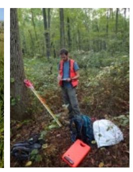
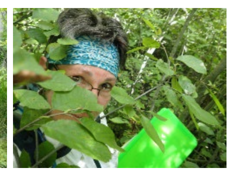
FIELD MANUAL FOR APPLYING RAPID ECOLOGICAL INTEGRITY ASSESSMENTS IN WETLANDS AND RIPARIAN AREAS IN NEW JERSEY

"This manual is adopted from the Washington Department of Natural Resources, Natural Heritage Program EIA manual Version 1.2. Only minor changes were made to make the manual geographically relevant."

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1.0 INTRODUCTION

The Ecological Integrity Assessment (EIA) is intended to measure current ecological condition as compared to a reference standard via a multi-metric index of biotic and abiotic measures of condition, size, and landscape context. Each metric is rated by comparing measured values with expected values under relatively unimpaired conditions (i.e. the reference standard), and the ratings are aggregated into a total score. Unimpaired is defined as the lack of deviation from the natural range of variability due to human-induced stressors. The EIA uses a scorecard matrix to communicate individual metric ratings, as well as an overall index of ecological integrity. Altogether, the EIA framework provides a standardized language for assessing and communicating ecosystem integrity across all terrestrial ecosystem types—upland and wetland ecosystems.

The EIA can be applied to occurrences as small as 0.05 ha and as large as thousands of hectares. EIAs can be conducted at three different sampling intensities: Level 1 (entirely GIS-based), Level 2 (rapid, mostly qualitative, field-based), and Level 3 (intensive, quantitative, field-based). This document describes the protocols for applying rapid, field-based Ecological Integrity Assessments (Level 2 EIA) to wetland and riparian ecological targets in New Jersey. EIA protocols for upland ecosystems in New Jersey will be developed in the near future. A more detailed overview of ecological integrity assessments is found in Rocchio and Crawford (2011) and Faber-Langendoen et al. (2016a, b,c). Users are strongly encouraged to read these documents before implementing the EIA in order to fully understand the reference benchmark concept and other assumptions inherent in the method.

The EIA assessment target is defined based on classification criteria. If the objective of the assessment is to determine whether the site meets the criteria of a Wetland of High Conservation Value (rare wetland type or element occurrence), then Walz et al (2022) is used to classify the native wetland or riparian vegetation type. A table of USNVC Wetland Groups in New Jersey with Global Rarity Ranks is provided in Appendix A. Otherwise, a specific HGM Class and U.S. National Vegetation Classification Formation type are used to define the assessment target. Specific project objectives may result in further adjustments to the assessment target. The process for establishing assessment target boundaries (i.e., assessment area) and protocols for collecting data necessary to apply the EIA metrics are provided in this document. Section 2 focuses on the steps needed to employ the Level 2 EIA, including which metrics to apply based on wetland type. Section 3 provides protocols for measuring each metric.

Once metrics are scored, they are rolled-up into six major ecological factors: landscape, buffer, vegetation, hydrology, soils, and size. These major ecological factor scores are in turn rolled-up into three primary rank factors: landscape context, condition, and size. These three factors can then be combined to calculate an overall EIA score/rank. Whether one needs to roll-up scores is dependent on the project objective. Land managers may only be interested in the metric scores, as they provide insight into management needs, goals, and measures of success. On the other hand, if the goal is to compare or prioritize sites for conservation, restoration, or management actions, an overall EIA score/rank may be needed. Primary and major ecological factor scores/ranks can be helpful for understanding the current status of primary ecological drivers.

2.0 Applying Level 2 Ecological Integrity Assessments

In addition to standard footwear and attire for working in wetlands, the following materials and supplies are needed for applying the EIA:

- EIA field forms for New Jersey
- *A Guide to Wetland Types in New Jersey with Ecoregional Floristic Quality Assessment Metrics (https://hdl.handle.net/10929/106770)*
- Local plant identification keys and field guides. Users are strongly encouraged to use technical dichotomous keys such as the *Manual of Vascular Plants of Northeastern United States and Adjacent Canada* (Gleason & Cronquist) and/or the *Flora of the Southeastern United States* (Alan S. Weakley, 2022) that includes New Jersey, especially for graminoids (sedges, grasses) which are notoriously difficult to identify. Guides to moss identification such as *Mosses, Liverworts, and Hornworts: A Field Guide to Common Bryophytes of the Northeast* (Ralph Pope, 2016) are recommended. Color photo field guides typically only list common species. While they are an indispensable tool for identification, they do not cover the entire flora.
- Munsell Soil Color Book and NRCS Field Indicators of Hydric Soils in the United States (Vasilas, Hurt and Berkowitz, 2018)
- Hand lens, GPS, compass, camera, small trowel or shovel or soil auger, chaining pins, pin flags and/or flagging/tape (for plot layout)
- GIS is recommended for assessing Landscape Context and Buffer metrics. However, using online map viewers could suffice. NatureServe's Ecological System's map is useful for determining land use patterns (http://www.natureserve.org/conservation-tools/terrestrial-ecological-systems-united-states).
- Historical imagery is helpful in determining site history, changes in land use, and stage of succession for forested systems.

Below are general guidelines for applying a Level 2 EIA.

Step 1: Assemble background information about the management and history of the site.

Step 2: Identify the assessment area(s). See Section 2.1 and 2.2 for details.

Step 2a: Classify the wetland to be assessed.

- If your objective is to identify a potential New Jersey Natural Heritage Program element occurrence (i.e., an occurrence of a rare wetland type or high-quality example of a common wetland type), then use Walz et al (2022) to classify the wetland to U.S. National Vegetation Classification Plant Association and Group types. Each potential element occurrence should be considered to be a separate assessment area (AA).

- Otherwise, classify the target wetland using HGM and U.S. National Vegetation Classification Formation keys provided in this document (see 3.0 Classification section). Each HGM and/or Formation type should be delineated as separate assessment areas to ensure that the correct EIA metrics are used.

Step 2b: Using the guidance in Section 2.2 below, delineate final AA boundaries.

Step 3: Using GIS, establish the landscape context boundary for the AA by delimiting the buffer (0-100 m), Core Area (100-250 m) and Supporting Area (250-500 m) boundary around the outer AA boundary.

Step 4: Before implementing the assessment, consult metric protocols to ensure they are measured systematically. Verify the appropriate season and other timing aspects of field assessment. (Section 3.0)

Step 5: Conduct the office assessment of landscape context, on-site conditions, and stressors of the AA.

Step 6: Conduct the field assessment of on-site conditions and stressors of the AA. The entire AA should be assessed, including--as much as feasibly possible--the 100 m buffer around the AA. This is typically aided by aerial photography or other imagery. The assessment often follows a site walkthrough approach where metrics are scored based on visual observations. For larger AAs, or for long-term monitoring, relevé plots are recommended for collecting data necessary to score metrics.

Step 7: Complete assessment scores and QA/QC Procedures. Automated EIA calculators are available on WNHP's website (http://www.dnr.wa.gov/NHP-EIA)

Step 8: Using the conservation status rank and overall EIA rank of the AA, refer to Table 3 to determine whether the wetland meets Wetland of High Conservation criteria.

2.1 Assessment Area

The Assessment Area (AA) is the spatial area within which the EIA will be applied. The AA is "the entire area, subarea, or point of an occurrence of a wetland type with a relatively homogeneous ecology and condition" (Faber-Langendoen et al. 2016a,b,c). There are many different approaches for determining the AA boundary. The approach used is contingent on project objectives, wetland target, etc. The approaches for AA delineation can generally be grouped into two categories: (1) point-based and (2) polygon-based.

2.1.1 Point-Based Assessment Area

Point-based approaches are best suited for assessing the ecological condition of a population of wetlands, such as an entire watershed or National Wildlife Refuge. These approaches typically define a relatively small area (e.g., 0.5 ha) around pre-determined points that are randomly distributed across the geographic area of interest. Assessments are then conducted within around these points. A point-based approach offers some advantages (Fennessy et al. 2007, Stevens and Jensen 2007):

- simple sampling design.
- does not require a mapped boundary of the ecosystem type
- limited practical difficulties in the field for assessing the entire area, as the area is typically relatively small (0.5–2 ha).
- long-term ambient monitoring programs often use a point-based approach because of these advantages.

For point-based AAs, some EIA metrics may not be applicable (e.g., Size metrics) or require modifications to rating criteria and/or roll-up procedures to make them logically consistent with their development. Those modifications are not within the scope of this document. Please contact the New Jersey Natural Heritage Program (NJNHP) for more information about using point-based sampling for EIAs.

2.1.1 Polygon-Based Assessment Area

The polygon approach is best suited for assessment of individual wetlands, as opposed to wetland populations. It is *possible* to use polygon-based AAs to estimate ecological condition of wetland populations, but point-based AAs are typically more conducive to those applications. Advantages of polygon-based AAs are:

- mapping boundaries facilitate whole ecosystem and landscape interpretations.
- decision-makers and managers are often more interested in "stands" or "occurrences," rather than points.
- programs that maintain mapped occurrences of ecosystem types are most interested in the status and trends of those occurrences.

This field manual is tailored for a polygon-based EIA approach.

2.2 Determine the Assessment Area Boundaries

Outlined below are the series of steps necessary to delineate an element occurrence and AA boundary.

Step 1. Estimation of Wetland Boundary*:* Map the wetland area to be assessed. This can be completed via a rigorous wetland delineation, as is often require for wetland regulatory applications, or using readily observable ecological attributes such as vegetation, soil, and hydrological characteristics.

Step 2. Classification and Mapping Variation within Wetland: AAs need to reflect a single HGM class and single U.S. National Vegetation Classification (USNVC) formation. These classification types form the basis for numerous metric ratings (Table 4). If your assessment objective is to determine whether a site meets the criteria for a Wetland of High Conservation Value, classify the various native wetland or riparian ecosystem types defined by Walz et al (2022). Each patch of a given type should be mapped within the wetland delineated in Step 1. [Note: Because vegetation types often occur in a mosaic, the final map of a given type may include multiple, discontinuous patches or polygons within the wetland mapped in Step 1.]). Each of the Walz et al (2022) types correspond to an individual USNVC Formation and Group.

If your project objectives are not concerned with Wetlands of High Conservation Value, you must determine if the mapped wetland boundary from Step 1 has multiple HGM classes and/or USNVC Formations (Faber-Langendoen et al. 2016c; keys are provided below). If so, an AA will need to be established for each of these classes. For example, if the target wetland mapped in Step 1 has two HGM classes (Riverine and Slope) and each HGM Class is considered to be part of the USNVC Freshwater Marsh, Wet Meadow, and Shrubland Formation, then two AAs should be established (one for the Riverine and another for the Slope type). However, if each HGM Class includes more than one USNVC Formation (e.g., Freshwater Marsh, Wet Meadow, and Shrubland Formation, Bog and Fen Formation, and Flooded and Swamp Forest Formation) then multiple AAs are required (e.g. one for each HGM and USNVC Formation combination; Figure 1). As noted above, a single AA may contain multiple patches or polygons within the wetland mapped in Step 1 (see AA #2 in Figure 1). Whether or not you are concerned with Wetlands of High Conservation Value, it is still necessary to identify the Group type of the AA--Group descriptions provide necessary guidance on scoring many of the metrics (Walz et al, 2022).

A key consideration in classifying and mapping is the concept of minimum size defined by the wetland patch type (Table 1). A patch or collection of patches must meet the minimum size criteria to justify classification and/or mapping as a separate AA. If the patch or collection of patches is smaller than the minimum size then those areas should be considered variation of the type, or AA, in which it is embedded. Refer Table 1 to determine the minimum size of the wetland type of interest.

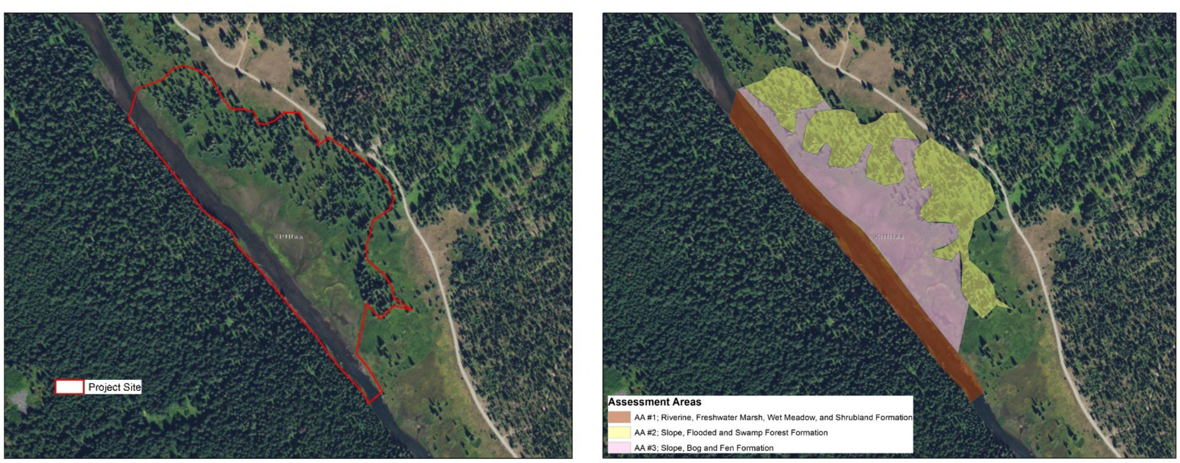

Figure 1. Assessment Area Delineation Based on HGM and USNVC Formation Types. LEFT: Project site boundary is shown by red line. RIGHT: Two HGM classes (Riverine and Slope) are present. Within the Riverine HGM

Class, only one USNVC Formation is present. Within the Slope HGM Class, two USNVC Formations are present. Thus, three distinct assessment areas are delineated.

Table 1. Patch Type and Minimum Size

Patch Size	Recommended Minimum Size for EO
Matrix (no wetlands in WA are of this type)	2 ha (~5 acres)
Large Patch (no wetlands in WA are of this type)	0.4 ha (~1 acre)
Medium Small Patch (salt marsh, intertidal)	0.2 ha (0.5 acre)
Small Patch (forested/shrub swamp, greasewood flat; marsh/meadow, peatland, aquatic bed, playa, interdunal, mudflat, and eelgrass)	0.05 ha (500 m^2)
Very Small Patch (seep/spring, horizontal wet rock, vernal pool)	50 m^2
Very Small Patch (vertical wet rock)	2 m in length
Linear (riparian)	30 meter in length

<u>HGM Classification Key</u>: (adapted from Hruby 2014a,b). Consider the entire wetland when using this key. If the criteria do not apply across the entire wetland, multiple HGM classes may be present.

1. Are tides one of the primary drivers of hydrology in the AA?

NO – go to 2 **YES** = **Estuarine Fringe (Tidal) Class**

2. Is the entire AA flat or elevated so that precipitation is the only source of water to it? Groundwater and surface water runoff are NOT sources of water to the unit.

NO – go to 3 **YES** = **Flats Class – go to 2.1**

2.1 Does the AA have organic soils (≥ 40 cm of peat)?

NO – Mineral Soils Flat Subclass **YES – Organic Soils Flat Subclass**

3. Does the entire AA **meet all** of the following criteria?

___The vegetated part of the wetland is on the shores of a body of permanent open water at least 8 ha (20 acres) in size;

___At least 30% of the open water area is deeper than 6.6 ft. (2 m).

NO – go to 4 **YES = Lacustrine Fringe Class**

4. Does the entire AA **meet all** of the following criteria?

____The AA is on a slope (*slope can be very subtle*);

____The water flows through the AA in one direction (unidirectional) and usually comes from seeps or springs. It may flow subsurface, as sheetflow, or in a swale without distinct banks;

____The water leaves the AA **without being impounded**.

NO - go to 5 **YES = Slope Class**

NOTE: Surface water does not pond in these type of wetlands except occasionally in very small and shallow depressions or behind hummocks (depressions are usually < 3 ft. in diameter and less than 1 ft. deep).

5. Does the entire AA **meet all** of the following criteria?

____The unit is in a valley, or stream channel, where it gets inundated by overbank flooding from that stream or river;

____ Overbank flooding is common, occurring at least once every two years (indicators include: scour marks, recent sediment deposition, vegetation damaged/bent in one direction, soils with alternating deposits, channel banks with flood marks).

NO - go to 6 YES = Riverine Class

6. Is the entire AA in a topographic depression in which water ponds, or soil is saturated to the surface, at some time during the year? *This means that any outlet, if present, is higher than the interior of the wetland.* ***OR*** Is the entire AA located in a very flat area with no obvious depression and no overbank flooding and does not have unidirectional flow? The unit does not pond surface water more than a few inches. The unit seems to be maintained by high groundwater in the area. The wetland may be ditched, but has no obvious natural outlet

NO – go to 7 YES = Depressional Class

7. The wetland is difficult to classify because of a confusing mix of hydrological regimes, some of which appear to be minor components of the wetland. Use Table 2 to identify the appropriate class. If you are still unable to determine which of the above criteria apply to your wetland, default to a classification of Depressional and note the confounding issues.

NOTE: Use this table only if the class that is recommended in the second column represents 10% or more of the total area of the AA. If the area of the HGM class listed in column 2 is less than 10% of the unit; classify the wetland using the class that represents more than 90% of the total area.

Table 2. How to Classify an AA with Multiple HGM Classes.

HGM Classes Within the Wetland Unit Being Rated	HGM Class to Use for EIA
Slope + Riverine	Riverine
Slope + Depressional	Depressional
Slope + Lake-fringe	Lake-fringe
Depressional + Riverine along stream within boundary of depression	Depressional
Depressional + Lake-fringe	Depressional
Riverine + Lake-fringe	Riverine
Salt Water Tidal Fringe and any other class of freshwater wetland	Estuarine Fringe

USNVC Formation Key: use the key below to assign the U.S. National Vegetation Classification Formation (based on key in Faber-Langendoen et al. 2016c).

1a. One or more layers of the vegetation's structure and/or composition determined by regular human activity such as planting, tilling, cropping, mowing, and/or irrigating---AGRICULTURAL & DEVELOPED VEGETATION (EIA IS NOT DESIGNED FOR USE IN THESE TYPES)

1b. Vegetation's structure and/or composition determined by a spontaneously growing set of plants species shaped by ecological processes---GO TO 2.

2a. Wetland dominated by trees---GO TO 3

2b. Wetland dominated by shrubs and/or herbaceous species---GO TO 4.

3a. Trees form closed canopy on mineral soils, or if on organic soils then very well decomposed (i.e. = sapric or muck); trees are relatively vigorous (generally straight, over 10 m) with pointed crowns; *Sphagnum* is absent or confined to sporadic patches near tree bases or small depressions; sites with a flowing, flooded, or fluctuating semi-permanent, near-surface water table ---FLOODED & SWAMP FOREST FORMATION

3b. Trees form relatively open canopy on organic soils; trees are generally stunted and may have a bonsai form, with rounded tops; trees > 5m are typically < 10% cover although denser stands can occur; organic soils are typically of hemic to fibric decomposition stage in top 16 in.; understory typically has nearly continuous cover of mosses (often Sphagnum); in western WA, *Ledum groenlandicum*, *Kalmia microphylla*, and/or *Gaultheria shallon* are typically dominant in the understory; in eastern WA, sedges, *Betula glandulosa*, and/or small-statured willows are common understory dominants---BOG AND FEN FORMATION

4a. Permanent still or slow-moving shallow waters dominated by floating or rooted, submerged aquatic plants---AQUATIC VEGETATION FORMATION
4b. Wetland dominated by emergent herbaceous species and/or shrubs---GO TO 5

5a. Wetland is dominated by salt-tolerant species; associated with tidal hydrology in western WA; interior salt marshes in eastern WA often have salt crusts on the soil surface; ---SALT MARSH FORMATION
5b. Wetland is freshwater, or if saline, then not affected by tides---GO TO 6

6a. Wetland occurs on organic soils with persistent soil saturation (but rarely significant depth above soil surface) and dominated by sedges; Sphagnum or other mosses often cover ground surface OR if drier, then ground cover is predominantly dominated by Sphagnum species with shrubs such as *Ledum groenlandicum*, *Kalmia microphylla*, *Vaccinium oxycoccos*, and/or *Gaultheria shallon*---BOG AND FEN FORMATION
6b. Wetland occurs on mineral soils OR if on organic soils then soils are highly decomposed and associated with fluctuating water regimes; sites may be semi-permanently to permanently flooded or seasonally flooded and drying during summer---FRESHWATER MARSH, WET MEADOW, AND SHRUBLAND FORMATION

If your project objectives are not concerned with Wetlands of High Conservation Value (rare wetlands or reference quality wetlands), then skip to Step 4. Otherwise, proceed to Step 3.

Step 3. Preliminary Determination of the Ecological Observation's Conservation Significance

In order to be considered a Wetland of High Conservation Value, the wetland must be a rare type or a common type of excellent ecological integrity (Table 3). Specifically, the conservation status rank (Global/State rank) of a native wetland or riparian vegetation type and the EIA rank of a specific occurrence of that type are used to determine whether that particular occurrence qualifies as a Wetland of High Conservation Value (Table 3). In other words, all occurrences of rare wetland types qualify, regardless of their condition, while only good to excellent condition examples of common types are considered Wetlands of High Conservation Value (Table 3).

Before proceeding further with the EIA, one should make a preliminary determination of whether the specific occurrence in question may qualify as a Wetland of High Conservation Value. To do this, consult Walz et al (2022) and the table in Appendix A to determine the conservation status rank of the vegetation type being assessed. If it is a common type (e.g., G4 or G5), use your professional judgment regarding the ecological condition of the occurrence to determine whether it is valuable to proceed further. For example, if the occurrence is a *Typha latifolia* Pacific Coast Marsh (conservation status rank = G5) and it appears very degraded, further assessment is probably unnecessary because only occurrences of G5 plant association elements with A-rank or "excellent integrity" are considered Wetlands of High Conservation Value (Table 3). If there is reason to believe the occurrence could have excellent ecological integrity (e.g., A rank) then continue to Step 4. Conversely, if the observation is of a plant association with a conservation status rank of G1, then further assessment is warranted since any EIA rank of that occurrence would make it a Wetland of High Conservation Value (Table 3).

Table 3. Decision Matrix to Determine Ecosystem Element Occurrences

Global / State Conservation Status Rank Combination	Ecological Integrity Assessment Rank			
	A Excellent integrity	B Good Integrity	C Fair integrity	D Poor integrity
G1S1, G2S1, GNRS1, GUS1				
G2S2, GNRS2, G3S1, G3S2, GUS2				
GUS3, GNRS3, G3S3, G4S1, G4S2, G5S1, G5S2, any SNR				
G4S3, G4S4, G5S3, G5S4, G5S5, GNRS4, GNRS5, GUS4, GUS5				
Red Shading = Element Occurrence				

<u>Step 4. Aggregate Polygons into AA Boundaries</u>: If each type identified in Step 2 or 3 has only one polygon or patch, then proceed to Step 5. Otherwise, use the key below to determine whether to aggregate multiple patches or polygons of the same wetland type as a single AA or to consider them as separate AAs.

1. Is the distance between two separate observation ≥ 5km?
   Yes = they are separate AAs
   No – GO TO 2
2. Do the observations share connected linear riparian / floodplain / coastal habitat?
   Yes = GO TO 3
   No – GO TO 4
3. Is there an area of cultural vegetation/development $\geq$ 2 km long (following linear habitat) between observations?
   Yes = they are separate AAs
   No – they are the same AA
4. Is there an area of development $\geq$ 100 m wide?
   Yes = they are separate AAs
   No – GO TO 5
5. Is there cultural vegetation / water $\geq$ 300 m wide?
   Yes = they are separate AAs
   No – GO TO 6
6. Is there contrasting wetlands / uplands $\geq$ 500 m wide? (i.e., if element is upland, contrast = wetland, and vice-versa)
   Yes = they are separate AAs
   No – GO TO 7

7. If the observations occur in depressional settings, are they hydrologically connected (e.g., they occur in the same basin or if in separate basins they have a hydrological connection via inlet/outlet or occasional overflow between them)?
   Yes = they are the same AA
   No – GO TO 5
8. If the observations are slope wetlands (e.g., groundwater discharge wetland) do they discharge into the same wetland complex and/or surface water drainage?
   Yes = they are same AA
   No – they are separate AAs

Step 5. Modifications to AA Boundaries Based on Variation in Land Use: If significant change in management or land use results in distinct ecological differences across the AA boundary then those areas should be considered separate AAs. Some examples follow:

- A heavily grazed wetland on one side of a fence line and ungrazed wetland on the other could result in separate AAs, even if they are both of the same HGM Class and USNVC Formation.
- Anthropogenic changes in hydrology. For example, ditches, water diversions, irrigation inputs, and roadbeds that substantially alter a site's hydrology relative to adjacent areas justify separate AAs if ecological integrity varies substantially between the different areas.

Step 6. Apply Level 2 EIA to AA boundaries: In most cases, the extent of the AA boundary at this stage will result in a reasonably sized area that allows practical application of the EIA. If the AA exceeds a reasonable size to survey as part of a rapid assessment, then consider: (1) creating sub-AAs so that each is a practical assessment unit for a site walkthrough approach to data collection OR (2) establish a series of random relevé plots within the AAs. If using sub-AAs, the EIA would be applied to each and then weighted based on area and merged to get the final EIA rank of the AA. Similarly, if using random relevé plots, data can be averaged across plots and then used to score EIA metrics. Section 2.3 discusses how to determine which metrics to apply, based on classification of the AA.

Table 4. EIA Metrics and Applicable Wetland Types

Primary Rank Factor	Major Ecological Factor	Metric/Variant NAME	Where Measured	Apply to:
LANDSCAPE CONTEXT	LANDSCAPE	LAN1 Contiguous Natural Cover (0-500 m)	Office then field check	All Types (not for use with sub-AAs or most point-based AAs)
		Submetrics: *Inner Landscape (0-100 m)*		
		Outer Landscape (100-500 m)		
		LAN2 Land Use Index (0-500 m)	Office then field check	All Types (not for use with sub-AAs or most point-based AAs)
		Submetrics: *Inner Landscape (0-100 m)*		
		Outer Landscape (100-500 m)		
	BUFFER	BUF1 Perimeter with Natural Buffer	Office then field check	All Types (not for use with sub-AAs or most point-based AAs)
		BUF2 Width of Natural Buffer Width	Office then field check	All Types (not for use with sub-AAs or most point-based AAs)
		BUF3 Condition of Natural Buffer	Office then field check	All Types (not for use with sub-AAs or most point-based AAs)
CONDITION	VEGETATION	VEG1 Native Plant Species Cover	Field	All Types; Use lowest submetric score
		Submetrics: *Tree Stratum*		Flooded & Swamp Forest Formation
		Shrub/Herb Stratum		All Types
		VEG2 Invasive Nonnative Plant Species Cover	Field	All Types
		VEG3 Native Plant Species Composition	Field	All Types
		Submetrics: *Native Diagnostic/Functional Species*		See USNNVC Group descriptions for guidance
		Native Species Diversity		
		Native Increasers		See USNNVC Group descriptions for guidance
		Native Decreasers		See USNNVC Group descriptions for guidance
		VEG4 Vegetation Structure	Field	All Types (variant differs by USNVC Formation)
		VEG4, variant 1		Flooded & Swamp Forest Formation
		Submetrics: *Canopy/subcanopy age class diversity*		

Primary Rank Factor	Major Ecological Factor	Metric/Variant NAME	Where Measured	Apply to:
		Old/large live trees		
		VEG4, variant 3		Freshwater Marsh, Wet Meadow and Shrubland Formation
		VEG4, variant 4		Salt Marsh Formation
		VEG4, variant 5		Bog and Fen Formation
		Submetrics: *Tree structure*		
		Shrub/herb structure		
		Bryophyte structure		
		VEG4, variant 6		Aquatic Vegetation Formation
		VEG5. Woody Regeneration	Field	Flooded & Swamp Forest Formation and optional for shrub-dominated types
		VEG6 Coarse Woody Debris, Snags, and Litter	Field	Flooded & Swamp Forest Formation and optional for shrub-dominated types
		VEG6, variant 1		Flooded & Swamp Forest Formation
		Submetrics: *CWD Size Diversity*		
		CWD Decay Class Diversity		
		Snag Size Diversity		
		Snag Decay Class Diversity		
		VEG6, variant 2		Nonforested wetlands
		Litter Source		
		Litter Accumulation		

Primary Rank Factor	Major Ecological Factor	Metric/Variant NAME	Where Measured	Apply to:
	HYDROLOGY	HYD1 Water Source	Field & Office	All Types (varies by HGM Class)
		HYD1, variant 1		Riverine (non-tidal)
		HYD1, variant 2		Organic Soil Flats, Mineral Soil Flats
		HYD1, variant 3		Depression, Lacustrine, Slope
		HYD1, variant 4		Estuarine Fringe (tidal)
		HYD2 Hydroperiod	Field	All Types (varies by HGM)
		HYD2, variant 1		Riverine (non-tidal)
		HYD2, variant 2		Organic Soil Flats, Mineral Soil Flats
		HYD2, variant 3		Depression, Lacustrine, Slope
		HYD2, variant 4		Estuarine Fringe (tidal)
		HYD3 Hydrologic Connectivity	Field	All Types (varies by HGM)
		HYD3, variant 1		Riverine (non-tidal)
		HYD3, variant 2		Organic Soil Flats, Mineral Soil Flats
		HYD3, variant 3		Depression, Lacustrine, Slope
		HYD3, variant 4		Estuarine Fringe (tidal)
	SOIL	SOI1 Soil Condition	Field	All Types (variant differs by USNVC Formation)
		SOI1, variant 1		Flooded and Swamp Forest, Freshwater Marsh, Wet Meadow and Shrubland (nontidal), Bog and Fen, and Aquatic Vegetation formations.
		SOI1, variant 2		Salt Marsh Formation and Freshwater Marsh, Wet Meadow, and Shrubland (tidal) Formation
SIZE	SIZE	SIZ1 Comparative Size (Patch Type)	Office then field check	All Types (ratings vary by patch type); not for use with sub-AAs or points
		SIZ2 Change in Size (optional)	Office then field check	All Types (not for use with sub-AAs or points)

3.0 Level 2 EIA Protocol

This section provides guidance on how to populate the field form. The first four sections address basic site-level data. Thereafter, protocols for each metric are described. They are organized by Rank Factor categories. The majority of protocols used for the WA wetland/riparian Level 2 EIAs are the same as outlined by Faber-Langendoen et al. (2016a,b). Occasionally, regional language is used for some of the metric ratings. Additionally, many of the metric ratings have been updated/combined/modified from EIA scorecard matrices previously developed by WNHP for specific Ecological Systems (Crawford 2011a-aj; Crawford & Rocchio, 2011; Rocchio, 2011a-e).

3.1 Site & Classification Information

Site Name: Provide a unique name for the survey site.

AA Name (if > 1 AAs): If multiple assessment areas are established at the site, provide a unique name/identifier for the assessment area. For example, if there are multiple AAs at a site called "Elk Lake" the individual AAs should be labeled something like "Elk Lake-01" and "Elk Lake-02".

Manual Version #: Enter the version # of the EIA manual you are using.

HGM: Note the HGM Class determined in Section 2.2

Cowardin: Use table below to assign applicable Cowardin categories to each level.

	Palustrine Systems	Lacustrine System	Estuarine System
Subsystem	n/a	Littoral	Intertidal Subtidal
Class/Subclass	AB – aquatic bed 1 Algal 2 Aquatic moss 3 Rooted Vascular 4 Floating vascular EM – Emergent 1 Persistent 2 Non-persistent 5 *Phragmites australis* ML – Moss-lichen 1 Moss 2 Lichen SS – Scrub-shrub 1 Broad-leaved deciduous 2 Needle-leaved deciduous 3 Broad-leaved evergreen 4 Needle-leaved evergreen 5 Dead 6 Deciduous 7 Evergreen FO – Forested 1 Broad-leaved deciduous 2 Needle-leaved deciduous 3 Broad-leaved evergreen 4 Needle-leaved evergreen	AB – aquatic bed 1 Algal 2 Aquatic moss 3 Rooted Vascular 4 Floating vascular EM – Emergent 2 Non-persistent	AB – aquatic bed 1 Algal 3 Rooted vascular 4 Floating Vascular EM – Emergent 1 Persistent 2 Non-persistent 5 *Phragmites australis*

	Palustrine Systems	Lacustrine System	Estuarine System
	5 Dead 6 Deciduous 7 Evergreen		
Water Regime	See definitions in Table 5.		
Water chemistry	**Coastal Halinity** 1 Hyperhaline – salinity > 40% ppt due to ocean-derived salts 2 Euhaline –salinity 30 to 40 ppt due to ocean-derived salts 3 Mixohaline (brackish) – salinity 0.5 to 30 ppt due to ocean-derived salts 4 Polyhaline – salinity 18 to 30 ppt due to ocean-derived salts 5 Mesohaline – salinity of 5 to 18 ppt due to ocean-derived salts 6 Oligohaline – salinity 0.5 to 5 ppt due to ocean-derived salts 0 Fresh – salinity < 0.5 ppt **Inland Salinity** 7 Hypersaline – salinity > 40% ppt due to land-derived salts 8 Eusaline –salinity 30 to 40 ppt due to land-derived salts 9 Mixosaline (brackish) – salinity 0.5 to 30 ppt due to land-derived salts 0 Fresh – salinity < 0.5 ppt **Freshwater (pH)** a Acid – pH < 5.5 t Circumneutral – pH of 5.5 to 7.4 I Alkaline – pH > 7.4		
Soil	g Organic – soil composed of predominantly organic rather than mineral material (=histosol) n Mineral – soil composed of predominantly mineral rather than organic materials.		
Special	b Beaver – wetland formed due to beaver dam impoundment d Partly drained/ditched – water level has been artificially lowered, but the area is still a wetland. f Farmed – soil surface has been mechanically or physically altered for crop production h Diked/impounded – created or modified by a barrier or dam (human) which purposely or unintentionally obstructs outflow of water. r Artificial - wetland created by humans. s Spoil – wetland formed on spoils excavated from elsewhere and deposited onsite. X Excavated – lies within a basin or channel excavated by humans.		

NVC Formation: Note the Formation type determined in Section 2.2.
NVC Group: Use the key provided in Walz et al (2022) to assign the Group name.
NVC Plant Association: Use the links provided in Walz et al (2022) to assign the National Vegetation Classification Plant Association name.
Global/State Rank: Use the table of New Jersey Wetland Groups with Global rarity ranks provided in in Appendix A to note Global and State Conservation Status ranks. Walz et al (2022) provides links within each USNVC Group description to the associated USNVC Alliances and Associations. The rarity ranks of these floristic levels of the classification are included in the NatureServe Explorer links.
Observer: first and last name of the surveyor(s).

<u>Date</u>: date of the survey.

<u>County</u>: county in which the site (or AA) occurs.

<u>VegPlot(s)</u>: If vegetation plots are established within the site/AA, list their unique plot codes.

<u>TRS</u>: Township, Range, and Section in which the AA occurs.

Table 5. Hydrological Regime Definitions (based on Cowardin et al. 1979)

Hydrological Regime	Definition
Nontidal	
B Saturated	Substrate is saturated to the surface for nearly the entire year, but surface water is seldom present, or if present, just a few inches above the soil surface in low spots.
E Seasonally saturated	Substrate is saturated to the surface through late spring/early summer, but thereafter tends to dry out.
H Permanently flooded	Water covers the surface throughout the year in all years.
G Intermittently exposed	Surface water is present throughout the year except in years of extreme drought.
F Semipermanently flooded	Water covers the surface throughout the growing season in most years. When surface water is absent the water table is usually at or very near the surface.
C Seasonally flooded	Surface water is present for extended periods, especially early in the growing season, but absent by the end of the season in most years. When surface water is absent, the water table often remains near the surface.
A Temporarily flooded	Surface water is present for brief periods during the growing season, but the water table usually lies well below the surface for most of the season. Plants that grow in both uplands and wetlands are characteristic.
J Intermittently flooded	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. Dominant plant communities may changes as soil moisture conditions changes. Some areas aren't considered wetlands under USFWS definitions.
K Artificially flooded	The amount and duration of flooding is controlled by means of pumps or siphons in combination with dikes or dams. In contrast to the Cowardin et al. 1979 definition, wetlands resulting from leakages from subsurface irrigation discharge/wastewater, artificial impoundments, irrigation from diversions or ditches ARE included here IF they wouldn't exist without these sources (i.e. they do not have a natural source of water).
Saltwater Tidal	
L Subtidal	Substrate is permanently flooded with tidal water
M Irregularly exposed	Substrate is exposed by low tides less often than daily
N Regularly flooded	Tidal water alternately floods and exposes the land surface at least once daily.
P Irregularly flooded	Tidal water floods the land surface less often than daily
Freshwater Tidal	
S Temporarily flooded-tidal	Same definition as above but for tidal sites
R Seasonally flooded-tidal	Same definition as above but for tidal sites
T Semipermanently flooded-tidal	Same definition as above but for tidal sites
V Permanently flooded-tidal	Same definition as above but for tidal sites

<u>Photos</u>: If photos are taken, please provide the photographer's name and associated file names. Files names ideally should have the photographer's initials and a numeric code (e.g., fjr_001). A

brief description of each photo's content should be documented in (1) a field notebook or (2) file name; or (3) in the photo's metadata.

EOID: This is the "element occurrence ID" code from BIOTICS. This only applies to existing records in New Jersey Natural Heritage Program's BIOTICS database.

Feature ID: This is the "Feature ID" code from BIOTICs. Element occurrences can have more than 1 polygon. The Feature ID is used to uniquely code each polygon. This only applies to existing records in New Jersey Natural Heritage Program's BIOTICS database.

Owner(s): List the owners of the site/AA.

Site Description: Please provide a written description of the site's characteristics. Focus on the setting in which the site occurs, ecological and vegetation patterns within and adjacent to the site, notable stressors or human activity, signs of wildlife, etc. A drawing may also be helpful.

3.2 Environmental

Slope (deg/%): Enter the slope of the AA in degrees or as percent slope.

Aspect (downslope): Facing downslope, note the aspect of the AA (in degrees).

Topographic Position: Select the landform that best fits the location of the AA; if needed, use the empty box to enter a landform not represented in the table.

Water Source: Select the primary water source for the AA; if more than one water source is present, check each and indicate in the comments field which is primary, secondary, etc.

Hydrodynamics: Refer to Table 6 and record the hydrodynamics that best describes the AA.

Table 6. Hydrodynamic Categories

Hydrodynamic Category	Definition
Stagnant	Stagnant to very gradually moving soil water; Vertical fluctuations minimal. Permanent surface saturation, but minimal or no surface flooding. Basins or hollows with stable water regimes. Abundant organic matter accumulation with high bryophyte cover.
Sluggish	Gradual groundwater movement through peat or fine-textured mineral soils along a hydrological gradient; Minor vertical water table fluctuations. Semi-permanent soil saturation with some elevated microsites or brief periods of surface aeration. Hollows, slopes, and water tracks in basins or lake flats not directly influenced by the waterbody. Abundant peat accumulation and bryophyte cover.
Mobile	Distinct flooding and drawdown or pronounced lateral water movements. Peripheral areas of peatlands, sites adjacent to open water tracks, small rivulets or ponds, small potholes with relatively stable water regimes, protected lake embayments, or backmarshes in estuaries. Can have deep, but well-decomposed, accumulations of peat. Patchy bryophyte cover.
Dynamic	Significant lateral flow and/or strong vertical water table fluctuations through mineral soils. Potholes in arid climates that experience significant drawdown, wave-exposed shores, floodplain back channels, and protected estuary sites. Little organic matter accumulation, few bryophytes.
Very dynamic	Highly dynamic surface water regime. Exposed tidal sites, shallow potholes in arid climates that experience significant drawdown, wave-exposed shores, and sites directly adjacent to and influenced by river flow. No organic matter accumulation; no bryophytes.

Soil Type: Select the primary type of soil found in the AA; if more than one type exists, select each and then describe the distribution of each type in the comments.

Mineral soil: soil is predominantly of abiotic origin; sand, silt, and clay dominate most layers. A histic epipedon or organic soil horizon may be present, but is less than 40 cm deep and is typically present as an O horizon on the surface.

Organic soil (sapric): highly decomposed organic material in which the original plant parts are not recognizable; contains more mineral matter and is usually darker in color than peat; often called muck (von Post H7 to H10; see below)

Organic soil (hemic): unconsolidated soil material consisting of accumulated, slightly decomposed organic matter (von Post H4 to H6).

Organic soil (fibric): unconsolidated soil material consisting of accumulated, relatively undecomposed organic matter (von Post H1 to H3).

Mineral Soil Texture: Using the key in Figure 2, determine soil texture at approximately 15 cm depth.

pH: Record pH using a handheld pH meter or other methods. Ideal measurements are from soil water (water drained into a soil pit), but other locations are possible (see Sample Source below).

Conductivity: Record electrical conductivity using a handheld meter. Be sure to record units of measurement (e.g., µS/cm). Ideal measurements are from soil water (water drained into a soil pit), but other locations are possible (see Sample Source below).

Temp: Record water temperature using a handheld meter. Be sure to record measurement units (C or F). Ideal measurements are from soil water (water drained into a soil pit), but other locations are possible (see Sample Source below).

Instrument: Indicate make/model of instrument used to determine pH/conductivity/temp (e.g., Hanna Instruments, HI98129 probe, pH paper strips, etc.)

Sample Source: Note the location from which water quality readings were taken. Location examples: (1) small pool; (2) water from soil pit; (3) water extracted from squeezing mosses; (4); moving surface water such as a creek or rill; or (5) pond or lakeshore.

Von Post Index (only applicable to organic soils): Grab a handful of peat and gently squeeze. Based on what is extracted from your hand, determine and record the von Post index using Table 7.

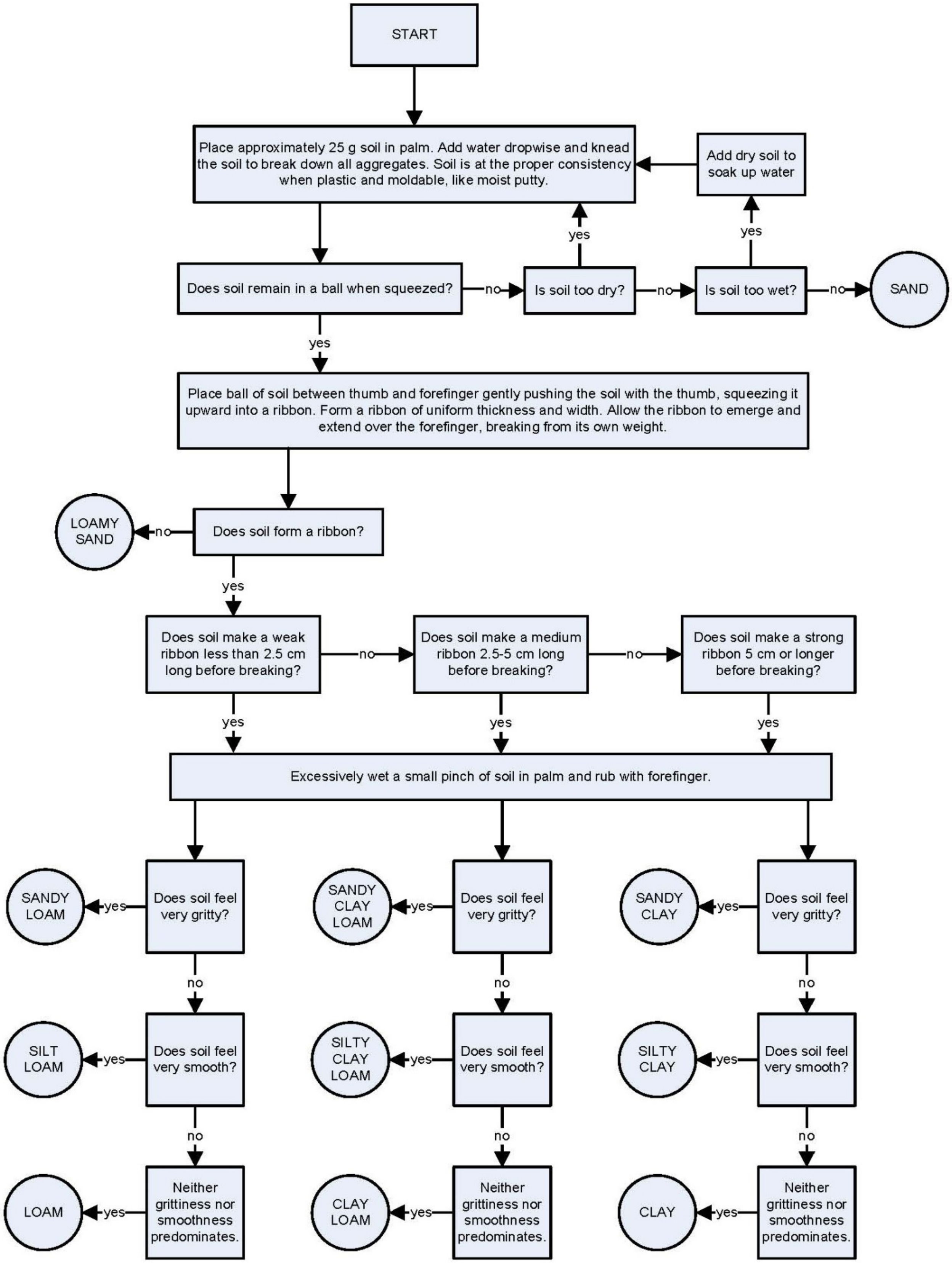

Figure 2. Soil Texture Key

Table 7. von Post Index

Von Post Index	Definition
H1:	Completely undecomposed peat (but not “live”); only clear water can be squeezed out.
H2:	Almost undecomposed and mud-free peat; water that is squeezed out is almost clear and colorless.
H3:	Very little decomposed and very slightly muddy peat; when squeezed water is obviously muddy but no peat passes through fingers. Residue retains structure of peat.
H4:	Poorly decomposed and somewhat muddy peat; when squeezed, water is muddy. Residue muddy but it clearly shows growth structure of peat.
H5:	Somewhat decomposed, rather muddy peat; growth structure visible but somewhat indistinct; when squeezed some peat passes through fingers but mostly very muddy water. Press residue muddy.
H6:	Somewhat decomposed, rather muddy peat; growth structure indistinct; less than 1/2 of peat passes through fingers when squeezed. Residue very muddy, but growth structure more obvious than in unpressed peat.
H7:	Rather well-decomposed, very muddy peat; growth structure visible, about 1/2 of peat squeezed through fingers. If water is squeezed out, it is porridge-like.
H8:	Well-decomposed peat; growth structure very indistinct; about 2/3 of peat passes through fingers when pressed, and sometimes a somewhat porridge-like liquid. Residue consists mainly of roots and resistant fibers.
H9:	Almost completely decomposed and mud-like peat; almost no growth structure visible. Almost all peat passes through fingers as a homogeneous porridge if pressed.
H10:	Completely decomposed and muddy peat; no growth structure visible; entire peat mass can be squeezed through fingers.

Natural Disturbance Comments: Comments may include information on vegetation or ground cover disturbance, evidence of animal use, disturbance history, erosion, fire, storms, etc. If available, information on the type of disturbance, intensity, frequency, years of past disturbances, and seasonality may also be provided. Only comments on the natural disturbance evidence within the AA itself should be included in this field; although including information on the surrounding context cannot entirely be avoided, the focus should be on the AA. Information on disturbances to the surrounding landscape should be entered in the Landscape Context Comments field instead.

Anthropogenic Disturbance Comments: Comments may include information on vegetation or ground cover disturbance, logging, plowing, scraping, mowing, fire suppression, etc. If available, information on the type of disturbance, intensity, frequency, years of past disturbances, and seasonality may also be provided.

Geology Comments: Description of the geologic substrate that influences the community Element Occurrence (EO).

Environmental Comments: Comments on other important aspects of the environment that affect this particular community Element Occurrence (EO), including information on climate, seasonality, or any other relevant environmental factors.

3.3 VEGETATION

Plot Type: Circle the type of plot used for data collection (write it in if not listed). The plot form is tailored for relevé or site walkthrough data collection. Columns for up to 10 relevé plots are provided on the form. If transect quadrats or nested subplots were used, attach the associated plot form to the EIA field form.

Plot Size: Note the plot size used. Standard plot sizes for specific strata include: 100 m^2 for herbaceous and shrubland types and 400 m^2 for forest types. Note size by dimension (e.g. 10x10 m; 20x20 m; 10x40 m, etc.). If site walkthrough method was used, estimate area walked and approximate time spent searching.

Species Cover: List the species observed in the AA in the left-hand column. For each species, enter the appropriate strata code. Columns for up to 10 relevé plots are provided. Estimate canopy cover (see definition above) of the species within the plot and enter the midpoint of the cover class (Table 8). For example, if *Carex stricta* has 10-25% cover, the midpoint value of 17.5% would be entered. If multiple plots are sampled, enter the average cover across plots for each species (this will help with metric calculations). For each species, be sure to enter the appropriate values for the Exotic/Invasive, Diagnostic, and Increaser/Decreaser columns. Examples of these species are listed in Subgroup descriptions (Rocchio et al., 2020b). Definitions of these categories are:

Exotic (Introduced, Nonnative) species: species not considered native to New Jersey.

Invasive species: aggressive nonnative species that change or transform the character, condition, form, or nature of ecosystems.

Diagnostic species: the characteristic combination of native species whose relative constancy or abundance differentiates one vegetation type from another, including character species (strongly restricted to a type), differential species (higher constancy or abundance in a type as compared to others), constant species (typically found in a type, whether or not restricted), and dominant species (high abundance or cover) (FGDC 2008). Together these species indicate specific ecological conditions--typically that of minimally disturbed sites.

Native Decreaser Species: native species that decline rapidly from stressors (sometimes referred to as "conservative species."). Species with a coefficient of conservatism value ≥ 7 should be considered a native "decreaser" (see New Jersey's Floristic Quality database and Northeast Ecoregional databases (by Omernik Level III Ecoregion) on UniversalFQA. The FQA values for New Jersey's vascular and non-vascular taxa are included in a tab on the EIA Calculator for New Jersey.

Native Increaser Species: Native species which dramatically increase due to anthropogenic stressors such as grazing, nutrient enrichment, soil disturbance, etc. Species with a coefficient of conservatism value ≤ 3 should be considered potential native "increasers" (see FQA databases previously cited). However, the simple presence of these species is not enough to indicate that they are acting as increasers. Rather, it is their relative proportion to what is expected that triggers such a designation. This concept tends to work well in wetlands exposed to conspicuous stressors such as grazing where these native species tend to dominate or become monocultures (e.g., *Phalaris arundinacea* or *Typha latifolia*). Because presence/absence is not enough to score this submetric it can be a difficult measure for many users. If that is the case, you can ignore this submetric and make a note in the metric Veg 3 comment section with your reasoning.

Table 8. Cover Classes

Cover Class	Range	Midpoint
1	Trace	0.25%
2	0-1%	0.5%
3	1-2%	1.5%
4	2-5%	3.5%
5	5-10%	7.5%
6	10-25%	17.5%
7	25-50%	37.5%
8	50-75%	62.5%
9	75-95%	85%
10	> 95%	97.5

3.4 EIA Metric Ratings and Scores

For each metric, an A, B, C, or D rank is selected. These ranks are informed by rating criteria descriptions contained within this manual, the wetland Group descriptions (Walz et al, 2022), field observations, useful GIS data, and any other relevant available data. Field crews are encouraged to assign a single rating, but a range rank may be used (i.e., AB, BC, or CD) in cases where the rank is uncertain. The range rank does not indicate an intermediate rank or "+/-" rank; it indicates that the metric may be one or the other. We also discourage the use of intermediate or plus/minus ranks (e.g., A- , B- or C-) at the metric level, because it may generate a false sense of precision for a rapid assessment. An exception can occur when an actual rating with a description has been provided for the intermediate rating (e.g., there are a few metrics, such as Hydroperiod, where we found it helpful to distinguish C+ from C). Metric ratings should be entered on the EIA field form. Associated scores for each rating are then used for roll-up calculations (Table 9).

Table 9. Metric rating and points. Occasionally, metric ratings are further subdivided (e.g. a B (3.0) and B- (2.5) or a C (2.0) and C- (1.5).

Metric Rating	Points
A	4.0
B	3.0
C	2.0
D	1.0

3.5 LANDSCAPE CONTEXT METRICS

LAN1 Contiguous Natural Land Cover

Definition: A measure of connectivity using the percent of natural habitat directly connected to the AA, including optional submetrics for the inner zone (0–100 m) and outer zone (100–500 m). Note that for large AAs (>50 ha), this metric is assessed at the scale of the entire AA, not for individual assessment points within the AA.

Background: This metric addresses the broader connectivity of the natural land cover by measuring the natural habitat that is directly contiguous to the AA. However, not all organisms and processes require directly contiguous habitat, and organisms perceive "connectivity" differently, so this metric may underestimate contiguous habitat for some organisms.

Apply To: All types.

Measurement Protocol: Select the statement that best describes the contiguous natural land cover within the 500 m zone that is connected to the AA. First, identify the percent of land cover that is directly connected to the AA within the 0-500 m area zone the AA. If you choose to use subzones, measure the inner (100 m) and outer (100-500 m) landscapes separately and then select the rating that best describes the integration of those two measures for the final rating. To measure natural land cover, it is recommended to use NatureServe's Ecological Systems map (http://www.natureserve.org/conservation-tools/terrestrial-ecological-systems-united-states) as a foundation for measurement. However, the National Land Cover database (http://www.mrlc.gov/nlcd2011.php) may also be used. Ground truthing is also advisable since remote sensing data sources may misinterpret some land cover types. Water is included with terrestrial natural land cover. Where water may be a degrading factor (e.g., a wetland next to a boat club may be exposed to excessive wave action), it can be accounted for in other metrics (i.e., Land Use Index and Buffer Condition). Well-traveled dirt roads and major canals break up unfragmented blocks, but vegetated two-track roads, hiking trails, hayfields, low fences and small ditches may be included.

Table **13** provides guidance for distinguishing natural from non-natural land cover). See Figure 3 for an example.

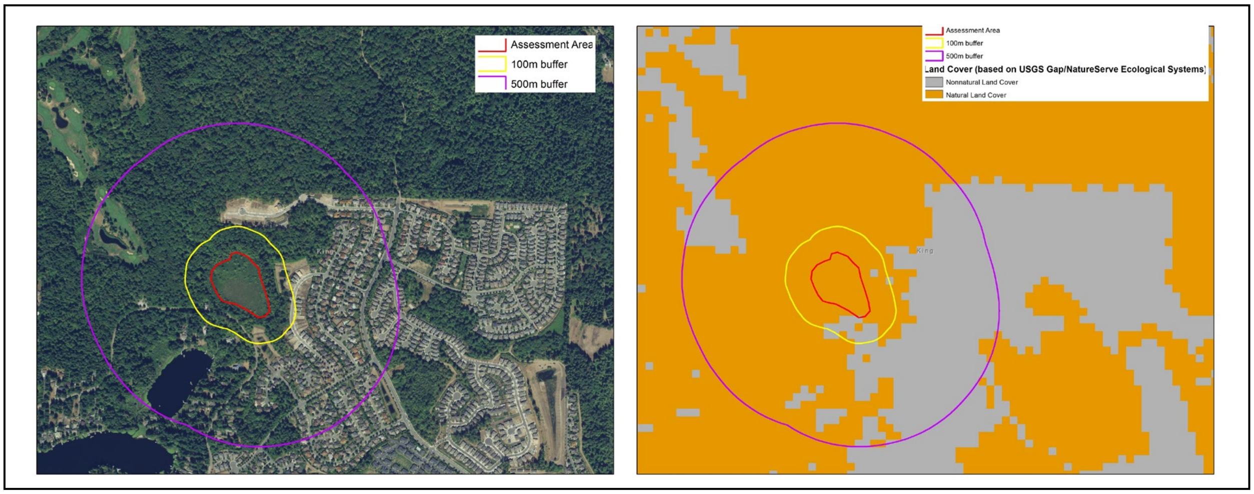

Figure 3. Contiguous Natural Land Cover evaluation based on percent natural vegetation directly adjacent to the AA. LEFT: aerial imagery showing the AA (red line), 100 m inner landscape (yellow line), and 500 m outer landscape (purple line). RIGHT: NatureServe's Ecological System map is used to show location of natural and non-natural land cover types (finer-scale categories which were lumped as natural or non-natural for this exercise). The recent aerial imagery on the left shows that development has occurred since the Ecological Systems map was produced (or that some areas were incorrectly classified). Using these maps, it appears that > 90% of the natural land cover within the inner landscape is directly connected to the AA (an "A" rating). After considering the discrepancies in the two maps, the outer landscape was rated as a "C" (the Ecological Systems map mischaracterizes some development south of the AA). The overall rating was estimated to be a "C".

Table 10. Contiguous Natural Cover Metric Rating.

Metric Rating	Contiguous Natural Cover	Overall	*Subzones*	
			Inner Landscape (0-100 m)	Outer Landscape (100-500 m)
EXCELLENT (A)	**Intact:** Embedded in 90-100% natural land cover that is contiguous with the AA. Connectivity is expected to be high; remaining natural habitat is in good condition (low modification); and a mosaic with gradients.			
GOOD (B)	**Variegated:** Embedded in 60-90% natural land cover that is contiguous with the AA. Connectivity is generally high, but lower for species sensitive to habitat modification; remaining natural habitat with low to high modification and a mosaic that may have both gradients and abrupt boundaries.			

FAIR (C)	**Fragmented**: Embedded in 20-60% natural land cover that is contiguous with the AA. Connectivity is generally low, but varies with mobility of species and arrangement on landscape; remaining natural habitat with low to high modifications and gradients shortened.			
POOR (D)	**Relictual**: Embedded in < 20% natural land cover that is contiguous with the AA. Connectivity is essentially absent; remaining natural habitat generally highly modified and generally uniform.			

LAN2 Land Use Index (0-500 m)

Definition: This metric measures the intensity of human-dominated land uses in the surrounding landscape, including optional submetrics for the inner zone (0–100 m) and outer zone (100–500 m). For AAs based on points, the landscape may largely consist of the same wetland that the point lies within, rather than surrounding habitat; preliminary testing has shown that it may be desirable to extend the zone to 1000 m to ensure that more of the landscape outside the wetland polygon is accounted for (K. Walz pers. comm. 2016).

Background: This metric is one aspect of the landscape context of specific stands or polygons of ecosystems. It is based on Hauer et al. (2002) and Mack (2006).

Apply To: All types.

Measurement Protocol: This metric documents the surrounding land use(s) within the inner and outer landscape areas. Ideally, both field data and remote sensing tools (e.g. aerial photography or satellite imagery) are used to identify an accurate percentage of each land use within the landscape area, but remote sensing data alone may also be used. To calculate a Total Land Use Score, estimate the percent of each Land Use type and then plug the corresponding coefficient (found on the field form and Table 11) into the following equation:

Sub-land use score = $\sum LU \times PC/100$

LU = Land Use weight for Land Use Type

PC = % of adjacent area in Land Use Type

Do this for each land use separately within the inner landscape (0 – 100 m) and outer landscape (100 - 500 m), then sum the Sub-Land Use Score to arrive at a Total Land Use Score across both areas. For example, if 30% of the Core Landscape area was moderately grazed (0.3 * 6 = 1.8), 10% composed of unpaved roads (0.1 * 1 = 0.1), and 60% was a natural area (e.g., no human land use) (1.0 * 6 = 6.0), the Total Core Landscape Land Use Score = 7.9 (1.8 + 0.1 + 6.0). The combined scores of the Inner and Outer Landscape are then plugged into a weighted calculation of the overall score. That score can then be rated using Table 12. See Figure 4 for an example.

Table 11. Land Use Index Table

Worksheet : Land Use Categories	Weight	Inner Landscape (0-100 m)		Outer Landscape (100-500 m)	
		% Area (0 to 1.0)	Score	% Area (0 to 1.0)	Score
Paved roads / parking lots	0				
Domestic, commercial, or publicly developed buildings and facilities (non-vegetated)	0				
Gravel pit / quarry / open pit / strip mining	0				
Unpaved roads (e.g., driveway, tractor trail, 4-wheel drive, logging roads)	1				
Agriculture: tilled crop production	2				
Intensively developed vegetation (golf courses, lawns, etc.)	2				
Vegetation conversion (chaining, cabling, roto-chopping, clearcut)	3				
Agriculture: permanent crop (vineyard, orchard, nursery, hayed pasture, etc.)	4				
Intense recreation (ATV use / camping / popular fishing spot, etc.)	4				
Military training areas (armor, mechanized)	4				
Heavy grazing by livestock on pastures or native rangeland	4				
Heavy logging or tree removal (50-75% of trees > 30 cm DBH removed)	5				
Commercial tree plantations / holiday tree farms	5				
Recent old fields and other disturbed fallow lands dominated by ruderal and exotic species (includes clearcuts that have regenerated with young native trees)	5				
Dam sites and flood disturbed shorelines around water storage reservoirs and motorized boating	5				
Moderate grazing of native grassland	6				
Moderate recreation (high-use trail)	7				
Mature old fields and other fallow lands with natural composition (includes former clearcuts with mature native forests)	7				
Selective logging or tree removal (< 50% of trees > 30 cm DBH removed)	8				
Light grazing or haying of native rangeland	9				
Light recreation (low-use trail)	9				
Natural area / land managed for native vegetation	10				
Total Land Use Score					
A = ≥9.5, **B** = 8.0-9.4, **C** = 4.0-7.9, **D** = < 4.0 **Total Land Use Rating**					
Combined Score (Inner score x 0.6) + (Outer Score X 0.4)					

Table 12. Metric Rating for Land Use Index

Metric Rating	*Rating Criteria*
EXCELLENT (A)	Average Land Use Score = 9.5-10
GOOD (B)	Average Land Use Score = 8.0-9.4
FAIR (C)	Average Land Use Score = 4.0-7.9
POOR (D)	Average Land Use Score = < 4.0

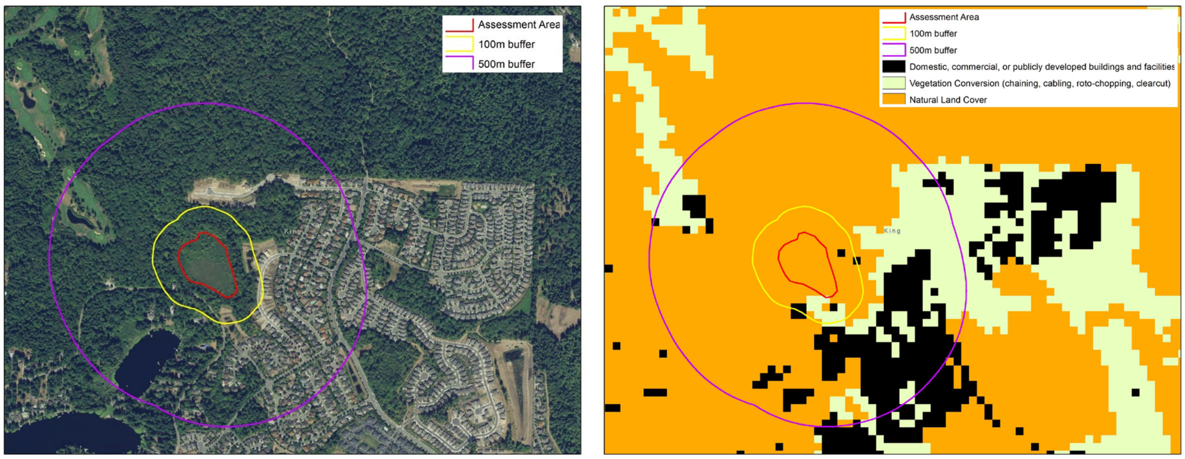

Figure 4. Application of land use coefficients to assess the Land Use Index metric in the inner and outer landscapes. The percent area of each land use is recorded and multiplied by the land use's weight. LEFT: aerial imagery showing the assessment area (red line), 100 m inner landscape (yellow line), and 500 m outer landscape (purple line). RIGHT: NatureServe's Ecological System map shows the various land uses (note: the labels shown on the map reflect those in Table 11 and not those in the original Ecological Systems map. Some interpretation between Table 11 and GIS data may be required.) The recent aerial imagery on the left shows that there has been some recent development since the Ecological System's map was produced (or that the Ecological System's map incorrectly classified some areas). In fact, most of the area labeled as "Vegetation Conversion" in the southeast portion of the outer landscape is now development. As such, the following estimates were made: Inner landscape: 90% natural land cover/water, 10% roads or development. After consulting Table 11, the weights were plugged into the following formula (0.90*10)+(0.10*0)=9.0, which according to Table 12 is a "B" rating. Outer landscape: 60% natural land cover/water, 35% development, 5% vegetation conversion. After consulting Table 11, the weights were plugged into the following formula (0.60*10)+(0.35*0)+(0.05*3)=6.15, which according to Table 12 is a "C" rating. An overall rating was then calculated by the following formula: (9*0.6)+(6.15*0.4)=7.86, or a "C" rating.

3.6 BUFFER

For rapid assessments, we assess the buffer immediately surrounding the assessment area (within a 100 m zone), using 3 metrics: (B1) Perimeter with Natural Buffer, (B2) Width of Natural Buffer, and (B3) Condition of Natural Buffer. This final metric requires a field visit in combination with aerial photography. Wetland buffers are defined as the natural cover that surrounds a wetland. Note that the Land Use Index (L2) includes an evaluation of all land uses within the buffer zone (0–100 m), so it addresses the condition of the non-natural parts of the buffer.

BUF1 Perimeter with Natural Buffer

Definition: A measure of the overall area and condition of the natural buffer immediately surrounding (100 m radius) the assessment area, using the percent of the perimeter that borders a natural buffer.

Background: The buffer is important to the biotic and abiotic aspects of the wetland. The Environmental Law Institute (2008) reviewed the critical role of buffers for wetlands. We assess key aspects of buffers within a 100 m zone but add a surrounding landscape assessment that extends to 500 m from the AA edge (see metrics LAN1 and LAN2 above).

We only include natural habitats as part of the buffer, as these habitats should be most typical of the historical condition of the buffer.

Table 13. Guidelines for identifying wetland buffers and breaks in natural buffers). The definition of natural habitats corresponds with that of the USNVC (i.e., both native habitat and ruderal habitats, including naturally invaded or degraded native habitats), thereby permitting a direct application of NVC and system maps to the evaluation. This definition is also consistent with the use of natural habitats for other EIA metrics.
Apply To: All types.

Measurement Protocol: Estimate the length of the AA perimeter contiguous with a natural buffer. This can be done using remote sensing data and/or field-based observations. If remote sensing data are used, field verification is recommended. Use a 10 m minimum buffer depth width and length. Perimeter includes open water (Table 13; Figure 5). Rate metric using Table 14.

Table 13. Guidelines for identifying wetland buffers and breaks in natural buffers

Examples of Land Covers Included in Natural Buffers	Examples of Land Covers Excluded from Natural Buffers	Examples of Land Covers Crossing and Breaking Natural Buffers[4]
Natural or ruderal[1] plant communities; open water[2]; old fields; naturally vegetated rights-of-way; natural swales and ditches; native or naturalized rangeland and non-intensive plantations[3]	Parking lots; commercial and private developments; roads (all types), intensive agriculture; intensive plantations; clearcut harvests that have not regenerated; orchards; vineyards; dry-land farming areas; railroads; planted pastures (e.g., from low intensity to high intensity horse paddock, feedlot, or turkey ranch); planted hayfields; lawns; sports fields; golf courses; Conservation Reserve Program pastures	Bike trails; horse trails; dirt, gravel or paved roads; residential areas; bridges; culverts; paved creek fords; railroads; sound walls; fences that interfere with movements of water, sediment, or wildlife species that are critical to the overall functions of the wetland

[1]Ruderal plant communities: Plant communities dominated or codominated by nonnative species OR communities dominated by native species but resulting from past human stressors and possessing no natural analog. For example, areas previously plowed can be revegetated by native vegetation but their composition is unlike other plant communities. Novel ecosystems also fall into this category.

[2]Open Water: Some protocols exclude open water (such as lakes, large rivers, or lagoons) from the buffer because the water quality or water disturbance regimes (natural waves vs. boat traffic waves) may or may not be in good condition. Here we include open water as part of the buffer. If desired, the condition of the open water can be assessed using the Buffer Condition submetric (3c).

[3]Plantations: Logged and replanted areas in which the overstory is allowed to mature and may regain some native component, and in which the understory of saplings, shrubs, and herbs are native or naturalized species and not strongly manipulated (i.e., they are not “row-crop tree plantings” with little to no vegetation in the understory, typical of intensive plantations).

[4]Land cover that breaks natural buffers: These land covers are added to the land covers excluded from natural buffers, so that, collectively, they may contribute to a 5 m break in the buffer.

Table 14. Buffer Perimeter Rating

Metric Rating	Percent of AA with Natural Buffer
EXCELLENT (A)	Natural buffer is 100% of AA perimeter
GOOD (B)	Natural Buffer is 75-99% of AA perimeter
FAIR (C)	Natural Buffer is 25-75% of AA perimeter
POOR (D)	Natural Buffer is < 25% of AA perimeter

BUF2 Width of Natural Buffer

Definition: A measure of the average width of natural buffer, extending from the edge of the Assessment Area to a maximum distance of 100 m.

Background: The buffer is important to the biotic and abiotic aspects of the wetland. The Environmental Law Institute (2008) has reviewed the critical role of buffers for wetlands. We assess key aspects of buffer within a 100 m zone but add a surrounding landscape assessment that extends to 500 m from the AA edge (see metrics LAN1 and LAN2 above).

We only include natural habitats as part of the buffer, as these habitats would be most typical of the historical condition of the buffer.

Table 13. Guidelines for identifying wetland buffers and breaks in natural buffers). The definition of natural habitats corresponds with that of the USNVC (i.e., both native habitat and ruderal habitats, including naturally invaded or degraded native habitats), thereby permitting a direct application of NVC and system maps to the evaluation (see Table 13). This definition is also consistent with the use of natural habitats for other EIA metrics.
Apply To: All types.

Measurement Protocol: Two approaches: (1) Point-based or simple polygon AAs or (2) complex polygon AAs:

<u>Point-based or simple polygon shapes</u>**:** Metric is adapted from Collins et al. (2006) and USA RAM (2011).

1. Using the most recent aerials (or in GIS), draw eight straight lines radiating out from the approximate center of the AA in eight cardinal directions (N, NE, E, SE, S, SW, W, NW), each extending 100 m beyond the edge of the AA (Figure 6).
2. Measure the length of each line from the edge of the AA perimeter to the outer extent of the natural buffer and record on data form (see example in

3. Table 15).
4. If desired, use the slope multipliers in Table 18 to adjust the rating of upslope buffer widths. Multiply the multipliers by the buffer rating values to get a new set of rating values. Slope can be estimated in the field or using imagery.
5. Assign a metric score based on the average buffer width (Table 17).

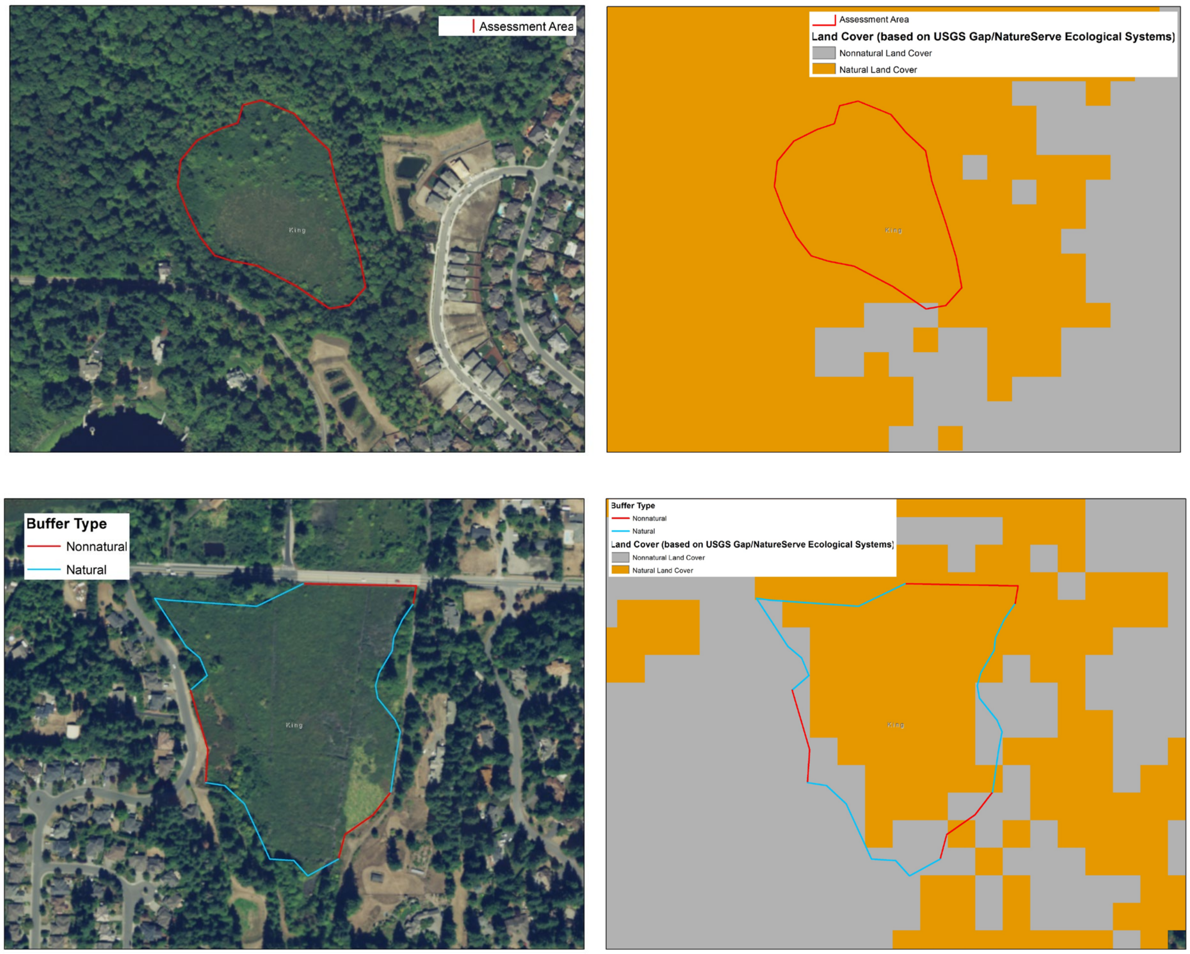

Figure 5. Buffer Perimeter Example. TOP LEFT: aerial imagery showing the AA (red line). TOP RIGHT: NatureServe's Ecological Systems map shows natural and non-natural land cover types. The Ecological Systems map on the right suggests a small portion of the AA perimeter abuts non-natural land cover; however, the recent aerial imagery on the left suggest this is an error and that, in fact, the entire length of the AA perimeter (red line) abuts natural land cover. As such, it would be given an "A" rating. BOTTOM LEFT: aerial imagery shows portions of the perimeter without a natural buffer (red lines) and portions with a natural buffer (blue lines). BOTTOM RIGHT: NatureServe's Ecological Systems map is used to show location of natural and non-natural land cover types. Clearly the Ecological Systems map missed the major road on the north end of the AA and also mischaracterized some additional areas. The rating for this AA was estimated to be "C".

Table 15. Buffer Width Calculation (simple polygon example)

Line	Buffer Width (m) (max = 100 m)
1	0
2	0
3	42
4	14
5	100
6	31
7	0
8	43
Average Buffer Width (m)	**28.75**

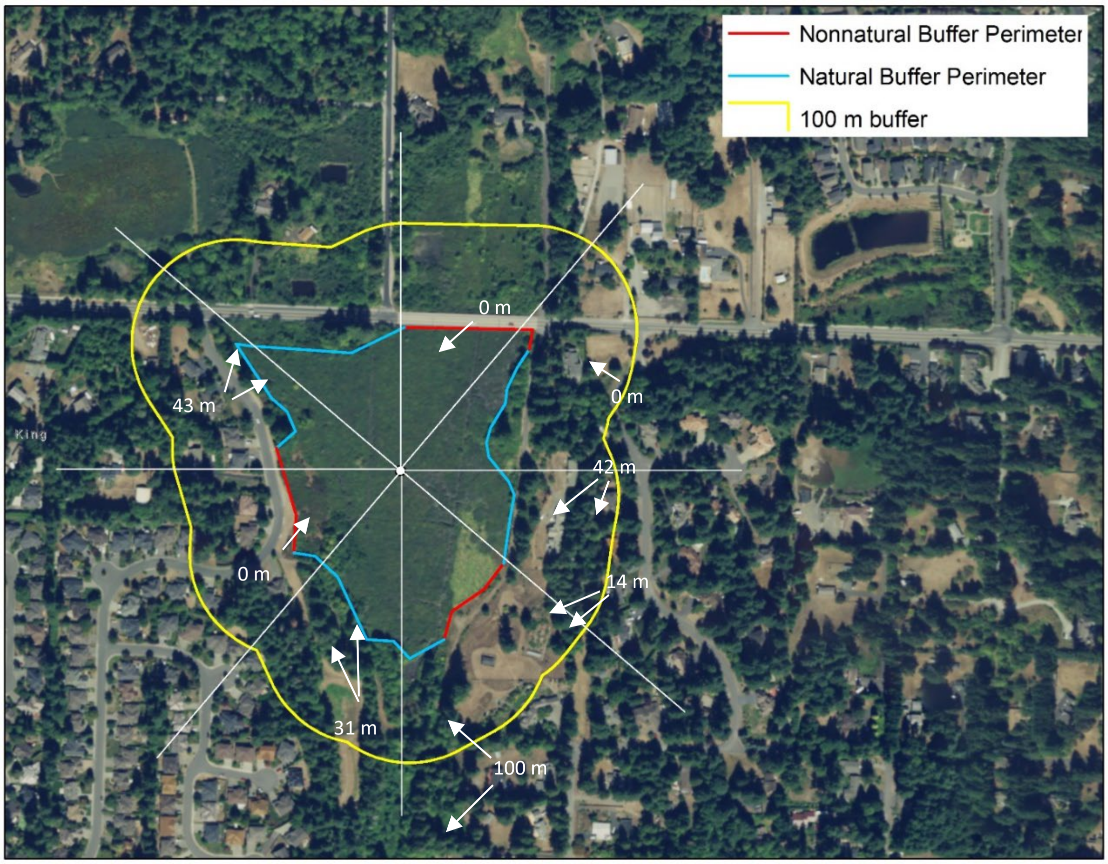

Figure 6. Buffer Width Calculation (point-based or simply polygons). The length of natural buffer is measured by calculating the distance between the edge of the AA and the 100 m buffer line along each of the eight white lines. Then an average is taken. In this example the calculation for average buffer length is (moving clockwise): (0+0+42+14+100+31+0+43)/8=28.75 m (Table 15). Consulting Table 17 this translates to a "C" rating.

<u>Complex polygon shapes</u>

1. 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 where the line follows the broad shape of the polygon, avoiding finer level twists and turns (Figure 7).
2. Once you have determined the length of the line along the wetland's long axis, divide the line by five, creating four equally spaced points along the axis. At each of the four points, draw a line perpendicular to the axis such that it extends out 100 m beyond each side of the AA's perimeter. For some arching wetlands that close back in on themselves, see guidance below to address situations that may arise from interior spokes (i.e., spokes radiating away from the wetland's interior arch).
   a. When two spokes cross one another, eliminate the spoke with the longer natural buffer width and locate a new spoke at the more northerly end of the AA's long axis; extend the axis 100 m beyond the AA perimeter to form new spoke.
   b. When a spoke heads back into the AA in less than 100 m, eliminate the spoke and locate a new spoke at the more northerly end of the AA's long axis.
   c. If two spokes need to be relocated, use both ends of the AA's long axis.
3. For spokes radiating out from the wetland's exterior arch, if the spoke begins to cross a smaller lobe of the system in less than 100 m, allow the spoke to continue in the same direction through the lobe and measure buffer width where the spoke can be extended beyond the lobe for 100 m (Figure 7).
4. For each of the eight spokes, determine the natural buffer width from the wetland's edge until either a non-buffer land cover is encountered in less than 100 m or 100 m of contiguous natural buffer width is measured.
5. Determine the average width of the buffer (Table 16).
6. If desired, use the slope multipliers in
7. Table 18 to adjust the rating of upslope buffer widths. Multiple the multipliers by the buffer rating values to get a new set of rating values. Slope can be estimated in the field or using imagery.
8. Assign a metric score based on the average buffer width (Table 17)

Table 16. Buffer Width Calculation (complex polygon example)

Spoke or Line	Buffer Width (out to a maximum of 100 m)
Single west terminal spoke	10
West exterior spoke	18
West interior spoke	100
West-central exterior spoke	0
West-central interior spoke	0
East-central exterior spoke	0
East-central interior spoke	Not Used
South-east exterior spoke	7
South-east interior spoke	10
Average Buffer Width (m)	**18**

Table 17. Buffer Width Rating

Metric Ratings	Average Natural Buffer Width (m)
EXCELLENT (A)	≥ 100 m, adjusted for slope.
GOOD (B)	75 -99 m, after adjusting for slope.
FAIR (C)	25-75 m, after adjusting for slope.
POOR (D)	< 25 m, after adjusting for slope.

Table 18. Slope Modifiers for Buffer Width

Slope Gradient	Additional Buffer Width Multiplier
5-14%	1.3
15-40%	1.4
> 40%	1.5

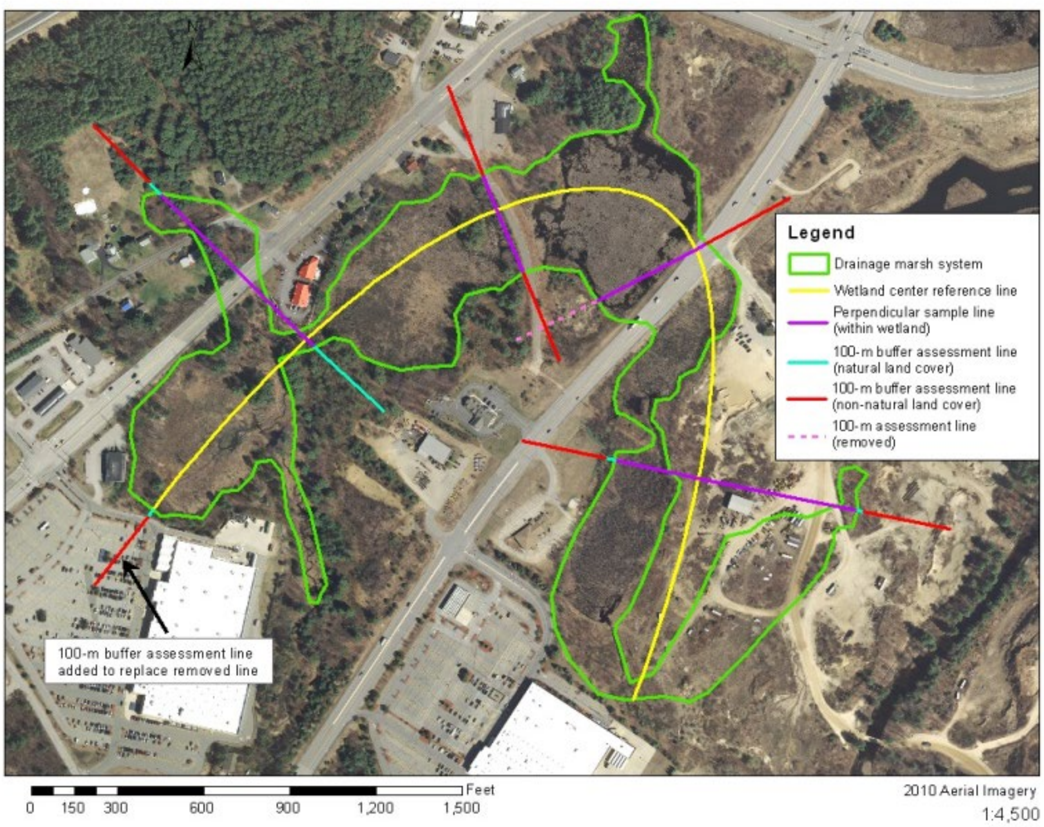

Figure 7. Buffer Width Calculation (complex polygon example). The eight spokes or lines are assessed for the buffer width. For example, the single west terminal spoke has a 10 m buffer. Once measured, average the eight buffer widths to calculate the average width of the buffer. Figure by Bill Nichols, New Hampshire Natural Heritage Program.

BUF3 Condition of Natural Buffer

Definition: A measure of the biotic and abiotic condition of the natural buffer, extending from the edge of the Assessment Area.

Background: The buffer is important to the biotic and abiotic aspects of the wetland. The Environmental Law Institute (2008) has reviewed the critical role of buffers for wetlands. We assess key aspects of the buffer within a 100 m zone.

Apply To: All types.

Measurement Protocol: Estimate the overall biotic and abiotic condition within that part of the perimeter that has a natural buffer. That is, if natural buffer length is only 30% of the perimeter, then assess condition within that 30%. Condition is based on percent cover of native vegetation, disruption to soils, signs of reduced water quality, amount of trash or refuse, various land uses, and intensity of human visitation and recreation, including from foot or boat traffic. The evaluation can be made by scanning an aerial photograph in the office, followed by ground truthing, as needed. Ground truthing could be made systematic by using the eight lines used to assess buffer width (BUF2).

Table 19. Condition of Natural Buffer Rating

Metric Ratings	Natural Buffer Condition
EXCELLENT (A)	Buffer is characterized by abundant (> 95%) cover of native vegetation, with intact soils, no evidence of loss in water quality or hydrologic integrity, and little or no trash or refuse.
GOOD (B)	Buffer is characterized by substantial (75–95%) cover of native vegetation, intact or moderately disrupted soils, minor evidence of loss in water quality or hydrologic integrity, moderate or lesser amounts of trash or refuse, and minor intensity of human visitation or recreation.
FAIR (C)	Buffer is characterized by a low (25–75%) cover of native vegetation, barren ground and moderate to highly compacted or otherwise disrupted soils, strong evidence of loss in water quality or hydrologic integrity, with moderate to strong or greater amounts of trash or refuse, and moderate or greater intensity of human visitation or recreation.
POOR (D)	Very low (< 25%) cover of native plants, dominant (> 75%) cover of nonnative plants, extensive barren ground and highly compacted or otherwise disrupted soils, moderate - great amounts of trash, moderate or greater intensity of human visitation or recreation, OR no buffer at all.

3.7 VEGETATION

For various aspects of the vegetation metrics, variants based on USNVC Formation are used (Table 20).

Table 20. Metric Variants for Vegetation by USNVC Formation

METRIC	VEGETATION	VEGETATION
Metric Variant by NVC Formation Type	V3. Native Plant Species Composition	**V4. Vegetation Structure***
Flooded & Swamp Forest Formation	v1*	v1
Freshwater Marsh, Wet Meadow and Shrubland Formation		V3
Salt Marsh Formation		V4
Bog and Fen Formation		V5
Aquatic Vegetation Formation		V6

* Metric can be refined at the Macrogroup or Group level of the NVC, or using Ecological Systems.

VEG1 Native Plant Species Cover

Definition: A measure of the relative percent cover of all plant species in the AA that are native to the region. The metric is typically calculated by estimating total absolute cover of all vegetation within each of the two major strata groups (tree and shrub/sapling + herbaceous) and expressing the total native species cover as a percentage of the total stratum cover. The stratum with the lowest percentage native cover is used as the basis for the score.

Background: This metric has been developed by NatureServe's Ecological Integrity Assessment Working Group (Faber-Langendoen et al. 2008). Nonvascular species are not included, desirable as that may be in some wetlands (especially bogs and fens), because of the difficulty of species identification and interpretation of what they indicate about ecological integrity.

Apply To: All types.

Measurement Protocol: This metric evaluates the relative percent cover of native species compared to all species (native and nonnative) for each of the three major strata (Native cover divided by / (Native + Nonnative cover) * 100). The protocol consists of a visual evaluation of native vs. nonnative species cover using midpoints of cover classes (on the field form). The field survey method may be either (1) a Site Survey (semi-quantitative) method, in which the observers walk the entire occurrence (or assessment area within the occurrence) and make notes on native and total species cover, or (2) Quantitative Plot Data, where a fixed area is surveyed, using either plots or transects. The plot or transect is typically a "rapid" plot, but a single intensive plot can also be taken. First, using cover class values in Table 8, estimate the total cover of vegetation by summing species cover across strata and growth forms (e.g., cover of the tree, shrub/regeneration/vine, and herb strata, combining growth forms within the same strata). The total may easily exceed 100%. Next, estimate the total cover of each nonnative species in each stratum (on field form) and subtract these values from the total vegetation cover values to get the total native cover for each stratum. Divide the total native cover by the total vegetation cover and multiply by 100. This method can be used when all species, or only dominant species, are listed. Assign the score in Table 21 based on the stratum with the lowest percent of native plant species cover. If plot data are used for this metric, it is important that the plot is representative of the larger system being assessed. In patchy types or large AAs, more than one plot may be desirable.

Table 21. Metric Ratings for Native Plant Cover (if scoring strata groups, choose lowest score between groups)

Rank	Main Metric Score	*Submetric: Tree Strata*	*Submetric: Shrub/Herb Strata*
Excellent (A) > 99% relative cover of native vascular plant species overall, OR in the key layer, either the tree stratum or shrub/herb strata, whichever is lower			
Very Good (A-) 95-99% relative cover of native vascular plant species overall, OR in the key layer, either the tree stratum or shrub/herb strata, whichever is lower			
Good (B) 85-94% relative cover of native vascular plant species overall, OR in the key layer, either the tree stratum or shrub/herb strata, whichever is lower			
Fair (C) 60-84% relative cover of native vascular plant species overall, OR in the key layer, either the tree stratum or shrub/herb strata, whichever is lower			
Poor (D) < 60% relative cover of native vascular plant species overall, OR in the key layer, either the tree stratum or shrub/herb strata, whichever is lower			

VEG2 Invasive Nonnative Plant Species Cover

Definition: The absolute percent cover of nonnative species that are considered invasive to the ecosystem being evaluated. Generally, an invasive species is defined as "*a species that is nonnative to the ecosystem under consideration and whose introduction causes or is likely to cause environmental harm*…" (Executive Presidential Order 1999, Richardson et al. 2000), thus potentially including species native to a region, but invasive to a particular ecosystem in that region. However, here we treat those "native invasives" as "native increasers" under the Native Species Composition metric. Nonvascular species are not included, desirable as that may be in some wetlands (especially bogs and fens), because of the difficulty of species identification and interpretation of what they indicate about ecological integrity.

Background: This metric is a counterpart to "Relative Native Plant Species Cover," but "Nonnative Invasive Plant Species Cover" includes only invasive nonnatives, not all nonnatives. Even here, judgment may be required. For example, some species are native to a small part of a region--or have mixed genotypes of both native and nonnative forms--and are widely invasive (e.g., *Phragmites*). Field crews must be provided with a definitive list of what is considered a nonnative invasive in their project area.

The definition of invasive used here is related to the perceived impact that invasives have on ecosystem condition, or what Richardson et al. (2000) refer to as "transformers". They distinguish invasives (naturalized plants that produce reproductive offspring, often in very large numbers, at considerable distances from parent plants and thus have the potential to spread over a considerable area) from "transformers" (A subset of invasive plants that change the character, condition, form, or nature of ecosystems over a substantial area relative to the extent of that ecosystem). Although our definition is essentially equal to that of "transformers" in that we are concerned with those naturalized plants that cause ecological impacts, we retain the term "invasive" as the more widely used term. Our use of the term also equates to "harmful non-indigenous plants" of Snyder and Kaufman (2004):

> "Invasive species that are capable of invading natural plant communities where they displace indigenous species, contribute to species extinctions, alter the community structure, and may ultimately disrupt the function of ecosystem processes."

Invasives are distinguished from "increasers," which are native species present in an ecosystem that respond favorably to increasing human stressors. For example, *Juncus effusus* ssp. *pacificus* and *Juncus arcticus* (=*J. balticus*) are native species that respond favorably to anthropogenic disturbances. Another native increaser is *Typha latifolia*, a native cattail that increases in response to eutrophication. Native increasers are treated under the "Native Species Composition" metric.

Apply To: All types.

Measurement Protocol: A comprehensive list of nonnative invasive species must be established in order to make the application of this metric as consistent as possible. Nonnative invasive species for each wetland type are listed in Group descriptions found in Walz et al. (2022). The protocol uses a visual evaluation of absolute cover of invasive species listed in the appropriate Group description in Walz et al. (2022). The cover of nonnative invasive species is summed to produce the total cover of invasive plant species. The field survey method may be either (1) a Site Survey (semi-quantitative) method, in which the observers walk the entire occurrence (or assessment area within the occurrence) and make notes on native and total species cover, or (2) Quantitative Plot Data, where a fixed area is surveyed, using either plots or transects. The plot or transect is typically a "rapid" plot, but a single intensive plot can also be taken. If plot data are used for this metric, it is important that the plot is representative of the larger system being assessed. In patchy types or large AAs, more than one plot may be desirable.

Table 22. Invasive Species Metric Rating

Metric Rating	*Invasive Nonnative Plant Species Cover*: ALL WETLANDS
EXCELLENT (A)	Invasive nonnative plant species are absent from all strata or cover is very low (< 1% absolute cover).
GOOD (B)	Invasive nonnative plant species are present in at least one stratum, but sporadic (1-4 % cover).
FAIR (C)	Invasive nonnative plant species somewhat abundant in at least one stratum (4-10% cover).
FAIR/POOR (C-)	Invasive nonnative plant species are abundant in at least one stratum (10-30% cover).
POOR (D)	Invasive nonnative plant species are very abundant in at least one stratum (> 30% cover).

VEG3 Native Plant Species Composition

Definition: An assessment of overall species composition and diversity, including native diagnostic species and native increasers (e.g., "native invasives" of Richardson et al. 2000), and evidence of species-specific diseases or mortality.

Background: This metric evaluates the degree of degradation to the native plant species, including decline in native species diversity and loss of key diagnostic species, as well as shifting dominance caused by positive response to stressors by Native Increasers (a.k.a., "native invasives", aggressive natives, successful competitors). Increaser species are native species in the wetland whose dominance is indicative of degrading ecological conditions, such as heavy grazing or browse pressure (Daubenmire 1968). Native increasers often have FQA coefficients of conservatism ≤ 3. Native decreasers are those species that decline rapidly due to stressors (species sensitive to human-induced disturbance or those species with FQA coefficients of conservatism ≥ 7). Diagnostic species, or the characteristic combination of species, are native plant species whose relative constancy or abundance differentiates one vegetation type from another, including character species (strongly restricted to a type), differential species (higher constancy or abundance in a type as compared to others), constant species (typically found in a type, whether or not restricted), and dominant species (high abundance or cover) (FGDC 2008). Together these species also indicate certain ecological conditions, typically that of minimally disturbed sites. Information on diagnostic species for USNVC types is available from Group descriptions (Walz et al. 2022). Degrading conditions that lead to presence of nonnative invasive species are treated in the "Invasive Plant Species Cover" metric.

Apply To: All types.

Measurement Protocol: The protocol requires a visual evaluation of variation in overall composition. This metric requires the ability to recognize the major/dominant aquatic, wetland, and riparian plants species of each layer or stratum. The field survey method may be either (1) a Site Survey (semi-quantitative) method, in which the observers walk the entire occurrence (or assessment area within the occurrence) and make notes on native and total species cover, or (2) Quantitative Plot Data, where a fixed area is surveyed, using either plots or transects. The plot or transect is typically a "rapid" plot, but a single intensive plot can also be taken. Using criteria in Table 23, assign ratings to submetrics on the field form.

Note: Native increasers can be difficult for many users to assess. This is because the presence of these species is not sufficient to indicate that they are acting as increasers. Rather, it is their relative proportion to what is expected that triggers such a designation. This concept tends to work well in wetlands exposed to conspicuous stressors such as livestock grazing where these species tend to dominate or become monocultures (e.g. *Iris missouriensis* or *Juncus arcticus* (=*J. balticus*)). If you find this submetric difficult to evaluate, make a note in the comment section and skip it.

Table 23. Native Plant Species Composition Rating Criteria

Metric Rating	*Vegetation Composition: ALL TYPES*
EXCELLENT (A)	**Native plant species composition (species abundance and diversity) minimally to not disturbed:** Submetrics: i) DIAGNOSTICS: Typical range of native diagnostic species present. ii) DIVERSITY: Typical diversity of native species present (note that some ecosystems are naturally species-poor). iii) NATIVE DECREASERS: Native species sensitive to anthropogenic degradation (native decreasers) present. iv) NATIVE INCREASERS: Native species indicative of anthropogenic disturbance (weedy or ruderal species) absent or, if naturally common in this type, present in expected amounts and not associated with conspicuous stressors.
GOOD (B)	**Native plant species composition with minor disturbed conditions:** Submetrics: i) DIAGNOSTICS: Some native diagnostic species absent or substantially reduced in abundance. ii) DIVERSITY: Native species richness slightly reduced, but within natural range of variability. iii) NATIVE DECREASERS: At least some native species sensitive to anthropogenic degradation present. iv) NATIVE INCREASERS: Native species indicative of anthropogenic disturbance (i.e. weedy or ruderal species) are present with low cover or, if naturally common in this

Metric Rating	*Vegetation Composition: ALL TYPES*
	type, present in slightly greater than expected amounts and associated with conspicuous stressors.
FAIR (C)	**Native plant species composition with moderately disturbed conditions:** Submetrics: i) DIAGNOSTICS: Many native diagnostic species absent or substantially reduced in abundance. ii) DIVERSITY: Native species richness substantially reduced. iii) NATIVE DECREASERS: No native species sensitive to anthropogenic degradation present. iv) NATIVE INCREASERS: Native species indicative of anthropogenic disturbance (i.e. weedy or ruderal species) are present with moderate cover and associated with conspicuous stressors.
POOR (D)	**Native plant species composition with severely disturbed conditions:** Submetrics: i) DIAGNOSTICS: Most or all native diagnostic species absent, a few may remain in very low abundance. Diagnostic species may be so few as to make the type difficult to key. ii) DIVERSITY: Extremely low native species richness for the ecosystem type. iii) NATIVE INCREASERS: Native species indicative of anthropogenic disturbance (i.e. weedy or ruderal species) are present in high cover and associated with conspicuous stressors.

VEG4 Vegetation Structure

Definition: An assessment of the overall structural complexity of 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.

Background: This metric has been drafted by NatureServe's Ecological Integrity Assessment Working Group (Faber-Langendoen et al.2008).

Apply To: All types (variant differs by USNVC Formation).

Measurement Protocol: This metric evaluates the horizontal and vertical structure of the vegetation relative to the reference condition of the dominant growth forms' structural heterogeneity. For forested wetlands, the protocol uses a visual evaluation of variation in overall structure of the tree stratum, including size and density of tree canopy, overall canopy cover, frequency of canopy gaps with regeneration, and number of different size classes of stems. For non-forested systems, an evaluation of the integrity of dominant growth forms is made (e.g. whether shrubs have been removed, killed, or increased or herbaceous layer has been reduced or homogenized by anthropogenic stressors). The field survey data used for estimating structure may consist of either 1) qualitative data where the observers walk the entire AA and make notes on vegetation structure, or 2) quantitative data, where a fixed area is surveyed, using either plots or transects. Metric ratings are scored using Table 24.

Table 24. Vegetation Structure Variant Rating Criteria. Variants are provided in six separate tables by NVC Vegetation Formation (V1: Flooded & Swamp Forest, V3: Freshwater Marsh, Wet Meadow & Shrubland, V4: Salt Marsh V5: Bog & Fen, V6: Aquatic Vegetation.

Metric Rating	*V1: Vegetation Structure Variant: FLOODED & SWAMP FOREST*
EXCELLENT (A)	FLOODED & SWAMP FOREST: Canopy Structure: Canopy a mosaic of patches of different ages or sizes. Gaps also of varying size. Number of medium live stems (30-50 cm /12-20 in DBH) and large live stems (> 50 cm/ > 20 in). DBH well within expected range. Large live trees: Large trees are present in mid- to late-seral stands and only a few if any large cut stumps. Large trees may be absent in early-seral stands, but if so, then large stumps are not present (or few) and evidence of natural disturbance event is present (e.g., large downed wood from wind storms or fire scars). Overall, no evidence of human-related degradation.
GOOD (B)	FLOODED & SWAMP FOREST: Canopy Structure: Canopy largely heterogeneous in age or size. Number of live stems of medium and large size very near expected range. Large live trees: Considering the natural stand development stage, there are more large trees than large cut stumps. Some (10-30%) of the old trees have been harvested. Overall, evidence of human degradation includes minor cutting, browsing, or grazing.
FAIR (C)	FLOODED & SWAMP FOREST: Canopy Structure: Canopy somewhat homogeneous in age or size. Number of live stems of medium and large size moderately below expected range. Large live trees: Considering the natural stand development stage, there are around as many large trees as large cut stumps. Many (over 50%) of the old trees have been harvested. Overall, evidence of human degradation includes moderate levels of cutting, browsing or grazing.
POOR (D)	FLOODED & SWAMP FOREST: Canopy Structure: Canopy very homogeneous, in age or size. Number of live stems of medium and large size substantially below expected range. Large Live Trees: Considering the natural stand development stage, most, if not all, old trees have been harvested. None or rare old trees present. Overall, evidence of human degradation includes major cutting, heavy browsing or grazing.

Metric Rating	*V3: Vegetation Structure Variant: FRESHWATER MARSH, WET MEADOW & SHRUBLAND*
EXCELLENT (A)	FRESHWATER MARSH, WET MEADOW & SHRUBLAND: Vegetation structure is at or near minimally disturbed natural conditions. Little to no structural indicators of degradation evident. Shrub and herb strata contain expected levels of abundance and diversity (some tall and some short) and/or low cover of shrubs or trees, where appropriate. Shrubs (Spiraea or Rosa sp.) cover (< 5%) in wet prairies limited to streambanks or scattered small patches with no evidence of increasing due to lack of natural disturbances such as fire. Overall, no evidence of human-related degradation.
GOOD (B)	FRESHWATER MARSH, WET MEADOW & SHRUBLAND: Vegetation structure shows minor alterations from minimally disturbed natural conditions. Structural indicators of degradation are minor. Shrubs (Spiraea or Rosa sp.) cover (5-10%) in wet prairies due to fire suppression. Overall, evidence of degradation includes minor cutting, mowing, browsing, or grazing.
FAIR (C)	FRESHWATER MARSH, WET MEADOW & SHRUBLAND: Vegetation structure is moderately altered from minimally disturbed natural conditions. Structural indicators of degradation are moderate (e.g., levels of grazing, mowing); Shrubs (Spiraea or Rosa sp.) cover (10-25%) in wet prairies due to fire suppression. Overall, evidence of degradation includes moderate levels of cutting, mowing, browsing or grazing.
POOR (D)	FRESHWATER MARSH, WET MEADOW & SHRUBLAND: Vegetation structure is greatly altered from minimally disturbed natural conditions. Structural indicators of degradation are strong (e.g., levels of grazing, mowing). Shrubs (Spiraea or Rosa sp.) cover (> 25%) in wet prairies due to fire suppression. Overall, evidence of human and degradation includes major cutting, mowing, browsing or grazing.

Metric Rating	*V4: Vegetation Structure Variant: SALT MARSH (salt/brackish marsh & shrubland) [Metric variant under development]*
EXCELLENT (A)	SALT MARSH: Vegetation structure is at or near minimally disturbed natural conditions. Overall, little to no structural indicators of degradation evident (e.g. cutting, mowing, browsing, or grazing).
GOOD (B)	SALT MARSH: Vegetation structure shows minor alterations from minimally disturbed natural conditions. Overall, structural indicators of degradation are minor (e.g., cutting, mowing, browsing, or grazing).
FAIR (C)	SALT MARSH: Vegetation structure is moderately altered from minimally disturbed natural conditions. Overall, structural indicators of degradation are moderate (e.g., cutting, mowing, browsing, or grazing).
POOR (D)	SALT MARSH: Vegetation structure is substantially altered from minimally disturbed natural conditions. Overall, structural indicators of degradation are strong (e.g., cutting, mowing, browsing, or grazing).

Metric Rating	*V5: Vegetation Structure Variant: BOG & FEN*
EXCELLENT (A)	BOG & FEN: Peatland is supporting structure with little to no evident influence of negative anthropogenic factors. Overall, no evidence of human-related degradation. Tree structure: Some very wet peatlands may not have any woody vegetation or only scattered stunted individuals. Woody vegetation mortality is due to natural factors. The site is near minimally disturbed natural conditions. *Bogs/acidic fen*: When present, trees are represented by relatively short, stunted, bonsai-like trees with rounded tops, and furrowed bark (even in short, small diameter individuals). *Circumneutral/rich fens*: Tree species, when present, do not form a closed canopy. Shrub / herb structure: Shrub and herb strata contain expected levels of abundance and diversity (some tall and some short). *Bogs/acidic fen*: Shrubs are < 50 cm and open enough to allow for a nearly continuous ground cover of *Sphagnum* and expected feather mosses (e.g. *Pleurozium schreberi*). *Circumneutral/rich fens*: primarily short-statured vegetation (some are dominated by tall sedge species). Shrubs may be present as a mosaic with open areas or if more continuous then open enough for abundance understory of graminoids. Dominant species are active peat-formers (e.g. dense stands of *Carex, Eriophorum*, *Eleocharis quinqueflora*, etc.) Bryophyte structure: *Bogs/acidic fen*: *Sphagnum* is actively growing and abundant. *Sphagnum* is nearly continuous and growing around tree/shrub bases AND in low hummocks, hollows, or other low areas. Areas of degenerating S*phagnum* are expected, but never more than local, small patches and never from anthropogenic stressors such as trampling, hydroperiod shifts or change in water chemistry. *Circumneutral/rich fens:* There is a nearly continuous cover of actively growing mosses (except in tall sedge fens - which are naturally more vigorous, homogenous, and often with little bryophyte cover).
GOOD (B)	BOG & FEN: Generally, peatland structure has only minor negative anthropogenic influences present, or the site is still recovering from major past human disturbances. Mortality or degradation due to grazing, peat mining, limited timber harvesting, or other anthropogenic factors may be present, though not widespread. The site can be expected to meet minimally disturbed conditions in the near future if negative influences do not continue. Shrubs and herbs show minor alterations from expected conditions. Overall, evidence of degradation includes minor cutting, mowing, browsing, fire, or grazing. Tree structure: *Bogs/acidic fen*: Some trees may have been or killed due to anthropogenic stressors OR a few, young, vigorous trees with straight pointy leaders present. *Circumneutral/rich fens:* Few trees have been cut or killed due to anthropogenic stressors OR tree canopy is starting to close in a few areas due to a shift in hydrology or water chemistry from anthropogenic stressors. Shrub / herb structure: *Bogs/acidic fen*: A few areas of dense and tall shrubs (> 1 m) may occur (dense enough to eliminate *Sphagnum*/moss growth). *Circumneutral/rich fens*: Shrub density is starting to exclude graminoids in some areas due to a shift in hydrology or water chemistry from anthropogenic stressors. A few dense stands of non-peat forming species may be present to locally abundant due to a shift in hydrology or water chemistry from anthropogenic stressors. Bryophyte structure: Some areas are experiencing loss of moss cover due to increased shrub density, trampling, or a change in hydroperiod/water chemistry. In *Bogs/acidic fen* this is in reference to *Sphagnum*.

Metric Rating	*V5: Vegetation Structure Variant: BOG & FEN*
FAIR (C)	BOG & FEN: Peatland structure has been moderately influenced by negative anthropogenic factors. Expected structural classes are not present. Human factors may have diminished the condition of woody vegetation. The site will recover to minimally disturbed conditions only with the removal of degrading influences and moderate recovery times. Shrubs and herbs moderately altered from expected conditions. Overall, evidence of degradation includes moderate levels of cutting, mowing, browsing, fire or grazing. Tree structure: *Bogs/acidic fen*: Many trees have been cut or killed due to anthropogenic stressors OR many young, vigorous trees with straight pointy leaders present. *Circumneutral/rich fens:* Many trees have been cut or killed due to anthropogenic stressors OR tree canopy is closing in many areas due to a shift in hydrology or water chemistry from anthropogenic stressors. Shrub / herb structure: Shrubs and/or herbaceous cover somewhat reduced or killed due to anthropogenic stressors. *Bogs/acidic fen*: Shrub cover averages > 1 m tall and is so dense that it is reducing *Sphagnum* cover in many areas. *Circumneutral/rich fens*: Shrub density is excluding graminoids in many areas due to a shift in hydrology or water chemistry from anthropogenic stressors. Dominance of active peat-formers (e.g. dense stands of *Carex, Eriophorum*, *Eleocharis quinqueflora*, etc.) is being reduced in favor of non-peat-forming grasses and forbs due to a shift in hydrology or water chemistry from anthropogenic stressors. Bryophyte structure: Many areas are experiencing loss of moss cover due to increased shrub density, trampling, or a change in hydroperiod/water chemistry. In *Bogs/acidic fen* this is in reference to *Sphagnum*.
POOR (D)	BOG & FEN: Expected peatland structure is absent or much degraded due to anthropogenic factors, such as peat mining. Woody regeneration is minimal and existing structure is in poor condition, unnaturally sparse, or depauperate. Recovery to minimally disturbed condition is questionable without restoration, or will take many decades. Shrubs and herbs substantially altered from expected conditions. Overall, evidence of degradation includes major cutting, mowing, browsing, fire or grazing. Tree structure: *Bogs/acidic fen*: Most to all trees have been cut or killed due to anthropogenic stressors OR dense stands of young, vigorous trees with straight pointy leaders dominate much of the site. *Circumneutral/rich fens:* Many trees have been cut or killed due to anthropogenic stressors OR closed/nearly closed tree canopy dominates much of the site due to a shift in hydrology or water chemistry from anthropogenic stressors. Shrub / herb structure: Shrubs and/or herbaceous cover drastically reduced or killed by anthropogenic stressors. *Bogs/acidic fen*: Tall (averages > 1 m) dense shrubs dominate much of the site and have reduced *Sphagnum* cover in most areas. *Circumneutral/rich fens*: Shrub density is excluding graminoids in most areas and/or cover of active peat-formers (e.g. dense stands of *Carex, Eriophorum*, and moss cover) dramatically reduced and site is now dominated by non-peat-forming grasses and forbs due to a shift in hydrology or water chemistry from anthropogenic stressors. Bryophyte structure: Most areas have lost moss cover due to increased shrub density, trampling, or a change in hydroperiod/water chemistry. In *Bogs/acidic fen* this is in reference to *Sphagnum*.

Metric Rating	*V6: Vegetation Structure Variant: AQUATIC VEGETATION [Metric variant under development]*
EXCELLENT (A)	AQUATIC VEGETATION: Vegetation structure is at or near minimally disturbed natural conditions. No structural indicators of degradation evident. Expected layers of free-floating (non-rooted and floating on water surface), floating-rooted (rooted with a conspicuous portion of vegetative plant body on water surface), and submergent vegetation (significant portion of vegetative plant body below surface) present.
GOOD (B)	AQUATIC VEGETATION: Vegetation structure shows minor alterations from minimally disturbed natural conditions. Structural indicators of degradation are minor. Minor changes to expected proportion of free-floating, floating-rooted, and submergent layers.
FAIR (C)	AQUATIC VEGETATION: Vegetation structure is moderately altered from minimally disturbed natural conditions. Structural indicators of degradation are moderate. Moderate changes to expected proportion of free-floating, floating-rooted, and submergent layers.
POOR (D)	AQUATIC VEGETATION: Vegetation structure is greatly altered from minimally disturbed natural conditions. Structural indicators of degradation are strong. Major changes to expected proportion of free-floating, floating-rooted, and submergent layers.

VEG5 Woody Regeneration (optional)

Definition An assessment of tree or tall shrub regeneration.

Background: This metric was developed by NatureServe and NHP staff from WA, NH, NJ, and CO. It combines both structural and compositional information, in that regeneration abundance is assessed with respect to native woody species.

Apply To: *Required* for Flooded & Swamp Forest Formation. *Optional* for shrub-dominated types.

Measurement Protocol: This metric evaluates the tree regeneration layer (tree seedlings less than 1.3 m tall and saplings > 1.3 m tall and ≤ 10 cm DBH) and/or the shrub regeneration layer. The protocol is a visual evaluation of tree seedlings and saplings abundance and/or young shrub growth. Information concerning this metric can be gained from tables that describe composition using strata or growth forms (Jennings et al. 2009) (see Table V.2 above). The field survey method for estimating woody regeneration may be either (1) a Site Survey (semi-quantitative) method where the observers walk the entire AA and make notes on regeneration of woody species, or (2) Quantitative Plot Data, where a fixed area is surveyed, using either plots or transects. Metric ratings are scored using Table 26.

Table 25. Woody Regeneration Ratings. The metric is typically applied in forested wetlands, but can be used for shrublands, or any other wetland with woody vegetation.

Metric Rating	*Woody Regeneration: ALL WETLANDS*
EXCELLENT (A)	Native tree saplings and/or seedlings or shrubs common to the type present in expected amounts and diversity; obvious regeneration. *Bogs/acidic fen*: Tree regeneration is minimal and sporadic.
GOOD (B)	Native tree saplings and/or seedlings or shrubs common to the type present, but less common and less diversity than expected. *Bogs/acidic fen*: A few vigorous, young and tall trees may be present and don't appear to be as stressed as expected under peatland conditions.
FAIR (C)	Native tree saplings and/or seedling or shrubs common to the type present, but less common and less diversity; little regeneration. *Bogs/acidic fen*: Abundant vigorous, young, tall trees appear to have recently invaded and don't appear to be as stressed as expected.
POOR (D)	Essentially no regeneration of native woody species common to the type. *Bogs/acidic fen*: Site is dominated by vigorous, young trees that don't appear stressed.

VEG6 Coarse Woody Debris, Snags, and Litter (optional)

Definition: An assessment of the coarse woody debris, standing or fallen, as well as fine litter.

Background: Woody debris plays a critical role in a variety of wetland systems, especially riparian systems.

Apply To: *Required* for Flooded & Swamp Forest Formation. *Optional* for shrub-dominated types.

Measurement Protocol:

Forested wetlands

Pay special attention to the amount of coarse woody debris when surveying the AA. Select the statement from the rating table 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 coarse woody debris.

Shrub and Herb wetlands

Note the quantity and distribution of litter compared with the baseline that may be expected in the landscape. Playas are typically low in litter; densely vegetated wetlands can be high in litter. Overgrazing, woody vegetation removal, and the presence of exotic earthworms can reduce and compact litter, while aggressive plant colonization or artificially reduced water levels can result in excessive litter. Excessive litter may choke out new growth and inhibit animal movement. Select the statement on the form that best describes the litter. Litter is often detached from the live plant, but dead plant material at the base of plants (growth from the prior year or before) is also considered litter. Be sure the assessment of litter is not based on seasonality (i.e., when a wetland is surveyed early in the year, the prior years' desiccated vegetation can appear more dense than later in the season because most new growth has yet to occur). Peatlands are dominated by peat-forming species which contribute enough litter and debris to maintain carbon dynamics.

Estimation of coarse woody debris may be based on either 1) qualitative data, where the observers walk the entire AA and make notes on vegetation strata, their cover, and exotic species, using tables such as shown in Table 8.1 or 8.2 above, or 2) quantitative data, where a fixed area is surveyed, using either plots or transects.

Table 26. Coarse Woody Debris, Snags, and Litter Ratings

Metric Rating	*V1: Coarse Woody Debris, Snags, and Litter variant: FLOODED & SWAMP FOREST*
EXCELLENT/GOOD (A/B)	CWD: Wide size-class diversity of CWD (downed logs); CWD in various stages of decay. CWD in various stages of decay Snags: Wide size-class diversity of standing snags. Larger size class (> 30 cm (12 in) DBH and > 2 m (6 ft.) long) present with 5 or more snags per ha (2.5 ac), but not excessive numbers (suggesting disease or other problems).
FAIR (C)	CWD: Moderate size- and decay-class diversity of downed CWD. Snags: Moderate size- and decay-class diversity of standing snags. Larger size class present with 1-4 snags per ha, or moderately excessive numbers (suggesting disease or other problems).
POOR (D)	CWD: Low size- and decay-class diversity of downed CWD. CWD mostly in early stages of decay. Snags: Low size- and decay-class diversity of snags. Larger size class present with < 1 snag per ha, or very excessive numbers (suggesting disease or other problems).

Metric Rating	*V2: Coarse Woody Debris, Snags, and Litter variant: FRESHWATER MARSH, WET MEADOW & SHRUBLAND, BOG & FEN [metric variant under development]*
EXCELLENT (A)	Coarse woody debris, litter and other organic inputs are typical of the system (e.g., playas should have low litter, whereas meadows and marshes have moderate amounts of litter). Litter Accumulation: No deviation in the accumulation of litter in the system (e.g. livestock grazing does not appear to have reduced fine herbaceous litter via either consumption or trampling). Litter Source: Litter appears to be made up almost entirely of native material (>95%). Litter is primarily from diagnostic dominant species that are typical of that system (e.g. perennial bunchgrass litter in wet prairies).
GOOD (B)	Standing snags, dead shrubs, down woody debris and litter show minor alterations to system. Litter Accumulation: Litter accumulation is greater or less than expected—due to grazing, tree encroachment, or other stressors—but remains within NRV.

	Litter Source: Litter is primarily native (>~85%), but fuels from exotic species are beginning to accumulate OR the proportion of woody or herbaceous material makes up a larger proportion than typical (due to tree encroachment or reduction of herbaceous material by grazing, etc.), but remains within NRV.
FAIR (C)	Standing snags, dead shrubs, down woody debris and litter show moderate alterations to system. Litter Accumulation: Litter accumulation is moderately greater or less than expected—due to grazing, fire suppression, tree encroachment, or other stressors. Litter Source: Litter may be largely native (>~60%), but fuels from exotic species are widespread OR the proportion of woody or herbaceous material (due to tree encroachment or reduction of herbaceous material by grazing, etc.) is outside NRV.
POOR (D)	Standing snags, dead shrubs, down woody debris and litter show substantial alterations to system. Litter Accumulation: Litter accumulation is significantly greater or less than expected—due to grazing, tree encroachment, or other stressors. Litter Source: Litter is mostly from exotic species, or nearly so (>~40%) OR the large majority of litter is made up of material of the wrong physiognomy (e.g. woody litter in herbaceous wetlands).

3.8 HYDROLOGY

Ratings for the hydrology metrics are based on HGM Classes (Table 27). The three metrics we use are not strictly independent. Hydrology is a complicated ecological factor to measure during a rapid assessment, and users will find that their evaluation of one metric partly relates to another. A simple way to portray the primary focus of each metric is as follows:

- Water Source: water coming into the wetland.
- Hydroperiod: water patterns within the wetland, regardless of source.
- Connectivity: water exchange between wetland and surrounding systems, regardless of patterns within the wetland.

Table 27. Hydrological metric variants by HGM Class

METRIC	HYDROLOGY		
Metric Variant by Hydrogeomorphic Class	H1. Water Source	H2. Hydroperiod	H3. Hydrologic Connectivity
Riverine (Non-tidal)	V1	V1	V1
Organic Soil Flats, Mineral Soil Flats	V2	V2	V2
Depression, Lacustrine, Slope	V3	V3	V3
Estuarine Fringe (Tidal)	V4	V4	V4

HYD1 Water Source

Definition: An assessment of the direct inputs of water into, or diversions of water away from, the wetland.

Background: Water Source encompasses the forms, or places, of direct inputs of water to the AA, as well as any unnatural diversions of water from the AA. Diversions are considered an impact to natural water sources because they directly affect the hydrology of the AA.

Apply To: All types (variant differs by HGM class).

Measurement Protocol: This metric can be assessed initially in the office using available imagery, and then revised based on the field visit. The metric focuses on direct sources of tidal and non-tidal water, comparing the natural sources to unnatural sources listed in Table 28.

Table 28. List of Water Sources

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

The office assessment can work outward from the AA to include identification of unnatural water sources, such as adjacent intensive development or irrigated agriculture, nearby wastewater treatment plants, and nearby reservoirs. These sources identified in the office can then be checked in the field. Assign metric rating based on criteria in Table 29.

Table 29. Water Source Variant Rating Criteria. Separate metric ratings are provided for Riverine (Non-tidal), Organic and Mineral Soil Flats, Depression, Lacustrine, & Slope, and Estuarine Fringe (Tidal).

Metric Rating	*V1: Water Source variant: RIVERINE (Non-tidal) Wetlands*
EXCELLENT (A)	Water source is natural; site hydrology is dominated by precipitation, groundwater, or overbank flow. There is no indication of direct artificial water sources. Land use in the local drainage area of the wetland is primarily open space or low density, passive uses. Lacks point source discharges into or adjacent to the site.
GOOD (B)	Water source is mostly natural, but wetland directly receives occasional or small amounts of inflow from anthropogenic sources. Indications of anthropogenic input include developed or agricultural land (< 20%) in the immediate drainage area of the wetland, some road runoff, small storm drains, or other minor point source discharges emptying into the wetland.
FAIR (C)	Water sources are moderately impacted by anthropogenic sources. Indications from anthropogenic sources include developed land or irrigated agriculture that comprises 20–60% of the immediate drainage basin, or moderate point source discharges into or adjacent to the site, such as many small storm drains, or a few large ones. The key factors to consider are whether the wetland is located in a topographic position that supported wetlands before development AND whether the wetland is still connected to its natural water source (e.g., modified ponds on a floodplain that are still connected to alluvial aquifers, natural stream channels that now receive substantial irrigation return flows).

Metric Rating	*V1: Water Source variant: RIVERINE (Non-tidal) Wetlands*
POOR (D-)	Water source contains a substantial amount of inflow from anthropogenic sources. Indications of anthropogenic sources include > 60% developed or agricultural land adjacent to the wetland and major point source discharges into or adjacent to the wetland.

Metric Rating	*V2: Water Source variant: ORGANIC SOIL FLATS, MINERAL SOIL FLATS*
EXCELLENT (A)	Water source is natural and site hydrology is dominated by precipitation. There is no indication of direct artificial water sources. Land use in the local drainage area of the site is primarily open space or low density, passive uses. Lacks point source discharges into or adjacent to the site.
GOOD (B)	Water source is mostly natural, but site directly receives occasional or small amounts of inflow from anthropogenic sources, or is ditched, causing peatland to dry out more quickly. Indications of anthropogenic input include developed land or agricultural land (< 20%) in the immediate drainage area of the site; or the presence of small storm drains, ditches, or other local discharges emptying into the site; road runoff; or the presence of scattered homes along the wetland that probably have septic systems. No large point sources discharge into or adjacent to the site.
FAIR (C)	Water sources are moderately impacted by anthropogenic sources, but are still a mix of natural and non-natural sources. Indications of moderate contribution from anthropogenic sources include developed land or irrigated agriculture that comprises 20–60% of the immediate drainage basin, or the presence of many small storm drains, or a few large ones. The key factors to consider are whether the wetland is located in a topographic position that supported wetlands before development AND whether the wetland is still connected to its natural water source (e.g., modified ponds on a floodplain that are still connected to alluvial aquifers, natural stream channels that now receive substantial irrigation return flows).
FAIRLY POOR (C-)	Water source is moderately impacted by increased inputs into the peatland, artificially impounded water, or other artificial hydrology. Indications of substantial artificial hydrology include > 20% developed or agricultural land adjacent to the site, and the presence of major point sources that discharge into or adjacent to the site.
POOR (D)	Water source is substantially impacted by impoundments or diversions of water or other inputs into or withdrawals directly from the site, its encompassing wetland, or from areas adjacent to the site or its wetland.

Metric Rating	*V3: Water Source variant: OTHER HGM (DEPRESSION, LACUSTRINE, SLOPE)*
EXCELLENT (A)	Water source is natural: Site hydrology is dominated by precipitation, groundwater, or natural runoff from an adjacent freshwater body. There is no indication of direct artificial water sources. Land use in the local drainage area of the site is primarily open space or low density, passive uses. Lacks point source discharges into or adjacent to the site.

Metric Rating	*V3: Water Source variant: OTHER HGM (DEPRESSION, LACUSTRINE, SLOPE)*
GOOD (B)	Water source is mostly natural, but site directly receives occasional or small amounts of inflow from anthropogenic sources. Indications of anthropogenic input include developed land or agricultural land (< 20%) in the immediate drainage area of the site, small storm drains or other local discharges emptying into the site, road runoff, or scattered homes along the wetland that probably have septic systems. No large point sources discharge into or adjacent to the site.
FAIR (C)	Water sources are moderately impacted by anthropogenic sources, but are still a mix of natural and non-natural sources. Indications of moderate contribution from anthropogenic sources include developed land or irrigated agriculture that comprises 20–60% of the immediate drainage basin or many small storm drains or a few large ones. The key factors to consider are whether the wetland is located in a topographic position supported wetland before development AND whether the wetland is still receiving a modified source of water (e.g., modified ponds on a floodplain that are still connected to alluvial aquifers, natural stream channels that now receive substantial irrigation return flows).
POOR (D)	Water source is primarily from anthropogenic sources (e.g., urban runoff, direct irrigation, pumped water, artificially impounded water, or other artificial hydrology. Indications of substantial artificial hydrology include > 60% developed or agricultural land adjacent to the site and the presence of major point sources that discharge into or adjacent to the site.

Metric Rating	*V4: Water Source: ESTUARINE FRINGE (Tidal) Wetlands*
EXCELLENT (A)	Tidal and non-tidal water sources are natural with no artificial alterations to natural salinity; no indication of direct artificial water sources (e.g., no tide gates, land use in the local drainage area of the wetland is primarily open space or low density, passive uses). Lacks point source discharges into or adjacent to the wetland.
GOOD (B)	Tidal and non-tidal water sources are mostly natural, with minor alterations to natural salinity. Site directly receives occasional or small continuous amounts of inflow from anthropogenic sources; indicators include < 20% of core landscape is agricultural or developed land, road runoff, storm drains, or other minor discharges emptying into the wetland.
FAIR (C)	Tidal and non-tidal water sources are moderately impacted by human activity; indicators of anthropogenic input include 20-60% developed or agricultural land adjacent to the site, including direct irrigation or pumped water, moderate amounts of road runoff, moderately sized storm drains, and/or moderate point source discharges into or adjacent to the wetland.
POOR (D)	Tidal and non-tidal water sources are substantially impacted by human activity. Indicators of anthropogenic input include > 60% developed or agricultural land adjacent to the site, large amounts of road runoff, large-sized storm drains, and major point source discharges into or adjacent to the wetland.

HYD2 Hydroperiod

Definition: An assessment of the characteristic frequency and duration of inundation or saturation of a wetland during a typical year.

Background: Hydroperiod integrates the inflows and outflows of water and varies by major wetland type. For tidal wetlands, there are many hydroperiod cycles corresponding to different periodicities in the orbital relationships among the earth, moon, and sun, creating a variety of tidal patterns at semi-daily, daily, semi-weekly, monthly, seasonal, and annual timeframes. For non-tidal wetlands with fluctuating hydroperiods, such as depressional, lacustrine, riverine, and mineral flats wetlands, cycles are governed by seasonal or annual patterns of rainfall and temperature. For non-tidal wetlands with more stable, saturated hydroperiods, such as groundwater-fed slope wetlands, these seasonal patterns are often overridden by groundwater flows. Lagoons can be episodically subjected to tidal inundation, but may otherwise have similar hydroperiods to lacustrine systems (Collins et al. 2006).

Apply To: All types (variant differs by HGM class).

Measurement Protocol: This metric evaluates recent changes in the hydroperiod, and the degree to which these changes affect the structure and composition of the wetland plant community. Common indicators are presented for the different wetland classes. A basic understanding of the natural hydrology or channel dynamics of the wetland type being evaluated is required to apply this metric.

<u>Measurement Protocols for Tidal Wetlands (Estuarine)</u>

Collins et al. (2006) describe the hydroperiod of estuaries:

> "The volume of water that flows into and from an estuarine wetland due to the changing stage of the tide is termed the "tidal prism". This volume of water consists of inputs from both tidal (i.e., marine) and non-tidal (e.g., fluvial or upland) sources. The timing, duration, and frequency of inundation of the wetland by these waters is termed the tidal hydroperiod. Under natural conditions, increases in tidal prism result in increases in sedimentation, such that increases in hydroperiod do not persist. For example, estuarine marshes tend to build upward in quasi-equilibrium with sea level rise. A decrease in tidal prism usually results in a decrease in hydroperiod. In lagoons, freshwater inputs are substantial and tidal prisms are altered by barriers to tidal inputs, which may occasionally be breached by occasional winds driving overwash across the tidal barrier or by seepage through the tidal barrier, etc."

To score this metric, visually survey the AA for field indicators (Table 30) of alterations to the estuarine hydroperiod (i.e., a change in the tidal prism; Collins et al. 2006), then use the Variant 4 Hydroperiod Rating Table.

Table 30. Hydroperiod Field Indicators for Tidal Wetlands (adapted from Collins et. al. 2006)

Condition	Hydroperiod Field Indicators for Evaluating Tidal Wetlands (Estuarine)
Stressors to tidal prism	• Changes in the relative abundance of plants indicative of either high or low marsh. • A preponderance of shrink cracks or dried pannes is indicative of decreased hydroperiod. • Inadequate tidal flushing may be indicated by algal blooms or by encroachment of freshwater vegetation. • Dikes, levees, ponds, ditches, and tide control structures are indicators of an altered hydroperiod resulting from management for flood control, salt production, waterfowl hunting, boating, etc.

Measurement Protocols for Non-Tidal Wetlands

Riverine (non-tidal): To score this metric, visually survey the AA for field indicators of aggradation or degradation (Table 31). After reviewing the entire AA and comparing the conditions to those described in the table, determine whether the AA is in equilibrium, aggrading, or degrading, then assign a metric rating based on criteria in Table 34.

Table 31. Riverine Hydroperiod Field Indicators (adapted from Collins et. al. 2006)

Condition	Hydroperiod Field Indicators for Evaluating Riverine Wetlands
Indicators of Channel Equilibrium	• 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. A topographic bench 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. • There is little or no active undercutting or burial of riparian vegetation.
Indicators of Active Degradation (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).

Condition	Hydroperiod Field Indicators for Evaluating Riverine Wetlands
Indicators of Active Aggradation (Sedimentation)	• 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.

Non-Riverine (non-tidal): Assessment of the hydroperiod for all non-riverine wetlands should be initiated with an office-based review of diversions or augmentations of flows or alteration of saturated conditions to the wetland. Field indicators are listed in Table 32 and should be used to help assign a metric rating based on criteria in Table 34.

Table 32. Non-riverine, non-tidal Hydroperiod Field Indicators (adapted from Collins et. al. 2006).

Condition	Hydroperiod Field Indicators for Evaluating Non-Riverine, Non-tidal Freshwater Wetlands
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. • 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 draining into the wetland. • Late-season vitality of annual vegetation. • Recently drowned riparian or terrestrial vegetation. • Extensive fine-grain deposits on the wetland margins.

Organic Soil Flats. Bogs have a very stable, saturated hydroperiod, or a much reduced cycle of saturation and partial drying. Because drying is limited to the upper layers of peat, bogs are rarely subject to fires, which can burn woody vegetation and upper peat layers when they do occur. The hydroperiod can be altered by ditches, which further increase drying of the peat layer, or by increased runoff into the system. If weakly minerotrophic (and not truly ombrotrophic), as occurs in poor fens, runoff can lead to nutrient enrichment. Surface removal of vegetation through peat mining may also alter the hydrology of the remainder of the bog by reducing evapotranspiration. Field indicators of alteration are show in Table 33 and should be used to assign metric rating based on criteria in Table 34.

Table 33. Organic Soil Flat Hydroperiod Field Indicators (adapted from Collins et. al. 2006).

Condition	Hydroperiod Field Indicators for Evaluating Organic Soil Flat
Reduced Extent and Duration of Saturation	• Upstream spring boxes, diversions, impoundments, pumps, ditching, or draining from the wetland. • Water withdrawal (regional or local wells) • Evidence of aquatic wildlife mortality. • Encroachment of terrestrial vegetation. • Encroachment of young, tall, vigorous trees • Stress or mortality of hydrophytes. • Drying or mortality of non-vascular species (e.g. *Sphagnum*) • Compressed or reduced plant zonation. • Dense, tall shrubs shading out underlying mosses • Organic soils occurring well above contemporary water tables.
Increased Extent and Duration of Saturation	• Berms, dikes, or other water control features that increase duration of ponding (e.g., pumps). • Diversions, ditching, or draining into the wetland. • Late-season vitality of annual vegetation. • Recently drowned riparian or terrestrial vegetation (e.g. Beaver created impoundment)

Table 34. Hydroperiod Metric Rating Criteria.

Metric Rating	*V1: Hydroperiod variant: RIVERINE (Non-tidal)*
EXCELLENT (A)	Hydroperiod (flood frequency, duration, level, and timing) is characterized by natural patterns, with no major hydrologic stressors present. The channel/riparian zone is characterized by equilibrium conditions, with no evidence of severe aggradation or degradation (based on the field indicators listed in Table 13.1).
GOOD (B)	Hydroperiod inundation and drying patterns (flood frequency, duration, level, and timing) deviate slightly from natural conditions due to presence of stressors such as: flood control dams upstream or downstream, small ditches or diversions; berms or roads at/near grade; minor pugging by livestock; or minor flow additions. If wetland is artificially controlled, the management regime closely mimics a natural analog (it is very unusual for a purely artificial wetland to be rated in this category). The channel/riparian zone is characterized by some aggradation or degradation, none of which is severe, and the channel seems to be approaching an equilibrium form (based on the field indicators listed in Table 31).
FAIR (C)	Hydroperiod filling or inundation and drying patterns (flood frequency, duration, level, and timing) deviate moderately from natural conditions due to presence of stressors such as: flood control dams upstream or downstream moderately affect hydroperiod ditches or diversions 1–3 ft. deep; two lane roads; culverts adequate for base stream flow, but not flood flow; moderate pugging by livestock that could channelize or divert water; or moderate flow additions. Outlets may be moderately constricted, but flow is still possible. If wetland is artificially controlled, the management regime approaches a natural analog. Site may be passively managed, meaning that the hydroperiod is still connected to and influenced by natural high flows timed with seasonal water levels. The channel/riparian zone is characterized by severe aggradation or degradation (based on the field indicators listed in Table 31).

Metric Rating	*V1: Hydroperiod variant: RIVERINE (Non-tidal)*
POOR (D)	Hydroperiod filling or inundation and drawdown (flood frequency, duration, level, and timing) deviate substantially from natural conditions because of high intensity alterations such as: flood control dams upstream or downstream moderately affect hydroperiod; a 4-lane highway; diversions > 3ft. deep that withdraw a significant portion of flow; large amounts of fill; significant artificial groundwater pumping; or heavy flow additions. Outlets may be significantly constricted, blocking most flow. If wetland is artificially controlled, the site is actively managed and not connected to any natural seasonal fluctuations, but the hydroperiod supports natural functioning of the wetland. Hydroperiod is dramatically different from natural. Upstream diversions severely stress the wetland. Riverine wetlands may run dry during critical times. If wetland is artificially controlled, hydroperiod does not mimic natural seasonality. Site is actively managed for filling or drawing down without regard for natural wetland functioning. The channel is concrete or artificially hardened (see field indicators in Table 31).

Metric Rating	*V2: Hydroperiod variant: ORGANIC SOIL FLATS, MINERAL SOIL FLATS*
EXCELLENT (A)	Hydroperiod is characterized by natural patterns of filling, inundation, saturation, and drying or drawdowns. There are no major hydrologic stressors that impact the natural hydroperiod (see field indicators listed in Table 32 and Table 33)
GOOD (B)	Hydroperiod filling or inundation patterns deviate slightly from natural conditions due to presence of stressors such as: small ditches or diversions; berms or roads at/near grade; minor pugging by livestock; or minor flow additions. Outlets may be slightly constricted. If wetland is artificially controlled, the management regime closely mimics a natural analog (it is very unusual for a purely artificial wetland to be rated in this category). Minor altered inflows or drawdown/drying (e.g., ditching) (see field indicators listed in Table 32 and Table 33)
FAIR (C)	Hydroperiod filling or inundation and drying patterns deviate moderately from natural conditions due to presence of stressors such as: ditches or diversions 1–3 ft. deep; two lane roads; culverts adequate for base stream flow, but not flood flow; moderate pugging by livestock that could channelize or divert water; or moderate flow additions. Outlets may be moderately constricted, but flow is still possible. If wetland is artificially controlled, the management regime approaches a natural analog. Site may be passively managed, meaning that the hydroperiod is still connected to and influenced by natural high flows timed with seasonal water levels. Moderately altered by increased runoff, or drawdown and drying (e.g., ditching). (see field indicators listed in Table 32 and Table 33)
POOR (D)	Hydroperiod filling or inundation and drawdown deviate substantially from natural conditions from high intensity alterations such as: a 4-lane highway; large dikes impounding water; diversions > 3 ft. deep that withdraw a significant portion of flow; large amounts of fill; significant artificial groundwater pumping; or heavy flow additions. Outlets may be significantly constricted, blocking most flow. If wetland is artificially controlled, the site is actively managed and not connected to any natural seasonal fluctuations, but the hydroperiod supports natural functioning of the

Metric Rating	*V2: Hydroperiod variant: ORGANIC SOIL FLATS, MINERAL SOIL FLATS*
	wetland. Hydroperiod is dramatically different from natural. Upstream diversions severely stress the wetland. If wetland is artificially controlled, hydroperiod does not mimic natural seasonality. Site is actively managed for filling or drawing down without regard for natural wetland functioning. Substantially altered by increased inflow from runoff, or significant drawdown and drying (e.g., ditching-see field indicators listed in Table 32 and Table 33)

Metric Rating	*V3: Hydroperiod variant: DEPRESSION, LACUSTRINE, SLOPE (including Playas)*
EXCELLENT (A)	Hydroperiod characterized by natural patterns associated with inundation – drawdown, saturation, and seepage discharge. There are no major hydrologic stressors that impact the natural hydroperiod (see field indicators listed in Table 32).
GOOD (B)	Hydroperiod filling or inundation patterns deviate slightly from natural conditions due to presence of stressors such as: small ditches or diversions; berms or roads at/near grade; minor pugging by livestock; or minor flow additions. Outlets may be slightly constricted. Playas are not significantly impacted, pitted, or dissected. If wetland is artificially controlled, the management regime closely mimics a natural analog (it is very unusual for a purely artificial wetland to be rated in this category). Some alteration to the natural patterns associated with inundation – drawdown, saturation, and seepage discharge (see field indicators listed in Table 32).
FAIR (C)	Hydroperiod filling or inundation and drying patterns deviate moderately from natural conditions due to presence of stressors such as: ditches or diversions 1–3 ft. deep; two lane roads; culverts adequate for base stream flow but not flood flow; moderate pugging by livestock that could channelize or divert water; shallow pits within playas; or moderate flow additions. Outlets may be moderately constricted, but flow is still possible. If wetland is artificially controlled, the management regime approaches a natural analog. Site may be passively managed, meaning that the hydroperiod is still connected to and influenced by natural high flows timed with seasonal water levels. Moderate alteration to the natural patterns associated with inundation – drawdown, saturation, and seepage discharge (see field indicators listed in Table 32).
POOR (D)	Hydroperiod filling or inundation and drawdown of the AA deviate substantially from natural conditions due to high intensity alterations such as: a 4-lane highway; large dikes impounding water; diversions > 3 ft. deep that withdraw a significant portion of flow; deep pits in playas; large amounts of fill; significant artificial groundwater pumping; or heavy flow additions. Outlets may be significantly constricted, blocking most flow. If wetland is artificially controlled, the site is actively managed and not connected to any natural season fluctuations, but the hydroperiod supports natural functioning of the wetland. Hydroperiod is dramatically different from natural. Upstream diversions severely stress the wetland. Riverine wetlands may run dry during critical times. If wetland is artificially controlled, hydroperiod does not mimic natural seasonality. Site is actively managed for filling or drawing down without regard for natural wetland functioning. Significant alteration to the natural patterns

Metric Rating	*V3: Hydroperiod variant: DEPRESSION, LACUSTRINE, SLOPE (including Playas)*
	associated with inundation – drawdown, saturation, and seepage discharge (see field indicators listed in Table 32).

Metric Rating	*V4: Hydroperiod variant: ESTUARINE FRINGE (Tidal*)
EXCELLENT (A)	Area is subject to the full tidal prism, with two daily tidal minima and maxima. Storm tides, tidal river flooding and onshore wind-maintained high tides causing short-term changes in tidal amplitude are within the expected norm. Lagoons: Area subject to natural inter-annual tidal fluctuations (range may be severely muted or vary seasonally), and is episodically fully tidal by natural breaching or overwash due to fluvial flooding, storm surge or wind-driven tides (extreme highs or lows).
GOOD (B)	Area is subject to somewhat reduced, or muted tidal prism, although two daily minima and maxima are observed. Lagoons: Area is subject to full tidal range more often than would be expected under natural circumstances due to artificial breaching of the tidal barrier.
FAIR (C)	Area is subject to moderately muted tidal prism, with tidal fluctuations evident only in relation to extreme daily highs or spring tides. Lagoons: Area is subject to full tidal range less often than would be expected under natural circumstances due to management of the breach to prevent its opening.
POOR (D)	Area is subject to substantially muted tidal prism; there is inadequate drainage, such that the marsh tends to remain flooded during low tide. Lagoons: Area appears to have no episodes of full tidal exchange.

HYD3 Hydrologic Connectivity

Definition: An assessment of the ability of the water to flow into or out of the wetland, or to inundate adjacent areas.

Background: Metric is adapted from Collins et al. (2006), with additional metric variants added.

Apply To: All types (variant differs by HGM class).

Measurement Protocol: Scoring of this metric is based solely on field observations. No office work is required. The metric is assessed in the field by observing signs of alteration to horizontal water movement within the assessment area. For riverine wetlands and riparian habitats, Hydrologic Connectivity is assessed in part based on the degree of alteration of flooding regimes (e.g., channel entrenchment). Entrenchment varies naturally with channel confinement. Channels in steep canyons naturally tend to be confined, and tend to have small entrenchment ratios indicating less hydrologic connectivity. Assessments of hydrologic connectivity based on entrenchment must therefore be adjusted for channel confinement based on the geomorphic setting of the riverine wetlands. Prevention of river flooding by human-created levees and dikes, or impairments caused by rivershore rip-rap, are other ways in which changes to hydrological connectivity can be assessed

(Collins et al. 2006). Natural levees may form as part of river dynamics, and may be breached during natural flooding events, also altering connectivity. Their form is distinct from human-created levees, helping to minimize misidentification. Assign metric rating using appropriate variant rating criteria in Table 35.

Table 35. Hydrologic Connectivity Variant Rating Criteria

Metric Rating	*V1: Hydrologic Connectivity variant: RIVERINE (Non-tidal)*
EXCELLENT (A)	Completely connected to floodplain (backwater sloughs and channels). No geomorphic modifications made to contemporary floodplain. Channel is not unnaturally entrenched.
GOOD (B)	Minimally disconnected from floodplain. Up to 25% of stream banks are affected due to dikes, rip rap and/or elevated culverts. Channel is somewhat entrenched (overbank flow occurs during most floods).
FAIR (C)	Moderately disconnected from floodplain due to multiple geomorphic modifications. Between 25-75% of stream banks are affected (e.g., dikes, tide gates, rip rap, concrete, and elevated culverts). Channel is moderately entrenched (overbank flow only occurs during moderate to severe floods).
POOR (D)	Channel is severely entrenched and entirely or extensively disconnected from the floodplain; > 75% of stream banks are affected due to dikes, tide gates, rip rap, concrete, and elevated culverts. Channel is substantially entrenched (overbank flow never occurs or only during severe floods).

Metric Rating	*V2: Hydrologic Connectivity variant: ORGANIC SOIL FLATS, MINERAL SOIL FLATS*
EXCELLENT (A)	No or very little direct connectivity to groundwater. Precipitation is the dominant or only source. Surrounding land cover / vegetation does not interrupt surface flow. No artificial channels feed water to wetland.
GOOD (B)	Minor hydrological connectivity, as caused by human activity (e.g., ditching). Surrounding land cover / vegetation does not interrupt surface flow. Artificial channels may feed minor amounts of excess water to wetland.
FAIR (C)	Moderate connectivity caused by human activity (e.g., ditching). Surrounding land cover / vegetation may interrupt surface flow. Artificial channels may feed moderate amounts of excess water to wetland.
POOR (D)	Substantial to full connectivity caused by human activity. Surrounding land cover / vegetation may dramatically restrict surface flow. Artificial channels may feed significant amounts of excess water to wetland.

Metric Rating	*V3: Hydrologic Connectivity variant: DEPRESSION, LACUSTRINE, SLOPE*
EXCELLENT (A)	No unnatural obstructions to lateral or vertical movement of ground or surface water, or if perched water table, then impermeable soil layer (fragipan or duripan) intact. 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.

Metric Rating	*V3: Hydrologic Connectivity variant: DEPRESSION, LACUSTRINE, SLOPE*
GOOD (B)	Minor restrictions to the lateral or vertical movement of ground or surface waters by unnatural features, such as levees or excessively high banks. Less than 25% of the site is restricted by barriers to drainage. If perched, impermeable soil layer partly disturbed (e.g., from drilling or blasting). Restrictions may be intermittent along the site, or the restrictions may occur only along one bank or shore. Flood flows may exceed the obstructions, but drainage back to the wetland is incomplete due to impoundment. Artificial channels may feed minor amounts of excess water to wetland.
FAIR (C)	Moderate restrictions to the lateral or vertical movement of ground or surface waters by unnatural features, such as levees or excessively high banks. Between 25-75% of the site is restricted by barriers to drainage. If perched, impermeable soil layer moderately disturbed (e.g., by drilling or blasting). Flood flows may exceed the obstructions, but drainage back to the wetland is incomplete due to impoundment. Artificial channels may feed moderate amounts of excess water to wetland.
POOR (D)	Essentially no hydrologic connection to adjacent wetlands or uplands. Most or all water stages are contained within artificial banks, levees, sea walls, or comparable features. Greater than 75% of wetland is restricted by barriers to drainage. If perched, impermeable soil layer strongly disturbed. Artificial channels may feed significant amounts of excess water to wetland.

Metric Rating	*V4: Hydrologic Connectivity variant: ESTUARINE FRINGE (Tidal)*
EXCELLENT (A)	Tidal channel sinuosity reflects natural processes; absence of channelization. Marsh receives unimpeded tidal flooding. Total absence of tide gates, flaps, dikes, culverts, or human-made channels.
GOOD (B)	Tidal channel sinuosity minimally altered: Marsh receives essentially unimpeded tidal flooding, with few tidal channels blocked by dikes or tide gates, and human-made channels are few. Culvert, if present, is of large diameter and does not significantly change tidal flow, as evidenced by similar vegetation on either side of the culvert.
FAIR (C)	Tidal channel sinuosity moderately altered: Marsh channels are frequently blocked by dikes or tide gates. Tidal flooding is somewhat impeded by small culvert size, as evidenced in obvious differences in vegetation on either side of the culvert.
POOR (D)	Tidal channel sinuosity extensively altered: Tidal channels are extensively blocked by dikes and tide gates; evidence of extensive human channelization. Tidal flooding is totally, or almost totally, impeded by tidal gates or obstructed culverts.

3. 9 SOIL / SUBSTRATE

Conducting rapid assessment of soil condition in wetlands is challenging, and here we limit the assessment to visible evidence of soil surface or soil profile alterations that degrade the soil structure.

<u>Note</u>: 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. Two water quality metrics, surface

water turbidity/pollutants and algal growth, have been tested but were found to be too difficult to assess to be practical for a rapid assessment (Faber-Langendoen et al. 2012a).

Table 36. Soil metric variants by USNVC Formation

Metric Variant by NVC Formation Type	S1. Soil Surface Condition
Flooded & Swamp Forest Formation	v1
Freshwater Marsh, Wet Meadow and Shrubland Formation	v1 or v2 (freshwater tidal)
Salt Marsh Formation	v2
Bog and Fen Formation	V1
Aquatic Vegetation Formation	V1

SOI1 Soil Condition

Definition: An indirect measure of soil condition based on stressors that increase the potential for erosion or sedimentation, assessed by evaluating intensity of human impacts to soils on the site.

Background: This metric is partly based on one developed by Mack (2001) and the NatureServe Ecological Integrity Working Group (Faber-Langendoen et al. 2008). This metric has also been called “Substrate / Soil Disturbance.”

Apply To: All types (variant differs by USNVC formation).

Measurement Protocol: Prior to fieldwork, aerial photography of the site can be reviewed to determine if any soil alterations have occurred, but the primary assessment is based on field observations of the AA. Assign metric rating based on appropriate variant rating criteria in Table 37.

Table 37. Soil Condition Variant Rating Criteria

Metric Rating	*V1: Soil Surface Condition variant: ALL FRESHWATER NON-TIDAL WETLANDS* (FLOODED & SWAMP FOREST, FRESHWATER MARSH, WET MEADOW & SHRUBLAND, BOG & FEN, AQUATIC VEGETATION)
EXCELLENT (A)	Little bare soil OR bare soil and soil disturbed areas are limited to naturally caused disturbances such as flood deposition or game trails OR soil is naturally bare (e.g., playas). No disturbances are evident from trampling, erosion, soil compaction, ruts, sedimentation, invasive earthworms, or boat traffic. *Peatlands*: peat surface almost entirely covered by bryophytes or dense graminoid growth. Any bare areas of peat are due to natural disturbances such as animal trails, windthrow, ponded water, etc.
GOOD (B)	Small amounts of bare or disturbed soil are present, but the extent and impact is minimal. Examples include disturbance from cattle (trampling or heavy grazing that leads to erosion), compaction or trampling by machinery, ruts or other disturbances from ATV or other vehicular activity, sedimentation due to human causes, invasive earthworms, or effects of boat traffic. The depth of disturbance is limited to only several centimeters (a few inches) and does not show evidence of ponding or channeling of water. *Peatlands*: Bare peat may be present but not

	widespread and results from grazing, limited timber harvesting, trampling, anthropogenic fire or other anthropogenic factors.
FAIR (C)	Moderate amounts of bare or disturbed soil are present and the extent and impact is moderate. Examples include disturbance from cattle (trampling or heavy grazing that leads to erosion), compaction or trampling by machinery, ruts or other disturbances from ATV or other vehicular activity, sedimentation due to human causes, invasive earthworms, or effects of boat traffic. The depth of disturbance may extend 5–10 cm (2–4 inches), with localized deeper ruts, and shows some evidence of ponding or channeling of water. *Peatlands*: Ground cover has as much bare peat as moss or graminoid cover due to grazing, limited timber harvesting, trampling, anthropogenic fire or other anthropogenic factors.
POOR (D)	Substantial amounts of bare or disturbed soil are present, with extensive and long lasting impacts. Examples include disturbance from cattle (trampling or heavy grazing that leads to erosion), compaction or trampling by machinery, ruts or other disturbances from ATV or other vehicular activity, sedimentation due to human causes, invasive earthworms, or effects of boat traffic. The depth of disturbance extends > 10 cm (4 inches); deeper ruts may be widespread and show some evidence of extensively altering hydrology (e.g., ponding or channeling of water). *Peatlands*: Ground cover is almost all bare peat due to grazing, limited timber harvesting, trampling, anthropogenic fire or other anthropogenic factors.

Metric Rating	*V2: Soil Surface Condition variant: ESTUARINE WETLANDS* (MANGROVE, SALT MARSH, and tidal variants of FRESHWATER MARSH, WET MEADOW & SHRUBLAND)
EXCELLENT (A)	Excluding mud flats, bare or disturbed soils are naturally occurring and largely limited to salt pannes.
GOOD (B)	Small amounts of bare or disturbed soil areas caused by rafts of anthropogenic debris (killing marsh vegetation and creating artificial pannes), ditch spoils impounding water and forming artificial pannes, trampling by livestock, and erosion of marsh and channel banks due to excavation by marine traffic and/or altered current/tidal patterns resulting from deficient culverts (leading to erosion).
FAIR (C)	Moderate amounts of bare or disturbed soil areas caused by rafts of anthropogenic debris (killing marsh vegetation and creating artificial pannes), ditch spoils impounding water and forming artificial pannes, trampling by livestock, and erosion of marsh and channel banks due to excavation by marine traffic and/or altered current/tidal patterns resulting from deficient culverts (leading to erosion).
POOR (D)	Substantial amounts of bare or disturbed soil areas caused by rafts of anthropogenic debris (killing marsh vegetation and creating artificial pannes), ditch spoils impounding water and forming artificial pannes, trampling by livestock, and erosion of marsh and channel banks due to excavation by marine traffic and/or altered current/tidal patterns resulting from deficient culverts (leading to erosion).

3.10 SIZE

The role of size in EIAs varies depending on the application. Inventory or monitoring programs that focus on the condition of wetlands across watersheds or jurisdictions, with an emphasis on statistical design, often rely on a point based sampling approach (e.g. a 0.5 ha AA). In this case, the overall wetland size is typically not used to evaluate the wetland. Conversely, programs that focus on identifying wetlands as entire polygons, with an emphasis on the condition of the polygon, more typically consider the size of the wetland as important to its overall integrity. Size does interact with landscape context, such that small occurrences embedded in entirely natural landscapes do not, necessarily, have less ecological integrity than a larger example in the same landscape. Conversely, a large occurrence in a fragmented landscape is likely to be more buffered from landscape stressors than a small one in a similarly fragmented landscape. Thus, a scorecard should give careful consideration to the appropriate manner in which to score size, taking into account this suite of contextual factors.

SIZ1 Comparative Size (Patch Type)

Definition: A measure of the current absolute size (ha) of the entire wetland type polygon or patch. The metric is assessed either with respect to expected patch-type sizes for the type across its range, or as a comparative size based on size distribution.

Background: This metric accounts for one aspect of the size of specific occurrences of a wetland type. Assessors are sometimes hesitant to use patch size as part of an EIA out of concern that a small, high quality example will be down-ranked unnecessarily. We address these concerns, to a degree, by providing an absolute patch-type scale, so that types that typically occur as small patches (seeps & springs) can use a different rating than types that may occur over large, extensive areas (e.g., marshes or boreal bogs/fens). Size is also more accurately assessed at finer scales of classification (e.g., Systems or Groups, rather than Formations).

Apply To: All types (variant differs by patchy type). Not used for point-based, fixed area AAs.

Measurement Protocol:

(1) Determine Spatial Size. It is important to know the spatial pattern typical of the wetland type being assessed (Table 38). This should be based on knowledge of the typical sizes of mid- to broad-scale ecological types (Formations, Groups, Systems) found in excellent condition. Table 41 shows the patterns for New Jersey wetland types.

Table 38. Patch type definitions that characterize the spatial patterning of ecosystems (ecological community and system types) (Comer et al. 2003).

PATCH TYPE	DEFINITION
Matrix	Ecosystems that form extensive and contiguous cover, occur on the most extensive landforms, and typically have wide ecological tolerances. Disturbance patches typically occupy a relatively small percentage (e.g., < 5%) of the total occurrence. In undisturbed conditions, **typical occurrences range in size from 2,000–10,000 ha (100 km^2) (5000 – 25,000 ac) or more.**
Large Patch	Ecosystems that form large areas of interrupted cover and typically have narrower ranges of ecological tolerances than matrix types. Individual disturbance events tend to occupy patches that can encompass a large proportion of the overall occurrence (e.g., > 20%). Given common disturbance dynamics, these types may tend to shift somewhat in location within large landscapes over time spans of several hundred years. In undisturbed conditions**, typical occurrences range from 50–2,000 ha (125-5,000 ac).**
Small Patch	Ecosystems that form small, discrete areas of vegetation cover, typically limited in distribution by localized environmental features. In undisturbed conditions, **typical occurrences range from 1–50 ha (3 – 125 ac).**
Linear	Ecosystems that occur as linear strips. They are often ecotonal between terrestrial and aquatic ecosystems. In undisturbed conditions**, typical occurrences range in linear distance from 0.5–100 km (1 – 60 mi).**

(2) Rate Size As Informed by Patch Type**.** Use Table 41 to assign a Spatial Pattern Size Metric Rating based on the wetland's patch type. Compare this to the Comparative Size Metric Rating from Table 39. Essentially, the rating from Table 41 is the same as Table 39.

For fragmented occurrences made up of several disjunct AAs, the Comparative Size Metric is scored based on the aggregate of all AAs AND the single largest one. If these are different, assign a range rating (e.g. if the aggregate results in a 'B' rating but the largest patch would only receive a 'C' rating on its own, the resulting rating is 'BC'; if they both come out as 'B', then the overall score is also 'B'.

Table 39. Comparative Size Metric Rating: Comparative.

Metric Rating	*Comparative Size: ALL WETLANDS*
EXCELLENT (A)	Very large size compared to other examples of the same type, based on current and historical spatial patterns (and meeting the requirements for all, or almost all, of the area-sensitive indicator species dependent on the system, if within range)
GOOD (B)	Large size compared to other examples of the same type, based on current and historical spatial patterns (and not meeting the requirements for some of the area-sensitive indicator species; i.e., they are likely to be absent, if within range[1]).

Metric Rating	*Comparative Size: ALL WETLANDS*
FAIR (C)	Medium to small size compared to other examples of the same type, based on current and historical spatial patterns (and not meeting the requirements for several to many of the area-sensitive indicator species, if within range[1]).
POOR (D)	Small to very small size, based on current and historical spatial patterns (and not meeting the requirements for most to all area-sensitive indicator species, if within range[1]).

[1] if known, record the area-dependent species that are missing.

SIZ2 Change in Size (optional)

Definition: A measure of the current size of the wetland divided by the historical wetland size (within most recent period of intensive settlement, or 200 years), multiplied by 100.

Background: This metric is one aspect of the size of specific occurrences of a wetland type, it assesses the relative proportion of the AA that has been converted or destroyed compared to its original extent.

Apply To: All types (variant differs by patchy type). Not used for point-based, fixed area AAs.

Measurement Protocol: Relative size can be measured in GIS using aerial photographs, orthophoto quads, National Wetland Inventory maps, or other data layers. Field assessments of current size may be required since it can be difficult to discern the historical area of the wetland from remote sensing data. However, use of old aerial photographs may also be helpful, as they may show the historical extent of a wetland. Relative size can also be estimated in the field using 7.5 minute topographic quads, NPS Vegetation maps, National Wetland Inventory maps, or a global positioning system. Wetland boundaries are not delineated using jurisdictional methods (U.S. Army Corps of Engineers 1987); rather, they are delineated by ecological guidelines for delineating the boundaries of the wetland type, based on a standard wetland classification. The definition of the "historical" timeframe will vary by region, but generally refers to the intensive Euro-American settlement that began in the 1600s in the eastern United States and extended westward into the 1800s. If the historical time frame is unclear, use a minimum of a 50-year time period--long enough to ensure that the effects of wetland loss are well-established and the wetland has essentially adjusted to the change in size. Assign the rating based on Table 40.

Table 40. Change in Size Metric Rating

Metric Rating	*Change in Size: ALL WETLANDS*
EXCELLENT (A)	Occurrence is at, or only minimally reduced[1] (< 5%) from its original, natural extent. See note below for interpretation of "reduction."
GOOD (B)	Occurrence is only somewhat reduced (5-10%) from its original natural extent.
FAIR (C)	Occurrence is modestly reduced (10-30%) from its original natural extent.
POOR (D)	Occurrence is substantially reduced (> 30%) from its original natural extent.

[1]Note: Reduction in size for metric ratings A-D may include conversion or disturbance (e.g., changes in hydrology due to roads, impoundments, development, human-induced drainage; or changes caused by recent cutting). Assigning a metric rating depends on the degree of reduction.

Table 41. Spatial Pattern Size Metric Rating: Area by Spatial Pattern of Type.

Metric Rating	*COMPARATIVE SIZE BY PATCH TYPE (hectares)*					
Spatial Pattern Type	**Large Patch (ha)** No large patch wetlands are known to occur in New Jersey.	**Medium-Small Patch (ha)** (salt marsh, intertidal)	**Small Patch (ha)** (forested/shrub swamp, greasewood flat; marsh/meadow, peatland, aquatic bed, playa, interdunal, mudflat, and eelgrass)	**Very Small Patch (m^2)** (seep/spring, horizontal wet sparse, vernal pool)	**Very Small Patch (m)** (vertical wet sparse)	**Linear (length in km)** (riparian)
EXCELLENT (A)	> 125	> 50	> 10	> 300 m^2	> 20 m high	> 5 km
GOOD (B)	25-125	10-50	2-10	200-300 m^2	10-20 m high	1-5 km
FAIR (C)	5-25	2-10	0.5-2	100-200 m^2	5-10 m high	0.1-1 km
POOR (D)	< 5	< 2	0.5	< 100 m^2	< 5 m high	< 0.1 km

OR

Metric Rating	*COMPARATIVE SIZE BY PATCH TYPE (acres)*					
Spatial Pattern Type	**Large Patch (ac)** No large patch wetlands are known to occur in New Jersey.	**Medium-Small Patch (ac)** (salt marsh, intertidal)	**Small Patch (ac)** (forested/shrub swamp, greasewood flat; marsh/meadow, peatland, aquatic bed, playa, interdunal, mudflat, and eelgrass)	**Very Small Patch (m^2)** (seep/spring, horizontal wet sparse, vernal pool)	**Very Small Patch (m)** (vertical wet sparse)	**Linear (length in km)** (riparian)
EXCELLENT (A)	> 300	> 125	> 25	> 300 m^2	> 20 m high	> 3 mi
GOOD (B)	60-300	25-125	5-25	200-300 m^2	10-20 m high	0.6-3 mi
FAIR (C)	12-60	5-25	1-5	100-200 m^2	5-10 m high	0.06-0.6 mi
POOR (D)	< 12	< 5	1	< 100 m^2	< 5 m high	< 0.06 mi

4.0 Calculate EIA Score and Determine Wetland of High Conservation Value Status.

4.1 Ecological Integrity Assessment Scorecard

The major components of the EIA include three primary rank factors (landscape context, on-site condition, and size) which are subdivided into six major ecological factors of landscape, buffer, vegetation, hydrology, soils, and size. Together these are the components that capture the structure, composition, processes, and connectivity of an ecological system. Whether one needs to roll up scores is dependent on the project objective. Land managers may only be interested in the metric scores, as they provide insight into management needs, goals, and measures of success. On the other hand, if the goal is to compare or prioritize sites for conservation, restoration, or management actions, then an overall EIA score/rank may be needed. Primary and major ecological factor scores/ranks can be helpful for understanding current status of primary ecological drivers. Details on the scorecard are provided in Faber-Langendoen et al. (2016b).

Landscape context metrics address the "outer workings" while on-site condition metrics measure the "inner workings" of a wetland. A third primary rank factor, the size of an ecosystem patch or occurrence, helps to characterize patterns of diversity, area-dependent species, and resistance to stressors. Addressing all of these characteristics and processes will contribute not only to understanding the current levels of ecological integrity, but to the resilience of the ecosystem in the face of climate change and other global stressors.

A point-based approach is used to facilitate integration of metrics into an overall rating. Undue emphasis should not be placed on numerical scoring--it is the overall rating that matters. Although metric ratings and scores are primarily based on a four part scale (Table 9), when two or more metrics are used to score a major ecological factor, a 7-part scale (A+, A-, B+, B-, C+, C-, D) can be informative. A "rounded" 4 part scale (A, B, C, D) can still be applied (Table 42).

Table 42. Ratings and Points for Ecological Integrity, Primary Rank Factors, and Major Ecological Factors.

EIA and Factor Rating*	*7 Part Scale*	*Metric Rating*	*4 Part Scale*
A+	3.8 - 4.00	A (Excellent)	3.5 - 4.0
A-	3.5 - 3.79		
B+	3.0 - 3.49	B (Good)	2.5 - 3.49
B-	2.5 - 2.99		
C+	2.0 - 2.49	C (Fair)	1.5 - 2.49
C-	1.5 - 1.99		
D	1 - 1.49	D (Poor)	1.0 - 1.49

*This scale is applied to the overall EIA, as well as Primary Rank Factors and Major Ecological Factors.

4.2 Calculate Major Ecological Factor (MEF) Scores and Ratings

Below are instructions on how to calculate each Major Ecological Factor score. Once scores are calculated, their associated ratings can be found Table 43.

Table 43. Conversion of Major Ecological Factor Scores/Ratings

Score/Rating Conversions for Major Ecological Factors							
Rank	A+	A-	B+	B-	C+	C-	D
Score	3.8 - 4.00	3.5 - 3.79	3.0 - 3.49	2.5 - 2.99	2.0 - 2.49	1.5 - 1.99	1 - 1.49

4.2.1 Landscape Context MEF Score/Rating

To calculate the Landscape Context MEF score, take the average of LAN1 and LAN2 metrics. Enter the score and associated rating on the field form.

4.2.2 Buffer MEF Score/Rating

The Buffer MEF score is calculated by first taking the geometric mean of BUF1 and BUF2 scores. Then the geometric mean of that result and BUF3 is used as the Buffer MEF score. A geometric mean gives greater weight to the lower of the two values. Enter the score and associated rating on the field form.

4.2.3 Vegetation MEF Score/Rating

For non-forested wetland types, the Vegetation MEF score is calculated by taking the average of VEG1+VEG2+VEG3+VEG4. Enter the score and associated rating on the field form.

For forested wetland types, Vegetation MEF score is calculated by taking the average of VEG1+VEG2+VEG3+VEG4+VEG5+VEG6. Enter the score and associated rating on the field form.

If VEG3 was not scored due to lack of expertise—or interpretation difficulties—take the average of the appropriate remaining vegetation metrics.

4.2.4 Hydrology MEF Score/Rating

The Hydrology MEF score is calculated by taking the average of HYD1+HYD2+HYD3. Enter the score and associated rating on the field form.

4.2.5 Soils MEF Score/Rating

The Soil MEF score is simply the score for SOI1. Enter the score and associated rating on the field form.

4.2.6 Size MEF Score/Rating

The Size MEF score is either simply the score for SIZ1 or, if also using SIZ2, then the average of SIZ1 and SIZ2. Enter the score and associated rating on the field form.

4.3 Calculate Primary Factor Scores

Below are instructions on how to calculate each of Primary Factor score. Once scores are calculated, their associated ratings can be found in Table 46.

Table 44. Conversion of Primary Factor Scores/Ratings

Score/Rating Conversions for Primary Factors							
Rank	A+	A-	B+	B-	C+	C-	D
Score	3.8 - 4.00	3.5 - 3.79	3.0 - 3.49	2.5 - 2.99	2.0 - 2.49	1.5 - 1.99	1 - 1.49

4.3.1 Landscape Context Primary Factor Score/Rating

The Landscape Context Primary Factor score is calculated by the following formula: (Buffer MEF score*0.77) + (Landscape Context MEF score*0.33). Enter the score and associated rating on the field form.

4.3.2 Condition Primary Factor Score/Rating

The Condition Primary Factor score is calculated by the following formula: (Vegetation MEF score*0.55) + (Hydrology MEF score*0.35) + (Soil MEF score*0.10). Enter the score and associated rating on the field form. If VEG3 was not scored, make an explicit note that the Condition Primary Factor Score does not include VEG3.

4.3.3 Size Primary Factor Score/Rating

The Size Primary Factor score is equivalent to the Size MEF score. Enter the score and associated rating on the field form.

4.4 Calculate Overall Ecological Integrity Assessment Score/Rating

The overall Ecological Integrity Assessment (EIA) score is calculated using only Landscape Context and Condition Primary Factor scores with the following formula: (Condition Primary Factor score*0.7) + (Landscape Context Primary Factor score*0.3). The associated rating for the score is found in Table 45. Enter the score and associated rating on the field form. If VEG3 was not scored, make an explicit note that the EIA Score does not include VEG3.

Table 45. Conversion of Overall Ecological Integrity Assessment Scores/Ratings

Score/Rating Conversions for Overall Ecological Integrity							
Rank	A+	A-	B+	B-	C+	C-	D
Score	3.8 - 4.00	3.5 - 3.79	3.0 - 3.49	2.5 - 2.99	2.0 - 2.49	1.5 - 1.99	1 - 1.49

Size is not used for the EIA score, as the role of patch size in assessing ecological integrity is not as straightforward as landscape context and condition. For some ecosystem types, patch size can vary widely for entirely natural reasons (e.g., a forest type may have very large occurrences on rolling landscapes, and be restricted in other landscapes to small occurrences on north slopes or ravines). Thus, smaller sites are not necessarily a result of degradation in ecological integrity. On the other hand, size overlaps with landscape context as a factor, where the more fragmented the landscape surrounding a wetland is, the more size becomes important in reducing edge effects or buffering the overall stand.

Thus, whereas from an EIA rating perspective, we can develop vegetation, soil, hydrology, and landscape metric ratings based on ecological considerations (e.g., we can establish the ecological criteria for which buffers are effective), it is harder to do so for size. Instead, Size is used as an additional factor to help prioritize sites for conservation actions (see below).

4.5 Calculate The Element Occurrence Rank

Ecological Integrity Assessment (EIA) scores and Element Occurrence Ranks (EORANKS) are closely related. The EIA score provides a succinct assessment of the current ecological condition and landscape context of a wetland. For conservation purposes, we often want to do more than that; namely, we want to establish its conservation value. The Element Occurrence (EO) is a core part of Natural Heritage Methodology and is defined as follows:

> *An **Element Occurrence** (EO) is an area of land and/or water in which a species or ecosystem (natural community, vegetation type or Ecological System) element is, or was, present. An EO should have practical conservation value for the Element as evidenced by potential continued (or historical) presence and/or regular recurrence at a given location. For ecosystem types ("elements"), the EO may represent a single stand or patch or a cluster of stands or patches of an ecosystem. (NatureServe 2002).*

In the context of this document, an EO is a stand of a wetland Subgroup or USNVC plant association. Thus, the EORANK is important for determining whether a site meets the Wetland of High Conservation Value criteria (see below).

For the EORANK approach, EIAs are foundational, but more is needed to determine the practical conservation value for an ecosystem. In particular, size plays a more substantial role in the EORANK process than in other applications of EIAs. This is because for many conservation purposes, larger observations are considered more important and more likely to retain their integrity than smaller observations. For some types, diversity of animals or plants may be higher in larger occurrences than in smaller occurrences that are otherwise similar. Larger occurrences often have more microhabitat features and are more resistant to hydrologic stressors or invasion by exotics, because they buffer their own interior portions. Thus, size can serve as a readily measured proxy for some ecological processes and for the diversity of interdependent assemblages of plants and animals. Even here, caution is needed, for although size helps identify higher diversity sites, higher diversity *per se* is not always tied to ecological integrity (i.e., sites vary naturally with respect to levels of diversity and size).

To calculate EORANK, points are added to the EIA score based on the wetland's patch size (Table 41) and Size Primary Factor rating (Table 46). The associated rating for the score is found in Table 47. Enter the score and associated rating on the field form. If VEG3 was not scored, make an explicit note that the EORANK Score does not include VEG3.

Table 46. Point Contribution of Size Primary Factor Score

Size Primary Factor Rating	Very Small/Small Patch	Large Patch	Matrix
A = Size meets A ranked rating	+ 0.75	+ 1.0	+1.5
B = Size meets B ranked rating	+ 0.25	+ 0.33	+0.5
C = Size meets C ranked rating	- 0.25	- 0.33	-0.5
D = Size meets D ranked rating	- 0.75	-1.0	-1.5

Table 47. Conversion of EORANK Scores/Ratings

Score/Rating Conversions for EORANK							
Rank	A+	A-	B+	B-	C+	C-	D
Score	3.8 - 4.00	3.5 - 3.79	3.0 - 3.49	2.5 - 2.99	2.0 - 2.49	1.5 - 1.99	1 - 1.49

4.6 Determine Wetland of High Conservation Value Status

Using the conservation status rank and the EORANK of the AA, refer to Table 48 to determine whether the wetland meets the Wetland of High Conservation criteria.

Table 48. Decision Matrix to Determine Ecosystem Element Occurrences

<table>
<tr><th rowspan="2">Global / State Conservation Status Rank Combination</th><th colspan="4">Ecological Integrity Assessment Rank</th></tr>
<tr><th>A+ or A-
Excellent
Integrity</th><th>B+ or B-
Good
Integrity</th><th>C+
Fair
Integrity</th><th>C- or D
Poor
Integrity</th></tr>
<tr><td>G1S1, G2S1,
GNRS1, GUS1</td><td style="background:red"></td><td style="background:red"></td><td style="background:red"></td><td style="background:red"></td></tr>
<tr><td>G2S2, GNRS2,
G3S1, G3S2, GUS2</td><td style="background:red"></td><td style="background:red"></td><td style="background:red"></td><td></td></tr>
<tr><td>GUS3, GNRS3, G3S3, G4S1,
G4S2, G5S1, G5S2, any SNR</td><td style="background:red"></td><td style="background:red"></td><td></td><td></td></tr>
<tr><td>G4S3, G4S4, G5S3, G5S4, G5S5,
GNRS4, GNRS5, GUS4, GUS5</td><td style="background:red"></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Red Shading = Element Occurrence</td></tr>
</table>

4.7 Using EIA for Wetland Mitigation

The EIA, as presented in this document, is intended to help identify high quality reference condition wetlands or for non-regulatory or proactive conservation, restoration, or management actions. If using EIA for regulatory activities such as wetland mitigation, the ways in which landscape context and size metrics affect mitigation transactions require careful consideration. Consultation with the New Jersey Department of Environmental Protection (NJDEP), Office of Natural Lands Management, , Natural Heritage Program and/or the NJDEP Watershed and Land Management, Mitigation Unit, is strongly recommended before employing EIA in regulatory contexts.

5.0 Stressor Checklist

A stressor is an anthropogenic perturbation within the AA or surrounding landscape that can negatively affect the condition and function of the wetland. Stressors are *direct threats* and are further defined as "the proximate (human) activities or processes that have caused, are causing, or may cause the destruction, degradation, and/or impairment of biodiversity and natural processes." Identifying stressors within the AA or its buffer can help determine causes of the AA's degradation. Stressors may be characterized in terms of ***scope*** and ***severity***. Scope is defined as the proportion of the AA that can reasonably be expected to be affected by the stressor with continuation of current circumstances and trends. Severity is the degree of degradation within the scope from the stressor, which can reasonably be expected with continuation of current circumstances and trends.

Step 1 Rate Scope and Severity of Stressors: Stressors are rated if they are observed or inferred to occur, but are not assessed if they are projected to occur in the near term, but do not yet occur. Record and estimate the scope and severity of applicable stressors (Table 49) in the AA or its buffer. Things to consider when filling out the form:

- Stressor checklists must be completed for all 4 categories (Buffer, Vegetation, Soils/Substrate, and Hydrology).
- Buffer perimeter is the entire perimeter **around the AA,** up to a distance of 100 m. Rely on imagery in combination with what you can field check.
- Assess buffer perimeter stressors and their effects within the buffer perimeter itself (**NOT how buffer stressors may impact the AA**).
- Stressors for Vegetation, Soils, and Hydrology are assessed across the AA.
- Some stressors may overlap (e.g., 10 [low impact recreation] may overlap with 26 [indirect soil disturbance]); choose the one with the highest impact and note overlap.
- Stressors are rated if they are observed or inferred to occur in the present (i.e., within a 10 year timeframe), or occurred anytime in the past with effects that persist into the present.

Step 2 Determine Impact Rating of Each Stressor: The impact rating of each stressor is based on the combination of its scope and severity score (Table 50). Enter the corresponding impact rating score in the "Impact" cell for each stressor. If no stressors are present or their impact is presumed to be minimal, check the appropriate box on the stressor form.

Step 3 Determine Overall Stressor Impact Rating for Stressor Categories: For each category (i.e. Buffer, Vegetation, Hydrology, and Soils), sum the total impact scores and enter the corresponding impact rating and point value (Table 51) in the appropriate cell at the bottom of the field form. For example, if the summed impact scores across all stressors in the Buffer category is 8, then the impact rating is "High" with a corresponding point value of 3.

Step 4 Determine Human Stressor Impact (HSI) Rating for AA: Next, using the algorithms on the field form, calculate overall impact scores based on each stressor category's impact points. HSI scores are calculated for three different metrics: (1) Total HSI (all stressor categories are used); (2) Onsite HSI (Buffer stressors are excluded); and (3) Abiotic HSI (Vegetation stressors are excluded). HSI scores can be converted to a rating using Table 52.

Table 49. Stressor Scoring Categories.

Assess for up to next 20 yrs.	Threat Scope (% of AA affected)	Assess for up to next 20 yrs.	Threat Severity within the Scope (degree of degradation of AA)
1 = Small	Affects a small (1-10%) proportion	1 = Slight	Likely to only slightly degrade/reduce
2 = Restricted	Affects some (11-30%)	2 = Moderate	Likely to moderately degrade/reduce
3 = Large	Affects much (31-70%)	3 = Serious	Likely to seriously degrade/reduce
4 = Pervasive	Affects most or (71-100%)	4 = Extreme	Likely to extremely degrade/destroy or eliminate

Table 50. Stressor Impact Ratings.

Stressor Impact Calculator		Scope			
		Pervasive	Large	Restricted	Small
Severity	Extreme	Very High=10	High=7	Medium=4	Low=1
	Serious	High=7	High=7	Medium=4	Low=1
	Moderate	Medium=4	Medium=4	Low=1	Low=1
	Slight	Low=1	Low=1	Low=1	Low=1

Table 51. Conversion of Total Impact Scores to Stressor Category Ratings/Points.

STRESSOR RATING Summary for Categories	Sum of Stressor Impact Scores	Stressor Rating	Pts
1 or more Very High, **OR** 2 or more High, **OR** 1 High + 1 or more Medium **OR** 3 or more Medium	10+	Very High	4
1 High, **OR** 2 Medium **OR** 1 Medium + 3 or more Low	7 – 9.9	High	3
1 Medium + 1-2 Low **OR** 4 -6 Low	4 – 6.9	Medium	2
1 to 3 Low	1 – 3.9	Low	1
0 stressors	0 – 0.9	Absent	0

Table 52. Conversion of Human Stressor Index (HSI) Scores to Ratings.

HSI Score	HSI Site Rating
3.5-4.0	Very High
2.5-3.4	High
1.5-2.4	Medium
0.5-1.4	Low
0.0-0.4	Absent

Release Notes

- v1.0 - November 16, 2016
    - Initial release
- v1.1 - October 2020
    - Fixed some minor formatting issues; clarified that BUF3 references to "water quality" also apply to general hydrologic integrity.
- v1.2 – January 2022
    - Tweaked metric language for VEG6 v1 and added submetrics to VEG6 v2
    - Added text to introduction encouraging users to read foundational EIA documents in order to understand the assumptions inherent in the method.
    - Made explicit that clearcut harvests should be treated as non-natural land cover until they have revegetated.
    - Removed "vegetated levees" from natural land cover.
    - Added guidance for how to calculate roll-up scores with missing metric ratings.
- V1.2 (NJ) – November 2022
    - The New Jersey manual was adopted from the Washington Department of Natural Resources, Natural Heritage Program EIA manual Version 1.2. Only minor changes were made to make the manual geographically relevant.

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Appendix A

USNVC Wetland Ecological Groups* in New Jersey		2022 Global Rarity Rank	ECOREGIONS IN NJ				
			67	58	64	84	63
FLOODED & SWAMP FOREST							
Floodplain Forest Groups							
G653	Silver Maple - Green Ash - Black Ash Floodplain Forest	G4	67	58			
G673	Silver Maple - American Sycamore - Sweetgum Floodplain Forest	G4	67	58			
G034	Swamp Chestnut Oak – Laurel Oak – Sweetgum Floodplain Forest	G4	67	58	64		
G759	Green Ash - American Elm - Black Willow Floodplain Forest	G3	67	58	64		
Swamp Forest Groups							
G046	Northern White-cedar - Black Ash - Red Maple Swamp Forest Group	G4	67	58			
G045	Red Maple - Red Spruce - Eastern Hemlock Swamp	G4	67	58			
G667	Northeastern Forest Vernal Pool	G3	67	58	64	84	63
G902	Red Maple - Blackgum - Green Ash Swamp Forest	G4	67	58			
G918	Red Maple - Black Ash - Swamp White Oak Swamp Forest	G3	67	58			
G039	Atlantic White-cedar - Pitch Pine Swamp	G3				84	63
FRESHWATER MARSH, WET MEADOW & SHRUB SWAMP							
Marsh, Wet Meadow & Shrub Swamp Groups							
G125	Bulrush species - Cattail species Freshwater Marsh	G4	67	58	64	84	63
G903	Appalachian-Northeast Wet Meadow & Shrub Swamp	G4	67	58	64	84	63
G904	Laurentian-Acadian Wet Meadow & Shrub Swamp	G4		58			
G925	Gray Alder / Prairie Cordgrass - Tufted Hairgrass Riverscour Vegetation	G3	67	58			
G755	Eastern North American Scrub & Herb Riverbed Wetland	G4	67	58	64		
G756	Eastern North American Wet Shoreline Vegetation	G4	67	58	64	84	63
G752	North Atlantic Coastal Interdunal Wetland	G2				84	
G915	Beaksedge - Spikerush - Yellow-eyed-grass species Pondshore & Wet Prairie	G3				84	63
G916	Beaksedge species - Spikerush species - Meadowbeauty species Pondshore	G3				84	63
Headwater Seep							
G189	Tawny Cottongrass - Jewelweed species - Skunk-cabbage Seep	G4	67	58	64		
Freshwater Tidal Marsh							
G914	Annual Wild Rice - Saltmeadow Cordgrass - Tidal-marsh Amaranth Freshwater Tidal Marsh	G4			64	84	63
Freshwater Aquatic Vegetation							
G114	American White Water-lily - Sago Pondweed - Pondweed species Freshwater Aquatic Vegetation	G4	67	58	64	84	63
BOG & FEN							
G1171	Leatherleaf- Dwarf Huckleberry / Walter's Sedge Bog & Fen	G3				84	63
G1172	Leatherleaf - Few-seed Sedge - Bog Laurel Eastern Boreal Bog & Acidic Fen	G4	67	58			
G805	Central Appalachian-Northeast Alkaline Fen	G3	67	58			
G804	Shrubby-cinquefoil - Woolly-fruit Sedge Eastern Boreal Alkaline Fen	GNR	67	58			
SALT MARSH							
G959	North Atlantic Brackish Tidal Marsh (formerly G123)	GNR			64	84	63
G957	North Atlantic Salt Marsh (formerly G120, G121, G122)	GNR			64	84	63

*Wetland Groups of High Conservation Value (Global Rarity Ranks of G1, G2, G3) are highlighted in Red. Note that finer scale floristic Alliances and Associations within each Group have additional Global and State Rarity Ranks. For an explanation of ranking see Definitions of NatureServe Conservation Status Ranks. For descriptions of Wetland Group, Alliance, and Association see "A Guide to Wetland Types in New Jersey with Ecoregional Floristic Quality Assessment Metrics" (Walz et al. 2022).

NJ Ecoregion Map for Wetland Groups