***Score***	***State***
Excellent (A)	5	Average buffer width is >200 m.
Very Good (A-)	4.5	Average buffer width is >100–200 m.
Good (B)	4	Average buffer width is >50–100 m.
Fair (C)	3	Average buffer width is >25–50 m.
Poor (D)	1	Average buffer width is ≤25 m OR no buffer exists.

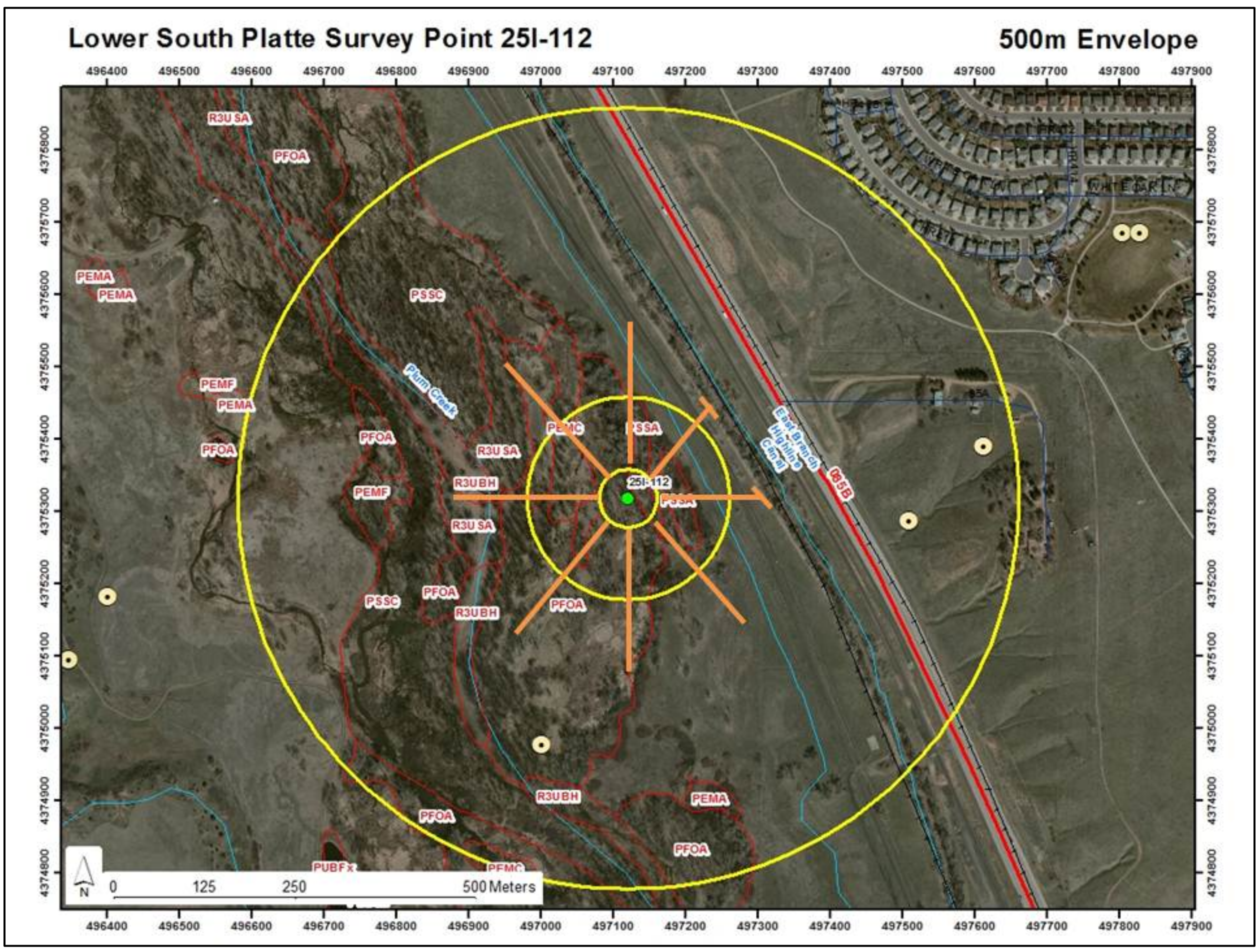


Figure 18. Orange buffer lines begin at the AA perimeter, continue up to 200m outside the AA, but stop upon reaching non-buffer land cover. The lines are used to determine average buffer width. This wetland has an average buffer width between 100-200m.

Metric References: Metric and thresholds adapted from Rocchio (2006), ELI (2008), Collins et al (2008; 2013), Faber-Langendeon et al. (2008; 2012), and Muldavin et al. (2011).

Metric 1e: Buffer Condition

Definition and Background: The condition of the buffer can also limit its effectiveness. A vegetated hay field (considered buffer) is better than parking lot (not considered buffer), but is far less effective at controlling nutrient loading and non-native species dispersal that a native prairie or shrubland. This metric evaluates two aspects of buffer separately, the vegetation and soil/substrate disturbance. These two aspects are then averaged for a final buffer condition score.

Metric Level: Level 2 (rapid assessment).

Metric Application: Use for all wetlands, regardless of classification.

Measurement Protocol: Walk through enough of the buffer to familiarize yourself with the dominant vegetation and any obvious signs of soil disturbance or dumping. Select one statement from *each* column on the form that best describes the buffer vegetation and buffer soils/substrate condition. Only consider *buffer areas* from 1c and 1d above. This metric is evaluating the condition of the *buffer itself,* not land covers determined to be non-buffer.

Metric Rating: Assign the metric ratings and associated scores based on the thresholds in Table 12.

Table 12. Rating for Buffer Condition

Rank	*Score*	*State – Vegetation*	*State – Soils/Substrate*
Excellent (A)	5	Abundant (≥95%) relative cover native vegetation and little or no (<5%) cover of non-native plants (remember to look for non-native hay grasses).	Intact soils, little or no trash or refuse, and no evidence of human visitation.
Good (B)	4	Substantial (≥75–95%) relative cover of native vegetation and low (5–25%) cover of non-native plants (remember to look for non-native hay grasses).	Intact or moderately disrupted soils, moderate or lesser amounts of trash, OR minor intensity of human visitation or recreation.
Fair (C)	3	Moderate (≥50–75%) relative cover of native vegetation (remember to look for non-native hay grasses).	Moderate or extensive soil disruption, moderate or greater amounts of trash, OR moderate intensity of human use.
Poor (D)	1	Low (<50%) relative cover of native vegetation (remember to look for non-native hay grasses) OR no buffer exists.	Barren ground and highly compacted or otherwise disrupted soils, moderate or greater amounts of trash, moderate or greater intensity of human use, OR no buffer exists.

Metric References: Metric and thresholds adapted from Collins et al (2008), Faber-Langendeon et al. (2008; 2013), and Muldavin et al. (2011).

Metric 1f: Natural Cover within a 100 m Envelope (Supplemental Metric)

Definition and Background: The complexity and composition of surrounding vegetation can help to buffer a wetland from potential impacts. Although this metric is not used to calculate EIA scores, knowing the structure and composition of surrounding land cover is important to understand the wetland's landscape context.

Metric Level: Level 2 (rapid assessment).

Metric Application: Use for all wetlands, regardless of classification.

Measurement Protocol: Using the table on the form (Table 13), estimate the total percent cover of non-natural land use within a 100 m envelope of the AA. The remaining cover represents the total cover of natural land use / natural cover. In this case, natural cover includes both *native and non-native vegetation*. From the total natural cover, separate natural wetland cover from natural upland cover. Then break total wetland cover and total upland cover by major cover types. Double check that: 1) for each row, upland + wetland cover = total % cover; 2) total upland cover (all rows) + total wetland cover (all rows) = total natural cover; and 3) total non-natural cover + total natural cover = 100%. Record dominant species for each cover type in the comments with the corresponding letter. If the surrounding landscape is not accessible (on a different landowner's property), guess to the best of your ability (e.g., native shortgrass prairie, or heavily grazed rangeland with kochia).

Table 13. Rating for Natural Cover

Natural Cover Type	*Total % Cover*	*Upland % Cover*	*Wetland % Cover*
Total non-natural cover (development, roads, row crops, feed lots, etc.).			
Total natural cover (breakdown by type below)			
A. Deciduous forest			
B. Coniferous forest			
C. Mixed forest type (neither deciduous nor coniferous trees dominate)			
D. Shrubland			
E. Perennial herbaceous (includes hay fields and CRP lands)			
F. Annual herbaceous or disturbed bare (generally weedy)			
G. Naturally bare (open water, rock, snow/ice)			

Metric Rating: There are no ratings assigned to this matric at this time.

Metric References: This metric is unique to the Colorado EIA method. We currently use it more for descriptive or explanatory purposes.

Landscape Stressors

Using the table on the field form (Table 14), estimate the scope of each land use within a 500 m envelope of the AA. Stressors can overlap and do not need to total 100% (e.g., light grazing and moderate recreation can both be counted in the same portion of the envelope). Scope rating: 1 = 1–10%, 2 = >10–25%, 3 = >25–50%, 4 = >50–75%, 5 = >75%.

Table 14. Landscape stressors

Landscape stressors/ Land use categories	*Scope*
Paved roads, parking lots, railroad tracks	
Unpaved roads (e.g., driveway, tractor trail, 4-wheel drive roads)	
Domestic or commercially developed buildings	
Intensively managed golf courses, sports fields, urban parks, expansive lawns	
Gravel pit operation, open pit mining, strip mining	
Mining (other than gravel, open pit, and strip mining), abandoned mines	
Resource extraction (oil and gas wells and surrounding footprint)	
Dam sites and flood disturbed shorelines around water storage reservoirs	
Agriculture – tilled crop production	
Agriculture – permanent crop (hay pasture, vineyard, orchard, tree plantation)	
Vegetation conversion (chaining, cabling, rotochopping, or clear-cutting of woody veg)	
Logging or tree removal with 50-75% of trees >50 cm dbh removed	
Selective logging or tree removal with <50% of trees >50 cm dbh removed	
Heavy grazing/browse by livestock or native ungulates	
Moderate grazing/browse by livestock or native ungulates	
Light grazing/browse by livestock or native ungulates	
Intense recreation or human visitation (ATV use / camping / popular fishing spot, etc.)	
Moderate recreation or human visitation (high-use trail)	
Light recreation or human visitation (low-use trail)	
Recent old fields and other fallow lands dominated by *non-native* species (weeds or hay grasses)	
CRP lands (grasslands planted with a mix of *native* and *non-native* species)	
Haying of *native* grassland (*not* dominated by non-native hay grasses)	
Beetle-killed conifers	
Evidence of recent fire (<5 years old, still very apparent on vegetation, little regrowth)	
Other:	

3.2 Vegetation Condition Metrics

Vegetation condition is at the heart of the EIA method. Ecological and biotic condition-based methods view vegetation (and other biological taxa) as able to synthetically express the range and degree of stress faced by the wetland over many years. Vegetation condition metrics are divided between two key ecological attributes: vegetation composition (largely based on the site species list) and vegetation structure. We strongly encourage users of the EIA method to carry out a vegetation survey, either using Level 3 vegetation plot or a more rapid Level 2.5 plotless survey. The data collected from this exercise can greatly inform conclusions regarding overall wetland health.

Key Ecological Attribute: Vegetation Composition

Typically, these metrics are calculated in office from a species list with cover values. If the EIA is carried out as a purely Level 2 assessment with no species list generated, Metrics 2a-c can be visually estimated, Metric 2d can be excluded, and the weighting of other vegetation composition metrics would be increased. However, we have found that these estimates often overlook non-native species with low cover and even ones with high cover that are not immediately recognized. Spending at least an hour with a trained botanist on a Level 2.5 rapid vegetation survey can add highly valuable information about the site's species composition. If the metrics are calculated based on the species list, notes should still be are recorded in the field on noxious species and overall composition for comparison with any post-field species identification results.

Metric 2a: Percent Cover Native Species

Definition and Background: This metric measures the relative percent cover of native species in the AA. This metric measures the degree to which native plant communities have been altered by human disturbance. Wetlands with high ecological integrity are dominated by native species, while increasing human disturbance can allow non-native species to invade and even dominant wetlands. Non-native species (and aggressive native species) can displace native species, alter hydrology, alter structure, and affect food web dynamics by changing the quantity, type, and accessibility to food. Wetlands dominated by non-native species typically support fewer native animals (Zedler and Kercher 2004).

Metric Level: Level 2 (rapid assessment), Level 2.5 (rapid vegetation survey), or Level 3 (intensive vegetation survey).

Metric Application: Use for all wetlands, regardless of classification.

Measurement Protocol: This metric is calculated by dividing the total cover of native species by the total cover of all species. This is a relative cover measure, meaning that a non-native species with 5% cover of the AA could only represent 2% relative cover if there is extensive overlap of vegetation layer. With overlapping vegetation layer, the total over of all species can be >100%. Alternatively, a non-native species with 5% cover of the AA could represent 20% relative cover in a sparsely vegetated wetland like a playa. If a species list with cover values has been created, this measure can be easily calculated from the field data. Otherwise, make an ocular estimate of the relative percent cover. Unidentified species that are recorded on the plant list are not included in this calculation unless if their nativity is known.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 15.

Table 15. Rating for Percent Cover Native Species

Rank	***Score***	***State***
Excellent (A)	5	>99% of vegetation cover within the AA is comprised of native species.
Good (B)	4	>95–99% of vegetation cover within the AA is comprised of native species.
Fair (C)	3	>80–95% of vegetation cover within the AA is comprised of native species.
Borderline (C-)	2	>50–80% of vegetation cover within the AA is comprised of native species.
Poor (D)	1	≤50% of vegetation cover within the AA is comprised of native species.

Metric References: Metric and thresholds adapted from Rocchio (2006) and Faber-Langendeon et al. (2008; 2013).

Metric 2b: Percent Cover Noxious Weeds

Definition and Background: Noxious weeds are non-native species that have been designated by state agricultural authorities as injurious to agriculture, horticulture, natural habitats, humans, or livestock. They can aggressively take over from native vegetation and should be eradicated or managed when found. For the purpose of the Colorado EIA, we define noxious weeds as all species on the Colorado Department of Agriculture Noxious Weed Lists A, B, and C (Appendix F).

Metric Level: Level 2 (rapid assessment), Level 2.5 (rapid vegetation survey), or Level 3 (intensive vegetation survey).

Metric Application: Use for all wetlands, regardless of classification.

Measurement Protocol: This metric is the absolute cover of noxious weeds encountered in the AA. This metric is *not* relative cover. The cover of noxious weeds is *not* divided by the total cover of all species. If a species list with cover values has been created, this measure can be easily calculated from the field data. Otherwise, make an ocular estimate of the absolute cover of noxious weeds.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 16.

Table 16. Rating for Noxious Weeds

Rank	***Score***	***State***
Excellent (A)	5	Noxious weeds absent.
Good (B)	4	Noxious weeds present, but sporadic (<3% absolute cover).
Fair (C)	3	Noxious weeds common (3–10% cover).
Poor (D)	1	Noxious weed abundant (>10%) cover.

Metric References: Metric and thresholds adapted from Rocchio (2006), Faber-Langendeon et al. (2008; 2013), and Muldavin et al. (2011).

Metric 2c: Percent Cover Aggressive Native Species

Definition and Background: For some wetland types, particularly marshes and other depressional wetlands, aggressive native species can be more problematic than non-native species. For the purpose of this metric, aggressive natives include reed canarygrass (*Phalaroides arundinacea = Phalaris arundinacea*); giant reed (*Phragmites australis*); and cattails (*Typha* spp.), which can dominate sites with excess nutrients. There are both native and non-native ecotypes of reed canarygrass. The non-native, Eurasian ecotype is naturalized in the northern U.S. and can spread aggressively. It is thought that the Colorado populations are likely the Eurasian ecotype, but may also contain the native ecotype. Since the native status is uncertain and the ecotypes are difficult to distinguish in the field, for the purpose of this method, reed canarygrass is considered an aggressive native species. Likewise, there is debate over the origins of some cattail species (*Typha angustifolia* in particular) and the degree to which native and non-native populations have hybridized. For the purpose of this metric, all cattail species are considered aggressive natives.

Metric Level: Level 2 (rapid assessment), Level 2.5 (rapid vegetation survey), or Level 3 (intensive vegetation survey).

Metric Application: Use for all wetlands, regardless of classification.

Measurement Protocol: This metric is the absolute cover of aggressive native species encountered in the AA, specifically reed canarygrass (*Phalaroides arundinacea = Phalaris arundinacea*), giant reed (*Phragmites australis*), and cattails (*Typha* spp.). Additional species could be considered aggressive natives with reasonable explanation. This metric is *not* relative cover. The cover of noxious weeds is *not* divided by the total cover of all species. If a species list with cover values has been created, this measure can be easily calculated from the field data. Otherwise, make an ocular estimate of the absolute cover of noxious weeds.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 17. The cover thresholds for reed canarygrass and giant reed are less than for cattails, due to the more aggressive nature of these two grass species. Assign the rank based on whichever species scores the lowest (i.e., 15% of cattails and 20% reed canarygrass would be rated with a C rank).

Table 17. Rating for Aggressive Natives

Rank	*Score*	*State*
Excellent (A)	5	Aggressive natives present, but sporadic (<10% absolute cover of cattails or <5% absolute cover of reed canarygrass or giant reed).
Good (B)	4	Aggressive natives common (10-25% absolute cover of cattails or 5-10% absolute cover of reed canarygrass or giant reed).
Fair (C)	3	Aggressive natives abundant (>25-50% absolute cover of cattails or 10-25% absolute cover of reed canarygrass or giant reed).
Poor (D)	1	Aggressive natives dominant (>50% absolute cover of cattails or >25% absolute cover of reed canary grass or giant reed grass).

Metric References: Metric and thresholds adapted from Rocchio (2006).

Metric 2d: Mean C

Definition and Background: Every wetland type has a specific range of species that can be expected to dominate under reference or minimally disturbed conditions. Those spices have naturally adapted to the environmental characteristics and disturbance regimes found within the wetland type. However, when disturbance (often human-induced) exceeds the natural range of variation, only those plants with wide tolerance to disturbance will survive. Conservative species (those with high fidelity to habitat integrity) will decline or disappear relative to the degree of disturbance (Wilhelm and Maters 1995). This predictable pattern is the basis behind the Floristic Quality Assessment (FQA; see Section 1.2 for more background). Mean C is the most basic measure of floristic quality that can be calculated using the FQA's coefficient of conservatism values (C-values). Mean C is the average of C-values for all species encountered within a site. It has been shown to be the single strongest measure of wetland condition within the EIA method (Lemly and Rocchio 2009a).

Metric Level: Level 2 (rapid assessment), Level 2.5 (rapid vegetation survey), or Level 3 (intensive vegetation survey).

Metric Application: Use for all wetlands, regardless of classification. Scoring thresholds differ by Ecological System.

Measurement Protocol: This metric is calculated by averaging C-values for all species encountered within the AA. C-values and an FQA Calculator can be found at CNHP's website. If a species list with cover values has been created, this measure can be easily calculated from the field data. Otherwise, this metric should be excluded and the weighting of other vegetation composition metrics should be increased.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 18. Scoring thresholds differ by Ecological System. Thresholds for low elevation wetlands are still being evaluated and may change in the future. Any input on threshold values is appreciated.

Table 18. Rating for Mean C

Rank	***Score***	***States***		
		Riparian Areas and Fens	***Wet Meadows***	***Marshes, Playas and Saline Wetlands***
Excellent (A)	5	Mean C > 6.0	Mean C > 6.0	Mean C > 4.5
Good (B)	4	Mean C > 5.5–6.0	Mean C > 5.5–6.0	Mean C > 4.0–4.5
Fair (C)	3	Mean C >5.0–5.5	Mean C >4.0–5.5	Mean C >3.0–4.0
Border line (C-)	2	Mean C >4.5–5.0	Mean C >3.0–4.0	Mean C >2.0–3.0
Poor (D)	1	Mean C ≤ 4.0	Mean C ≤ 3.0	Mean C ≤ 2.0

Metric References: Metric and thresholds adapted from Rocchio (2006), Lemly and Rocchio (2009a; 2009b), Lemly et al. (2011), Lemly and Gilligan (2012).

Key Ecological Attribute: Vegetation Structure

Vegetation structure metrics evaluate structural components of wetland vegetation, both vertically through the regeneration of native woody species and horizontally through the interspersion of physical and vegetation patches. In addition, structure includes the accumulation and distribution of organic materials, both woody debris and litter. Structure is an important reflection of dynamic ecosystem processes, including hydrologic regime, regeneration, and nutrient cycling. More complex structure allows for many, small-scale habitat niches for both wildlife and plant species.

Metric 2e: Regeneration of Native Woody Species

Definition and Background: Intensive grazing by domestic livestock, heavy browse by native ungulates, and/or alteration of natural flow regimes can reduce to eliminate regeneration of native woody plants (Elmore and Kauffman 1994). Species such as willow (*Salix* spp.) and cottonwood (*Populus* spp.) need episodic flooding to create new bare surfaces suitable for germination of seedlings (Woods 2001). In addition, base flows following flooding need to be high enough to maintain soil water content in these areas at or above 15% through the late summer in order for these seedlings to survive long enough for to establish a deep root system. Lack of reproduction is indicative of altered ecological processes and has adverse impacts to the biotic integrity of the riparian area.

Metric Level: Level 2 (rapid assessment).

Metric Application: Use for all wetlands where woody cover would be expected. This includes most riparian Ecological Systems, though not every occurrence of them. For example, some instances of the Western Great Plains Riparian system naturally lack woody growth due to very limited hydrologic inputs. At the same time, some instances of riparian systems (i.e., some streams in South Park) are now completely devoid of woody vegetation where they likely once had abundant cover of willows. In addition, some Rocky Mountain Subalpine-Montane Fens have woody cover, but it is not expected in all fens. A degree of familiarity with wetland systems across Colorado is needed to recognize where woody species should occur. Looking at aerial photography to understand landscape-scale hydrologic processes can help discern whether woody vegetation should be expected.

Measurement Protocol: During the vegetation survey or while walking through the AA, pay special attention to the regeneration of native woody species. Select the statement on the form that best describes regeneration within the AA. Keep in mind that healthy, functioning woody systems should contain a mix of age classes, indicating natural disturbance regimes. Consider the effects of grazing and other stressors on potential regeneration. This metric is scored a N/A in naturally herbaceous wetlands.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 19.

Table 19. Rating for Regeneration of Native Woody Species

Rank	*Score*	*State*
N/A	--	Woody species are naturally uncommon or absent.
Excellent (A)	5	All age classes of desirable (native) woody riparian species present.
Good (B)	4	Age classes restricted to mature individuals and young sprouts. Middle age groups absent.
Fair (C)	3	Stand comprised of mainly mature species OR mainly evenly aged young sprouts that choke out other vegetation.

Poor (D)	1	Woody species predominantly consist of decadent or dying individuals OR AA has >5% canopy cover of Russian Olive and/or Salt Cedar.

Metric References: Metric and thresholds adapted from Rocchio (2006), Faber-Langendeon et al. (2008; 2013), and Muldavin et al. (2011).

Metric 2f: Coarse and Fine Woody Debris

Definition and Background: Woody debris plays a critical role in riparian systems. There is extensive documentation of the importance of in stream wood for altering channel form and characteristics, enhancing aquatic and riparian habitat, retention of organic matter and nutrients (Wohl 2011). Though much research on woody debris has focused on the Pacific Northwest, research specific to Colorado's Rocky Mountains finds the same relationships hold true, even if the volume and size of woody debris is often smaller than found elsewhere (Richmond and Fausch 1995). Prior to European settlement, Colorado's streams likely had greater amounts of woody debris, but these volumes were reduced through widespread logging and trapping of beaver.

Metric Level: Level 2 (rapid assessment).

Metric Application: Use for all wetlands where woody debris would be expected. This includes most riparian Ecological Systems, though not every occurrence of them. For example, some instances of the Western Great Plains Riparian system naturally lack woody growth, and therefore woody debris, due to very limited hydrologic inputs. Low gradient systems in open areas and systems with few natural trees either within or surrounding will naturally have less woody debris. However, some woody debris can be found in all systems, even marshes and fens, if there are occasional large trees or tall shrubs. A degree of familiarity with wetland systems across Colorado is needed to recognize where woody debris should occur.

Measurement Protocol: During the vegetation survey or while walking through the AA, pay special attention to the amount of coarse and fine woody debris. Select the statement on the form that best describes the amount of woody debris within the AA. Riverine wetlands that have incised banks, no longer experience flooding, experience overgrazing, or are no longer at a dynamic equilibrium may lack. This metric is scored a N/A in naturally herbaceous wetlands.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 20.

Table 20. Rating for Buffer Width

Rank	***Score***	***State***
N/A	--	There are no obvious inputs of woody debris.
Very Good (AB)	5	AA characterized by moderate amount of coarse and fine woody debris, relative to expected conditions. For riverine wetlands, debris is sufficient to trap sediment, but does not inhibit stream flow. For non-riverine wetlands, woody debris provides structural complexity, but does not overwhelm the site.
Fair (C)	3	AA characterized by small amounts of woody debris OR debris is somewhat excessive. For riverine wetlands, lack of debris may affect stream temperatures and reduce available habitat.

Poor (D)	1	AA lacks woody debris, even though inputs are available.

Metric References: Metric and thresholds adapted from Faber-Langendeon et al. (2008) with input from the literature.

Metric 2g: Herbaceous / Deciduous Litter Accumulation

Definition and Background: The accumulation of organic material and an intact litter layer are integral to a variety of wetland functions, such as surface water storage, percolation and recharge, nutrient cycling, and support of wetland plants. Intact litter layers provide areas for primary production and decomposition that are important to maintaining functioning food chains. They nurture fungi essential to the growth of rooted wetland plants. They support soil microbes and other detritivores that comprise the base of the food web in many wetlands. The abundance of organic debris and coarse litter on the substrate surface can significantly influence overall species diversity and food web structure. Fallen debris serves as cover for macroinvertebrates, amphibians, rodents, and even small birds. Litter is the precursor to detritus, which is a dominant source of energy for most wetland ecosystems.

Metric Level: Level 2 (rapid assessment).

Metric Application: Use for all wetlands, regardless of classification.

Measurement Protocol: During the vegetation survey or while walking through the AA, note the quantity and distribution of litter compared with a baseline that may be expected in the landscape. Playas are typically low in litter; densely vegetated wetlands can be high in litter. Overgrazing or woody vegetation removal can reduce and compact litter and aggressive plant colonization or artificially reduced water levels can result in excessive litter. Excessive litter can choke out new growth and inhibit animal movement. Select the statement on the form that best describes the litter. Litter is often detached from the live plant, but dead plant material at the base of plants that was growth from the prior year or before is also considered litter. Be sure the assessment of litter is not based on seasonality (i.e., when a wetland is surveyed early in the year, the prior years' desiccated vegetation can appear more dense than later in the season because most new growth has yet to occur).

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 21.

Table 21. Rating for Buffer Width.

Rank	*Score*	*State*
Very Good (AB)	5	AA characterized by moderate amount of herbaceous and/or deciduous leaf litter. New growth is more prevalent than previous years'. Litter and duff layers in pools and topographic lows are thin. Organic matter is neither lacking nor excessive.
Fair (C)	3	AA characterized by small amounts of litter with little plant recruitment OR litter is somewhat excessive.
Poor (D)	1	AA lacks litter OR litter is extensive and limiting new growth.

Metric References: Metric and thresholds adapted from Rocchio (2006) and Faber-Langendeon et al. (2008).

Metric 2h: Horizontal Interspersion / Complexity

Definition and Background: Ecological diversity of a site is often correlated with the complexity of abiotic and biotic patches. Increased complexity leads to increased habitat niches and can enhance ecological processes.

Metric Level: Level 2 (rapid assessment) or Level 3 (intensive vegetation survey).

Metric Application: Use for all wetlands, regardless of classification. Different wetland systems have differing ranges of expected patch types. Some systems are naturally more complex (e.g., riparian systems) than others (e.g., wet meadows and some fens), though the benefit of complexity are universal. Therefore, we are evaluating whether this metric should be weighted less for some systems than for others.

Measurement Protocol: Using observations gathered while walking the AA and examining aerial photography, create a sketch of both vegetation zones and physical patch types within the AA. These should be documented in the site sketch on Page 3 of the field form. Major vegetation zones should also be listed on Page 2 of the field form for descriptive purposes, following rules for defining vegetation zones in Section 2.3 of this manual. Along with vegetation zones, include physical patch types when evaluating interspersion. Table 22 provides a list of potential physical patch types to note. On the field form, refer to interspersion diagrams (Figure 19) and circle the letter that best describes the horizontal interspersion within the AA either for the riverine (linear) or non-riverine (oval) diagram.

Table 22. Descriptions of physical patch types potentially found within the AA.

Patch Type	Description
Open water - river / stream	Areas of flowing water associated with a sizeable channel.
Open water - tributary / secondary channels	Areas of flowing water entering the main channel from a secondary source.
Open water – swales on floodplain or along shoreline	Swales are broad, elongated, vegetated, shallow depressions that can sometimes help to convey flood flow to and from vegetated floodplains. They lack obvious banks, regularly spaced deeps and shallows, or other characteristics of channels. Swales can entrap water after flood flows recede. They can act as localized recharge zones and they can sometimes receive emergent groundwater.
Open water - oxbow / backwater channels	Areas that hold stagnant or slow moving water from that has been partially or completely disassociated from the primary river channel.
Open water - rivulets / streamlet	Areas of flowing water associated with a small, diffuse channel. Often occurring near the outlet of a wet meadow or fen or at the very headwaters of a stream.
Open water - pond or lake	Medium to large natural water body.
Open water - pools	Areas that hold stagnant or slow moving water from groundwater discharge but are not associated with a defined channel.
Open water - beaver pond	Areas that hold stagnant or slow moving water behind a beaver dam.
Active beaver dams	Debris damming a stream, clearly constructed by beaver (note gnawed ends of branches).
Beaver canals	Canals cut through emergent vegetation by beaver.
Debris jams / woody debris in channel	Aggregated woody debris in stream channel deposited by high flows.
Pool / riffle complex	Deep, slow-moving pools alternating with shallow, fast-moving riffles along the relatively straight course of a stream or river.
Point bars	A low ridge of sediment (sand or gravel) formed on the inner bank of a meandering stream.

Patch Type	Description
Interfluves on floodplain	The area between two adjacent streams or stream channels flowing in the same general direction.
Bank slumps or undercut banks in channel or along shoreline	A bank slope is the portion of a stream or other wetland bank that has broken free from the rest of the bank but has not eroded away. Undercuts are areas along the bank or shoreline of a wetland that have been excavated by waves or flowing water.
Adjacent or onsite seeps/springs	Localized point of emerging groundwater, often on or at the base of a sloping hillside.
Animal mounds or burrows	Many vertebrates make mounds or holes as a consequence of their forage, denning, predation, or other behaviors. The resulting disturbance helps to redistribute soil nutrients and influences plant species composition and abundance.
Mudflats	An accumulation of mud of the edge of shallow waters, such as a lake or pond. Often intermittently flooded and exposed.
Salt flats / alkali flats	Dry open areas of fine grained sediment and accumulated salts. Often wet in the winter months or with heavy precipitation.
Hummock / tussock	In fens, a mound composed of organic material (peat) either created by *Sphagnum,* other moss, or formed by sedges and grasses that have a tussock growth habit as they raise themselves on a pedestal of persistent rhizomes and roots.
Water tracks / hollows	In fens, a depression found between hummocks or mounds which remains permanently saturated or is inundated with slow moving surface water.
Floating mat	Mats of peat held together by roots and rhizomes of sedges. Floating mats are found along the edges of ponds and lakes and are slowing encroaching into open water. The mats are underlain by water and/or very loose peat.
Marl/Limonite beds	Marl is a calcium carbonate precipitate often found in calcareous fens. Limonite forms in iron fens when iron precipitates from the groundwater incorporating organic matter.

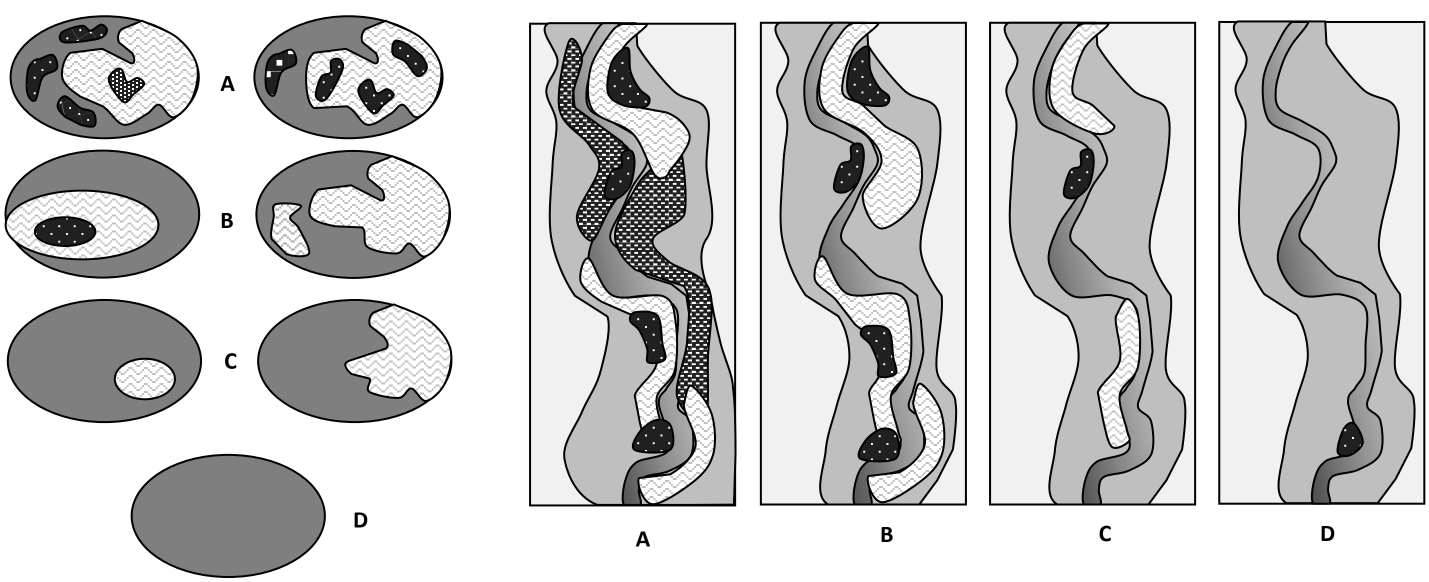


Figure 19. Potential states of Horizontal Interspersion.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 23.

Table 23. Rating for Horizontal Interspersion.

Rank	*Score*	*State*
Excellent (A)	5	High degree of horizontal interspersion: AA characterized by a very complex array of nested or interspersed zones with no single dominant zone.
Good (B)	4	Moderate degree of horizontal interspersion: AA characterized by a moderate array of nested or interspersed zones with no single dominant zone.
Fair (C)	3	Low degree of horizontal interspersion: AA characterized by a simple array of nested or interspersed zones. One zone may dominate others.
Poor (D)	1	No horizontal interspersion: AA characterized by one dominant zone.

Metric References: Metric and thresholds adapted from Rocchio (2006), Collins et al (2008; 2013), Faber-Langendeon et al. (2008; 2012), and Muldavin et al. (2011).

Vegetation Stressors

Using the table on the field form (Table 24), estimate the scope of each vegetation stressor within the AA. Some of these stressors may have already been rated as occurring within the landscape (500 m envelope), but the stressors on this list should be occurring directly within the AA. Stressors can overlap and do not need to total 100% (e.g., light grazing and moderate recreation can both be counted in the same portion of the envelope). Scope rating: 1 = 1–10%, 2 = >10–25%, 3 = >25–50%, 4 = >50–75%, 5 = >75%.

Table 24. Vegetation stressors

Vegetation stressor categories	*Scope*
Unpaved Roads (e.g., driveway, tractor trail, 4-wheel drive roads)	
Vegetation conversion (chaining, cabling, rotochopping, clearcut)	
Logging or tree removal with 50-75% of trees >50 cm dbh removed	
Selective logging or tree removal with <50% of trees >50 cm dbh removed	
Heavy grazing/browse by livestock or native ungulates	
Moderate grazing/browse by livestock or native ungulates	
Light grazing/browse by livestock or native ungulates	
Intense recreation or human visitation (ATV use / camping / popular fishing spot, etc.)	
Moderate recreation or human visitation (high-use trail)	
Light recreation or human visitation (low-use trail)	
Recent old fields and other fallow lands dominated by *non-native* species (weeds or hay)	
Haying of *native* grassland (*not* dominated by non-native hay grasses)	
Beetle-killed conifers	
Evidence of recent fire (<5 years old)	
Other:	

3.3 Hydrologic Condition Metrics

Hydrology is the key driver and defining attribute for all wetlands. Without water, there would be no wetland. The EIA method assesses the condition of a wetland's hydrology through three inter-related metrics: water source, hydroperiod (the timing and duration of inundation or saturation), and hydrologic connectivity (the ability of water to move naturally through and beyond the wetland). Because the metrics are interconnected, where when one metric rates poorly, it is likely that others will too. However, this is not always the case, particularly in managed situations where some natural attributes of hydrology can be mimicked while others cannot. Wetland size and distance from hydrology stressors can also buffer the effects of alterations on hydrology. Examining the size and influence of hydrology stressors is also helpful. To fully understand stressors, it is necessary to look significantly bound the AA itself, particularly for riverine features that have been impacted by diversion, withdrawals and additions far upstream.

Key Ecological Attribute: Hydrology

Metric 3a: Water Source

Definition and Background: Water sources encompass the *forms* or *places* of *direct inputs of water* to the AA. Inputs of water, especially during the growing season, are important because they strongly influence structure and composition of wetland plant and animal communities. This metric compares the proportion of water that enters the wetland from natural vs. artificial sources. Natural water sources include precipitation, groundwater discharge, and flooding of the AA due to naturally high flows, seasonal runoff, etc. Examples of unnatural sources include storm drains that empty directly into the AA; pipes directly controlling water inputs (even if for wildlife habitat purposes); urban or agricultural runoff; and irrigated sources via direct irrigation application and sub-irrigated water from ditch seepage. Sub-irrigation water sources can appear natural (and some land managers view them as naturalized), but they are not considered natural in the EIA method because if the pipe or ditch was turned off, the source would be depleted. It is important to understand potential water sources in different topographic locations and wetland types. Is the wetland in a natural geomorphic floodplain where it could be tied into alluvial aquifer? Or is the wetland in an otherwise dry landscape position, but downslope from one or more ditches that cut across the slope. Plant and soil indicators of water source permanence and consistency are useful to consider. For instance, the presence of peat (>16 in organic soil) does confirm a natural groundwater source (at least in part), because the rate of peat accumulation (~8 in/1,000 yrs: Chimner and Cooper XXXX) is slow enough that true peat could not have formed since European settlement. It can be tempting to link this metric to concerns about water quality, but that is not the focus of this metric. The metric is solely focused on the natural vs. artificial sources and pathways of water delivery.

Metric Level: Level 2 (rapid assessment) with some Level 1 (remote sensing) background information.

Metric Application: Use for all wetlands, regardless of classification. Metric rating includes variants to consider based on HGM class or Ecological System.

Measurement Protocol: Review the aerial photo and topographic map for potential sources. It is important to look at the larger landscape, not just the immediate surroundings. Look for direct channels or saturated zones indicating flow paths. Then walk the AA and buffer to confirm the dominant source of water. Use the checklist on the field form (Table 25) to identify all major water sources influencing the AA and designate the dominant source with a star. Mark all inlets on the aerial photo and those within the AA on the site sketch. If there is an indication that inflow during the growing season is controlled by artificial water sources, explain in comments. Then select the statement on the form that best describes the water sources feeding the AA during the growing season.

In riverine systems, inputs and controls to the water source are examined up to ~2 km upstream from AA, but with greater emphasis on the most immediate water sources, and decreasing emphasis with distance from AA. In non-riverine systems, inputs are generally examined in closer proximity to the site. New development such as roads or oil and gas wells that occurred after the aerial photography was taken may disconnect a former flow path from reaching the wetland, in effect altering or removing the water source. This information should be verified in office with GIS, so comments about visible alterations in the field that are not on shown the aerial photo are particularly useful.

Table 25. Potential water source checklist. Natural sources are on the left; non-natural sources are on the right.

Potential Water Sources			
_____	Overbank flooding	_____	Irrigation via direct application
_____	Alluvial aquifer	_____	Irrigation via seepage
_____	Groundwater discharge	_____	Irrigation via tail water run-off
_____	Natural surface flow	_____	Urban run-off / culverts
_____	Precipitation	_____	Pipes (directly feeding wetland)
_____	Snowmelt	_____	Other:

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 26.

Table 26. Rating for Water Source.

Rank	***Score***	***State***
Excellent (A)	5	Water sources are precipitation, groundwater, natural runoff, or natural flow from an adjacent freshwater body. The system may naturally lack water at times,even in the growing season (e.g. playas). There is no indication of direct artificial water sources, either point sources or non-point sources. Land use in the local watershed is primarily open space or low density, passive use with little irrigation.
Good (B)	4	Water sources are mostly natural, but also include occasional or small amounts of inflow from anthropogenic sources. Indications of anthropogenic sources include developed land or irrigated agriculture that comprises < 20% of the immediate drainage basin, the presence of a few small storm drains or scattered homes with septic system. No large point sources control the overall hydrology.
Fair (C)	3	Water sources are moderately impacted by anthropogenic sources, but are still a mix of natural and non-natural sources. Indications of moderate contribution from anthropogenic sources include developed land or irrigated agriculture that comprises ~20–60% of the immediate drainage basin or the presence of a many small storm drains or a few large ones. The key factor to consider is whether the wetland is located in a landscape position supported wetland before development and whether the wetland is still connected to its natural water source (e.g., modified ponds on a floodplain that are still connected to alluvial aquifers, natural stream channels that now receive substantial irrigation return flows).

Borderline (C-)	2	Water sources are primarily from anthropogenic sources (e.g., urban runoff, direct irrigation, pumped water, artificially impounded water, or another artificial hydrology). Indications of substantial artificial hydrology include developed or irrigated agricultural land that comprises > 60% of the immediate drainage basin of the AA, or the presence of major drainage point source discharges that obviously control the hydrology of the AA. The key factor to consider is whether the wetland is located in a landscape position that likely never supported a wetland prior to human development. The reason the wetland exists is because of direct irrigation, irrigation seepage, irrigation return flows, urban storm water runoff, or direct pumping.
Poor (D)	1	Natural sources have been **eliminated** based on the following indicators: impoundment of all wet season inflows, diversions of all dry-season inflows, predominance of xeric vegetation, etc. The wetland is in steady decline and may not be a wetland in the near future.

Metric References: Metric and thresholds adapted from Collins et al (2008; 2013) and Faber-Langendoen et al. (2008; 2012).

Metric 3b: Hydroperiod

Definition and Background: This metric assesses the characteristic frequency, timing, extent, and duration of inundation or saturation of a wetland during a typical year, compared to an unaltered state. Depressional, lacustrine, and riverine wetlands may have daily variations in water height that are governed by diurnal increases in evapotranspiration, and seasonal cycles that are governed by wet season rainfall and runoff. Slope wetlands that depend on groundwater may have relatively slight seasonal variations in hydroperiod.

Regardless of wetland type, alterations to the water source can result in changes in to the hydroperiod, such as raising or lowering water levels or altering flow rates and timing. Alterations to the hydroperiod are best considered in light of the potential hydrologic modifications impacting the site and its contributing watershed (Table 29). Some alterations reduce the amount, frequency and timing of water on site (e.g., upstream dams and diversions, onsite ditches moving water out of the wetland, groundwater wells that can lower local groundwater tables), while other alterations actually contribute additional water to the wetland, either by adding greater volume of water to the system (trans-basin diversions or other diversions that add water) or by impounding water and altering the timing of drawdown. Pits in playa wetlands, berms to form stock ponds, or impoundments caused by road grades or inadequate culverts are examples of alterations that alter the timing of drawdown. For fens in the subalpine, even small scale ditching can dramatically change the hydroperiod and dry peat bodies, leading to decomposition and loss of plant diversity.

Hydroperiod can be closely connected to water source. In most cases, the water source rating can be viewed as limiting the hydroperiod rating. If the water source is either predominantly artificial or essentially eliminated, the hydroperiod may score a correspondingly low score. However, the two are not always rated the same. Some site may have completely natural water sources (e.g., riparian shrublands along mountain streams), but their hydroperiod may be significantly impacted by dams and diversions immediately upstream. On the other hand, some wetlands with entirely managed water sources may still mimic a natural hydroperiod, or at least approximate natural seasonality. For entirely artificial wetlands, consider the management purpose of the wetland and whether the hydroperiod mimics a natural analogue, such as a natural floodplain depression or a natural seeping slope. Best professional judgment will be needed to rate this metric for artificially controlled wetlands. Good notes on the rationale for metric rating will be essential in these cases.

Metric Level: Level 2 (rapid assessment) with some Level 1 (remote sensing) background information.

Metric Application: Use for all wetlands, regardless of classification. Metric rating includes variants to consider based on HGM class.

Measurement Protocol: Review aerial photography and topographic maps to identify hydrologic stressors and modifications. Remember to look upstream of the AA in riverine systems, as the largest hydrologic alterations may be well outside the AA. This may involve using large-scale maps, such as an atlas or gazetteer, while in the field. If it is possible to obtain and reference GIS layers of dams, local diversions, trans-basin diversions, and groundwater wells, they can help inform the degree of alteration. Compare the GIS-based information with observed effects of hydroperiod alterations in-field. If nearby upstream ditches are large, they likely have a gate that impacts the natural hydroperiod. New development such as roads or oil and gas wells that occurred after the aerial photography was taken may divert water and slow or increase flows, altering the hydroperiod. These recent changes should be noted on the field form for later reference. Once all available information is gathered, select the statement that best describes the alteration to the hydroperiod during the growing season.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 27. Metric ratings at the low end of the spectrum are still under review.

Table 27. Rating for Hydroperiod.

Rank	***Score***	***State***
Excellent (A)	5	Hydroperiod is characterized by natural patterns of filling or inundation and drying or drawdowns. There are no major hydrologic stressors that impact the natural hydroperiod.
Good (B)	4	Hydroperiod filling or inundation patterns deviate slightly from natural conditions due to presence of stressors such as: small ditches or diversions; berms or roads at/near grade; minor pugging by livestock; or minor flow additions. Outlets may be slightly constricted. Playas are not significantly impacted pitted or dissected. *If wetland is artificially controlled,* the management regime closely mimics a natural analogue (it is very unusual for a purely artificial wetland to be rated in this category).
Fair (C)	3	Hydroperiod filling or inundation and drying patterns deviate moderately from natural conditions due to presence of stressors such as: ditches or diversions 1–3 ft. deep; two lane roads; culverts adequate for base stream flow but not flood flow; moderate pugging by livestock that could channelize or divert water; shallow pits within playas; or moderate flow additions. Outlets may be moderately constricted, but flow is still possible. *If wetland is artificially controlled,* the management regime approaches a natural analogue. Site may be passively managed, meaning that the hydroperiod is still connected to and influenced by natural high flows timed with seasonal water levels.
Borderline (C-)	2	Hydroperiod filling or inundation and drawdown of the AA deviate substantially from natural conditions from high intensity alterations such as: a 4-lane highway; large dikes impounding water; diversions > 3ft. deep that withdraw a significant portion of flow, deep pits in playas; large amounts of fill; significant artificial groundwater pumping; or heavy flow additions. Outlets may be significantly constricted, blocking most flow. *If wetland is artificially controlled,* the site is actively managed and not connected to any natural season fluctuations, but the hydroperiod supports natural functioning of the wetland.
Poor (D)	1	Hydroperiod is dramatically different from natural. Upstream diversions severely stress the wetland. Riverine wetlands may run dry during critical times. *If wetland is artificially controlled,* hydroperiod does not mimic natural seasonality. Site is actively managed for filling or drawing down without regard for natural wetland functioning.

Metric References: Metric and thresholds adapted from Rocchio (2006), Collins et al. (2008; 2013) and Faber-Langendoen et al. (2008; 2012).

Metric 3c: Hydrologic Connectivity

Definition and Background: This metric assesses the ability of water to flow across and out of the wetland laterally, or to accommodate rising flood waters without persistent changes in water level that can result in stress to wetland plants and animals. Assessment of this metric is based solely on field indicators and is different by HGM class. For riverine wetlands, an important aspect of hydrologic connectivity is the degree of channel entrenchment. Channel entrenchment itself is an optional riverine metric (see page XX). If it is possible to measure channel entrenchment, it will inform this rating. If not, it can be estimated from visual clues.

Metric Level: Level 2 (rapid assessment).

Metric Application: Use for all wetlands, regardless of classification. Metric rating includes variants to consider based on HGM class.

Measurement Protocol: Search the AA for hard obstacles that impound and constrain flood waters, such as retaining walls, road grades, or entrenched banks. Use best professional judgment to determine the overall condition of the hydrologic connectivity and *s*elect the statement that best describes the AA.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 28.

Table 28. Rating for Hydrologic Connectivity.

Rank	*Score*	*State*
Excellent (A)	5	Rising water has unrestricted access to adjacent areas without levees or other obstructions to the lateral movement of flood waters. Channel, if present, is not entrenched and is still connected to the floodplain (see entrenchment ratio in optional riverine metrics).
Good (B)	4	Unnatural features such as levees or road grades limit the amount of adjacent transition zone or the lateral movement of floodwaters, relative to what is expected for the setting, but limitations exist for <50% of the AA boundary. Restrictions may be intermittent along the margins of the AA, or they may occur only along one bank or shore. Channel, if present, is somewhat entrenched. If playa, surrounding vegetation does not interrupt surface flow.
Fair (C)	3	The amount of adjacent transition zone or the lateral movement of flood waters to and from the AA is limited, relative to what is expected for the setting, by unnatural features for 50–90% of the boundary of the AA. Features may include levees or road grades. Flood flows may exceed the obstructions, but drainage out of the AA is probably obstructed. Channel, if present, may be moderately entrenched and disconnected from the floodplain except in large floods. If playa, surrounding vegetation may interrupt surface flow.
Poor (D)	1	The amount of adjacent transition zone or the lateral movement of flood waters is limited, relative to what is expected for the setting, by unnatural features for >90% of the boundary of the AA. Channel, if present, is severely entrenched and entirely disconnected from the floodplain. If playa, surrounding vegetation may dramatically restrict surface flow.

Metric References: Metric and thresholds adapted from Rocchio (2006), Collins et al (2008; 2013), Faber-Langendeon et al. (2008; 2012), and Muldavin et al. (2011).

Hydrology Stressors

Using the table on the field form (Table 29), mark the presence of each hydrology stressor either within the AA, upstream of the AA, or downstream of the AA. For stressors within the AA, use the scope rating to indicate the amount of the AA that is affected: 1 = 1–10%, 2 = >10–25%, 3 = >25–50%, 4 = >50–75%, 5 = >75%. For stressors outside the AA, mark the stressors with a 'X' to acknowledge their presence.

Table 29. Hydrology stressors

Hydrology stressor categories	*Within AA*	*Upstream / Upslope*	*Downstream / Downslope*
Dam / reservoir			
Impoundment / stock pond			
Spring box diverting water from wetland			
Pumps, diversions, ditches that move water *out of* the wetland			
Pumps, diversions, ditches that move water *into* the wetland			
Berms, dikes, levees that hold water in the wetland			
Deeply dug pits for holding water			
Weir or drop structure that impounds water and controls energy of flow			
Observed or potential agricultural runoff			
Observed or potential urban runoff			
Flow obstructions into or out of wetland (roads without culverts)			
Dredged inlet or outlet channel			
Engineered inlet or outlet channel (e.g., riprap)			
Other:			

3.4 Physiochemical Condition Metrics

Physiochemical metrics assess water quality within the wetland, both in terms of turbidity and pollutants and in terms of algal growth, along with the integrity of the soil or predominant substrate.

Key Ecological Attribute: Water Quality

Improving water quality by filtering nutrients, sediment and other pollutants is one of the most valuable functions wetlands provide. Wetlands naturally have varying water quality states, including a range of natural pH and salinity. Their water quality can also differ dramatically over the course of the growing season as runoff increases or decreases and water levels rise and fall. The EIA method evaluates water quality with two metrics: surface water turbidity/pollutants and algal growth. To fully understand the water quality of any given site, more intensive data collection would be needed. CNHP is actively seeking funding opportunities to expand our understanding of the natural range of variation for water quality measurements. We hope that in the coming years, these metrics will become more precise and quantitative.

Metric 4a: Surface Water Turbidity/Pollutants

Definition and Background: Water quality is difficult to assess visually in the field. However, sometimes there are obviously water quality problems that can be documented, such as oil sheens or excess nutrient runoff. Seasonality and weather can play into the rating of this metric. Riverine wetland can be turbid if flood waters are high. Playas can also be naturally turbid when filled, due to their fine sediments. Other depressional wetlands should not be turbid, although recent weather events can affect turbidity. Even if the turbidity appears natural, it is still good to note its presence in the wetland to help document wetland types that tend to be turbid when the wetland is in good condition. Water color can be an indicator of pollutant issues such as a blue-green tint from cyanobacteria bloom or a red-orange tint from mine tailings. Knowledge of surrounding land uses can help inform if water discoloration is due to pollutant issues or natural occurrences such as tannins from decomposition or iron oxide in the soil substrate.

Metric Level: Level 2 (rapid assessment).

Metric Application: Use for all wetlands with standing water at the time of the survey.

Measurement Protocol: Use all available data sources—aerial photos, topographic maps, and other GIS data sources, as well as observations in the field—to record any potential impacts water quality in the physiochemical stressors table (Table 33). Keeping these stressors in mind, select the statement on the form that best describes the turbidity or pollutant load of surface waters within the AA. If the water looks turbid, but there are no obvious sources of pollutants, the wetland should still be rated with a 'B' to acknowledge the current conditions during sampling. Ratings of 'C' or 'D', however, should be reserved for sites with obvious sources of pollutants (excessive livestock dung, adjacent agricultural fields, urban runoff, feedlots, surface mining, etc.).

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 33.

Table 30. Rating for Surface Water Turbidity/Pollutants.

Rank	*Score*	*State*
N/A	--	No open water in AA
Excellent (A)	5	No visual evidence of degraded water quality. No visual evidence of turbidity or other pollutants.

Good (B)	4	Some negative water quality indicators are present, but limited to small and localized areas within the wetland. Water is slightly cloudy, but there is no obvious source of sedimentation or other pollutants.
Fair (C)	3	Water is cloudy or has unnatural oil sheen, but the bottom is still visible. Sources of water quality degradation are apparent (identify in comments below). *Note: If the sheen breaks apart when you run your finger through it, it is a natural bacterial process and not water pollution.*
Poor (D)	1	Water is milky and/or muddy or has unnatural oil sheen. The bottom is difficult to see. There are obvious sources of water quality degradation (identify in comments below). *Note: If the sheen breaks apart when you run your finger through it, it is a natural bacterial process and not water pollution.*

Metric References: Metric and thresholds adapted from Rocchio (2006) and Faber-Langendeon et al. (2008).

Metric 4b: Algal Growth

Definition and Background: Algae can be problematic in sites with excessive nutrient loading. Thick algal mats can block light from reaching the water profiles and can also reduce dissolved oxygen levels. However, some amount of algae can also be entirely natural. Like the surface water turbidity/pollutant metrics, it is best to rate this metric in terms of how you encounter the wetland during the survey, but to also keep in mind potential sources of nutrient enrichment in the surrounding landscape.

Metric Level: Level 2 (rapid assessment).

Metric Application: Use for all wetlands with standing water at the time of the survey *or* sites where water has been drawn down recently, but algae is still evident.

Measurement Protocol: Select the statement on the form that best describes algal growth within current or recent surface water in the AA. Algal growth often happens naturally with pond dry-down. Use best professional judgment to assess if the algal growth is a problem, as it will often be present in these dynamic ecosystems. Small patches of algae that appear natural should still be rated with a 'B' to acknowledge the current conditions during sampling. Ratings of 'C' or 'D', however, should be reserved for sites with more extensive algal growth that is likely related to water quality concerns.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 31.

Table 31. Rating for Algal Gowth.

Rank	***Score***	***State***
N/A	--	No open water in AA or evidence of open water.
Excellent (A)	5	Water is clear with minimal algal growth.
Good (B)	4	Algal growth is limited to small and localized areas of the wetland. Water may have a greenish tint or cloudiness.
Fair (C)	3	Algal growth occurs in moderate to large patches throughout the AA. Water may have a moderate greenish tint or sheen. Sources of water quality degradation are apparent (identify in comments below).

Poor (D)	1	Algal mats are extensive, blocking light to the bottom. Water may have a strong greenish tint and the bottom is difficult to see. There are obvious sources of water quality degradation (identify in comments below).

Metric References: Metric and thresholds adapted from Rocchio (2006) and Faber-Langendeon et al. (2008; 2012).

Key Ecological Attribute: Substrate / Soils

Soils play a key role in overall ecological integrity. Many of the biogeochemical processes integral to wetland functioning take place within the soil. Disturbance to the soil surface can disrupt these processes, hindering plant growth, slowing or increasing decomposition rates, and altering hydrologic flow paths.

Metric 4c: Substrate / Soil Disturbance

Definition and Background: This metric assess the degree to which human impacts have disturbed the natural soil or substrate. Common sources of disturbance include: fill or sediment dumping; human recreation, either foot traffic of motorized vehicles; and cows that can cause unnatural hummocks (pugging), which in turn can alter the wetland hydrology and disrupt soil process like organic accumulation. A lack of soil horizons can indicate the substrate was filled or tilled when it is not otherwise obvious. It is important to rate this metric according to wetland type. For example, bare patches may be a sign of unnatural disturbance in many wetlands. Playas, however, should have bare ground with compact soils. In playas, extra sediment on top of the naturally compacted soil can be an indicator of undesirable disturbance. Because it can be difficult to assess the degree of compaction in playas as they fill and close with water, best professional judgment will be needed.

Metric Level: Level 2 (rapid assessment).

Metric Application: Use for all wetlands, regardless of classification. Metric rating includes variants to consider based on HGM class.

Measurement Protocol: Select the statement on the form that best describes the substrate or soil disturbance within the AA, in the context of the wetland ecosystem.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 32.

Table 32. Rating for Buffer Width

Rank	*Score*	*State*
Excellent (A)	5	No soil disturbance within AA. Little bare soil OR bare soil areas are limited to naturally caused disturbances such as flood deposition or game trails OR soil is naturally bare (e.g., playas). No pugging, soil compaction, or sedimentation.
Good (B)	4	Minimal soil disturbance within AA. Some amount of bare soil, pugging, compaction, or sedimentation present due to human causes, but the extent and impact are minimal. The depth of disturbance is limited to only a few inches and does not show evidence of altering hydrology. Any disturbance is likely to recover within a few years after the disturbance is removed.

Fair (C)	3	Moderate soil disturbance within AA. Bare soil areas due to human causes are common and will be slow to recover. There may be pugging due to livestock resulting in several inches of soil disturbance. ORVs or other machinery may have left some shallow ruts. Sedimentation may be filling the wetland. Damage is obvious, but not excessive. The site could recover to potential with the removal of degrading human influences and moderate recovery times.
Poor (D)	1	Substantial soil disturbance within AA. Bare soil areas substantially degrade the site and have led to altered hydrology or other long-lasting impacts. Deep ruts from ORVs or machinery may be present, or livestock pugging and/or trails are widespread. Sedimentation may have severely impacted the hydrology. The site will not recover without active restoration and/or long recovery times.

Metric References: Metric and thresholds adapted from Rocchio (2006) and Faber-Langendeon et al. (2008; 2012).

Physiochemical Stressors

Using the table on the field form (Table 33), estimate the scope of each physiochemical stressor on the water quality or soil of AA. Stressors can occur within the AA or immediately adjacent to the AA's water source. Stressors can overlap and do not need to total 100% (e.g., soil compaction can occur with trash or refuse). Scope rating: 1 = 1–10%, 2 = >10–25%, 3 = >25–50%, 4 = >50–75%, 5 = >75%.

Table 33. Physiochemical stressors

Physiochemical stressors	*Scope*
Erosion	
Sedimentation	
Current plowing or disking	
Historical plowing or disking (evident by abrupt A horizon boundary at plow depth)	
Substrate removal (excavation)	
Filling or dumping of sediment	
Trash or refuse dumping	
Compaction and soil disturbance by livestock or native ungulates	
Compaction and soil disturbance by human use (trails, ORV use, camping)	
Mining activities, current or historic	
Obvious point source of water pollutants (discharge from waste water plants, factories)	
Agricultural runoff (drain tiles, excess irrigation)	
Direct application of agricultural chemicals	
Discharge or runoff from feedlots	
Obvious excess salinity (dead or stressed plants, salt encrustations)	
Other:	

3.5 Size Metrics

Size metrics evaluate both the relative size of the wetland or AA (relative to presumed historicalsize) and the absolute size. Size itself is not a measure of condition, as many natural, high quality wetlands can be small. However, for conservation interests, size can be a useful metric to compare between wetlands. A larger high quality wetland may have more conservation value than a smaller one, based on the amount of habitat is provides or the level of other ecosystem services it can provide. Size metrics can be included or excluded for over roll-up score, depending on the focus of the assessment.

Key Ecological Attribute: Size

Metric 5a: Relative Size

Definition and Background: This metric is an indication of the degree to which human modification has altered the size of the original wetlands. In the traditional sense, we think of human alteration as limiting wetland size, either through ditching, draining, development, or fill other. Complicating this analysis is the fact that the size of many wetlands in the arid West have actually been increased my water and land management practices, either intentionally or unintentionally. In fact, there are many wetlands along the Front Range and in Colorado's agricultural landscapes that are created solely due to water management.

Metric Level: Level 1 (remote sensing) with Level 2 (rapid assessment) verification.

Metric Application: Use for all wetlands, regardless of classification.

Measurement Protocol: Use all available data sources—aerial photos, topographic maps, and other GIS data sources, as well as observations in the field—to estimate the presumed historical size of the wetland. The definition of historical generally refers to the size of the wetland prior to European settlement. If the wetland has been enlarged or created from management action and is located in an area that would otherwise be upland, this metric can be rated as 'A'. The impacts of those management actions should be reflected elsewhere on the form, if they alter the condition. This metric can be difficult to evaluate. Notes on rationale behind the conclusion are very important.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 34.

Table 34. Rating for Relative Size.

Rank	*Score*	*State*
Excellent (A)	5	Wetland area ≈ onsite abiotic potential; <5% of wetland has been reduced.
Good (B)	4	Wetland area < abiotic potential; 5–25% of wetland has been reduced.
Fair (C)	3	Wetland area < abiotic potential; 25–50% of wetland has been reduced.
Poor (D)	1	Wetland area < abiotic potential; >50% of wetland has been reduced.

Metric References: Metric and thresholds adapted from Rocchio (2006), Faber-Langendeon et al. (2008; 2012), and Muldavin et al. (2011).

Metric 5b: Absolute Size

Definition and Background: This metric measures the absolute size of the wetland. While many high quality wetlands can be naturally small, size can be an important aspect of the overall value of the wetland from a functional and conversation perspective. The diversity of plants or animals may be higher in larger wetlands. Larger wetlands may be more resilient to hydrologic stressors and invasions by exotics, as they essentially buffer their own inner cores. Size should be evaluated in comparison to similar wetland types. Therefore, the ratings are based on Ecological Systems.

Metric Level: Level 1 (remote sensing) with Level 2 (rapid assessment) verification.

Metric Application: Use for all wetlands, regardless of classification.

Measurement Protocol: Use all available data sources—aerial photos, topographic maps, and other GIS data sources, as well as observations in the field—to estimate the absolute size of the wetland. If the assessment is based on a fixed area, absolute size should reflect the entire wetland that they AA is part of. If the wetland occurs in a mosaic of different wetland types, use the rules in the Ecological System key to delineate distinct occurrences of each Ecological System (i.e., a few cattails within a wet meadow is not a separate wetland, but a major expanse of cattails at the far end of a wet meadow may mean a change in system and therefore should not be included in the size calculation). If there is a major change in land use in the wetlands, such that the condition rating of other metrics would be affected, use that as a break in the size as well. This metric will be combined with the others and will be used to assess the size of the wetland in more or less the same condition.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 35.

Table 35. Rating for Absolute Size by Ecological System.

Rank	*Score*	*State*			
		Wet Meadows	*Marshes*	*Fens*	*Playas*
Excellent (A)	5	>30 hectares	>20 hectares	>10 hectares	>5 hectares
Good (B)	4	10–30 hectares	10–20 hectares	2–10 hectares	2–5 hectares
Fair (C)	3	1–10 hectares	1-10 hectares	0.5–2 hectares	0.5–2 hectares
Poor (D)	1	<1 hectare	<1 hectare	<0.5 hectares	<0.5 hectares

Rank	*Score*	*State (must be >10 m throughout the extent)*	
		Riparian Woodlands	*Subalpine Riparian Shrublands*
Excellent (A)	5	>8 linear km	>2.5 linear km
Good (B)	4	5–8 linear km	1.5–2.5 linear km
Fair (C)	3	1.5–5 linear km	0.5–1.5 linear km
Poor (D)	1	<1.5 linear km	<0.5 linear km

Metric References: Metric and thresholds adapted from Rondeau (2001), Rocchio (2006), Faber-Langendeon et al. (2008; 2012), and Muldavin et al. (2011).

3.6 Optional Riverine Hydrology Metrics

There are many specific properties of streams that affect the riverine wetlands they support. Numerous protocols have been developed for assessing stream health that focus on physical properties of streams more than the biotic properties of surrounding wetlands. For riverine wetlands that are adjacent to streams, it can be useful to consider two additional metrics regarding the physical integrity of the stream itself: channel/bank stability and entrenchment ratio. These metrics can be integrated with the hydrology metrics for riverine wetlands.

Metric 6a: Channel/Bank Stability

Definition and Background: Channel stability is assessed as the degree of channel aggradation (net accumulation of sediment on the channel bed such that it is rising over time) or degradation (net loss of sediment from the bed such that it is being lowered over time). This metric can be filled out for AAs in riverine wetlands that include a channel or are adjacent to a channel. The stream does not have to be waded to assess many of the variables in this metric. If the channel is not within or adjacent to the AA, this metric can be left blank.

Every stable riverine channel tends to have a particular form in cross section, profile, and plan view that is in **dynamic equilibrium** with the inputs of water and sediment. If these supplies change enough, the channel will tend to adjust toward a new equilibrium. An increase in the supply of sediment, relative to the supply of water, can cause a channel to aggrade (i.e., the elevation of the channel bed increases), which might cause simple increases in the duration of inundation for existing wetlands, or complex changes in channel location and morphology through braiding, avulsion, burial of wetlands, creation of new wetlands, spray and fan development, etc. An increase in water relative to sediment might cause a channel to incise (i.e., the bed elevation decreases), leading to bank erosion, headward erosion of the channel bed, floodplain abandonment, and dewatering of riparian habitats. For most riverine systems, chronic incision (i.e., bed degradation) is generally regarded as more deleterious than aggradation because it is more likely to cause significant decreases in the extent of riverine wetland and riparian habitats.

Metric Level: Level 2.5 (quantitative measurement of channel properties).

Metric Application: Optional metric for riverine wetlands where the channel is in close proximity to the AA.

Measurement Protocol: There are many well-known field indicators of equilibrium conditions, or deviations from equilibrium, that can be used to assess the existing mode of behavior of a channel and hence the degree to which its hydroperiod can sustain wetland and riparian habitats. To evaluate this metric, visually survey the AA for field indicators of aggradation or degradation given on the form (Table 36). Check “Y” for all those observed and “N” for those not observed.

Metric Rating: Review the indicators checked and determine which statement in Table37 best describes the overall channel/bank stability.

Metric References: Metric and thresholds adapted from Rocchio (2006), Collins et al (2008; 2013), Faber-Langendeon et al. (2008; 2012), and Muldavin et al. (2011).

Table 36. Field indicators of channel equilibrium, aggradation or degradation.

Condition	***Field Indicators***
Indicators of Channel Equilibrium / Natural Dynamism	Y N ☐ ☐ The channel (or multiple channels in braided systems) has a well-defined usual high water line or bankfull stage that is clearly indicated by an obvious floodplain, topographic bench that represents an abrupt change in the cross-sectional profile of the channel throughout *most* of the site. ☐ ☐ The usual high water line or bank full stage corresponds to the lower limit of riparian vascular vegetation. ☐ ☐ Leaf litter, thatch, wrack, and/or mosses exist in most pools. ☐ ☐ The channel contains embedded woody debris of the size and amount consistent with what is available in the riparian area. ☐ ☐ Active undercutting of banks or burial of riparian vegetation is limited to localized areas and not throughout site. ☐ ☐ There is little evidence of recent deposition of cobble or very coarse gravel on the floodplain, although recent sandy deposits may be evident. ☐ ☐ There are no densely vegetated mid-channel bars and/or point bars, indicating flooding at regular intervals. ☐ ☐ The spacing between pools in the channel tends to be 5-7 channel widths, if appropriate. ☐ ☐ The larger bed material supports abundant periphyton.
Indicators of Active Aggradation / Excessive Sediment	☐ ☐ The channel through the site lacks a well-defined usual high water line. ☐ ☐ There is an active floodplain with fresh splays of sediment covering older soils or recent vegetation. ☐ ☐ There are partially buried tree trunks or shrubs. ☐ ☐ Cobbles and/or coarse gravels have recently been deposited on the floodplain. ☐ ☐ There is a lack of in-channel pools, their spacing is greater than 5-7 channel widths, or many pools seem to be filling with sediment. ☐ ☐ There are partially buried, or sediment-choked, culverts. ☐ ☐ Transitional or upland vegetation is encroaching into the channel throughout most of the site. ☐ ☐ The bed material is loose and mostly devoid of periphyton.
Indicators of Active Degradation / Excessive Erosion	☐ ☐ The channel through the site is characterized by deeply undercut banks with exposed living roots of trees or shrubs. ☐ ☐ There are abundant bank slides or slumps, or the banks are uniformly scoured and unvegetated. ☐ ☐ Riparian vegetation declining in stature or vigor, and/or riparian trees and shrubs may be falling into channel. ☐ ☐ Abundant organic debris has accumulated on what seems to be the historical floodplain, indicating that flows no longer reach the floodplain. ☐ ☐ The channel bed appears scoured to bedrock or dense clay. ☐ ☐ The channel bed lacks fine-grained sediment. ☐ ☐ Recently active flow pathways appear to have coalesced into one channel (i.e. a previously braided system is no longer braided). ☐ ☐ There are one or more nick points along the channel, indicating headward erosion of the channel bed.

Table 37. Rating for Channel/Bank Stability.

Rank	*Score*	*State*
Excellent (A)	5	Most of the channel within or near the AA is characterized by naturally dynamic equilibrium conditions, with little evidence of excessive aggradation or degradation. Streambanks typically dominated (>90% cover) by stabilizing plant species, including trees, shrubs, herbs.
Good (B)	4	Most of the channel within or near the AA is characterized by some aggradation or degradation, none of which is severe, and the channel seems to be approaching an equilibrium form. Streambanks may have 70–90% cover of stabilizing plant species, but some bare areas occur.
Fair (C)	3	There is evidence of severe aggradation or degradation of most of the channel within or near the AA or the channel is artificially hardened through less than half of the AA. Streambanks may have 50–70% cover of stabilizing plant species within several bare areas.
Poor (D)	1	The channel is concrete or otherwise artificially hardened through most of the AA. Streambanks have <50% cover of stabilizing plant species.

Metric 6b: Entrenchment Ratio

Definition and Background: Entrenchment is a field measurement calculated as the flood-prone width divided by the bankfull width. Bankfull width is the channel width at the height of bankfull flow. The flood-prone channel width is measured at the elevation of twice the maximum bankfull depth. Entrenchment is a quantitative measure of how deeply the channel has been downcut.

Metric Level: Level 2.5 (quantitative measurement of channel properties).

Metric Application: Optional metric for riverine wetlands where the channel is in close proximity to the AA *and* is wadable.

Measurement Protocol: The process for estimating entrenchment is outlined in Table 38 below and illustrated in Figure 20. Once estimated, use best professional judgment to determine if entrenchment is affecting hydrologic connectivity. Use the calculations as a guide, but sometimes it is clear a channel is entrenched even when the math does not indicate this, and sometimes a channel is not entrenched despite the math. Long term changes to river levels can cause entrenchment. Criteria are different for confined and unconfined streams.

Table 38. Steps for estimating entrenchment ratio.

1. Estimate bankfull width.	This is a critical step requiring experience. If the stream is entrenched, the height of bankfull flow is identified as a scour line, narrow bench, or the top of active point bars well below the top of apparent channel banks. If the stream is not entrenched, bankfull stage can correspond to the elevation of a broader floodplain with indicative riparian vegetation. Estimate or measure the distance between the right and left bankfull contours.
2. Estimate max bankfull depth.	Imagine a line between right and left bankfull contours. Estimate or measure the height of the line above the thalweg (the deepest part of the channel).

3. Estimate flood prone height.	Double the estimate of maximum bankfull depth from Step 2.
4. Estimate flood prone width.	Imagine a level line having a height equal to the flood prone depth from Step 3. Note the location of the new height on the channel bank. Estimate the width of the channel at the flood prone height.
5. Calculate entrenchment.	Divide the flood prone width (Step 4) by the max bankfull width (Step 1).

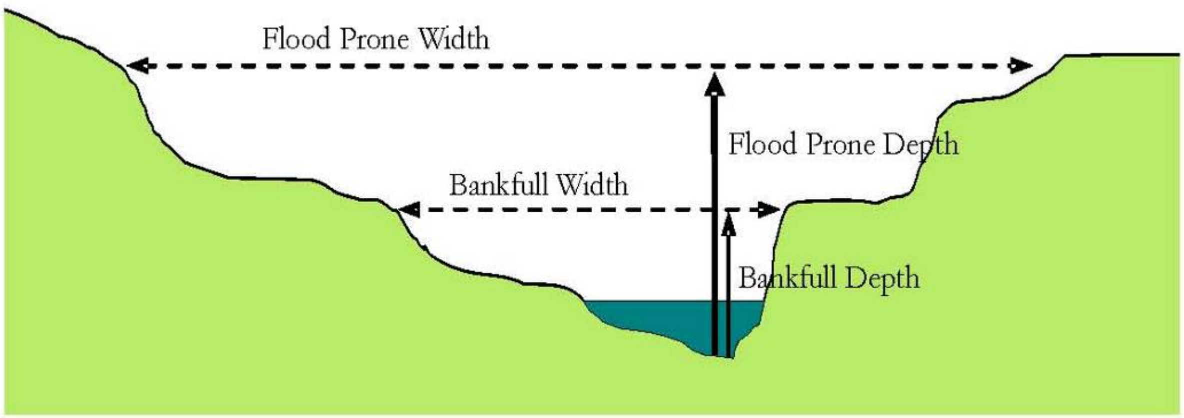


Figure 20. Elements of calculating entrenchment ration. Illustration from Collins *et al.* 2008. California Rapid Assessment Method for Wetlands v 5.0.2

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table XX. Criteria are different for confined and unconfined streams. These thresholds are from Collins et al. (2006; 2013) and are still being tested in Colorado.

Table 39. Rating for Entrenchment Ratio.

Rank	*Score*	*State – Confined Valleys*	*State – Unconfined Valleys*
Excellent (A)	5	Entrenchment ratio >2.0.	Entrenchment ratio >2.2.
Good (B)	4	Entrenchment ratio 1.6–2.0.	Entrenchment ratio 1.9–2.2.
Fair (C)	3	Entrenchment ratio 1.2–1.5.	Entrenchment ratio 1.5–1.8.
Poor (D)	1	Entrenchment ratio <1.2.	Entrenchment ratio <1.5.

Metric References: Metric and thresholds adapted from Rocchio (2006), Collins et al (2008; 2013), Faber-Langendeon et al. (2008; 2012), and Muldavin et al. (2011).

REFERENCES

Bedford, B.L. (1996) The need to define hydrologic equivalence at the landscape scale for freshwater wetland mitigation. *Ecological Applications*, **6**: 57-68.

Brinson, M.M. (1993) A Hydrogeomorphic classification for wetlands. US Army Corps of Engineers Technical Report WRP-DE-4, Washington DC.

Comer, P. *et al.* (2003) Ecological Systems of the United States: a working classification of US terrestrial systems. NatureServe, Arlington, VA.

Collins, J.N. et al. (2008) California rapid assessment method (CRAM) for wetlands. Version 5.0.2. San Francisco Estuary Institute. San Francisco, California. Available online at: http://www.cramwetlands.org/

Cowardin, L. M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States, U. S. Department of the Interior, Fish and Wildlife Services, Office of Biological Services, Washington D.C.

Detenbeck, N.E. et al. (2005) Watershed-based survey designs. *Environmental Monitoring and Assessment*, **103**: 59-81.

Faber-Langendoen, D. et al. (2009) NatureServe Level 2 and Level 3 Ecological Indicator Assessments: Wetlands. NatureServe, Arlington, Virginia.

Faber-Langendoen, D. *et al.* (2008) Ecological performance standards for wetland mitigation: an approach based on Ecological Integrity Assessments. NatureServe, Arlington, Virginia.

Gwin, S. et al. (1999) Evaluating the effects of wetland regulation through hydrogeomorphic classification and landscape profiles. *Wetlands*, **19**: 477-489.

Hauer, F. R., et al. (2002). A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Riverine Floodplains in the Northern Rocky Mountains. ERDC/EL TR-02-21, U.S. Army Engineer Research and Development Center, Vicksburg, MS

Johnson, B.J. (2005) Hydrogeomorphic wetland profiling: an approach to landscape and cumulative impacts analysis. *EPA/620/R-05/001.* US Environmental Protection Agency, Washington DC.

Lemly, J. and L. Gilligan. (2012) North Platte River basin wetland profile and condition assessment. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.

Lemly, J. and J. Rocchio. (2009a) Field testing of the subalpine-montane riparian shrublands Ecological Integrity Assessment (EIA) in the Blue River watershed, Colorado. Unpublished report prepared for U.S. Environmental Protection Agency Region 8 and Colorado Division of Wildlife, Denver, CO. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Lemly, J. and J. Rocchio. (2009b) Vegetation Index of Biotic Integrity (VIBI) for headwater wetlands in the Southern Rocky Mountains. Version 2.0: Calibration of selected VIBI models. Unpublished report prepared for U.S. Environmental Protection Agency Region 8 and Colorado Division of Wildlife, Denver, CO. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Lemly, et al. (2011) Statewide strategies to improve effectiveness in protecting and restoring Colorado's wetland resource. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Mack, J.J. (2004a) Integrated wetland assessment program. Part 4: Vegetation index of biotic integrity (VIBI) and tiered aquatic life uses (TALUs) for Ohio wetlands. *Ohio Technical Report WET/2004-4.* Ohio Environmental Protection Agency, Division of Surface Water, Wetland Ecology Group, Columbus, Ohio.

Mack, J.J. (2004b) Integrated wetland assessment program. Part 9: Field manual for the vegetation index of biotic integrity for wetlands v. 1.3. *Ohio Technical Report WET/2004-9.* Ohio Environmental Protection Agency, Division of Surface Water, Wetland Ecology Group, Columbus, Ohio.

Omernik, J.M. 1987. Ecoregions of the conterminous United States. Map (scale 1:7,500,000). Annals of the Association of American Geographers 77(1):118-125

Peet, R.K. et al. (1998) A flexible, multipurpose method for recording vegetation composition and structure. *Castanea*, **63**: 262–274.

Rocchio, J. (2007a) Floristic Quality Assessment indices for Colorado plant communities. Unpublished report prepared for the Colorado Department of Natural Resources and US EPA Region 8 by the Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.

Rocchio, J. (2007b) Assessing ecological condition of headwater wetlands in the Southern Rocky Mountains using a vegetation index of biotic integrity. (Version 1.0). Unpublished report prepared for the Colorado Department of Natural Resources and US EPA Region 8 by the Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.

Stevens, D.L., Jr. 1997. Variable density grid-based sampling designs for continuous spatial populations. *Environmetrics*, 8:167-95.

Stevens, D.L., Jr. and A.R. Olsen. 1999. Spatially restricted surveys over time for aquatic resources. *Journal of Agricultural, Biological, and Environmental Statistics*, 4:415-428.

Stevens, D.L., Jr. and A.R. Olsen. 2004. Spatially-balanced sampling of natural resources in the presence of frame imperfections. Journal of American Statistical Association 99: 262-278.

Stoddard, J.L., D.P. Larsen, C.P. Hawkins, R.K. Johnson, and R.H. Norris. 2006. Setting Expectation for the Ecological Condition of Streams: The Concept of Reference Condition.

Swetnam, T.W., C.D. Allen, and J.L. Betancourt. 1999. Applied Historical Ecology: Using the Past to Manage for the Future. Ecological Applications 9(4): 1189-1206.

Theobald, D.M. et al. (2007) Using GIS to generate spatially balanced random survey designs for natural resource applications. *Environmental Management*, **40**: 134-146.

USFWS. 2009. A system for mapping riparian areas in the western United States. US Fish and Wildlife Service Division of Habitat and Resource Conservation, Branch of Resource and Mapping Support, Arlington, Virginia.

APPENDICES

APPENDIX A: **Field Key to Wetland and Riparian Ecological Systems of Colorado**

APPENDIX B: **National Wetland Inventory Classification Modified from Cowardin *et al.* 1979**

APPENDIX C: **Field Key to the Hydrogeomorphic (HGM) Classes of Wetlands in the Rocky Mountains**

APPENDIX D: **Soil Texture Flowchart**

APPENDIX E: **Notes on Hydric Soil Indicators for the Mountain West**

APPENDIX F: **Colorado Noxious Weed List**

APPENDIX A: Field Key to Wetland and Riparian Ecological Systems of Colorado

Last Updated February 1, 2013

1b. Wetlands and riparian areas of Colorado's Great Plains, including all areas below ~6,000 ft. from the Front Range east to the Kansas boarder. Within Colorado, this area is referred to as the Eastern Plains, but from a national perspective, these are the Western Great Plains or the High Plains. *[If on the edge of the foothills, try both Key A and Key B]*.. **KEY A**: **WETLANDS AND RIPARIAN AREAS OF THE WESTERN GREAT PLAINS**

1b. Wetland and riparian areas west of the Great Plains **2**

2a. Wetlands and riparian areas with alkaline or saline soils within the inter-mountains basins of the Rocky Mountains (San Luis Valley, South Park, North Park, etc.). *[If the site does not match any of the descriptions within Key B, try Key C as well. Not all wetlands and riparian areas of the inter-mountain basis will fit within this key.]* ....**KEY B: WETLANDS AND RIPARIAN AREAS OF THE INTER-MOUNTAIN BASINS**

2b. Wetlands and riparian areas of the Rocky Mountains, including the foothills of the Front Range and all of the West Slope. Localized "hanging garden" wetlands of the Colorado Plateau are also keyed here, as they are the only system specific to that region. ....**KEY C: WETLANDS AND RIPARIAN AREAS OF THE ROCKY MOUNTAINS**

KEY A: WETLANDS AND RIPARIAN AREAS OF THE WESTERN GREAT PLAINS

1a. Low stature shrublands dominated by species such as *Sarcobatus vermiculatus, Atriplex* spp., *Ericameria nauseosa*, *Artemisia cana*, and *Artemisia tridentata.* Vegetation may be sparse and soils may be saline. Sites may be located on flats or in washes, but typically not associated with river and stream floodplains. *[These systems were originally described for the Inter-Mountain Basins, but may extend to the plains.]* **2**

1b. Wetland is not a low stature shrub-dominated saline wash or flat. **3**

2a. Shrublands with >10% total vegetation cover, located on flats or in temporarily or intermittently flooded drainages, and dominated by *Sarcobatus vermiculatus* and *Atriplex* spp. with inclusions of

Sporobolus airoides, Pascopyrum smithii, Distichlis spicata, Puccinellia nuttalliana, and *Eleocharis palustris* herbaceous vegetation.. **Inter-Mountain Basins Greasewood Flat**

2b. Sites with < 10% total vegetation cover and restricted to temporarily or intermittently flooded drainages with a variety of sparse or patchy vegetation including *Sarcobatus vermiculatus*, *Ericameria nauseosa*, *Artemisia cana*, *Artemisia tridentata*, *Grayia spinosa*, *Distichlis spicata*, and *Sporobolus airoides*.. **Inter-Mountain Basins Wash**

3a. Sites located within the floodplain or immediate riparian zone of a river or stream. Vegetation may be entirely herbaceous or may contain tall stature woody species, such as *Populus* spp. or *Salix* spp. Water levels variable. Woody vegetation that occurs along reservoir edges can also be included here.... **4**

3b. Herbaceous wetlands of the Western Great Plains that are isolated or partially isolated from floodplains and riparian zones, often depressional with or without an outlet. **9**

4a. Herbaceous wetlands within the floodplain with standing water at or above the surface throughout the growing season, except in drought years. Water levels are often high at some point during the growing season, but managed systems may be drawn down at any point depending on water management regimes. Vegetation typically dominated by species of *Typha, Scirpus, Schoenoplectus*, *Carex*, *Eleocharis*, *Juncus*, and floating genera such as *Potamogeton*, *Sagittaria*, and *Ceratophyllum*. The floodplain expression of this system is located on the floodplain, but may be disconnected from flooding regimes. The hydrology may be entirely managed. Water may be brackish or not. Soils are highly variable. This system includes natural warm water sloughs and other natural floodplain marshes as well as a variety of managed wetlands on the floodplain (e.g., recharge ponds, moist soil units, shallow gravel pits, etc.) .... **Western North American Emergent Marsh**

4b. Not as above. Wetland and riparian vegetation that typically lacks extensive standing water. Vegetation may be herbaceous or woody. Management regimes variable.. **5**

5a. Large herbaceous wetlands within the floodplain associated with a high water table that is controlled by artificial overland flow (irrigation). Sites typically lack prolonged standing water. Vegetation is dominated by native or non-native herbaceous species; graminoids have the highest canopy cover. Species composition may be dominated by non-native hay grasses. Patches of emergent marsh vegetation and standing water are less than 0.1 ha in size and not the predominant vegetation..... .... **Irrigated Wet Meadow (not an official Ecological System)**

5b. Predominantly natural vegetation (though may be weedy and altered) within the floodplain or immediate riparian zone of a river or stream, dominated by either woody or herbaceous species. Not obviously controlled by irrigation. **6**

6a. Riparian woodlands and shrublands of the Rocky Mountain foothills on the very western margins of the Great Plains. Woodlands are dominated by *Populus* spp. (*Populus angustifolia*, *P. deltoides,* or the hybrid *P. acuminata*). Common native shrub species include *Salix* spp., *Alnus incana*, *Betula occidentalis, Cornus sericea*, and *Crataegus* spp. Exotic shrub species include *Tamarix spp.* and *Elaeagnus angustifolia.* Sites are most often associated with a stream channel, including ephemeral, intermittent, or perennial streams (Riverine HGM Class). This system can occur on slopes, lakeshores, or around ponds, where the vegetation is associated with groundwater discharge or a subsurface connection to lake or pond water, and may experience overland flow but no channel formation (Slope, Flat, Lacustrine, or Depressional HGM Classes). It is also typically found in backwater channels and other perennially wet but less scoured sites, such as floodplain swales and irrigation ditches. .... **Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland**

6b. Riparian woodlands, shrublands and meadows of Colorado's Western Great Plains. Dominant native species include *Populus deltoides*, *Salix fragilis, Salix amygdaloides, Salix exigua, Acer negundo, Fraxinus* spp., and *Ulmus* spp. Dominant non-native species include *Tamarix* spp., *Elaeagnus angustifolia,* and other introduced woody species **7**

7a. Woodlands, shrublands, and meadows of draws and ravines associated with steep north-facing slopes or canyon bottoms that do not experience prolonged flooding. Common tree species include *Acer negundo, Populus tremuloides*, *Fraxinus* spp., and *Ulmus* spp. Important shrub species include *Crataegus* spp., *Prunus virginiana*, *Rhus* spp., *Rosa woodsii*, *Symphoricarpos occidentalis*, and *Shepherdia argentea. [It is uncertain how common this type is in Colorado. This type is more common on the plains to the north and east of Colorado (Wyoming, Nebraska, and South Dakota), where there is more relief to the landscape.]* .... **Western Great Plains Wooded Draw and Ravine**

7b. Woodlands, shrublands, and meadows of small to large streams and rivers of the Western Great Plains. Overall vegetation is lusher than above and includes more wetland indicator species. **8**

8a. Riparian woodlands, shrublands, and meadows along medium and small rivers and streams. Sites have less floodplain development and flashier hydrology than the next, and all streamflow may drawdown completely for some portion of the year. Water sources include snowmelt runoff (streams close to the Rocky Mountain front), groundwater (prairie streams), and summer rainfall. Dominant species include *Populus deltoides, Salix* spp., *Fraxinus pennsylvanica, Artemisia cana* ssp. *cana, Pascopyrum smithii, Panicum virgatum, Panicum obtusum, Sporobolus cryptandrus,* and *Schizachyrium scoparium. Carex* spp., *Tamarix* spp., *Elaeagnus angustifolia,* and less desirable grasses and forbs can invade degraded examples. Groundwater depletion, lack of fire, heavy grazing, and/or agriculture have resulted in species and hydroperiod changes. .... **Western Great Plains Riparian**

8b. Woodlands, shrublands, and meadows along large rivers with extensive floodplain development and periodic flooding that is more associated with snowmelt and seasonal dynamics in the mountains than with local precipitation events. Dominant communities within this system range from floodplain forests to wet meadow patches, to gravel/sand flats dominated by early successional herbs and annuals; however, they are linked by underlying soils and the flooding regime. Dominant species include *Populus deltoides* and *Salix* spp., *Panicum virgatum*, *Andropogon gerardii*, and *Carex* spp. *Tamarix* spp., *Elaeagnus angustifolia,* and non-native grasses have invaded degraded areas within the floodplains, which are subjected to heavy grazing and/or agriculture. Groundwater depletion and lack of fire have created additional alterations in species composition and hydroperiod. In most cases, the majority of the native wet meadow and prairie communities may be extremely degraded or extirpated from examples of this system. ....**Western Great Plains Floodplain**

9a. Natural shallow depressional wetlands in the Western Great Plains with an impermeable soil layer, such as dense hardpan clay, that causes periodic ponding after heavy rains. Sites generally have closed contour topography and are surrounded by upland vegetation. Hydrology is typically tied to precipitation and runoff and lacks a groundwater connection. Ponding is often ephemeral and sites may be dry throughout the entire growing season during dry years. Species composition depends on soil salinity, may fluctuate depending on seasonal moisture availability, and many persistent species may be upland species. *[On Colorado's Eastern Plains, wetlands within this group are collectively referred to* ***playas or playa lakes****. Ecological systems listed below separate playas based on the level of salinity and total cover of vegetation.]* **10**

9b. Herbaceous wetlands in the Western Great Plains not associated with hardpan clay soils. Sites may or may not be depressional and may or may not be natural. **11**

10a. Shallow depressional wetlands with less saline soils than the next. Dominant species are typically not salt-tolerant. Sites may have obvious vegetation zonation of tied to water levels, with the most hydrophytic species occurring in the wetland center where ponding lasts the longest. Common native species include *Pascopyrum smithii, Buchloe dactyloides, Eleocharis* spp., *Oenothera canescens, Ratibida tagetes, Plantago* spp., *Polygonum* spp., and *Phyla cuneifolia.* Non-native species are very common in these sites, including *Salsola australis, Bassia sieversiana, Verbena bracteata,* and *Conyza canadensis.* Sites have often been disturbed by agriculture and heavy grazing. Many have been dug out or "pitted" to increase water retention and to tap shallow groundwater. *[Most of the playas on Colorado's Eastern Plains will likely fit within this ecological system.]*.........**Western Great Plains Closed Depression Wetland**

10b. Shallow depressional herbaceous wetlands with saline soils. Salt encrustations can occur on the surface. Species are typically salt-tolerant, including *Distichlis spicata*, *Puccinellia* spp., *Salicornia* spp., *Schoenoplectus maritimus. Sporobolus airoides,* and *Hordeum jubatum.* Other commonly occurring taxa include *Puccinellia nuttalliana, Salicornia rubra, Schoenoplectus maritimus, Schoenoplectus americanus, Suaeda calceoliformis, Spartina* spp., *Triglochin maritima,* and occasional shrubs such as *Sarcobatus vermiculatus* and *Krascheninnikovia lanata. [It is not clear how common this system is in Colorado. This* *system occurs more commonly in surrounding states where plains soils are more saline. Note: Low stature shrub-dominant wetlands key in the flats and wash systems above.]* .... **Western Great Plains Saline Depression Wetland**

11a. Herbaceous wetlands with standing water at or above the surface throughout the growing season, except in drought years. Water levels are often high at some point during the growing season, but managed systems may be drawn down at any point depending on water management regimes. Vegetation typically dominated by species of *Typha, Scirpus, Schoenoplectus*, *Carex*, *Eleocharis*, *Juncus*, and floating genera such as *Potamogeton*, *Sagittaria*, and *Ceratophyllum*. The isolated expression of this system can occur around ponds, as fringes around lakes, and at any impoundment of water, including irrigation run-off. The hydrology may be entirely managed or artificial. Water may be brackish or not. Soils are highly variable. .... **Western North American Emergent Marsh**

11b. Herbaceous wetlands associated with a high water table that is controlled by artificial overland flow (irrigation) or artificial groundwater seepage (including from leaky irrigation ditches). Sites typically lack prolonged standing water. Vegetation is dominated by native or non-native herbaceous species; graminoids have the highest canopy cover. Species composition may be dominated by non-native hay grasses. Patches of emergent marsh vegetation and standing water are less than 0.1 ha in size and not the predominant vegetation. .... **Irrigated Wet Meadow (not an official Ecological System)**

KEY B: WETLANDS AND RIPARIAN AREAS OF THE INTER-MOUNTAIN BASINS

1a. Depressional, herbaceous wetlands occurring within dune fields of the inter-mountain basins (e.g., Great Sand Dunes National Park and Preserve, North Sand Hills Recreation Area in North Park). .... **Inter-Mountain Basins Interdunal Swale Wetland**

1b. Wetlands not associated with dune fields **2**

2a. Depressional wetlands. Soils are typically alkaline to saline clay with hardpans. Salt encrustation typically visible on the soil surface or along the water edge. Water levels various. Cover of vegetation variable, can be extremely sparse (<10% cover) or moderate to high (30–60% cover). Typically herbaceous dominated, but may contain salt-tolerant shrubs on the margins. **3**

6b. Non-depressional wetlands on flats or in washes, with alkaline to saline soils. Cover of vegetation variable, can be extremely sparse (<10% cover) or moderate to high (30–60% cover). Typically shrub dominated. Most common species are *Sarcobatus vermiculatus* and *Atriplex* spp. **4**

3a. Depressional, alkaline wetlands that are seasonally to semipermanently flooded, usually retaining water into the growing season and drying completely only in drought years. Many are associated with hot and cold springs, located in basins with internal drainage. Seasonal drying exposes mudflats colonized by annual wetland vegetation. Vegetation cover is generally >10% and species are typically salt-tolerant such as *Distichlis spicata*, *Puccinellia* spp., *Leymus* sp., *Poa secunda*, *Schoenoplectus maritimus, Schoenoplectus americanus, Triglochin maritima,* and *Salicornia* spp*.* This system can occur in alkaline basins and swales and along the drawdown zones of lakes and ponds.. .... **Inter-Mountain Basins Alkaline Closed Depression**

3b. Barren and sparsely vegetated playas (generally <10% plant cover). Salt crusts are common throughout, with small saltgrass beds in depressions and sparse shrubs around the margins. These systems are intermittently flooded. The water is prevented from percolating through the soil by an impermeable soil subhorizon and is left to evaporate. Soil salinity varies with soil moisture and greatly affects species composition. Characteristic species may include *Sarcobatus vermiculatus, Distichlis spicata,* and/or *Atriplex* spp.. **Inter-Mountain Basins Playa**

4a. Shrublands with >10% total vegetation cover, located on flats or in temporarily or intermittently flooded drainages. Vegetation dominated by *Sarcobatus vermiculatus* and *Atriplex* spp. with inclusions of *Sporobolus airoides, Pascopyrum smithii, Distichlis spicata, Puccinellia nuttalliana,* and *Eleocharis palustris* herbaceous vegetation... **Inter-Mountain Basins Greasewood Flat**

4b. Sites with < 10% total vegetation cover and restricted to temporarily or intermittently flooded drainages with a variety of sparse or patchy vegetation including *Sarcobatus vermiculatus*, *Ericameria nauseosa*, *Artemisia cana*, *Artemisia tridentata*, *Distichlis spicata*, and *Sporobolus airoides.* .... **Inter-Mountain Basins Wash**

KEY C: WETLANDS AND RIPARIAN AREAS OF THE ROCKY MOUNTAINS

1a. Herbaceous wetlands (“hanging gardens”) associated with seeps and springs within canyons of the Colorado Plateau region, typically along drainages of the major rivers of the region and their tributaries. Vegetation is supported by perennial water sources (seeps) that form pocketed wetlands and draping vegetation across wet cliff faces. Typical plant species include southern maidenhair fern (*Adiantum capillus-veneris*), northern maidenhair fern (*Adiantum pedatum*), Eastwood’s monkeyflower (*Mimulus eastwoodiae*), common large monkeyflower (*Mimulus guttatus*), Hapeman's coolwort (*Sullivantia hapemanii*), Rydberg’s thistle (*Cirsium rydbergii*), and several species of columbine, including Mancos columbine (*Aquilegia micrantha*). .... **Colorado Plateau Hanging Garden**

1b. Wetlands not as above. Not associated with seeps and springs within canyons of the Colorado Plateau. **2**

2a. Wetland defined by groundwater inflows and organic soil (peat) accumulation of at least 40 cm in the upper 80 cm. Vegetation can be woody or herbaceous. If the wetland occurs within a mosaic of non-peat forming wetland or riparian systems, then the patch must be at least 0.1 hectares (0.25 acres). If the wetland occurs as an isolated patch surrounded by upland, then there is no minimum size criteria. ... . **Rocky Mountain Subalpine-Montane Fen**

2b. Wetland does not have at least 40 cm of organic soil (peat) accumulation or occupies an area less than 0.1 hectares (0.25 acres) within a mosaic of other non-peat forming wetland or riparian systems ... **3**

3a. Total woody canopy cover generally 25% or more within the overall wetland/riparian area. Any purely herbaceous patches are less than 0.5 hectares and occur within a matrix of woody vegetation. *[Note: Relictual woody vegetation such as standing dead trees and shrubs are included here.]* **4**

3b. Total woody canopy cover generally less than 25% within the overall wetland/riparian area. Any woody vegetation patches are less than 0.5 hectares and occur within a matrix of herbaceous wetland vegetation **6**

4a. Riparian woodlands and shrublands of the foothill and lower montane zones on both the east and west slopes of Colorado's Rocky Mountains. Woodlands are dominated by *Populus* spp. (*Populus angustifolia*, *P. deltoides,* or the hybrid *P. acuminata*). Common native shrub species include *Salix* spp., *Alnus incana*, *Betula occidentalis, Cornus sericea*, and *Crataegus* spp. Exotic shrub species include *Tamarix spp.* and *Elaeagnus angustifolia.* Sites are most often associated with a stream channel, including ephemeral, intermittent, or perennial streams (Riverine HGM Class). This system can occur on slopes, lakeshores, or around ponds, where the vegetation is associated with groundwater discharge or a subsurface connection to lake or pond water, and may experience overland flow but no channel formation (Slope, Flat, Lacustrine, or Depressional HGM Classes). It is also typically found in backwater channels and other perennially wet but less scoured sites, such as floodplain swales and irrigation ditches. .... **Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland**

4b. Riparian woodlands and shrublands of the montane or subalpine zone **5**

5a. Montane or subalpine riparian woodlands (canopy dominated by trees). This system occurs as a narrow streamside forest lining small, confined low- to mid-order streams. Common tree species include *Abies lasiocarpa*, *Picea engelmannii*, *Pseudotsuga menziesii*, and *Populus tremuloides* .... **Rocky Mountain Subalpine-Montane Riparian Woodland**

5b. Montane or subalpine shrub wetlands (canopy dominated by shrubs with sparse or no tree cover). This system is most often associated with streams (Riverine HGM Class), occurring as either a narrow band of shrubs lining streambanks of steep V-shaped canyons *or* as a wide, extensive shrub stand on alluvial terraces in low-gradient valley bottoms (sometimes referred to as a *shrub carr*). Beaver activity is common within the wider occurrences. In addition, this system can occur around the edges of fens, lakes, seeps, and springs on slopes away from valley bottoms. This system can also occur within a mosaic of multiple shrub- and herb-dominated communities within snowmelt-fed basins. In all cases, vegetation is dominated by species of *Salix*, *Alnus*, or *Betula*. .... **Rocky Mountain Subalpine-Montane Riparian Shrubland**

6a. Herbaceous wetlands with a permanent water source throughout all or most of the year. Water is at or above the surface throughout the growing season, except in drought years. This system can occur around ponds, as fringes around lakes and along slow-moving streams and rivers. The vegetation is dominated by common emergent and floating leaved species including species of *Scirpus*, *Schoenoplectus*, *Typha*, *Juncus*, *Carex*, *Potamogeton*, *Polygonum*, and *Nuphar*. .... **Western North American Emergent Marsh**

6b. Herbaceous wetlands that typically lacks extensive standing water. Patches of emergent marsh vegetation and standing water are less than 0.1 ha in size and not the predominant vegetation. **7**

7a. Herbaceous wetlands associated with a high water table or overland flow, but typically lack standing water. Sites with *no channel formation* are typically associated with snowmelt or groundwater and not subjected to high disturbance events such as flooding (Slope HGM Class). Sites *associated with a stream channel* are more tightly connected to overbank flooding from the stream channel than with snowmelt and groundwater discharge and may be subjected to high disturbance events such as flooding (Riverine HGM Class). Vegetation is dominated by herbaceous species; typically graminoids have the highest canopy cover including *Carex* spp., *Calamagrostis* spp., and *Deschampsia caespitosa* .... **Rocky Mountain Alpine-Montane Wet Meadow**

7b. Large herbaceous wetlands associated with a high water table that is controlled by artificial overland flow (irrigation). Sites typically lack prolonged standing water, but may have standing water early in the season if water levels are very high. Vegetation is dominated by native or non-native herbaceous species; graminoids have the highest canopy cover. Species composition may be dominated by non-native hay grasses. .... **Irrigated Wet Meadow (not an official Ecological System)**

APPENDIX B National Wetland Inventory Classification

Modified from Cowardin et al. 1979

Cowardin System:

Upland (UPL): Non-wetland areas on land.

Open Water (OW): Deep water > 2 m deep.

Palustrine (P): All wetlands sampled within the REMAP project will fall under the Palustrine Cowardin System because they are vegetated. This system includes all wetlands dominated by trees, shrubs, and emergent, herbaceous vegetation. Wetlands lacking vegetation are also included in this system if they are less than 8 hectares (20 acres) and have a depth less than 2 meters (6.6 feet) in the deepest portion of the wetland.

Cowardin Classes:

Aquatic Bed (AB): Wetlands with vegetation that grows on or below the water surface for most of the growing season.

Emergent (EM): Wetlands with erect, rooted herbaceous vegetation present during most of the growing season.

Scrub-Shrub (SS): Wetlands dominated by woody vegetation that is less than 6 meters (20 feet) tall. Woody vegetation includes tree saplings and trees that are stunted due to environmental conditions.

Forested (FO): Wetland is dominated by woody vegetation that is greater than 6 meters (20 feet) tall.

Unconsolidated Bottom (UB): Wetlands that have a muddy or silty substrate with at least 25% cover.

Unconsolidated Shore (US): Wetlands with less than 75% areal cover of stones, boulders, or bedrock AND with less than 30% vegetative cover AND are irregularly exposed due to seasonal or irregular flooding and subsequent drying.

Cowardin Water Regime Modifiers (in order from driest to wettest):

Intermittently Flooded (J): The substrate is usually exposed, but surface water is present for variable periods without detectable seasonal periodicity. Weeks, months, or even years may intervene between periods of inundation.

Temporarily Flooded (A): Surface water is present for brief periods during the growing season, but the water table usually lies well below the soil surface for most of the season. Plants that grow both in uplands and wetlands are characteristic of the temporarily flooded regime.

Saturated (B): The substrate is saturated to the surface for extended periods during the growing season, but surface water is seldom present. This modifier is applied to fen like areas with stable water tables regardless of their connectivity.

Seasonally Flooded (C): Surface water is present for extended periods especially early in the growing season, but is absent by the end of the season in most years. When surface water is absent, the water table is often near the land surface.

Semi-permanently Flooded (F): Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land surface.

Intermittently Exposed (G): Surface water is present throughout the year except in years of extreme drought. This is applied to large ponds and shallow lakes where the water does not appear likely to dry up.

Permanently Flooded (H): Water covers the land surface throughout the year in all years. Vegetation is composed of obligate hydrophytes. Mostly applied to deepwater habitats such as lakes where there is no chance drying.

Cowardin Special Modifiers

Beaver (b): This modifier describes wetlands that are formed within and adjacent to streams by beaver activity.

Excavated (x): This modifier describes wetlands that were created through the excavation of soils.

Partially ditched/drained (d): This modifier describes manmade alterations to wetlands including ditches.

Diked/impounded (h): This modifier describes manmade alterations to wetlands where impoundments or dikes have been added.

Farmed (f): This modifier describes wetlands that have been altered due to farming practices.

Examples of Palustrine System:

To classify Palustrine wetlands, we combine the codes for the system, class, and water regime. The following are examples of types of wetlands and how they would be coded for wetland mapping purposes.

1. Cattail marsh that has standing water for most of the year: **PEMF**
2. A prairie pothole dominated by grasses and sedges that is only wet at the beginning of the growing season: **PEMA**
3. A fen in the subalpine zone: **PEMB**
4. A small shallow pond that has lily pads and other floating vegetation and holds water throughout the growing season: **PABF**
5. A small shallow pond with less than 30% vegetation and a muddy substrate that holds water for most of the year: **PUBF**
6. A wetland dominated by willows adjacent to a stream that is only periodically flooded: **PSSA**

APPENDIX C: Field Key to the Hydrogeomorphic (HGM) Classes of Wetlands in the Rocky Mountains

1a. Entire wetland unit is flat and precipitation is the primary source (>90%) of water. Groundwater and surface water runoff are not significant sources of water to the unit .... **Flats HGM Class**

1b. Wetland does not meet the above criteria; primary water sources include groundwater and/or surface water **2**

2a. Entire wetland unit meets ***all*** of the following criteria: a) the vegetated portion of the wetland is on the shores of a permanent open water body at least 8 ha (20 acres) in size; b) at least 30% of the open water area is deeper than 2 m (6.6 ft); c) vegetation in the wetland experiences bidirectional flow as the result of vertical fluctuations of water levels due to rising and falling lake levels. .... **Lacustrine Fringe HGM Class**

2b. Wetland does not meet the above criteria; wetland is not found on the shore of a water body, water body is either smaller or shallower, OR vegetation is not effected by lake water levels.. **3**

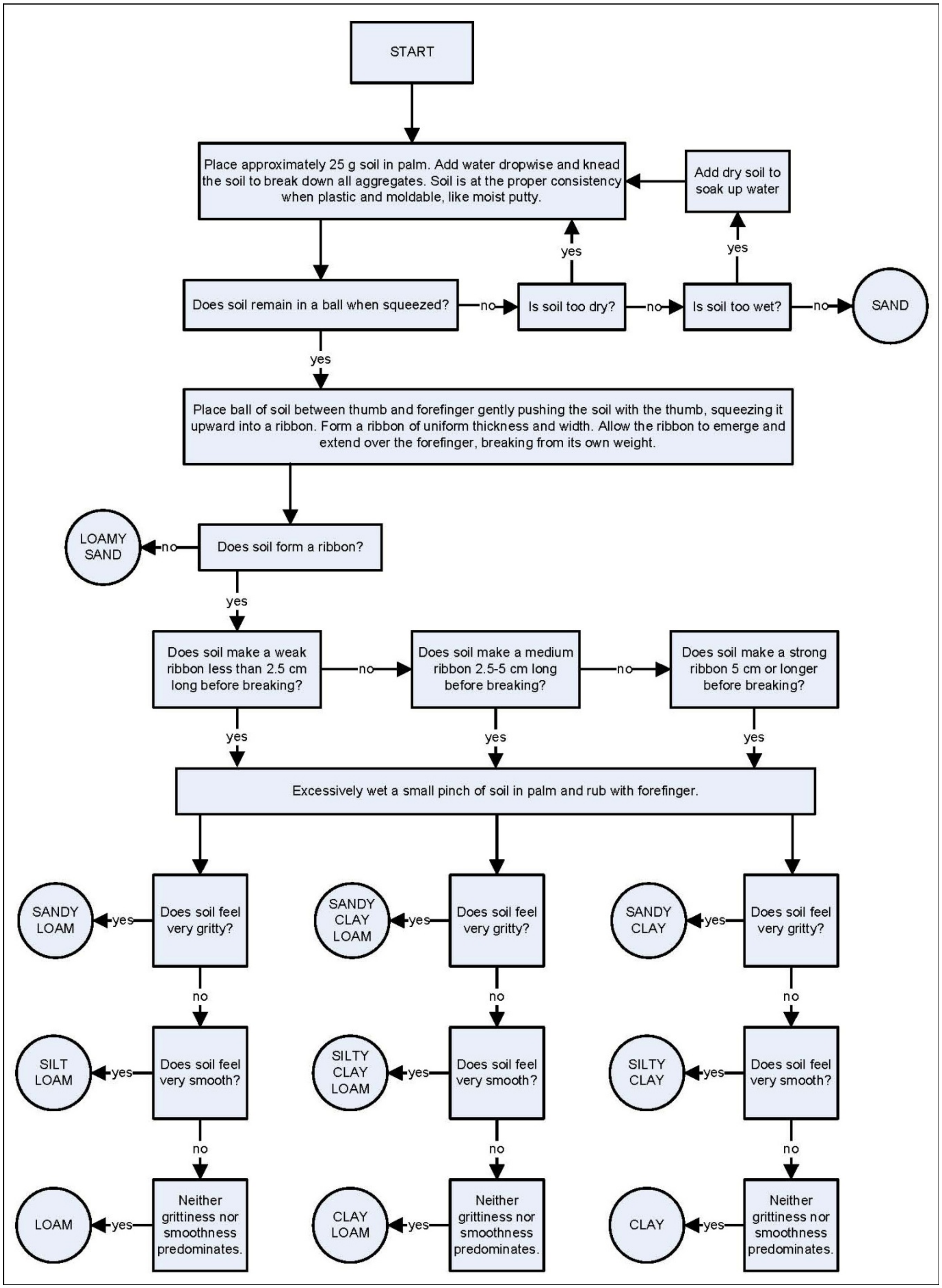
3a. Entire wetland unit meets ***all*** of the following criteria: a) wetland unit is in a valley, floodplain, or along a stream channel where it is inundated by overbank flooding from that stream or river; b) overbank flooding occurs at least once every two years; and c) wetland does not receive significant inputs from groundwater. **NOTE:** *Riverine wetlands can contain depressions that are filled with water when the river is not flooding such as oxbows and beaver ponds*.. **Riverine HGM Class**

3b. Wetland does not meet the above criteria; if the wetland is located within a valley, floodplain, or along a stream channel, it is outside of the influence of overbank flooding or receives significant hydrologic inputs from groundwater. **4**

4a. Entire wetland unit meets ***all*** of the following criteria: a) wetland is on a slope (slope can be very gradual or nearly flat); b) groundwater is the primary hydrologic input; c) water, if present, flows through the wetland in one direction and usually comes from seeps or springs; and d) water leaves the wetland without being impounded. **NOTE:** *Small channels can form within slope wetlands, but are not subject to overbank flooding. Surface water does not pond in these types of wetlands, except occasionally in very small and shallow depressions or behind hummocks (depressions are usually < 3ft diameter and less than 1 foot deep).* .... **Slope HGM Class**

4b. Wetland does not meet all of the above criteria. Entire wetland unit is located in a topographic depression in which water ponds or is saturated to the surface at some time during the year. **NOTE:** *Any outlet, if present, is higher than the interior of the wetland.* .... **Depressional HGM Class**

APPENDIX E: Soil Texture Flowchart



APPENDIX F: Notes on Hydric Soil Indicators for the Mountain West

All Soil Types

A1. Histosol: Organic soil material **≥ 40 cm** think within the top **80 cm**.

A2. Histic Epipedon: Organic soil material **≥ 20 cm** thick above a mineral soil layer. Aquic conditions or artificial drainage *required,* but can be assumed if hydrophytic vegetation and wetland hydrology are present.

A3. Black Histic: Very dark organic soil material **≥ 20 cm** thick that starts **within 15 cm** of soil surface. Color: hue = 10YR or yellower; value ≤ 3; chroma ≤ 1. Aquic conditions or artificial drainage *not required. Rare in our region.*

A4. Hydrogen Sulfide: Rotten egg odor within **30 cm** of the soil surface due to the reduction of sulfur. Most commonly found in areas that are permanently saturated or inundated; almost never at the wetland boundary.

A11. Depleted Below Dark Surface: Depleted (colorless) layer **≥ 15 cm** that starts **within 30 cm** of the soil surface. Color: chroma ≤ 2. Redox features required if color = 4/1, 4/2, 5/2. Layers above must be dark. See Table 1 for specifics.

A12. Thick Dark Surface. Depleted (colorless) layer **≥ 15** cm that starts **below 30 cm** of the soil surface. Color: chroma ≤ 2. Redox features required if color = 4/1, 4/2, 5/2. Layers above must be dark. See Table 1 for specifics. *Not common in our region.*

For the remaining indicators, unless otherwise indicated, all mineral layers above the indicators must have a dominant chroma of ≤ 2 or the layers with dominant chroma of > 2 must be < 15 cm thick.

Sandy Soil Types Sandy soil indicators are generally shallower and thinner than loamy/clayey soil indicators.

S1. Sandy Mucky Mineral: A layer of mucky modified sandy soil material **≥ 5 cm** starting **within 15 cm** of the soil surface. *Limited in our region,* but found in swales associated with sand dunes.

S4. Sandy Gleyed Matrix: Gleyed matrix that occupies **≥ 60%** of a layer starting **within 15 cm** of the soil surface. No minimum thickness required. Gley colors are not synonymous with grey colors. They are found on the Gley page. *Rare in our region;* only found where sandy soils are almost continuously saturated.

S5. Sandy Redox: Redox features in a depleted (colorless) layer **≥ 10 cm** that starts **within 15 cm** of the soil surface. Color: chroma ≤ 2. See Table 1 for specifics. *Most common indicator in our region of the wetland boundary for sandy soils.*

S6. Stripped Matrix: A layer starting **within 15 cm** of the surface in which iron/manganese oxides and/or organic matter has been stripped and the base color of the soil material is exposed. Evident by faint, diffuse splotchy patterns of two or more colors. Stripped zones are ≥ 10% and ~1–3 cm in diameter.

Loamy / Clayey Soil Types Loamy/clayey soil indicators are generally deeper and thicker than sandy soil indicators.

F1. Loamy Mucky Mineral: A layer of mucky modified loamy or clayey soil material **≥ 10 cm** starting within 15 cm of the soil surface. Difficult to tell without testing.

F2. Loamy Gleyed Matrix: Gleyed matrix that occupies **≥ 60%** of a layer starting **within 30 cm** of the soil surface. No minimum thickness required. Gley colors are not synonymous with grey colors. They are found on the Gley page.

F3. Depleted Matrix: Depleted (colorless) layer **≥ 5 cm** thick **within 15 cm** *or* **≥ 15 cm** thick w**ithin 30 cm** of the soil surface. Color: chroma ≤ 2. Redox features required if color = 4/1, 4/2, 5/2. See Table 1 for specifics. *Most common indicator at wetland boundaries.*

F6. Redox Dark Surface: A dark surface layer with **redox features.** Depth and location: **≥ 10 cm** thick entirely **within 30 cm of** the mineral soil. Matrix color and redox features: matrix value ≤ 3 and chroma ≤ 1 with ≥ 2% distinct, prominent redox concentrations OR matrix value ≤ 3 and chroma ≤ 2 with ≥ 5% distinct, prominent redox concentrations. The chroma can be higher with more redox features. *Very common indicator to delineate wetlands,* though difficult to see in soils with high organic matter.

F7. Depleted Dark Surface: A dark surface layer with **redox depletions.** Depth and location: **≥ 10 cm** thick entirely **within 30 cm of** the mineral soil. Matrix color and redox depletions: matrix value ≤ 3 and chroma ≤ 1 with ≥ 10% redox depletions OR matrix value ≤ 3 and chroma ≤ 2 with ≥ 20% redox depletions. The chroma can be higher with more redox depletions. Redox depletions themselves should have value ≥ 5 and chroma ≤ 2. *Rare in our region.*

F8. Redox Depressions: A layer **≥ 5 cm** thick entirely **within 15 cm** of soil surface with ≥ 5% distinct or prominent redox concentrations in closed depressions subject to ponding. *No color requirement for the matrix soil, but only applies to depressions in otherwise flat landscapes.*

Table 1. Comparison of indicators with depleted matrices and redox features.

	A11	***A12***	***F3***	***S5***
Depleted matrix extent	≥ 60%	≥ 60%	≥ 60%	≥ 60%
Depleted matrix color	chroma ≤ 2	chroma ≤ 2	chroma ≤ 2	chroma ≤ 2
Redox requirements	≥ 2% distinct or prominent redox concentrations ***if matrix color is*** 4/1, 4/2, 5/2	≥ 2% distinct or prominent redox concentrations ***if matrix color is*** 4/1, 4/2, 5/2	≥ 2% distinct or prominent redox concentrations ***if matrix color is*** 4/1, 4/2, 5/2	≥ 2% distinct or prominent redox concentrations
Starting within	< 30 cm	≥ 30 cm	see below	> 15 cm
Min thickness	15 cm or 5 cm if fragmental soil material	15 cm	**5 cm** within 15 cm of soil surface OR **15 cm** within 25 cm of soil surface	10 cm
Color of layers above	***loamy/clayey*** value ≤ 3 chroma ≤ 2 ***sandy material*** value ≤ 3 chroma ≤ 1 70% coated with organic material	***all types to 30cm*** value ≤ 2.5 chroma ≤ 1 ***all types below 30 cm and above depleted matrix*** value ≤ 3 chroma ≤ 1 ***all sandy material*** 70% coated with organic material	no requirements	no requirements

APPENDIX D: Colorado Noxious Weed List

Source: Colorado Department of Agriculture Noxious Weed Program.

List A species in Colorado that are designated by the Commissioner for eradication:

- African rue *(Peganum harmala)*
- Camelthorn *(Alhagi pseudalhagi)*
- Common crupina *(Crupina vulgaris)*
- Cypress spurge *(Euphorbia cyparissias)*
- Dyer's woad *(Isatis tinctoria)*
- Giant salvinia *(Salvinia molesta)*
- Hydrilla *(Hydrilla verticillata)*
- Meadow knapweed *(Centaurea pratensis)*
- Mediterranean sage *(Salvia aethiopis)*
- Medusahead *(Taeniatherum caput-medusae)*
- Myrtle spurge *(Euphorbia myrsinites)*
- Orange hawkweed *(Hieracium aurantiacum)*
- Purple loosestrife *(Lythrum salicaria)*
- Rush skeletonweed *(Chondrilla juncea)*
- Sericea lespedeza *(Lespedeza cuneata)*
- Squarrose knapweed *(Centaurea virgata)*
- Tansy ragwort *(Senecio jacobaea)*
- Yellow starthistle *(Centaurea solstitialis)*

List B weed species are species for which the Commissioner, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, develops and implements state noxious weed management plans designed to stop the continued spread of these species:

- Absinth wormwood *(Artemisia absinthium)*
- Black henbane *(Hyoscyamus niger)*
- Bouncingbet *(Saponaria officinalis)*
- Bull thistle *(Cirsium vulgare)*
- Canada thistle *(Cirsium arvense)*
- Chinese clematis *(Clematis orientalis)*
- Common tansy *(Tanacetum vulgare)*
- Common teasel *(Dipsacus fullonum)*
- Corn chamomile *(Anthemis arvensis)*
- Cutleaf teasel *(Dipsacus laciniatus)*
- Dalmatian toadflax, broad-leaved *(Linaria dalmatica)*
- Dalmatian toadflax, narrow-leaved *(Linaria genistifolia)*
- Dame's rocket *(Hesperis matronalis)*
- Diffuse knapweed *(Centaurea diffusa)*
- Eurasian watermilfoil *(Myriophyllum spicatum)*
- Hoary cress *(Cardaria draba)*
- Houndstongue *(Cynoglossum officinale)*
- Leafy spurge *(Euphorbia esula)*

- Mayweed chamomile *(Anthemis cotula)*
- Moth mullein *(Verbascum blattaria)*
- Musk thistle *(Carduus nutans)*
- Oxeye daisy *(Chrysanthemum leucanthemum)*
- Perennial pepperweed *(Lepidium latifolium)*
- Plumeless thistle *(Carduus acanthoides)*
- Quackgrass *(Elytrigia repens)*
- Redstem filaree *(Erodium cicutarium)*
- Russian knapweed *(Acroptilon repens)*
- Russian-olive *(Elaeagnus angustifolia)*
- Salt cedar *(Tamarix chinensis, T.parviflora, and T. ramosissima)*
- Scentless chamomile *(Matricaria perforata)*
- Scotch thistle *(Onopordum acanthium)*
- Scotch thistle *(Onopordum tauricum)*
- Spotted knapweed *(Centaurea maculosa)*
- Spurred anoda *(Anoda cristata)*
- Sulfur cinquefoil *(Potentilla recta)*
- Venice mallow *(Hibiscus trionum)*
- Wild caraway *(Carum carvi)*
- Yellow nutsedge *(Cyperus esculentus)*
- Yellow toadflax *(Linaria vulgaris)*

List C weed species are species for which the Commissioner, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, will develop and implement state noxious weed management plans designed to support the efforts of local governing bodies to facilitate more effective integrated weed management on private and public lands. The goal of such plans will not be to stop the continued spread of these species but to provide additional education, research, and biological control resources to jurisdictions that choose to require management of List C species.

- Chicory *(Cichorium intybus)*
- Common burdock *(Arctium minus)*
- Common mullein *(Verbascum thapsus)*
- Common St. Johnswort *(Hypericum perforatum)*
- Downy brome *(Bromus tectorum)*
- Field bindweed *(Convolvulus arvensis)*
- Halogeton *(Halogeton glomeratus)*
- Johnsongrass *(Sorghum halepense)*
- Jointed goatgrass *(Aegilops cylindrica)*
- Perennial sowthistle *(Sonchus arvensis)*
- Poison hemlock *(Conium maculatum)*
- Puncturevine *(Tribulus terrestris)*
- Velvetleaf *(Abutilon theophrasti)*
- Wild proso millet *(Panicum miliaceum)*