Ecological Integrity Assessment for Colorado Wetlands

Field Manual, Version 2.1

COLORADO NATURAL HERITAGE PROGRAM

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Colorado State University

Ecological Integrity Assesment (EIA) for Colorado Wetlands Field Manual, Version 2.1

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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, soils, water quality, and size into a multi-metric index. Final EIA scores rank a wetland's condition on a four-tiered scale (excellent/good/fair/poor: Table 1), 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. Since 2008, 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 & Gilligan 2012; Lemly et al. 2013; Lemly et al. 2014; Lemly et al. 2015). These studies have been funded by U.S. Environmental Protection Agency (EPA) Region 8 Wetland Program Development Grants and 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. Results from these studies have 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 EPA pursuant to Section 303d and 305b of the Federal Clean Water Act (CWA).

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 the 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.

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[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.

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.

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" (USEPA 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) (USEPA 1998).

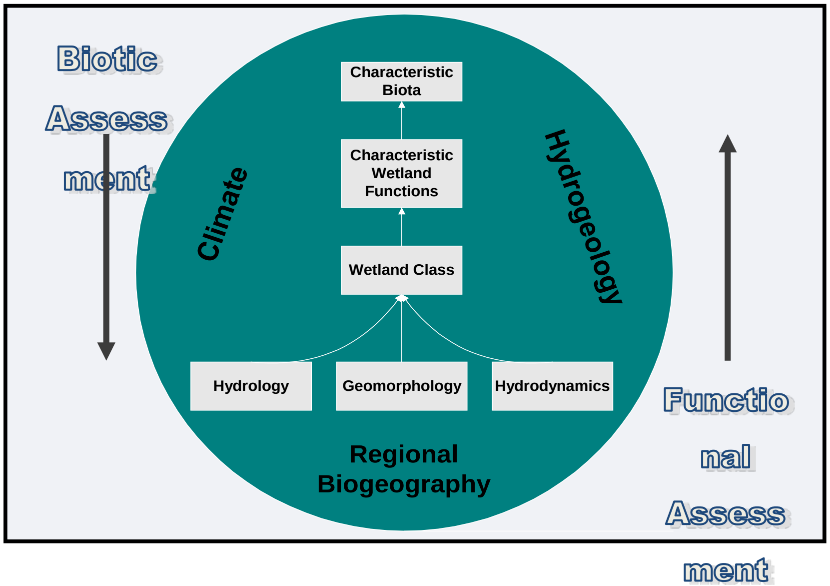


Figure 1. Schematic representation of the top-down and bottom-up approaches used in assessment. Biotic or ecological condition assessments use biological response to infer impacts to basic physical drivers. Functional assessments do just the opposite. Figure from Lemly et al. (2013).

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 2).

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

Reference Condition

The Colorado EIA method, like most ecological integrity assessments, is a reference-based approach (Stoddard et al. 2006). 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 (Swetnam et al. 1999).

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.

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, followed by keys to HGM types (Appendix B) and Cowardin codes (Appendix C). Several metrics, particularly vegetation metrics, 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.

1.2 Background and Development of Colorado's EIA Method

NatureServe's Ecological Integrity Assessment Framework

The Ecological Integrity Assessment (EIA) Method has been developed collaboratively over many years. 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; Faber-Langendoen et al. 2012).

Most recently, NatureServe and four partner Natural Heritage Programs (Colorado, New Hampshire, New Jersey, and Washington), were awarded a National EPA Wetland Program Development Grant in 2013 to compare variations of the EIA methods across several states. The joint project has been hugely important in refining the EIA metrics and the overall framework. A report from that project is currently being prepared (Faber-Langendoen et al. 2015).

The Colorado EIA methods are a direct descendant from the original EIA Framework developed by NatureServe. Most of the metrics in the 2015 version of the Colorado EIA manual follow the refined NatureServe language from the National EPA project. However, specific protocols have been modified 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 2009). Through several completed and ongoing wetland assessment projects (Lemly et al. 2011; Lemly and Gilligan 2012; Lemly et al. 2013; Lemly et al. 2014; Lemly et al. 2015; Smith and Kuhn 2015), 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 may 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 nonnative 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 2007). 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. A calculator for FQA indices can be downloaded at: http://www.cnhp.colostate.edu/cwic/assessment/fqa.asp.

Table 3. C-value ranges and associated interpretation.

C-Values	*Interpretation*
0	Nonnative 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).

Level 1-2-3 Framework for Wetland Assessment

The EIA Method uses concepts from the EPA's Level 1-2-3 Framework for Wetland Assessment to describe the level of intensity needed for data collection. EPA developed the three-tiered approach to wetland assessment because it is impossible to visit every wetland across a landscape to determine the range of condition (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

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

assessments can be applied 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.

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.

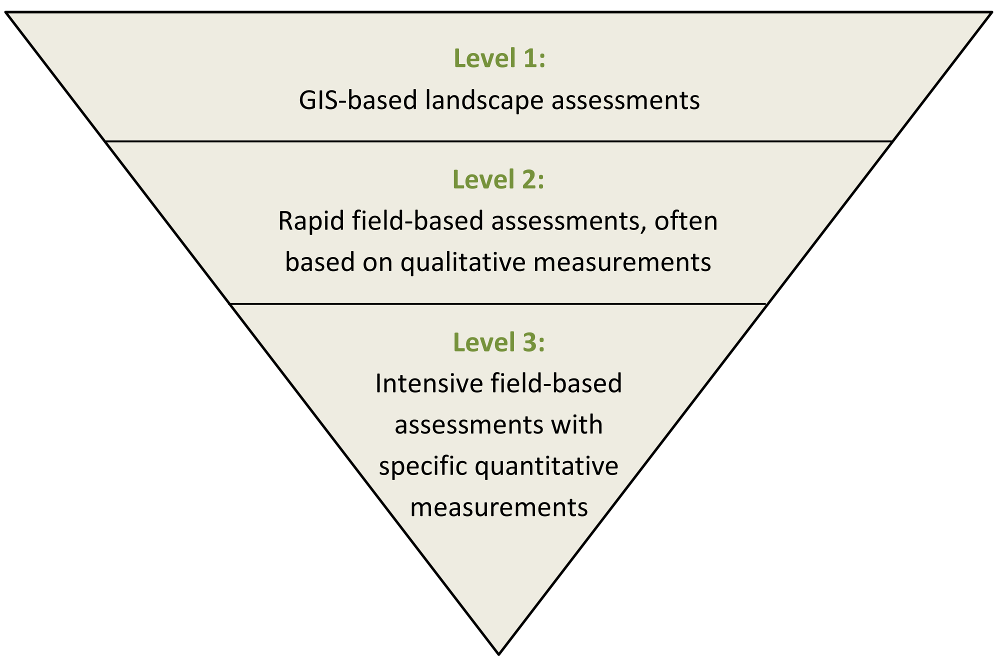


Figure 2. Graphical illustration of the Level 1-2-3 Framework.

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.

1.3 Structure of Colorado's EIA Method

Rank Factors, Major Ecological Factors, and Metrics

The EIA method is based on a three-tiered hierarchical structure (Table 4). At the highest level, the EIA divides wetland integrity into three major **Rank Factors:** Landscape Context, Condition, and Size. Within each of those Rank Factors, the EIA identifies one or more **Major Ecological Factors** integral to wetland integrity that are feasible to monitor. For each of the Major Ecological Factors, one or more individual **Metrics** are selected to be measure in the field. Metric rating can vary by wetland type and some metrics are optional.

Table 4. Hierarchical structure of the Colorado EIA method.

Rank Factor	*Major Ecological Factor*	*Metrics*[1]	*Metric Variants*
Landscape Context	Landscape	L1. Contiguous Natural Land Cover L2. Land Use Index	
	Buffer	B1. Perimeter with Natural Buffer B2. Width of Natural Buffer B3. Condition of Natural Buffer	
Condition	Vegetation	V1. Native Plant Species Cover V2. Invasive Nonnative Plant Species Cover V3. Native Plant Species Composition V4. Vegetation Structure V5. Regeneration of Native Woody Species **[opt.]** V6. Coarse and Fine Woody Debris **[opt.]**	V3 and V4 vary by wetland type. V5 and V6 are for woody systems.
	Hydrology	H1. Water Source H2. Hydroperiod H3. Hydrologic Connectivity	H1, H2, and H3 vary by wetland type.
	Physiochemistry	S1. Soil Condition S2. Surface Water Turbidity / Pollutants **[opt.]** S3. Algal Growth **[opt.]**	S2 and S3 are for sites with surface water.
Size	Size	Z1. Comparative Size **[opt.]** Z2. Change in Size **[opt.]**	Z1 and Z2 are for assessments of entire wetlands.

[1] Optional metrics noted as **[opt.]** can be used depending on study design and wetland type.

Stressor Checklist

In addition to the condition metrics, the EIA protocol involves collecting data on stressor within each of the Major Ecological Factors (except Size). Each stressor is designated with a severity and scope rating, indicating the intensity of the stressor and percent of the AA or landscape that it affects. 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.

Scorecard Reporting

Once EIA metrics have been scored, Rank Factor, Major Ecological Factor, and Overall Ecological Integrity scores are calculated based on a set weighting system in a scorecard format (Table 5). An Excel spreadsheet is available for calculating EIA scores.

Table 5. Example EIA Scorecard. Example site is an herbaceous wetland with surface water.

	Weight	Field Rating	Field Points	Calc Points	Calc Rating
Overall Ecological Integrity Score and Rank				**3.00**	**B-**
Overall Ecological Integrity + Size Score and Rank				**2.53**	**B-**
Rank Factor: LANDSCAPE CONTEXT	0.30			**2.78**	**B-**
LANDSCAPE METRICS	0.33			**2.50**	**B-**
L1. Contiguous Natural Land Cover	1	B	3		
L2. Land Use Index	1	C	2		
BUFFER METRICS[1]	0.67			**2.91**	**B-**
B1. Perimeter with Natural Buffer	n/a	A	4		
B2. Width of Natural Buffer	n/a	C	2		
B3.1. Condition of Natural Buffer - Veg	n/a	B	3		
B3.2. Condition of Natural Buffer - Soils	n/a	B	3		
Rank Factor: CONDITION	0.70			**2.79**	**B-**
VEGETATION METRICS	0.55			**2.75**	**B-**
V1. Native Plant Species Cover	1	A	4		
V2. Invasive Nonnative Plant Species Cover	1	B	3		
V3. Native Plant Species Composition	1	C	2		
V4. Vegetation Structure	1	C	2		
V5. Regen. of Native Woody Species **(opt.)**	1		NULL		
V6. Coarse and Fine Woody Debris (**opt.)**	1		NULL		
HYDROLOGY METRICS	0.35			**3.00**	**B+**
H1. Water Source	1	A	4		
H2. Hydroperiod	1	B	3		
H3. Hydrologic Connectivity	1	C	2		
PHYSIOCHEMISTRY METRICS	0.10			**2.25**	**C+**
S1. Soil Condition	1	C	2		
S2. Surface Water Turbidity / Pollutants **(opt.)**	0.5	B	3		
S3. Algal Growth **(opt.)**	0.5	C	2		
Rank Factor: SIZE	n/a			**2.00**	**C+**
SIZE METRICS	1			**2.00**	**C+**
Z1. Comparative Size **(opt.)**	1	B	3		
Z2. Change in Size **(opt.)**	1	D	1		

[1] Buffer metrics are combined into a Buffer Index: $(((B1*B2)^{1/2}) * ((B3.1 + B3.2)/2))^{1/2}$.

SECTION 2: APPLYING COLORADO'S EIA METHOD

2.1 Defining an Assessment Area (AA)

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.

The basis of the carrying out the EIA method is identifying and establishing an **assessment area (AA)** in which data collection is concentrated. For random sampling, it is advisable to set a standard shape and size for the AA, such as a 40-m radius circle. Detailed instructions on defining a standard AA for random sampling can be found in Appendix D. For targeted sampling, the AA can be of variable size and shape and can be bound by the entire wetland itself, if so desired. In general, the AA should be one Ecological System (see Appendix A) and one HGM type (see Appendix B). The AA may be bound by land ownership or management units or be a specific project area slated for management action.

For either type of study design, there are a variety of available data sources to help define the boundaries of the AA. Potential data sources include 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.

2.2 Describing the Assessment Area (AA)

Location and General Information

The first page of the **2015 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.

Site ID: This ID could be anything project specific and will vary by user.

Site Name: This is a name given to the site by the field user. This name should reflect either the site location or 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.

Level 2.5 or Level 3: These check boxes indicate whether the site was sampled with Level 2.5 rapid protocols or Level 3 intensive protocols. The primary difference between these two protocols is that Level 3 surveys include detailed vegetation plots and Level 2 surveys are plotless and the same data are 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 practitioners 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: 40-m radius circles are for standard random AAs. Freeform polygons are for non-standard random AAs. Wetland boundaries or other are for targeted site. Please describe in comments.

Elevation: Record elevation at AA center in meters.

Slope: Record slope at AA center in degrees, averaging slope of wetland within AA between uphill and downhill. Slope is measured either with a clinometer or a compass. Depressional wetlands generally do not slope in one direction and slope should be marked as 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), record the slope of the larger landscape that includes the AA.

Aspect: Visualize the direction that water would flow downhill within the AA, 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.. In depressional wetlands, aspect is generally N/A. *Make sure to set the declination on your compass.*

GPS Points of the Assessment Area

AA-Center: If AA is a standard 40-m radius circle, record the center waypoint number and UTMs. In non-standard AAs, the center point is not needed.

AA-1 through AA-4: These are reference points that are generally taken at four evenly spaced intervals around the perimeter of the AA. At each reference point, UTMs and associated photos are taken to document the site. In standard AAs, the reference points are located at the cardinal directions, facing the AA center. In non-standard AAs, these points are better located at the midpoints of along the long and short axes, facing into the AA center. In long linear or sinuous AAs, the two points along the long axes may not be directly across from each other, may instead may face the opposite bank, but the two midpoints along the short axes 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).

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. The following are CNHP's standards for photos, which can be adapted according to project needs. There are various standard photos CNHP takes in each AA, with the photo numbers recorded:

1) Four AA reference points
2) Vegetation plots, for Level 3 sampling
3) Soil pit photos
4) Unknown plant photos
5) Photos of anything notable
6) When possible, it is helpful to have an overview photo of the entire wetland

CNHP uses a **photo placard** in all the AA reference point photos (Figure 3). Photo placards are placed at the edge 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.

Figure 3. Example AA photos. Note placement of photo placard at edge and information written on placard.

Environmental Description and Classification of the Assessment Area

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

Wetland / Riparian / Upland Inclusions: CNHP's surveys include both wetlands and non-wetland riparian areas. We recommend specifying how more of either is in the AA, but this is not essential. We also limit upland inclusions to <10%.

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 (fidelity), and explain in the comments section below when confidence is medium or low.

Cowardin Classification: Record the appropriate Cowardin classification code for the majority of the AA, using the definitions provided in **Appendix B**. Designate fidelity to key.

HGM Class: Select the appropriate HGM Class using the key provided in **Appendix C.** Try to pick only one dominant HGM Class. Designate fidelity to key. If it seems there is >1 dominant HGM, reconsider the boundary of the AA. *Note that additional classification 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 4) and unconfined (Figure 5) settings behave very differently. Confinement results from hard geomorphic barriers such as a rock wall that impedes flow, not to incised or entrenched banks. There are two pieces of information necessary to determine whether a stream is confined or unconfined: bankfull width and valley width (Figure 6). **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. 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. In confined valley setting, valley width is less than 2x bankfull width. In unconfined valley settings, valley width is greater than 2x bankfull width.

Stream Flow Duration: Record whether you think the stream is perennial, intermittent or ephemeral. Perennial streams flow throughout the year. Intermittent streams flow seasonally in response to snowmelt and/or elevated groundwater tables resulting from increased periods of precipitation and/or decreased evapotranspiration. Ephemeral streams are those that only flow during and in immediate response to precipitation events (McDonough et al. 2011). If it is difficult to determine the difference between intermittent and ephemeral, make your best guess.

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.

Stream Depth: 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 4. Example of a confined valley setting.

Figure 5. Example of an unconfined valley setting.

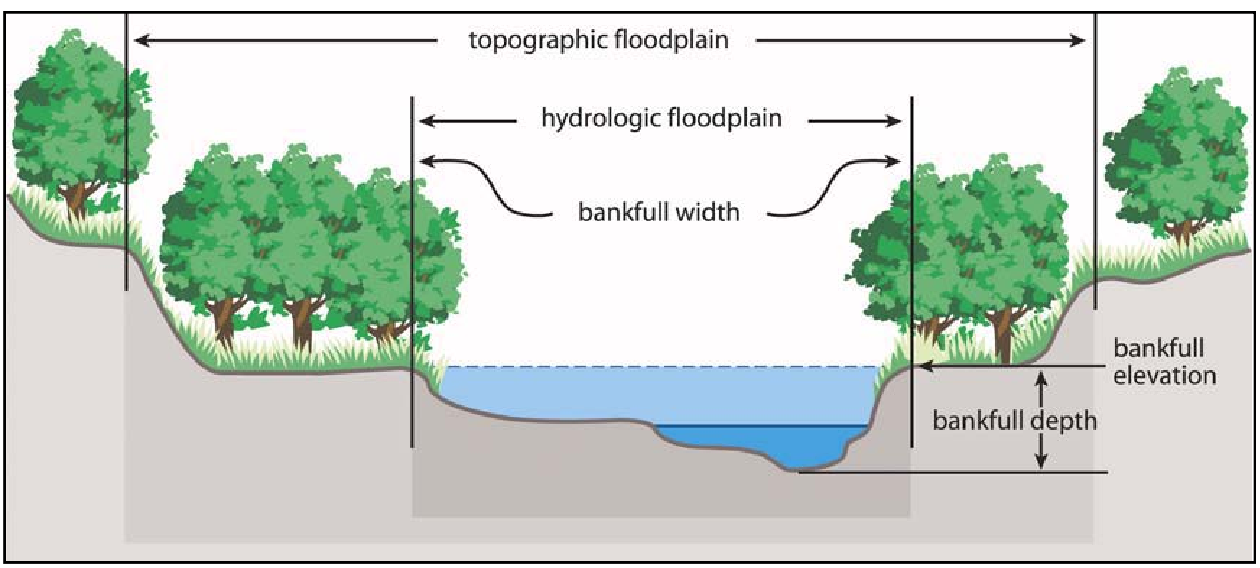


Figure 6. Graphical illustration of bankfull width and the topographic floodplain.

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. This information is purely descriptive, so don't agonize over how to split out zone, but try to paint a picture of the major components of the AA.

For each zone identified, note the physiognomy of the dominant stratum, the dominant species (e.g., *Populus deltoides / Salix exigua*), 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 or forbs dominate, can specify tall or short)
- **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)

Environmental and Classification Comments: Include any comments related to the classifications above.

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

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.

2.3 Vegetation Sampling Protocols

Level 2.5 vs. Level 3 Vegetation Sampling

CNHP recommends one of two vegetation sampling protocols to address metrics in the Vegetation Major Ecological Factor of the EIA. It is advisable to 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. Strictly speaking, the EIA method could be carried out as a true Level 2 Assessment without collecting vegetation data. However, we believe that rating the vegetation metrics would be very difficult without collecting some level of vegetation data. It would also be difficult to check the quality of the data once back in the office.

For Level 2.5 Assessments, walk through the AA and identify as many plant species as possible within one to two hours. 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). Once the species list is compiled, estimate cover for each plant species within the entire AA. If the AA is very large, multiple species lists could be compiled from various areas of the wetland and compared to rate EIA metrics.

Level 3 Assessments, lay out vegetation plots to collect detailed vegetation data. CNHP uses vegetation plot protocols from the EPA's National Wetland Condition Assessment (USEPA 2011), as explained in Appendix E. Various vegetation plot methods could be used, however, and the exact specifics are at the users discretion.

Regardless of survey level, a few points of guidance are provided below:

- **Nomenclature** for all plant species should follow the Weber and Wittmann 3rd edition (Weber and Wittmann 2001a, b) to be most compatible with the FQA calculator available form CNHP. C-values from the FQA for Colorado wetlands were determined based on the nomenclature in these floras and data analysis tools rely 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 should be recorded on the field form using the fully spelled out scientific name.

- Any **unknown species** should be entered on the field form with a descriptive name. All unknown species should be collected for later identification.

- *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.**

- 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 should receive a **collection number**, such as a running sequential series of numbers that starts at every site. This collection number can be written on the field form in the column "Coll #". 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 should be visually estimated for the plot or the AA using the following cover classes (Peet *et al*. 1998) or by increments of 1 or 5%. The visual aids for estimating cover provided in Figures 7 and 8 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%

Vegetation Plot Ground Cover and Vertical Strata

In addition to species data, information on the ground cover and vertical vegetation strata should also be recorded to help with vegetation structure metrics.

Actual 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. This overall cover is then divided into zones with open water, emergent vegetation, and submergent/floating vegetation.

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

Actual maximum depth of standing water: Estimate the maximum depth of standing water. Walk through the plot to make sure you identify the maximum depth.

Potential cover of water at ordinary high water: This field is to estimate how high he water could be within the AA.

Potential predominant depth: Estimate the potential predominant depth at ordinary high water.

Stability of water level: Estimate whether the water levels are stable, fluctuate, or are emphermal.

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 mm–25 cm in diameter; and 3) bedrock, rock, or boulders > 25 cm in diameter.

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 prostrate dead herbaceous vegetation, particularly annual vegetation or dead attached leaves from the previous year, which would become litter if detached.

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.

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 (e.g., 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.

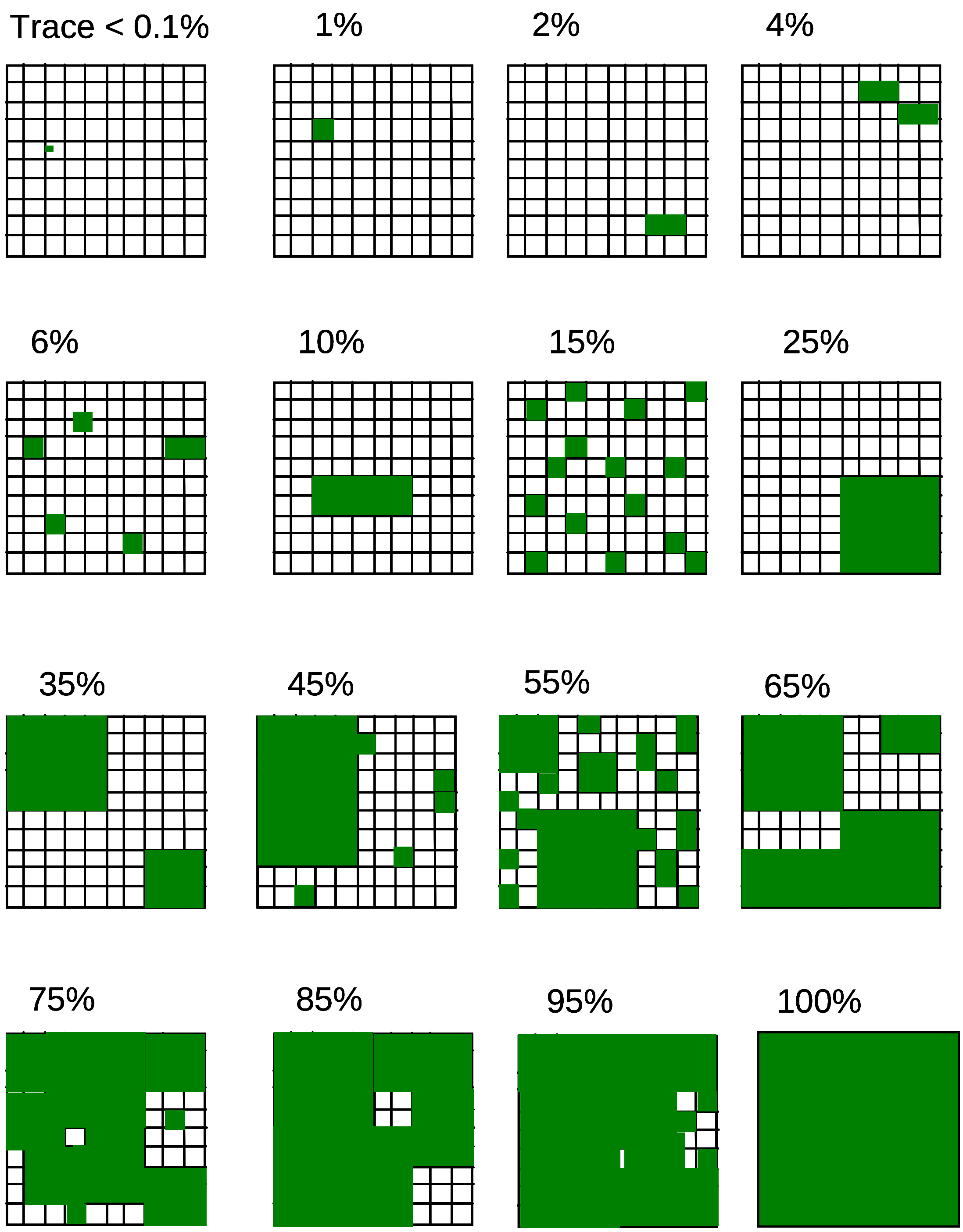


Chart 1. Examples of Percent Cover Estimates. Each large square = 100 m^2 module, grid squares = 1 m^2 (i.e., one grid square = 1% cover in a module), shaded areas represent cover of a vegetation stratum or of an individual species.

Figure 7. Examples of percent cover estimate.

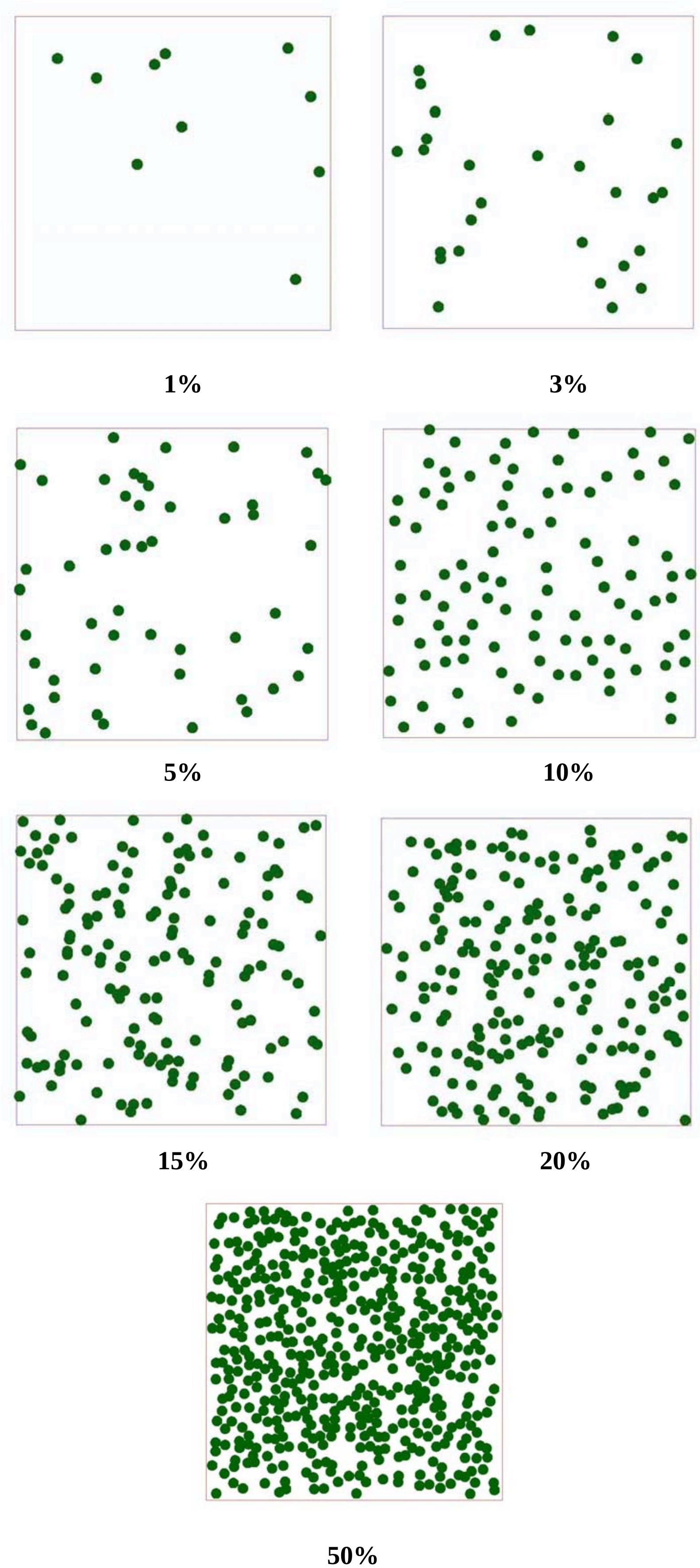


Figure 8. Examples of percent cover estimate.

2.4 Soil Profile Descriptions and Basic Water Chemistry Sampling

CNHP recommends digging at least two soil pits in the AA to describe soil profiles. In addition, if possible, basic water chemistry measurement of temperature, pH, and electro-conductivity (EC) can be made with a simple handheld meter. The location of soil and water sampling site should be determined 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: 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 F); 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 G 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 can be measured 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 Rank Factor: Landscape Context

Landscape context metrics evaluate the condition of the landscape surrounding the wetland AA. Anthropogenic impacts within the landscape can have a significant impact on wetland processes. These metrics include two Major Ecological Factors: 1) Landscape—the degree of natural connectivity in the landscape, as measured by contiguous natural land cover and the land use index; and 2) Buffer—the extent, width and condition of the natural buffer.

Major Ecological Factor: Landscape

Landscape metrics measure overall integrity of the landscape itself and the degree to which the wetland is connected to large-scale natural process.

Metric L1: Contiguous Natural Land Cover

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. 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 9). This percent of unfragmentated landscape can have small fragmentation inclusions (e.g., individual houses in a forested landscape, etc.), but roads that bisect the landscape form a hard boundary to the unfragmented block. Well-traveled dirt roads and major canals count as fragmentation, but hiking paths, non-tilled hayfields, open fences, and small lateral ditches can be included in unfragmented blocks (Table 7). 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.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 6.

Table 6. Rating for Landscape Fragmentation

Rank	*Score*	*State*
Excellent (A)	4	Intact: AA embedded in 90–100% contiguous natural landscape.
Good (B)	3	Variegated: AA embedded in 60–90% contiguous natural landscape.
Fair (C)	2	Fragmented: AA embedded in 20–60% contiguous natural landscape.
Poor (D)	1	Relictual: AA embedded in <20% contiguous natural landscape.

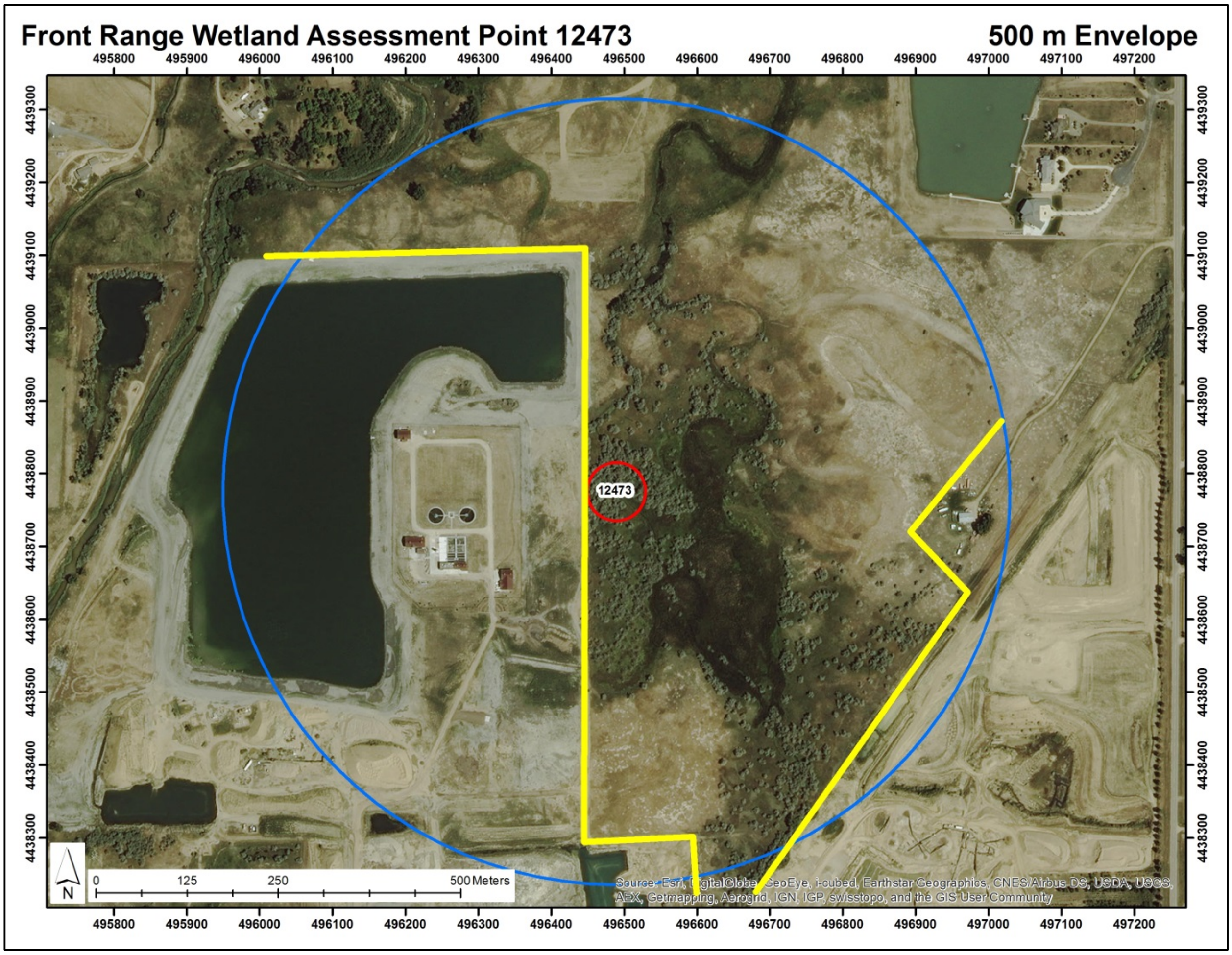


Figure 9. Example of calculating Metric L1: Contiguous Natural Land Cover. The AA is marked with a red circle. The 500 m envelope is marked with a blue circle. Yellow lines mark the edge of contiguous land cover in the 500 m radius envelope. In this example, only 58% of the 500 m envelope is contiguous with the AA, resulting in a C rating. The landscape is interrupted by roads and gravel extraction on the floodplain.

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.

Metric References: Metric concept and thresholds adapted from Rondeau (2001), Rocchio (2006a-g), and Faber-Langendoen et al. (2008). The categorical ratings are based on McIntyre and Hobbs (1999) and Heinz Center (2002).

Table 7. Land covers that are included and excluded from unfragmented blocks and natural buffers.

Examples of Land Covers Included in Unfragmented Blocks or Natural Buffers	*Examples of Land Covers Excluded from Unfragmented Blocks or Natural 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 Low 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/nonnative landscaping o Golf courses o Sports fields o Urbanized parks with active recreation o Paved or heavily used pedestrian/bike trails (frequent traffic) o Trails or levees that are significantly built up with fill 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 L2: Land Use Index

Definition and Background: This metric measures the intensity of human dominated land uses in the surrounding landscape and is based on Hauer et al. (2002) and Mack (2006). The intensity of human activity in the landscape has a proportionate impact on the ecological processes of natural ecosystems. Assessing land use incorporates both "habitat destruction" and "habitat modification" (sensu McIntyre and Hobbs 1999), at least for non-natural habitats. In addition to simply converting natural habitat to non-natural land uses, the Land Use Index takes into account the intensity of that land use. The Land Use Index weights intensive land uses (urban development) more heavily than passive land uses (recreation).

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

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

Measurement Protocol: The Land Use Index is measured by documenting surrounding land uses within 500 m of the AA. The assessment should be completed in the office using remote sensing imagery, such as aerial photographs, satellite imagery, or landcover datasets. Where feasible, the rating should be verified in the field, using roads or transects to verify land use categories. Ideally, both field data as well as remote sensing tools are used to identify an accurate percent of each land use within the landscape area, but remote sensing data alone can be used. This metric can be calculated as an automated GIS process using the National Land Cover Dataset[4] or the LANDFIRE Dataset[5], though both should be reviewed for accuracy.

To calculate a Land Use Index, estimate the percent of each land use category and calculate the corresponding category score based on land use coefficients (Table 9) and the following equation:

Land use category score = LU x PC/100

LU = Land use coefficient for each category

PC = % of adjacent area in each category

Do this for each land use category separately, then sum each category score to calculate the Total Land Use Score. If land uses overlap, use the more intensive land use for the calculation. For example, if 10% of the landscape contains unpaved roads (1 * 0.10 = 0.1), 30% is under moderate grazing (6 * 0.30 = 1.8), and 60% is natural vegetation (10 * 0.60 = 6.0), the Total Land Use Score would be 7.9 (0.1 + 1.8 + 6.0), for a rating of C.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 8.

Table 8. Rating for Land Use Index

Rank	*Score*	*State*
Excellent (A)	4	Land Use Index = 9.5–10.0.
Good (B)	3	Land Use Index = 8.0–9.49.
Fair (C)	2	Land Use Index = 4.0–7.99.
Poor (D)	1	Land Use Index = <4.0.

[4] The National Land Cover Dataset 2011 is available for download at: http://www.mrlc.gov/nlcd2011.php.
[5] The LANDFIRE Dataset is available for download at: http://www.landfire.gov/.

Table 9. Land use categories and coefficients. An example site is calculated below for illustration.

Land Use Categories[1]	*Coefficient*	*500 m Envelope*	
		% Area	*Score*
Paved roads, parking lots, domestic, commercial, and industrial buildings	0		
Gravel pit operation, open pit mining, strip mining, abandoned mines	0		
Unpaved roads (e.g., driveway, tractor trail, 4-wheel drive roads)	1	10%	0.1
Resource extraction (oil and gas)	1		
Tilled agricultural crop production (corn, wheat, soy, etc.)	2		
Intensively managed golf courses, sports fields, lawns	2		
Vegetation conversion (chaining, cabling, rotochopping, clearcut)	3		
Heavy grazing by livestock	3		
Logging or tree removal with 50-75% of large trees removed	4		
Intense recreation (ATV use / camping / popular fishing spot, etc.)	4		
Permanent crop agriculture (hay pasture, vineyard, orchard)	4		
Dam sites and disturbed shorelines around water storage reservoirs. Include open water of reservoir is there is intensive recreation, such as boating.	5		
Old fields and other disturbed fallow lands dominated by nonnative species	5		
Moderate grazing on rangeland	6	30%	1.8
Moderate recreation (high-use trail)	7		
Selective logging or tree removal with <50% of large trees	8		
Light grazing on rangeland	9		
Light recreation (low-use trail)	9		
Natural area / land managed for native vegetation	10	60%	6.0
Total Land Use Score			7.9

[1] Modified from Hauer et al. 2002.

Metric References: Metric and thresholds adapted from Hauer et al. (2002), Rocchio (2006a-g), and Faber-Langendoen et al. (2012).

Major Ecological Factor: Buffer

This factor evaluates the overall area and condition of the natural buffer immediately surrounding the AA using three measures: perimeter of the AA with natural buffer, width of the natural buffer (up to 100 m from the AA), and condition of the natural buffer. Natural wetland buffers are vegetated areas free from intensive management that surround a wetland (see Table 7 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 nonnative species, filtering nutrients and pollutants, and reducing erosion and sedimentation (ELI 2008).

Unlike other standalone metrics, the three Buffer metrics scores for the three Buffer metrics are combined during the overall roll-up. Each metric measures a different but related aspect of the buffer. A buffer that surrounds the entire wetland is good, but much better if it is wide. And a wide buffer is all the better if it is in good condition. For this reason, we use the following formula, which uses a geometric mean, for combining the buffer metrics: Buffer MEF Score = $(((B1*B2)^{1/2}) * B3)^{1/2}$

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 B1: Perimeter with Natural Buffer

Definition and Background: This metric measures the percent of the AA perimeter that is immediately surrounded by natural buffer land covers. 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 a natural buffer (Table 9). To be considered as a buffer, a suitable land cover must extend out from the AA edge at least 5 m in width and continue for at least 10 m in length around the AA perimeter (Figure 10).

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)	4	Natural buffer surrounds 100% of the AA perimeter.
Good (B)	3	Natural buffer surrounds 75–99% of the AA perimeter.
Fair (C)	2	Natural buffer surrounds 25–74% of the AA perimeter.
Poor (D)	1	Natural buffer surrounds <25% of the AA perimeter.

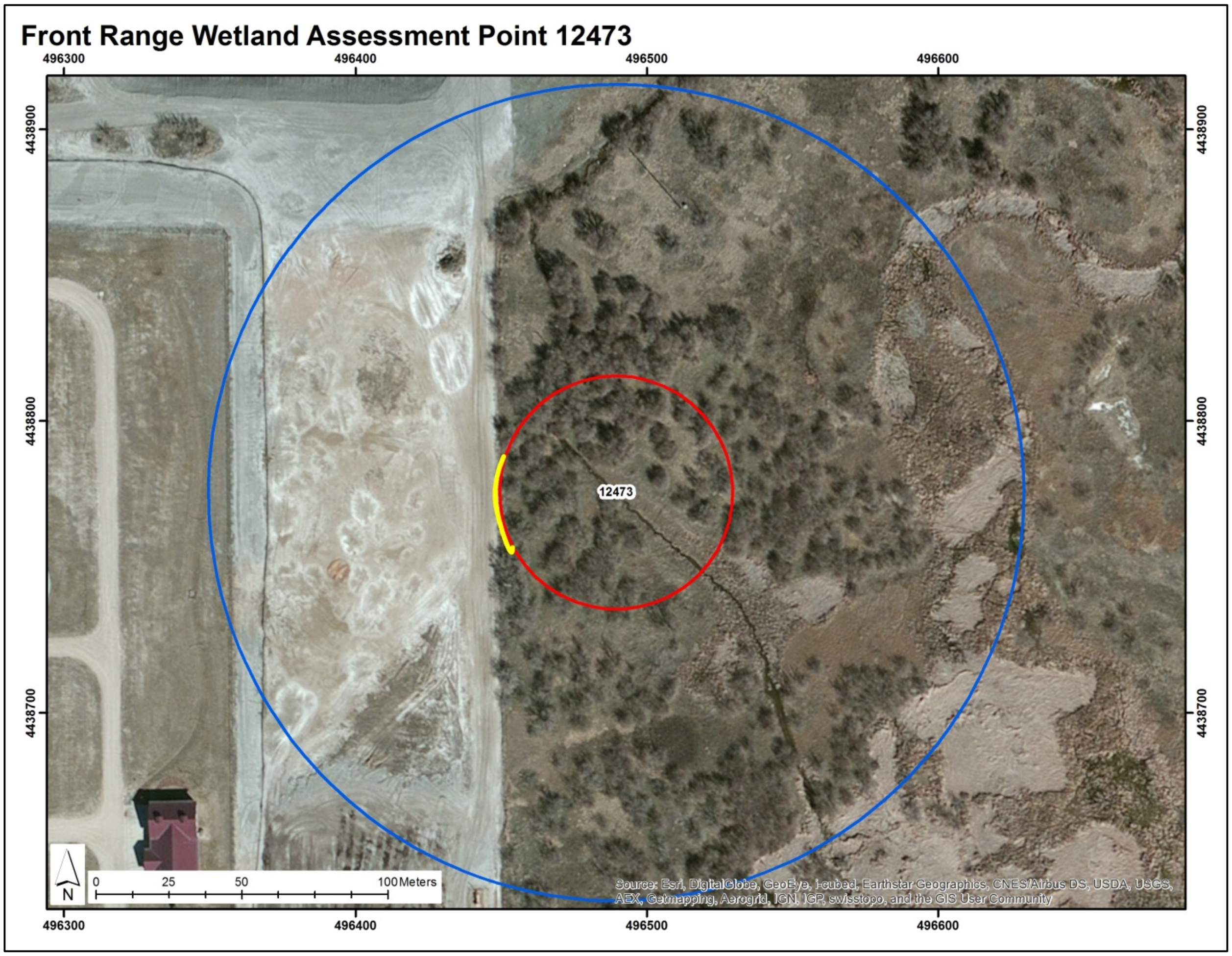


Figure 10. Example of calculating Metric B1: Perimeter with Natural Buffer. The AA is marked with a red circle. The yellow line indicates a portion of the AA perimeter lacking natural buffer.

Metric References: Metric and thresholds adapted from Collins et al. (2008), CWMW (2012), and Faber-Langendoen et al. (2008; 2012). Similar metrics are used in many other assessment methods.

Metric B2: Width of Natural Buffer

Definition and Background: This metric measures the width of the natural buffer, up to 100 m from the AA edge. Like perimeter, 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 100 m from the AA perimeter (Figure 11). End each line when it encounters a non-buffer land cover, as they do in Figure 11 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 worksheet on the back of the field form, calculate the average, and select the narrative description that matches the average.

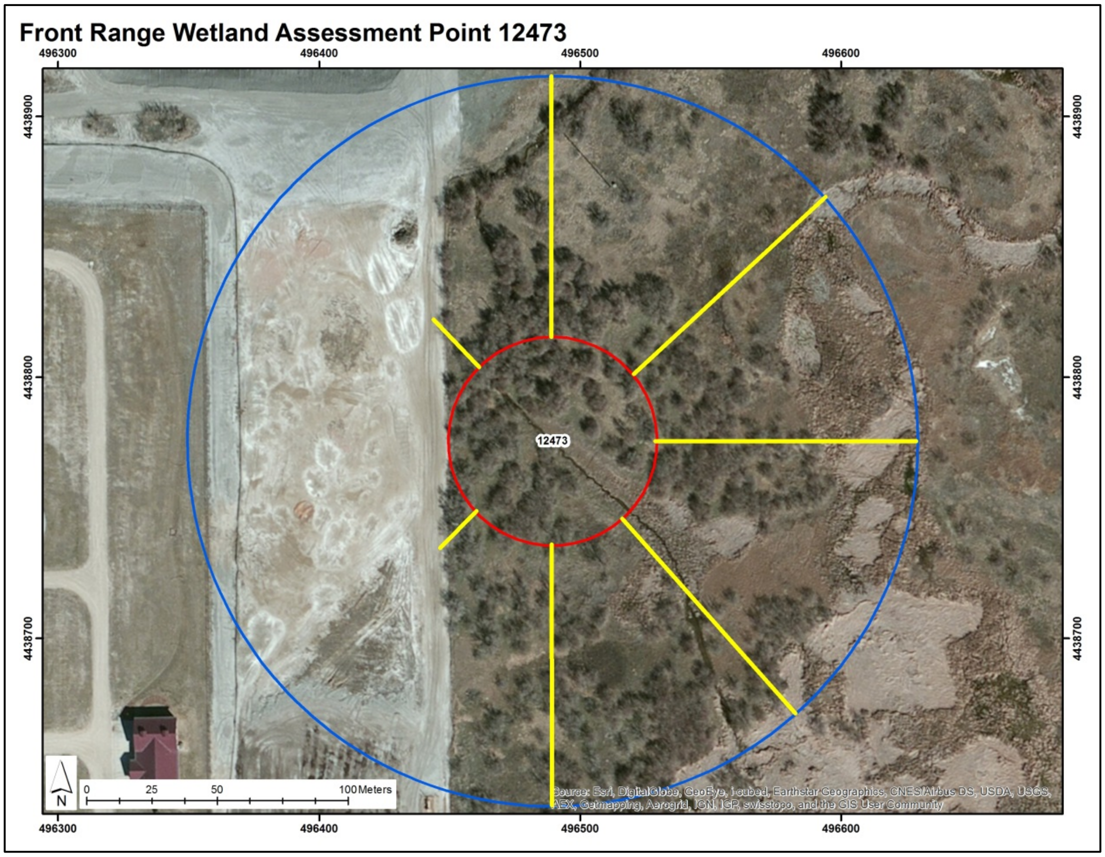
For wetland polygons lacking a centroid from which eight spokes could reasonably radiate from, draw a line as near to the center of the wetland polygon's long axis as possible (Figure 12). Once you have determined the length of the line along the wetland's long axis, divide the line by five to pinpoint four equally spaced locations along the axis. At each of the four points, draw a line perpendicular to the axis such that it extends out 100 m on both sides of the wetland's perimeter.

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)	4	Average buffer width is at least 100 m.
Good (B)	3	Average buffer width is 75–99 m.
Fair (C)	2	Average buffer width is 25–74 m.
Poor (D)	1	Average buffer width is <25 m.

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



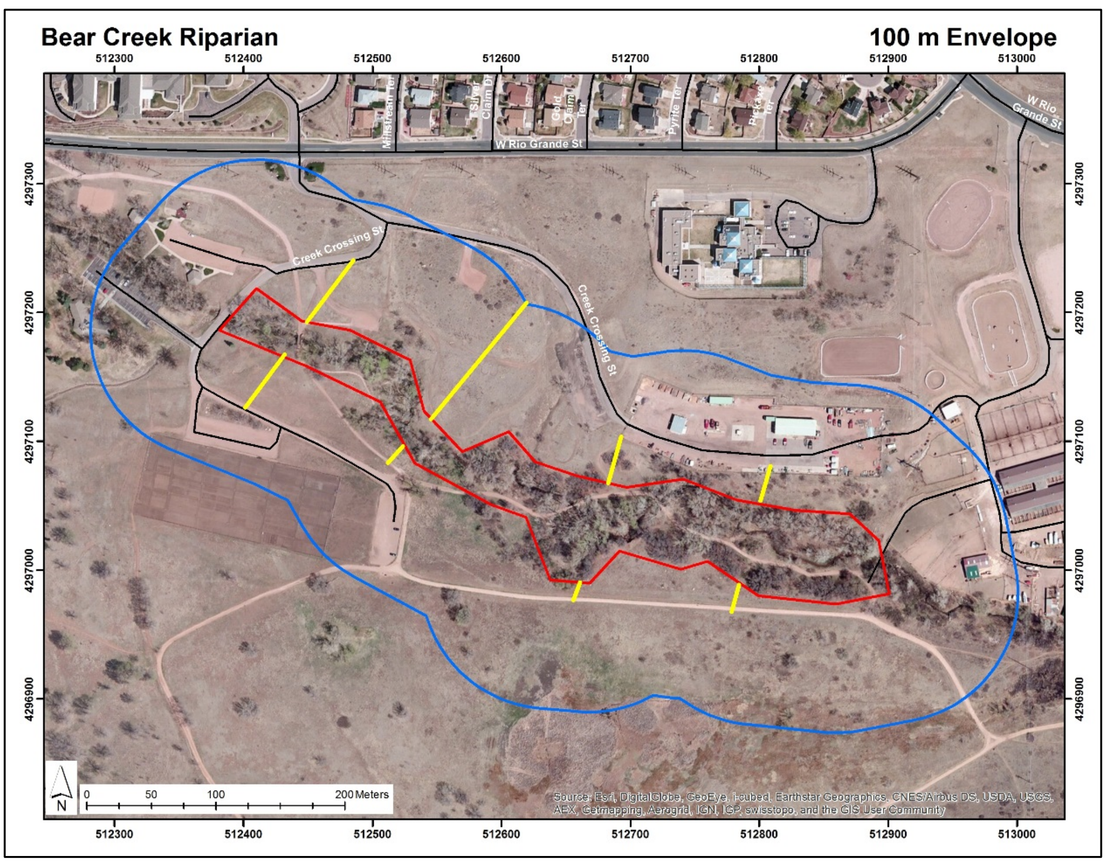


Figure 11. Examples of calculating Metric B2: Width of Natural Buffer. Top is with a circular AA. Bottom is a non-circular AA. The AAs are marked with red polygons. The 100 m envelopes are marked with blue polygons. Yellow lines extend to the edge of natural buffer land covers.

Metric B3: Condition of Natural Buffer

Definition and Background: The condition of the buffer can also limit its effectiveness. While a vegetated hay field (considered buffer) is better than parking lot (not considered buffer), but is far less effective at controlling nutrient loading and nonnative 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. Remember to look for nonnative hay grasses when evaluating vegetation in the buffer. Only consider *buffer areas* from B1 and B2 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. The two scores will be averaged in the scorecard calculations.

Table 12. Rating for Buffer Condition

Rank	***Score***	***State – Vegetation***	***State – Soils/Substrate***
Excellent (A)	4	Abundant (≥95%) relative cover native vegetation and little or no (<5%) cover of nonnative plants.	Intact soils, no water quality concerns, little or no trash, AND little or no evidence of human visitation.
Good (B)	3	Substantial (75–95%) relative cover of native vegetation and low (5–25%) cover of nonnative plants.	Intact or minor soil disruption, minor water quality concerns, moderate or lesser amounts of trash, AND/OR minor intensity of human visitation or recreation.
Fair (C)	2	Low (25–75%) relative cover of native vegetation and moderate to substantial (25–75%) cover of nonnative plants.	Moderate or extensive soil disruption, moderate to strong water quality concerns, moderate or greater amounts of trash, AND/OR moderate intensity of human use.
Poor (D)	1	Very low (<25%) relative cover of native vegetation and dominant (>75% cover) of nonnative plants OR no buffer exists.	Barren ground and highly compacted or otherwise disrupted soils, significant water quality concerns, substantial amounts of trash, extensive human use, OR no buffer exists.

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

3.2 Rank Factor: Condition

Condition metrics directly evaluate the condition the wetland AA. These metrics focus on three Major Ecological Factors: 1) vegetation condition; 2) hydrologic condition; and 3) physiochemical condition, including soils and water quality.

Major Ecological Factor: Vegetation

Vegetation condition is at the heart of the EIA method. Ecological and biological-based condition 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 into two groups: vegetation composition 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.

Metric V1: Native Plant Species Cover (Relative)

Definition and Background: This metric measures the relative percent cover of native species in the AA. This metric is one measure of 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 nonnative species to invade and even dominant wetlands. Nonnative 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 nonnative 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 nonnative species with 5% cover of the AA could only represent 2% relative total cover if there is extensive overlap of vegetation layer. With overlapping vegetation layers, the total cover of all species can be >100%. Alternatively, a nonnative 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 their nativity is known.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 13.

Table 13. Rating for Percent Cover Native Species

Rank	*Score*	*State*
Excellent (A)	4	AA contains >99% relative cover of native plant species.
Good (B)	3	AA contains 95–99% relative cover of native plant species.
Fair (C)	2	AA contains 85–95% relative cover of native plant species.
Fairly Poor (C-)	1.5	AA contains 60–85% relative cover of native plant species.
Poor (D)	1	AA contains <60% relative cover of native plant species.

Metric V2: Invasive Nonnative Plant Species Cover (Absolute)

Definition and Background: This metric measures the absolute percent cover of invasive nonnative plant species. An invasive species is defined as "a species that is nonnative to the ecosystem whose introduction causes or is likely to cause environmental harm." (Executive Presidential Order 1999, Richardson et al. 2000), For the purpose of the Colorado EIA, we rely mainly on the Colorado Department of Agriculture Noxious Weed Lists A, B, and C (Appendix H) to define invasive nonnative species. Noxious weeds are nonnative 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. Using the Colorado Noxious Weed Lists provides a standard list that is easily accessible for all users. In addition to the official Noxious Weed Lists, we also consider kochia or burning bush (*Kochia scoparia* syn = *Bassia scoparia* or *Bassia sieversiana*) and Russian thistle (*Salsola tragus* syn = *Salsola iberica*) as invasive nonnative species for the purpose of this metric. Both are extremely common and aggressive. Other species may be considered at the user's discretion.

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 by summing all invasive nonnative species. 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 14.

Table 14. Rating for Noxious Weeds

Rank	*Score*	*State*
Excellent (A)	4	Invasive nonnative species are absent from all strata.
Good (B)	3	Invasive species present, but sporadic (<4% absolute cover).
Fair (C)	2	Invasive species somewhat abundant (4–10% cover).
Fairly Poor (C-)	1.5	Invasive species abundant (11–30% cover).
Poor (D)	1	Invasive species very abundant (>30% cover).

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

Metric V3: Native Plant Species Composition

Definition and Background: This metric measures the overall vascular plant species composition and diversity of native diagnostic species and native increasers (including the "native invasives" of Richardson et al. 2000). Every wetland type has a specific range of species that can be expected to dominate under reference or minimally disturbed conditions. Those species 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 1996). This predictable pattern is the basis behind the Floristic Quality Assessment (FQA; see Section 1.2 for more background). The integrity of ecosystems is optimized when a characteristic native plant species composition dominates the plant community, and suitable habitat exists for multiple animal species. Much of the natural microbial, invertebrate, and vertebrate species of wetlands respond to overall vegetation composition. Vegetation composition also reflects the interactions between plants and physical processes, especially hydrology. A change in vegetation composition, as a result of invasive and exotic plant invasions for example, can have cascading effects on system form, structure, and function.

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

Metric Application: Use for all wetlands. Further detail by wetland type available from CNHP.

Measurement Protocol: Walk the AA and observe the abundance and diversity of native species and select a statement that best describes the composition. Look for native species diagnostic of the system vs. native increasers that may thrive in human disturbance. A species list with cover values can be very helpful rating this metric, or comparing one site to others of the same type. FQA indices, such as Native Mean C or the Floristic Quality Index (FQI) can be used to assess the metric. Refer to further documentation by CNHP for rating guidance by wetland type.

The metric refers to both diagnostic and increaser species. Diagnostic species are native plant species whose relative abundance or constancy differentiates one type from another, including dominant species (those with high abundance or cover) and character species (those strongly restricted to a type). Together these species can indicate certain ecological conditions, typically that of minimally disturbed sites. Increaser species are native species whose dominance is indicative of degrading ecological conditions, such as heavy grazing or browse pressure (Daubenmire 1968). For some wetland types, particularly marshes and other depressional wetlands, increaser species can be more problematic than nonnative species due to excess nutrients. For the purpose of this metric, reed canarygrass (*Phalaroides arundinacea = Phalaris arundinacea*); giant reed (*Phragmites australis*); and cattails (*Typha* spp.), which all have both native and nonnative types, are considered native increasers.

This metric focuses on native plant composition and does not ask directly about nonnative plant species. To rate the metric, it is helpful imagine the wetland will all nonnative species removed. However, since the metric language asks whether native diagnostics species have been reduced in abundance, the metric does address nonnative indirectly. If the prevalence of nonnative species results in low cover of native species, the metric would be rated lower.

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

Table 15. Rating for Native Plant Species Composition.

Rank	*Score*	*State*
Excellent (A)	4	Native plant species composition with expected natural conditions: i) Typical range of native diagnostic species present, AND ii) Native species sensitive to anthropogenic degradation are present, AND iii) Native species indicative of anthropogenic disturbance (i.e., increasers, weedy or ruderal species) absent to minor.
Good (B)	3	Native plant species composition with minor disturbed conditions: i) Some native diagnostic species absent or substantially reduced in abundance, OR ii) Native species indicative of anthropogenic disturbance are present with low cover.
Fair (C)	2	Native plant species composition with moderately disturbed conditions: i) Many native diagnostic species absent or substantially reduced in abundance, OR ii) Native species indicative of anthropogenic disturbance are present with moderate cover.
Poor (D)	1	Native plant species composition with severely disturbed conditions: i) Most or all native diagnostic species absent, a few remain in low cover, OR ii) Native species indicative of anthropogenic disturbance are present with high cover.

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

Metric V4: Vegetation Structure

Definition and Background: This metric measures overall structural complexity of the vegetation layers and growth forms, including presence of multiple strata, age and structural complexity of canopy layer, and evidence of the effects of disease or mortality on structure. In addition, this metric includes the accumulation and distribution of organic materials, both woody debris and litter. In wetlands, vegetation structure can have an important controlling effect on composition and processes. 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. 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.

For all systems, this metric also incorporated litter and organic inputs. 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.

For woody systems, rating on Metrics V5 (Regeneration of Native Woody Species) and V6 (Coarse and Fine Woody Debris) can inform the overall rating of this metric.

Metric Level: Level 2 (rapid assessment).

Metric Application: Use for all wetlands. Specific guidance provided by wetland type.

Measurement Protocol: During the vegetation survey or while walking through the AA, note the overall structure of the vegetation and the quantity and distribution of litter compared with expected condition. It can be helpful to refer to the AA sketch and the description of biotic and abiotic zone when thinking about the complexity of the site. Table 19 provides a list of potential physical patch types to note. Then select the statement that best describes the vegetation structure within the AA.

Metric Rating: Assign the metric rating and associated score based on the thresholds in Table 16. Specific guidance is provided for marshes, meadows, and playas (Table 17) and for riparian areas (Table 18).

Table 16. General Rating for Vegetation Structure.

Rank	***Score***	***State***
Excellent (A)	4	Vegetation structure is at or near minimally disturbed natural conditions. Little to no structural indicators of degradation evident.
Good (B)	3	Vegetation structure shows minor alterations from natural conditions.
Fair (C)	2	Vegetation structure is moderately altered from natural conditions.
Poor (D)	1	Vegetation structure is greatly altered from natural conditions.

Table 17. Specific Guidance for Marshes, Meadows and Playas.

Rank	*Score*	*State*
Excellent (A)	4	**All types:** Structural patches/zones are appropriate in number and type for the system (can be few in playas, fens, meadows). There is diversity in vertical strata within the herbaceous vegetation (some tall and some short layers and/or low cover of shrubs or trees, where appropriate). Litter and other organic inputs are typical of the system (i.e., playas should have low litter while meadows and marshes should have moderate amounts of litter).
Good (B)	3	***Marshes***: Cattail and bulrush density may prevent animal movement in some areas of the wetland, but not throughout. ***Meadows:*** Grazing and mowing have minor effects. Litter accumulation is slightly affected. ***Playas:*** Natural areas of bare ground are still prevalent, though non-native or weedy species may be encroaching.
Fair (C)	2	***Marshes***: Cattail and bulrush density may prevent animal movement in half or more of the wetland. Litter accumulation is high and dense. ***Meadows:*** Grazing and mowing have moderate effects. Litter accumulation is moderately affected. ***Playas:*** Natural areas of bare ground are present, but non-native or weedy species have filled in many area.
Poor (D)	1	***Marshes***: Cattail and bulrush density prevent animal movement throughout the wetland. Accumulated litter may fill in spaces between plants, further blocking movement. ***Meadows:*** Grazing and mowing greatly affect the structure of the vegetation and prevalence of litter. ***Playas:*** Natural areas of bare ground are absent due to an abundance of non-native or weedy species.

Table 18. Specific Guidance for Riparian Areas.

Rank	*Score*	*State*
Excellent (A)	4	AA is characterized by a complex array of nested or interspersed patches. Canopy (if present) contains a mosaic of different ages or sizes, including large old trees and obvious regeneration. Number of live stems is well within expected range. Shrub and herbaceous layers are complex, providing a diversity of vertical strata. Woody species are of sufficient size and density to provide future woody debris to stream or floodplain. Litter layer is neither lacking nor extensive.
Good (B)	3	AA is characterized by a moderate array of nested or interspersed zones with no single dominant zone, though some structural patches (especially open zones) may be missing. Canopy still heterogeneous in age or size, but may be missing some age classes. Vertical strata may be somewhat less complex than natural conditions. Woody debris or litter may be somewhat lacking.
Fair (C)	2	AA is characterized by a simple array of nested or interspersed zones. One zone may dominate others. Vertical strata may be moderately less complex than natural conditions. Site may be denser than natural conditions (due to non-native woody species) or may be more open and decadent. Woody debris or litter may be moderately lacking.
Poor (D)	1	AA is characterized by one dominant zone and several expected structural patches or vertical strata are missing. Site is either extremely dense with non-native woody species or open with predominantly decadent or dead trees. Woody debris and/or litter may be absent entirely or may be excessive due to decadent trees.

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

Table 19. 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.
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.

Metric V5: Regeneration of Native Woody Species [optional]

Definition and Background: This metric measures the regeneration of native woody species within the AA. 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 need to be high enough following flooding to maintain moist soil through the late summer in order for seedlings to survive and establish a deep root system. Lack of reproduction is indicative of altered ecological processes and has adverse effects on the integrity of a riparian area and its ability to provide wildlife habitat.

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 20.

Table 20. Rating for Regeneration of Native Woody Species

Rank	*Score*	*State*
N/A	--	Woody species are naturally uncommon or absent.
Excellent (A)	4	All age classes of *native* woody species present. Native tree saplings /seedlings and shrubs common to the type present in expected amounts and diversity. Regeneration in obvious.
Good (B)	3	Age classes of *native* woody species restricted to mature individuals and young sprouts. Middle age groups appear to be absent or there is some other indication that regeneration is moderately impacted.
Fair (C)	2	*Native* woody species comprised of mainly mature individuals OR mainly evenly aged young sprouts that choke out other vegetation. Regeneration is obviously impacted. Site may contain Russian Olive and/or Salt Cedar.
Poor (D)	1	*Native* woody species predominantly consist of decadent or dying individuals OR are absent from an area that should be wooded. Site may be dominated by Russian Olive / Salt Cedar.

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

Metric V6: 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 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 21.

Table 21. Rating for Coarse and Fine Woody Debris

Rank	*Score*	*State*
N/A	--	There are no obvious inputs of woody debris.
Excellent / Good (A/B)	4	AA characterized by moderate amount of coarse and fine woody debris, relative to expected conditions. There is wide size-class diversity of standing snags and downed logs in various stages of decay. 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)	2	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-Langendoen et al. (2008) with input from the literature.

Major Ecological Factor: Hydrology

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 (where the water is coming from); hydroperiod (the timing and duration of inundation or saturation); and hydrologic connectivity (the ability of water to both reach the wetland and move naturally through and beyond it). 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 temper the effects of alterations on hydrology. Examining the size and influence of hydrology stressors is 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.

Metric H1: Water Source

Definition and Background: This metric assesses the *direct inputs of water* to the AA, which are essential to the very existence of wetlands, especially during the growing season. The water inputs affect the processes, structure, and geomorphology of wetlands. Natural wetlands have developed in response to natural water sources. Artificial water sources often different dramatically in terms of hydroperiod, sediment and nutrient loads, and predictability.

This metric compares the proportion of water that enters the wetland from natural vs. artificial sources. Natural water sources include precipitation, groundwater discharge, overbank flooding, 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 if the source would be depleted if the pipe or ditch was turned off.

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 groundwater? Or is the wetland in a dry landscape, 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 inches of organic soil) does confirm a natural groundwater source (at least in part), because the rate of peat accumulation (~8 in/1,000 yrs: Chimner et al. 2002 is slow enough that true peat could not have formed since European settlement.

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

Metric Application: Use for all wetlands. Specific guidance provided by wetland type.

Measurement Protocol: Review the aerial photos and topographic maps for potential sources. It is important to look at the larger landscape, not just the immediate surroundings. 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. 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 22) to identify all major water sources influencing the AA. Mark all inlets on the aerial photo and those within the AA on the site sketch. New development such as new roads or oil and gas wells should be noted. If there is an indication that inflow during the growing season is controlled by artificial water sources, explain in comments. Once all available information is gathered, select the statement on the form that best describes the water sources feeding the AA during the growing season.

Table 22. 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 groundwater	_____ 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 23.

Table 23. Rating for Water Source.

Rank	***Score***	***State***
Excellent (A)	4	Water sources are natural. Site hydrology is fed by precipitation, groundwater, natural runoff, or natural flow from an adjacent freshwater body. The system may naturally lack water at times, even for several years. 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)	3	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 area, some road runoff, small storm drains or other minor point source discharges. No large point sources control the overall hydrology.
Fair (C)	2	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 area or moderate point source discharges into the wetland, such as many small storm drains or a few large ones or many sources of irrigation runoff. The key factors to consider are whether the wetland is located in a landscape position that supported wetlands before irrigation / 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 or natural stream channels that now receive substantial irrigation return flows).
Poor (D)	1	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 factors to consider are whether the wetland is located in a landscape position that likely never supported a wetland prior to human development *OR* did support a wetland, but is now disconnected from its natural water source. The reason the wetland exists is because of direct irrigation, irrigation seepage, irrigation return flows, urban storm water runoff, or direct pumping.

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

Metric H2: 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. Riverine wetlands may have seasonal cycles that are governed by rainfall and runoff. Depressional and lacustrine wetlands may have daily variations in water height that are governed by diurnal increases in evapotranspiration. 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. 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, urban storm water inputs, agricultural runoff) 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 predominantly artificial, 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. Specific guidance provided by wetland type.

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. New development, such as new roads or oil and gas wells, should be noted on the field form for later reference. During the site walk through, look for indicators of altered hydroperiod (Tables 24 and 25). Once all available information is gathered, select the statement that best describes the alteration to the hydroperiod during the growing season.

Table 24. Hydroperiod Field Indicators for Evaluating Riverine / Riparian Wetlands.

Condition	***Field Indicators***
Indicators of Channel Equilibrium / Natural Dynamism	• 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 or 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 bankfull stage corresponds to the lower limit of riparian vascular vegetation. • The channel contains embedded woody debris of the size and amount consistent with what is available in the riparian area. • Leaf litter, thatch, wrack, and/or mosses exist in most pools. • 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. The lack of this vegetation indicates flooding at regular intervals.
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 are partially buried, or sediment-choked, culverts.
Indicators of Active Degradation / Excessive Erosion	• Portions of the channel are 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 may be declining in stature or vigor, and/or riparian trees and shrubs may be falling into the channel. • The channel bed lacks any 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 25. Hydroperiod Field Indicators for Evaluating Non-Riverine Wetlands.

Condition	***Field Indicators***
Reduced Extent and Duration of Inundation or Saturation	• Upstream spring boxes, diversions, impoundments, pumps, ditching, or draining from the wetland. • Evidence of aquatic wildlife mortality. • Encroachment of terrestrial vegetation. • Stress or mortality of hydrophytes. • Compressed or reduced plant zonation. • Drying organic soils occurring well above contemporary water tables.
Increased Extent and Duration of Inundation or Saturation	• Berms, dikes, or other water control features that increase duration of ponding (e.g., pumps). • Diversions, ditching, or runoff moving water into the wetland. • Late-season vitality of annual vegetation. • Recently drowned riparian or terrestrial vegetation. • Extensive fine-grain deposits on the wetland margins.

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

Table 26. Rating for Hydroperiod.

Rank	*Score*	*State*
Excellent (A)	4	Hydroperiod is characterized by natural patterns of inundation/saturation and drawdown and/or flood frequency, duration, level and timing. There are no major hydrologic stressors that impact the natural hydroperiod. Riparian channels are characterized by equilibrium conditions with no evidence of severe aggradation or degradation indicative of altered hydrology.
Good (B)	3	Hydroperiod inundation and drying patterns deviate slightly from natural conditions due to presence of stressors such as: flood control/water storage dams upstream; berms or roads at/near grade; minor pugging by livestock; small ditches or diversions removing water; or minor flow additions from irrigation return flow or storm water runoff. Outlets may be slightly constricted, but not to significantly slow outflow. Riparian channels may have some sign of aggradation or degradation, but approach equilibrium conditions. 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)	2	Hydroperiod inundation and drying patterns deviate moderately from natural conditions due to presence of stressors such as: flood control/water storage dams upstream or downstream that moderately effect hydroperiod; 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; ditches or diversions 1–3 ft. deep; or moderate flow additions. Outlets may be moderately constricted, but flow is still possible. Riparian channels may show distinct signs of aggradation or degradation. *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.
Poor (D)	1	Hydroperiod inundation and drawdown patterns deviate substantially from natural conditions from high intensity alterations such as: significant flood control / water storage das upstream or downstream; 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. Riparian channels may be concrete or artificially hardened. *If wetland is artificially controlled,* the site is actively managed and not connected to any natural season fluctuations.

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

Metric H3: Hydrologic Connectivity

Definition and Background: This metric assesses the ability of water to flow to, 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 predominantly on field observation and is different by wetland type. For riverine wetlands, an important aspect of hydrologic connectivity is the degree of channel entrenchment, which limits the amount of water that can reach floodplain wetlands. Optional guidance on measuring entrenchment is included in Table 31 and Figure 10. If it is possible to measure channel entrenchment, it will inform this rating. If not, it can be estimated from visual clues. For certain wetland types, including playas and fens, artificial connectivity may actually degrade the site by adding excess water or causing drying.

Metric Level: Level 2 (rapid assessment).

Metric Application: Use for all wetlands. Specific guidance provided by wetland type.

Measurement Protocol: Search the AA for hard obstacles that impound and constrain flood waters, such as retaining walls, road grades, or entrenched banks. For playas and fens, look for artificial connectivity that may degrade the site. 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 Tables 27–30.

Table 27. Rating for Hydrologic Connectivity for Riverine / Riparian Systems.

Rank	*Score*	*State*
Excellent (A)	4	Completely connected to floodplain (backwater sloughs and channels). No geomorphic modifications made to contemporary floodplain. Channel is not entrenched.
Good (B)	3	Minimally disconnected from floodplain. Up to 25% of stream banks may be affected by dikes, rip rap, and/or elevated culverts. Channel may be somewhat entrenched, but overbank flow occurs during most floods.
Fair (C)	2	Moderately disconnected from floodplain due to multiple geomorphic modifications. Between 25-75% of stream banks may be affected by dikes, rip rap, concrete, and/or elevated culverts. Channel may be moderately entrenched and disconnected from the floodplain except in large floods.
Poor (D)	1	Channel is severely entrenched and entirely disconnected from the floodplain. More than 75% of stream banks may be affected by dikes, rip rap, concrete and/or elevated culverts. Overbank flow never occurs or only in severe floods.

Table 28. Rating for Hydrologic Connectivity for Marshes and Meadows.

Rank	*Score*	*State*
Excellent (A)	4	No unnatural obstructions to lateral or vertical movement of surface or ground water. Rising water in the site has unrestricted access to adjacent upland, without levees, excessively high banks, artificial barriers, or other obstructions to the lateral movement of flood flows.
Good (B)	3	Minor restrictions to the lateral or vertical movement of surface and ground water by unnatural features such as levees, road grades or excessively high banks. Up to 25% of the site may be restricted by barriers to drainage. Restrictions may be intermittent along the margins of the AA, or they may occur only along one bank or shore. Flood flows may exceed the impoundments, but drainage back into the wetland may be incomplete due to the impoundments.
Fair (C)	2	Moderate restrictions to the lateral or vertical movement of surface and ground water by unnatural features such as levees, road grades or excessively high banks. Between 25–75% of the site may be restricted by barriers to drainage. Flood flows may exceed the impoundments, but drainage back into the wetland may be incomplete due to the impoundments.
Poor (D)	1	Essentially no hydrologic connection to adjacent landscape. Most or all stages may be contained within artificial banks, levees, or comparable features. Greater than 75% of the site is restricted by barriers to drainage.

Table 29. Rating for Hydrologic Connectivity for Playas.

Rank	*Score*	*State*
Excellent (A)	4	Surrounding land cover / vegetation does not interrupt surface flow. No artificial channels feed water to playa.
Good (B)	3	Surrounding land cover / vegetation may interrupt a minor amount of surface flow. Artificial channels may feed minor amounts of excess water to playa.
Fair (C)	2	Surrounding land cover / vegetation may interrupt a moderate amount of surface flow. Artificial channels may feed moderate amounts of excess water to playa.
Poor (D)	1	Surrounding land cover / vegetation may dramatically restrict surface flow. Artificial channels may feed significant amounts of excess water to playa.

Table 30. Rating for Hydrologic Connectivity for Fens.

Rank	*Score*	*State*
Excellent / Good (A / B)	4	No artificial connectivity with the surrounding water bodies that may cause unnatural drying.
Fair (C)	2	Partial connectivity (e.g., ditching or draining to dry the fen).
Poor (D)	1	Substantial to full artificial connectivity that has obvious effects of drying the peat body.

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

Table 31. 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).
6. Interpretation of entrenchment ratios.	Entrenched: Ratio < 1.4 Moderately Entrenched: Ratio 1.4–2.2 Slightly Entrenched: Ratio > 2.2

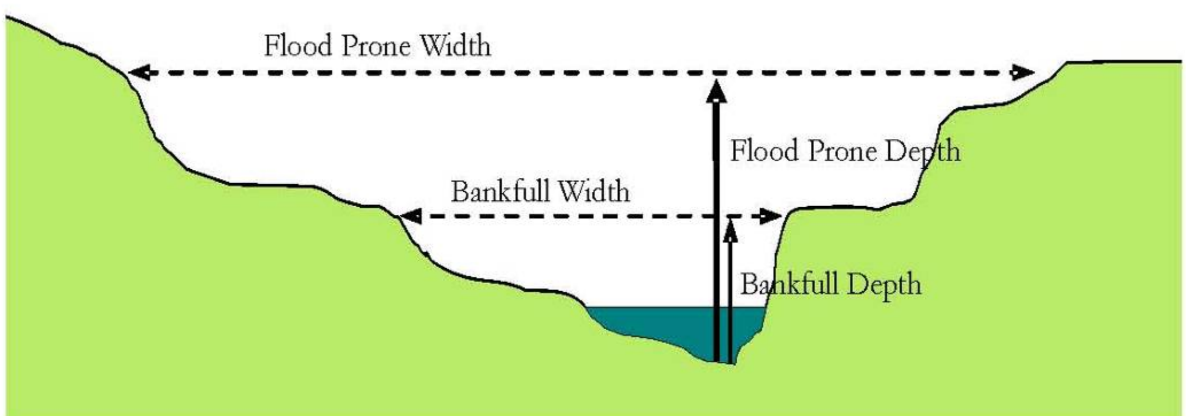


Figure 10. Elements of calculating entrenchment ration. Illustration from Collins et al. (2008).

Major Ecological Factor: Physiochemistry (Soils and Water Quality)

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

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.

Metric S1: 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. Specific guidance provided by wetland type.

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 Soil / Substrate Disturbance

Rank	*Score*	*State*
Excellent (A)	4	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)	3	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)	2	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 (2006a-g) and Faber-Langendoen et al. (2008; 2012).

Metric S2: 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: Walk the AA and observe any signs of turbidity or water pollutants in surface water. Select the statement on the form that best describes the turbidity or pollutant load of surface waters within the AA.

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

Table 33. 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 (2006a-g) and Faber-Langendoen et al. (2008).

Metric S3: 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 based on 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 marsh or pond dry-down, but would likely be rated a 'B'.

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

Table 34. Rating for Algal Gowth.

Rank	*Score*	*State*
N/A	--	No open water in AA or evidence of open water.
Excellent (A)	4	Water is clear with minimal algal growth.
Good (B)	3	Algal growth is limited to small and localized areas of the wetland. Water may have a greenish tint or cloudiness.
Fair (C)	2	Algal growth occurs in moderate to large patches throughout the AA. Water may have a moderate greenish tint or sheen.
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.

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

3.3 Rank Factor: Size

Size metrics evaluate both the comparative size of the wetland or AA (compared to other wetlands of the same type) and the change in 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. If they are included, size ranks will increase or decrease the site score by the following values: A = +0.50 points, B = +0.25 points, C = -0.25 points, and D = -0.50 points.

Major Ecological Factor: Size

Metric Z1: Comparative 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 wetland type.

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

Metric Application: Optional metric to be used if size is an important consideration. If used, ranks vary by wetland type.

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 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. 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.

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

Table 35. Rating for Comparative Size by Wetland Type.

Rank	*Score*	*State*		
		Meadows and Marshes	*Playas and Fens*	*Riparian Areas (must be >10 m throughout the extent)*
Excellent (A)	4	>10 hectares (>25 acres)	>2 hectares (>5 acres)	>5 km (>3 miles)
Good (B)	3	2–10 hectares (25 acres)	0.5–2 hectares (5 acres)	1–5 km (3 miles)
Fair (C)	2	0.5–2hectares (5 acres)	0.1–0.5 hectares (1 acre)	0.1–1 km (0.6 mile)
Poor (D)	1	<0.5 hectare (<1 acre)	<0.1 hectare (<0.25 acre)	<0.1 km (<0.06 mile)

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

Metric Z2: Change in Size

Definition and Background: This metric assesses 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 36.

Table 36. Rating for Change in Size.

Rank	*Score*	*State*
Excellent (A)	5	Occurrence is at, or only minimally reduced (<15%) from its original, natural extent, and has not been artificially reduced in size.
Good (B)	4	Occurrence is only somewhat reduced (15-10%) from its original natural extent.
Fair (C)	3	Occurrence is modestly reduced (10-30%) from its original, natural extent.
Poor (D)	1	Occurrence is substantially reduced (>30%) from its original, natural extent.

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

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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 June 6, 2015

Ecological systems are dynamic assemblages of plant communities that 1) occur together on the landscape; 2) are tied together by similar ecological processes and underlying abiotic environmental factors (soils, hydrology, landscape position, disturbance regime, etc.); and 3) form a readily identifiable unit on the ground. Ecological systems include both native, natural vegetation and non-native, human influenced vegetation. All wetland and riparian areas encountered in the Lower Arkansas River Basin should fit within the key. If a wetland or riparian area is clearly manipulated, created, or otherwise does not fit a description, attempt to fit it in one of the ecological systems and take note of how and why it differs from the description given. Within this version of the key, many comments are specific to the Lower Arkansas River Basin.

The scale at which ecological systems are delineated is important. Within the context of CNHP's wetland assessment projects, an assessment area (AA) could represent the entire extent of an ecological system or just part of one. If a wetland or riparian area is larger than the AA, all aspects of the system should be considered in the key, not just those within the AA. ***Make sure to look at the larger landscape when using this key.*** A mosaic of herbaceous and shrubby vegetation patches does not necessarily mean multiple ecological systems. Changes in dominant soil type or hydrology, however, can mean multiple ecological systems. Pay close attention to the size thresholds in the key when determining the ecological system or systems present. Percent cover thresholds are guidelines for the *footprint of an entire stratum*, not the percent cover of individual species, and are determined for the overall ecological system rather than the confines of the specific AA.

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. Wetlands that are isolated or partially isolated from floodplains and riparian zones. Often depressional or sloping, but may have an outlet. May be influenced by direct or indirect irrigation water. Vegetation is generally herbaceous. Large marshes associated with reservoirs key here, as do marshes located on the historic floodplain of the Arkansas River, but far from the active area of overbank flooding.................................... **2**

2b. Sites located within the floodplain or immediate riparian zone of a river or stream. Look at the entire landscape context to determine if the site is in a riparian zone, as some riparian sites may seem depressional in local areas. Vegetation often contains tall stature woody species, such as *Populus* spp, *Salix* spp., or non-native woody species (Salt Cedar and/or Russian Olive) OR vegetation may be entirely herbaceous and can sometimes seem marshy in character. Woody vegetation that occurs along reservoir edges can also be included here.. **5**

2a. 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 significantly depending on seasonal moisture availability, and many persistent species may be upland species. 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. ....**Western Great Plains Playa Wetland Group**

- **i.** In less saline environments, dominant species are typically not salt-tolerant. 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. ....**Western Great Plains Closed Depression Wetland**
- **ii.** In saline environments, salt encrustations can occur on the surface. Species are typically salt-tolerant, including *Distichlis spicata*, *Puccinellia* spp., *Salicornia* spp., *Schoenoplectus spp,. Sporobolus airoides,* and *Hordeum jubatum.* Other commonly occurring taxa include *Puccinellia nuttalliana, Suaeda calceoliformis, Spartina* spp., *Triglochin maritima,* and occasional shrubs such as *Sarcobatus vermiculatus* and *Krascheninnikovia lanata.* ....**Western Great Plains Saline Depression Wetland**

2b. 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.. **3**

3a. Herbaceous wetlands with persistent, deep standing water at or above the surface at some point in the growing season, except in drought years. The hydrology may be entirely managed or artificial. Managed systems may be drawn down at any point depending on water management regimes. Water may be brackish or not. Soils are highly variable. Vegetation typically dominated by species of *Typha, Scirpus, Schoenoplectus*, with *Carex*, *Eleocharis*, and *Juncus* spp. in lesser amount around the edges and floating genera such as *Potamogeton*, *Sagittaria*, and *Ceratophyllum* in open water. If located within a matrix of vegetation communities, the portion of the wetland meeting these characteristics must be at least **0.1 hectares (0.25 acres)** to be classified here (i.e., a small puddle with a few cattails does not count). The isolated expression of this system can occur as fringes around ponds or lakes, or associated with any impoundment of water, including irrigation run-off. The floodplain expression of this system can be located on the floodplain, but may be disconnected from flooding regimes. This system includes natural oxbows, sloughs, and other natural floodplain marshes as well as a variety of managed wetlands on the floodplain .... **North American Arid West Emergent Marsh**

3b. Herbaceous wetlands with that lack persistent, deep standing water at some point in the growing season OR experience extreme fluctuation in water levels to the point that wetland vegetation is difficult to establish or has died back. May be natural or non-natural. **4**

4a. Herbaceous wetlands associated with a high water table at or near the surface that typically lack prolonged standing water. Sites may be dominated by *natural* groundwater inputs with fairly stable hydrology. These wetlands generally occur on the landscape where there is a break in slope, seeps or springs, and/or stream headwaters. Sites may also be controlled by *artificial* overland flow (surface or subsurface irrigation runoff or return flow) or artificial groundwater seepage (including from leaky irrigation ditches). Site may be small or very large in size. These sites may be intentionally managed for hay production or may be the result of unintentional return flows, runoff or seepage. Vegetation is dominated by native or non-native herbaceous species; graminoids (grasses, sedges, rushes) 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. .... **Western Great Plains Wet Meadow (not an official Ecological System)**

4b Herbaceous (or occasionally herbaceous and woody mixed) sites within an obviously disturbed or non-natural landscape position, including reservoir fringes and/ or impounded ponds. Hydrology is often inconsistent and vegetation may not me dominated by wetland species. .... **Western Great Plains Disturbed Vegetation (not an official Ecological System)**

5a. Riparian woodlands and shrublands of the Rocky Mountain foothills. 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 also 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, 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**

5b. 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 Site may lack woody vegetation and be entirely herbaceous. **6**

6a. 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 closer to the Rocky Mountain front), groundwater seeps (prairie streams), and summer rainfall. Some spring-fed sites can include patches of marshy vegetation with very slow moving water. Dominant species include *Populus deltoides, Salix* spp., *Fraxinus pennsylvanica, Artemisia cana, Carex* spp., *Pascopyrum smithii, Panicum virgatum, Panicum obtusum, Sporobolus cryptandrus,* and *Schizachyrium scoparium.* Non-native species including *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**

6b. Woodlands, shrublands, and meadows along large rivers (the Arkansas River) with extensive floodplain development and periodic flooding that is more associated with snowmelt and seasonal dynamics in the mountains than with local precipitation events. Site may or may not be wetland. 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 <u>linked by underlying soils and the historic flooding regime</u>. Dominant species include *Populus deltoides* and *Salix* spp., *Carex* spp., *Panicum virgatum*, and *Andropogon gerardii.* Non-native species including *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**

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**

2b. 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*. .... **North Arid West 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 are typically associated with snowmelt or groundwater and not subjected to high disturbance events such as flooding (Slope HGM Class), though some may be *associated with a stream channel* and are more tightly connected to overbank flooding from the stream channel (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 nonnative herbaceous species; graminoids have the highest canopy cover. Species composition may be dominated by nonnative 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.

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 D: Defining an Assessment Area (AA) for Random Sampling

Establishing the Randomly Selected Assessment Area

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, crews should examine aerial photos of the points 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 crew 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 crew show always document the process used to move the AA and accompanying 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 be 0.5 ha (5000 m^2) where possible, but can be as small as 0.1 ha (1000 m^2) if necessary. For playas, the AA can be up to 100 m radius circle (31,415 m^2 or 3.14 ha) to capture the gradient of vegetation.

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 crew, which may be different for different crews 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) Take a GPS point at the original target point and record the waypoint number on the datasheet as the 'Point.'
2) Determine if the original point is target. Is it wetland or riparian area? Is there wetland or riparian area within 60 m? Record the Cowardin class of the original point on the datasheet to ground truth the NWI mapping.
3) Identify Ecological Systems at and surrounding the target point. Does the target point may fall on or near a boundary between two Ecological Systems? Once you have determine which Ecological System you will sample, then define the best AA. Do not assume that the 40-m radius circle on the field map is the best AA. Look beyond the circle to first understand the wetlands in the landscape.
4) Determine AA shape. This will be a 40-m radius circle, unless size and shape constraints require an alternative shape.
5) 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'. This should be a separate waypoint from the 'Point', even if the AA is centered on the original point. Record elevation, slope, and aspect at the center.
6) For non-standard AAs, including large area AAs for playas, 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.
7) Walk and 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.
8) 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.
9) 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 D.1). 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 D.2).

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.

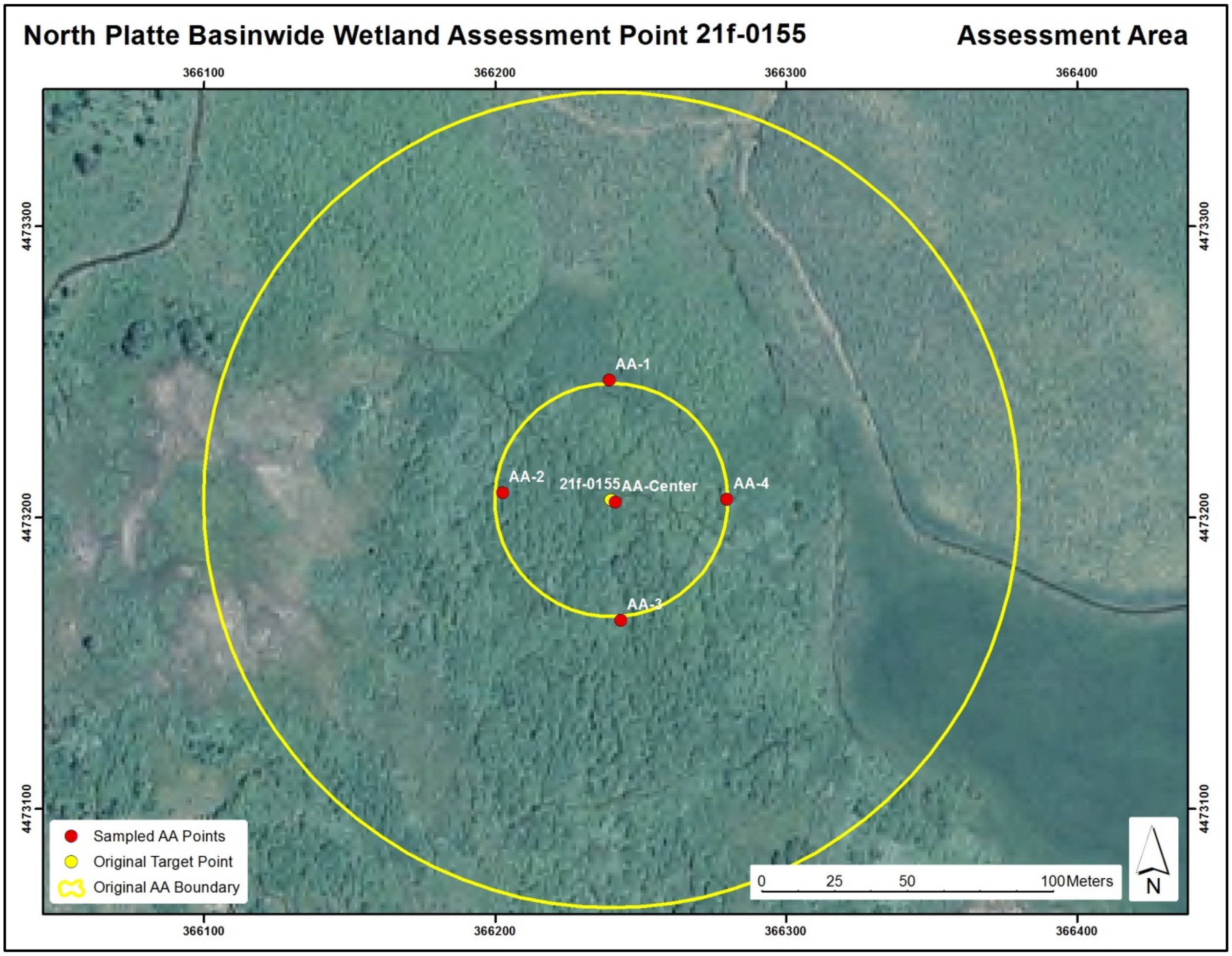


Figure D.1. Field map showing a standard 40-m radius circle AA layout centered on the target point. The inner yellow circle is the AA and the outer yellow circle is a 100 m envelope. The yellow point is the original target point and the red points are the AA-center and AA-perimeter points taken in the 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 D.2. 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 – 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 D.3). 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.

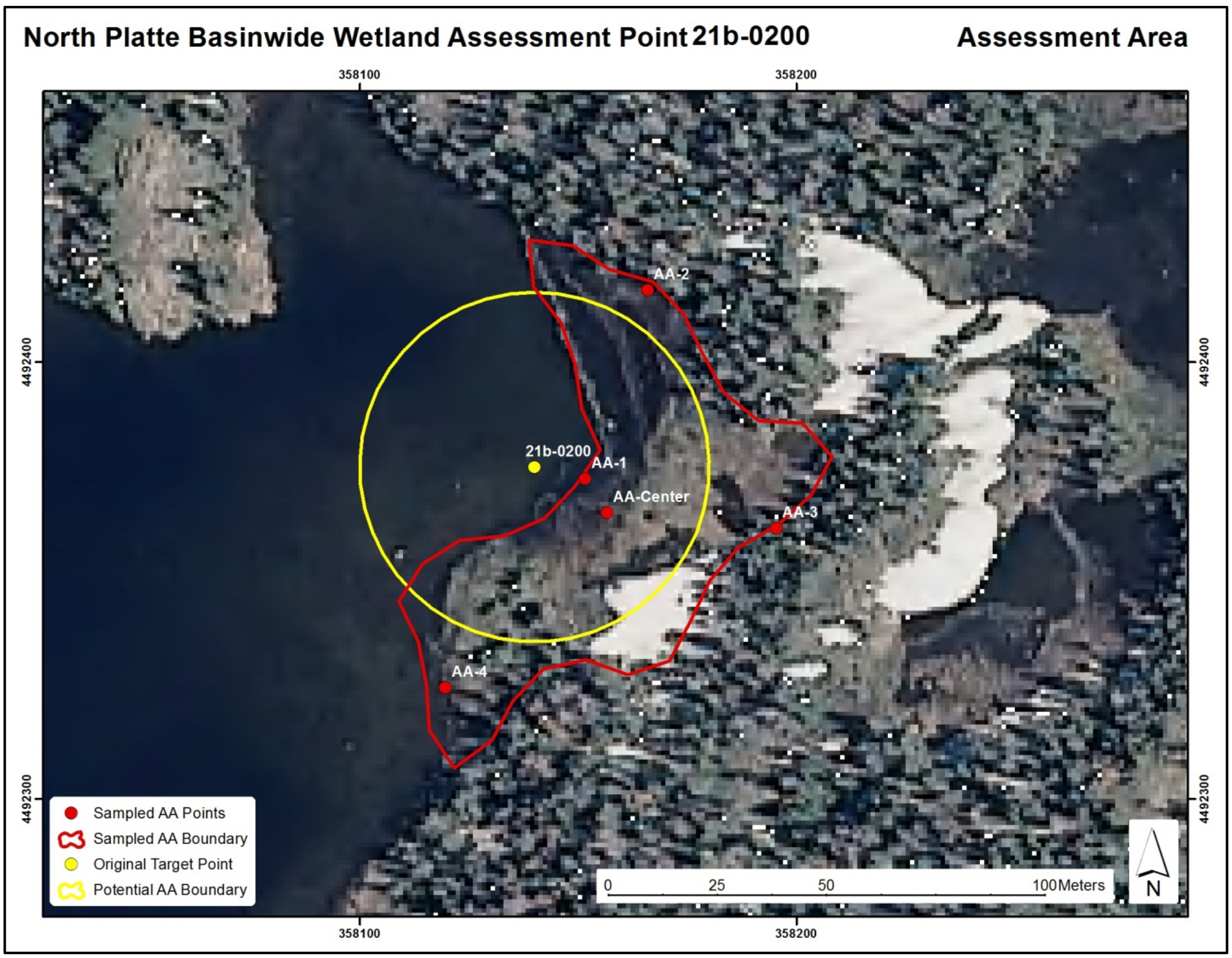


Figure D.3. Example of a freeform AA delineated during field sampling. The yellow point and circle represent the original target point and potential AA, which included water too deep to sample. The red polygon represents the 5000 m^2 freeform AA delineated in the field and the red point is the center of the sampled AA.

APPENDIX E: Level 3 Vegetation Sampling Protocols

Determining Placement of the Vegetation Plots

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 (USEPA 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.

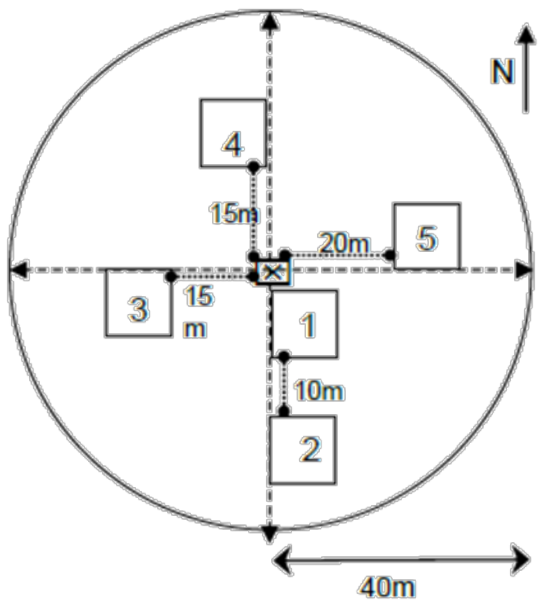
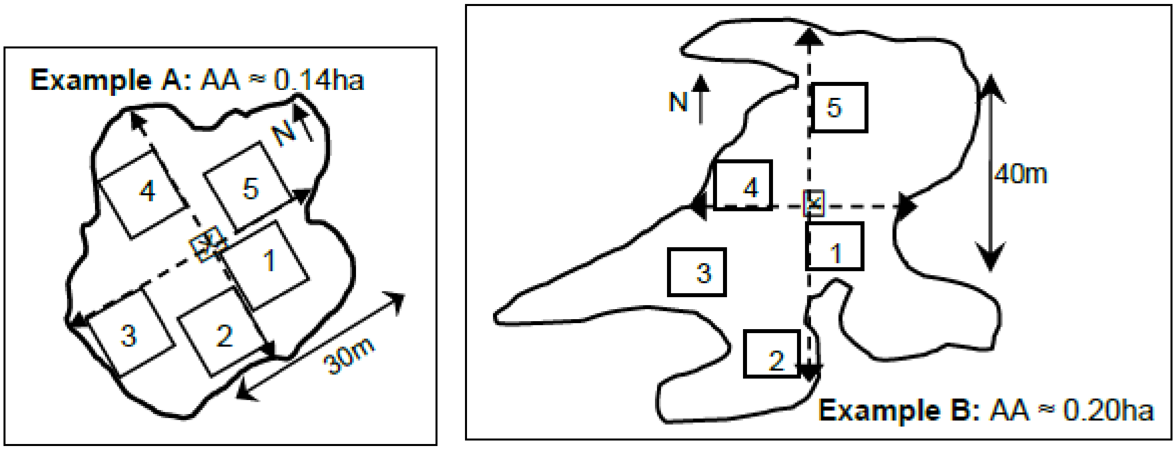


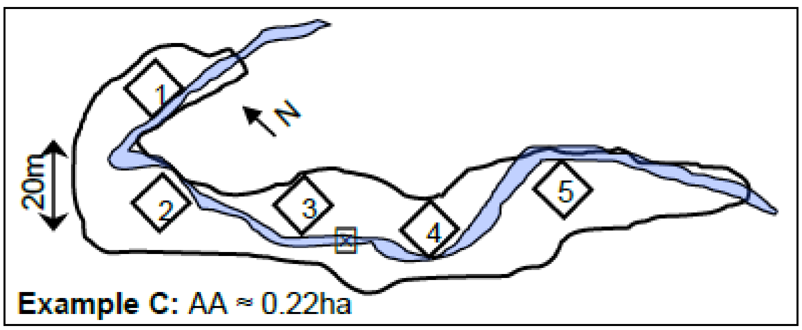
Figure E.1.. Standard Level 3 Veg Plot Layout. Vegetation Plots are located at specified distances from the AA center. Figure from USEPA (2011).

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. E.2)

2a) AA width and length >30m .... Wide Polygon Veg Plot layout (Fig. E.3)
2b) AA is ≤ 30m wide .... Narrow Polygon Veg Plot Layout (Fig. E.4)





Distribute the 5 Veg Plots using the most efficient arrangement to fit them in and cover the AA. Where possible arrange Veg Plots to conform with Standard or Polygon Layout configurations.

Orient Veg Plots on cardinal directions when possible, but if space is limiting orient individual Veg Plots to bearings allowing them to fit in the AA.

Figure E.2. 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 USEPA (2011).

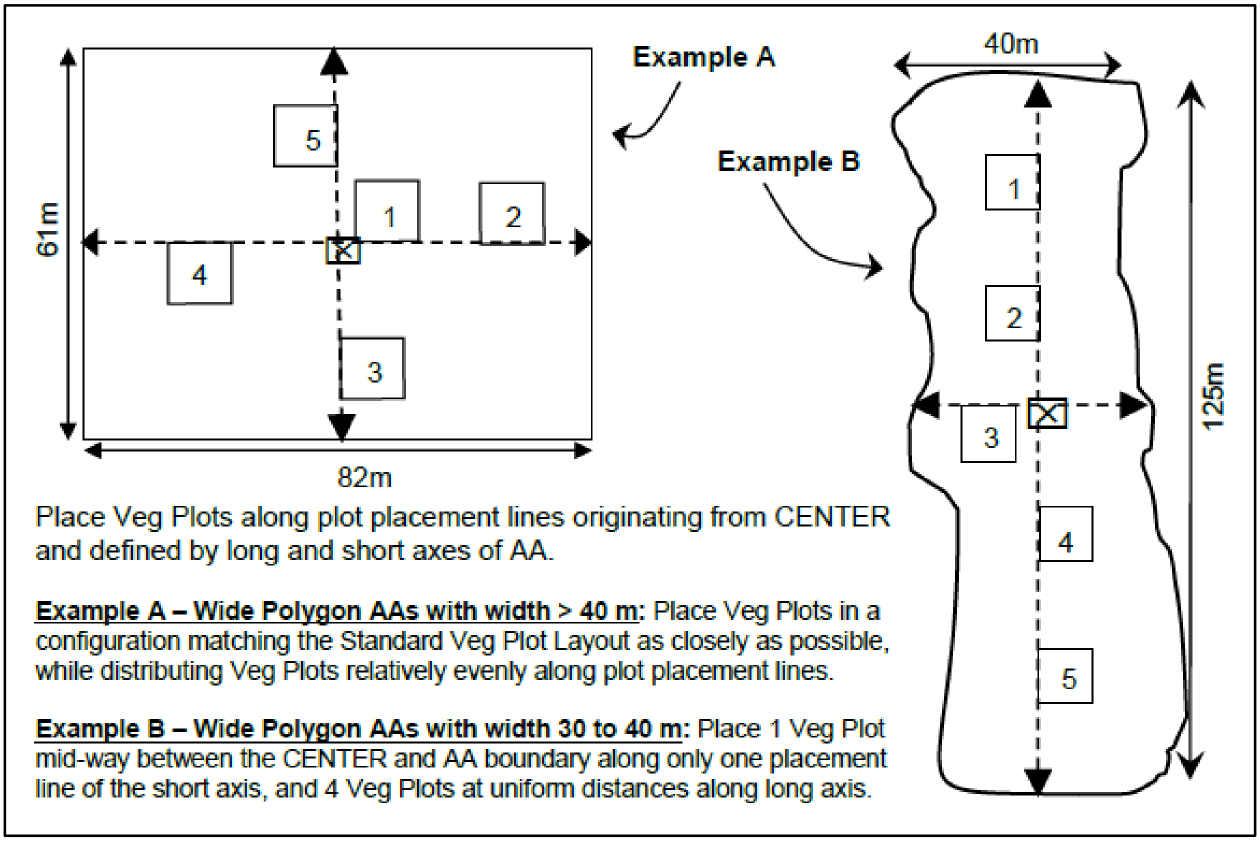


Figure E.3. Examples of Wide Polygon Veg Plot Layouts. Veg plots are laid out along both axis as close to the standard layout as possible. Figures from USEPA (2011).

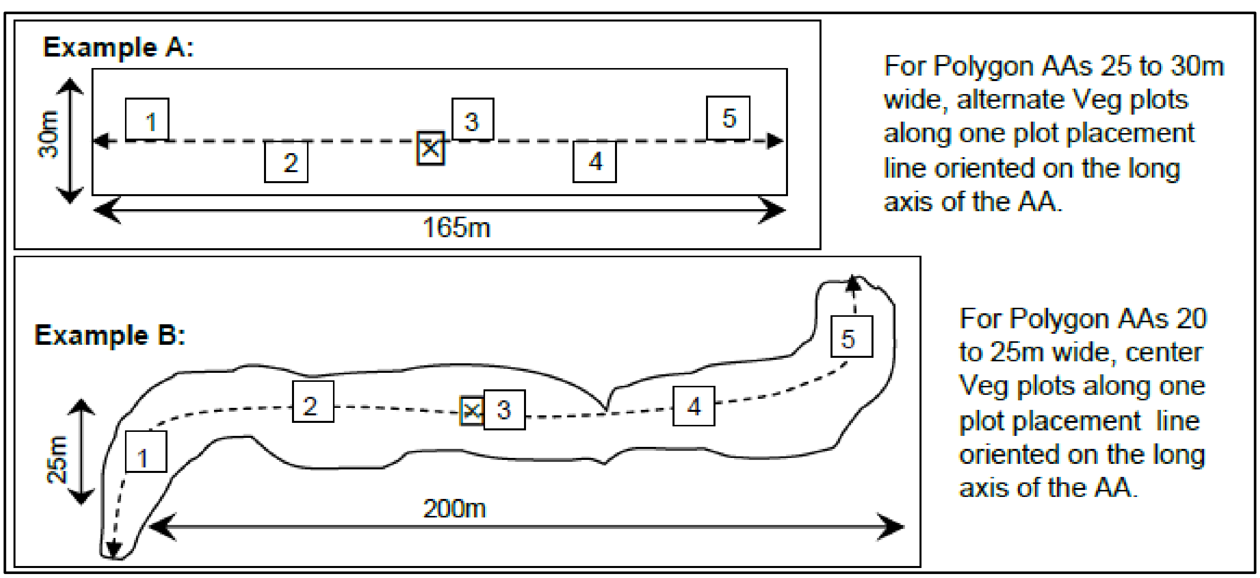


Figure E.4. Examples of Narrow Polygon Veg Plot Layouts. Veg plots are laid out along one axis of the AA, spaced as evenly as possible. Figures from USEPA (2011).

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.

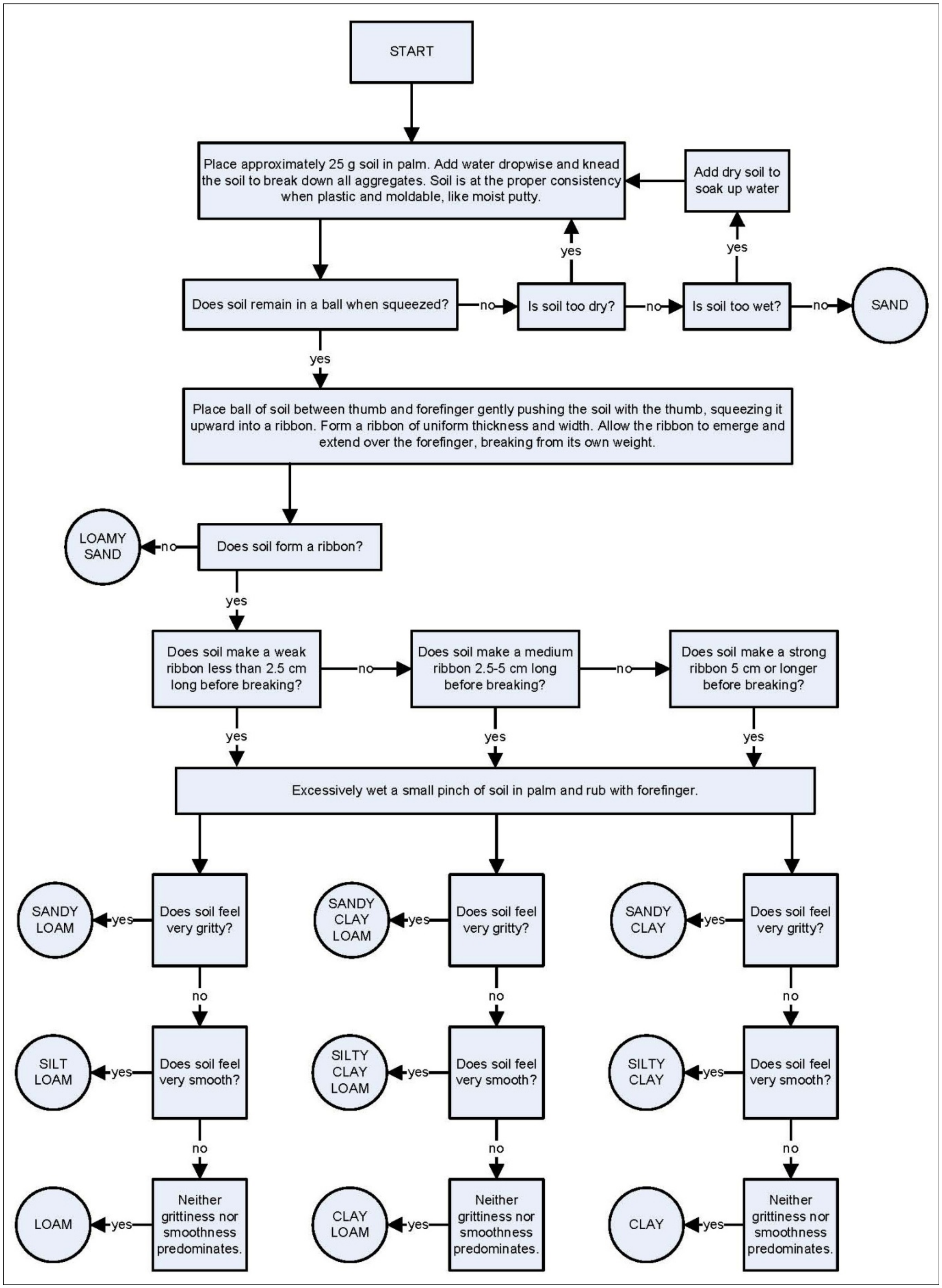
Vegetation Plot Species Table

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. Once all species have been identified for the plot, cover is estimated using the cover classes presented on page 18 of this manual.

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.

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.

APPENDIX F: Soil Texture Flowchart



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

Does the soil layer have?

Organic matter ≥ 40 cm thick (you can combine layers of Peat, Muck, and Mucky Peat)
Look at **A1**
≥ 20 cm thick (you can combine layers of Peat, Muck, and Mucky Peat)
Look at **A2, A3**
Mucky Mineral texture
Look at **S1, F1**

Smells like rotten eggs?
Look at **A4**

A Gleyed Matrix with a Hue of N, 10Y, 5GY, 10GY, 5G, 10G, 5BG, 10BG, 5B, 10B, 5PB
Look at **S4** if texture is Sand or Loamy Sand and **F2** for all other textures

A stripped matrix (Faint, splotchy patterns of 2 or more colors)
Look at **S6**

Redox concentrations in the first 15 cm and is in a depression
Look at **F8**

Chroma ≤ 2
Value ≥ 4
This layer could be a depleted matrix. Look at **A11, A12, F3**

Value ≤ 3
w/ redox concentrations
Look at **S5** if texture is Sand or Loamy Sand and, **F6** for all other textures

w/ redox depletions
Look at **S6** if texture is Sand or Loamy Sand and, **F7** for all other textures

Brief Indicator Descriptions

<u>All Soil Types</u>

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 H: Colorado Noxious Weed List

Source: Colorado Department of Agriculture Noxious Weed Program (March 31, 2016)

List A Species are designated by the Commissioner for eradication.

- African rue *(Peganum harmala)*
- Bohemian knotweed (*Polygonum* x *bohemicum*)
- Camelthorn *(Alhagi maurorum)*
- Common crupina *(Crupina vulgaris)*
- Cypress spurge *(Euphorbia cyparissias)*
- Dyer's woad *(Isatis tinctoria)*
- Elongated mustard *(Brassica elongata)*
- Flowering rush (*Butomus umbellatus*)
- Giant knotweed (*Polygonum sachalinense*)
- Giant reed *(Arundo donax)*
- Giant salvinia *(Salvinia molesta)*
- Hairy willow-herb *(Epilobium hirsutum)*
- Hydrilla *(Hydrilla verticillata)*
- Japanese knotweed *(Polygonum cuspidatum)*
- Meadow knapweed *(Centaurea nigrescens)*
- Mediterranean sage *(Salvia aethiopis)*
- Medusahead *(Taeniatherum caput-medusae)*
- Myrtle spurge *(Euphorbia myrsinites)*
- Orange hawkweed *(Hieracium aurantiacum)*
- Parrotfeather (*Myriophyllum aquaticum*)
- Purple loosestrife *(Lythrum salicaria)*
- Rush skeletonweed *(Chondrilla juncea)*
- Squarrose knapweed *(Centaurea virgata)*
- Tansy ragwort *(Senecio jacobaea)*
- Yellow starthistle *(Centaurea solstitialis)*

List B 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 their continued spread.

- 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)*
- Jointed goatgrass *(Aegilops cylindrica)*
- Leafy spurge *(Euphorbia esula)*
- Mayweed chamomile *(Anthemis cotula)*
- Moth mullein *(Verbascum blattaria)*
- Musk thistle *(Carduus nutans)*
- Oxeye daisy *(Leucanthemum vulgare)*
- Perennial pepperweed *(Lepidium latifolium)*
- Plumeless thistle *(Carduus acanthoides)*
- Russian knapweed *(Acroptilon repens)*
- Russian-olive *(Elaeagnus angustifolia)*
- Salt cedar *(Tamarix chinensis, T. parviflora,* and *T. ramosissima)*
- Scentless chamomile *(Tripleurospermum perforata)*
- Scotch thistle *(Onopordum acanthium, O. tauricum)*
- Spotted knapweed *(Centaurea stoebe)*
- Spotted x diffuse knapweed hybrid (*Centaurea* x *psammogena* = *C. stoebe* x *C. diffusa*)
- Sulfur cinquefoil *(Potentilla recta)*
- Wild caraway *(Carum carvi)*
- Yellow nutsedge *(Cyperus esculentus)*
- Yellow toadflax *(Linaria vulgaris)*
- Yellow x Dalmatian toadflax hybrid (*Linaria vulgaris* x *L. dalmatica*)

List C 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.

- Bulbous bluegrass *(Poa bulbosa)*
- 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)*
- Perennial sowthistle *(Sonchus arvensis)*

- Poison hemlock *(Conium maculatum)*
- Puncturevine *(Tribulus terrestris)*
- Quackgrass *(Elymus repens)*
- Redstem filaree *(Erodium cicutarium)*
- Velvetleaf *(Abutilon theophrasti)*
- Wild proso millet *(Panicum miliaceum)*

Watch List Species have been determined to pose a potential threat to the agricultural productivity and environmental values of the lands of the state. The Watch List is intended to serve advisory and educational purposes only. Its purpose is to encourage the identification and reporting of these species to the Commissioner in order to facilitate the collection of information to assist the Commissioner in determining which species should be designated as noxious weeds.

- Asian mustard *(Brassica tournefortii)*
- Baby's breath *(Gypsophila paniculata)*
- Bathurst burr, Spiney cocklebur *(Xanthium spinosum)*
- Brazilian egeria, Brazilian elodea *(Egeria densa)*
- Common bugloss *(Anchusa officinalis)*
- Common reed *(Phragmites australis)*
- Garden loosestrife *(Lysimachia vulgaris)*
- Garlic mustard *(Alliaria petiolata)*
- Himalayan blackberry *(Rubus armeniacus)*
- Japanese blood grass/cogongrass *(Imperata cylindrica)*
- Meadow hawkweed *(Hieracium caespitosum)*
- Onionweed *(Asphodelus fistulosus)*
- Purple pampas grass *(Cortaderia jubata)*
- Scotch broom *(Cytisus scoparius)*
- Sericea lespedeza *(Lespedeza cuneata)*
- Swainsonpea *(Sphaerophysa salsula)*
- Syrian beancaper *(Zygophyllum fabago)*
- Water hyacinth *(Eichhornia crassipes)*
- Water lettuce *(Pistia stratiotes)*
- White bryony *(Bryonia alba)*
- Woolly distaff thistle *(Carthamus lanatus)*
- Yellow flag iris *(Iris pseudacorus)*
- Yellow floatingheart *(Nymphoides peltata)*
- Yellowtuft *(Alyssum murale, A. corsicum)*

APPENDIX I: EIA Rank Guidance by Ecological System for Plains Systems

EIA RANK GUIDANCE: NORTH AMERICAN ARID WEST EMERGENT MARSH

Landscape Settings: Depressions surrounded by upland vegetation, riparian zones or mixed prairie. Natural marshes occur on the fringes of ponds, lakes, and reservoirs, and along slow-flowing streams and rivers as riparian marshes.

Soils: Typically mineral soils (loam, sandy loam, sandy clay loam) that can accumulate organic soils and anaerobic characteristics.

Distribution: Widespread throughout arid and semi-arid regions of Colorado extending into semi-arid portions of Western Great Plains.

NatureServe Ecological System Crosswalk: North American Arid West Emergent Marsh

Spatial Pattern: Small to medium patch wetlands. Irrigation or water storage influenced marshes can be extensive.

Non-native Plant Species (Metric V1, V2)

Listed below are the most common **non-native species** found in this system. Species with an asterisk (*) are Colorado listed noxious weeds.

<u>Woody</u>
Elaeagnus angustifolia (Russian olive) *
Tamarix ramosissima (saltcedar) *

<u>Graminoids</u>
Anisantha tectorum (cheatgrass) *
Bromopsis inermis (smooth brome)
Bromus japonicus (field brome)
Echinochloa crus-galli (barnyard grass)
Polypogon monospeliensis (annual rabbitsfoot grass)

<u>Forbs</u>
Bassia sieversiana (burningbush; kochia)
Breea arvensis (Canada thistle) *
Caradaria latifolia (broadleaved pepperweed)
Conium maculatum (poison hemlock) *
Lactuca serriola (prickly lettuce)
Persicaria maculata (spotted ladysthumb)
Plantago major (common plantain)
Rumex crispus (curly dock)
Rumex stenophyllus (narrowleaf dock)
Salsola sp. (Russian thistle)
Thlapsi arvense (field pennycress)

Native Plant Species Composition (Metric V3)

North American Arid West Emergent Marsh vegetation communities change along with hydrologic cycles; therefore marshes often have a variety of vegetation types that may change over the course of a season. Marshes that experience adequate flushing are more open and have higher species diversity. Marshes are typically herbaceous systems, but may have woody species on their margins. **Native species** characteristic of higher condition and lower condition sites are listed below.

Higher Condition Sites

Listed below are the most common **native** species found in <u>high condition</u> examples of this system. Species with a plus/minus (±) may occur in lower condition sites, but often with lower cover values and/or along with many non-native species.

<u>Woody</u>
Populus deltoides ssp. monilifera (plains cottonwood) ±
Salix amygdaloides (peachleaf willow)
Salix exigua (coyote willow) ±
Symphoricarpos occidentalis (Western snowberry)

<u>Graminoids</u>
Carex nebrascensis (Nebraska sedge)
Critesion jubatum (foxtail barley)
Distichlis stricta (saltgrass)
Eleocharis erythropoda (bald spikerush)
Eleocharis macrostachya (pale spikerush)
Schoenoplectus lacustris ssp. *acutus* (hardstem bulrush) ±
Scirpus pallidus (cloaked bulrush)
Spartina gracilis (alkali cordgrass)
Spartina pectinata (prairie cordgrass)

<u>Forbs</u>
Chenopodium simplex (mapleleaf goosefoot)
Asclepias speciosa (showy milkweed)
Mentha arvensis (wild mint)
Typha angustifolia (narrowleaf cattail) ±
Typha latifolia (broadleaf cattail) ±

<u>Aquatics</u>
Berula erecta (cutleaf waterparsnip)
Mimulus glabratus (roundleaf monkeyflower)
Veronica anagallis-aquatica (American speedwell)

Lower Condition Sites

Listed below are **native** species found in low condition sites, and are often indicative of disturbance, especially when observed in high cover. When *Typha* spp. is observed in extremely dense cover, especially if it inhibits wildlife passage, site is not likely in high condition.

Woody
Salix exigua (coyote willow)

Graminoids
Critesion jubatum (foxtail barley)
Diplachne fascicularis (bearded sprangletop)
Eleocharis macrostachya (pale spikerush)
Phalaroides arundinacea (reed canarygrass)
Schoenoplectus lacustris ssp. acutus (hardstem bulrush)

Forbs
Helianthus annuus (common sunflower)
Persicaria spp. (knotweeds)
Typha angustifolia (narrowleaf cattail)
Typha latifolia (broadleaf cattail)

Aquatics
Lemna minor (common duckweed)

Noteworthy Species

Listed below are species of **conservation concern** or species highly sensitive to anthropogenic disturbance that may occur in this system.

Amorpha fruticosa (desert false indigo)
Carex lanuginosa (woolly sedge)
Spartina gracilis (alkali cordgrass)
Spartina pectinata (prairie cordgrass)

Vegetation Structure (Metric V4, V5, V6)

The vegetation in a marsh system is indicative its hydroperiod. A high quality marsh that experiences seasonal inundation and periodic flushing or scouring should have a variety of graminoids and sedges. A healthy functioning marsh usually has water depths up to 2 meters and the deeper central zone will likely be dominated by cattail (*Typha* spp.) and bulrushes (*Schoenoplectus* spp., *Scirpus* spp.). Many floodplain-situated marshes will have a woody component with cottonwoods, willow species, and snowberry. High condition emergent marshes should have some diversity in their structural patches/zones, including open water, and variety in vertical strata within the herbaceous zone, such as different heights and species of graminoids and aquatics. If the cattail or bulrush stands and their associated litter are so dense that it impedes animal movement or chokes out other vegetation strata, the system should be marked down for vegetative structure.

Water Source (Metric H1)

Natural water sources for marshes include precipitation, groundwater, natural runoff, and natural flow from adjacent water bodies. Common non-natural sources are agricultural and residential runoff and irrigation diversions entering the system. Some marsh sites, especially in Colorado eastern plains, are created or modified from irrigation canal seepage, man-made reservoirs, or from development. The key factor is to consider if the landscape position supported wetlands before the anthropogenic disturbance, and if the wetland is still connected to its natural water source.

Hydroperiod (Metric H2)

An emergent marsh will range from seasonally inundated (Cowardin Hydrologic Modifier: C) to semi-permanently inundated (Cowardin Hydrologic Modifier: F). If a marsh is cut off from its water source due to anthropogenic hydrologic modification evidenced by lack of saturated soils, dying aquatic vegetation and encroachment of upland vegetation, the site should be downgraded substantially. If a site is holding water for longer than is considered "natural" due to anthropogenic management, often evidenced by >10% wetland having water depths > than 2 meters, lack of small graminoids and sedges, drowned vegetation, irrigation diversions into wetland, or berms or dikes causing increased inundation, the site should be downgraded.

Hydrologic Connectivity (Metric H3)

Marsh function and health is dependent on its connection with local landscape hydrology, and unobstructed vertical and lateral water movement. Obstructions to hydrologic movement and rising waters in the immediate and local area may include levees, roads, and high banks.

Stressors

- Anthropogenic impacts to hydrology and therefore vegetation include reservoir management, irrigation canals and ditches, and manmade physical obstructions to water movement. Conversion of wetland to agricultural land by drainage or ditching alters hydrology.
- Moderate to heavy grazing decreases herbaceous diversity and causes soil compaction.
- Invasive species such as common reed or reed canarygrass may become established after disturbance

EIA Rank Guidance: Western Great Plains Wet Meadow-Marsh Complex

Landscape Settings: Toeslopes; open depressions of headwaters or headcuts that drain into plains streams; and slow-moving reaches where separate channels of the same or different streams join and disperse hyporheic flow to the surface, creating alluvial backwater or an inverse delta.

Soils: Permanently or seasonally moist, ranging from predominately organic, to mostly mineral and clayey with redoximorphic features. Wet meadows along slow moving channels can have ribbons of alluvium interspersed with finer soils and organic layers.

Distribution: In Colorado, small patches are embedded in upland prairie at the headwaters and along slow flowing reaches of groundwater-influenced plains streams. Larger patches form in the herbaceous zone of the large floodplains. These extend into the foothills at toeslopes.

NatureServe Ecological System Crosswalk: Western Great Plains Open Freshwater Depression

Spatial Pattern: Small to medium patch wetlands.

Non-native Plant Species (Metric V1, V2)

Listed below are the most common **non-native species** found in this system. Species with an asterisk (*) are Colorado listed noxious weeds.

Woody
Elaeagnus angustifolia (Russian olive) *

Graminoids
Anisantha tectorum (cheatgrass) *
Bromopsis inermis (smooth brome)
Bromus japonicus (field brome)
Elytrigia repens (quackgrass) *
Poa pratensis (Kentucky bluegrass)

Forbs
Bassia sieversiana (burningbush; kochia)
Breea arvensis (Canada thistle) *
Lactuca serriola (prickly lettuce)
Melilotus albus (sweetclover)
Melilotus officinale (yellow sweetclover)
Rumex crispus (curly dock)
Taraxacum officinale (common dandelion)
Tragopogon dubius (yellow salsify

Native Plant Species Composition (Metric V3)

Western Great Plains Wet Meadow-Marsh Complex communities are characterized by perennial wetland graminoids typic of moist soil, with dominance of sedge, rush, grasses, and forbs, with smaller patches of marsh species. Wetter zones support aquatic forbs such as *Mimulus* and *Berula*, and taller marsh vegetation such as *Typha* and *Schoenoplectus*. Vegetation composition and richness ranges from wet meadow associations more typical of higher elevations than plains wetlands (e.g., *Carex aurea, C. utriculata,* and *C. simulata*), to dominance by *Juncus arcticus* and *Carex nebrascensis*, to smaller patches of saline vegetation, such as *Critesion* spp. and *Distichlis stricta,* and marsh zones. Healthy systems often support sedges. **Native species** characteristic of higher condition and lower condition sites are listed below.

Higher Condition Sites

Listed below are the most common **native** species found in high condition examples of this system. Species with a plus/minus (±) may occur in lower condition sites, but often with lower cover values and/or along with many non-native species.

Woody
Salix spp. (willow)
Symphoricarpos occidentalis (western snowberry)

Graminoids
Calamagrostis spp. (reedgrass)
Carex aquatilis (water sedge)
Carex aurea (golden sedge)
Carex lanuginosa (C. pellita; woolly sedge*)*
Carex nebrascensis (Nebraska sedge) ±
Carex simulata (analogue sedge)
Carex utriculata (Northwest Territory sedge)
Eleocharis macrostachya (pale spikerush)
Eleocharis quinqueflora (fewflower spikerush)
Glyceria spp. (mannagrass)
Schoenoplectus lacustris ssp. acutus (hardstem bulrush)
Spartina gracilis (alkali cordgrass)
Spartina pectinata (prairie cordgrass)

Forbs
Achillea lanulosa (western yarrow)
Berula erecta (cutleaf waterparsnip)
Bidens cernua (nodding beggartick)
Dalea purpurea (purple prairie clover)
Geum spp. (avens)
Hippochaete laevigata (smooth horsetail)
Hecatonia scelerata (cursed buttercup)
Mentha arvensis (wild mint)
Mimulus spp. (monkeyflower)
Monocots: Iridaceae, Liliaceae, Orchidaceae
Sagittaria spp. (arrowhead)
Sidalcea spp. (checkerbloom)
Sisyrinchium spp. (blue-eyed grass)
Stachys palustris (hairy hedgenettle)
Triglochin spp. (arrowgrass)
Veronica anagallis-aquatica (water speedwell)

Lower Condition Sites

Listed below are **native** species found in <u>low condition</u> sites, and are often indicative of disturbance, especially when observed in high cover.

<u>Graminoids</u>
Panicum virgatum (switchgrass)
Pascopyrum smithii (western wheatgrass)
Phalaroides arundincaea (reed canarygrass)

<u>Forbs</u>
Ambrosia psilostachya (Cuman ragweed)
Chenopodium spp .(goosefoot) *when in high/dominant cover
Conyza canadensis (Canadian horseweed)
Grindelia squarrosa (curlycup gumweed)
Helianthus annuus (common sunflower)
Polygonum spp. (knotweed)

Noteworthy Species

Numerous species of **conservation concern** or are sensitive to anthropogenic disturbance in this system. Listed below are common examples.

<u>Graminoids</u>
Carex aquatilis (water sedge)
Carex aurea (golden sedge)
Carex simulata (analogue sedge)
Carex lanuginosa (pellita; woolly sedge)
Carex utriculata (Northwest Territory Sedge)
Eleocharis quinqueflora (fewflower spikerush)

Vegetation Structure (Metric V4, V5, V6)

Western Great Plains wet meadow-marsh systems are characterized by wet meadow vegetation, sometimes with patches of short willow or snowberry shrubs. The stable or seasonal high water table supports vegetation zonation along topographic variation, such as hummocks and swales, open water springs or streamlets and shallow inundated lowlands, and depressional to sideslope location. Healthy systems will include a variety of vegetation structural zones that have not been simplified by overgrazing, mechanical, or herbicide treatments. Species diversity can be low on deep organic soils or saline zones, but otherwise should be moderate to high. Sufficient graminoid and forb litter is key to maintain the microclimate that supports wet meadow ecosystems in the semi-arid plains. Grazed meadows frequently lack sufficient litter to maintain healthy vegetation diversity. Open water marsh zones are generally less dominant than wet meadow zones across each wetland complex, but the two patch types intergrade. Saline and freshwater patches can co-occur in close proximity.

Water Source (Metric H1)

Natural sources are groundwater-influenced and include: seep/spring sources, high water table in headwaters or lowlands, and slow-moving alluvial ground or surface waters. These sources are often coupled with precipitation, where systems fall in localized depressions or larger basins. Where natural, these ecosystems do not occur without a groundwater component. The most common impacts to water sources are interception of natural water sources by groundwater depletion (wells, pipes, upslope stock pond impoundments), irrigation water diverted into system, agricultural inputs and herbicide use, and landcape alterations that restrict groundwater movement (ex: pugging/compaction from grazing, berms/roads, excavation for stock ponds).

Hydroperiod (Metric H2)

The dominant water regimes of wet meadow-marshes range from “seasonally flooded” to “permanently saturated” regimes (C and B in Cowardin classification), but also include zones of “semi-permanently inundated” (F) in the low marsh zones*.* As a groundwater-influenced system, meadows are sensitive to the human management of their water. Common drying signs are invasion by weeds, dessicated peat, discolored moss, pugging or denuded substrate; and compacted, exposed hardpan, or cracked non-saline soils. Hydroperiod can also be sensitive to stream and bank alterations when ecosystem abuts a stream.

Hydrologic Connectivity (Metric H3)

Vegetation and soils in this ecosystem are supported a consistently high water table, and are very susceptible to degradation, drying, and invasion by weeds with any land use that restricts groundwater access to or movement within site.

Stressors

Stressors that impact the site hydrology are the most serious: eg, rural development, roads, livestock use, groundwater extraction, dugout or impounded stock ponds, and replacement/shift of natural water to less predictable irrigated sources. These stressors can also increase site nutrients and compact soils, affecting vegetation composition and abiotic complexity. Other stressors can include broadcasted herbicides, and land uses that reduce litter (eg: mowing, grazing) which can compact and dry the substrate. Invasion of undesirable plants is typically a response to another stressor. .

EIA Rank Guidance: Western Great Plains Closed / Saline Depression (Playas)

Landscape Settings: Shallow clay-lined depressional basins or lakes embedded within upland shortgrass prairie. Closed Depression playas are isolated from the regional groundwater system. Saline Depressions can be connected to the regional groundwater system.

Soils: Hardpan clay that perch water following precipitation. Textures range from clay, sandy clay loam and clay loam. Surface cracks are common, and can indicate recent wetting. Deep cracks show lack of sedimentation.

Distribution: High Plains region of the Southern Great Plains, which includes Southeastern Colorado and the adjacent shortgrass prairie region.

NatureServe Ecological System Crosswalk: Western Great Plains (WGP) Closed Depression / WGP Saline Depression

Spatial Pattern: Small patch wetlands

Note: This EIA Rank includes information for WGP Closed Depression and WGP Saline Close Depression wetlands in Colorado. Plants and characteristics heavily overlap for these systems, but plants associated with mainly saline wetlands are noted.

Non-native Plant Species (Metric V1, V2)

Listed below are the most common **non-native species** found in this system. Species with an asterisk (*) are Colorado listed noxious weeds.

Graminoids
Anisantha tectorum (cheatgrass) *
Echinochloa crus-galli (barnyard grass)
Eragrostis cilianensis (stinkgrass)

Forbs
Amaranthus blitoides (mat amaranth)
Ambrosia artemisiifolia (annual ragweed)
Bassia sieversiana (burningbush; kochia)

(Forbs, cont'd.)
Chenopodium album (lambsquarters)
Convolvulus arvensis (field bindweed) *
Lactuca serriola (prickly lettuce)
Melilotus officinale (yellow sweetclover)
Polygonum arenastrum (oval-leaf knotweed)
Portulaca oleracea (little hogweed)
Salsola australis or *collina* (Russian thistle)
Tragopogon sp. (salsify)

Native Plant Species Composition (Metric V3)

Western Great Plains Closed Depression systems are characterized by dynamically changing vegetation composition tied to wetting patterns and pond morphology. Pond depth and length of inundation drive vegetation zonation, in which aquatic plants such as spikerushes will grow in the deepest zones, FAC/FACW forbs and grasses will inhabit middle zones, and upland plants will make up outermost, least wet zones. Because playas have irregular wetting patterns, plant composition has a high turnover rate, therefore plants adapted to grow and produce seeds quickly are commonly found in closed depressions. It is important to note that because of this fast-changing, disruption prone environment, plants that indicate a healthy, typical playa may be considered weedy or aggressive in other systems. **Native species** characteristic of higher condition and lower condition sites are listed below.

Higher Condition Sites

Listed below are the most common **native** species found in high condition examples of this system. Species with a plus/minus (±) may occur in lower condition sites, but often with lower cover values and/or along with many non-native species.

Graminoids
Buchloe dactyloides (buffalograss) ±
Chondrosum gracile (blue grama)
Critesion jubatum (foxtail barley)
Critesion pusillum (little barley)
Distichlis stricta (saltgrass) **(saline depressions)**
Eleocharis acicularis (needle spikerush)
Eleocharis macrostachya (pale spikerush) ±
Pascopyrum smithii (western wheatgrass) ±

Forbs
Agaloma marginata (snow-on-the-mountain)
Ambrosia tomentosa (skeletonleaf bur ragweed)

(Forbs, cont'd.)
Chenopodium desiccatum (aridland goosefoot)
Iva axillaris (povertyweed) ±
Oenothera canescens (spotted eveing primrose)
Phyla cuneifolia (wedgeleaf) ±
Plantago patagonica (woolly plantain)
Ratibida tagetes (green prairie coneflower)
Rorippa sinuata (spreading yellowcress)
Suckleya suckleyana (poison suckleya) **(saline depressions)**
Verbena bracteata (bigbract verbena)

Aquatics
Marsilea mucronata (hairy waterclover)

Lower Condition Sites

Listed below are **native** species found in low condition sites, and are often indicative of disturbance. A healthy wetland may contain low to moderate cover of any of the following plants, but in a playa with a highly disturbed hydrologic regime, these plants may dominate along with non-natives, especially *Anisantha tectorum* (cheatgrass) and *Bassia sieversiana* (burningbush), and occasionally no aquatic species will be present. Extremely dense vegetation with lack of bare ground indicates the typical wetting cycle is impacted.

Graminoids
Distichlis stricta (saltgrass)
Panicum virgatum (switchgrass)
Pascopyrum smithii (western wheatgrass)

Forbs
Ambrosia grayi (wollyleaf bur ragweed)
Iva axillaris (povertyweed)
Grindelia squarrosa (curlycup gumweed)
Helianthus annuus (common sunflower)
Phyla cuneifolia (wedgeleaf)

Noteworthy Species

Listed below are species of **conservation concern** or species highly sensitive to anthropogenic disturbance that may occur in this system.

Astragalus drummondii (Drummond's milkvetch)
Bouteloua curtipendula (sideoats grama)
Carex stenophylla ssp*. eleocharis* (needleleaf sedge)
Echinacea angustifolia (blacksamson echinace)
Muhlenbergia cuspidate (plains muhly)

Vegetation Structure (Metric V4, V5, V6)

The ephemeral nature of wetting in closed depression systems impacts vegetation structure and species composition as plants adapt to changing hydrology conditions. Therefore when assessing the ecological integrity of pond vegetation, it is important to consider the playa's wetness stage as well as recent patterns in weather and climate. During pond flooding, a healthy system is made up of emergent and submergent aquatic species. Healthy playas with moist, but not inundated soil conditions or zones support annual species that produce high quantities of seeds such as listed above. When playas or parts of them are dry, forbs and grasses associated with surrounding uplands areas, and sometimes weedy species, will populate the open space. Sparse vegetation is not uncommon after the ponds drawdown, and often vegetation will be 50% cover or less, with the rest as bare, cracked clay ground. Low to moderate vegetation diversity is not uncommon and considered "healthy". A healthy, dry playa will have low litter and organic inputs, prevalent bare-ground, and encroachment of non-native, weedy species is low. Playas generally lack woody species, with the occasional shrub or cactus on its borders. Saline playas are often surrounded by *Sarcobatus vermiculatus* (greasewood) or *Atriplex canescens* (saltbush).

Water Source (Metric H1)

Most playas have a unique, isolated hydrology, and are fed by precipitation and surface water runoff with no connection to groundwater, though some saline playas are connected to the groundwater table. The most common non-natural water sources are irrigation runoff from nearby croplands or artificial filling that alters the playa to be more like a reservoir.

Hydroperiod (Metric H2)

Western Great Plains Closed Depressions and Saline Closed Depression naturally exhibit "Intermittent Flooding" hydrologic regime (Cowardin Hydrologic Modifier: J). The substrate is often exposed, but surface water is present for variable period between without strong seasonal periodicity. Weeks, months or even years may intervene between periods of inundation. Pitting and severe pugging are the most common hydroperiod modifications in playas, and cause uneven and concentrated ponding. Sedimentation from nearby agricultural erosion creates a loamy layer that impedes the impermeable clay from ponding and alters the hydroperiod. If a playas inundation or saturation regime has been reduced, upland plants and weeds will be prevalent, and bare ground will be less than typical.

Hydrologic Connectivity (Metric H3)

Playas should have an unimpeded and subtle connection to surrounding upland landscape. Roads, berms, and ditches/canals will impact surface water movement, and reduce the EIA score.

Stressors

- The majority of closed depressions in Colorado exist on agricultural or range land. Heavy and continuous grazing can impact soil, hydrology and vegetation. Intensive cattle movement can break up the clay layer, causes deep pugging, and impact ponding dynamics.
- Sedimentation and erosion produced from farming/tillage in or around the playa have a negative impact on hydrology dynamics.
- Pitting, a common practice in playas, concentrates water for agricultural uses, creates stock ponds, and increases the duration in which surface water is present, and can have negative implications for playa function. Some land managers take advantage of the natural depression in the landscape and fill playas to use as stock ponds and/or reservoirs.

EIA RANK GUIDANCE: WESTERN GREAT PLAINS FLOODPLAIN

Landscape Settings: Floodplain forest to wet meadows to gravel/sand flats linked by flooding regimes and underlying soils on medium and large river systems in Eastern Colorado. These are large perennial rivers that are driven by snowmelt and rainfall originating in their headwaters.

Soils: Substrates are alluvial and usually range from sand to loamy sand with occasional fine-textured soils. Most soils do not exhibit hydric indicators.

Distribution: Found on the lower reaches of the North and South Platte, Platte, Arkansas, and Canadian rivers.

NatureServe Ecological System Crosswalk: Western Great Plains Floodplain

Spatial Pattern: Linear mosaic of communities linked by soils and flooding regime.

Non-native Plant Species (Metric V1, V2)

The combination of a frequent disturbance regime and often being situated adjacent to development and agriculture leaves riparian areas vulnerable to invasion by non-native and noxious species. Listed below are the most common **non-native species** found in this system. Species with an asterisk (*) are Colorado listed noxious weeds.

Woody
Elaeagnus angustifolia (Russian olive) *
Salix fragilis (crack willow)
Tamarix ramosissima (saltcedar) *
Ulmus pumila (Siberian elm)

Graminoids
Anisantha tectorum (cheatgrass) *
Bromopsis inermis (smooth brome)
Bromus japonicus (field brome)
Echinochloa crus-galli (barnyard grass)
Elytrigia repens (quackgrass) *

Forbs
Bassia sieversiana (burningbush; kochia)
Breea arvensis (Canada thistle) *
Cardaria latifolia (broadleaved pepperweed)
Chenopodium album (lambsquarters)
Conium maculatum (poison hemlock) *
Lactuca serriola (prickly lettuce)
Melilotus albus (sweetclover)
Rumex crispus (curly dock)
Salsola sp. (Russian thistle)
Thlaspi arvense (field pennycress)
Tithymalus uralensis (Russian leafy spurge)
Verbascum Thapsus (common mullein)

Native Plant Species Composition (Metric V3)

For Western Great Plains Floodplains, species and community composition are driven by the dynamics and hydrology of a meandering body of water. Sediment deposition and bank erosion create microtopography and benches that drive a mosaic of wetland and upland plant communities. In Eastern Colorado, floodplain systems have been highly degraded and no exemplary floodplains have been sampled, therefore the vegetation list contains many weedy species even in high condition sites. **Native species** characteristic of higher condition and lower condition sites are listed below.

Higher Condition Sites

Listed below are the most common **native** species found in high condition examples of this system. Species with a plus/minus (±) may occur in lower condition sites, but often with lower cover values and/or along with many non-native species.

Woody
Populus deltoides ssp. *monilifera* (plains cottonwood) ±
Salix amygdaloides (peachleaf willow)
Salix exigua (narrowleaf willow) ±
Symphoricarpos occidentalis (western snowberry) ±

Graminoids
Chondrosum gracile (blue grama)
Carex nebrascensis (Nebraska sedge)
Critesion jubatum (foxtail barley) ±
Diplachne fascicularis (bearded sprangletop)
Pascopyrum smithii (western wheatgrass)
Schoenoplectus lacustris ssp. *acutus* (hardstem bulrush)
Spartina pectinata (prairie cordgrass)
Sporobolus cryptandrus (sand dropseed)

Forbs
Ambrosia psilostachya (Cuman ragweed)
Asclepias speciosa (showy milkweed)
Chamaesyce serpyllifolia (thymeleaf sandmat)
Glycyrrhiza lepidota (American licorice)
Helianthus annuus (common sunflower)
Urtica gracilis (California nettle)

Lower Condition Sites

Listed below are **native** species found in low condition sites, and are often indicative of disturbance, especially when observed in high cover. Many of the species listed above under high condition may occur in low condition sites, but are often being replaced by non-natives and weedy species. In low quality sites, cottonwood and willow regeneration is often very low with non-natives taking over the shrub layer.

Woody
Fraxinus pennsylvanica var. lanceolata (green ash)

Graminoids
Distichlis stricta (saltgrass)
Panicum virgatum (switchgrass)
Phalaroides arundinacea (reed canarygrass)
Phragmites australis (common reedgrass)

Forbs
Chenopodium simplex (mapleleaf goosefoot)
Conyza canadensis(Canadian horseweed)
Helianthus annuus (common sunflower)
Grindelia squarrosa (gumweed)

Noteworthy Species

Listed below are species of **conservation concern** or species highly sensitive to anthropogenic disturbance that may occur in this system.

Atriplex canescens (fourwing saltbush)
Chamaesyce missurica (prairie sandmat)
Spartina gracilis (alkali cordgrass)
Spartina pectinata (prairie cordgrass)

Vegetation Structure (Metric V4, V5, V6)

In healthy floodplain systems, vegetation occurs in a variety of patchy structural zones, and they tend to be stratified in terraces along with distance and height from the river. Dominant communities within this system include floodplain forests, wet meadows and sparsely vegetated gravel and sand flats. Open cottonwood (*Populus deltoides)* forest galleries with mixed prairie grass and forb understory are generally well-above the river. Lower terraces frequently include *Salix exigua*, narrower terraces of dense tall herbaceous vegetation (often annuals), and moderate to sparsely populated sandbars with species ranging from weedy annuals to wetland perennial herbs and graminoids. Herbaceous cover is an important part of this system and is a mix of tallgrass species, including switchgrass (*Panicum virgatum)* and western wheatgrass (*Pascopyrum smithii)*. Invasion of exotic species is one consequence of anthropogenic alteration including tamarisk (*Tamarix* spp.), Russian olive (*Elaeagnus angustifolia*), and less desirable or exotic grasses and forbs which displace native species. A high-grade system should have obvious regeneration in tree and shrub layers, diverse plant composition in herbaceous zones, and a range of vertical strata. Field characteristics of low-condition systems are the dominance of a single zone and missing strata, dense cover of non-native species, dying or dead trees predominate, and woody debris is excessive or entirely absent. Many floodplain systems in the Colorado plains are degraded to the point where the cottonwood overstory is the only remaining natural component.

Water Source (Metric H1)

Plains floodplain sites are fed by the surface and subsurface alluvial flow of medium to large rivers, which include return flows and seepage from the surrounding irrigated landscape (non-natural source). The most common non-natural water sources that downgrade a system are irrigation water diverted into system via ditches and canals, agricultural and residential runoff, and artificially impounded water.

Hydroperiod (Metric H2)

Plains floodplain systems exhibit intermittently flooded hydrologic regimes. Historically, rivers overbanked in the spring, flooding the entire width of the geomorphic floodplain, but today the floodplain's hydrology is separated into the active river channel and the cottonwood gallery zone. Field indicators of active degradation and excessive erosion are deeply undercut banks with exposed living roots, bank slumps, declining vigor of riparian vegetation, lack of fine-grained sediment in channel bed, lack of braiding of flow-paths, and nick points indicating headward erosion of the channel bed. Splays of fresh sediment on older soils and buried vegetation are signs of aggradation.

Hydrologic Connectivity (Metric H3)

Floodplain systems with excellent hydrologic connectivity are completely connected to the floodplain (backwater sloughs and channels) and their water source. Sites with channel entrenchment, geomorphic modifications (dikes, rip rap, and elevated culverts), and lack of overbank flows into riparian zones are evidence of impacted connectivity and should be proportionately downgraded.

Stressors

Major stressors to floodplain systems include heavy grazing, invasion of non-native species especially *Tamarix spp.*, human management of flows via dam and reservoir control and irrigation diversions and canals, and pollutant-ridden runoff from residential and agricultural areas.

EIA Rank Guidance: Western Great Plains Riparian

Landscape Settings: Riparian zones of medium and small rivers and streams including intermittent and ephemeral streams throughout the Western Great Plains. Landscapes vary from deep canyons to wide, braided streams.

Soils: Found on alluvial soils. Soils are loamy ranging from clay loam to sandy loam. Sandier soils exist at sites with drier, wash characteristics. Hydric features can be observed including redoximorphic features, depleted layers, and organic surface.

Distribution: In Colorado, found along small to medium streams throughout the South Platte, Arkansas, Cimmaron, and Canadian river basins. For streams that originate in the mountains, this systems extends to the Rocky Mountain Lower-Montane Foothill Riparian Woodland and Shrubland.

NatureServe Ecological System Crosswalk: Western Great Plains Riparian

Spatial Pattern: Linear system confined to bands that generally follow the branching configuration of stream channels.

Non-native Plant Species (Metric V1, V2)

The combination of a frequent disturbance regime and often being situated adjacent to development and agriculture leave riparian areas vulnerable to invasion by non-native and noxious species. Listed below are the most common **non-native species** found in this system. Species with an asterisk (*) are Colorado listed noxious weeds.

<u>Woody</u>
Elaeagnus angustifolia (Russian olive) *
Salix fragilis (crack willow)
Tamarix ramosissima (saltcedar) *

<u>Graminoids</u>
Anisantha tectorum (cheatgrass) *
Bromopsis inermis (smooth brome)
Bromus japonicus (field brome)
Echinochloa crus-galli (barnyard grass)
Elytrigia repens (quackgrass) *
Poa pratensis (Kentucky bluegrass)
Polypogon monspeliensis (annual rabbitsfoot grass)

<u>Forbs</u>
Ambrosia artemisiifolia (annual ragweed)
Bassia sieversiana (burningbush; kochia)
Breea arvensis (Canada thistle) *
Chenopodium album (lambsquarters)
Convolvulus arvensis (field bindweed) *
Lactuca serriola (prickly lettuce)
Melilotus albus (sweetclover)
Melilotus officinale (yellow sweetclover)
Rumex crispus (curly dock)
Taraxacum officinale (common dandelion)
Tragopogon dubius (yellow salsify)

Native Plant Species Composition (Metric V3)

Western Great Plains Riparian systems are characterized by narrow to wide stands of riparian forests or woodlands dominated by cottonwood trees, shrublands dominated by willows, and herbaceous zones with sedges, rushes, tallgrass, and forbs, and sometimes zones of gravel/sand flats. Vegetation composition and regeneration in riparian communities is intimately tied to the hydrologic and flooding regimes. When a stream overflows its banks, it feeds water to the surrounding plants and soils, and creates natural levees and deposits sediments, all of which have a direct impact on plants. Plant species characteristic of aquatic areas and moist soils, as well as those found in upland zones are commonly found here. **Native species** characteristic of higher condition and lower condition sites are listed below.

Higher Condition Sites

Listed below are the most common **native** species found in <u>high condition</u> examples of this system. Species with a plus/minus (±) may occur in lower condition sites, but often with lower cover values and/or along with many non-native species.

<u>Woody</u>
Populus deltoides ssp. monilifera (plains cottonwood) ±
Salix amygdaloides (peachleaf willow)
Salix exigua (narrowleaf willow)
Symphoricarpos occidentalis (western snowberry)

<u>Graminoids</u>
Carex nebrascensis (Nebraska sedge)
Carex lanuginosa (bottlebrush sedge)
Chondrosum gracile (blue grama)
Critesion jubatum (foxtail barley) ±
Distichlis stricta (saltgrass) ±
Eleocharis macrostachya (pale spikerush)
Elymus canadensis (Canada wildrye)
Panicum virgatum (switchgrass)
Pascopyrum smithii (western wheatgrass) ±
Schoenoplectus lacustris ssp. *acutus* (hardstem bulrush)
Schoenoplectus pungens (common threesquare)
Sporobolus cryptandrus (sand dropseed)

<u>Forbs</u>
Ambrosia psilostachya (Cuman ragweed)
Asclepias speciosa (showy milkweed)
Glycyrrhiza lepidota (American licorice)
Lemna minor (duckweed)
Solidago canadensis (Cananda goldenrod)

Lower Condition Sites

Listed below are **native** species found in low condition sites, and are often indicative of disturbance, especially when observed in high cover.

Woody
Populus deltoides ssp. monilifera (plains cottonwood)

Graminoids
Elymus elymoides (squirreltail)
Juncus arcticus (mountain rush)
Panicum virgatum (switchgrass)
Pascopyrum smithii (western wheatgrass)
Phragmites australis (common reedgrass)

Forbs
Ambrosia acanthicarpa (flatspine burr rageweed)
Cyclachaena xanthifolia (Carlessweed; giant sumpweed)
Gaura mollis (velvetweed)
Grindelia squarrosa (curlycup gumweed)
Helianthus annuus (common sunflower)
Persicaria amphibia (longroot smartweed)
Typha angustifolia (cattail)
Xanthium strumarium (rough cocklebur)

Noteworthy Species

Listed below are species of **conservation concern** or species highly sensitive to anthropogenic disturbance that may occur in this system.

Woody
Ribes aureum (golden currant)
Sabina monosperma (oneseed juniper)

Aquatics
Carex hystericina (bottlebrush sedge)
Carex lanuginosa (woolly sedge)
Veronica Americana (American speedwell)

Forbs
Cirsium canescens (prairie thistle)
Ipomopsis pumila (dwarf ipomopsis)
Oxybaphus hirsutus (hairy four o'clock)

Graminoids
Poa palustris (fowl bluegrass)

Vegetation Structure (Metric V4, V5, V6)

Excellent-grade riparian systems should include a complex array of interspersed patches with a diverse vertical strata, obvious regeneration of native species in canopy and shrub layers, and no single dominant vegetation zone. Many riparian sites will have swaths of open gravel or sand. Canopy and shrub layers are commonly dominated by a few species, but herbaceous layers should demonstrate at least moderate diversity in a healthy system. Woody debris should not be sparse, but not too dense (usually occurs with high mortality of trees).

Water Source (Metric H1)

Sources include moving surface waters and below ground alluvial groundwater. Riparian zones in the north and west are more impacted by snowmelt dynamics than those sites further east, which are more dependent on local precipitation. Common non-natural water sources that downgrade a system are irrigation water diverted into system, agricultural and residential runoff, and artificially impounded water.

Hydroperiod (Metric H2)

The majority of Western Great Plains Riparian systems exhibit "temporarily flooded" regimes (Cowardin Hydrologic Modifier: A). If a site is not experiencing natural flooding, often evidenced by invasion of upland species and soils without hydric-indicators, this may be due to bank incision or human management and should be downgraded. Other field indicators of an impacted hydroperiod, and therefore channel disequilibrium, are deeply undercut banks with exposed living roots, bank slumps, declining vigor of riparian vegetation, lack of fine-grained sediment in channel bed or excessive sediment in channel and on banks (aggradation), lack of braiding of flow-paths, and nick points along the channels indicating headward erosion of the channel bed.

Hydrologic Connectivity (Metric H3)

Sites with excellent hydrologic connectivity are completely connected to the floodplain (backwater sloughs and channels) and its water source. Sites with channel entrenchment, geomorphic modifications (dikes, rip rap, and elevated culverts), and lack of overbank flows into riparian zones are evidence of impacted connectivity and should be proportionately downgraded.

Stressors

Riparian systems in these drier ecosystems are sensitive to human management and extraction of water. Channel entrenchment, lack of overbank flows, and simplification of vegetation diversity and structure are some examples of physical evidence of impacts. Small streams on agricultural lands are often exposed to grazing, which can result in barren soils, loss of plant diversity, over-compaction, and erosion of river banks. Runoff from grazing and croplands are detrimental to water quality, and impact plant composition. Invasive species often invade riparian areas, and decrease overall biodiversity and regeneration of native plants.

EIA RANK GUIDANCE: ROCKY MT. LOWER MONTANE-FOOTHILL RIPARIAN WOODLAND & SHRUBLAND

Landscape Settings: Found within the flood zone of rivers, on islands, sand or cobble bars and on immediate streambanks, forming large, wide occurrences in larger rivers or narrow banks on small, rocky canyon tributaries and well-drained benches.

Soils: Soils are coarse-grained alluvial material ranging from gravel to sand. Further from the waterbody, loamy soils occur.

Distribution: Colorado this system is found primarily in the western half of the state throughout the lower montane Rocky Mountain and Colorado Plateau regions within a broad elevation range from approximately 5,000–9,000 ft. (1,525–2750 m). A band of this system is also found along the foothills of the Front Range on the eastern half of the state.

NatureServe Ecological System Crosswalk: Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland

Spatial Pattern: Linear system confined to bands that generally parallel the linear and branching configuration of stream channels and lakes.

Non-native Plant Species (Metric V1, V2)

The combination of a frequent disturbance regime and often being situated adjacent to development and agriculture leave riparian areas vulnerable to invasion by non-native and noxious species. Listed below are the most common **non-native species** found in this system. Species with an asterisk (*) are Colorado listed noxious weeds.

Woody
Elaeagnus angustifolia (Russian olive) *
Salix fragilis (crack willow)

Graminoids
Anisantha tectorum (cheatgrass) *
Bromopsis inermis (smooth brome)
Bromus japonicus (field brome)
Poa pratensis (Kentucky bluegrass)

Forbs
Arctium minus (lesser burdock)
Breea arvensis (Canada thistle) *
Conium maculatum (poison hemlock) *
Convolvulus arvensis (field bindweed) *
Lactuca serriola (prickly lettuce)
Melilotus albus (sweetclover)
Rumex crispus (curly dock)
Taraxacum officinale (common dandelion)
Tragopogon dubius (yellow salsify)
Verbascum thapsus (common mullein)

Native Plant Species Composition (Metric V3)

Rocky Mountain Lower Montane-Foothills riparian systems are characterized by narrow to wide stands of riparian forests or woodlands dominated by cottonwood trees, shrublands, herbaceous zones with sedges and forbs, and zones of gravel/sand flats. Vegetation composition and regeneration is intimately tied to the hydrology regime. When a stream overflows its banks, it feeds water to the surrounding plants and soils, creates natural levees, and deposits sediments, all of which have a direct impact on plant species. Healthy foothill riparian zones should have a diverse plant composition and structure. There may be some non-natives even in healthy systems, but not dominant in cover. **Native species** characteristic of higher condition and lower condition sites are listed below.

Higher Condition Sites

Listed below are the most common **native** species found in high condition examples of this system. Species with a plus/minus (±) may occur in lower condition sites, but often with lower cover values and/or along with many non-native species.

Woody
Alnus incana ssp. tenuifolia (thinleaf alder)
Negundo aceroides (boxelder) ±
Padus virginiana ssp. melanocarpa (black chokecherry)
Populus acuminata (lanceleaf cottonwood)
Populus deltoides ssp. monilifera (plains cottonwood) ±
Ribes inerme (whitestem gooseberry)
Rosa woodsia (Woods' rose)
Rubus idaeus ssp. melanolasius (grayleaf red raspberry)
Salix amygaloides (peachleaf willow) ±
Salix exigua (narrowleaf willow) ±
Salix irrorata (dewystem willow)
Salix ligulifolia (strapleaf willow)
Symphoricarpos occidentalis (western snowberry) ±

Graminoids
Carex emoryi (Emory's sedge)
Carex lanuginosa (wooly sedge)
Carex nebrascensis (Nebraska sedge)
Eleocharis macrostachya (pale sprikerush)
Scirpus pallidus (cloaked bulrush)

Forbs
Equisetum arvense (field horsetail)
Mentha arvensis (wild mint)
Persicaria amphibia (water smartweed)
Toxicodendron rydbergii (Western poison ivy)
Typha latifolia (cattail)
Urtica gracilis (California nettle)
Vitis riparia (riverbank grape)

Lower Condition Sites

Listed below are **native** species found in low condition sites. Low condition foothill riparian sites are often invaded with non-native species, and contain native species indicative of disturbance, as well as some of the diagnostic native species, but in low cover.

Woody
Fraxinus pennsylvanica var. lanceolata (green ash)

Forbs
Typha angustifolia (cattail)

Graminoids
Juncus arcticus (mountain rush)
Phragmites australis (common reedgrass)
Phalaroides arundinacea (reed canarygrass)

Noteworthy Species

Listed below are species of **conservation concern** or species highly sensitive to anthropogenic disturbance that may occur in this system.

Amorpha fruticosa (desert false indigo)
Euthamia occidentalis (western goldtop)
Geum aleppicum (yellow avens)
Maianthemum stellatum (starry false lily of the valley)

Vegetation Structure (Metric V4, V5, V6)

Lower Montane-Foothill Riparian Woodland and Shrubland systems occur as a mosaic of shrub and tree-dominated plant communities. A variety of plant species are associated with this system, varying with elevation, stream gradient, floodplain width, and flooding events. Many sites will have swaths of open gravel or sand. Riparian forest and woodland communities of this system are often dominated by plains cottonwood (*P. deltoides*), lanceleaf cottonwood (*P. acuminata)* and peachleaf willow (*S. amygdaloides).* A high-grade system should have obvious regeneration in tree and shrub layers, diverse plant composition in herbaceous and shrub zones, and a range of vertical strata. Field characteristics of low-condition systems are the dominance of a single zone and missing strata, high cover of non-native species, site is open with predominantly dying or dead trees, and woody debris is excessive or entirely absent.

Water Source (Metric H1)

Sources include moving surface waters and below ground alluvial groundwater. Riparian zones in the north and west are more impacted by snowmelt dynamics than those sites further east, which are more dependent on local precipitation. The most common non-natural water sources that downgrade a system are irrigation water, agricultural and residential runoff, and artificially impounded water.

Hydroperiod (Metric H2)

The majority of Western Great Plains Riparian systems exhibit "temporarily flooded" regimes (Cowardin Hydrologic Modifier: A). If a site has not wetted in an abnormally long period of time, often evidenced by invasion of upland species and soils without hydric-indicators, this may be due to bank incision, and should be downgraded. Other field indicators of an impacted hydroperiod, and therefore channel disequilibrium, are deeply undercut banks with exposed living roots, bank slumps, declining vigor of riparian vegetation, lack of fine-grained sediment in channel bed or excessive sediment in channel and on banks (aggradation), and lack of braiding of flow-paths.

Hydrologic Connectivity (Metric H3)

Riparian systems with excellent hydrologic connectivity are completely connected to the floodplain (backwater sloughs and channels) and their water source. Sites with channel entrenchment, geomorphic modifications (dikes, rip rap, and elevated culverts), and lack of overbank flows into riparian zones are evidence of impacted connectivity and should be proportionately downgraded.

Stressors

- System hydrology is highly impacted by upstream human management of rivers via dams, reservoirs, diversions, and irrigation canals. Channel entrenchment, lack of overbank flows, and simplification of vegetation diversity and structure are some examples of physical evidence from this water management.
- Small streams on agricultural lands are often exposed to grazing, which can result in barren soils, loss of plant diversity, over-compaction, and erosion of river banks. Runoff from grazing and croplands are detrimental to water quality, and impact plant composition.
- Invasive species often invade riparian areas, and decrease overall biodiversity and regeneration of native plants.