Survey and Assessment of Critical Urban Wetlands:

City of Aurora

December 2020

Warner College of Natural Resources
Colorado State University

CNHP's mission is to advance the conservation of Colorado's native species and ecosystems through science, planning, and education for the benefit of current and future generations.

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Front Cover: Wetlands at the Sand Creek Riparian Preserve in north central Aurora.

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City of Aurora

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EXECUTIVE SUMMARY

The city of Aurora, located within the South Platte River Basin, is the third most populous city in Colorado, and is rapidly expanding its developed land area. Wetlands in dense urban centers differ from natural systems due to their modified hydrology, geomorphology, and increased non-native plant species, but they perform critical functions such as reducing flood risk, improving water quality, and providing wildlife habitat. Prior to this study, knowledge of the wetland extent for much of the city was outdated and coarse, much of it based on 1980's mapping. Information was needed on the status and trends of extant wetlands throughout the City of Aurora. This study provides specific data on wetland locations and the condition of important wetlands in the City of Aurora. This information can be used for strategic urban planning, from prioritizing development projects to have the least impact to critical resources, to identifying the most important resources to protect and restore, and their management needs. To assess the extent and types of wetlands in Aurora, existing National Wetland Inventory (NWI) maps were updated with new imagery and ancillary spatial data layers. To assess the condition of important Aurora wetlands, Ecological Integrity Assessment (EIA) and Functional Assessment of Colorado Wetlands (FACWet) methods were used in 20 targeted wetlands selected for management priority, size, vegetated buffer, and likelihood of higher function within Aurora. Other Aurora wetlands, waterbodies, and riparian areas are viewable with their updated NWI mapping on the USFWS Wetlands Mapper: http://www.fws.gov/Wetlands/Data/Mapper.html.

The wetland mapping results indicate that wetlands and riparian areas (including waterbodies) are uncommon in Aurora and account for 2.5% of the land area. The majority of acres mapped in the National Wetland Inventory (NWI) are large, constructed water storage reservoirs, water conveyance canals, and natural rivers that dot the landscape. These waterbodies provide surface water storage, sediment retention, groundwater recharge, and aquatic habitat. Vegetated wetlands and small ponds represent only 0.7% of the land area, but they provide nutrient cycling, shoreline stabilization, support biodiversity and native plant establishment, and terrestrial habitat function.

The EIA and FACWet scores indicate the 20 targeted wetlands are in good to poor condition. One wetland assessment area (AA) rated B, 10 rated C, and 9 rated D with the EIA method. It should be noted that the EIA and FACWet methods evaluate wetlands relative to wetlands of the same type that are in "reference" condition, that is with no or minimal human impact. Urban wetlands are not expected to score high on such a scale. The wetlands with the highest ecological condition scores were generally located in the eastern, less developed part of the city. The wetlands with the lowest ecological condition score were generally located within the urban core –however, these truly urban wetlands scored the highest on a social rating scale indicating their importance for valued recreation and green space benefits.

Historical aerial photographs indicate the streams along the Front Range were previously wide sandy washes with flashy flood flows. Many factors associated with urbanization including an increase in paved surfaces creating increased stormwater runoff, and flow constrictions from impoundments, road crossings, and culverts creating ponding, have changed the character of the

streams. Hydrologic alteration is compounded by the fact that local watersheds receive additional water above their natural flow through transbasin diversions. Irrigation of lawns and parks may infiltrate into the soil and drain to local streams, increasing their base flow and further altering their character.

Condition alone is not the full measure of wetland value. Functioning urban wetlands perform numerous ecosystem services that are acutely needed in highly developed watersheds, such as improving water quality, maintaining base flows, attenuating flood waters, providing habitat for plants, animals, and pollinators, as well as offering recreational and educational opportunities. Although water draining to urban wetlands contains high pollutant loads, wetlands filter some of those pollutants and provide cleaner water to downstream flows. While urban wetlands contain high cover of non-native species, their very presence in the developed landscape provides vital habitat where it is scare. Equally important, natural and green spaces within urban areas provide recreational and therapeutic opportunities for all residents, including children and families, to connect with nature. These ecosystem services are essential to watershed health and provide major economic benefits to society. However, degraded conditions impact a wetland's functional capacity. Maintaining or improving the condition of urban wetlands can enhance their ability to provide these essential services.

A balanced assessment of urban wetlands must consider both perspectives. First, it is important to document the condition of wetland resources and the stressors they face in order to recommend practical management actions to improve condition. Second, the assessment must consider the enormous benefit wetland ecosystems provide to urban residents and prioritize their conservation and management for current and future generations. This study of critical wetlands in the City of Aurora addresses both perspectives. While impacted by historic and current land use, all the wetlands surveyed in this project provide important wetland functions and are worthy of protection and restoration, even the lowest condition wetlands.

Recommended management efforts for protecting and improving Aurora's urban wetlands include protecting existing wetland and riparian buffers, minimizing construction activities impacts near wetlands and riparian areas, planning for watershed friendly trails, and limiting chemicals in weed treatment. In some areas streams have become disconnected from their floodplains due to stream entrenchment; reconnecting these streams to their floodplains and facilitating structural diversity would improve or restore a variety of wetland functions to Aurora wetlands. Additionally, the possibility of controlling non-native invasive bullfrogs that threaten the existing population of northern leopard frog, a Tier 1 species of greatest conservation need in Colorado should be investigated.

The 20 wetland sites chosen for on-the-ground survey were chosen based on review of aerial photography with input from the stakeholder group. Wetlands that appeared to have the highest potential to be a natural feature, to be a functioning wetland, and/or with the presence of a vegetated buffer were chosen for on-the-ground survey. Most of the selected wetlands were in existing City of Aurora Natural Areas or Parks indicating Aurora has been proactive in protecting their wetlands.

SUMMARY OF FINDINGS

Wetland Mapping

- National Wetland Inventory (NWI) maps were updated for the City of Aurora using multiple sources of updated imagery.
- 2,568 acres or 2.5% of the City of Aurora is mapped as wetlands, waterbodies and riparian areas.
- 34% of the mapped acres (867 acres) are lakes and reservoirs and 13% (331 acres) are rivers, streams and canals.
- 26% of mapped acres (680 acres) are vegetated wetlands and ponds. Of these, herbaceous wetlands and ponds were the most common.
- The remaining 27% of mapped acres (690 acres) are non-wetland riparian areas.

Wetland Condition Assessment

- Ecological Integrity Assessments (EIA) and surveys for critical biological resources were conducted at 20 targeted assessment areas that together covered 380 acres.
- The 20 wetlands surveyed ranged from good to poor condition. One wetland rated a B EIA score; 50% rated as C, and 45% rated as D.
- The condition of surveyed Aurora wetlands rated higher on average than the critical wetlands surveyed in the city of Denver and lower on average than the randomly sampled wetlands throughout the Lower South Platte River Basin.
- Five of the nine wetlands with D (poor) EIA condition scores had a very high or high social rating. The high social rating indicates that "poor" condition wetlands provide many social benefits including recreation and therapeutic opportunities and green space benefits.
- The highest rated wetlands were all plains riparian ecosystems. Lower scoring wetlands were a mix of plains riparian and marsh ecosystems.
- Most wetlands had high cover of non-native plants. Patches of wetlands with moderate to high C-value plants or native sedges, rushes, and spikerushes represent potential remnant native wetland and hydrology, and have important conservation value.
- Wetland/riparian area size and buffers positively affect wetland condition. Sites with long unfragmented corridors and wide buffers have important conservation value.
- Fifty new county records for vascular plants were documented during the survey.
- Northern leopard frogs, Tier 1 Colorado Parks and Wildlife species of greatest conservation need, were observed in four wetland assessment areas, with new occurrences documented.
- Bullfrogs, non-native invasive predators of northern leopard frogs, were observed along Coal Creek including a location where they co-occur with northern leopard frogs.
- Bald eagles, a Tier 2 Colorado Parks and Wildlife species of greatest conservation need, use Aurora riparian areas as nesting habitat.
- Spatial and tabular data for all rare animal species were entered into CNHP's Biotics database as Element Occurrences.

Management Recommendations

- **Protect Wetland and Riparian Areas:** Create a city-wide watershed health plan, with wetland and riparian protection measures and impact avoidance guidelines. Identify wetland and riparian areas in better condition and prioritize their full protection. Native wetlands and riparian areas are limited in Aurora, and urban development has resulted in ongoing loss of native wetland function and riparian area. A planning strategy is needed as soon as possible to prevent further native ecosystem degradation and water resource loss.
- **Protect Wetland/Riparian Buffers:** Wide wetland and riparian buffer protection standards will best conserve wetland health and function.
- **Minimize Construction Activities and Impacts:** Avoid construction near or adjacent to wetlands and riparian areas, and minimize construction footprint where unavoidable. Follow BMPs that require off site concrete washouts and other measures to minimize disruptive impacts including sedimentation.
- **Incorporate Wetland/Riparian Health in Stormwater Planning:** Invest in green infrastructure to reduce stormwater impacts to water resource quality, and to benefit social values. Incorporate wetland and riparian health BMPs in Aurora's stormwater manual.
- **Watershed-Friendly Trails and Recreation:** Place new trails and recreation infrastructure away from wetlands and riparian areas. Avoid raised trails. For recreation corridors, focus trail impacts outside of the wetland/riparian zone, or limit to areas that already have human-created hydrology such as gravel ponds, ditches, and reservoirs.
- **Limit Chemicals:** Chemical weed and lawn treatments in or near wetlands and riparian areas should be avoided to protect water quality, sensitive wildlife, and native vegetation diversity. Prioritize non-chemical treatment and timely weed-mowing; pair weed treatment with a native revegetation plan. Follow BMPs for treating weeds in wildlands.
- **Encourage Beaver:** Manage riparian areas for existing and expanded beaver habitat. Beaver naturally restore wetlands so they provide better ecosystem services.
- **Monitor Cattail:** Many of Aurora's riparian areas and wetlands are invaded by dense cattail. Monitor the relationship between development near wetland/riparian areas and cattail invasion, and avoid land uses near water resources associated with cattail expansion.
- **Control Invasive Bullfrogs:** Bullfrogs threaten the continued existence of northern leopard frogs, a Tier 1 species of greatest conservation need in Colorado.
- **Monitor Bald Eagles:** Continue current policy of monitoring and enforcing seasonal closures to protect nesting bald eagles from human disturbance.

Acknowledgements

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TABLE OF CONTENTS

Executive Summary i
Summary of Findings iii
Wetland Mapping iii
Wetland Condition Assessment iii
Management Recommendations iv
1.0 Introduction 1
1.1 Statewide Strategies for Colorado Wetlands 2
1.2 Project Objectives 2
2.0 Study Area 3
2.1 Geography 3
2.2 Ecoregions and Vegetation 3
2.3 Climate 6
2.4 Hydrology 6
2.5 Geology 8
2.6 Land Use History 9
3.0 Methods 10
3.1 City of Aurora Wetland Mapping 10
NWI Classification 10
3.2 Site Selection 11
3.3 Wetland Assessment 12
Ecological Integrity Assessment (EIA) 12
Functional Assessment of Colorado Wetlands (FACWet) 15
Social Rating 16
Field Methods 17
Data Analysis 18
3.4 Natural Heritage Methodology 19
3.5 Data Management 20
4.0 Results 21
4.1 Mapped Wetlands of the City of Aurora 21
Wetland Acres by General Wetland Type 21

Wetland Acres by Hydrologic Regime 22
Wetland Acres by Extent Modified 23
4.2 Wetland Condition Assessment Results 24
Classification of Aurora Wetlands 24
Ecological Integrity Assessment 26
4.3 Functional Assessment of Colorado Wetlands (FACWet) 32
4.4 Social Rating 34
4.5 Vegetation Composition 36
Plant Species Richness 36
Common Plant Species 37
Relative Cover of Native Plants 39
Mean C, Native Mean C, and High C-Value Species 39
Invasive Cattail and Reed Canary Grass 40
Noxious Weeds 40
County Records 40
4.6 Wildlife Observations 43
Amphibians 43
Birds 44
Beaver 44
4.7 Natural Heritage Results 47
Rare Animals, Plants, and Plant Communities 47
5.0 Discussion 49
5.1 Condition and Value of Aurora Wetlands 49
Wetland Condition 50
Urban Stressors 51
Natural Riparian Wetlands 52
Wetland Social Ratings 56
5.2 Plants and Animals of Conservation or Management Importance 56
High Quality Plants 56
Noxious Weeds 57
Beaver 58
Northern Leopard Frog and Invasive Bullfrog 59
Invasive Red-eared Slider 60

Bald Eagle 60
5.3 Management Implications 60
Conserve Unfragmented Riparian Area and Buffers 60
Historical Data Review to Guide Restoration Efforts 61
Cattail Invasion 62
Noxious Weeds 62
Northern Leopard Frogs and Invasive Bullfrogs 62
Nesting Bald Eagles 62
6.0 References 64

LIST OF FIGURES

Figure 1. Study area and wetland sites. 4
Figure 2. Level IV Ecoregions in the City of Aurora Study Area in Colorado. 5
Figure 3. Period of record average monthly temperature and precipitation data for Stapleton Airport weather station. 6
Figure 4. Streams and Hydrologic Unit Code (HUC) 8 boundaries in the vicinity of Aurora. 7
Figure 5. Colorado surface water hydrology. 8
Figure 6. City of Aurora wetland mapping project area. 11
Figure 7. National Wetland Inventory (NWI) mapped features in the City of Aurora. 21
Figure 8. Overall Environmental Integrity Assessment (EIA) scores by Assessment Area (AA). 27
Figure 9. Plant Species Richness at City of Aurora Wetland Assessment Areas (AAs) 37
Figure 10. Comparison of Aurora, Denver, and Lower South Platte River Basin Wetland Condition Ranks using Ecological Integrity Assessment methods. 51
Figure 11. Change over time at Red-tailed Hawk Park.. 54
Figure 12. Change over time at Coal Creek at Senac.. 55

LIST OF TABLES

Table 1. Ecological Integrity Assessment metrics used to evaluate wetland condition....13
Table 2. C-value ranges and associated interpretation....14
Table 3. Functional Assessment of Colorado Wetlands metrics used to evaluate wetland condition. 16
Table 4. Social rating metrics. 17
Table 5. Definition of Ecological Integrity Assessment ranks....19
Table 6. National Wetland Inventory (NWI) acreage mapped in the City of Aurora....22
Table 7. National Wetland Inventory (NWI) acreage mapped in the City of Aurora by hydrologic regime code....23
Table 8. National Wetland Inventory (NWI) acreage mapped in the City of Aurora by NWI modifier. 24
Table 9. Ecological systems for the Assessment Areas (AAs) in the City of Aurora. 25
Table 10. Wetland Assessment Areas (AAs) ranked highest to lowest by overall Ecological Integrity Assessment (EIA) scores. 26
Table 11. Wetland Assessment Areas (AAs) with landscape context, vegetation, hydrology, and physiochemistry subscores and overall EIA score.. 29
Table 12. Water quality field parameters measured at Aurora Wetland Assessment Areas (AAs)....31
Table 13. Wetland Stressor Ratings in a 500 meter area landscape surrounding the AAs and in the wetland vegetation, soils, and hydrology.. 32
Table 14. Wetland Functional Capacity Indices ranked by overall Functional Assessment of Colorado Wetland (FACWet) scores.. 33
Table 15. Social ratings for Aurora Wetland Assessment Areas (AAs). 35
Table 16. List of Wetland Assessment Areas (AAs) with subscores for Species Richness, Relative Cover Native, Mean C, and Native Mean C.. 36
Table 17. Most commonly encountered plants in surveyed wetland Aurora AAs 38
Table 18. Noxious Weeds found in Aurora wetlands. 41
Table 19. List of Plant Species collected for submission to local herbaria - not previously reported for Adams/Arapahoe County based on herbarium search records in 2019....42
Table 20. Amphibians and reptiles documented in Aurora wetlands. 45
Table 21. Bird species observed in Aurora wetland sites during 2019 surveys 46
Table 22. Number of bird species documented in Aurora wetland sites during 2019 surveys....47

APPENDICES

Appendix A. Colorado Natural Heritage Program Wetland Mapping Procedures

Appendix B. Wetland Condition Assessment Field Forms

Appendix C. Field Key to Wetland and Riparian Ecological Systems and Field Key to Hydrogeomorphic (HGM) Classes

Appendix D. Scoring Formulas for Ecological Integrity Assessment (EIA) Metric

Appendix E. Natural Heritage Program Methodology

Appendix F. Rare Plants, Animals, and Plant Communities with Potential to Occur in Aurora

Appendix G. Site Descriptions and Plant Lists for Aurora Wetland Assessment Areas

Appendix H. List of Plant Taxa Documented in Aurora

1.0 INTRODUCTION

Wetlands cover only two percent of the landscape in Colorado (Lemly et al. 2020), but are among the most biologically diverse and productive ecosystems in the state. Wetlands provide a vast array of ecosystem services including water filtration, flood protection, groundwater recharge, nutrient cycling, channel stabilization, and fish and wildlife habitat (Millennium Ecosystem Assessment 2005; Mitsch & Gooselink 2007). Despite these essential services, studies indicate that freshwater vegetated wetlands have been reduced by 50 percent across the nation (Dahl 2011). Urbanization is one of the major causes of direct loss and degradation of wetlands (EPA 2001; McKinney 2002). Urban wetlands face considerable stress from human disturbance impacts and poor water quality, but they still provide valuable functions, especially surface water storage, ground water recharge, flood prevention, sediment retention, and also water quality improvement. These functions are critical in urban areas where impervious surfaces may account for much of the ground area. The City of Aurora is the center of a large, continuously urbanized area of Colorado called the Front Range and it is the third most populous city in Colorado with more than 370,000 residents (City of Aurora 2018) and over 2,400 people per square mile. Thus, the pressure to develop on or adjacent to wetlands and the need to protect them are extremely high in the City of Aurora. With development, native wetlands and riparian areas are lost and nearby wetlands are degraded, reducing invaluable ecosystem services that wetlands provide to cities and watersheds.

Globally, native wetlands have experienced continued loss and human-made wetland types such as reservoirs have increased without replacing native wetland functions. The Colorado Front Range follows suit with major loss of riverine wetlands and increase of ponded wetlands (Lemly et al. 2013). Wetlands are vital to sustainable development and human survival, and the global trend of native wetland loss/degradation and increase in human-made wetland types needs intervention (Ramsar Convention Secretariat 2018). The Ramsar Convention on Wetlands details a path to wetland protection and wise use, including preserving wetland ecological character and ecosystem services while halting degradation, with multi-level government wetland planning, inventory and research, protection, and investment in wetlands and their role in natural infrastructure (Ramsar Convention Secretariat 2018).

Although recent studies have focused on wetland condition along Colorado's Front Range (Cooper 1989, Lemly et al. 2012, Lemly et al. 2013; Lemly et al. 2014, Smith and Kuhn 2015), and the Triple Creek Greenway Corridor study (Sovell et al. 2014) examined wildlife and plants along a stretch of Sand, Coal, and Senac Creeks, information was needed on the status and trends of extant wetlands throughout the City of Aurora. Current information on the location and condition of wetlands in dense urban areas is needed for planners, land managers, and the public across the country to prioritize effective conservation and restoration efforts. The main goal of this project was to provide the City of Aurora with a prioritized list of wetlands that were evaluated for condition and function using metrics that have been used across the state.

1.1 Statewide Strategies for Colorado Wetlands

The Colorado Natural Heritage Program (CNHP) has been conducting wetland surveys across the state since 1992. In 2010, CNHP partnered with Colorado Parks and Wildlife (CPW) to develop *Statewide Strategies for Colorado's Wetlands* (Lemly et al. 2011). Under the guidance of these strategies, both organizations have worked together to catalog the location, type, and condition of Colorado's wetlands through a series of river basin-scale wetland mapping and condition assessment projects. The Rio Grande Headwaters River Basin Assessment was completed in 2011 (Lemly et al. 2011); the North Platte River Basin was completed in 2012 (Lemly and Gilligan 2012); the Lower South Platte River Basin Assessment was completed in 2014 (Lemly et al. 2014), and the Lower Arkansas River Basin was completed in 2017 (Lemly et al 2015; Lemly et al. 2017). CNHP and CPW are actively working to complete wetland assessments for all of the river basins in Colorado.

In addition to basin-scale assessments completed through the statewide strategies, CNHP has also completed a series of studies to document the condition, function, of urban wetlands along the Front Range. These include an assessment of wetlands along the northern Front Range (Lemly et al. 2013), the City and County of Denver (Smith and Kuhn 2015), an ongoing study of wetlands in Boulder County (*in preparation)*. Those studies, and this study of wetlands in the City of Aurora, contribute to the greater understanding of Colorado's often-overlooked urban wetlands. Information from completed assessments is available on the CNHP website at https://cnhp.colostate.edu/cwic/condition/assessments/.

The basin wide projects and urban wetland studies have two major components: digital wetland mapping and field-based assessments. Digital National Wetland Inventory (NWI) maps are created by digitizing existing paper maps or updating maps based on new aerial photography. These maps are then used to summarize the types, abundance, and distribution of wetlands in a defined geographic area. Field-based assessments are conducted to examine the ecological condition and stressors present at individual wetlands. These assessments can be used to provide an overall picture of wetlands across the study area. The overall goal of these projects is to provide land managers with information to inform conservation and restoration efforts.

1.2 Project Objectives

The five primary objectives of the Survey and Assessment of Critical Urban Wetlands for the City of Aurora are as follows:

1. Use aerial imagery to delineate newly updated NWI maps for the City of Aurora.
2. Assess the condition, function, and societal value of targeted wetlands within the City of Aurora.
3. Create a prioritized list of wetlands based on condition assessment data.
4. Provide the City of Aurora with geospatial data on any rare species documented in the study area.
5. Create an educational brochure highlighting the importance of Aurora's urban wetlands.

2.0 Study Area

2.1 Geography

The project area encompasses the City of Aurora, Colorado. This large municipality includes portions of Adams, Arapahoe, and Douglas counties, and abuts the City and County of Denver to the northwest (Figure 1). Aurora covers some 160 sq. miles (420 km^2, City of Aurora 2018) and is the third most populous city in Colorado following the cities of Denver and Colorado Springs. The city is part of the Denver metropolitan area, within the larger Front Range urban corridor which extends from Colorado Springs in El Paso County north to Fort Collins in Larimer County. Aurora is situated in the South Platte River drainage, which forms the northern portion of Colorado's eastern plains north of the Palmer Divide.

Elevations within the city do not span a great range in comparison to Colorado as a whole. The city is at its lowest elevation in areas closest to the South Platte River (around 5,300 ft near the boundary with Denver), and gradually rises in elevation to the east and south, reaching a high point of about 6,230 ft in Douglas County. Elevation of Aurora wetlands chosen for ecological assessment ranged from ~5,300 ft to ~5,900 ft.

2.2 Ecoregions and Vegetation

Ecoregions are land areas having similar geology, soils, vegetation, and climate, and are generally used to provide a spatial framework for the description and management of similar environmental resources. The City of Aurora lies at the western edge of the Great Plains ecoregion, within sight of the Southern Rocky Mountains. Within the ecoregion, Aurora can be characterized by two Level IV ecoregional subdivisions as defined by the EPA (Omernik and Griffith 2014). The northern portion of the city lies on Flat to Rolling Plains, while the southern portion consists of Moderate Relief Plains (Figure 2). The flat to rolling plains are stabilized areas of sandy soils formed originally from wind-blown deposits. Prior to development these areas were probably dominated by sandsage prairie and other vegetation characteristic of sandy soils on Colorado's eastern plains. Moderate relief plains have areas of somewhat greater slopes in comparison to the rolling plains, and are underlain by generally silty and clay loam soils. These areas were historically dominated by shortgrass prairie vegetation. Much of Aurora's land is now highly urbanized or cultivated agricultural land, however, small areas in the eastern part of the city still support the characteristic natural ecoregional vegetation.

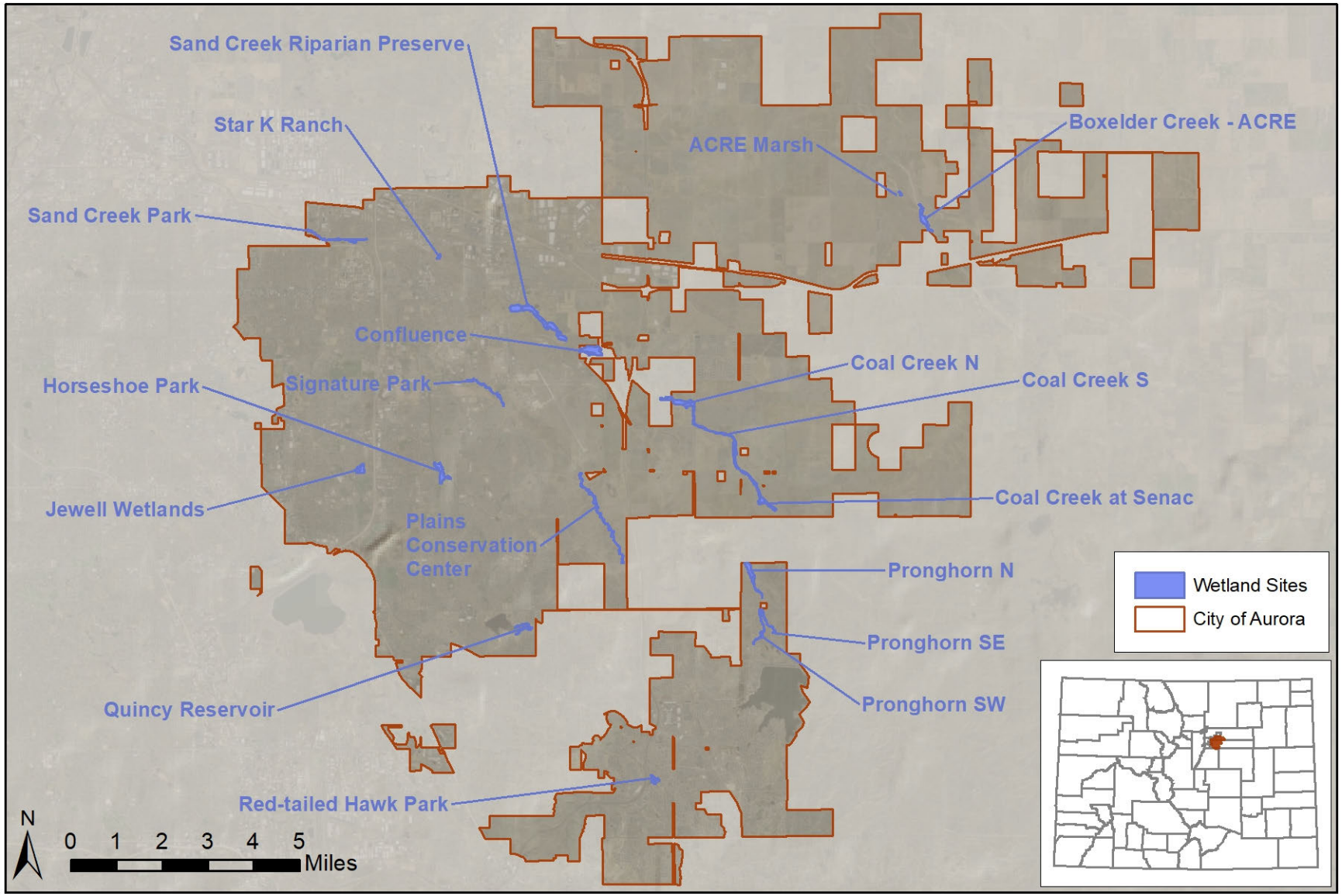

Figure 1. Study area and wetland sites (Inset: location of the City of Aurora in Colorado).

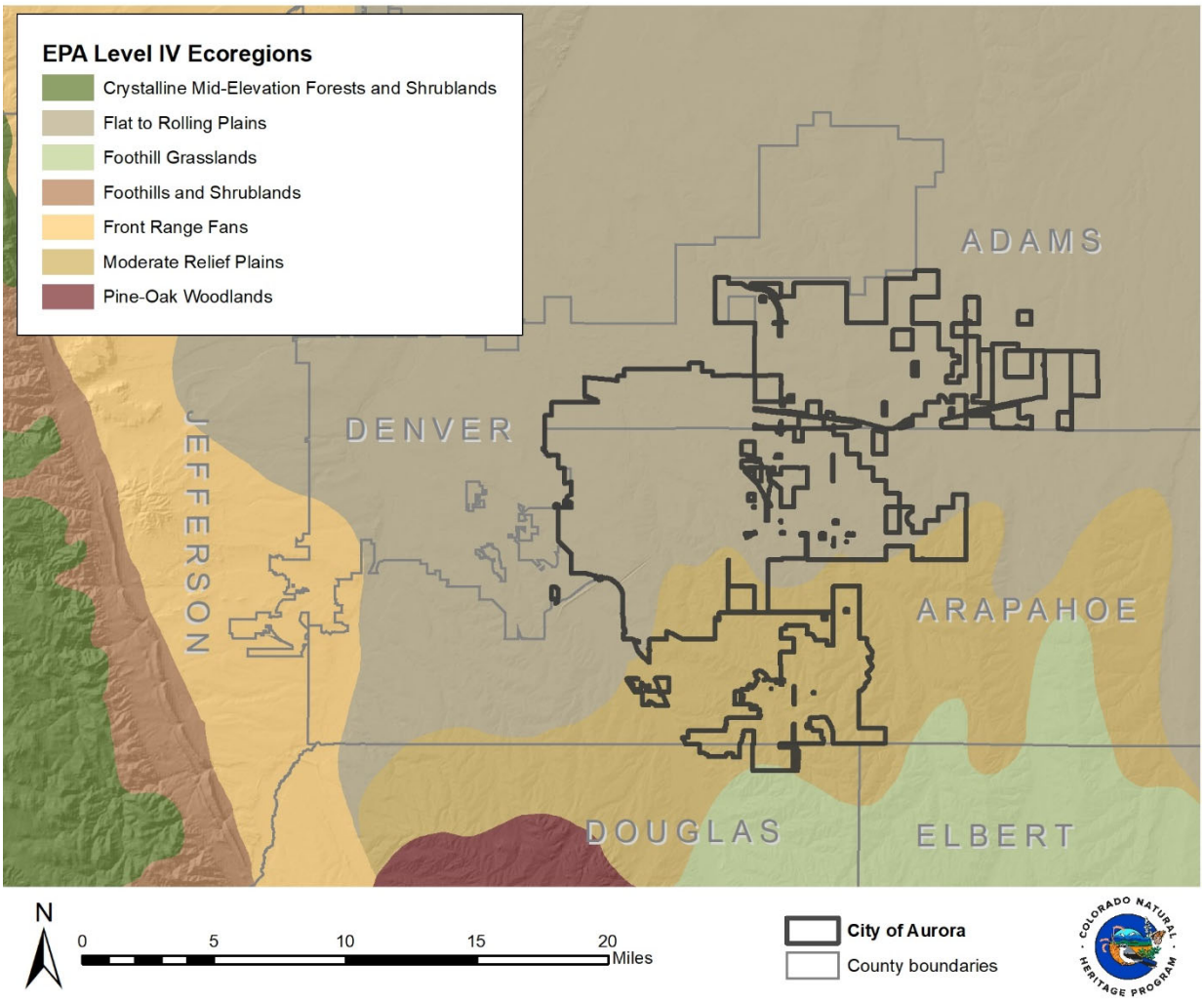

Figure 2. Level IV Ecoregions in the City of Aurora Study Area in Colorado.

Wetlands located in the western portion of the city were often within parks and riparian areas owned by the City of Aurora. Although much of the native vegetation within the bounds of Aurora has been replaced by urban development, the stream corridors and wetlands support a range of native vegetation even within the urban area. Common species include native overstory species such as coyote willow (*Salix exigua*) and plains cottonwood (*Populus deltoides*), as well as non-native species like crack willow (*Salix fragilis*), Canada thistle (*Cirsium arvense*) and smooth brome (*Bromus inermis*). Emergent marshes in the area were typically dominated by native bulrushes (*Schoenoplectus* spp.) and cattails (*Typha* spp.).

2.3 Climate

Aurora is positioned on the western margin of the plains within the rain shadow of the Southern Rocky Mountains; the climate is therefore considered semi-arid. Weather station data from 1948–2019 at the former Stapleton Airport site shows an average annual precipitation of 15.2 inches or 38.6 cm (Colorado Climate Center 2020). Spring rains and summer thunderstorms bring most of the annual precipitation that falls in the study area. About 70% of annual precipitation falls during the growing season of April through September (Figure 3). Severe storm events can cause major flooding along the South Platte River and its tributaries in Aurora. Winters are typically cold and dry, but typically not as harsh as in some higher elevation areas of Colorado. During the hot summer months, the average daily high temperature is 88°F (Colorado Climate Center 2020).

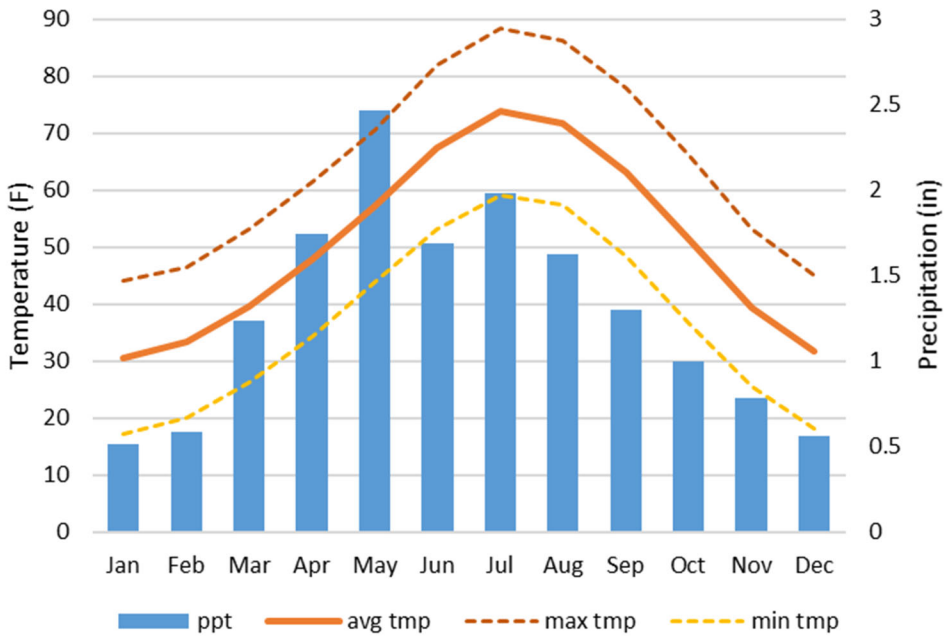

Figure 3. Period of record average monthly temperature and precipitation data for Stapleton Airport weather station (Colorado Climate Center 2020).

2.4 Hydrology

Hydrology is the movement of water in relation to the landscape and is the key driver for wetlands. The United States have been divided by a hierarchy of hydrologic units and each is identified by a hydrologic unit code or HUC. The City of Aurora is within the South Platte River basin (HUC 6), and entirely within the Middle South Platte River – Cherry Creek sub-basin (HUC 8) (Figure 4).

The South Platte River flows from south to north just west of the city. Several South Platte River tributaries that originate on the Palmer Divide flow through the City of Aurora from the southeast to the northwest. The main tributaries within Aurora (from west to east) include Piney Creek,

Tollgate Creek (with East and West branches), Sand Creek (and its tributaries Coal Creek, Murphy Creek, and Senac Creek), First Creek, and Box Elder Creek. Cherry Creek flows on the western border of Aurora, above and below Cherry Creek Reservoir. Because these streams do not originate in the mountains, they are primarily driven by warm season precipitation runoff, rather than by snowmelt, as is the case with the South Platte River main stem.

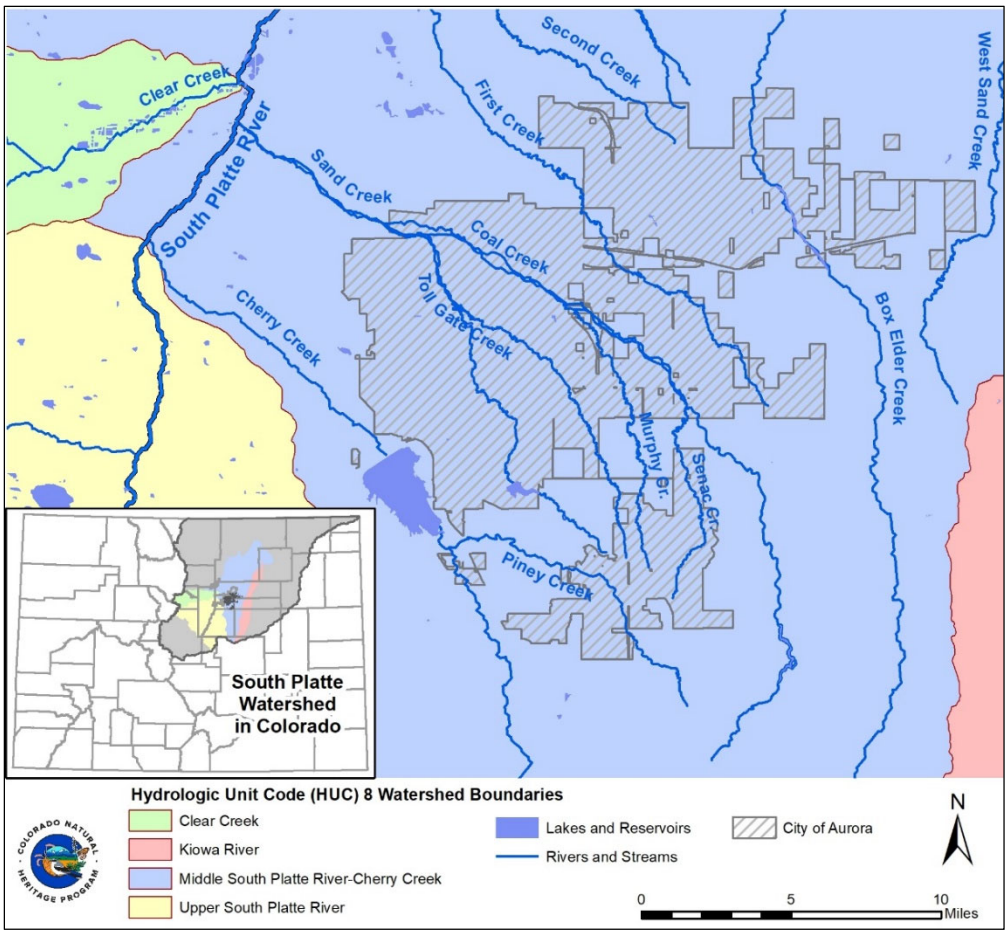

Figure 4. Streams and Hydrologic Unit Code (HUC) 8 boundaries in the vicinity of Aurora (USGS 2014).

The South Platte River basin is home to 85% of Colorado's population concentrated along the Front Range urban corridor. The basin also contains the most productive agricultural lands. However, the basin's natural water supply is limited. Though variable by year, the basin's 1.4 million acre-feet of native flow represents only about 20% of the State's total water supply (Figure 5). To meet the basin's water needs, the water supply is supplemented by several transbasin diversions that bring approximately 400,000 acre-feet of water from the Colorado, Arkansas, and North Platte basins and increase the volume of water within the basin by nearly one-third (CWCB 2019). The City of Aurora receives 95% of its water supply from surface water sources derived primarily from the Colorado, Arkansas, and South Platte river basins (City of Aurora 2020). The increased water in Aurora and the overall South Platte Basin is used by municipal, industrial, agricultural, and recreational users;

it also sustains the ecological and environmental resources that depend on water. While vital to Aurora and to the basin, increased water and significant land use development have certainly impacted the area's natural hydrology.

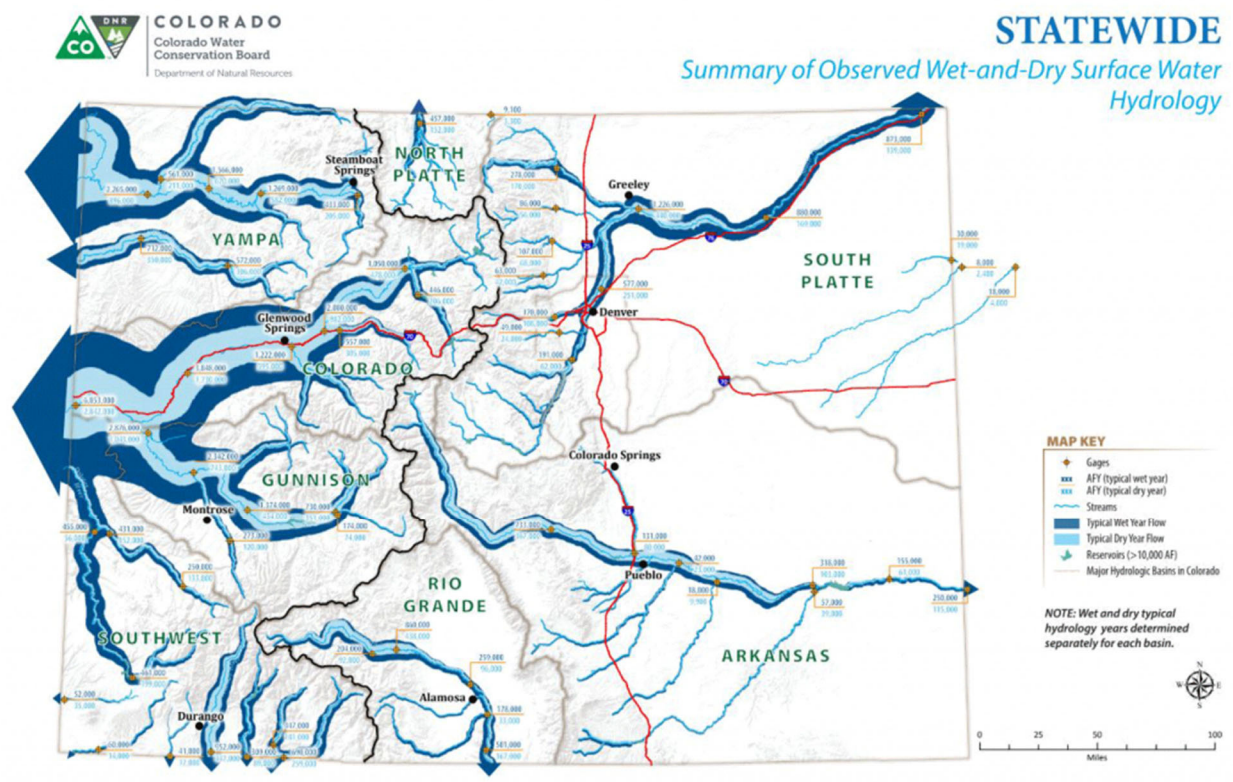

Figure 5. Colorado surface water hydrology (CWCB 2017).

2.5 Geology

The City of Aurora is located in the Denver Basin, a large structural depression that extends from the Front Range to the eastern plains of Colorado, stretching from Boulder, Colorado Springs, and east to Limon (Barclay and Johnson 2004). The basin contains strata deposited during the uplift of the Rocky Mountain Front Range in the Late Cretaceous and Paleogene Period (Kirkham and Ladwig 1979; Raynolds and Johnson 2002; Barclay et al. 2003). Much of Aurora is underlain by alluvium of Quaternary age; the depositional history of the area is dominated by the erosive action of the South Platte River and its tributaries. Below these deposits, older formations include the Castle Rock Conglomerate and the Denver Formation (ranging in age from the upper Cretaceous to lower Oligocene) and outcrops may occur between drainages, primarily in the southern portion of the city (Trimble and Machette 1979).

2.6 Land Use History

The waters of the South Platte River and its tributaries have supported human occupation of Colorado's eastern plains and foothills for at least 13,000 years, but the region remained sparsely populated until the arrival of horses in the seventeenth century (Gunnerson 1987; Weber 1994; Yohe and Bamforth 2013). The introduction of the horse enabled many Native American groups to become nomadic hunters on the bison-rich plains. The Great Plains – especially the riparian zones along the South Platte and its tributaries – saw a dramatic increase in human use in this period (West 2000; Hämäläinen 2009). The study area likely served as hunting and overwintering grounds for the Arapaho and Cheyenne since the early eighteenth century (Fowler 1989). These tribes occupied parts of Wyoming, Kansas, Nebraska, and eastern Colorado.

In the mid-nineteenth century, white settlers moved into the area, slaughtering bison herds, and creating conflict with the Arapaho and Cheyenne tribes and others. In 1858, when gold was discovered near Denver at the confluence of Dry Creek and the South Platte River, miners, farmers, city-dwellers, and politicians streamed into the area, making nomadic lifestyles ever more difficult (Fowler 1989; West 2000). During that same year, entrepreneurs founded the towns of Auraria and Denver on opposite banks of Cherry Creek (Limerick 2012). Later, in 1869, the United States Government compelled many Arapaho and Cheyenne to abandon their territory, relocating them to a new reservation in Oklahoma.

Originally incorporated in 1891 as the town of Fletcher some six miles directly east of the Colorado state capitol building in Denver, Aurora has expanded dramatically to the south, east, and northeast. The city's population grew accordingly, from about 75,000 in 1970 to an estimated 379,000 in 2019 (US Census Bureau 2020). Today, the western and central portions of the City of Aurora are characterized by urban and industrial land use. These areas support residential and commercial development dotted with open spaces and parks. The eastern and northern portions of the city contain a mix of low density residential development and large tracts of land that include agricultural fields.

3.0 METHODS

3.1 City of Aurora Wetland Mapping

The U.S Fish and Wildlife Service's National Wetland Inventory (NWI) program originally mapped wetlands and waterbodies of the southeast portion of City of Aurora in the 1980s, and the northwest portion of the city was included in Denver's 2010 NWI mapping update (Smith and Kuhn 2015). Widespread land use changes in the last 10 to 30+ years, along with substantial increases in the quality of aerial images and changes in mapping methods, necessitated an update to the NWI maps and was completed as a part of this project. The wetland mapping project area is a simplified boundary that encompasses all City of Aurora lands in one continuous project area (Figure 6). To complete wetland mapping for the City of Aurora, CNHP obtained high resolution (3cm) color infra-red (CIR) and true color aerial photography flown in 2016 from the City of Aurora. Along with this high quality imagery provided by the city, a combination of ancillary data sources were used to identify and classify wetland features in the study area, including 2005, 2006, 2009, 2011 and 2017 true color images, topographic maps, and previously mapped NWI polygons (see Appendix A for detailed mapping methodologies). Wetlands were attributed according to the NWI wetland classification system (Cowardin et al. 1979; FGDC 2013), which has become the federal standard for wetland classification. In addition to following the NWI mapping standards, *non-wetland* riparian areas were also mapped following a supplemental riparian mapping standard (USFWS 2019). Non-wetland riparian areas lack the amount or duration of surface and ground water present in wetlands, but are adjacent to waterbodies and provide valuable wildlife habitat.

Using the imagery described above, CNHP wetland mapping specialists visually analyzed each part of the City of Aurora landscape to identify existing wetlands and waterbodies. Each mapped polygon was attributed with the NWI classification. The electronic data that accompanies this report includes GIS layers with the updated NWI mapping for the wetland mapping project area for the City of Aurora. NWI data is available to view through the U.S. Fish and Wildlife Service's Wetlands Mapper: http://www.fws.gov/Wetlands/Data/Mapper.html and the data is downloadable as part of the Colorado dataset: https://www.fws.gov/wetlands/data/State-Downloads.html

NWI Classification

The NWI classification system (Cowardin et al. 1979) is based on the following definition of wetlands:

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

The classification is a hierarchical system that describes wetlands and waterbodies at varying scales of specificity. All mapped polygons are attributed using the NWI hierarchy of system,

subsystem, class, hydrology, and special modifiers. The result is a 4–6 character alpha-numeric code (see Appendix A for the full classification system). It is important to note that NWI data contains deep waterbodies (lakes and rivers) as well as wetlands.

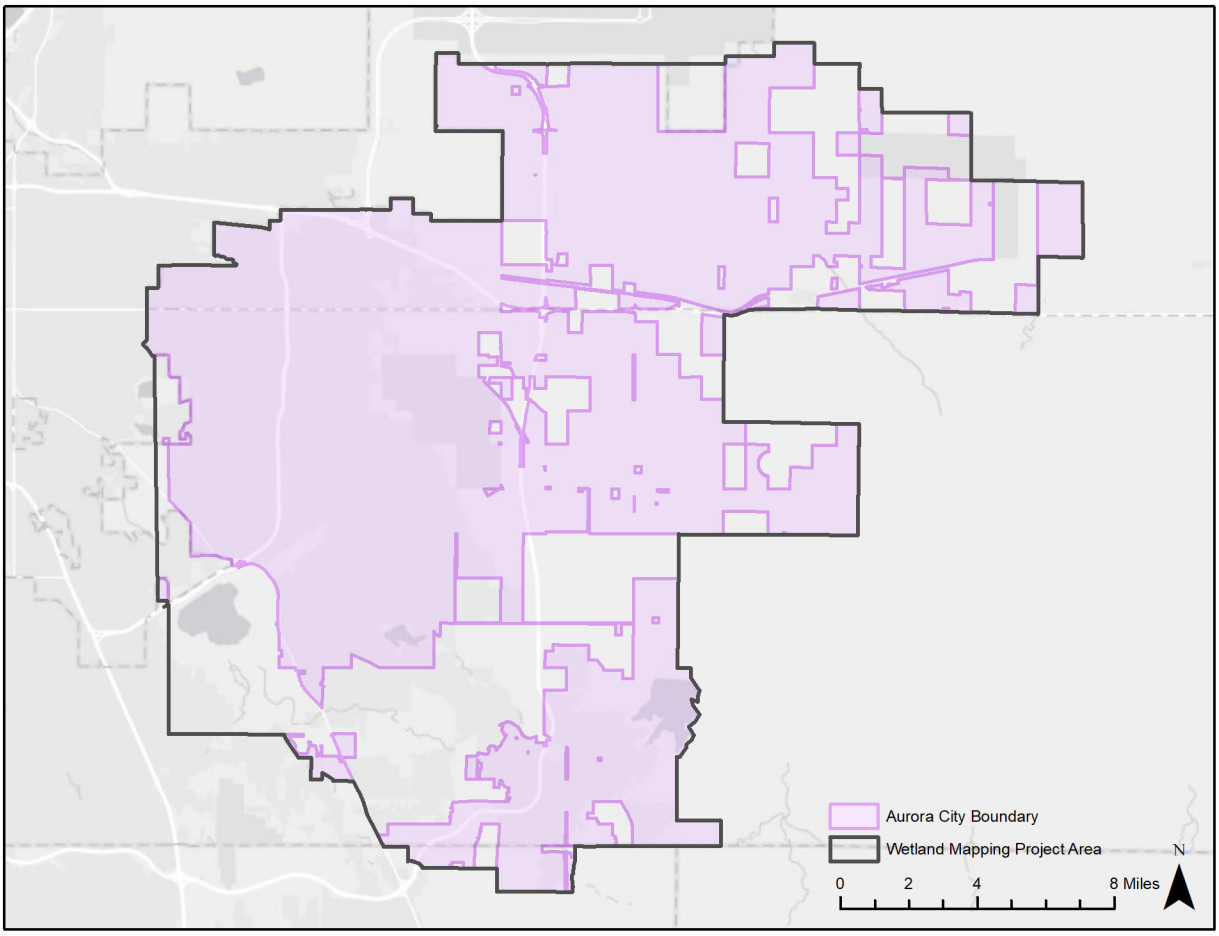

Figure 6. City of Aurora wetland mapping project area.

3.2 Site Selection

Twenty wetland assessment areas (AAs) in 17 target wetlands were surveyed for the study (Figure 1). Target wetlands were selected using aerial imagery, topographical maps, pre-existing NWI maps, and new NWI maps generated by CNHP for this project. Additional input was contributed by a stakeholder group, which met at a kickoff meeting during the planning phase. Using stakeholder input and map resources, a list of target wetlands was created. The targeted sites were prioritized based on size (>0.5 acre) and potential to be a natural feature and/or a functioning wetland. The surrounding landscape (presence of a vegetated buffer) was also important criteria for prioritizing our target sites. Random sampling was not a part of the study design, since we were targeting the highest quality wetlands. Wetland survey plots included interspersed wetland/non-

wetland riparian area, because the natural wetlands in the study area are mostly located in plains riparian areas, and the reaches that are wholly wetland are generally predominately cattail and lower condition. Survey area was not limited to size but included the entire wetland or at least as much of the wetland as a one-day survey and legal access permitted.

3.3 Wetland Assessment

The Ecological Integrity Assessment (EIA) and the Functional Assessment of Colorado Wetlands (FACWet) are two similar methods of wetland assessment. Both methods, discussed below, were used to assess the City of Aurora wetlands. Additionally, a measure of social values of wetlands was conducted.

Ecological Integrity Assessment (EIA)

The Ecological Integrity Assessment (EIA) framework was developed by NatureServe (Faber-Langendoen et al. 2006; Faber-Langendoen et al. 2008) and modified by the Colorado Natural Heritage Program (Lemly et al. 2016). The EIA framework evaluates wetland condition based on biotic and abiotic categories including landscape context, vegetation condition, hydrologic condition, and physiochemical condition (Table 1). Each category contains three to six metrics, which are used to evaluate how far the wetland deviates from reference condition (i.e., before human disturbance). Both qualitative and quantitative criteria are used to score each metric. The metric scores are then rolled up into a category score, and category scores are rolled up into an overall EIA score and rank. Possible scores range from 1.0 to 5.0[1], and can be given alphabetic ranks of A, B, C or D, which correspond to different levels of alteration and represent different management opportunities. The EIA metrics are described in Table 1 below and the EIA roll-up scores are discussed in the Data Analysis section.

The EIA protocols were developed specifically for wetland types in Colorado by CNHP with funding from EPA Region 8 and Colorado Parks and Wildlife (Lemly and Rocchio 2009; Lemly et al. 2011; Lemly and Gilligan 2013; Lemly et al. 2016). The EIA method can be used at varying levels of intensity. For this study, the EIA method was used as a rapid assessment to evaluate the general condition of wetlands. The field portion of the assessments took approximately 4–5 hours depending on the size of the site. In addition, a substantial amount of time was spent on data entry, quality checking, analysis, and interpretation of the results.

One of the primary goals for this study was to assist the City of Aurora in prioritizing a list of wetlands that were evaluated for condition and function using metrics that have been applied state-wide. The EIA metrics have typically been used in Colorado to evaluate more natural wetlands, however, other studies have successfully applied condition assessment methods in urban settings (Mack and Micacchion 2007; Smith and Kuhn 2015). Prior to beginning our assessment, we anticipated that very few of the urban wetland sites would score above average (~C rank). We expected most of our sites to have D ranks for the following reasons: 1) many urban wetlands have

[1] The 5 point scale scoring method described in Field Manual Version 1.0 (Lemly and Gilligan 2013) was used for this project instead of the 4 point scale described in Field Manual Version 2.1 (Lemly et al. 2016). The 5-point scale was used to provide consistency with the scoring method used in the Denver (Smith and Kuhn 2015) and South Platte River Basin (Lemly et al. 2014) wetland assessments. (See Appendix D for scoring details.)

been created or heavily modified by human land use; 2) they are greatly impacted by a high percentage of impervious surfaces within their watersheds; and 3) the vegetated buffers in the landscape are either narrow or non-existent.

Table 1. Ecological Integrity Assessment metrics used to evaluate wetland condition (Lemly et al. 2016).

Rank Factor	*Major Ecological Factor*	*Metric*
Landscape Context **Weight = 0.3**	Landscape Weight = 0.33	Contiguous natural land cover, land use index
	Buffer Weight = 0.67	Perimeter with natural buffer, width of natural buffer, condition of natural buffer
Condition **Weight = 0.7**	Vegetation Weight = 0.55	Native plant species cover, invasive non-native species cover, native plant species composition, vegetation structure, regeneration of woody species, coarse and fine woody debris
	Hydrology Weight = 0.35	Water source, hydroperiod, hydrologic connectivity
	Physiochemistry Weight = 0.10	Soil/substrate disturbance, surface water turbitidy/pollutants, algal growth

Landscape Context Metrics

The Landscape Context scores were based on qualitative and quantitative metrics that reflect the quality of the landscape that surrounds the AA, including fragmentation, buffer size and buffer condition (Table 1).

Condition Metrics

Vegetation Condition

Vegetation condition scores were based on the plant species data with additional information on the community structure and regeneration. Out of the ecological categories used to generate EIA scores, the Vegetation Condition category was assigned the highest weight (Lemly et al. 2016). This was due to our high confidence in assessing plant species composition and structure.

Nested within the Vegetation Condition assessment is the Floristic Quality Assessment (FQA) which allows for the calculation of various indices that reflect the quality of the site from the species list and cover data collected. The FQA method uses the proportion of conservative plant species in a plant community to assess the degree of "naturalness" of an area (Swink and Wilhelm 1994; Wilhelm and Masters 1996). In the FQA method, every plant species in a state or regional flora is assigned a Coefficient of Conservatism, or C-value. C-values range from 0 to 10 and represent an estimated probability that a plant is likely to occur in a landscape relatively unaltered from pre-

European settlement conditions (Table 2). High C-values are assigned to species which are obligate to high-quality natural areas and cannot tolerate habitat degradation, while low C-values are assigned to species with a wide tolerance to human disturbance. In Colorado, C-values of 0 are reserved for non-native species. C-values for Colorado plant species were assigned by a panel of botanical experts (Rocchio 2007; Smith et al. 2020)[2].

Table 2. C-value ranges and associated interpretation.

C-Value	*Interpretation*
0	Non-native species. Very prevalent in new ground or non-natural areas.
1-3	Commonly found in non-natural areas.
4-6	Equally found in natural and non-natural areas
7-9	Obligate to natural areas but can sustain some habitat degradation.
10	Obligate to high quality natural areas – no evidence species occurs outside high quality natural areas.

Several metrics can be calculated based on the C-values of all species within a site. The most basic FQA index is Mean C, a simple average of C-values for a given site. For the Aurora sites, the Mean C as well as the Mean Native C, the average C-value for just the native plant species, were calculated.

The Aurora wetland project follows the 2020 FQA (Smith et al. 2020) native status and C-values. In the 2020 FQA, narrowleaf cattail (*Typha angustifolia*), hybrid cattail (*Typha* x *glauca*), and reed canarygrass (*Phalaris arundinacea*), are considered cryptogenic species. Cryptogenic species include taxa with both native and non-native varieties and where the non-native variety is often invasive (Magee et al. 2019). These cryptogenic species were thus not treated as native vegetation cover or composition in EIA vegetation metrics. This treatment differs from the methodology of Lemly et al. (2016). Plant species evaluated in the invasive non-native vegetation metric included both species from the state noxious weed list following Lemly et al. (2016), and the above listed cryptogenic species, due to their invasive nature in the study area and Front Range. Changes in EIA methodology to reflect the updated 2020 FQA and cryptogenic taxa and their corresponding treatment in this study's vegetation analyses will be reported in a 2021 Colorado EIA protocol update (EIA 2.2, *in-prep*).

Hydrologic Condition

Hydrologic condition scores are based on the water source (e.g., ground water, surface water, runoff), connectivity to other wetlands, and non-natural alterations to the hydroperiod. Water sources and other aspects of hydrology are difficult to determine in densely urbanized developments. Therefore, a lower weight was used to calculate the Hydrologic Condition score (Lemly et al. 2016).

[2] C-values for Colorado plant species are available on the CNHP website https://cnhp.colostate.edu/cwic/tools/calculator/.

Physiochemical Condition

Physiochemical condition scores are calculated based on both water quality and the soil disturbances within the AA. The physiochemical condition was assigned the lowest weight of all the ecological categories. Water quality is difficult to determine solely from a single field observation and requires repeated observations and chemical sampling over time. The metric for this study was not meant to replicate that type of an effort. However, there are some obvious indicators of water quality that can be observed or inferred. One of the biggest indicators of water quality impacts is the percentage of impervious surfaces. Many reports indicate water quality is impacted at 10% impervious cover. In dense urban metropolitan areas, like Aurora, impervious surfaces may account for the majority of the ground area (Homer et al. 2015). Based on that information alone, the water quality in urban Aurora is significantly impacted. Other observations include hydric soil presence, soil compaction or sedimentation, excessive algal growth, and water turbidity.

Stressors

There were four categories of stressors (landscape, vegetation, hydrological and physiochemical) that were scored corresponding to four ecological categories that comprise the EIA score (Landscape Context, Vegetation Condition, Hydrologic Condition and Physiochemical Condition, respectively). Each stressor was assigned a scope of area affected and a severity rating. These stressors and severity ratings were combined into an overall threat impact to the wetland (Lemly et al 2016). Stressors were evaluated within a 500m envelope zone surrounding the AA, and within the AA itself. Hydrology stressors were also evaluated further upstream, up to ~2 km, if stressors were visible that significantly affected the AA's hydrology such as a large reservoir. The landscape, soil, and hydrological stressors were estimated from satellite imagery and GIS layers (including groundwater wells, gravel and other mines, stormwater, diversions and oil/gas), then were field-verified to the extent possible from within the wetland and during travel to the wetland. Vegetation stressors were also rated based on both imagery and from site visits, but information on the upland surrounding vegetation composition such as weeds was more heavily informed by vantage points within and near the field sites.

Functional Assessment of Colorado Wetlands (FACWet)

The Functional Assessment of Colorado Wetlands (FACWet) method was developed by Brad Johnson and others (2013) for the Colorado Department of Transportation. The method is similar to the EIA method in that it rates site condition as deviation from a reference condition without human alteration. FACWet applies more scoring weight to hydrologic and geomorphic conditions, while EIA applies more weight to vegetation condition; but both methods rank both concepts (Lemly et al. 2013). FACWet does not rate human values of the wetland function as they relate to ecosystem services, such as a floodplain wetland near an urban area that offers higher valuated flood protection than a floodplain in an unpopulated area. It also does not measure the net function performed, such as the total water storage. Rather, the FACWet rates the ability of the wetland to successfully perform its natural functions. FACWet evaluates wetland function based on the abiotic and biotic categories shown in Table 3. The metric scores are then rolled up into an overall FACWet 5-point rank ranging from A (reference standard) to F (non-functioning).

Table 3. Functional Assessment of Colorado Wetlands metrics used to evaluate wetland condition (modified from Johnson et al. 2013).

Attribute	*State Variable Name*	*Sub-variable Name*
Buffer and Landscape Context Weight = 0.15	Habitat Connectivity	Neighboring wetland and riparian habitat loss, barriers to migration and dispersal
	Contributing Area	Buffer condition, buffer extent, buffer width, surrounding land use
Hydrology Weight = 0.48	Water Source	No sub-variables
	Water Distribution	No sub-variables
	Water Outflow	No sub-variables
Abiotic and Biotic Habitat Weight = 0.37	Geomorphology	No sub-variables
	Chemical Environment	Nutrient enrichment, sedimentation/turbidity, toxic contamination, temperature, soil chemistry and redox
	Vegetation Structure and Complexity	Tree stratum, shrub stratum, herb stratum, aquatic stratum

Social Rating

Wetlands are highly valued for their ecosystem services, the many benefits wetlands provide to humans. Some of these ecosystem services are directly tied to the wetland's condition, function, and physical properties, such as biodiversity and groundwater recharge. Some wetland ecosystem services are valued for the interaction between the wetland's condition or function with specific human needs, such as such as flood protection and water pollution reduction. Wetlands also provide cultural ecosystem services where interactions between people and the wetland positively affect human well-being (Pedersen et al. 2019). These cultural ecosystem services are more researched in in psychology and sociology fields than in ecology, and they include social values of wetlands that are especially valued in populated areas, yet not well-represented by wetland condition or function concepts. To address this wetland social value gap in identifying the critical wetlands of the City of Aurora, we created a social rating for this urban wetland assessment that highlights the interactive benefits that wetlands provide to the public.

The social rating includes categories that affect human use and interactions with the wetland, but not the values that relate to social benefits of wetland functions such as such as flood protection or groundwater recharge. The evaluation criteria included many concepts in the literature related to social wetland values including nearby population, impervious surface as a measure of green space deprivation, wetland size as a measure of green space provision, biodiversity support, and positive well-being; and from select metric concepts in the 'Public Use and Recognition' rating from the Oregon Rapid Wetland Assessment Protocol (Adamus and Verble 2020) including public use, recreation, and education. Table 4 summarizes the scoring categories and weights. The social rating score ranges from 0-12 points, with each metric worth two points. The rating is scored additively, as the rating does not attempt to identify the relative importance or interactions of individual measures.

Table 4. Social rating metrics.

Social Rating Metric	*Metric Description and Score Values*
Public Access	Whether wetland has public access and if access is free. **Score** **2.0:** Free and public **1.0:** Public with use fee **0:** Not public
Population Density	Population density estimate of people/mi^2 based on census tracts in 0.5 mi envelope surrounding surveyed wetland. **Score** **2.0:** ≥1650 **1.5**: 800 - <1650 **1.0**: 201 - <800 **0:** ≤200[1]
Impervious Surface	Mean % impervious surface estimate in 0.5 mi^2 envelope surrounding surveyed wetland. **Score** **2.0:** >30% **1.5:** >20-30% **1.0:** >10-20% **0.5:** >0-10% **0:** 0
Recreation	Tally of site recreation amenities that increase and enhance wetland visitation, including dirt trail, paved or gravel trail, boardwalk, benches, open water visible from trail/overlook, and adjacent recreation facility such as sports park, or playground. **Score** **2.0:** 4+ **1.5:** 3 **1.0:** 2 **0.5:** 1 **0:** 0
Education	Educational features at the wetland including trailhead, educational signage along wetland, and interpretive visitor center. **Score** **2.0**: Visitor center or educational signage **1.0:** Trailhead **0:** None
Size	Colorado Ecological Integrity Assessment[2] size score of wetland, based on AA and its contiguous wetland in the same condition/land use and wetland type. **Score** Riparian Areas: **2.0:** >5 km (>3 mi) **1.5:** 1-5 km (3 mi) **1.0:** 0.1-1 km **0:** <0.1 km Marsh/wet meadows: **2.0:** >10 ha (>25 ac) **1.5:** 2-10 ha (25 ac) **1.0** 0.5-2 ha (5 ac) **0:** <0.5 ha (<1 ac)

[1] Thresholds based on Nordbø et al. 2019. [2] EIA scores from EIA Manual 2.1 (Lemly et al. 2016).

Field Methods

In the field, Assessment Areas (AAs) were defined as the entire wetland or portion of the wetland targeted for the condition assessment. These areas were first delineated on paper maps and/or air photos and final boundaries were confirmed with field visits. Once the AA was established, field forms were used to record data and make observations at the site (Appendix B). Field forms were completed for both the Ecological Integrity Assessment (EIA) and the Functional Assessment of Colorado Wetlands (FACWet) methods.

Information was collected included the following attributes:

- UTM coordinates and photo points taken at four locations on the perimeter of the AA
- Elevation, slope, and aspect
- Land ownership
- Ecological System classification (see Appendix C)

- HGM classification (see Appendix C)
- Cowardin classification
- Species list of all plants observed with estimated cover class
- Incidental wildlife observations
- Basic field water quality parameters (pH and electrical conductivity)
- Description of onsite and adjacent ecological processes and land use
- Description of general site characteristics and a site drawing
- Description of soil profile

Soil pits were used to assess and describe the soil type and hydric indicators in the wetland. Some sites lacked wetland outside of the creek due to fill or entrenchment. For those, a soil pit was less informative, and soil maps were used to describe soil characteristics at these sites.

Wildlife observations recorded included amphibians, birds, and beaver. Amphibian surveys consisted of careful visual searches for frogs and tadpoles during slow walks along the edges of ponds and other water bodies. The primary species of interest for the amphibian surveys were the state Tier 1 species of conservation concern northern leopard frog (*Lithobates pipiens*) (CPW 2015), and the non-native invasive bullfrog (*Lithobates catesbeianus*). However, all amphibians and reptiles encountered during the wetland surveys were recorded. The invasive non-native red-eared slider turtle (*Trachemys scripta elegans*) was also of interest and documented when encountered.

In response to concerns over the emerging amphibian chytrid fungus disease, chytrid fungus testing was incorporated into the amphibian surveys. The pathogenic chytrid fungus (*Batrachochytrium dendrobatidis*) has been implicated in amphibian declines around the world (Daszak et al. 2003) and has been documented in Colorado populations of northern leopard frogs (Muths et al. 2003; Livo 2004; Johnson 2011). Metamorphosed amphibians encountered during the surveys were swabbed for chytrid fungus using swab kits provided by Pisces Molecular in Boulder, Colorado. The samples were then sent to Pisces Molecular for analysis. Waders and equipment were sterilized between sites with a 10% bleach solution to help stop the accidental introduction or spread of disease or pathogens.

Bird surveys consisted of incidental observations made during the wetland condition assessments. All bird observations were submitted through eBird, a global citizen science online database of bird distribution and abundance (Sullivan et al. 2009). The primary species of interest was the Tier 2 species of conservation concern bald eagle (*Haliaeetus leucocephalus*) (CPW 2015).

The presence of beaver (*Castor canadensis)* at the survey locations was noted as beaver are considered an important component of hydrological functioning.

Data Analysis

Data collected in the field and gleaned from air photos and wetland mapping were used to rate each EIA and FACWet metric. To calculate the overall EIA and FACWet scores, subscores were first calculated for the categories based on their component metrics (Tables 1 and 3). The formulas and weights for each metric and category are provided in Appendix D. The metric categories were then weighted and combined to generate an overall numeric EIA and FACWet score and an

accompanying EIA and FACWet rank. The weights for each category are based on the relative importance of each category to the overall score. EIA Ranks are summarized in Table 5; FACWet Ranks are similarly defined.

Table 5. Definition of Ecological Integrity Assessment ranks (Lemly et al. 2016).

Rank Value	*Description*
A	**Reference Condition (No or Minimal Human Impact):** Wetland functions within the bounds of natural disturbance regimes. The surrounding landscape contains natural habitats that are essentially unfragmented with little to no stressors; vegetation structure and composition are within the natural range of variation, non-native species are essentially absent, and a comprehensive set of key species are present; soil properties and hydrological functions are intact. Management should focus on preservation and protection.
B	**Slight Deviation from Reference:** Wetland predominantly functions within the bounds of natural disturbance regimes. The surrounding landscape contains largely natural habitats that are minimally fragmented with few stressors; vegetation structure and composition deviate slightly from the natural range of variation, non-native species and noxious weeds are present in minor amounts, and most key species are present; soils properties and hydrology are only slightly altered. Management should focus on the prevention of further alteration.
C	**Moderate Deviation from Reference:** Wetland has a number of unfavorable characteristics. The surrounding landscape is moderately fragmented with several stressors; the vegetation structure and composition is somewhat outside the natural range of variation, non-native species and noxious weeds may have a sizeable presence or moderately negative impacts, and many key species are absent; soil properties and hydrology are altered. Management would be needed to maintain or restore certain ecological attributes.
D	**Significant Deviation from Reference:** Wetland has severely altered characteristics. The surrounding landscape contains little natural habitat and is very fragmented; the vegetation structure and composition are well beyond their natural range of variation, non-native species and noxious weeds exert a strong negative impact, and most key species are absent; soil properties and hydrology are severely altered. There may be little long term conservation value without restoration, and such restoration may be difficult or uncertain.

3.4 Natural Heritage Methodology

One of CNHP's core research activities is managing a statewide database that details the locations of rare and imperiled species and natural plant communities in Colorado. The data are compiled and managed in Biodiversity Information Management System (Biotics), a web-enabled database platform hosted by NatureServe. The species and natural plant communities CNHP tracks are assigned global and state imperilment ranks based on rarity, threats, and trends, and their locations are mapped as element occurrences (see Appendix E for detail on heritage methodology). Element occurrences include spatial data as well as details on condition, size, and landscape context.

Prior to the field season, a target list of CNHP-tracked aquatic-dependent rare species and plant communities with the potential to occur in the survey area was compiled. Species and plant communities defined by CNHP and NatureServe as being state and or globally vulnerable, impaired,

or critically impaired were included (Appendix E). The list of target plant and animal species, compiled using nearby existing element occurrences and herbarium and museum searches, is presented in Appendix F.

Where rare aquatic-dependent species were encountered an element occurrence record was completed and the data added to the CNHP Biotics database.

3.5 Data Management

To efficiently store and analyze data collected from wetland condition assessment projects, a Microsoft Access database was built by CNHP in 2008. EIA and vegetation data were entered into the database at the completion of the field season. A pre-defined species list was used for plant species entry. During data entry, unknown or ambiguous species (e.g., *Carex* sp.) were entered into the database, but not included in Floristic Quality data analysis. Data entry was reviewed by an independent observer for quality control. All plant specimens collected during the project will be deposited at Colorado State University Herbarium (CSU) or Kathryn Kalmbach Herbarium (KKH) at Denver Botanic Gardens.

The species table from the Colorado FQA (Smith et al. in progress) was used as the pre-defined species list and to populate native status, wetland indicator status, and C-values in the database for each species in each AA. Species nomenclature follows Ackerfield (2015), though all names are cross-referenced to the nationally accepted names in the U.S. Department of Agriculture's PLANTS Database[3].

Results from chytrid testing conducted as part of the amphibian surveys are presented in the results section of this report and were submitted to Colorado Parks and Wildlife as part of our permit requirements, along with the Aurora amphibian/reptile observations. The online database Bd-Maps that has previously been used to store data on where chytrid samples have been collected and how many samples are positive or negative for the fungus is now defunct.

Element occurrence records for CNHP-tracked species were entered in the CNHP Biodiversity Information Management System (Biotics) database (CNHP 2020a) following heritage program methodology (Appendix E).

[3] PLANTS National Database can be accessed at the following website: http://plants.usda.gov.

4.0 Results

4.1 Mapped Wetlands of the City of Aurora

The updated U.S. Fish and Wildlife Service National Wetland Inventory (NWI) mapping results showed that the City of Aurora contains 2,568 acres of wetlands, waterbodies, and riparian areas (Table 6), accounting for 2.5% of the City of Aurora landscape. Of this total, only 680 acres were mapped as wetlands, representing 0.7% of the City of Aurora. The NWI data shown in Figure 7 is available online at https://www.fws.gov/wetlands/data/State-Downloads.html

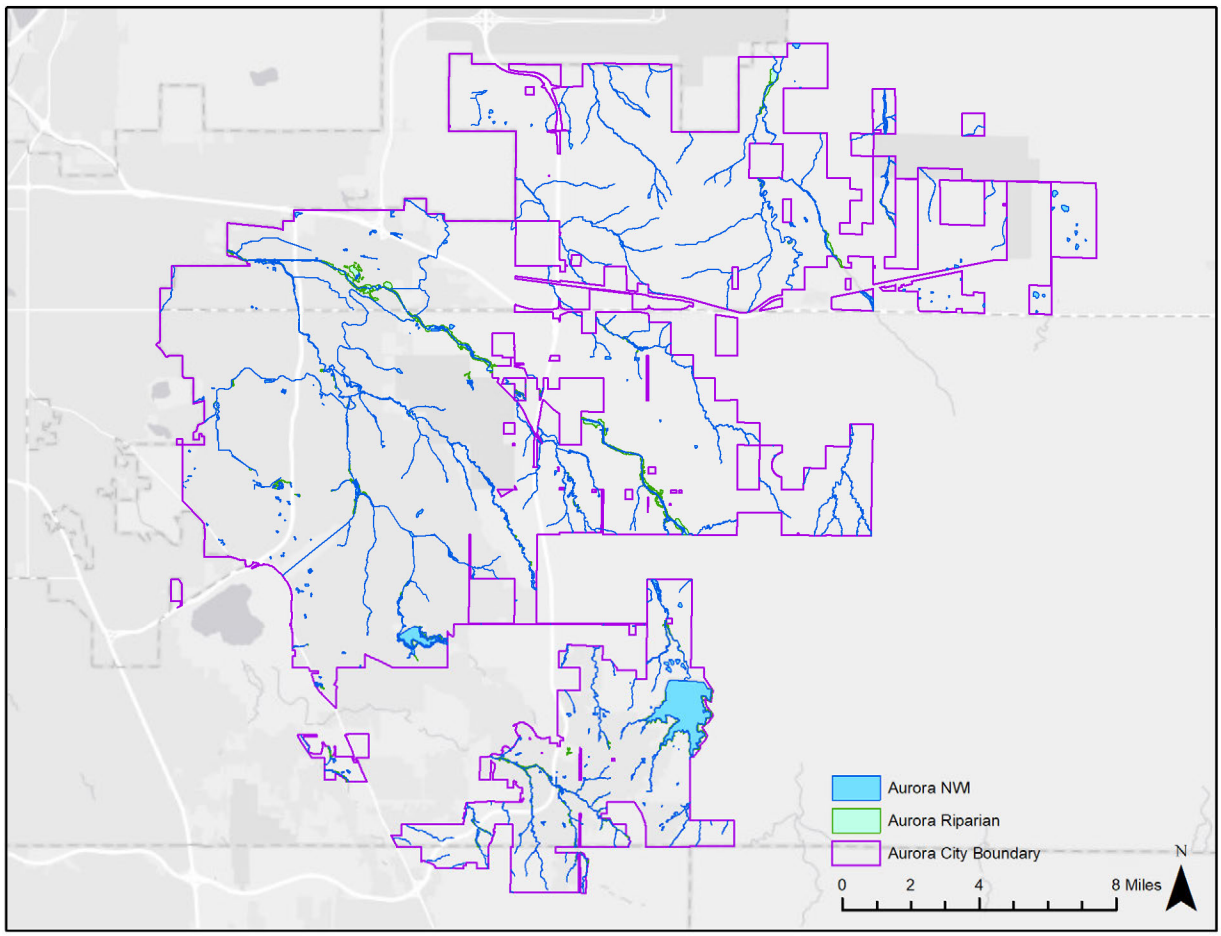

Figure 7. National Wetland Inventory (NWI) mapped features in the City of Aurora.

Wetland Acres by General Wetland Type

Aquatic resources of the City of Aurora are dominated by lakes and shores, which make up the largest resource type mapped at 867 acres, representing 34% of the total mapped acres (Table 6). Similar to the rest of Colorado's Front Range, many of the lakes in the study area are artificially

created reservoirs, primarily used for water storage. Non-wetland riparian areas, which are too dry to meet the definition of a wetland, were the second largest resource type mapped at 690 acres (27% of mapped acres).

Mapped wetlands, with waterbodies and non-wetland riparian areas removed, represented only 26% of all mapped acres, highlighting the large amount of waterbodies and riparian areas relative to wetlands. Herbaceous wetlands were the most dominant wetland type with 397 acres, making up 88% of mapped wetlands, though still only representing 15% of all mapped acres and only 0.4% of the entire city. Ponds were the second largest wetland type, with 158 mapped acres.

Table 6. National Wetland Inventory (NWI) acreage mapped in the City of Aurora.

Wetland and Waterbody Type		*Acreage*	*% of City Acreage*	*% of NWI Acreage*	*% of Wetland Acreage*
Total Area of City		102,092	100.0%	---	---
Upland Area		99,524	97.5%	---	---
NWI Code	**Wetland Type**				
PEM	Herbaceous Wetlands	397	0.4%	15%	58%
PSS	Shrub Wetlands	60	0.1%	2%	9%
PFO	Forested Wetland	12	0.0%	0%	2%
PAB/PUB	Pond	158	0.2%	6%	23%
----	Other	53	0.1%	2%	8%
Wetlands Only (excl. Lakes & Rivers)		**680**	**0.7%**	**26%**	**100%**
L	Lakes and Shores	867	0.8%	34%	---
R	Rivers, Streams, Canals	331	0.3%	13%	---
Rp	Riparian	690	0.7%	27%	---
Wetlands, Waterbodies and Riparian Areas		**2,568**	**2.5%**	**100%**	**---**

Wetland Acres by Hydrologic Regime

Permanently Flooded (H) is the most common hydrologic regime attributed to lakes and was the most prevalent hydrologic regime of all NWI mapped acres in the City of Aurora at 867 acres (34% of all mapped features; Table 7). The next most common hydrologic regime of all mapped features was Seasonally Flooded (16%) and Temporarily Flooded (12%). Riparian features (Rp) and palustrine farmed wetlands (Pf) are not assigned a hydrologic regime.

The most prevalent hydrologic regime in wetlands specifically was Seasonally Flooded at 208 acres (31% of wetlands). This is a common hydrologic regime for herbaceous wetlands, which are a major wetland type in the City of Aurora landscape.

Table 7. National Wetland Inventory (NWI) acreage mapped in the City of Aurora by hydrologic regime code.

NWI Code	*Hydrologic Regime*	*Acreage*	*% of NWI Acreage*	*Wetland Acreage*	*% of Wetland Acreage*
A	Temporarily Flooded	312	12%	198	29%
C	Seasonally Flooded	408	16%	208	31%
F	Semipermanently Flooded	106	4%	95	14%
G	Intermittently Exposed	109	4%	109	16%
H	Permanently Flooded	874	34%	---	---
J	Intermittently Flooded	52	2%	52	8%
Rp	Riparian	690	27%	---	---
Pf	None (farmed)	17	1%	17	2%
Total		**2,568**	**100%**	**680**	**100%**

Wetland Acres by Extent Modified

Roughly half (49%) all NWI acres in the City of Aurora were mapped with a modifier (Table 8). Lakes primarily drive this trend with all lakes in the City of Aurora mapped as impounded. Sixteen percent of river features were mapped as excavated. These acres represent the canal network, including the High Line Canal, that conveys water to agricultural lands on the edges and beyond the City. While the remaining river features were mapped without a modifier, it is important to note that NWI modifiers do not represent diversions or inputs that modify river flow. Most rivers throughout the Front Range have significant hydrologic modification, so these 84% unmodified rivers should not be viewed as a functional statement, only what is observable from aerial images. Most vegetated wetlands were not mapped with a modifier. However, almost all ponds were mapped as excavated or impounded.

Table 8. National Wetland Inventory (NWI) acreage mapped in the City of Aurora by NWI modifier.

Wetland Type	*Total Acreage*	*No Modifier*		*Excavated*		*Dammed / Impounded*		*Farmed*	
		Acres	*% of Type*	*Acres*	*% of Type*	*Acres*	*% of Type*	*Acres*	*% of Type*
Herbaceous	397	285	72%	20	5%	39	10%	53	13%
Shrub	60	55	92%	--	--	5	8%	-	-
Forested	12	12	100%	--	--	-	-	-	-
Ponds	158	1	1%	138	87%	18	12%	-	-
Other (Pf/PUS)	53	1	2%	24	45%	11	22%	17	32%
Wetlands Only	**680**	**354**	**52%**	**182**	**27%**	**73**	**11%**	**70**	**1%**
Lakes and Shores	867	--	--	--	--	867	100%	-	-
Rivers, Streams, Canals	331	279	84%	52	16%	-	-	-	-
Riparian	690	690	100%	-	-	-	-	-	-
Wetlands, Waterbodies and Riparian Areas	**2,568**	**1,323**	**51%**	**234**	**9%**	**940**	**37%**	**70**	**3%**

4.2 Wetland Condition Assessment Results

Seventeen sites were assessed for wetland condition as part of the City of Aurora project. At three of the sites, the riparian and marsh portions were assessed separately resulting in a total of 20 assessment areas (AAs). An 18th site (Box Elder Creek) was visited in the field but was classified as non-wetland riparian and contained no true wetland habitat. A general description and a plant list for Box Elder Creek are included in this report, but the condition was not assessed. The 18 visited sites cover 400 acres (Figure 1). The size of the wetland assessment areas or AAs ranged from 2 to 83 acres with an average size of 22 acres. Of the 18 sites visited, 16 were owned and managed by the City of Aurora and two were privately owned. Detailed site descriptions for each of AAs are provided in Appendix G.

Classification of Aurora Wetlands

All of the study sites were classified as one of two ecological systems (Tables 9 and 10). Ecological systems are dynamic assemblages or complexes of plant and/or animal communities that 1) occur together on the landscape; 2) are tied together by similar ecological processes, underlying abiotic environmental factors or gradients; and 3) form a readily identifiable unit on the ground (Comer et al. 2003; Decker et al. 2020). The most common system was the Western Great Plains Riparian (12 AAs), followed by Western North American Emergent Marsh (8 AAs). These two ecological systems regularly occur together along riparian corridors and floodplains. Patches of marsh vegetation were scattered throughout all of the surveyed sites, even in riparian system where the hydrology was driven by stream flow. A key to the ecological systems is included in Appendix C and their

descriptions can be found in Decker et al. (2020) at https://cnhp.colostate.edu/cwic/wetlandtypes/ecological-systems/.

Table 9. Ecological systems for the Assessment Areas (AAs) in the City of Aurora.

Ecological System	*# AAs*	*Common Dominant Species*
Western North American Emergent Marsh	8	narrowleaf cattail *(Typha angustifolia*), broadleaf cattail (*Typha latifolia*)
Western Great Plains Riparian	12	plains cottonwood (*Populus deltoides* ssp. *monilifera*), coyote willow (*Salix exigua)*

Three sites—Signature Park, Pronghorn North, and Red-tailed Hawk Park—had distinct marsh and riparian systems adjacent to each other. For these three sites, a separate AA was designated for each ecological system. Eight more sites had moderate-sized patches of both ecological systems on site, but the systems were not as spatially discrete, thus they were surveyed as one AA and classified based on which system dominated. Those dominated by riverine creek flow through the central wetland, though intermittently slowed by impoundments, were classified as plains riparian (Pronghorn SW and Plains Conservation Center). Those with cattail in the central wetland and depressional geomorphology were classified as marshes (Star K Ranch, Confluence Open Space, Jewell Wetlands, Quincy Reservoir, and Aurora Campus for Renewable Energy [ACRE] Marsh). Large sections of cattail within these mixed systems were assessed as lower condition vegetation (simplified structure and composition) within a riparian ecosystem.

There were three major Hydrogeomorphic (HGM) (Brinson 1993) wetland types surveyed across the study area: lacustrine fringe, depressional, and riverine. One site was classified as lacustrine fringe, seven sites were classified as depressional, and the remaining thirteen sites were classified as riverine (Table 10). The wetlands along Quincy Reservoir were classified as lacustrine (reservoir) fringe because they had formed adjacent to a waterbody >20 acres in size. Depressional wetlands were found in low lying areas near riparian areas, ditches, or excavated floodplains. Jewell Wetlands and Red-tailed Hawk Park depressional wetlands were heavily influenced by development and urban inputs, but they also likely received slope groundwater seepage. The other depressional HGM wetlands had been excavated in the past. Riverine wetlands had hydrology and geomorphology shaped by throughflow along rivers, streams, and ditches. The Signature Park Marsh, N Pronghorn Marsh, and SW Pronghorn Riparian (with marsh sections) were characterized by slow flowing water with large areas of cattail established behind impoundments and were classified as riverine-impounded HGM. Plains Conservation Center was predominately riverine with several areas of riverine-impounded HGM.

Table 10. Wetland Assessment Areas (AAs) ranked highest to lowest by overall Ecological Integrity Assessment (EIA) scores.

Site Name	*Site Code*	*Ecological System**	*HGM*	*Ownership*	*Size Rank*	*EIA Score*
Coal Creek at Senac	AA-7	Riparian	Riverine	Aurora	1.3 mi** (A)	3.62 (B)
Pronghorn N - riparian	AA-1A	Riparian	Riverine	Aurora	1.1 mi (B)	3.47 (C)
Coal Creek S	AA-6	Riparian	Riverine	Private	1.7 mi (B)	3.38 (C)
Sand Creek Riparian Preserve***	AA-13	Riparian	Riverine	Aurora	1.5 mi** (B)	3.29 (C)
Plains Conservation Center	AA-3	Riparian, Marsh	Riverine	Aurora	2.2 mi (B)	3.09 (C)
Coal Creek N	AA-8	Riparian	Riverine	Private	1.2 mi (B)	2.94 (C)
Pronghorn N - marsh	AA-1B	Marsh	Riverine-Impounded	Aurora	19 ac (B)	2.87 (C)
Pronghorn SE	AA-21	Riparian	Riverine	Aurora	0.9 mi (B)	2.82 (C)
Star K Ranch	AA-9	Marsh, Riparian	Depressional	Aurora	2 ac (B)	2.74 (C)
Pronghorn SW	AA-2	Riparian, Marsh	Riverine-Impounded	Aurora	1.5 mi (B)	2.71 (C)
Sand Creek Park	AA-11	Riparian	Riverine	Aurora	1.4 mi** (A)	2.56 (C)
Confluence Open Space***	AA-16	Marsh	Depressional	Aurora	44 ac (A)	2.38 (D)
Jewell Wetlands	AA-4	Marsh, Riparian	Depressional	Aurora	15 ac (B)	2.25 (D)
Red-tailed Hawk Park - riparian	AA-15A	Riparian	Riverine	Aurora	0.3 mi (C)	2.03 (D)
Signature Park - marsh	AA-12B	Marsh	Riverine-Impounded	Aurora	3 ac (B)	1.95 (D)
Signature Park - riparian	AA-12A	Riparian	Riverine	Aurora	1.2 mi (B)	1.94 (D)
Red-tailed Hawk Park - marsh	AA-15B	Marsh	Depressional	Aurora	2 ac (B)	1.92 (D)
Quincy Reservoir	AA-14	Marsh, Riparian	Lacustrine Fringe	Aurora	10 ac (B)	1.90 (D)
Horseshoe Park	AA-5	Riparian	Riverine	Aurora	0.5 mi (C)	1.82 (D)
ACRE Marsh	AA-18	Marsh	Depressional	Aurora	2 ac (B)	1.81 (D)

*Riparian = Western Great Plains Riparian; Marsh = Western North American Emergent Marsh

**Riparian area continues off of property. Measurement based on property, rank on full corridor length.

***Also known as Triple Creek Greenway

Ecological Integrity Assessment

Ecological Integrity Assessment (EIA) condition scores were calculated for the 20 assessment areas. EIA scores are translated into a 4-tiered ranking system of A, B, C, D, with each letter corresponding to a range of numeric scores (see Tables 1 and 5 for more detail):

A = >4.5–5.0 Excellent: no or minimal human impact
B = >3.5–4.5 Good: slight deviation from reference
C = >2.5–3.5 Moderate: moderate deviation from reference
D = 1.0–2.5 Poor: significant to severe deviation from reference

Overall EIA scores of the surveyed wetlands ranged from 1.81 to 3.62 on a 1.00–5.00 point scale (Figure 8; Table 10). The highest EIA score was from Coal Creek at Senac located in eastern Aurora; this site received a B or Good rank. Eleven sites received C ranks based on EIA scores ranging from 2.56 to 3.47; these sites were generally located in eastern Aurora outside of the main urbanized area, with the exception of Sand Creek Riparian Preserve located in central Aurora. Nine of the AAs received D ranks based on scores ranging from 1.81 to 2.38; these sites are either located within the urbanized area of Aurora or are highly altered hydrologically.

In addition to overall EIA scores, numeric subscores were also calculated for the four main ecological categories (Landscape Context, Vegetation Condition, Hydrologic Condition, and Physiochemical Condition) for all 20 AAs (Table 11). The calculations for the EIA metric ranking criteria are provided in Appendix D.

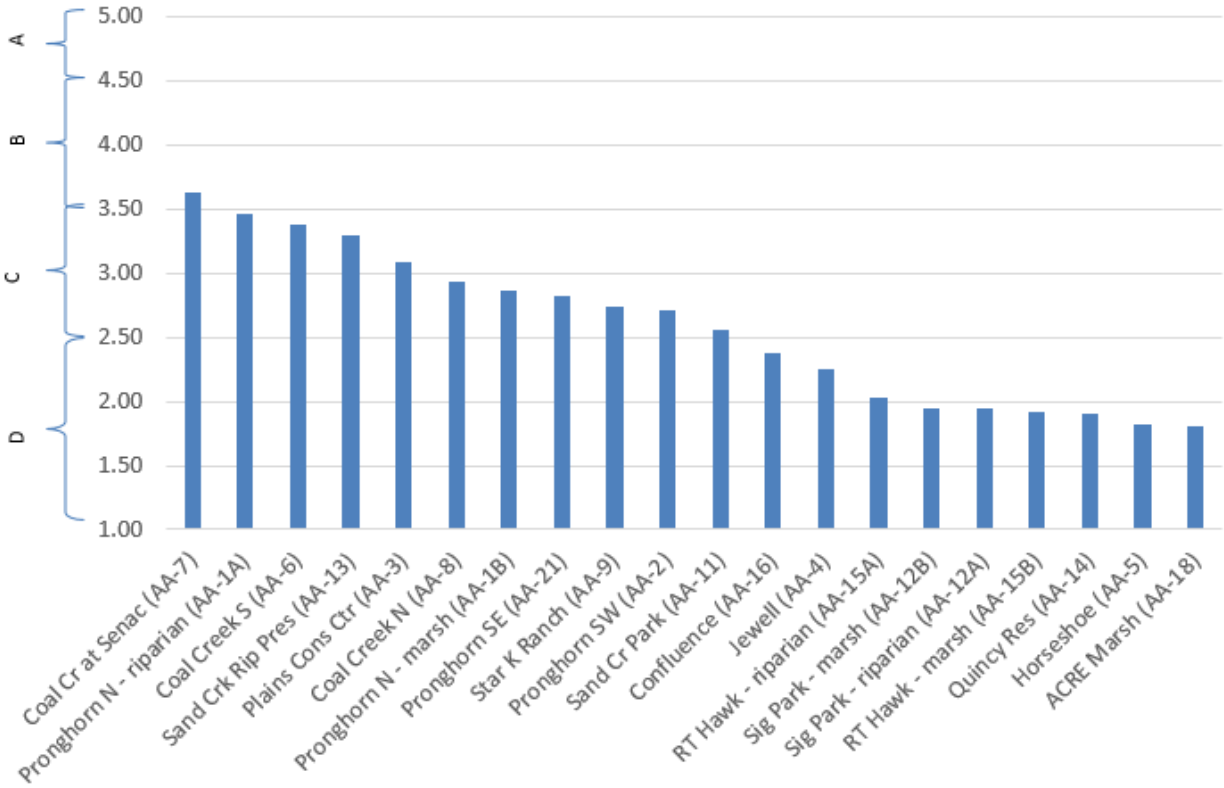

Figure 8. Overall Environmental Integrity Assessment (EIA) scores by Assessment Area (AA).

Landscape Context Scores

Landscape context scores are based on the degree of landscape fragmentation and the extent and condition of the buffer within a 500 m zone surrounding an Assessment Area (AA). Lands surrounded by more natural vegetation score higher while lands dominated by pavement, manicured lawns, highways, buildings and residential developments score lower. The surrounding landscapes play a large part in the protection of the diversity of plants and animals, water quality, and overall health of the wetlands. Five of the 20 AAs scored as B-ranked, 6 scored as C-ranked, and 9 scored as D-ranked (Table 11). The B-scoring AAs were Pronghorn Natural Area (3 AAs), Plains Conservation Center, and Coal Creek at Senac. These sites were located in the less developed eastern areas of the City of Aurora.

Vegetation Condition Scores

Vegetation condition scores are based on the floristic data collected during the field surveys. Metrics calculated from these data include species richness, native plant cover, and structural complexity (see Appendix D). Seven of the 20 AAs scored as C-ranked on this category and 13 scored as D-ranked (Table 11). Most sites had lower quality vegetation composition with non-native, noxious, and invasive cryptogenic species impacting those scores. However, most riparian sites scored better in overall structural and regeneration metrics, exhibiting the positive impact of the riparian ecosystem tree and woody structure to the vegetation site condition.

Hydrologic Condition Scores

Hydrologic condition scores are related to the water source, alteration to the natural hydroperiod, and hydrologic connectivity. Two of the 20 AAs had B-ranked scores for hydrologic condition: Coal Creek at Senac and Sand Creek Riparian Preserve. An additional 5 AAs had C-ranked scores and 13 had D-ranked scores (Table 11). Scores ranged from 1.00 to 3.67. Beaver were present at 6 AAs that spanned a wide range of hydrologic conditions, and were present throughout the B-rated Sand Creek Riparian Preserve. Where beaver occurred in sites with lower rated hydrology, they were observed in isolated sections of the AA, but their presence clearly improved the hydrologic connectivity compared to reaches or wetland areas without beaver.

Physiochemical Condition Scores

Physiochemical condition scores include metrics for water quality and soil disturbances within AAs. Three of the 20 AAs received B ranks for physiochemical condition: Coal Creek at Senac, Coal Creek South, and Sand Creek Riparian Preserve (Table 11). These sites had good microtopography and healthy zones of wetland throughout the riparian areas. Twelve AAs received C ranks and 5 received D ranks. D scores were related to sites with excavation such as cut streamlines or gravel pits. The high degree of current development and former land uses in and around the wetlands, along with high cover of impervious surfaces and the associated stormwater pollutants that reach urban wetlands contributed to physiochemical site condition.

Table 11. Wetland Assessment Areas (AAs) with landscape context, vegetation, hydrology, and physiochemistry subscores and overall EIA score. Shading indicates B, C, D ranking for subscores and overall EIA score.

Site Name	*Site Code*	*Landscape Context*	*Vegetation*	*Hydrology*	*Physio-chemistry*	*EIA Score*
ACRE Marsh	AA-18	1.33 (D)	2.33 (D)	1.67 (D)	1.50 (D)	**1.81 (D)**
Coal Creek at Senac	AA-7	3.66 (B)	3.50 (C/B)	3.67 (B)	4.00 (B)	**3.62 (B)**
Coal Creek N	AA-8	2.67 (C)	3.00 (C)	3.00 (C)	3.50 (C/B)	**2.94 (C)**
Coal Creek S	AA-6	3.17 (C)	3.50 (C/B)	3.33 (C)	3.75 (B)	**3.38 (C)**
Confluence Open Space	AA-16	3.31 (C)	2.17 (D)	1.67 (D)	2.00 (D)	**2.38 (D)**
Horseshoe Park	AA-5	1.00 (D)	2.00 (D)	2.33 (D)	2.50 (D/C)	**1.82 (D)**
Jewell Wetlands	AA-4	1.86 (D)	2.33 (D)	2.33 (D)	3.25 (C)	**2.25 (D)**
Plains Conservation Center	AA-3	3.84 (B)	2.50 (D/C)	3.00 (C)	3.50 (C/B)	**3.09 (C)**
Pronghorn N - riparian	AA-1A	3.75 (B)	3.33 (C)	3.33 (C)	3.50 (C/B)	**3.47 (C)**
Pronghorn N - marsh	AA-1B	3.75 (B)	2.00 (D)	3.00 (C)	3.50 (C/B)	**2.87 (C)**
Pronghorn SE	AA-21	3.81 (B)	2.67 (C)	1.67 (D)	3.50 (C/B)	**2.82 (C)**
Pronghorn SW	AA-2	3.31 (C)	2.33 (D)	2.33 (D)	3.50 (C/B)	**2.71 (C)**
Quincy Reservoir	AA-14	2.30 (D)	2.00 (D)	1.00 (D)	2.75 (C)	**1.90 (D)**
Red-tailed Hawk Park - riparian	AA-15A	1.49 (D)	2.50 (D/C)	1.67 (D)	3.00 (C)	**2.03 (D)**
Red-tailed Hawk Park - marsh	AA-15B	1.49 (D)	2.00 (D)	2.00 (D)	3.00 (C)	**1.92 (D)**
Sand Creek Park	AA-11	2.49 (D)	2.67 (C)	2.33 (D)	3.00 (C)	**2.56 (C)**
Sand Creek Riparian Preserve	AA-13	2.83 (C)	3.33 (C)	3.67 (B)	3.75 (B)	**3.29 (C)**
Signature Park - riparian	AA-12A	2.00 (D)	2.00 (D)	1.67 (D)	2.25 (D)	**1.94 (D)**
Signature Park - marsh	AA-12B	1.91 (D)	1.50 (D)	2.33 (D)	3.25 (C)	**1.95 (D)**
Star K Ranch	AA-9	3.44 (C)	2.50 (D/C)	2.33 (D)	2.50 (D/C)	**2.74 (C)**

Size Condition Scores

Size can be a useful metric to compare between wetlands of the same type. A larger wetland may have more conservation value than a smaller one, based on the amount of habitat it provides or the level of other ecosystem services it can provide. Though size was not included in the overall EIA score, this study compared the AAs and their off-site contiguous wetland/riparian area relative to other wetlands of the same type (Table 10). For this study, riparian corridor lengths were assessed including both their wetland and non-wetland sections, because wetland occurrences in riverine plains riparian ecological systems are a naturally patchy mosaic with non-wetland when in a healthy state. Most AAs scored B relative size scores, and 3 sites scored A: the Coal Creek at Senac and Sand Creek Park plains riparian corridors (both of which extended offsite), and Confluence

Open Space marsh (Table 10). Red-tailed Hawk Park marsh and Horseshoe Park riparian area scored C, and there were no sites that scored D.

Water Quality and Chemistry

Basic field parameters of pH, electrical conductivity (EC), and temperature were collected at the Aurora sites using a Hanna Instruments hand-held meter (Model # HI98129). These measurements represent a snapshot in time for these parameters; overall water quality is difficult to determine based on field parameters and solely from a single field observation. Understanding water quality within a site requires repeated observations over time. Field measurements showed pH values from 7.2 to 8.3 and EC values from 430 to 3600 µmho/cm (Table 12). These values are within the range of variability documented in Lower Arkansas River Basin marshes and riparian areas (Lemly et al. 2017). In general, the EC (a surrogate for total dissolved solids) was highest (2400 – 3600 µmho/cm) in the most downstream sites (Confluence Open Space, Sand Creek Riparian Preserve, and Sand Creek Park). Exceptions to this were high EC readings in East Tollgate Creek at Signature Park (2400-3200 µmho/cm) and Coal Creek South (2800 µmho/cm). Temperature measurements ranged from 16 to 25℃ with one outlier of 30℃. Water temperature can fluctuate widely in shallow stagnant pools as it is highly dependent on ambient air temperature.

Sand Creek from the confluence of Murphy Creek and Coal Creek to its confluence with the South Platte River is included on the 303(d) List of Impaired Waters (CDPHE 2020). The reach includes Confluence Open Space (AA-16), Sand Creek Riparian Preserve (AA-13), and Sand Creek Park (AA-11). This reach of Coal Creek is included on this list due to exceedances in *E. coli* concentrations relative to recreational uses. Over 100 water body segments in Colorado are included on this list due to *E. coli* indicating this is a common issue for Colorado streams.

Stressors

Overall site stress rated very high at all sites except for Coal Creek at Senac, where it was rated high (Table 13). Densely populated urban areas are expected to have a high amount of many stressors. In general, there were very high levels of landscape stress surrounding all the wetlands, including the less populated areas. Soil and substrate stressors were the most frequent type of observed stressors, with the following stressors observed in over 75% of AAs or surrounding land within 500 meters: excessive sediment inputs, erosion, fill and excavation, trash, indirect soil disturbance (such as compaction from human or wildlife use), and direct soil disturbance (such as grading). The highest rated AAs (B and C+ with EIA scores > 3.0) were the only sites to rate with medium or low overall soil stress. The highest rated AAs also had medium or low vegetation stress.

Each stressor at each site was assigned an impact rating that combined the scope and severity of the stressor. Stressors that affected a large area of the wetland or surrounding landscape or were more severe received high impact ratings. Noxious weeds, residential development, roads, direct soil disturbance, and groundwater extraction (based on mapped wells) had the highest impact ratings. Other common stressors that occurred in at least 90% of AAs were non-point source discharge, flow obstructions, weedy fallow lands, or hay fields in the 500 m surrounding landscape.

Table 12. Water quality field parameters measured at Aurora Wetland Assessment Areas (AAs).

Site Name	*Site Code*	*Date*	*pH*	*EC (µmho/cm)*	*Temperature (˚C)*
ACRE Marsh	AA-18	2019-09-10	7.2	740	24
Coal Creek at Senac	AA-7	2019-08-14	7.7-7.9	1500-1700	24.4-30.3
Coal Creek N	AA-8	2019-08-28	7.4	2040	20
Coal Creek S	AA-6	2019-08-15	7.5	2840	23
Confluence Open Space	AA-16	2019-08-28	7.5	3170	23
Horseshoe Park	AA-5	2019-07-24	7.9	1890	22.9
Jewell Wetlands	AA-4	2019-07-23	7.9	1740	19.1
Plains Conservation Center	AA-3	2019-06-27	7.6-7.7	1580-1730	21.4-21.9
Pronghorn N - riparian	AA-1A	2019-07-24	7.9	1250	20.5
Pronghorn N - marsh	AA-1B	2019-07-24	7.9-8.0	1260-1280	19.9-20.9
Pronghorn SE	AA-21	2019-08-01	7.6	2260	16.2
Pronghorn SW	AA-2	2019-07-22	8.3	1040	21.1
Quincy Reservoir	AA-14	2019-09-05	7.6	1576	24.2
Red-tailed Hawk Park - riparian	AA-15A	2019-09-05	7.6-7.7	430-950	18.4-24.6
Sand Creek Park	AA-11	2019-10-08	7.7-7.9	2360-2670	22-23
Sand Creek Riparian Preserve	AA-13	2019-08-29	7.4	2600	19.9
Signature Park - riparian	AA-12A	2019-06-18	7.6	2420	17.4
Signature Park - marsh	AA-12B	2019-08-07	7.7	3600	25.2
Star K Ranch	AA-9	2019-07-03	7.5-7.6	1880-2200	22.1-22.2

Table 13. Wetland Stressor Ratings in a 500 meter area landscape surrounding the AAs and in the wetland vegetation, soils, and hydrology. L=low, M=medium, H=high, VH=very high.

Site Name	*Site Code*	*Landscape Stress*	*Vegetation Stress*	*Soils Stress*	*Hydrology Stress*	***Overall Stressor Index***
ACRE Marsh	AA-18	VH	M	VH	H	**VH**
Coal Creek at Senac	AA-7	VH	L	L	H	**H**
Coal Creek N	AA-8	VH	M	H	VH	**VH**
Coal Creek S	AA-6	VH	L	M	M	**VH**
Confluence Open Space	AA-16	VH	M	VH	VH	**VH**
Horseshoe Park	AA-5	VH	M	H	VH	**VH**
Jewell Wetlands	AA-4	VH	VH	VH	M	**VH**
Plains Conservation Center	AA-3	VH	M	M	H	**VH**
Pronghorn N - riparian	AA-1A	VH	M	M	VH	**VH**
Pronghorn N - marsh	AA-1B	VH	M	M	VH	**VH**
Pronghorn SE	AA-21	VH	M	H	VH	**VH**
Pronghorn SW	AA-2	VH	H	H	VH	**VH**
Quincy Reservoir	AA-14	VH	M	H	VH	**VH**
Red-tailed Hawk Park - riparian	AA-15A	VH	H	VH	VH	**VH**
Red-tailed Hawk Park - marsh	AA-15B	VH	H	VH	VH	**VH**
Sand Creek Park	AA-11	VH	H	VH	VH	**VH**
Sand Creek Riparian Preserve	AA-13	VH	M	M	VH	**VH**
Signature Park- riparian	AA-12A	VH	H	VH	VH	**VH**
Signature Park - marsh	AA-12B	VH	M	H	VH	**VH**
Star K Ranch	AA-9	VH	H	VH	H	**VH**

4.3 Functional Assessment of Colorado Wetlands (FACWet)

The range of FACWet scores was 0.60 (D/functioning impaired) to 0.78 (C/functioning) across the study area (Table 14). None of the wetland sites were non-functioning, and all the sites provided a suite of important functional values, although the ACRE marsh was borderline functioning. The site with the highest EIA score, Coal Creek at Senac, also scored the highest FACWet score with a 0.78. Sand Creek Riparian scored the second highest FACWet score of mid-C. Each of the rated functions averaged a similar mean score across the study area of 0.68. Riparian sites had relatively higher functional score and marshes rated with impaired function. The two wetlands with the lowest function were unnatural features: the reservoir fringe (Quincy Reservoir) and a deep excavated marsh (ACRE Marsh).

Table 14. Wetland Functional Capacity Indices ranked by overall Functional Assessment of Colorado Wetland (FACWet) scores. EIA scores shown for comparison.

Site Name (AA Code)	*Wildlife Habitat*	*Aquatic Habitat*	*Flood Attenu-ation*	*Water Storage*	*Nutrient/ Toxicant Removal*	*Sediment and Stability*	*Export/ Food Chain*	*FACWet Score*		*EIA Score*
Coal Creek at Senac (AA-7)	0.77	0.79	0.79	0.79	0.78	0.77	0.78	**0.78 (C)**		3.62 (B)
Sand Creek Riparian Preserve (AA-13)	0.73	0.76	0.76	0.79	0.71	0.76	0.76	**0.75 (C)**		3.29 (C)
Coal Creek S (AA-6)	0.74	0.74	0.74	0.74	0.74	0.74	0.74	**0.74 (C)**		3.38 (C)
Coal Creek N (AA-8)	0.72	0.71	0.72	0.72	0.72	0.72	0.72	**0.72 (C)**		2.94 (C)
Pronghorn N - riparian (AA-1A)	0.74	0.69	0.70	0.69	0.70	0.72	0.71	**0.71 (C)**		3.47 (C)
Pronghorn N - marsh (AA-1B)	0.69	0.71	0.70	0.71	0.72	0.69	0.70	**0.70 (C)**		2.87 (C)
Plains Conservation Center (AA-3)	0.73	0.70	0.70	0.68	0.70	0.68	0.70	**0.70 (C)**		3.09 (C)
Pronghorn SW (AA-2)	0.68	0.68	0.68	0.67	0.68	0.67	0.68	**0.68 (D)**		2.71 (C)
Sand Creek Park (AA-11)	0.69	0.67	0.68	0.69	0.67	0.68	0.68	**0.68 (D)**		2.56 (C)
Star K Ranch (AA-9)	0.72	0.64	0.65	0.62	0.67	0.69	0.67	**0.67 (D)**		2.74 (C)
Confluence Open Space (AA-16)	0.67	0.67	0.67	0.66	0.69	0.66	0.66	**0.67 (D)**		2.38 (D)
Pronghorn SE (AA-21)	0.68	0.68	0.68	0.66	0.68	0.67	0.67	**0.67 (D)**		2.82 (C)
Jewell (AA-4)	0.64	0.68	0.66	0.67	0.65	0.65	0.66	**0.66 (D)**		2.25 (D)
Red-tailed Hawk Park (AA-15*)	0.65	0.66	0.66	0.66	0.66	0.69	0.67	**0.66 (D)**		2.03 (D)
Horseshoe Park (AA-5)	0.64	0.68	0.66	0.67	0.65	0.65	0.66	**0.66 (D)**		1.82 (D)
Signature Park - riparian (AA-12A)	0.65	0.66	0.65	0.66	0.64	0.65	0.67	**0.65 (D)**		1.94 (D)
Signature Park- marsh (AA-12B)	0.62	0.64	0.64	0.65	0.63	0.64	0.64	**0.64 (D)**		1.95 (D)
Quincy Res.(AA-14)	0.64	0.60	0.60	0.60	0.62	0.63	0.63	**0.62 (D)**		1.90 (D)
ACRE Marsh (AA-18)	0.60	0.60	0.59	0.59	0.61	0.62	0.61	**0.60 (D)**		1.81 (D)

* One FACWet assessment was conducted for the entire Red-tailed Hawk Park site.

4.4 Social Rating

The City of Aurora has numerous wetlands and riparian areas that provide valued recreation and green space benefits to its residents and visitors. As such, 45% of the surveyed sites received a high or very high social rating. The social rating scores ranged from 1-11 on a 0-12 point scale (Table 15). Sand Creek Park rated the highest, scoring 11 points or very high due to public access with recreation amenities such popular trails, a higher likelihood of use and access based on higher population density within a half mile, and its important contribution to urban green and blue space by its long riparian corridor and also its location in an area surrounded by substantial impervious surface (concrete and housing). The other wetlands that received a very high rating (>9 points) were Jewell Wetlands, Horseshoe Park, Quincy Reservoir, and the Red-tailed Hawk Park riparian area. The Red-tailed Hawk Park marsh, Star K Ranch, Plains Conservation Center, and the Sand Creek Riparian Preserve rated high (7-9 points). Wetlands that rated medium were in less densely populated locations and with less impervious surface in the half mile surrounding the wetland (e.g. less green space deprivation), except for Signature Park which was not a public recreation park. The wetlands that scored a low social rating were not open to public use at the time of survey and were situated in less developed areas.

Table 15. Social ratings for Aurora Wetland Assessment Areas (AAs).

Site Name	*Site Code*	*Public Access*	*Population Density (within 0.5 mi buffer)*	*Impervious Surface*	*Recreation*	*Education*	*Size*	*Score (0-12)*
Sand Creek Park	AA-11	2	2	2	2	1	2	**11**
Jewell Wetlands	AA-04	2	2	2	2	1	1.5	**10.5**
Horseshoe Park	AA-05	2	2	2	2	1	1.5	**10.5**
Quincy Reservoir	AA-14	1	2	2	2	1	1.5	**9.5**
Red-tailed Hawk Park - riparian	AA-15A	2	1.5	2	2	1	1	**9.5**
Star K Ranch	AA-09	2	1	1.5	1.5	2	1	**9**
Plains Conservation Center	AA-03	2	1.5	0.5	1.5	2	1.5	**9**
Red-tailed Hawk Park - marsh	AA-15B	2	1.5	1.5	2	1	1	**9**
Sand Creek Riparian Preserve	AA-13	2	0	1	2	1	1	**7**
Pronghorn N - riparian	AA-01A	2	0	0	1	1	1.5	**5.5**
Pronghorn N - marsh	AA-01B	2	0	0	0.5	1	1.5	**5**
Pronghorn SW	AA-02	2	0	0.5	1	0	1.5	**5**
Signature Park - riparian	AA-12A	0	1.5	1.5	0	0	1.5	**4.5**
Signature Park - marsh	AA-12B	0	1.5	2	0	0	1	**4.5**
Pronghorn SE	AA-21	2	0	0	0	1	1.5	**4.5**
Confluence Open Space	AA-16	0	0	0.5	0	0	2	**2.5**
Coal Creek at Senac	AA-07	0	0	0	0	0	2	**2**
Coal Creek N	AA-08	0	0	0.5	0	0	1.5	**2**
Coal Creek S	AA-06	0	0	0	0	0	1.5	**1.5**
ACRE Marsh	AA-18	0	0	0	0	0	1	**1**

4.5 Vegetation Composition

A total of 260 plant species were found in the City of Aurora AAs (including Box Elder Creek at ACRE non-wetland riparian site). The list of taxa is presented in Appendix H and plant lists for individual sites are included in Appendix G.

Plant Species Richness

Plant species richness is the number of different plant species observed in each of the AAs (Table 16; Figure 9). The number of plant species at individual AAs ranged from 22 to 88 with an average of 57. Coal Creek at Senac and Red-tailed Hawk Park had the highest species richness at 88 and 87 species, respectively. The lowest species richness was documented at the ACRE Marsh.

Table 16. List of Wetland Assessment Areas (AAs) with subscores for Species Richness, Relative Cover Native, Mean C, and Native Mean C. EIA Score shown for comparison.

Site Name	*Site Code*	*Species Richness*	*Relative Cover Native*	*Mean C 0-10*	*Native Mean C 0-10*	*EIA Score*
ACRE Marsh	AA-18	22	81%	1.59	3.09	1.81 (D)
Box Elder Creek at ACRE[1]	AA-19	49	66%	3.00	4.11	NA
Coal Creek at Senac	AA-7	88	57%	2.21	3.53	3.62 (B)
Coal Creek N	AA-8	64	45%	2.38	3.73	2.94 (C)
Coal Creek S	AA-6	72	66%	2.07	3.35	3.38 (C)
Confluence Open Space	AA-16	31	38%	1.83	3.18	2.38 (D)
Horseshoe Park	AA-5	78	43%	1.54	3.61	1.82 (D)
Jewell Wetlands	AA-4	67	41%	1.52	3.30	2.25 (D)
Plains Conservation Center	AA-3	75	52%	1.93	3.28	3.09 (C)
Pronghorn N - riparian	AA-1A	38	65%	1.92	3.09	3.47 (C)
Pronghorn N - marsh	AA-1B	52	48%	2.19	3.47	2.87 (C)
Pronghorn SE	AA-21	54	41%	1.71	3.14	2.82 (C)
Pronghorn SW	AA-2	52	22%	2.04	3.68	2.71 (C)
Quincy Reservoir	AA-14	80	44%	1.89	3.78	1.90 (D)
Red-tailed Hawk Park[2] - riparian	AA-15A	87	49%	2.38	3.88	2.03 (D)
Sand Creek Park	AA-11	63	42%	1.75	3.18	2.56 (C)
Sand Creek Riparian Preserve	AA-13	64	69%	2.21	3.69	3.29 (C)
Signature Park - riparian	AA-12A	59	37%	1.47	3.20	1.94 (D)
Signature Park - marsh	AA-12B	37	30%	1.89	3.47	1.95 (D)
Star K Ranch	AA-9	54	52%	1.94	3.57	2.74 (C)

[1] Plant list for Box Elder Creek at ACRE for non-wetland riparian – no EIA conducted.
[2] Plant list for Red-tailed Hawk AAs is a combined list for riparian and marsh. The Riparian EIA score is listed above.

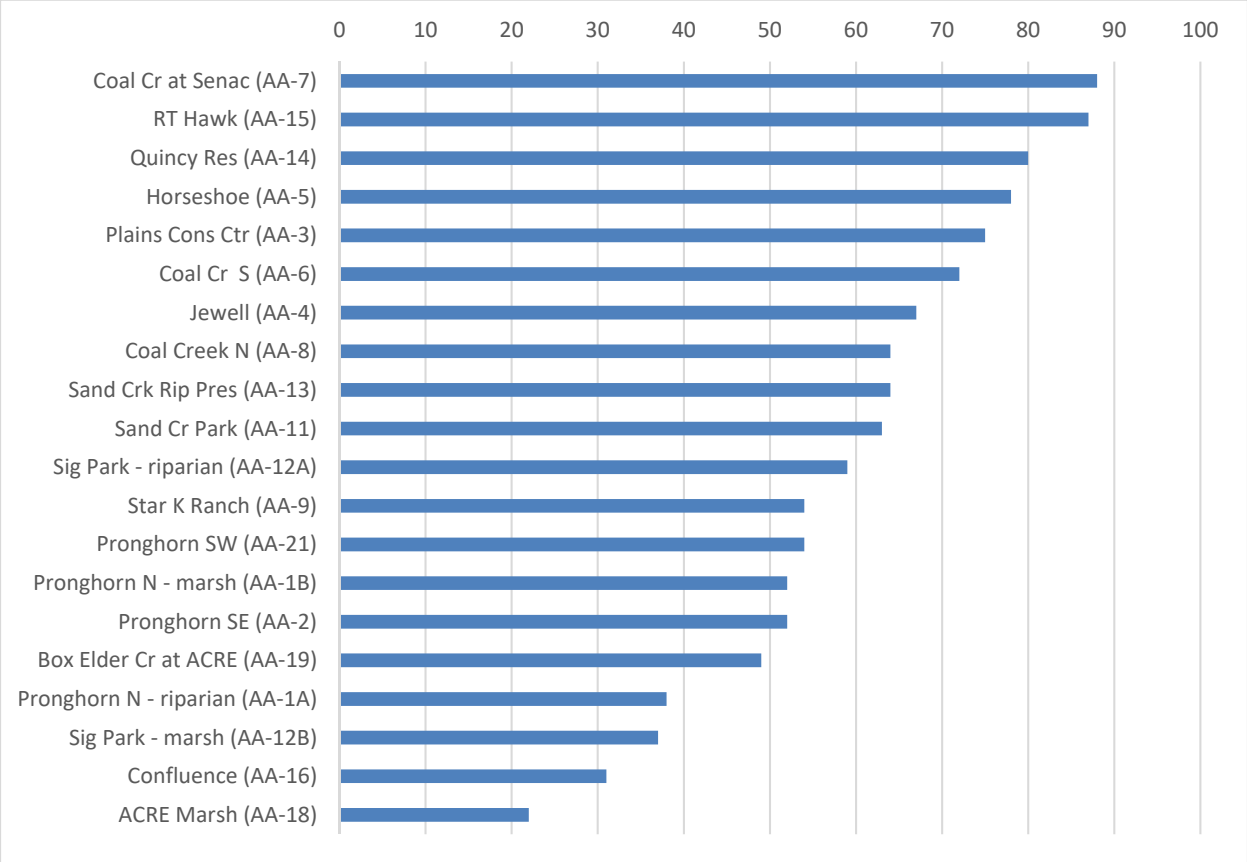

Figure 9. Plant Species Richness at City of Aurora Wetland Assessment Areas (AAs)

Common Plant Species

Ten species were encountered in >75% of the 20 surveyed AAs, and together their cover represented more than half of the total vegetation cover recorded in this study (Table 17). Smooth brome (*Bromus inermis*) and peachleaf willow were the most commonly encountered plant species, and were recorded in 19 AAs. Narrowleaf cattail (*Typha angustifolia*) was found in 18 of 20 sites and had the highest cover across all sites, accounting for 17% of total vegetation cover in the AAs. Another four species occurred in 18 of 20 AAs: plains cottonwood (*Populus deltoides*), coyote willow (*Salix exigua*), showy milkweed (*Asclepias speciosa*), and Canada thistle (*Cirsium arvense*). Hardstem bulrush (*Schoenoplectus tabernaemontani*), needle spikerush (*Eleocharis palustris*), and leafy spurge (*Euphorbia esula*) were present in 16 sites. The 20 most commonly encountered plants are listed in Table 17. Of the top 20 species, almost half are native, one is cryptogenic, and the other half are non-native, including three noxious weed species.

Table 17. Most commonly encountered plants in surveyed wetland Aurora AAs, in order of most commonly encountered.

Scientific Name	*Common Name*	*# of AAs*	*Wetland Status*[1]	*Native Status*	*C-Value*
Bromus inermis	Smooth brome	19	UPL	Non-native	0
Salix amygdaloides	Peachleaf willow	19	FACW	Native	5
Asclepias speciosa	Showy milkweed	18	FAC	Native	3
Cirsium arvense	Canada thistle	18	FACU	Non-native List B noxious weed	0
Populus deltoides	Plains cottonwood	18	FAC	Native	3
Salix exigua	Coyote willow	18	FACW	Native	3
Typha angustifolia	Narrowleaf cattail	18	OBL	Cryptogenic	1
Eleocharis palustris	Pale spikerush	16	OBL	Native	3
Euphorbia esula	Leafy spurge	16	---	Non-native	0
Schoenoplectus tabernaemontani	Softstem bulrush	16	OBL	Native	3
Conyza canadensis	Canadian horseweed	15	FACU	Native	1
Lactuca serriola	Prickly lettuce	15	FAC	Non-native	0
Rumex crispus	Curly dock	15	FAC	Non-native	0
Elaeagnus angustifolia	Russian olive	14	FACU	Non-native List B noxious weed	0
Glycyrrhiza lepidota	American licorice	14	FACU	Native	3
Schoenoplectus pungens	Common threesquare	14	OBL	Native	4
Convolvulus arvensis	Field bindweed	13	---	Non-native List C noxious weed	0
Melilotus albus	White sweet clover	13	FACU	Non-native	0
Polypogon monspeliensis	Annual rabbitsfoot grass	13	FACW	Non-native	0
Typha latifolia	Broadleaf cattail	13	OBL	Native	4

[1] Wetland Indicator Status based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands. --- indicates not included on National Wetland Plant List.

Relative Cover of Native Plants

The relative cover of native plants was derived from ocular estimates of cover for all species present assigned to cover classes, and unlike a plant list, provides a view of the overall cover. Percent cover of native vegetation is one of the component metrics in the EIA vegetation condition category. Percent native cover ranged from 22% to 81% across all 20 AAs (Table 16), with the ACRE Marsh having the highest rank. The following five sites had between 60-81% native cover: ACRE Marsh, Box Elder Creek, Coal Creek South, Pronghorn North Riparian, and Sand Creek Riparian Preserve. The remainder of the sites had less than 60% cover of native vegetation.

As mentioned in the methods section, narrowleaf cattail (*Typha angustifolia*), hybrid cattail (*Typha* x *glauca*), and reed canarygrass (*Phalaris arundinacea*) are cryptogenic species and were not considered native for this analysis.

Mean C, Native Mean C, and High C-Value Species

Mean C can provide another way to look at site quality using the plant list. Each species in the Colorado flora have been assigned a value between 0-10, with higher C-values indicating higher fidelity to high quality habitat or less tolerance to disturbance (see methods section for more detail). The scores for City of Aurora AAs ranged between 1.47–3.00 (Table 16). The lower scores reflect the higher number of non-native plant species, as well as native plant species that are able to tolerate high levels of disturbance. The highest Mean C in the project area (3.00) was found at the non-wetland riparian area evaluated at Box Elder Creek on the ACRE property. This site was not evaluated as an AA because it is non-wetland riparian but a plant list and site description are included in Appendix G. The lowest Mean C (1.47) was found at Signature Park - riparian.

Another FQA metric calculated from the C-values is Native Mean C, which is the average C-value of just the native plants at a site. Native Mean C for the AAs ranged from 3.09 to 4.11 (Table 16). High Native Mean C indicates a relatively better quality native vegetation community. The sites with the highest Native Mean C were Red-tailed Hawk Park (AA-15) and the non-wetland riparian Box Elder Creek (AA-19).

There were 19 species documented in the study area with C-values 6-8 (see species list in Appendix H and individual site species lists in Appendix G). Examples of these include the obligate wetland or facultative wetland species *Carex pellita, Epilobium palustre* var. *gracile, Juncus articulatus, Puccinellia nuttalliana, Sagittaria cuneata,* and *Spartina pectinata*. Examples of high C-value upland species interspersed within the wetlands or in adjacent buffers were *Andropogon hallii, Calamovilfa longifolia, Hesperostipa comata*, and *Ribes aureum.* Sites with several of these species, or one species that occurred throughout the site or with high cover in one area, have important vegetation features that are especially notable in an urban region with higher anthropogenic disturbance. There were 41 species with moderately conservative C-values of 5. These species also are indicators of good quality native habitat in plains wetland ecosystems. Examples include characteristic graminoids of plains wetlands and riparian areas, such as *Carex nebrascensis, Carex praegracilis, Panicum virgatum, Pascopyrum smithii*, and *Juncus torreyi*. *Berula erecta, Lycopus americanus,* and *Bidens cernua* are C-value 5 species that are frequently located in areas of healthy hydrology, often associated with groundwater discharge. *Solidago* species have

good correlation with remnant plains wet meadow habitat in slope or riparian wetlands, based on observations of their coverage throughout the Colorado Plains (CNHP 2020b). Red-tailed Hawk Park had the most high C-value plants, with high C-value plants occurring in both the marsh and riparian areas. Red-tailed Hawk Park also had one of the highest Native Mean C ratings in the study.

Invasive Cattail and Reed Canary Grass

Narrowleaf cattail (*Typha angustifolia*) is often considered non-native in North America (Smith 1993+; Magee et al. 2019) but not all experts are in agreement (e.g., Shih and Finkelstein 2008). Regardless of native status, it is known that narrowleaf cattail, and its difficult-to-distinguish hybrids, can invade wetlands forming dense monocultures (Ciotir et al. 2013; Bansal et al. 2019). Broadleaf cattail (*Typha latifolia*) is considered native and in many places is apparently being replaced by narrowleaf cattail (Smith 1993+). All the Aurora marsh sites, except the ACRE Marsh, and some riparian sites had wide stands of cattail visible in aerial imagery (AAs: 1B, 2, 3, 4, 9, 12B, 14, 15B and 16). Narrowleaf cattail was present at moderately high to high cover (10–75% cover) in all those sites, as well as the ACRE Marsh, while the native broadleaf cattail was present at lower rates (trace-10% cover with the exception of Pronghorn North Marsh (AA-1B) with 25-50% cover).

Similarly, cryptogenic reed canarygrass (*Phalaris arundinacea*) can quickly dominate wetlands (e.g., Swearingen and Bargeron 2016). Reed canarygrass had high cover in Sand Creek Park (AA-11) and Horseshoe Park (AA-5) (25-50% cover class) and moderately high cover in the Signature Park Riparian AA-15A (10-25% cover class).

Noxious Weeds

The Colorado Department of Agriculture Noxious Weed Program and the Colorado Weed Management Association provide lists of noxious weeds. List A plants are required to be eradicated as designated by the State Commissioner. List B plants are treated based on management plans with local governments. List C plants are also treated based on management strategies with local governments and private land holders, with an emphasis on integrated management techniques. Watch List species are suspected of being a potential invasive species. The list used for this survey was updated in 2020 (Colorado Department of Agriculture 2020a).

There were one List A, 14 List B, 9 List C, and 3 Watch List noxious weed species observed at the City of Aurora wetlands (Table 18) (see Appendix G for individual AAs). The List A species, hairy willowherb (*Epilobium hirsutum*), was found in Red-tailed Hawk Park (AA-15) in scattered locations in the cattail marsh and along Piney Creek. Of the List B species, six were found in one or two AAs, four were found in three to six AAs, and four were found in over 10 AAs. The List C species were found within 1 to 14 AAs and the Watch List species were found within 1 to 6 AAs.

County Records

Fifty vascular plant species that had not been previously reported for either Adams County or Arapahoe County were documented during the wetland surveys (Table 19). This list includes 29 native and 21 non-native plant species. Of the non-native plant species, four are on the State List of noxious weeds. All specimens listed in Table 19 were deposited at the Colorado State University Herbarium or the Kathyrn Kalmbach Herbarium at Denver Botanic Gardens. County records were

verified using the following data sources: USDA Plants, SEINet, and Colorado State University Herbarium.

Table 18. Noxious Weeds found in Aurora wetlands.

Species Name	*Common Name*	*Colorado Noxious Weed Status*	*Number of AAs*
Epilobium hirsutum	Hairy willowherb	List A	1
Carduus nutans	Musk thistle	List B	10
Centaurea diffusa	Diffuse knapweed	List B	1
Cirsium arvense	Canada thistle	List B	19
Cirsium vulgare	Bull thistle	List B	1
Cynoglossum officinale	Houndstongue	List B	3
Dipsacus fullonum	Common teasel	List B	1
Dipsacus laciniatus	Cutleaf teasel	List B	6
Elaeagnus angustifolia	Russian-olive	List B	14
Euphorbia esula	Leafy spurge	List B	16
Hesperis matronalis	Dame's rocket	List B	1
Lepidium latifolium	Perennial pepperweed	List B	2
Onopordum acanthium	Scotch thistle	List B	6
Saponaria officinalis	Bouncingbet	List B	2
Tamarix ramosissima	Saltcedar	List B	4
Arctium minus	Common burdock	List C	3
Bromus tectorum	Cheatgrass	List C	8
Cichorium intybus	Chicory	List C	5
Conium maculatum	Poison hemlock	List C	6
Convolvulus arvensis	Field bindweed	List C	13
Elymus repens	Quackgrass	List C	9
Poa bulbosa	Bulbous bluegrass	List C	1
Sonchus arvensis	Perennial sowthistle	List C	1
Verbascum thapsus	Common mullein	List C	10
Ailanthus altisima	Tree of Heaven	Watch List	1
Phragmites australis	Common reed	Watch List	2
Ulmus pumila	Siberian elm	Watch List	6

Table 19. List of plant species collected for submission to local herbaria - not previously reported for Adams/Arapahoe County based on herbarium search records in 2019.

Species Name	*Common Name*	*County*	*Specimen Number*	*Native Status*
Acer saccharinum	Silver maple	Arapahoe	2019-02	Non-native
Ailanthus altissima	Tree of Heaven	Adams	2019-53	Noxious Watch List
Alisma triviale	Northern water plantain	Arapahoe	2019-40	Native
Alopecurus arundinaceus	Creeping meadow foxtail	Adams	2019-05	Non-native
Anaphalis margaritacea	Western pearly everlasting	Arapahoe	2019-48 2019-50	Native
Artemisia biennis	Biennial wormwood	Arapahoe	2019-25	Non-native
Artemisia campestris	Field sagewort	Adams	2019-32	Native
Astragalus cicer	Chickpea milkvetch	Arapahoe	2019-19	Non-native
Barbarea orthoceras	American yellowrocket	Arapahoe	2019-01 2019-04	Native
Bidens frondosa	Devil's beggartick	Arapahoe	2019-44	Native
Bolboschoenus maritimus	Cosmopolitan bulrush	Adams	2019-54	Native
Bothriochloa laguroides	Silver beardgrass	Adams	2019-55	Native
Caragana arborescens	Siberian peashrub	Arapahoe	2019-16	Non-native
Carex pellita	Woolly sedge	Arapahoe	2019-17	Native
Catalpa speciosa	Catalpa	Arapahoe	2019-27	Non-native
Chamaesyce missurica	Prairie sandmat	Adams	2019-33 2019-51	Native
Chamaesyce serpyllifolia	Thymeleaf sandmat	Arapahoe	2019-28	Native
Chenopodium desiccatum	Aridland goosefoot	Adams	2019-34	Native
Chenopodium rubrum	Red goosefoot	Adams Arapahoe	2019-56 2019-47	Native
Chenopodium simplex	Mapleleaf goosefoot	Arapahoe	2019-13	Native
Cryptantha fendleri	Sanddune cryptantha	Adams Arapahoe	2019-35 2019-20	Native
Dactylis glomerata	Orchardgrass	Adams	2019-06	Non-native
Epilobium hirsutum	Hairy willowherb	Arapahoe	2019-21	List A noxious weed
Epilobium palustre	Bog willowherb	Arapahoe	2019-49	Native
Fraxinus pennsylvanica	Green ash	Arapahoe	2019-29	Non-native
Lepidium chalapensis	Lenspod whitetop	Adams	2019-03 2019-07	Non-native
Lepidium latifolium	Perennial pepperweed	Adams	2019-41 2019-57	List B noxious weed
Lycopus americanus	American water horehound	Adams	2019-08	Native
Maianthemum stellatum	Starry false lily of the valley	Arapahoe	2019-22	Native
Mentha ×piperita	Peppermint	Arapahoe	2019-45	Non-native
Oenothera pallida ssp. *latifolia*	Mountain evening primrose	Adams	2019-36	Native
Oxalis dillenii	Slender yellow woodsorrel	Arapahoe	2019-23	Native
Physalis hederifolia	Ivyleaf groundcherry	Adams	2019-37	Native

Species Name	Common Name	County	Specimen Number	Native Status
Potamogeton foliosus	Leafy pondweed	Adams	2019-42	Native
Potamogeton pusillus	Small pondweed	Arapahoe	2019-30	Native
Ranunculus aquatilis	Longbeak buttercup	Adams	2019-09	Native
Ranunculus cymbalaria	Alkali buttercup	Adams	2019-10	Native
Rhamnus cathartica	Common buckthorn	Adams	2019-15	Non-native
Robinia neomexicana	New Mexico locust	Adams	2019-52	Native
Sarcobatus vermiculatus	Greasewood	Arapahoe	2019-31	Native
Schedonorus arundinaceus	Tall fescue	Adams	2019-11	Non-native
Scrophularia lanceolata	Lanceleaf figwort	Arapahoe	2019-26	Native
Secale cereale	Cereal rye	Adams	2019-12	Non-native
Solanum dulcamara	Climbing nightshade	Arapahoe	2019-46	Non-native
Sonchus arvensis	Field sowthistle	Arapahoe	2019-18	List C noxious weed
Sonchus uliginosus	Moist sowthistle	Arapahoe	2019-24	Non-native
Spergularia media	Media sandspurry	Arapahoe	2019-14	Non-native
Trifolium fragiferum	Strawberry clover	Arapahoe	2019-38	Non-native
Ulmus americana	American elm	Adams	2019-43	Non-native
Zannichellia palustris	Horned pondweed	Arapahoe	2019-39	Native

4.6 Wildlife Observations

Amphibians

Native amphibians were found at eight of the study sites (Table 20). Successful breeding sites with substantial populations of northern leopard frogs (*Lithobates pipiens*) were observed at Coal Creek at Senac (AA-7) and the Pronghorn Natural Area, both north and south of Quincy Ave. (AA-1B, AA-2, AA-21). Northern leopard frogs are a Tier 1 species of conservation concern in Colorado (CPW 2015). Invasive non-native bullfrogs (*Lithobates catesbeiana*) were not found in the Pronghorn Natural Area sites but were present in large numbers at the Coal Creek at Senac site where they co-occurred with northern leopard frogs. Bullfrogs were also noted downstream throughout the Coal Creek/Sand Creek drainage from the Coal Creek at Senac through Sand Creek Park and at additional sites noted in Table 20.

Samples for the pathogenic chytrid fungus (*Batrachochytrium dendrobatidis*) were taken at the five sites where amphibians were observed and captured, including the Coal Creek at Senac and the Pronghorn Natural Area sites. The samples were positive for chytrid at the Pronghorn Natural Area sites and negative at Coal Creek at Senac. Results from the chytrid testing are summarized in Table 20 and were provided to Colorado Parks and Wildlife (CPW) as part of our permit requirements, along with the Aurora amphibian/reptile observations. The online database Bd-Maps that has previously been used to store data on where chytrid samples have been collected and how many samples are positive or negative for the fungus is now defunct.

All amphibians and reptiles encountered during the wetland surveys were recorded and are reported in Table 20. The invasive non-native red-eared slider turtle (*Trachemys scripta elegans*) was documented at three sites.

Birds

A total of 77 bird species were observed during the 2019 wetland surveys (Table 20). These represent incidental sightings made during the wetland surveys as no formal bird surveys were conducted. Number of species observed at the survey sites ranged from 14 to 34 (Table 21).

Bald eagle, a Tier 2 species of conservation concern in Colorado (CPW 2015), were nesting at three of the survey sites: Plains Conservation Center (AA-3), Coal Creek at Senac (AA-7), and Confluence Open Space (AA-16). City of Aurora actively monitors the nests and enforces seasonal closures to protect the nesting eagles.

All bird observations were submitted to eBird, a global citizen science project created by researchers at Cornell University; eBird utilizes submitted bird observations to document bird distribution, abundance, habitat use, and trends (Sullivan et al. 2009). Nine of the survey areas are included in eBird as "hotspots" and as such additional data compiled from multiple observers over multiple years and seasons are available for those areas. The total number of species recorded at the nine eBird hotspots (as of November 2020) are reported in Table 21.

Beaver

Beaver dams were observed on numerous sites supporting and actively improving watershed function. The beaver dams were found within the Coal Creek/Sand Creek drainage basin at the sites listed below in upstream to downstream order.

Coal Creek/Sand Creek

- Coal Creek N (AA-8)
- Confluence Open Space (AA-16)
- Sand Creek Riparian Preserve (AA-13)
- Sand Creek Park (AA-11)

Tollgate Creek - tributary joining Sand Creek between Sand Creek Riparian Preserve and Sand Creek Park

- Signature Park (East Tollgate Creek) (AA-15)
- Horseshoe Park (West Tollgate Creek) (AA-5)

Table 20. Amphibians and reptiles documented in Aurora wetlands.

Site Name	*Site Code*	*Native Amphibians*	*Non-native Amphibians*	*Chytrid Testing*	*Native Reptiles*	*Non-native Reptiles*
Pronghorn N	AA-1	Northern leopard frog	---	Positive	Plains garter snake	---
Pronghorn SE, SW	AA-2 AA-21	Northern leopard frog; Boreal chorus frog	---	Positive	---	---
Jewell Wetlands	AA-4	---	Bullfrog	---	Painted turtle	Red-eared slider
Horseshoe Park	AA-5	---	Bullfrog	---	Snapping turtle; Western terrestrial garter snake	---
Coal Creek S	AA-6	Woodhouse's toad	Bullfrog	Negative	---	---
Coal Creek at Senac	AA-7	Northern leopard frog	Bullfrog	Negative	Plains garter snake	---
Coal Creek N	AA-8	---	Bullfrog	---	---	---
Star K Ranch	AA-9	Woodhouse's toad (tadpoles); Boreal chorus frog	---	Negative	Painted turtle; Yellowbelly racer snake	Red-eared slider
Sand Creek Park	AA-11	---	---	---	Yellowbelly racer snake	Red-eared Slider
Sand Creek Riparian Preserve	AA-13	Woodhouse's toad	Bullfrog	---	---	---
Confluence Open Space	AA-16	Woodhouse's toad	Bullfrog	---	---	---
ACRE Marsh	AA-18	---	Bullfrog	---	---	---
Box Elder Creek	AA-19	---	---	---	Prairie rattlesnake	---

Table 21. Bird species observed in Aurora wetland sites during 2019 surveys

Common Name		
American Coot	Common Nighthawk	Northern Rough-winged Swallow
American Crow	Common Yellowthroat	Pied-billed Grebe
American Goldfinch	Cooper's Hawk	Red-breasted Nuthatch
American Kestrel	Dark-eyed Junco	Red-tailed Hawk
American Robin	Double-crested Cormorant	Red-winged Blackbird
American White Pelican	Downy Woodpecker	Ring-billed Gull
American Wigeon	Eastern Kingbird	Rock Pigeon (Feral Pigeon)
Bald Eagle	Eurasian Collared-Dove	Say's Phoebe
Barn Swallow	European Starling	Snowy Egret
Belted Kingfisher	Great Blue Heron	Song Sparrow
Black-billed Magpie	Great Horned Owl	Spotted Sandpiper
Black-capped Chickadee	Horned Lark	Swainson's Hawk
Black-crowned Night-Heron	House Finch	Tree Swallow
Blue Grosbeak	House Sparrow	Vesper Sparrow
Blue Jay	House Wren	Virginia Rail
Blue-winged Teal	Killdeer	Warbling Vireo
Brewer's Sparrow	Lark Bunting	Western Kingbird
Broad-tailed Hummingbird	Lark Sparrow	Western Meadowlark
Brown-headed Cowbird	Lazuli Bunting	Western Wood-Pewee
Bullock's Oriole	Lesser Goldfinch	White-breasted Nuthatch
Bushtit	Loggerhead Shrike	White-faced Ibis
Canada Goose	Mallard	Wilson's Warbler
Cassin's Kingbird	Marsh Wren	Wood Duck
Chipping Sparrow	Mourning Dove	Yellow Warbler
Cliff Swallow	Northern Flicker	Yellow-breasted Chat
Common Grackle	Northern Harrier	

Table 22. Number of bird species documented in Aurora wetland sites during 2019 surveys.

Site Name	*Site Code*	*Number of Bird Species Observed during 2019 Wetland Surveys*	*eBird Hotspot Name*	*Number of Species per eBird Hotspot (as of November 2020)*
Pronghorn N, SW, and SE	AA-01, AA-02, AA-21	34	Pronghorn Natural Area	98
Plains Conservation Center	AA-03	24	Plains Conservation Center	99
Jewell	AA-04	26	Jewell Wetlands Park	103
Horseshoe Park	AA-05	31	Horseshoe Park	71
Coal Creek S	AA-06	14	---	---
Coal Creek at Senac	AA-07	20	E. Jewell Ave. crossing of Coal Creek	47
Coal Creek N	AA-08	17	---	---
Star K Ranch	AA-09	19	Morrison Nature Center at Star K Ranch	121
Sand Creek Park	AA-11	16	Sand Creek Park	97
Signature Park	AA-12	27	---	---
Sand Creek Riparian Preserve	AA-13	32	---	---
Quincy Reservoir	AA-14	26	Quincy Reservoir	163
Red-tailed Hawk Park	AA-15	29	Red-tailed Hawk Park	37
Confluence Open Space	AA-16	33	---	---
ACRE Marsh and Box Elder Creek	AA-18, AA-19	25	---	---

4.7 Natural Heritage Results

Rare Animals, Plants, and Plant Communities

Two aquatic-dependent animal species documented during the 2019 surveys, northern leopard frog and bald eagle, are tracked by CNHP. Element occurrence records were updated or added as new records in the CNHP Biotics database.

The CNHP database shows northern leopard frogs documented within the Coal Creek/Senac Creek drainage in 2013, 2011, and 2005 (Sovell et al. 2006 and 2014; Sovell and Rondeau 2011; CNHP 2020a). The 2019 survey resulted in several new northern leopard frog locations being added to the CNHP element occurrence record. The bald eagle nest sites being monitored by Aurora represent new bald eagle locations for the CNHP database.

One additional aquatic-dependent CNHP tracked species, the plateau spreadwing (*Lestes alacer*), a damselfly, has been documented in Aurora. The plateau spreadwing is a Tier 2 species of greatest conservation concern (CPW 2015) and was found at a pond on Buckley Air Force Base in 2015. The pond where the damselfly was found was drained in 2018/2019 and that population is likely extirpated. The same species was documented in a retention pond along Westerly Creek in Denver in 2019 so it is likely additional populations of plateau spreadwing will be found in Aurora (CNHP 2020a).

No CNHP tracked plants or plant communities were found during the survey. The list of potential species and plant communities occurring in the area is included in Appendix F.

5.0 Discussion

5.1 Condition and Value of Aurora Wetlands

Wetlands in urban environments are highly impacted by both direct and indirect stressors. Increased development and associated pavement increases stormwater runoff to wetlands. Coupled with flow constrictions from impoundments, road crossings, and undersized culverts, these changes lead to increased ponding and greater water level fluctuation (Wright et al. 2006). In Colorado's South Platte River Basin, hydrologic alteration is compounded by the fact that many watersheds receive additional water above their natural flow through transbasin diversions (CWCB 2019). Outdoor water use in urban settings, such as irrigation of parks and lawns, may infiltrate into the soil and drain to local streams, increasing late season base flows (Lerner 2002). In addition, urban wetlands receive greater inputs of many common water pollutants, including sediment, nutrients, and chloride. Pollutant loads in urban stormwater are typically one to two orders of magnitude greater than predevelopment conditions (Schueler 1987). Changes to wetland hydroperiods and pollutant loads often lead to compromised plant and animal communities with lower diversity and greater prevalence of invasive species (Wright et al 2006). In short, many urban wetlands are highly altered and these alterations degrade wetland condition when compared to "reference" or minimally impacted sites.

Condition alone is not the full measure of wetland value. Functioning urban wetlands perform numerous ecosystem services that are acutely needed in highly developed watersheds, such as improving water quality, maintaining base flows, attenuating flood waters, providing habitat for plants, animals, and pollinators, as well as offering recreational, therapeutic, and educational opportunities (Millennium Ecosystem Assessment 2005; Russell et al. 2011). Even though water draining to urban wetlands contains high pollutant loads, wetlands filter some of those pollutants and provide cleaner water to downstream users (Johnson 1991; Wright et al. 2006). While urban wetlands contain high cover of non-native species, their very presence in the developed landscape provides vital habitat where it is scarce. Equally important, natural and green spaces within urban areas provide opportunities for all residents, including children and families, to connect with nature. These ecosystem services are essential to watershed health and provide major economic benefits to society. However, degraded conditions impact a wetland's functional capacity. Maintaining or improving the condition of urban wetlands can enhance their ability to provide these essential services.

A balanced assessment of urban wetlands must consider both wetland condition and ecosystem services perspectives. First, it is important to document the condition of wetland resources and the stressors they face in order to recommend practical management actions to improve condition. Second, the assessment must consider the enormous benefit wetland ecosystems provide to urban residents and prioritize their conservation and management for current and future generations. This study of critical wetlands in the City of Aurora addresses both perspectives. While impacted by historic and current land use, all the wetlands surveyed in this project provide important wetland functions and are worthy of protection and restoration, even the lowest condition wetlands.

Wetland Condition

This study focused on twenty assessment areas (AAs) located within seventeen different sites across the City of Aurora. Land use within Aurora ranges from highly developed residential, commercial, and industrial areas to less developed suburban and rural areas. The condition of wetlands within Aurora closely followed this land use gradient. Condition scores, as measured through the EIA framework, ranged from good (B rank) condition in less developed areas to fair (C rank) and poor (D rank) condition within the urban core. In addition to ecological condition, wetland functional capacity was also rated through the FACWet method and similarly ranged from functioning to functioning impaired following the same gradient.

While no examples of excellent (A rank) sites were found in the City of Aurora, the AAs in the highest condition and functional capacity were plains riparian systems located in the less-developed eastern side of the city. Except for Sand Creek Riparian Preserve, they also had less intensive recreation land uses. The sites rated highest for condition also rated higher for functional capacity, but the relationship between condition and function scores was weaker in lower condition sites. Coal Creek at Senac was the highest rated for condition, the only overall B-ranked site, and the highest rated for functional capacity. Sand Creek Riparian Preserve rated second to the Coal Creek at Senac site with the FACWet method; here beaver activity and complex wooded vegetation structure contributed to sections of good site function. Pronghorn N riparian rated the second highest EIA; here a large buffer, diversity of vegetation patches, and hydrologic connectivity contributed to sections of good wetland and riparian condition. These sites were long riparian areas with seep/spring pools and varied vegetation structure, and they had fewer alterations to their outflow and stream channel than lower rating sites. Their creeks have well-connected floodplains, wide buffers, and support important wildlife species. Every effort should be made to protect not only these and the other wetlands, but also the buffers that protect them.

ACRE Marsh had the lowest score for functional capacity, but was not the lowest rated site for condition. Open water within the site and diverse vegetation structure from wooded stands to aquatic vegetation in a small area was notable in an otherwise tilled agricultural field. Wetland-dependent wildlife may rely on the unique aquatic resource. However, because the site is not a natural feature (likely an abandoned gravel pit) restoration efforts are best dedicated elsewhere. Horseshoe Park, surrounded by dense development, was the lowest scoring wetland for condition, but rated slightly higher for functional capacity. The riparian area had altered hydrology and simplified vegetation, but beaver created localized reaches with higher function, and a small sedge-vegetated seep area was likely due to previous beaver ponds.

For a regional comparison, wetland condition ranks have been documented for randomly selected sites in the lower South Platte River Basin (Lemly et al. 2014) and hand-selected sites in the City and County of Denver (Smith and Kuhn 2015) (Figure 12). Condition scores for Aurora wetlands were higher than wetlands in neighboring Denver, but lower than the randomly selected sites across the entire South Platte Basin. This is understandable as condition ranks follow the urban development gradient. The evaluated Denver wetlands were almost exclusively within urban areas while many of the Aurora sites were in the eastern portion of the city, which is much less developed. Randomly selected sites from the entire South Platte Basin included many sites on the undeveloped plains.

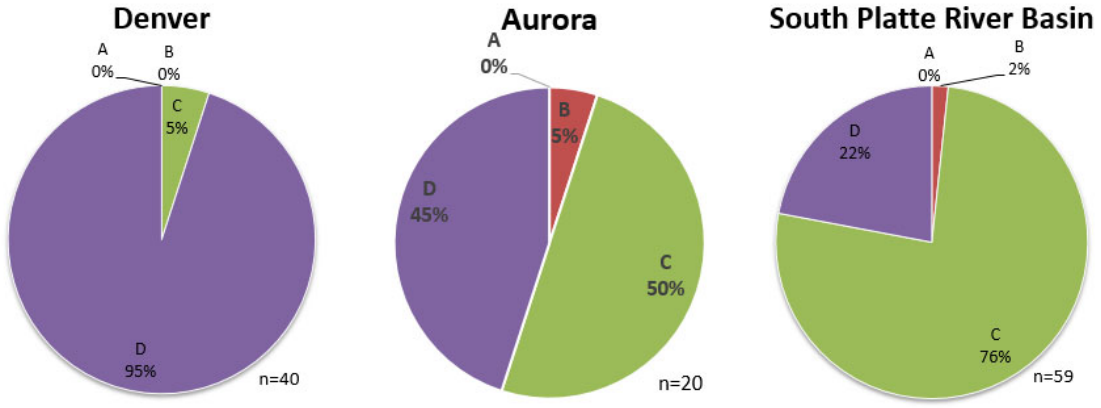

Figure 10. Comparison of Aurora, Denver, and Lower South Platte River Basin Wetland Condition Ranks using Ecological Integrity Assessment methods. Wetland condition ranks are as follows: A = Excellent; B = Good; C = Fair; D = Poor.

Urban Stressors

Urban ecosystems face numerous ambient stressors that cannot be entirely avoided as urban areas grow. The degree of ecosystem functions, such as flood attenuation and capacity of wetlands to remove nutrients, can be significantly altered in urban wetlands if they are not protected and managed (Wright et al. 2006). Identifying key stressors that reduce wetland function can help guide restoration and management actions that enhance wetland condition and function. While some factors that lower wetland condition are difficult to change, there are site-scale factors that are within the control of city managers and planners. Numerous stressors were observed within and surrounding Aurora wetlands. The most common stressors were impacts to the substrate and ground surface, prevalent noxious weeds, and non-point source water inputs.

Many of Aurora's urban wetlands are located in heavily modified riparian zones, with straightened channels, downcut banks, and development encroaching on riparian zones and headwaters. These changes correspond with losses to hydrologic connectivity and wetted herbaceous areas within the riparian corridor. The hydrology of Aurora's watersheds and streams has been reshaped by both the loss of small natural tributaries and large stormwater additions. Even before urban development expanded eastward, the landscape had been altered by farming and mining, which simplified the natural drainage networks and reduced their functional area. Built urban infrastructure often follow stream gradients and encroach the riparian zone, causing hydrologic and habitat fragmentation and increased wetland hydrologic stress. Land uses within the contributing watershed concentrate impacts in wetlands due to their low topographic position (Wright et al. 2006). These collective land use changes can cause loss of shallow water and saturated wetland habitat, and in other cases may impound and stabilize outflow, which encourages the development of in-stream cattail marsh over natural riparian habitat (Bansal et al. 2019).

Together, these common modifications can cause substantial stress on natural wetland and riparian function, and transform wetlands into eutrophic ponds and marshes. As Aurora expands, additional stormwater additions will continue to transform the city's wetlands. Construction and processes that introduce fill to riparian corridors can disconnect functioning riparian hydrology and

transform wetlands through energy loss and cattail expansion. Watershed plans and local ordinances can help set watershed goals to protect the function and condition of wetlands and their drainage networks. Incorporation of wetland health into stormwater management and urban development planning protocols, and creating green infrastructure networks to decrease direct wetland inputs can help reduce wetland hydrologic change as urban development continues.

Natural Riparian Wetlands

Ecological condition measured through the EIA framework describes the degree to which wetlands deviate from "reference" condition in the absence of human disturbance. Understanding the current condition of Aurora's wetlands requires understanding how the landscape has changed over the past century or more. The earliest aerial imagery we reviewed for this study, from the 1930's - 1960's (e.g., Google Earth, historicaerials.com), reveal that in general, many of Aurora's creekbeds were previously wider open sandy washes with sparse vegetation, and flashy flows driven by precipitation events. They were fringed by bands of open trees, with more mesic and wetland herbaceous patches in the outer floodplain and surrounding confluences. In addition, although these appeared more connected than present-day, some drainages already seemed downcut in the earlier 20th century, such as East Tollgate Creek in the Plains Conservation Center and Signature Park. Many factors, including historic agriculture within headwater tributaries, urban development encroaching into riparian corridors, flow constrictions, increased stormwater runoff, and an influx of water applied to urban lawns and parks, have all changed the character of these stream reaches.

Based on historical aerial imagery, each of the surveyed wetlands in this study except the Jewell Wetlands site, were located in a plains riparian setting. The history of Jewell Wetlands is unclear but it may have been fed by a seep. The plains riparian sites often had a sparsely vegetated central drainage, an outer wooded floodplain with sparse trees, mesic or seep-fed areas concentrated in the floodplain and around confluences, and narrow contributing headwater drainages. Many of the drainages were wider and sandier historically than in present day (Figures 10 and 11). Several sandy creeks surveyed in this study—Coal Creek, Box Elder Creek, the south creek in Red-tailed Hawk Park (Sampson Gulch)—have retained some of their sandy substrate and open vegetation; however, all creeks surveyed have some vegetation infilling. There may also have been other historical wetland types in this region, such as natural wet meadow or marsh ecosystems along seeps at toeslopes, within low order herbaceous drainages, and possibly within the stream channels prior to impoundment. There is a consistent trend in increased water retention and cattail growth throughout the study area. In some sites, such as Pronghorn North marsh and Red-tailed Hawk Park, aerial imagery shows the concurrent infilling of cattail as the surrounding land is developed (Figure 10).

Today, half of the surveyed wetlands have converted to cattail marshes or contain large patches of cattail marsh within the AAs. In addition, many wetlands had reaches of cattail that filled the stream channel. Older aerial imagery shows substantial change, with cattail density clearly increasing even in the last few decades. Excavation, impoundments, water additions, increased nutrient loading, and adjacent developments can increase cattail marsh area within wetlands (Wilcox et al. 1984, Bansal et al. 2019). Monitoring cattail for expansion, and avoiding new wetland outflow restrictions or major water additions, especially for higher condition wetlands, can help maintain native

ecosystems and watershed health. Maintaining wide buffers and open space corridors in local watersheds will also sustain healthy wetlands.

Figure 11. Change over time at Red-tailed Hawk Park. Green outline shows AA and its contributing drainages. The top photo shows a sandy, dry creek with sparse riparian vegetation. The bottom photo shows a highly developed contributing area and marsh vegetation within the creek (S central wetland branch). Date of top photo: 12/1956 and bottom photo: 6/2020.

Figure 12. Change over time at Coal Creek at Senac. Images show that less change has occurred over time than in other riparian reaches. The sandy substrate is retained. Date of top photo: 6/1993 and bottom photo: 6/2020.

Wetland Social Ratings

Many of Aurora's urban wetlands were developed for recreational use and received high social ratings that cultivate positive human-wetland interaction and well-being. This rating only evaluated interactive benefits that wetlands provide to the public, and not other functions and services that wetlands provide. There were two sites with nature centers, and miles of biking and hiking trails throughout the city that paralleled riparian areas. There was a diverse range of recreational and educational opportunities along the wetlands and within their larger open space parks. The trail system follows lengthy riparian corridors along Sand Creek. As the city plans future trail expansion and recreation sites near wetlands, implementing large buffers to maintain wetland/riparian health, prioritizing development near sites that are already impacted, and protecting higher condition wetlands from raised trails and higher recreational use will allow those critical wetlands to continue to provide a range of wetland functions such as cleaner water, flood protection, and water supply.

Five of the nine wetlands with D (poor) EIA condition scores had very high or high social ratings. The high social rating indicates that "poor" condition wetlands provide many social benefits including recreation opportunities and green space benefits. In contrast, the higher condition Coal Creek wetlands received a low social rating for human use and enjoyment because it is currently inaccessibility to the public. However, increasing trails and recreational use in high condition sites, such as Coal Creek at Senac, increases the likelihood of negative impacts to the condition.

5.2 Plants and Animals of Conservation or Management Importance

High Quality Plants

There were no observations of rare plants in this study. The AAs were large, and it is possible some uncommon plants in low cover were not seen with the rapid EIA survey methodology. Several wetland plant species observed such as *Carex pellita, Epilobium palustre, Puccinellia nuttaliana, Sagittaria cuneata,* and *Spartina pectinata* had mid-high C-values, and the locations of those species can indicate areas of higher site quality and native wetland with higher protection value.

The Native Mean C FQA metric, the average C-value of only native species within a site, indicates the quality of the remaining native plant community. This metric is not as correlated to the site condition as the Mean C (Gorss 2018). Since urban sites like these Aurora wetlands have high overall human disturbance and a low Mean C, the remaining native vegetation helps inform the site potential. The Native Mean C metric may indicate potential for remnant wetland patches remaining within a larger site, point to areas of the site with fewer non-native species, and can indicate the suite of native species that can persist at the site of interest. One caveat of Mean C metrics is that the interpretation of data from restoration sites may not be comparable to remnant sites, and likewise, restoration activities should not plant only higher C-value species (Gorss 2018). Native riparian habitat should include a range of species appropriate to the current or desired successional status of the site, including some early successional riparian habitat species (i.e., lower C-value) that grow in low gradient, temporarily flooded, emergent vegetation zones.

Any wetland area with native non-invasive plant species has higher protection value. Those include sites with wetland graminoid understory cover such as at Sand Creek Riparian Preserve (AA-13); patches of native understory mesic graminoid cover such as at Star K Ranch (AA-9); sites with important seep forbs like *Berula*, *Sagittaria*, and *Alisma* (Coal Creek AA-7 and AA-8); and wetland areas with high C-value plants such as Red-tailed Hawk Park (AA-15), sedge patches at Plains Conservation Center (AA-3), and *Carex* and *Spartina* areas in Pronghorn North riparian (AA-1A). Upland buffers are especially important around these wetlands, and also in sites with high quality native upland vegetation such as Plains Conservation Center and areas of Pronghorn Natural Area and Coal Creek. The amount and types of higher C-value plants at Red-tailed Hawk Park indicate this site was likely once higher quality wet meadow (where the marsh is presently) and riparian area, and that remnants of that important native wetland resource remain. Efforts to protect the sandy cottonwood gallery wash and more mesic wetland vegetation fringing the cattail marsh are valuable for conservation. Avoiding further soil disturbance to the area, and efforts to keep sprinklers, urban hydrologic inputs, and new hydrologic alterations out of the wetland and riparian resources are recommended. In addition, some riparian trails are lined with mostly non-native weeds. Consider native revegetation of those areas.

Noxious Weeds

A total of one List A, 14 List B, nine List C, and three Watch List noxious weed species observed at the City of Aurora wetlands. The List A species, hairy willowherb (*Epilobium hirsutum*), was found at Red-tailed Hawk Park. List B species and List C species were found at all 20 of the AAs. The three Watch List species found were Siberian elm (*Ulmus pumila*) which is common and widespread in urban areas; tree of heaven (*Ailanthus altisima*) found only at Sand Creek Park; and common reed (*Phragmites australis*) found at Sand Creek Park and Qunicy Reservoir. For List A species, the management plan is always eradicate; management plans for List B species are devised by counties (Colorado Department of Agriculture 2020b); and List C species are considered lower priority (Colorado Department of Agriculture 2020a). The Watch List is intended to serve advisory and educational purposes only and is used to assist in determining which species should be designated as noxious weeds (Colorado Department of Agriculture 2020a).

The first goal in any successful landscape management of weeds is to protect intact habitats from anthropogenic disturbances. Intact habitats are resilient to weed infestations. Disrupting native landscapes to treat targeted weed species creates the high likelihood of either introducing more weeds or increasing the footprint of the existing weeds (Pritekel et al. 2006; Nicholas et al. 2008; Cal-IPC 2012). Treating weeds in wildlands is very different from treating weeds in agricultural lands and rangelands. Unfortunately, the majority of the weed fact sheets and methods available for treating weeds are not specific to wildlands. The recommended cultural, mechanical and chemical actions are often too aggressive or harmful to wildlands, especially wetlands. Wildlands are far more complex and success is much more difficult. Wildlife including insect pollinators must be protected and many chemicals (including the adjuvants) used on agriculture and rangelands are not safe or even tested for wildlife (Cal-IPC 2015).

Any treatments for weeds should have a site-specific plan that takes into account the life cycle of the weed of concern, any weeds in the vicinity that could potentially move into the area following disturbance associated with treatment, and other potential adverse impacts to the surrounding

plant and wildlife community. Tackling small areas and conducting follow-up monitoring is recommended. One assumption in weed management is that the weeds will always increase if you do not treat them. This is not always the case. That is why site-specific plans are needed to look at each treatment area before an action is selected and priority given to areas where weeds are expanding. In recovering systems some treatments could set the area back to a more disturbed time and actually increase the weed cover (Pearson et al. 2016).

Herbicide use is common, but it can have many hidden costs because the resulting contamination poses risks to soil microorganisms, insects, plants, fish and birds. A recent study (Fugere et al. 2020; McGill University 2020) showed that glyphosate-based herbicides, such as Roundup, can trigger loss of biodiversity in freshwater ecosystems. Investigating non-chemical means of control including mechanical removal of flower heads and digging out mature plants is recommended.

The treatment of Canada thistle (*Cirsium arvense*), a class B noxious weed, is an example of how chemical weed control might not be the first choice. In a long-term weed study in Colorado (Rondeau and Lavender 2012), it was found that if a non-native grass species, smooth brome (*Bromus inermis*) was present, the herbicide treatments used for Canada thistle resulted in an increased cover of smooth brome. Additionally, the treatments also resulted in the disappearance of native shrubs thought to be weakened by the herbicide. Native shrubs that offered complex vegetation structure for wildlife habitat were eliminated, as well as the floral resources that are offered by Canada thistle for pollinators. Overall, the herbicide treatments resulted in a reduction in biodiversity. A better treatment course would be to consider mechanical removal of flowering heads rather than chemical applications that could weaken surrounding plants and give smooth brome an advantage. This study is of particular importance to Aurora land management practices because the two most common herbaceous plant species in the surveyed wetlands were smooth brome and Canada thistle. In addition, smooth brome was often present in high cover in the wetland buffers.

Beaver

Beaver wetlands provide exceptionally high levels of ecosystem services, and beaver dams and lodges were present in six AAs surveyed in this study. For example, beaver wetlands can provide flood control by storing water and excess runoff in depressions and hydrophilic riparian zones. This results in reduced streamflow energy and allows sediment and pollutants to fall out of the water column, which improves water quality with the help of anaerobic microbes. As water is retained, it recharges later season stream flow and water supply. Active beaver gnaw down trees that add organic matter to the riparian ecosystem, some of which becomes stored carbon. The downed wood ponds water, adds to potential vegetation habitat and structure, and supports biodiversity, which humans enjoy the benefits of for connecting with nature. These diverse wetland functions and services are especially valued in urban areas that have increased pollutant loads, more stormwater, less infiltration from impervious surfaces, and compacted soil (Bailey et al 2018). As beaver restore wetland and stream condition, a higher degree of ecosystem services is performed. To the extent possible, managing wetlands and large wetland buffers for current and expanded beaver colonization in the wetlands where they are known, maintaining an adaptive management approach, and conserving ample riparian buffer and open space for their potential establishment in new reaches can minimize conflict and add resilience to increasingly urbanizing watersheds.

Northern Leopard Frog and Invasive Bullfrog

Northern leopard frogs, a Tier 1 species of greatest conservation need (CPW 2015), are found in wide variety of habitats in Colorado at elevations ranging from 3,500 ft. to 11,000 ft. (Hammerson 1999). In Colorado, northern leopard frogs are typically found in wet meadows, marshes, ponds, streams, lakes and reservoirs. Breeding occurs in mid-sized ponds and shallow areas of permanent ponds and in seasonally flooded areas adjacent to permanent pools or streams (Hammerson 1999).

Localized declines at high and low elevation sites in Colorado have been reported (Hammerson 1999, Johnson et al. 2011). Although the expanse and severity of these declines are not well known, various agencies have expressed interest in the conservation status of the northern leopard frog. The non-native bullfrog has been implicated in declines of northern leopard frogs through direct predation and competition (Hammerson 1982) and should be regarded as an invasive threat for native amphibians in the study area. Another concern for northern leopard frogs is the amphibian chytrid fungus which has been documented in Colorado populations of northern leopard frogs. The impacts of the fungus on this species are not well known. Recent studies have suggested that while direct mortality from the fungus is not common, other effects like weakened immune systems (Caseltine et al. 2016) and stunted growth (Voordouw et al. 2010) could increase vulnerability to other threats. Northern leopard frogs could also be a carrier of the fungus to new environments where other amphibian species that are more susceptible could be impacted. The chytrid positive samples taken from northern leopard frogs at the Pronghorn sites is concerning but the numerous juveniles found throughout the site along with adults indicates a fairly substantial breeding population with successful reproduction. Future monitoring at this site is recommended to assess the impacts of chytrid on this population of northern leopard frogs.

The invasive bullfrog is the primary concern for the northern leopard frog and other native amphibians within the City of Aurora Open Space properties. Bullfrogs are native to the eastern U.S. and Canada and have been introduced into Colorado and are now established throughout much of the Front Range and eastern plains (Hammerson 1999). Bullfrogs are a very successful colonizer of new habitats and are impacting native amphibian populations around the world (Johnson et al. 2011). Hammerson (1982) describes the decline of northern leopard frogs at a site in Boulder County after the introduction of bullfrogs. In 2019 bullfrogs were documented at eight of the Aurora study sites with multiple age classes that indicate established breeding populations. The Coal Creek at Senac site was especially concerning due to the co-occurrences of northern leopard frogs and numerous bullfrogs. Through direct predation and competition, the bullfrog poses a serious threat to this population of northern leopard frogs. In addition, bullfrogs are considered a carrier species for chytrid fungus and capable of spreading the disease to new environments. Management of the bullfrog is encouraged although control of this species can be difficult. Methods to eradicate populations of bullfrogs can include direct capture and removal which can reduce adult and juvenile numbers but the removal of tadpoles can be difficult. Current studies suggest that seasonal reduction of breeding pond hydroperiods can be the most effective measure for eradicating this species (Peterson et al. 2013). This method can be effective because bullfrogs require permanent breeding ponds due to the time required for tadpole metamorphosis. In Colorado bullfrogs overwinter and tadpoles require 1-2 years to complete metamorphosis whereas northern leopard frogs complete metamorphosis in one summer.

Invasive Red-eared Slider

The red-eared slider turtle (*Trachemys scripta elegans*) is another invasive species that should be monitored closely. This popular pet trade aquatic turtle native to southeastern U.S. is often released into ponds in urban areas and is capable of surviving the winters in Colorado (Livo et al. 2017). The native western painted turtle (*Chrysemys picta*) is native to the study area and occupies a similar ecological niche to the red-eared slider. The red-eared slider could compete negatively with painted turtles for basking sites and food resources (Livo et al. 2017). Red-eared slider turtles were found at three sites: Star K Ranch, the pond just west of Jewell Wetlands, and a pond near the Peoria St. parking lot at Sand Creek Park. The pond at Jewell Wetlands had numerous red-eared sliders of different age classes found along with western painted turtles and Star K Ranch had both turtle species co-occurring as well. Opportunities to educate the public about releasing unwanted pets like the red-eared slider into open space properties would be valuable to help stop the introduction of invasive species.

Bald Eagle

Bald eagle is a Tier 2 species of greatest conservation need in Colorado (CPW 2015). When the Endangered Species Act was enacted in 1973 this species, within the Lower 48 states, was included on the original Endangered Species List. Through successful conservation efforts bald eagles are currently increasing in numbers and the species was delisted in 2007. In 1974, only a single breeding pair was documented in Colorado and by 2006 that number had risen to 65 (Center for Biological Diversity 2007). Many of these breeding pairs occur along the Front Range. Breeding habitat includes riparian corridors with tall trees and adequate prey base. Typical breeding locations include access to an active fishery (Colorado Bird Atlas Partnership 2016). Threats to nesting bald eagles include human development and disturbance at breeding sites. Additionally, climate change may threaten bald eagles in Colorado due to extended reservoir drawdowns leading to decreased prey availability and increased completion among pairs (Jackman et al. 2007). The three nesting bald eagle pairs in Aurora are monitored and protected from disturbance by seasonal exclosures.

5.3 Management Implications

Protect Wetlands

Wetlands provide crucial ecosystem services that reduce risk and costs of water issues associated with both urban development and extreme weather, and their protection is needed. Reactionary responses to development and associated wetland stress has resulted in loss and degradation of important native ecosystems in Aurora and globally. Instead, municipalities and governments need watershed plans to protect and strategically manage wetlands and their ecosystem services for sustainable urban development, supporting healthy and desirable urban centers, and improving environmental equity. Protecting wetland area and healthy ecosystems is inextricably linked to human health, from air quality improvement, to buffering climate change carbon loss and increased temperatures, to safeguarding water source and quality, to decreasing economic and infrastructure loss from natural and climate-change induced disturbance events, and to human-environment

cultural values and overall quality of life (Horwitz et al. 2012). In short, healthy watersheds support healthy people, and the protection and wise management of wetlands and riparian areas is key to healthy watersheds.

Minimize Construction Activities near Wetlands and Riparian Areas

Limit new construction and other ground disturbance near or adjacent to wetlands and riparian areas. Where possible, avoid wetlands and riparian areas when planning for repairs. Follow BMPs that require off site concrete washouts and other measures to minimize disruptive impacts.

Conserve Unfragmented Riparian Area and Buffers

Aurora's highest scoring EIA wetland attribute was the overall size. The wetland and riparian resource size can be used as a measure of conservation value, especially when paired with better scoring wetland condition sites. The condition of the upland buffer also indicates conservation value. The larger wetland and riparian resource sizes in Aurora's watershed network provides critical biodiversity support needed in urban areas (Lynch 2018). Most AAs rated as good in relative size for their type, and several sites ranked as excellent in size. These larger wetlands can be more resilient to hydrologic and weedy invasion, and their natural functions buffer the wetland health across their area (Lemly et al. 2016). For example, the Sand Creek Park riparian site ranked A for its relative size, contributes miles of ecosystem services to Aurora which results in higher net environmental benefits. That wetland is a good candidate for targeted management to improve ecological health, due to its lower functional and ecological condition scores and higher site potential. In contrast, the Coal Creek at Senac Site not only scored an A for size but the was highest condition and function rated site in the study area, and thus this resource is a high priority site to apply conservation-based management and protection that minimizes impact to the wetland, riparian area, and surrounding upland buffer, for its important contributions to overall watershed health and available wetland resource.

Historical Data Review to Guide Restoration Efforts

The EIA condition data shows that all of the surveyed sites have undergone significant change from the natural riparian or seep wetland ecosystems, that would be expected in this region, to dense marshes, downcut riparian areas, or stream channels with infilled vegetation.

Designing restoration efforts in urban areas is a balance of improving watershed health and function by mimicking least-disturbed, high functioning native ecosystems, and acknowledging the reality of land use constraints today. This effort can be guided by knowledge of site potential and features that supported wetland hydrology and healthy streamflow in the past. Historical photos and topographic maps are a rich resource in this endeavor, but are by no means 'reference condition'. Instead, imagery is a snapshot of history, of stream and creek structure prior to dense urban development and stormwater inputs and the current degree of transbasin water additions. Old aerials also can identify historical land use stressors, help direct restoration efforts such as revegetation or removing fill that intercepts connectivity. They display the restoration succession of allowing natural vegetation to grow over former substrate disturbance like gravel pits, berms, and fill, and also the success that beavers provide in rewetting a riparian zone and restoring vegetation structure. When developing a restoration plan, along with referencing EIA data, we recommend reviewing available historical aerial imagery and topographic maps for the site, and examining

locations of prior wetlands, drainages, and streamflow, to better understand site potential and historical impacts that may be fixed. The same goes for urban development: if a development is planning stormwater discharge into a creek, the potential impacts can be better anticipated by studying the hydrologic and vegetation changes that have happened over time following previous development.

Cattail Invasion

Analysis of the EIA species data, together with review of change over time in publicly available aerial imagery, reveals a consistent trend of cattail (*Typha*) invasion. The extent of invasion varies from infilling long ribbons of creek bottoms, to increased cover of broad monotypic cattail marsh in the AAs as upslope development occurs in the surrounding area. Cattail is known to invade in a variety of site conditions, especially with stabilized increased water levels and higher nutrients (Wilcox et al. 1984, Bansal et al. 2019; Magee et al. 2019). Of the two cattail species common in Colorado, broadleaf cattail (*Typha latifolia*) is a native species and narrowleaf cattail (*Typha angustifolia*) is often considered non-native and invasive (Swearingen and Bargeron 2016; Magee et al. 2019). In our field studies, narrowleaf cattail was the dominant species in the cattail invasion areas. Monitoring cattail invasion is important to identify and avoid land uses that are causing its spread, which appear to be associated with development. A ratio of 1:1 open water to emergent vegetation improves habitat for wildlife including dabbling ducks (CPW 2020), indicating thinning of cattail may be desirable in some situations. Cattail management methods include water level manipulation, burning, grazing, mowing, and chemical treatment (Bansal et al. 2019).

Noxious Weeds

Priority noxious weeds for treatment include List A species, any new introductions of Watch List species, and List B Noxious Weed species that are not widespread and are designated for elimination by the Adams or Arapahoe county as identified in the Rules Pertaining to the Administration and Enforcement of the Colorado Noxious Weed Act (8 CCR 1206-2). The only List A species found during the wetland surveys was hairy willowherb (*Epilobium hirsutum*) which was found at Red-tailed Hawk Park. The bright magenta flowers of this species should be watched for during flowering time (June to August) in marshes and along creeks.

Northern Leopard Frogs and Invasive Bullfrogs

The continued existence of the leopard frogs at Coal Creek at Senac and Pronghorn Natural Area is seriously threatened by the presence of invasive bullfrogs. Bullfrogs were not found at the Pronghorn Natural Area in 2019 but without bullfrog control that migration is likely to occur. Front Range cities and counties have been investigating various control measures (Triece et al. 2018). Current studies suggest that seasonal reduction of breeding pond hydroperiods can be the most effective measure for eradicating this species (Peterson et al. 2013). Other management recommendations for northern leopard frog are summarized in a Colorado Parks and Wildlife factsheet (CPW 2020).

Nesting Bald Eagles

The current City of Aurora protocols of enforcing seasonal closures in the vicinity of the nests has likely contributed to their presence and persistence. Additional management recommendations for

maintaining and improving bald eagle habitat are summarized in a Colorado Parks and Wildlife factsheet (CPW 2020).

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APPENDICES

Appendix A. Colorado Natural Heritage Program Wetland Mapping Procedures

Appendix B. Wetland Condition Assessment Field Forms

Appendix C. Field Key to Ecological Systems of Colorado's Eastern Plains and Field Key to Hydrogeomorphic (HGM) Classes

Appendix D. Scoring Formulas for Ecological Integrity Assessment (EIA) Metric

Appendix E. Natural Heritage Program Methodology

Appendix F. Rare Plants, Animals, and Plant Communities with Potential to Occur in Aurora

Appendix G. Site Descriptions and Plant Lists for Wetland Assessment Areas

Appendix H. List of Plant Taxa Documented in Aurora

APPENDIX A: COLORADO NATURAL HERITAGE PROGRAM WETLAND MAPPING PROCEDURES

Version Date: November 19, 2020

Scope of Document

This document was prepared by the Colorado Natural Heritage Program (CNHP), a research unit of the Warner College of Natural Resources and Colorado State University. It describes procedures used by CNHP to map wetlands in Colorado. Wetlands were attributed according to the NWI wetland classification system (Cowardin et al. 1979; FGDC 2013), which has become the federal standard for wetland classification. In addition to following the NWI mapping standards, non-wetland riparian areas were also mapped following a supplemental riparian mapping standard (USFWS 2019). Non-wetland riparian areas lack the amount or duration of surface and ground water present in wetlands, but are connected to surface or subsurface water and provide valuable wildlife habitat.

This document is primarily intended as an internal communication tool for CNHP's Wetland Mapping Specialists. Certain sections, therefore, may lack background information of interest to external readers. More information is available upon request.

Funding for CNHP's wetland mapping projects has come from a variety of partners, including U.S. Environmental Protection Agency (EPA), U.S. Forest Service (USFS), Bureau of Land Management (BLM), and National Academy of Science (NAS)'s Transportation Research Board (TRB). Non-Federal matching support has come from Colorado Parks and Wildlife (CPW), Great Outdoor Colorado (GOCO), Colorado Department of Transportation (CDOT), and Colorado Water Conservation Board (CWCB).

A. Project Check-out/Prep Work

1. ***Checkout Project Area from NWI:*** Choose a shape to represent the project area. It can be quads but it also could be a city, county or watershed boundary. Submit to Regional NWI Coordinator John Swords (John_Swords@fws.gov) and NWI Database Administrator Jane Harner (Jane_Harner@fws.gov).

2. ***Aerial Imagery for New Mapping Updates:*** New mapping updates will be based on the most current digital aerial photography available. In most cases, this imagery will be obtained from the USDA Farm Service Agency, Aerial Photography Field Office in Salt Lake City, Utah (http://www.apfo.usda.gov). In special circumstances, imagery may be provided by a project sponsor for a specific project area. The imagery used must be color infra-red (CIR) and must meet all requirements stated in the FGDC standard for wetland mapping (FGDC 2009). The minimum imagery needed to perform new mapping updates is CIR imagery for the year the wetland mapping is being updated to, and CIR imagery for one other year. Two or more additional years is preferable, as having multiple years available (such as a drought year and wet year) supports more accurate water regime determination.

B. Workflow for NWI Mapping Updates

1. Prepare ¼ quad images with mosaic method of choice.

2. Create a line shapefile to add features to.

3. Map smaller streams, channel, canals, and linear features, then buffer to the appropriate width.

4. Create a polygon shapefile to add features to.

5. Begin mapping large water bodies and rivers.

6. Attribute NWI wetland codes (Cowardin et al., 1979) as you go, keeping the following in mind:

    - Map to the image, not historic or predicted.
    - Be conscious of mowing changing the intensity of vegetation signatures.
    - Be conscious of haying changing the texture and color.
    - "Farmed" modifier describes tiled agriculture, not pastureland or mowed areas.

7. Save backups at least weekly to the P drive.

8. Important things to keep in mind:

    - Examine the wetlands for consistent alignment with features on the imagery.
    - Examine for correct System/Subsystem (mostly lakes and rivers).

- Examine for correct Class (look for shadows denoting trees and shrubs, look carefully at smaller ponds for aquatic vegetation, and larger lakes for rings of aquatic vegetation).
- Examine for correct Water Regime (use several dates if possible) compare with reference sites of field visits.
- Examine for correct Modifiers (only put modifier if confident).
- Look at large riparian systems carefully for matrix and isolated wetland pockets.

C. National Wetland Inventory (NWI) Classification

Wetlands were attributed according to the NWI wetland classification system (Cowardin et al. 1979; FGDC 2013), which has become the federal standard for wetland classification. System is the primary division in the classification and divides mapped features into a handful of aquatic resource types and is followed (when appropriate) by a numeric subsystem code. The four systems used for Colorado NWI mapping are Riverine (rivers), Lacustrine (lakes), Palustrine (vegetated wetlands) and Riparian (non-wetland vegetated areas adjacent to waterbodies) (Table A-1).

After system and subsystem, class identifies the dominate substrate or vegetation structure present and is represented by a two-letter code (Table A-2). Hydrologic regimes describe the duration and timing of flooding and is represented by a single letter character (Table A-3). Duration increases from A-H, though B sites are rarely flooded, but have water at or very near the surface consistently. Areas mapped as Riparian do not receive a hydrologic regime code. The final component of the code is an optional special modifier, represented by a lowercase letter. Many modifiers are possible, though only a handful of codes were applied in the study area (Table A-4). To facilitate generalizations about the mapping data, Cowardin codes were combined into eight broad groups (Table A-5), of which five are considered true wetlands and the remaining three are lakes, rivers/streams and riparian.

Table A-1: NWI Cowardin system and subsystem codes and interpretation.

System	*Subsystem*	*Code*	*Interpretation*
Riverine		**R**	**Rivers and streams**
	Lower Perennial	2	low gradient, slow moving channels
	Upper Perennial	3	steep, fast moving channels
	Intermittent	4	channels that do not flow year round, including manmade ditches
Lacustrine		**L**	**Lakes (water bodies >20 acres and/or > 2 m deep)**
	Limnetic	1	lake water > 2 m deep
	Littoral	2	lake water < 2 m deep along lake margins
Palustrine		**P**	**Vegetated wetlands (marshes, swamps, bogs, etc.) even if associated with rivers or lakes**
Riparian		**Rp**	**Non-wetland areas adjacent to waterbodies with vegetation distinct from surrounding uplands**

Table A-2: NWI Cowardin class codes and interpretation.

Class	*Code*	*Interpretation*
Aquatic Bed	AB	aquatic rooted or floating vegetation
Emergent	EM	herbaceous, non-woody vegetation
Scrub-shrub	SS	low woody vegetation
Forested	FO	trees
Unconsolidated Bottom	UB	habitats with at least 25% cover of particles smaller than stones and less than 30% areal cover of vegetation
Unconsolidated Shore	US	unconsolidated substrates with less than 75% areal cover of stones, boulders or bedrock and less than 30% areal cover of vegetation
Stream Bed	SB	unvegetated surfaces with variable substrate sizes within stream channels

Table A-3: NWI Cowardin hydrologic regime codes and interpretation.

Code	*Interpretation*
A	temporarily flooded
B	saturated
C	seasonally flooded
F	semi-permanently flooded
G	intermittently exposed
H	permanently flooded
K	artificially flooded

Table A-4: NWI Cowardin special modifier codes and interpretation.

Code	*Interpretation*
x	Excavated
h	Dammed/impounded
b	Beaver

Table A-5: NWI attribute groups for summary tables.

NWI Group	*Codes*	*Interpretation*
Herbaceous Wetlands	PEM*	all herbaceous wetlands (e.g., marshes, wet meadows, playas, etc.)
Shrub Wetlands	PSS*	shrub dominated wetlands (e.g. willow stands)
Forested Wetlands	PFO*	tree dominated wetlands (e.g., wet cottonwood stands)
Ponds	PAB*/PUB*	ponds of all kinds, either vegetated or not, but with open water < 2 m (e.g. beaver ponds, stock ponds, golf ponds, etc.)
Other Wetlands	PUS*/Pf	misc. other classes, primarily unvegetated surface (i.e. sparsely vegetated salt flats) and some farmed wetlands (used only rarely)
Lakes and Lakeshores	L*	all lakes and unvegetated lake shores
Rivers / Streams / Canals	R*	all river and stream channels, including manmade ditches, and their associated unvegetated shores (i.e., unvegetated sandbars)
Riparian	Rp*	Non-wetland areas adjacent to waterbodies with vegetation distinct from surrounding uplands

D. Riparian Classification

Riparian Features – Riparian features are mapped at the same time as wetland features using the USFWS 2019 Riparian classification. The USFWS defines riparian features as "contiguous to and affected by… lotic and lentic water bodies (rivers, streams, lakes or drainage ways)". The have either distinctly different vegetation (species) or significantly more robust growth. These areas are transitional between uplands and wetlands and can be considered to have a less predictable flooding regime and is often drier than an "A" water regime from NWI.

It is important to consider subsurface flow as well. Sandy washes, wooded draws, etc. are affected by collection of water during storm events and/or water tables closer to the surface.

Residential areas can be trickier, as runoff from lawn watering, impervious surfaces, etc. often elevate water tables in these areas. Look at the type of tree and proximity to water feature. Golf courses contain many trees and well watered vegetation but are not likely Rp.

Coding: Class is defined by the tallest life form that composes at least 30% of the area. No modifiers are applied to the riparian code. Tilled fields, even those close to rivers and streams are not mapped as riparian.

System	**Rp** (Riparian)		
SubSystem	**1** (lotic-flowing)	**2** (lentic – standing)	
Class	**EM** (emergent)	**SS** (scrub-shrub)	**FO** (forested)

Examples: Rp1FO, Rp1SS, Rp2FO

Common settings: *Rp1SS* – shrubby draw or drainage, often interrupted with drier herbaceous patches or by locations of incision. Shrubs can be dense or not. Often very narrow and linear in appearance. These will often be mapped as a linear feature then buffered out to the appropriate width.

Rp1EM – often along larger R4's with terraces. Often the same type of vegetation as the surround area, but much more robust. Channel scars and swales will usually be and NWI wetland code PEMA or PEMC, so one needs to look broadly.

Rp1EM/Rp1FO – matrix of herb/tree pockets in a larger floodplain. Look closely at denser pockets and the overall % cover to decide a class. Must choose one, DO NOT USE MIXED CODE.

Rp2FO – a ring of trees along a lake with a waterlevel that appears to fluctuate. Look closely at the understory (if visible) to determine if it's really Rp or NWI code PFOA.

E. QA/QC Procedures

CNHP uses the Wetland Data Verification Toolset developed by the U.S. Fish and Wildlife Service National Wetlands Inventory. The tool and its supporting document is available at: http://www.fws.gov/wetlands/Data/Tools-Forms.html

This toolset contains an ArcGIS 10 toolbox with 6 QAQC tests, a geodatabase containing a complete list of all currently valid NWI wetland codes and a PDF set of instructions. All data must clear these tests (or have justifications provided for records that get flagged as errors but are in fact correct) to be accepted by the NWI.

E1. QAQC Work Flow for All Mapping Projects

1. **Run topology (rule: features must not overlap), correct all errors**

2. **Run the "NWI Wetlands Data Verification Toolset" using the version appropriate for the version of ArcMap:**
   http://www.fws.gov/wetlands/Data/tools/Wetlands-Data-Verification-Toolset-Installation-Instructions-and-User-Information.pdf

3. **QAQC Code description:** Shows up in the form "NNNNNN". "N" means no error.
   C – incorrect wetland code
   U – sliver uplands*
   A – adjacent polygons with same attribute, this test also catches multipart features
   S – sliver wetlands, less than 0.1 acres *
   L – L1 or L2 < 20 acres *
   P – PUB or PAB > 20 acres *
   O – overlapping polygons (topology should render this test moot)
   ** indicates this test is "optional" in the sense that there can be polygons that are correct but not slivers, there can be Lakes less than 20 acres, etc.*

4. **Visual Scan -** new mapping only, see following section F5 for procedure.

E2. Description of the Verification Tests

A brief description of each of the verification functions is provided below.

Code "C" - Incorrect Wetland Codes: This model identifies wetland polygons with incorrect wetland codes, or null or blank values in the 'attribute' field. Bad wetland code and wetland code synonym summary tables are created and stored with your wetlands file geodatabase. The model changes the first character of QAQC_Code = 'C' if the wetland code is bad.

Code "U" - Sliver Uplands: This model identifies upland islands or holes in wetlands that are less than 0.01 acres. These may be actual upland features but are identified as errors as they are typically errors in wetland delineation. The model changes the fourth character of QAQC_Code = 'U', in wetland polygons adjacent to the upland sliver.

Code "A" - Adjacent Wetlands: This model identifies wetland polygons that are adjacent to other wetland polygons with the same 'attribute' and changes the second character of QAQC_Code = 'A'. Adjacent wetlands with the same attribute are not allowed and need to be corrected. This test also highlights multi-part features, which need to be corrected.

Code "S" Sliver Wetlands: This model identifies wetland polygons less than 0.01 acres and changes the third character of QAQC_Code = 'S'. These wetland features exceed the minimum mapping standard for wetlands and should be reviewed. Actual wetland features flagged as sliver wetlands can be justified as correct in the comments field of the QAQC_Summary table.

Code "L" or" P" - Lake and Pond Size: This model identifies Lakes that are less than 20 acres in size and Ponds that are greater or equal to 20 acres in size. It changes the fifth character of QAQC_Code ='L' for small lakes or 'P' for large ponds. These may or may not be errors and can be justified based on water depth of the identified waterbody or small lake portions on the edge of the mapping project area. Comments can be added to the 'comments' field of the QAQC_Summary table for those wetland features flagged that are valid based on depth requirements outlined in the wetlands mapping standards.

Code "O" - Overlapping Wetlands: This model identifies overlapping wetland polygons and changes the sixth character of QAQC_Code = 'O'. The overlapping portions of these polygons are

stored in your wetlands file geodatabase as an Overlapping_Polygons feature class to assist in locating these features. This model does not validate topology of the wetlands file geodatabase. The CONUS_wet_poly_Topology layer in your wetlands file geodatabase can be validated using the topology toolbar in ArcMap and also to view the errors. This model and the wet_poly_topology identify the same errors and either can be used. Overlapping wetland features are not allowed in the dataset.

E3. QAQC Notes

Water Regimes Available for Each Class (red = default for P systems):

EM – Emergent	Water Regimes = A, B, C, F, G, H, or J
SS – Shrub/Scrub	Water Regimes = A, B, C, F, G, H, or J
FO – Forested	Water Regimes = A, B, C, F, G, H, or J
UB – Unconsolidated Bottom	Water Regimes = H, G, or F
AB – Aquatic Bed	Water Regimes = H, G, F or C
US – Unconsolidated Shore	Water Regimes = C, B, A or J

PAB/PUB and LAB/LUB: Ensure that only lakes and ponds with "apparent" aquatic vegetation are labeled as PAB. Be aware that flooded shrubs can look like aquatic vegetation.

PEMC/PEMF: Can be confusing in that some PEMF (especially bulrush) can look pale. Examine 2005 true color image. PEMF's are usually very dark.

Rp1SS/PSSA: PSSA needs to be wet and should be in proximity to other wet areas. Along streams Rp1SS is most common unless back channels, etc. suggest wetter conditions.

DONUTS: Be aware for areas where wetlands form inset, concentric circles to ensure that the inner polygon is "clipped" to remove that area from the larger polygon when analysis is completed.

E4. QA/QC Procedures: Visual Inspection on New Mapping

Goal: 100% of features visually inspected by a wetland mapper who did not create the dataset.

1. Examine the wetlands for consistent alignment with features on the imagery.
2. Examine for correct System/Subsystem (mostly lakes and rivers).
3. Examine for correct Class (look for shadows denoting trees and shrubs, look carefully at smaller ponds for aquatic vegetation, and larger lakes for rings of aquatic vegetation).
4. Examine for correct Regime (use several dates if possible) compare with reference sites of field visits.
5. Examine for correct Modifiers (only put modifier if confident).
6. Look at large riparian systems carefully for matrix and isolated wetland pockets.

F. Project Completion

1. ***Submit for NWI QAQC*** - After Internal QAQC checks have either been cleared (no errors) or justified (for example, small kettle ponds often come in under 20 acres and trigger the wetland sliver test, they are in fact true small water bodies) submit the full draft dataset including metadata to NWI. NWI staffers will review the data, and possibly send the dataset out for a thorough third party QAQC inspection and report.

2. ***Address any issues –*** If the third party QAQC report includes mapping inconsistencies that fit into a pattern, address that pattern throughout the project area as thoroughly as possible. Then resubmit the data.

3. ***Check in Project Area to NWI/Data accepted*** – Once all QAQC issues have been resolved NWI will accept the project dataset into the NWI master dataset. The NWI typically updates the master dataset twice a year (spring/fall).

G. References

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Federal Geographic Data Committee (FGDC). 2013. Classification of Wetlands and Deepwater Habitats of the United States. FGDC-STD-004-2013. Second Edition. Wetlands Subcommittee, Federal Geographic Data Committee and U.S. Fish and Wildlife Service, Washington, D.C.

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APPENDIX B: WETLAND CONDITION ASSESSMENT FIELD FORMS

APPENDIX B.1: ECOLOGICAL INTEGRITY ASSESSMENT (EIA) FIELD FORM

2015 COLORADO WETLAND ECOLOGICAL INTEGRITY ASSESSMENT (EIA) – SITE INFORMATION

LOCATION AND GENERAL INFORMATION

Site ID: _____ Site Name_____ LEVEL 2.5 ASSESSMENT

Date: _____ Surveyors:_____ _____

General Location: _____ County: _____

General Ownership: _____ Specific Ownership: _____

Directions to Point:

Access Comments (note permit requirements or difficulties accessing the site):

GPS COORDINATES OF TARGET POINT AND ASSESSMENT AREA

Dimensions of AA:	Elevation (m):
____40-m radius circle	Slope (deg):
____ Freeform polygon, limited to 0.5 ha	
____Wetland boundary, other (note in comments)	Aspect (deg):

AA-Center (Circle AAs Only) WP #: _____ UTM E: ___ ___ ___ ___ ___ ___ UTM N: ___ ___ ___ ___ ___ ___ ___ Error (+/-): _____

AA-1 WP #: _____ UTM E: ___ ___ ___ ___ ___ ___ UTM N: ___ ___ ___ ___ ___ ___ ___ Error (+/-): _____

AA-2 WP #: _____ UTM E: ___ ___ ___ ___ ___ ___ UTM N: ___ ___ ___ ___ ___ ___ ___ Error (+/-): _____

AA-3 WP #: _____ UTM E: ___ ___ ___ ___ ___ ___ UTM N: ___ ___ ___ ___ ___ ___ ___ Error (+/-): _____

AA-4 WP #: _____ UTM E: ___ ___ ___ ___ ___ ___ UTM N: ___ ___ ___ ___ ___ ___ ___ Error (+/-): _____

AA-Track Track Name: _____ Area: _____

AA Placement and Dimensions Comments:

PHOTOS OF ASSESSMENT AREA (Taken at four points on edge of AA looking in. Record WPs of each photo in table above.)

		Photo Range:
AA-1 Photo #: _____	Aspect: _____	
AA-2 Photo #: _____	Aspect: _____	Comments:
AA-3 Photo #: _____	Aspect: _____	
AA-4 Photo #: _____	Aspect: _____	

Site ID / Name:_____ Date: _____

ENVIRONMENTAL DESCRIPTION AND CLASSIFICATION OF ASSESSMENT AREA

Wetland / riparian / upland inclusions: *(should = 100%)*

_____ % AA with true wetland and/or water

_____ % AA with non-wetland riparian area

_____ % AA with upland inclusions

Wetland origin: *(if known)*

____ Natural feature with minimal alteration

____ Natural feature, but altered or augmented by modification

____ Non-natural feature created by passive or active management

____ Unknown

Ecological System: (see manual for key and pick the *best match*) Fidelity: High Med Low

Cowardin Classification Fidelity: High Med Low

(see manual and pick *one each* of System, Class, Water Regime, and optional Modifier for dominant type)

HGM Class: (pick *only one*) Fidelity: High Med Low

____Riverine* ____Lacustrine Fringe

____Depressional ____ Slope

____ Flats ____ Novel (Irrigation-Fed) Riverine / Slope

**Specific classification and metrics apply to the Riverine HGM Class*

RIVERINE SPECIFIC CLASSIFICATION OF THE ASSESSMENT AREA

Confined vs. Unconfined Valley Setting

_____ Confined Valley Setting (valley width < 2x bankfull width)

_____ Unconfined Valley Setting (valley width ≥ 2x bankfull width)

Stream Flow Duration

_____ Perennial

_____ Intermittent

_____ Ephemeral

Proximity to Channel

_____ AA includes the channel and both banks

_____ AA is adjacent to or near the channel (< 50 m) and evaluation includes one or both banks

_____ AA is > 50 m from the channel and banks were not evaluated

Stream Depth at Time of Survey (if evaluated)

_____ Wadeable

_____ Non-wadeable

MAJOR ZONES WITHIN THE ASSESSMENT AREA (See manual for rules and definitions. Mark each zone on the site sketch.)

Zone 1 Description _____ Dom spp: _____ % of AA: _____

Zone 2 Description _____ Dom spp: _____ % of AA: _____

Zone 3 Description _____ Dom spp: _____ % of AA: _____

Zone 4 Description _____ Dom spp: _____ % of AA: _____

Zone 5 Description _____ Dom spp: _____ % of AA: _____

ENVIRONMENTAL AND CLASSIFICATION COMMENTS

Classification Issues (important for sites with medium or low fidelity to one or more classification systems):

AA REPRESENTATIVENESS

Is AA the entire wetland/riparian area? ☐ Yes ☐ No

If no, is AA representative of larger wetland/riparian area? ☐ Yes ☐ No ☐ NA (*if AA is the entire wetland*)

Comments:

ASSESSMENT AREA DRAWING

Add north arrow and approx. scale bar. Document **habitat features** and **biotic and abiotic zones** (particularly open water), inflows and outflows, and indicate direction of drainage. Include location of **AA points, soil pits,** and **water chemistry** samples. If appropriate, add a **cross-sectional diagram** and indicate slope of side.

ASSESSMENT AREA DESCRIPTION AND COMMENTS

Overall site description and details on site hydrology, soil, and vegetation.

Site ID / Name:_____ Date: _____

LEVEL 2.5 VEGETATION, SOILS & BASIC WATER CHEMISTRY

VEGETATION PLOT SPECIES TABLE

Cover Classes 1: trace **2:** <1% **3:** 1–<2% **4:** 2–<5% **5:** 5–<10% **6:** 10–<25% **7:** 25–<50% **8:** 50–<75% **9:** 75–<95% **10:** >95%

Scientific Name or Pseudonym	Coll #	Press (√)	Photos	Cover Class	Workspace

Site ID / Name:_____ Date: _____

VEGETATION PLOT SPECIES TABLE

Cover Classes 1: trace **2:** <1% **3:** 1–<2% **4:** 2–<5% **5:** 5–<10% **6:** 10–<25% **7:** 25–<50% **8:** 50–<75% **9:** 75–<95% **10:** >95%

Scientific Name or Pseudonym	Coll #	Press (√)	Photos	Cover Class	Workspace

Site ID / Name:_____ Date: _____

GROUND COVER BY HABITAT TYPE		
Estimate cover of each ground cover by habitat type. Estimate cover based on 1% or 5% increments (not cover classes).		
Cover (unless otherwise noted) →	**C**	**Comments**
Actual cover of water (any depth, vegetated or not, standing or flowing) (A+B+C below)		
Actual cover of open water zone and no vegetation (or only algae) (A)		
Actual cover of water zone with emergent vegetation (B)		
Actual cover of water zone with submergent / floating vegetation (C)		
Actual predominant depth of water (cm)		
Actual max depth of water (cm)		
Potential cover of water at ordinary high water		
Potential predominant depth at ordinary high water (cm)		
Stability of water level *(Pick one:* A: permanent and stable / B: permanent but fluctuates / C: intermittent or ephemeral)		
Cover of exposed bare ground (any substrate, can have algae cover)		
Cover of litter (all cover, including under water or vegetation)		
Depth of litter (cm) – average of four non-trampled locations where litter occurs		
Count of standing dead trees (>25 cm diameter at breast height)		
Cover of standing dead shrubs or small trees (<25 cm diameter at breast height)		
Cover of downed coarse woody debris (fallen trees, rotting logs, >25 cm diameter)		
Cover of downed fine woody debris (<25 cm diameter)		
Cover bryophytes (all cover, including under water, vegetation or litter cover)		
Cover lichens (all cover, including under water, vegetation or litter cover)		
Cover algae (all cover, including under water, vegetation or litter cover)		

VERTICAL STRATA BY HABITAT TYPE			
Estimate cover of each vertical strata by habitat type. Estimate height using classes. Estimate cover base on 1% or 5% increments (not classes).			
Height Classes 0: <0.2 m 1: 0.2–0.5 m 2: 0.5–1m 3: 1–2 m 4: 2–5 m 5: 5–10 m 6: 10–15 m 7: 15–20 m 8: 20–35 m 9: 35–50 m 10: >50 m			
Vertical Vegetation Strata (live or very recently dead) **Height / Cover →**	**H**	**C**	**Comments**
(T1) Dominant canopy trees (>5 m and >~ 30% cover)			
(T2) Sub-canopy trees (> 5m but < dominant canopy height) or trees with sparse cover			
(S1) Tall shrubs, tree saplings or seedling (>2 m)			
(S2) Short shrubs (<2 m)			
(HT) Herbaceous total			
(H1) Graminoids (grass and grass-like plants)			
(H2) Forbs (all non-graminoids)			
(AQ) Submergent or floating aquatics			

Site ID / Name:_____ Date: _____

SOIL PROFILE DESCRIPTION – SOIL PIT 1 ☐ **Representative Pit?** **WP # _____ Photo #s _____ (mark on site sketch)**

Depth to saturated soil (+/-cm): _____ Depth to free water (+/-cm): _____ ☐ Pit dry and groundwater not observed Settling Time: _____

Horizon (optional)	Depth (cm)	Matrix Color (moist)	Dominant Redox Features Color (moist)	%	Secondary Redox Features Color (moist)	%	Texture	Remarks (*note % visible salts in each layer)*
_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____

Hydric Soil Indicators: See field manual for descriptions and 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 Features (S5/F6/F8/S6/F7)
____**No Hydric Indicators**

Comments:

Major Soil Type:
____Histosol
____Histic Epipedon
____Clayey/Loamy
____Sandy

SOIL PROFILE DESCRIPTION – SOIL PIT 2 ☐ **Representative Pit?** **WP # _____ Photo #s _____ (mark on site sketch)**

Depth to saturated soil (+/-cm): _____ Depth to free water (+/-cm): _____ ☐ Pit dry and groundwater not observed Settling Time: _____

Horizon (optional)	Depth (cm)	Matrix Color (moist)	Dominant Redox Features Color (moist)	%	Secondary Redox Features Color (moist)	%	Texture	Remarks (*note % visible salts in each layer)*
_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____

Hydric Soil Indicators: See field manual for descriptions and 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 Features (S5/F6/F8/S6/F7)
____**No Hydric Indicators**

Comments:

Major Soil Type:
____Histosol
____Histic Epipedon
____Clayey/Loamy
____Sandy

Site ID / Name:_____ Date: _____

SOIL PROFILE DESCRIPTION – SOIL PIT 3 ☐ **Representative Pit?** **WP # _____ Photo #s _____ (mark on site sketch)**

Depth to saturated soil (+/-cm): _____ Depth to free water (+/-cm): _____ ☐ Pit dry and groundwater not observed Settling Time: _____

Horizon (optional)	Depth (cm)	Matrix Color (moist)	Dominant Redox Features Color (moist)	Dominant Redox Features %	Secondary Redox Features Color (moist)	Secondary Redox Features %	Texture	Remarks (*note % visible salts in each layer)*

Hydric Soil Indicators: See field manual for descriptions and 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 Features (S5/F6/F8/S6/F7)
____**No Hydric Indicators**

Comments:

Major Soil Type:
____Histosol
____Histic Epipedon
____Clayey/Loamy
____Sandy

BASIC WATER CHEMISTRY - PH, EC, AND TEMPERATE MEASUREMENTS ☐ **No water observed**

Take pH, EC, and water temperature recording at up to four locations within the AA and circle the appropriate characteristics. Take measurements within representative examples of the water within or adjacent to the AA, including channels, pools, and/or groundwater. Take GPS Waypoints at each location. Estimate water depth in cm, + for surface water, - for groundwater.

#	GPS WP#	Time of day	Location	Depth (+/-cm)	Surface OR Ground	Standing OR Flowing (NA for ground)	Clear OR Turbid (NA for ground)	Open OR Shade (NA for ground)	pH	EC	Temp
1					Surface / Ground	Standing / Flowing	Clear / Turbid	Open / Shade			
2					Surface / Ground	Standing / Flowing	Clear / Turbid	Open / Shade			
3					Surface / Ground	Standing / Flowing	Clear / Turbid	Open / Shade			
4					Surface / Ground	Standing / Flowing	Clear / Turbid	Open / Shade			
5					Surface / Ground	Standing / Flowing	Clear / Turbid	Open / Shade			
6					Surface / Ground	Standing / Flowing	Clear / Turbid	Open / Shade			

Water chemistry measurement comments:

Site ID / Name: _____ Date: _____

2015 COLORADO WETLAND ECOLOGICAL INTEGRITY ASSESSMENT (EIA) – METRICS

LANDSCAPE METRICS

L1. CONTIGUOUS NATURAL LAND COVER		L2. LAND USE INDEX	
Select the statement that best describes the **contiguous natural land cover** within the 500 m envelope surrounding the AA. See list of natural land covers in the field manual.		Select the statement that best describes the intensity of surrounding land use. Use the **Land Use Index** Worksheet (last page) to calculate the Land Use Index score.	
Intact: AA embedded in 90–100% contiguous natural land cover.	**A**	Land Use Index = 9.5–10.0	**A**
Variegated: AA embedded in 60–90% contiguous natural land cover.	**B**	Land Use Index = 8.0–9.4	**B**
Fragmented: AA embedded in 20–60% contiguous natural land cover.	**C**	Land Use Index = 4.0–7.9	**C**
Relictual: AA embedded within <20% contiguous natural land cover.	**D**	Land Use Index = <4.0	**D**

Landscape comments:

BUFFER METRICS

B1. PERIMETER WITH NATURAL BUFFER		B2. WIDTH OF NATURAL BUFFER	
Select the statement that best describes the **perimeter of the AA with natural buffer**. Buffer land covers must be ≥ 5 m wide and extend along ≥ 10 m of the AA perimeter. See list of buffer land covers in the field manual.		Select the statement that best describes the **width of the natural buffer**. Estimate the width of buffer land covers along eight lines radiating out from the AA at the cardinal and ordinal directions (N, NE, E, SE, S, SW, W, NW) and average their width. Estimate up to 100 m.	
Natural buffer surrounds 100% of the AA perimeter.	**A**	Average buffer width is 100 m	**A**
Natural buffer surrounds 75–99% of the AA perimeter.	**B**	Average buffer width is 75–99 m	**B**
Natural buffer surrounds 25–74% of the AA perimeter.	**C**	Average buffer width is 25–74 m	**C**
Natural buffer surrounds <25% of the AA perimeter.	**D**	Average buffer width is <25 m	**D**

B3. CONDITION OF NATURAL BUFFER

Select the statement that best describes the **natural buffer condition**. Select one statement per column. Only consider the actual natural buffer measured in metrics above. *Remember to look for **non-native hay grasses** when evaluating native / non-native vegetation in the buffer.*

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

Buffer comments:

Site ID / Name: _____ Date: _____

VEGETATION COMPOSITION METRICS

V1. NATIVE PLANT SPECIES COVER (RELATIVE)		V2. INVASIVE NONNATIVE PLANT SPECIES COVER (ABSOLUTE)	
Select the statement that best describes the relative cover of **native plant species** within the AA.		Select the statement that best describes the absolute cover of **invasive nonnative plant species** within the AA. Use list provided in the manual.	
AA contains >99% relative cover of native plant species.	**A**	Invasive nonnative species are absent from all strata.	**A**
AA contains 95–99% relative cover of native plant species.	**B**	Invasive species present, but sporadic (<4% absolute cover).	**B**
AA contains 85–95% relative cover of native plant species.	**C**	Noxious weeds somewhat abundant (4–10% cover).	**C**
AA contains 60–85% relative cover of native plant species.	**C-**	Noxious weeds abundant (10–30% cover).	**C-**
AA contains <60% relative cover of native plant species.	**D**	Noxious weed very abundant (>30% cover).	**D**

V3. NATIVE PLANT SPECIES COMPOSITION

Select the statement that best describes the **native plant species composition** (species abundance and diversity) within the AA. Look for native species diagnostic of the system vs. native increasers that may thrive in human disturbance.

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

Vegetation composition comments:

VEGETATION STRUCTURE METRICS

V4. VEGETATION STRUCTURE (VERTICAL AND HORIZONTAL)

Select the statement below that best describes the **overall vertical and horizontal structure** within the AA. Vertical structure relates to the number of vertical vegetation strata. Horizontal structure relates to the number and complexity of biotic and abiotic patches within the wetland/riparian area. See reference card for potential structural patches. Assess each site based on the expected conditions within its Ecological System type. For woody systems, rate regeneration and woody debris individually on next page, then consider those ratings in the overall assessment of structure.

Herbaceous systems: Marsh, Meadow, Playa	***Woody systems: Riparian and Floodplain***	
General: Vegetation structure is at or near minimally disturbed natural conditions. Little to no structural indicators of degradation evident.		**A**
Structural patches/zones are appropriate in number and type for the system (can be few in playas, fens, meadows). There is diversity in vertical strata within the herbaceous vegetation (some tall and some short layers and/or low cover of shrubs or trees, where appropriate). Litter and other organic inputs are typical of the system (i.e., playas should have low litter while meadows and marshes should have moderate amounts of litter).	AA is characterized by a complex array of nested or interspersed patches. Canopy (if present) contains a mosaic of different ages or sizes, including large old trees and obvious regeneration. Number of live stems is well within expected range. Shrub and herbaceous layers are complex, providing a diversity of vertical strata. Woody species are of sufficient size and density to provide future woody debris to stream or floodplain. Litter layer is neither lacking nor extensive.	

General: Vegetation structure shows minor alterations from natural conditions.		
Marshes: cattail and bulrush density may prevent animal movement in some areas of the wetland, but not throughout. ***Meadows:*** grazing and mowing have minor effects. ***Playas:*** natural areas of bare ground are still prevalent, though non-native or weedy species may be encroaching.	AA is characterized by a moderate array of nested or interspersed zones with no single dominant zone, though some structural patches (especially open zones) may be missing. Canopy still heterogeneous in age or size, but may be missing some age classes. Vertical strata may be somewhat less complex than natural conditions. Woody debris or litter may be somewhat lacking.	**B**
General: Vegetation structure is moderately altered from natural conditions.		
Marshes: cattail and bulrush density may prevent animal movement in half or more of the wetland. ***Meadows:*** grazing and mowing have moderate effects. ***Playas:*** natural areas of bare ground are present, but non-native or weedy species have filled in many area.	AA is characterized by a simple array of nested or interspersed zones. One zone may dominate others. Vertical strata may be moderately less complex than natural conditions. Site may be denser than natural conditions (due to non-native woody species) or may be more open and decadent. Woody debris or litter may be moderately lacking.	**C**
General: Vegetation structure is greatly altered from natural conditions.		
Marshes: cattail and bulrush density prevent animal movement throughout the wetland. ***Meadows:*** grazing and mowing greatly affect the structure of the vegetation and prevalence of litter. ***Playas:*** natural areas of bare ground are absent due to an abundance of non-native or weedy species.	AA is characterized by one dominant zone and several expected structural patches or vertical strata are missing. Site is either extremely dense with non-native woody species or open with predominantly decadent or dead trees. Woody debris and/or litter may be absent entirely or may be excessive due to decadent trees.	**D**

V5. REGENERATION OF NATIVE WOODY SPECIES		**V6. COARSE AND FINE WOODY DEBRIS**	
Select the statement that best describes the **regeneration of native woody species** within the AA.		Select the statement that best describes **coarse and fine woody debris** within the AA.	
Woody species are naturally uncommon or absent.	**NA**	There are no obvious inputs of woody debris or woody species are naturally uncommon.	**NA**
All age classes of *native* woody species present. Native tree saplings /seedlings and shrubs common to the type present in expected amounts and diversity. Regeneration in obvious.	**A**	AA characterized by moderate amount of coarse and fine woody debris, relative to expected conditions. There is wide size-class diversity of standing snags and downed logs in various stages of decay. For riverine wetlands, debris is sufficient to trap sediment, but does not inhibit stream flow. For non-riverine wetlands, woody debris provides structural complexity, but does not overwhelm the site.	**A/B**
Age classes of *native* woody species restricted to mature individuals and young sprouts. Middle age groups appear to be absent or there is some other indication that regeneration is moderately impacted.	**B**		
Native woody species comprised of mainly mature individuals OR mainly evenly aged young sprouts that choke out other vegetation. Regeneration is obviously impacted. Site may contain Russian Olive and/or Salt Cedar.	**C**	AA characterized by small amounts of woody debris OR debris is somewhat excessive. For riverine wetlands, lack of debris may affect stream temperatures and reduce available habitat.	**C**
Native woody species predominantly consist of decadent or dying individuals OR are absent from an area that should be wooded. Site may be dominated by Russian Olive / Salt Cedar.	**D**	AA lacks woody debris, even though inputs are available.	**D**

Vegetation structure comments (including regeneration and woody debris):

Site ID / Name: _____ Date: _____

HYDROLOGY METRICS

H1. WATER SOURCE

Check off all *major* water sources in the table to the right. Select the statement below that best describes the **water sources** feeding the AA during the growing season.	_____ Overbank flooding _____ Alluvial aquifer _____ Groundwater discharge _____ Natural surface flow _____ Precipitation _____ Snowmelt	_____ Irrigation via direct application _____ Irrigation via seepage _____ Irrigation via tail water run-off _____ Urban run-off / culverts _____ Pipes (directly feeding wetland) _____ Other:

Water sources are natural. Site hydrology is fed by precipitation, groundwater, natural runoff, or natural flow from an adjacent freshwater body. The system may naturally lack water at times, even for several years. There is no indication of direct artificial water sources, either point sources or non-point sources. Land use in the local watershed is primarily open space or low density, passive use with little irrigation.	**A**
Water sources are mostly natural, but also include occasional or small amounts of inflow from anthropogenic sources. Indications of anthropogenic sources include developed land or irrigated agriculture that comprises < 20% of the immediate drainage area, some road runoff, small storm drains or other minor point source discharges. No large point sources control the overall hydrology.	**B**
Water sources are moderately impacted by anthropogenic sources, but are still a mix of natural and non-natural sources. Indications of moderate contribution from anthropogenic sources include developed land or irrigated agriculture that comprises 20–60% of the immediate drainage area or moderate point source discharges into the wetland, such as many small storm drains or a few large ones or many sources of irrigation runoff. The key factors to consider are whether the wetland is located in a landscape position that supported wetlands before irrigation / development *AND* whether the wetland is still connected to its natural water source (e.g., modified ponds on a floodplain that are still connected to alluvial aquifers or natural stream channels that now receive substantial irrigation return flows).	**C**
Water sources are primarily from anthropogenic sources (e.g., urban runoff, direct irrigation, pumped water, artificially impounded water, or another artificial hydrology). Indications of substantial artificial hydrology include developed or irrigated agricultural land that comprises > 60% of `the immediate drainage basin of the AA, or the presence of major drainage point source discharges that obviously control the hydrology of the AA. The key factors to consider are whether the wetland is located in a landscape position that likely never supported a wetland prior to human development *OR* did support a wetland, but is now disconnected from its natural water source. The reason the wetland exists is because of direct irrigation, irrigation seepage, irrigation return flows, urban storm water runoff, or direct pumping.	**D**
Water source comments:	

H2. HYDROPERIOD

Select the statement below that best describes the **hydroperiod** within the AA (extent and duration of inundation and/or saturation). Search the AA and 500 m envelope for hydrologic stressors (see list on following pages). Use best professional judgment to determine the overall condition of the hydroperiod. For some wetlands, this may mean that water is being channelized or diverted away from the wetland. For others, water may be concentrated or increased. *Please add comments on next page.*

Hydroperiod is characterized by natural patterns of inundation/saturation and drawdown and/or flood frequency, duration, level and timing. There are no major hydrologic stressors that impact the natural hydroperiod. Riparian channels are characterized by equilibrium conditions with no evidence of severe aggradation or degradation indicative of altered hydrology.	**A**
Hydroperiod inundation and drying patterns deviate slightly from natural conditions due to presence of stressors such as: flood control/water storage dams upstream; berms or roads at/near grade; minor pugging by livestock; small ditches or diversions removing water; or minor flow additions from irrigation return flow or storm water runoff. Outlets may be slightly constricted, but not to significantly slow outflow. Riparian channels may have some sign of aggradation or degradation, but approach equilibrium conditions. Playas are not significantly impacted pitted or dissected. *If wetland is artificially controlled,* the management regime closely mimics a natural analogue (it is very unusual for a purely artificial wetland to be rated in this category).	**B**
Hydroperiod inundation and drying patterns deviate moderately from natural conditions due to presence of stressors such as: flood control/water storage dams upstream or downstream that moderately effect hydroperiod; two lane roads; culverts adequate for base stream flow but not flood flow; moderate pugging by livestock that could channelize or divert water; shallow pits within playas; ditches or diversions 1–3 ft. deep; or moderate flow additions. Outlets may be moderately constricted, but flow is still possible. Riparian channels may show distinct signs of aggradation or degradation. *If wetland is artificially controlled,* the management regime approaches a natural analogue. Site may be passively managed, meaning that the hydroperiod is still connected to and influenced by natural high flows timed with seasonal water levels.	**C**

Hydroperiod inundation and drawdown patterns deviate substantially from natural conditions from high intensity alterations such as: significant flood control / water storage das upstream or downstream; a 4-lane highway; large dikes impounding water; diversions > 3ft. deep that withdraw a significant portion of flow, deep pits in playas; large amounts of fill; significant artificial groundwater pumping; or heavy flow additions. Outlets may be significantly constricted, blocking most flow. Riparian channels may be concrete or artificially hardened. *If wetland is artificially controlled,* the site is actively managed and not connected to any natural season fluctuations.	**D**

Hydroperiod comments:

H3. HYDROLOGIC CONNECTIVITY

Select the statement below that best describes the degree to which **hydrology within the AA is connected to the larger landscape** throughout the year, but particularly at times of high water. Consider the effect of impoundments, entrenchment, or other obstructions to connectivity that occur within the surrounding landscape, if those impoundments clearly impact the AA.

Marsh / Meadow variant	***Playa variant***	***Riverine / Riparian variant***	
No unnatural obstructions to lateral or vertical movement of surface or ground water. Rising water in the site has unrestricted access to adjacent upland, without levees, excessively high banks, artificial barriers, or other obstructions to the lateral movement of flood flows.	Surrounding land cover / vegetation does not interrupt surface flow. No artificial channels feed water to playa.	Completely connected to floodplain (backwater sloughs and channels). No geomorphic modifications made to contemporary floodplain. Channel is not entrenched.	**A**
Minor restrictions to the lateral or vertical movement of surface and ground water by unnatural features such as levees, road grades or excessively high banks. Up to 25% of the site may be restricted by barriers to drainage. Restrictions may be intermittent along the margins of the AA, or they may occur only along one bank or shore. Flood flows may exceed the impoundments, but drainage back into the wetland may be incomplete due to the impoundments.	Surrounding land cover / vegetation may interrupt a minor amount of surface flow. Artificial channels may feed minor amounts of excess water to playa.	Minimally disconnected from floodplain. Up to 25% of stream banks may be affected by dikes, rip rap, and/or elevated culverts. Channel may be somewhat entrenched, but overbank flow occurs during most floods.	**B**
Moderate restrictions to the lateral or vertical movement of surface and ground water by unnatural features such as levees, road grades or excessively high banks. Between 25–75% of the site may be restricted by barriers to drainage. Flood flows may exceed the impoundments, but drainage back into the wetland may be incomplete due to the impoundments.	Surrounding land cover / vegetation may interrupt a moderate amount of surface flow. Artificial channels may feed moderate amounts of excess water to playa.	Moderately disconnected from floodplain due to multiple geomorphic modifications. Between 25-75% of stream banks may be affected by bikes, rip rap, concrete, and/or elevated culverts. Channel may be moderately entrenched and disconnected from the floodplain except in large floods.	**C**
Essentially no hydrologic connection to adjacent landscape. Most or all stages may be contained within artificial banks, levees, or comparable features. Greater than 75% of the site is restricted by barriers to drainage.	Surrounding land cover / vegetation may dramatically restrict surface flow. Artificial channels may feed significant amounts of excess water to playa.	Channel is severely entrenched and entirely disconnected from the floodplain. More than 75% of stream banks may be affected by dikes, rip rap, concrete and/or elevated culverts. Overbank flow never occurs or only in severs floods.	**D**

Hydrologic connectivity comments:

PHYSIOCHEMICAL METRICS

S1. SUBSTRATE / SOIL DISTURBANCE

Select the statement below that best describes disturbance to the substrate or soil within the AA. For playas, the most significant substrate disturbance is sedimentation or unnaturally filling, which prevents the system's ability to pond after heavy rains. For other wetland types, disturbances may lead to bare or exposed soil and may increase ponding or channelization where it is not normally. For any wetland type, consider the disturbance relative to what is expected for the system.

No soil disturbance within AA. Little bare soil OR bare soil areas are limited to naturally caused disturbances such as flood deposition or game trails OR soil is naturally bare (e.g., playas). No pugging, soil compaction, or sedimentation.	**A**
Minimal soil disturbance within AA. Some amount of bare soil, pugging, compaction, or sedimentation present due to human causes, but the extent and impact are minimal. The depth of disturbance is limited to only a few inches and does not show evidence of altering hydrology. Any disturbance is likely to recover within a few years after the disturbance is removed.	**B**
Moderate soil disturbance within AA. Bare soil areas due to human causes are common and will be slow to recover. There may be pugging due to livestock resulting in several inches of soil disturbance. ORVs or other machinery may have left some shallow ruts. Sedimentation may be filling the wetland. Damage is obvious, but not excessive. The site could recover to potential with the removal of degrading human influences and moderate recovery times.	**C**
Substantial soil disturbance within AA. Bare soil areas substantially degrade the site and have led to altered hydrology or other long-lasting impacts. Deep ruts from ORVs or machinery may be present, or livestock pugging and/or trails are widespread. Sedimentation may have severely impacted the hydrology. The site will not recover without active restoration and/or long recovery times.	**D**

Substrate / soil comments and photo #'s:

S2. SURFACE WATER TURBIDITY / POLLUTANTS

Select the statement that best describes the **turbidity or evidence or pollutants** in surface water within the AA.

No open water in AA	**NA**
No visual evidence of turbidity or other pollutants.	**A**
Some turbidity in water (such as turbidity caused by high flows or naturally occurring in playas) OR presence of other pollutants, but limited to small and localized areas within the wetland. Water may be slightly cloudy.	**B**
Water is cloudy or has unnatural oil sheen, but the bottom is still visible. *Note: If the sheen breaks apart when you run your finger through it, it is a natural bacterial process and not water pollution.*	**C**
Water is milky and/or muddy or has unnatural oil sheen. The bottom is difficult to see. *Note: If the sheen breaks apart when you run your finger through it, it is a natural bacterial process and not water pollution.*	**D**

S3. ALGAL GROWTH

Select the statement that best describes **algal growth** within surface water in the AA. Exclude *Chara* (multicellular algae) in cover estimate.

No open water in AA or evidence of open water.	**NA**
Water is clear with minimal algal growth.	**A**
Algal growth is limited to small and localized areas of the wetland. Water may have a greenish tint or cloudiness.	**B**
Algal growth occurs in moderate to large patches throughout the AA. Water may have a moderate greenish tint or sheen.	**C**
Algal mats are extensive, blocking light to the bottom. Water may have a strong greenish tint and the bottom is difficult to see.	**D**

Water quality comments and photo #'s:

Turbidity and algal growth may be natural depending on recent weather patterns and flow timing (i.e., higher flows are often more turbid). Please rank the system as you see it, regardless of whether the conditions are natural. Include good notes and take photos.

Site ID / Name: _____ Date: _____

SIZE METRICS

Z1. COMPARATIVE SIZE

Select the statement below that best describes the **absolute size** of the wetland, as compared with others of its type.

Meadows and Marshes	*Playas and Fens*	*Riparian Areas*	
>10 hectares (>25 acres)	>2 hectares (>5 acres)	>5 km (>3 miles)	**A**
2–10 hectares (25 acres)	0.5–2 hectares (5 acres)	1–5 km (3 miles)	**B**
0.5–2hectares (5 acres)	0.1–0.5 hectares (1 acre)	0.1–1 km (0.6 mile)	**C**
<0.5 hectare (<1 acre)	<0.1 hectare (<0.25 acre)	<0.1 km (<0.06 mile)	**D**

Comparative size comments:

Z2. CHANGE IN SIZE

Select the statement below that best describes the **change in size** of the wetland.

Occurrence is at, or only minimally reduced (<15%) from its original, natural extent, and has not been artificially reduced in size.	**A**
Occurrence is only somewhat reduced (15-10%) from its original natural extent.	**B**
Occurrence is modestly reduced (10-30%) from its original, natural extent.	**C**
Occurrence is substantially reduced (>30%) from its original, natural extent.	**D**

Change in size comments:

Land Use Index Worksheet

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

Buffer Width Worksheet

1: _____ 5: _____

2: _____ 6: _____

3: _____ 7: _____

4: _____ 8: _____

Average width: _____

Site ID / Name: _____ Date: _____

2015 COLORADO ECOLOGICAL INTEGRITY ASSESSMENT (EIA) –STRESSOR CHECKLIST

Stressors: *direct threats*; "the proximate (human) activities or processes that have caused, are causing, or may cause the destruction, degradation, and/or impairment of biodiversity and natural processes" or altered disturbance regime (e.g. flooding, fire, or browse).

Some Important Points about Stressors Checklists:

1. The Stressors Checklist must be completed for the 500 m envelop surrounding the AA (Landscape) and for the 0.5 ha AA (Veg, Hydro, Soils). Rely on imagery in combination with what you can field check.
2. Assess stressors in the 500 m envelope for their effects on land surrounding the AA (*NOT how they may impact the AA*)
3. Stressors for Vegetation, Soils, and Hydrology are assessed across the full 0.5 ha assessment area (AA)
4. Severity has been pre-assigned for many stressors. If the severity differs from the pre-assigned rating, cross it out and note the true severity. If there is more than one pre-assigned value, circle the appropriate value.
5. To comment, note the stressor number before writing comments.

SCOPE of Threat (% of AA or Buffer affected by direct threat)	
1 = Small	Affects a small portion (1-10%) of the AA or landscape
2 = Restricted	Affects some (11-30%) of the AA or landscape
3 = Large	Affects much (31-70%) of the AA or landscape
4 = Pervasive	Affects all or most (71-100%) of the AA or landscape
SEVERITY of Threat within the defined Scope (degree of degradation to AA or Buffer)	
1 = Slight	Likely to only slightly degrade/reduce
2 = Moderate	Likely to moderately degrade/reduce
3 = Serious	Likely to seriously degrade/reduce
4 = Extreme	Likely to extremely degrade/destroy or eliminate

		500 m Envelope Landscape			ASSESSMENT AREA (0.5 ha)									
					Vegetation			Soil / Substrate			Hydrology			
	STRESSORS CHECKLIST	Scope	Severity	IMPACT	Scope	Severity	IMPACT	Scope	Severity	IMPACT	Scope	Severity	IMPACT	Comments
	1. Residential, recreational buildings, associated pavement		3											
D	2. Industrial, commercial, military buildings, associated pavement		4											
E	3. Oil and gas wells and surrounding footprint		4											
V	4. Roads (gravel=2, paved=3, highway=4), railroad=3		2, 3, 4											
E	5. Sports field, golf course, urban parkland, expansive lawns		2											
L	6. Row-crop agriculture, orchard, nursery		3											
O	7. Hay field, fallow field		2, 3											
P	8. Utility / power line corridor		1, 2, 3			1, 2, 3								
	9. Other [specify]:													
R	10. Low impact recreation (hunting, fishing, camping, hiking, bird-watching, canoe/kayak)		1			1								
E	11. High impact recreation (ATV, mountain biking, motor boats)		3			3								
C	12. Other [specify]:													
	13. Tree resource extraction (clear cut=3 or 4, selective cut= 2 or 3)		2, 3, 4			2, 3, 4								
	14. Vegetation management (cutting, mowing)		2			2								
V	15. Livestock grazing, excessive herbivory by native species (ungulates, prairie dogs) (low=1, mod=2, high=3)		1, 2, 3			1, 2, 3								
E	16. Insect pest damage (low=1, mod=2, high=3)		1, 2, 3			1, 2, 3								
G	17. Invasive plant species (see noxious weed list)		3			3								
	18. Direct application of agricultural chemicals, herbicide spraying		2, 3			2, 3								
	19. Other [specify]:													
N	20a. Evidence of recent fire (low=1, mod=2, high=3)		1, 2, 3			1, 2, 3								
A	20b. Recent beaver dam blowout		1, 2			1, 2								
T	21. Other [specify]:													

Site ID / Name: _____ Date: _____

		500 m Envelope Landscape			ASSESSMENT AREA (0.5 ha)									
					Vegetation			Soil / Substrate			Hydrology			
	STRESSORS CHECKLIST	Scope	Severity	IMPACT	Scope	Severity	IMPACT	Scope	Severity	IMPACT	Scope	Severity	IMPACT	Comments
SOILS	22. Excessive sediment or organic debris (inputs from recently logged sites, sedimentation in playas)													
	23. Excessive erosion or loss of organic matter (gullying, decay of organic soils)													
	24. Trash or refuse dumping													
	25. Filling or dumping of sediment (spoils from excavation)													
	26. Substrate removal (excavation)													
	27. Indirect soil disturbance (compaction or trampling by livestock, human use, vehicles)													
	28. Direct soil disturbance (grading, compaction, plowing, discing, deeply dug fire lines)													
	29. Physical resource extraction (rock, sand, gravel, minerals, etc.)													
	30. Obvious excess salinity (dead or stressed plants, salt crusts)													
	31. Other [specify]:													
HYDROLOGY	32. PS discharge (waste water treatment, factory discharge, septic)													
	33. NPS discharge (urban / storm water runoff)													
	34. NPS discharge (agricultural runoff, excess irrigation, feedlots, excess manure)													
	35. NPS discharge (mine runoff, discharge from oil and gas)													
	36. Large dams / reservoirs													
	37. Impoundments, berms, dikes, levees that hold water in or out													
	38. Canals, diversions, ditches, pumps that move water in or out													
	39. Excavation for water retention (gravel ponds, pitted playas)													
	40. Groundwater extraction (few small wells=2, extensive extraction cause a lowered water table=4)													
	41. Flow obstructions (culverts, paved stream crossings)													
	42. Engineered channel (riprap, armored channel bank, bed)													
	43. Control of flow and energy (weir/drop structure, dredging)													
	44. Other [specify]:													
Stressors Very Minimal or Not Evident (check box, if true)		☐			☐			☐			☐			
STRESSOR RATING BY CATEGORY (Envelope, Veg, Soils, Hydro)		Score:	Rating:		Score:	Rating:		Score:	Rating:		Score:	Rating:		HIS Score: / HIS Rating:
OVERALL HUMAN STRESSOR INDEX (HSI) – use category weights		0.3			0.3			0.1			0.3			

Threat Impact Calculator		Scope			
		Pervasive = 4	Large = 3	Restricted = 2	Small = 1
Severity	Extreme = 4	VERY HIGH = 10	High = 7	*Medium = 4*	Low = 1
	Serious = 3	High = 7	High = 7	*Medium = 4*	Low = 1
	Moderate = 2	*Medium = 4*	*Medium = 4*	Low = 1	Low = 1
	Slight = 1	Low = 1	Low = 1	Low = 1	Low = 1

Category / HSI Roll-up Formulas	
Score	Rating
10+	Very High
7 – 9.9	High
4 – 6.9	Medium
1 – 3.9	Low
0 – 0.9	Absent

APPENDIX B.2: FUNCTIONAL ASSESSMENT OF COLORADO WETLANDS (FACWET) FIELD FORM

ADMINISTRATIVE CHARACTERIZATION

General Information		Date of Evaluation:	
Site Name or ID:		Project Name:	
404 or Other Permit Application #:		Applicant Name:	
Evaluator Name(s):		Evaluator's professional position and organization:	

Location Information:			
Site Coordinates (Decimal Degrees, e.g., 38.85, -104.96):		Geographic Datum Used (NAD 83):	
		Elevation	
Location Information:			
Associated stream/water body name:		Stream Order:	
USGS Quadrangle Map:		Map Scale: (Circle one)	1:24,000 1:100,000 Other 1:
Sub basin Name (8 digit HUC):		Wetland Ownership:	

Project Information:			
This evaluation is being performed at: *(Check applicable box)*	☐ *Project Wetland* ☐ *Mitigation Site*	Purpose of Evaluation (check all applicable):	☐ *Potentially Impacted Wetlands* ☐ *Mitigation; Pre-construction* ☐ *Mitigation; Post-construction* ☐ *Monitoring* ☐ *Other (Describe)*
Intent of Project: *(Check all applicable)*	☐ Restoration	☐ Enhancement	☐ Creation

Total Size of Wetland Involved: (Record Area, Check and Describe Measurement Method Used)	ac.	☐ Measured ☐ Estimated					
Assessment Area (AA) Size (Record Area, check appropriate box. Additional spaces are used to record acreage when more than one AA is included in a single assessment)	ac.	☐ Measured	ac.	ac.	ac.	ac.
		☐ Estimated	ac.	ac.	ac.	ac.
Characteristics or Method used for AA boundary determination:						

Notes:	

ECOLOGICAL DESCRIPTION 1

Special Concerns

Check all that apply

- ☐ Organic soils including Histosols or Histic Epipedons are present in the AA (i.e., AA includes core fen habitat).
- ☐ Project will directly impact organic soil portions of the AA including areas possessing either Histosol soils or histic epipedons.
- ☐ Organic soils are known to occur anywhere within the contiguous wetland of which the AA is part.
- ☐ The wetland is a habitat oasis in an otherwise dry or urbanized landscape?
- ☐ Federally threatened or endangered species are **KNOWN** to occur in the AA? List Below.

_____

_____

- ☐ Federally threatened or endangered species are **SUSPECTED** to occur in the AA?

_____

_____

_____

- ☐ Species of concern according to the Colorado Natural Heritage (CNHP) are known to occur in the AA?
- ☐ The site is located within a potential conservation area or element occurrence buffer area as determined by CNHP?
- ☐ Other special concerns (please describe)

_____

HYDROGEOMORPHIC SETTING

- ☐ AA wetland maintains its fundamental natural hydrogeomorphic characteristics
- ☐ AA wetland has been subject to change in HGM classes as a result of anthropogenic modification
  If the above is checked, please describe the original wetland type if discernable using the table below.
- ☐ AA wetland was created from an upland setting.

Current Conditions

Describe the hydrogeomorphic setting of the wetland by circling all conditions that apply.

HGM Setting	**Water source**	Surface flow	Groundwater	Precipitation	Unknown	
	Hydrodynamics	Unidirectional	Vertical	Bi-directional		
	Wetland Gradient	0 - 2%	2-4%	4-10%	>10%	
	# Surface Inlets	Over-bank	0	1	2	3	>3
	# Surface Outlets	0	1	2	3	>3
	Geomorphic Setting (Narrative Description. Include approx. stream order for riverine)					
	HGM class	Riverine	Slope	Depressional	Lacustrine	

Historical Conditions

Previous wetland typology	**Water source**	Surface flow	Groundwater	Precipitation	Unknown
	Hydrodynamics	Unidirectional	Vertical		
	Geomorphic Setting (Narrative Description)				
	Previous HGM Class	Riverine	Slope	Depressional	Lacustrine

Notes (include information on the AA's HGM subclass and regional subclass):

ECOLOGICAL DESCRIPTION 2

Vegetation Habitat Description

US FWS habitat classification according as reported in Cowardin et al. (1979).

System	Subsystem	Class	Subclass	Water Regime	Other Modifiers	% AA
Lacustrine	Littoral; Limnoral	Rock Bot. (RB) Uncon Bottom(UB) Aquatic Bed(AB) Rocky Shore(RS) Uncon Shore(US) Emergent(EM) Shrub-scrub(SS) Forested (FO)	Floating vascular; Rooted vascular; Algal; Persistent; Non-Persistent; Broad-leaved deciduous; Needle-leaved evergreen; Cobble - gravel; Sand; Mud; Organic	**Examples** Temporarily flooded(A); Saturated(B); Seasonally flooded(C); Seas.-flood./sat.(E); Semi-Perm. flooded(F); Intermittently exposed(G); Artificially flooded(K); Sat./semiperm./Seas. (Y); Int. exposed/permenant(Z)	Hypersaline(7) ; Eusaline(8); Mixosaline(9); Fresh(0); Acid(a); Circumneutral(c); Alkaline/calcareous(i); Organic(g); Mineral(n); Beaver(b); Partially Drained/ditched(d); Farmed(f); Diked/impounded(h); Artificial Substrate(r); Spoil(s); Excavated(x)	
Palustrine	Palustrine					
Riverine	Lower perennial; Upper perennial; Intermittent					

Site Map

Scale: 1 sq. =

Draw a sketch map of the site including relevant portions of the wetland, AA boundary, structures, habitat classes, and other significant features.

Variable 1: Habitat Connectivity

The Habitat Connectivity Variable is described by two sub-variables – Neighboring Wetland and Riparian Habitat Loss and Barriers to Migration and Dispersal. These sub-variables were treated as independent variables in FACWet Version 2.0. The merging of these variables makes their structure more consistent with that of other composite variables in FACWet. The new variable configuration also makes this landscape variable more accurately reflect the interactions amongst aquatic habitats in Colorado's agricultural and urbanized landscapes, which have a naturally low density of wetlands. The two Habitat Connectivity Sub-variables are scored in exactly the same manner as their FACWet 2.0 counterparts, as described below. The Habitat Connectivity Variable score is simply the arithmetic average of the two sub-variable scores which is entered on the second page of the Variable 1 data form. If there is little or no wetland or riparian habitat in the Habitat Connectivity Envelope (defined below), then Sub-variable 1.1 is not scored.

SV 1.1 - Neighboring Wetland and Riparian Habitat Loss
(Do not score if few or no wetlands naturally exist in the HCE)

This sub-variable is a measure of how isolated from other naturally-occurring wetlands or riparian habitat the AA has become as the result of habitat destruction. To score this sub-variable, estimate the percent of naturally-occurring wetland/riparian habitat that has been lost (by filling, draining, development, or whatever means) within the 500-meter-wide belt surrounding the AA. This zone is called the Habitat Connectivity Envelope (HCE). In most cases the evaluator must use best professional judgment to estimate the amount of natural wetland loss. Historical photographs, National Wetland Inventory (NWI) maps, hydric soil maps can be helpful in making these determinations. Floodplain maps are especially valuable in river-dominated regions, such as the Front Range urban corridor. Evaluation of landforms and habitat patterns in the context of perceivable land use change is used to steer estimates of the amount of wetland loss within the HCE.

Rules for Scoring:

1. On the aerial photo, create a 500 m perimeter around the AA.
2. The area within this perimeter is the **Habitat Connectivity Envelope (HCE)**.
3. Within the HCE, outline the current extent of naturally occurring wetland and riparian habitat. Do not include habitats such as excavated ponds or reservoir induced fringe wetlands.
4. Outline the historical extent of wetland and riparian habitats (i.e., existing natural wetlands plus those that have been destroyed).

   - Use your knowledge of the history of the area and evident land use change to identify where habitat losses have occurred. Additional research can be utilized to increase the accuracy of this estimate including consideration of floodplain maps, historical aerial photographs, soil maps, etc.

5. Calculate the area of existing and historical wetlands. Divide the area of existing wetland by the total amount of existing and historical wetland and riparian habitat, and determine the variable score using the guidelines below. Enter sub-variable score at the bottom of p.2 of the Habitat Connectivity data form.

Variable Score	Condition Grade	Scoring Guidelines
1.0 - 0.9	***A*** *Reference Standard*	Wetland losses are absent or negligible or there is no evidence to suggest the native landscape within the HCE historically contained other wetland habitats
<0.9 - 0.8	***B*** *Highly Functioning*	More than 80% of historical wetland habitat area within the HCE is still present (less than 20% of habitat area lost).
<0.8 - 0.7	***C*** *Functioning*	80 to 60% of historical wetland habitat area within the HCE is still present (20% to 40% of habitat area lost).
<0.7 - 0.6	***D*** *Functioning Impaired*	Less than 60 to 25% of historical wetland habitat area within the HCE is still present (more than 40 to 75% of habitat area lost).
<0.6	***F*** *Non-functioning*	Less than 25% of the historical wetland habitat area within the HCE still in existence (more than 70% of habitat lost).

Notes:

Variable 1: Habitat Connectivity p. 2

SV 1.2: Migration/Dispersal Barriers

This sub-variable is intended to rate the degree to which the AA has become isolated from existing neighboring wetland and riparian habitat by artificial barriers that inhibit migration or dispersal of organisms. On the aerial photograph, identify the man-made barriers within the HCE that intercede between the AA and surrounding wetlands and riparian areas, and identify them by type on the stressor list. Score this variable based on the barriers' impermeability to migration and dispersal and the amount of surrounding wetland/riparian habitat they affect.

Rules for Scoring:

1. On the aerial photo, outline **all** existing wetland and riparian habitat areas within the HCE. This includes naturally occurring habitats, as well as those purposefully created or induced by land use change.

2. Identify artificial barriers to dispersal and migration of organisms within the HCE that intercede between the AA and surrounding habitats. Mark the stressors present with a check in the first column and describe the general nature, severity and extent of each. List additional stressors in empty rows at the bottom of the table and explain.

3. Considering the composite effect of all of identified barriers to migration and dispersal (i.e., stressors), assign an overall variable score using the scoring guidelines.

Stressors = artificial barriers	✔	Stressors	Comments/description
		Major Highway	
		Secondary Highway	
		Tertiary Roadway	
		Railroad	
		Bike Path	
		Urban Development	
		Agricultural Development	
		Artificial Water Body	
		Fence	
		Ditch or Aqueduct	
		Aquatic Organism Barriers	

Variable Score	Condition Grade	Scoring Guidelines
1.0 - 0.9	***A*** *Reference Standard*	No appreciable barriers exist between the AA and other wetland and riparian habitats in the HCE; or there are no other wetland and riparian areas in the HCE.
<0.9 - 0.8	***B*** *Highly Functioning*	Barriers impeding migration/dispersal between the AA and up to 33% of surrounding wetland/riparian habitat highly permeable and easily passed by most organisms. Examples could include gravel roads, minor levees, ditches or barbed-wire fences. More significant barriers (see "functioning category below) could affect migration to up to 10% of surrounding wetland/riparian habitat.
<0.8 - 0.7	***C*** *Functioning*	Barriers to migration and dispersal retard the ability of many organisms/propagules to pass between the AA and up to 66% of wetland/riparian habitat. Passage of organisms and propagules through such barriers is still possible, but it may be constrained to certain times of day, be slow, dangerous or require additional travel. Busy two-lane roads, culverted areas, small to medium artificial water bodies or small earthen dams would commonly rate a score in this range. More significant barriers (see "functioning impaired" category below) could affect migration to up to 10% of surrounding wetland/riparian habitat.
<0.7 - 0.6	***D*** *Functioning Impaired*	Barriers to migration and dispersal preclude the passage of some types of organisms/propagules between the AA and up to 66% of surrounding wetland/riparian habitat. Travel of those animals which can potential negotiate the barrier are strongly restricted and may include a high chance of mortality. Up to 33% of surrounding wetland/riparian habitat could be functionally isolated from the AA.
<0.6	***F*** *Non-functioning*	AA is essentially isolated from surrounding wetland/riparian habitat by impermeable migration and dispersal barriers. An interstate highway or concrete-lined water conveyance canal are examples of barriers which would generally create functional isolation between the AA and wetland/riparian habitat in the HCE.

SV 1.1 Score	
SV 1.2 Score	

Add SV 1.1 and 1.2 scores and divide by two to calculate variable score

Variable 1 Score [ ]

Variable 2: Contributing Area

The AA's Contributing Area is defined as the 250-meter-wide zone surrounding the perimeter of the AA. This variable is a measure of the capacity of that area to support characteristic functions of high quality wetland habitat. Depending on its condition, the contributing area can help maintain wetland condition or it can degrade it. Contributing Area condition is evaluated by considering the AA's Buffer and its Surrounding Land Use. Buffers are strips or patches of more-or-less natural upland and/or wetland habitat more than 5m wide. Buffers are contiguous with the AA boundary and they intercede between it and more intensively used lands. The AA Buffer is characterized with three sub-variables: Buffer Condition, Buffer Extent, and Average Buffer Width. The Surrounding Land Use Sub-variable considers changes within the Contributing Area that limit its capacity to support characteristic wetland functions. Many of the acute, on-site effects of land use change in the Contributing Area are specifically captured by Variables 3 - 8.

Rules for Scoring:

1. Delimit the Contributing Area on an aerial photograph as the zone within 250 meters of the outer boundary of the AA.
2. Evaluate and then rate the Buffer Condition sub-variable using the scoring guidelines. Record the score in the cell provided on the datasheet.
3. Indicate on the aerial photograph zones surrounding the AA which have ≥5m of buffer vegetation and those which do not.
4. Calculate the percentage of the AA which has a Buffer and record the value where indicated on the data sheet.
5. Rate the *Buffer Extent* Sub-variable using the scoring guidelines.
6.Determine the average Buffer width by drawing a line perpendicularly from the AA boundary to the outer extent of the buffer habitat. Measure line length and record its value on the data sheet. Repeat this process until a total of 8 lines have been sampled.
7. Calculate the average buffer width and record value on the data form. Then determine the sub-variable score using the scoring guidelines.
8.Score the Surrounding Land Use sub-variable by recording land use changes on the stressor list that affect the capacity of the landscape to support characteristic wetland functioning.
9. Enter the **lowest** of the three Buffer sub-variable scores along with the Surrounding Land Use Sub-variable score in the Contributing Area Variable scoring formula at the bottom of p. 2 of the data form. The Contributing Area Variable is the average of the two sub-variable scores.

SV 2.1 - Buffer Condition

SV 2.1 - Buffer Condition Score

Subvariable Score	Condition Grade	Buffer Condition Scoring Guidelines
1.0 - 0.9	*Reference Standard*	Buffer vegetation is predominately native vegetation, human-caused disturbance of the substrate is not evident, and human visitation is minimal. Common examples: Wilderness areas, undeveloped forest and range lands.
<0.9 - 0.8	*Highly Functioning*	Buffer vegetation may have a mixed native-nonnative composition, but characteristic structure and complexity remain. Soils are mostly undisturbed or have recovered from past human disturbance. Little or only low-impact human visitation. Buffers with higher levels of substrate disturbance may be included here if the buffer is still able to maintain predominately native vegetation. Common examples: Dispursed camping areas in national forests, common in wildland parks (e.g. State Parks) and open spaces.
<0.8 - 0.7	*Functioning*	Buffer vegetation is substantially composed of non-native species. Vegetation structure may be somewhat altered, such as by brush clearing. Moderate substrate distrbance and compaction occurs, and small pockets of greater disturbance may exist. Common examples: City natural areas, mountain hay meadows.
<0.7 - 0.6	*Functioning Impaired*	Buffer vegetation is substantially composed of non-native species and vegetation structure has been strongly altered by the complete removal of one or more strata. Soil disturbance and the intensity of human visitation are generally high. Common examples: Open lands around resource extraction sites (e.g., gravel mines), clear cut logging areas, ski slopes.
<0.6	*Non-functioning*	Buffer is nearly or entirely absent.

SV 2.2 - Buffer Extent

Precent of AA with Buffer

SV 2.2 - Buffer Extent

Subvariable Score	Condition Class	% Buffer Scoring Guidelines
1.0 - 0.9	*Reference Standard*	90 - 100% of AA with Buffer
<0.9 - 0.8	*Highly Functioning*	70-90% of AA with Buffer
<0.8 - 0.7	*Functioning*	51-69% of AA with Buffer
<0.7 - 0.6	*Functioning Impaired*	26-50% of AA with Buffer
<0.6	*Non-functioning*	0-25% of AA with Buffer

Variable 2: Contributing Area (p. 2)

SV 2.3 - Average Buffer Width

Record measured buffer widths in the spaces below and average.

Buffer Width (m)									
Line #	1	2	3	4	5	6	7	8	Avg. Buffer Width (m)

SV 2.3 - Average Buffer Width Score

Subvariable Score	Condition Grade	Buffer Width Scoring Guidelines
1.0 - 0.9	*Reference Standard*	Average Buffer width is 190-250m
<0.9 - 0.8	*Highly Functioning*	Average Buffer width is 101-189m
<0.8 - 0.7	*Functioning*	Average Buffer width is 31-100m
<0.7 - 0.6	*Functioning Impaired*	Average Buffer width is 6-30m
<0.6	*Non-functioning*	Average Buffer width is 0-5m

SV 2.4 - Surrounding Land Use

SV 2.4 - Surrounding Land Use Score

Catalog and characterize land use changes in the surrounding landscape and score.

Stressors = Land Use Changes

✓	Stressors	Comments/description
	Industrial/commercial	
	Urban	
	Residential	
	Rural	
	Dryland Farming	
	Intensive Agriculture	
	Orchards or Nurseries	
	Livestock Grazing	
	Transportation Corridor	
	Urban Parklands	
	Dams/impoundments	
	Artificial Water body	
	Physical Resource Extraction	
	Biological Resource Extraction	

Variable Score	Condition Grade	Scoring Guidelines
1.0 - 0.9	***A*** *Reference Standard*	No appreciable land use change has been imposed Surrounding Landscape.
<0.9 - 0.8	***B*** *Highly Functioning*	Some land use change has occurred in the Surrounding Landscape, but changes have minimal effect on the the landscape's capacity to support characteristic aquatic functioning, either because land use is not intensive, for example haying, light grazing, or low intensity silviculture, or more substantial changes occur in approximately less than 10% of the area.
<0.8 - 0.7	***C*** *Functioning*	Surrounding Landscape has been subjected to a marked shift in land use, however, the land retains much of its capacity to support natural wetland function and it is not an overt source of pollutants or sediment. Moderate-intensity land uses such as dry-land farming, urban "green" corridors, or moderate cattle grazing would commonly be placed within this scoring range.
<0.7 - 0.6	***D*** *Functioning Impaired*	Land use changes within the Surrounding Landscape has been substantial including the a moderate to high coverage (up to 50%) of impermeable surfaces, bare soil, or other artificial surfaces; considerable in-flow urban runoff or fertilizer-rich waters common. Supportive capacity of the land has been greatly diminished but not totally extinguished. Intensively logged areas, low-density urban developments, some urban parklands and many cropping situations would
<0.6	***F*** *Non-functioning*	The Surrounding Landscape is essentially comletely developed or is otherwise a cause of severe ecological stress on wetland habitats. Commercial developments or highly urban landscapes generally rate a score of less than 0.6.

Buffer Score (Lowest score) **Surrounding Land Use**

([ ] + [ ]) ÷ 2 = **Variable 2 Score** [ ]

Variable 3: Water Source

This variable is concerned with ***up-gradient*** *hydrologic connectivity. It is a measure of impacts to the AA's water source, including the quantity and timing of water delivery, and the ability of source water to perform work such as sediment transport, erosion, soil pore flushing, etc. To score this variable, identify stressors that alter the source of water to the AA, and record their presence on the stressor list. Stressors can impact water source by depletion, augmentation, or alteration of inflow timing or hydrodynamics. This variable is designed to assess water quantity, power and timing, not water quality. Water quality will be evaluated in Variable 7.*

Scoring rules:

1. Use the stressor list and knowledge of the watershed to catalog type-specific impairments of the AA's water source. Mark the stressors present with a check in the first column and describe the general nature, severity and extent of each. List additional stressors in empty rows at the bottom of the table and explain.

2. Considering the composite effect of stressors on the water source, rate the condition of this variable with the aid of the scoring guidelines.

✔	Stressors	Comments/description
	Ditches or Drains (tile, etc.)	
	Dams	
	Diversions	
	Groundwater pumping	
	Draw-downs	
	Culverts or Constrictions	
	Point Source (urban, ind., ag.)	
	Non-point Source	
	Increased Drainage Area	
	Storm Drain/Urban Runoff	
	Impermeable Surface Runoff	
	Irrigation Return Flows	
	Mining/Natural Gas Extraction	
	Transbasin Diversion	
	Actively Managed Hydrology	

Variable Score	Condition Grade	Depletion	Augmentation
1.0 - 0.9	***A*** *Reference Standard*	Unnatural drawdown events minor, rare or non-existent, very slight uniform depletion, or trivial alteration of hydrodynamics.	Unnatural high-water events minor, rare or non-existent, slight uniform increase in amount of inflow, or trivial alteration of hydrodynamics.
<0.9 - 0.8	***B*** *Highly Functioning*	Unnatural drawdown events occasional, short duration and/or mild; or uniform depletion up to 20%; or mild to moderate reduction of peak flows or capacity of water to perform work.	Occasional unnatural high-water events, short in duration and/or mild in intensity; or uniform augmentation up to 20%; or mild to moderate increase of peak flows or capacity of water to perform work.
<0.8 - 0.7	***C*** *Functioning*	Unnatural drawdown events common and of mild to moderate intensity and/or duration; or uniform depletion up to 50%; or moderate to substantial reduction of peak flows or capacity of water to perform work.	Common occurrence of unnatural high-water events, of a mild to moderate intensity and/or duration; or uniform augmentation up to 50%; or moderate to substantial increase of peak flows or capacity of water to perform work.
<0.7 - 0.6	***D*** *Functioning Impaired*	Unnatural drawdown events occur frequently with a moderate to high intensity and/or duration; or uniform depletion up to 75%; or substantial reduction of peak flows or capacity of water to perform work. **Wetlands with actively managed or wholly artificial hydrology will usually score in this range or lower.**	Common occurrence of unnatural high-water events, some of which may be severe in nature or exist for a substantial portion of the growing season; or uniform augmentation more than 50% or capacity of water to perform work. **Wetlands with actively managed or wholly artificial hydrology will usually score in this range or**
<0.6	***F*** *Non-functioning*	Water source diminished enough to threaten or extinguish wetland hydrology in the AA.	Frequency, duration or magnitude of unnaturally high-water great enough to change the fundamental characteristics of the wetland.

Variable 3 Score [ ]

Variable 4: Water Distribution

This variable is concerned with hydrologic connectivity ***within*** *the AA. It is a measure of alteration to the spatial distribution of surface and groundwater within the AA. These alterations are manifested as local changes to the hydrograph and generally result from geomorphic modifications within the AA. To score this variable, identify stressors within the AA that alter flow patterns and impact the hydrograph of the AA, including localized increases or decreases to the depth or duration of the water table or surface water.*

Because the wetland's ability to distribute water in a characteristic fashion is fundamentally dependent on the condition of its water source, ***in most cases the Water Source variable score will define the upper limit Water Distribution score****. For example, if the Water Source variable is rated at 0.85, the Water Distribution score will usually have the potential to attain a maximum score of 0.85. Additional stressors within or outside the lower end of the AA effecting water distribution (e.g., ditches and levees) will reduce the score from the maximum value.*

Scoring rules:

1. Identify impacts to the natural distribution of water throughout the AA and catalog them in the stressor table.

2. Considering all of the stressors identified, assign an overall variable score using the scoring guidelines. In most cases, the Water Source variable score will set the upper limit for the Water Distribution score.

✔	Stressors	Comments/description
	Alteration of Water Source	
	Ditches	
	Ponding/Impoundment	
	Culverts	
	Road Grades	
	Channel Incision/Entrenchment	
	Hardened/Engineered Channel	
	Enlarged Channel	
	Artificial Banks/Shoreline	
	Weirs	
	Dikes/Levees/Berms	
	Diversions	
	Sediment/Fill Accumulation	

Variable Score	Condition Grade	Non-riverine	Riverine
1.0 - 0.9	***A*** *Reference Standard*	Little or no alteration has been made to the way in which water is distributed throughout the wetland. AA maintains a natural hydrologic regime.	Natural active floodplain areas flood on a normal recurrence interval. No evidence of alteration of flooding and subirrigation duration and intensity.
<0.9 - 0.8	***B*** *Highly Functioning*	Less than 10% of the AA is affected by *in situ* hydrologic alteration; or more widespread impacts result in less than a 2 in. (5 cm) change in mean growing season water table elevation.	Channel-adjacent areas have occasional unnatural periods of drying or flooding; or uniform shift in the hydrograph less than typical root depth.
<0.8 - 0.7	***C*** *Functioning*	Between 10 and 33% of the AA is affected by *in situ* hydrologic alteration; or more widespread impacts result in a 4 in. (5 cm) or less change in mean growing season water table elevation.	In channel-adjacent area, periods of drying or flooding are common; or uniform shift in the hydrograph near root depth.
<0.7 - 0.6	***D*** *Functioning Impaired*	33 to 66% of the AA is affected by *in situ* hydrologic alteration; or more widespread impacts result in a 6 in. (15 cm) or less change in mean growing season water table elevation. Water table behavior must still meet jurisdictional criteria to merit this rating.	Adjacent to the channel, unnatural periods of drying or flooding are the norm; or uniform shift in the hydrograph greater than root depth.
<0.6	***F*** *Non-functioning*	More than 66% of the AA is affected by hydrologic alteration which changes the fundamental functioning of the wetland system, generally exhibited as a conversion to upland or deep water habitat.	Historical active floodplain areas are almost never wetted from overbank flooding, and/or groundwater infiltration is effectively cut off.

Variable 4 Score [ ]

Variable 5: Water Outflow

This variable is concerned with ***down-gradient*** *hydrologic connectivity and the flow of water and water-borne materials and energy out of the AA. In particular it illustrates the degree to which the AA can support the functioning of down-gradient habitats. It is a measure of impacts that affect the hydrologic outflow of water including the passage of water through its normal low- and high-flow surface outlets, infiltration/groundwater recharge, and the energetic characteristics of water delivered to dependent habitats. In some cases, alteration of evapotranspiration rates may be significant enough of a factor to consider in scoring. Score this variable by identifying stressors that impact the means by which water is exported from the AA. To evaluate this variable focus on how water, energy and associated materials are exported out of the AA and their ability it support down-gradient habitats in a manner consistent with their HGM (regional) subclass.*

Because the wetland's ability to export water and materials in a characteristic fashion is to a very large degree dependent the condition of its water source, as with the Water Distribution variable, ***in most cases the Water Source variable score will define the upper limit Water Outflow score****.*

Scoring rules:

1. Identify impacts to the natural outflow of water from the AA and catalog them in the stressor table.

2.Considering all of the stressors identified, assign an overall variable score using the scoring guidelines. Take in to account the cumulative effect of stressors on the wetland's ability to export water and water-borne materials. In most cases the Water Source variable will set the upper limit for the Water Outflow score.

✔	Stressors	Comments/description
	Alteration of Water Source	
	Ditches	
	Dikes/Levees	
	Road Grades	
	Culverts	
	Diversions	
	Constrictions	
	Channel Incision/Entrenchment	
	Hardened/Engineered Channel	
	Artificial Stream Banks	
	Weirs	
	Confined Bridge Openings	

Variable Score	Condition Grade	Scoring Guidelines
1.0 - 0.9	***A*** *Reference Standard*	Stressors have little to no effect on the magnitude, timing or hydrodynamics of the AA water outflow regime.
<0.9 - 0.8	***B*** *Highly Functioning*	High- or low-water outflows are mildly to moderately affected, but at intermediate ("normal") levels flow continues essentially unaltered in quantity or character.
<0.8 - 0.7	***C*** *Functioning*	High- or low-water outflows are moderately affected, mild alteration of intermediate level outflow occurs; or hydrodynamics moderately affected.
<0.7 - 0.6	***D*** *Functioning Impaired*	Outflow at all stages is moderately to highly impaired resulting in persistent flooding of portions of the AA or unnatural drainage; or outflow hydrodynamics severely disrupted.
<0.6	***F*** *Non-functioning*	The natural outflow regime is profoundly impaired. Down-gradient hydrologic connection severed or nearly so. Alterations may cause widespread unnatural persistent flooding or dewatering of the wetland system.

Variable 5 Score [ ]

Variable 6: Geomorphology

This variable is a measure of the degree to which the geomorphic setting has been altered within the AA. Changes to the surface configuration and natural topography constitute stressors. Such stressors may be observed in the form of fill, excavation, dikes, sedimentation due to absence of flushing floods, etc. In riverine systems, geomorphic changes to the stream channel should be considered if the channel is within the AA (i.e, small is size). Alterations may involve the bed and bank (substrate embeddedness or morphological changes), stream instability, and stream channel reconfiguration. Geomorphic changes are usually ultimately manifested as changes to wetland surface hydrology and water relations with vegetation. Geomorphic alterations can also directly affect soil properties, such as near-surface texture, and the wetland chemical environment such as the redox state or nutrient composition in the rooting zone. In rating this variable, ***do not*** *include these resultant effects of geomorphic change; rather focus on the physical impacts* ***within the footprint*** *of the alteration* ***within the AA*** *– For example, the width and depth of a ditch or the size of a levee* ***within the AA*** *would describe the extent of the stressors. The secondary effects of geomorphic change are addressed by other variables. All alterations to geomorphology should be evaluated including small-scale impacts such as pugging, hoof sheer, and sedimentation which can be significant but not immediately obvious.*

Scoring Rules:

1. Identify impacts to geomorphological setting and topography within the AA and record them on the stressor checklist.
2. Considering all of the stressors identified, assign an overall variable score using the scoring guidelines.

✔		Stressors	Comments
	General	Dredging/Excavation/Mining	
		Fill, including dikes, road grades, etc.	
		Grading	
		Compaction	
		Plowing/Disking	
		Excessive Sedimentation	
		Dumping	
		Hoof Shear/Pugging	
		Aggregate or Mineral Mining	
		Sand Accumulation	
	Channels Only	Channel Instability/Over Widening	
		Excessive Bank Erosion	
		Channelization	
		Reconfigured Stream Channels	
		Artificial Banks/Shoreline	
		Beaver Dam Removal	
		Substrate Embeddedness	
		Lack or Excess of Woody Debris	

Variable Score	Condition Grade	Scoring Guidelines
1.0 - 0.9	***A*** *Reference Standard*	Topography essentially unaltered from the natural state, or alterations appear to have a minimal effect on wetland functioning and condition. Patch or microtopographic complexity may be slightly altered, but native plant communities are still supported.
<0.9 - 0.8	***B*** *Highly Functioning*	Alterations to topography result in small but detectable changes to habitat conditions in some or all of the AA; or more severe impacts exist but affect less than 10% of the AA.
<0.8 - 0.7	***C*** *Functioning*	Changes to AA topography may be pervasive but generally mild to moderate in severity. May include patches of more significant habitat alteration; or more severe alterations affect up to 20 % of the AA.
<0.7 - 0.6	***D*** *Functioning Impaired*	At least one important surface type or landform has been eliminated or created; microtopography has been strongly impacted throughout most or all of the AA; or more severe alterations affect up to 50% of the AA. Evidence that widespread diminishment or alteration of native plant community exist due to physical habitat alterations. Most incidentally created wetland habitat such as that created by roadside ditches and the like would score in this range or lower.
<0.6	***F*** *Non-functioning*	Pervasive geomorphic alterations have caused a fundamental change in site character and functioning, commonly resulting in a conversion to upland or deepwater habitat.

Variable 6 Score [ ]

Variable 7: Water and Soil Chemical Environment

This variable concerns the chemical environment of the soil and water media within the AA, including pollutants, water and soil characteristics. The origin of pollutants may be within or outside the AA. Score this variable by listing indicators of chemical stress in the AA. Consider point source and non-point sources of pollution, as well as mechanical or hydrologic changes that alter the chemical environment. Because water quality frequently cannot be inferred directly, the presence of stressors is often identified by the presence of indirect indicators. Five sub-variables are used to describe the Water and Soil Chemical Environment: Nutrient Enrichment/Eutrophication/Oxygen; Sedimentation/Turbidity; Toxic Contamination/pH; Temperature; and Soil Chemistry and Redox Potential. Utilization of web-based data mining tools is highly recommended to help inform and support variable scores.

Scoring rules:

1. Stressors are grouped into sub-variables which have a similar signature or set of causes.
2. Use the indicator list to identify each stressor impacting the chemical environment of the AA.
3. For each sub-variable, determine its score using the scoring guideline table provided on the second page of the scoring sheet. Scoring sub-variables is carried out in exactly the same way as normal variable scoring.
   -If the AA is part of a water body that is recognized as impaired or recommended for TMDL development for one of the factors, then score that sub-variable 0.65 or lower.
4. Transcribe sub-variable scores to the following variable scoring page and compute the sum.
5. The lowest sub-variable score sets the letter grade range. The composite of sub-variables influences the score within that range.

Sub-variable	Stressor Indicator	✓	Comments	Sub-variable Score
SV 7.1 Nutrient Enrichment/ Eutrophication/ Oxygen (D.O.)	Livestock			
	Agricultural Runoff			
	Septic/Sewage			
	Excessive Algae or Aquatic Veg.			
	Cumulative Watershed NPS			
	CDPHE Impairment/TMDL List			
SV 7.2 Sedimentation/ Turbidity	Excessive Erosion			
	Excessive Deposition			
	Fine Sediment Plumes			
	Agricultural Runoff			
	Excessive Turbidity			
	Nearby Construction Site			
	Cumulative Watershed NPS			
	CDPHE Impairment/TMDL List			
SV 7.3 Toxic contamination/ pH	Recent Chemical Spills			
	Nearby Industrial Sites			
	Road Drainage/Runoff			
	Livestock			
	Agricultural Runoff			
	Storm Water Runoff			
	Fish/Wildlife Impacts			
	Vegetation Impacts			
	Cumulative Watershed NPS			
	Acid Mine Drainage			
	Point Source Discharge			
	CDPHE Impairment/TMDL List			
	Metal staining on rocks and veg.			
SV 7.4 Temperature	Excessive Temperature Regime			
	Lack of Shading			
	Reservoir/Power Plant Discharge			
	Industrial Discharge			
	Cumulative Watershed NPS			
	CDPHE Impairment/TMDL List			
SV 7.5 Soil chemistry/ Redox potential	Unnatural Saturation/Desaturation			
	Mechanical Soil Disturbance			
	Dumping/introduced Soil			
	CDPHE Impairment/TMDL List			

Variable 7: Water and Soil Chemical Environment p.2

Sub-variable Scoring Guidelines

Variable Score	Condition Class	Scoring Guidelines
1.0 - 0.9	***A*** *Reference Standard*	Stress indicators not present or trivial.
<0.9 - 0.8	***B*** *Highly Functioning*	Stress indicators scarcely present and mild, or otherwise not occurring in more than 10% of the AA.
<0.8 - 0.7	***C*** *Functioning*	Stress indicators present at mild to moderate levels, or otherwise not occurring in more than 33% of the AA.
<0.7 - 0.6	***D*** *Functioning Impaired*	Stress indicators present at moderate to high levels, or otherwise not occurring in more than 66% of the AA
<0.6	***F*** *Non-functioning*	Stress indicators strongly evident throughout the AA at levels which apparently alter the fundamental chemical environment of the wetland system

Input each sub-variable score from p. 1 of the V7 data form and calculate the sum.

Nutrient enrichment/ Eutrophication/ Oxygen (D.O.)		Sedimentation/ Turbidity		Toxic contamination/ pH		Temperature		Soil chemistry/ Redox potential		Sum of Sub-variable Scores
	+		+		+		+		=	

Use the table to score the Chemical Environment Variable circling the applicable scoring rules.

Variable Score	Condition Grade	Scoring Rules		
		Single Factor		**Composite Score**
1.0 - 0.9	***A*** *Reference Standard*	No single factor scores < 0.9		The factor scores sum > 4.5
<0.9 - 0.8	***B*** *Highly Functioning*	Any single factor scores ≥ 0.8 but < 0.9		The factor scores sum >4.0 but ≤4.5
<0.8 - 0.7	***C*** *Functioning*	Any single factor scores ≥ 7.0 but < 0.8		The factor scores sum >3.5 but ≤ 4.0
<0.7 - 0.6	***D*** *Functioning Impaired*	Any single factor scores ≥ 0.6 but <0.7		The factor scores sum >3.0 but ≤3.5
< 0.6	***F*** *Non-functioning*	Any single factor scores < 0.6		The factor scores sum < 3.0

Variable 7 Score

Variable 8: Vegetation Structure and Complexity

This variable is a measure of the condition of the wetland's vegetation relative to its native state. It particularly focuses on the wetland's ability to perform higher-order functions such as support of wildlife populations, and influence primary functions such as flood-flow attenuation, channel stabilization and sediment retention. Score this variable by listing stressors that have affected the structure, diversity, composition and cover of each vegetation stratum that would normally be present in the HGM (regional) subclass being assessed. For this variable, stressor severity is a measure of how much each vegetation stratum differs functionally from its natural condition or from the natural range of variability exhibited the HGM subclass or regional subclass. This variable has four sub-variables, each corresponding to a stratum of vegetation: Tree Canopy; Shrub Layer; Herbaceous Layer; and Aquatics.

Rules for Scoring:

1. Determine the number and types of vegetation layers present within the AA. Make a judgment as to whether additional layers were historically present using direct evidence such as stumps, root wads or historical photographs. Indirect evidence such as local knowledge and expert opinion can also be used in this determination.
2. Do not score vegetation layers that would not normally be present in the wetland type being assessed.
3. Estimate and record the current coverage of each vegetation layer at the top of the table.
4. Record the Reference Standard or expected percent coverage of each vegetation layer to create the sub-variable weighting factor. The condition of predominant vegetation layers has a greater influence on the variable score than do minor components.
5. Enter the percent cover values as decimals in the row of the stressor table labeled " Reference/expected Percent Cover of Layer". Note, percentages will often sum to more than 100% (1.0).
6. Determine the severity of stressors acting on each individual canopy layers, indicating their presence with checks in the appropriate boxes of the stressor table. The difference between the expected and observed stratum coverages is one measure of stratum alteration.
7. Determine the sub-variable score for each valid vegetation layer using the scoring guidelines on the second page of the scoring sheet. Enter each sub-variable score in the appropriate cell of the row labeled "Veg. Layer Sub-variable Score". If a stratum has been wholly removed score it as 0.5.
8. Multiply each layer's *Reference Percent Cover of Layer* score by its Veg. Layer Sub-variable scores and enter the products in the labled cells. These are the weighted sub-variable scores. Individually sum the *Reference Percent Cover of Layer* and *Weighted Sub-variables scores.*
9. Divide the sum of "Veg. Layer Sub-variable Scores" by the total coverage of all layers scored. This product is the Variable 8 score. Enter this number in the labeled box at the bottom of this page.

	Vegetation Layers				
Current % Coverage of Layer					
Stressor	**Tree**	**Shrub**	**Herb**	**Aquatic**	**Comments**
Noxious Weeds					
Exotic/Invasive spp.					
Tree Harvest					
Brush Cutting/Shrub Removal					
Livestock Grazing					
Excessive Herbivory					
Mowing/Haying					
Herbicide					
Loss of Zonation/Homogenization					
Dewatering					
Over Saturation					
DIFFERENCE BETWEEN CURRENT COVERAGE AND REFERENCE/EXPECTED					

Reference/Expected % Cover of Layer		+		+		+		=	
	x		x		x		x		
Veg. Layer Sub-variable Score								÷	
	=		=		=		=		
Weighted Sub-variable Score		+		+		+		=	

See sub-variable scoring guidelines on following page

Variable 8 Score

Variable 8: Vegetation Structure and Complexity p. 2

Sub-variable 8 Scoring Guidelines:

Based on the list of stressors identified above, rate the severity of their cumulative effect on vegetation structure and complexity for each vegetation layer.

Variable Score	Condition Grade	Scoring Guidelines
1.0 - 0.9	***A*** *Reference Standard*	Stressors not present or with an intensity low enough as to not detectably affect the structure, diversity or composition of the vegetation layer.
<0.9 - 0.8	***B*** *Highly Functioning*	Stressors present at intensity levels sufficient to cause detectable, but minor, changes in layer composition. Stress related change should generally be less than 10% for any given attribute (e.g., 10% cover of invasive, 10% reduction in richness or cover) if the stressor is evenly distributed throughout the wetland. Stress related change could be as high as 33% for a given attribute if stressors are confined to patches comprising less than 10% of the wetland.
<0.8 - 0.7	***C*** *Functioning*	Stressors present with enough intensity to cause significant changes in the character of vegetation, including alteration of layer coverage, structural complexity and species composition. The vegetation layer retains its essential character though. AA's with a high proportion of non-native grasses will commonly fall in this class. Stress related change should generally be less than 33% for any given attribute (e.g., 33% cover of invasive, 33% reduction in richness or cover) if the stressor is evenly distributed throughout the wetland. Stress related change could be as much as 66% for a given attribute if stressors are confined to patches comprising less than 25% of the wetland.
<0.7 - 0.6	***D*** *Functioning Impaired*	Stressor intensity severe enough to cause profound changes to the fundamental character of the vegetation layer. Stress-related change should generally be less than 66% for any given attribute (e.g., 66% cover of invasive, 66% reduction in richness or cover) if the stressor is evenly distributed throughout the wetland. Stress related change could be as much as 80% of a given attribute if stressors are confined to patches comprising less than 50% of the wetland.
<0.6	***F*** *Non-functioning*	Vegetation layer has been completely removed or altered to the extent that is no longer comparable to the natural structure, diversity and composition.

FACWet Score Card

Scoring Procedure:

1. Transcribe variable scores from each variable data sheet to the corresponding cell in the variable score table.
2. In each Functional Capacity Index (FCI) equation, enter the corresponding variable scores in the equation cells. Do not enter values in the crossed cells lacking labels.
3. Add the variable scores to calculate the total functional points achieved for each function.
4. Divide the total functional points achieved by the functional points possible. The typical number of total points possible is provided, however, if a variable is added or subtracted to FCI equation the total possible points must be adjusted
5. Calculate the Composite FCI, by adding the FCI scores and dividing by the total number of functions scored (usually 7).
6. If scoring is done directly in the Excel spreadsheet, all values will be transferred and calculated automatically.

VARIABLE SCORE TABLE

Buffer & Landscape Context	**Variable 1:**	**Habitat Connectivity (Connect)**	
	Variable 2:	**Contributing Area (CA)**	
Hydrology	**Variable 3:**	**Water Source (Source)**	
	Variable 4:	**Water Distribution (Dist)**	
	Variable 5:	**Water Outflow (Outflow)**	
Abiotic and Biotic Habitat	**Variable 6:**	**Geomorphology (Geom)**	
	Variable 7:	**Chemical Environment (Chem)**	
	Variable 8:	**Vegetation Structure and Complexity (Veg)**	

Functional Capacity Indices

Function	Equation	Total Functional Points		FCI
Function 1 -- Support of Characteristic Wildlife Habitat	$V1_{connect} + V2_{CA} + (2 \times V8_{veg})$		÷ 4 =	
Function 2 -- Support of Characteristic Fish/aquatic Habitat	$(3 \times V3_{source}) + (2 \times V4_{dist}) + (2 \times V5_{outflow}) + V6_{geom} + V7_{chem}$		÷ 9 =	
Function 3 -- Flood Attenuation	$V2_{CA} + (2 \times V3_{source}) + (2 \times V4_{dist}) + (2 \times V5_{outflow}) + V6_{geom} + V8_{veg}$		÷ 9 =	
Function 4 -- Short- and Long-term Water Storage	$V3_{source} + (2 \times V4_{dist}) + (2 \times V5_{outflow}) V6_{geom}$		÷ 6 =	
Function 5 -- Nutrient/Toxicant Removal	$(2 \times V2_{CA}) + (2 \times V4_{dist}) + V6_{geom} V7_{chem}$		÷ 6 =	
Function 6 -- Sediment Retention/Shoreline Stabilization	$V2_{CA} + (2 \times V6_{geom}) + (2 \times V8_{veg})$		÷ 5 =	
Function 7 -- Production Export/Food Chain Support	$V1_{connect} + (2 \times V5_{outflow}) + V6_{geom} + V7_{chem} + (2 \times V8_{veg})$		÷ 7 =	

Sum of Individual FCI Scores

Divide by the Number of Functions Scored ÷ 7

Composite FCI Score

APPENDIX C: FIELD KEY TO WETLAND AND RIPARIAN ECOLOGICAL SYSTEMS AND FIELD KEY TO HYDROGEOMORPHIC (HGM)CLASSES

APPENDIX C.1: FIELD KEY TO WETLAND AND RIPARIAN ECOLOGICAL SYSTEMS OF COLORADO'S EASTERN PLAINS

Excerpted from Guide to the Ecological Systems of Colorado (Decker et al. 2020)
https://cnhp.colostate.edu/cwic/wetlandtypes/ecological-systems/

Ecological systems are dynamic assemblages or complexes of plant and/or animal communities that 1) occur together on the landscape; 2) are tied together by similar ecological processes, underlying abiotic environmental factors or gradients; and 3) form a readily identifiable unit on the ground (Comer et al. 2003). These systems provide a coarser level unit than plant associations and alliances as defined under the US National Vegetation Classification (USNVC) standard, and are more easily identified on the ground.

How to Use this Key

All wetland and riparian areas should fit within the key. If a wetland or riparian area is clearly manipulated, created, or otherwise does not fit a description, attempt to fit it in one of the ecological systems and take note of how and why it differs from the description given. Within this version of the key, comments specific to the Lower South Platte River Basin are noted *[in brackets and italics].*

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

Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. Ecological Systems of the United States: A Working Classification of U.S. Terrestrial Systems. NatureServe, Arlington, VA.

Keys to Wetland or Riparian Ecological Systems

Wetland or Riparian

Wetland ecological systems occur in areas with hydric soils, that are permanently or seasonally saturated with water. Dominant species are those typically associated with wetlands. Riparian ecological systems are directly adjacent to surface waters such as streams or lakes, and dominant species are tolerant of occasional saturated and/or flooded conditions.

Wetland and Riparian Key: Colorado's Eastern Plains

1a. Low stature shrublands dominated by species such as greasewood (*Sarcobatus vermiculatus*), saltbush (*Atriplex* spp.), rabbitbrush (*Ericameria nauseosa*), silver sagebrush (*Artemisia cana*), and big sagebrush (*Artemisia tridentata*). Vegetation may be sparse and soils may be saline. Sites may be located on flats or in washes, but typically not associated with river and stream floodplains. Shrublands with >10% total vegetation cover, located on flats or in temporarily or intermittently flooded drainages, and dominated by *Sarcobatus vermiculatus* and *Atriplex* spp. with inclusions of alkali sacaton (*Sporobolus airoides*), western wheatgrass (*Pascopyrum smithii*), saltgrass (*Distichlis spicata*), Nuttall's alkaligrass (*Puccinellia nuttalliana*), and common spikerush (*Eleocharis palustris*) herbaceous vegetation. ..... **Inter-Mountain Basins Greasewood Flat**

1b. Wetland is not a low stature shrub-dominated saline wash or flat. **2**

2a. Herbaceous wetlands of the Western Great Plains that are isolated or partially isolated from surface water stream networks, not located on floodplains, headwaters, or in riparian zones, often depressional basins with or without an outlet..... **3**

2b. Sites located within the floodplain or immediate riparian zone of a river or stream and part of the surface water stream network. Sites may occur at the vary headwaters of a stream network and be primarily groundwater driven. Vegetation may be entirely herbaceous or may contain tall stature woody species, such as cottonwood (*Populus* spp.) or willow (*Salix* spp.). Water levels variable. Woody vegetation that occurs along reservoir edges can also be included here. **5**

3a. Natural shallow depressional wetlands in the Western Great Plains, often called playas or playa lakes, with an impermeable soil layer, such as dense hardpan clay, that causes periodic ponding after heavy rains. Playas are variable in size and can range from less than an acre to many acres in size. Sites generally have closed contour topography and are surrounded by upland vegetation. Hydrology is typically tied to precipitation and runoff, though some sites have a strong groundwater connection. Ponding is often ephemeral or seasonal and sites may be dry throughout the entire growing season during dry years. Sites with a groundwater connection or artificial inflows can stay wet throughout the year. Species composition depends on soil salinity, may fluctuate depending on seasonal moisture availability, and many persistent species may be upland species. *[Within the Lower South Platte Basin, wetlands within this group are collectively referred to* ***playas or playa lakes****. Ecological systems listed below separate playas based on the level of salinity and total cover of vegetation.]* **4**

3b. Herbaceous wetlands in the Western Great Plains not associated with playas or saline basins. If depressional, the system has a connection to a downslope drainage network. .... **Western Great Plains Wet Meadow and Marsh Drainage Network**

4a. Shallow depressional wetlands with less saline soils than the next. Dominant species are typically not salt-tolerant. 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. Common native species include western wheatgrass (*Pascopyrum smithii*), buffalograss (*Buchloe dactyloides*), spikerush (*Eleocharis* spp.), spotted evening primrose (*Oenothera canescens*), green prairie coneflower (*Ratibida tagetes*), plantain (*Plantago* spp.), knotweed (*Polygonum* spp.), and wedgeleaf (*Phyla cuneifolia*). Non-native species are very common in these sites, including Russian thistle (*Salsola tragus, =australis*), burningbush (*Bassia scoparia, =sieversiana*), and bigbract verbena (*Verbena bracteata*). Site zonation and hydrology can be impacted by agriculture and concentrated grazing. Many have been dug out or "pitted" to increase water retention and to tap shallow aquifers *[Most of the playas within the Lower South Platte River Basin will likely fit within this ecological system.]*. ....**Western Great Plains Closed Depression Wetland & Playa**

4b. Shallow depressional wetlands with high salinity. Salt encrustations frequently occur on the surface, and the accumulation of salt concentrations in the lowest central area of the basin can limit species cover to bare or sparse vegetation. Presence of halophytes such as pickleweed (*Salicornia* spp.), seepweed (*Suaeda* spp.), verrucose seapurslane (*Sesuvium verrucosum*), salt heliotrope (*Heliotropium curassavicum*), and media sandspurry *Spergularia maritima, =media*) can be indicator species. Other species are typically salt-tolerant, including saltgrass (*Distichlis spicata*), alkaligrass (*Puccinellia* spp.), bulrush (*Schoenoplectus* spp.), alkali sakaton (*Sporobolus airoides*), and foxtail barley (*Hordeum jubatum*). These herbaceous saline depressions can have occasional shrubs such as greasewood (*Sarcobatus vermiculatus*) and winterfat (*Krascheninnikovia lanata*), or can transition to shrub cover in the less wetland, more mesic outer zones. *[Most of the playas within the Lower South Platte Basin will likely fit within this ecological system.]*..... ....**Western Great Plains Saline Depression Wetland**

5a. Riparian to floodplain-dominated systems with enough fluvial energy and alluvial processes to support development of tree species and floodplain features such as bed and bank. Vegetation typically a complex of non-wetland and wetland zones that range from sparsely vegetated washes with occasional trees, to closed woodlands and complex patchy floodplains. Inclusion of herbaceous vegetation is possible, especially when in-channel flow is augmented with springs or other sources of groundwater discharge ……..**6**

5b. Lower energy groundwater-dependent or surface flow systems within the headwaters of drainage networks or on low-order streams. Processes are driven by groundwater discharge or by overland flow caught in depressions within ephemeral to intermittent channels. In-channel flow may occur during local high precipitation events, but the dominant factor in wetland creation is seasonal to continuous groundwater discharge and/or ponding in within-channel depressions. Substrate soil texture and vegetation zonation is less shaped by alluvial processes and more by longer residence times from groundwater discharge or ponding. Some examples are broad and expansive, but most are narrow and linear. Sites range from herbaceous meadows and marshes with minimal woody vegetation, but shrub zones can occur and even dominate local slopes where seasonal to continuous groundwater expression occurs. Herbaceous side channels and sloughs supported by groundwater but set within a mosaic of riparian or floodplain system supporting trees generally belong above due to dominance of alluvial processes and site capacity required for tree establishment in the plains. **8**

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

6b. Riparian and floodplain woodlands and shrublands of Colorado's eastern plains. Dominant species include plains cottonwood (*Populus deltoides*), crack willow (*Salix fragilis*), peachleaf willow (*Salix amygdaloides*), narrowleaf willow (*Salix exigua*), ash (*Fraxinus* spp.), and elm (*Ulmus* spp.). Invasive woody species including saltcedar (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia*) can invade sites. Examples of native herbaceous understory species include switchgrass (*Panicum virgatum*), western wheatgrass (*Pascopyrum smithii*), alkali cordgrass (*Spartina gracilis*), prairie cordgrass (*S. pectinata*), and needlegrasses. Non-native or native-invasive species in the genera *Agrostis, Bromus, Phalaris,* and *Phragmites* frequently invade understory with managed or impaired hydrology ..... **(7)**

7a. Riparian woodlands and shrublands along small to medium streams where streamflow may dry completely for some portion of the year or water depths are generally wadeable by mid-summer. These riparian areas have less floodplain development and flashier hydrology than the next. Dominant water sources are summer rainfall and alluvial groundwater, although plains riverine systems can have various secondary water sources including irrigation runoff and groundwater. Dominant species include plains cottonwood (*Populus deltoides*), peachleaf willow (*Salix amygdaloides*), narrowleaf willow (*Salix exigua*), green ash (*Fraxinus pennsylvanica*), western wheatgrass (*Pascopyrum smithii*), switchgrass (*Panicum virgatum*), vine mesquite (*Panicum obtusum*), sand dropseed (*Sporobolus cryptandrus*), and little bluestem (*Schizachyrium scoparium*). Wetland graminoids such as sedges (*Carex* spp.) and bulrush (*Schoenoplectus* spp.) can occupy seasonally inundated channel-fringe zones, secondary channels, swales, or patches of groundwater discharge. Saltcedar (*Tamarix* spp.), Russian olive (*Elaeagnus angustifolia*), and less desirable grasses and forbs can invade degraded examples. Groundwater depletion, lack of fire and beaver, concentrated grazing, and/or adjacent agricultural activities have resulted in species and hydroperiod changes. Like Rocky Mountain Lower Montane Riparian Woodland and Shrublands, this system can occur around artificial lakeshores where the vegetation is connected to an open water body that may experience fluctuating shoreline water levels. This can mimic the flooding and saturated conditions that occur along riverine channels and their floodplains. *[For the Lower South Platte Basin, this system applies to all streams and rivers outside the South Platte floodplain from Greeley west. Irrigation ditches lined with woody vegetation will fall into this system.]* .... **Western Great Plains Riparian**

7b. Woodlands, shrublands, meadows, and marshes along large rivers with extensive floodplain development and with a diversity of floodplain-associated structural features. Hydroperiod and flooding is more associated with snowmelt and seasonal dynamics in the mountains than with local precipitation events. Dominant communities within this system include floodplain forests and open cottonwood galleries, mesic to wet shrublands, wet meadow and marsh communities within swales and sloughs, gravel/sand bars, and in-channel islands dominated by early successional herbs and annuals. The diverse array of patches is linked by underlying soils and the flooding regime. Dominant species include plains cottonwood (*Populus deltoides*) and willow (*Salix* spp.), western snowberry (*Symphoricarpos occidentalis*), switchgrass (*Panicum virgatum*), and saltgrass (*Distichlis spicata*). Saltcedar (*Tamarix* spp.), Russian olive (*Elaeagnus angustifolia*), kochia, and non-native grasses and thistles have invaded degraded areas within the floodplains, which are subjected to heavy grazing and/or agriculture. Areas with more intact hydrology can support wetland graminoids such as cordgrass (*Spartina* spp.) and Emory's sedge (*Carex emoryi*). Groundwater depletion and lack of fire have created additional alterations in species composition and hydroperiod. Nearly all native wet meadow communities are heavily impacted by irrigation and water management, and the majority of the remaining mesic to wet meadow floodplain are extremely degraded examples of this system. *[For the Lower South Platte Basin, this system applies to the South Platte floodplain from Greeley east.]*..... ..... **Western Great Plains Floodplain**

8a. Herbaceous wetland systems including emergent marshes, wet meadows, fens, and narrow drainages set in the headwaters of eastern Colorado prairie streams and along small tributary drainages. Primary water sources include groundwater discharge or surface flow captured in local depressions within drainage networks. Wetland species dominate and vegetation patches include wet meadows at the headwaters of drainages, which can be expansive, and small to medium sized marshes along the drainage where groundwater discharge supplements surface runoff. Shrubs can also occur, including in fen patches and on spring-fed headwater slopes. If depressional, the system has an outlet and eventual connection to a drainage. Seasonal to semi-permanent at-surface saturation or flooding throughout the growing season is common, except in drought years. …….. ..... **Western Great Plains Wet Meadow and Marsh Drainage Network**

8b. Expansive herbaceous wetlands with standing water at or above the surface throughout the growing season, except in drought years. Water levels are often high at some point during the growing season, but managed systems may be drawn down at any point depending on water management regimes. Vegetation typically dominated by species of cattail (*Typha*), bulrush (*Schoenoplectus*), sedge (*Carex*), spikerush (*Eleocharis*), and floating genera such as pondweed (*Potamogeton*), and arrowhead (*Sagittaria*). While this system is located on the floodplain, it may be disconnected from flooding regimes and the hydrology may be entirely managed. Water may be brackish or not. Soils are highly variable. This system includes a variety of managed wetlands on floodplains (e.g., recharge ponds, moist soil units, shallow gravel pits, etc.). .... **Western North American Emergent Marsh**

APPENDIX C.2: FIELD KEY TO 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. **NOTE:** *Flat wetlands are very uncommon in Colorado.* .....**Flats HGM Class**

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

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

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

3a. Entire wetland unit meets ***all*** of the following criteria: a) wetland unit is in a valley, floodplain, or along a stream channel where it is inundated by overbank flooding from that stream or river; b) overbank flooding occurs at least once every five 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. However, depressions on the floodplain that are not strongly influenced by flooding would be classified as true depressions. These include depressions disconnected due to modified hydrology and channel entrenchment, and impounded managed wetlands.* ..... **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 or managed hydrology..... **4**

4a. 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**

4b. Wetland does not meet the above criteria. There is no significant ponding except at times of very high water.....**5**

5a. Wetland unit meets the following criteria: a) wetland is on a slope (slope can be very gradual or nearly flat); b) *natural* 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**

5b. Wetland water source, when surface water flow or subsurface groundwater expression, is largely connected to irrigation water, either through direct application or seepage from fields or ditches**Novel Irrigation-Fed HGM Class**

APPENDIX D: SCORING FORMULAS FOR ECOLOGICAL INTEGRITY ASSESSMENT (EIA)

(SEE LEMLY ET AL. [2016][1] FOR ADDITIONAL DETAIL)

	Key Ecological Attribute	Indicator / Metric	Metric Rating Criteria			
		Rank / Score	A / 5	B / 4	C / 3	D / 1
		Interpretation	Reference (No or Minimal Human Impact)	Slight Deviation from Reference	Moderate Deviation from Reference	Significant Deviation from Reference
LANDSCAPE CONTEXT	Landscape	*L1. Contiguous Natural Land Cover within 500 m*	Embedded in 90-100% contiguous natural landscape.	Embedded in 60–90% contiguous natural landscape.	Embedded in 20–60% contiguous natural landscape.	Embedded in <20% contiguous natural landscape.
		L2. Land Use Index[2]	Land Use Index = 9.5–10.0.	Land Use Index = 8.0–9.49.	Land Use Index = 4.0–7.99.	Land Use Index = <4.0.
	Buffer	*B1. Perimeter with Natural Buffer*	Natural buffer at least 5 m wide surrounds 100% of AA.	Natural buffer at least 5 m wide surrounds 75–99% of AA.	Natural buffer at least 5 m wide surrounds 25–74% of AA.	Natural buffer at least 5 m wide surrounds <25% of AA.
		B2. Buffer Width	Average buffer width is >100 m.	Average buffer width is 75-99 m.	Average buffer width is 25-74 m.	Average buffer width is <25 m.
		B3. Buffer Condition: Vegetation	Abundant (>95%) relative cover native vegetation and little or no (<5%) cover of non-native plants.	Substantial (75–95%) cover of native vegetation and low (5–25%) cover of non-native plants.	Low (25–75%) cover of native vegetation and moderate to substantial (25-75%) cover of non-native plants.	Dominant (>50%) cover of non-native plants.
		B4. Buffer Condition: Soils/Substrate	Intact soils, no water quality concerns, little or no trash, AND little or no evidence of human visitation.	Intact or minor soil disruption, minor water quality concerns, moderate or lesser amounts of trash, AND/OR minor intensity of human visitation or recreation.	Moderate-or extensive soil disruption, moderate to strong water quality concerns, moderate and greater amounts of trash, AND/OR moderate intensity of human use.	Barren ground and highly compacted or otherwise disrupted soils, significant water quality concerns, substantial amounts of trash, extensive human use, OR no buffer exists.

	Key Ecological Attribute	Indicator / Metric	Metric Rating Criteria				
		Rank / Score	A / 5	B / 4	C / 3	C- / 2 –OR– D / 1	
		Interpretation	Reference (No or Minimal Human Impact)	Slight Deviation from Reference	Moderate Deviation from Reference	Significant or Severe Deviation from Reference	
VEGETATION CONDITION	**Vegetation**	*V1. Relative Cover Native[3] Plant Species*	Relative cover native plants > 99%	Relative cover native plants >95-99%	Relative cover native plants >85-95%	**C-:** Relative cover native plants 60-85%	**D:** Relative cover native plants <60%
		V2. Invasive Non-native[3] Absolute Cover	Absolute cover noxious weeds and invasive cryptogenics = 0%	Absolute cover noxious weeds and invasive cryptogenics <4%	Absolute cover noxious weeds and invasive cryptogenics >4-10%	**C-:** Noxious weeds and invasive cryptogenics 11-30%	**D:** Noxious weeds and invasive cryptogenics >30%
		V3. Native[3] Plant Species Composition	Native plant species composition with expected natural conditions:	Native plant species composition with minor disturbed conditions.	Native plant species composition with moderately disturbed conditions:	**D:** Native plant species composition with severely disturbed conditions.	
		V4. Vegetation Structure[4]	Vegetation structure is at or near minimally disturbed natural conditions. Little to no structural indicators of degradation evident	Vegetation structure shows minor alterations from natural conditions.	Vegetation structure is moderately altered from natural conditions.	**D:** Vegetation structure is greatly altered from natural conditions.	
		V5. Regeneration of Native Woody Species (**N/A** if woody spp. naturally uncommon/absent)	All age classes of native woody species present. Native tree saplings /seedlings and shrubs common to the type present in expected amounts and diversity. Regeneration in obvious.	Age classes of native woody species restricted to mature individuals and young sprouts. Middle age groups appear to be absent or there is some other indication that regeneration is moderately impacted.	*Native* woody species comprised of mainly mature individuals OR mainly evenly aged young sprouts that choke out other vegetation. Regeneration is obviously impacted. Site may contain Russian Olive and/or Salt Cedar.	**D:** Native woody species predominantly consist of decadent or dying individuals OR are absent from an area that should be wooded. Site may be dominated by Russian Olive / Salt Cedar.	
		V6. Coarse and Fine Woody Debris (**N/A** if no obvious inputs of woody debris)	**A/B Score 4:** Moderate amount of coarse and fine woody debris, relative to expected conditions.		Moderate amount of coarse and fine woody debris relative to expected conditions.	Small amounts of woody debris OR debris is somewhat excessive.	

	Key Ecological Attribute	Indicator / Metric	Metric Rating Criteria			
		Rank / Score	A / 5	B / 4	C / 3	D / 1
		Interpretation	Reference (No or Minimal Human Impact)	Slight Deviation from Reference	Moderate Deviation from Reference	Significant Deviation from Reference
HYDROLOGIC CONDITION[1]	**Hydrology**	*H1. Water Source*	Water sources are natural. Site hydrology is fed by precipitation, groundwater, natural runoff, or natural flow from an adjacent freshwater body.	Water sources are mostly natural, but also include occasional or small amounts of inflow from anthropogenic sources.	Water sources are moderately impacted by anthropogenic sources, but are still a mix of natural and non-natural sources.	Water sources are primarily from anthropogenic sources (e.g., urban runoff, direct irrigation, pumped water, artificially impounded water, or another artificial hydrology).
		H2. Hydroperiod	Hydroperiod is characterized by natural patterns of inundation/saturation and drawdown and/or flood frequency, duration, level and timing.	Filling and drying patterns deviate slightly from natural conditions due to presence of stressors such as: flood control/water storage dams upstream; berms or roads at/near grade; minor pugging by livestock; small ditches or diversions removing water; or minor flow additions from irrigation return flow or storm water runoff. Outlets may be slightly constricted, but not to significantly slow outflow.	Filling and drying patterns deviate moderately from natural conditions due to presence of stressors such as: flood control/water storage dams upstream or downstream that moderately effect hydroperiod; two lane roads; culverts adequate for base stream flow but not flood flow; moderate pugging by livestock that could channelize or divert water; shallow pits within playas; ditches or diversions 1–3 ft. deep; or moderate flow additions. Outlets may be moderately constricted, but flow is still possible.	Filling and drying patterns deviate substantially from natural conditions due to high intensity alterations such as: significant flood control / water storage das upstream or downstream; a 4-lane highway; large dikes impounding water; diversions > 3ft. deep that withdraw a significant portion of flow, deep pits in playas; large amounts of fill; significant artificial groundwater pumping; or heavy flow additions. Outlets may be significantly constricted, blocking most flow.
		H3. Hydrologic Connectivity[4] (continued below)	**Riparian:** completely connected to floodplain (backwater sloughs and channels). No geomorphic modifications made to contemporary floodplain. Channel is not entrenched.	**Riparian:** minimally disconnected from floodplain. Up to 25% of stream banks may be affected by dikes, rip rap, and/or elevated culverts. Channel may be somewhat entrenched, but overbank flow occurs during most floods.	**Riparian:** moderately disconnected from floodplain due to multiple geomorphic modifications. Between 25-75% of stream banks may be affected by dikes, rip rap, concrete, and/or elevated culverts. Channel may be moderately entrenched and disconnected from the floodplain except in large floods.	**Riparian:** channel is severely entrenched and entirely disconnected from the floodplain. More than 75% of stream banks may be affected by dikes, rip rap, concrete and/or elevated culverts. Overbank flow never occurs or only in severe floods.

	Hydrology	*H3. Hydrologic Connectivity[4] (continued from above)*	**Marsh**: no unnatural obstructions to lateral or vertical movement of surface or ground water. Rising water in the site has unrestricted access to adjacent upland, without levees, excessively high banks, artificial barriers, or other obstructions to the lateral movement of flood flows.	**Marsh**: minor restrictions to the lateral or vertical movement of surface and ground water by unnatural features such as levees, road grades or excessively high banks. Up to 25% of the site may be restricted by barriers to drainage. Restrictions may be intermittent along the margins of the AA, or they may occur only along one bank or shore. Flood flows may exceed the impoundments, but drainage back into the wetland may be incomplete due to the impoundments.	**Marsh**: moderate restrictions to the lateral or vertical movement of surface and ground water by unnatural features such as levees, road grades or excessively high banks. Between 25–75% of the site may be restricted by barriers to drainage. Flood flows may exceed the impoundments, but drainage back into the wetland may be incomplete due to the impoundments.	**Marsh**: essentially no hydrologic connection to adjacent landscape. Most or all stages may be contained within artificial banks, levees, or comparable features. Greater than 75% of the site is restricted by barriers to drainage.

	Metric Rating Criteria				
	Rank / Score	**A / 5**	**B / 4**	**C / 3**	**D / 1**
	Interpretation	**Reference (No or Minimal Human Impact)**	**Slight Deviation from Reference**	**Moderate Deviation from Reference**	**Significant Deviation from Reference**
PHYSIOCHEMICAL CONDITION	*S1. Substrate / Soil Disturbance*	No soil disturbance within AA. Little bare soil OR bare soil areas are limited to naturally caused disturbances such as flood deposition or game trails OR soil is naturally bare (e.g., playas). No pugging, soil compaction, or sedimentation.	Minimal soil disturbance within AA. Some amount of bare soil, pugging, compaction, or sedimentation present due to human causes, but the extent and impact are minimal. The depth of disturbance is limited to only a few inches and does not show evidence of altering hydrology. Any disturbance is likely to recover within a few years after the disturbance is removed.	Moderate soil disturbance within AA. Bare soil areas due to human causes are common and will be slow to recover. There may be pugging due to livestock resulting in several inches of soil disturbance. ORVs or other machinery may have left some shallow ruts. Sedimentation may be filling the wetland. Damage is obvious, but not excessive. The site could recover to potential with the removal of degrading human influences and moderate recovery times.	Substantial soil disturbance within AA. Bare soil areas substantially degrade the site and have led to altered hydrology or other long-lasting impacts. Deep ruts from ORVs or machinery may be present, or livestock pugging and/or trails are widespread. Sedimentation may have severely impacted the hydrology. The site will not recover without active restoration and/or long recovery times.
	S2. Surface Water Turbidity/Pollutants (**N/A** if no open water in AA)	No visual evidence of degraded water quality. No visual evidence of turbidity or other pollutants.	Some negative water quality indicators are present, but limited to small and localized areas within the wetland. Water is slightly cloudy, but there is no obvious source of sedimentation or other pollutants.	Water is cloudy or has unnatural oil sheen, but the bottom is still visible. Sources of water quality degradation are apparent (identify in comments below). Note: If the sheen breaks apart when you run your finger through it, it is a natural bacterial process and not water pollution.	Water is milky and/or muddy or has unnatural oil sheen. The bottom is difficult to see. There are obvious sources of water quality degradation. Note: If the sheen breaks apart when you run your finger through it, it is a natural bacterial process and not water pollution.
	S3. Algal Growth (**N/A** if no open water in AA)	Water is clear with minimal algal growth.	Algal growth is limited to small and localized areas of the wetland. Water may have a greenish tint or cloudiness.	Algal growth occurs in moderate to large patches throughout the AA. Water may have a moderate greenish tint or sheen.	Algal mats are extensive, blocking light to the bottom. Water may have a strong greenish tint and the bottom is difficult to see.

[1] The 5 point scale scoring method described in Field Manual Version 1.0 (Lemly and Gilligan 2013) and shown above was used for this project instead of the 4 point scale described in Field Manual Version 2.1 (Lemly et al. 2016).

[2] See EIA Field Form in Appendix C or Lemly et al. (2016) for Land Use Index Scoring.

[3] EIA 2.2, In-prep, will detail EIA treatment of cryptogenic species as invasive and non-native in metrics V1, V2, and V3.

[4] See Lemly et al. (2016) for Specific Guidance for Marshes, Meadows and Playas, and Specific Guidance for Riparian Areas.

EIA Scoring Formulas:

Landscape Context Score = [Average (L1, L2)] * 0.33 + $[(B1*B2)^{1/2}$ * Average (B3.1, B3.2)$]^{1/2}$ *0.67

Vegetation Condition Score = Average (V1, V2, V3, V4, V5, V6)

Hydrologic Condition Score = Average (H1, H2, H3)

Physiochemistry Condition Score = (S1+(S2+S3)/2)/2

Overall EIA Score = (Landscape Context Score * 0.3) + [(Vegetation Condition Score * 0.55) + (Hydrologic Condition Score * 0.35) + (Hydrologic Condition Score * 0.1)] * 0.7

<u>Overall Score to Rank Conversion:</u>

A = >4.5[1] – 5.0 B = >3.5 – 4.5 C= >2.5 - 3.5 D= 1.0 - 2.5

[1] The rank threshold uses the scoring method of rank breaks with the higher rank minimum set at the greater than 0.5 mark, as described in Field Manual Version 1.0 (Lemly and Gilligan 2013), instead of the higher rank minimum set at the 0.5 mark as described in Field Manual Version 2.1 (Lemly et al. 2016). This change will be updated in EIA 2.2, in-prep.

APPENDIX E: NATURAL HERITAGE PROGRAM METHODOLOGY

To determine the status of species within Colorado, CNHP gathers information on plants, animals and plant communities. Each of these elements of natural diversity is assigned a rank that indicates its relative degree of imperilment on a five-point scale (for example, 1 = extremely rare/imperiled, 5 = abundant/secure). The primary criterion for ranking elements is the number of occurrences (in other words, the number of known distinct localities or populations). This factor is weighted more heavily than other factors because an element found in one place is more imperiled than something found in twenty-one places. Also of importance are the size of the geographic range, the number of individuals, the trends in both population and distribution, identifiable threats and the number of protected occurrences.

Element imperilment ranks are assigned both in terms of the element's degree of imperilment within Colorado (its State-rank or S-rank) and the element's imperilment over its entire range (its Global-rank or G-rank). Taken together, these two ranks indicate the degree of imperilment of an element. CNHP actively collects, maps and electronically processes specific occurrence information for animal and plant species considered extremely imperiled to vulnerable in the state (S1 - S3). Several factors, such as rarity, evolutionary distinctiveness and endemism (specificity of habitat requirements), contribute to the conservation priority of each species. Certain species are “watch listed,” meaning that specific occurrence data are collected and periodically analyzed to determine whether more active tracking is warranted. A description of each of the Natural Heritage ranks is provided in Table E-1.

This single rank system works readily for all species except those that are migratory. Those animals that migrate may spend only a portion of their life cycles within the state. In these cases, it is necessary to distinguish between breeding, non-breeding and resident species. As noted in Table E- 1, ranks followed by a "B,” for example S1B, indicate that the rank applies only to the status of breeding occurrences. Similarly, ranks followed by an "N,” for example S4N, refer to non-breeding status, typically during migration and winter. Elements without this notation are believed to be year-round residents within the state.

Table E-1. Definition of Natural Heritage imperilment ranks.

G/S1	Critically imperiled globally/state because of rarity (5 or fewer occurrences in the world/state; or 1,000 or fewer individuals), or because some factor of its biology makes it especially vulnerable to extinction.
G/S2	Imperiled globally/state because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or because other factors demonstrably make it very vulnerable to extinction throughout its range.
G/S3	Vulnerable throughout its range or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals).
G/S4	Apparently secure globally/state, though it may be quite rare in parts of its range, especially at the periphery. Usually more than 100 occurrences and 10,000 individuals.
G/S5	Demonstrably secure globally/state, though it may be quite rare in parts of its range, especially at the periphery.
G/SX	Presumed extinct globally, or extirpated within the state.
G#?	Indicates uncertainty about an assigned global rank.
G/SU	Unable to assign rank due to lack of available information.
GQ	Indicates uncertainty about taxonomic status.
G/SH	Historically known, but usually not verified for an extended period of time.
G#T#	Trinomial rank (T) is used for subspecies or varieties. These taxa are ranked on the same criteria as G1-G5.
S#B	Refers to the breeding season imperilment of elements that are not residents.
S#N	Refers to the non-breeding season imperilment of elements that are not permanent residents.
SC	Element is extant only in captivation or cultivation.
S	Migrant whose occurrences are too irregular, transitory and/or dispersed to be reliably identified, mapped and protected.
SA	Accidental in the state.
SR	Reported to occur in the state but unverified.
S?	Unranked. Some evidence that species may be imperiled, but awaiting formal rarity ranking.

Note: Where two numbers appear in a state or global rank (for example, S2S3), the actual rank of the element is uncertain, but falls within the stated range.

Legal Designations for Rare Species

Natural Heritage imperilment ranks should not be interpreted as legal designations. Although most species protected under state or federal endangered species laws are extremely rare, not all rare species receive legal protection. Legal status is designated by both the U.S. Fish and Wildlife Service under the Endangered Species Act or by the Colorado Division of Wildlife under Colorado Statutes 33-2-105 Article 2. In addition, the U.S. Forest Service recognizes some species as "Sensitive," as does the Bureau of Land Management. Table E-2 defines the special status assigned by these agencies and provides a key to abbreviations used by CNHP.

Table E-2. Federal and state agency special designations for rare species.

Federal Status:

1. U.S. Fish and Wildlife Service (58 Federal Register 51147, 1993) and (61 Federal Register 7598, 1996)

LE	Listed Endangered: defined as a species, subspecies, or variety in danger of extinction throughout all or a significant portion of its range.
LT	Listed Threatened: defined as a species, subspecies, or variety likely to become endangered in the foreseeable future throughout all or a significant portion of its range.
P	Proposed: taxa formally proposed for listing as Endangered or Threatened (a proposal has been published in the Federal Register, but not a final rule).
C	Candidate: taxa for which substantial biological information exists on file to support proposals to list them as endangered or threatened, but no proposal has been published yet in the Federal Register.
PDL	Proposed for delisting.
XN	Nonessential experimental population.

2. U.S. Forest Service (Forest Service Manual 2670.5) (noted by the Forest Service as S")

FS	Sensitive: those plant and animal species identified by the Regional Forester for which population viability is a concern as evidenced by: Significant current or predicted downward trends in population numbers or density. Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

3. Bureau of Land Management (BLM Manual 6840.06D) (noted by BLM as "S")

BLM	Sensitive: those species found on public lands designated by a State Director that could easily become endangered or extinct in a state. The protection provided for sensitive species is the same as that provided for C (candidate) species.

4. State Status:

Colorado Parks and Wildlife has developed categories of imperilment for non-game species (refer to the Colorado Division of Wildlife's Chapter 10 – Nongame Wildlife of the Wildlife Commission's regulations). The categories being used and the associated CNHP codes are provided below.

E	Endangered: those species or subspecies of native wildlife whose prospects for survival or recruitment within this state are in jeopardy, as determined by the Commission.
T	Threatened: those species or subspecies of native wildlife which, as determined by the Commission, are not in immediate jeopardy of extinction but are vulnerable because they exist in such small numbers, are so extremely restricted in their range, or are experiencing such low recruitment or survival that they may become extinct.
SC	Special Concern: those species or subspecies of native wildlife that have been removed from the state threatened or endangered list within the last five years; are proposed for federal listing (or are a federal listing "candidate species") and are not already state listed; have experienced, based on the best available data, a downward trend in numbers or distribution lasting at least five years that may lead to an endangered or threatened status; or are otherwise determined to be vulnerable in Colorado.

Element Occurrences and their Ranking

Actual locations of elements, whether they are single organisms, populations, or plant communities are referred to as element occurrences. The element occurrence is considered the most fundamental unit of conservation interest and is at the heart of the Natural Heritage Methodology. To prioritize element occurrences for a given species, an element occurrence rank (EO-Rank) is assigned according to the ecological quality of the occurrences whenever sufficient information is available. This ranking system is designed to indicate which occurrences are the healthiest and ecologically the most viable, thus focusing conservation efforts where they will be most successful. The EO-Rank is based on three factors:

> **Size** – a measure of the area or abundance of the element's occurrence. Takes into account factors such as area of occupancy, population abundance, population density, population fluctuation and minimum dynamic area (which is the area needed to ensure survival or re-establishment of an element after natural disturbance). This factor for an occurrence is evaluated relative to other known and/or presumed viable, examples.
>
> **Condition/Quality** – an integrated measure of the composition, structure and biotic interactions that characterize the occurrence. This includes measures such as reproduction, age structure, biological composition (such as the presence of exotic versus native species), structure (for example, canopy, understory and ground cover in a forest community) and biotic interactions (such as levels of competition, predation and disease).
>
> **Landscape Context** – an integrated measure of two factors: the dominant environmental regimes and processes that establish and maintain the element and connectivity. Dominant environmental regimes and processes include herbivory, hydrologic and water chemistry regimes (surface and groundwater), geomorphic processes, climatic regimes (temperature and precipitation), fire regimes and many kinds of natural disturbances. Connectivity includes such factors as a species having access to habitats and resources needed for life cycle completion, fragmentation of ecological communities and systems and the ability of the species to respond to environmental change through dispersal, migration, or re-colonization.

Each of these factors is rated on a scale of A through D, with A representing an excellent rank or D representing a poor rank. These ranks for each factor are then averaged to determine an appropriate EO-Rank for the occurrence. If not enough information is available to rank an element occurrence, an EO-Rank of E is assigned. EO-Ranks and their definitions are summarized in Table E-3.

Table E-3. Element Occurrence ranks and their definitions.

A	Excellent viability.
B	Good viability.
C	Fair viability.
D	Poor viability.
H	Historic: known from historical record, but not verified for an extended period of time.
X	Extirpated (extinct within the state).
E	Extant: the occurrence does exist but not enough information is available to rank.
F	Failed to find: the occurrence could not be relocated.

APPENDIX F: AQUATIC DEPENDENT RARE PLANTS, ANIMALS, AND PLANT COMMUNITIES WITH POTENTIAL TO OCCUR IN AURORA

Table F-1. CNHP tracked aquatic dependent wildlife species with potential to occur within Aurora

Common Name	Scientific Name	Status[1]	CNHP Rank[2]
Amphibians			
Northern leopard frog	*Lithobates pipiens*	BLM, FS, SC, F, SWAP1	G5 S3
Birds			
Bald eagle	*Haliaeetus leucocephalus*	BLM, FS, SC, F, SWAP2	G5 S3B, S3N
Wilson's phalarope	*Phalaropus tricolor*	F	G5 S4B, S4N
Insects			
Desert forktail	*Ischnura barberi*	F	G4 S2
Horned clubtail	*Arigomphus cornutus*	F	G4 S1
Plateau spreadwing	*Lestes alacer*	F, SWAP2	G5 S2S3
Saffron-bordered meadowfly	*Sympetrum costiferum*	F	G5 S3
Mammals			
Preble's meadow jumping mouse	*Zapus hudsonius preblei*	LT, FS, ST, SWAP1, F	G5T2 S1
Mollusks			
Giant floater	*Anodonta grandis (Pyganodon grandis)*	F	G5 S2

[1] LT = Federal Threatened Status under the ESA; BLM = BLM Sensitive Species; FS = Forest Service Sensitive Species; ST = State Threatened Species; SC = State Special Concern Species; F = CNHP full tracking status; SWAP1 and SWAP2 = Tier 1 and Tier 2 species of greatest conservation need, Colorado State Wildlife Action Plan.
[2] See Appendix G for CNHP rank descriptions.

Table F-2. CNHP tracked aquatic dependent plants with potential to occur within Aurora

Common Name	Scientific Name	Status[1]	CNHP Rank[2]	Habitat[3]	Flowering Period[3]
Sweet flag	*Acorus calamus*	F	G4? S1	Wet meadows and ditches.	June-July
Plains ragweed	*Ambrosia linearis*	F	G3 S3	Playa lake basins on plains, roadsides, clay-rich soils.	June-August
Crawe's sedge	*Carex crawei*	F	G5 S1	Moist open ground, 5,500-7,000 feet.	June-August
Southwestern waterwort	*Elatine rubella*	F	G5 S2	Pond-shores, muddy banks, shallow water, plains to foothills.	April-July
Yellow stargrass	*Hypoxis hirsuta*	F	G5 S1	Moist swales and wetlands, plains grasslands where seeps occur.	April-July
Gay-feather	*Liatris ligulistylis*	F	G5? S2	Wet meadows, plains to lower foothills.	July-September
Square-stem monkeyflower	*Mimulus ringens*	F	G5 SH	Wet meadows, ponds, streambanks (not seen in Colorado since 1895)	July-August
Colorado butterfly plant	*Oenothera coloradensis (Gaura neomexicana* ssp. *coloradensis*)	SWAP1, F	G3T2 S1	Moist soils in wet meadows of floodplains.	June-September
Waterthread pondweed	*Potamogeton diversifolius*	F	G5 S1	Ditches and ponds.	June-September
American currant	*Ribes americanum*	F	G5 S2	Very moist areas, along streams and around springs.	May-July
Rocky Mountain bulrush	*Schoenoplectus saximontanus*	F	G5 S1	Pond and reservoir shores.	July-October
Broadfruit bur-reed	*Sparganium eurycarpum*	F	G5 S2	Shallow water of ponds and wet meadows.	June-August
Ute ladies' tresses	*Spiranthes diluvialis*	LT, F, SWAP1	G2G3 S2	Along streams and open seepage areas.	July-September
New England aster	*Symphyotrichum novae-angliae (Virgulus novae-angliae)*	F	G5 S2	Floodplain, moist locations on plains.	August-October

[1] LT = Federally Listed Threatened Species; SWAP1 = Tier 1 Plants of Greatest Conservation Need identified in Colorado State Wildlife Action Plan, Rare Plant Addendum; F = CNHP full tracking status.
[2] See Appendix G for CNHP rank descriptions.
[3] Sources for habitat and flowering period information: CNHP (1997), Ackerfield (2015), Wingate (2017).

Table F-3. CNHP wetland and riparian plant associations with potential to occur within Aurora[1].

Plant Association	Common Name	CNHP Rank[2]	CNHP Tracking Status[3]
Western North American Emergent Marsh			
Bolboschoenus maritimus Marsh	Emergent Wetland (Marsh)	G4 S2	Full
Calamagrostis canadensis Western Wet Meadow	Western Bluejoint Wet Meadow	G4 S4	Partial
Carex nebrascensis Wet Meadow	Nebraska Sedge Wet Meadow	G4 S4	Partial
Carex praegracilis Wet Meadow	Clustered Sedge Wetland	G3G4 S2	Full
Carex utriculata Wet Meadow	Beaked Sedge Montane Wet Meadows	G5 S5	Partial
Distichlis spicata - (*Scirpus nevadensis*) Alkaline Wet Meadow	Salt Grass-Nevada Rush Salt Meadow	G4 S3?	Partial
Eleocharis palustris Marsh	Common Spikerush Marsh	G5 S5	Partial
Glyceria borealis Wet Meadow	Northern Mannagrass Wet Meadow	G4 S2	Full
Juncus arcticus ssp. *littoralis* Wet Meadow	Western Slope Wet Meadows	G5 S5	Partial
Myriophyllum sibiricum Aquatic Vegetation	Western Slope Floating/Submerged Palustrine Wetlands	GUQ S1	Full
Phalaris arundinacea Western Marsh	Western Reed Canarygrass Marsh	G5 S5	Partial
Phragmites australis ssp. *australis* Western Ruderal Wet Meadow	Western Slope Marsh	GNA S5	Partial
Potamogeton diversifolius Aquatic Vegetation	Great Plains Floating/submergent Palustrine Wetlands	G1? SU	Ful
Potamogeton foliosus Aquatic Vegetation	Montane Floating/Submergent Palustrine Wetlands	G3? S1	Full
Potamogeton natans Aquatic Vegetation	Montane Floating/Submergent Wetland	G5? S1	Full
Ranunculus aquatilis - Callitriche palustris Aquatic Vegetation	Montane Floating/submergent Palustrine Wetlands	GU SU	Full
Salicornia rubra Salt Flat	Western Slope Salt Meadows	G2G3 S1	Full
Schoenoplectus acutus - Typha latifolia - (*Schoenoplectus tabernaemontani*) Sandhills Marsh	Great Plains Marsh	G4 S4	Partial

Plant Association	Common Name	CNHP Rank[2]	CNHP Tracking Status[3]
Schoenoplectus acutus Marsh	Hardstem Bulrush Marsh	G5 S5	Partial
Schoenoplectus americanus - *Carex* spp. Marsh	Great Plains Marsh	GNR S3	Full
Schoenoplectus americanus - *Eleocharis palustris* Marsh	Bulrush - Spikerush Marsh	G4 S4	Partial
Schoenoplectus americanus - *Eleocharis* spp. Marsh	Bulrush - Spikerush Marsh	GNR S2S3	Full
Schoenoplectus americanus Western Marsh		G3Q S3	Full
Schoenoplectus pungens Marsh	Common Threesquare Marsh	G3G4 S3	Full
Schoenoplectus tabernaemontani Temperate Marsh		G5 S5	Partial
Sparganium angustifolium Aquatic Vegetation	Montane Floating/submergent Palustrine Wetlands	G4 S2	Full
Sparganium eurycarpum Aquatic Vegetation	Foothills/Plains Floating/Submergent Palustrine Wetlands	G4 S1	Full
Spartina gracilis Wet Meadow	Western Slope Salt Meadows	GU S1	Full
Spartina pectinata Western Wet Meadow	Prairie Slough Grass	G3? S2	Full
Stuckenia filiformis Aquatic Vegetation	Montane Floating/submergent Palustrine Wetlands	GU SU	Full
Triglochin maritima Fen	Western Slope Salt Meadows	GU S1	Full
Typha (*latifolia, angustifolia*) Western Marsh	Cattail Marsh	G5 S5	Partial
Typha domingensis Western Marsh	Western Slope Marsh	G5? S1	Full
Western Great Plains Riparian			
Panicum obtusum Grassland	Vine-mesquite Herbaceous Vegetation	G3? S2	Full
Panicum virgatum - (*Pascopyrum smithii*) Wet Meadow	Switchgrass Wet-Mesic Tallgrass Prairie	G2Q S2	Full
Populus deltoides - (*Salix amygdaloides*) / *Salix* (*exigua, interior*) Floodplain Woodland	Plains Cottonwood Riparian Woodland	G3G4 S3	Full
Populus deltoides (ssp. *wislizeni,* ssp. *monilifera*) / *Salix exigua* Riparian Woodland	Cottonwood Riparian Forests	G3G4 S3	Full

Plant Association	Common Name	CNHP Rank[2]	CNHP Tracking Status[3]
Populus deltoides (ssp. *wislizeni,* ssp. *monilifera) / Sporobolus airoides* Flooded Woodland	Plains Cottonwood / Alkali Sacaton	G3 S2	Full
Populus deltoides / Carex pellita Floodplain Woodland	Plains Cottonwood Riparian Woodland	G2 S2	Full
Populus deltoides / Panicum virgatum - Schizachyrium scoparium Floodplain Woodland	Plains Cottonwood Riparian Forests	G2 S2	Full
Populus deltoides / Pascopyrum smithii - Panicum virgatum Floodplain Woodland	Cottonwood / Western Wheatgrass - Switchgrass Floodplain Woodland	GNR S2	Full
Populus deltoides / Symphoricarpos occidentalis Floodplain Woodland	Plains Cottonwood Riparian Woodland	G2G3 S2	Full
Salix exigua / Mesic Graminoids Western Wet Shrubland	Coyote Willow/Mesic Graminoid	G5 S5	Partial
Spartina pectinata Western Wet Meadow	Prairie Slough Grass	G3? S2	Full
Symphoricarpos occidentalis Shrubland	Snowberry Shrubland	G4G5 S4	Partial

1 Lists developed from Decker et al. 2020.

[2] See Appendix G for CNHP rank descriptions.

[3] CNHP Tracking Status is dependent upon state rarity rank. For associations ranked S4 or S5 (common in the state), only the best condition occurrences are recorded (partial tracking). For associations ranked S1, S2, S3, SU all occurrences are recorded (full tracking).

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APPENDIX G: SITE DESCRIPTIONS AND PLANT LISTS FOR AURORA WETLAND ASSESSMENT AREAS

Aurora Campus for Renewable Energy (ACRE) Marsh (AA-18) G-1
Box Elder Creek (AA-19) G-4
Coal Creek at Senac (AA-7) G-8
Coal Creek South (AA-6) and Coal Creek North (AA-8) G-13
Confluence Open Space/Triple Creek Greenway (AA-16) G-20
Horseshoe Park (AA-5) and Toll Gate Creek Greenway G-24
Jewell Wetlands (AA-4) G-29
Plains Conservation Center (AA-3) G-34
Pronghorn North Riparian Area (AA-1A) and Marsh (AA-1B) G-39
Pronghorn Southeast Riparian Area (AA-21) G-44
Pronghorn Southwest Riparian Area (AA-2) G-49
Quincy Reservoir (AA-14) G-54
Red-tailed Hawk Park Riparian Area (AA-15A) and Marsh (AA-15B) G-59
Sand Creek Park and Sand Creek Greenway (AA-11) G-65
Sand Creek Riparian Preserve/northern Triple Creek Greenway (AA-13) G-70
Signature Park Riparian Area (AA-12A) and Marsh (AA-12B) G-74
Star K Ranch (AA-9) G-80

Aurora Campus for Renewable Energy (ACRE) Marsh (AA-18)

EIA Overall Rank: 1.81 D	**FACWet Overall Rank: 0.60 D**

Landscape Context: 1.33 D
Vegetation Condition: 2.33 D
Hydrologic Condition: 1.67 D
Physiochemical Condition: 1.50 D

Mean C: 1.59
Native Mean C: 3.09
Size: 2 acres
Social Rating: 1.0 Low

Ecological System: Western North American Emergent Marsh
Hydrogeomorphic Class: Depressional

ACRE Marsh

Site Overview
This woody and marsh wetland is located in a deep depression surrounded by tilled farmland west of Box Elder Creek between Watkins Road and Hudson Mile Road. The wetland is an unusual feature: a pit that ranges from ~15-25 feet below ground level with steep sandy to loamy slopes. The wetland's soil unit is mapped as a gravel pit, surrounded by non-hydric Truckton Loamy Sand. Vegetation structure is varied with trees, shrubs, dead shrubs in the central ponded area, and a mix of wetland species and upland species higher up the bank. The presence of woody vegetation also resembles a riparian site, but due to the majority of the depressional site with deep water and herbaceous vegetation, the site is classified as a depressional marsh. The site elevation is 1669 meters.

Land Use: The ACRE Marsh is located within agricultural lands that are part of the Aurora Campus for Renewable Energy. The land surrounding the pit is farmed and there is scattered housing nearby. Aerial imagery in the 1980's shows that the historical landscape setting was open riparian, that may have once drained as a broad wash between Coyote Run and Box Elder Creek prior to farming.

Condition: This wooded marsh was rated a low D overall. This is an unnatural feature – likely an old gravel pit – within a tilled agricultural field. However, this wetland with its varied and layered vegetation structure and open water provides wetland function for wildlife.

Vegetation: The site's dominant plants occupied various strata, with complex vertical and horizontal vegetation zonation. Plains cottonwood (*Populus deltoides* ssp. *monilifera)* and peachleaf willow (*Salix amygdaloides*) were in the overstory, coyote willow (*Salix exigua)* was present in mid-layers and open shrub wetland zones, both narrowleaf and broadleaf cattail (*Typha angustifolia* and *T. latifolia*) were common in the less steep south wetland, and common duckweed (*Lemna minor*) was abundant in the open water. There were healthy shrubs but a central shrub zone is inundated and standing dead. There were 22 species observed at the site. Scotch and Canada thistle (*Cirsium arvense* and *Onopordum acanthium)* were common.

Recommendations:

- The wetland has value for its diverse structure and for wildlife habitat. However, the wetland is an unnatural feature in poor condition, that does not mimic a natural wetland type, so management endeavors may be better prioritized for healthy and at-risk wetlands.

Table G-1. List of Plant Taxa documented at ACRE Marsh (AA-18) (Field Season 2019)

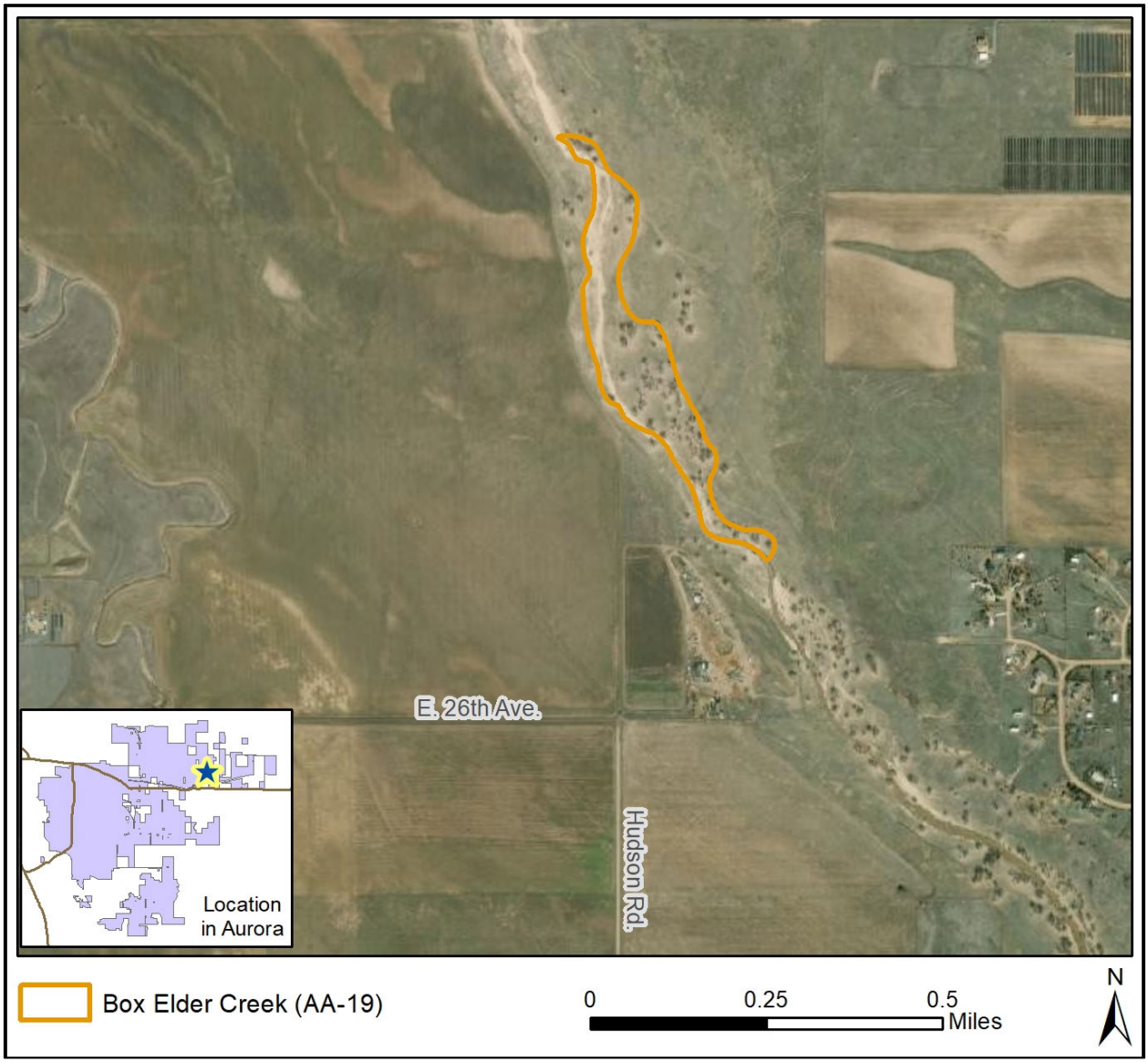
Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Bidens cernua	Native	5		OBL
Bromus inermis	Non-native	0		UPL
Carduus nutans	Non-native	0	List B	FACU
Cirsium arvense	Non-native	0	List B	FACU
Convolvulus arvensis	Non-native	0	List C	
Conyza canadensis	Native	1		FACU
Epilobium ciliatum	Native	4		FACW
Lactuca serriola	Non-native	0		FAC
Lemna minor	Native	2		OBL
Melilotus albus	Non-native	0		FACU
Mentzelia nuda	Native	4		
Nepeta cataria	Non-native	0		FACU
Onopordum acanthium	Non-native	0	List B	
Persicaria lapathifolia	Native	2		OBL
Populus deltoides ssp. *monilifera*	Native	3		FAC
Salix amygdaloides	Native	5		FACW
Salix exigua	Native	3		FACW
Typha angustifolia	Cryptogenic	1		OBL
Typha latifolia	Native	4		OBL
Ulmus pumila	Non-native	0	Watch List	UPL
Verbascum thapsus	Non-native	0	List C	UPL
Veronica anagallis-aquatica	Native	1		OBL

* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

Box Elder Creek (AA-19)

Mean C: 3.00
Native Mean C: 4.11
Size: 24 acres

Ecological System: Western Great Plains Riparian
Hydrogeomorphic Class: Riverine



Box Elder Creek Non-Wetland Riparian Area (no EIA)

Site Overview

Box Elder Creek was visited, but since no wetland was observed in the riparian area there was no EIA conducted. The AA was assessed for plants along the creek between Hudson Mile Rd. and E 26th Ave, north of Watkins. The sandy wash had open cottonwoods and diverse healthy native grasses, and a species list was recorded to document the notable site diversity. The sandy open wash character of this stream may represent the character of Aurora streams, such as Sand Creek, prior to urban development. This stream likely has flash flows and may only support surface flow during large precipitation events. The site elevation is 1673 meters.

Land Use: The Box Elder Creek AA is located within the Aurora Campus for Renewable Energy. The land surrounding the creek is primarily open grassland and agricultural tilled field.

Condition: The site was in moderately good condition and had maintained its sandy open character, appearing less-altered in aerial photos than many other channelized riparian areas in Aurora. Hydrology in the area is altered but its vegetation composition and open structure serves as an example of best-available riparian areas in the study. The central wash band had soft sand with sparsely vegetated forbs and scattered short statured coyote willows (*Salix exigua*) and prairie sunflower (*Helianthus petiolaris*). Some of the willows were browsed. Plains cottonwoods (*Populus deltoides*) flanked the wash on a slightly higher terrace. The soil was not hydric in a soil pit dug in the willows. The site is located in a riparian wash, and abuts tilled farmland without buffer in some areas, and open grassland in others. Wells in the area may be lowering the water table. There are housing developments farther from the AA. Other cottonwood areas had high quality grass understory.

Vegetation: The vegetation was moderately diverse with 50 species. The upland grass blue grama (*Bouteloua gracilis*) was the most common species, along with plains cottonwood (*Populus deltoides* ssp. *monilifera*) and cheatgrass (*Bromus tectorum*). A mixture of native and non-native grasses were also

common. This site had uniquely high quality native vegetation, with the highest occurrences of high C-values (from 5-8) in the study. The most conservative species (C-values 6-8) included the upland grasses sand bluestem (*Andropogon hallii*), prairie sandreed (*Calamovilfa longifolia*), and needle and thread (*Hesperostipa comata*) and upland forbs snowball sand verbena (*Abronia fragrans*) and prairie sandmat (*Chamaesyce missurica*).

Recommendations:

- *Conservation:* Protecting this unique site will conserve an ecosystem type that is frequently subject to development or ecosystem transformation. Its conserved sandy soil habitat was once more common in City of Aurora streams, and its native upland grass diversity is of conservation value.
- *Research:* This site is an example of a less-developed sandy riparian area with high quality native vegetation. Its native plant communities and hydrology can be studied to better understand the potential site history of other riparian zones in Aurora that have lost their sandy substrate and native vegetation.

Table G-2. List of Plant Taxa documented at Box Elder Creek (AA-19) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Abronia fragrans	Native	6		
Achnatherum hymenoides	Native	5		FACU
Agropyron cristatum	Non-native	0		
Aliciella pinnatifida	Native	5		FAC
Alyssum simplex	Non-native	0		
Ambrosia psilostachya	Native	3		FACU
Andropogon hallii	Native	8		
Artemisia campestris var. *caudata*	Native	5		UPL
Artemisia dracunculus	Native	3		
Bouteloua gracilis	Native	4		
Bromus inermis	Non-native	0		UPL
Bromus tectorum	Non-native	0	List C	
Calamovilfa longifolia	Native	7		
Chamaesyce missurica	Native	6		
Chenopodium desiccatum	Native	3		
Chenopodium sp.	Unknown			
Cichorium intybus	Non-native	0	List C	FACU
Cryptantha fendleri	Native	3		
Cycloloma atriplicifolium	Native	2		FACU
Distichlis stricta	Native	4		FACW
Erigeron divergens	Native	4		
Eriogonum annuum	Native	4		
Euphorbia esula	Non-native	0	List B	
Helianthus petiolaris	Native	2		
Hesperostipa comata	Native	6		
Kochia scoparia	Non-native	0		FACU
Lactuca serriola	Non-native	0		FAC
Lygodesmia juncea	Native	4		
Oenothera pallida ssp. *latifolia*	Native	5		

Scientific Name	Native Status	C-Value	CO Noxious	Wetland Indicator
Opuntia fragilis	Native	3		
Opuntia macrorhiza	Native	3		
Pascopyrum smithii	Native	5		FACU
Physalis hederifolia var. *comata*	Native	5		
Plantago patagonica	Native	2		UPL
Poa pratensis	Non-native	0		FACU
Polanisia dodecandra ssp. *trachysperma*	Native	1		FACU
Populus deltoides ssp. *monilifera*	Native	3		FAC
Psoralidium lanceolatum	Native	5		
Rhus trilobata var. *trilobata*	Native	5		UPL
Robinia neomexicana	Native	4		
Salix amygdaloides	Native	5		FACW
Salix exigua	Native	3		FACW
Saponaria officinalis	Non-native	0	List B	FACU
Secale cereale	Non-native	0		
Senecio spartioides	Native	5		
Thinopyrum intermedium	Non-native	0		
Tradescantia occidentalis	Native	5		UPL
Ulmus pumila	Non-native	0	Watch List	UPL
Xanthium strumarium	Native	1		FAC

* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

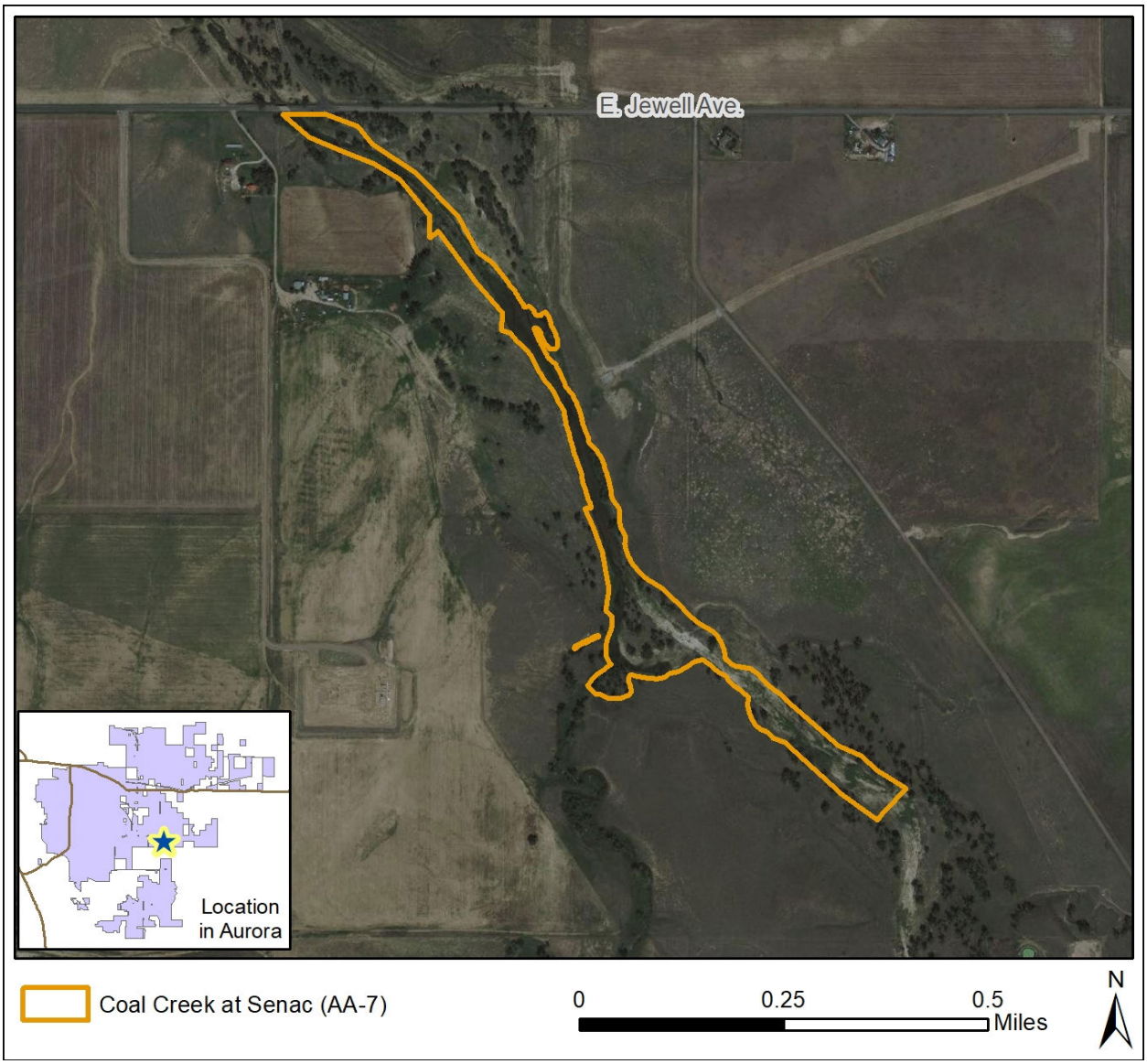
Coal Creek at Senac (AA-7)

EIA Overall Rank: 3.62 B	FACWet Overall Rank: 0.78 C

Landscape Context: 3.66 B
Vegetation Condition: 3.50 C/B
Hydrologic Condition: 3.67 B
Physiochemical Condition: 4.00 B

Mean C: 2.21
Mean Native C: 3.53
Size: 1.3 miles
Social Rating: 2.0 Low

Ecological System: Western Great Plains Riparian
Hydrogeomorphic Class: Riverine



Coal Creek at Senac

Site Overview

The Coal Creek at Senac wetland AA includes herbaceous riparian wetland with occasional trees along Coal Creek. The site is located just above and below Coal Creek's confluence with Senac Creek, west of E Yale Ave. and south of E Jewell Ave. Soils are hydric, sand to sandy loam with oxidized rhizospheres, black organic lenses around sand, and sections with shallow muck at the surface, but are mapped as non-hydric Sandy Alluvial Land. Water is slow moving to ponded or intermittent, with areas of groundwater input. The creek has pools and sandy splays. Northern leopard frog (*Lithobates pipiens*), a Colorado Parks and Wildlife Tier 1 species of greatest conservation need (SGCN), are present within the site as well as non-native invasive bullfrogs (*Lithobates catesbeianus*). Additionally, bald eagle, a Tier 2 SGCN, nest within the site. The wetland was not open to the public at the time of survey, and its lack of trails and more rural location likely contributed to its overall good condition. The site elevation is 1716 meters.

Land Use: The Coal Creek at Senac AA is owned by the City of Aurora and is currently not open to the public. The Coal Creek riparian area around its confluence with Senac Creek are set in open space, fallow fields, and farmland, with gentle topography. There is an oil/gas pad in in the site's buffer, and a landfill upstream. The site received the lowest stressor score, with low overall stress in the vegetation and soils categories; however overall site stress was still high. Small tributary drainages and seeps that would feed into Coal Creek have reduced or lost function due to farming history. Aerial imagery shows some infilling of wetland vegetation over the formerly sandy channel, but much of the upstream sandy channel in the upstream half of the AA is intact. Older aerial imagery shows management of the downstream channel width and scraping of the adjacent substrate. This site is in a relatively rural area compared with other sites in this study.

Site Condition: This site received the highest EIA rating in the study. The landscape context, hydrology, and physiochemical condition were rated as B. Vegetation was rated B/C, with good structure and diversity. There was a sizeable buffer with both native prairie grassland species and other cheatgrass (*Bromus tectorum*) zones. There were localized patches of algae concentrated in pools, which leopard frogs utilized for basking, but water was in good condition overall. The site is unique for maintaining a sandy channel, but vegetation has grown in moderately in the last decade, indicating hydrologic change. There were also indicators of groundwater discharge. There is historical terracing influencing channel connectivity, but the wetland is minimally disconnected from upland overall.

Vegetation: The site supported high diversity with 88 species recorded at the time of survey. Vegetation was mostly herbaceous, dominated by common threesquare (*Schoenoplectus pungens*) and redtop (*Agrostis gigantea*), and 5-10% cover class of narrow-leaf cattail (*Typha angustifolia*). There were scattered plains cottonwood (*Populus deltoides* ssp. *monilifera*) and peachleaf willow (*Salix amygdaloides*) trees, and several Russian olives (*Eleagnus angustifolia*). The remainder of species were approximately evenly mixed between native and non-native species in lower cover. There were 9 noxious weed species, with most species in sparse cover. There were desirable fine wetland graminoids including sedges (*Carex nebrascensis* and *C. praegracilis)*, and rushes (*Juncus arcticus* var. *balticus, J. articulatus,* and *J. torreyi*) in lower cover. This wetland had 14 moderately conservative native species with a C-value of 5-6, such as velvety goldenrod (*Solidago mollis*), arumleaf arrowhead (*Sagittaria cuneata*), common hops (*Humulus neomexicanus*), and small pondweed (*Potamogeton pusillus*); more occurrences of higher C-value plants than the other surveyed wetland sites except Red-tailed Hawk Park.

Wildlife Species of Greatest Conservation Need: Northern leopard frogs, a Tier 1 species of greatest conservation need, were abundant at a pond near the confluence of Coal Creek and Senac Creek. Invasive bullfrogs were abundant in a separate pond, also near the confluence of Coal Creek and Senac Creek. Both species were present at lower density throughout the drainage. Through direct predation and competition, the bullfrog poses a serious threat to this population of northern leopard frogs. Control of bullfrogs, though difficult, is recommended to maintain the existing northern leopard frog population. Testing for the chytrid fungus was negative at this location. Bald eagle, a Tier 2 species of greatest conservation need, nest within this reach of Senac and Coal Creek. The area is currently not open to the public which limits disturbance to the nesting eagles.

Recommendations:

- *Land Use:* Site has a long intact riparian corridor with native sandy substrate and large patches of native grass upland buffer, both worthy of preservation. The site supports important wildlife habitat in an urban area and contributes to downstream aquatic resource health. Management with a focus on conservation and limiting development in its local contributing watershed can help maintain wetland health.
- *Weeds:* Avoid chemical weed treatment to avoid impacts to the diverse pollinator species and other sensitive wildlife. Scattered Russian olives are growing in the outer wetland zone that should be managed.
- *Wildlife:* Leopard frogs were observed at this site coexisting with non-native invasive bullfrogs. Monitoring of the leopard frogs and control of the bullfrog population is recommended.

Table G-3. List of Plant Taxa documented at Coal Creek at Senac (AA-7) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Agrostis gigantea	Non-native	0		FACW
Alopecurus arundinaceus	Non-native	0		FACW
Alyssum desertorum	Non-native	0		
Ambrosia psilostachya	Native	3		FACU
Ambrosia trifida var. *trifida*	Native	3		FAC
Asclepias speciosa	Native	3		FAC
Asparagus officinalis	Non-native	0		FACU
Bromus inermis	Non-native	0		UPL
Bromus japonicas	Non-native	0		FACU
Carduus nutans	Non-native	0	List B	FACU
Carex nebrascensis	Native	5		OBL
Carex praegracilis	Native	5		FACW
Chenopodium pratericola	Native	4		
Chenopodium simplex	Native	2		
Chenopodium sp.	Unknown			
Cichorium intybus	Non-native	0	List C	FACU
Cirsium arvense	Non-native	0	List B	FACU
Conium maculatum	Non-native	0	List C	FACW
Convolvulus arvensis	Non-native	0	List C	
Conyza canadensis	Native	1		FACU
Cuscuta sp.	Native			
Descurainia sophia	Non-native	0		
Elaeagnus angustifolia	Non-native	0	List B	FACU
Eleocharis palustris	Native	3		OBL
Elymus canadensis	Native	4		FACU
Elymus repens	Non-native	0	List C	FACU
Epilobium ciliatum	Native	4		FACW
Equisetum laevigatum	Native	4		FAC
Euphorbia dentata	Native	1		
Euphorbia esula	Non-native	0	List B	
Fallopia convolvulus	Non-native	0		FACU
Glycyrrhiza lepidota	Native	3		FACU
Grindelia squarrosa	Native	1		UPL
Helianthus annuus	Native	1		FACU
Helianthus petiolaris	Native	2		
Hordeum jubatum	Native	2		FACW
Humulus neomexicanus	Native	5		FACU
Juncus arcticus var. *balticus*	Native	4		FACW
Juncus articulatus	Native	6		OBL
Juncus torreyi	Native	5		FACW
Lactuca serriola	Non-native	0		FAC
Lactuca tatarica var. *pulchella*	Native	3		UPL
Lemna minor	Native	2		OBL
Lycopus americanus	Native	5		OBL
Medicago lupulina	Non-native	0		FACU
Medicago sativa	Non-native	0		UPL
Melilotus albus	Non-native	0		FACU
Melilotus officinalis	Non-native	0		FACU
Mentha arvensis	Native	4		FACW

Scientific Name	Native Status	C-Value	CO Noxious	Wetland Indicator
Mirabilis sp.	Unknown			
Muhlenbergia asperifolia	Native	4		FACW
Oenothera villosa	Native	4		FACU
Pascopyrum smithii	Native	5		FACU
Plantago major	Non-native	0		FAC
Poa bulbosa	Non-native	0	List C	FACU
Polanisia dodecandra ssp. *trachysperma*	Native	1		FACU
Polygonum ramosissimum	Native	2		FACW
Polypogon monspeliensis	Non-native	0		FACW
Populus deltoides ssp. *monilifera*	Native	3		FAC
Potamogeton foliosus	Native	4		OBL
Potamogeton pusillus	Native	5		OBL
Ranunculus cymbalaria	Native	4		OBL
Ranunculus sceleratus var. *multifidus*	Native	1		OBL
Ribes aureum	Native	6		FACU
Rorippa sinuata	Native	4		FACW
Rosa arkansana	Native	5		FACU
Rumex stenophyllus	Non-native	0		FACW
Sagittaria cuneata	Native	6		OBL
Salix amygdaloides	Native	5		FACW
Salix exigua	Native	3		FACW
Salsola sp.	Non-native	0		
Saponaria officinalis	Non-native	0	List B	FACU
Schoenoplectus pungens	Native	4		OBL
Schoenoplectus tabernaemontani	Native	3		OBL
Solidago canadensis/gigantea	Native	5		
Solidago mollis	Native	6		
Sonchus asper	Non-native	0		FAC
Sphenopholis obtusata	Native	5		FAC
Symphoricarpos occidentalis	Native	3		UPL
Symphyotrichum ericoides	Native	4		FACU
Taraxacum officinale	Non-native	0		FACU
Thlaspi arvense	Non-native	0		FACU
Trifolium fragiferum	Non-native	0		FAC
Typha angustifolia	Cryptogenic	1		OBL
Typha latifolia	Native	4		OBL
Veronica anagallis-aquatica	Native	1		OBL
Xanthium strumarium	Native	1		FAC
Zannichellia palustris	Native	2		OBL

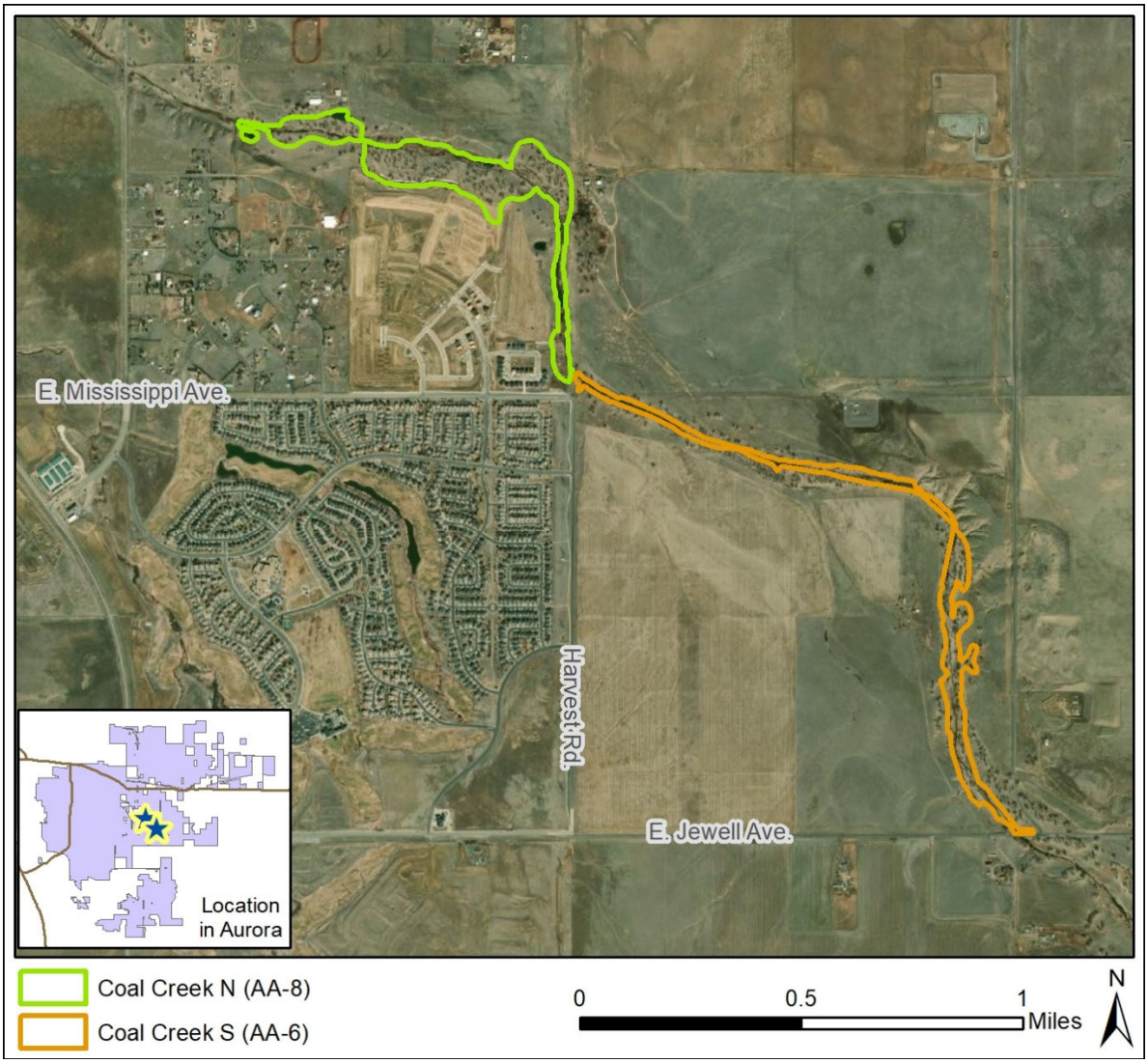
* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

Coal Creek South (AA-6) and Coal Creek North (AA-8)

AA-6: EIA Overall Rank: 3.38 C	**AA-6: FACWet Overall Rank: 0.74 C**
AA-8: EIA Overall Rank: 2.94 C	**AA-8: FACWet Overall Rank: 0.72 C**

AA-6: Landscape Context: 3.17 C	Mean C: 2.07
Vegetation Condition: 3.50 C/B	Native Mean C: 3.35
Hydrologic Condition: 3.33 C	Size: 1.7 miles
Physiochemical Condition: 3.75 B	Social Rating: 1.5 Low
AA-8: Landscape Context: 2.67 C	Mean C: 2.38
Vegetation Condition: 3.00 C	Native Mean C: 3.73
Hydrologic Condition: 3.00 C	Size: 1.2 miles
Physiochemical Condition: 3.50 C/B	Social Rating: 2.0 Low

Ecological System: Western Great Plains Riparian
Hydrogeomorphic Class: Riverine



Coal Creek S, AA-6 **Coal Creek N, AA-8**

Site Overview

The north and south Coal Creek wetlands include the riparian wetland area along wooded Coal Creek west of S Powahatan Rd. (AA-6; Coal Creek S) downstream to northeast of the recent Waterstone development (AA-8; Coal Creek N). These AAs include a narrow herbaceous riparian wetland band with patches of shrubs and trees along the creek, but not the higher adjacent terraces of non-wetland riparian woodland. Beaver have populated stretches of the wetland. Localized seeps support emergent wetland aquatic species. There is little open flowing water, with most of the once sandy drainage now infilled with wetland graminoids and cattail (*Typha* spp.). A soil pit dug in a patch of common threesquare (*Schoenoplectus pungens*) had dense hydric loamy-sandy clay loam overlain by 5 cm of sand that appeared deposited by streamflow, and other riparian areas appeared more loamy-sandy. Similarly, soil map units are mapped as non-hydric Sandy Alluvial Land and Loamy Alluvial land. Other soils across the long riparian area appeared more loamy-sandy. The site elevation is 1700 m.

Land Use: The Coal Creek South AA is privately owned. The Coal Creek wetlands are set in a partly farmed open landscape and gentle topography, where residential development tracts have periodically encroached closer to the creek over the last few decades. The riparian area is privately owned and as such is not open to the public. The open space southwest of Coal Creek N AA-8 was being developed at the time of survey. Review of historic aerial photos shows that braided creeks and likely mesic seep areas have been lost through time due to farming and development. Small tributary drainages that would feed into Coal Creek are mostly farmed over and have reduced or lost function. Aerial imagery shows the infilling of wetland vegetation over the formerly sandy channel, and this is likely influenced by development. There are several mapped groundwater wells along the creek, and adjacent housing developments with numerous wells. These sites are in a relatively rural area compared with other sites in this study, and their surrounding landscape to the east includes farmed playas.

Site Condition: Both sites rated a C overall, and in the landscape context and hydrologic condition metric categories. The upstream AA-6 rated the third highest EIA score, slightly higher than AA-8, due to less impact from surrounding development. The upstream AA-6 site had moderate localized algae issues but good substrate condition, which supported areas of seep hydrology and vegetation and sandy soils. The downstream AA-8 site had good water condition but some substrate alteration, sedimentation influence from construction, and some bare areas. Both sites had signs of hydrologic stress due to their mostly vegetated channel, and potential for further wetland width contraction evident by weeds such as sweetclover (*Melilotus* spp.) lining their edges. These wetlands were both valuable to conserve for their length and relatively undeveloped surrounding landscape, with miles of contiguous riparian length and good vegetation buffer, where the woody upper riparian terraces buffered the stream channel wetland. Wetlands such as these with persistent sandy channel have more connectivity and native function than many other wetlands in Aurora's watershed.

Vegetation: Coal Creek AA-6 and AA-8 had good quality vegetation complexity and structure, but the upstream site (AA-6) vegetation was less seriously impacted by non-native and noxious species, scoring a B/C, and downstream (AA-8) a C. Vegetation was filling in the channel bed with increasing density downstream, and the downstream AA-8 had higher non-native and invasive cover than AA-6. There were 10 state noxious or watch-listed species recorded.

There is a mixture of herbaceous, shrub, and forested stretches of riparian area, with dominant woody species including coyote willow (*Salix exigua*) and plains cottonwood (*Populus deltoides* ssp. *monilifera*). Common threesquare (*Schoenoplectus pungens*) was the most dominant understory species upstream, and redtop (*Agrostis gigantea*) was dominant downstream and common upstream. Other common understory species in both AAs were smooth brome (*Bromus inermis*), and white sweetclover *(Melilotus albus*). The downstream AA had higher quackgrass (*Elymus repens*) cover, and both sites had several Russian olives (*Eleagnus angustifolia*). Intermixed with those non-native species in the channel were obligate wetland marsh species, with softstem bulrush (*Schoenoplectus tabernaemontani*) and narrow-leaf cattail (*Typha angustifolia*). The upstream AA had seep areas with consistent cover of the obligate native forbs arumleaf arrowhead (*Sagittaria cuneata*) and northern water plantain (*Alisma triviale*). Higher cover of those aquatic emergent forbs is unique for urban plains wetlands and at this site is associated with seeps. The downstream site vegetation structure was positively influenced by beaver.

Wildlife of Note: At least one beaver pond and lodge were present in the Coal Creek North AA-8. Beaver maintain and restore overall site health. Northern leopard frogs were not found in Coal Creek North or Coal Creek South during the 2019 surveys. CNHP surveys during 2012 recorded northern leopard frogs at one location within Coal Creek South (AA-6) and one location within Coal Creek North (AA-8). Bullfrogs were present throughout AA-6 and AA-8 in 2019 and may have displaced the northern leopard frogs.

Recommendations:

- *Land Use:* A wider buffer is needed between the site and adjacent development and farmed areas; allowing the vegetation to naturalize within contributing drainages can help restore site hydrology.
- *Connectivity:* Cottonwood outer riparian zone provides important buffer against sedimentation from farmland. The site was unique for its good hydrologic connectivity. Avoid new trails, especially near the riparian zone and seeps, to maintain higher site quality. Trails can change hydrology and divert site water supply especially in low energy riparian sites.

- *Substrate:* Sandy substrate has infilled with vegetation, but sandy soil is still present. Monitor site vegetation in stream for signs of change from hydrologic stress, and sedimentation from construction and adjacent farm field, and avoid impacts to drainage to conserve sandy soil.
- *Hydrology:* The wetland is unique for limited stormwater inputs and seeps. Stormwater addition and impacts to seep areas should be avoided.
- *Beaver:* Beaver maintain and restore overall site health, manage for their continued presence.
- *Weeds:* Avoid chemical weed treatment to avoid impacts to the diverse pollinator species and other sensitive wildlife.

Table G-4. List of Plant Taxa documented at Coal Creek at South (AA-6) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Agrostis gigantea	Non-native	0		FACW
Alisma triviale	Native	3		OBL
Ambrosia psilostachya	Native	3		FACU
Apocynum cannabinum	Native	2		FAC
Asclepias speciosa	Native	3		FAC
Asparagus officinalis	Non-native	0		FACU
Astragalus cicer	Non-native	0		
Berula erecta	Native	5		OBL
Bromus inermis	Non-native	0		UPL
Bromus japonicus	Non-native	0		FACU
Bromus tectorum	Non-native	0	List C	
Carex nebrascensis	Native	5		OBL
Centaurium pulchellum	Non-native	0		FACU
Chenopodium simplex	Native	2		
Cichorium intybus	Non-native	0	List C	FACU
Cirsium arvense	Non-native	0	List B	FACU
Conium maculatum	Non-native	0	List C	FACW
Convolvulus arvensis	Non-native	0	List C	
Conyza canadensis	Native	1		FACU
Cyclachaena xanthifolia	Native	2		FAC
Echinochloa crus-galli	Non-native	0		FAC
Elaeagnus angustifolia	Non-native	0	List B	FACU
Eleocharis palustris	Native	3		OBL
Elymus repens	Non-native	0	List C	FACU
Elymus trachycaulus	Native	4		FACU
Epilobium ciliatum	Native	4		FACW
Equisetum laevigatum	Native	4		FAC
Euphorbia esula	Non-native	0	List B	
Glycyrrhiza lepidota	Native	3		FACU
Grindelia squarrosa	Native	1		UPL
Helianthus annuus	Native	1		FACU
Juncus arcticus var. *balticus*	Native	4		FACW
Juncus articulatus	Native	6		OBL
Juncus bufonius	Native	3		OBL
Juncus torreyi	Native	5		FACW
Lactuca serriola	Non-native	0		FAC
Lemna minor	Native	2		OBL

Scientific Name	Native Status	C-Value	CO Noxious	Wetland Indicator
Lycopus americanus	Native	5		OBL
Medicago lupulina	Non-native	0		FACU
Medicago sativa	Non-native	0		UPL
Melilotus albus	Non-native	0		FACU
Mirabilis linearis	Native	5		
Muhlenbergia asperifolia	Native	4		FACW
Oenothera villosa	Native	4		FACU
Panicum virgatum	Native	5		FAC
Pascopyrum smithii	Native	5		FACU
Persicaria lapathifolia	Native	2		OBL
Plantago major	Non-native	0		FAC
Polanisia dodecandra ssp. *trachysperma*	Native	1		FACU
Polygonum ramosissimum	Native	2		FACW
Polypogon monspeliensis	Non-native	0		FACW
Populus deltoides ssp. *monilifera*	Native	3		FAC
Ranunculus cymbalaria	Native	4		OBL
Ranunculus sceleratus var. *multifidus*	Native	1		OBL
Ratibida columnifera	Native	4		
Rumex stenophyllus	Non-native	0		FACW
Sagittaria cuneata	Native	6		OBL
Salix amygdaloides	Native	5		FACW
Salix exigua	Native	3		FACW
Schoenoplectus pungens	Native	4		OBL
Schoenoplectus tabernaemontani	Native	3		OBL
Symphyotrichum ericoides	Native	4		FACU
Tamarix chinensis	Non-native	0	List B	FACW
Taraxacum officinale	Non-native	0		FACU
Trifolium fragiferum	Non-native	0		FAC
Typha angustifolia	Cryptogenic	1		OBL
Typha latifolia	Native	4		OBL
Unknown forb	Unknown			
Unknown forb	Unknown			
Verbascum thapsus	Non-native	0	List C	UPL
Veronica anagallis-aquatica	Native	1		OBL
Xanthium strumarium	Native	1		FAC

* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

Table G-5. List of Plant Taxa documented at Coal Creek North (AA-8) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Agrostis gigantea	Non-native	0		FACW
Alopecurus arundinaceus	Non-native	0		FACW
Ambrosia psilostachya	Native	3		FACU
Asclepias incarnata	Native	4		FACW
Asclepias speciosa	Native	3		FAC
Astragalus cicer	Non-native	0		
Berula erecta	Native	5		OBL
Bidens cernua	Native	5		OBL
Bolboschoenus maritimus ssp. *paludosus*	Native	5		OBL
Bromus inermis	Non-native	0		UPL
Carduus nutans	Non-native	0	List B	FACU
Carex praegracilis	Native	5		FACW
Centaurea diffusa	Non-native	0	List B	
Chenopodium berlandieri var. *zschackii*	Native	2		
Chenopodium leptophyllum	Native	5		FACU
Cichorium intybus	Non-native	0	List C	FACU
Cirsium arvense	Non-native	0	List B	FACU
Convolvulus arvensis	Non-native	0	List C	
Cyclachaena xanthifolia	Native	2		FAC
Echinochloa crus-galli	Non-native	0		FAC
Elaeagnus angustifolia	Non-native	0	List B	FACU
Eleocharis palustris	Native	3		OBL
Elymus repens	Non-native	0	List C	FACU
Epilobium ciliatum	Native	4		FACW
Equisetum laevigatum	Native	4		FAC
Euphorbia esula	Non-native	0	List B	
Glycyrrhiza lepidota	Native	3		FACU
Grindelia squarrosa	Native	1		UPL
Helianthus annuus	Native	1		FACU
Hordeum jubatum	Native	2		FACW
Juncus arcticus var. *balticus*	Native	4		FACW
Juncus articulatus	Native	6		OBL
Juncus torreyi	Native	5		FACW
Lemna minor	Native	2		OBL
Lycopus americanus	Native	5		OBL
Medicago sativa	Non-native	0		UPL
Melilotus albus	Non-native	0		FACU
Melilotus officinalis	Non-native	0		FACU
Mentha arvensis	Native	4		FACW
Mentzelia nuda	Native	4		
Muhlenbergia asperifolia	Native	4		FACW
Panicum virgatum	Native	5		FAC
Pascopyrum smithii	Native	5		FACU
Persicaria sp.	Unknown			
Plantago major	Non-native	0		FAC
Polypogon monspeliensis	Non-native	0		FACW
Populus deltoides ssp. *monilifera*	Native	3		FAC
Rumex crispus	Non-native	0		FAC
Rumex stenophyllus	Non-native	0		FACW

Scientific Name	Native Status	C-Value	CO Noxious	Wetland Indicator
Sagittaria cuneata	Native	6		OBL
Salix amygdaloides	Native	5		FACW
Salix exigua	Native	3		FACW
Schoenoplectus pungens	Native	4		OBL
Schoenoplectus tabernaemontani	Native	3		OBL
Solidago canadensis/gigantea	Native	5		
Sonchus asper	Non-native	0		FAC
Symphyotrichum ericoides	Native	4		FACU
Symphyotrichum lanceolatum ssp. *hesperium*	Native	5		FACW
Trifolium fragiferum	Non-native	0		FAC
Typha angustifolia	Cryptogenic	1		OBL
Typha latifolia	Native	4		OBL
Veronica anagallis-aquatica	Native	1		OBL
Xanthium strumarium	Native	1		FAC
Zannichellia palustris	Native	2		OBL

* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

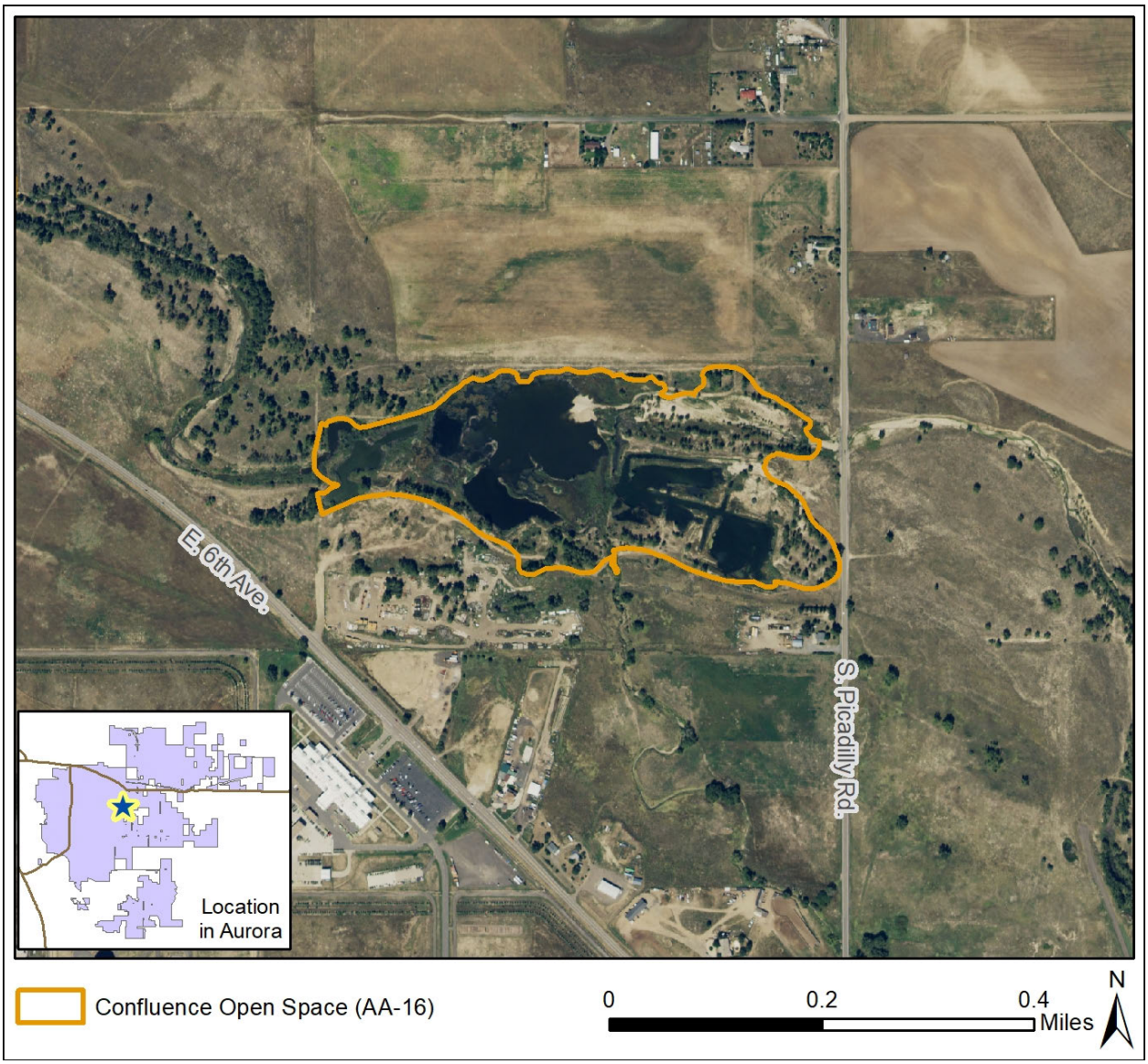
Confluence Open Space/Triple Creek Greenway (AA-16)

EIA Overall Rank: 2.38 D	**FACWet Overall Rank: 0.67 D**

Landscape Context: 3.31 C
Vegetation Condition: 2.17 D
Hydrologic Condition: 1.67 D
Physiochemical Condition: 2.00 D

Mean C: 1.83
Native Mean C: 3.18
Size: 44 acres
Social Rating: 2.5 Low

Ecological System: Western North American Emergent Marsh
Hydrogeomorphic Class: Depressional



Confluence Open Space

Site Overview
The Confluence Open Space is located at the confluence where Murphy Creek and Coal Creek converge into Sand Creek east of Picadilly Road. The site is a former gravel pit complex that has revegetated into a cattail (*Typha*) and shrub marsh surrounding open water ponds. The AA includes the wetlands and riparian vegetation in and adjacent to the ponds, including herbaceous, shrub, and scattered tree vegetation. There is also non-wetland cottonwood gallery floodplain preserved by the two washy creeks on the outer gravel pit complex, not included in the AA. Depressional hydrology is confined by shallow to deep water in the gravel pond banks, and also intercepts floodplain alluvium. Soils are a mixture of fill and berms bounding the ponds, and are sandy where not excavated, with a restrictive layer in one soil pit at a depth of 20 cm. They are mapped as non-hydric sandy alluvial land. There is a beaver lodge in the large open water area. Additionally, bald eagle, a Tier 2 SGCN, nest within the site. There is a dirt trail on the north side of the AA, but the wetland area was not open to the public at the time of survey. The site elevation is 1692 meters.

Land Use: Confluence is a City of Aurora Open Space that is not yet open to the public except for scheduled educational programs. Historical imagery shows this former gravel pond site was transformed from a once washy floodplain to gravel ponds, to partially vegetated marsh ponds with steep berms that prevent shallow water emergent vegetation zones. The surrounding landscape had low density development and residential areas, and a network of larger roads, interspersed with high-value open space which buffered the contributing and outflowing creeks. New developments are being constructed north of the site after the 2019 survey.

Condition: This depressional marsh and shrubland AA was rated a high D score. The surrounding landscape rated a B/C with its mix of open space and development. Site hydrology had a largely natural surface water source and some alluvial groundwater inputs, with unnaturally deep water and limited connectivity between the pond berms. Vegetation was weedy and had large patches of single species, but at a larger scale structure is more varied. In narrow confined flooded areas the water quality had turbidity and algae issues, but in the open water near beaver condition was generally good. Most of the water lacked woody debris except the beaver dam. The substrate was rated in poor condition from excavation and fill impacts, but is naturalizing over time.

Vegetation: Vegetation was a mixture of dense cattail (*Typha*) and coyote willow (*Salix exigua*) along the excavated banks. A sandy floodplain band had young coyote willow ingrowth that appeared even-aged. There is high cover of white and yellow sweetclover (*Melilotus albus* and *M. officinalis*) along the berms just outside the cattail/willow zones. The vegetation survey recorded 31 species in the wetland and adjacent riparian area. There is about 30% cover of noxious or watch-listed weeds from 6 species, including Canada thistle (*Cirsium arvense*), Russian olive (*Elaeagnus angustifolia*), leafy spurge (*Euphorbia esula*), nodding plumeless thistle (*Carduus nutans*), quackgrass (*Elymus repens*) and field bindweed (*Convolvulus arvensis*). There is moderate native wetland graminoid diversity in low cover, including common threesquare (*Schoenoplectus pungens*), pale spikerush (*Eleocharis palustris*), mountain rush (*Juncus arcticus* var. *balticus*), Torrey's rush (*Juncus torreyi*), hardstem bulrush (*Schoenoplectus acutus*), and softstem bulrush (*Schoenoplectus tabernaemontani*). The upland buffer has a mixture of native and non-native grasses.

Wildlife Species of Greatest Conservation Need: Bald eagle, a Tier 2 species of greatest conservation need, nest within this area. The open space is currently not open to the public which limits disturbance to the nesting eagles.

Other Wildlife of Note: Beaver are well established within this site.

Recommendations:

- *Beaver:* Beaver support riverine wetland health and provide natural restoration services. There is a beaver lodge in the marsh, which should be supported by management.
- *Plants:* Site is revegetated but could improve in condition. The banks of the gravel pits are steep, non-native vegetation is common, and the water is mostly deep. Grading the banks, adding coarse woody debris to water edge, and planting native vegetation could improve wildlife habitat and overall function.
- *Land Use:* Although a human-altered wetland, this site is positioned at a confluence in the historical floodplain, providing important floodplain functions such as sediment capture, water storage, and nutrient transformation. The site is a valuable open space feature to conserve for downstream riparian health.
- *Weeds:* Avoid chemical weed treatment to avoid impacts to the diverse pollinator species and other sensitive wildlife.

Table G-6. List of Plant Taxa documented at Confluence Open Space (AA-16) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Agrostis gigantea	Non-native	0		FACW
Asclepias speciosa	Native	3		FAC
Carduus nutans	Non-native	0	List B	FACU
Chenopodium sp.	Unknown			
Cirsium arvense	Non-native	0	List B	FACU
Convolvulus arvensis	Non-native	0	List C	
Elaeagnus angustifolia	Non-native	0	List B	FACU
Eleocharis palustris	Native	3		OBL
Elymus repens	Non-native	0	List C	FACU
Euphorbia esula	Non-native	0	List B	
Helianthus petiolaris	Native	2		
Juncus arcticus var. *balticus*	Native	4		FACW
Juncus torreyi	Native	5		FACW
Lemna minor	Native	2		OBL
Lycopus americanus	Native	5		OBL
Melilotus albus	Non-native	0		FACU
Melilotus officinalis	Non-native	0		FACU
Mentha arvensis	Native	4		FACW
Panicum capillare	Native	1		FAC
Pascopyrum smithii	Native	5		FACU
Polypogon monspeliensis	Non-native	0		FACW
Ranunculus sceleratus var. *multifidus*	Native	1		OBL
Rumex crispus	Non-native	0		FAC
Salix amygdaloides	Native	5		FACW
Salix exigua	Native	3		FACW
Schoenoplectus acutus	Native	3		OBL
Schoenoplectus pungens	Native	4		OBL
Schoenoplectus tabernaemontani	Native	3		OBL
Sonchus oleraceus	Non-native	0		UPL
Typha angustifolia	Cryptogenic	1		OBL
Xanthium strumarium	Native	1		FAC

* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

Horseshoe Park (AA-5) and Toll Gate Creek Greenway

EIA Overall Rank: 1.82 D	**FACWet Overall Rank: 0.65 D**

Landscape Context: 1.00 D
Vegetation Condition: 2.00 D
Hydrologic Condition: 2.33 D
Physiochemical Condition: 2.50 D/C

Mean C: 1.54
Native Mean C: 3.61
Size: 1.5 miles
Social Rating: 10.5 Very High

Ecological System: Western Great Plains Riparian
Hydrogeomorphic Class: Riverine

Horseshoe Park

Site Overview

Horseshoe Park includes an herbaceous and shrub-dominated riparian area along West Tollgate Creek and its confluence with a tributary to the creek that is now West Cherry Creek Channel. The channel artificially connects upstream to Cherry Creek Spillway from Cherry Creek Reservoir. West Tollgate Creek receives major stormwater input and creek throughflow. Several drop structures control flow and at least two beaver dams are also restoring the stream with natural 'drop structures.' The soil map unit is mostly Wet Alluvial land (75% hydric), and likely historically flooded each spring. The current soil is hardened and flat, and no soil pit was dug. Current land use is highly urban and popular for recreation. The site elevation is 1680 meters.

Land Use: Horseshoe Park/Natural Area is a City of Aurora property set in a densely populated area; it includes a confluence of popular walking and bike trails and is adjacent to a recreational field. The site received a very high social rating.

Condition: This site's overall score and each major metric category were rated in D condition. The riparian area is surrounded by urban housing and recreation trails. The riparian buffer's substrate is impacted by a pipeline, and there is managed vegetation along a powerline. The hydrology is highly altered - with a cut stream channel, stormwater inputs, non-point source residential impacts, drop controls, and an infrequently used reservoir spillway; but beaver improve hydrologic condition where established. Their ponds provide water storage and slow outflow, and they add complexity to the landscape with downed wood and more natural vegetation structure. The site has reed canary grass invasion (*Phalaris arundinacea*). The wetland provides high green space value and developed trails popular for recreation. The low condition of the wetland limits the potential overall wetland function and influences water quality, sediment retention, and nutrient transformation, but the beaver dams provide areas of improved wetland function.

Vegetation: This riparian area has an open peachleaf willow (*Salix amygdaloides*) and plains cottonwood (*Populus deltoides* ssp. *monilifera*) overstory, a patchy mid-layer of coyote willow (*Salix exigua*). The understory is primarily reed canarygrass (*Phalaris arundinacea*), smooth brome (*Bromus inermis*) and quackgrass (*Elymus repens*) – all non-native invasives. A total of 78 species were recorded in the AA, 12 of which were noxious weeds. Vegetation was rated a D due to the invasive reed canarygrass and high cover of non-native and noxious species. Trees and shrubs added vegetation diversity and structural complexity to the simplified ecosystem, with native species such as prairie rose (*Rosa arkansana*), lanceleaf cottonwood (*Populus x acuminata),* black chokecherry *(Prunus virginiana* var. *melanocarpa),*

and golden currant *(Ribes aureum).* Russian olive *(Elaeagnus angustifolia),* Siberian elm *(Ulmus pumila),* and crack willow (*Salix ×fragilis)* trees were also present, along with other non-native tree and shrub species in low cover. In wetter herbaceous areas and more complex stream zones, small patches of higher quality vegetation included Nebraska sedge (*Carex nebrascensis*) and mountain rush (*Juncus arcticus* var. *balticus*). These native herbaceous vegetation patches were small and on unhardened substrate, such as one sedge patch in a location shaped by past beaver use.

Wildlife of Note: At least two beaver dams were noted within the park/natural area. One of the beaver dams was constructed on top of an existing grade control structure. A large snapping turtle (*Chelydra serpentine*) was noted in the stream.

Recommendations:

- *Beaver:* Beaver significantly increase site quality and zones of wetland vegetation and hydrology: allow beaver to persist and they will continue to restore the cut stream and dried riparian zone.
- *Plants:* Riparian zone is dominated by reed canary grass (*Phalaris arundinacea*) and smooth brome (*Bromus inermis*) and could benefit from native plant restoration.
- *Social Value:* River crossings and bike trails along the creek support positive human-wetland connection.
- *Weeds:* Avoid chemical weed treatment to avoid impacts to the diverse pollinator species and other sensitive wildlife.

Table G-7. List of Plant Taxa documented at Horseshoe Park (AA-5) (Field Season 2019)

Scientific Name	Native Status	C-Value	CO Noxious	Wetland Indicator
Agropyron cristatum	Non-native	0		
Alopecurus arundinaceus	Non-native	0		FACW
Ambrosia trifida var. *trifida*	Native	3		FAC
Asclepias speciosa	Native	3		FAC
Astragalus bisulcatus	Native	5		
Bromus inermis	Non-native	0		UPL
Bromus tectorum	Non-native	0	List C	
Camelina microcarpa	Non-native	0		UPL
Carex nebrascensis	Native	5		OBL
Chamaesyce serpyllifolia	Native	2		
Chenopodium album	Non-native	0		FACU
Chorispora tenella	Non-native	0		
Cirsium arvense	Non-native	0	List B	FACU
Conium maculatum	Non-native	0	List C	FACW
Convolvulus arvensis	Non-native	0	List C	
Dactylis glomerata	Non-native	0		FACU
Descurainia sophia	Non-native	0		
Dipsacus laciniatus	Non-native	0	List B	UPL
Distichlis stricta	Native	4		FACW
Elaeagnus angustifolia	Non-native	0	List B	FACU
Elymus repens	Non-native	0	List C	FACU
Euphorbia esula	Non-native	0	List B	
Euthamia occidentalis	Native	4		OBL
Fraxinus pennsylvanica	Non-native	0		FAC
Glycyrrhiza lepidota	Native	3		FACU
Helianthus annuus	Native	1		FACU
Helianthus petiolaris	Native	2		
Juncus arcticus var. *balticus*	Native	4		FACW
Juniperus sp.	Unknown			
Kochia scoparia	Non-native	0		FACU
Lactuca serriola	Non-native	0		FAC
Lactuca tatarica var. *pulchella*	Native	3		UPL
Lepidium chalapensis	Non-native	0		
Lonicera tatarica	Non-native	0		FACU
Malus pumila	Non-native	0		
Malva neglecta	Non-native	0		
Medicago sativa	Non-native	0		UPL
Melilotus albus	Non-native	0		FACU
Melilotus officinalis	Non-native	0		FACU
Nepeta cataria	Non-native	0		FACU
Oenothera curtifolia	Native	1		UPL
Onopordum acanthium	Non-native	0	List B	
Panicum capillare	Native	1		FAC
Panicum virgatum	Native	5		FAC
Parthenocissus vitacea	Native	3		FAC
Pascopyrum smithii	Native	5		FACU
Phalaris arundinacea	Cryptogenic	1		FACW
Populus ×acuminata	Native	5		FAC
Populus deltoides ssp. *monilifera*	Native	3		FAC

Scientific Name	Native Status	C-Value	CO Noxious	Wetland Indicator
Potamogeton pusillus	Native	5		OBL
Prunus virginiana var. melanocarpa	Native	4		FACU
Psathyrostachys juncea	Non-native	0		FACU
Rhamnus cathartica	Non-native	0		FACU
Ribes aureum	Native	6		FACU
Rosa arkansana	Native	5		FACU
Rumex crispus	Non-native	0		FAC
Salix ×fragilis	Non-native	0		FAC
Salix amygdaloides	Native	5		FACW
Salix exigua	Native	3		FACW
Sarcobatus vermiculatus	Native	4		FAC
Schoenoplectus tabernaemontani	Native	3		OBL
Solanum dulcamara	Non-native	0		FACU
Symphoricarpos occidentalis	Native	3		UPL
Symphyotrichum lanceolatum ssp. *hesperium*	Native	5		FACW
Symphyotrichum sp.	Native			
Taraxacum officinale	Non-native	0		FACU
Thlaspi arvense	Non-native	0		FACU
Tragopogon dubius	Non-native	0		
Typha angustifolia	Cryptogenic	1		OBL
Typha latifolia	Native	4		OBL
Ulmus pumila	Non-native	0	Watch List	UPL
Unknown forb	Unknown			
Unknown forb	Unknown			
Unknown ornamental	Non-native	0		
Unknown ornamental	Non-native	0		
Unknown ornamental	Non-native	0		
Urtica dioica ssp. *gracilis*	Native	3		FAC
Verbascum thapsus	Non-native	0	List C	UPL

* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

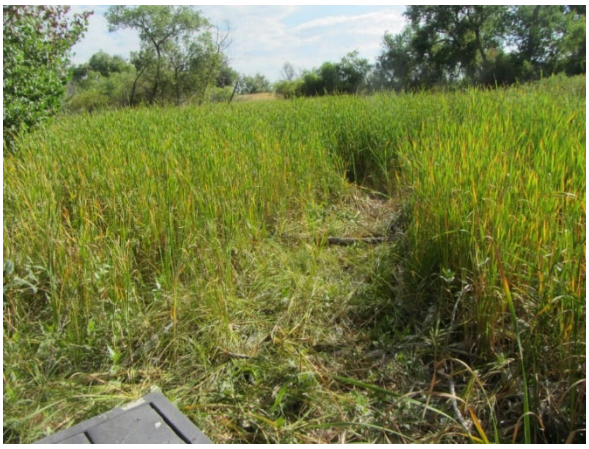
Jewell Wetlands (AA-4)

EIA Overall Rank: 2.25 D	**FACWet Overall Rank: 0.66 D**

Landscape Context: 1.86 D
Vegetation Condition: 2.33 D
Hydrologic Condition: 2.33 D
Physiochemical Condition: 3.25 C

Mean C: 1.52
Native Mean C: 3.30
Size: 15 acres
Social Rating: 10.5 Very High

Ecological Systems: Western North American Marsh (central wetland) and Western Great Plains Riparian (outer wooded ecosystem)
Hydrogeomorphic Class: Depressional



Jewell Wetlands

Site Overview

The marsh and wooded wetlands at Jewell Wetlands are NW of E Jewell Ave. and S Potomac St. The AA includes Jewell Tributary, and its adjoining wetland with a central marsh vegetation opening surrounded by a wooded wetland and riparian mosaic. There are urban, groundwater, and precipitation hydrologic inputs to the depressional wetland, and the creek has moderate flow. The site is popular for recreation with accessible boardwalks and trails, benches, and educational signage. The mapped soil unit is hydric Bijou sandy loam wet (a wet meadow range site), and the soil pit dug in the marsh vegetation was hydric sandy loam overlain by sandy clay loam. The site was classified as riparian due to Jewell Tributary and the larger woody riparian landscape, although the site had a central cattail marsh area. The site elevation is 1698 meters.

Land Use: Jewell Wetlands is a City of Aurora Open Space and has a social rating of very high due in part to its proximity to densely populated areas and its trails and educational signage. It is set in an otherwise highly developed landscape and is popular for recreation use. The park is utilized for flood storage, and the outer park receives stormwater drainage and non-point source inputs. The surveyed AA has less directly impacted hydrology with groundwater and precipitation direct inputs, but is adjacent to an excavated water storage pond. The groundwater source was more visible in aerial photos prior to development in the 1990's that channelized the wetland's seep sources. Although the wetland is shaped by surrounding development, its outer watershed position with converging topography, locally depressional location, and mapped hydric soil suggests it may have been a natural wetland in the past prior to stormwater input and development.

Site Condition: This site was rated D condition overall, shaped by its surrounding urban influences. There is open space upland buffer between surrounding development, but trails surround the wetland and limit onsite connectivity. Development has impacted the site's native hydrology and decreased groundwater source connectivity, but upslope groundwater seepage also supports natural wetland function. The site may be recently stressed or experiencing temporary drought based on substantial cover of dry cattail. The site is a hardworking wetland green space within an urban area. As the wetland receives seepage and stormwater inputs, it provides important buffer capacity, sediment catchment, nutrient transformation, intercepts water and reduces downstream floodplain risk, and supports wildlife habitat and human education/recreation value.

Vegetation: The vegetation had high cover of narrowleaf cattail (*Typha angustifolia*), coyote willow (*Salix exigua*), and peachleaf willow (*Salix amygdaloides*). A total of 67 species were observed during the survey, with a diverse mix of natives and non-natives, including woody ornamental species. The wetland provides varied structural diversity from marsh to meadow, shrubland, and cottonwood gallery, although vegetation was dense overall and native woody regeneration was low.

Vegetation composition was rated a D due to substantial non-native and invasive cover, especially of herbaceous species such as narrowleaf cattail (*Typha angustifolia*), smooth brome (*Bromus inermis*), Canada thistle (*Cirsium arvense*), Kentucky bluegrass (*Poa pratensis*), and cultivated rye (*Secale cereale*); and presence of 11 state watch-listed or noxious weeds. Various natives characteristic of diverse wetland habitats also remained in low cover, such as woodbine (*Parthenocissus vitacea*), softstem bulrush (*Schoenoplectus tabernaemontani*), white panicle aster (*Symphyotrichum lanceolatum* ssp. *hesperium*), mountain rush (*Juncus arcticus* var. *balticus*), Canada goldenrod (*Solidago canadensis*), scratchgrass (*Muhlenbergia asperifolia*), Nebraska sedge (*Carex nebrascensis*), and evening primrose (*Oenothera villosa*).

Wildlife of Note: The pond just east of the AA had numerous invasive red-eared sliders (*Trachemys scripta elegans*) of different age classes found along with native western painted turtles. The red-eared slider is a popular pet trade aquatic turtle native to southeastern U.S. and is often released into ponds in urban areas. The pond also supports the invasive bullfrog (*Lithobates catesbeianus*).

Recommendations:

- *Ecology:* Evaluate pest control operations within the natural area. Pest control risks a cascading effect on trophic levels and predators.
- *Plants:* The wetland has high cover of non-native species but good potential for some native plant restoration in areas of dominant non-native understory. Vegetation in areas still supporting several native wetland graminoids should be protected.
- *Social Value:* This site has likely reached an equilibrium with the level of human visitation. By being in lower condition with high use and many visitation amenities, this site is valuable for promoting human-wetland connection, but further development is not recommended.
- *Weeds:* Avoid chemical weed treatment to avoid impacts to the diverse pollinator species and other sensitive wildlife.

Table G-8. List of Plant Taxa documented at Jewell Wetlands (AA-4) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Agropyron cristatum	Non-native	0		
Alopecurus arundinaceus	Non-native	0		FACW
Alyssum simplex	Non-native	0		
Apocynum cannabinum	Native	2		FAC
Argemone polyanthemos	Native	3		
Asclepias speciosa	Native	3		FAC
Bidens frondosa	Native	3		FACW
Bromus inermis	Non-native	0		UPL
Bromus tectorum	Non-native	0	List C	
Carex nebrascensis	Native	5		OBL
Carex praegracilis	Native	5		FACW
Chamaesyce glyptosperma	Native	2		
Chorispora tenella	Non-native	0		
Cirsium arvense	Non-native	0	List B	FACU
Cirsium vulgare	Non-native	0	List B	UPL
Conium maculatum	Non-native	0	List C	FACW
Conyza canadensis	Native	1		FACU
Descurainia sophia	Non-native	0		
Dipsacus laciniatus	Non-native	0	List B	UPL
Elaeagnus angustifolia	Non-native	0	List B	FACU
Eleocharis palustris	Native	3		OBL
Elymus repens	Non-native	0	List C	FACU
Eragrostis pilosa	Native	1		FACU
Euphorbia dentata	Native	1		
Euphorbia esula	Non-native	0	List B	
Hordeum jubatum	Native	2		FACW
Juncus arcticus var. *balticus*	Native	4		FACW
Juniperus sp.	Unknown			
Lactuca serriola	Non-native	0		FAC
Lonicera tatarica	Non-native	0		FACU
Melilotus sp.	Non-native	0		
Mentha x piperita	Non-native	0		FACW
Muhlenbergia asperifolia	Native	4		FACW
Nepeta cataria	Non-native	0		FACU
Oenothera villosa	Native	4		FACU
Onopordum acanthium	Non-native	0	List B	
Panicum capillare	Native	1		FAC
Parthenocissus vitacea	Native	3		FAC
Persicaria amphibia	Native	4		OBL
Poa pratensis	Non-native	0		FACU
Populus ×acuminata	Native	5		FAC
Populus deltoides ssp. *monilifera*	Native	3		FAC
Prunus virginiana var. *melanocarpa*	Native	4		FACU
Rhamnus cathartica	Non-native	0		FACU
Ribes aureum	Native	6		FACU
Rosa woodsii (blanda)	Native	5		FACU
Rumex crispus	Non-native	0		FAC
Salix amygdaloides	Native	5		FACW
Salix exigua	Native	3		FACW

Scientific Name	Native Status	C-Value	CO Noxious	Wetland Indicator
Schoenoplectus tabernaemontani	Native	3		OBL
Secale cereale	Non-native	0		
Sisymbrium altissimum	Non-native	0		FACU
Solidago canadensis	Native	5		FACU
Sonchus asper	Non-native	0		FAC
Sporobolus cryptandrus	Native	2		FACU
Symphyotrichum lanceolatum ssp. *hesperium*	Native	5		FACW
Taraxacum officinale	Non-native	0		FACU
Thinopyrum intermedium	Non-native	0		
Thlaspi arvense	Non-native	0		FACU
Typha angustifolia	Cryptogenic	1		OBL
Ulmus pumila	Non-native	0	Watch List	UPL
Unknown ornamental	Non-native	0		
Unknown ornamental	Non-native	0		
Unknown ornamental	Non-native	0		
Verbascum thapsus	Non-native	0	List C	UPL
Verbena bracteata	Native	2		FACU
Viburnum lantana	Non-native	0		

* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

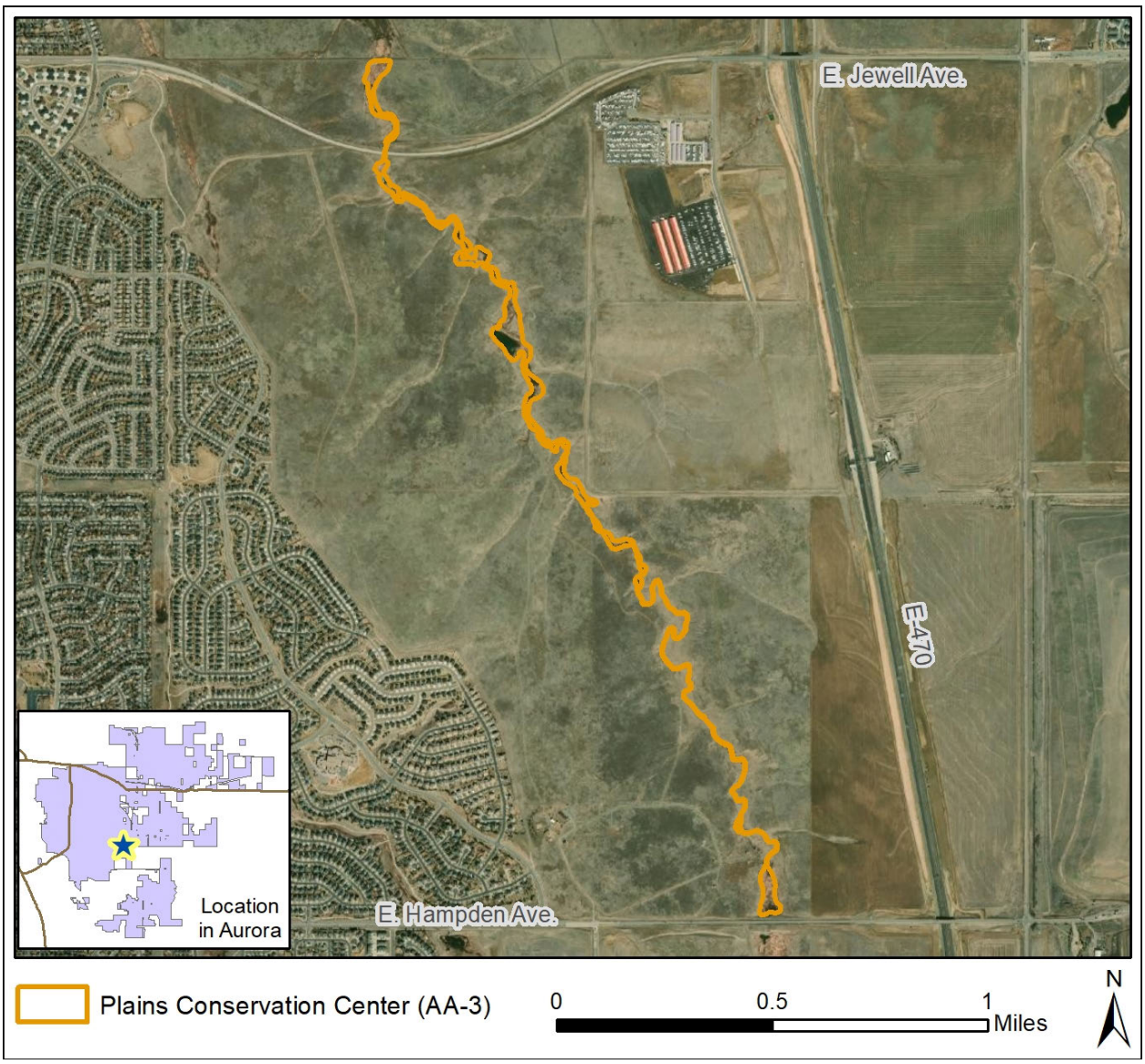
Plains Conservation Center (AA-3)

EIA Overall Rank: 3.09 C	**FACWet Overall Rank: 0.70 C**

Landscape Context: 3.84 B
Vegetation Condition: 2.50 D/C
Hydrologic Condition: 3.00 C
Physiochemical Condition: 3.50 C/B

Mean C: 1.96
Native Mean C: 3.28
Size: 2.2 miles
Social Rating: 9.0 High

Ecological Systems: Western Great Plains Riparian (majority of AA), and inclusions of Western North American Marsh
Hydrogeomorphic Class: Riverine



Plains Conservation Center

Site Overview

The wetlands at Plains Conservation Center include a riparian area with stretches of marsh vegetation along East Tollgate Creek, between E Hampden Ave. and E Jewell Ave. The site includes open herbaceous wetland and non-wetland riparian zones with patches of shrubs and scattered trees, set within untilled prairie. Site hydrology was riparian, shaped by both by slow flow of the sinuous creek and high water precipitation events. Sections of broad marsh zones bordered impoundments and roads, and narrow marsh vegetation was present in the channel where the banks were downcut. Bald eagles nest in cottonwoods along the channel. The mapped soil units are non-hydric, primarily Loamy Alluvial land, Nunn loam, and Renohill-Litle-Thedalund complex. A hydric sandy loam soil was observed at a soil pit in spikerush (*Eleocharis*) wetland riparian vegetation. The site elevation is 1737 meters.

Land Use: Plains Conservation Center is a City of Aurora nature preserve and educational center. The site includes trails and hosts a range of programs for school groups and the public. The area supports a stretch of riparian corridor and surrounding remnant prairie within an otherwise developed upper watershed of East Tollgate Creek. The creek originates approximately 4 miles upstream. The site was initially railroad property, and older aerial imagery shows a mostly farmed contributing watershed, until urban housing development picked up during the last ~30 years. Now much of the contributing watershed is dense housing that adds urban stormwater to the creek upstream, and some agricultural open space, but the upland prairie grassland at Plains Conservation Center remains conserved.

Site Condition: This site was rated a C in overall condition, with the more open-vegetated riparian areas in fair-good condition, with good hydrologic connectivity, open water in the channel, and some patches of native wetland graminoids next to the creek. The denser shrubland, marsh, and *Typha*-dominated areas in the lower reach were in fair-poor condition with higher noxious weed cover, areas of entrenchment and sloughing banks, and lower native diversity and compacted substrate. However, the upstream marsh and shrubland at the site boundary had good adjacent hydrologic connectivity and better native plant composition. The site has high conservation value due its lengthy and meandering riparian corridor which supports nesting bald eagles and provides numerous benefits to wildlife and water quality in an urban region. This site was rated with the highest landscape score in this study, and its upland buffer had excellent native grass diversity despite intermixed weeds.

Vegetation: Vegetation composition was rated a C/D in the riparian areas due to substantial non-native cover and vegetation patches with high noxious weed cover, and a portion of the site in the central marsh had high invasion where cattail (*Typha* spp.) dominate, and weedy riparian edges have substantial Canada thistle (*Cirsium arvense*). Vegetation structure and diversity was simplified in the marsh and shrub areas, and the graminoid wetland riparian zones were more diverse and in better condition.

The most prevalent species was narrow-leaved cattail (*Typha angustifolia*). Despite substantial non-native cover and cattail invasion, species composition was diverse with 75 species recorded in the AA. There were scattered patches of higher quality native riparian wetland vegetation including clustered field sedge (*Carex praegracilis),* pale spikerush (*Eleocharis palustris*), Nebraska sedge *(Carex nebrascensis),* and woolly sedge (*Carex pellita)*. Western wheatgrass (*Pascopyrum smithii*) was also common in non-wetland riparian zones. There were occasional peachleaf willow (*Salix amygdaloides*) and plains cottonwood (*Populus deltoides* ssp. *monilifera*) trees, and scattered patches of coyote willow *(Salix exigua)* throughout the site. Common native plains wetland forbs present throughout included showy milkweed (*Asclepias speciosa*), American licorice (*Glycyrrhiza lepidota*), pitseed goosefoot (*Chenopodium berlandieri*) and velvetweed (*Gaura mollis*). Non-native white sweetclover (*Melilotus albus*) also had higher cover around the marshes. Tall tumblemustard (*Sisymbrium altissimum)* had low cover in the wetland, but high cover in the adjacent upland intermixed with native grass species, and its dried skeletons had settled into the wetland drainages in areas.

There were seven state watch-listed or noxious species in the riparian and marsh zones, with low overall cover except for Canada thistle which had an estimated cover of 5-10%. The B-list salt cedar (*Tamarix chinensis/ramosissima*) was present at limited locations and at very low cover.

Wildlife Species of Greatest Conservation Need: Bald eagle, a Tier 2 species of greatest conservation need, nest within the Plains Conservation Center. Seasonal trail closures limit disturbance to the nesting eagles.

Recommendations:

- *Plants:* Site vegetation appears to be increasing in density. Some ingrowth may be positive due to cessation of grazing, but cattail and thistles are dominant, and shrubs are dense in areas. Monitoring with vegetation transects and repeat photos would help detect stress and hydrologic change, including in areas of dense cattail and shrubs with foliar dieback, and in areas of good hydrologic connectivity where native graminoid riparian vegetation borders the creek and the channel has open flowing water.
- *Weeds:* Recommend mapping location(s) of salt cedar (*Tamarix chinensis*); it is present at limited locations and at low cover and control at this stage is recommended. Consider removal of *Sisymbrium* skeletons where they have filled into the stream channel. Consider impacts on areas of native plant composition and water quality in treatment of invasives, and revegetate with natives if thistle is treated. Avoid chemical weed treatment when possible to avoid impacts to the diverse pollinator species and other sensitive wildlife. A leaf that was suspected to from the List A hairy willowherb (*Epilobium hirsutum*) was found along the creek but the presence of the species was not verified in 2019. We recommend searching for the species bright magenta flowers during the flowering period (June – August) to confirm the species is not present.

- *Land use:* Recreation land use is currently low, trails are mostly out of riparian zone, and do not visibly affect riparian area: maintain low level of development and use. Keep upland vegetated particularly in grazed demonstration areas to limit sediment in runoff events.

Table G-9. List of Plant Taxa documented at Plains Conservation Center (AA-3) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Alopecurus arundinaceus	Non-native	0		FACW
Ambrosia psilostachya	Native	3		FACU
Ambrosia trifida var. *trifida*	Native	3		FAC
Asclepias speciosa	Native	3		FAC
Bolboschoenus maritimus ssp. *paludosus*	Native	5		OBL
Bromus inermis	Non-native	0		UPL
Carduus nutans	Non-native	0	List B	FACU
Carex nebrascensis	Native	5		OBL
Carex pellita	Native	6		OBL
Carex praegracilis	Native	5		FACW
Chenopodium berlandieri var. *zschackii*	Native	2		
Chenopodium simplex	Native	2		
Cirsium arvense	Non-native	0	List B	FACU
Convolvulus arvensis	Non-native	0	List C	
Conyza canadensis	Native	1		FACU
Cyclachaena xanthifolia	Native	2		FAC
Descurainia sophia	Non-native	0		
Elaeagnus angustifolia	Non-native	0	List B	FACU
Eleocharis palustris	Native	3		OBL
Epilobium ciliatum	Native	4		FACW
Equisetum laevigatum	Native	4		FAC
Euphorbia esula	Non-native	0	List B	
Galium aparine	Native	1		FACU
Glycyrrhiza lepidota	Native	3		FACU
Helianthus annuus	Native	1		FACU
Helianthus petiolaris	Native	2		
Hordeum jubatum	Native	2		FACW
Juncus arcticus var. *balticus*	Native	4		FACW
Juncus compressus	Non-native	0		FACW
Juncus sp.	Unknown			
Kochia scoparia	Non-native	0		FACU
Lactuca serriola	Non-native	0		FAC
Lathyrus sp.	Unknown			
Lemna minor	Native	2		OBL
Medicago lupulina	Non-native	0		FACU
Medicago sativa	Non-native	0		UPL
Melilotus albus	Non-native	0		FACU
Melilotus officinalis	Non-native	0		FACU
Muhlenbergia asperifolia	Native	4		FACW
Oenothera curtifolia	Native	1		UPL
Oenothera villosa	Native	4		FACU
Onosmodium bejariense var. *occidentale*	Native	5		
Pascopyrum smithii	Native	5		FACU

Scientific Name	Native Status	C-Value	CO Noxious	Wetland Indicator
Persicaria sp.	Unknown			
Phalaris arundinacea	Cryptogenic	1		FACW
Physalis sp.	Unknown			
Plantago major	Non-native	0		FAC
Poa pratensis	Non-native	0		FACU
Polypogon monspeliensis	Non-native	0		FACW
Populus deltoides ssp. *monilifera*	Native	3		FAC
Ranunculus cymbalaria	Native	4		OBL
Ranunculus sceleratus var. *multifidus*	Native	1		OBL
Ribes aureum	Native	6		FACU
Rorippa sinuata	Native	4		FACW
Rosa arkansana	Native	5		FACU
Rosa woodsii (blanda)	Native	5		FACU
Rumex crispus	Non-native	0		FAC
Salix amygdaloides	Native	5		FACW
Salix exigua	Native	3		FACW
Salsola sp.	Non-native			
Schedonorus arundinaceus	Non-native	0		FACU
Schoenoplectus pungens	Native	4		OBL
Schoenoplectus tabernaemontani	Native	3		OBL
Sisymbrium altissimum	Non-native	0		FACU
Tamarix chinensis	Non-native	0	List B	FACW
Taraxacum officinale	Non-native	0		FACU
Thlaspi arvense	Non-native	0		FACU
Typha angustifolia	Cryptogenic	1		OBL
Typha latifolia	Native	4		OBL
Unknown forb	Unknown			
Unknown grass	Unknown			
Verbascum thapsus	Non-native	0	List C	UPL
Veronica anagallis-aquatica	Native	1		OBL
Veronica sp.	Unknown			
Xanthium strumarium	Native	1		FAC

* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

Pronghorn North Riparian Area (AA-1A) and Marsh (AA-1B)

AA-1A EIA Overall Rank: 3.47 C	**AA-1A FACWet Overall Rank: 0.71 C**
AA-1B EIA Overall Rank: 2.87 C	**AA-1B FACWet Overall Rank: 0.70 C**

AA-1A: Landscape Context: 3.75 B	Mean C: 1.92
Vegetation Condition: 3.33 C	Native Mean C: 3.09
Hydrologic Condition: 3.33 C	Size: 1.1 mile
Physiochemical Condition: 3.50 C/B	Social Rating: 5.5 Medium
AA-1B: Landscape Context: 3.75 B	Mean C: 2.19
Vegetation Condition: 2.00 D	Native Mean C: 3.47
Hydrologic Condition: 3.00 C	Size: 19 acres
Physiochemical Condition: 3.50 C/B	Social Rating: 5.0 Medium

Ecological Systems: Western Great Plains Riparian (1A) and Western North American Marsh (1B)
Hydrogeomorphic Classes: Riverine (1A) and Riverine (impounded) (1B)

Pronghorn North – Riparian, AA-1A

Pronghorn North – Marsh, AA-1B

Site Overview

The Pronghorn North AA is a wet meadow riparian area with scattered willow (*Salix)* trees and intermittent narrow marsh vegetation that broadens downstream into a cattail (*Typha*) marsh. The site is located north of E Quincy Ave. along Senac Creek, north of Aurora Reservoir, and downstream of the confluence of Haynes and Senac Creek. The riparian AA (1A) includes the open wooded riparian wetland and non-wetland riparian area and the marsh AA (1B) includes the northern third of the site. In the northern third the site transforms to a mostly cattail (*Typha*) wetland with multiple shallow inundated areas instead of a single-channel creek. Northern leopard frog (*Lithobates pipiens*), a Colorado Parks and Wildlife species of greatest conservation need (Tier 1), were found within the cattail marsh. Downstream of a berm in the cattail marsh, outflow consolidates back into a single channel creek, where cattail cover decreases and weedy forbs are more common. The primary soil map unit is non-hydric loamy alluvial land. The area has a lightly used dirt trail and parking lot. The site elevation is 1755 meters.

Land Use: Pronghorn North AA is part of a City of Aurora Natural Area and is open to the public. Pronghorn Natural Area north of Quincy Ave. includes a 1.2 mile hiking trail through prairie. Past land use impacts have shaped the site's and surrounding landscape's substrate and hydrology. Older aerial imagery shows gravel ponds and agriculture in much of the upland buffer, which intercepted natural drainage paths into the wetland. There were road crossings across the streams, which are now naturalized berms. The upland buffer ponds are now dry, and the adjacent landscape is now mostly fallow and weedy. Once Aurora Reservoir was constructed, many of the remaining natural small drainage inputs in the wetland's upstream watershed were intercepted or impacted by development.

Condition: The Pronghorn North riparian and marsh AAs were rated C, in fair overall condition, with the riparian AA (1A) rating a very high C. This attests to the buffering capacity across a lengthy riparian and wetland corridor, and the value of undeveloped surrounding open space, given the upstream reservoir and significant site land use history. The riparian AA (1A) received the third highest condition score. This site is in a lengthy riparian corridor with excellent buffer, and its adjacent landscape is mostly undeveloped open space, rating a B in landscape condition; providing high conservation value as a wildlife corridor and natural riparian habitat. Native riparian wetland plant communities that are less common in Front Range urban areas were regularly present where the creek widened and had meanders. Historical agricultural and mining land uses, current upstream flow modifications, reservoir impacts, and stormwater additions have altered the site's hydrology. The riparian substrate had compaction and loss of wetted riparian area, and old roads that crossed the creek now function as berms. Water was in good condition with scattered algae patches and other clear flow areas over sand.

Vegetation: The species list for both AAs combined includes 66 species. The riparian wetland area (1A) was generally narrow, but its vegetation structure was complex and diverse without one dominant species. Farther downstream the stream transitions to a marsh (1B) with a tall, dense, and mostly monotypic stand of narrowleaf cattail (*Typha angustifolia)*. Several mature trees and other snags provided important standing and downed wood for wildlife habitat in both AAs. Overall vegetation composition rated C in the riparian zone, due to good native diversity but moderate non-native and invasive species cover. The marsh vegetation rated a D, with edges in better condition, but the central marsh was a large cattail monoculture. There were four B list noxious weeds recorded in the wetlands, with higher cover of Canada thistle (*Cirsium arvense)* and leafy spurge *(Euphorbia esula).* Common native species in the riparian area were characteristic of healthy plains riparian ecosystems and included pale spikerush (*Eleocharis palustris*), foxtail barley (*Hordeum jubatum)*, common threesquare (*Schoenoplectus pungens*), softstem bulrush (*Schoenoplectus tabernaemontani*), water speedwell (*Veronica anagallis-aquatica),* plains cottonwood *(Populus deltoides* ssp. *monilifera)* and peachleaf willow (*Salix amygdaloides*) trees. Mixed cattail (*Typha latifolia* and *T. angustifolia*) had patchy cover. There was lower cover but a diversity of good quality native species including*:* prairie cordgrass *(Spartina pectinata),* Torrey's rush *(Juncus torreyi),* yellowcress species (*Rorippa palustris* and *R. sinuata*), violet *(Viola* sp.*),* Nebraska sedge *(Carex nebrascensis),* lanceleaf figwort *(Scrophularia lanceolata),* western wheatgrass *(Pascopyrum smithii),* slender wheatgrass (*Elymus trachycaulus),* and stinging nettle (*Urtica dioica).*

Wildlife Species of Greatest Conservation Need: Northern leopard frogs, a Tier 1 species of greatest conservation need, were found in the cattail wetland and leopard frogs likely occur along the riparian area. Individuals at this AA tested positive for chytrid fungus. Numerous juveniles were found though no pond of sufficient depth for breeding was found in Pronghorn North. The frogs may breed within the ponds on Haynes Gulch south of Qunicy Ave. (in Pronghorn SE [AA-2]). Importantly, there were no non-native invasive bullfrogs (*Lithobates catesbeianus*) found within the Pronghorn Natural Area either north or south of Quincy Ave. The closest documented bullfrogs occur about 1 mile north in the Coal Creek at Senac AA (AA-7).

Recommendations:

- *Land Use:* Manage for continued naturalization of the site and its surrounding upslope watershed, avoiding substrate disturbance (including new or raised trails), stormwater additions, and development in the site's watershed.
- *Weeds:* Avoid chemical weed treatment due to risk of native diversity loss and sensitive wildlife.
- *Cattail invasion:* Monitor cattail area for expansion.
- *Hydrologic connectivity:* Consider upslope and onsite berm and stock pond restoration to natural conditions. Evaluate land use impacts to tributary inputs.
- *Wildlife:* This site supports northern leopard frogs. Monitor leopard frog populations and consider bullfrog control at downstream sites.

Table G-10. List of Plant Taxa documented at Pronghorn North Riparian Area (AA-1A) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Agropyron cristatum	Non-native	0		
Agrostis gigantea	Non-native	0		FACW
Ambrosia psilostachya	Native	3		FACU
Ambrosia trifida var. *trifida*	Native	3		FAC
Asclepias speciosa	Native	3		FAC
Bromus inermis	Non-native	0		UPL
Chenopodium berlandieri var. *zschackii*	Native	2		
Chenopodium simplex	Native	2		
Cirsium arvense	Non-native	0	List B	FACU
Convolvulus arvensis	Non-native	0	List C	
Conyza canadensis	Native	1		FACU
Cyclachaena xanthifolia	Native	2		FAC
Eleocharis palustris	Native	3		OBL
Elymus trachycaulus	Native	4		FACU
Euphorbia esula	Non-native	0	List B	
Helianthus petiolaris	Native	2		
Hordeum jubatum	Native	2		FACW
Juncus torreyi	Native	5		FACW
Kochia scoparia	Non-native	0		FACU
Lactuca serriola	Non-native	0		FAC
Oenothera curtifolia	Native	1		UPL
Onopordum acanthium	Non-native	0	List B	
Pascopyrum smithii	Native	5		FACU
Poa pratensis	Non-native	0		FACU
Polypogon monspeliensis	Non-native	0		FACW
Populus deltoides ssp. *monilifera*	Native	3		FAC
Rumex crispus	Non-native	0		FAC
Salix amygdaloides	Native	5		FACW
Salix sp.	Unknown			
Schoenoplectus pungens	Native	4		OBL
Schoenoplectus tabernaemontani	Native	3		OBL
Sonchus asper	Non-native	0		FAC
Spartina pectinata	Native	7		FACW
Typha angustifolia	Cryptogenic	1		OBL
Typha latifolia	Native	4		OBL
Unknown forb	Unknown			
Urtica dioica ssp. *gracilis*	Native	3		FAC
Veronica anagallis-aquatica	Native	1		OBL

Table G-11. List of Plant Taxa documented at Pronghorn North Marsh (AA-1B) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Agropyron cristatum	Non-native	0		
Agrostis gigantea	Non-native	0		FACW
Alopecurus arundinaceus	Non-native	0		FACW
Ambrosia trifida var. *trifida*	Native	3		FAC
Anaphalis margaritacea	Native	4		FACU
Artemisia biennis var. *biennis*	Non-native	0		FACU

Scientific Name	Native Status	C-Value	CO Noxious	Wetland Indicator
Asclepias incarnata	Native	4		FACW
Asclepias speciosa	Native	3		FAC
Barbarea orthoceras	Native	5		OBL
Bidens tripartita	Native	3		FACW
Bolboschoenus maritimus ssp. *paludosus*	Native	5		OBL
Bromus inermis	Non-native	0		UPL
Carex nebrascensis	Native	5		OBL
Chenopodium simplex	Native	2		
Cirsium arvense	Non-native	0	List B	FACU
Conyza canadensis	Native	1		FACU
Distichlis stricta	Native	4		FACW
Echinochloa crus-galli	Non-native	0		FAC
Eleocharis palustris	Native	3		OBL
Elymus trachycaulus	Native	4		FACU
Epilobium ciliatum	Native	4		FACW
Erigeron sp.	Unknown			
Euphorbia esula	Non-native	0	List B	
Euthamia occidentalis	Native	4		OBL
Hordeum jubatum	Native	2		FACW
Juncus bufonius	Native	3		OBL
Juncus torreyi	Native	5		FACW
Kochia scoparia	Non-native	0		FACU
Medicago sativa	Non-native	0		UPL
Pascopyrum smithii	Native	5		FACU
Persicaria lapathifolia	Native	2		OBL
Persicaria maculosa	Non-native	0		FACW
Poa pratensis	Non-native	0		FACU
Polygonum aviculare	Non-native	0		FACU
Polypogon monspeliensis	Non-native	0		FACW
Ranunculus sceleratus var. *multifidus*	Native	1		OBL
Rorippa palustris	Native	4		OBL
Rorippa sinuata	Native	4		FACW
Rumex crispus	Non-native	0		FAC
Salix exigua	Native	3		FACW
Schoenoplectus pungens	Native	4		OBL
Schoenoplectus tabernaemontani	Native	3		OBL
Scrophularia lanceolata	Native	5		FAC
Sonchus asper	Non-native	0		FAC
Symphyotrichum ericoides	Native	4		FACU
Thlaspi arvense	Non-native	0		FACU
Typha angustifolia	Cryptogenic	1		OBL
Typha latifolia	Native	4		OBL
Unknown grass	Unknown			
Unknown mustard	Unknown			
Veronica anagallis-aquatica	Native	1		OBL
Viola sp.	Unknown			

* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

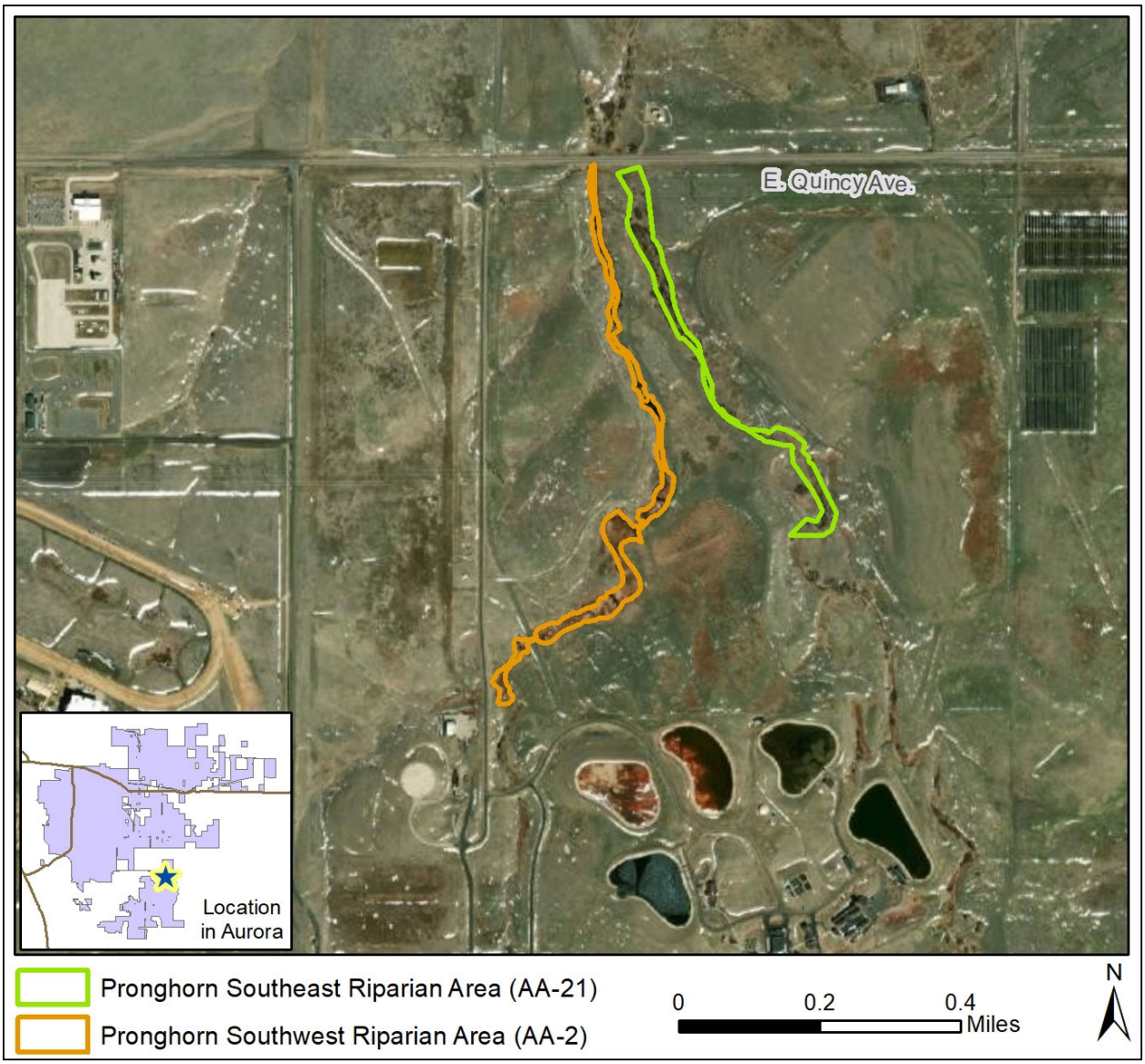
Pronghorn Southeast Riparian Area (AA-21)

EIA Overall Rank: 2.82 C	**FACWet Overall Rank: 0.67 D**

Landscape Context: 3.81 B
Vegetation Condition: 2.67 C
Hydrologic Condition: 1.67 D
Physiochemical Condition: 3.50 C/B

Mean C: 1.71
Native Mean C: 3.14
Size: 0.9 mile
Social Rating: 4.5 Medium

Ecological System: Western Great Plains Riparian
Hydrogeomorphic Class: Riverine



Pronghorn SE, AA-21

Site Overview

The southeast AA at Pronghorn Natural Area is a woody riparian area along Senac Creek. The site is located north of Aurora Reservoir and south of E Quincy Ave., before its confluence with Haynes Gulch. The site alternates between non-wetland riparian and narrow wetland fringe, and is confined by entrenchment along part of its reach. This riparian AA has patchy vegetation, with wooded overstory, emergent wetland graminoids and aquatic forbs along seeps, and mesic seasonally ponded depressions interspersed with grassy areas upstream. Cattail (*Typha* spp.) has infilled wetter stretches of the creek. Northern leopard frog (*Lithobates pipiens*), a Colorado Parks and Wildlife species of greatest conservation need (Tier 1), are present along the stream. The mapped soil units are non-hydric, primarily Nunn loam, Renohill-Litle-Thedalund complex, and Terrace Escarpment. The site did not have wetland beyond the vegetated intermittent creek. A soil pit dug in the seepy upstream AA channel had coarse sand with masked with black organic lenses in the upper 2 cm. This west side of Pronghorn Natural Area did not appear to receive regular foot traffic. The site elevation is 1737 meters.

Land Use: Pronghorn Natural Area is a City of Aurora Natural Area and is open to the public. The south side of Pronghorn Natural Area's current land use is open space with light recreation. The southeast Pronghorn AA lacks maintained trails, and the natural area use is concentrated along the trail above the southwest AA. Extensive land uses have impacted much of the creek upstream, AA buffer, and some of the wetland. Historical aerial imagery shows numerous upslope drainages feeding into Senac Creek that were removed or disconnected from the AA with construction of Aurora Reservoir, the Binney Water Purification Facility ponds, and also as a result of prior land uses. In the 1980's the site had open water gravel ponds in the east upslope contributing watershed, and there is a history of irrigated agriculture on either side of the site. Trails that are now vegetated once bordered the agriculture and crossed the AA with a berm, but these features are now cheatgrass (*Bromus tectorum*) and weed vectors. These substrate modifications create major impacts on the site's hydrology.

Condition: This AA was rated in fair/C condition overall. The hydroperiod and site connectivity rated D's, heavily impacted by the upslope and upstream land uses. The site has signs of groundwater discharge/seeps in the channel. The Pronghorn SE site has high conservation value to the city with its lengthy riparian corridor, sensitive wildlife species habitat and relatively undeveloped surrounding open space, and the site landscape condition rated a B. The hardened and downcut banks rated a C, and water was clear with scattered algae.

Vegetation: Vegetation vertical structure was moderately complex, mixed from open herbaceous to a plains cottonwood (*Populus deltoides* ssp. *monilifera*) overstory. Overall vegetation composition was diverse with 54 species recorded in the AA, but narrowleaf cattail (*Typha angustifolia*) was dominant. Vegetation condition was rated C with non-wetland riparian areas dominated by non-native grasses smooth brome (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis*). The noxious weeds Canada thistle (*Cirsium arvense*), leafy spurge (*Euphorbia esula*) and nodding plumeless thistle (*Carduus nutans*) were also common. There was good native plant community representation. The species in relatively higher cover occupied a variety of riparian and wetland niches, such as: peachleaf willow (*Salix amygdaloides*), western snowberry (*Symphoricarpos occidentalis*), Cuman ragweed (*Ambrosia psilostachya*), giant sumpweed (*Cyclachaena xanthifolia*), American licorice (*Glycyrrhiza lepidota*), showy milkweed (*Asclepias speciosa*), pitseed goosefoot (*Chenopodium berlandieri* var. *zschackii*), water speedwell (*Veronica anagallis-aquatica*), cursed buttercup (*Ranunculus sceleratus* var. *multifidus*), pale spikerush (*Eleocharis palustris*), and softstem bulrush (*Schoenoplectus tabernaemontani*). Cheatgrass (*Bromus tectorum*) was common in much of the adjacent upland, but some upland buffer had patches of high quality native grasses such as needle and thread (*Hesperostipa comata*).

Wildlife Species of Greatest Conservation Need: Adult and juvenile northern leopard frogs, a Tier 1 species of greatest conservation need, were found throughout the AA. There were no breeding ponds found within this AA and breeding likely occurs at the ponds within the Pronghorn SE AA. Importantly, there were no non-native invasive bullfrogs (*Lithobates catesbeianus*) found within the Pronghorn Natural Area north or south of Quincy Ave. The closest documented bullfrogs occur about 1 mile north of Pronghorn Natural Area in the Coal Creek at Senac AA (AA-7). Frogs from Pronghorn SW tested positive for chytrid fungus.

Recommendations:

- *Land Use:* Manage for continued naturalization of the site and its surrounding upland, avoiding substrate disturbance (including new or raised trails), stormwater additions, and development in the contributing watershed downstream of the reservoir.
- *Plants:* Targeted native plant restoration in adjacent upland, especially in cheatgrass areas, would improve site quality and help conserve the remnant native grassland diversity.
- *Cattail invasion:* Monitor cattails and entrenched zone for expansion.
- *Weeds:* Avoid chemical weed treatment to avoid impacts to the diverse pollinator species and other sensitive wildlife.
- *Wildlife:* This site supports northern leopard frogs. Monitor leopard frog populations and consider bullfrog control at downstream sites.

Table G-12. List of Plant Taxa documented at Pronghorn Southeast Riparian Area (AA-21) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Agropyron cristatum	Non-native	0		
Ambrosia psilostachya	Native	3		FACU
Arctium minus	Non-native	0	List C	FACU
Artemisia ludoviciana	Native	4		UPL
Asclepias speciosa	Native	3		FAC
Bromus inermis	Non-native	0		UPL
Bromus japonicus	Non-native	0		FACU
Carduus nutans	Non-native	0	List B	FACU
Chenopodium berlandieri var. *zschackii*	Native	2		
Cirsium arvense	Non-native	0	List B	FACU
Convolvulus arvensis	Non-native	0	List C	
Conyza canadensis	Native	1		FACU
Cyclachaena xanthifolia	Native	2		FAC
Cynoglossum officinale	Non-native	0	List B	FACU
Descurainia sophia	Non-native	0		
Eleocharis palustris	Native	3		OBL
Epilobium ciliatum	Native	4		FACW
Equisetum laevigatum	Native	4		FAC
Euphorbia esula	Non-native	0	List B	
Glycyrrhiza lepidota	Native	3		FACU
Helianthus annuus	Native	1		FACU
Hesperostipa comata	Native	6		
Heterotheca villosa	Native	3		
Hordeum jubatum	Native	2		FACW
Juncus torreyi	Native	5		FACW
Kochia scoparia	Non-native	0		FACU
Lactuca serriola	Non-native	0		FAC
Lemna minor	Native	2		OBL
Lycopus sp.	Native			
Medicago sativa	Non-native	0		UPL
Melilotus officinalis	Non-native	0		FACU
Onopordum acanthium	Non-native	0	List B	
Plantago major	Non-native	0		FAC
Poa pratensis	Non-native	0		FACU
Polygonum aviculare	Non-native	0		FACU
Polypogon monspeliensis	Non-native	0		FACW
Populus deltoides ssp. *monilifera*	Native	3		FAC
Psoralidium tenuiflorum	Native	5		
Ranunculus sceleratus var. *multifidus*	Native	1		OBL
Ratibida columnifera	Native	4		
Rumex crispus	Non-native	0		FAC
Salix amygdaloides	Native	5		FACW
Schoenoplectus pungens	Native	4		OBL
Schoenoplectus tabernaemontani	Native	3		OBL
Symphoricarpos occidentalis	Native	3		UPL
Symphyotrichum ericoides	Native	4		FACU
Thlaspi arvense	Non-native	0		FACU
Tragopogon dubius	Non-native	0		
Typha angustifolia	Cryptogenic	1		OBL

Scientific Name	Native Status	C-Value	CO Noxious	Wetland Indicator
Typha latifolia	Native	4		OBL
Unknown aster	Unknown			
Urtica dioica ssp. *gracilis*	Native	3		FAC
Verbascum thapsus	Non-native	0	List C	UPL
Veronica anagallis-aquatica	Native	1		OBL

* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

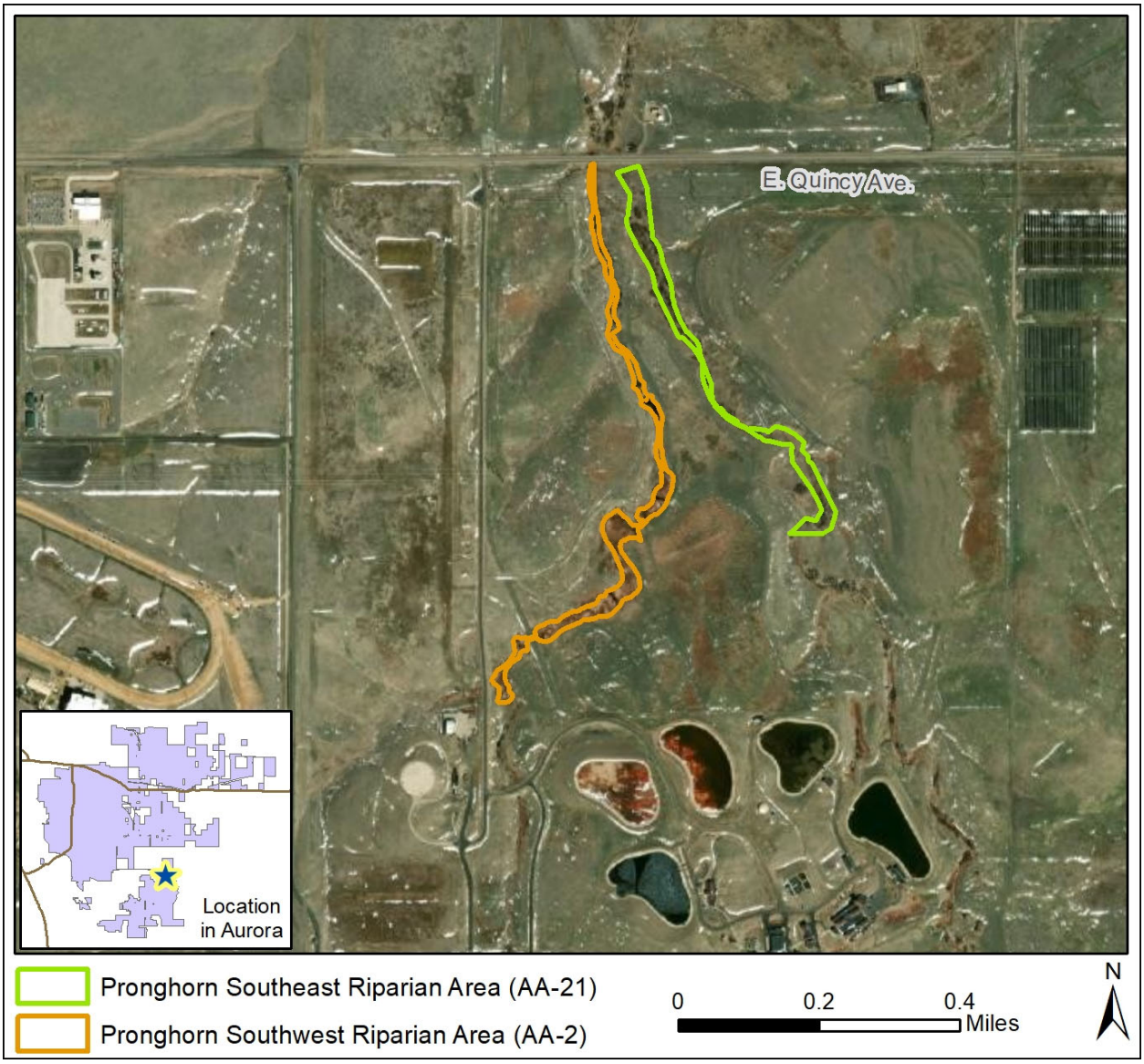
Pronghorn Southwest Riparian Area (AA-2)

EIA Overall Rank: 2.71 C	**FACWet Overall Rank: 0.68 D**

Landscape Context: 3.31 C
Vegetation Condition: 2.33 D
Hydrologic Condition: 2.33 D
Physiochemical Condition: 3.50 C/B

Mean C: 2.04
Native Mean C: 3.68
Size: 1.5 miles
Social Rating: 5.0 Medium

Ecological Systems: Western Great Plains Riparian (majority of AA) and Western North American Marsh (above grade controls and upstream)
Hydrogeomorphic Class: Riverine



Pronghorn SW, AA-2

Site Overview

The southwest AA at Pronghorn Natural Area is a riparian area with intermittent marsh vegetation along Haynes Gulch. The site is located north of Aurora Reservoir and south of E Quincy Ave., upstream of the confluence with Senac Creek. A series of grade control structures widen and slow flow, creating open water conditions followed by patches of cattail (*Typha* spp.) along the open wooded and otherwise narrow riparian zone of Haynes Gulch. The site has higher cattail cover upstream and more riparian and open wooded conditions downstream. Northern leopard frog (*Lithobates pipiens*), a Colorado Parks and Wildlife species of greatest conservation need (Tier 1), are present in the riparian area and ponds created by the grade control structures. The mapped soil units are non-hydric Loamy Alluvial and Nunn Loams, and a soil pit dug in the riparian zone was also non-hydric sandy loam. The site was assessed as one riparian AA due to its streamflow-driven hydrology, despite the riparian marsh inclusions. There is a raised trail and a parking lot opposite the road. The site elevation is 1756 meters.

Land Use: Pronghorn Natural Area is a City of Aurora Natural Area and is open to the public. Pronghorn Natural Area south of Quincy Ave. includes a 0.8 mile trail. The site is just downstream of Aurora Reservoir and the Binney Water Purification Facility. Stormwater from dense upstream development is discharged into Haynes Creek. Past land uses have also impacted much of the AA's buffer and some of the wetland. Older aerial imagery shows gravel ponds and agriculture in much of the upland buffer, which intercepted natural drainage paths into the wetland. Those adjacent land uses are discontinued but the upland has patches of high weed cover, possibly due to the fill areas. There were also trails on either side of the riparian area, which later naturalized, then a raised trail was constructed in 2006 which removed wide strips of native vegetation from the riparian area and likely introduced more fill to the wetland. Construction of Aurora Reservoir, grade controls, and ponds below the reservoir also impact runoff and/or stream flow entering Haynes Gulch. Large portions of the wetland's contributing watershed have a history of substrate disturbance. These substrate and hydrologic modifications have transformed the site's hydrology.

Condition: This AA was rated in fair/C condition. Surrounding land uses have degraded the riparian substrate and buffer condition, but sections of native landscape remain, and those areas are high quality native grasses worth protecting. The non-marshy riparian wetland zones were generally narrow and had more non-wetland riparian stretches than wet meadow. The site's natural water sources were reduced by soil disturbance, including a raised trail that intercepts Haynes Gulch surface water inputs. The hydroperiod is highly altered, with grade controls, major urban inputs, and loss of natural inputs. Water was fast moving for the outer watershed location, with slight turbidity. However, this site has high conservation value for its lengthy riparian corridor with varied vegetation structure and habitat

potential, moderate native vegetation diversity, wetland buffering effects on urban hydrology inputs, and for its open space benefits supporting riparian wetland functions. The marsh areas slow streamflow, transform nutrients, and trap sediment. The riparian zone provides diverse wildlife habitat and corridor.

This site's proximity to the reservoir and its substantial urban inputs from a relatively small upper watershed creates high hydrologic stress. If beaver can populate reaches of this stream, they would support a more natural hydroperiod, add complexity to the stream channel and buffer high flows, and would likely improve native wetland vegetation cover and restore dried riparian soil. Soil disturbance and (potentially associated) noxious weeds were impactful stressors.

Vegetation: Overall vegetation composition was diverse with 52 species recorded in the AA. Vegetation condition was rated D due to substantial cover of non-native and invasive species, especially thistles (*Cirsium arvense, Carduus nutans,* and *Onopordum acanthium),* and bromes (*Bromus tectorum* and *Bromus inermis)* that populated drier riparian sections, and cattail (*Typha* spp.) in high cover upstream. Vegetation varied along the stream length, but overall narrowleaf cattail (*Typha angustifolia*) was dominant, especially in marsh areas. Wetter marsh areas supported native wetland graminoids in lower cover including mixed bulrush (*Schoenoplectus* spp.), Nebraska sedge (*Carex nebrascensis)*, common duckweed (*Lemna minor),* and mountain rush (*Juncus arcticus* var. *balticus)*. There are scattered plains cottonwood (*Populus deltoides)* and peachleaf willow (*Salix amygdaloides*) trees, and native shrubs including golden currant (*Ribes aureum),* coyote willow (*Salix exigua),* and black chokecherry *(Prunus virginiana* var. *melanocarpa).* There was a characteristic mix of native prairie and wetter riparian species such as showy milkweed (*Asclepias speciosa),* giant sumpweed *(Cyclachaena xanthifolia),* switchgrass *(Panicum virgatum),* upright prairie coneflower *(Ratibida columnifera),* and American licorice (*Glycyrrhiza lepidota)*, interspersed with similar cover of non-native plants. Higher quality native prairie species were present in low cover that diversified site pollinator habitat such as mintleaf bergamot (*Monarda fistulosa* var. *menthifolia)*, longleaf phlox (*Phlox longifolia),* American yellowrocket *(Barbarea orthoceras),* and slimflower scurfpea *(Psoralidium tenuiflorum)*.

Wildlife Species of Greatest Conservation Need: Adult and juvenile northern leopard frogs, a Tier 1 species of greatest conservation need, were found throughout the AA. The ponds created by grade control structures are likely breeding habitat though no eggs or tadpoles were found during our site visits. Importantly, there were no non-native invasive bullfrogs (*Lithobates catesbeianus*) found within the Pronghorn Natural Area north or south of Quincy Ave. The closest documented bullfrogs occur about 1 mile north of Pronghorn Natural Area in the Coal Creek at Senac AA (AA-7). No frogs from Pronghorn SW were tested for chytrid, but frogs from the adjacent Pronghorn North (AA-1B) and Pronghorn Southwest (AA-21) tested positive indicating this area is also positive for the fungus.

Recommendations:

- *Land Use:* Conserve the open space in the contributing watershed. Further development into the site's small watershed, especially into the remaining native drainages to the site, risks surpassing a threshold of site degradation, given the existing site stress level.
- *Cattail Invasion:* Cattails can be invasive in high cover, monitor their coverage.
- *Weeds and Native Vegetation:* Avoid chemical weed treatment to maintain the diverse pollinator habitat and the numerous native plant species guilds. Consider non-chemical weed removal and native revegetation in zones of dense thistle cover. Native diversity was high in localized areas.

- *Beaver:* If beaver are suitable for this site, they can add complexity and wetland area to the narrowed stream and filled riparian areas, naturalize site hydrology, and add natural vegetation structure and roughness to the stream channel – as natural grade controls.
- *Wildlife:* This site supports northern leopard frogs. Monitor leopard frog populations and consider bullfrog control at downstream sites.

Table G-13. List of Plant Taxa documented at Pronghorn Southwest Riparian Area (AA-2) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Apocynum cannabinum	Native	2		FAC
Arctium minus	Non-native	0	List C	FACU
Artemisia ludoviciana	Native	4		UPL
Asclepias speciosa	Native	3		FAC
Barbarea orthoceras	Native	5		OBL
Bromus inermis	Non-native	0		UPL
Bromus tectorum	Non-native	0	List C	
Capsella bursa-pastoris	Non-native	0		FACU
Carduus nutans	Non-native	0	List B	FACU
Carex nebrascensis	Native	5		OBL
Chenopodium berlandieri var. *zschackii*	Native	2		
Chorispora tenella	Non-native	0		
Cirsium arvense	Non-native	0	List B	FACU
Convolvulus arvensis	Non-native	0	List C	
Conyza canadensis	Native	1		FACU
Cyclachaena xanthifolia	Native	2		FAC
Euphorbia esula	Non-native	0	List B	
Glycyrrhiza lepidota	Native	3		FACU
Hordeum jubatum	Native	2		FACW
Juncus arcticus var. *balticus*	Native	4		FACW
Kochia scoparia	Non-native	0		FACU
Lactuca serriola	Non-native	0		FAC
Lemna minor	Native	2		OBL
Lygodesmia juncea	Native	4		
Melilotus albus	Non-native	0		FACU
Melilotus officinalis	Non-native	0		FACU
Monarda fistulosa var. *menthifolia*	Native	6		UPL
Onopordum acanthium	Non-native	0	List B	
Panicum virgatum	Native	5		FAC
Phlox longifolia	Native	6		
Polygonum sp.	Unknown			
Polypogon monspeliensis	Non-native	0		FACW
Populus deltoides ssp. *monilifera*	Native	3		FAC
Prunus virginiana var. *melanocarpa*	Native	4		FACU
Psathyrostachys juncea	Non-native	0		FACU
Psoralidium tenuiflorum	Native	5		
Ratibida columnifera	Native	4		
Ribes aureum	Native	6		FACU
Rumex crispus	Non-native	0		FAC

Scientific Name	Native Status	C-Value	CO Noxious	Wetland Indicator
Salix amygdaloides	Native	5		FACW
Salix exigua	Native	3		FACW
Schoenoplectus acutus	Native	3		OBL
Schoenoplectus pungens	Native	4		OBL
Schoenoplectus tabernaemontani	Native	3		OBL
Sisymbrium altissimum	Non-native	0		FACU
Sonchus asper	Non-native	0		FAC
Symphyotrichum ericoides	Native	4		FACU
Thlaspi arvense	Non-native	0		FACU
Tragopogon dubius	Non-native	0		
Typha angustifolia	Cryptogenic	1		OBL
Urtica dioica ssp. *gracilis*	Native	3		FAC
Verbascum thapsus	Non-native	0	List C	UPL

* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

Quincy Reservoir (AA-14)

EIA Overall Rank: 1.90 D	**FACWet Overall Rank: 0.62 D**

Landscape Context: 2.30 D
Vegetation Condition: 2.00 D
Hydrologic Condition: 1.00 D
Physiochemical Condition: 2.75 C

Mean C: 1.89
Native Mean C: 3.78
Size: 10 acres
Social Rating: 9.5 Very High

Ecological Systems: Western North American Marsh (cattail inlet) and Western Great Plains Riparian (woody reservoir fringe)
Hydrogeomorphic Class: Lacustrine Fringe

Quincy Reservoir

Site Overview

Quincy Reservoir was surveyed along its vegetated fringe at the eastern lobe/inlet area. Quincy Reservoir is located north of West Tollgate Creek, south of E Quincy Ave. and west of S Reservoir Rd. The site includes the eastern reservoir inlet with dense cattail (*Typha*), and a mix of open tree and clustered shrub vegetation fringing the reservoir. The vegetated grade to the reservoir is steep beyond the cattail zone, and much of the wetland width is a narrow band around the reservoir, with non-wetland woody riparian species in outer zones. A soil pit close to the water had clayey soil with a surface layer of sandy soil, some with dark organic lenses, and a high percentage of salts. The substrate also has salt crusts and mudflats with the lower water levels due to a September survey. The reservoir fringe site is largely classified as riparian due to dominance of overstory woody vegetation, however the cattail areas at the inlet also have features of a depressional marsh. The site is popular for recreation trails, fishing, and non-motorized boating. The area provides many social value benefits and received a very high social rating. The site elevation is 1742 meters.

Land Use: Quincy Reservoir is a City of Aurora Open Space. The reservoir receives inflow from transbasin diversions and provides drinking water storage for the City of Aurora. The site is a fringe wetland and riparian zone of the reservoir, with wetlands present in the fluctuating inundation zone. The reservoir was built in 1973 to support the city's water supply and is also managed for recreation. The reservoir is surrounded by popular trails, and dense urban housing. Upstream of the reservoir, West Tollgate Creek splits away from the reservoir to the south, where it intercepts urban stormwater inputs.

Site Condition: The overall site condition was rated a D. The wetlands had a narrow riparian buffer between the surrounding upland, and an open space break with trails before reaching the surrounding

landscape of dense housing. Site hydrology was shaped by introduced and managed water source, and water quality showed signs of stress with salts and algae cover in areas. The substrate adjacent to the water was natural from regular inundation, but the outer substrate was compact and hardened. The transition zones from wetland or forest to upland are weedy, and thistles (C*irsium*) surround the cattail area. Despite being a human-created resource, the wetland provides important water storage, wildlife habitat, and social value functions.

Vegetation: Mixed dense cattail (*Typha* spp.) and coyote willow (*Salix exigua*) were the dominant reservoir fringe vegetation. Plains cottonwood (*Populus deltoides* ssp. *monilifera*) trees provided an open overstory, adding good structure to the resource. The understory was more stressed, with the non-native herbaceous species smooth brome (*Bromus inermis*) and Canada thistle (*Cirsium arvense*) present throughout, along with many exotic species and ornamentals. Hardstem and softstem bulrushes (*Schoenoplectus acutus* and *S. tabernaemontani*) were in intermittent cover along the water edge. Russian olive (*Elaeagnus angustifolia*) and peachleaf willow (*Salix amygdaloides*) were also present in regular low cover. Site diversity was moderately high with 74 species recorded. There was about 30% total cover of Colorado noxious or watch-listed weeds, with 11 species observed. There were several native salt tolerant species in low cover such as Nuttall's alkaligrass (*Puccinellia nuttalliana*), red goosefoot (*Chenopodium rubrum*), and saltgrass (*Distichlis stricta*).

Recommendations:

- *Weeds:* Avoid chemical weed treatment to avoid impacts to the diverse pollinator species and other sensitive wildlife. Consider control of Russian olive (*Eleagnus angustifolia*); there are cut stumps indicating previous control efforts.
- *Social values:* Site offers well maintained popular recreation trails, which is an opportunity for educational signage about urban imported water resources.

Table G-14. List of Plant Taxa documented at Quincy Reservoir (AA-14) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Alopecurus arundinaceus	Non-native	0		FACW
Ambrosia psilostachya	Native	3		FACU
Apocynum cannabinum	Native	2		FAC
Asclepias speciosa	Native	3		FAC
Bolboschoenus maritimus ssp. paludosus	Native	5		OBL
Bromus inermis	Non-native	0		UPL
Bromus japonicus	Non-native	0		FACU
Bromus tectorum	Non-native	0	List C	
Carduus nutans	Non-native	0	List B	FACU
Chenopodium fremontii	Native	6		FACU
Chenopodium glaucum	Non-native	0		FAC
Chenopodium rubrum	Native	2		OBL
Chenopodium simplex	Native	2		
Cirsium arvense	Non-native	0	List B	FACU
Convolvulus arvensis	Non-native	0	List C	
Descurainia sophia	Non-native	0		
Dipsacus fullonum	Non-native	0	List B	FACU
Dipsacus laciniatus	Non-native	0	List B	UPL
Distichlis stricta	Native	4		FACW
Elaeagnus angustifolia	Non-native	0	List B	FACU
Eleocharis acicularis	Native	5		OBL
Eleocharis palustris	Native	3		OBL
Epilobium ciliatum	Native	4		FACW
Erigeron divergens	Native	4		
Euphorbia esula	Non-native	0	List B	
Fraxinus pennsylvanica	Non-native	0		FAC
Glycyrrhiza lepidota	Native	3		FACU
Hordeum jubatum	Native	2		FACW
Juncus compressus	Non-native	0		FACW
Juniperus sp.	Unknown			
Kochia scoparia	Non-native	0		FACU
Lactuca tatarica var. *pulchella*	Native	3		UPL
Linum lewisii	Native	4		
Malus pumila	Non-native	0		
Medicago sativa	Non-native	0		UPL
Melilotus albus	Non-native	0		FACU
Melilotus officinalis	Non-native	0		FACU
Muhlenbergia asperifolia	Native	4		FACW
Oenothera curtifolia	Native	1		UPL
Parthenocissus vitacea	Native	3		FAC
Pascopyrum smithii	Native	5		FACU
Phragmites australis	Non-native	0	Watch List	FACW
Plantago major	Non-native	0		FAC
Poa pratensis	Non-native	0		FACU
Polypogon monspeliensis	Non-native	0		FACW
Populus deltoides ssp. *monilifera*	Native	3		FAC
Potamogeton sp.	Unknown			
Prunus americana	Native	6		UPL
Prunus virginiana var. *melanocarpa*	Native	4		FACU

Scientific Name	Native Status	C-Value	CO Noxious	Wetland Indicator
Puccinellia nuttalliana	Native	6		OBL
Ranunculus aquatilis var. *diffusus*	Native	3		OBL
Ranunculus cymbalaria	Native	4		OBL
Rhamnus cathartica	Non-native	0		FACU
Rhus trilobata var. *trilobata*	Native	5		UPL
Ribes aureum	Native	6		FACU
Rosa acicularis ssp. *sayi*	Native	5		FACU
Rosa sp.	Unknown			
Rumex crispus	Non-native	0		FAC
Salix amygdaloides	Native	5		FACW
Salix exigua	Native	3		FACW
Schedonorus arundinaceus	Non-native	0		FACU
Schoenoplectus acutus	Native	3		OBL
Schoenoplectus pungens	Native	4		OBL
Schoenoplectus tabernaemontani	Native	3		OBL
Sisymbrium altissimum	Non-native	0		FACU
Sonchus asper	Non-native	0		FAC
Spergularia media	Non-native	0		FACU
Symphoricarpos occidentalis	Native	3		UPL
Symphyotrichum lanceolatum ssp. *hesperium*	Native	5		FACW
Symphyotrichum sp.	Native			
Tamarix chinensis	Non-native	0	List B	FACW
Taraxacum officinale	Non-native	0		FACU
Thlaspi arvense	Non-native	0		FACU
Tragopogon dubius	Non-native	0		
Typha angustifolia	Cryptogenic	1		OBL
Typha hybrid	Cryptogenic	1		OBL
Typha latifolia	Native	4		OBL
Ulmus pumila	Non-native	0	Watch List	UPL
Unknown ornamental	Non-native	0		
Veronica sp.	Unknown			

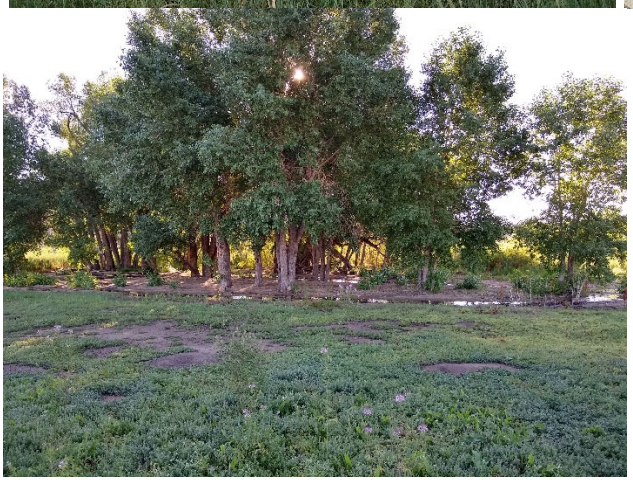
* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

Red-tailed Hawk Park Riparian Area (AA-15A) and Marsh (AA-15B)

AA-15A EIA Overall Rank: 2.03 D	**AA-15A FACWet Overall Rank: 0.66 D**
AA-15B EIA Overall Rank: 1.92 D	**AA-15B FACWet Overall Rank: 0.66 D**

AA-15A: Landscape Context: 1.49 D	Mean C: 2.38
Vegetation Condition: 2.50 D/C	Native Mean C: 3.88
Hydrologic Condition: 1.67 D	Size: 0.3 mile
Physiochemical Condition: 3.00 C	Social Rating: 9.5 Very High
AA-15B: Landscape Context: 1.49 D	Mean C: 2.38
Vegetation Condition 2.00 D	Native Mean C: 3.88
Hydrologic Condition: 2.00 D	Size: 2 acres
Physiochemical Condition: 3.00 C	Social Rating: 9.0 High

Ecological Systems: Western Great Plains Riparian (15A) and Western North American Marsh (15B)
Hydrogeomorphic Classes: Riverine (15A) and Depressional (15B)



Red-tailed Hawk Park— Riparian, AA-15A **Red-tailed Hawk Park – Marsh, AA-15B**

Site Overview

Red-Tailed Hawk Park is located at the confluence of Piney Creek and Sampson Gulch and is south of E Arapahoe Rd., west of S Aurora Pkwy, and east of E-470. The Red-tailed Hawk riparian AA (15A) is the woody riparian area of Piney Creek and Sampson Gulch. The Piney Creek drainage has more shrub cover and the Sampson Gulch drainage is more wooded, and both had intermittent cattail (*Typha*). The Red-tailed Hawk marsh (15B) is an area of dense tall cattail between the two creeks' confluence. The park is a popular recreation area, with a sports field, trails that cross over the marsh and riparian resource, and a boardwalk that extends into the cattail. Both sites receive natural hydrology from creek flow and alluvial groundwater, and heavy stormwater inputs. The park field next to the cattail also has a sprinkler system, and the marsh also receives slope groundwater discharge. There is housing directly next to the riparian area. Soils in the riparian area are sandy but are undergoing change with vegetation infilling and sedimentation. Their soil map units are non-hydric Sandy Alluvial Land. There are prairie dogs in the surrounding upland. The site elevation is 1798 m.

Land Use: Red-tailed Hawk Park is a City of Aurora park and includes ball fields, playgrounds, and access to the Piney Creek Trail. It received a very high social rating. The site has a long history of land use and was surrounded by agricultural land until park development. The current land use surrounding the wetland is primarily residential and transportation corridors, including highways. Historical aerial imagery indicates the marsh was once a wet meadow seep with a patch of trees. The riparian areas

were open and sandy with scattered trees. Both sites have increased in wetness and vegetation density as development occurred over the last 2 decades. The wide creeks have since contracted into a channel and Piney Creek soils now have finer sediment, though sandy soil has persisted in the woody Sampson Gulch. The meadow has converted to a marsh and cattail have continuously infilled. The park trails had less impact on site connectivity when they were dirt, but in 2008 a hardened trail and field was constructed that filled large patches the riparian area and adjacent upland with fill. This impacted site connectivity and vegetation, and the upland is now weedy, especially in these fill areas.

Site Condition: Both sites (15A and 15B) overall condition was rated a D due to impacts by numerous stressors of the developed surrounding urban landscape and onsite park activities such as trails, park sprinkler irrigation, and a recreational field. The sandy soil section of wooded Sampson Gulch is in much better condition, but is a small section of the riparian AA. Fill from trail construction covered nearly a third of the park's riparian area and buffer. In those areas there are upland weeds and denser vegetation in the drainage. The riparian area lacks upland buffer between the housing, and housing maintenance at the time of survey was releasing sediment from the terraces down into the creek. Hydrology is impacted by stormwater and runoff inputs, with water sources receiving sprinkler and stormwater contributions. There are sheet piling grade controls in Piney Creek, and areas of entrenchment. The E-470 highway confines the riparian outflow to the west. The substrate has sedimentation in the wetland and is hardened in the buffer with fill impacts. The impacts of high development stress the wetland, but also facilitate a positive human-wetland connection experience. The site also is situated at a confluence; an important location with higher wetland functional value.

Vegetation: The vegetation for both AAs consists of a few dominant species, but in both wetland types the site was unique for persistent higher quality vegetation species in low cover, indicating that the site still has small remnant patches of native wetland habitat. However, the south wooded riparian area was in good condition. The riparian areas had more complex vegetation, with open plains cottonwood (*Populus deltoides* ssp. *monilifera*) mixed with narrowleaf cottonwood (*Populus angustifolia*), peachleaf willow (*Salix amygdaloides*) to denser narrowleaf willow (*Salix exigua*), rated in C/D condition. The marsh vegetation was largely narrowleaf cattail (*Typha angustifolia*) and duckweed (*Lemna minor*) and rated a D. The state A-list noxious weed hairy willowherb (*Epilobium hirsutum*) was present in the marsh and scattered locations downstream along Piney Creek. There was good diversity with 86 species recorded, and there was high quality native vegetation present, but also moderate diversity of non-native plants. There were 18 plant species with C-values 5-8, and this park had the most moderately conservative to conservative plants in this study. Bog willowherb (*Epilobium leptophyllum*), prairie sandreed (*Calamovilfa longifolia*), prairie cordgrass (*Spartina pectinata*), and starry false lily of the valley (*Maianthemum stellatum*) had high C-values of 7-8. Western wheatgrass (*Pascopyrum smithii*), prairie wedgescale (*Sphenopholis obtusata*), switchgrass (*Panicum virgatum*), slender wheatgrass (*Elymus trachycaulus*) also added to higher quality native grass composition in the riparian zones. There are seep zones outside of the cattail, and abutting the sports field, with fine wetland graminoids such as woolly sedge (*Carex lanuginosa*), Nebraska sedge (*Carex nebrascensis),* clustered field sedge (*Carex praegracilis*), and mountain rush (*Juncus arcticus* var. *balticus*). There were 5 Colorado noxious weeds, with Canada thistle (*Cirsium arvense*) in regular cover and the others in low cover.

Recommendations:

- *Hydrology:* The sprinkler watering may add undesired hydrology to the wetland, and the prairie dog colonies also had sprinklers. Evaluate the watering locations to minimize effect on the wetland.
- *Land Use:* The open forested sandy wash area along Sampson Gulch has good hydrology, vegetation, and substrate, and is worth protecting - avoiding new trails, development, and stormwater inputs.
- *Land Use:* Piney Creek, a formerly open sandy creek, has been invaded by dense vegetation and is entrenched, but areas of sandy substrate remain. The lack of wetland buffer between housing may influence these issues: conserve the buffer around the remainder of the wetland.
- *Cattail invasion:* Much of the marsh is dense cattail, but there was interesting diversity on its edges, especially around the seep area west of the field. Reducing stormwater and sprinkler and inputs may help avoid further cattail invasion and retain valuable wet meadow species.
- *Weeds:* The A-list noxious weed hairy willowherb (*Epilobium hirsutum*) is currently present at low cover. Map locations of hairy willow-herb and plan for eradication. Look for the bright magenta flowers during the flowering period (June - August). Trail use is popular for recreation, but upland areas around trails have high weedy cover. Limit further trail development and restore native trailside upland buffer. The existing native grass planted areas are successful and support good upland diversity. Avoid chemical weed treatment when possible to avoid impacts to the diverse pollinator species and other sensitive wildlife.
- *Sedimentation:* Housing area directly above riparian area had maintenance activities at the time of visit that were loosening sediment so it settled in the wetland. Fully vegetate sloped housing area and conduct neighborhood management and construction with practices to minimize sediment.

Table G-15. List of Plant Taxa documented at Red-tailed Hawk Park (AA-15) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Agrostis gigantea	Non-native	0		FACW
Agrostis stolonifera	Non-native	0		FACW
Alopecurus arundinaceus	Non-native	0		FACW
Anaphalis margaritacea	Native	4		FACU
Asclepias speciosa	Native	3		FAC
Astragalus cicer	Non-native	0		
Bromus inermis	Non-native	0		UPL
Calamovilfa longifolia	Native	7		
Carex nebrascensis	Native	5		OBL
Carex pellita	Native	6		OBL
Carex praegracilis	Native	5		FACW
Chenopodium berlandieri var. zschackii	Native	2		
Chenopodium sp.	Unknown			
Cirsium arvense	Non-native	0	List B	FACU
Conyza canadensis	Native	1		FACU
Cryptantha sp.	Unknown			
Dactylis glomerata	Non-native	0		FACU
Echinochloa crus-galli	Non-native	0		FAC
Elaeagnus angustifolia	Non-native	0	List B	FACU
Eleocharis palustris	Native	3		OBL
Ellisia nyctelea	Native	3		FACU
Elymus trachycaulus	Native	4		FACU
Epilobium ciliatum	Native	4		FACW
Epilobium hirsutum	Non-native	0	List A	FACW
Epilobium palustre var. *gracile*	Native	8		OBL
Euphorbia esula	Non-native	0	List B	
Glycyrrhiza lepidota	Native	3		FACU
Helianthus annuus	Native	1		FACU
Helianthus petiolaris	Native	2		
Hordeum jubatum	Native	2		FACW
Juncus arcticus var. *balticus*	Native	4		FACW
Juncus compressus	Non-native	0		FACW
Juncus torreyi	Native	5		FACW
Lactuca serriola	Non-native	0		FAC
Lemna minor	Native	2		OBL
Lycopus americanus	Native	5		OBL
Maianthemum stellatum	Native	7		FACU
Medicago lupulina	Non-native	0		FACU
Melilotus albus	Non-native	0		FACU
Melilotus officinalis	Non-native	0		FACU
Nepeta cataria	Non-native	0		FACU
Oenothera curtifolia	Native	1		UPL
Oenothera villosa	Native	4		FACU
Oxalis dillenii	Native	4		FACU
Panicum virgatum	Native	5		FAC
Parthenocissus vitacea	Native	3		FAC
Pascopyrum smithii	Native	5		FACU
Persicaria maculosa	Non-native	0		FACW
Phalaris arundinacea	Cryptogenic	1		FACW

Scientific Name	Native Status	C-Value	CO Noxious	Wetland Indicator
Plantago major	Non-native	0		FAC
Poa pratensis	Non-native	0		FACU
Polypogon monspeliensis	Non-native	0		FACW
Populus ×acuminata	Native	5		FAC
Populus angustifolia	Native	5		FACW
Populus deltoides ssp. *monilifera*	Native	3		FAC
Prunus virginiana var. *melanocarpa*	Native	4		FACU
Ranunculus cymbalaria	Native	4		OBL
Ranunculus sceleratus var. *multifidus*	Native	1		OBL
Ribes aureum	Native	6		FACU
Rorippa palustris	Native	4		OBL
Rosa sp.	Unknown			
Rumex crispus	Non-native	0		FAC
Rumex stenophyllus	Non-native	0		FACW
Salix amygdaloides	Native	5		FACW
Salix exigua	Native	3		FACW
Schoenoplectus pungens	Native	4		OBL
Schoenoplectus tabernaemontani	Native	3		OBL
Scirpus pallidus	Native	5		OBL
Setaria pumila ssp. *pumila*	Non-native	0		FACU
Sisymbrium altissimum	Non-native	0		FACU
Solidago mollis	Native	6		
Sonchus uliginosus	Non-native	0		FAC
Spartina pectinata	Native	7		FACW
Sphenopholis obtusata	Native	5		FAC
Symphoricarpos occidentalis	Native	3		UPL
Symphyotrichum ericoides	Native	4		FACU
Taraxacum officinale	Non-native	0		FACU
Thinopyrum ponticum	Non-native	0		
Thlaspi arvense	Non-native	0		FACU
Toxicodendron rydbergii	Native	3		FACU
Tragopogon dubius	Non-native	0		
Typha angustifolia	Cryptogenic	1		OBL
Typha latifolia	Native	4		OBL
Urtica dioica ssp. *gracilis*	Native	3		FAC
Verbascum thapsus	Non-native	0	List C	UPL
Veronica anagallis-aquatica	Native	1		OBL
Zannichellia palustris	Native	2		OBL

* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

Sand Creek Park and Sand Creek Greenway (AA-11)

EIA Overall Rank: 2.56 C	**FACWet Overall Rank: 0.68 D**

Landscape Context: 2.49 D
Vegetation Condition: 2.67 C
Hydrologic Condition: 2.33 D
Physiochemical Condition: 3.00 C

Mean C: 1.75
Native Mean C: 3.18
Size: 1.4 miles
Social Rating: 11.0 Very High

Ecological System: Western Great Plains Riparian
Hydrogeomorphic Class: Riverine

Sand Creek Park

Site Overview
This AA is an urban mixed herbaceous and shrub riparian area along Sand Creek north of Fitzsimons Pkwy with an extensive trail system throughout. The AA included the riparian wetlands but not the ponds at higher elevation near the Peoria St. parking area. Beaver are present upstream and provide important buffering and wetland health services, adding to shallow water habitat, supporting steady alluvial hydrology, and reducing flashy water levels and flow rates from the channelized creek upstream. There are grade controls mid-reach with a wide fast flowing channel and visible sediment inputs. Downstream, the active channel widens and has more complexity with seasonal side channels and vegetated sandbars. Mapped soil units include Ellicott-Glenburg complex, occasionally flooded, Loamy Alluvial Land drainageways, and Terrace Escarpments, all classified as non-hydric. The soil is varied in texture by location and depositional layers, ranging from clay loam to sandy, and two pits in the vegetated riparian area were hydric including one in the reed canary grass (*Phalaris arundinacea*). The park is popular for recreation with an extensive trail system and various amenities for open space enjoyment. The site elevation is 1618 meters.

Land Use: Sand Creek Park, a City of Aurora Park, is a popular destination with its extensive trail system. The surrounding landscape is urban with housing, roads, industrial areas, and a golf course. The proximity to densely populated areas and the accessibility for recreation and enjoyment contribute to this sites very high social rating. Though highly valued socially, the high use adjacent trails and ponds impact the immediate floodplain connectivity. Old aerial imagery shows that Sand Creek was once a braided sandy channel in the AA, and the site has increased in vegetation density and lost much of its sandy substrate. There are numerous stormwater inputs to the creek, grade controls slowing flow in the middle of the AA, and a waste water treatment plant at the downstream end of the AA. Beaver dams are partially surrounded by hardened walls.

Site Condition: This site was rated an overall low C, with numerous impacts from the developed urban landscape and hydrology inputs. The substrate within the wetland riparian area has good microtopography and is not compacted, but has visible sedimentation from urban inputs and sections of downcut banks. The banks outside the wetland area and in the upland buffer are compacted and have rip rap, affecting hydrologic connectivity. The water is turbid and the channel bed lacks complexity. There is also considerable wetland floodplain width that is likely attributable to beaver, and otherwise likely be drier. There is enough plastic in high water wrack to impact site condition. This site is notable for its size: one of two A-size scores, continuing for more than 3 miles including out of the park. The

overall urban stressors and lower condition of the site can limit functional performance, but established beaver are continually improving these functions. Amidst urban development, this wetland and riparian area provides valuable floodplain functions that reduce flood risk to the surrounding population and improve water quality.

Vegetation: Reed canary grass (*Phalaris arundinacea*) and coyote willow (*Salix exigua*) were the dominant site species, alternating in herbaceous to woody patches. Narrowleaf cattail (*Typha angustifolia*) and reed canary grass had sections of high cover in the site. There was also moderate cover of smooth brome (*Bromus inermis*), wild cucumber (*Echinocystis lobata*) and sweetclover (*Melilotus* spp.). 63 species were recorded at the site, of which 8 were noxious or state-watchlisted species, including Russian olive (*Eleagnus angustifolia*). Plains cottonwood (*Populus deltoides*), crack willow (*Salix* x *fragilis*), and peachleaf willow (*Salix amygdaloides*) created open scattered tree cover.

Wildlife of Note: Beaver have established themselves in the upstream reach of the site, in Sand Creek above the confluence with Toll Gate Creek.

Recommendations:

- *Land Use:* The less developed downstream site has maintained important stream features such as secondary flow paths and sandbars. Avoid further downstream development or hardening of trails to maintain these features.
- *Social Value:* The site has the highest social value rating, with an outdoor education area and greenway, and lots of potential for public enjoyment and use. Wetland educational signage on the functions of wetlands and flood protection would have a broad reach here.
- Trash pickups would help the plastic trash problems in the creek.
- *Beaver:* Beaver have occupied this site for a long time. They provide resilience and restoration to an urban site with inputs from a straightened urban confined stream and stormwater. Management to enable beaver expansion would further restore site adding complexity to stream and slowing flow.
- *Hydrology:* The grade controls buffer stormwater flow rates, but result in a wide open channel. Restoration could add smaller gravel riffles, pools, and emergent bank zones with diverse aquatic and wetland species to support aquatic life and intercept stream flow.
- *Weeds:* Avoid chemical weed treatment to avoid impacts to the diverse pollinator species and other sensitive wildlife.

Table G-16. List of Plant Taxa documented at Sand Creek Park (AA-11) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Acer negundo	Native	4		FAC
Ailanthus altisima	Non-native	0	Watch List	FACU
Alopecurus arundinaceus	Non-native	0		FACW
Amaranthus retroflexus	Non-native	0		FACU
Ambrosia psilostachya	Native	3		FACU
Ambrosia trifida var. *trifida*	Native	3		FAC
Apocynum cannabinum	Native	2		FAC
Asclepias incarnata	Native	4		FACW
Asclepias speciosa	Native	3		FAC
Bidens cernua	Native	5		OBL
Bolboschoenus maritimus ssp. *paludosus*	Native	5		OBL
Bothriochloa laguroides	Native	2		
Bromus inermis	Non-native	0		UPL
Carex praegracilis	Native	5		FACW
Chenopodium album	Non-native	0		FACU
Chenopodium rubrum	Native	2		OBL
Cirsium arvense	Non-native	0	List B	FACU
Conyza canadensis	Native	1		FACU
Crataegus sp.	Unknown			
Dactylis glomerata	Non-native	0		FACU
Dipsacus laciniatus	Non-native	0	List B	UPL
Distichlis stricta	Native	4		FACW
Echinochloa crus-galli	Non-native	0		FAC
Echinocystis lobata	Native	3		FAC
Elaeagnus angustifolia	Non-native	0	List B	FACU
Eleocharis acicularis	Native	5		OBL
Eleocharis palustris	Native	3		OBL
Elymus repens	Non-native	0	List C	FACU
Equisetum laevigatum	Native	4		FAC
Eragrostis cilianensis	Non-native	0		FACU
Euthamia occidentalis	Native	4		OBL
Fraxinus pennsylvanica	Non-native	0		FAC
Gleditsia triacanthos	Non-native	0		FACU
Glycyrrhiza lepidota	Native	3		FACU
Grindelia squarrosa	Native	1		UPL
Hordeum jubatum	Native	2		FACW
Kochia scoparia	Non-native	0		FACU
Lactuca serriola	Non-native	0		FAC
Lemna minor	Native	2		OBL
Lepidium latifolium	Non-native	0	List B	FACW
Medicago sativa	Non-native	0		UPL
Melilotus albus	Non-native	0		FACU
Melilotus sp.	Non-native	0		
Oenothera curtifolia	Native	1		UPL
Panicum capillare	native	1		FAC
Panicum virgatum	Native	5		FAC
Persicaria lapathifolia	Native	2		OBL
Phalaris arundinacea	Cryptogenic	1		FACW
Phragmites australis	Non-native	0	Watch List	FACW

Scientific Name	Native Status	C-Value	CO Noxious	Wetland Indicator
Populus deltoides ssp. *monilifera*	Native	3		FAC
Potamogeton foliosus	Native	4		OBL
Rumex crispus	Non-native	0		FAC
Salix ×fragilis	Non-native	0		FAC
Salix amygdaloides	Native	5		FACW
Salix exigua	Native	3		FACW
Schoenoplectus tabernaemontani	Native	3		OBL
Secale cereale	Non-native	0		
Sonchus sp.	Unknown			
Symphyotrichum lanceolatum ssp. *hesperium*	Native	5		FACW
Typha angustifolia	Cryptogenic	1		OBL
Ulmus pumila	Non-native	0	Watch List	UPL
Unknown ornamental	Non-native	0		
Xanthium strumarium	Native	1		FAC

* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

Sand Creek Riparian Preserve/northern Triple Creek Greenway (AA-13)

EIA Overall Rank: 3.29 C	**FACWet Overall Rank: 0.75 C**

Landscape Context: 2.83 C
Vegetation Condition: 3.33 C
Hydrologic Condition: 3.67 B
Physiochemical Condition: 3.75 B

Mean C: 2.21
Native Mean C: 3.69
Size: 1.5 miles
Social Rating: 7.0 High

Ecological System: Western Great Plains Riparian
Hydrogeomorphic Class: Riverine

Sand Creek Riparian Preserve

Site Overview

The AA is located along a plains cottonwood gallery along Sand Creek north of East 6th Ave., south of the Aurora Sports Park, and east of Tower Rd. The forested creek has patches of dense shrubs and is braided with seasonal side channels and slow-flowing main flow path that supports cattail (*Typha*) and other understory wetland vegetation. Beaver are active throughout, and create open water pools, and improve site quality. Soil is sandy with a silty surface layer. The mapped soil units were non-hydric Loamy Alluvial Land and Sandy Alluvial land. The site is a wooded refuge next to an urban park, supporting wildlife habitat and riparian wetland function. There is a hardened trail next to the wetland popular for recreation and meandering dirt trails in the wetland. The site elevation is 1664 meters.

Land Use: Sand Creek Riparian Preserve is a City of Aurora Natural Area. The riparian area is managed for natural vegetation with several dirt trails within the wetland-riparian corridor and hardened bike trails outside the corridor. The Sand Creek Parkway Trail provides access to the area and the site received a high social rating. To the north, adjacent land uses are highly urban with the adjacent Aurora Sports Park and high impervious surface area from roads, housing, and businesses; to the south of the site is mostly open space with localized industrial use. The wetland receives stormwater inputs next to the recreational fields, but the site does not appear hydrologically stressed.

Site Condition: Site condition was rated a high C overall. The surrounding landscape was in fair condition. The hydrology within the forested riparian corridor is notably good, with beaver activity creating layered wetland substrate and ponds with small fish and a braided channel. The substrate is naturally hummocked and vegetation zones follow microtopography by wetness. There were groundwater-influenced seep areas supporting fine herbaceous native wetland understory, especially near the southwest break and slope. These were interspersed with other areas of non-native grass and larger marsh species. Native wetland understory is uncommon throughout the Colorado plains, so this site is notable for having wetland understory; which is likely related to beaver presence and sections of healthy native substrate.

Vegetation: Plains cottonwood (*Populus deltoides* ssp. *monilifera)* dominates this riparian area with scattered peachleaf willow trees (*Salix amygdaloides*). Coyote willow (*Salix exigua)* and mixed cattail *(Typha*) and bulrush (*Schoenoplectus tabernaemontani* and *S. pungens*) species also populate the low-middle strata, and the remainder of species are mostly herbaceous. There is good structural complexity,

with various densities of cottonwood, open shrub layers, and varied understory vegetation types. The vegetation survey included 64 species records, of which 8 were noxious or watch-listed. Smooth brome (*Bromus inermis*), mountain rush (*Juncus arcticus* var. *balticus*), and quackgrass (*Elymus repens*) also have moderate cover. This riparian area had 11 moderately conservative native species with C-values of 5-6 in low cover, such as Canada goldenrod (*Solidago canadensis*), three sedges (*Carex pellita, C. nebrascensis,* and *C. praegracilis*), and cosmopolitan bulrush (*Bolboschoenus maritimus* ssp. *paludosus*); representing good forested understory wetland species potential.

Wildlife of Note: Beaver are well established within this site.

Recommendations:

- *Beaver:* The forested wetland substrate is healthy, which is notable for urban wetlands. Resident beaver positively influence substrate by shaping natural floodplain hydrology and vegetation. Manage to allow long-term occupation by beaver.
- *Plants:* The site supports native wetland herbaceous understory vegetation – remnant vegetation of Colorado plains forested wetlands. Avoid management that will stress these native areas.
- *Trails:* Focus trail maintenance on greenway trails above wetland and consider minimizing trail use in the riparian area especially in areas of groundwater discharge. Restoration/naturalization signage could limit spreading dirt footpaths.
- *Land Use:* Preserve the upland open space to the south, especially along its drainage paths and seeps, and manage area for native vegetation.
- *Weeds:* Avoid chemical weed treatment to avoid impacts to the diverse pollinator species and other sensitive wildlife.

Table G-17. List of Plant Taxa documented at Sand Creek Riparian Preserve (AA-13) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Agrostis gigantea	Non-native	0		FACW
Ambrosia psilostachya	Native	3		FACU
Apocynum cannabinum	Native	2		FAC
Artemisia ludoviciana	Native	4		UPL
Asclepias speciosa	Native	3		FAC
Asparagus officinalis	Non-native	0		FACU
Bolboschoenus maritimus ssp. *paludosus*	Native	5		OBL
Bromus inermis	Non-native	0		UPL
Bromus tectorum	Non-native	0	List C	
Caragana arborescens	Non-native	0		
Carduus nutans	Non-native	0	List B	FACU
Carex nebrascensis	Native	5		OBL
Carex pellita	Native	6		OBL
Carex praegracilis	Native	5		FACW
Conyza canadensis	Native	1		FACU
Echinochloa crus-galli	Non-native	0		FAC
Elaeagnus angustifolia	Non-native	0	List B	FACU
Eleocharis palustris	Native	3		OBL
Elymus repens	Non-native	0	List C	FACU
Equisetum laevigatum	Native	4		FAC

Scientific Name	Native Status	C-Value	CO Noxious	Wetland Indicator
Euphorbia esula	Non-native	0	List B	
Euthamia occidentalis	Native	4		OBL
Glycyrrhiza lepidota	Native	3		FACU
Grindelia squarrosa	Native	1		UPL
Hordeum jubatum	Native	2		FACW
Juncus arcticus var. *balticus*	Native	4		FACW
Juncus articulatus	Native	6		OBL
Juncus compressus	Non-native	0		FACW
Juncus torreyi	Native	5		FACW
Juniperus sp.	Unknown			
Lactuca serriola	Non-native	0		FAC
Lycopus americanus	Native	5		OBL
Muhlenbergia asperifolia	Native	4		FACW
Parthenocissus sp.	Unknown			
Plantago major	Non-native	0		FAC
Poa pratensis	Non-native	0		FACU
Polypogon monspeliensis	Non-native	0		FACW
Populus deltoides ssp. *monilifera*	Native	3		FAC
Potamogeton foliosus	Native	4		OBL
Prunus virginiana var. *melanocarpa*	Native	4		FACU
Ranunculus sceleratus var. *multifidus*	Native	1		OBL
Ribes aureum	Native	6		FACU
Rumex crispus	Non-native	0		FAC
Rumex stenophyllus	Non-native	0		FACW
Salix amygdaloides	Native	5		FACW
Salix exigua	Native	3		FACW
Schoenoplectus pungens	Native	4		OBL
Schoenoplectus tabernaemontani	Native	3		OBL
Secale cereale	Non-native	0		
Solidago canadensis	Native	5		FACU
Sonchus arvensis	Non-native	0	List C	FAC
Symphoricarpos occidentalis	Native	3		UPL
Symphyotrichum lanceolatum ssp. *hesperium*	Native	5		FACW
Tamarix chinensis	Non-native	0	List B	FACW
Toxicodendron rydbergii	Native	3		FACU
Trifolium pratense	Non-native	0		FACU
Trifolium repens	Non-native	0		FACU
Typha angustifolia	Cryptogenic	1		OBL
Typha hybrid	Cryptogenic	1		OBL
Typha latifolia	Native	4		OBL
Unknown grass	Unknown			
Verbascum thapsus	Non-native	0	List C	UPL
Veronica anagallis-aquatica	Native	1		OBL
Zannichellia palustris	Native	2		OBL

* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

Signature Park Riparian Area (AA-12A) and Marsh (AA-12B)

AA-12A EIA Overall Rank: 1.94 D	**AA-12A FACWet Overall Rank: 0.65 D**
AA-12B EIA Overall Rank: 1.95 D	**AA-12B FACWet Overall Rank: 0.64 D**

AA-12A: Landscape Context: 2.00 D	Mean C: 1.47
Vegetation Condition: 2.00 D	Native Mean C: 3.20
Hydrologic Condition: 1.67 D	Size: 1.2 miles
Physiochemical Condition: 2.25 D	Social Rating: 4.5 Medium
AA-12B: Landscape Context: 1.91 D	Mean C: 1.89
Vegetation Condition: 1.50 D	Native Mean C: 3.47
Hydrologic Condition: 2.33 D	Size: 3 acres
Physiochemical Condition: 3.25 C	Social Rating: 4.5 Medium

Ecological Systems: Western Great Plains Riparian (12A) and Western North American Marsh (12B)
Hydrogeomorphic Class: Riverine (12A) and Riverine-impounded (12B)

Signature Park – Riparian, AA-12A

Signature Park – Marsh, AA-12B

Site Overview

The Signature Park Riparian area (12A) and marsh (12B) AAs are along East Tollgate Creek east of S Airport Blvd and north of E Alameda Pkwy. The stream is deeply entrenched in the riparian portion of the site, downstream to where beaver have established and are restoring the site connectivity and complexity. Upstream of beaver, banks are sloughing into the channel. Downstream of the beaver the site widens into a cattail (*Typha*) and coyote willow (*Salix exigua*) marsh above the Airport Blvd culvert. Two soil pits were dug outside of the riparian site bank, which were clay loam and lacking visible hydric features, likely representing fill. The marsh soil pit emitted a hydrogen sulfide odor and had silty loam texture. Most of the mapped soil unit was non-hydric Nunn loam with 1-3% slopes. The site hydrology receives throughflow and stormwater from upstream housing. There were no public trails or recreation amenities at the site at the time of survey. The site elevation is 1667 m.

Land Use: Signature Park is a City of Aurora property that is currently closed to the public. The site is an undeveloped stretch of East Tollgate Creek open space in a developed surrounding landscape that has sustained cumulative impacts to the wetland. There is a construction sand pile area south of the marsh and a lengthy upland buffer that is impacted by fill and a high cover of weeds. The buffer had much more wetland area in 1980's imagery both onsite and downstream, where much has been converted to compacted non-wetland. Aerial photography also shows regular management that removes vegetation in strips. Sections of the former creek were straightened upstream, and the south secondary channel is disconnected from the main wetland. The culvert and steep banks to the marsh prevent a shallow water and vegetated wetland zone outside of the channel. There are major stormwater inputs to the site.

Site Condition: The riparian and marsh sites both rated a D overall, and for many of the component metric categories. The riparian site ranked lower due to higher hydrologic stress, more noxious weeds, and sections of deep entrenchment. The site is a long undeveloped stretch of the creek with a lower condition but broad upland buffer, valuable for its size and floodplain functions. The upland buffer has exposed bare ground and noxious weed areas. Hydrology is impacted by stormwater inputs and potentially by construction, and there is riprap around the marsh and scattered sections of riparian area. Based on eroding channel banks and wrack deposits, streamflow is flashy. The surrounding buffer is hardened, and substrate alterations around contributing drainages may not easily carry surface water flow into the creek. Hydrology may be highly stressed overall, and vegetation show signs of stress. Although hydrology is in poor condition in general, where beaver are established, hydrologic connectivity and flow path complexity is significantly improved. Beaver are restoring the wetland function and structure, and they will likely continue to improve the site and the many riparian wetland

functions over time. The upland buffer has stress and reduced floodplain function, but beaver are not restoring the upland areas.

Vegetation: Both AAs have high non-native and invasive vegetation cover, with large patches of noxious species. The site had moderate diversity with 76 species observed in the AA. The marsh AA and sections of the riparian area are dominated by narrowleaf cattail (*Typha angustifolia*) and coyote willow (*Salix exigua*). Coyote willow continues in higher cover upstream, codominant with reed canary grass (*Phalaris arundinacea*). The noxious weed poison hemlock (*Conium maculatum*) is in high cover on the banks throughout the site, and cutleaf teasel (*Dipsacus laciniatus*) has regular lower cover. Canada thistle (*Cirsium arvense*) has high cover in the marsh but is present throughout. There are scattered peachleaf willow (*Salix amygdaloides*) and plains cottonwood (*Populus deltoides*) trees adding structure to the site, and some are stressed with dead branches and foliage loss. Occasional short shrub species are present in the channel. Most other species are forbs, often facultative or facultative-upland species, except several sedge family (Cyperaceae) in low cover including pale spikerush (*Eleocharis palustris*), softstem bulrush (*Schoenoplectus tabernaemontani*), common threesquare (*Schoenoplectus pungens*) and cosmopolitan bulrush (*Bolboschoenus maritimus* ssp. *paludosus*).

Wildlife of Note: Beaver have established in the downstream portion of the site.

Recommendations

- *Beaver:* Site has deep entrenchment and severe channel erosion, but beaver are successfully restoring downstream riparian connectivity. Manage to allow beaver expansion, and keep trails far from creek to leave room for stream restoration and widening. A wetted and connected riparian zone provides more flood attenuation and overall wetland function.
- *Hydrology:* This site has a wide floodplain but has poor buffer condition and deep entrenchment. Efforts to restore riparian processes will help restore wetland function and potential flood attenuation.
- *Hydrologic Connectivity:* The former stream path east of S Quintero Way is disconnected from the now main channel. Reconnecting this side channel may reduce the channelized flow and associated erosion and restore wetland connectivity and improve site hydrology over time.
- *Weeds:* There is high cover of noxious weeds on dry riparian soil, that appear to have colonized a once wetter riparian zone where substrate disturbance is visible on aerial imagery. Native vegetation restoration and avoiding further substrate disturbance to the riparian zone could help native vegetation establishment and hydrologic support. Avoid chemical weed treatment to avoid impacts to the diverse pollinator species and other sensitive wildlife.

Table G-18. List of Plant Taxa documented at Signature Park Riparian Area (AA-12A) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Acer negundo	Native	4		FAC
Apocynum cannabinum	Native	2		FAC
Arctium minus	Non-native	0	List C	FACU
Asclepias speciosa	Native	3		FAC
Bromus inermis	Non-native	0		UPL
Capsella bursa-pastoris	Non-native	0		FACU
Carduus nutans	Non-native	0	List B	FACU
Chamaesyce sp.	Unknown			
Chenopodium incanum var. *incanum*	Native	5		
Chenopodium pratericola	Native	4		
Cirsium arvense	Non-native	0	List B	FACU
Conium maculatum	Non-native	0	List C	FACW
Convolvulus arvensis	Non-native	0	List C	
Conyza canadensis	Native	1		FACU
Cucurbita foetidissima	Native	2		
Cynoglossum officinale	Non-native	0	List B	FACU
Descurainia sophia	Non-native	0		
Dipsacus laciniatus	Non-native	0	List B	UPL
Dyssodia papposa	Native	2		
Elaeagnus angustifolia	Non-native	0	List B	FACU
Eleocharis palustris	Native	3		OBL
Elymus repens	Non-native	0	List C	FACU
Fraxinus pennsylvanica	Non-native	0		FAC
Galium aparine	Native	1		FACU
Gleditsia triacanthos	Non-native	0		FACU
Glycyrrhiza lepidota	Native	3		FACU
Hesperis matronalis	Non-native	0	List B	FACU
Kochia scoparia	Non-native	0		FACU
Lactuca serriola	Non-native	0		FAC
Lathyrus eucosmus	Native	6		
Malus sp.	Unknown			
Medicago sativa	Non-native	0		UPL
Melilotus officinalis	Non-native	0		FACU
Nepeta cataria	Non-native	0		FACU
Oenothera curtifolia	Native	1		UPL
Parthenocissus vitacea	Native	3		FAC
Phalaris arundinacea	Cryptogenic	1		FACW
Populus deltoides ssp. *monilifera*	Native	3		FAC
Portulaca oleracea	Non-native	0		FAC
Prunus americana	Native	6		UPL
Prunus virginiana var. *melanocarpa*	Native	4		FACU
Psathyrostachys juncea	Non-native	0		FACU
Ranunculus sceleratus var. *multifidus*	Native	1		OBL
Rhamnus cathartica	Non-native	0		FACU
Ribes aureum	Native	6		FACU
Rumex crispus	Non-native	0		FAC
Salix amygdaloides	Native	5		FACW
Salix exigua	Native	3		FACW
Salvia reflexa	Native	2		

Scientific Name	Native Status	C-Value	CO Noxious	Wetland Indicator
Schedonorus arundinaceus	Non-native	0		FACU
Sisymbrium altissimum	Non-native	0		FACU
Sonchus asper	Non-native	0		FAC
Symphyotrichum sp.	Native			
Tragopogon dubius	Non-native	0		
Unknown mint	Unknown			
Urtica dioica ssp. *gracilis*	Native	3		FAC
Verbascum thapsus	Non-native	0	List C	UPL
Verbena bracteata	Native	2		FACU
Vicia americana	Native	5		FACU

* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

Table G-19. List of Plant Taxa documented at Signature Park Marsh (AA-12B) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Amaranthus albus	Non-native	0		FACU
Apocynum cannabinum	Native	2		FAC
Asclepias speciosa	Native	3		FAC
Bolboschoenus maritimus ssp. *paludosus*	Native	5		OBL
Bromus inermis	Non-native	0		UPL
Cichorium intybus	Non-native	0	List C	FACU
Cirsium arvense	Non-native	0	List B	FACU
Conium maculatum	Non-native	0	List C	FACW
Convolvulus arvensis	Non-native	0	List C	
Conyza canadensis	Native	1		FACU
Dipsacus laciniatus	Non-native	0	List B	UPL
Elaeagnus angustifolia	Non-native	0	List B	FACU
Eleocharis palustris	Native	3		OBL
Euthamia occidentalis	Native	4		OBL
Glycyrrhiza lepidota	Native	3		FACU
Lemna minor	Native	2		OBL
Lepidium latifolium	Non-native	0		FACW
Melilotus albus	Non-native	0		FACU
Melilotus officinalis	Non-native	0		FACU
Oenothera villosa	Native	4		FACU
Phalaris arundinacea	Cryptogenic	1		FACW
Physalis longifolia	Native	4		
Populus deltoides ssp. *monilifera*	Native	3		FAC
Portulaca oleracea	Non-native	0		FAC
Ranunculus cymbalaria	Native	4		OBL
Ribes aureum	Native	6		FACU
Rumex crispus	Non-native	0		FAC
Salix amygdaloides	Native	5		FACW
Salix exigua	Native	3		FACW
Salix sp.	Unknown			
Salsola sp.	Non-native			
Schoenoplectus pungens	Native	4		OBL
Schoenoplectus tabernaemontani	Native	3		OBL
Sonchus asper	Non-native	0		FAC
Symphoricarpos occidentalis	Native	3		UPL
Typha angustifolia	Cryptogenic	1		OBL
Typha latifolia	Native	4		OBL

* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

Star K Ranch (AA-9)

EIA Overall Rank: 2.74 C	**FACWet Overall Rank: 0.67 D**

Landscape Context: 3.44 C
Vegetation Condition: 2.50 D/C
Hydrologic Condition: 2.33 D
Physiochemical Condition: 2.50 D/C

Mean C: 1.94
Native Mean C: 3.57
Size: 2 acres
Social Rating: 9.0 High

Ecological Systems: Western North American Emergent Marsh (center and majority of AA); and Western Great Plains Riparian (outer ecosystem)
Hydrogeomorphic Class: Depressional

Star K Ranch

Site Overview
Star K Ranch is located in the Sand Creek floodplain west of Airport Blvd between Sand Creek and Smith Road. The site is a former gravel pit complex that has revegetated into a cattail (*Typha*) marsh surrounding open water ponds. The outer AA and surrounding landscape is wooded, and in its native state the site would be a plains riparian wetland ecosystem. The soil is sandy loam on top of coarse sand. Mapped soil units include Ellicott-Glenburg complex, occasionally flooded, and Loamy Alluvial Land drainageways, both non-hydric, and mapped gravel pits abutting the SW side of the site. Some open water areas had dense algae at the time of survey. The water sources are likely adjacent alluvial groundwater and precipitation. The site provides well-maintained trails, overlooks, and a nature center. The site elevation is 1638 meters.

Land Use: Star K Ranch is a popular City of Aurora Natural Area with trails including a wetland loop. It is the home of the Morrison Nature Center. Additionally, the Sand Creek Greenway and High Line Canal trails are accessed here. All these features contribute to the very high social rating for the Star K Ranch AA. The wetland is a restored gravel pit, located in a backwater area of the Sand Creek floodplain. The site is separated from the main creek by the Sand Creek Greenway Trail to the south, and industrial development to the northwest. There are secondary channels and wetland (often marsh) in 1940 topographic maps that are now developed or drier. The wooded oxbow was wetter and still more connected to the creek in the 1980's, and the herbaceous open space to the east also appears to have reduced hydrology from past aerial imagery.

Site Condition: This site received a C rating for condition. The surrounding landscape scored a C with a mixture of naturally vegetated floodplain, fallow fields, industrial areas, and housing. Cattail (*Typha*) dominated the inundated marsh, and the wooded outer wetland was in better condition with good woody vegetation structure. Shallow water areas were limited, but a small mudflat that is likely inundated earlier in the season provided important shallow water wildlife habitat and higher quality vegetation. Floating downed wood was used as wildlife basking sites. The hydrology was rated a D due to reduced connectivity: the steep banks from excavation interfered with site connectivity to the surrounding wetland and riparian area, and the hydroperiod shows signs of lacking flushing, with moderately restricted outlets. The water quality also rated a D with extensive algal (*Chara* sp.) mats, turbidity, and milky water in the center of the AA. The substrate is compacted from trails and former

land use but is mostly vegetated. The wetland provides valuable water storage, wildlife habitat, and human-watershed connection, and the surrounding forested areas provide floodplain functions.

Vegetation: The marsh AA vegetation was dominated by narrowleaf cattail (*Typha angustifolia*) in the deepest vegetated water. Other secondary dominants include common threesquare (*Schoenoplectus pungens*), mountain rush (*Juncus arcticus* var. *balticus*), and coyote willow (*Salix exigua*). Plains cottonwood (*Populus deltoides* ssp. *monilifera*) and peachleaf willow (*Salix amygdaloides*) trees surround the marsh and had some understory patches of mesic grass to wetland graminoids with rush (*Juncus*) and sedge (*Carex*) species. The woody vegetation had good vertical structure and a combination of young and mature individuals, but provided little shade to the open water. Smooth brome (*Bromus inermis*) and pale spikerush (*Eleocharis palustris*) were also are present in low-moderate cover. The site had moderate diversity with 54 species observed in the AA, and most of the remaining species were a mix of forbs and mesic to wetland graminoids. Some aquatic and rooted mudflat species added to the vegetation diversity, such as longbeak buttercup (*Ranunculus aquatilis* var. *diffusus*) and alkali buttercup (*Ranunculus cymbalaria*).

Wildlife of Note: The pond supports invasive red-eared sliders (*Trachemys scripta elegans*) along with native western painted turtles. The red-eared slider is a popular pet trade aquatic turtle native to southeastern U.S. and is often released into ponds in urban areas. Opportunities to educate the public about releasing unwanted pets like the red-eared slider into open space properties would be valuable to help stop the introduction of invasive species. Native Woodhouse's toad (*Bufo woodhousii*) and boreal chorus frog (*Pseudacris maculata*) were found during the surveys. No invasive bullfrogs (*Lithobates catesbeianus*) were noted. Chytrid fungus testing on the amphibians was negative.

Recommendations:

- *Social Value:* This site supports recreation and education, with maintained trails and a nature center. As a former gravel pond site, the site is a novel wetland type where human use and existing trails have relatively less impact on current site health than natural wetlands. The public education and access to the wetland at this site contribute to its high social rating.
- *Plants:* The upland to the east has disturbed vegetation. Targeted vegetation restoration in the buffer may positively impact wetland site hydrology and health.
- *Weeds:* Avoid chemical weed treatment to avoid impacts to the diverse pollinator species and other sensitive wildlife.
- *Water Quality:* During the site visit, the water had dense algae (*Chara* sp.), and the central open water was milky in color. Monitor algae levels and water quality through the growing season.

Table G-20. List of Plant Taxa documented at Star K Ranch (AA-9) (Field Season 2019)

Scientific Name	**Native Status**	**C-Value**	**CO Noxious**	**Wetland Indicator**
Alopecurus arundinaceus	Non-native	0		FACW
Apocynum cannabinum	Native	2		FAC
Asclepias speciosa	Native	3		FAC
Asparagus officinalis	Non-native	0		FACU
Bromus inermis	Non-native	0		UPL
Bromus tectorum	Non-native	0	List C	
Carex pellita	Native	6		OBL
Carex praegracilis	Native	5		FACW
Chenopodium simplex	Native	2		
Cirsium arvense	Non-native	0	List B	FACU
Conyza canadensis	Native	1		FACU
Cynoglossum officinale	Non-native	0	List B	FACU
Dactylis glomerata	Non-native	0		FACU
Elaeagnus angustifolia	Non-native	0	List B	FACU
Eleocharis palustris	Native	3		OBL
Equisetum laevigatum	Native	4		FAC
Euphorbia esula	Non-native	0	List B	
Euthamia occidentalis	Native	4		OBL
Glycyrrhiza lepidota	Native	3		FACU
Juncus arcticus var. *balticus*	Native	4		FACW
Juncus bufonius	Native	3		OBL
Juniperus sp.	Unknown			
Lactuca serriola	Non-native	0		FAC
Lemna minor	Native	2		OBL
Lepidium chalapensis	Non-native	0		
Lonicera tatarica	Non-native	0		FACU
Lycopus americanus	Native	5		OBL
Medicago sativa	Non-native	0		UPL
Melilotus albus	Non-native	0		FACU
Melilotus officinalis	Non-native	0		FACU
Panicum virgatum	Native	5		FAC
Parthenocissus vitacea	Native	3		FAC
Plantago major	Non-native	0		FAC
Poa pratensis	Non-native	0		FACU
Polypogon monspeliensis	Non-native	0		FACW
Populus deltoides ssp. *monilifera*	Native	3		FAC
Prunus virginiana var. *melanocarpa*	Native	4		FACU
Psathyrostachys juncea	Non-native	0		FACU
Ranunculus aquatilis var. *diffusus*	Native	3		OBL
Ranunculus cymbalaria	Native	4		OBL
Ranunculus sceleratus var. *multifidus*	Native	1		OBL
Rhamnus cathartica	Non-native	0		FACU
Ribes aureum	Native	6		FACU
Salix ×fragilis	Non-native	0		FAC
Salix amygdaloides	Native	5		FACW
Salix exigua	Native	3		FACW
Schedonorus arundinaceus	Non-native	0		FACU
Schoenoplectus pungens	Native	4		OBL
Secale cereale	Non-native	0		

Scientific Name	Native Status	C-Value	CO Noxious	Wetland Indicator
Symphyotrichum ericoides/falcatum	Native			
Symphyotrichum lanceolatum ssp. *hesperium*	Native	5		FACW
Toxicodendron rydbergii	Native	3		FACU
Typha angustifolia	Cryptogenic	1		OBL
Verbena hastata	Native	4		FACW

* Wetland Indicator based on the 2018 National Wetland Plant List for the Great Plains region (USACE 2018). OBL = Obligate Wetland, almost always occur in wetlands; FACW = Facultative Wetland, usually occurs in wetlands; FAC = Facultative, occurs in wetlands and non-wetlands; FACU = Facultative Upland, usually occur in non-wetlands, but may occur in wetlands; UPL = Obligate Upland, almost never occurs in wetlands.

Appendix H: List of Plant Taxa documented in Aurora (May-September 2019)

USDA Symbol	Plant Family	Scientific Name (Ackerfield 2015)	Common Name	Native Status	C-Value	CO Noxious Weed	Wetland Indicator
ABFR2	Nyctaginaceae	*Abronia fragrans*	Snowball sand verbena	Native	6		
ACNE2	Sapindaceae	*Acer negundo*	Boxelder	Native	4		FAC
ACHY	Poaceae	*Achnatherum hymenoides*	Indian ricegrass	Native	5		FACU
AGCR	Poaceae	*Agropyron cristatum*	Crested wheatgrass	Non-native	0		
AGGI2	Poaceae	*Agrostis gigantea*	Redtop	Non-native	0		FACW
AGST2	Poaceae	*Agrostis stolonifera*	Creeping bentgrass	Non-native	0		FACW
AIAL	Simaroubaceae	*Ailanthus altisima*	Tree of Heaven	Non-native	0	Watch List	FACU
ALPI2	Polemoniaceae	*Aliciella pinnatifida*	Sticky gilia	Native	5		FAC
ALTR7	Alismataceae	*Alisma triviale*	Northern water plantain	Native	3		OBL
ALAR	Poaceae	*Alopecurus arundinaceus*	Creeping meadow foxtail	Non-native	0		FACW
ALDE	Brassicaceae	*Alyssum desertorum*	Desert madwort	Non-native	0		
ALSI8	Brassicaceae	*Alyssum simplex*	Alyssum	Non-native	0		
AMAL	Amaranthaceae	*Amaranthus albus*	Prostrate pigweed	Non-native	0		FACU
AMRE	Amaranthaceae	*Amaranthus retroflexus*	Redroot amaranth	Non-native	0		FACU
AMPS	Asteraceae	*Ambrosia psilostachya*	Cuman ragweed	Native	3		FACU
AMTRT2	Asteraceae	*Ambrosia trifida* var. *trifida*	Great ragweed	Native	3		FAC
ANMA	Asteraceae	*Anaphalis margaritacea*	Western pearly everlasting	Native	4		FACU
ANHA	Poaceae	*Andropogon hallii*	Sand bluestem	Native	8		
APCA	Apocynaceae	*Apocynum cannabinum*	Indianhemp	Native	2		FAC
ARMI2	Asteraceae	*Arctium minus*	Common burdock	Non-native	0	List C	FACU
ARPO2	Papaveraceae	*Argemone polyanthemos*	Crested pricklypoppy	Native	3		
ARBIB	Asteraceae	*Artemisia biennis* var. *biennis*	Biennial wormwood	Non-native	0		FACU
ARCAC	Asteraceae	*Artemisia campestris* var. *caudata*	Field sagewort	Native	5		UPL
ARDR4	Asteraceae	*Artemisia dracunculus*	Tarragon	Native	3		
ARLU	Asteraceae	*Artemisia ludoviciana*	White sagebrush	Native	4		UPL
ASIN	Apocynaceae	*Asclepias incarnata*	Swamp milkweed	Native	4		FACW
ASSP	Apocynaceae	*Asclepias speciosa*	Showy milkweed	Native	3		FAC
ASOF	Asparagaceae	*Asparagus officinalis*	Garden asparagus	Non-native	0		FACU
ASBI2	Fabaceae	*Astragalus bisulcatus*	Twogrooved milkvetch	Native	5		
ASCI4	Fabaceae	*Astragalus cicer*	Chickpea milkvetch	Non-native	0		
BAOR	Brassicaceae	*Barbarea orthoceras*	American yellowrocket	Native	5		OBL
BEER	Apiaceae	*Berula erecta*	Cutleaf waterparsnip	Native	5		OBL
BICE	Asteraceae	*Bidens cernua*	Nodding beggartick	Native	5		OBL
BIFR	Asteraceae	*Bidens frondosa*	Devil's beggartick	Native	3		FACW
BITR	Asteraceae	*Bidens tripartita*	Threelobe beggarticks	Native	3		FACW
BOMAP4	Cyperaceae	*Bolboschoenus maritimus* ssp. *paludosus*	Cosmopolitan bulrush	Native	5		OBL
BOLA2	Poaceae	*Bothriochloa laguroides*	Silver beardgrass	Native	2		
BOGR2	Poaceae	*Bouteloua gracilis*	Blue grama	Native	4		
BRIN2	Poaceae	*Bromus inermis*	Smooth brome	Non-native	0		UPL
BRAR5	Poaceae	*Bromus japonicus*	Field brome	Non-native	0		FACU
BRTE	Poaceae	*Bromus tectorum*	Cheatgrass	Non-native	0	List C	

Appendix H: List of Plant Taxa documented in Aurora (May-September 2019)

USDA Symbol	Plant Family	Scientific Name (Ackerfield 2015)	Common Name	Native Status	C-Value	CO Noxious Weed	Wetland Indicator
CALO	Poaceae	*Calamovilfa longifolia*	Prairie sandreed	Native	7		
CAMI2	Brassicaceae	*Camelina microcarpa*	Littlepod false flax	Non-native	0		UPL
CABU2	Brassicaceae	*Capsella bursa-pastoris*	Shepherd's purse	Non-native	0		FACU
CAAR18	Fabaceae	*Caragana arborescens*	Siberian peashrub	Non-native	0		
CANU4	Asteraceae	*Carduus nutans*	Musk thistle	Non-native	0	List B	FACU
CANE2	Cyperaceae	*Carex nebrascensis*	Nebraska sedge	Native	5		OBL
CAPE42	Cyperaceae	*Carex pellita*	Woolly sedge	Native	6		OBL
CAPR5	Cyperaceae	*Carex praegracilis*	Clustered field sedge	Native	5		FACW
CEDI3	Asteraceae	*Centaurea diffusa*	Diffuse knapweed	Non-native	0	List B	
CEPU3	Gentianaceae	*Centaurium pulchellum*	Branched centaury	Non-native	0		FACU
CHGL13	Euphorbiaceae	*Chamaesyce glyptosperma*	Ribseed sandmat	Native	2		
CHMI8	Euphorbiaceae	*Chamaesyce missurica*	Prairie sandmat	Native	6		
CHSE6	Euphorbiaceae	*Chamaesyce serpyllifolia*	Thymeleaf sandmat	Native	2		
CHAL7	Chenopodiaceae	*Chenopodium album*	Lambsquarters	Non-native	0		FACU
CHBEZ	Chenopodiaceae	*Chenopodium berlandieri* var. *zschackii*	Pitseed goosefoot	Native	2		
CHDE	Chenopodiaceae	*Chenopodium desiccatum*	Aridland goosefoot	Native	3		
CHFR3	Chenopodiaceae	*Chenopodium fremontii*	Fremont's goosefoot	Native	6		FACU
CHGL3	Chenopodiaceae	*Chenopodium glaucum*	Oakleaf goosefoot	Non-native	0		FAC
CHINI	Chenopodiaceae	*Chenopodium incanum* var. *incanum*	Mealy goosefoot	Native	5		
CHLE4	Chenopodiaceae	*Chenopodium leptophyllum*	Narrowleaf goosefoot	Native	5		FACU
CHPR5	Chenopodiaceae	*Chenopodium pratericola*	Desert goosefoot	Native	4		
CHRU	Chenopodiaceae	*Chenopodium rubrum*	Red goosefoot	Native	2		OBL
CHSI2	Chenopodiaceae	*Chenopodium simplex*	Mapleleaf goosefoot	Native	2		
CHTE2	Brassicaceae	*Chorispora tenella*	Crossflower	Non-native	0		
CIIN	Asteraceae	*Cichorium intybus*	Chicory	Non-native	0	List C	FACU
CIAR4	Asteraceae	*Cirsium arvense*	Canada thistle	Non-native	0	List B	FACU
CIVU	Asteraceae	*Cirsium vulgare*	Bull thistle	Non-native	0	List B	UPL
COMA2	Apiaceae	*Conium maculatum*	Poison hemlock	Non-native	0	List C	FACW
COAR4	Convolvulaceae	*Convolvulus arvensis*	Field bindweed	Non-native	0	List C	
COCA5	Asteraceae	*Conyza canadensis*	Canadian horseweed	Native	1		FACU
CRFE3	Boraginaceae	*Cryptantha fendleri*	Sanddune cryptantha	Native	3		
CUFO	Cucurbitaceae	*Cucurbita foetidissima*	Missouri gourd	Native	2		
	Convolvulaceae	*Cuscuta* sp.	Dodder	Native			
CYXA	Asteraceae	*Cyclachaena xanthifolia*	Giant sumpweed	Native	2		FAC
CYAT	Chenopodiaceae	*Cycloloma atriplicifolium*	Winged pigweed	Native	2		FACU
CYOF	Boraginaceae	*Cynoglossum officinale*	Houndstongue	Non-native	0	List B	FACU
DAGL	Poaceae	*Dactylis glomerata*	Orchardgrass	Non-native	0		FACU
DESO2	Brassicaceae	*Descurainia sophia*	Herb sophia	Non-native	0		
DIFU2	Dipsacaceae	*Dipsacus fullonum*	Common teasel	Non-native	0	List B	FACU
DILA4	Dipsacaceae	*Dipsacus laciniatus*	Cutleaf teasel	Non-native	0	List B	UPL
DISP	Poaceae	*Distichlis stricta*	Saltgrass	Native	4		FACW

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DYPA	Asteraceae	*Dyssodia papposa*	Fetid marigold	Native	2		
ECCR	Poaceae	*Echinochloa crus-galli*	Barnyardgrass	Non-native	0		FAC
ECLO	Cucurbitaceae	*Echinocystis lobata*	Wild cucumber	Native	3		FAC
ELAN	Elaeagnaceae	*Elaeagnus angustifolia*	Russian olive	Non-native	0	List B	FACU
ELAC	Cyperaceae	*Eleocharis acicularis*	Needle spikerush	Native	5		OBL
ELPA3	Cyperaceae	*Eleocharis palustris*	Pale spikerush	Native	3		OBL
ELNY	Hydrophyllaceae	*Ellisia nyctelea*	Aunt Lucy	Native	3		FACU
ELCA4	Poaceae	*Elymus canadensis*	Canada wildrye	Native	4		FACU
ELRE4	Poaceae	*Elymus repens*	Quackgrass	Non-native	0	List C	FACU
ELTR7	Poaceae	*Elymus trachycaulus*	Slender wheatgrass	Native	4		FACU
EPCI	Onagraceae	*Epilobium ciliatum*	Fringed willowherb	Native	4		FACW
EPHI	Onagraceae	*Epilobium hirsutum*	Hairy willow-herb	Non-native	0	List A	FACW
EPLE2	Onagraceae	*Epilobium palustre* var. *gracile*	Bog willowherb	Native	8		OBL
EQLA	Equisetaceae	*Equisetum laevigatum*	Smooth horsetail	Native	4		FAC
ERCI	Poaceae	*Eragrostis cilianensis*	Stinkgrass	Non-native	0		FACU
ERPI2	Poaceae	*Eragrostis pilosa*	Indian lovegrass	Native	1		FACU
ERDI4	Asteraceae	*Erigeron divergens*	Spreading fleabane	Native	4		
ERAN4	Polygonaceae	*Eriogonum annuum*	Annual buckwheat	Native	4		
EUDE4	Euphorbiaceae	*Euphorbia dentata*	Toothed spurge	Native	1		
EUES	Euphorbiaceae	*Euphorbia esula*	Leafy spurge	Non-native	0	List B	
EUOC4	Asteraceae	*Euthamia occidentalis*	Western goldentop	Native	4		OBL
POCOC2	Polygonaceae	*Fallopia convolvulus*	Black bindweed	Non-native	0		FACU
FRPE	Oleaceae	*Fraxinus pennsylvanica*	Green ash	Non-native	0		FAC
GAAP2	Rubiaceae	*Galium aparine*	Stickywilly	Native	1		FACU
GLTR	Fabaceae	*Gleditsia triacanthos*	Honeylocust	Non-native	0		FACU
GLLE3	Fabaceae	*Glycyrrhiza lepidota*	American licorice	Native	3		FACU
GRSQ	Asteraceae	*Grindelia squarrosa*	Curlycup gumweed	Native	1		UPL
HEAN3	Asteraceae	*Helianthus annuus*	Common sunflower	Native	1		FACU
HEPE	Asteraceae	*Helianthus petiolaris*	Prairie sunflower	Native	2		
HEMA3	Brassicaceae	*Hesperis matronalis*	Dame's rocket	Non-native	0	List B	FACU
HECO26	Poaceae	*Hesperostipa comata*	Needle and thread	Native	6		
HEVI4	Asteraceae	*Heterotheca villosa*	Hairy false goldenaster	Native	3		
HOJU	Poaceae	*Hordeum jubatum*	Foxtail barley	Native	2		FACW
HULUN	Cannabaceae	*Humulus neomexicanus*	Common hop	Native	5		FACU
JUARL	Juncaceae	*Juncus arcticus var. balticus*	Mountain rush	Native	4		FACW
JUAR4	Juncaceae	*Juncus articulatus*	Jointleaf rush	Native	6		OBL
JUBU	Juncaceae	*Juncus bufonius*	Toad rush	Native	3		OBL
JUCO	Juncaceae	*Juncus compressus*	Roundfruit rush	Non-native	0		FACW
JUTO	Juncaceae	*Juncus torreyi*	Torrey's rush	Native	5		FACW
BASC5	Chenopodiaceae	*Kochia scoparia*	Burningbush	Non-native	0		FACU
LASE	Asteraceae	*Lactuca serriola*	Prickly lettuce	Non-native	0		FAC

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LATAP	Asteraceae	*Lactuca tatarica* var. *pulchella*	Blue lettuce	Native	3		UPL
LAEU	Fabaceae	*Lathyrus eucosmus*	Bush vetchling	Native	6		
LEMI3	Araceae	*Lemna minor*	Common duckweed	Native	2		OBL
CACH42	Brassicaceae	*Lepidium chalapensis*	Lenspod whitetop	Non-native	0		
LELA2	Brassicaceae	*Lepidium latifolium*	Perennial pepperweed	Non-native	0	List B	FACW
LILE3	Linaceae	*Linum lewisii*	Prairie flax	Native	4		
LOTA	Caprifoliaceae	*Lonicera tatarica*	Tatarian honeysuckle	Non-native	0		FACU
LYAM	Lamiaceae	*Lycopus americanus*	American water horehound	Native	5		OBL
LYJU	Asteraceae	*Lygodesmia juncea*	Rush skeletonplant	Native	4		
MAST4	Ruscaceae	*Maianthemum stellatum*	Starry false lily of the valley	Native	7		FACU
MAPU	Rosaceae	*Malus pumila*	Paradise apple	Non-native	0		
MANE	Malvaceae	*Malva neglecta*	Common mallow	Non-native	0		
MELU	Fabaceae	*Medicago lupulina*	Black medick	Non-native	0		FACU
MESA	Fabaceae	*Medicago sativa*	Alfalfa	Non-native	0		UPL
MEOF	Fabaceae	*Melilotus albus*	White sweetclover	Non-native	0		FACU
MEOF	Fabaceae	*Melilotus officinalis*	Yellow sweetclover	Non-native	0		FACU
MEAR4	Lamiaceae	*Mentha arvensis*	Wild mint	Native	4		FACW
MEPI		*Mentha x piperita*	Peppermint	Non-native	0		FACW
MENU	Loasaceae	*Mentzelia nuda*	Bractless blazingstar	Native	4		
MILI3	Nyctaginaceae	*Mirabilis linearis*	Narrowleaf four o'clock	Native	5		
MOFIM2	Lamiaceae	*Monarda fistulosa* var. *menthifolia*	Mintleaf bergamot	Native	6		UPL
MUAS	Poaceae	*Muhlenbergia asperifolia*	Scratchgrass	Native	4		FACW
NECA2	Lamiaceae	*Nepeta cataria*	Catnip	Non-native	0		FACU
OECU2	Onagraceae	*Oenothera curtifolia*	Velvetweed	Native	1		UPL
OELA2	Onagraceae	*Oenothera pallida* ssp. *latifolia*	Mountain evening primrose	Native	5		
OEVI	Onagraceae	*Oenothera villosa*	Hairy evening primrose	Native	4		FACU
ONAC	Asteraceae	*Onopordum acanthium*	Scotch thistle	Non-native	0	List B	
ONBEO	Boraginaceae	*Onosmodium bejariense* var. *occidentale*	Western marbleseed	Native	5		
OPFR	Cactaceae	*Opuntia fragilis*	Brittle pricklypear	Native	3		
OPMA2	Cactaceae	*Opuntia macrorhiza*	Twistspine pricklypear	Native	3		
OXDI2	Oxalidaceae	*Oxalis dillenii*	Slender yellow woodsorrel	Native	4		FACU
PACA6	Poaceae	*Panicum capillare*	Witchgrass	Native	1		FAC
PAVI2	Poaceae	*Panicum virgatum*	Switchgrass	Native	5		FAC
PAVI5	Vitaceae	*Parthenocissus vitacea*	Woodbine	Native	3		FAC
PASM	Poaceae	*Pascopyrum smithii*	Western wheatgrass	Native	5		FACU
POAME	Polygonaceae	*Persicaria amphibia*	Longroot smartweed	Native	4		OBL
POLA4	Polygonaceae	*Persicaria lapathifolia*	Curlytop knotweed	Native	2		OBL
POPE3	Polygonaceae	*Persicaria maculosa*	Spotted ladysthumb	Non-native	0		FACW
PHAR3	Poaceae	*Phalaris arundinacea*	Reed canarygrass	Cryptogenic	1		FACW
PHLO2	Polemoniaceae	*Phlox longifolia*	Longleaf phlox	Native	6		
PHAU7		*Phragmites australis*	Common reed	Non-native	0	Watch List	FACW

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PHHEC	Solanaceae	*Physalis hederifolia* var. *comata*	Ivyleaf groundcherry	Native	5		
PHLO4	Solanaceae	*Physalis longifolia*	Virginia groundcherry	Native	4		
PLMA2	Plantaginaceae	*Plantago major*	Common plantain	Non-native	0		FAC
PLPA2	Plantaginaceae	*Plantago patagonica*	Woolly plantain	Native	2		UPL
POBU	Poaceae	*Poa bulbosa*	Bulbous bluegrass	Non-native	0	List C	FACU
POPR	Poaceae	*Poa pratensis*	Kentucky bluegrass	Non-native	0		FACU
PODOT	Capparaceae	*Polanisia dodecandra* ssp. *trachysperma*	Redwhisker clammyweed	Native	1		FACU
POAV	Polygonaceae	*Polygonum aviculare*	Prostrate knotweed	Non-native	0		FACU
PORA3	Polygonaceae	*Polygonum ramosissimum*	Bushy knotweed	Native	2		FACW
POMO5	Poaceae	*Polypogon monspeliensis*	Annual rabbitsfoot grass	Non-native	0		FACW
POAC5	Salicaceae	*Populus ×acuminata*	Lanceleaf cottonwood	Native	5		FAC
POAN3	Salicaceae	*Populus angustifolia*	Narrowleaf cottonwood	Native	5		FACW
PODEM	Salicaceae	*Populus deltoides* ssp. *monilifera*	Plains cottonwood	Native	3		FAC
POOL	Portulacaceae	*Portulaca oleracea*	Little hogweed	Non-native	0		FAC
POFO3	Potamogetonaceae	*Potamogeton foliosus*	Leafy pondweed	Native	4		OBL
POPU7	Potamogetonaceae	*Potamogeton pusillus*	Small pondweed	Native	5		OBL
PRAM	Rosaceae	*Prunus americana*	American plum	Native	6		UPL
PRVIM	Rosaceae	*Prunus virginiana* var. *melanocarpa*	Black chokecherry	Native	4		FACU
PSJU3	Poaceae	*Psathyrostachys juncea*	Russian wildrye	Non-native	0		FACU
PSLA3	Fabaceae	*Psoralidium lanceolatum*	Lemon scurfpea	Native	5		
PSTE5	Fabaceae	*Psoralidium tenuiflorum*	Slimflower scurfpea	Native	5		
PUNU2	Poaceae	*Puccinellia nuttalliana*	Nuttall's alkaligrass	Native	6		OBL
RALO2	Ranunculaceae	*Ranunculus aquatilis* var. *diffusus*	Longbeak buttercup	Native	3		OBL
RACY	Ranunculaceae	*Ranunculus cymbalaria*	Alkali buttercup	Native	4		OBL
RASCM	Ranunculaceae	*Ranunculus sceleratus* var. *multifidus*	Cursed buttercup	Native	1		OBL
RACO3	Asteraceae	*Ratibida columnifera*	Upright prairie coneflower	Native	4		
RHCA3	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	Non-native	0		FACU
RHTRT	Anacardiaceae	*Rhus trilobata* var. *trilobata*	Skunkbush sumac	Native	5		UPL
RIAU	Grossulariaceae	*Ribes aureum*	Golden currant	Native	6		FACU
RONE	Fabaceae	*Robinia neomexicana*	New Mexico locust	Native	4		
ROPA2	Brassicaceae	*Rorippa palustris*	Bog yellowcress	Native	4		OBL
ROSI2	Brassicaceae	*Rorippa sinuata*	Spreading yellowcress	Native	4		FACW
ROACS	Rosaceae	*Rosa acicularis* ssp. *sayi*	Prickly rose	Native	5		FACU
ROAR3	Rosaceae	*Rosa arkansana*	Prairie rose	Native	5		FACU
ROWO		*Rosa woodsii (blanda)*	Woods' rose	Native	5		FACU
RUCR	Polygonaceae	*Rumex crispus*	Curly dock	Non-native	0		FAC
RUST4	Polygonaceae	*Rumex stenophyllus*	Narrowleaf dock	Non-native	0		FACW
SACU	Alismataceae	*Sagittaria cuneata*	Arumleaf arrowhead	Native	6		OBL
SAFR	Salicaceae	*Salix ×fragilis*	Crack willow	Non-native	0		FAC
SAAM2	Salicaceae	*Salix amygdaloides*	Peachleaf willow	Native	5		FACW
SAEX	Salicaceae	*Salix exigua*	Coyote willow	Native	3		FACW

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	Chenopodiaceae	*Salsola* sp.	Russian thistle	Non-native			
SARE3	Lamiaceae	*Salvia reflexa*	Lanceleaf sage	Native	2		
SAOF4	Caryophyllaceae	*Saponaria officinalis*	Bouncingbet	Non-native	0	List B	FACU
SAVE4	Chenopodiaceae	*Sarcobatus vermiculatus*	Greasewood	Native	4		FAC
SCAR7	Poaceae	*Schedonorus arundinaceus*	Tall fescue	Non-native	0		FACU
SCAC3	Cyperaceae	*Schoenoplectus acutus*	Hardstem bulrush	Native	3		OBL
SCPU10	Cyperaceae	*Schoenoplectus pungens*	Common threesquare	Native	4		OBL
SCTA2	Cyperaceae	*Schoenoplectus tabernaemontani*	Softstem bulrush	Native	3		OBL
SCPA8	Cyperaceae	*Scirpus pallidus*	Cloaked bulrush	Native	5		OBL
SCLA	Scrophulariaceae	*Scrophularia lanceolata*	Lanceleaf figwort	Native	5		FAC
SECE	Poaceae	*Secale cereale*	Cereal rye	Non-native	0		
SESP3	Asteraceae	*Senecio spartioides*	Broom-like ragwort	Native	5		
SEPUP2	Poaceae	*Setaria pumila* ssp. *pumila*	Yellow foxtail	Non-native	0		FACU
SIAL2	Brassicaceae	*Sisymbrium altissimum*	Tall tumblemustard	Non-native	0		FACU
SODU	Solanaceae	*Solanum dulcamara*	Climbing nightshade	Non-native	0		FACU
SOCA6	Asteraceae	*Solidago canadensis*	Canada goldenrod	Native	5		FACU
	Asteraceae	*Solidago canadensis/gigantea*	Goldenrod	Native	5		
SOMO	Asteraceae	*Solidago mollis*	Velvety goldenrod	Native	6		
SOAR2	Asteraceae	*Sonchus arvensis*	Perennial sowthistle	Non-native	0	List C	FAC
SOAS	Asteraceae	*Sonchus asper*	Spiny sowthistle	Non-native	0		FAC
SOOL	Asteraceae	*Sonchus oleraceus*	Common sowthistle	Non-native	0		UPL
SOARU	Asteraceae	*Sonchus uliginosus*	Moist sowthistle	Non-native	0		FAC
SPPE	Poaceae	*Spartina pectinata*	Prairie cordgrass	Native	7		FACW
SPMA10	Caryophyllaceae	*Spergularia media*	Media sandspurry	Non-native	0		FACU
SPOB	Poaceae	*Sphenopholis obtusata*	Prairie wedgescale	Native	5		FAC
SPCR	Poaceae	*Sporobolus cryptandrus*	Sand dropseed	Native	2		FACU
SYOC	Caprifoliaceae	*Symphoricarpos occidentalis*	Western snowberry	Native	3		UPL
SYERE	Asteraceae	*Symphyotrichum ericoides*	White heath aster	Native	4		FACU
	Asteraceae	*Symphyotrichum ericoides/falcatum*	Aster	Native			
SYLAH	Asteraceae	*Symphyotrichum lanceolatum* ssp. *hesperium*	White panicle aster	Native	5		FACW
TARA	Tamaricaceae	*Tamarix chinensis*	Salt cedar	Non-native	0	List B	FACW
TAOF	Asteraceae	*Taraxacum officinale*	Common dandelion	Non-native	0		FACU
THIN6	Poaceae	*Thinopyrum intermedium*	Intermediate wheatgrass	Non-native	0		
THPO7	Poaceae	*Thinopyrum ponticum*	Tall wheatgrass	Non-native	0		
THAR5	Brassicaceae	*Thlaspi arvense*	Field pennycress	Non-native	0		FACU
TORY	Anacardiaceae	*Toxicodendron rydbergii*	Western poison ivy	Native	3		FACU
TROC	Commelinaceae	*Tradescantia occidentalis*	Prairie spiderwort	Native	5		UPL
TRDU	Asteraceae	*Tragopogon dubius*	Yellow salsify	Non-native	0		
TRFR2	Fabaceae	*Trifolium fragiferum*	Strawberry clover	Non-native	0		FAC
TRPR2	Fabaceae	*Trifolium pratense*	Red clover	Non-native	0		FACU
TRRE3	Fabaceae	*Trifolium repens*	White clover	Non-native	0		FACU

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TYAN	Typhaceae	*Typha angustifolia*	Narrowleaf cattail	Cryptogenic	1		OBL
TYGL		*Typha* hybrid	Cattail	Native	1		OBL
TYLA	Typhaceae	*Typha latifolia*	Broadleaf cattail	Native	4		OBL
ULPU	Ulmaceae	*Ulmus pumila*	Siberian elm	Non-native	0	Watch List	UPL
URDIG	Urticaceae	*Urtica dioica* ssp. *gracilis*	California nettle	Native	3		FAC
VETH	Scrophulariaceae	*Verbascum thapsus*	Common mullein	Non-native	0	List C	UPL
VEBR	Verbenaceae	*Verbena bracteata*	Bigbract verbena	Native	2		FACU
VEHA2	Verbenaceae	*Verbena hastata*	Swamp verbena	Native	4		FACW
VEAN2	Plantaginaceae	*Veronica anagallis-aquatica*	Water speedwell	Native	1		OBL
VILA	Adoxaceae	*Viburnum lantana*	Wayfaringtree	Non-native	0		
VIAM	Fabaceae	*Vicia americana*	American vetch	Native	5		FACU
	Violaceae	*Viola* sp.	Violet	Unknown			
XAST	Asteraceae	*Xanthium strumarium*	Rough cocklebur	Native	1		FAC
ZAPA	Zannichelliaceae	*Zannichellia palustris*	Horned pondweed	Native	2		OBL