# EPA LEVEL II RAPID ASSESSMENT METHOD FOR NEVADA WETLANDS

## Field Manual

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# EPA Level II Rapid Assessment Method for Nevada Wetlands Field Manual (Draft)

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Based on NatureServe's Ecological Integrity Assessment Framework, as adapted by the Colorado Natural Heritage Program and the Wyoming Natural Diversity Database.

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# TABLE OF CONTENTS

TABLE OF CONTENTS ..... 4
List of Figures ..... 6
List of Tables ..... 6
SECTION 1: INTRODUCTION ..... 7
1.1 Purpose of the Nevada Wetland Rapid Assessment Method ..... 7
1.2 Nevada Wetland Rapid Assessment Method Development ..... 8
1.3 Assessing Wetland Ecological Condition and Integrity versus Wetland Function ..... 10
1.4 Targets of NV Wetland RAM ..... 11
1.5 Wetland Classification ..... 12
SECTION 2: APPLYING THE NV WETLAND RAPID ASSESSMENT METHOD ..... 13
2.1 Assessment Design: Desktop Assessment and Preparing for the Field ..... 14
2.2 Defining an Assessment Area (AA) ..... 15
2.3 Establishing the Assessment Area ..... 15
2.3.a. Assessment Areas for Targeted Sampling ..... 15
2.3.b. Assessment Areas for Random Sampling ..... 16
2.3.c. General Principles ..... 16
2.3.d. AA Layout Protocol in Brief ..... 17
2.3.e. Standard AA Layout – 40 m radius circle ..... 18
2.3.f. Alternate AA Layout 1 – Rectangle ..... 20
2.3.g. Alternate AA Layout 2 – Freeform shape ..... 20
2.4 Describing the Assessment Area (AA) ..... 22
2.4.a. Location and General Information ..... 23
2.4.b. Assessment Area and GPS Coordinates ..... 23
2.4.c. Classification of the Assessment Area ..... 26
2.5. Assessment Area Drawing and Description ..... 26
2.6 Soil Profile Description- Soil Pit Protocol ..... 27
2.6.a. Soil Profile Description ..... 28
2.6.b. Soil Pit Water Table and Chemistry ..... 29
2.7 Water Chemistry Sampling (for Soil Pits and General Water Chemistry Measurements) ..... 30
2.8. General Animal Observations ..... 30

2.9 Vegetation Sampling Protocols ........ 31
2.9.a. Vegetation Species List ........ 31
2.9.b. AA Cover Classes and Litter Descriptions ........ 31
2.10 Post-Assessment Activities ........ 32
2.10.a. In Field Activities ........ 32
2.10.b.In Office ........ 33
SECTION 3: Future Work and Recommendations ........ 34
3.1 Validate, finalize, and training on Nevada Rapid Assessment Method ........ 34
3.2 Develop full Ecological Integrity Assessment ........ 34
REFERENCES ........ 36
APPENDICES
Appendix A. Cowardin Systems, Classes, and Water Regime and Special Modifiers........40
Appendix B. Field Key to the Hydrogeomorphic (HGM) Classes of Wetlands........43
Appendix C. Wetland Types in Nevada's Great Basin, Eastern Sierras, and Mojave........44
Appendix D. Simplified Key to Soil Texture........51
Appendix E. Notes on Hydric Soil Indicators for the Mountain West........52
Appendix F. Nevada Wetland RAM Field Equipment and Supplies List........56
Appendix G. Nevada Wetland RAM Expert Engagement Summary........58
Appendix H. Sample Level 1 Nevada Wetland Analysis Toolbar Report........61
Appendix I. Nevada Wetland Rapid Assessment Method Data Sheets........75

# List of Figures

Figure 1. USEPA National Wetlands Monitoring Level 1, 2, and 3 Assessment Definitions

Figure 2. Nevada RAM Decision Matrix

Figure 3. Assessment Area Standard 40 m Radius Layout

Figure 4. Assessment Area Rectangular Layout

Figure 5. Assessment Area Freeform Layout

Figure 6. Example AA Photo Placard

Figure 7. Example Assessment Area Drawing, Setting, and Surrounding Landscape Description

Figure 8. Example Soil Profile Description Procedure

# List of Tables

Table 1. Example EIA Scores, Ranks and Associated definitions from WYNDD

Table E1. Comparison of indicators with depleted matrices and redox features

# List of Acronyms

| | |
|---|---|
| AA | Assessment Area |
| CNHP | Colorado Natural Heritage Program |
| DRI | Desert Research Institute |
| EIA | Environmental Integrity Assessment |
| GIS | Geographic Information System |
| GPS | Geographic Positioning System |
| NNHP | Nevada Natural Heritage Program |
| NV RAM | Nevada Rapid Assessment Method |
| NWI | National Wetland Inventory |
| m | meter |
| RMRS | Rocky Mountain Research Station |
| TNC | The Nature Conservancy |
| USDA-FS | United States Department of Agriculture Forest Service |
| USEPA | United States Environmental Protection Agency |
| WPP | Wetland Program Plan |
| WYNDD | Wyoming Natural Diversity Database |

# SECTION 1: INTRODUCTION

***Disclaimer:*** *The Nevada Wetland Rapid Assessment Method (NV RAM) should be considered in draft form until additional resources are secured to finalize the protocol. The "[Nevada Natural Heritage Program] NNHP Wetland Protection Development-Data Mapping, Management and Springsnail Conservation Grant- 99T65201" advanced the protocol to the assemblage of the method and initial field verification phases. The following additional phases are required to finalize the protocol: verify the ability of the method to distinguish between wetlands along a continuum of conditions; calibrate and validate the method against sets of quantitative data representing more intensive measures of wetland condition; and implement the method through outreach and training of the intended users (Sutula et al., 2006).*

The Nevada Wetland Rapid Assessment Method (NV RAM) is a *draft* assessment protocol developed under the U.S. Environmental Protection Agency (USEPA) National Wetlands Monitoring Workgroup's Level 1, 2 and 3 approach to wetland monitoring (USEPA, 2019). The NV RAM Level 2 assessment approach measures overall wetland condition with an emphasis on biological integrity and is based on other ecological integrity assessments (EIA) developed for the western United States (Lemly et al., 2016; Washoviak et al., 2018; USDA-FS, 2012). For the purposes of this manual, ecological integrity is defined as the structure, composition and function of an ecosystem operating within the bounds of natural or historic disturbance regimes, and the ability of an ecosystem to support and maintain a full suite of organisms with species composition, diversity, and function comparable to similar systems in an undisturbed state, which is similar to the definition provided by Lemly et al. (2016). Ecological integrity is typically assessed by measuring or quantifying certain aspects of wetland assemblages along with associated wetland attributes. The NV RAM uses quantitative vegetation metrics, plus physicochemical (i.e., soils and water quality) and biological data, to establish current ecological condition and is intended to be a method that can be performed by an experienced team of two people in four hours at one assessment area.

## 1.1 Purpose of the Nevada Wetland Rapid Assessment Method

The NV RAM was created to advance the strategies documented in the State of Nevada Wetland Program Plan, 2017-2022 (WPP), for improving Nevada wetland resource protection and restoration. Estimates suggest Nevada has lost (i.e., converted to another type of land cover or use) approximately 52% of its historic wetland acreage (NNHP, 2016). Despite the need by researchers and land managers for information to manage the state's water resources for various purposes, wetland data are decentralized with no single entity tracking the location, type (class) or condition of wetlands in Nevada, nor documenting the projects underway to protect, mitigate, or conserve these valuable natural resources. Responding to targeted stakeholder outreach, the primary impetus that guided the NV RAM development was the shared need of agencies for a cost-effective method for ambient wetland condition assessment within Nevada's hydrographic areas (i.e., groundwater administrative units) or within specific land management units (Appendix G- Nevada Assessment Expert Engagement Summary).

The field manual presented here is a product of a 2017 USEPA grant to NNHP entitled "Wetland Protection Development- Data Mapping, Management and Springsnail Conservation Grant- 99T65201" (NNHP, 2017; hereafter referred to as NNHP 2017 Project) and is intended to establish consistent methods for performing rapid assessments of Nevada wetlands to provide better knowledge of regional distribution and condition of wetland habitats across the state. Under this grant, the NV RAM development advanced to the field verification phase of RAM development (Sutula et al., 2006). Future phases of finalizing the NV RAM are included in Section 3. A final NV RAM could be used by land or resource managers to measure wetland ecological integrity, target sites for restoration or protection, track changes over time, or identify stressors. Where specific assessment methods are required for permitting, users should follow guidance provided by those programs to identify the appropriate assessment method.

In its current form, the NV RAM is a suitable tool for Level 2 wetland assessments. However, until resources are secured to advance it to the field validation phase, it should be considered in draft form.

## 1.2 Nevada Wetland Rapid Assessment Method Development

The wetland mapping and assessment efforts by The Nature Conservancy of Nevada (TNC) and the Desert Research Institute (DRI) were developed according to the USEPA National Wetlands Monitoring Workgroup Wetland Monitoring and Assessment guidance definitions for Level 1 and 2 assessments, which "breaks assessment procedures into a hierarchy of three levels that vary in intensity and scale, ranging from broad, landscape-scale assessments (known as Level 1 methods), rapid field methods (Level 2) to intensive biological and physicochemical measures (Level 3)" (USEPA, 2019; Figure 1). As laid out by the USEPA approach, the NV RAM Level 2 assessment is structured to be able to validate and possibly correct information generated by Level 1 assessments using DRI's Wetland Analysis Toolbar. While not addressed under this grant nor in this manual, a Level 3 biological assessment could be developed in the future. Several of the other existing assessment methods described in Section 1.4 include elements of a Level 3 assessment and could be considered for use in the interim.

DRI's Level 1 Wetland Analysis Toolbar is a *landscape assessment*, relying on coarse, landscape scale inventory information, gathered through remote sensing and stored in a geographic information system (GIS) format. The Level 1 assessment classifies wetlands according to information available through the National Wetland Inventory (NWI), the National Hydrography Dataset, and logical inferences from the amount of vegetation and frequency of flooding. An output of the DRI's product is a "Nevada Wetland Mapping Level 1 Report" that provides much of the information and data needed for the desktop-planning stage of the RAM, including tools to help infer a probable Assessment Area (AA) where the RAM will be focused and the times of year when the assessment will be most effective.

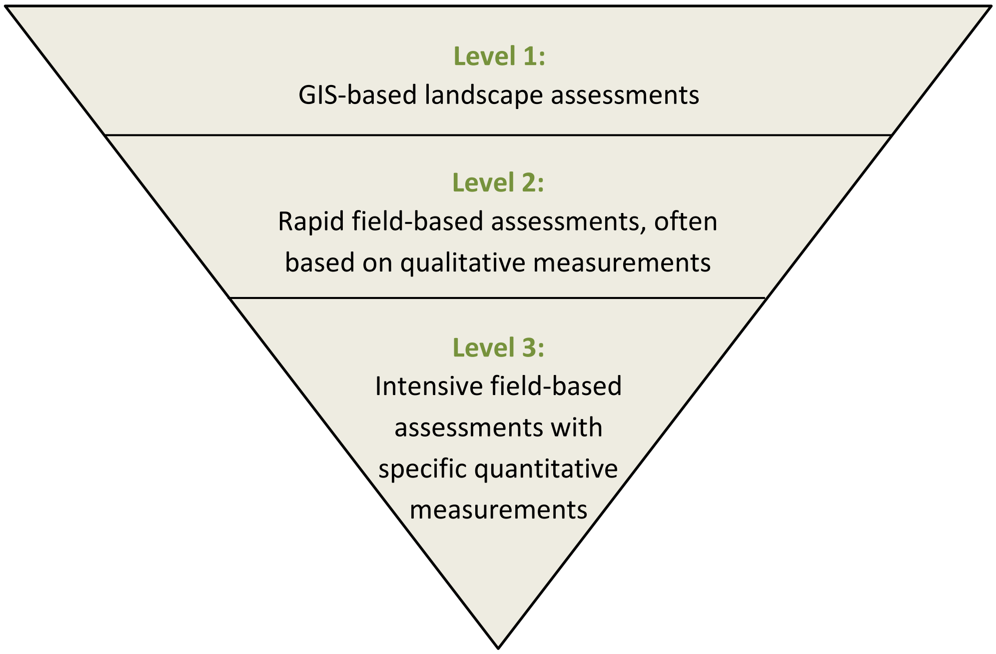



**Figure 1.** The USEPA National Wetlands Monitoring Workgroup Wetland Monitoring and Assessment guidance definitions for Level 1, 2, and 3 assessments (USEPA, 2019).

TNC's Level 2 NV RAM follows USEPA's Level 2 definition, as a "*rapid assessment* at the specific wetland site scale, using relatively simple, rapid protocols that are to be validated by and calibrated to Level 3 assessments" (USEPA, 2019). USEPA (2019) further notes that RAMs should "provide sound, quantitative information on the status of the wetland resource with a relatively small investment of time and effort."

The approaches recommended by Sutula et al. (2006) were applied for determining the most appropriate RAM for defined targets, as well as to help navigate the numerous considerations that inform RAM development. Development of the NV RAM involved engagement with wetland experts from Nevada and surrounding states to determine the appropriate approach, including identifying the RAM target applications and assessment endpoints for wetlands in Nevada. RAMs are by nature location-specific and often designed to meet specific agency management targets and there are many rapid assessment methods currently in use and under development in the region that overlaps with Nevada (Fennessy et al., 2004; Lemly et al., 2016; Collins et al., 2006; USDA-FS, 2012; Miller et al., TBD).

With the goal of developing a tool that establishes consistent methods for performing rapid assessments of Nevada wetlands and enables better knowledge of regional distribution and condition of wetland habitats across the state, the project team identified RAMs currently in use by federal or state agencies, and that covered specific ecoregions or wetland classes through extensive partner and stakeholder outreach throughout 2018 and 2019 (Figure 2,

Appendix G). The verification stage (i.e., testing to determine whether the proposed RAM accurately measures stated assessment endpoints, Sutula et al., 2006) was initiated by TNC and interested stakeholders at two wetlands in the Mojave Desert and four wetlands in the Great Basin in May and July 2019, respectively, as detailed in the Nevada Wetland RAM Expert Engagement Summary (Appendix G).

## 1.3 Assessing Wetland Ecological Condition and Integrity versus Wetland Function

The NV RAM is built upon the EIA Method framework shared by many Natural Heritage Program-inspired wetland assessment programs in the Intermountain West (Washkoviak et al., 2018; Lemly et al., 2016). The framework was initially developed in 2004 by ecologists from four state Natural Heritage Programs across the U.S., as well as NatureServe and TNC ecologists, and three major reports have been published by NatureServe on the EIA Framework (Lemly et al., 2016; Faber-Langendoen et al., 2008; 2012). EIA frameworks provide a rapid and repeatable evaluation of the wetland ecological condition and have recently been successfully refined to meet specific assessment endpoints and targets by wetland programs in Colorado and Wyoming (Washkoviak et al., 2018).

Ecological, or biotic, assessment approaches that underlie EIAs are top-down approaches that use biological response, such as characteristic biota, wetland functions, and wetland class to indicate elements of impairment (e.g., hydrology, water chemistry, etc.). Functional assessments are bottom-up approaches that use observations of ecosystem functions that generally fall within the categories of hydrology, biogeochemistry, or physical habitat (e.g., geomorphology, hydrodynamics, etc.) to infer impacts to biota (Lemly et al., 2016). A rapid assessment method focused on ecological, versus functional, condition aligns with the NNHP WPP goal of developing tools that will guide users to actions that maintain and enhance the wetland condition of Nevada's aquatic ecosystems, including wildlife and fish species (NNHP, 2016).

Sutula et al. (2006) stress the importance of articulating an assessment endpoint before initiating RAM development and suggests that an assessment endpoint can include assessment of wetland function, values, stressors, and other drivers of wetland condition. The NNHP WPP supports ecological integrity as the NV RAM assessment endpoint for wetland condition. Ecological integrity describes the ability of an ecosystem to support its structure, composition, and function within the bounds of natural or historic disturbance regimes, with high ecological integrity describing an ecosystem with complete structural components and ecological processes functioning optimally (Lemly et al., 2016). A RAM that establishes condition by way of EIA offers the ability to infer the impacts to basic physical drivers, and point to appropriate protection, restoration or mitigation actions. EIA can assess the degree to which, under current conditions, a system matches reference characteristics of similar systems with high ecological integrity (Lemly et al., 2016). The output of the NV RAM, as verified to date, is an indication of ecological integrity. Section 3 includes recommendations for developing the NV RAM into a full EIA tool.

## 1.4 Targets of NV Wetland RAM

The NNHP WPP (2016) provides guidance for the development of the NV RAM and infers the need for a single assessment endpoint that establishes basic condition for the various wetland classes occurring throughout the Sierra Nevada, Great Basin, Mojave Desert and Columbia Plateau Ecoregions that includes parts of Nevada (TNC, 1999a; 1999b; 2001a; 2001b).

Other RAMs have been adopted by agencies or are currently under development in Nevada that are tailored for groundwater dependent (USDA-FS, 2012) and riparian and wet meadow ecosystems and may better serve the specific needs of some agencies (Merritt et al., 2017; Miller et al., 2019). The NV RAM Decision Matrix (Figure 2) guides users to the most appropriate RAM for a particular landowner or agency, a specific topographic or hydrologic setting, target ecosystem, or regulatory need. Some agencies like the Bureau of Land Management use the Proper Functioning Condition  approach, but that approach is not included in Figure 2 because its level of detail is not equivalent to the USEPA Level 2 assessment. While several ecoregions span state lines, the NV RAM is intended for assessing wetlands in the Nevada portions of these ecoregions.

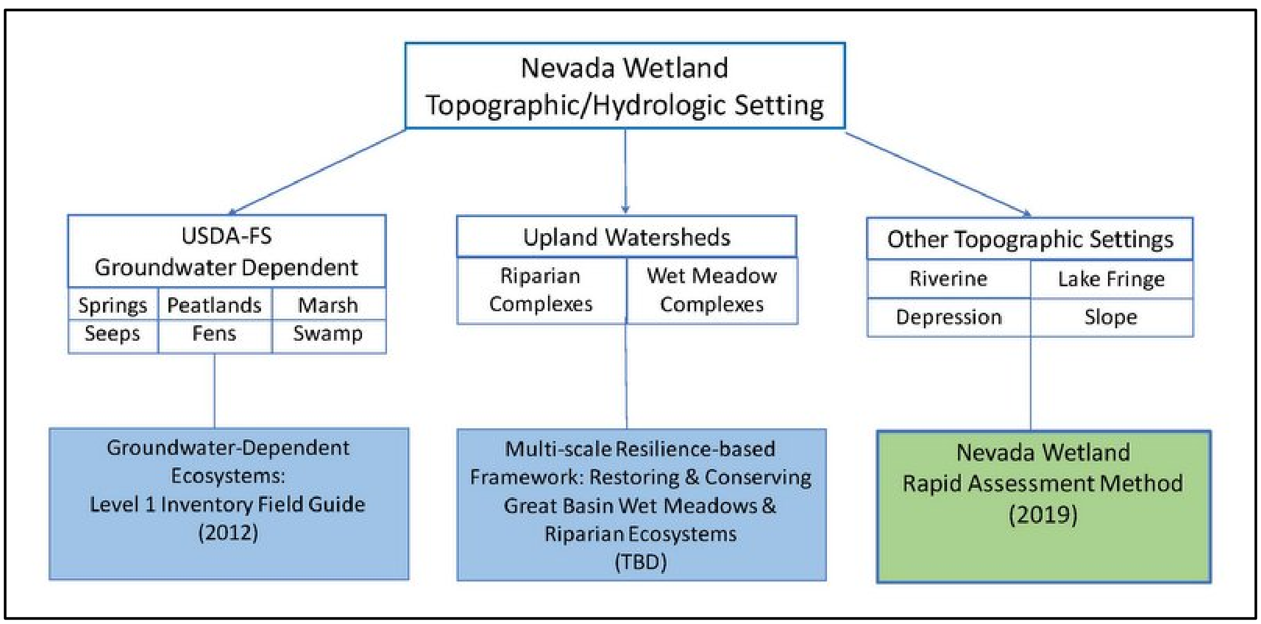



**Figure 2.** The NV RAM Decision Matrix. This NV RAM schematic guides users to the appropriate RAM for their geography, agency, or regulatory need within Nevada (USDA-FS, 2012; Merritt et al., 2017; Miller et al., TBD). The NV RAM can be used on springs, seeps, peatlands, fens, marshes and swamps that are not under USDA-FS jurisdiction. The Upland Watersheds RAM is still under development by the USDA-FS and should be available in 2020.

The NNHP WPP (NNHP, 2016) calls for the "development of a monitoring and assessment strategy consistent with the 'Elements of a State Water Monitoring and Assessment Program for Wetlands' (USEPA, 2003) to characterize existing and historic wetlands in the state and provide an understanding of the function and condition of those wetlands to enable stakeholders to make informed management decisions." The NNHP WPP also calls for a cost-effective method that works for wetland monitoring within and among regions. To meet these goals, the NV RAM establishes a multiple (versus single) target application that uses consistent methods to collect wetland distribution and condition data for multiple wetland classes across Nevada. The consistent methods for the NV RAM were developed through discussions with likely end users and synthesis of a variety of potential protocols (Sutula et al., 2006). The stakeholders engaged in this project saw the benefit of enhancing the consistency of wetland assessment to assist them within their management and regulatory settings (Appendix G).

## 1.5 Wetland Classification

Building off the DRI's Wetland Analysis Toolbar, the classification frameworks selected for this RAM include the NWI (based on the Cowardin system), which is in the process of being updated for Nevada, and the Hydrogeomorphic classification system (Cowardin et al., 1979; Brinson, 1993). The EIA framework upon which the NV RAM is based relies on the International Vegetation Classification System and "U. S. Ecological Systems" informed and developed over many years by NatureServe and the Network of Natural Heritage Programs (Faber-Langendoen et al., 2008). The RAM follows the EIA framework as closely as possible; however, developing a key to the Ecological Systems of Nevada fell outside the scope of this project. Instead, the "Wetland Types in Nevada's Great Basin, Eastern Sierras, and Mojave" was developed in coordination with the USDA-FS Rocky Mountain Research Station (RMRS). This Nevada-specific wetland classification tool is shared by this protocol and the RMRS Multi-scale Resilience-based Framework team and provides a framework for categorizing wetland types found in the Great Basin, Eastern Sierras and Mojave Desert of Nevada (Appendix C).

# SECTION 2: APPLYING THE NV WETLAND RAPID ASSESSMENT METHOD

The NV RAM field protocol is directly adapted from the Colorado Natural Heritage Program (CNHP) RAM and Wyoming Natural Diversity Database (WYNDD) (Lemly et al., 2016; Washkoviak et al., 2018), and is intended to be able to be applied by two experienced people in four hours or less at a given assessment area. The NV RAM can be applied in a variety of circumstances with varying study design approaches based on the assessment need. It is beyond the scope of this manual to fully outline study design options, but **random sampling** and **targeted sampling** represent the two most common types of study designs. Additionally, each assessment team will eventually implement the protocols according to their individual expertise and work style.

Random sampling involves sampling a randomly selected, statistically representative set of sites out of a much larger population. The benefit of a random design is that it provides the ability to make statistically defensible statements about the overall condition of wetlands across the population. If the goal of a study is to assess wetland condition across a large area (e.g., entire agency management unit or entire watershed), then a random design is preferable. Targeted sampling is used if one already knows the site or number of sites to assess and involves selecting a specific set of sites to sample without the need to make estimates about a larger population. Targeted sampling is most appropriate when there is a discrete number of wetlands to be assessed. For more detailed explanation of the two approaches, see Lemly et al. (2016).

For either type of study design, it is important to identify **available data sources** to help locate the population of interest. These data sources may be US Fish and Wildlife Service (USFWS) NWI maps, US Geological Survey (USGS) topographic maps, Natural Resources Conservation Service (NRCS) soil maps, local vegetation maps that depict wetlands, or aerial photography. There is an abundance of good data sources available online today that can help both identify potential sample sites and assess landscape scale metrics. Parallel to the preparation of the NV RAM, DRI was funded to generate Level 1 wetland analysis datasets for the state of Nevada. These datasets were produced with a wetland analysis toolbar developed for ArcMap GIS software by DRI called "WetBar." WetBar uses available geospatial and satellite imagery to generate a Level 1 wetland report for the selected area and provides context for assessing wetland condition. WetBar is available at http://www.dri.edu/wetland-mapnv.

Another important consideration is how to define the **target population**. If random sampling is being used, understanding the limits of the target population is crucial for setting up an assessment area. If a targeted assessment is being done, it is just as important to know when the wetland ends and the upland begins. The NNHP WPP acknowledges that various agencies managing land and water in Nevada will have different targets and may use different criteria to classify wetlands based on their various objectives for statutory protection and management. Thus, the definition of wetlands in the WPP is intended to encompass all wet areas in Nevada that provide ecosystem services and habitat for plants, wildlife, and aquatic species including: wet meadows, seeps and springs, playas, riparian areas, perennial streams, and intermittent and ephemeral washes (NNHP, 2016). The USFWS definition of a wetland is used as it best represents the range of wetland types applied by resource managers familiar with Nevada's wildlife, water, and water-influenced vegetation resources:

> *Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water.*
>
> *For purposes of this classification, wetlands must have one or more of the following three attributes:*
>
> *(1) at least periodically, the land supports predominantly hydrophytes,*
> *(2) the substrate is predominantly undrained hydric soil, or*
> *(3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year. (Cowardin et al., 1979)*

## 2.1 Assessment Design: Desktop Assessment and Preparing for the Field

The Level 1 Wetland Analysis Toolbar (WetBar) developed by DRI can provide valuable insights for planning a Level 2 assessment. These include:

- inspection of high-resolution aerial or satellite imagery of current conditions and issues associated with site access,
- examination of SSURGO soils maps in order to understand within-site environmental variability,
- prior aerial imagery and time-series plots of satellite-based vegetation and hydrology indices to understand changes at the site over the past 35 years,
- plots of monthly-averaged satellite-based indices, temperature, and precipitation that indicate when the site may be inaccessible (e.g., snow-covered, flooded), and what the expected state of vegetation would be at the time of a field visit,
- locations of known springs in and around the site,
- a map indicating the frequency of inundation at the site,
- a map indicating the current expanse of inundation at the site,
- information from geospatial data sources that can provide information about transportation networks and jurisdictional and land-ownership boundaries, and
- automated delineation of candidate 40-meter radius sampling areas for the field crew superimposed on aerial imagery and digital files with GPS center coordinates.

The Level 1 products were used in the planning of Level 2, NV RAM testing during the summer of 2019. Having selected a general study area, the team explored the study areas with the Level 1 WetBar tool http://www.dri.edu/wetland-mapnv. This included an assessment of local patterns in hydrology and soils, assessment of accessibility and travel times, checking for indications of recent changes at the site, and selection of candidate sites for NV RAM

Assessment Areas (AAs) that might be used by the field crew. Having selected candidate AAs, the WetBar tool provided a report for the field crews that was used to orient them to the site before going into the field and to help guide the selection of the actual AAs.

In the future, it may be possible to utilize the Level 1 Wetland Analysis Toolbar (Wetbar) to automatically populate a number of fields in the Level 2 RAM field forms, such as Nevada State Engineer Hydrographic Area Name, HUC 10#, Site Ownership, GPS coordinates and road access, and imagery as a backdrop for the site sketch map.

Additional field work preparation for efficient implementation of the NV RAM includes gathering all the necessary field equipment (Appendix F) and using the Level 1 report to plan travel logistics to the site at the appropriate season for vegetation identification and access to the site after snow-melt runoff.

For efficient implementation of the NV RAM in the field, the soil profile description procedure, including digging an actual soil pit, and the water chemistry sampling, including water probe calibration, should be attempted prior to performing those procedures in the field. It is recommended to develop an online "how to" web-based or pre-recorded tutorial for these procedures.

## 2.2 Defining an Assessment Area (AA)

The basis of the NV RAM is identifying and establishing an assessment area (AA) in which data collection may be concentrated. For random sampling, the standard shape and size for each AA is a 40-m radius circle (i.e., 0.5 ha or 5,000 $m^2$). For targeted sampling, each AA can be of variable size and shape and can be bound by the entire wetland itself, if so desired. Ideally, the AA should be one wetland class and type (see Appendices A, B and C) and one hydrogeomorphic (HGM) type (see Appendix B), but this is not always possible. However, it is still possible to apply the NV RAM protocol in those cases. The AA may be bounded by land ownership or management units or be a specific project area slated for management action. The general principles to consider when establishing an AA are further explained in Section 2.3.c.

For either type of study design, there are a variety of available data sources to help define the boundaries of the AA, including the Wetland Analysis Toolbar described in Section 2.1, as well as the USFWS NWI maps, USGS topographic maps, NRCS soil maps, local vegetation maps that depict wetlands, or aerial photography.

## 2.3 Establishing the Assessment Area

### *2.3.a. Assessment Areas for Targeted Sampling*

The NV RAM protocol is designed around a targeted sampling approach to accommodate various wetland assessment needs. A targeted AA can be of variable size and shape, or can be bounded by the entire wetland itself, and refined onsite to meet the objectives of the wetland assessors depending on the need. However, using the Level 1 Wetland Analysis Toolbar for the NV RAM Desktop Assessment phase directs assessors to initiate the process using the random, point-based sampling approach to establish the AA (refer to Section 2.3.b.). This is a simple way for assessors to identify a likely AA and orient themselves to the wetland site prior to embarking on the field work (refer to Section 2.1). Once in the field, the information and data collected on page 1 of the data sheet directs assessors to adjust the AA to meet the targeted assessment need.

### *2.3.b. Assessment Areas for Random Sampling*

For random sampling designs, it is often preferable to define the initial AA as a standard area around a fixed point. Because wetlands are so variable in size, random sampling often employs what is called an area-based design. Each AA represents a specific area of wetland and, therefore, a specific proportion of the wetland resource under investigation. The recommended standard AA is a 40 m radius circle (i.e., 0.5 ha or 5,000 $m^2$) centered on the random target point. However, there can be considerable flexibility in establishing an AA depending on wetland size and shape.

Proper placement of the actual AA is crucial because it defines the area for most of the data collection. Before heading into the field, users should examine aerial photos of the point and should strategize the most likely placement of the initial AA based on observed wetland features surrounding the point. The Wetland Analysis Toolbar can be used to determine the likely AA. It can be useful to choose several potential AAs and then determine the best AA that meets your target wetland once in the field. Once in the field and the area surrounding the point has been identified to be suitable for sampling, the user will establish the actual AA to bound further sampling. The actual AA should be located in the closest possible suitable sample area from the original point. The user should always document the process used to move vegetation plots when the original (initial) center point and standard AA are not used.

### *2.3.c. General Principles*

The following are general principles to consider when establishing an AA; however, it is not necessary to exactly adhere to these principles if they are not practical for a particular site:

1) The AA should be targeted for *only one* General Wetland Category and Dominant Category for NV Wetlands (Appendix C). Changes in dominant soil type, vegetation, or hydrology, however, can indicate there are secondary wetland types present. The presence of secondary wetland types should be noted in the “Classification of the AA, General Wetland Categories for NV” section of the data sheets.
2) The AA should be 0.5 ha (5,000 $m^2$) where possible, but can be as small as 0.1 ha (1,000 $m^2$) if necessary.
3) The maximum AA length is 200 m, regardless of shape. The minimum AA width is 10 m, regardless of shape.

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

### *2.3.d. AA Layout Protocol in Brief*

1) Determine AA shape: this may be a 40 m radius circle, or if size and shape constraints require an alternate shape: freeform, rectangle, or entire wetland.

2) For standard circular AAs, take a GPS point at the center and record the waypoint number, UTMs and error on the datasheet as the '**AA-Center.'** Record elevation, slope, and aspect at the AA-Center.

3) For non-standard AAs, it is not required to take a GPS point in the center, as it will likely be easier to determine in GIS based on the AA polygon. Record elevation and accuracy in a representative area of the AA.

4) Flag AA boundary. For standard **40 m radius** AAs, flag at least the cardinal directions. For **freeform** AAs, track the boundary using the GPS and flag as often as needed to visualize the AA. For **rectangular** AAs, flag at each corner, and at mid-points if helpful.

5) Take GPS points and photos from at least four standard locations on the edge of the AA looking in, either at the cardinal directions for **40 m radius** AAs or at four logical locations on the edge of **rectangular** or **freeform** AAs. Record the waypoint numbers, UTMs, accuracy, and photo number (e.g., AA-1, AA-2, etc.) on the datasheet.

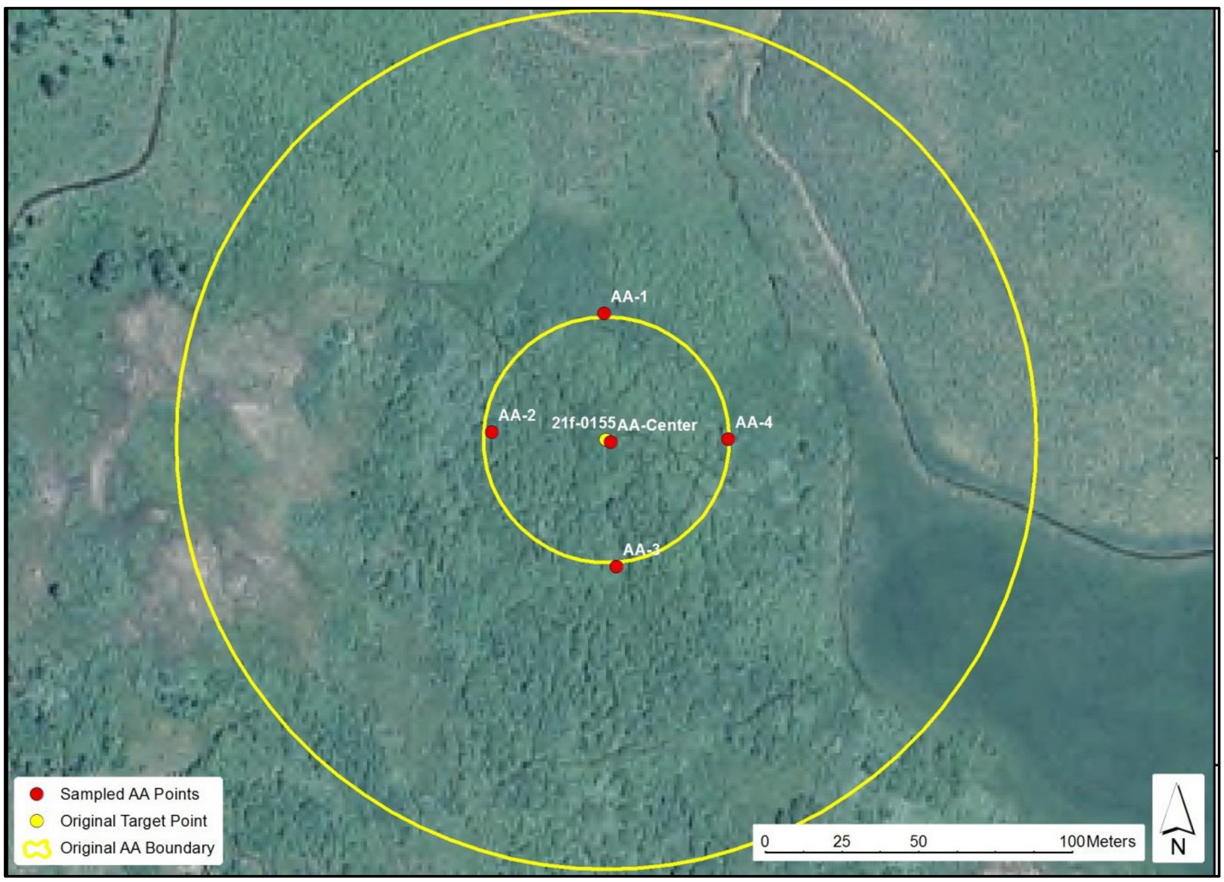
6) When AA boundaries are set, sketch the AA shape on the **Assessment Area Drawing** page of the data sheet (Figure 7). Ideally, this is done on the color aerial photo if possible. It is best to first draw in pencil then trace with a permanent marker.

### *2.3.e. Standard AA Layout – 40 m radius circle*

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

The perimeter of the AA should be flagged and this process may vary depending on thickness of vegetation. Use judgment to maximize layout efficiency. Further details on flagging the perimeter in open vs. dense vegetation are provided below. Site photos can be taken as the AA is flagged (more common in open vegetation) or can be taken after the AA is flagged (more common in dense vegetation that is difficult to traverse). Flagging options include biodegradable forestry flagging in visible colors such as pink or orange (easiest in tall vegetation and woody areas) or pin flags (at least 36" tall, and easiest in short vegetation and open water). If it is not possible to stand on the cardinal azimuth of each AA edge (as in deep water), take the reference point UTMs and photos as close as possible to the target position as outlined in Section 2.3.d.4., and note in comments how the reference point(s) are offset.

**A.**



**B.**


**Figure 3.** Map of standard 40 m radius circle AA layout centered on the target point. **A.** The inner yellow circle is the targeted AA, and the outer yellow circle shows the 100 m envelope within which the AA could have been shifted. The yellow point is the target point and the red points are the AA-center and AA-perimeter photo points. **B.** The original target AA is show in yellow, and the shifted/sampled AA, in red. Images from Washkoviak et al. (2018).

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

**If vegetation is dense or difficult to walk through** with a 50 m tape, the GPS unit can be a helpful tool to assist with delineating the AA. Mark the center with the GPS, then use the "GO TO" function to measure a 40 m distance from the AA-center in a cardinal direction. The GPS "GO TO" function can be used to delineate each cardinal direction edge without use of the tape.

### *2.3.f. Alternate AA Layout 1 – Rectangle*

If a 40 m radius circle does not fit within the wetland area, a rectangular shape may be used to delineate the AA (Figure 4). Compared to free-form AAs, rectangular AAs are easy to lay out because the layout is more standardized, and the perimeter does not need to be tracked with the GPS. First estimate the required dimensions to reach ~5,000 $m^2$. For example, a square AA should be 70.5 m on each side (70.5 m x 70.5 m = 4,970 $m^2$). If the wetland is 50 m wide, the rectangle should be about 100 m in length. Rectangular AAs may be centered on the point or their edges may be up to 60 m from the point, depending on the wetland area. However, rectangular AAs should only be used where the wetland area is generally straight, and the size of the AA is not compromised by bends in the wetland boundary. For this reason, rectangular AAs are not common. GPS waypoints and photos should be taken at each of the four corners of rectangular AAs looking diagonally into the AA.

### *2.3.g. Alternate AA Layout 2 – Freeform shape*

When is not possible to lay out a standard or rectangular AA in 5000 $m^2$, the AA perimeter is usually confined by the size or shape of the wetland or by deep water. This is considered a freeform AA shape (Figure 5). If the wetland is small, the entire wetland will become the AA. If the wetland is larger but oddly shaped, the user should first estimate the general dimensions of the wetland using the aerial photos provided and strategize about the best way to lay out a 0.5 ha (5,000 $m^2$) AA. Based on this estimate, the perimeter of the AA is walked with the GPS in TRACK mode, flagging the edges as the perimeter is walked. It is important to visualize the AA layout before walking it out. Once visualized, one crew member leads and flags the AA perimeter while the second crew member follows with the GPS in TRACK mode. This keeps track edges smooth. Before walking the AA track, clear tracks on the GPS (this action will not clear previously saved tracks). When finished, switch out of track mode, use the GPS Area Calculation function to determine AA track size, and record the area of the actual AA in $m^2$. If the AA perimeter ends up significantly larger than 5,000 $m^2$ (~5,500 $m^2$ or larger), some portions of the area should be excluded to ensure the actual AA is comparable to others using the NV RAM protocol. The GPS track should be saved on the GPS unit and named by the point code.

In cases of wetlands along a pond fringe where the water gets deep (>1 m) or substrate becomes dangerously soft towards the center, a donut- or boomerang-shaped freeform actual

AA may be necessary. In some cases, the deepest boundary of the wetland may not be wadeable in areas, and instead of a complete track, the AA is delineated by a partial track, with 2 to 4 extra waypoints along the deep boundary that are also noted on the AA drawing. The AA drawing should also clearly indicate the wetland perimeter, and should describe the portion of the edge that has track data and the portion to edit in the office. These resources will be referenced in the office to clip any non-target area out of the AA track in GIS.


**Figure 4.** Map of rectangular AA adjusted from the target AA-Center point. The yellow point is the initial AA-Center point and the yellow circle is the initial 40 m radius AA, which included unsampleable upland area. The red polygon represents the 5,000 $m^2$ rectangular actual AA delineated in the field and the red point is the center of the sampled AA. Image from Washoviak et al. (2018).

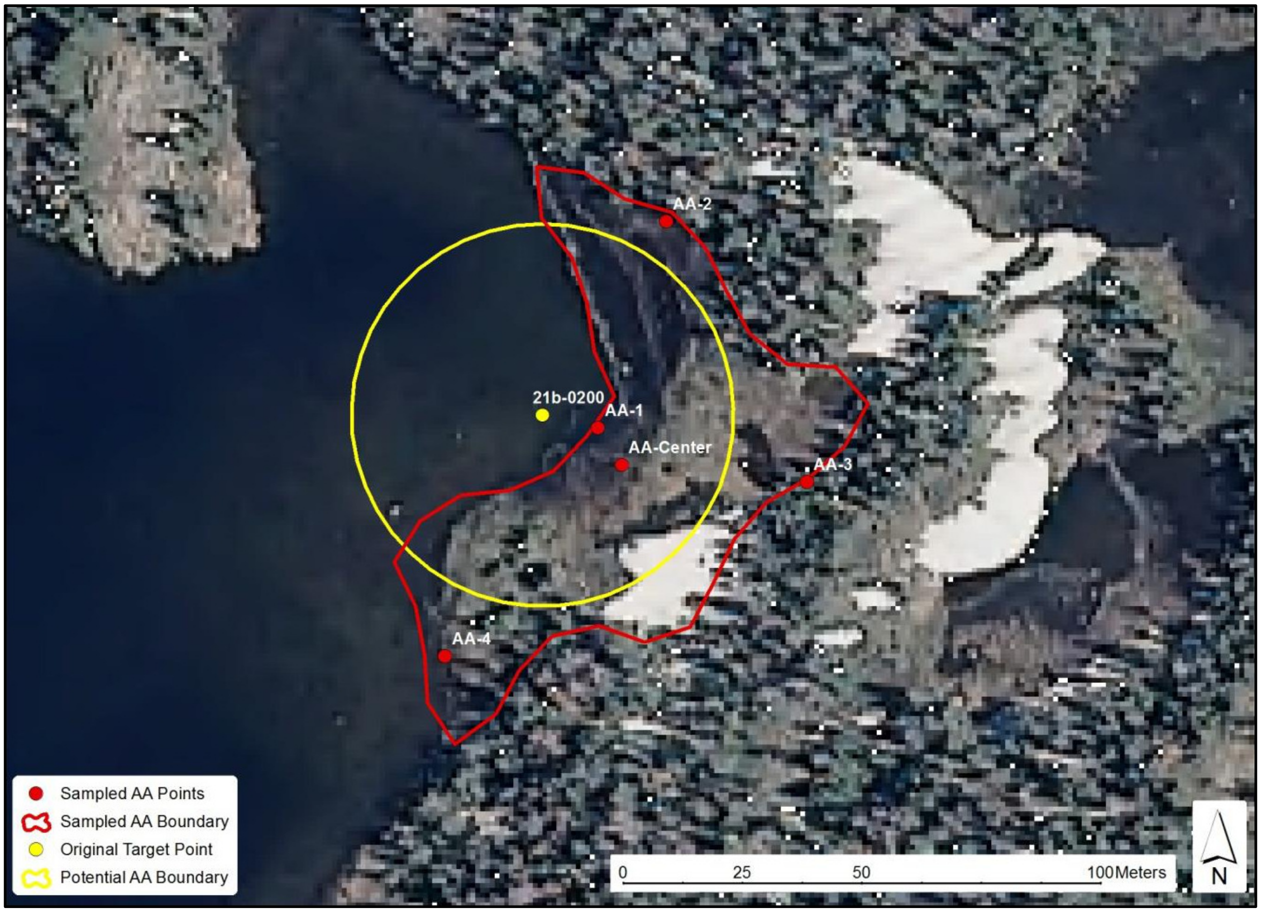



**Figure 5**. Example of a freeform AA. The yellow point and circle represent the original target point and initial AA, which included water too deep to sample. The red polygon represents the 5,000 $m^2$ freeform AA delineated in the field and the red point is the center of the sampled AA. Image from Washkoviak et al. (2018).

## 2.4 Describing the Assessment Area (AA)

The first page of the 2019 **NV Wetland RAM Data Sheets** contains general information about the site, much of which can be found on the DRI Level 1 Wetland Assessment Analysis Toolbar report (example provided in Appendix H). This information can be filled out once the user determines that a target sample area is located at or near the sample point. The following guidance will assist in filling out this section of the data sheet.

**NOTE:** Once each section of the data sheet is filled out, place an “X” in the red box ☐ located at the top right of each section box to confirm that the data from each section are fully recorded. At the end of the assessment, a check should be performed to ensure each red box is marked and all of the assessment information is complete.

### *2.4.a. Location and General Information*

**Point Code:** The code of the original sample point. This code could be anything project specific.

**Site Name:** A descriptive name for the sample wetland.

**Date:** Date of sampling, written as month, day, year (e.g., July 12, 2016 or 7/12/2016).

**Time Start and End:** Time assessment begins and ends in military time.

**Weather and Air Temperature:** Circle the best description of recent precipitation. Take the air temperature with a thermometer and record in Celsius degrees.

**State Engineer Hydrographic Area Name & HUC 10#:** Populate from the Level 1 Assessment report, if available.

**Site Ownership:** Include the name of the site owner or manager, include the federal or state descriptor, if available.

**Surveyors:** The first initial and last name of field user members sampling the site (e.g., L. Saito, K. McGwire) and circle the name of the person recording the data.

**Access Comments:** Directions to the Assessment Area should specify a starting point (e.g. "From Reno" or "From I-80 heading W" or "From the 'x' trailhead outside of Lockwood"). Include route taken, approximate mileage traveled on dirt roads, trails, and off trail navigation, and parking location used. Also record any information that would be helpful if one were to revisit the site, such as access restrictions (e.g., parking limitations, keys needed, gate codes, or entry facilitation by agency person or landowner, permit needed) or if challenging structures/vegetation require an indirect approach. Some of this information may be obtained from the Level 1 Assessment report, if available.

### *2.4.b. Assessment Area and GPS Coordinates*

**Dimensions of AA:** Mark appropriate lines with an "X". Standard AAs are the 40 m radius circle. Rectangular AAs are rectangular. Free-form AAs are adjusted to the shape of the wetland/target area boundary. Entire wetland indicates the AA represents the entire wetland type. **GPS AA Tracks** should be taken only for freeform and entire wetlands.

**Target Wetland Type:** Record if the wetland being assessed is the assessment area that was initially identified in the Level 1, pre-field work assessment.

**AA Representativeness:** If the AA encompasses the entire wetland, mark Yes. If the AA is part of a larger wetland or a complex of more than one wetland class, category and/or type, write the other descriptors from Appendices A, B, and C.

**AA GPS Coordinates:**

- **AA-Center:** If AA is a standard 40-m radius circle, record the center **waypoint number** and **UTMs**. Record **accuracy** once the error number appears to stabilize on the GPS unit. In non-standard AAs, the center point is not needed.
- **Elevation:** Record elevation at AA center in meters. For all GPS points, when >1 UTM Zone occurs in the study area, users should note the UTM Zone of all GPS points.

**AA Photos:**

The aim of AA photos is to represent the AA in photographs—as they say, a photo is worth 1,000 words. There are various standard photos that must be taken in each AA, with the photo numbers recorded:

1) Four standard AA positions (record photo number on **page 1- WP/Photo #**), with goal of presenting landscape context and vegetation communities,
2) Soil pit photos (record photo number on **page 3- Soil Profile Description**),
3) Unknown plant photos (record photo range on **page 5- Vegetation Species List**),
4) **Photos of anything notable**- When possible, it is helpful to have photos looking down at the entire wetland. Photo numbers should always be recorded when photo is taken outside the AA. When there are questions on how to record data, take photos and record their numbers to represent the issue in question, recording photo number and photo type on **page 2- Assessment Area Drawing**). Otherwise, not all photos within AAs must be labeled if they fall within the AA and are not standard photo.

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

A **photo placard** will be held in all four of the standard AA photos (**Figure 6**). Photo placards will be placed in a corner of the photo, taking up only a small portion of the frame, with as little arm or body visible as possible. The camera should be tilted to represent as much of the AA as possible, and photos should be reviewed for clarity before moving on. In dense vegetation, one may want to hold the camera higher and move branches directly in front of the camera out of the way. The **point code** should be written in full on the first line of the placard (e.g., 21i-191). The second line of the placard will contain the **aspect** that the photo is facing and the location of the photo (e.g., 140°/AA-4, 300°/AA-1, 90°/AA-1). Aspect should be rounded to the nearest 5 degrees in all photo points. *Make sure to set the declination of your compass.* **Date** should be written as MM/DD/YYYY (e.g., 07/07/2016). The standard photos can be taken while walking the perimeter of the AA, or after the AA perimeter is flagged. It is essential that two people participate in taking the placard photographs.


**Figure 6.** Example AA photo placard. Note placement of photo placard in corner and information written on placard: Point code, Aspect, and Date.

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

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

### *2.4.c. Classification of the Assessment Area*

Starting at the bottom of the first page, the data sheet contains wetland classification information. Guidance is given below. For any classification where there is doubt, ambiguity, or further explanation is necessary, make note in the **Region** comment section below.

**Cowardin Class,** and **Cowardin Modifiers: Water Regime** and **Modifiers: Special:** Place an "X" next to the dominant wetland **System** and **Class,** and **Modifiers** from the Cowardin classification codes, using the definitions provided in **Appendix A**. If Class was pre-populated with Level 1 assessment data, verify or correct the Class. More than one **Special Modifier** selection may be made.

**HGM Class:** Select the appropriate HGM Class using the key provided in **Appendix B.** Pick one dominant HGM Class.

**Region/General Wetland Categories for NV/Type:** Circle the **Region** and **General Wetland Category for NV** and select and write in the **wetland type** from the descriptions provided in **Appendix C**.

***NOTE:*** *It is recommended to revisit the wetland classes selected at the end of performing the rest of the RAM to double-check whether the selections fit after collecting the soil, water quality, and vegetation data. Change if necessary.*

## 2.5. Assessment Area Drawing and Description

Provide a drawing of the AA illustrating the AA shape, boundary, center point, landscape features, dominant vegetation and community types, drainage direction into and out of the wetland, and slope. Also, the standardized key provided on the AA Drawing data sheet should be used for the following: locations of photos (**diamond**), waypoints (**star**), soil pit(s) (**rectangle**), and water chemistry test(s) (**circle**). Human-made features such as culverts, berms, springboxes or impoundments should also be included in the sketch. Include a north arrow and approximate scale bar. The drawing can be done once the AA is established or it can be done after all sampling is complete, if you have a better understanding of the site. An example is provided in Figure 7.

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

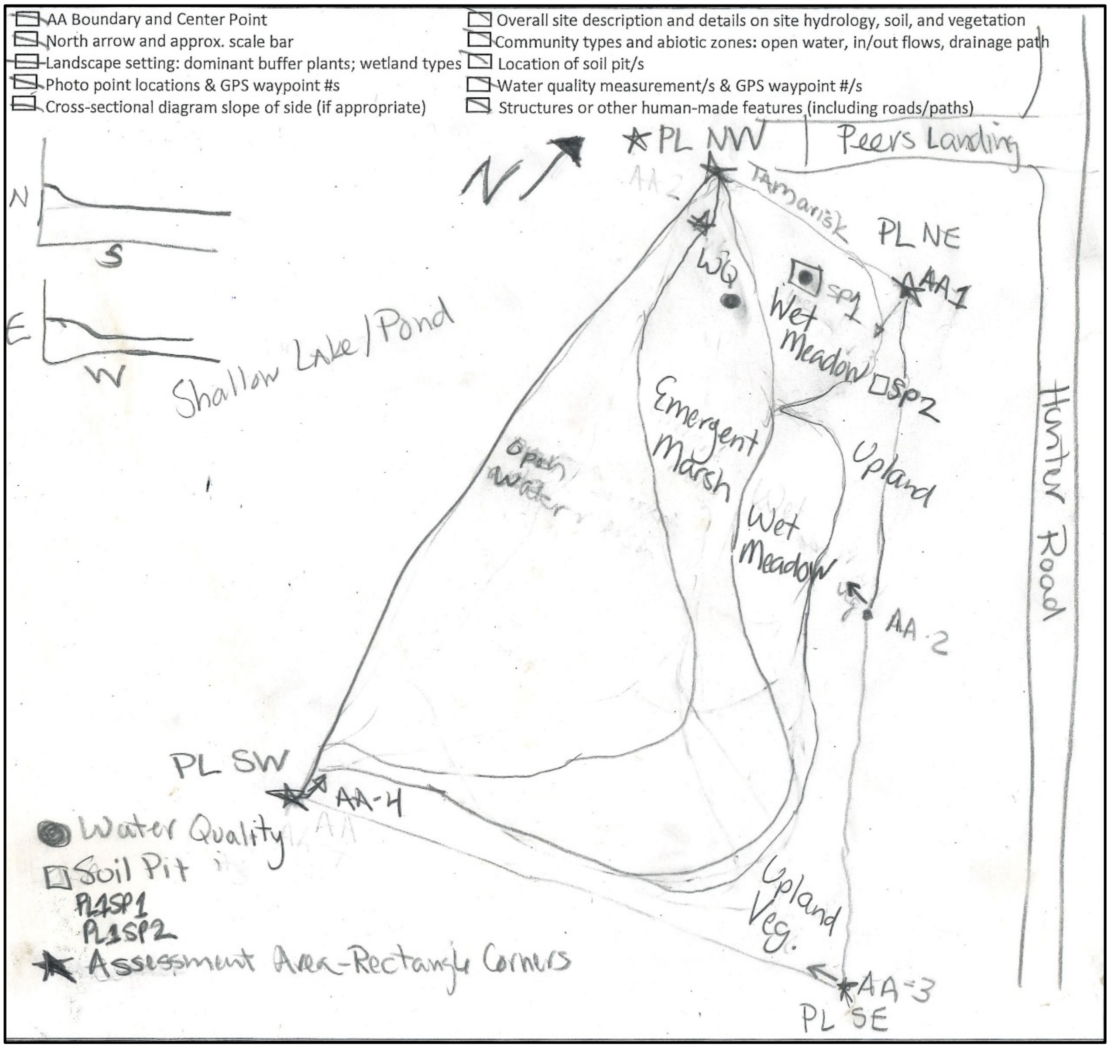



**Figure 7.** Example AA drawing, setting, and surrounding landscape description.

## 2.6 Soil Profile Description- Soil Pit Protocol

The location of soil pit(s) and water table sampling will be determined while laying out the AA. Care should be made not to trample the soil pit or water sampling locations while completing the assessment. If there is free-standing water in the soil pit, follow water chemistry sampling procedures in Section 2.7 to test water within the soil pits.

It is advised to review guidance in the U.S. Department of Agriculture, NRCS “Field Indicators of the Hydric Soils in the United States: A Guide for Identifying and Delineating Hydric Soils, Version 8.2” (2018) during the **assessment planning phase**. It is also recommended for at least one person from the project team to participate in a short soil assessment training or have some experience with soils assessment before departing for the field.

### *2.6.a. Soil Profile Description*

Soil pits should be placed in vegetation communities that are representative of the AA and noted as a **representative pit** on the data sheet. If the vegetation and soil surface appear relatively homogenous, only one soil pit is necessary. If there is variability within the vegetation and soil, at least two soil pits should be dug to capture the range of variation within the site. Note the **soil pit number 1 or 2** on the data sheet. Additional soil pits may be deemed necessary if determined that two would not capture the AA variability. When soil pits are variable, indicate on the data sheet which soil pit best represents the AA.

Digging soil pits is difficult in standing water. If standing water is a significant part of the AA, it is advisable to pick a location on the edge of deep water, if possible. For all soil pits, take a GPS waypoint and record the **GPS WP number** on the field data sheet. Take photographs, if possible, of the pit and the soil profile that has been laid out. Mark all soil pits on the **site drawing**.

Follow these steps to dig the soil pit with a 40 cm sharp shooter shovel and a soil knife, and refer to photos in **Figure 8**:

1) Minimize ground surface disturbance by digging the soil pit only slightly larger than the width of the shovel, but wide enough to enable a clear view of the soil horizons on all sides. Soil pits will be dug to at least one shovel length depth (35 to 40 cm) when possible.
2) Use a soil knife to smooth the soil pit wall that faces the sun for illumination of the best view and photography of the soil horizons. Use the knife to poke and expose roots and feel for changes in the soil horizon and texture. Measure depth to bottom of pit using a measuring tape, with “0 cm” at ground-surface (Figure 8).
3) In the soil pit, identify and mark the distinct soil horizons/layers between ground surface and the bottom of the soil pit using pins or sticks. In riverine or lacustrine fringe wetlands, relatively thin alternating layers may be observed and can be grouped as one horizon/layer but note this in the “horizon-notes” (Figure 8).
4) Use the shovel to remove a core or slice that includes all horizons. If it is difficult to take an intact slice, use a trowel to remove material from each horizon. Lay it down next to the soil pit, possibly on a small tarp or piece of plastic. Take care to keep all layers/horizons intact and in order. A bucket auger can be used to examine the soil deeper in the profile if needed to find hydric soil indicators.
5) Describe each distinct horizon/layer in the soil pit and record the following information:
    a. **Horizon/Layer depth** (cm): Measured depth of each distinct layer/horizons, with 0 cm at ground-surface
    b. **Matrix, color**: Use a Munsell Soil Color Chart (Munsell Soil Color Guide M50215B) to identify the code for moistened soil
    c. **Dominant redox features**: Note the matrix’s dominant redoximorphic features (mottles and oxidized root channels) and amount of redox features observed (i.e., None, Very Few, Few, Many)

d. **Texture:** Determine the soil texture using the Soil Texture Flowchart (Appendix D)
e. **Roots**: Estimate the amount of roots (i.e., None, Very Few, Few, Many)
f. **Gravel:** Lay a slice or scoop of the layer/horizon on a small piece of tarp or plastic and estimate the amount of gravel (i.e., None, Very Few, Few, Many)
g. **Notes**: include any noteworthy observations about the layer/horizon

6) Use Appendix E to identify the **Hydric Soil Indicators** and check all that apply. Include any comments.

If previous soil survey information is known for the assessment area (e.g., NRCS soil survey, USGS report, etc.), write down the soil survey unit name and note if the soil pit matched the soil survey description.

**Figure 8.** Soil Profile Description procedures pictured here: (at left) determining soil pit depth with a measuring tape, and (at right) removing a soil core in order to identify and mark the soil horizon depths using small sticks at 3 cm and 6 cm.

### *2.6.b. Soil Pit Water Table and Chemistry*

The water table will be measured in soil pits where groundwater is visible. Allow the soil pit to sit while describing the soil features before measuring depth to saturation and depth to free water. In sunny weather, while waiting for the water to fill and settle, shade the soil pit to avoid skewing the temperature and dissolved oxygen (DO) readings. Once the soil pit has equilibrated as much as possible, note on the data sheet the **water settling time,** measure the **depth to saturated soil** (0 cm at ground level) and **depth to free water**. Saturated soil can be identified by a sheen on the soil surface or water seeping and oozing into the soil pit. Free water is an approximation of the groundwater table, but in some cases may not represent the true groundwater table because it can take many hours for the water table to equilibrate. If free water is **not observed**, note whether the soil pit is **dry** or if it appears to be **slowly filling**. If free-standing water is observed, follow the instructions for **water chemistry sampling** found in Section 2.7.

## 2.7 Water Chemistry Sampling (for Soil Pits and General Water Chemistry Measurements)

Basic field measurements of water chemistry, including **temperature** in degrees Celsius **(°C)**, **pH**, **electrical conductivity** (EC) in deci-siemens per millimeter **(dS/m)**, and **dissolved oxygen** (DO) in parts per million **(ppm)** should be taken using a handheld meter where water is present in the AA. Be sure to calibrate the handheld meter and log each calibration before collecting date on each day of use and keep the electrode(s) clean at all times. A small squirt bottle of water is helpful to carry in the field to keep the electrode clean before and after using it.

Water chemistry measurements can be sampled at different locations within the AA (e.g., in soil pits that fill with water or in a stream or pool alongside or within the AA). Be sure to record the associated units for each water chemistry parameter taken if not in the standard units on the data sheet. For all water chemistry sampling, note the **reading location** indicating where in the AA the data were collected, note the **GPS waypoint number (#)** and mark on the field form whether the sample was taken in **standing or flowing water**. Note the water chemistry sampling locations on the site AA drawing. In the **comments,** note the model name of the handheld water chemistry meter, and, if more than two readings were collected, include the additional readings in this section.

To characterize groundwater-fed systems (e.g., fens, seeps or springs), it is best to take water chemistry measurements in soil pits where groundwater is evident. If the assessment interest is a particular animal such as amphibians, it is best to take water chemistry measurements in surface water. It is important to recognize that surface water parameters fluctuate widely during the day, throughout the season, and with varying water levels, and that soil pit water chemistry could be affected by the disturbance in digging the soil pit. A single measurement is only a snapshot.

## 2.8. General Animal Observations

Record any general animal observations on the table, noting species (if known) or common names of all organisms observed or encountered at or near the AA. Specifically look for the types of organisms listed the box above the table and mark the box "X" if observed, in addition to listing the species and/or its common name in the table; these organisms are of specific interest in Nevada. Note the photo # for any photos captured. If individuals are observed, write the number in the "# Individuals" column. If possible, note the type of observation that occurred: nest, vocal, tracks, or scat. Record any additional information that can help quantify wildlife usage at the site.

## 2.9 Vegetation Sampling Protocols

No more than one hour should be spent on the full vegetation sampling process: species list, cover classes, and litter descriptions.

### *2.9.a. Vegetation Species List*

The vegetation rapid assessment sample is based on a visual estimation of the AA. The RAM first visually groups the vegetation across the AA into the main **up to four** observable "community types" and names the types. If more than four main types are present, additional rows and columns can be added to the data sheet. **Community type names** can be based on the vegetation assemblages listed for the common wetland types found in Nevada's Great Basin, Eastern Sierras, and Mojave (Appendix C). The RAM then estimates the **percent of the total AA** occupied by these main vegetation community types, as well as estimates the **average height** for each of the following strata within those types: **trees**, **shrubs,** or **grasses/forbs**.

After the main community types are specified, each community type is walked, and a list of vegetation species' **scientific names or pseudonym/common names** is compiled. Any **unknown species** are entered on the table with a descriptive name. If the genus of the species is known, the descriptive name should include the genus name (e.g., Carex 1 sp. or Aster 2 sp). The descriptive name should also include some identifiable characteristics to distinguish multiple unknown species from the same genus (e.g., Carex sp. elongate black head or Carex sp. clustered brown head). If the genus is not known, the descriptive name should include any descriptors necessary (e.g., fuzzy round basal leaves or purple united corolla). All collected unknown species will receive a **collection number**, which will be a running sequential series of numbers that starts at every site. This collection number, and any **photo numbers** taken are written on the table row next to the species' names.

Next, the presence of each species is estimated via **percent cover within each community** type, noted under the corresponding 1 – 4 community type columns, with the following bins: "not present" (**NP**) "trace" (**T** for 0 - 5%), "uncommon" (**U** for 6 - 10%), "common" (**C** for 11 - 50%), or "dominant" (**D** for > 50%). Observations of known **invasive** and **non-native species** are also noted with "INV" or "NN."

### *2.9.b. AA Cover Classes and Litter Descriptions*

After completing the vegetation species list by community type, information on the cover classes and litter descriptions are recorded for the entire AA. The following bin categories will be used where noted below: **NP** (not present), **1** (0 - 5%), **2** (6 - 10%), **3** (11 - 50%), or **4** (> 50%).

**Percent cover** of the AA by **water** is recorded using the bin categories for the following: **standing water** or **running water** of any depth, **open water**, or **water with emergent** and **floating** or **submerged vegetation.**

**Percent cover** of the AA by **exposed ground** will be recorded using the bin categories for the following:  **bare ground** with **soil, sand, or sediment**; **gravel or cobble ~2 – 250 mm** in diameter; and **bedrock, rock, or boulders >250 mm** in diameter. Exposed ground with **salt crust over any exposed ground** will also be noted using the same bin categories.

**Percent cover** by **litter** across the AA, including litter that is hidden beneath vegetation or water, is recorded using the bin categories. In cases where dense herbaceous vegetation covers the AA, this can be difficult to determine, as the current year's herbaceous vegetation can intermix with litter from previous years. Litter can also include standing dead herbaceous vegetation, particularly annual vegetation or dead attached leaves from the previous year, which would become litter once it fell over.

**Depth of litter** is estimated as an average of the depth (in cm) of litter in four representative areas within the AA. The measured litter height should not be trampled but should reflect the height at which it occurs naturally. Record the **litter depth at the 4 areas** on the datasheet in cm, and the **average of the 4 depths** should be entered in the far-right column.

Circle the **predominant litter type** among the following choices: **C** (coniferous), **E** (broadleaf evergreen), **D** (deciduous), **S** (sod/thatch), **F** (forb). Sod/thatch is used for graminoid litter (i.e., grass).

**Percent cover** of the AA by **standing and downed woody debris** is recorded using the bin categories for the following: **standing dead at greater** or **less than 5 cm at breast height,** and **downed coarse** or **woody debris.** The cover of woody debris is estimated based on whether it is standing or downed, and the diameter either at breast height or the average diameter of the debris. To differentiate downed debris from standing debris, use the 45° rule. If a tree is leaning more than 45° from upright, it is considered downed woody debris. If it is leaning less than 45° from upright, it is considered a standing dead tree or snag.

**Percent cover** of the AA by **other,** or nonvascular species, will be recorded using the bin categories for the following: **bryophytes, lichens,** and **algae.** For each species group, make sure to look underneath vegetation. The cover of these species groups is often underestimated because people do not look for them hiding among the leaves of graminoids or under shrubs.

## 2.10 Post-Assessment Activities

### *2.10.a. In Field Activities*

Final Review of RAM Field Forms: As the AA data are recorded and completed for each section, an "X" should have been made in each of the red boxes located at the top-right of each section. Before completing the RAM and leaving the field, check that each red box is marked and the data from each section is fully recorded and written legibly. Revisit the wetland classification selected at the beginning of the visit to make sure that it still seems appropriate after site visit data have been collected.

Assessment Area Inspection: Walk the AA and pull any flagging, fill all soil and water quality pits. Perform an equipment-check to ensure all equipment has been collected and returned to the vehicle before leaving.

Equipment Cleaning: Check and clean off footwear and clothing of mud or seeds to prevent inadvertently transporting seeds to other wetland sites and to prevent cross-contamination between wetland sites, especially white-top seed. Also, wash off all trowels and knives.

### *2.10.b.In Office*

Database: A system for storing the collected data should be developed for the entity performing the NV RAM. A Microsoft Excel sample database was created to store data collected during the NV RAM field tests. A copy of the NV Wetland RAM Spreadsheet is available at the NNHP website: www.heritage.nv.gov. Because various wetland RAMS are in use or under development in Nevada, it is recommended that a common database for Nevada wetlands be developed and used.

# SECTION 3: Future Work and Recommendations

## 3.1 Validate, finalize, and training on Nevada Rapid Assessment Method

This NV RAM was developed through the initial field verification phase of RAM development (Sutula et. al., 2006). Future phases of finalizing the NV RAM should also include final RAM verification, calibration and validation, as well as outreach and implementation (USEPA, 2019; Sutula et al., 2006). Once the RAM validation phase is completed, the tool could be used by land or resource managers to measure wetland ecological integrity, target sites for restoration or protection, track changes over time, or identify stressors. Beyond a NV RAM database, a common Nevada wetland database should be developed to capture data collected by the various RAMs in use and under development (see Section 1.4).

As described in Section 2.1, as part of finalizing the NV RAM it may be possible to utilize the Level 1 analysis to automatically populate a number of fields in the Level 2 RAM field forms, such as State Engineer Hydrographic Area Name, HUC 10#, Site Ownership, GPS coordinates and road access, and imagery as a backdrop for the site sketch map. Additional linkages and iteration between the Level 1 Wetland Analysis Toolbar and NV RAM should be explored.

For efficient implementation of the NV RAM in the field and adherence to the 4-hour EPA Level 2 framework, a training program should be developed that focuses, in particular, on the soil profile description procedure (especially digging soil pits, and using the Munsell and hydric soils keys), as well as the water chemistry sampling (especially water probe calibration). An online “how to” web-based or pre-recorded tutorial for these procedures may suffice and be the most effective use of resources.

In addition to validating the NV RAM, developing a qualitative EIA metric framework similar to those of the Colorado Natural Heritage Program (CNHP) and Wyoming Natural Diversity Database (WYNDD), is recommended (Lemly et al., 2016; Washoviak et al., 2018). Although not included in this manual, the NV RAM can be expanded in the future to include qualitative metrics that evaluate landscape context and hydrologic condition into a multi-metric index. This would produce a final EIA score to rank a wetland’s condition on a four-tiered scale (excellent/good/ fair/poor: Table 1), as compared to unaltered wetlands of the same type. This approach has been developed for both Colorado and Wyoming and is recommended for a future NV RAM development project phase.

## 3.2 Develop full Ecological Integrity Assessment

Once fully developed, a NV EIA RAM could include assessment of multiple wetland functions that go beyond the typical EIA framework and better account for “novel” wetland systems found in Nevada that are influenced, altered, impaired, or in some cases supported by human land or water management using a hybrid approach taken by the WYNDD and TNC-WY (Washkoviak et al., 2018; Tibbets et al., 2015).

While development of a full EIA method was outside the bounds of the resources of this project, a future effort could establish the rank, condition category, and interpretations for EIA scores because the draft NV RAM was developed with the elements of the full EIA at its core. The CNHP and WYNDD EIA manuals provide examples of how this could be accomplished (Lemly et al., 2016; Washkoviak et al., 2018).

**Table 1.** Overall EIA scores and ranks and associated definitions developed for the WYNDD Little Snake Basin Wetland Assessment Sampling Manual (adapted from Washkoviak et al., 2018).

| ***Rank*** | ***Condition*** | ***Interpretation*** |
|---|---|---|
| **A** | **Excellent / Reference Condition**<br>**(No or Minimal Human Impact)** | Wetland functions within the bounds of natural disturbance regimes:<br>• Surrounding landscape contains natural vegetation communities, essentially unfragmented with little to no stressors;<br>• Vegetation structure and composition w/in natural range of variation, nonnative species essentially absent, comprehensive set of key species present; and<br>• Soil properties and hydrological functions intact.<br>*Management should focus on preservation and protection.* |
| **B** | **Good / Slight Deviation from Reference** | Wetland predominantly functions w/in bounds of natural disturbance regimes:<br>• Surrounding landscape contains largely natural vegetation communities, minimally fragmented with few stressors;<br>• Vegetation structure and composition deviate slightly from natural range of variation, nonnative species and noxious weeds present in minor amounts, and most key species present; and<br>• Soils properties and hydrology only slightly altered.<br>*Management should focus on the prevention of further alteration.* |
| **C** | **Fair / Moderate Deviation from Reference** | Wetland has number of unfavorable characteristics:<br>• Surrounding landscape moderately fragmented w/several stressors;<br>• Vegetation structure and composition somewhat outside natural range of variation, nonnative species and noxious weeds may have sizeable presence or moderately negative impacts, and many key species absent; and<br>• Soil properties and hydrology are altered.<br>*Management needed to maintain or restore some ecological attributes.* |
| **D** | **Poor / Significant Deviation from Reference** | Wetland has severely altered characteristics:<br>• Surrounding landscape contains little natural vegetation and very fragmented;<br>• Vegetation structure and composition well beyond their natural range of variation, nonnative species and noxious weeds exert strong negative impact, and most key species absent; and<br>• Soil properties and hydrology severely altered.<br>*May be little long-term conservation value without restoration, and restoration may be difficult or uncertain.* |

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# Appendix A. Cowardin Systems, Classes, Water Regimes, and Special Modifiers

The descriptions are ordered from driest to wettest and are modified from Cowardin et al. (1979) as cited in Lemly et al. (2016).

## Cowardin System

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

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

## Cowardin Classes

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

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

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

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

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

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

## Water Regime Modifiers

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

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

**Saturated (ST):** The substrate is saturated to the surface for the entire year. This modifier is applied to fen like areas and some depressional wetlands and saturated meadow systems with stable water tables regardless of their connectivity.

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

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

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

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

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

## Special Modifiers

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

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

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

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

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

**Spoil (s):** This modifier refers to manmade alterations to wetlands where spoils from mining activity form the substrate.

**Reservoir (r):** This modifier describes wetlands that are formed adjacent to artificially constructed ponds or lakes.

**Channel (c):** This modifier describes wetlands that are formed adjacent to artificially constructed channels, such as canals or ditches.

**Spring-box (sb):** This modifier describes wetlands that are formed adjacent to human-made spring-boxes.

## Appendix B: Field Key to the Hydrogeomorphic (HGM) Classes

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

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

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

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

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

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

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

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

# Appendix C. Wetland Types in Nevada's Great Basin, Eastern Sierras, and Mojave

These descriptions are based on Castelli et al. (2000), Comer (2003), Lord et al. (2011), Lemly et al. (2016), and Weixelman et al. (1996, 1999). More detailed classifications are available for riparian ecosystems and meadow complexes in the central Great Basin (Manning and Padgett, 1995; Weixelman et al., 1996) and the Sierras (Weixelman et al., 1999.

## INTERMOUNTAIN BASIN PLAYA WETLANDS

These are natural, shallow wetlands with an impermeable soil layer, such as dense hardpan clay, which causes periodic ponding after heavy rains. Sites generally have closed contour topography, and are surrounded by upland vegetation. Hydrology is often tied to precipitation and runoff and may or may not have a groundwater connection. Ponding is often ephemeral and sites may be dry throughout the entire growing season during dry years. Species composition depends on climate and soil salinity, and may fluctuate significantly depending on seasonal moisture availability. Many persistent species may be upland species. Sites may have obvious vegetation zonation tied to water levels, with the most hydrophytic species occurring in the wetland center where ponding lasts the longest.

**Depression Alkaline to Saline Wetland** – Seasonally to semipermanently flooded, usually retaining water into the growing season and drying completely only in drought years. Many are associated with hot and cold springs and are located in closed basins. Soils are typically saline clay; salt encrustations can occur on the surface. Water levels vary. Species are typically salt-tolerant, including saltgrass (*Distichlis spicata*), alkali grass (*Puccinellia* spp.), wildrye (*Leymus* spp.), pickleweed or glasswort (*Salicornia* spp.), bulrush (*Schoenoplectus* spp.), and foxtail barley (*Hordeum jubatum*). Other commonly occurring taxa include Horned sea-blite (*Suaeda calceoliformis*), cordgrass (*Spartina* spp.), arrowgrass (*Triglochin* spp.), and occasional shrubs such as greasewood (*Sarcobatus vermiculatus*). This system can occur along the drawdown zones of lakes and ponds.

**Closed Depression Wetland -** In less saline environments, dominant species are typically not highly salt-tolerant. Common native species include western wheatgrass (*Pascopyrum smithii*), creeping wildrye (*Elymus triticoides*), basin wildrye (*Leymus cinereus*), spikerushes (*Eleocharis* spp.), fleaworts (*Plantago* spp.), and buckwheat (*Eriogonum* spp.). Non-native species are very common in these sites, including buckbush (*Salsola australis*), common kochia (*Bassia scopraria*), bigbract verbena (*Verbena bracteata*), and Canadian horseweed (*Conyza canadensis*). Sites have often been disturbed by agriculture and heavy grazing.

**Non-depressional Wetlands/Greasewood Flat –** Located on flats or in washes, with alkaline to saline soils. Cover of vegetation is variable, can be extremely sparse (<10% cover) or moderate to high (30–60% cover). Vegetation is typically dominated by shrubs such as greasewood (*Sarcobatus vermiculatus*) and saltbush (*Atriplex* spp.) with inclusions of alkali sacoton

(*Sporobolus airoides*), saltgrass (*Distichlis spicata*), Nuttall's alkaligrass (*Puccinellia nuttalliana*), and creeping spike rush (*Eleocharis palustris*) herbaceous vegetation.

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

## MARSHES

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

## FENS

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

## MONTANE RIPARIAN ECOSYSTEMS

The Montane Riparian system is found within a broad elevation range from about 4,000 ft (1,220 m) to over 9,000 ft (2,743 m). The general ecological type is found in low- to high-elevation canyons and draws, on floodplains, or in steep-sided canyons or narrow V-shaped valleys with varying substrates. Sites are subject to temporary flooding during spring runoff.

Stream gradient is dependent on local landforms and geomorphology. The water table is typically closely associated with the stream system, except when associated with springs or down-valley constrictions. Surface water is generally high for variable periods during spring runoff. Soils are typically alluvial deposits of sand, clays, silts and cobbles that are highly stratified with depth due to flood scour and deposition. Diagnostic species include willow (*Salix* spp.), cottonwood or aspen (*Populus spp.*), and conifers. Because stream gradients, substrates, and water availability are heterogeneous along stream/river reaches, vegetation is heterogeneous.

**Subalpine-Montane Conifer.** This system occurs on occurs on stream terraces or trough-shaped floodplains. Common tree species at higher elevations with colder soils include limber pine (*Pinus flexilis*), white fir (*Abies concolor*), subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*), and Douglas fir (*Pseudotsuga menziesii*). Ponderosa pine (*Pinus ponderosa*) and Rocky Mountain juniper (*Juniperus scopulorum*) can occur at more moderate elevations with warmer soils. Limber pine (*Pinus flexilis*) occurs in the central part of the Great Basin, but most of these types are more common in in the eastern portion of the Great Basin. Common shrubs are red twig dogwood (*Cornus sericea*), Wood's rose (*Rosa woodsii*), chokecherry (*Prunus virginiana*), and willow (*Salix* spp.). A wide variety of herbaceous species occur on these sites, with graminoids being more common on sites with finer textured soils and shallower depths to field capacity, and forbs occurring more often on site with a higher proportion of cobbles and greater depths to field capacity.

**Subalpine-Montane Quaking Aspen (*Populus tremuloides*).** This type commonly occurs on trough floodplains but is also found on stream terraces and toe slopes. Soils are relatively cold. On sites with relatively shallow depth to field capacity (27 ± 27 cm in the eastern Sierras), graminoids occur in understory and willows and alder may be present. On sites where depth to field capacity is greater (53 ± 53 cm in the eastern Sierras) shrub species include willow (*Salix* spp.), grey alder (*Alnus incana*), currant (*Ribes* spp.), and snowberry (*Symphoricarpos* spp.). Understory species can include sweet cicely (*Osmorhiza* spp.), buttercup (*Thalictrum* spp.), bluebells (*Mertensia* spp.), bloody cranesbill (*Geranium sanguineum*.), Gray's licorice-root (*Ligusticum grayi*), western columbine (*Aquilegia formosa*), Columbian monkshood (*Aconitum columbianum*), Wheeler's bluegrass (*Poa wheeleri*), mountain brome (*Bromus marginatus*), and wildrye (*Elymus* spp.).

**Subalpine-Montane Cold Willow.** This ecological type typically occurs on trough floodplains or trough stream terraces but also occurs on gravelbars. These sites occur at higher elevation in areas with steeper valley slopes (2.5 to 8%). Soils are sandy and depth to field capacity is close to the soil surface (about 10 to 50 cm). The dominant willow species are Booth's willow (*Salix boothii)*, yellow willow (*Salix lutea* x *Salix boothii*), Pacific willow (*Salix lucida* ssp. *Lasiandra*), and Geyer willow (*Salix geyeriana*). Sites with fewer cobbles where field capacity is close to the soil surface tend to have understories dominated by graminoids. Sites with a higher percentage of cobbles in the soil layers and greater depths to field capacity tend to have understories dominated by forbs.

**Montane Water Birch (*Betula occidentalis*).** This type typically occurs on stream terraces or trough-shaped floodplains that tend to be found in canyon constrictions. Average soil temperatures tend to be warmer but exhibit a broad range. Soils typically have a high proportion of coarse fragments (gravels, cobbles, and boulders). Sites usually have a dense overstory *of* water birch (*Betula occidentalis*).

**Lower Montane Warm Willow.** This ecological type typically occurs on gravelbars but is also found on trough-shaped floodplains, stream terraces, and incised landforms (Riverine HGM Class). These sites have a tendency to be found at lower elevations with gentler valley slopes (1-5%). Sites are associated with gravel-bed streams, and depth to field capacity is relatively close to the surface (approximately 80 cm). Warm willow species dominate (*Salix exigua*, *S. lutea*, *S. lemmoni*, or *S. lasiolepis*). On very warm sites, exotic shrub species may include salt-cedar (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia*). Sites with finer textured soils where field capacity is close to the soil surface tend to have understories dominated by graminoids; those with coarser textured soils and a high percentage of cobbles in the soil layers tend to have understories dominated by forbs. This system may occur on slopes, lakeshores, or around ponds where the vegetation is associated with groundwater discharge or a subsurface connection to lake or pond water, and may experience overland flow but no channel formation (Slope, Lacustrine, or Depressional HGM Classes). It is also typically found in backwater channels and other perennially wet but less scoured sites, such as floodplain swales and irrigation ditches.

**Lower Montane Cottonwood.** This type is most commonly found on stream terraces but also occurs on trough-shaped floodplains.  Soils are relatively warm. Usually, no more than 15% cobbles are found in any one soil horizon. Cottonwoods, either Fremont's cottonwood (*Populus fremontii*), black cottonwood (*Populus balsamifera* ssp. *Trichocarpa*) or narrowleaf cottonwood (*Populus angustifolia*) are overstory species. Understory shrubs may include willow (*Salix* spp.), chokecherry (*Prunus* spp.), skunkbush sumac (*Rhus trilobata*), dogwood (*Cornus* spp.), or sagebrush (*Artemisia* spp.). Understory grasses and forbs may include needlegrasses (*Achnatherum* spp.), slender wheatgarss (*Elymus* spp.), wildrye (*Leymus* spp.), California brome (*Bromus carinatus*), mountain brome (*Bromus marginatus*), muttongrass (*Poa fendleriana*), lupines (*Lupinus* spp.), bloody cranesbill (*Geranium* spp.), sweet cicely (*Osmorhiza* spp.), false Solomon's seal (*Maianthemum racemosum*), crimson columbine (*Aquilegja formosa*), buttercup (*Thalictrum* spp.), and western monkshood (*Aconitum columbianum*). This system can also occur on lakeshores or around ponds where the vegetation is associated with groundwater discharge or a subsurface connection to lake or pond water, and may experience overland flow but no channel formation (Slope, Lacustrine, or Depressional HGM Classes).

**Lower Montane *Artemisia tridentata* ssp. *tridentata*.** This type occurs along trough-shaped drainage ways and floodplains, stream terraces and toe slopes. This type may also occur in associations with incised or avulsed landforms. Soil temperatures are relatively warm. In systems that are not incised, field capacity is typically within a meter of the surface, but in incised systems field capacity is often greater than 1 m. Coarse fragments (gravels, cobbles, and boulders) are typically less than 60% by volume for unincised systems, but can be greater than 60% for incised systems. The graminoids needlegrass (*Achnatherum* spp.), basin wildrye (*Leymus cinereus*), slender wheatgrass (*Leymus trachycaulus* ssp. *trachycaulus*), or rush bluegass (*Poa secunda* ssp. *juncifolia*) are the most common grasses on unincised sites. Following incision, pine bluegrass (*Poa secunda* ssp. *secunda*), squirreltail (*Elymus elymoides*), and cheatgrass (*Bromus tectorum*) can be the most common grasses. This type may also occur at relatively high elevations in association with mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*).

## Meadow Complexes

Herbaceous wetlands associated with a relatively high-water table (ranges from 0 cm to about 400 cm depth to water table) that typically lack prolonged standing water. These wetlands generally occur on the landscape in association with a break in slope, seeps or springs, and/or montane streams. Sites may be dominated by *natural* groundwater inputs with fairly stable hydrology. Sites may exhibit ground water sapping, lowered water tables, and changes in vegetation composition when located adjacent to incising (downcutting) streams. Sites may also be controlled by *artificial* overland flow (surface or subsurface irrigation runoff or return flow) or artificial groundwater seepage (including from leaky irrigation ditches). Sites may be small or very large in size. These sites may be intentionally managed for hay production or may be the result of unintentional return flows, runoff, or seepage. Vegetation is dominated by native or non-native herbaceous species; graminoids (grasses, sedges, rushes) typically have the highest canopy cover. Species composition may be dominated by non-native hay grasses. Patches of emergent marsh vegetation and standing water are less than 0.1 ha in size and not the predominant vegetation.

**Montane Meadow** - Herbaceous wetlands associated with a high-water table or overland flow that typically lack standing water. Sites are typically associated with snowmelt or groundwater. Sites associated with the Flats or Slope HGM class are rarely subjected to high disturbance events such as flooding. Those associated with a stream channel are more tightly connected to overbank flooding from the stream channel (Riverine HGM Class) and may be affected by avulsion and/or incision. Sites vary in size; montane meadow vegetation may occur on stream terraces with elevated water tables. Vegetation is dominated by herbaceous species; graminoids typically have the highest canopy cover. Different plant community types are associated with different groundwater levels and are indicated by species with different physiological tolerances for depth to water table.

- ***Meadows with perennial standing water*** — Depth to water table is +10 cm above ground surface to 0 cm. Characteristic species include water sedge (*Carex aquatilis*), northwest territory sedge (*Carex utriculata*), panicled bulrush (*Scirpus microcarpus*), or water ragwort (*Senecio hydrophilus*).

- ***Wet meadow*** — Depth to water table is 5 to 30 cm. Characteristic species include Nebraska sedge (*Carex nebrascensis*), slender hairgrass (*Deschampsia elongata*)*,* or tufted hairgrass (*Deschampsia cespitosa*).
- ***Mesic meadow*** — Depth to water table – 30 to 90 cm. Characteristic species include smallwing sedge (*Carex microptera*), clustered field sedge (*Carex praegracilis*), rush bluegrass (*Poa secunda* ssp. *juncifolia*), mountain rush (*Juncus arcticus* ssp. *littoralis*), and tufted hairgrass (*Deschampsia cespitosa*). Kentucky bluegrass (*Poa pratensis*) is common and increases with grazing.
- ***Dry meadow*** — Depth to water table – 90 to 170 cm. Characteristic species include creeping wildrye (*Leymus triticoides*), slender wheatgrass (*Elymus trachycaulus*), rush bluegrass (*Poa secunda* ssp. *juncifolia*), and mat muhly (*Muhlenbergia richardsonis*).
- ***Dry shrub meadow*** — Depth to water table is 125 to 275 cm. Characteristic species include big sagebrush (*Artemisia tridentata* spp.), Douglas sedge (*Carex douglassii*), and basin wildrye (*Leymus cinereus*). Kentucky bluegrass (*Poa pratensis*) is common and increases with grazing.

**Irrigated Wet Meadow-** Large herbaceous wetlands associated with a high-water table that is controlled by artificial overland flow (irrigation). Sites typically lack prolonged standing water but may have standing water early in the season if water levels are very high. Vegetation is dominated by native or nonnative herbaceous species; graminoids have the highest canopy cover. Species composition may be dominated by non-native hay grasses such as bluegrass (*Poa* spp.), foxtail grass (*Alopecurus* spp.), timothy (*Phleum pretense*), *and* smooth brome (*Bromus inermis* spp. *inermis*). There can be patches of emergent marsh vegetation and standing water less than 0.1 ha in size; these are not the predominant vegetation.

## ADDITIONAL MOJAVE SYSTEMS

**Warm Desert Riparian Forest** – Riparian forest typically associated with a river or stream channel; streams may be perennial, intermittent, or ephemeral (Riverine HGM class) and may be adjacent to low elevation shrublands. The forest is dominated by cottonwood (*Populus fremontii*) and mulefat (*Baccharis salicifolia*) is often present. Velvet ash (*Fraxinus velutina*), and Goodding's willow (*Salix gooddingii*) may be present in low abundance (<5% cover). Elevation is typically below 4,000 ft (1,220 m). When mesquite low bosque is the dominant type outside of perennial waterways, the type is also found at elevations lower than 3,600 ft (1,100 m) along intermittent streams or in valley bottoms along playa edges with a perched water table. Other common associates may include arrowweed (*Pluchea sericea*), saltgrass (*Distichlis spicata*), alkali sacaton (*Sporobolis airoides*), *Carex* spp., *Typha* spp., sandbar willow (*Salix exigua*), mesquite (*Prosopis* spp.), and rubber rabbitbrush (*Ericameria nauseosa* (=*Chrysothamnus* *nauseosus*)). Halophytic shrub-dominated patches typically occur on drier sediment deposits or saltier surfaces. *Tamarix* spp. may replace native willows (*Salix* spp.) or mesquite (*Prosopis* spp.) shrublands or other native vegetation. Russian olive (*Elaeagnus angustifolia*) is also common. These invasive species can also occur on riverbanks, floodplains, basins, sandbars, side channels, springs, salt flats, and other saline habitats. Stands grow especially well along regulated rivers and rivers with agricultural runoff which increases the salts in the water. The **Warm Desert Riparian Forest** can also occur on the shores of reservoirs where the vegetation is associated with groundwater discharge or a subsurface connection to groundwater and may experience overland flow but no channel formation (Lacustrine or Depressional HGM Classes). Vegetation is dependent upon periodic flooding.

**Mesquite wet scrub** – Closed woodlands dominated by honey mesquite (*Prosopis glandulosa*), screwbean mesquite (*P. pubescens*), and/or velvet mesquite (*P. velutina*). Sites include mesic areas such as floodplains, streambanks, intermittently flooded arroyo terraces, alkali sinks, and washes. Substrates are generally coarse-textured, gravelly alluvium. The age of stands, substrate conditions, and moisture availability determine the canopy composition and cover. The understory shrub layer may include species of *Acacia*, *Atriplex*, *Baccharis*, and *Suaeda*, but also may include many other species. Succulents may occur, including species of prickly pear *(Opuntia* spp.*)* and yucca (*Yucca* spp.). The introduced shrub, tamarisk (*Tamarix* spp.)*,* may outcompete *Prosopis pubescens* in areas with relatively low water tables.

**Mesquite low bosques and desert shrubland –** Low elevation desert riparian vegetation dominated by honey mesquite (*Prosopis glandulosa*), and/or velvet mesquite (*P. velutina*) and/or shrubs such as mulefat (*Baccharis salicifolia*), arrowweed (*Pluchea sericea*), Geyer's willow (*Salix geyeriana*), silver buffaloberry (*Sheperdia argenta*), and/or sandbar willow (*Salix exigua*). This type occurs along perennial and intermittent streams and rivers throughout canyons and desert valleys with alluvial soils. Vegetation is dependent on an annual rise in the water table or annual/periodic flooding associated with sediment scour for growth and reproductions.

**Saline Meadow** - The saline meadow system is wetted by an elevated water table or is spring-fed. Saturated soils support graminoid dominance. Soils are deep and saline. These wet meadows are found at the bottom of broad valleys and on alluvial flats at sea level up to 1,524 m (5,000 ft.) with slopes between 0-2%, usually surrounded by salt tolerant plant communities. Average annual precipitation ranges from 10 to 25 cm (4" to 10"). Alkali sacaton (Sporobolus airoides), muly *(Muhlenbergia* spp.), or threesquare bulrush (*Schoenoplectus pungens*) dominates, although inland saltgrass (Distichlis spicata) may co-dominate on some soils. Mesquite (*Prosopis* spp.), especially expressed as low shrubs, black greasewood (*Sarcobatus vermiculatus*), quailbush (*Atriplex lentiformis*), cattle saltbush (*Atriplex polycarpa*), and four-wing saltbush (*Atriplex canescens*) may be present at low abundance*.*

# Appendix D: Simplified Key to Soil Texture

**Simplified Key to Soil Texture**
(Adapted from Brewer and McCann 1982)

Place about three teaspoons of soil in the palm of your hand. Take out any particles ≥ 3 mm in size.

**A.** Does soil remain in ball when squeezed in your hand palm?

Yes, soil does remain in a ball when squeezed.............................................................................. **B**

No, soil does not remain in a ball when squeezed........................................................................ **sand**

SAND Sand (class unknown)
Very coarse texture..........................................................COSA Coarse sand
Moderately coarse texture.................................................MESN Medium sand
Moderately fine texture......................................................FISN Fine sand

**B.** Add a small amount of water until the soil feels like putty. Squeeze the ball between your thumb and forefinger, attempting to make a ribbon that you push up over your finger. Does soil make a ribbon?

Yes, soil makes a ribbon; though it may be very short.................................................................**C**

No, soil does not make a ribbon..................................................................................**loamy sand**

Very gritty with coarse particles................................................COLS Coarse, loamy sand
Moderately to slightly gritty with medium to fine particles.........MELS Medium to very fine, loamy sand

**C.** Does ribbon extend more than one inch?

Yes, soil extends > 1 inch.........................................................................................................**D**

No, soil does not extend > 1 inch.........................................................................Add excess water

Soil feels gritty or not smooth............................................... **sandy loam or loam**

LOAM Loam (class unknown)
Very gritty with coarse particles...............................................MCSL Moderately coarse, sandy loam
Moderately gritty with medium to fine particles........................MESA Medium to very fine, sandy loam
Slightly gritty ..............................................................................MELO Medium loam

Soil feels very smooth...........................................................................................**silt loam**

MESIL medium silt loam

**D.** Does ribbon extend more than 2 inches?

Yes, ribbon extends more than 2 inches, and does not crack if bent into a ring...........................**E**

No, soil breaks when 1–2 inches long; cracks if bent into a ring.......................Add excess water

Soil feels gritty or not smooth..........................................**sandy clay loam or clay loam**
Moderately to very gritty................................................ MFSA Moderately fine sandy clay loam
Slightly gritty or not smooth............................................ MFCL Moderately fine clay loam

Soil feels very smooth.......................................................................**silty clay loam or silt**
Moderately fine texture.....................................................MFSL Moderately fine silty clay loam
Very fine texture...............................................................MESI Medium silt

**E.** Soil makes a ribbon 2+ inches long; does not crack when bent into a ring................Add excess water

Soil feels gritty or not smooth..........................................................**sandy clay or clay**
Moderately to very gritty................................................ FISA Fine sandy clay
Slightly gritty or not smooth............................................ FICL Fine clay
CLAY Clay (class unknown)

Soil feels very smooth........................................................................................**silty clay**

FISC Fine silty clay

UNKN = UNKNOWN PEAT = PEAT MUCK = MUCK

## Appendix E: Notes on Hydric Soil Indicators for the Mountain West (from Lemly et al., 2016)

### Does the soil layer have…

Organic matter ≥ 40 cm thick (you can combine layers of Peat, Muck, and Mucky Peat) Look at **A1**

≥ 20 cm thick (you can combine layers of Peat, Muck, and Mucky Peat) Look at **A2, A3**

Mucky Mineral texture

Look at **S1, F1**

Smells like rotten eggs?

Look at **A4**

A Gleyed Matrix with a Hue of N, 10Y, 5GY, 10GY, 5G, 10G, 5BG, 10BG, 5B, 10B, 5PB

Look at **S4** if texture is Sand or Loamy Sand and **F2** for all other textures

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

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

Chroma ≤ 2

Value ≥ 4

This layer could be a depleted matrix. Look at **A11, A12, F3**

Value ≤ 3

w/ redox concentrations

Look at **S5** if texture is Sand or Loamy Sand and, **F6** for all other textures

w/ redox depletions

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

## Brief Indicator Descriptions

## All Soil Types

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

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

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

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

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

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

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

## Sandy Soil Types

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

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

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

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

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

## Loamy / Clayey Soil Types

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

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

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

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

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

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

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

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

**Table E1.** Comparison of indicators with depleted matrices and redox features.

# Appendix F: Nevada Wetland RAM Field Equipment and Supplies List

## Field staff supplies:

- Sun protection: Sun hat, Sunscreen, Long-sleeve shirt, Sunglasses
- Rain jacket
- Bug protection: Bug spray, Long pants
- Muck boots (or field shoes or waders, depending on site)
- Gallon drinking water
- Field pack
- Lunch/field snacks

## Documents:

- NV RAM Data Sheets
- Nevada Wetland Rapid Assessment Method Appendices
- DRAFT RAM Field Manual (excerpts)
- NV Wetland Level 1 “Wet Bar” Report for each site
- NV plants 4 condition assessment (S Swanson, 2016)

## General Equipment:

- 1- Large plastic tub, for equipment
- 1- Retractable tape-measure, at least 50 meters (for assessment area)
- 1- Digital Camera, plus charged batteries
- 2- SD cards for camera
- 1- Dry erase board, at least 8” x 11” (for photo #, compass aspect, date)
- 2- Dry erase markers
- 1- GPS Unit, plus extra batteries
- 10 – Flags, 4 at least 36” tall, plus a variety of heights for various wetland vegetation
- 1- Roll of flagging
- 1- Compass
- 2- Clipboards
- 1- Air temperature thermometer
- 4- Mechanical pencils w/erasers
- 1-box gallon zip-lock bags
- 1- Long blade shovel (for soil pits)
- 1- Soil trowel
- 1- Soil knife with depth markings
- 1- Stiff tape-measurer, at least 30 cm (for soil and water chemistry pits)
- 10- Small pins to mark soil layer differentiations
- 2- Squirt bottle

- 1- Cup for water chemistry sample
- 1- Small magnifying glass
- Water chemistry meter: Temp (C), pH, Electrical Conductivity (dS), Dissolved Oxygen (DO)
- 1 - Plant Press
- Small tarp/piece of plastic
- Extra water and hard bristle brush (for cleaning footwear of mud and seeds)
- Bleach solution (for cleaning gear if site harbors invasive pests, e.g. quagga or zebra mussels or mud snails)

## Field Guides:

**Vegetation-**

- Swanson S. 2016. Nevada Plants Useful for Riparian Condition Assessment and Monitoring. Special Publication 16-15. University of Nevada Cooperative Extension.
- Checklist of non-native plants for So. NV: https://www.unce.unr.edu/publications/files/nr/2005/SP0505.pdf
- Invasive weed identification for NV: https://www.unce.unr.edu/publications/files/nr/2003/SP0309.pdf
- Nevada Noxious weeds field guide: https://www.unce.unr.edu/publications/files/nr/2010/sp1001.pdf

**Soils-**

- Munsell Soil Color Chart
- U.S. Army Corps of Engineers. 2008. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region (Version 2.0). Hydric soil key for the arid west region, Section 3.
- U.S. Department of Agriculture, Natural Resources Conservation Service. 2018. Field Indicators of the Hydric Soils in the United States: A Guide for Identifying and Delineating Hydric Soils, Version 8.2.

# Appendix G. Nevada Wetland RAM Expert Engagement Summary

Extensive partner and stakeholder outreach activities were conducted throughout the development of the NV RAM in 2018 and 2019. The core NV RAM development team, represented by the authors of this manual, convened meetings, workshops and field trips to gather input from developers of other western U.S. RAMs and feedback from likely users from Nevada. The goal was to synthesize this input into a RAM capable of addressing multiple wetland targets and the variety of wetland classes found in Nevada and to meet the NNHP WPP (2017) call for a cost-effective RAM that works for wetland monitoring within and among regions. A common theme heard from targeted stakeholder outreach was the agencies' needs for a cost-effective method for ambient wetland condition assessment within Nevada's hydrographic areas (i.e., groundwater administrative areas) or within specific land management units. The stakeholders engaged in this project expressed that they saw the benefit of enhancing the consistency of wetland assessments, and enabling better knowledge of regional distribution and condition of wetland habitats across the state.

In early June 2018, a virtual meeting of regional wetland assessment experts occurred that included Jeanne Chambers (USDA-FS Rocky Mountain Research Station), Don Faber-Langendoen (NatureServe), Eric Stein (Southern CA Coastal Water Research Project), and Joanna Lemly (CO Natural Heritage Program). These wetland experts have been directly involved in developing many of the existing RAMs successfully deployed throughout the Western US. Their advice included identifying likely end users, surveying potential assessors regarding their needs for a NV wetland RAM, exploring how to leverage existing efforts and RAM frameworks, and suggesting processes for RAM development.

We developed a survey that was distributed in June 2018 to 67 likely NV RAM users and/or water resource managers. We received a 37% (25) response rate from 12 organizations, including the Bureau of Land Management (BLM), US Fish and Wildlife Service (USFWS), National Park Service (NPS), USDA Natural Resources Conservation Service (NRCS), USDA Forest Service (USDA-FS), US Geological Survey (USGS), Nevada Division of Environmental Protection (NDEP), Nevada Department of Transportation (NDOT), Nevada Department of Wildlife (NDOW), The Nature Conservancy (TNC), University of Nevada Cooperative Extension (UNCE) and Colorado State University (CSU[1]). The eight-question survey covered the following topics and provided the following input (*question topics are **bold- italicized***):

1. Respondents foresaw ***using a wetland RAM*** primarily for restoration planning.
2. Assessing general wetland ecological health was the ***priority objective for a RAM to be useful for their organization's work.*** Assessing relative wetland ecosystem resiliency;

[1] CSU's Center for Environmental Management on Military Lands (CEMML) conducts wetland monitoring on military sites in Nevada.

prioritizing wetlands for restoration, management actions, and protection; and synthesizing management strategies for different wetlands types also ranked high.

3. The National Wetlands Inventory was the ***wetland classification system*** reported as most useful for their work. Cowardin, NDOW, and Hydrogeomorphic systems also ranked high. Several respondents indicated they use Proper Functioning Condition which was not an option on our list.
4. The ***wetland types or classes prioritized most for rapid assessment*** included streams, including riparian zones, meadows, and freshwater marshes. Springs were indicated frequently under the "other" category. BLM commented that prioritization of wetlands for assessment may be broader than by type or class to include resource values, risk factors, and potential for responses to management.
5. Wetland vegetation, wet meadow vegetation, and riparian vegetation were the ***wetland dependent species most targeted by their work***. Birds, fish, and macroinvertebrates also ranked high.
6. Eight organizations have ***clearly articulated management or work goals,*** or ***objectives or targets related to wetlands***. USDA-FS has an acres-to-restore target and TNC has species-specific targets, whereas USFWS includes both. BLM is tied to the Proper Functioning Condition assessments. NDOT and NRCS are guided by regulatory compliance. CSU provides wetland assessment services to military installations and is thus tied to their wetland targets.
7. Eight agencies/organizations have ***used a wetland RAM*** from another state or agency, or their organization ***requires an existing wetland RAM***.

Other survey takeaways included that the state agencies do not seem to have a consistent mandated approach. However, federal agencies have approaches they tend to use but are not always consistently used within an agency. There was not a clear takeaway on which classification system would be best; although NWI was the classification system most selected as useful, there were two respondents who indicated they would not use it, and a couple of comments about its lack of utility. Target species of interest to most respondents were vegetative (i.e., riparian, wet meadow, or wetland vegetation). The notion that wetland rapid assessments could be useful for multiple objectives and purposes was clear. The survey also elicited responses that strongly encouraged building upon existing protocols.

The core team, plus Dr. Jeanne Chambers of the USDA-FS Rocky Mountain Research Station, further refined the RAM parameters during a July 2018 tour of 12 central and northern Nevada wetland sites, many of which Dr. Chambers and her team have studied for decades. The discussion centered on identifying the Nevada wetland types lacking assessment method coverage and which targets and endpoints would align with the needs of Nevada's primary water resource managers: NNHP, BLM, USDA-FS, and NDOW. The core team was also joined by Larry Teske (NDOW, retired) and John McCann (USDA-FS Hydrologist).

The survey results and tour feedback directly influenced the parameters of the NV RAM and the decision to build the NV RAM upon the work of the CNHP and WYNDD. Subsequent outreach to the WYNDD RAM authors resulted in the decision to build the NV RAM upon their most recent refinements to the protocol for the Little Snake Basin in southern Wyoming (Washkoviak et al., 2018).

An initial draft of the NV RAM was shared at a workshop in February 2019 held at the DRI offices in Reno and Las Vegas. Remote connection was also available for the workshop. Twenty participants attended from the following agencies and organizations: USFWS, Colorado State University (CEMML), TNC, USDA-FS, Department of Defense, NDOW, USDA-NRCS, DRI, BLM, NNHP, University of Nevada Cooperative Extension, Nevada Division of Environmental Protection, Nevada Department of Transportation, USGS, Intermountain West Joint Venture, and US-EPA. Agreement on the approach, classification systems and use of the WYNDD RAM framework was reached by the attendees, and suggested refinements to the protocol were applied to the draft NV RAM.

The draft NV RAM was tested during the in-field verification stage in May and July 2019 to determine whether the protocol accurately measured the stated assessment endpoints for Nevada specific wetlands, and could be performed within the two-person, four-hour EPA guidance for a Level 2 assessment. In May 2019, two Mojave desert wetland sites were assessed by TNC, Colorado State-CEMML and NNHP wetland experts and field staff. The Warm Desert Riparian, Arid West Emergent Marsh, and Saline Meadow wetland types were tested at TNC's Torrance Ranch and 7J Ranch. In July 2019, three Great Basin (TNC's McCarran and River Fork Ranches, and the USFWS Stillwater National Wildlife Refuge) and one Eastern Sierra (Dog Valley) wetland sites were assessed. Note that Dog Valley is located just over the California border. While the site served as a proxy for slope wetland sites farther east in Great Basin that for logistical reasons the team was not able to access in July, it also provided an opportunity to try the NV RAM in the Eastern Sierras. Across the four sites assessed in July, the draft NV RAM was tested at the following wetland types: Depression Alkaline, Saline Wetland, Arid West Emergent Marsh, Warm Desert Riparian, Meadow Complex, Montane Meadow, and Wet Meadow. See Appendix C for descriptions of these Nevada wetland types. Wetland experts and field staff from USDA-FS, NDOW, USFWS, University of NV-Reno, TNC, NNHP, and DRI performed the July assessment and provided detailed feedback.

Collectively the input and detailed feedback provided through these meetings, workshops and field verification assessments informed the Draft NV RAM.

# Appendix H. Sample Level 1 Nevada Wetland Assessment Toolbar Report

# Nevada Wetland Mapping Level 1 Report

2019-07-11

Site Name: Goose Lake

Ownership: Stillwater National Wildlife Refuge, FWS

County: Churchill

Location: -118.436147, 39.600141 Lon/Lat WGS-84

376696, 4384364 UTM Zone 11 NAD83

Area: 119.8 acres

Perimeter: 1.9 miles

HUC10: 1605020304

S.E. Area: Carson Desert

| Environmental Conditions | Average | Range |
|---|---|---|
| Elevation (m) | 1183 | 1182, 1185 |
| Slope (%) | 0 | 0, 2 |
| Dominant Aspect(s) | Flat | |
| Annual precipitation (mm) | 521.1 | |
| Minimum monthly temperature (C) | 3.2 | -6.1, 14.0 |
| Mean monthly temperature (C) | 11.8 | 0.5, 24.6 |
| Maximum monthly temperature (C) | 20.4 | 6.8, 35.1 |

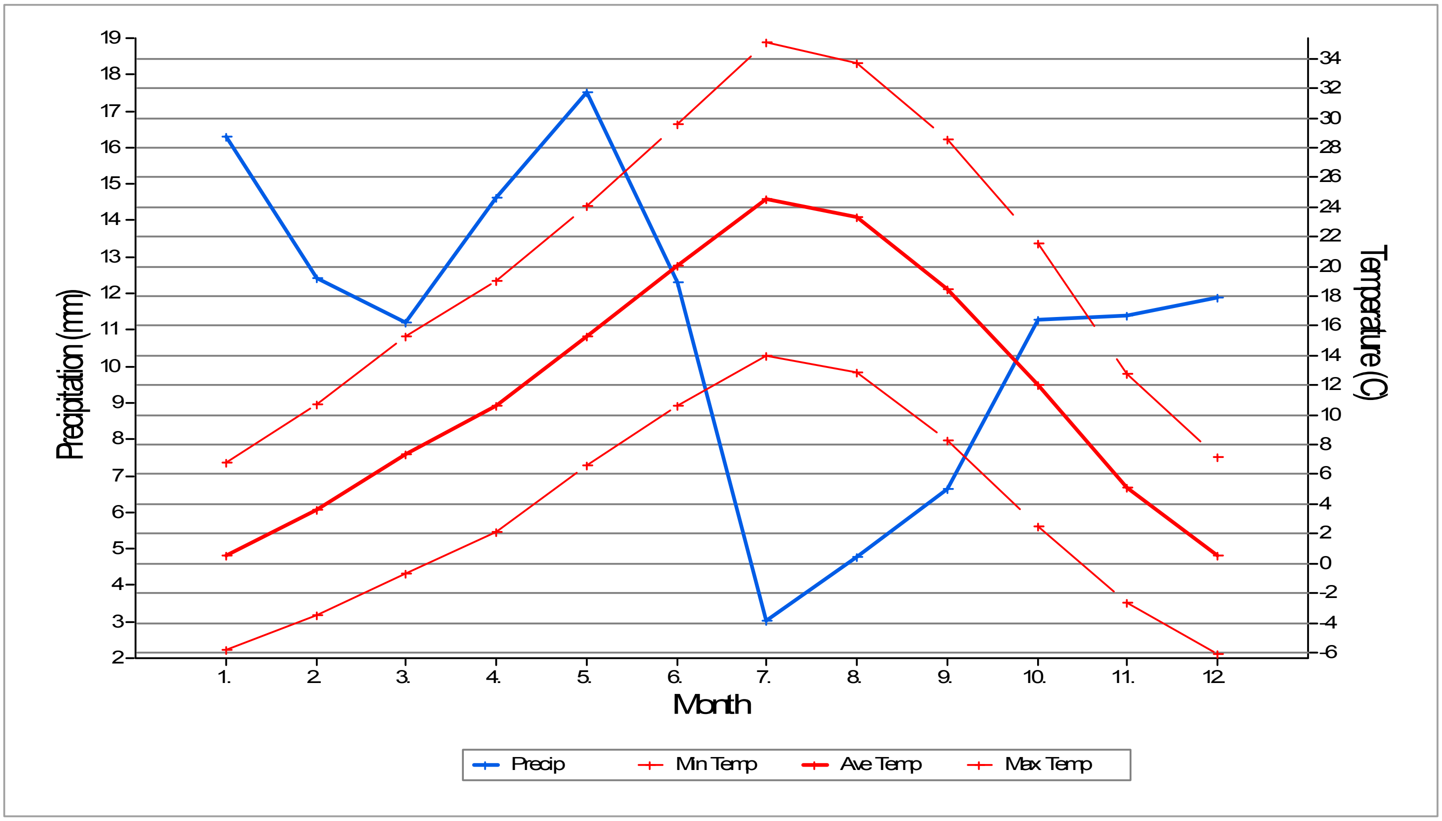
Soils:
Parran-Isolde complex, 0 to 4 percent slopes 53.2%
Water 30.6%
Isolde-Parran-Appian, clay substratum complex, 0 to 15 percent slopes 10.5%
Carson-Mackerlake-Turupah complex, 0 to 1 percent slopes 5.7%

NWI Class:
Lake, : 0.1%
Littoral, aquatic bed: 9.8%
Littoral, emergent: 10.9%
Palustrine, shoreline: 20.4%
Palustrine, vegetated shoreline: 56.0%
Riparian, undifferentiated: 2.7%

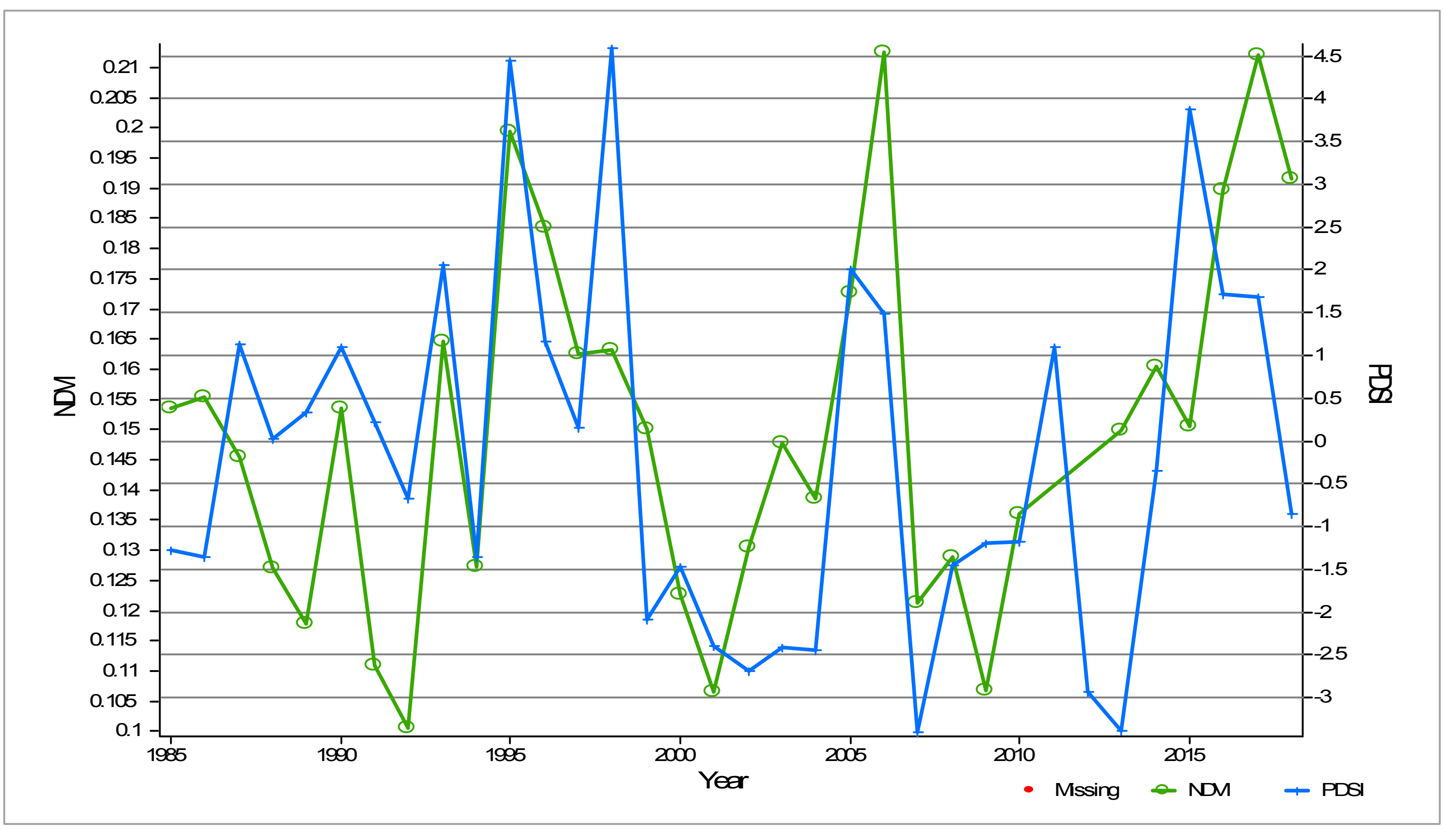
Groups: TNC

# Goose Lake

## Monthly Climatology

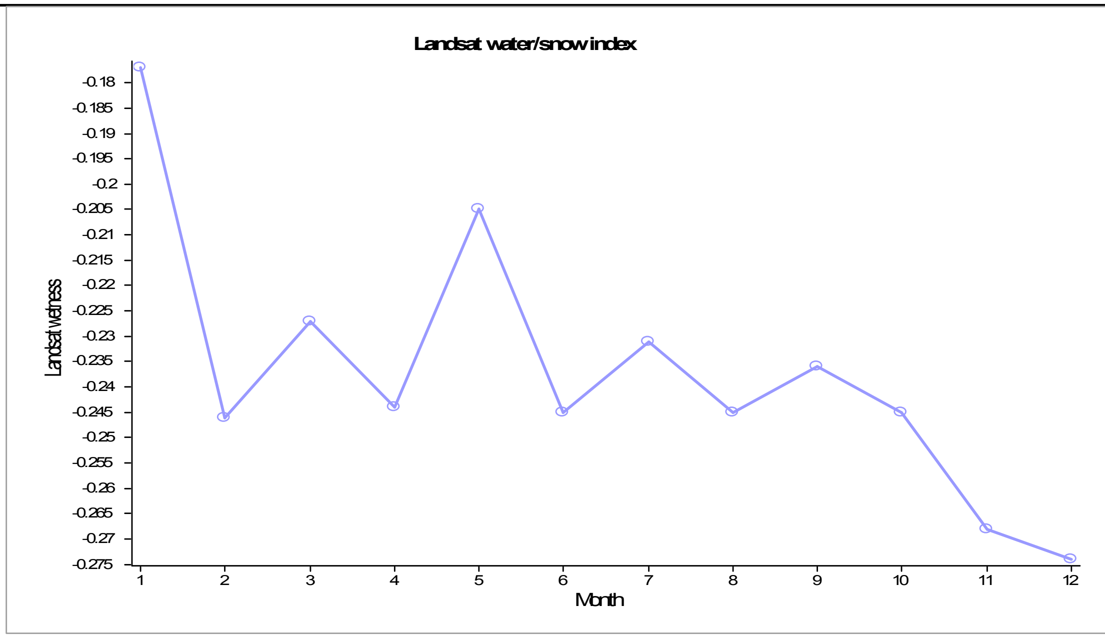


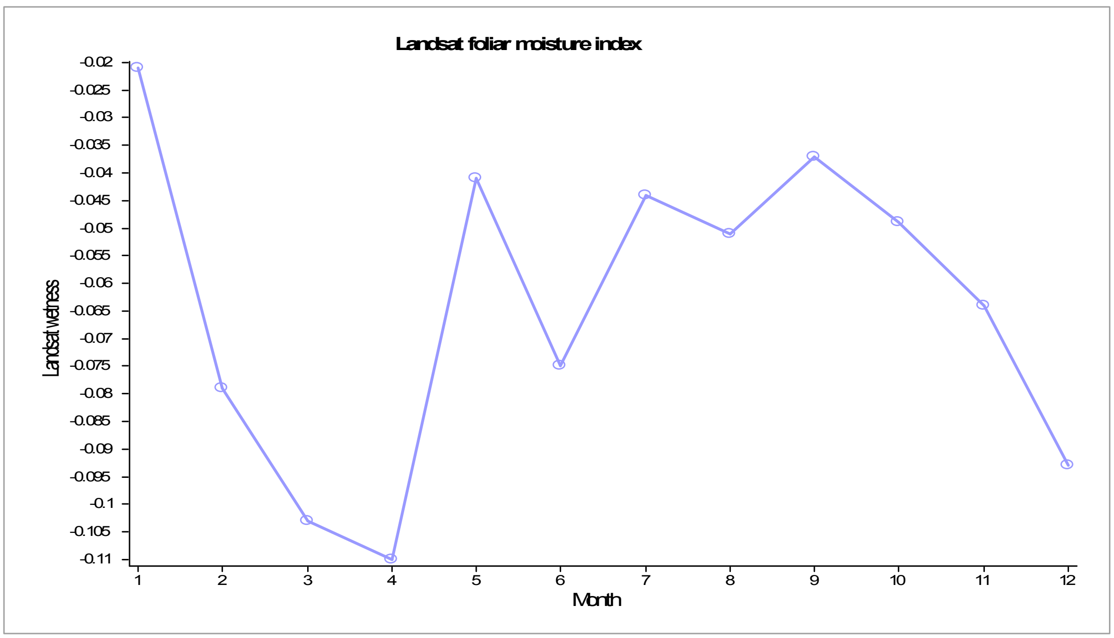

## Trends

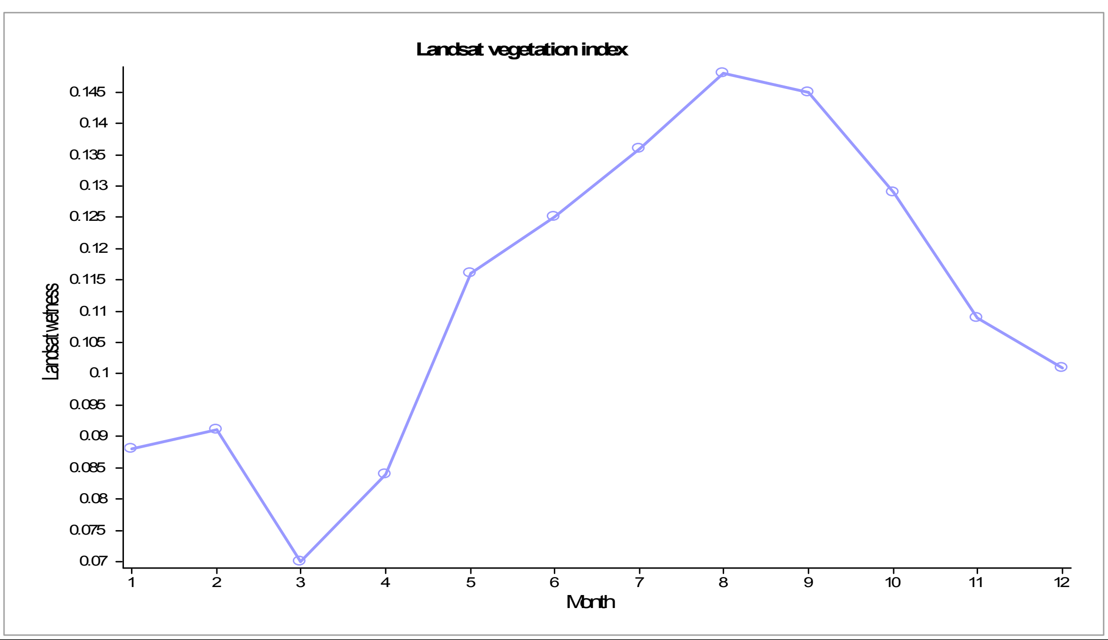


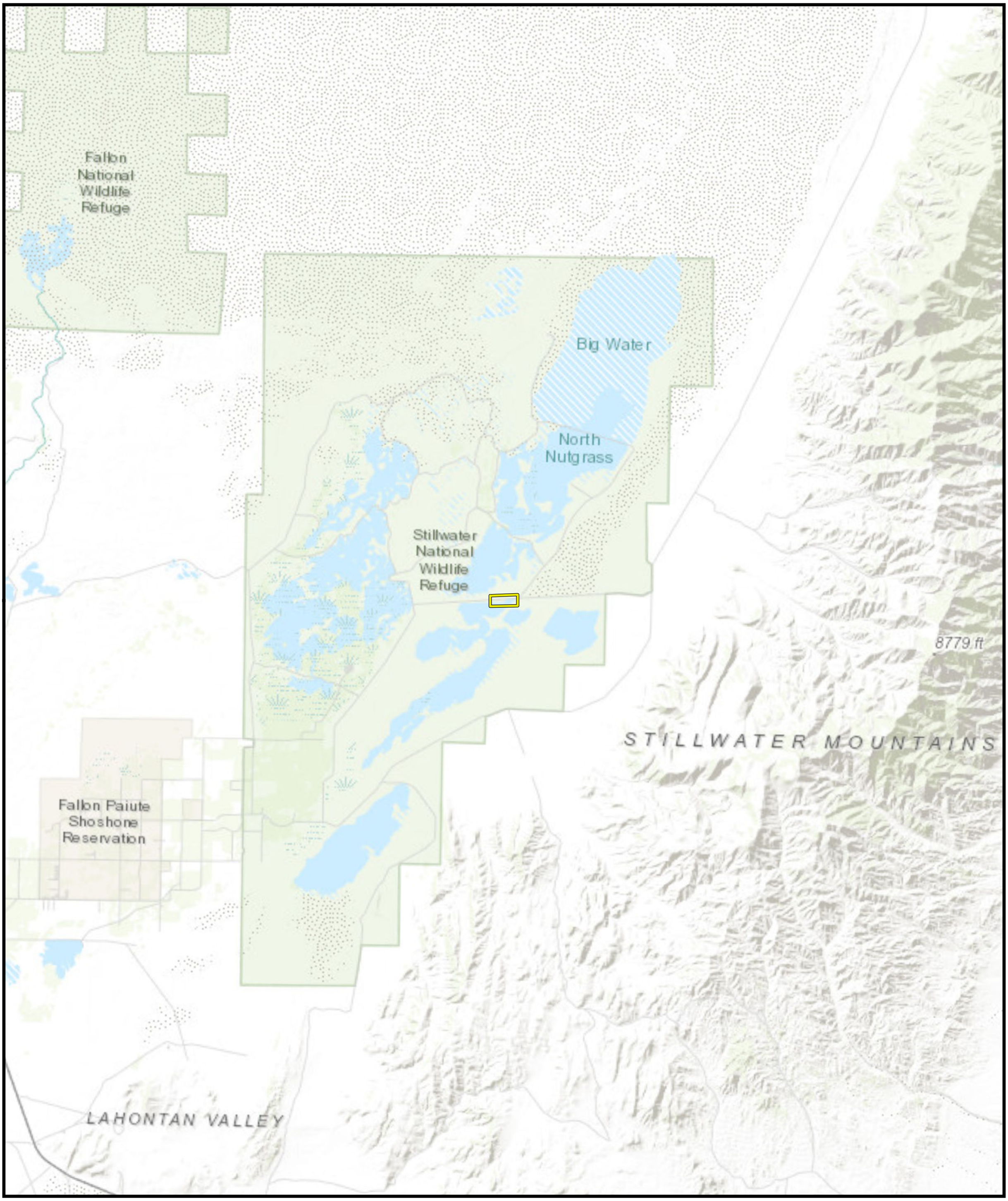

Landsat Late-Summer NDVI

Palmer Drought Severity Index


Landsat water/snow index
Landsat wetness
-0.18
-0.185
-0.19
-0.195
-0.2
-0.205
-0.21
-0.215
-0.22
-0.225
-0.23
-0.235
-0.24
-0.245
-0.25
-0.255
-0.26
-0.265
-0.27
-0.275
1 2 3 4 5 6 7 8 9 10 11 12
Month


Landsat foliar moisture index
Landsat wetness
-0.02
-0.025
-0.03
-0.035
-0.04
-0.045
-0.05
-0.055
-0.06
-0.065
-0.07
-0.075
-0.08
-0.085
-0.09
-0.095
-0.1
-0.105
-0.11
1 2 3 4 5 6 7 8 9 10 11 12
Month

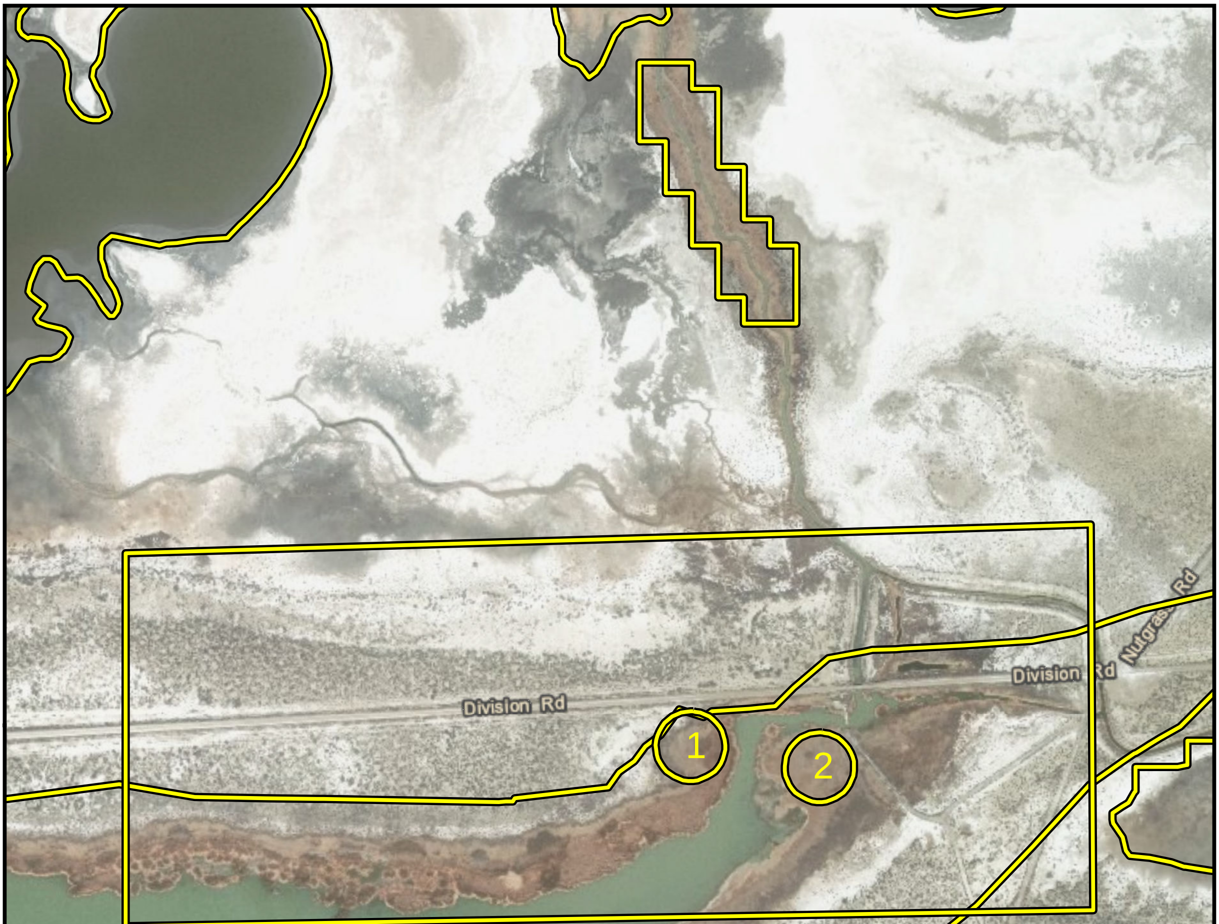

Landsat vegetation index
Landsat wetness
0.145
0.14
0.135
0.13
0.125
0.12
0.115
0.11
0.105
0.1
0.095
0.09
0.085
0.08
0.075
0.07
1 2 3 4 5 6 7 8 9 10 11 12
Month



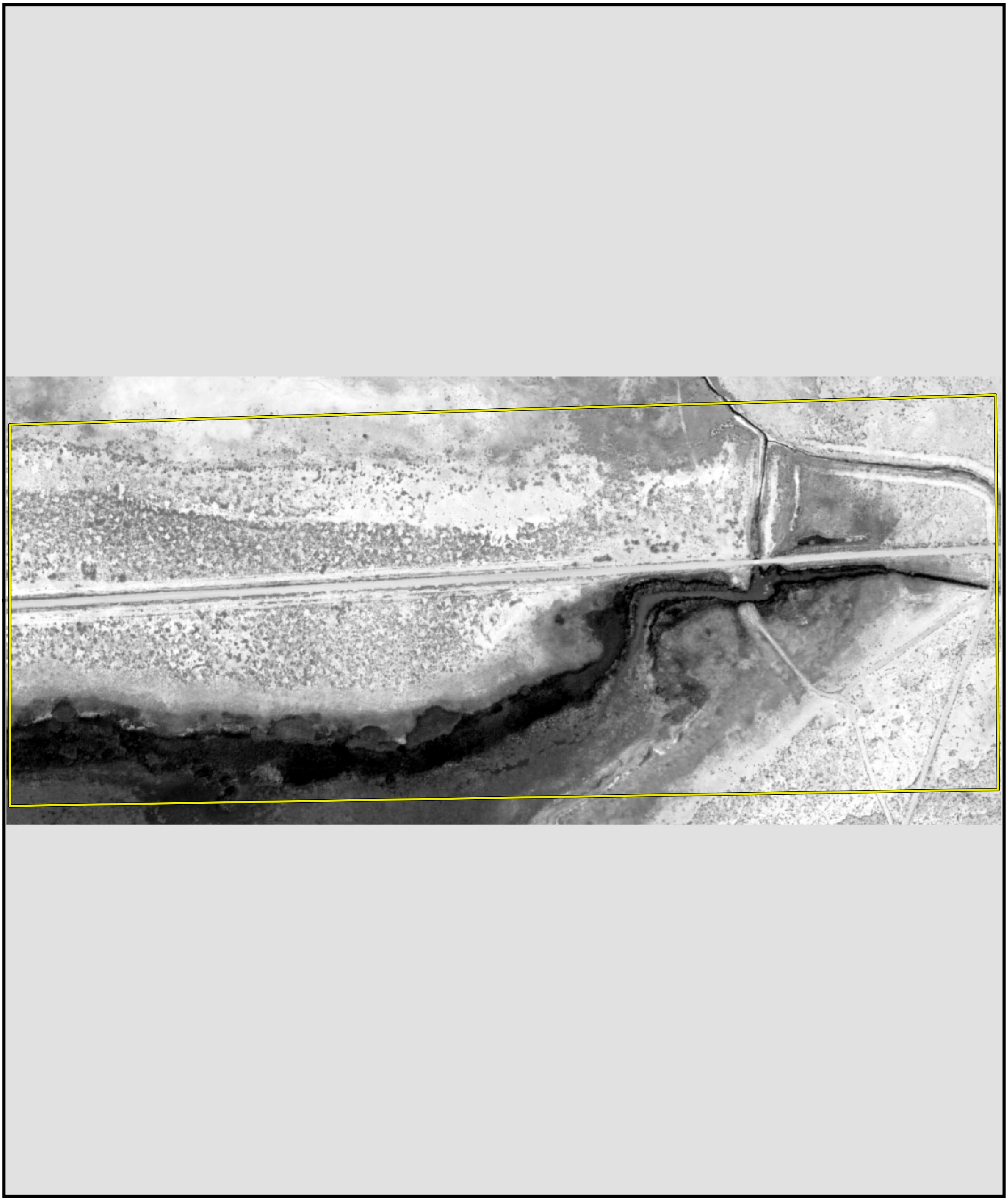

Goose Lake

N 0 15 Miles

Road Map

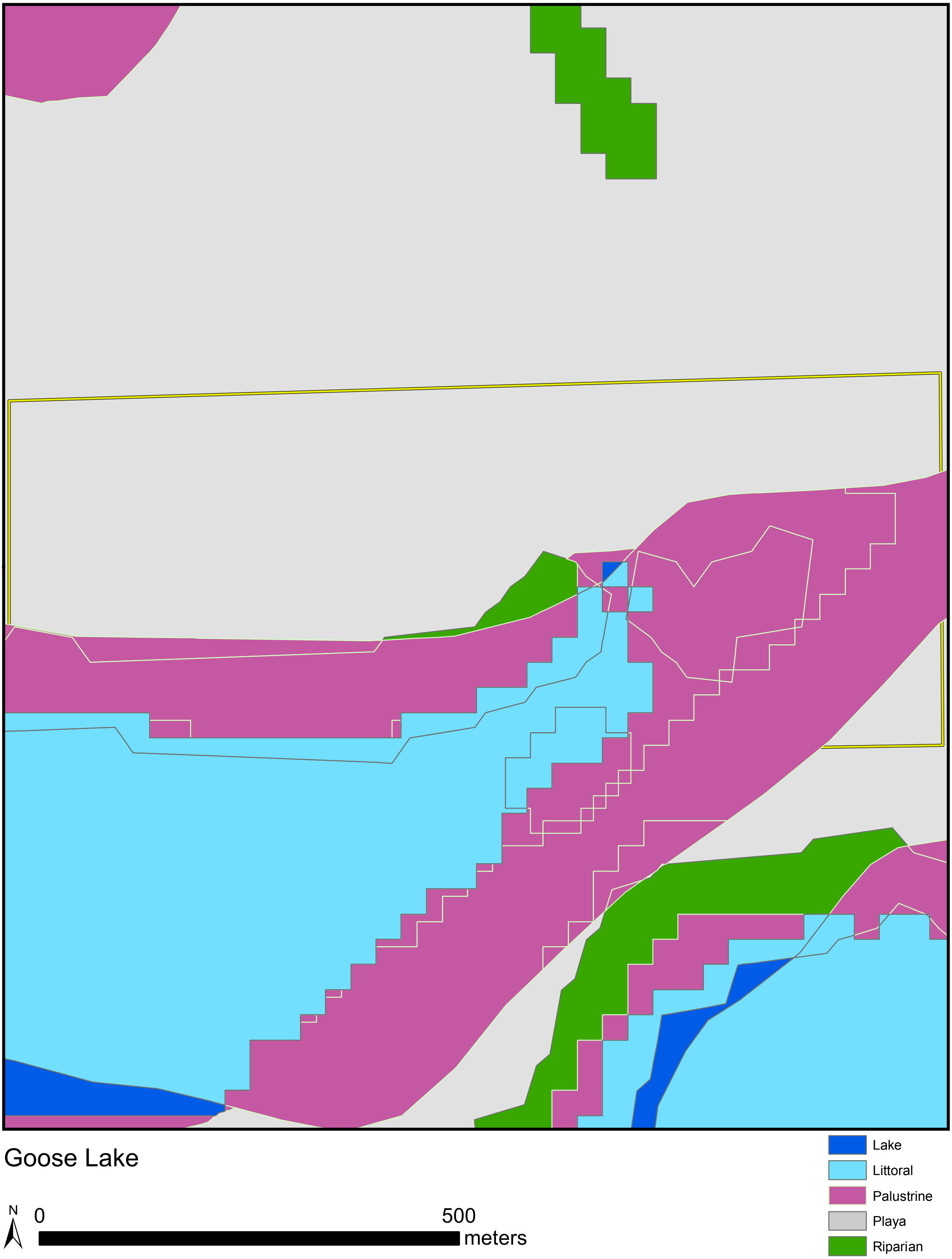



Goose Lake: Recent

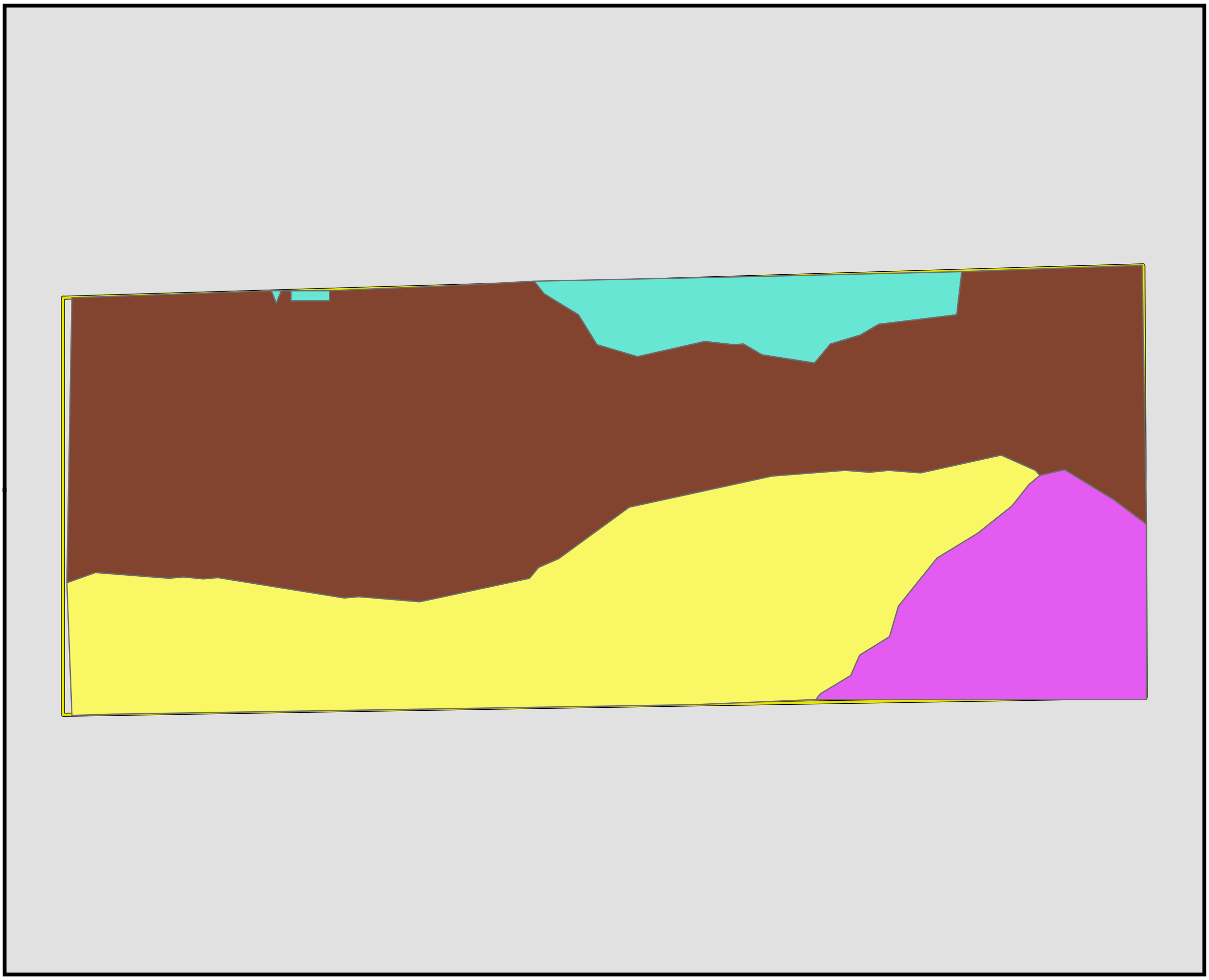


Goose Lake: 2003-2007


Mid-2000s NAIP



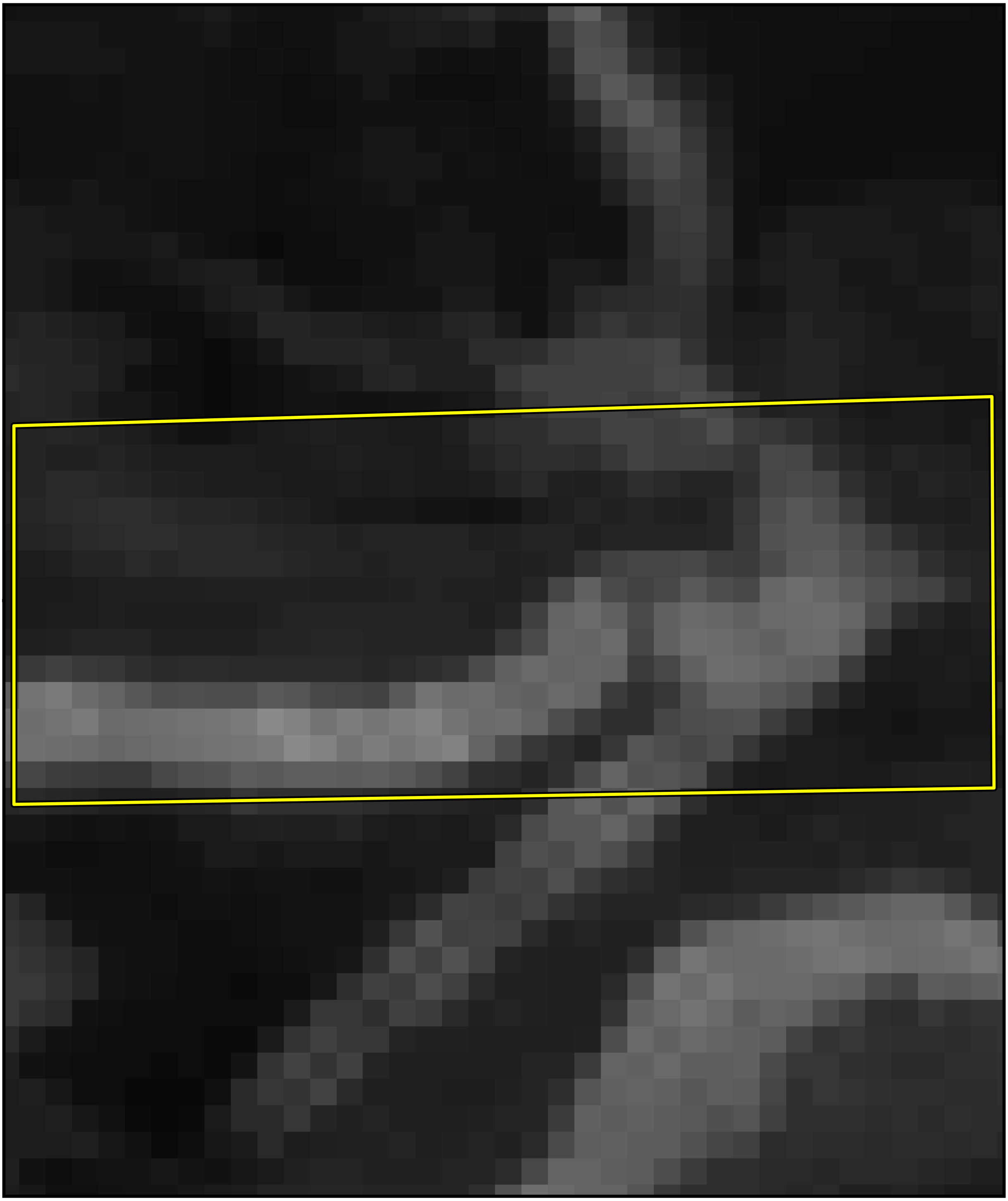

Goose Lake



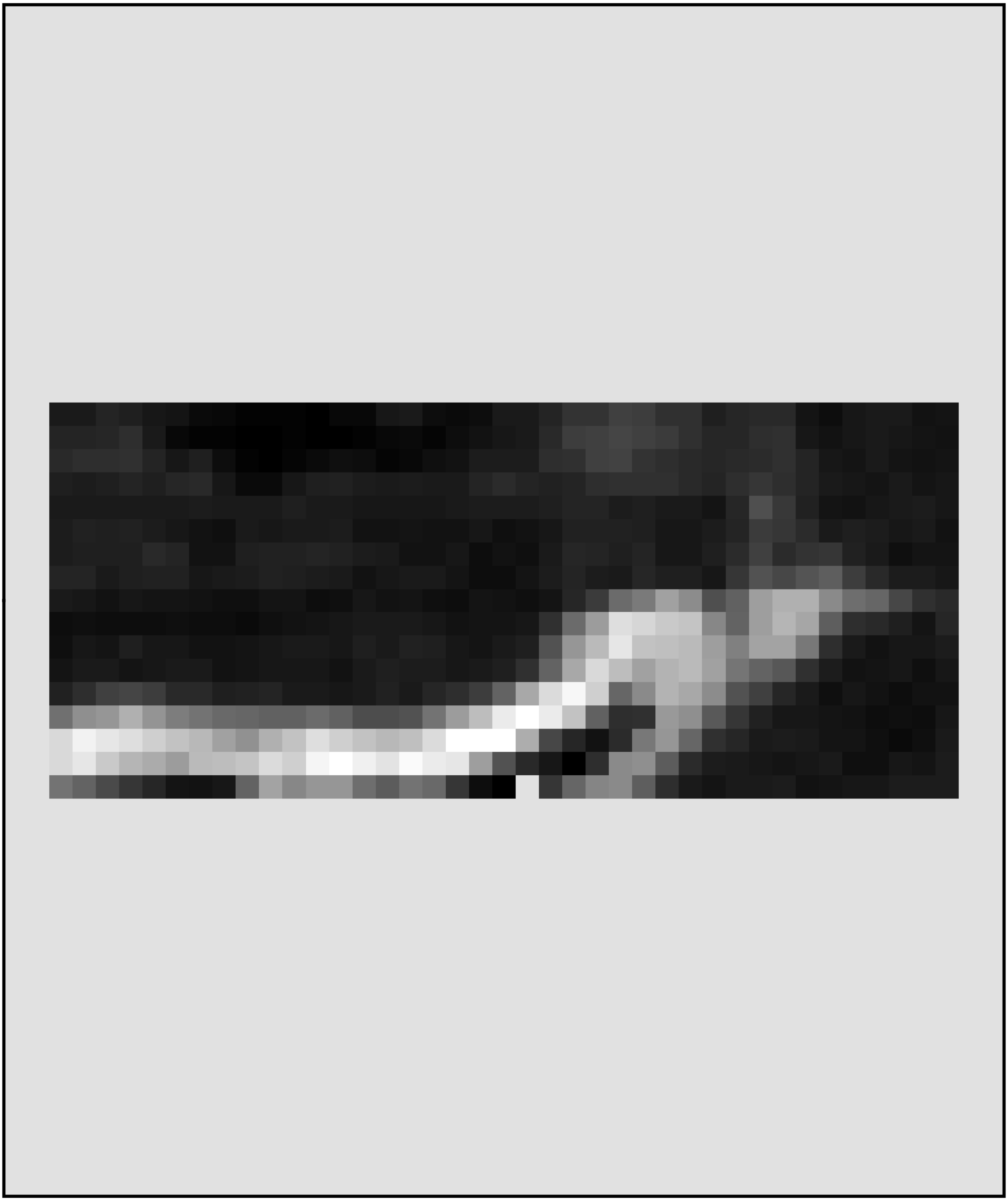
Carson-Mackerlake-Turupah complex, 0 to 1 percent slopes
Isolde-Parran-Appian, clay substratum complex, 0 to 15 percent slopes
Parran-Isolde complex, 0 to 4 percent slopes
Water

N
0 500 meters

Goose Lake

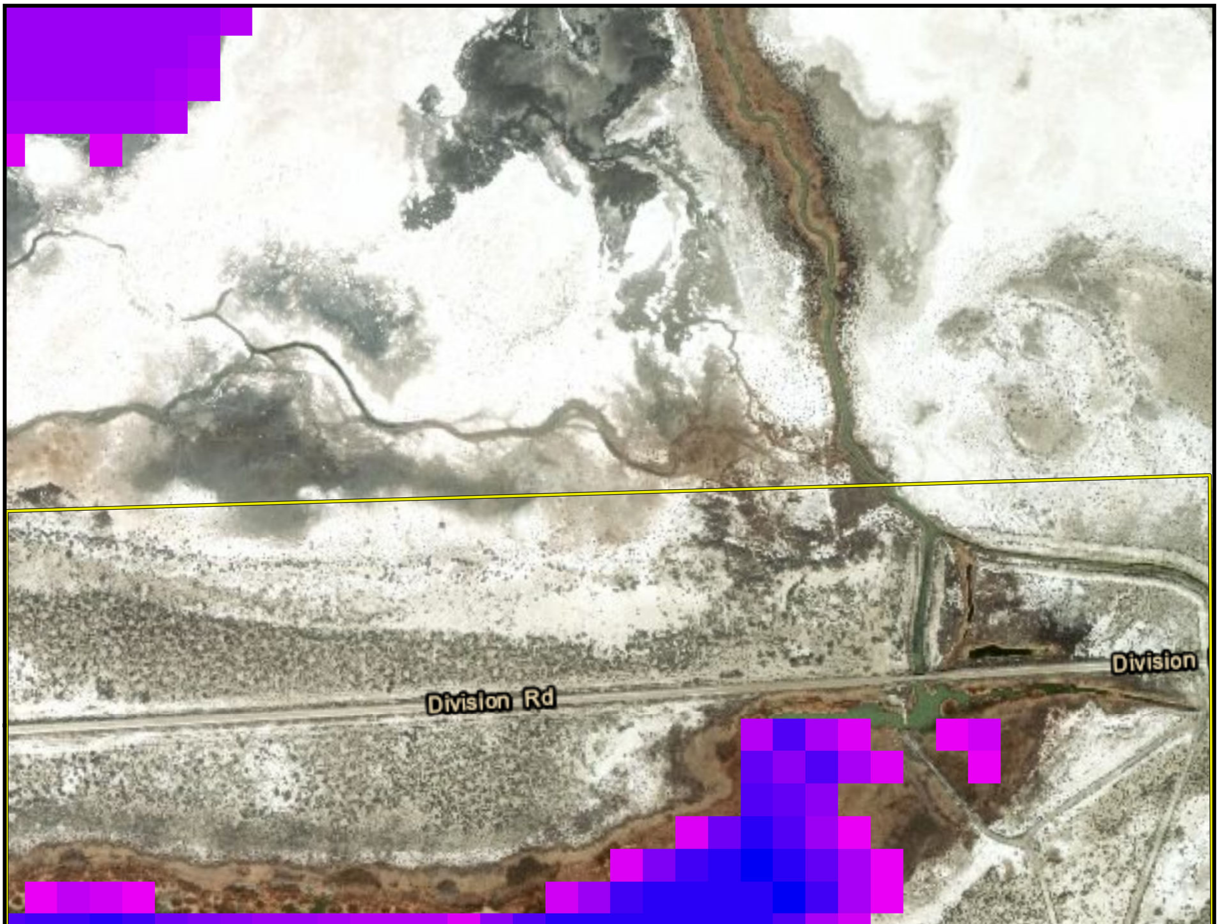


Goose Lake



Goose Lake: Max interannual change


Max interannual change in NDVI




Goose Lake

N
0 0.075 0.15 0.3 km

**Wetland Likelihood**
Higher
Lower

**Years Flooded**
30
1

GL1: Recent

N 0 50 meters

**Legend**

SSI springs

Site Map

GL2: Recent


**Legend**

SSI springs

Site Map

# APPENDIX I: Nevada Wetland Rapid Assessment Method Data Sheets

# Nevada Wetland Rapid Assessment Method (RAM) Data Sheets

***Pre-field Survey entry (*) information available from the NV Level 1 Wetland Mapping Tool, "Wet Bar". Verify or correct information during field survey activities. Attach Level 1 Wetland Analysis Toolbar Report to data sheets.***

## LOCATION AND GENERAL INFORMATION* (Field Manual p. 23, Sec. 2.4.a.) ☐

**Point Code**: ____________ **Site Name**: ____________________________________________ **Date**: ________________

**Time Start**: _________ **Time End**: _________ **Weather**: Recent rain/Rain/Snowfall/Snow on ground/No current, recent precip. **Air Temp (°C)** _______

**State Engr Hydrographic Name**: ____________________________ **HUC 10#**: ________________________ **Site Ownership^**: __________________

**Surveyors** (circle recorder): ____________________________________________________________ *^Federal/state land descriptor*

**Access Comments** (Note permit requirements, changes to driving directions, or difficulties accessing the site):

## ASSESSMENT AREA AND GPS COORDINATES* (Field Manual p. 23, Sec. 2.4.b.) ☐

**Dimensions of AA:**

____ **40 m radius circle** _____ **Rectangle**: Width ____________ Length ____________ Area __________

____ **Freeform:** Min 10 m wide; Max 200 m long **AA-Track #**: _____________________ **Freeform area**: ______________________

____ **Entire wetland** (Complete AA Representativeness section) **AA-Track #**: ______________________

**Target Wetland Type**: ____Yes ____No

**AA Representativeness:** Is AA the entire wetland? ______Yes _____No. IF NO, is AA representative of larger wetland or complex? ___Yes ____No

Provide comments. If part of complex, indicate if other HGM or Cowardin classes, or general wetland categories & type are present (**Appendix A, B, C**):

**AA GPS Coordinates:** AA-Center Waypoint #: ________________

(NAD 83) UTM Zone: _______ Easting: ________________________________________ Northing: ________________________________

Accuracy (+/-): ______________ Elevation (m): _________________

**AA Photos** ☐ **40 m radius circle**: Take from AA-Center point, looking out in 4 cardinal directions; *ONLY INCLUDE WP/Photo # and Aspect.*

☐ **Freeform**: Take from 4 points on AA edge looking-in OR ☐ **Rectangle:** From 4 corners, looking diagonal at opposite corner. *INCLUDE UTMs.*

| | | | | |
|---|---|---|---|---|
| AA-1 | WP/Photo #: __________ | Aspect: ____________ | UTM/Easting: ______________________ | Northing: ______________________ |
| AA-2 | WP/Photo #: __________ | Aspect: ____________ | UTM/Easting: ______________________ | Northing: ______________________ |
| AA-3 | WP/Photo #: __________ | Aspect: ____________ | UTM/Easting ______________________ | Northing: ______________________ |
| AA-4 | WP/Photo #: __________ | Aspect: ____________ | UTM/Easting ______________________ | Northing: ______________________ |

## CLASSIFICATION OF ASSESSMENT AREA* (Field Manual p. 26, Sec. 2.4.c./Appendix A, B, & C) ☐

**Cowardin Class*** Pick *one class for the dominant wetland type.* If using *NV Level 1 Wetland Analysis,* populate with National Wetland Inventory Class.

**System**: ___ Palustrine _____ Upland

**Class**: ______ Aquatic Bed _____ Emergent _____ Scrub-Shrub _____ Forested _____ Unconsolidated Bottom _____ Unconsolidated Shore

**HGM Class***

____Riverine ____Lacustrine Fringe

____Depressional ____Slope _______Flats

**Cowardin Modifiers: Water Regime (helps describe wetland origin)**

_____Intermittently Flooded/IF _____Seasonally Flooded/SF

_____Temporarily Flooded/TF _____Semi-Permanently Flooded/SPF

_____Saturated/ST _____Intermittently Exposed/IE

_____Seasonally Saturated/SS _____Permanently Flooded/PF

**Cowardin Modifiers: Special (Optional)**

_____ Beaver (b) _______ Farmed (f)

_____ Excavated (x) + _______ Spoil (s)

_____ Partially ditched/drained (d) _______ Reservoir (r)

_____ Diked/Impounded (h) _______ Channel (c)

\+ *Excavated may include restored wetlands* _______Springbox (sb)

**REGION**: Great Basin / Eastern Sierra / Mojave **GENERAL WETLAND CATEGORIES FOR NV**: Intermountain Basin Playa, Marshes, Fens, Montane Riparian Ecosystems, Additional Mojave. **Circle appropriate Region & Dominant category from above. List specific Type from Appendix C:**

______________________________________________________________________________

**ASSESSMENT AREA DRAWING, SETTING AND SURROUNDING LANDSCAPE DESCRIPTION (Field Manual p.26, Sec. 2.5)**

**Include the following, plus a legend.**

- ☐ AA Boundary and Center Point
- ☐ North arrow and approx. scale bar
- ■ Location of soil pit/s
- ◆ Photo point locations & GPS waypoint or track #s
- ● Water chemistry measurement/s
- ★ GPS waypoint #/s
- ☐ Additional site description notes on site hydrology, soil, and vegetation
- ☐ Community types and abiotic zones: open water, in/out flows, drainage path
- ☐ Landscape setting: dominant plants; wetland types
- ☐ AA slope cross-sectional diagram (show from N-S & E-W)
- ☐ Structures or other human-made features (including roads/paths)
- ☐ Dominant vegetation types & community types (note if user opted to take a GPS track around the community type, or another method to outline those types)

**SOIL PROFILE DESCRIPTION – SOIL PIT 1** ☐ **Representative Pit? (Field Manual p. 27, Sec. 2.6/ Appendices D & E)**

**SP GPS WP#:** _______ (NAD 83) UTM Zone: _____ Easting:_________________Northing: _________________

IF NO FREE-STANDING WATER observed: ☐Pit filling slowly OR ☐Pit appears dry

Water Settling Time (s):_____Depth to saturated soil (cm):____________Depth to free water (cm):___________Temp (°C)_____ pH_______ EC (dS/m)____________ DO (ppm)__________

| Horizon Depth (cm) | Matrix Color (moist) | Dominant Redox Features Color (moist) | Observed | Texture Appendix D | Roots Observed | Gravel Observed | Notes |
|---|---|---|---|---|---|---|---|
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**Dominant Redox, Roots and Gravel Amounts Observed qualitative descriptor choices =** None / Very Few / Few / Many

**Hydric Soil Indicators:** See **Appendix E** for descriptions. Check all that apply to pit.

____Histosol (A1)
____Histic Epipedon (A2/A3)
____Mucky Mineral (S1/F1)
____Hydrogen Sulfide Odor (A4)
____Gleyed Matrix (S4/F2)
____Depleted Matrix (A11/A12/F3)
____Redox Concentrations (S5/F6/F8)
____Redox Depletions (S6/F7)
___Surface Salt Crusts
___Translocated Salts

Comments:

**SOIL PROFILE DESCRIPTION – SOIL PIT 2** ☐ **Representative Pit?** ***2 or MORE PITS ONLY NEEDED IF GREAT VARIABLITY ACROSS ASSESSMENT AREA***

**SP GPS WP#:** _______ (NAD 83) UTM Zone: _____ Easting:_________________Northing: _________________

IF NO FREE-STANDING WATER observed: ☐Pit filling slowly OR ☐Pit appears dry

Water Settling Time (s):____Depth to saturated soil (cm):____________Depth to free water (cm):___________Temp (°C)_____ pH_______ EC (dS/m)____________ DO (ppm)__________

| Horizon Depth (cm) | Matrix Color (moist) | Dominant Redox Features Color (moist) | Observed | Texture Appendix D | Roots Observed | Gravel Observed | Notes |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
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**Dominant Redox, Roots and Gravel Amounts Observed qualitative descriptor choices =** None / Very Few / Few / Many

**Hydric Soil Indicators:** See **Appendix E** for descriptions. Check all that apply to pit.

____Histosol (A1)
____Histic Epipedon (A2/A3)
____Mucky Mineral (S1/F1)
____Hydrogen Sulfide Odor (A4)
____Gleyed Matrix (S4/F2)
____Depleted Matrix (A11/A12/F3)
____Redox Concentrations (S5/F6/F8)
____Redox Depletions (S6/F7)
___Surface Salt Crusts
___Translocated Salts

Comments:

**GENERAL ANIMAL OBSERVATIONS** – Record any animal observations from AA in the table. Specifically look for the organisms of interest in Nevada from the list below. If animal presence observed without visible sighting, check the columns by which the observation was made. (Field Manual p. **30, Sec. 2.8**)

**Check AA for the following organisms: ** invasive in Nevada***

___ Springsnails (Pyrgulopsis, Fluminicola, Juga, Tryonia) ___ Other snails (Physids, land snails, ***Melanoides****) ____ Clams ___ ***Crayfish****
___ Amphipods ___ Odonata (dragonflies and damselflies) ___ Other aquatic insects (caddisflies, beetles, striders, etc.) ___ Other insects
___ Fish (native/non-native) ___ Amphibians (frogs, toads, ***bullfrogs****) ___ Reptiles (turtles, snakes, lizards) ___ Birds (aquatic/upland)
___ Mammals (aquatic/upland)

| Animal & Brief Comments: | Photo # | # Individuals | Nest | Vocal | Tracks | Scat |
|---|---|---|---|---|---|---|
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**WATER CHEMISTRY –** Take > than 1 reading if AA represents larger wetland **or** complex with different wetland classes. **Field Manual p. 30, Sec. 2.7**

**Reading 1 Location:**_______________ GPS Waypoint #_____________

(NAD 83) UTM Zone: _______ Easting:________________________________Northing: _____________________

**Standing or Flowing (Circle)**

Temp (°C)___________ pH _____________ Electrical Conductivity/EC (dS/m)___________ Dissolved Oxygen/DO (ppm)__________________

**Reading 2 Location:**_____________________ GPS Waypoint #_____________

(NAD 83) UTM Zone: _______ Easting:__________________________Northing: ______________________

**Standing or Flowing (Circle)**

Temp (°C)___________ pH _____________ Electrical Conductivity/EC (dS/m)___________ Dissolved Oxygen/DO (ppm)__________________

**COMMENTS**- Note the water meter brand & model. Enter additional Reading location, GPS Waypoint, and measurements if more than 2 reading collected.

**VEGETATION SPECIES LIST (Field Manual p. 31, Sec. 2.9, Appendix C)** *Spend no more than 1-hour total on the Vegetation RAM.* ☐

1) **Walk the AA**- Note the dominant vegetation community types (refer to Appendix C. Wetland Types) in rows 1-4. For each community type visually estimate the % of the AA covered, as well as the approximate average height for each stratum: trees, shrubs and grasses/forbs within each community type.

| | Community Type Name | % of AA | Tree Height (m) | Shrub Height (m) | Grass/Forb Height (m) |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |

**2)** **Walk each community type area-** Identify as many species as possible within each. In the columns corresponding to the 1-4 community type rows above, estimate percent cover of each species within each community type. Use the bin-categories below. Note known invasive and non-native species. Note photos or collections taken for any species.

**Not Present** (NP) / **Trace** (T = 0 - 5%) / **Uncommon** (U= 6 - 10%) / **Common** (C = 11 - 50%) / **Dominant** (D = > 50%)

| Scientific Name or Pseudonym/Common name<br>*Note if collection and/or photo taken* | 1 | 2 | 3 | 4 | Non-Native / Invasive |
|---|---|---|---|---|---|
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**VEGETATION SPECIES LIST- ADDITIONAL PAGE (Field Manual p. 31, Sec. 2.9.a., Appendix C)**

**Not Present** (NP) / **Trace** (T: 0 - 5%) / **Uncommon** (U: 6 - 10%) / **Common** (C: 11 - 50%) / **Dominant** (D: > 50%)

| **Scientific Name or Pseudonym/Common name**<br>***Note if collection and/or photo taken*** | **1** | **2** | **3** | **4** | **Non-Native / Invasive** |
|---|---|---|---|---|---|
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**AA COVER CLASSES & LITTER DESCRIPTION (Field Manual p. 31, Sec. 2.9.b.)** *Spend no more than 1-hour total on the Vegetation RAM.*

| **COVER CLASSES** **NP** = Not present **1:** 0 - 5% **2:** 6 - 10% **3:** 11 - 50% **4:** > 50% | |
|---|---|
| **WATER** | |
| Standing water of any depth - vegetated or not | |
| Running water of any depth - vegetated or not | |
| Open water - plant canopy cover < 10% | |
| Water with emergent vegetation | |
| Water with floating or submerged vegetation | |
| **EXPOSED GROUND** | |
| Bare ground – soil / sand / sediment | |
| Bare ground – gravel / cobble (~2–250 mm) | |
| Bare ground – bedrock / rock / boulder (>250 mm) | |
| Salt crust all cover - <u>including over vegetation or litter cover</u> | |
| **LITTER** | |
| All cover - including under water or vegetation | |
| Depth of litter (cm) – average of four non-trampled locations where litter occurs:<br>**Depth 1** cm **Depth 2** cm **Depth 3** cm **Depth 4** cm **Ave. depth:** | |
| Predominant litter type (**C** = coniferous, **E** = broadleaf evergreen, **D** = deciduous, **S** = sod/thatch, **F** = forb) | |
| **DEBRIS** | |
| Standing dead trees, >5 cm diameter at breast height | |
| Standing dead shrubs or small trees, <5 cm diameter at breast height | |
| Downed coarse woody debris - fallen trees, rotting logs, >5 cm diameter | |
| Downed fine woody debris, <5 cm diameter | |
| **OTHER** | |
| Bryophytes - all cover, including under water, vegetation or litter cover | |
| Lichens - all cover, including under water, vegetation or litter cover | |
| Algae - all cover, including under water, vegetation or litter cover | |