NAHANT MARSH
EDUCATION CENTER
MASTER PLAN

OCTOBER
2022

US Army Corps of Engineers ®
Rock Island District

NAHANT MARSH
EDUCATION CENTER

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Prepared By

NAHANT MARSH EDUCATION CENTER

US Army Corps of Engineers®

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ACRONYM PAGE

ADA= Americans with Disabilities Act

ADT = American Discovery Trail

Corps = U.S. Army Corps of Engineers

CRP = Conservation Reserve Program

DNR = Department of Natural Resources

EPA = Environmental Protection Agency

EICC = Eastern Iowa Community Colleges

FREE = Funds for Recreation and Environmental Education

GART = Great American Rail Trail

INHF = Iowa Natural Heritage Foundation

LSAMP = Louis Stokes Alliance for Minority Participation

MRT = Mississippi River Trail

NHPA = National Historic Preservation Act

NMEC = Nahant Marsh Education Center

NRCS = Natural Resources Conservation Service

PAS = Planning Assistance to States and Tribes

PDT = Project Delivery Team

PSCW = Partners of Scott County Watersheds

USFWS = U.S. Fish and Wildlife Service

USGS = U.S. Geological Survey

WIU = Western Illinois University

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Executive Summary

The following report prepared for Nahant Marsh Education Center (NMEC) is an update and revision to its master plan produced in October of 1998. Of the twenty-two suggested improvements outlined in the 1998 master plan, NMEC has completed seventeen including renovation of the building into an education center, creating a boardwalk and trails, land acquisition, ecological enhancement, and developing educational programs. This report will outline future improvements, projects, and objectives.

NMEC has grown from 78 acres to 375 acres since its inception in 2000. The Putnam museum oversaw the education program from 2000 to 2005. In 2007, the NMEC Board established a formal partnership with Eastern Iowa Community Colleges (EICC) to develop and oversee the education program. The education program has grown from serving 1,800 people annually to over 22,000 people impacted in 2019. With such rapid growth in both natural resources and education, NMEC has increased staffing needs. With these increases, there have been challenges. The NMEC Board and staff see tremendous potential to enhance environmental and recreational opportunities for the community, but they are currently limited by the size and conditions of the current building, lack of a long-term site plan, sedimentation, and other pollution threats to the main marsh.

The NMEC Board and staff requested assistance from the U.S. Army Corps of Engineers (Corps) to facilitate an updated Master Plan. The purpose of the Corps involvement is to help with data collection and inform the development of future project efforts for NMEC. At the completion of this project, NMEC will be provided with data and recommendations for paths forward provided by the Project Delivery Team (PDT) to set the stage for further development outlined in the Scope of Work (SOW).

The purpose of this Master Plan is to:

- Review the current facilities, trails, and amenities to provide recommended changes and improvements.
- Evaluate programming and operations to plan for future recreational and educational needs.
- Evaluate natural and cultural resources, water quality, and environmental threats to better protect, enhance, and restore the Marsh.

*include header title (e.g. assessment, recommendations, etc)

Introduction and History

NMEC is a 375-acre preserve in southwest Davenport, IA. It is cooperatively owned by the City of Davenport and NMEC, a 501(C)(3) non-profit organization governed by the NMEC Board. It is part of a larger 513-acre wetland complex bordered by the Mississippi River, Interstate 280, and Highway 22. It is the largest urban wetland on the Upper Mississippi River and because of its proximity to the interstate and metro area, is easily accessible to the community. It provides unique natural ecosystems comprising open water, mesic, wet and sand prairie, bottomland forest, and a spring fed quarry. The NMEC Board directs fundraising, recreational, conservation, and restoration efforts and EICC provides support for educational programming.

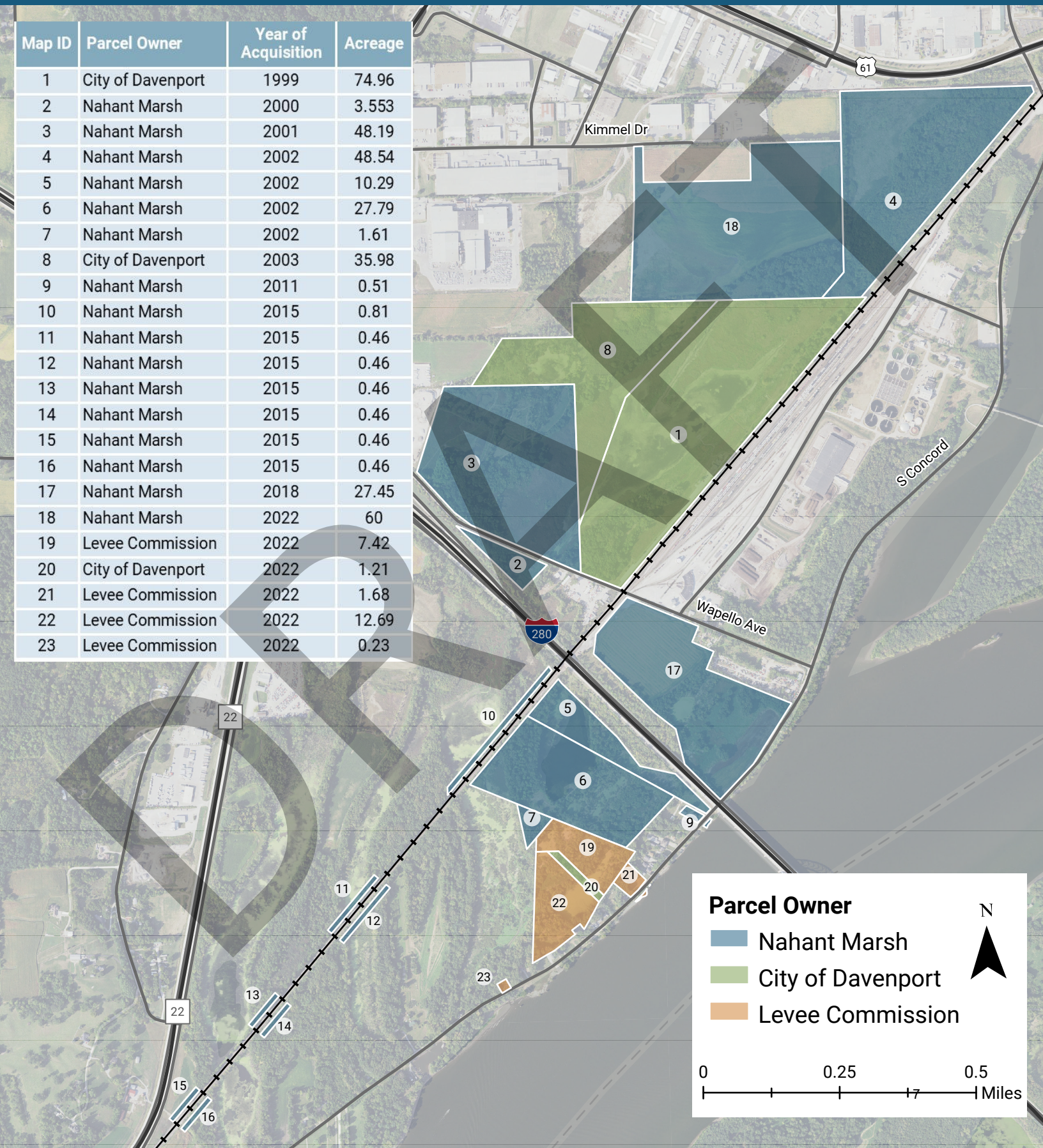
The land and building were once used as a sportsman's club. After investigations showed that the main marsh had high levels of lead, the U.S. Fish and Wildlife Service (USFWS), River Action, Quad City Audubon Society, and the Iowa Department of Natural Resources (DNR) came together to restore the marsh and its biotic community. The Environmental Protection Agency (EPA) determined the marsh to be a Superfund site and began the cleanup of lead. These efforts greatly improved the wetland and it was decided to create a nature preserve. NMEC was founded in 2000.

The mission of NMEC is to protect, enhance, and restore the marsh through education, research, and conservation. Ongoing research, including water quality testing, turtle population monitoring, and avian population studies guide NMEC's management practices. NMEC's staff, programs, and attendance have grown steadily since 2007, with a record breaking 22,600 people impacted in 2019. The NMEC Board raised funds in 2015 to add an additional classroom to the original building.

A Master Plan was created by an independent consulting firm in 1998 in anticipation of the establishment of the preserve, which covered approximately 177 acres at the time. Since then, NMEC has expanded to 375 acres.

Nahant Marsh Parcels

Map ID	Parcel Owner	Year of Acquisition	Acreage
1	City of Davenport	1999	74.96
2	Nahant Marsh	2000	3.553
3	Nahant Marsh	2001	48.19
4	Nahant Marsh	2002	48.54
5	Nahant Marsh	2002	10.29
6	Nahant Marsh	2002	27.79
7	Nahant Marsh	2002	1.61
8	City of Davenport	2003	35.98
9	Nahant Marsh	2011	0.51
10	Nahant Marsh	2015	0.81
11	Nahant Marsh	2015	0.46
12	Nahant Marsh	2015	0.46
13	Nahant Marsh	2015	0.46
14	Nahant Marsh	2015	0.46
15	Nahant Marsh	2015	0.46
16	Nahant Marsh	2015	0.46
17	Nahant Marsh	2018	27.45
18	Nahant Marsh	2022	60
19	Levee Commission	2022	7.42
20	City of Davenport	2022	1.21
21	Levee Commission	2022	1.68
22	Levee Commission	2022	12.69
23	Levee Commission	2022	0.23



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Timeline

10,700 BC - early 1800's: Native American people used the area in and around Nahant Marsh for thousands of years. Bird-bone beads found at Nahant Marsh were 500-600 years old. Artifacts found on the bluffs above Nahant and in nearby Buffalo Township date as far back to 10,750 BC.
1814: Future president, Zachary Taylor, engaged in a War of 1812 battle against Sauk and British forces on Credit Island and along the Mississippi River shoreline near Nahant.
1833: The first Euro-American settler established a farmstead on the north edge of Nahant Marsh.
1835 -1851: The Village of Rockingham was established between the Mississippi River and Nahant Marsh. Although the village initially flourished, two major floods in the 1840's and the failed bid for county seat left the town largely abandoned by 1850.
1882: The railroad, railyard, and depot was constructed through the marsh and the area started to become known as Nahant.
1880 -1949: The Village of Nahant grew as industry centered around the railroad and nearby steamboat port thrived. Large icehouses, hotels, and taverns flourished through the 1920's, but when refrigeration replaced ice harvesting and diesel replaced steam engines, the workforce in the area declined and the area was annexed into Davenport.
1920s-1950s: A series of drainage ditches are created around and through Nahant Marsh in an attempt to drain the area to make it more suitable for farming and future development.
1969: The Scott County Sportsmen's Association acquired 78 acres of Nahant Marsh for a gun club. A clubhouse was built and trap and skeet shooting took place over the main marsh.
1973: Construction on Interstate 280 is completed, essentially cutting Nahant Marsh in half.
1986- The City of Davenport Riverfront Plan presented the first vision for an education center and nature preserve at Nahant Marsh.
1995: After the discovery of high levels of lead in the water and dead waterfowl, the gun club ceased operations. The Iowa DNR, US EPA, AND US Fish and Wildlife Service investigated the site. The Nahant Marsh steering committee, led by River Action, and made up of citizens and professionals, was formed.
1995 -1998: Ranch Riders Motorcycle Club used the site as a clubhouse.
1998: The first Nahant Marsh Master Plan was created under the direction of the Nahant Marsh Steering Committee consisting of local non-profits and governmental agencies.
1998 -1999: A $2 million clean-up, led by the US EPA, removed nearly 140 tons of lead from the marsh. The US Fish and Wildlife Service and volunteers restored prairie and wetlands. The City of Davenport took title of the 78-acre property.
2000, October 16: Nahant Marsh Education Center was founded. The original clubhouse is renovated into classroom and lab space. The Putnam Museum led the education program through 2005.
2007: A new partnership with Eastern Iowa Community Colleges formed to develop an education program. The preserve was then 260 acres. The education program served 1,800 people.
2011: NMEC establishes a partnership with Iowa AmeriCorps programs to provide seasonal educators.

2015: A building addition with classroom, restrooms, and storage was constructed to allow for increased programming.
2018:The preserve grew to 305 acres. Work begins to establish a wetland mitigation bank.
2019: Despite all-time record flooding and the building being closed for 36 days during spring field trip season, the education program served 22,600 people.
2022:

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Master Plan Process

This Master Plan was a collaboration between the NMEC Board of Directors, NMEC staff, the Corps, stakeholders, and the public. The Corps and NMEC entered into a cost-share agreement in July of 2020. NMEC staff and members of the Corps formed the PDT composed of project managers, biologists, archaeologists, engineers, geographic information specialists, and environmental protection specialists from the Corps and various members of NMEC staff. The PDT worked together to hold forums for NMEC stakeholders and the public in November and December of 2020. Comments on the future vision of NMEC in the areas of recreation, education, natural resource management, opportunities, and limitations were taken at the forums and online.

The PDT took these comments and developed the projects and studies needed to complete this plan. Research and studies were completed in the winter of 2021 and spring of 2022. Expert opinions, modeling, and various analyses of collected data were conducted to inform discussion and recommendations.

The material presented in this Master Plan is based on scientific data, visual inspections of existing site and facility conditions, oral and written comments from the community, and research of other nature centers.

This Master Plan was created to outline the current programs, facilities, and landholdings of NMEC and to explore future programs, opportunities, facility and amenities improvements, and operational needs.

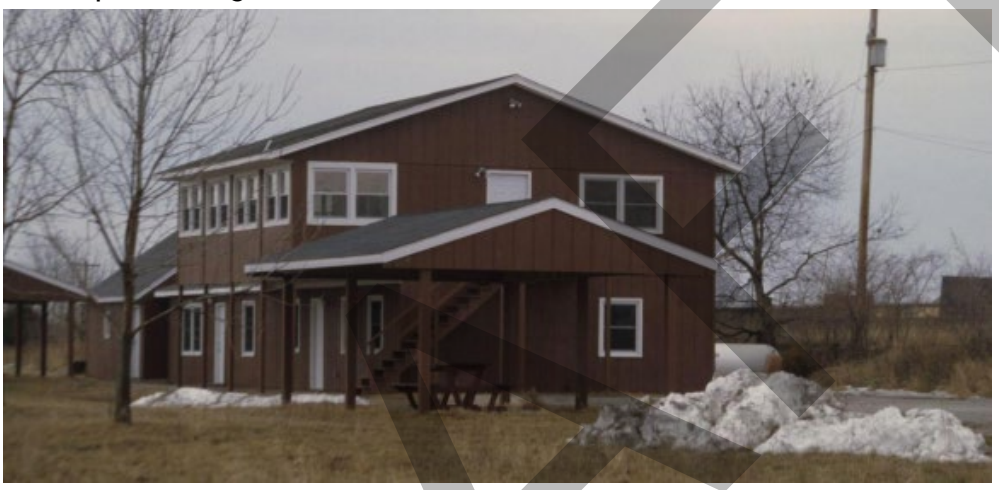
Should NMEC choose to pursue partnership with the Corps for future projects, they will need to follow programmatic guidelines outlined for that specific inquiry. NMEC can use this document internally to help guide future projects and operational decisions.

*include header title (e.g. assessment, recommendations, etc)

Facilities and Programming Assessment

EDUCATION CENTER - EXTERIOR

The NMEC original building is in fair to satisfactory condition related to the overall condition of materials based on their age and original integrity. The original building is 49 years old and was built in 1973. The garage was built in 1975. The original building was remodeled in 1999 to update the building from a club house to a nature center. There was also work done in 2015 including adding an exterior door to the upstairs, supports for the upstairs office area, and a new deck. Exterior materials include a wood frame with vinyl siding and asphalt shingle for the roof.



Even though windows were replaced and insulation added in 1999 and the roof replaced in 2004, the building is not energy efficient and the original portion is still prone to flooding when the Mississippi river reaches flood stage above 22' on the Mississippi River gage* in Rock Island.

The NMEC addition built in 2015 is in good condition. It is a wood frame with vinyl siding and asphalt shingles for the roof. The grade of the addition is 18" higher than the original building.

The main entrance is part of the 2015 building addition. It is ADA accessible and is an obvious entrance for visitors. There are four entrance doors all on the north side of the building. The upstairs door has

issues with the locking mechanism. The entrance doors to the animal room and back classroom were installed in 1999. There have been issues with locks and water in the past that have been resolved.

NMEC uses a well and septic system, with the well tested quarterly. As part of the 2015 renovation work, the septic was replaced and improved. While the original building continues to use liquid propane for heating, the 2015-addition is heated and cooled by a geothermal system (ground-source heat pump). The building does not currently have a sprinkler system or fire hydrant, with the closest access for municipal water on the opposite side of Wapello Avenue from the Education Center. There are also no municipal sewers near NMEC property.

The garage was built in 1975 and is in fair condition based on age and integrity. Support beams were added for the second level storage in 2009. It is a wood framed building with vinyl siding and asphalt roofing.

*U.S. Geological Survey (USGS) official spelling is gage versus using gauge. For more information about the USGS and the history of gage see [Why does the USGS use the spelling "gage" instead of "gauge"? | U.S. Geological Survey]'.

EDUCATION CENTER - INTERIOR

The education center is 4,168 square feet and is undersized to meet the current demands of the staff and programming. The original building was not designed for education, but was built as a clubhouse. The interior space was rehabilitated in 1999 including electrical, HVAC, and plumbing updates, drywall replacement and porch conversion to office space. A second restroom was added in 2008 in the original building.

There is no basement or storm shelter at NMEC. Staff uses the interior restrooms as a safe space for storms.

EICC took responsibility for IT and added internet and new equipment in 2008. In 2018, NMEC was connected to the City of Davenport's fiber network which is beamed from the compost facility to a receiver at NMEC. This greatly improved the speed from 1.5mbs to 100mbs. The phone systems were updated in 2014.

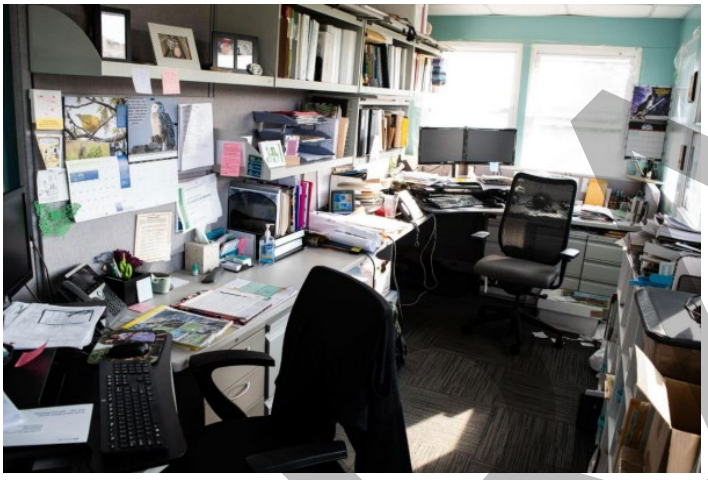
Due to the overall scale and layout of the building, Nahant staff have to be creative in their scheduling and group accommodations. Programming decisions are based on space availability and weather conditions, rather than what is needed or desired for the community. This limits the extent and flexibility of the programming offered. The building often feels crowded or cramped when there are various programs at the same time. It also causes conflict and confusion for visitors when they are trying to enjoy NMEC's offerings during field trips or public programs.

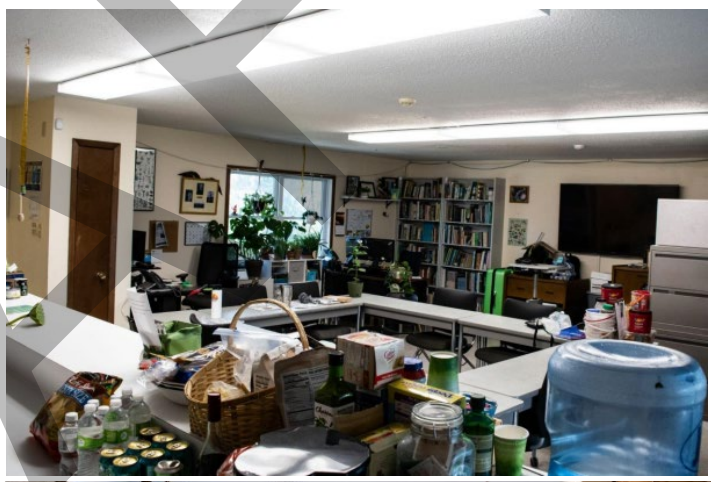
The 2015 building addition includes a geothermal HVAC system, a reception area, one large classroom, a large storage closet, a small gift shop area, two ADA accessible restrooms, and a utility closet. The addition leads to the original building which contains the following: a room housing the animal habitats, animal care space, two utility closets, two restrooms, one small classroom/lab on the main floor with a small storage closet, one small classroom upstairs that is not ADA accessible, a kitchenette, open office space scattered throughout, and office space in what was once the porch. The main entrance opens directly into the main classroom. This leads to distractions during programming and confusion of visitors. The animal room is also used for programming. There is no way to block the ramp between the main classroom and the animal room and sound carries. It is difficult to have groups in both rooms during large field trips or inclement weather.

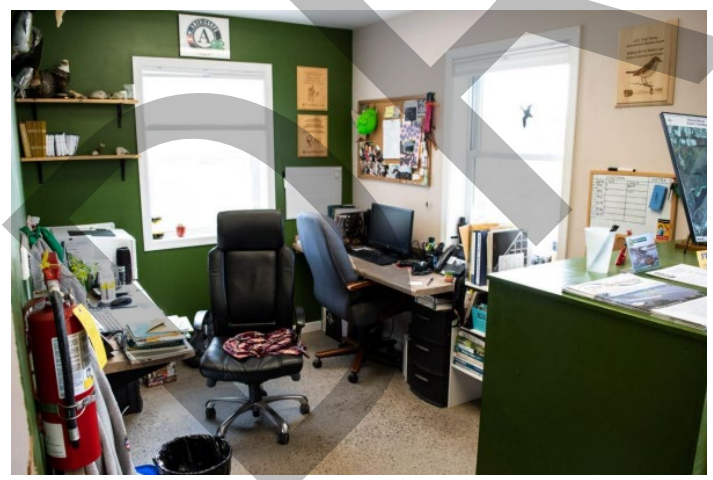
The back classroom has become a storage area for research equipment, education supplies, and natural resources materials that need to be kept above freezing. This makes this room unusable for large groups. Summer student researchers use it as their lab/work space in the summer. During the year it can be used for small meetings or small groups, though it is often cluttered and not welcoming to the public.

*include header title (e.g. assessment, recommendations, etc)

NMEC staff has grown from one full-time employee in 2007 to eleven permanent staff, two interns, four temporary AmeriCorps positions, an opening for a Western Illinois University (WIU) assistantship student, and up to ten student researchers. Office space is currently wherever desks/cubicles can be placed, even in the main classrooms. This leads to lack of work efficiency and communication. This also causes congestion of main spaces and allows limited prep, storage, and collaborative spaces.







GARAGE

The NMEC garage is an oversized one-car garage, 576 square feet, located 8 feet to the east of the main building. It is used to store large equipment, personal protective equipment, and hand tools. There are two workbenches and an upstairs attic used for storage of recreational and water quality supplies.

The ladder to the attic is narrow and difficult to carry items up and down. The attic floor is damaged in some areas and treacherous to walk on. The main garage space is cluttered and does not offer a safe environment to work on projects. The natural resources staff often use the adjacent shelter to work on their projects. This takes coordination between the education team's programming and the natural resources team's projects.

NMEC also currently has two large storage containers on the property. One directly to the east of the garage and one in the main parking lot. These are used to store other equipment that does not fit in the garage or building. NMEC also owns a 1,612 square foot house on the Mississippi with a 1,056 square feet lower garage and an exterior 1,000 square foot garage. NMEC also has items stored in both of these garages.

CARP LAKE HOUSE

Adjacent to Carp Lake, a deep lake surrounded by bottomland woods, is a house located on the river that was built pre-1900 and was raised 8 feet in 2001. Nahant acquired and remodeled this house in 2011 and it is in fair condition. The garage was built in 1945. They are built from wood framing with vinyl siding and asphalt shingles for the roof. It is raised on concrete blocks. A new roof was installed in 2001. HVAC is approximately 30 years old and appliances vary in age, but are at least 10 years old. The remodel included new drywall and flooring, added insulation, significant structural support, plumbing and updated the electrical on the main level. Some modifications have been made to the detached garage including tearing down an older portion and adding a new garage door in 2021. This is used as housing for a Nahant employee. In exchange, that employee keeps an eye on NMEC's Carp Lake property and allows interns or NCCC AmeriCorps teams to stay there occasionally. The house becomes inaccessible when river level reaches 15' and water enters the house at approximately 18.5'.

*include header title (e.g. assessment, recommendations, etc)

PARKING

NMEC has three parking lots with additional parking on the lawn. The parking lot adjacent to the building has one handicap space, a bus turn around, and 27 additional parking spaces. Currently, one of the storage containers is taking up five of those spaces. There is an outer parking lot with 22 spaces. This is open to the public when the main gate is closed during non-business hours. There is also a parking lot with 20 spaces to the southwest across the road and railroad tracks on NMEC's 2018 acquired parcel. During large events, the public uses the grass along the drive to park on. The two parking lots on the main property and the drive are maintained by the City of Davenport. There is often a lack of parking during busy days, large field trips, and large events. There is also a small sinkhole in one of the spots, making it unusable.

*include header title (e.g. assessment, recommendations, etc)

FACILITY HOURS

NMEC is open Monday through Friday from 8:30 a.m. to 4:30 p.m. and on Saturdays from 9 a.m. to noon (extended to 3 p.m. from April through October). Trails are open daily from sunrise to sunset. If the main gate is locked, trails are accessible from the front parking lot. During the Master Plan data collection process, NMEC staff created and distributed a survey to assess the public's view of their hours and amenities. NMEC collected 105 surveys via in-person and online. The survey asked six questions and left space for additional comments. The data is found in Appendix A.

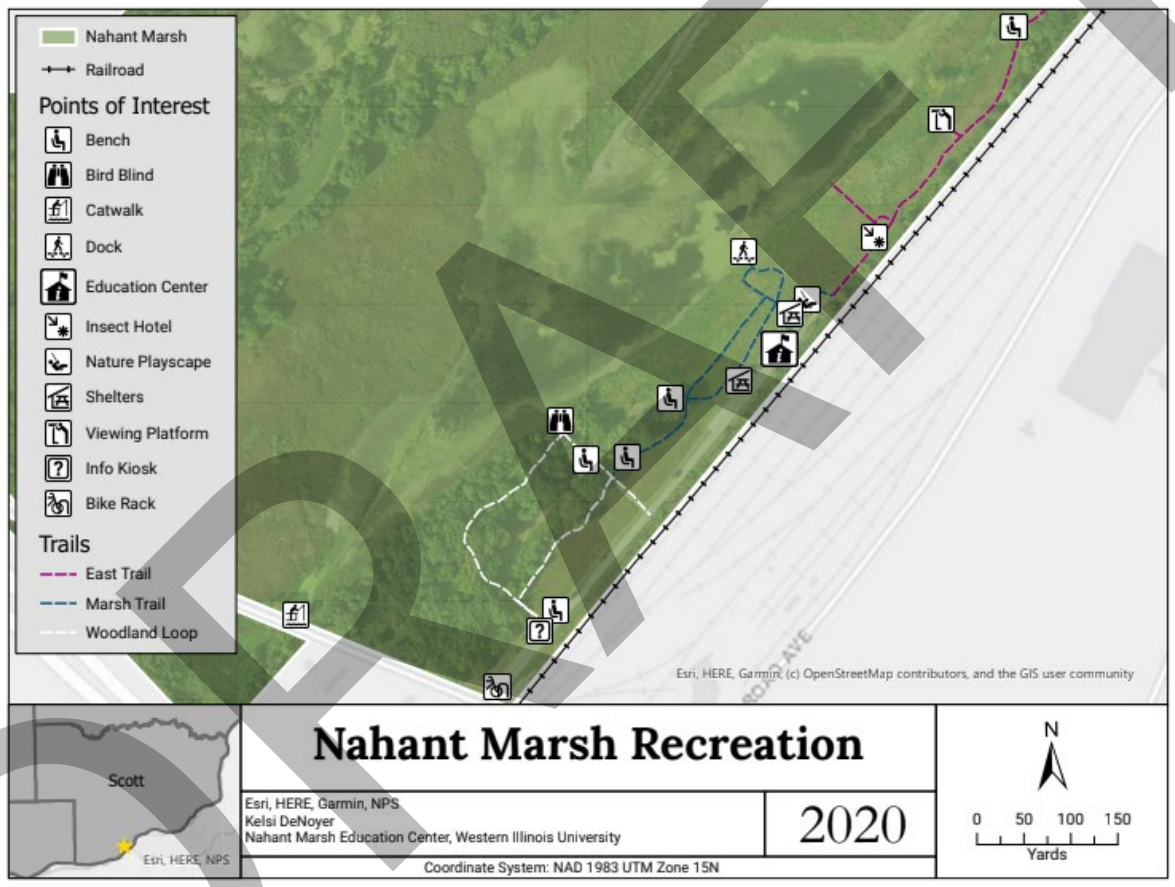
Out of those surveyed, 78 of 105 typically visit NMEC during business hours. The top four activities those surveyed participated in are hiking, attending educational programming, birding, and photography. Of those surveyed, 56 prefer attending public programs during business hours followed closely by evenings and 35 of those surveyed said they would visit and use building amenities on Sunday followed by 26 that said maybe. Of those surveyed, 33 said they would use the building and its amenities if NMEC extended its hours in the evening during the summer, followed by 27 who said maybe, while one person commented that they would like to see the center opened later one evening a week during the summer.

EXISTING PROGRAMMING - INFORMAL USE

NMEC's vision is to foster wonder, appreciation, and stewardship of the natural world. One way NMEC strives to fulfill this vision is by welcoming visitors to enjoy NMEC's trails, variety of habitats, and amenities. Informal use of the site is available from either of the main parking lots from dawn to dusk. Approximately 30,000 people annually use NMEC's trails to hike, engage in wildlife photography, bird watching, picnic, cross country ski and snowshoe. Informal use of the building includes viewing NMEC's animal ambassadors and displays, borrowing equipment to use outdoors, and borrowing self-led outdoor activities. Fishing, hunting, and boating are prohibited at the main marsh.

There are currently one and three quarter miles of publicly-accessible trails through various habitats including bottomland woods, tall-grass prairie, sand prairie, and a new oak savanna restoration. NMEC plans to add two and one quarter miles

of additional trails over the next three to five years. NMEC also plans to pave or install crushed rock on nearly two and half miles of trails for better Americans with Disabilities Act (ADA)-compliant opportunities and safer biking. New and improved trails will increase opportunities for bicycling, running and fitness, bird watching and nature photography, cross country skiing and snowshoeing, skateboarding, rollerblading, and e-biking. The new paved trails would connect the main marsh to three national trails - the American Discovery Trail (ADT), the Mississippi River Trail (MRT), and the Great American Rail Trail (GART). They would also connect the neighborhoods in southwest Davenport to NMEC and the City of Davenport Bike routes. This would provide a rest stop with water and restrooms for those riding these trails. NMEC trails also provide educational signage redesigned and installed in 2022, a bird blind, dock, and viewing platform offering views from a wide expanse of the main marsh.



EXISTING PROGRAMMING - FORMAL USE

NMEC has several ongoing and long-term relationships with school districts, afterschool programs, and summer programs. Appendix B is a list of current NMEC partners. Programmed opportunities, either scheduled school field trips or programs offered by program staff for the community, provide hands-on educational experiences for thousands of participants every year. Programs are provided for all ages from toddlers to seniors.

NMEC serves public and private schools in the Quad City area through field trips, classroom presentations (virtual and in-person), and after-school programs. Education programs are also available

to area homeschool groups and youth serving agencies. The majority of school programming is geared toward first through fifth grades with occasional programs for upper grade levels. Due to high demand for spring field trips, there was an effort to increase fall field trips. This was successful; however, spring is still favorable with most schools and teachers. Research shows exposing children to nature increases creativity, physical wellness, mental wellness, social skills, and a sense of stewardship to the natural world making NMEC's education programs a vital part of their mission.

Current public programming includes the following monthly programs: Breakfast Nature Club, Toddler Tales, Nature Hikes, and Birding Tours. Sunset hikes are offered a few times throughout the year. The Master Conservationist program is offered annually and takes place in the evenings and on Saturdays. Day camps are offered throughout the summer for preschool through sixth grade. Other public programs and workshops are scheduled on evenings and Saturdays, if staffing is available. Special events include the Oberholtzer Awards, Spring Celebration and Egg Hunt, and the Monarch Release Party. NMEC staff also provide programming offsite for preschools, classrooms, afterschool programs, community groups, and senior care centers.

*include header title (e.g. assessment, recommendations, etc)

STAFFING

Nahant currently has eleven permanent staff, two interns, four temporary AmeriCorps positions, an opening for a WIU assistantship student, and up to ten summer research students. The education team is composed of the Director of Education, a full-time naturalist, a full-time naturalist/research coordinator, one full-time AmeriCorps position, one half-time AmeriCorps position, and two quarter-time AmeriCorps positions. The education team also utilizes one of the natural resources employees for animal care and the occasional program. The education team is responsible for providing on-site educational programming for schools; providing on-site programs, summer camps, and workshops for the community; providing outreach programs to schools, after school groups, community organizations, and events; organizing and running public special events; staffing and maintaining the building for visitors; leading the summer research students; and leading recreational programs and trips. With the growth of the educational program to over 22,000 people served in 2019, it was important to have permanent, full-time education staff to provide consistent, quality programming.

The natural resources team is composed of the Natural Resource Manager and three permanent, part-time Natural Resource Technicians and two summer interns. The natural resources team maintains the trails, preserves ecosystems, repairs and maintains equipment, vehicle and small building needs, regularly tests the water quality, organizes volunteer projects, and surveys and maintains the wetland mitigation banks.

The rest of the staff is composed of the full-time Executive Director, the full-time Director of Operations and Donor Relations, part-time Marketing and Events Coordinator, and the Partners of Scott County Watersheds (PSCW) Coordinator/NMEC Volunteer Coordinator/Admin Assistant, who splits their time between PSCW and NMEC.

Currently, the Marketing and Events Coordinator and the Volunteer Coordinator/Admin Assistant are responsible for planning fundraising events, marketing NMEC, and coordinating volunteers. There are two full-time staff members that fundraise both for capital and operational funds: the Executive Director and the Director of Operations and Donor Relations. These two positions write grants, solicit donations from private donors and corporate sponsors, help with fundraising events, conduct donor and grant research, meet with potential donors, and cultivate and steward donors. They are also responsible for daily operations, the bookkeeping, human resources, grant reporting, organizing committees, partnership support, providing occasional on-site and outreach programs, data tracking and reporting, public relations, capital and grant projects, budgeting, and communicating with stakeholders. The large staffing costs and minimal staff dedicated to fundraising is putting strain on those positions and not allowing for the necessary growth for operational support.

NMEC also utilizes volunteers to help docent the building, staff booths at outreach events, natural resource management, plan events, and serve on various committees. Over the last 11 years, NMEC has grown their volunteer program from 364 volunteer hours to 3,661 hours annually. NMEC's volunteers are vital to the care and maintenance of the 375 acre preserve.

RESEARCH

Research is carried out at Nahant Marsh through the Louis Stokes Alliance for Minority Participation (LSAMP) program, a National Science Foundation-funded program designed to increase the number of bachelor and master degrees awarded to historically-represented minorities that major in science, technology, engineering, or mathematics, thereby diversifying our nation's workforce in those disciplines. NMEC is partnered with EICC, which is part of the 16 colleges and universities in the alliance's Midwest region comprising three states (Iowa, Illinois, and Nebraska).

NMEC currently offers annual 12-week summer internships through the LSAMP program, which began in 2012, with up to 10 students selected each year. Applicants that qualify to be in the LSAMP program are compensated throughout their internship. Students that do not qualify may still be accepted into the program, but these students are not compensated for their time.

NMEC also lends its facilities and grounds to other colleges and universities such as doctorate, graduate, and undergraduate students at WIU and undergraduates at Augustana College and St. Ambrose University to perform research. All students typically present their results at professional conferences or public forums. Research is also sometimes conducted by independent contractors. Vildmark Inc., for example, has studied wild turtle populations at Nahant Marsh since 2010.

*include header title (e.g. assessment, recommendations, etc)

The Iowa DNR, in assistance with the USFWS and River Action, conducted a telemetry study on Blanding's turtles from 2010-2012. Volunteers and NMEC staff also contribute to research efforts. Point count bird surveys, which began in 2014, are conducted by volunteers once weekly. NMEC staff monitors water quality (e.g., temperature, pH, dissolved O_2, nitrates, nitrates, chloride) approximately every other week. In 2018, a bioblitz was conducted at Nahant Marsh to document as many species as logistically possible.

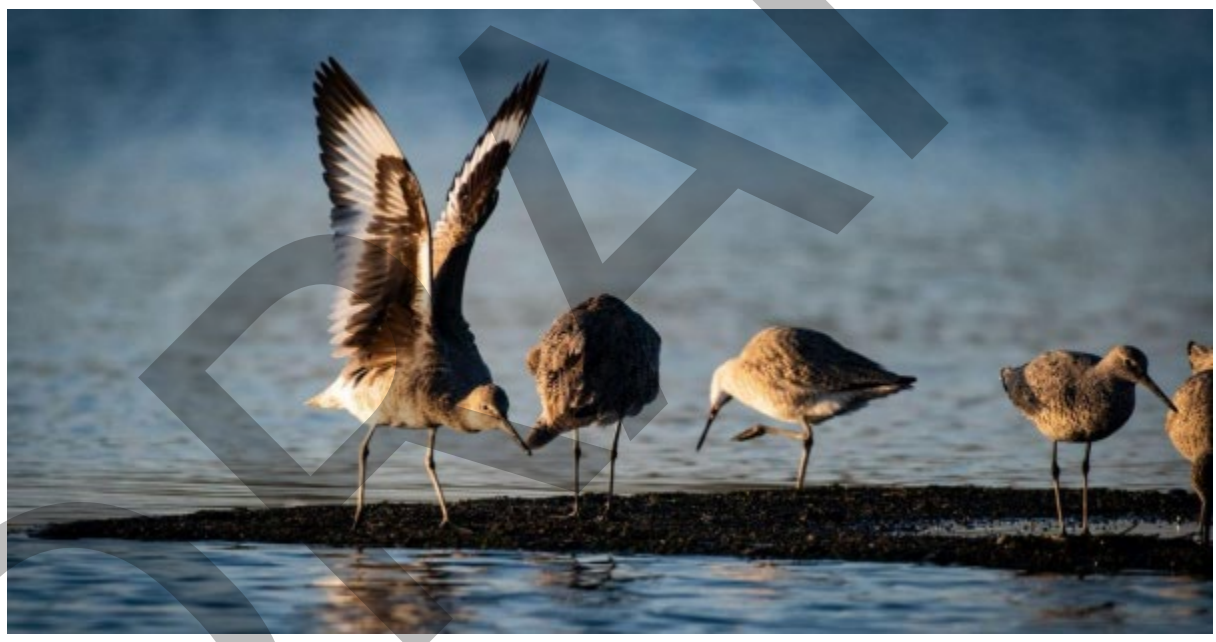
The high number of students, classes, and organizations conducting research and using NMEC facilities has caused even more congestion in the main building and does not provide adequate space for all the programs, employees, and researchers on-site at a given time.

The research program at NMEC affords the opportunity to receive grant funding to support student research projects. Research at NMEC informs staff about natural phenomena important to making management decisions. Research investigations also help NMEC identify potential problems (e.g., invasive species, poor water quality), which presents the opportunity to remediate potential threats to the preserve. NMEC will share research findings and data on the website to inform the public and other scientists of the current research projects at Nahant Marsh.

*include header title (e.g. assessment, recommendations, etc)

CITIZEN SCIENCE

Volunteers currently survey bird populations on a weekly basis. NMEC staff participate in annual Christmas Bird Counts in and around the preserve. In the past, NMEC participated in IOWATER, a volunteer water monitoring program managed by the Iowa DNR. This program was discontinued in 2016. In April 2018, NMEC offered an Iowa Butterfly Network Survey workshop to train volunteers to monitor butterfly species. Currently there are a handful of volunteer-led butterfly surveys at Nahant Marsh and surrounding areas. Staff have been trained or contribute to a variety of community science databases including the Integrated Monarch Monitoring Program, Monarch Larva Monitoring Project, Monarch Watch, iNaturalist, and Bumble Bee Watch. In coordination with other partner agencies, NMEC staff have organized and participated in bioblitzes at various locations including Nahant Marsh, Illiniwek, and Sunderbruch Park. These events included public participation and presentations. NMEC staff has also given presentations to adult groups highlighting specific community science programs in which the public can participate. NMEC partnered in 2022 with USFWS to lead and promote the first annual Backyard Bee Blitz to help collect pollinator data from the public.



PROFESSIONAL DEVELOPMENT

NMEC offers a Master Conservationist program annually and certificates are given to participants who complete the course. NMEC staff have also provided a variety of teacher workshops over the years for recertification and teacher credit. NMEC has also hosted Wilderness First Aid, Chainsaw Certification Courses, Invasive Species Workshops, and various other workshops. NMEC is the primary location for the core classes in EICC's Conservation Technology Associates of Science Degree; internship opportunities for area colleges are also available through NMEC.

*include header title (e.g. assessment, recommendations, etc)

NATURE PRESCHOOL

NMEC has interest in the development of a nature-based preschool. Nature-based preschools are gaining popularity in the United States. Studies show that there are many benefits of nature-based early learning. Children who spend more time outdoors have increased social, emotional, and physical wellness. Outdoor learning provides a safe space for children to learn; early positive outdoor experiences also leads to increased adult stewardship. Reports show that the interest in nature-based schooling is on a steady increase and projections indicate it will continue to rise. Indian Creek, another non-profit nature center in Iowa, launched their nature preschool in the fall of 2021 and filled both their AM and PM classes with a waiting list. The spots for the 2022 school year filled in 20 minutes with a lengthy waitlist (Appendix C, redacted for public view). A nature-based preschool at NMEC would also help to diversify revenue streams.

*include header title (e.g. assessment, recommendations, etc)

Facilities and Programming Recommendations

Facility Deficiencies include the following:

- Original building condition is fair, but too small for current use.
- Garage condition is fair, but too small for current use.
- Flooding is a concern for the original building.
- The original building and garage are energy inefficient.
- The main classroom as the main entrance causes distractions to program participants and confusion to visitors.
- Inadequate storm shelter.
- Insufficient parking for large groups and events.
- Insufficient storage for educational, recreational, research, and natural resources materials and equipment.
- Insufficient classroom space for large field trips, camps, and groups.

To meet the current needs, the original building and garage would need the following renovations:

- An addition for classrooms, storage, and office space
- Flood proofing
- Interior design plan
- New appliances
- HVAC replaced with geothermal
- New windows
- Flooring replaced
- Restrooms need new knobs, replaced fixtures, and lighting
- New exit doors
- Fire suppression system
- Elevator
- Storm shelter
- Additional parking plan
- New roof in a few years

Due to the number of deficiencies, elevation, and condition of the existing building, reusing the building is not a wise investment.

NMEC is building a new operations building (Appendix D) in 2022 with completion scheduled for 2023. This will provide work space and storage for the natural resources team, storage for educational and research equipment, office space for five of the staff, work space for summer research interns and

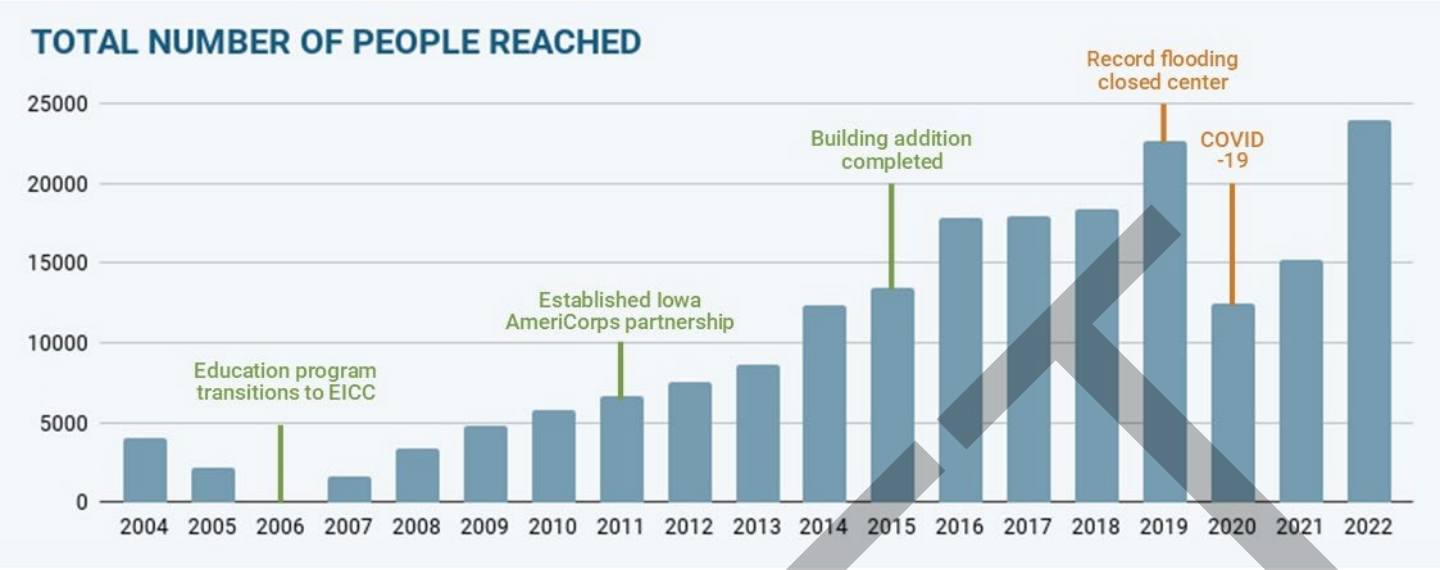
coordinator, a classroom for up to 24 students, and restrooms. The staff also plans to make the current garage into an educational space until a new education center can be built.

Due to increased flooding conditions, large flood events, larger groups, and increased programming demands, it is recommended for NMEC to remove the current garage and original portion of the building. A new, efficient center should be built in its place to better meet programming and community needs.

Since 2015, attendance and staff needs have continued to grow (see Figure 1). NMEC is in need of office space, classroom space, hands-on displays for the public, a large gathering space for events, and storage. During the flood of 1993, it was reported that 4-6 inches of water had entered the building. During subsequent flooding, NMEC staff sandbagged around the building and ran pumps to prevent water from entering the building. A new education center would be elevated above the floodplain to protect the building, animals, and equipment. Additional parking would also need to be developed. The anticipated education center construction is in 10 to 15 years. Considerations will be square footage and building features, including events room/programming rooms, small store, storage, office space, project space, interactive displays, animal room, café, donor display, kitchen, and restroom facilities.

The HVAC system at the Carp Lake House will need to be updated, as well as the appliances as needed. The house will be kept as staff housing unless a FEMA buyout is offered, at which time the NMEC Board and staff would consider the offer and demolition of the house. The acreage would remain with NMEC.

*include header title (e.g. assessment, recommendations, etc)



A new education center would provide new office space and allow NMEC staff to work more efficiently, provide higher quality education programming, provide hands-on experiences to the public, and create an exciting tourist destination for the Quad Cities. There could be an increase in revenue streams through admission prices, memberships, and rental fees. It would provide better work areas and storage areas for NMEC staff and provide a safer environment for the staff, volunteers, and visitors. It would also provide a safer location for education animals, equipment, and supplies. The new building would be more flood resistant, energy efficient, and more in-line with NMEC's environmental mission. Due to the volatility of the current market, there is not an estimate for the work, but based on the cost of other newer nature centers and inflation, the estimated cost for a building this size and magnitude is $9 - $12M. NMEC Board and staff will need to raise those funds through grants and capital giving. NMEC should also consider raising funds for the endowment to support future operations and maintenance during the capital campaign. NMEC staff will also need to communicate with the City of Davenport since they are the owners of the current building and the land it sits on before launching a capital campaign.

PARKING

NMEC parking is insufficient for large groups and events. The newest parking lot is across the railroad tracks. While this will add overflow parking, a potential rail merger is predicted to increase train traffic by 175%. Any visitors, staff, or program participants that park in that lot could potentially be trapped by the train for hours, making it inconvenient to use for parking for the main marsh.

Other options for parking would be paving the strip of lawn along the main drive or adding parking under a new nature center in the future.

*include header title (e.g. assessment, recommendations, etc)

FACILITY HOURS

Facility hours vary at other Iowa nature centers and are not consistent across the state. NMEC will maintain their current business hours and offer programming during business hours, on weekends, and in the evenings. NMEC staff will continue surveying visitors and program participants, as well as monitor trail and traffic counters in partnership with Bi-State Regional Commission every two years, and adjust programming and business hours accordingly. Staff will continue to be on-site during business hours and utilize volunteers to docent and manage the building during Saturdays and special events. As NMEC increases their volunteer pool and projects, volunteers could decrease the staff burden allowing NMEC to extend business hours especially during peak seasons. NMEC staff will continue to make special arrangements for occasional events.

EXISTING PROGRAMMING - INFORMAL USE

New and improved trails for both hiking and biking, new amenities like viewing platforms, picnic shelters, boardwalks and restrooms, winter sports rentals, and the addition of a playground with natural play area, a rental space in a new education center, and adding hands-on educational exhibits and displays in the building addition would increase visitors and recreational users to NMEC. With the addition of paved trails, NMEC could also explore adaptive tricycles and guided ATV tours for those with mobility issues. NMEC is currently applying for several grants for trail building and improvements. If NMEC is granted these awards, trails and amenities should be completed by 2026. Fundraising efforts will be needed for a playground area and hands-on displays. A capital campaign will be needed for a new educational building.

EXISTING PROGRAMMING - FORMAL USE

NMEC has a robust educational program that will continue to be monitored and modified to maintain effectiveness. Some areas for growth include winter and off-season opportunities like snowshoeing and

cross country skiing programs, recreational programming and trips, off-season outreach programs, and programming for senior centers and daycares. Increasing evening and weekend programs could increase attendance, program revenue, and education and visibility of the marsh and its significance within the larger ecosystem, creating stewards of the natural world.

Increasing programming at NMEC may need an increase in education staff. Currently, they are providing programs Monday through Friday during normal business hours, Saturdays during regular hours, and some evenings and off-hours on the weekends. Lastly, there are often requests from community groups (youth/scout groups and adult groups) for evening and weekend tours. By scheduling more public programs, NMEC would potentially limit the available dates for community groups to schedule programs and tours. Strengthening partnerships with presenters and other organizations with similar missions, as well as strengthening relationships with educational volunteers and teachers could help reduce the burden of increased school groups, evening and weekend programming, and community groups for NMEC staff.

The current building is not conducive to increasing on-site programming. Once the new operations building is constructed and the current building and garage are cleared out, renovations to the current building and garage could help with indoor and outdoor classroom space. This would allow the NMEC staff to more easily coordinate multiple groups or larger field trips until a new education center can be built.

NMEC currently has a Nahant Funds for Recreation and Environmental Education (FREE) scholarship fund to help cover busing and program costs for under served youth and schools in need of monetary support. As busing costs, operating costs, and overhead continue to rise, this scholarship fund will become even more important in sustaining this part of Nahant's mission. NMEC Board of Directors and staff will need to continue to raise funds for Nahant FREE.

*include header title (e.g. assessment, recommendations, etc)

STAFFING

NMEC currently holds 375 acres and the education program directly impacts over 22,000 people annually. Over the next 20 years, Nahant has the potential to grow to over 500 acres and directly impact 40,000 people annually and an additional 60,000 recreating on NMEC's trails. NMEC also hopes to construct a new education center and nature preschool in the next ten to fifteen years. To make these goals a reality, NMEC will need to increase their staffing and core volunteer group.

Research found that Indian Creek, another non-profit nature center, in a similarly-sized midwest community was established 26 years prior to NMEC and reached goals in 2019 similar to NMEC's future goals. Their staff consists of five administrative positions, three natural resource positions, three educational positions, five developmental and marketing positions, a janitor, several employees for their store, and 850 volunteers with a core group of 160 volunteers. They held 500 acres and served over 30,000 visitors, students, and event participants in 2021. That year, they saw 82,000 people total including event rentals, meetings, and trail users.

Organizations use different techniques to identify and achieve their goals. NMEC Board of Directors and NMEC staff are developing a strategic plan, which will include an outline for future staffing and volunteer needs, as well as methods for fundraising operational, administrative, and staffing costs. NMEC plans to have a strategic plan completed early in 2023. To raise funds yearly for operational costs, additional administrative and development positions seem necessary, as well as expanding and maintaining a strong volunteer base for various opportunities including education, fundraising, event planning, and natural resource management.

RESEARCH

NMEC's research program is well established and currently running at capacity. A Naturalist/Research Coordinator was hired in 2021. This position will add consistency to the NMEC-led research program and coordination with other programs using NMEC as a site for their research. The NMEC-led research program is currently supported through grant funding, which is an unstable funding source. To increase research opportunities, other funding sources would need to be explored and more staff time, partners, or volunteers would need to be identified to oversee researchers and projects.

CITIZEN SCIENCE

Offering more community science opportunities could lead to a higher number of community members' investments in nature and stewardship. NMEC staff will continue to research and attend citizen science program training opportunities and provide citizen science programs to community members.

*include header title (e.g. assessment, recommendations, etc)

PROFESSIONAL DEVELOPMENT

NMEC is interested in increasing the number of professional development opportunities and workshops for environmental professionals. NMEC staff will continue fostering partnerships with organizations that issue certifications and continuing education credits. This is a great way to provide opportunities for NMEC staff and other environmental professionals, diversify program opportunities, serve a wider audience, and diversify funding streams.

NATURE PRESCHOOL

For NMEC to establish a nature-based preschool, staff need to create a business model, hire a program director and teaching staff, apply for necessary licensing and certifications, build indoor and outdoor facilities, develop a curriculum, and solicit funding from grants and private donors. A potential location for a nature-based preschool is the newly acquired 60 acres off of Kimmel Drive. This property is accessible year-round, even during major flood events. It is away from the main marsh, so congestion in the current building or parking areas will not increase. Appendix C, redacted for public view, is an example business plan for NMEC's reference. Another resource for future planning is the Iowa Child Care Resource and Referral Program - https://iowaccrr.org. As the cost for materials are volatile at the time of this report, there are no cost estimates for new facilities.

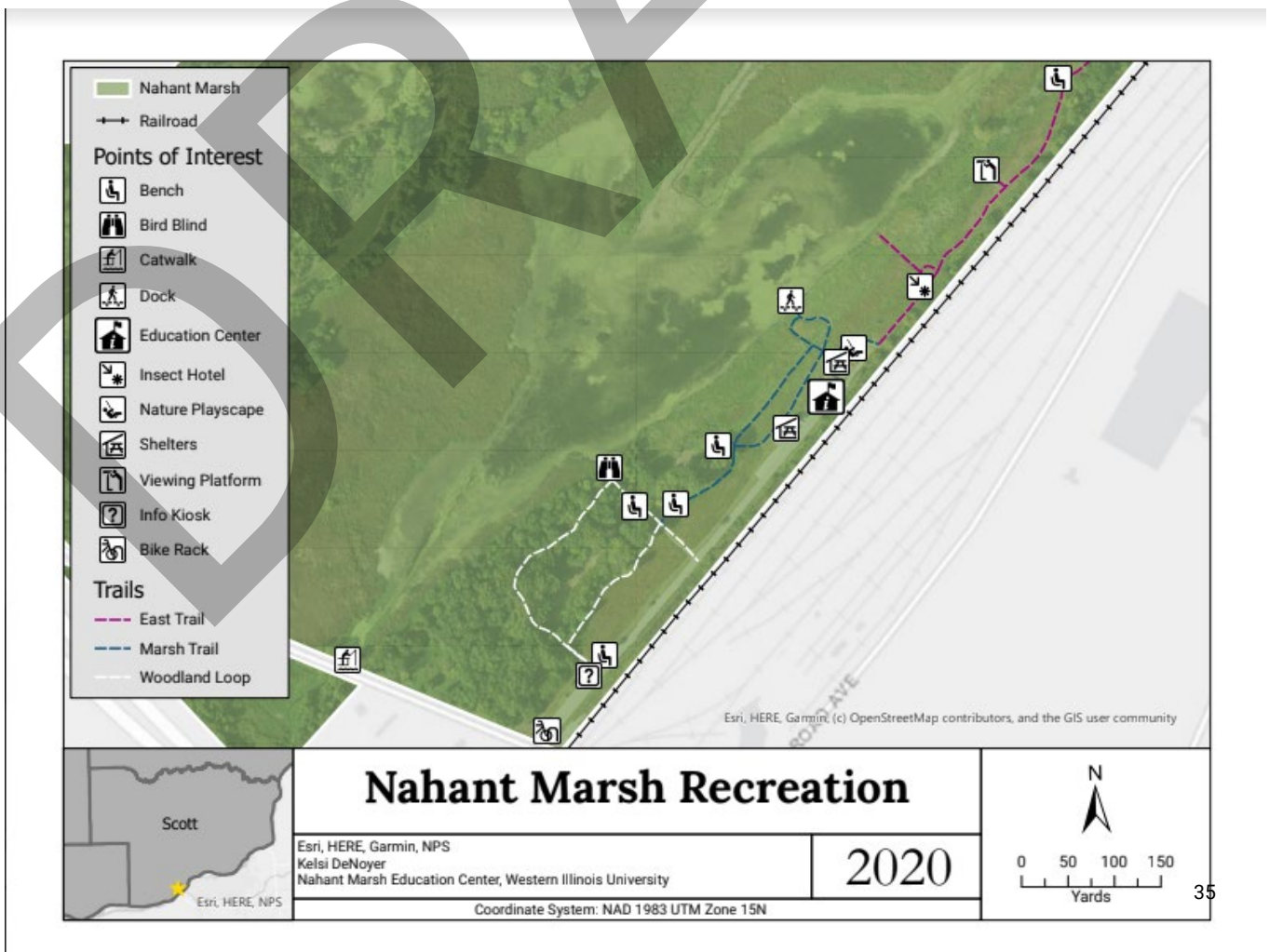
*include header title (e.g. assessment, recommendations, etc)

Trail and Amenities Assessment

TRAILS - PUBLIC

NMEC currently has one and eight-tenths miles of trails open to the public: one trail is one mile east from the building to S. Concord. The other is eight-tenths of a mile from the front of the building and through the bottomland woods. These are either mowed grass or cinder/gravel covered trails. The trails leading to the bottomland woods contains an abundance of poison ivy. The trail to S. Concord is often wet making it difficult to walk and mow. The amount of poison hemlock along the trails poses a danger for NMEC staff and visitors. During 2021NMEC staff installed 337 feet of geomesh to help keep trails drier and accessible. NMEC is completing a half mile paved trail on their most recently acquired property. This trail connects the main marsh to the ADT, MRT, GART, and Credit Island Bridge.

NMEC is also adding a half mile of mowed trails to this property. NMEC is applying for grants to pave the trail to S. Concord and River Drive. This additional trail will improve accessibility for visitors and resolve walking through wet areas. Nahant is applying for grants to add one and one-half miles of trails in the next four years. The additional trails will create more recreational opportunities for local residents and tourists.



*include header title (e.g. assessment, recommendations, etc)

TRAILS - PRIVATE/MAINTENANCE

NMEC currently has one and three quarter miles of maintenance trails that are one mile on the north side of the main marsh and three quarters of a mile at the Carp Lake Property. The Carp Lake trails are mowed, easily accessible, and usually dry. Trails on the north side of the main marsh are seasonally flooded and usually only half a mile of trails are accessible and able to be mowed throughout the summer. NMEC staff installed 347 feet of geomesh in 2017, 2019, and 2020 in low areas to keep maintenance trails drier and accessible. These trails allow NMEC staff, volunteers, and researchers to safely reach and maintain all areas of the preserve. They also serve as burn breaks for prescribed fire activities on the preserve.

CARP LAKE

NMEC's Carp Lake property is a former sand quarry site that is now a 12-foot deep lake surrounded primarily by bottomland woods and marshes. The site was acquired in 2002 by the NMEC Board. There are one and two-tenths miles of rocked and mowed trails, a boardwalk built in 2011 in good condition, and a picnic shelter built in 2017 in good condition. Following flooding and a straight-line wind event in 2008, staff and volunteers cleared downed trees and debris. The following year, they planted over 100 new trees, primarily on the west end of the lake to help improve diversity and habitat. The trees consisted primarily of northern pecan, swamp white oak, bur oak, and paper birch. Several of these trees are now over 30 feet tall.

It was discovered that slag and foundry sand from the now defunct Blackhawk Foundry was dumped along the Southeast edge of the lake. The area is approximately one-half acre and consists of approximately 6,250 cubic yards of material. Since 2017, Western Illinois University's Institute for Environmental Studies has been studying the slag pile and its potential impacts on the lake and surrounding ground. Heavy metals were identified in the slag and are potentially leaching into the lake (Appendix E, redacted for public view). Phase I and II Environmental Site Assessments have been completed and submitted to the State of Iowa. The area remains closed to the public to reduce potential risk.

*include header title (e.g. assessment, recommendations, etc)

AMENITIES

Front Kiosk

The information kiosk found at NMEC's front parking area was installed in 2005. It is seldom used by Nahant Staff and is faded and outdated.

Signage

Nahant removed old, faded educational signage and an outdated preserve entrance sign in 2022 and installed 14 new educational signs along NMEC's main trails. There are 6 older signs that were not removed: a sign on the building, two preserve rules signs at the east and west entrances of the preserve, an educational sign in front of the amphitheater, a sign on the viewing platform, and a keyhole garden sign. They are in good condition, but out of date with either NMEC's branding or information.

Picnic Shelters/Amphitheater

NMEC currently has two picnic shelters. Both shelters were built in 1975 and the west shelter was moved and refurbished in 2015. They are 12’ x 24’ and 12’x 30’ and are currently in good condition. The picnic benches in the shelter near the parking lot are wooden and in fair condition. The picnic benches in the shelter outside the garage are made from recycled plastic and are in good condition.

The amphitheater contains 9 wooden benches. Three benches are 14’, three are 12’, and three are 10’ long. These were installed in 2008 and are used for large events, school groups, and summer programs.

NMEC plans to add another picnic shelter to the 2018-acquired parcel and one is incorporated into the grant budget for the 2022-acquired parcel.

*include header title (e.g. assessment, recommendations, etc)

Bridge/Bird Blind

NMEC currently has a bridge crossing the bottomland woods and leading to the bird blind. This provides access and views to the plants and wildlife on the west side of the main marsh. The bridge was built in 2001 and bird blind was built in 2007. They are in good condition. Flooding has caused slight shifts in the bird blind support footings. These footings require a reset. These amenities are used for almost every group and program at NMEC. There are also two wooden benches on the bridge that are in fair condition.


Boardwalk/Dock

NMEC has a wooden boardwalk leading to their dock which is centrally located at the main marsh. It was built in 2009 and has been through several minor and major flood events. The boardwalk is in fair condition. The dock was purchased from EZ Dock and is made out of a plastic composite material and was installed in 2009. It has also been through many flood events and needs to be reset every few years but is in good condition. The boardwalk and the dock are also used for the majority of NMEC's programs.


*include header title (e.g. assessment, recommendations, etc)

Viewing Platforms

NMEC has one wooden viewing platform on the east side of the trail at the main marsh. It was completed in 2015 and is in good condition. NMEC plans to add two viewing platforms on the 2018-acquired parcel and a viewing tower on the 2022-acquired parcel.

Restrooms

NMEC currently has a porta potty and no outdoor drinking water available for the public when the visitor center is closed.

Trail and Amenities Recommendations

Adding trails, observation areas, and amenities will provide additional recreational opportunities, educational programs, and increased health benefits for the public. These trails and amenities will increase the need for maintenance and security. The NMEC Board and staff will address those needs prior to construction. The board will also consider accessibility needs for a variety of users, including those in wheelchairs. Trails will not be built in areas where sensitive wildlife, plants, or cultural sites exist.

TRAILS - PUBLIC USE

NMEC would like to improve and expand public trails to four and a half miles in the next five years and up to 7 miles within the next 10 years, with at least two and a half miles as multi-use trails. Increased trails will lead to increased recreational users and new opportunities for visitors and groups to experience the outdoors. The expanded trails will connect the neighborhoods of SW Davenport to NMEC making it accessible to those residents. Multi-use trails will provide new audiences to NMEC such as cyclists, skateboarders, and rollerbladers. Trailheads with parking areas will be created on the 2018- and 2022-acquired parcels. Gates and fencing will be installed at these trailheads to control access to the parcels. Other trailheads will be added in the future based on need and feasibility.

Recreational areas are shown to increase tourism, enhance residents' health and happiness, and help to retain employees in the area. The trail improvement project to S. Concord is estimated to cost $300,000 and the proposed trail and amenities on the 2022 acquired parcel is estimated to cost $1.2 million. NMEC will use grant funding for these projects.

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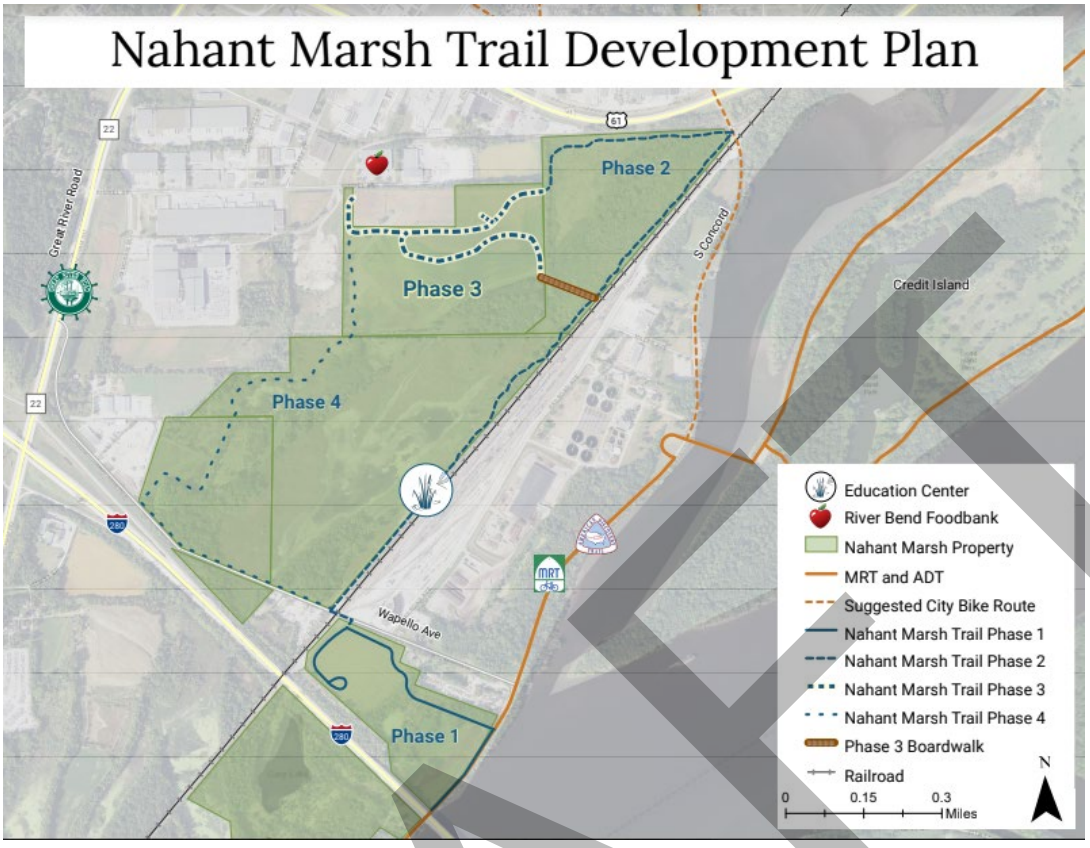

TRAILS - PRIVATE/MAINTENANCE

NMEC will add nearly one half mile of maintenance trails to the 2018- and 2022-acquired parcels. Improvements for current maintenance trails are needed in certain sections, primarily through low-lying areas that are prone to ruts during wet times. Improvements would involve the installation of geotextile fabric, geogrid, and crushed rock. Access would be controlled by installing gates and fencing where necessary.

CARP LAKE

A plan to remediate the site is under development. One option would involve screening and removing the slag/sand material for beneficial reuse in concrete. This would involve trucking the material to a nearby concrete manufacturing facility. Further restoration would be required following slag removal to improve aquatic and terrestrial habitat. Another option would be to cap the site with dredge spoils or some other material. This may include filling some or all of the lake. NMEC may work with the Corps to explore Corps programs such as CAP section 204 for beneficial reuse of dredge materials. A third option may involve keeping the site as is and limiting access to researchers and staff only.

AMENITIES

Front Kiosk

A faded and outdated sign at the entrance to the preserve is not welcoming to the public. Eventually, NMEC should consider updating or replacing this kiosk so that NMEC's entrance will be more welcoming to visitors.

Signage

NMEC has plans to replace the sign on the building, as well as adding more educational signage to improved trails and newly acquired properties. NMEC will also replace outdated signs as they are able. NMEC staff plans to incorporate QR codes to the signage to provide more information for the public in 2023. Survey comments and feedback from NMEC staff also included an interest in seeing a large entrance sign on Wapello Avenue, signage on S. Concord and River Drive, larger signage on Rockingham Road/Highway 22, and wayfinding signage throughout the preserve.

NMEC currently does not have any wayfinding signage to indicate lengths of trails or even direction of trails. This signage is built into the budget of the trail grants. NMEC does not currently have an alternative method of interpretive signage for the blind and visually imparied. This is something NMEC is interested in investigating in the future.

Picnic Shelters/Amphitheater

NMEC and City staff will need to continue to provide general maintenance and inspections of these structures. Annual or bi-annaul cleaning and sealing of benches and picnic tables should continue to occur. The amphitheater benches will likely need to be replaced or refurbished in the next 5-7 years.

NMEC plans to add a picnic shelter to the 2018-acquired parcel and a larger pavilion to the 2022-acquired parcel. These will provide shaded rest areas for visitors and programming space for NMEC staff.

Bridge/Bird Blind

Even though both structures are in good shape, annual inspections should be conducted to ensure the structures are stable and to assess maintenance needs. Cleaning and sealant application should be conducted as needed, likely annually or bi-annually. The support posts for the bird blind should be assessed for repair.

Boardwalk/Dock

*include header title (e.g. assessment, recommendations, etc)

The boardwalk to the dock will likely need to be replaced in the next three to five years. Currently, the boardwalk sits on trapezoidal pads and does not have permanent footings. This design causes issues during major flood events. A new design should be considered for a future boardwalk to make it more flood resilient. The dock is in good shape with the exception of the support posts which need to be straightened occasionally following flooding and/or ice and wind events.

Viewing Platforms

The current viewing platform is in good condition. NMEC plans to add two viewing platforms to the 2018-acquired parcel: one to look over the restored wetland and prairie and one dedicated to train watchers. NMEC already has dedicated funds for these projects. NMEC also plans to add a turtle shaped viewing platform to the 2022-acquired parcel located between the main marsh and Kimmel Dr. These unique viewing areas will attract new and different audiences to NMEC.

Outdoor Restrooms

NMEC plans to have a restroom that is directly accessible from the outdoors and an outdoor water fountain as part of the new operations building. There are also plans to add a restroom facility on the 2022-acquired parcel.

*include header title (e.g. assessment, recommendations, etc)

Natural Resources Assessment

LAND ACQUISITION

NMEC was established as a nature center in 2000. At that time, Nahant Marsh was a 78-acre preserve. Since then, the NMEC Board, a 501(C)(3) non-profit, has purchased 240 additional acres, and the City of Davenport has added an additional 57 acres which created the current 375-acre wetland preserve. NMEC acquired 39 acres of farmland in 2018; this property was restored to wetlands and prairie as part of a wetland mitigation bank. In 2022, NMEC began managing 20 acres held by the City of Davenport/ Levee Commission near the existing Carp Lake property. Additionally, in 2022, NMEC, with assistance from the Iowa Natural Heritage Foundation (INHF), acquired 60 acres. The City of Davenport currently owns 134 of the 375-acre preserve.

Currently, INHF holds permanent conservation easements on three separate parcels consisting of around 163 acres. INHF staff conducts annual inspections to ensure that the parcels are being managed in a way that protects the ecosystems and promotes biodiversity. These conservation easements help to provide permanent protection, regardless of the owner.

NMEC's mission is to protect, enhance, and restore Nahant Marsh through education, research, and conservation. Protecting and restoring the adjacent watershed is vital to the protection of the current wetland preserve. This is possible with land acquisition through donation or purchase within a three-mile radius from NMEC.

Acquisition of land within Nahant Marsh's watershed would allow for the protection and preservation of the main marsh from runoff, enhance the watershed's water retention during flooding events, increase filtration of nutrients in the watershed, provide higher quality habitat for local flora and fauna to include threatened and endangered species, increased recreational opportunities for the public, increased educational opportunities for all ages, and increased research opportunities. There would also be possible revenue streams through the Natural Resources Conservation Service's (NRCS) Conservation Reserve Program (CRP), NRCS's Wetlands Reserve Program, wetland mitigation banking, or other conservation programs. Acquisition of land through donation or bargain sale have tax benefits for donors. More information can be found at: http://www.iowalandoptions.org/protection-options/donation-options/land-donation/

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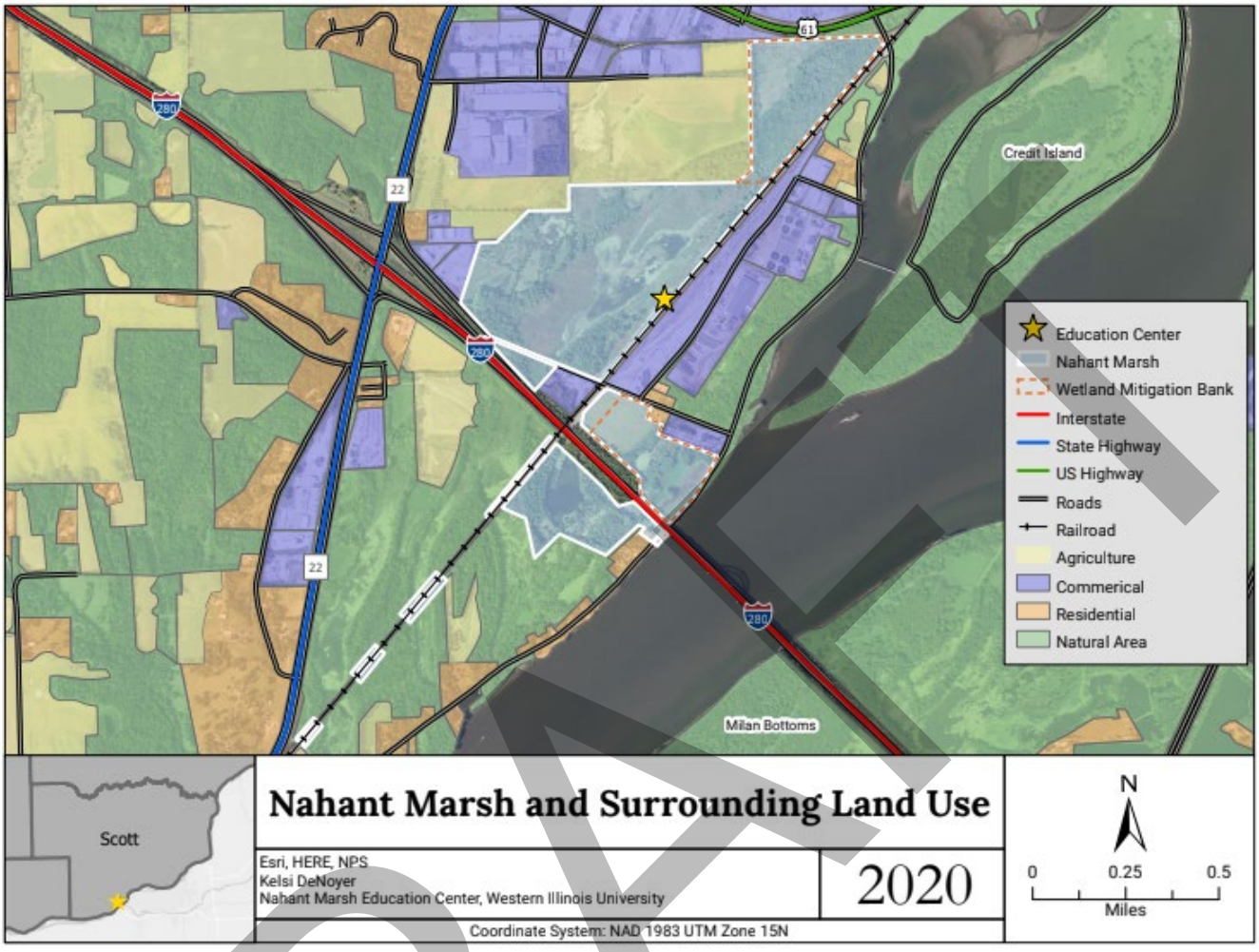


NATURAL RESOURCES

NMEC staff and volunteers maintain 375 acres of tallgrass prairie, mesic prairie, sand prairie, open water, bottomland woods, small ponds and wetlands, wetland mitigation banks, and oak savanna. Researchers and staff have documented 434 plant species, 213 bird species, 43 mammals, 16 reptiles, 8 amphibians, over 300 invertebrates, 62 mushrooms, and 27 fish species on the preserve. Of these species, three are listed as federally threatened or endangered, and 27 are state endangered, threatened, or of special concern. See Appendix F for full listing.

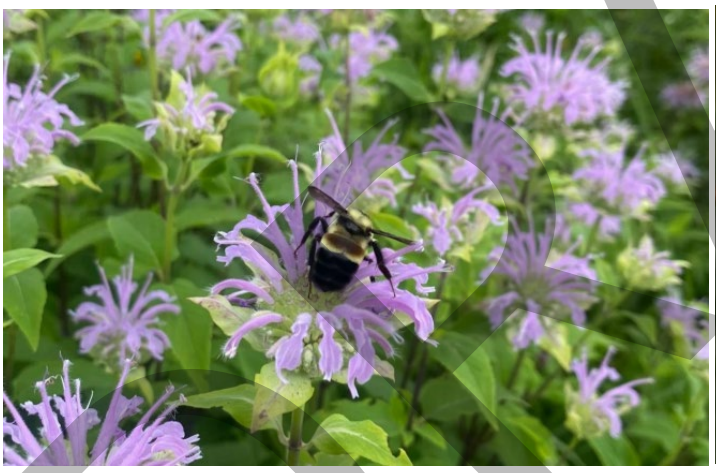
Current issues NMEC faces are water, noise, air and light pollution, habitat fragmentation, illegal dumping, invasive species, increased flooding, increased drought, potential hazardous areas around the preserve, and sedimentation. Water quality testing is done by NMEC staff and research students in the summer. Invasive species are managed by NMEC staff and volunteers. Illegal dumps are cleaned up by NMEC staff and volunteers or reported to the City of Davenport. NMEC acquires more land as they are able, and then converts that land to wetlands and prairie.

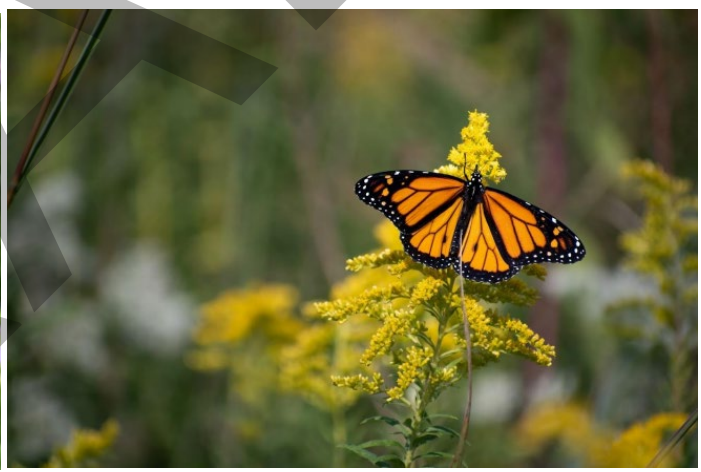
*include header title (e.g. assessment, recommendations, etc)

Growth of the urban environment continues to threaten the ecological integrity of NMEC. Culverts from I-280 and Wapello Avenue bisect the marsh and inhibit the natural connectivity of the marsh itself and its connectivity with the Mississippi River.

In the 1990s, USFWS and EPA did pre- and post-cleanup surveys of plant, animals, and lead contamination. Subsequent flora, fauna, and water quality surveys have been conducted by NMEC staff, volunteers, and local colleges.

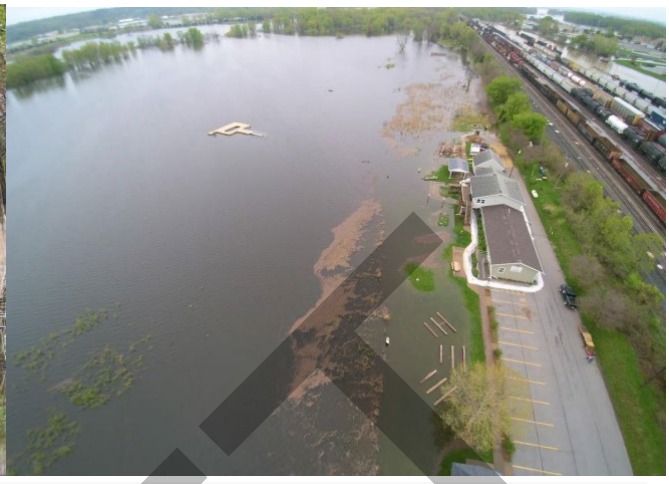
The Corps accessed the USFWS's Information for Planning and Consultation website for a list of Federally threatened, endangered, and/or candidate species and critical habitat that "may be present" within NMEC's land holdings. The listed species for Scott County, Iowa include: Indiana bat (*Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), spectaclecase mussel (*Cumberlandia monodonta*), monarch butterfly (*Danaus plexippus*), rusty-patched bumble bee (*Bombus affinis*), eastern prairie fringed orchid (*Platanthera leucophaea*), and western prairie fringed orchid (*Platanthera preclara*). No critical habitat is present within NMEC's property. Some of these species have been documented at Nahant Marsh over the last 15 years. See Appendix G for more information. Additionally, Nahant Marsh has documented 27 state endangered, threatened, and special concern species on-site.

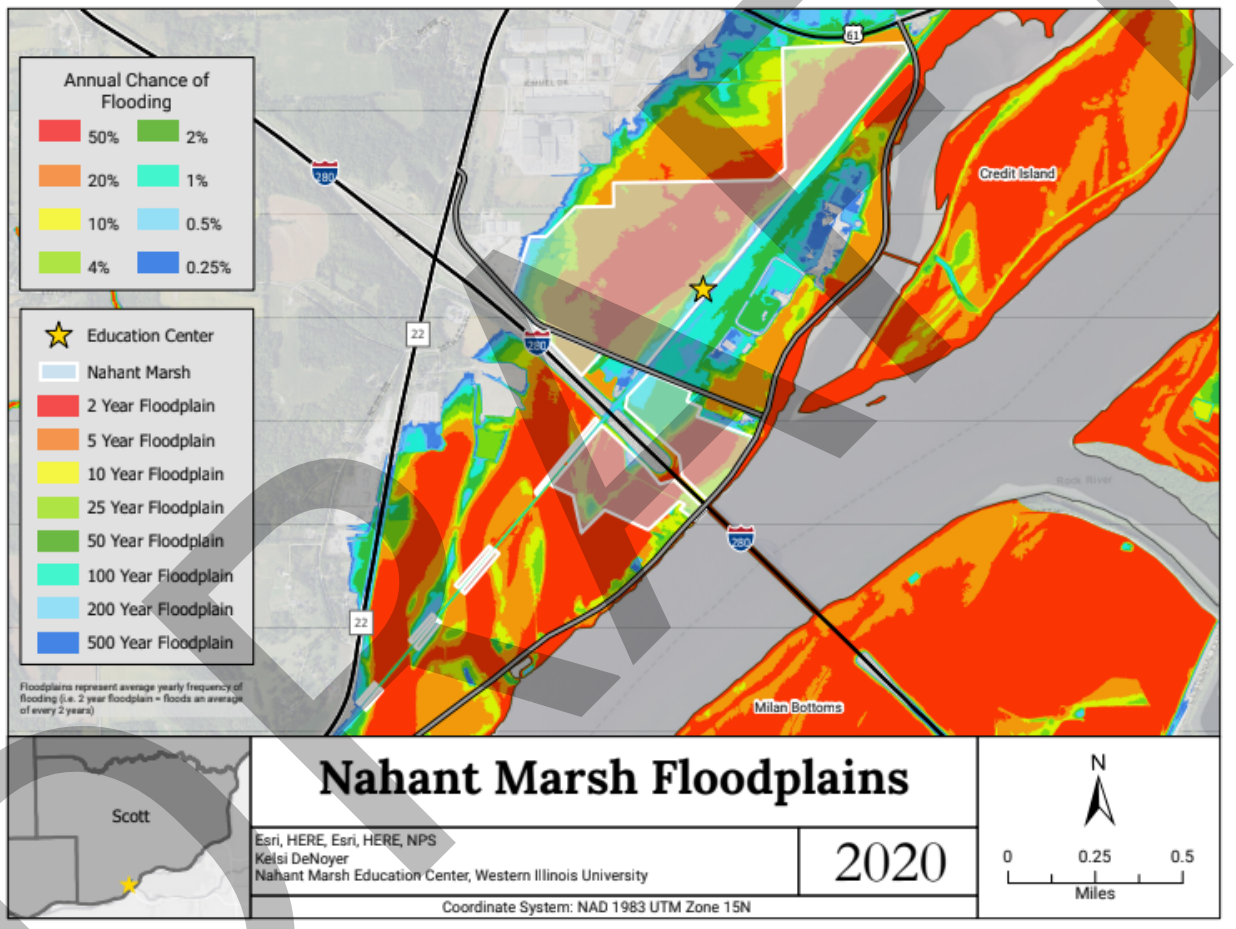




Due to concerns about flooding, sedimentation, and runoff, NMEC requested that the Corps conduct bathymetry, hydrology, and other studies to determine sedimentation rates, access points for pollution, to model and develop strategies to mitigate future floods, to develop a strategy for managing the sedimentation of the main marsh, and to delineate the watershed to identify the inlets and outlets. NMEC was also interested in better understanding the connection between Mississippi River and Rock River water levels and the impact on Nahant Marsh water levels. As a result, the Corps provided a staff gage that NMEC installed in the marsh near the culvert at Wapello and began taking daily readings. During 2021-2022, Corps staff conducted baseline bathymetric, hydrologic, and geological surveys. Permanent location and survey stakes were established at various points throughout the preserve to be used for future sampling.

*include header title (e.g. assessment, recommendations, etc)





*include header title (e.g. assessment, recommendations, etc)

Environmental Engineering

In order to better understand the issues facing NMEC, various investigative measures were conducted during the Planning Assistance to States and Tribes (PAS) Study. Limited data existed prior to development of the PAS Study regarding sedimentation, elevations of the bed of the open water of the main marsh, elevations of certain structures, types and nature of sediments present, and water quality. As such, survey transects across the marsh were conducted, soil borings were installed, soil samples collected, and elevations of structures were collected. In addition, Nahant staff had collected water quality data at various points on the NMEC property, which were utilized by the Corps to develop an understanding of marsh water quality parameters. Given the goal of the marsh to support migratory waterfowl, water level management is a critical issue and further development of options was required.

Survey transects of the marsh indicated bed elevations range from 550 to 551 feet MSL and are fairly uniform with little topographic diversity or variation. Water quality analysis shows that chloride, turbidity, nutrients and dissolved oxygen can be a concern at various times of the year. Suspended sediment and nutrient load can be from upstream off-site sources and from backflow during Mississippi River flooding. Sediment rate analysis provided an estimate of 1.8 inches/year of accumulation. Sediment analyses indicated a high phosphorus concentration, which could be potentially leached out to the water column under certain conditions. Data can be found in Appendix G.

Geotechnical

The Corps conducted a subsurface investigation at NMEC on January 12th, 2022. The primary purpose of the investigation was to determine the amount of accumulated sediment on the Marsh floor, but the soil samples collected were used for environmental and cultural assessments. The investigation included performing eight borings at various locations throughout the main marsh.

As a result of the investigation, the Corps classified the subsurface material, estimated ranges for existing sediment thicknesses, and installed monuments for future sediment monitoring. Overall, the marsh subsurface consists of a top layer of dark gray silty clay with high organics content and traces of shells, a thin transition layer (approximately 1 or 2 inches), and a bottom light gray clay layer, which is assumed to be native soil. The top layer is considered sediment build-up and ranges in thickness from 3 to 5 feet. Data can be found in Appendix I.

Hydraulics and Hydrology

The Corps studied the hydraulic and hydrologic state of the main marsh. The goal of this work was to establish what information and data is already available, find data gaps and how to fill in those gaps, determine runoff/flow paths to the main marsh, and create a set of alert guidelines for NMEC staff when the Mississippi River is forecasted to rapidly rise. The Corps and NMEC staff also installed a staff gage in February 2022 to supplement upstream gage data from Lock and Dam 15. Data can be found in Appendix J.

The main marsh is in a hydrologically complex area. Waters from the mainstem of the Mississippi River as well as the junction of the Rock River immediately upstream can have flashy rises. Discerning which

river flows or impacts are coming from can be extremely challenging. While there is data upstream for both rivers, there is little information for the main marsh itself. With the installation of the staff gage and regular data collection, there will be more data to work with for future studies and efforts at the main marsh. The resources available provide context for where water is entering the main marsh, beyond obvious points of entry, with the identification of flow paths and 2D modeling. With available lidar topobathy and newly collected surveys, the transects of the main marsh can be used to track sedimentation and changes of the main marsh bottom overtime when updated surveys are collected. Water surface elevation profiles from the Mississippi River Flow Frequency Study allows for estimation of flood alert stages so NMEC staff can take action when points of interest are forecasted to be inundated.

Natural Resources Recommendations

LAND ACQUISITION

The NMEC Board and staff should create a land acquisition policy with a ranking system. Land acquisition ranking can be based on donation versus purchase, proximity to current land holdings, purchase and funding availability, possible hazards or liabilities, and land that falls within NMEC's mission. The goal would be to only obtain acreage that can be feasibly restored and managed by NMEC staff. Priorities would include acquisitions to prevent sedimentation, vulnerable ecosystems, expanded recreational opportunities, increased sustainability, and resiliency of NMEC's mission. There is also a potential for public/private & public/public partnerships with other organizations to increase the effectiveness of NMEC's watershed through conservation easements and management plans. Acquiring land and expanding NMEC's property holdings would increase connectivity through the nature corridor.

As NMEC increases landholdings, the need for staffing, volunteers, and security increases. The NMEC Board and staff will need to evaluate the type of land versus the maintenance and upkeep, then make decisions based on the financial feasibility of all factors involved. Other concerns include liability; safety; Hazardous, Toxic and Radioactive Waste; surveys; and the costs associated with those.

NATURAL RESOURCES

General Recommendations are to:

- Finish updating natural resource management plan.
- Continued monitoring of both native and invasive species, water quality, sedimentation, and water levels.
- Meet CRP and mitigation bank requirements including invasive species removal, maintaining planted trees and shrubs, and performing yearly monitoring and photo documentation.
- Develop a more robust citizen science base of volunteers to assist with certain monitoring.
- Continue to recruit and train natural resources volunteers.

- Seek funding and cost share programs to assist with future professional bathymetric, ecological, and other surveys.
- Seek funding and/or cost share to implement recommendations for future studies.
- Investigate impacts of noise, light, and air pollution.
- Develop and/or strengthen relationships with other natural areas or agencies for the sake of sharing knowledge, seeds, equipment, etc.
- Use volunteer and professional research to continue to identify ecological sensitive areas. Use this information for future trials and for developing restricted areas.
- Continue to implement adaptive management strategies to effectively face potential challenges and threats related to a changing climate, surrounding urban areas, and finances.

NMEC is concerned about the potential impact of noise, air, and light pollution from the surrounding industrial area. In particular, NMEC is concerned about the potential impact of a proposed rail merger.

NMEC is interested in adaptively managing structures on or adjacent to the property. These include water control structures, facilities, and trails. Additional areas to monitor are the external influences such as light and noise, air pollution and flooding, and their effect on the ecosystems and wildlife of NMEC. NMEC would also be interested in a long-term strategy for slowing the spread of invasive species and to mitigate runoff from surrounding areas. NMEC would also like to study the impact of increased human presence and where trails and amenities should and should not be placed, water level management and water control opportunities, and ways to improve ecosystem management.

Resource monitoring and adaptive management would provide short- and long-term qualitative and quantitative analysis of the marsh, to adapt to changing conditions and needs. Current NMEC resources limit the types or extents of surveys and studies and may need external support to identify and accomplish studies or projects. The high cost of projects and mitigation efforts presents a challenge to implementation. Some of the disturbance or degradation issues are on surrounding lands and NMEC may not have future acquisition or cooperation from those land owners.

Connecting NMEC and the Mississippi River allows movement of wildlife. The projects mentioned above will allow staff to better manage the preserve's ecosystems. NMEC would provide additional and improved benefits to the health of the Mississippi River.

Environmental Considerations Recommendations

NMEC is a unique ecosystem composed of marshy areas, various prairie types, and bottomland forest. The over 300-acre preserve provides recourse for hundreds of plant and animal species. Of these species, four are listed as federally threatened, endangered and/or candidate* species: Indian bat (*Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), monarch butterfly (*Danaus plxippus*)*, and rusty

patched bumble bee (*Bombus affinis*). NMEC currently implements a variety of research and conservation efforts to learn and protect the quality of the habitat.

It is recommended that NMEC staff, interns, and volunteers continue to conduct surveys to collect data on plant and animal species that utilize the area. Continued terrestrial invasive species management is also recommended to control the spread of invasive plants that can outcompete native plant species critical for pollinator success, including the federally endangered rusty patched bumble bee which has been documented at Nahant in 2020 and 2021. Habitat evaluations and/or assessments are also recommended to determine if suitable habitat exists for threatened and endangered species not observed during surveys.

The USDA NRCS and The Xerces Society for Invertebrate Conservation provides habitat evaluation protocols for monarch butterfly and rusty patched bumble bee respectively (protocols located in Appendix G). Identifying and enhancing suitable habitat for threatened, endangered, and candidate pollinator species will also improve the population of other important pollinators. It's recommended to utilize the USFWS *Rusty Patched Bumble Bee Midwest Plant Guide* for any seeding efforts (located in appendix G).

There have been 9 different bat species documented at NMEC. Of those, two are federally listed: Indian bat and northern long eared bat. As white-nose syndrome continues to threaten bat populations, more bat species will likely be added to the federal threatened and endangered species list. It is recommended that NMEC staff, interns, and/or volunteers assess potential bat roosting habitat following USFWS *Range-Wide Indiana Bat & Northern Long-Eared Bat Survey Guidelines, Appendix A* (located in Appendix G). Evaluating and protecting habitat for these threatened and endangered species will also benefit other bat species.

Environmental Engineering Recommendations

Recommendations include continued efforts to reduce sediment and nutrient inflows, determine sources of high chloride levels, implement a method of more precise water level management, and continue sediment and gage measurements.

Geotechnical Recommendations

A plan to record the marsh bed elevations at the sediment monuments should be generated, including a discussion on the frequency needed to collect readings. To start, the readings may be collected quarterly and transition to yearly if the data shows little or no changes.

Hydrology Summary and Future Recommendations

The main marsh is in a hydrologically complex area. Waters from the main stem of the Mississippi River, as well as the junction of the Rock River, located immediately upstream have flashy rises. Discerning where river flows/impacts are coming from is extremely challenging. While there is data upstream for both rivers, there is little information for the main marsh itself. With the installation of the

staff gage (a measuring tool used to provide a visual indication of water depth) and regular data collection, there will be additional data for future studies and efforts at the main marsh. With the identification of flow paths and 2D modeling available, it is now possible to learn where non-obvious points of entry to the main marsh occur. Water surface elevation profiles from available Mississippi River Flow Frequency Studies allow for estimation of flood alert stages so NMEC staff can take action when points of interest are forecasted to be inundated.

From a hydraulic and hydrologic standpoint, it is recommended that NMEC staff continue to collect data from their staff gage at the finest frequency possible. In the future, it would be best to find ways to automate data collection. When sufficient data is collected, there is potential to perform regression or other analyses to determine relationships between water levels at the main marsh and whether it was related to flows on the Mississippi or Rock Rivers. This information can supplement and refine the flood alert system developed using information from the Mississippi River only.

NMEC natural resources staff will update the management plan based on data the Corps provides by the end of 2023. This plan is updated as new studies are done and new data is compiled. Fundraising efforts will be needed to conduct all of the studies NMEC is interested in.

*include header title (e.g. assessment, recommendations, etc)

Cultural Resources Assessment and Recommendations

NMEC has done internal research about the history of the area and provided presentations and displays of local history. Staff research includes Native American history and the history of the Rockingham and Nahant communities that were once there. NMEC has had archeological surveys done on 2 out of 17 parcels. Phase 1A and 1 archaeological surveys were completed on the Ruhl and 2018-acquired parcels as a requirement for the wetland mitigation bank (Appendix K, redacted for public view). Amateur archeologists have done independent surveys as well.

The Corps facilitated a Phase IA archeological and geomorphological assessments on 400 acres (162 hectares) at NMEC and surrounding areas of interest for potential future acquisition (Moe, 2022). The assessments' purpose was to further understand the cultural history of the marsh and identify areas with potential for archeological and architectural remnants. A Phase I investigation is the first step in determining whether a proposed project contains any potentially significant cultural resources. Specific tasks include Phase IA (literature and document review and sensitivity assessment) and Phase IB (field investigations). Phase IA investigations are intended to gather information concerning the environmental/ physical setting of a specific project area as well as its cultural setting. It is the interrelationship of the physical environment and cultural/historical setting that provides the basis for the sensitivity assessment.

The Corps conducted the geomorphology assessment to gain knowledge on NMEC's sediments and established soils. Geomorphology deals with the processes of the earth's surface and the shape of the earth. Archeology, on the other hand, deals with what the historical remnants of the landscape can tell us about the human past. Because geomorphology focuses on a combination of physical geography and surficial geology, it can assist archaeological studies by focusing on the landscape and formation processes on a wide range of spatial and temporal scales, from soil micromorphology to continents and from minutes to millennia. Geomorphology and archeology intersect in almost every part of an excavation and landscape assessment because both sciences can provide relevant information about past environments, where humans lived, and contribute to geomorphic processes and sequences.

The Phase IA assessment examined areas of the marsh not previously subjected to archeological assessment, but the geomorphological assessment was limited to the current NMEC property as well as city-owned property. No specific undertakings are planned at this time. The purpose of the investigations is to document and assess the potential for archeological resources in NM and make recommendations regarding the need for additional archeological investigations for future undertakings. This study involved an examination of prior archeological investigations and historic documents, as well as an assessment of local topography, soils, and geomorphological data.

Historic plat maps and U.S. Army Corps of Engineers property acquisition maps show nineteenth- and early twentieth-century buildings and structures were located within or near NMEC. Remains of these buildings or structures may still exist within NMEC. There is a small chance a portion of the now abandoned Rockingham townsite may also exist within NMEC.

The geomorphological assessment shows an Early-Middle Holocene Channel Belt landform is situated within the NMEC, as evident in the high levels of gleying and redoximorphic features common in wet or frequently flooded soils[1]. Marshy wetland areas are typically not suitable for human habitation. As such,

this location is not likely to contain archeological material. Although impacts related to industrial and railway construction are evident, potential for cultural material is present within the Kingston Terrace landform within NMEC. The buried soil present on the Kingston Terrace illustrates the potential for intact archeological deposits in this area (Figure 2, redacted for public view). Additionally, features such as pits and post molds, which would have been dug into intact B horizons, could still exist within the landform. As such, the Kingston Terrace landform is considered to have high potential for intact cultural resources.

Intensive Phase I archeological survey is recommended for the entire Kingston Terrace landform, as well as the northernmost Fan/Colluvial Slope landform within the study area, especially prior to any land disturbance. A Phase I archeological survey would entail systematic testing to determine whether an archeological site is present. No further archeological survey is recommended for the Early-Middle Holocene Channel Belt landform within the majority of the study area. However, the part of the Early-Middle Holocene Channel Belt which postdates 7,000 BP, located in the far southern portion of the study area on the Iowa side, is recommended for intensive Phase I archeological survey (Figure 2, redacted for public view).

During the geomorphological field visit, historic foundation remains were recorded (Moe, 2022). It is recommended this foundation and its surroundings be subjected to intensive Phase I archeological survey to refine the site's boundaries and gather information that could be used to make a recommendation concerning its eligibility for the National Register of Historic Places based on the site's eligibility and actual size, the additional Phase I survey would help determine the development, or recreational improvements that could be undertaken and not impact the cultural resource significance of the site.

If any previously unreported and/or unanticipated historic properties, cultural resources, or human remains are found during any land disturbing activities, a qualified archeologist should be immediately notified. Work should be suspended within a 45-meter radius of the discovery until a qualified archaeologist can inspect the area and all requirements of the applicable Federal and State laws and regulations, including Section 106 of the NHPA (36 CFR § 800), have been met.

Section 106 of the National Historic Preservation Act (NHPA; 54 USC § 306108) requires Federal agencies to take into account potential impacts of proposed actions on significant cultural resources when actions are on Federal land or Federal funding or permits are necessary. If NMEC pursues actions with non-federal funding that do not require federal permits they are not required to conduct further cultural investigation. The recent cultural assessment provides insight to NMEC to make decisions about future work and potential NHPA requirements if the above outlined stipulations are met. Actions that do not involve ground disturbance or the use of heavy equipment, such as gravel placement for a trail, are not likely to impact archeological sites. Actions that involve excavation or the use of heavy equipment (that may cause rutting or compaction) such as building construction, vegetation planting or removal, or landscape modifications are likely to impact cultural resources. In these instances, further archeological investigations would be recommended to avoid adverse effects on significant archeological sites.

*include header title (e.g. assessment, recommendations, etc)

[1] Gleying soils are characterized when low oxygen soil conditions (such as a high water table) cause iron and manganese to reduce, and make the soil gray. There are some cases where plants grow in soils that have low oxygen, and the roots that go into the gleyed soil provide just enough oxygen so that iron and manganese don't reduce, and the soil remains an orangey color- just around the roots. Soils saturated and contain ferrous iron at the time of sampling may change color upon exposure to the air, as ferrous iron is rapidly converted to ferric iron in the presence of oxygen. Such soils are said to have a reduced matrix. Redox concentrations, depletions, and reduced matrices are collectively referred to as redoximorphic features.

NOTE: The National Historic Preservation Act, Section 304, protects certain sensitive information about historic properties from disclosure to the public when such disclosure could result in a significant invasion of privacy, damage to the historic property, or impede the use of a traditional religious site by practitioners. Therefore, certain cultural resource location information has been redacted from this section.

*include header title (e.g. assessment, recommendations, etc)

Ecotourism Assessment and Recommendations

One outcome of the COVID pandemic was that people sought out new ways to connect with the natural environment. The United States currently leads the world in ecotourism experiences, and these are only likely to increase. "The ecotourism market is expected to grow by 15% Compound Annual Growth Rate between 2021 and 2031" (Future Market Insights: Ecotourism Market, 2021). This presents a tremendous opportunity for growth for Nahant Marsh.

NMEC is one of ten interpretive centers on The Great River Road in Iowa. NMEC has recently published ads in Big River Magazine. River Action publishes NMEC events in their quarterly publication. NMEC has been featured on Iowa Outdoors and other public television shows. NMEC was able to secure signage installed along I-280 and US-61 in 2017 or 2018.

An ecotourism campaign or program would help NMEC gain wider recognition. Connecting with other natural areas creates more appeal as an ecotourism destination, as well as economic benefit to the area.

It is recommended that NMEC should investigate the feasibility of the following ecotourism options and designations:

- Viking River Cruises, American Cruise Lines, and other river cruises
- Increased NMEC signage along Great River Road, Great American Rail-Trail, and Mississippi River Trail
- Unite West Lake Park, Sunderbruch Park, Nahant Marsh, and Black Hawk Creek as an environmental recreation corridor for west Davenport
- Connect Nahant Marsh with Milan Bottoms and Credit Island (physically and marketing)
- Develop a regional framework and connections between Louisa County, Iowa and Clinton and Rock Island Counties, Iowa and Illinois
- Billboards along I-280
- Silos and Smokestacks
- Iowa Great Places designation with the City of Davenport
- Ecotourism marketing campaign with such groups as Visit Quad Cities

*include header title (e.g. assessment, recommendations, etc)

Summary

Nahant Marsh Education Center has been a treasured gem within the City of Davenport even before its establishment in 2000. After completing the master plan, we find ourselves with exciting possibilities to expand trails, programming, facilities, and natural resource management practices. Recommendations within this plan address the current demand and future needs of NMEC.

Nahant Marsh is a unique story of resiliency. While nearly 95% of wetlands in Iowa were destroyed during the 19th and 20th centuries, Nahant Marsh managed to survive and is thriving as a result of community investment, diverse partnerships, and a dedicated group of staff, board members, and volunteers. While new threats to the marsh continue to emerge, NMEC is much better positioned to deal with them than any time in the past.

As NMEC has continued to grow and establish itself as a leader in regional conservation during the past 20+ years, NMEC remains dedicated to the core mission of protection, enhancement, and restoration of the marsh and surrounding ecosystems through education, research, and conservation. This plan helps to establish a clearer vision for NMEC and helps to prepare for both the challenges and possibilities for the next 20 years. If successful with the strategies listed in this plan, NMEC will continue to grow and serve the region.

*include header title (e.g. assessment, recommendations, etc)

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*include header title (e.g. assessment, recommendations, etc)

Appendices

Appendix A	NEMC Survey Responses
Appendix B	NMEC Programming Partnerships
Appendix C	Preschool Business Plan Example*
Appendix D	Operations Building Plans
Appendix E	Carp Lake Environmental Assessments*
Appendix F	NMEC Species Lists
Appendix G	NMEC Environmental Considerations Environmental
Appendix H	Engineering Report
Appendix I	Geotechnical Report
Appendix J	Hydraulics and Hydrology Report
Appendix K	Ruhl and 2018 Acquired Parcel Archeological Report*

* This content is redacted for public view due to sensitivity of information

Appendix A

Table A-1. Programming and Operational Hours Survey Questions and Responses.

	When do you typically visit the Marsh?	What activities do you participate in while you are here?	If you participate in our education programs, what time do you prefer?	If we were to have the building open on Sundays, would you visit and use the indoor amenities?	If we were to extend our weekday business hours in the summer, would you use the indoor amenities?
Business Hours	78		56		
Evenings	29		41		
Saturday PM	24		23		
Sundays	28		19		
Hiking		74			
Photography		34			
Education Programming		73			
Volunteering		5			
Biking		6			
Birding		41			
Plant ID		2			
Meetings		2			
Art		2			
Lending Library		1			
Monarch Release		1			
Donating		1			
Wildlife		2			
No				20	19
Yes				35	33
Maybe				26	27
Probably Not				12	15
Only for a class					2

Are there other amenities you would like to see in our building or at the preserve?	Other Comments
Outdoor Interpretive Signage	I like that you are making an effort to see if expanded or different hours will ensure more people. We enjoyed the evening bee program and small fall hike with Amy very much.
Evening BNC	Need another way to get there. Train backs up traffic and can't get to Nahant without a long wait or turn around and maybe try to visit another time. Maybe information about good times to visit that possibly have less train traffic to make the visit enjoyable.
Outdoor Bathroom	My kids honestly can’t get enough of your classes. We appreciate the homeschool classes and summer camps so much.
Thanks for all you do!	We love this place and appreciate how well you take care of it, utilize it and all the great programs.
Pop Machine	I have never visited Nahant. I support you because I think that preserving wild areas is vital to the good of our nation and the world. Your online informational emails are enjoyable for me.
Great Place! Thank you.	I appreciate the frequency and quality of the communications. I think it would be neat to have a recommended book-of-the-month. I know there are many staff furthering their education, and there are always good books to read. I'd be curious to know what those are! Thank you all for your hard work. Nahant Marsh is my family's favorite place to be.
More Programs and Animals!	You do a beautiful job
More Land - all property west of Wapello	Thank you for all you do. Such a beautiful peaceful place to go
Hammermill, storage, and drying racks for seeds	I haven't taken advantage of Nahant since the pandemic started, but really appreciate what staff and volunteers have accomplished. I hope to get there again soon.
Establish other relationships to share or	Thank you!

*include header title (e.g. assessment, recommendations, etc)

trade seed	
Bathroom at Front Parking Lot	Wonderful place to have in our area.
Demonstration Rain Gardens	Great place to visit and the time and effort that has been put into the marsh is evident. Thank you!
More Public Outreach on the Marsh's role of flood prevention	I would like to see more variety of colors for your apparel, maybe go for something tie dye, it will stand out to the public more. Sweatshirts, shirts, possibly sweatpants to look into.. Maybe have more selection of bigger sizes like 2x and 3x. A majority of the public is on the bigger side.
More Jewelweed and Black Raspberries	Nahant Marsh is a treasure!
BIG sign outside gates	We do not do the activities because there is always a conflict of time
Bigger signage on Concord and River Drive	I'm so glad you are part of our community
Stay open late one night a week in the summer	Great place to experience nature
More trails	I love visiting Nahant! I'm thankful we have access to such a unique and beautiful preserve.
A clearly marked outdoor bathroom for the public	Let the general public know what you'd appreciate in donations besides tons of money.
Expanded Trail System	The marsh is a beautiful area. I wish it had more hiking trails.
Canoeing or kayaking	I already have a prior commitment the first Friday of every month so I miss most of the breakfast educational programs..would be nice if presented at different times.
More boardwalks to see more of the preserve	I actually live in Northwest Iowa. I have never been to Nahant Marsh. My daughter lives in Eldridge and works at MCC. She sent me the info. about t-shirt to save the Blanding Turtle. Hopefully someday I will get to your preserve and facility!
Restrooms after hours	I feel refreshed after visiting the Marsh.
Common plant and wildlife at Nahant brochures to check out	The only amenities that come to mind are the live animals, maybe I'm missing others

*include header title (e.g. assessment, recommendations, etc)

Nahant Library/Book Club	You all do a great job! Thank you!!!
Big Outdoor Playground	Nice Programs
More accessible trails	Love it here
We love the educational opportunities	
Benches along the trails	
Rental snowshoes, skis, bicycles	
More adult education classes during business hours - gardening with natives, growing a flower cutting garden, bird ID	
Another bird blind	
Toilets	
More trash cans	
Trail Maps/markers	
Increased homeschool activities	
We love what you provide. Thanks. Maybe more homeschooling - once a month is not enough of you!	
Outdoor drinking fountain	
I think there is room for improvement	
More parking	
We love all the education you provide	
Food/Drink	
Snacks	

Appendix B

Organizations served or partnered with from 2018 to 2021.

School Districts

- Davenport Community School District
- Moline School District
- Rock Island School District
- Geneseo Community School District
- Bettendorf Community School District
- Carbon Cliff-Barstow School District 36
- Mercer County Schools
- Prophetstown-Lyndon-Tampico School District
- North Scott School District
- Hampton School District
- Northern Suburban Special Education District
- Annawan Community Unit School District 226
- Riverdale CUSD#100
- Muscatine Community School District

Public Schools

- Adams Elementary Schools
- Alan Shepard Elementary School
- Buchanan Elementary School
- Buffalo Elementary School
- Butterworth Elementary School
- Davenport North High School
- Eagle Ridge School
- Ed White Elementary School
- Eisenhower Elementary School
- Frances Willard Elementary School
- Garfield Elementary School
- Hayes Elementary School
- John Glenn Elementary School
- Logan Elementary School
- Longfellow Elementary School
- McKinley Elementary School
- Mercer County Jr. High
- Millikin Elementary School
- North Shore Academy
- Ridgewood Elementary School
- Riverdale Elementary School
- Rock Island Academy
- Rock Island Center for Math & Science
- Roosevelt Elementary School
- Sherrard Jr. High School
- Southwest Elementary School
- Thomas Jefferson Elementary School
- Truman Elementary School
- Walcott Elementary School
- Washington Elementary School
- Willard Elementary Schools
- Wilson Elementary School

Private Schools

- St. Paul of the Apostle
- Jordan Catholic
- Seton Catholic School
- Villa Montessori School

*include header title (e.g. assessment, recommendations, etc)

Homeschool Groups

- Our Ladies of Joy Co-op
- Classical Conversations
- Chaulk Teen Group
- Davenport Home Schooling Assistance Program
- Rivers Edge Homeschool Friends

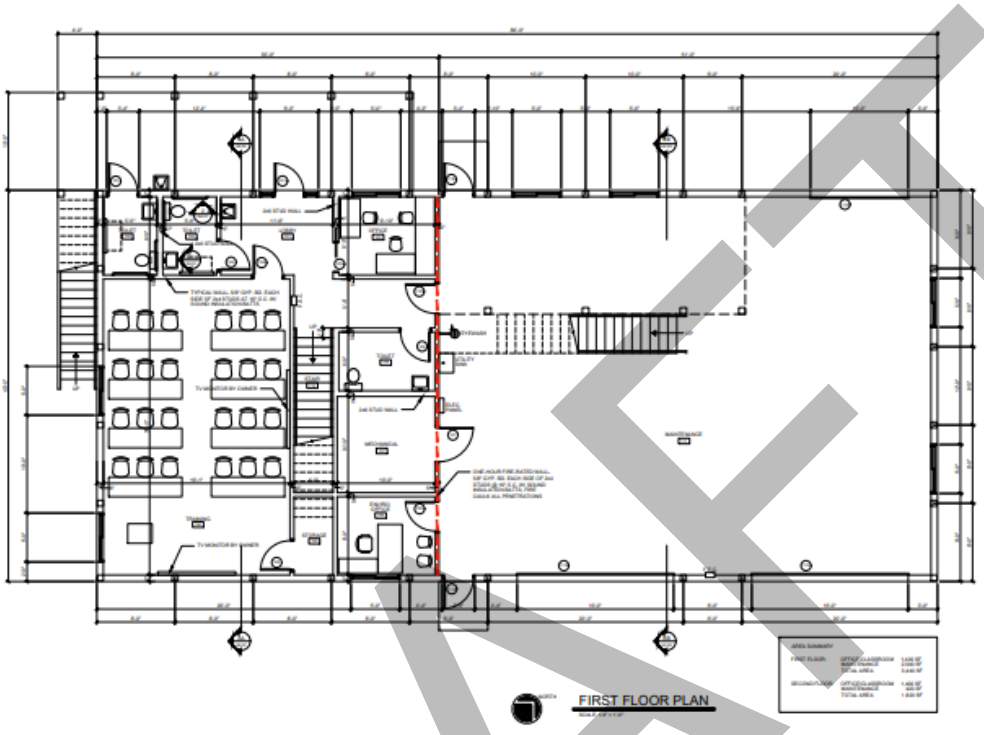
Youth Serving Agencies

- Scott County Family Y
- Two River YMCA
- Rock Island YMCA
- KinderCare – IA and IL
- Fairmount Pines
- Open Sesame Childcare Center
- Red Apple
- Hand in Hand
- Hope at the Brick House
-
- Spring Forward – 3 schools
- Stepping Stones
- Project Renewal
- Noah's Ark Preschool
- In a Kid's World
- Red Rover Preschool
- Skip-a-Long Preschool
- Stepping Stones – 2 school

Community and Regional Partnerships

- Eastern Iowa Community Colleges
- City of Davenport
- AmeriCorps
- Bi-CAN
- Delta Waterfowl
- Augustana College
- Western Illinois University
- St. Ambrose University
- Iowa Association of Naturalists
- Quad City Earth Coalition
- Fairmount Cemetery
- Native American Coalition
- Scott County Master Gardeners
- Partners of Scott County Watersheds
- XStream Cleanup
- Living Lands and Waters
- Wapsi River EE Center – Scott County Conservation
- Waste Commission of Scott County
- Eagle View Sierra Club
- WVIK
- Muscatine County Conservation
- Clinton County Conservation
- Girl Scouts
- Boy Scouts
- Our Lady of the Prairie Retreat
- Iowa DNR
- Iowa State University Extension
- University of Illinois Extension
- AEA 9
- RIROE
- Niabi Zoo
- Rock Island Soil and Water Conservation District
- Guardians of the Prairie and Forest
- U.S. Fish and Wildlife
- U.S Army Corps of Engineers
- Scott County IRVM
- Wild Ones
- Pheasants Forever

Appendix D



STUDIO 483 ARCHITECTS

NAHANT MARSH OPERATIONS BUILDING

4220 WAPELLO AVENUE
DAVENPORT, IOWA

FIRST FLOOR PLAN

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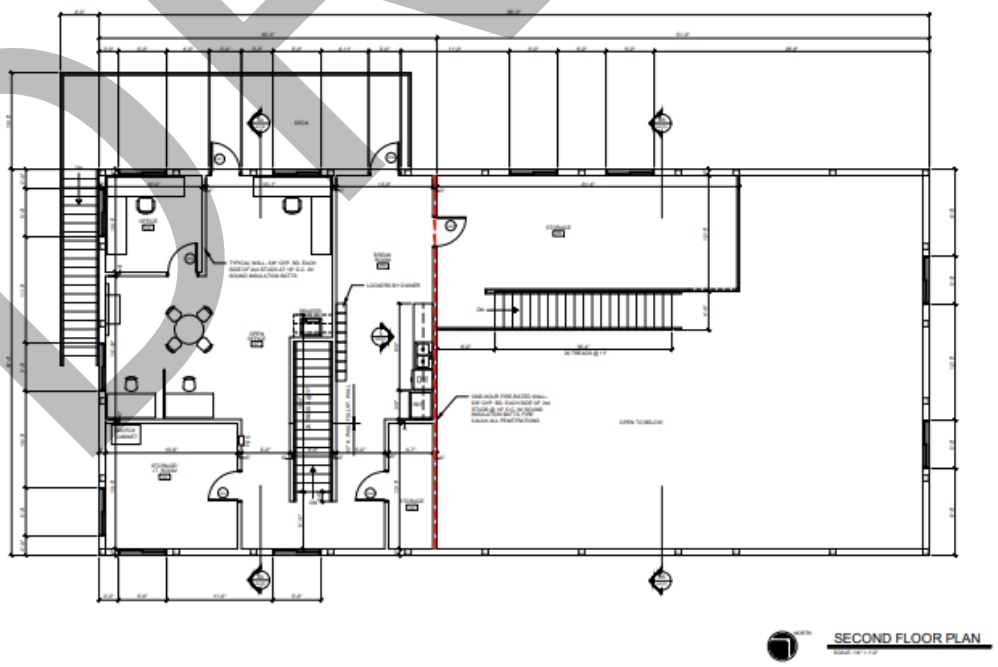

STUDIO 483 ARCHITECTS

NAHANT MARSH OPERATIONS BUILDING

4220 WAPELLO AVENUE
DAVENPORT, IOWA

SECOND FLOOR PLAN

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Appendix F

Table F-1. Endangered, Threatened, and Special Concern Species Documented

Species Name	Status	Year(s) Documented	Location
Mammals			
Indiana Bat *Myotis sodalist*	Federally Endangered	2017, 2019, 2021 (Probable bat analog recording- USFWS)	2017, 2021 Carp Lake 2019 Ruhl
Northern long-eared bat *Myotis sepentrionalis*	Federally Threatened	2017, 2019 (Probable bat analog recording- USFWS)	2017 Carp Lake 2019 Ruhl
Birds			
Red-shouldered Hawk *Buteo lineatus*	State Endangered	Year-round resident. Nesting reported in Carp Lake and north part of marsh	Carp Lake/ South Concord St./ North part of Nahant Marsh
Northern Harrier *Circus cyaneus*	State Endangered	Annual sightings- frequent winter visitor	Various- main marsh
King Rail *Rallus elegans*	State Endangered	Hodges, 1946	Record states Nahant Marsh/Nobis Slough
Forster's Tern *Sterna forsteri*	State Special Concern	2012,2015,2016- Ritter, Malake	Main Marsh
Black Tern *Chlidonias niger*	State Special Concern	2000, 2016, July 2020- Sowl, Ritter, Malake, Wiebler	Main Marsh
Peregrine Falcon *Falco peregrinus*	State Special Concern	Annual sightings, nests reported on I-280 bridge	Main Marsh/S. Concord St.
Bald Eagle *Haliaeetus leucocephalus*	State Special Concern	Frequent visitor, nests at Nahant	Nest in North Part of Marsh- used 2018-2020
Reptiles			
Copperbelly Water Snake *Nerodia erythrogaster (*either subspecies *neglecta* or *flavigaster*)	State Endangered (Possibly federally endangered if *neglecta*)	2002, 2015 Probable	Observed by naturalist in main marsh. One apparently caught in 2015 in Blackhawk Creek
Blanding's Turtle *Emydoidea blandingii*	State Threatened	2000-2017, 22 adult Individuals confirmed, 1 hatchling (2013)	Primarily in smaller ponds on north side of the marsh. Hatchling was observed along the north edge of property.
Diamondback Water Snake *Nerodia rhombifera*	State Threatened	2006- Bryant probable sighting	Main marsh at Wapello Ave.
Mussels			

Yellow Sandshell *Lampsilis teres anodontoides*	State Endangered	2017- Ritter, Nielsen	Found in Carp Lake
Fish			
Grass Pickeral *Esox americanus*	State Threatened	2011-2017, 2018, 2019 Ritter, IA DNR	Found multiple times in the main marsh
Plants			
Large-bracted corydalis *Corydalis curvisiliqua*	State Endangered	2008 Bryant	Unknown
Waxy meadowrue *Thalictrum revolutum*	State Endangered	2009, 2015 Bryant, Ritter	Railroad berm next sand prairie to the NE of the building
Winged monkey flower *Mimulus alatus*	State Threatened	1998, 2001, 2009 USFWS, Anderson, Bryant	North side
Clustered sedge *Carex aggregate*	State Special Concern	2009, Bryant	Carp Lake
Hoplike sedge *Carex lupuliformis*	State Special Concern	2009, Bryant	Carp Lake, wet woods NE of building (Ruhl property)
Pink turtlehead *Chelone obliqua*	State Special Concern	1998, 2002 Bryant, Sowl	Edge of wet woods near NE gate.
Upland boneset *Eupatorium sessilifolium*	State Special Concern	1998, 2010 USFWS, Bryant	North side of Nahant
Northern cranesbill *Geranium bicknellii*	State Special Concern	2008, 2017- Bryant, Ritter	Carp Lake and sand prairie NE of the building
Spring avens *Geum vernum*	State Special Concern	2000	Unknown
False loosestrife *Ludwigia peploides*	State Special Concern	2000, 2009 Bryant	Carp Lake area and in sedge meadow in front of the education center
Swamp rose *Rosa palustris*	State Special Concern	2017	North side, south of the gate.
Eared false foxglove *Tomanthera auriculata*	State Special Concern	2008, 2009, 2016 Bryant, Ritter	Found after disturbances on north side and near the dock in front of the building.
Spiderwort *Tradescantia virginiana*	State Special Concern	Abundant	Likely planted in several prairies at Nahant
Summer grape *Vitis aestivalis*	State Special Concern	2008, Dr. Mohlenbrock	Edge of woods near main driveway entrance
Frost grape *Vitis vulpina*	State Special Concern	2017 Bryant, Ritter	North side of marsh
Insects			
Rusty Patched Bumblebee *Bombus affinis*	Federally Endangered	July 6, 2020 and 2021	2020 Amy Loving got a photograph of one in front of the ed center. Confirmed by USFWS.

			2021 in prairie in front of the education center. Confirmed by USFWS.

Table F-2. Bird Species Found at NMEC

Scientific Name	**Common Name**
Empidonax alnorum	Alder Flycatcher
Recurvirostra americana	American Avocet
Botaurus lentiginosus	American Bittern
Anas rubripes	American Black Duck
Fulica americana	American Coot
Corvus caurinus	American Crow
Carduelis tristis	American Goldfinch
Falco sparverius	American Kestrel
Anthus rubescens	American Pipit
Setophaga ruticilla	American Redstart
Turdus pilaris	American Robin
Spizella arborea	American Tree sparrow
Pelecanus erythrorhynchos	American White Pelican
Mareca americana	American Wigeon
Scolopax minor	American Woodcock
Haliaeetus leucocephalus	Bald Eagle
Icterus galbula	Baltimore Oriole
Riparia riparia	Bank Swallow
Hirundo rustica	Barn Swallow
Strix varia	Barred Owl
Setophaga castanea	Bay-breasted Warbler

Vireo bellii	Bell's Vireo
Megaceryl alcyon	Belted Kingfisher
Chlidonias niger	Black tern
Mniotilta varia	Black-and-white Warbler
Parus atricapillus	Black-capped Chickadee
Nycticorax nycticorax	Black-crowned Night-Heron
Setophaga virens	Black-throated Green Warbler
Setophaga fusca	Blackburnian Warbler
Setophaga striata	Blackpoll Warbler
Anser caerulescens	Blue goose (i.e., Snow Goose)
Cyanocitta cristata	Blue Jay
Polioptila caerulea	Blue-gray gnatcatcher
Anas discors	Blue-winged Teal
Vermivora cyanoptera	Blue-winged Warbler
Dolichonyx oryzivorus	Bobolink
Euphagus cyanocephalus	Brewer's blackbird
Buteo platypterus	Broad-winged Hawk
Certhia americana	Brown Creeper
Toxostoma rufum	Brown Thrasher
Molothrus ater	Brown-headed Cowbird
Bucephala albeola	Bufflehead
Branta hutchinsii	Cackling Goose
Branta canadensis	Canada Goose
Aythya valisineria	Canvasback
Thryothorus ludovicianus	Carolina Wren
Hydroprogne caspia	Caspian Tern

Bubulcus ibis	Cattle Egret
Bombycilla cedrorum	Cedar Waxwing
Setophaga pensylvanica	Chestnut-sided Warbler
Chaetura pelagica	Chimney swift
Spizella passerina	Chipping sparrow
Spizella pallida	Clay-colored Sparrow
Petrochelidon pyrrhonota	Cliff Swallow
Bucephala clangula	Common Goldeneye
Quiscalus quiscula	Common Grackle
Gavia immer	Common Loon
Mergus merganser	Common Merganser
Chordeiles minor	Common Nighthawk
Sterna hirundo	Common Tern
Geothlypis trichas	Common Yellowthroat
Accipiter cooperii	Cooper's Hawk
Junco hyemalis	Dark-eyed Junco
Spiza americana	Dickcissel
Phalacrocorax auritus	Double-crested Cormorant
Picoides pubescens	Downy Woodpecker
Podiceps nigricollis	Eared Grebe
Sialia sialis	Eastern Bluebird
Tyrannus tyrannus	Eastern Kingbird
Sturnella magna	Eastern Meadowlark
Sayornis phoebe	Eastern Phoebe
Pipilo erythrophthalmus	Eastern Towhee
Contopus virens	Eastern Wood-Pewee

Streptopelia decaocto	Eurasian Collared-Dove
Passer montanus	Eurasian Tree Sparrow
Sturnus vulgaris	European Starling
Spizella pusilla	Field Sparrow
Sterna forsteri	Forster's Tern
Passerella iliaca	Fox Sparrow
Leucophaeus pipixcan	Franklin's Gull
Anas strepera	Gadwall
Larus hyperboreus	Glaucous Gull
Regulus satrapa	Golden-crowned Kinglet
Dumetella carolinensis	Gray Catbird
Catharus minimus	Gray-cheeked Thrush
Ardea herodias	Great Blue Heron
Myiarchus crinitus	Great Crested Flycatcher
Casmerodius albus	Great Egret
Bubo virginianus	Great Horned Owl
Aythya marila	Greater Scaup
Anser albifrons	Greater White-fronted Goose
Tringa melanoleuca	Greater Yellowlegs
Butorides virescens	Green Heron
Anas crecca	Green-winged teal
Leuconotopicus villosus	Hairy Woodpecker
Zonotrichia querula	Harris Sparrow
Catharus guttatus	Hermit Thrush
Larus argentatus	Herring gull
Lophodytes cucullatus	Hooded Merganser

Podiceps auritus	Horned Grebe
Eremophila alpestris	Horned Lark
Haemorhous mexicanus	House Finch
Passer domesticus	House Sparrow
Troglodytes aedon	House Wren
Passerina cyanea	Indigo Bunting
Charadrius wilsonia	Killdeer
Rallus elegans	King Rail
Calcarius lapponicus	Lapland Longspur
Ammodramus leconteii	Le Conte's Sparrow
Ixobrychus exilis	Least Bittern
Empidonax minimus	Least Flycatcher
Calidris minutilla	Least Sandpiper
Larus fuscus	Lesser Black-backed gull
Aythya affinis	Lesser Scaup
Tringa flavipes	Lesser Yellowlegs
Melospiza lincolnii	Lincoln's Sparrow
Egretta caerulea	Little Blue Heron
Parkesia motacilla	Louisiana Waterthrush
Setophaga magnolia	Magnolia Warbler
Anas platyrhynchos	Mallard
Limosa fedoa	Marbled Godwit (Hodges, 1946)
Cistothorus palustris	Marsh Wren
Zenaida macroura	Mourning Dove
Geothlypis philadelphia	Mourning Warbler
Cygnus olor	Mute Swan

Leiothlypis ruficapilla	Nashville Warbler
Colinus virginianus	Northern Bobwhite
Cardinalis cardinalis	Northern Cardinal
Colaptes auratus	Northern Flicker
Mimus polyglottos	Northern Mockingbird
Setophaga americana	Northern Parula
Anas acuta	Northern Pintail
Stelgidopteryx serripennis	Northern Rough-winged Swallow
Anas clypeata	Northern Shoveler
Lanius borealis	Northern shrike
Parkesia noveboracensis	Northern Waterthrush
Circus cyaneus	Nothern Harrier
Vermivora celata	Orange-crowned Warbler
Icterus spurius	Orchard Oriole
Pandion halieatus	Osprey
Setophaga palmarum	Palm Warbler
Calidris melanotos	Pectoral Sandpiper
Falco peregrinus	Peregrine Falcon
Vireo philadelphicus	Philadelphia Vireo
Podilymbus podiceps	Pied-billed Grebe
Hylatomus pileatus	Pileated Woodpecker
Spinus pinus	Pine Siskin
Protonotaria citrea	Prothonotary Warbler
Haemorhous purpureus	Purple Finch
Progne subis	Purple Martin
Melanerpes carolinus	Red-bellied Woodpecker

Vireo olivaceus	Red-eyed Vireo
Melanerpes erythrocephalus	Red-headed Woodpecker
Podiceps grisegena	Red-necked Grebe (Hodges, 1948)
Buteo lineatus	Red-shouldered Hawk
Buteo jamaicensis	Red-tailed Hawk
Agelaius phoeniceus	Red-winged Blackbird
Aytha americana	Redhead
Laridae spp.	Ring-billed Gull
Aythya collaris	Ring-necked Duck
Phasianus colchicus	Ring-necked Pheasant
Columba livia	Rock Pigeon
Pheucticus ludovicianus	Rose-breasted Grosbeak
Anser rossii	Ross's Goose
Buteo lagopus	Rough-legged Hawk
Regulus calendula	Ruby-crowned Kinglet
Archilochus colubris	Ruby-throated Hummingbird
Oxyura jamaicensis	Ruddy Duck
Euphagus carolinus	Rusty Blackbird
Grus canadensis	Sandhill Crane
Passerculus sandwichensis	Savannah Sparrow
Piranga olivacea	Scarlet Tanager
Cistothorus stellaris	Sedge Wren
Charadrius semipalmatus	Semipalmated Plover
Calidris pusilla	Semipalmated Sandpiper
Accipiter striatus	Sharp-shinned hawk
Ammospiza nelsoni	Sharp-tailed sparrow

Chen caerulescens	Snow Goose
Tringa solitaria	Solitary Sandpiper
Melospiza georgiana	Song Sparrow
Porzana carolina	Sora
Actitis macularia	Spotted Sandpiper
Catharus ustulatus	Swainson's Thrush
Melospiza georgiana	Swamp Sparrow
Leiothlypis peregrina	Tennessee Warbler
Tachycineta bicolor	Tree Swallow
Cygnus buccinator	Trumpeter Swan
Baeolophus bicolor	Tufted Titmouse
Cygnus columbianus	Tundra Swan
Cathartes aura	Turkey Vulture
Catharus fuscescens	Veery
Rallus limicola	Virginia Rail
Vireo gilvus	Warbling Vireo
Sturnella neglecta	Western Meadowlark
Numenius phaeopus	Whimbrel
Sitta carolinensis	White-breasted Nuthatch
Zonotrichia leucophrys	White-crowned Sparrow
Plegadis chihi	White-Faced Ibis
Zonotrichia albicollis	White-throated Sparrow
Meleagris gallopavo	Wild Turkey
Tringa semipalmata	Willet
Empidonax traillii	Willow Flycatcher
Gallinago delicata	Wilson's Snipe

Cardellina pusilla	Wilson's Warbler
Troglodytes hiemalis	Winter Wren
Aix sponsa	Wood Duck
Hylocichla mustelina	Wood Thrush
Dendroica petechia	Yellow Warbler
Empidonax virescens	Yellow-bellied Flycatcher
Sphyrapicus varius	Yellow-bellied Sapsucker
Coccyzus americanus	Yellow-billed Cuckoo
Xanthocephalus xanthocephalus	Yellow-headed Blackbird
Dendroica coronata	Yellow-rumped Warbler
Vireo flavifrons	Yellow-throated Vireo

Table F-3. Fish Species Found At NMEC

Scientific Name	**Common Name**
Ictiobus cyprinellus	Bigmouth Buffalo
Pomoxis nigromaculatus	Black Crappie
Lepomis macrochirus	Bluegill
Amia calva	Bowfin
Lepomis cyanellus	Green Sunfish
Notemigonus crysoleucas	Golden Shiner
Esox americanus vermiculatus	Grass Pickerel
Micropterus salmoides	Largemouth Bass
Gambusia affinis	Mosquito Fish
Etheostoma asprigine	Mud Darter
Esox lucius	Northern Pike
Lepomis gibbosus	Pumpkinseed
Lepomis gulosus	Warmouth Sunfish
Ameiurus natalis	Yellow Bullhead
Perca flavescens	Yellow Perch

Ameiurus melas	Black Bullhead
Ictalurus punctatus	Channel Catfish
Pylodictis olivaris	Flathead Catfish
Pomoxis annularis	White Crappie
Ictiobus bubalus	Smallmouth Buffalo
Hypophthalmichthys nobilis	Bighead Carp
Lepisosteus osseus	Longnose gar
Lepisosteus platostomus	Shortnose gar
Scaphirhynchus platorynchus	Shovelnose sturgeon
Dorosoma cepedianum	Gizzard shad
Hiodon alosoides	Goldeye
Aplodinotus grunniens	Freshwater Drum

Table F-4. Fungi and Slime Mold Species Found at NMEC

Scientific Name	**Common Name**
Amanita vaginata	
Auricularia auricula	
Ceratiomyxa fruticulosa var. flexuosa	
Ceratiomyxa fruticulosa var. poroides	
Clavicorona pyxidata	
Crepidotus applanatus	
Daldina concentrica	
Ganoderma applanatum	
Lentinus tigrinus	
Lycogala epidendrum	
Marasmius rotula	
Nidulariaceae	Bird's Nest Fungi
Palegia radiata	
Pleurotus ostreatus	
Pluteus cervinus	
Pluteus longistratus	
Polyporus arcularis	

Polyporus mori	
Schizophyllum commune	
Stemonitis axifera	
Stereum complicatum	
Trametes versicolor	
Xerula radicata	

Table F-5. Reptiles and Amphibian Species Found at NMEC

Scientific Name	**Common Name**	
Lithobates catesbeianus	American Bullfrog	
Anaxyrus americanus	American Toad	
Emydoidea blandingii	Blanding's Turtle	
Thamnophis sirtalis	Common Garter Snake	
Chelydra serpentina	Common Snapping Turtle	
Hyla chrysoscelis	Cope's Gray Tree Frog	
Nerodia erythrogaster neglecta	Copperbelly water snake	
Storeria dekayi	Dekay's Brown Snake	
Nerodia rhombifer	Diamondback Watersnake	
Hyla versicolor	Eastern Gray Tree Frog	
Pantherophis vulpinus	Fox Snake	
Lithobates clamitans	Green Frog	
Acris crepitans	Northern Cricket Frog	
Lithobates pipiens	Northern Leopard Frog	
Nerodia sipedon	Northern Watersnake	
Graptemys ouachitensis	Ouachita Map Turtle	
Thamnophis radix	Plains Garter Snake	
Trachemys scripta	Red-eared Slider	
Apalone spinifera	Spiny Softshell	
Pseudacris triseriata	Western Chorus Frog	
Chrysemys picta	Western Painted Turtle	
Trachemys scripta scripta	Yellow-bellied Slider*	*Non-native

Figure F-6. Invertebrate Species Found at NMEC

Scientific Name	**Common Name**
Acmaeodera pulchella	Flat Headed Bald Cypress Sapwood Borer
Acrolophus arcanella	Grass Tubeworm Moth
Acrolophus popeanella	Clemen's Grass-tubeworm Moth
Acutalis tartarea	Black and Green Treehopper
Acutalis tartarea	
Adaina ambrosiae	Ambrosia Plume Moth
Adelphocoris lineolatus	Alfalfa Plant Bug
Aethes spartinana	
Agapostemon virescens	Green Sweat Bee
Agrilus ruficollis	
Agrotis ipsilon	Ipsilion Dart
Allograpta obliqua	
Allonemobius sp.	
Alobates pensylvanica	False Mealworm Beetle
Alydus eurinus	Broad-headed Bug
Amblema plicata	Three Ridge
Ammophila nigricans	
Anagrapha falcifera	Celery Looper Moth
Anania tertialis	Crowned Phlyctaenia Moth
Anasa tristis	Squash Bug
Anavitrinella pampinaria	Common Gray
Anax junius	Common Green Darner
Andrena rudbeckiae	Mining Bee
Andrena wilkella	

Anodonta suborbiculata	Flat Floater
Anopheles sp.	Mosquito
Anoplius sp.	
Apantesis nais	Nais Tiger Moth
Aphaenogaster sp.	Myrmicine Ant
Apis mellifera	Honeybee
Araneus marmoreus	Marbled Orb Weaver
Argyrotaenia velutinana	Red Banded Leafroller Moth
Armadillium vulgare	
Atteva aurea	Ailanthus Webworm Moth
Atteva punctella	
Augochlora pura	Green Sweat Bee
Augochlorella sp.	
Autographa precationis	The Common Looper Moth
Axarus festivus	Midge
Azenia obtusa	Obtuse Yellow
Battaristis concinnusella	
Bombus affinis	Rusty-patched Bumblebee
Bombus auricomus	Black and Gold Bumblebee
Bombus bimaculatus	Two-spotted Bumblebee
Bombus griseocolis	Brown-belted Bumblebee
Bombus pensylvanicus	American Bumblebee
Bombus vagans	Half-black Bumblebee
Bracon sp.	Wasp
Caenurgina erechtea	Forage Looper Moth
Calliopsis sp.	Mining Bee

Calliphora vicina	
Camponotus chromaiodes	Red Carpenter Ant
Camponotus pennsylvanicus	Black Carpenter Ant
Capsis sp.	
Celastrina neglecta	Summer Azure
Celithemis eponina	Halloween Pennant
Celypha cespitana	Celypha Moth
Ceratomia catalpae	Catalpa Sphinx Moth
Ceratomia undulosa	Waved Sphinx Moth
Cerceris insolita	Weevil Wasp
Cerceris sp.	
Chauliodes rastricornis	Spring Fishfly
Chauliognathus marginatus	Margined Soldier Beetle
Chauliognathus pennsylvanicus	Goldenrod Soldier Beetle
Chionodes pereyra	
Chlaenius tricolor	
Choristoneura rosaceana	Oblique-banded Leafroller Moth
Chrysis sp.	
Chrysochus auratus	Dogbane Beetle
Chrysomelidae	Leaf Beetle
Chrysopa oculata	Golden-eyed Lacewing
Chrysopa sp.	Green Lacewing
Chrysopilus sp.	Snipe Fly
Chrysoteuchia topiarius	Topiary Grass-veneer
Cisseps fulvicollis	Yellow-Collared Scape Moth
Clastoptera sp.	

Clepsis peritana	Garden Tortricid
Clepsis peritana	Garden Tortrix
Coccinella septempunctata	
Cochylis aurorana	
Coeloxys sp.	
Coleomegilla maculata	Spotted Lady Beetle
Coleotechnites sp.	Spotted White Tortricid
Colias eurytheme	Orange Sulfur
Colias philodice	Clouded Sulphur
Collops quadrimaculatus	Soft-winged Flower Beetle
Colopha ulmicola	Elm Cockscomb Gall Aphid
Condylostylus sipho	Long-legged Fly
Conocephalus brevipennis	Short-winged Meadow Katydid
Conocephalus fasciatus	Slender Meadow Katydid
Conocephalus strictus	Straight-lanced Meadow Katydid
Corbicula fluminea	Asiatic Clam
Cosmopepla lintneriana	Twice-stabbing Sting Bug
Costaconvexa centrostrigaria	The Bent-line Carpet
Crambus agitatellus	Double-banded Grass-veneer Moth
Cryptocephalus sp.	
Culex pipiens	Mosquito
Cupido comyntas	Eastern Tailed-blue
Curculionidae	
Cycloneda munda	Polished Lady Beetle
Danaus plexippus	Monarch
Darapsa myron	Virginia Creeper Sphinx Moth

Dargida rubripennis	The Pink-streak
Delphinia picta	Picturepwinged Fly
Deltocephalus flavocostatus	
Depressaria radiella	Parsnip Webworm Moth
Deraeocoris histrio	
Dermacentor variabilis	Dog Tick
Desmia funeralis-maculalis	
Diabrotica barberi	Northern Corn Rootworm
Diabrotica cristata	Leaf Beetle
Diabrotica undecimpunctata	Spotted Cucumber Beetle
Diacme adipaloides	Darker Diacme Moth
Diapheromera undetermined	
Dichomeris aleatrix	Buffy Dichomeris Moth
Dichomeris ligulella	Palmerworm Moth
Digrammia gnophosaria	Hollow-spotted Angle
Digrammia ocellinata	Faint-spotted Angle
Diploschizia impigritella	Yellow Nutsedge Moth
Dolichovespula maculata	Baldfaced Hornet
Dolomedes sp.	
Draeculacephala mollipes	
Draeculacephala robinsoni	
Draeculacephala sp.	
Dytiscidae	
Elateridae	
Elophila obliteralis	Waterlily Leafcutter Moth
Elophila tinealis	Black Duckweed Moth

Empis sp.	
Empoasca fabae	Potato Leafhopper
Enallagma civile	
Enallagma signatum	Orange Bluet
Endothenia hebesana	Verbena Bud Moth
Entypus fulvicornis	Spider Wasp
Epargyreus clarus	Silver-spotted Skipper
Epargyreus clarus	
Epiblema otiosana	Bidens Borer Moth
Epiblema strenuana	Ragweed Borer Moth
Epicauta vittata	Striped Blister Beetle
Episimus argutana	Sumac Leaftier Moth
Eremnophila aureonotata	Thread-waisted Wasp
Erynnis horatius	
Erythemis simplicicollis	Eastern Pondhawk
Eucera hamata	Longhorn Bee
Euchaetes egle	Milkweed Tussock Moth
Eulogia ochrifrontella	Broad-banded Eulogia Moth
Eumenes fraternus	Potter Wasp
Eunemobius carolinus	
Euodynerus sp.	Small Potter Wasp
Eupithecia miserulata	Common Eupithecia
Eurosta solidaginis	Goldenrod Gall Fly
Eusattus sp.	
Euschistus servus	Brown Stink Bug
Euschistus sp.	Stink Bug

Euthochtha galeator	Helmeted Squash Bug
Euthycera sp.	Marsh Fly
Euxesta notata	
Exema sp.	
Fissicrambus mutabilis	Changeable Grass Veneer Moth
Galgula partita	The Wedgling
Gammaridae	Scud
Garella nilotica	Black-olive Caterpillar Moth
Geometridae	Brown Banded Moth
Geron sp.	
Glaphyria sesquistrialis	White-roped Glaphyria Moth
Gluphisia septentrionis	Common Gluphisia Moth
Gomphurus vastus	Cobra Clubtail
Graminella nigrifrons	Black-faced Leafhopper
Haematopis grataria	Chickweed Geometer
Halictus confusus	Southern Bronze Furrow Bee
Halictus ligatus	Ligated Furrow Bee
Halictus parallelus	Parallel Furrow Bee
Haliplus sp.	
Halyomorpha halys	Brown Marmorated Stink Bug
Harmonia axyridis	Multicolored Asian Lady Beetle
Harmonia axyridis	
Harpalus pensylvanicus	
Hedychrum sp.	
Helophilus fasciatus	
Hemerobius sp.	

Herminiidae	Litter Moth
Herpetogramma thestealis	Zigzag Herpetogramma Moth
Heteromurus nitidus	Slender Springtail
Hexatoma sp.	
Holcopasites calliopsidis	Cuckoo Bee
Homaeotarsus cinctus	
Hydropsyche sp.	
Hylaens modesta	Hylaeus Bee
Hypagyrtis unipunctata	One-Spotted Variant
Hypena scabra	Green Cloverworm Moth
Hypsopygia costalis	Clover Hayworm Moth
Ichneumonidae sp. 1	
Ichneumonidae sp. 2	
Ichneumonidae sp. 3	
Idiocerus sp.	
Ischnura posita	Fragile Forktail
Ischnura verticalis	Eastern Forktail
Junonia coenia	Common Buckeye
Labidomera clivicollis	Swamp Milkweed Leaf Beetle
Lacinipolia renigera	Bristly Cutworm Moth
Lampsilis teres	Yellow Sandshell
Laphria sp.	
Larinioides cornutus	Furrow Orbweaver
Larinioides patagiatus	
Larinus planus	
Lascoria ambigualis	Ambiguous Moth

Lasioglossum spp.	Sweat Bee
Leiobunum aldrichi	Harvestman
Leiobunum sp. 2	Red harvestman
Lema sp.	
Leptodea fragilis	Fragile Papershell
Leptophlebia sp.	Mayfly
Leschenaultia sp.	
Lestes rectangularis	Slender Spreadwing
Lestica sp.	Bee
Lethocerus americanus	Giant Water Bug
Leucania inermis	Unarmed Wainscot Moth
Leuconycta diphteroides	Green Leuconycta
Libellula luctuosa	Widow Skimmer
Libellula pulchella	
Libellula pulchelle	Twelve-spotted Skimmer
Limenitis archippus	Viceroy
Limenitis archippus	
Limnaecia phragmitella	Moth
Limnia sp.	
Limonia sp.	Crane Fly
Limotettix anthracinus	Leafhopper
Listronotus oregonensis	Carrot Weevil
Lithobates pipiens	Northern Leopard Frog
Lixus macer	
Lopidea sp.	Plant Bug
Lucilia sericata	Common Green Bottle Fly

Lycaena hyllus	Bronze Copper
Lygaeus turcicus	Milkweed Bug
Lygus lineolaris	Tarnished Plant Bug
Lygus lineolaris	
Lygus sp.	
Macrosiagon limbata	Wedge-shaped Beetle
Marpissa formosa	
Mecaphesa sp.	
Megachile brevis	Megachilid bee
Megachile sp. 2	
Megachile sp. 3	
Melanoplinae	
Melanoplus bivattatus	
Melanoplus bivittatus	Two-Striped Grasshopper
Melanoplus differentialis	
Melanoplus femurrubrum	Red-legged Grasshopper
Melanoplus undetermined	
Melissodes bimaculata	
Microrhopala vittata	Goldenrod Leaf Miner
Micrutalis calva	
Misumena sp.	Crab Spider
Misumena vatia	Goldenrod Crab Spider
Misumenoides spp.	Crab Spider
Mompha eloisella	Red-streaked Mompha
Monobia quadridens	
Mordella marginata	Flower Beetle

Mordellistena cervicalis	
Moromorpha tetra	
Musca domestica	House Fly
Muscidae	
Mythimna unipuncta	Armyworm Moth
Nectopsyche sp.	White Miller
Nemotelus kansensis	Soldier Fly
Neodactria zeellus	
Neokolla dolobrata	Blue Leafhopper
Neokolla hierophyphica	
Neopamera albocincta	
Neotibicen lyricen	Dark Lyric Cicada
Nephrotoma sp.	Crane Fly
Noctuidae	Twin Spot Owlet
Nomada sp.	Nomad Bee
Nomophila nearctica	Lucerne Moth
Notonectidae	
Nycteola cinereana	
Nymphalis antiopa	Mourning Cloak
Odontocorynus salebrosus	Weevil
Odontomyia sp.	
Odontosciara nigra	
Ogdoconta cinereola	Common Pinkband
Olethreutes valdanum	
Oncopeltus fasciatus	Large Milkweed Bug
Orthonama abstipata	Butterfly Moth

Ossiannilssonola sp.	
Ostrinia nubilalis	European Corn Borer Moth
Ostrinia penitalis	American Lotus Borer Moth
Pachydiplax longipennis	Blue Dasher
Palaemonetes kadiakensis	Ghost Shrimp
Pantala flavescens	Wandering Glider
Pantala hymenaea	Spot-winged Glider
Papilio glaucus	Eastern Tiger Swallowtail
Papilio polyxenes	Black Swallowtail
Papilio polyxenes	Eastern Black Swallowtail
Parancistrocerus sp.	
Parapediasia teterrellus	Bluegrass Webworm
Parapediasia teterrellus	Bluegrass Webworm Moth
Paraphlepsius collitus	
Paraphlepsius irroratus	Brown Mottled Leafhopper
Parapoynx badiusalis	Chestnut-marked Pondweed Moth
Paria spp.	Leaf Beetle
Pediasia trisecta	Sod Webworm Moth
Pelochrista vagana	
Perithemis tenera	Eastern Amberwing
Pero ancetaria	Hubner's Pero
Petrophila fulicalis	
Phalaenostola larentioides	Black-banded Owlet Moth
Phalaenostola metonalis	Pale Phalaenostola Moth
Phidippus audax	
Philanthus sp.	

Philodromus spp.	Philodromid Crab Spider
Photinus pyralis	Eastern Firefly
Photuris sp.	Firefly
Phyciodes tharos	Pearl Crescent
Phycoides tharos	
Phyllophaga congrua	
Phyllophaga sp. 2	
Phymata americana	Ambush Bug
Physidae	Pouch Snail
Physocephala sp.	
Pieris rapae	Cabbage White
Pintalia vibex	Planthopper
Planorbidae	Orb Snail
Plathemis lydia	Common Whitetail
Platynota flavedana	Black Shaded Platynota Moth
Platynota idaeusalis	Tufted Apple Bud Moth
Platynus decentis	
Pleuroprucha insulsaria	Common Tan Wave
Plusiodonta compressipalpis	Moonseed Moth
Podabrus tomentosus	Soldier Beetle
Podisus maculiventris	Spined Soldier Bug
Polistes dominula	European Paper Wasp
Polistes fuscatus	
Polistes metricus	
Polites peckius	Peck's Skipper
Pollenia rudis	Common Cluster Fly

Polygonia comma	Eastern Comma
Polygonia interrogationis	Question Mark
Ponometia candefacta	Olive-shaded Bird-dropping Moth
Ponometia erastrioides	Small Bird-dropping Moth
Popillia japonica	Japanese Beetle
Potamyia flava	Netspinning Caddisfly
Prenolepis imparis	Winter Ant
Proxenus miranda	Miranda Moth
Pseudeustrotia carneola	Pink-barred Pseudeustrotia
Pterophorini	White Plume Moth
Pyganodon grandis	Giant Floater
Pyractomena angulata	Firefly
Pyrausta signatalis	Raspberry Pyrausta Moth
Pyropyga sp.	
Pyrrharctia isabella	Isabella Tiger Moth
Pyrrhia cilisca	Bordered Sallow
Rabidosa rabida	Rabid Wolf Spider
Rachiplusia ou	Gray Looper Moth
Ranatra fasca	Brown Water Scorpion
Rhyssomatus lineaticollis	
Rivellia sp.	Signal Fly
Rivellia sp. 2	
Rivula propinqualis	Spotted Grass Moth
Sassacus sp.	
Sceliphron caementarium	
Schinia gaurae	Clouded Crimson Moth

Sciota basilaris	
Scolops sulcipes	Partridge Bug
Scoparia basalis	Many-spotted Scoparia Moth
Scudderia furcata	Fork-tailed Bush Katydid
Scudderia sp.	
Scutigra coleoptrata	House Centipede
Sehirus cinctus	Burrowing Bug
Sepsis sp.	
Sinea sp.	
Sitona hispidulus	Clover Weevil
Spargaloma sexpunctata	Six-spotted Gray Moth
Speyeria cybele	Great Spangled Fritillary
Sphaerophoria spp.	Hoverfly
Spilosoma virginica	Virginian Tiger Moth
Spodoptera frugiperda	Fall Armyworm Moth
Spodoptera ornithogalli	Yellow-striped Armyworm Moth
Spodoptera sp.	
Spragueia leo	Common Spragueia
Staphylinidae	
Stenolophus lecontei	
Stenolophus lineola	
Stratiomyidae	
Stylurus plagiatus	Russet-tipped Clubtail
Svastra obliqua	
Sympetrum sp.	
Synchlora aerata	Wavy-Lined Emerald

Syrphus sp.	
Tachinidae spp. 1	
Tachinidae spp. 2	
Tanytarsus sp.	
Tetraopes tetrophthalmus	Red milkweed beetle
Thyanta sp.	Sting Bug
Thymelicus lineola	European Skipper
Thysanoptera	Reddish Thrip
Timandra amaturaria	Cross-lined Waved
Tinea apicimaculella	
Tiphiidae	Solitary Wasp
Tipula platytipula	Crane Fly
Tipula sp.	
Tortricidae sp. 2	White Banded Tortricid
Tortrididae sp. 1	Brown Mottled Tortricid
Tosale oviplagalis	Dimorphic Tosale Moth
Toxolasma parvum	Lilliput
Toxomerus geminatus	Syrphid Fly
Toxomerus marginatus	
Trachea delicata	
Tramea lacerata	Black Saddlebags
Tramea onusta	Red Saddlebags
Trapanea actinobola	
Triaedones sp.	
Triaenodes tardus	
Trombiculidae	Red Mite

Tyloderma foveolatum	Hidden snout weevil
Udea rubigalis	Celery Leaftier Moth
Utterbackia imbecillis	Paper Pondshell
Vanessa atalanta	Red Admiral
Wallengrenia egeremet	
Xanthotype urticaria-sospeta	
Zale lunata	Lunate Zale Moth
Zonitis sp.	
	Crayfish

Figure F-7. Mammal Species Found at NMEC

Scientific Name	**Common Name**
Neovison vison	American Mink
Castor canadensis	American Beaver
Eptesicus fuscus	Big Brown Bat
Lynx rufus	Bobcat
Canis latrans	Coyote
Peromyscus maniculatus	Deer Mouse
Felis catus	Domestic Cat
Tamias striatus	Eastern Chipmunk
Sylvilagus floridanus	Eastern Cottontail
Sciurus carolinensis	Eastern Grey Squirrel
Scalopus aquaticus	Eastern Mole
Lasiurus borealis	Eastern Red Bat
Nycticeius humeralis	Evening Bat
Sciurus niger	Fox squirrel
Urocyon cinereoargenteus	Grey fox
Lasiurus cinereus	Hoary Bat
Mus musculus	House Mouse

Myotis sodalis	Indiana Bat
Myotis lucifugus	Little Brown Bat
Zapus hudsonius	Meadow Jumping Mouse
Microtus pennsylvanicus	Meadow Vole
Ondatra zibethicus	Muskrat
Lontra canadensis	North American River Otter
Myotis septentrionalis	Northern Myotis
Rattus norvegicus	Norway Rat
Geomys bursarius	Plains Pocket Gopher
Procyon lotor	Raccoon
Vulpes vulpes	Red Fox
Blarina brevicauda	Short-tailed Shrew
Lasionycteris noctivagans	Silver Haired Bat
Mephitis mephitis	Striped Skunk
Perimyotis subflavus	Tri-colored Bat
Didelphis virginiana	Virginia Oppossum
Peromyscus leucopus	White-footed Mouse
Odocoileus virginianus	White-tailed Deer
Marmota monax	Woodchuck

Figure F-8. Plant Species Found at NMEC

Scientific Name	**Common Name**
Acorus calamus	Calamus Plant
Abutilon theophrasti	Velvet-leaf/buttonweed
Acalypha rhomboidea	Three sided mercury
Acer negundo	Box Elder
Acer saccharinum	Silver Maple
Agalinis auriculata (Tomenthera auriculata)	earleaf false foxglove
Agalinis tenuifolia	Slenderleaf false foxglove
Agastache foeniculum	Blue giant (Anise) Hyssop
Agastache nepetoides	Yellow Hyssop

Ageratina altissima (Eupatorium rogosum)	White Snakeroot
Ailanthus altissima	Tree of heaven
Alisma subcordatum	American Water Plantain
Alisma triviale	Northern Water Plantain
Alliaria petiolata	Garlic Mustard
Allium canadense	Wild onion
Allium cernuum	Nodding onion
Amaranthus retroflexus	Rough Pigweed or Redroot Amaranth
Ambrosia artemisiifolia	Common ragweed
Ambrosia trifida	Giant Ragweed
Ammannia coccinea	Toothcup or Valley Redstem
Amorpha fruticosa	False Indigo
Amphicarpaea bracteata	Hogpeanut
Andropogan gerardii	Big Bluestem
Anemone canadensis	Canada Anemone
Apios americana	Groundnut
Apocynum cannabinum	Indianhemp or Dogbane
Apocynum sibiricum	Clasping Dogbane
Arctium minus	Common Burdock
Asclepias incarnata	Swamp Milkweed
Asclepias syriaca	Common Milkweed
Asclepias tuberosa	Butterfly Milkweed
Asclepias verticillata	Whorled Milkweed
Asimina triloba	Pawpaw
Asplenium platyneuron	Ebony SpleenWort
Astragalus canadensis	Canada Milk vetch

Azolla mexicana	Mosquito Fern
Baptisia alba (lactea)	White wild Indigo
Baptisia australis	Blue baptisia/blue wild indigo
Barbarea vulgaris	yellow rocket
Betula nigra	River Birch
Bidens aristosa (polylepis)	Bearded beggarticks/Swamp beggar-ticks
Bidens bipinnata	Spanish Needle
Bidens cernua	Nodding beggartick (bur marigold)
Bidens connata	Purplestem Tickseed
Bidens coronata	Crowned beggarticks/Tickseed Sunflower
Boehmeria cylindrica	Smallspike False Nettle/bog hemp
Bolboschoenus fluviatilis (Scirpus fluviatilis)	River Bulrush
Boltonia asteroides	White doll's daisy/False aster
Botrychium dissectum	Cutleaf Grape Fern
Botrychium virginianum	Rattlesnake Fern
Bouteloua curtipendula	Side-oats Grama
Brassica nigra	Black mustard
Brickellia eupatorioides	False Boneset
Bromus inermis	Smooth brome
Bromus japonicus	Japanese Brome
Bromus tectorum L.	Downy chess (cheatgrass)
Callirhoe involucrata	Purple Poppy Mallow
Calystegia sepium	Hedge false bindweed
Campanulastrum americanum (Campanula americana)	Small American bellflower/Tall Bellflower
Cannabis sativa	Hemp

Cardamine parviflora	sand bittercress/small flowered bittercress
Cardamine pensylvanica	Pennsylvania Bittercress
Carduus nutans	Nodding plumeless thistle/Musk Thistle
Carex aggregata	Glomerate sedge
Carex atherodes	Wheat sedge/Hairy-sheathed sedge
Carex brevior	Shortbeak sedge
Carex conjuncta	Soft fox sedge
Carex davisii	Davis' sedge
Carex granularis	Limestone meadow sedge
Carex grisea	Inflated narrow-leaf sedge
Carex haydenii	Hayden's sedge
Carex hystericina	Bottlebrush/Porcupine sedge
Carex lacustris	Hairy/Lake sedge
Carex laeviconica	Smoothcone sedge
Carex leavenworthii	Leavenworth's sedge
Carex lupiformis	False Hop sedge
Carex lupilina	Hop sedge
Carex molesta	Troublesome sedge
Carex molestiformis	Frightful sedge
Carex muskingumensus	Muskingum sedge
Carex squarrosa	Squarrose sedge (Bearded flatsedge)
Carex trichocarpa	Hairyfruit sedge
Carex typhina	Cattail sedge
Carex vulpinodea	fox sedge
Carya cordiformis	Bitternut Hickory
Carya illinoinensis	Pecan

Catalpa bignonioides	Southern Catalpa
Catalpa speciosa	Northern Catalpa
Celastrus orbiculatus	Oriental Bittersweet
Celtis occidentalis	Common Hackberry
Cenchrus longispinus	Mat Sand Bur
Cephalanthus occidentalis	Common Buttonbush
Ceratophyllum demersum	Coon's tail
Chamaecrista fasciculata (Cassia fasciculata)	Partridge Pea
Chamaesyce geyeri	Geyer's sandmat/ Geyer's Spurge
Chamaesyce maculata (Chamaesyce supina)	Small spotted sandmat/Milk Spurge
Chelone obliqua var. speciosa	Pink turtlehead/Rose Turtlehead
Chenopodium album	Lambsquarters
Cichorium intybus	Chicory
Cicuta maculata	Spotted water Hemlock
Cirsium arvense	Canada Thistle
Cirsium vulgare	Bull Thistle
Clematis pitcheri	bluebill/Leatherflower
Clematis virginiana	devil's darning needles/Small flowered clematis
Commelina communis	Asiatic dayflower
Conyza canadensis	Canadian Horseweed
Coreopsis lanceolata	Lanceleaf tickseed
Coreopsis tripteris	Tall tickseed
Cornus drummondii	Rough-leaved Dogwood
Cornus racemosa	Gray Dogwood
Cornus sericea (Cornus stoloninfera)	red-osier Dogwood
Corydalis curvisiliqua ssp grandibracteata	Bracted Corydalis

Corylus americana	American Hazelnut
Crataegus crus-galli	Hawthorne cockspur
Cretaegus mollis	Downy Hawthorn
Croton glandulosus var. septentrionalis	vente conmiga/Sand Croton
Cuscuta glomerata	Rope Dodder
Cuscuta gronovii	scaldweed/Dodder
Cuscuta polygonorum	knotweed dodder
Cycloloma atriplicifolium	Winged Pigweed
Cyperus erythrorhizos	Redroot flatsedge/Redrooted cyperus
Cyperus esculentus	Yellow nutsedge
Cyperus odoratus	fragrant Nutsedge
Cyperus strigosus	Strawcolored flatsedge/Lean Sedge
Dactylis glomerata	Orchard Grass
Dalea purpurea (Petalostemum purpureum)	Purple Prairie Clover
Daucus carota	Queen Anne's Lace
Delphinium carolinianum	Carolina Larkspur/Wild Blue Larkspur
Descurainia sophia	herb sofia/Flixweed/Tawsy mustard
Desmodium canadense	Showy ticktrefoil
Dichanthelium oligosanthes	Few-flowered panicgrass/Scribner's Panic Grass
Dipsacus fullonum (sylvestris)	Fuller's/Common Teasel
Duchesnea indica (Potentilla indica)	Indian strawberry/Mock Strawberry
Echinacea purpurea	Eastern Purple Coneflower
Echinochloa crusgalli	Barnyard Grass
Echinocystis lobata	Wild Cucumber
Elaeagnus umbellata	Autumn Olive
Eleocharis acicularis	Needle spikerush

Eleocharis obtusa	Blunt spikerush
Eleocharis palustris	Common/Marsh sprikerush
Eleusine indica	Goose Grass
Elymus canadensis	Canada Wild Rye
Elymus riparius	Riverbank wildrye
Elymus submuticus	Awnless wildrye (virginia wildrye -usda)
Elymus virginicus	Virginia Wild Rye
Epilobium coloratum	Purpleleaf Willowherb
Equisetum arvense	Field/Common Horsetail
Equisetum fluviatile	Water/Swamp Horsetail
Equisetum hyemale	Scouringrush horsetail
Equisetum pratense	Meadow Horsetail
Erechtites hieracifolia	Burnween/fireweed
Erigeron strigosus	Prairie Fleabane/Daisy Fleabane
Eryngium yuccifolium	Button eryngo/Rattlesnake master
Erysimum cheiranthoides	wormseed wallflower/mustard
Eupatorium altissimum	tall thoroughwort/boneset
Eupatorium perfoliatum	Common Boneset
Eupatorium serotinum	Lateflowering thoroughword/late boneset
Eupatorium sessilifolium	Upland Boneset
Euphorbia corollata	Flowering Spurge
Euphorbia dentata	Toothed Spurge
Euphorbia geyeri	Geyer's Sandmat/Spurge
Euphorbia maculata	Spotted sandmat/Carpet Spurge
Eutrochium maculatum (Eupatorium maculatum)	Spotted Joe-Pye-Weed
Eutrochium purpureum (Eupatorium purpereum)	Sweetscented/Purple Joe-Pye-Weed

Fraxinus nigra	Black Ash
Fraxinus pennsylvanica	Green Ash
Galium aparine	stickywilly/Cleavers bedstraw
Galium boreale	Northern bedstraw
Galium obtusum	blunt leaved bedstraw
Galium tinctorium	Stiff marsh Bedstraw
Galium trifidum	threepetal bedstraw/Small Bedstraw
Gentiana alba	Cream Gentian
Geranium bicknelli	Bicknell's cranesbill/Northern Cranesbill
Geranium maculatum	spotted geranium/Wild geranium
Geum aleppicum	Yellow Avens
Geum vernum	Spring Avens
Glechoma hederacea	Ground ivy/Creeping charlie
Gleditsia triacanthos	Honey locust
Hackelia virginiana	beggarslice/Stickseed
Helenium autumnale	Common Sneezeweed
Helianthus grosseserratus	Sawtooth Sunflower
Helianthus strumosus	Paleleaf Woodland Sunflower
Helianthus tuberosus	Jerusalem artichoke
Hemerocallis fulva	Domestic Day Lily (orange)
Heracleum maximum (Heracleum lanatum)	Common cowparsnip
Heuchera richardsonii	Richardsons' Alumroot
Hibiscus laevis	Halberdleaf Rosemallow
Hibiscus trionum	Flower-of-an-hour
Hieracium canadense	Canadian hawkweed
Hordeum jubatum	Squirrel-tail barley

Hypericum sphaerocarpum	Roundseed St. John'swort
Impatiens capensis	Jewelweed/Spotted Touch-me-not
Impatiens pallida	Pale touch-me-not
Ipomoea hederacea	Ivyleaf morning-Glory
Ipomoea lacunosa	Whitestar/Small White Morning glory
Ipomoea pandurata	Man of the earth/Morning Glory/Wild sweet potato
Iris virginica var. shrevei	Shreve's Iris/Blue Flag
Juglans nigra	Black Walnut
Juncus arcticus subsp. littoralis (Juncus balticus)	Mountain rush/Lakeshore rush
Juncus dudleyi	Dudley's rush
Juncus interior	Inland rush
Juncus nodosus	Knotted rush/Jointed rush
Juncus torreyi	Torrey's rush/Big Round-headed rush
Juniperus virginiana	Eastern Redcedar
Lactuca biennis	Tall blue Lettuce
Lactuca serriola	Prickly Lettuce
Lamium amplexicaule	Henbit deadnettle
Lamium purpureum	Purple deadnettle
Laportea canadensis	Canadian Woodnettle
Lappula squarrosa (Lappula echinata)	European stickseed/Beggars Lice
Leersia lenticularis	Catchfly Grass
Leersia oryzoides	Rice Cutgrass
Leersia virginica	White grass
Lemna minor	Common/Lesser Duckweed
Lepidium virginicum	Virginia pepperweed/ poor-mans pepper
Lespedeza capitata	Green-headed Bush Clover

Liatris pycnostachya	Prairie Blazing Star
Lobelia cardinalis	Cardinal flower
Lobelia siphilitica	Great Blue Lobelia
Lolium perenne	Pernnial Rye
Lonicera maackii	Amur Honeysucke
Lotus corniculatus	Birds-foot Trefoil
Ludwigia polycarpa	False loosetrife/Manyfuit primrose-willow
Lycopus americanus	American/Common Water Horehound
Lycopus rubellus	Taperleaf water horehound/Stalked water horehound
Lysimachia ciliata	Fringed/Winged loosestrife
Lysimachia terrestris	Earth loosestrife/Swamp louse
Lythrum salicaria	Purple Loosestrife
Malus coronaria	American crabapple
Malus sp	Apple sp (Cortland, gala, yellow delicious, domestic)
Malva neglecta	Common mallow/cheese
Matricaria discoidea (Matricaria matricariodes)	Disc mayweed/Pineapple weed
Melilotus officinalis	Yelllow & White Sweetclover
Menispermum canadense	Common Moonseed
Mentha arvensis	Wild mint
Mimulus alatus	Sharpwing Monkeyflower
Mirabilis nyctaginea	Heartleaf Four O'Clock/Wild Four-o'clock
Monarda fistulosa	Wild Bergamont
Monarda punctata	Spotted beebalm/Dotted horsemint
Morus alba	White mulberry
Morus rubra	Red mulberry
Muhlenbergia frondosa	Wirestem Muhly grass

Nelumbo lutea	American Lotus
Nepeta cataria	Catnip
Nuphar lutea	yellow Water lily
Oenothera biennis	Common Evening Primrose
Oenothera guara (Gaura biennis)	biennial beeblossom/Butterfly Flower
Oenothera laciniata	Cutleaf Evening Primrose
Oligoneuron rigidum (Solidago rigida)	Stiff goldenrod
Onoclea sensibilis	Sensitive Fern
Oxalis dillenii (Oxalis florida)	Slender yellow woodsorrel
Oxalis stricta	Common Yellow Oxalis (woodsorrel)
Panicum capillare	Witch grass
Panicum virgatum	Switch Grass
Parthenium integrifolium	Wild Quinine
Parthenocissus quinquefolia	Virginia Creeper
Penstemon digitatlis	Foxglove Beardtongue
Penstemon grandiflorus	Giant Beardtongue
Penthorum sedoides	Ditch Stonecrop
Phalaris arundinacea	Reed Canary Grass
Phragmites australis	Common Reed
Phyla lanceolata	Lanceleaf Fogfruit
Physalis heterophylla	Common Ground Cherry
Physalis pubescens	Downy Ground Cherry
Physalis virginiana	Virginia Ground Cherry
Physostegia virginiana (speciosa)	False Dragonhead
Phytolacca americana	American Pokeweed
Pilea pumila	Canadian Clearweed

Plantago lanceolata	Lance-leaved Plantain/Buckhorn plantain
Plantago major	Common Plantain
Platanus occidentalis	American Sycamore
Poa pratensis	Kentucky Bluegrass
Poa sylvestris	Woodland Bluegrass
Poa trivialis	Meadow Grass
Polygonum punctatum	Dotted smartweed
Polygonum scandens	Climbing False Buckwheat
Polygum amphibium	Water Smartweed
Polygum convolvulus	Black Bindweed/ water knotweed
Polygum hydropiper	Marshpepper knotweed/Water Pepper
Polygum hydropiperoides	swamp smartweed
Polygum pensylvanicum	Common Smartweed/pinkweed
Polygum ramosissimum	Bushy knotweed
Polygum sagittarium	Arrowleaf Tearthumb
Polygum virginianum	Jumpseed/Virginia Knotweed
Pontederia cordata	Pickerelweed
Populus deltoides	Eastern Cottonwood
Potamogeton crispus	Curly Pondweed
Potentilla recta	Sulphur cinquefoil
Potentilla simplex	Common Cinquefoil
Prunella vulgaris	Common Selfheal
Prunus americana	Wild Plum
Prunus serotina	Black Cherry
Pycnanthemum tenuifolium	Narrowleaf Mountain Mint
Quercus bicolor	Swamp White Oak

Quercus macrocarpa	Bur Oak
Quercus palustris	Pin Oak
Ranunculus pensylvanicus	Pennsylvania buttercup/Bristly Crowfoot
Ratibida pinnata	pinnate prairie coneflower/Grey headed coneflower
Rhus aromatica	Fragrant Sumac
Rhus glabra	Smooth Sumac
Ribes americanum	American black currant
Ribes cynosbati	Eastern Prickly Gooseberry
Ribes missouriense	Missouri Gooseberry
Riccia fluitans	Riccia (liverwort group)
Robinia pseudoacacia	Black Locust
Rorippa palustris	bog yellowcress/marsh cress
Rorippa sylvestris	creeping yellow cress
Rosa blanda	Smooth Wild Rose
Rosa multiflora	Multiflora Rose
Rubus allegheniensis	Blackberry
Rubus occidentalis	Black Raspberry
Rudbeckia hirta	Blackeyed Susan
Rudbeckia subtomentosa	Sweet coneflower/Sweet blackeyed Susan
Rudbeckia triloba	Browneyed Susan
Rumex altissimus	Pale Dock
Rumex crispus	Curly Dock
Rumex obtusifolius	Bitter dock
Rumex verticillatus	Swamp dock
Sagittaria brevirostra	Shortbeak Arrowhead
Sagittaria latifolia	Broadleaf Arrowhead

Salix amygdaloides	Peach-leave Willow
Salix babylonica	Weeping Willow
Salix cordata	Heartleaf willow
Salix discolor	Pussy Willow
Salix exigua	Narrowleaf Willow (Sandbar Willow)
Salix nigra	Black Willow
Salix petiolaris	Meadow willow/Slender Willow
Salix serissima	Autumn willow
Salvia reflexa	Lanceleaf sage/Blue Sage
Sambucus nigra subsp. Canadensis	American Black Elderberry
Sanicula marilandica	Maryland sanicle/Black Snakeroot
Sassafras albidum	Sassafras
Schizachyrium scoparium	Little Bluestem
Schoenoplectus acutus	Hardstem Bulrush
Schoenoplectus americanus (Scirpus americanus)	Chairmaker's bulrush/threesquare
Schoenoplectus tabernaemontani (Scirpus validus)	Softstem Bulrush
Scirpus atrovirens	Dark-green Bulrsuh
Scrophularia lanceolata	lanceleaf figwort/early Figwort
Scrophularia marilandica	Carpenter's square/late figwort
Scutellaria galericulata	Marsh Skullcap
Scutellaria lateriflora	Blue skullcap/Mad-dog skullcap
Securigera varia (Coronilla varia)	Crownvetch
Senna marilandica	Maryland Senna
Setaria pumila subsp. pumila (Setaria glauca)	Yellow Foxtail
Setaria viridus	Green foxtail

Sicyos angulatus	Oneseed Bur Cucumber
Silene antirrhina	Sleepy silene/catchfly
Silene latifolia subsp. Alba (Silene pratensis)	bladder campion /White Campion
Silphium integrifolium	Rosinweed
Silphium lacinatum	Compass plant
Silphium perfoliatum	Cup-plant
Sisymbrium officinale	Hedge Mustard
Sium suave	Hemlock Water Parsnip
Smilax lasioneura (Smilax herbacea)	Blue ridge Carrion flower
Smilax rotundifolia	roundleaf greenbrier
Smilax tamnoides (Smilax hispida)	Bristly Greenbrier
Solanum carolinense	Carolina Horse Nettle
Solidago altissima	Canada Goldenrod
Solidago caesia	Wreath/Woodland Goldenrod
Solidago gigantea	Giant Goldenrod/Late Goldenrod
Solidago ulmiflora	Elm-leaved Goldenrod
Sonchus arvensis	Field Sow Thistle
Sonchus oleracerus	Common Sow Thistle
Sorghastrum nutans	Indian grass
Sparganium eurycarpum	broadleaf bur-reed/Giant Bur-reed
Spartina pectinata	Prairie Cord Grass
Spirodela polyrrhiza	Common duckweed
Sporobolus compositus (Sporobolus asper)	Rough Dropseed/ Composite dropseed
Stachys palustris	marsh hedgenettle
Stachys tenuifolia	Smooth Hedgenettle
Strophostyles helvola	Amerique-bean/Trailing Wild Bean

Symphyotrichum lanceolatum (Aster lanceolatus)	Little white aster or White panicle aster
Symphyotrichum novae-angliae (Aster novae-angliae)	New England Aster
Symphyotrichum ontarionis (Aster ontarianus)	Bottomland Aster
Symphyotrichum oolentangiense (Aster azureus)	Skyblue Aster
Symphyotrichum parviceps (Aster parviceps)	Little head aster
Symphyotrichum pilosum (Aster pilosus)	Hairy white oldfield aster
Taraxacum officinale	Common Dandelion
Teucrium canadense	Canada Germander
Thalictrum dasycarpum	Purple Meadow Rue
Thalictrum revolutum	Waxyleaf meadow rue
Thelypteris palustris	Eastern Marsh Fern
Thlaspi arvense	Field Penny Cress
Toxicodendron radicans	Poison Ivy (forb/vine)
Toxicodendron rydbergii	Western Poison ivy
Tradescantia ohiensis	Bluejacket/Ohio Spiderwort
Tradescantia virginiana	Virginia Spiderwort
Tragopogon porrifolius	Salsify
Tridens flavus	Purple-top Tridens
Trifolium dubium	suckling Clover
Trifolium pratense	Red Clover
Triodanis perfoliata	Clasping Venus Looking Glass
Typha angustifolia	Narrow-leaved Cattail
Typha latifolia	Broadleaf Cattail
Ulmus americana	American Elm
Ulmus pumila	Siberian Elm

Ulmus rubra	Slippery Elm
Urtica dioica	Stinging Nettle
Verbascum thapsus	common Mullein
Verbena hastata	Swamp verbena/Blue Vervain
Verbena stricta	Hoary Verbena/Vervain
Verbena urticifolia	White Vervain
Vernonia fasciculata	Ironweed
Veronicastrum virginicum	Culver's Root
Viola missouriensis	Missouri Violet
Vitis riparia	Riverbank Grape
Vitis vulpina	Frost/Fox grape
Wolffia columbiana	Columbian Watermeal
Xanthium strumarium	Rough/Common Cocklebur
Yucca glauca	Soapweed yucca
Zizia aurea	Golden Alexander/Golden zizia

Table F-9. Zooplankton Species Found at Nahant Marsh

Scientific Name
Acanthocyclops vernalis
Brachonius quadridentatus
Ceriodaphnia lacustris
Collotheca pelagica
Daphnia spp.
Eubosmina longispina
Hydracarina spp.
Microcyclops rubellus
Monogononta ploimida
Monostyla copeis
Monostyla quadridentata
Platyias patulus

Nahant Marsh Environmental Considerations

Current Conditions. Nahant Marsh is a 305-acre preserve, part of a larger 513-acre wetland complex, that is bordered by the Mississippi River, Interstate 280, and Highway 22 in Davenport, Iowa. It is comprised of marshy areas, mesic, wet and sand prairie, and bottomland forest. A spring-fed quarry, known as Carp Lake, and the surrounding grounds, are part of the Nahant Marsh preserve as well.

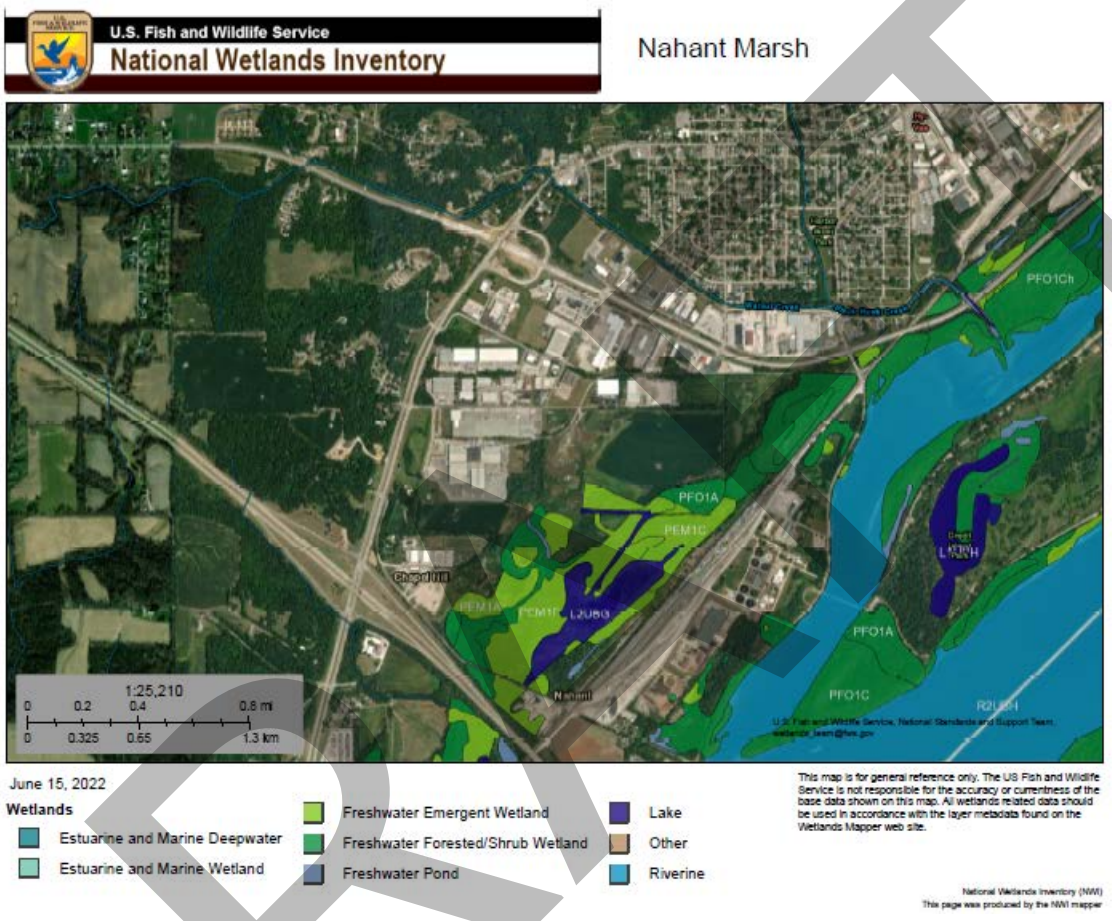


Figure 1. Map of wetland types located in Nahant Marsh.

Nahant Marsh was once used as a sportsman club until it was noted that high levels of lead were contaminating the plant and wildlife community that utilized the area.Years of multi-agency cleanup efforts have helped to bring back the health and habitat diversity of Nahant Marsh.

Federally Listed Threatened and Endangered Species. The Corps accessed the U.S. Fish and Wildlife Service's Information for Planning and Consultation (IPaC) website for a list of Federally threatened, endangered, and/or candidate species and critical habitat that "may be present" within the project areas (Project Code 2022-0053815). The listed species for Scott County, Iowa include: Indiana bat (Myotis sodalis), northern long-eared bat (Myotis septentrionalis), higgins eye pearlymussel (Lampsilis higginsii), sheepnose mussel (Plethobasus cyphyus), spectaclecase mussel (Cumberlandia monodonta), monarch butterfly (Danaus plexippus), rusty-patched bumble bee (Bombus affinis), eastern prairie fringed orchid (Platanthera leucophaea), and western prairie fringed orchid (Platanthera preclara). No critical habitat is present within Nahant Marsh. Some of these species have been documented at Nahant Marsh over the last 15 years.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Illinois-Iowa Ecological Services Field Office
Illinois & Iowa Ecological Services Field Office
1511 47th Ave
Moline, IL 61265-7022
Phone: (309) 757-5800 Fax: (309) 757-5807

In Reply Refer To:
Project Code: 2022-0053815
Project Name: Nahant Marsh

June 14, 2022

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)

(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Migratory Birds: In addition to responsibilities to protect threatened and endangered species under the Endangered Species Act (ESA), there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts see https://www.fws.gov/birds/policies-and-regulations.php.

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable NEPA documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures see https://www.fws.gov/birds/bird-enthusiasts/threats-to-birds.php.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit https://www.fws.gov/birds/policies-and-regulations/executive-orders/e0-13186.php.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Code in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List
- USFWS National Wildlife Refuges and Fish Hatcheries
- Wetlands

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

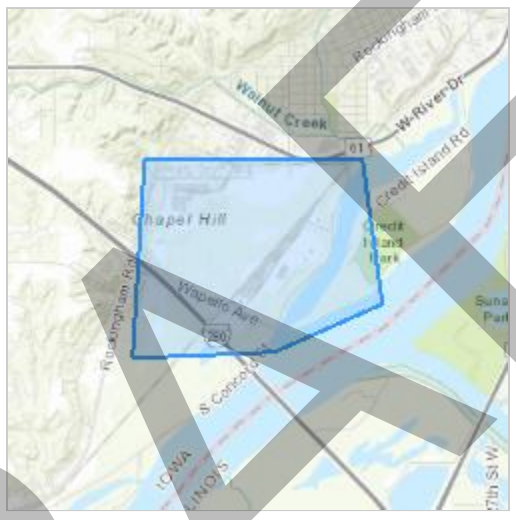
This species list is provided by:

Illinois-Iowa Ecological Services Field Office
Illinois & Iowa Ecological Services Field Office
1511 47th Ave
Moline, IL 61265-7022
(309) 757-5800

Project Summary

Project Code: 2022-0053815
Event Code: None
Project Name: Nahant Marsh
Project Type: Land Management Plans - NWR
Project Description: Master Plan
Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@41.49135235,-90.63413714284718,14z



Counties: Scott County, Iowa

Endangered Species Act Species

There is a total of 9 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Mammals

NAME	STATUS
Indiana Bat *Myotis sodalis* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/5949	Endangered
Northern Long-eared Bat *Myotis septentrionalis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9045	Threatened

Clams

NAME	STATUS
Higgins Eye (pearlymussel) *Lampsilis higginsii* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/5428	Endangered
Sheepnose Mussel *Plethobasus cyphyus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/6903	Endangered
Spectaclecase (mussel) *Cumberlandia monodonta* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/7867	Endangered

Insects

NAME	STATUS
Monarch Butterfly *Danaus plexippus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9743	Candidate
Rusty Patched Bumble Bee *Bombus affinis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9383	Endangered

Flowering Plants

NAME	STATUS
Eastern Prairie Fringed Orchid *Platanthera leucophaea* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/601	Threatened
Western Prairie Fringed Orchid *Platanthera praeclara* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/1669	Threatened

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

USFWS National Wildlife Refuge Lands And Fish Hatcheries

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS OR FISH HATCHERIES WITHIN YOUR PROJECT AREA.

Wetlands

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

RIVERINE

- Riverine

FRESHWATER EMERGENT WETLAND

- Palustrine

LAKE

- Lacustrine

IPaC User Contact Information

Agency: Army Corps of Engineers
Name: Kelsey Hoffmann
Address: 219 Rodman Ave
City: Rock Island
State: IL
Zip: 61299
Email kelsey.a.hoffmann@usace.army.mil
Phone: 3097945759

Lead Agency Contact Information

Lead Agency: Army Corps of Engineers

State Listed Threatened and Endangered Species. Nahant Marsh is home to more than 150 species of birds and 400 species of plants, and a wide variety of mammals, fish, reptiles, amphibians and insects, including several rare and endangered species. The study area may not provide suitable habitat for all of these species, however the close proximity to the Mississippi River may increase the likelihood of some species using Nahant Marsh. For detailed information, see the Iowa DNR's Natural Areas Inventory webpage for up-to-date information on state listed species: https://programs.iowadnr.gov/naturalareasinventory/pages/RepDistinctSpeciesByCounty.aspx?CountyID=82.

Below is the current list of endangered, threatened, and special concern species for the State of Iowa from chapter 77 of the Iowa Administrative Code.

571—77.2 (481B) Endangered, threatened, and special concern animals. The natural resource commission, in consultation with scientists with specialized knowledge and experience, has determined the following animal species to be endangered, threatened or of special concern in Iowa:

77.2(1) *Endangered animal species:*

Mammals

Indiana Bat	Myotis sodalis
Plains Pocket Mouse	Perognathus flavescens
Red-backed Vole	Clethrionomys gapperi
Spotted Skunk	Spilogale putorius

Birds

Red-shouldered Hawk	Buteo lineatus
Northern Harrier	Circus cyaneus
Piping Plover	Charadrius melodus
Common Barn Owl	Tyto alba
Least Tern	Sterna antillarum
King Rail	Rallus elegans
Short-eared Owl	Asio flammeus

Fish

Lake Sturgeon	Acipenser fulvescens
Pallid Sturgeon	Scaphirhynchus albus
Pugnose Shiner	Notropis anogenus
Weed Shiner	Notropis texanus
Pearl Dace	Semotilus margarita

Freckled Madtom	Noturus nocturnus
Bluntnose Darter	Etheostoma chlorosomum
Least Darter	Etheostoma microperca

Reptiles

Yellow Mud Turtle	Kinosternon flavescens
Wood Turtle	Clemmys insculpta
Great Plains Skink	Eumeces obsoletus
Copperbelly Water Snake	Nerodia erythrogaster neglecta
Western Hognose Snake	Heterodon nasicus
Copperhead	Agkistrodon contortrix
Prairie Rattlesnake	Crotalus viridis
Massasauga Rattlesnake	Sistrurus catenatus

Amphibians

Blue-spotted Salamander	Ambystoma laterale
Crawfish Frog	Rana areolata

Butterflies

Dakota Skipper	Hesperia dacotae
Ringlet	Coenonympha tullia

Land Snails

Iowa Pleistocene Snail	Discus macclintocki
Minnesota Pleistocene Ambersnail	Novisuccinea new species A
Iowa Pleistocene Ambersnail	Novisuccinea new species B
Frigid Ambersnail	Catinella gelida
Briarton Pleistocene Vertigo	Vertigo briarensis
Bluff Vertigo	Vertigo meramecensis
Iowa Pleistocene Vertigo	Vertigo new species

Fresh Water Mussels

Spectacle Case	Cumberlandia monodonta
Slippershell	Alasmidonta viridis
Buckhorn	Tritogonia verrucosa
Ozark Pigtoe	Fusconaia ozarkensis
Bullhead	Plethobasus cyphyus
Ohio River Pigtoe	Pleurobema sintoxia
Slough Sandshell	Lampsilis teres teres
Yellow Sandshell	Lampsilis teres anodontoides
Higgin’s-eye Pearly Mussel	Lampsilis higginsi

77.2(2) *Threatened animal species:*

Mammals

Least Shrew	Cryptotis parva
Southern Bog Lemming	Synaptomys cooperi

Birds

Long-eared Owl	Asio otus
Henslow's Sparrow	Ammodramus henslowii

Fish

Chestnut Lamprey	Ichthyomyzon castaneus
American Brook Lamprey	Lampetra appendix
Grass Pickerel	Esox americanus
Blacknose Shiner	Notropis heterolepis
Topeka Shiner	Notropis topeka
Western Sand Darter	Ammocrypta clara
Black Redhorse	Moxostoma duquesnei
Burbot	Lota lota
Orangethroat Darter	Etheostoma spectabile

Reptiles

Slender Glass Lizard	Ophisaurus attenuatus
Common Musk Turtle	Sternotherus odoratus
Blanding's Turtle	Emydoidea blandingii
Ornate Box Turtle	Terrapene ornata
Diamondback Water Snake	Nerodia rhombifera
Western Worm Snake	Carphophis amoenus vermis
Speckled Kingsnake	Lampropeltis getulus

Amphibians

Mudpuppy	Necturus maculosus
Central Newt	Notophthalmus viridescens

Butterflies

Powesheik Skipperling	Oarisma powesheik
Byssus Skipper	Problema byssus
Mulberry Wing	Poanes massasoit
Silvery Blue	Glaucopsyche lygdamus
Baltimore	Euphydryas phaeton

Snails

Midwest Pleistocene Vertigo	Vertigo hubrichti
Occult Vertigo	Vertigo occulta

Fresh Water Mussels

Cylinder	Anodontoides ferussacianus
Strange Floater	Strophitus undulatus
Creek Heelsplitter	Lasmigona compressa
Purple Pimpleback	Cyclonaias tuberculata
Butterfly	Ellipsaria lineolata
Ellipse	Venustaconcha ellipsiformis

77.2(3) *Special concern animal species:*

Mammals

Southern Flying Squirrel	Glaucomys volans

Birds

Forster's Tern	Sterna forsteri
Black Tern	Chlidonias niger
Peregrine Falcon	Falco peregrinus
Bald Eagle	Haliaeetus leucocephalus

Fish

Pugnose Minnow	Notropis emiliae
Pirate Perch	Aphredoderus sayanus

Reptiles

Smooth Green Snake	Opheodrys vernalis
Bullsnake	Pituophis catenifer sayi

Butterflies

Dreamy Duskywing	Erynnis icelus
Sleepy Duskywing	Erynnis brizo
Columbine Duskywing	Erynnis lucilius
Wild Indigo Duskywing	Erynnis baptisiae
Ottoe Skipper	Hesperia ottoe
Leonardus Skipper	Hesperia l. leonardus

Pawnee Skipper	Hesperia leonardus pawnee
Beardgrass Skipper	Atrytone arogos
Zabulon Skipper	Poanes zabulon
Broad-winged Skipper	Poanes viator
Sedge Skipper	Euphyes dion
Two-spotted Skipper	Euphyes bimacula
Dusted Skipper	Atrytonopsis hianna
Salt-and-pepper Skipper	Amblyscirtes hegon
Pipevine Swallowtail	Battus philenor
Zebra Swallowtail	Eurytides marcellus
Olympia White	Euchloe olympia
Purplish Copper	Lycaena helloides
Acadian Hairstreak	Satyrium acadicum
Edward's Hairstreak	Satyrium edwardsii
Hickory Hairstreak	Satyrium caryaevorum
Striped Hairstreak	Satyrium liparops
Swamp Metalmark	Calephelis mutica
Regal Fritillary	Speyeria idalia
Baltimore	Euphydryas phaeton ozarkae

[**ARC 8105B**, IAB 9/9/09, effective 10/14/09]

571—77.3(481B) Endangered, threatened, and special concern plants. The natural resource commission, in consultation with scientists with special knowledge and experience, determined the following plant species to be endangered, threatened, or of special concern in Iowa.

77.3(1) *Endangered plant species:*

COMMON NAME	SCIENTIFIC NAME
Pale false foxglove	Agalinus skinneriana
Blue giant-hyssop	Agastache foeniculum
Bearberry	Arctostaphylos uva-ursi
Black chokeberry	Aronia melanocarpa
Eared milkweed	Asclepias engelmanniana
Mead's milkweed	Asclepias meadii
Narrow-leaved milkweed	Asclepias stenophylla
Ricebutton aster	Aster dumosus
Large-leaved aster	Aster macrophyllus
Schreber's aster	Aster schreberi
Fern-leaved false foxglove	Aureolaria pedicularia
Matricary grape fern	Botrychium matricariifolium
Poppy mallow	Callirhoe triangulata
Cordroot sedge	Carex chordorrhiza
Large-bracted corydalis	Corydalis curvisiliqua
Silky prairie-clover	Dalea villosa
Swamp-loosestrife	Decodon verticillatus
Northern panic-grass	Dichanthelium boreale
Roundleaved sundew	Drosera rotundifolia
False mermaid	Floerkea proserpinacoides
Bog bedstraw	Galium labradoricum
Povertygrass	Hudsonia tomentosa
Northern St. Johnswort	Hypericum boreale
Pineweed	Hypericum gentianoides
Winterberry	Ilex verticillata
Black-based quillwort	Isoetes melanopoda
Water-willow	Justicia americana
Dwarf dandelion	Krigia virginica
Cleft conobea	Leucospora multifida
Whiskbroom parsley	Lomatium foeniculaceum
Running clubmoss	Lycopodium clavatum
Bog clubmoss	Lycopodium inundatum
Annual skeletonweed	Lygodesmia rostrata
Water marigold	Megalodonta beckii
Northern lungwort	Mertensia paniculata
Bigroot pricklypear	Opuntia macrorhiza
Clustered broomrape	Orobanche fasciculata
Ricegrass	Oryzopsis pungens
Cinnamon fern	Osmunda cinnamomea
Purple cliffbrake	Pellaea atropurpurea

Arrow arum	Peltandra virginica
Pale green orchid	Platanthera flava
Eastern prairie fringed orchid	Platanthera leucophaea
Clammyweed	Polansia jamesii
Crossleaf milkwort	Polygala cruciata
Purple milkwort	Polygala polygama
Jointweed	Polygonella articulata
Douglas' knotweed	Polygonum douglasii
Three-toothed cinquefoil	Potentilla tridentata
Canada plum	Prunus nigra
Frenchgrass	Psoralea onobrychis
Pink shinleaf	Pyrola asarifolia
Prickly rose	Rosa acicularis
Meadow spikemoss	Selaginella eclipes
Rough-leaved goldenrod	Solidago patula
Bog goldenrod	Solidago uliginosa
Yellow-lipped ladies-tresses	Spiranthes lucida
Pickering morning-glory	Stylisma pickeringii
Rough-seeded fameflower	Talinum rugospermum
Waxy meadowrue	Thalictrum revolutum
Long beechfern	Thelypteris phegopteris
Large-leaved violet	Viola incognita
Rusty woodsia	Woodsia ilvensis
Yellow-eyed grass	Xyris torta

77.3(2) *Threatened plant species:*

Northern wild monkshood	Aconitum noveboracense
Round-stemmed false foxglove	Agalinus gattingerii
Nodding wild onion	Allium cernuum
Fragrant false indigo	Amorpha nana
Virginia snakeroot	Aristolochia serpentaria
Woolly milkweed	Asclepias lanuginosa
Showy milkweed	Asclepias speciosa
Forked aster	Aster furcatus
Rush aster	Aster junciformis
Flax-leaved aster	Aster linariifolius
Water parsnip	Berula erecta
Kittentails	Besseya bullii
Bog birch	Betula pumila
Pagoda plant	Blephilia ciliata
Leathery grapefern	Botrychium multifidum
Little grapefern	Botrychium simplex
Sweet Indian-plantain	Cacalia suaveolens
Poppy mallow	Callirhoe alcaeoides
Pipsissewa	Chimaphila umbellata

Golden saxifrage	Chrysosplenium iowense
Dayflower	Commelina erecta
Spotted coralroot	Corallorhiza maculata
Bunchberry	Cornus canadensis
Golden corydalis	Corydalis aurea
Pink corydalis	Corydalis sempervirens
Showy lady's-slipper	Cypripedium reginae
Slim-leaved panic-grass	Dichanthelium linearifolium
Jeweled shooting star	Dodecatheon amethystinum
Glandular wood fern	Dryopteris intermedia
Marginal shield fern	Dryopteris marginalis
Woodland horsetail	Equisetum sylvaticum
Slender cottongrass	Eriophorum gracile
Yellow trout lily	Erythronium americanum
Queen of the prairie	Filipendula rubra
Blue ash	Fraxinus quadrangulata
Black huckleberry	Gaylussacia baccata
Oak fern	Gymnocarpium dryopteris
Green violet	Hybanthus concolor
Twinleaf	Jeffersonia diphylla
Creeping juniper	Juniperus horizontalis
Intermediate pinweed	Lechea intermedia
Hairy pinweed	Lechea villosa
Prairie bush clover	Lespedeza leptostachya
Twinflower	Linnaea borealis
Western parsley	Lomatium orientale
Wild lupine	Lupinus perennis
Tree clubmoss	Lycopodium dendroideum
Rock clubmoss	Lycopodium porophilum
Hairy waterclover	Marsilea vestita
Bog buckbean	Menyanthes trifoliata
Winged monkeyflower	Mimulus alatus
Yellow monkeyflower	Mimulus glabratus
Partridge berry	Mitchella repens
Pinesap	Monotropa hypopithys
Small sundrops	Oenothera perennis
Little pricklypear	Opuntia fragilis
Royal fern	Osmunda regalis
Philadelphia panic-grass	Panicum philadelphicum
Slender beardtongue	Penstemon gracilis
Hooker's orchid	Platanthera hookeri
Northern bog orchid	Platanthera hyperborea
Western prairie fringed orchid	Platanthera praeclara
Purple fringed orchid	Platanthera psycodes
Pink milkwort	Polygala incarnata

Silverweed	Potentilla anserina
Shrubby cinquefoil	Potentilla fruticosa
Pennsylvania cinquefoil	Potentilla pensylvanica
One-sided shinleaf	Pyrola secunda
Meadow beauty	Rhexia virginica
Beaked rush	Rhynchospora capillacea
Northern currant	Ribes hudsonianum
Shining willow	Salix lucida
Bog willow	Salix pedicellaris
Low nutrush	Scleria verticillata
Buffaloberry	Sheperdia argentea
Scarlet globemallow	Sphaeralcea coccinea
Slender ladies-tresses	Spiranthes lacera
Oval ladies-tresses	Spiranthes ovalis
Hooded ladies-tresses	Spiranthes romanzoffiana
Spring ladies-tresses	Spiranthes vernalis
Rosy twisted-stalk	Streptopus roseus
Fameflower	Talinum parviflorum
Large arrowgrass	Triglochin maritimum
Small arrowgrass	Triglochin palustre
Low sweet blueberry	Vaccinium angustifolium
Velvetleaf blueberry	Vaccinium myrtilloides
False hellebore	Veratrum woodii
Kidney-leaved violet	Viola renifolia
Oregon woodsia	Woodsia oregana

77.3(3) *Special concern plant species:*

Balsam fir	Abies balsamea
Three-seeded mercury	Acalypha gracilens
Three-seeded mercury	Acalypha ostryifolia
Mountain maple	Acer spicatum
Moschatel	Adoxa moschatellina
Water plantain	Alisma gramineum
Wild onion	Allium mutabile
Amaranth	Amaranthus arenicola
Lanceleaf ragweed	Ambrosia bidentata
Saskatoon serviceberry	Amelanchier alnifolia
Low serviceberry	Amelanchier sanguinea
Raccoon grape	Ampelopsis cordata
Pearly everlasting	Anaphalis margaritacea
Sand bluestem	Andropogon hallii
Broomsedge	Andropogon virginicus
Purple angelica	Angelica atropurpurea
Purple rockcress	Arabis divaricarpa
Green rockcress	Arabis missouriensis

Lakecress	Armoracia lacustris
Fringed sagewort	Artemisia frigida
Common mugwort	Artemisia vulgaris
Pawpaw	Asimina triloba
Curved aster	Aster falcatus
Hairy aster	Aster pubentior
Prairie aster	Aster turbinellus
Standing milkvetch	Astragalus adsurgens
Bent milkvetch	Astragalus distortus
Missouri milkvetch	Astragalus missouriensis
Blue wild indigo	Baptisia australis
Yellow wild indigo	Baptisia tinctoria
Prairie moonwort	Botrychium campestre
Watershield	Brasenia schreberi
Buffalograss	Buchloe dactyloides
Poppy mallow	Callirhoe papaver
Water-starwort	Callitriche heterophylla
Grass pink	Calopogon tuberosus
Low bindweed	Calystegia spithamaea
Clustered sedge	Carex aggregata
Back's sedge	Carex backii
Bush's sedge	Carex bushii
Carey's sedge	Carex careyana
Flowerhead sedge	Carex cephalantha
Field sedge	Carex conoidea
Crawe's sedge	Carex crawei
Fringed sedge	Carex crinita
Double sedge	Carex diandra
Douglas' sedge	Carex douglasii
Dry sedge	Carex foena
Thin sedge	Carex gracilescens
Delicate sedge	Carex leptalea
Mud sedge	Carex limosa
Hoplike sedge	Carex lupuliformis
Yellow sedge	Carex lurida
Intermediate sedge	Carex media
Backward sedge	Carex retroflexa
Richardson's sedge	Carex richardsonii
Rocky Mountain sedge	Carex saximontana
Sterile sedge	Carex sterilis
Soft sedge	Carex tenera
Deep green sedge	Carex tonsa
Tuckerman's sedge	Carex tuckermanii
Umbrella sedge	Carex umbellata
Wild oats	Chasmanthium latifolium

Pink turtlehead	Chelone obliqua
Fogg's goosefoot	Chenopodium foggii
Missouri goosefoot	Chenopodium missouriensis
Coast blite	Chenopodium rubrum
Bugbane	Cimicifuga racemosa
Hill's thistle	Cirsium hillii
Swamp thistle	Cirsium muticum
Wavy-leaved thistle	Cirsium undulatum
Western clematis	Clematis occidentalis
Blue-eyed Mary	Collinsia verna
Cancer-root	Conopholis americana
Fireberry hawthorn	Crataegus chrysocarpa
Red hawthorn	Crataegus coccinea
Two-fruited hawthorn	Crataegus disperma
Hawthorn	Crataegus pruinosa
Hawksbeard	Crepis runcinata
Prairie tea	Croton monanthogynus
Crotonopsis	Crotonopsis elliptica
Waxweed	Cuphea viscosissima
Dodder	Cuscuta indecora
Small white lady's-slipper	Cypripedium candidum
Carolina larkspur	Delphinium carolinianum
Sessile-leaved tick trefoil	Desmodium sessilifolium
Fingergrass	Digitaria filiformis
Buttonweed	Diodia teres
Purple coneflower	Echinacea purpurea
Waterwort	Elatine triandra
Purple spikerush	Eleocharis atropurpurea
Green spikerush	Eleocharis olivacea
Oval spikerush	Eleocharis ovata
Dwarf spikerush	Eleocharis parvula
Few-flowered spikerush	Eleocharis pauciflora
Wolf's spikerush	Eleocharis wolfii
Interrupted wildrye	Elymus interruptus
Dwarf scouring rush	Equisetum scirpoides
Ponygrass	Eragrostis reptans
Tall cottongrass	Eriophorum angustifolium
Tawny cottongrass	Eriophorum virginicum
Upland boneset	Eupatorium sessilifolium
Spurge	Euphorbia commutata
Missouri spurge	Euphorbia missurica
Slender fimbristylis	Fimbristylis autumnalis
Umbrella grass	Fuirena simplex
Rough bedstraw	Galium asprellum
Small fringed gentian	Gentianopsis procera

Northern cranesbill	Geranium bicknellii
Spring avens	Geum vernum
Early cudweed	Gnaphalium purpureum
Limestone oak fern	Gymnocarpium robertianum
Bitterweed	Helenium amarum
Mud plantain	Heteranthera limosa
Water stargrass	Heteranthera reniformis
Hairy goldenaster	Heterotheca villosa
Common mare's-tail	Hippuris vulgaris
Canadian St. Johnswort	Hypericum canadense
Drummond St. Johnswort	Hypericum drummondii
White morning glory	Ipomoea lacunosa
Sumpweed	Iva annua
Alpine rush	Juncus alpinus
Toad rush	Juncus bufonius
Soft rush	Juncus effusus
Green rush	Juncus greenii
Edged rush	Juncus marginatus
Vasey's rush	Juncus vaseyi
Potato dandelion	Krigia dandelion
Pinweed	Lechea racemulosa
Duckweed	Lemna perpusilla
Creeping bush clover	Lespedeza repens
Silvery bladder-pod	Lesquerella ludoviciana
Wild flax	Linum medium
Brook lobelia	Lobelia kalmii
False loosestrife	Ludwigia peploides
Crowfoot clubmoss	Lycopodium digitatum
Adder's-mouth orchid	Malaxis unifolia
Globe mallow	Malvastrum hispidum
Two-flowered melic-grass	Melica mutica
Ten-petaled blazingstar	Mentzelia decapetala
Millet grass	Milium effusum
Rock sandwort	Minuartia michauxii
Naked mitrewort	Mitella nuda
Scratchgrass	Muhlenbergia asperifolia
Water milfoil	Myriophyllum heterophyllum
Rough water milfoil	Myriophyllum pinnatum
Water milfoil	Myriophyllum verticillatum
Glade mallow	Napaea dioica
Showy evening primrose	Oenothera speciosa
Northern adders-tongue fern	Ophioglossum vulgatum
Louisiana broomrape	Orobanche ludoviciana
Mountain ricegrass	Oryzopsis asperifolia
Gattinger's panic-grass	Panicum gattingeri

White beardtongue	Penstemon albidus
Cobaea penstemon	Penstemon cobaea
Tube penstemon	Penstemon tubiflorus
Cleft phlox	Phlox bifida
Annual ground cherry	Physalis pubescens
Heart-leaved plantain	Plantago cordata
Wood orchid	Platanthera clavellata
Green fringed orchid	Platanthera lacera
Plains bluegrass	Poa arida
Chapman's bluegrass	Poa chapmaniana
Weak bluegrass	Poa languida
Bog bluegrass	Poa paludigena
Meadow bluegrass	Poa wolfii
Hairy Solomon's-seal	Polygonatum pubescens
Large-leaved pondweed	Potamogeton amplifolius
Ribbonleaf pondweed	Potamogeton epihydrus
White-stemmed pondweed	Potamogeton praelongus
Spiralled pondweed	Potamogeton spirillus
Tussock pondweed	Potamogeton strictifolius
Vasey's pondweed	Potamogeton vaseyi
Bird's-eye primrose	Primula mistassinica
Prionopsis	Prionopsis ciliata
Mermaid weed	Proserpinaca palustris
Dwarf cherry	Prunus besseyi
Hortulan plum	Prunus hortulana
Sand cherry	Prunus pumila
Lemon scurfpea	Psoralea lanceolata
Crowfoot	Ranunculus circinatus
Gmelin's crowfoot	Ranunculus gmelinii
Buckthorn	Rhamnus alnifolia
Dwarf sumac	Rhus copallina
Northern gooseberry	Ribes hirtellum
Yellow cress	Rorippa sinuata
Swamp rose	Rosa palustris
Tooth-cup	Rotala ramosior
Dewberry	Rubus hispidus
Western dock	Rumex occidentalis
Widgeon grass	Ruppia maritima
Prairie rose gentian	Sabatia campestris
Sage willow	Salix candida
Sassafras	Sassafras albidum
Tumblegrass	Schedonnardus paniculatus
Scheuchzeria	Scheuchzeria palustris
Sensitive briar	Schrankia nuttallii
Hall's bulrush	Scirpus hallii

Prairie bulrush	Scirpus maritimus
Pedicelled bulrush	Scirpus pedicellatus
Smith's bulrush	Scirpus smithii
Torrey's bulrush	Scirpus torreyi
Veiny skullcap	Scutellaria nervosa
Wild stonecrop	Sedum ternatum
Rock spikemoss	Selaginella rupestris
Butterweed	Senecio glabellus
False golden ragwort	Senecio pseudaureus
Knotweed bristlegrass	Setaria geniculata
Virginia rockcress	Sibara virginica
Prairie dock	Silphium terebinthinaceum
Burreed	Sparganium androcladum
Great plains ladies-tresses	Spiranthes magnicamporum
Clandestine dropseed	Sporobolus clandestinus
Rough hedge-nettle	Stachys aspera
Needle-and-thread	Stipa comata
White coralberry	Symphoriocarpos albus
Eared false foxglove	Tomanthera auriculata
Spiderwort	Tradescantia virginiana
Humped bladderwort	Utricularia gibba
Flat-leaved bladderwort	Utricularia intermedia
Small bladderwort	Utricularia minor
Valerian	Valeriana edulis
American brookline	Veronica americana
Marsh speedwell	Veronica scutellata
Maple-leaved arrowwood	Viburnum acerifolium
Black arrowwood	Viburnum molle
Black haw	Viburnum prunifolium
Spurred violet	Viola adunca
Lance-leaved violet	Viola lanceolata
Macloskey's violet	Viola macloskeyi
Pale violet	Viola striata
Summer grape	Vitis aestivalis
Frost grape	Vitis vulpina

Habitat Evaluation/Assessment Protocols. N The following pages include that various habitat evaluational protocols mentioned in the Environmental Consideration Recomendations.

USDA NRCS MONARCH BUTTERFLY WILDLIFE HABITAT EVALUATION GUIDE (WHEG) AND DECISION SUPPORT TOOL; *Midwest Edition*: Version 2.0

EXECUTIVE SUMMARY

In response to the decline in the monarch butterfly population, USDA Natural Resources Conservation Service (NRCS) is providing technical and financial assistance to agricultural producers and other landowners to assist in the establishment of new monarch butterfly habitat and to assist with the enhancement of existing habitat. In the Midwestern United States, the effort is primarily focused on improving monarch habitat on NRCS land uses of Crop, Farmsteads, Range, and Associated Agricultural Land as defined by NRCS Field Office Technical Guides[1].

When working with decision-makers on the nation's private agricultural lands, the NRCS uses a 9-step conservation planning process (USDA 2013). During the planning process, if wildlife is identified as a resource concern, NRCS policy requires the use an approved Wildlife Habitat Evaluation Guide to identify habitat deficiencies (USDA 2010), and to present alternatives to the client. When the monarch butterfly *(Danaus plexippus)* is the target species, NRCS staff in the Midwestern United States will utilize this guide (*USDA NRCS Monarch Butterfly Wildlife Habitat Evaluation Guide and Decision Support Tool; Midwest Edition 2.0*) to support implementation the conservation planning process.

Monarch butterflies prefer a mid-successional (seral stage) plant community, rich and abundant in nectar-rich forbs. These conditions are seldom static, but rather require regular monitoring to identify the need to implement periodic disturbance (e.g. mowing, burning, disking, grazing or application of herbicides).

Temporary and permanent changes to soils, the seed bank and soil hydrology from past or current row-crop farming can complicate wildlife habitat development. The NRCS National Planning Procedures Handbook (NPPH) explains that conservation planning by its nature "is both progressive and adaptive" (USDA 2013). Unlike many NRCS national conservation practices (e.g. 328-Pond, 340-Cover Crop, and 649-Structures of Wildlife), the development of targeted conditions of a forb-rich perennial grassland habitat is seldom accomplished during a single year.

This Monarch Butterfly Wildlife Habitat Evaluation Guide (WHEG) and Decision Support Tool is designed to assess and rate current monarch habitat condition (benchmark conditions) on different portions of a farm or ranch, provide habitat development alternatives for each assessment area[2], predict/plan future outcomes (planned conditions), and to provide a mechanism to quantify gains in habitat quality (applied conditions). Unique to this guide, quantitative scores for each assessment area is converted to a qualitative monarch butterfly habitat rating of N/A, *poor*, *fair*, *good* or *excellent*. Thus, an agricultural operation, is not provided a monarch rating for the entire operation, but rather a different rating is provided to each assessment area (AA). The user of this WHEG will discover that it is constructed to be applied in a flexible approach depending on the objectives of the conservation planner and decision maker.

This conservation planning tool includes the body of the WHEG (commonly referred to as the "instructions"), an excel field data sheet, and technical support documents (planting lists, plant identification guides) contained in the appendices.

[1] Land use terms are from USDA-NRCS NPPH Circular 180-14-1, 10-1-2013

[2] *Assessment Area* is a portion of the larger monarch butterfly habitat development project that has unique abiotic (soils, slope, or wetness) or vegetative conditions.

TABLE OF CONTENTS

INTRODUCTION

The portion of the North American monarch butterfly (*Danaus plexippus*) population that overwinters in the highlands of Central Mexico, has suffered significant declines over the last two decades. For more specific information on the monarch butterfly population decline and biology, users of this WHEG are encouraged to read the document titled *NRCS Monarch Butterfly Habitat Development Project* (USDA 2015)[3] and the Appendix to this WHEG. Implementing NRCS conservation practices to benefit the monarch butterfly will benefit other grassland wildlife species that occupy periodically disturbed mid-successional (seral plant community stage) habitats. Any monarch butterfly habitat project must target forbs.

Monarch Butterfly and Habitat in the Midwest. In the absence of natural free-ranging herbivory and natural wildfires, artificial disturbances (e.g. prescribed burning, treatments with herbicides, brush management, prescribed grazing, or light disking) are periodically required to achieve and/or sustain the desired habitat condition of a mid-seral grassland plant community. Without such disturbance, the forb component will reduce in both richness and abundance (Figure 1), as will sedges and rushes in herbaceous wetlands. These habitats also require periodic management actions to control encroachment of trees and shrubs.

Figure 1: Without periodic disturbances, grassland habitats in the Midwest often become monotypic stands of grass, of poor value to monarch butterflies.

The foundation to all wildlife habitats, and the restoration of those habitats, is the soil. The highly productive grass-dominated ecosystems in the Midwest support primarily deep fertile soils, high in base compounds and organic matter (Mollisols, or soils with a mollic epipedon). Today, this region is

[3] http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/plantsanimals/pollinate/?cid=nrcseprd402207. For more detailed information on the biology of the monarch and its habitat, staff can access monarch webpages sponsored by Monarch conservation organizations, such as the Monarch Joint Venture https://monarchjointventure.org/, Monarch Watch http://www.monarchwatch.org/, Xerces http://www.xerces.org/, and Journey North's citizen observational data https://www.learner.org/jnorth/.

dominated by highly mechanized row-crop farming operations supporting continuous cultivation (Figure 2).

Figure 2: The Midwest supports some of the most productive and profitable farming operations in the world, limiting opportunities to incorporate monarch butterfly habitat.

Of much lesser extent, other soils in this region derived under woodland vegetation, or a combination of grasses and trees (savannah ecosystem). Years of soil tillage and erosion have reduced the organic matter, altered structure and minimized soil biota (Figure 3). These permanent changes (degradation) in the soils, seed bank, and the natural plant community complicate habitat restoration efforts, particularly efforts to re-construct a sustainable native forb component. Consideration of invasive and noxious grasses (e.g. fescue, smooth brome, and Reed canary grass) and broadleaf weeds (e.g. Canada thistle, purple loosestrife, and Russian knapweed), further complicate the monarch butterfly habitat development process in this region.

Figure 3: The impacts of intense cropping systems on soils necessitate habitat projects that can be integrated into highly altered Midwest landscapes.

Evaluating Monarch Habitat

Most NRCS wildlife evaluation guides determine the quality of habitat at the farm/ranch scale and provide a cumulative habitat score for the entire farm or ranch. The objective of these types of wildlife habitat guides is to identify the most limiting habitat factor (USDA 2003). The habitat needs for the target species are typically well understood. These types of WHEGs include the consideration of proximity and interrelationships to adjacent habitats, including habitats not within the project area (area encompassing all AAs). This approach is particularly appropriate for resident species with limited mobility (e.g. gopher tortoise, sage grouse, lesser prairie chicken). Identifying limiting factors for a highly mobile, multi-generational, migratory, invertebrate species, mandates a different approach.

When not migrating, the movement of individual monarchs is not well understood, though adults appear to move very long distances to acquire life requirements (Brower 1995, Brower et al.2011). Additionally, little is known about the importance of the spatial connectivity of habitats. What is known, is that the Eastern population of the North American monarch butterfly is at-risk (USDA 2015). Increasing the abundance, quality and distribution of habitat across its summer range is considered paramount to recover the species (Flockhart et al. 2014, Inamine et al. 2016, and Throgmartin et el. 2017). In consideration of the above statements, this monarch butterfly habitat guide recognizes that monarch butterflies are highly mobile and that the importance of connectivity and adjacency is unknown[4]. Thus, this WHEG is applied independently to different portions of the project area. Each unique area within the project area, is referred to as an *assessment area*. A farm or ranch (project area) will commonly have multiple assessment areas, including narrow linear habitats (Figure 4). Following independent implementation of the protocols to each assessment area.

Figure 4: Common milkweed (Asclepias syriaca) growing adjacent to a soybean field. Milkweed (Asclepias spp.*) and floral resources are often near cropland. The opportunities for large scale habitat restoration in the Midwest are limited, as this region supports some of the most productive soils in the world.*

[4] Within the monarch conservation community, many suspected that the lack of somewhat evenly distributed habitats across the migration path, may be as limiting to the overwintering population as is total acres of habitat. Hence one population stressor might be inadequate distribution of habitat acres, rather than total acres.

Based on best available science (Pleasants and Oberhauser 2012; Brower et al. 2011), a limiting factor for monarchs in the Midwest is the availability of quality breeding habitat (i.e., grassland containing a significant milkweed component). Additionally, others suggest the lack of nectaring habitat, particularly during the fall migration, may be a population stressor (Agrawal 2018; Agrawal 2017; Brower et al. 2006). Because the importance of nectar habitat is gaining appreciation within the scientific community this WHEG provides for three scores. One score for nectaring habitat, another for breeding habitat, and a composite score for those projects with an objective pf providing both breeding and nectaring habitat.

The habitat quality ratings (N/A, *poor*, *fair*, *good*, and *excellent*) derived from this WHEG are not designed to be used as a ranking mechanism for Farm Bill conservation programs. Maintaining the integrity of this WHEG as a planning tool and not a Farm Bill program ranking tool, allows the conservation planner the opportunity to apply the WHEG with flexibility by incorporating professional judgments deemed necessary for unique site conditions, including varying financial resources and objectives. With the decision to limit the WHEG as a planning tool, the scoring process is not encumbered with concern of consequences of the rating related to Farm Bill program eligibility.

Time Requirements to Apply the WHEG

This WHEG is designed to allow for application of Rapid Methods for most projects. It is anticipated that application of the rapid approach will only add less than one hour to the traditional conservation planning process. Application of the vegetative sampling methods required in the comprehensive method will add approximately two additional hours to the conservation planning process.

REFERENCE DOMAIN

Figure 5 provides the reference domain (area of applicability) for the NRCS Monarch WHEG; Midwest edition. The reference domain includes two Land Resource Regions (LRR) (USDA 2006) - M (Central Feed Grains and Livestock Region) and K (Northern Lake States Forest and Forage Region).

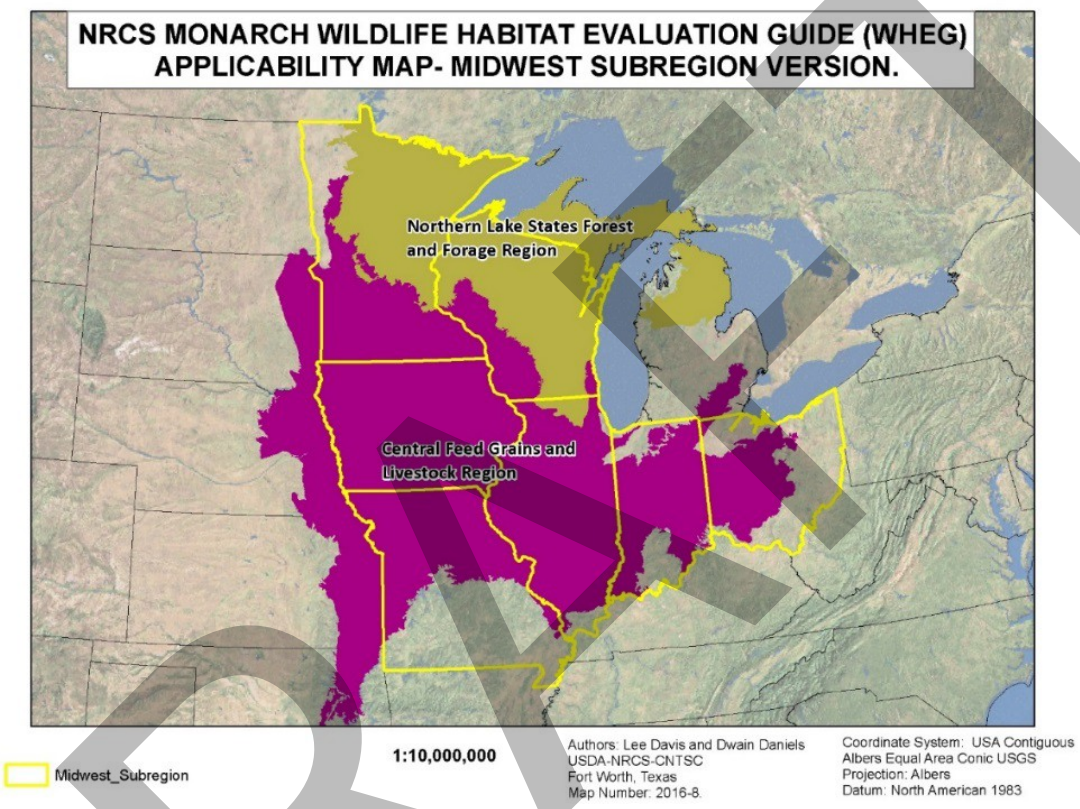

Figure 5: Applicability region for the NRCS Monarch WHEG; Midwest Edition.

The application of this WHEG on lands located in LRR's immediately adjacent to the reference domain may be appropriate if approved by the NRCS State Conservationist.

EXCLUSIONS

This WHEG is designed for use on degraded habitats that were once fully functional grasslands, savannas, or woodland within the reference domain. The WHEG will not be applied to current forested areas (forested swamps, riparian forested areas or forested uplands)[5] or other rare and declining habitats that are currently providing other important ecosystem services. Such areas contained within the project area will be rated as "N/A".

[5] Prairie soils invaded by early-successional woody are not considered forested for this exclusion. Examples of woody species that commonly invade grasslands in the Midwest include black locust (*Robinia pseudoacacia*), box elder *(Acer negundo*), eastern red cedar (*Juniperus virginiana*), elms (*Ulmus* spp.) and ash (*Fraxinus* spp.)

MONARCH BUTTERFLY: QUICK FACTS

Most key wildlife species in North America have been studied extensively for centuries. Life and habitat requirements of these species are well understood and well documented. This is not true for the monarch butterfly, as the science remains very dynamic. The Midwestern U.S. is critical to monarch butterflies that overwinter in Mexico. The WHEG is based on the best available science with the anticipation of future modifications.

The following are well understood:

- Adult monarchs leaving the overwintering grounds in Mexico move primarily north and northeast.
- Gravid females (i.e., carrying fertilized eggs internally) from Mexico, interrupt their northern migration, to lay eggs, primarily in Texas, but also in northern Mexico and other southcentral and southeastern states. Monarchs (1st Generation) born in in this region breed and migrate north and northeast to lay eggs (2nd Generation), some reaching Canada.
- Depending on the annual variability in weather, monarchs produce 3-5 generations of butterflies each year.
- Gravid females lay eggs (200-400 eggs) almost exclusively on plants in the genus *Asclepias*.
- The most important plant family for nectaring is the Composite family (Asteraceae).
- Summer breeding habitat in many portions of the Midwest is very limited (Pleasants and Oberhauser 2112; Brower et al. 2011).
- Monarchs with a natal origin of the Midwest contribute significantly to the total overwintering population in Mexico (Wassenaar, L.I. and K.A. Hobson 1998; Flockhart et al 2016; Flockhart et al. 2017). Note: The percent contribution from any one region of the U.S. varies each year, depending on the annual variability in weather (Flockhart et al. 2017).
- Gravid females are selective of the digestibility of individual plants (Baum and Sharber 2012; Fischer et al. 2015)
- Recent data demonstrates some sensitivity to milkweed density (Kasten et al. 2016).

The following are not well understood:

- individual monarch movements of gravid females, particularly during egg laying
- the movements (distance traveled) of wild gravid females during egg laying[6]
- preferred or importance of spatial scale and/or configuration of patterns of the monarch butterfly habitats for either migration or reproduction

[6] Female monarchs lay 400+/- eggs over many weeks, but the vast majority of the eggs are laid within a 7-10-day period (Edson 2007).

TIMING OF THE EVALUATION

For most situations, this WHEG can be applied during any time of the year with the use of remote sensing and/or a field visit without herbaceous vegetative data collection. However, for some situations, an inventory of forbs and milkweed (*Asclepias* spp.) is required. Ideally, this vegetative inventory is applied when species richness of the forb component is at its highest level, and when conditions are suitable for plant identification.

Figure 6: Late summer is an ideal time of the year to inventory a site for species richness and abundance.

RECOMMENDED SUPPLIES AND EQUIPMENT

If the assessment area supports enough *Asclepias* and other forbs to warrant vegetative sampling of the herbaceous community (as explained in the Instructions section), the following may be needed to conduct this assessment.

- Backpack
- GPS
- 100-foot measuring tape
- Pin flags or stakes
- Compass
- Clipboard
- WHEG, supporting documents and data sheets
- Plant ID field guide

INSTRUCTIONS

STEP 1: Develop a Project Base Map (Figures 7 and 8):

a. Delineate the entire area to be evaluated on aerial imagery. The area to be considered for monarch habitat improvements is referred as the "*project area*," which may consist of one or more assessment areas (AAs). *Note: Commonly, the project area will be the USDA Tract boundaries, but not always. In some situations, it may be a single field or a portion of field. The decision of the project area boundary is left to the discretion of the conservation planner and client (decision-maker).*

b. Identify areas within the project area that will *not* be evaluated. Within the project area, identify and delineate those areas where the decision-maker has no interest in development of monarch habitat. For example, the client might not be interested in converting a cropland field into monarch habitat. Identify such areas by placing the word "OUT" on the base map.

c. Identify all areas with the monarch WHEG land-type[7] of *Forested.* These areas include narrow zones of woody vegetation (riparian areas) and blocks of forested species such as elm (*Ulmus* spp.), green ash (*Fraxinus pennsylvanica),* pecan (*Carya illinoinensis*), or oaks (*Quercus* spp.). The *forested* monarch land-type is limited to areas that were historically and currently forested, and do not include sites that were once grasslands or savannahs. Exclude all such areas from the application of this WHEG. If determined to be the *forested* monarch WHEG land-type, document a rating of "N/A" on the base map and continue the evaluation other areas.

> *Monarch Fact*: Narrow forested riparian areas and edges of larger blocks of land supporting trees often provide important resting cover (micro-climates) for migrating monarchs, particularly during the fall migration.

d. Subdivide the remainder of the project area into unique assessment areas (AAs). As appropriate, subdivide the remainder of the project area into areas that have similar characteristics, such as ecological sites, vegetation, soils, slope, and management. These unique areas are referred to as *assessment areas* (AA). Identify each AA on the base map. To not conflict with Common Land Units (CLU) and USDA field numbering, choose an alphabetical notation (A, B, and C). An assessment area need not be fully contained in a contiguous polygon. For example, if more than one portion of the project area supports similar characteristics such as a dense stand of eastern red *cedar* (*Juniperus virginiana*) on steep slopes, then each polygon supporting these conditions will be assigned the same AA label. For these situations, follow a sequential numeric notation (A1, A2, A3, etc.) to denote that a group of non-contiguous areas ("sub-assessment areas" or "sub-areas") have similar characteristics and will be considered as one assessment area.

e. Determine size of each area. Determine and denote the acres in each assessment areas (including each sub-area) on the base map.

[7] This monarch butterfly WHEG requires the identification of a "Monarch Butterfly WHEG Land-type" for each Assessment Area. Monarch habitat development options and decisions are provided for each monarch land-type. There are 5 Monarch Butterfly WHEG Land-Types in this WHEG: *FORESTED, CROP, MONOTYPIC GRASS OR LEGUMES, FORESTED,* or *OTHER PRIMARILY HERBACEOUS COMMUNITIES*. The FORESTED Monarch WHEG Land-type is unique as the WHEG prohibits conversion of the FORESTED monarch WHEG land-type to monarch habitat.

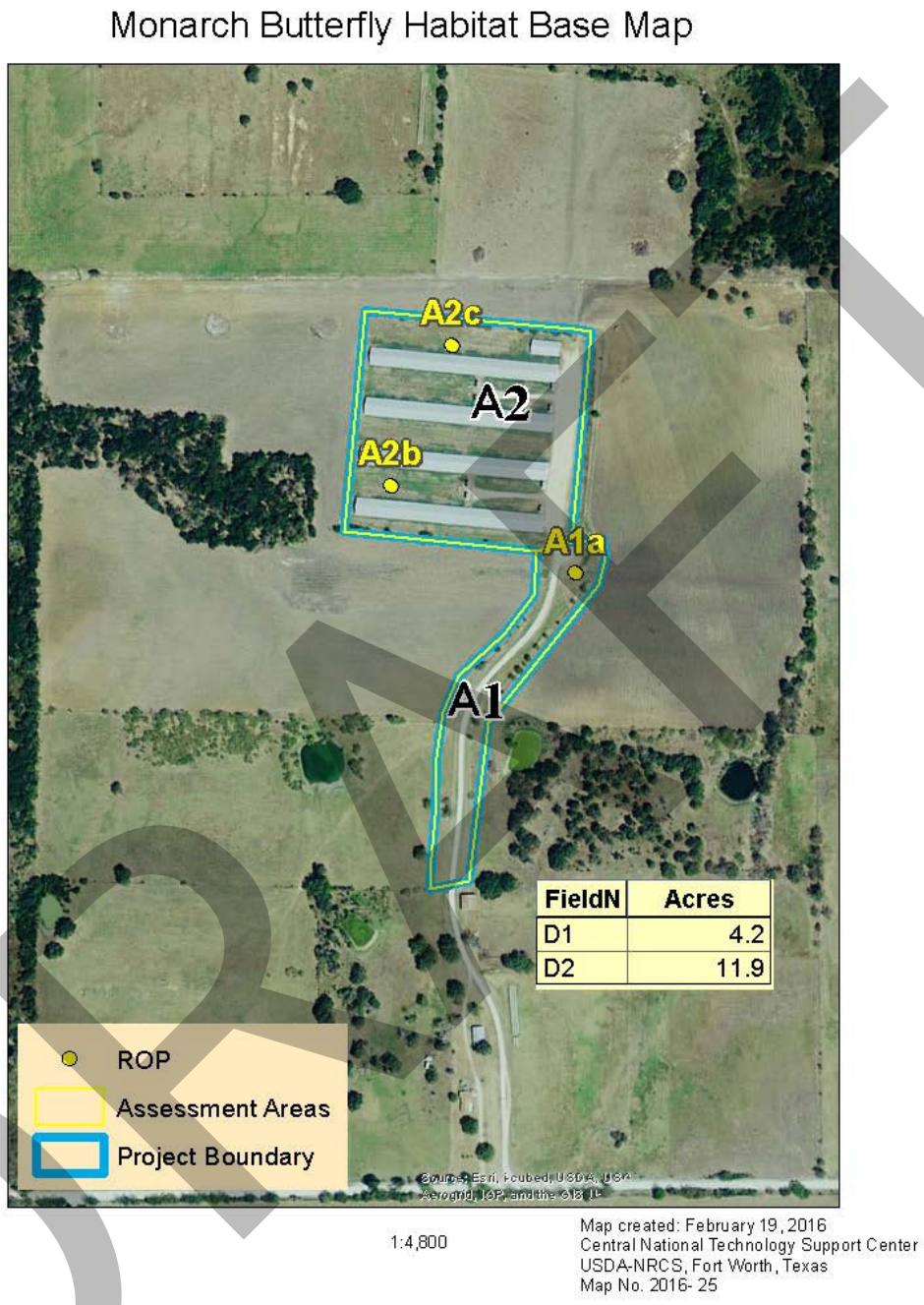

Figure 7: Example of a monarch habitat development base map for a less complex project. Note the concept that an assessment area need not be contiguous. This assessment area (A) is divided into two subareas (A1 and A2). ROP denotes Representative Observation Point (e.g., A1a, A2b, and A2c).

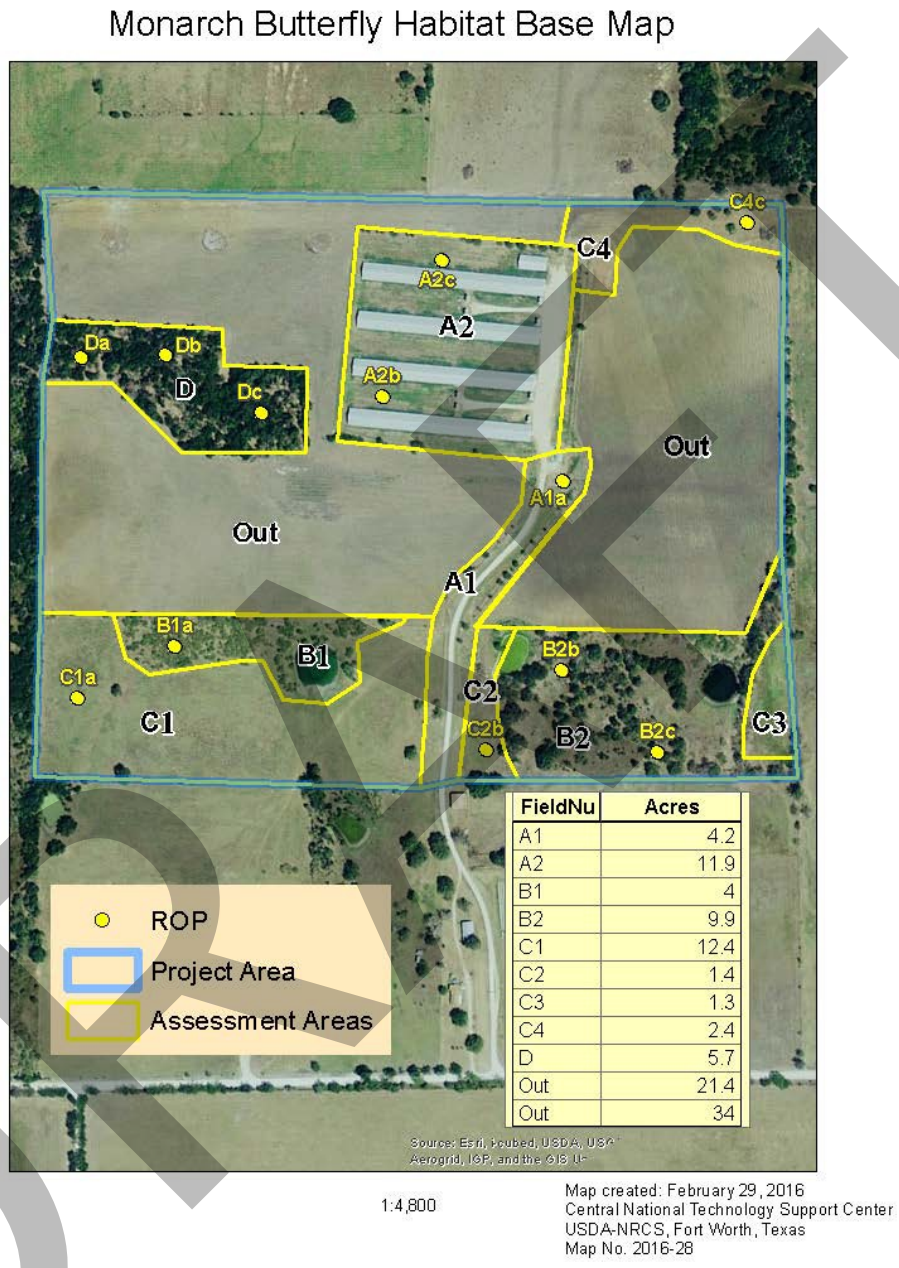

Figure 8: Example of a monarch habitat development base map for a complex project. Note the concept that an assessment area need not be contiguous. As an example, the open herbaceous assessment area C has four subareas (C1, C2, C3, and C4). ROP denotes Representative Observation Point (e.g., B1a, B2b, B2c, Da, Db, and Dc).

USER NOTE: To save staff time, this WHEG allows the planner to rapidly screen AAs that will not require the full application of the WHEG protocols, based on the plant community. For example, vegetative sampling to determine the density of milkweed and/or nectaring species has no value for a cropland area under consideration of conversion to monarch habitat. This rapid screening process, and the presentation of conservation planning alternatives, are based on four monarch WHEG Land-types[8]. Each type is defined in Steps 2 (Rapid Method) and 3 (Comprehensive Method). To support the rapid screening concept, no vegetative sampling or numeric scoring will occur in Step 2. Rather, the WHEG directs the user to apply a benchmark rating of *poor*.

STEP 2 (Rapid Method): Identify Monarch WHEG Land-types that have low species richness or abundance. These Monarch Land-types allow for a rapid decision on monarch butterfly habitat quality.

a. Determine the Monarch WHEG Land-type and document the decision on the data sheet(s) for the assessment area.

i. *CROP* – Any area that (i) is being annually planted for harvest of a product, or (ii) is planted to alfalfa *(Medicago sativa*).

A. Document a benchmark condition rating of *poor* and end the assessment.

B. If the planning consideration below are an objective of the decision maker, continue to Step 4; otherwise, identify the AA as "OUT" on the base map per step 1b and end the assessment[9].

- Alternatives and Planning Considerations:

— Decision maker will convert the AA into productive habitat by implementing a core habitat establishment practice standard (Appendix C.) such as Conservation Cover (327) or Field Border (386), with the additional criteria to enhance wildlife, pollinator and beneficial organism habitat, with the monarch butterfly as the target wildlife species.

— In addition, the decision maker will implement threat reduction techniques and/or practices sufficient to achieve minimum variable scores of V^{IR}= 0.2, and V^{WMR}= 0.3.

— Implement any number of supporting practices (Appendix C.), as appropriate.

ii. *MONOTYPIC GRASSES or LEGUMES (including pasture, managed hay, farmsteads, and other frequently-managed areas, OR areas with low forb richness or abundance)* - These areas support primarily monotypic non-native or native grass species. Plant species richness is low. Examples are reed canary grass (*Phalaris arundinacea*), Kentucky bluegrass (*Poa pratensis*), smooth brome (*Bromus inermis*), fescue (*Schedonorus* spp.), bluestems (*Andropogon and Schizachyrium* spp.), switch grass (*Panicum virgatum*), and clover (*Trifolium* spp.). There may be some woody encroachment, but not to such a level to warrant a land-type of *Brush*.

A. Document a benchmark condition rating of *poor* and end the assessment of benchmark habitat conditions on the datasheet.

[8] Monarch WHEG Land-types are related specifically to this WHEG and should not be confused with the term "landuse" in the NRCS National Conservation Planning Manual or program guidance. The WHEG's rapid method is used to determine monarch habitat quality ratings for CROP, MONOTYPIC GRASS or LEGUMES and BRUSH types. A more rigorous protocol is used for the Land-type of OTHER PRIMARILY HERBACEOUS COMMUNITIES.

[9] If the CROP AA is immediately adjacent to monarch habitat, consider pesticide drift risks to the adjacent habitat.

B. If any of the planning considerations below are an objective of the decision maker, continue to Step 4; otherwise, identify the AA as "OUT" on the base map per step 1b and end the assessment for this AA.
   - Alternatives and Planning Considerations:
     - Decision maker will convert the AA into productive habitat by implementing core management practice standards, such as Herbaceous Weed Treatment (315), Prescribed Burning (338) or Early Successional Habitat Development and Management (357); and habitat establishment practice standards (Appendix C.), such as Conservation Cover (327) or Field Border (386), as appropriate. , with the additional criteria to enhance wildlife, pollinator and beneficial organism habitat, with the monarch butterfly as the target wildlife species.
     - In addition, the decision maker will implement threat reduction techniques and/or practices sufficient to achieve minimum variable scores of V^{IR}= 0.2, and V^{WMR}= 0.3.
     - Implement any number of supporting practices, as appropriate.
     - Implement strategic disturbance periodically throughout the life of the plan to increase milkweed and/or monarch nectaring plant species richness, abundance and cover by applying core management practices.

iii. *BRUSH* – These areas support woody vegetation (brush) at a density that prohibits implementation of other management options (e.g. herbaceous vegetation is minimized due to shading). The planner and decision-maker agree that the brush must be addressed prior to implementation of any other monarch habitat efforts. This land-type should not be used if forested, rather it is used for historic grasslands invaded by woody plants (e.g. cedar, boxelder, green ash).

A. Document a benchmark condition rating of *poor* and end the assessment of benchmark habitat conditions on the datasheet.

B. If any of the planning considerations below are an objective of the decision maker, continue to Step 4; otherwise, identify the AA as OUT on the base map per step 1b and end the assessment.
   - Alternatives and Planning Considerations:
     - Decision maker will convert the AA into productive habitat by implementing core management practice Brush Management (314) and as needed, core establishment practices such as Conservation Cover (327) or Field Border (386).
     - In addition, the decision maker will implement threat reduction techniques and/or practices sufficient to achieve minimum variable scores of V^{IR}= 0.2, and V^{WMR}= 0.3.
     - Implement any number of supporting practices, as appropriate.

STEP 3 (Comprehensive Method): Assign ratings for the subset of the other AAs with a monarch WHEG land type of *Other Primarily Herbaceous Communities.*

i. *OTHER PRIMARILY HERBACEOUS COMMUNITIES* – These areas support grasses and may have a significant forb component including glades, prairies, savanna, conservation areas, old fields, and odd areas. There may be some woody encroachment, but not to the level to warrant a land-type of *Brush*.
   A. Document the benchmark habitat conditions on the datasheet.
   B. Continue to Step 4

Determine the monarch habitat scores for the assessment areas identified as the Monarch land-type *OTHER PRIMARILY HERBACEOUS COMMUNITIES*, by considering the following monarch habitat variables:

— Insecticide Risk Condition V^{IR}
— Weed Management Risk Condition V^{WMR}
— Average Milkweed Stem Density V^{MWD}
— Forb Cover V^{FC}
— Forb Richness V^{FR}

Insecticide Risk Condition

V^{IR} Insecticide Risk Condition[10]	Benchmark Score	Planned Score	Applied Score
A portion of the AA is treated with insecticides, including insecticidal seed treatments.	STOP (AA rating is *poor*)		
A portion of the AA is located within 100 feet of areas treated with insecticides, AND no insecticide drift techniques are be assured.	0.2	0.2	0.2
A portion of the AA is located within 100' of areas treated with insecticides, AND the AA is either (a) located where it is not downwind of the areas treated with insecticides (seed treatment or foliar), based on prevailing wind direction during the growing season[11], or (b) insecticides are not applied (seed treatment or foliar) when wind is blowing towards the AA.			
AND > 25% of the AA is within 100' of treated areas.	0.5	0.5	0.5
AND <25% of the AA is within 100' of treated areas.	0.7	0.7	0.7

[10] V is used for the term "variable". These are variables used to calculate the final score and rating for the AA.
[11] State Offices will provide guidance on how staff will determine prevailing wind direction.

The AA meets conditions for a score of 0.5 above, AND offsite pesticide drift mitigation techniques from Table 3 of TN-190-AGR-9 are implemented to meet a target index score of at least 20 points.	0.8	0.8	0.8
The AA meets conditions for a score of 0.7 above, AND offsite pesticide drift mitigation techniques from Table 3 of TN-190-AGR-9 are implemented to meet a target index score of at least 20 points.	0.9	0.9	0.9
The entire AA is greater than 100' from any area treated with insecticides (including seed treatment).	1.0	1.0	1.0

Weed Management Risk Condition

V ^{WMR} Weed Management Risk Condition	Benchmark Score	Planned Score	Applied Score
AA is treated with herbicides[1], OR weed management of the AA is inconsistent with Monarch Best Management Practices adopted by the state.	STOP (AA rating is *poor*)		
A portion of the AA is located within 30' of areas treated with herbicides, AND weed management of the AA is consistent Monarch Best Management Practices adopted by the State.	0.3	0.3	0.3
AA meets the requirement for 0.3 (above), AND the Client agrees to implement off-site drift prevention or mitigation practices and/or techniques from Table 3 of TN 190-AGR-9 totaling an index score of at least 20.	0.6	0.6	0.6
Weed management is consistent with all applicable BMPs adopted by the state, AND the entire AA is located more than 30' of areas treated herbicides, while a portion of the AA is located within 100' of areas treated with herbicides.	0.5	0.5	0.5
AA meets all conditions prescribed for a score of 0.5 (above), AND the Client agrees to implement off-site drift prevention or mitigation practices and/or techniques from Table 3 of TN 190-AGR-9 totaling an index score of at least 20.	0.85	0.85	0.85
The entire AA is greater than 100' from any area treated with herbicides, AND weed management is consistent with all applicable monarch Best Management Practices.	1.0	1.0	1.0

[1] *Do not consider treatments, such as NCP Brush Management (314), Herbaceous Weed Treatment (315), or Individual Plant Treatments (IPT) when required for establishment of milkweed or nectaring habitat.*

SAMPLE VEGETATION TO DETERMINE MILKWEED DEINSITY AND FORB COVER AND RICHNESS

i. Use the following process for variable factors V^{MWD}, V^{FC}, and V^{FR}
   - Locate *Representative Observation Points* (ROP's): Within the assessment area, locate at least three observation points that best represent the vegetative conditions (e.g. species, density, richness) that occur in the AA. If the assessment area supports subareas (noncontiguous areas with similar vegetation, soils, slopes, etc.) the determination of the location of the ROP's will be based on locations that best represent the assessment area, without the need in having a ROP in each subarea. *Note: If the AA is small and/or the community is ecologically diverse (species are evenly distributed within the AA), then selection of a single ROP, or inventorying the entire AA would be suitable.*
   - At each ROP, determine the direction of a 72.6 X 6' belt transect that would capture vegetation most representative of the community in the assessment area. If the plant community within a 72.6-foot radius from the ROP is homogeneous, then the belt transect may be oriented in any direction.
   - Denote the vegetative transect geo-location and direction on the data sheet or base map.
   - Sample vegetation within each assessment area by doing the following: *Note: There will be one data sheet for each assessment area; however, subareas are combined in one data sheet.*
     - **Milkweed**: Walk the full distance of the belt transect (72.6' X 6') noting the presence of *Asclepias* plants[12] emerging from within one side of the belt transect (72.6' X 3'). Upon the return to the ROP, repeat this process on the other side of the belt transect (72.6' X 3').[13] Document the findings on the data sheet for this assessment area.
     - **Monarch Nectaring Forbs**: Collect monarch nectaring forb data within three 6' x 6' plots. The first 6' X 6' plot will be between 10 – 16 feet; the 2nd between 34 – 40 feet; and the 3rd between 60 and 66 feet. Visually estimate the absolute percent cover[14] of monarch nectaring forbs[15] in each plot. Document the findings on the data sheet.
   - Repeat this sampling approach at each transect within the assessment area.

[12] A milkweed "plant" is a stem emerging from the ground, surrounded by soil. The most common milkweeds in the Midwest (common and swamp milkweeds) are rhizomatous with above ground stems having a common root system. To count in this tally, the stem must originate from the soil within the belt transect. Each stem emerging from the soils is considered a plant for tallying purposes, regardless of the origination point under the soil surface.

[13] Young milkweed plants, and smaller species are difficult to inventory in dense or tall vegetation. Sub-diving the belt transect into halves (3' wide) allows for an improved inventory. In some plant communities, milkweed plants are obvious and inventorying the entire 6' wide belt transect can be done in a single pass.

[14] Absolute cover is the percent shading that would occur if the sun was directly over the plot. Absolute cover for a single species would never exceed 100 percent, but cumulative (many species) would commonly exceed 100 percent in an herbaceous plant community.

[15] Nectaring forbs are included on the Monarch WHEG Plant List in the appendix. *Asclepias* spp. serve as preferred nectaring species. As such, they are included in the monarch nectaring forb inventory.

V^{MWD}: Average milkweed stem density per acre	Benchmark Score	Planned Score	Applied Score
Milkweed absent in belt transects and the AA.	0.10	0.10	0.10
Milkweed absent in belt transects; however, individual milkweed stems present in the AA.	0.15	0.15	0.15
100 – 200	0.30	0.30	0.30
201 – 300	0.50	0.50	0.50
301 – 500	0.80	0.80	0.80
> 500	1.00	1.00	1.00

- Alternatives and Planning Considerations:
  - If the score is 0.15 or less, the decision-maker will implement a core habitat establishment practice standard such as Conservation Cover (327), Field Border (386), etc. to increase milkweed density to at least 500 stems per acre.
  - If the score is 0.3 – 0.5, the decision-maker will implement one of the following options. Both options will increase milkweed density and improve larval-monarch foraging habitat as the targeted condition with monarch breeding and foraging habitat as the stated purpose:
    - Option 1: Conservation Cover (327) alone, or in combination with 315 or 338 or 647.
    - Option 2: Herbaceous Weed Treatment (315), Prescribed Burning (338), Early Successional Habitat Development and Management (647), etc.
  - If the score is 0.8 - 1.0, the decision-maker will implement core management practices such as Prescribed Burning (338), Early Successional Habitat Development and Management (647), etc. and as appropriate, supporting practices to maintain milkweed density.

V^{FC}: Forb Cover: Average monarch nectaring forb cover within the AA	Benchmark Score	Planned Score	Applied Score
Absent (≤ 2.0%)	0.10	0.10	0.10
Rare (2.1-5.0%)	0.20	0.20	0.20
Uncommon (5.1 – 15.0%)	0.30	0.30	0.30
Moderately abundant (15.1 – 25.0% cover)	0.60	0.60	0.60
Abundant (25.1% – 35.0% cover)	0.80	0.80	0.80
Very Abundant (> 35.0%)	1.00	1.00	1.00

V^{FR}: Forb Richness: Average number of monarch nectaring forb-species within the AA	Benchmark Score	Planned Score	Applied Score
< 1	0.10	0.10	0.10
1 -2	0.30	0.30	0.30
2.1 – 3.5	0.50	0.50	0.50
> 3.5	0.80	0.80	0.80
> 3.5 and two or more species of *Asclepias* are represented in the bel transect.	1.00	1.00	1.00

- Alternatives and Planning Considerations (applies to V^{FC} and V^{FR}):
  - If the score is less than 0.3, the decision-maker will implement a core habitat establishment practice such as Conservation Cover (327), Field Border (386), etc. to increase forb cover.
  - If the score is 0.3 – 0.5, the decision maker will implement one of the following options. Both options will increase nectaring forb cover, and improve foraging habitat as the targeted conditions4,6 with breeding and foraging habitat as the stated purpose
    - Option 1: Conservation Cover (327) alone, or in combination with 315 or 338 or 647, with the additional criteria to "enhance wildlife, pollinator and beneficial organism habitat", with an improvement in monarch nectaring habitat being the target conditions.
    - Option 2: Herbaceous Weed Treatment (315), Prescribed Burning (338), Early Successional Habitat Development and Management (647), etc., with the additional criteria to "enhance wildlife, pollinator and beneficial organism habitat", with wildlife habitat as the purpose and monarch nectaring habitat as the target conditions.
  - If the score is > 0.5, the decision-maker will implement core management practices such as Prescribed Burning (338), Early Successional Habitat Development and Management (647), etc., and as appropriate, supporting practices to maintain nectaring forb cover or richness, respectively.

ii. Apply the following formula(s) to determine Monarch Habitat Condition Rating (benchmark, planned, or applied rating) for the target habitat objectives (breeding, nectaring, or both breeding and nectaring).

Breeding Habitat Formula:

$$BH\ Score = (2V^{IR} + V^{WMR} + 6V^{MWD})/9$$

Nectaring Habitat Formula:

$$NH\ Score = (V^{IR} + 2V^{WMR} + 4V^{FC} + 3V^{FR})/10$$

Composite Habitat Formula

$$WHEG\ Score = (BH + \mathrm{NH})/2$$

iii. Determine benchmark monarch habitat condition rating for the target habitat (breeding, nectaring, or composite) and end the assessment of current conditions.

Monarch Habitat Condition Score	Benchmark Score	Planned Score	Applied Score
0.00 – 0.25	*poor*	*poor*	*poor*
0.26 – 0.49	*fair*	*fair*	*fair*
0.50 – 0.74	*good*	*good*	*good*
0.75 – 1.00	*excellent*	*excellent*	*excellent*

STEP 4: DETERMINE PLANNED MONARCH HABITAT CONDITION RATING

Monarch Habitat Success Criteria: The minimum criteria to meet conservation practice standard Upland Wildlife Habitat Management (645) for the monarch butterfly is a rating of *good* for the limiting factor (breeding, nectaring or a composite score). Based upon the best professional judgement of NRCS staff biologists, the implementation of core establishment practices with or without core management practices is expected to result in a future WHEG score of 1.0 (*excellent* rating). However, the implementation of core management practices alone is expected to achieve a lower planned score of 0.8 (also an excellent rating). The above planned scores and ratings presume a weed management risk condition (V^{WMR}) score of at least 0.6. Based upon the best professional judgement of NRCS staff biologists, if the weed management risk condition score is less than 0.6, both forb cover and forb richness will suffer. For this reason, planned scores for these habitat variables will be automatically discounted in the WHEG datasheet, thereby, leaving no guesswork to the planner. If planned conditions are rated *poor* or f*air* and the monarch remains a resource concern for that AA, then the plan does not meet a Resource Management System (RMS) (NRCS 2013). Determine if monarch habitat remains a resource concern for the AA. Continue the progressive planning process.

STEP 5: DOCUMENT DECISIONS

Following consideration of the findings and presentation of alternatives, incorporate monarch butterfly habitat decisions in the conservation plan for those AA's where the monarch butterfly remains an objective. Provide plan implementation assistance, as needed.

STEP 6: FOLLOW UP

Seldom can any conservation practice be installed with confidence without the need to revisit the site to determine the post implementation conditions and identify adaptive management needs that would benefit the conservation effort. As mentioned in the executive summary, the NRCS National Planning Procedures Handbook (NPPH) explains that conservation planning by its nature "is both progressive and adaptive" (USDA 2013). This statement is particularly true for wildlife habitat efforts on grasslands. Progressive and adaptive planning requires follow up, monitoring and flexibility. It is anticipated that this WHEG may be used in subsequent years to not only measure gains in monarch habitat quality (applied conditions ratings), but also to continue the progressive and adaptive planning process.

DEFINITIONS

Assessment area (AA): A portion(s) of a planning unit of a project area that differ from other portions of the project area. This subdivision/delineation of AA's is based on differences in soils[16], slope, vegetation, current or future land use, etc. Delineations are made when the differences between two areas are significant enough to result in either (i) a different rating or (ii) a different habitat development recommendation. The purpose of delineation of an AA is to allow for input (data collection) and output (alternatives for treatment). Unique areas contained within a larger AA that are too small for application of a different conservation practice, should be included in a larger AA; however, they will not be sampled. An AA may include non-contiguous sub-assessment areas (subareas). An example would be if a project contained three non-contiguous areas on steep slopes with shallow soils, and each area is dominated by juniper. The characteristics (and treatments) of these three subareas are so similar that they are considered a single AA.

Base map: A map of the entire project area with delineations and notations of assessment areas, sizes of assessment areas and/or subarea, representative observation points, transects, other notations. The final map will denote the baseline condition rating, or the rating may be provided in another format (e.g. tabular)

Benchmark habitat condition rating (benchmark rating): A qualitative rating (e.g. N/A, poor, fair, good, or excellent) that reflects the current habitat conditions or value. This rating is often derived from cumulative quantitative scoring of different habitat condition variables.

Habitat condition variable (V): A non-static habitat characteristic (e.g. vegetation, size, connectivity) that can be changed with the implementation of conservation practice standards. Static conditions or characteristics (e.g. soil type) fail to meet the definition of a variable. Variables are assigned scores from 0.1 – 1.0 based on the matrix being measured or planned within the assessment area. A score of 1.0 reflects the range of conditions for that variable that would occur if the habitat is in excellent condition. Similarly, a score of 0.4 reflects the range of conditions (matrix being measured) that would occur for that variable when at 40% of the value to the species needed to reach 1.0. The final habitat condition rating (N/A, *poor*, *fair*, *good* or *excellent*) is based on a single habitat condition variable, or a subset of variables applied to a mathematical formula. In a habitat assessment rating formula, variables are often mathematically weighted by importance. A score of 0.0 is reserved for conditions that are not salvageable or restorable.

Planned habitat condition rating (planned rating): In consideration of habitat development alternatives, the WHEG can be re-applied to plan future conditions or results. If the rating remains as *poor* or *fair*, additional alternatives are needed to meet the criteria of National Conservation Practice Standard 645. If the rating is *good*, additional alternatives are presented for consideration. If the rating is *good* or *excellent*, the requirements of operation and maintenance is presented to the decision maker.

Project area: A single polygon (outside boundaries) that delineates the entire area being evaluated for potential monarch habitat. Most commonly the project area will follow common land unit or field boundaries, but not always. There will commonly be areas within the project area where monarch habitat is not identified as a resource concern (e.g. cropland field, hay field, bottomland hardwood forest).

Reference domain: From Smith et al. (1995). The furthest-most geographic reach, range, scope of the applicability of the WHEG. The reference domain delineates the outside boundary of the area (single polygon) that contains all sites (reference sites) used to build, test, or calibrate the WHEG. The reference domain establishes a boundary of applicability of the WHEG. There may be areas, within the reference domain, where the WHEG is not applicable. For example, in application of an early successional upland grassland WHEG, it would be prohibited to apply the WHEG on mature forested swamp community. Those areas are typically assigned a rating of N/A. These situations are described in the Exclusions section of the WHEG.

Representative observation point (ROP): Concept derived from the Corps of Engineers Wetland Delineation Manual (1987). A point contained within an assessment area that represents the average conditions (e.g. soils, vegetation, disturbance, slope, and wetness) that are occurring within the AA. Proper selections of ROP's allow for sampling intensities to be less than what would be required under random sampling strategies.

Applied habitat condition rating (applied rating): After full implementation of the selected national conservation practice standard(s), the WHEG can be re-applied to the assessment area to determine results. If the rating remains as *poor* or *fair*, additional alternatives are needed to meet the criteria of National Conservation Practice Standard 645. If the rating is *good*, additional alternatives may be presented for consideration. If the rating is *good* or *excellent*, consideration of actions required to maintain the habitat are presented.

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Appendix A: Monarch WHEG Data Sheet:

— The data sheet can be accessed at the NRCS Monarch Butterfly Webpage.

Appendix B: Important Plants of the Monarch Butterfly – Midwest Staff Guide, Ver. 2.0

— The data sheet can be accessed at the NRCS Monarch Butterfly Webpage.

Appendix C: Commonly Applied Conservation Practices

— Provide on page 27

Appendix C: Commonly Applied Conservation Practices for the Development or Management of Monarch Butterfly Habitat in the Midwest

Conservation Practice Standard	Code	Category (CR)[2]	Practice Type[3]
Access Control	472	Supporting[4]	Management
Brush Management	314	Core	Management
Conservation Cover	327	Core	Establishment
Critical Area Planting	342	Supporting	Establishment
Early Successional Habitat	340	Supporting	Management
Fence	382	Supporting	Management
Field Border	386	Core	Establishment
Fire Break	394	Supporting	Management
Forage Harvest Management	511	Core	Management
Hedgerow Planting	422	N/A	Establishment
Herbaceous Weed Treatment	315	Supporting	Management
Integrated Pest Management	595	Supporting	Management
Prescribed Burning	338	Core	Management
Prescribed Grazing	528	Core	Management
Restoration of Rare or Declining Natural Communities	643	Supporting	Establishment
Riparian Forest Buffer	391	Supporting	Establishment

[2] NRCS and the USFWS developed a Monarch Butterfly Conference Report (CR) in 2016. A CR serves as part of the consultation requirements of Section 7 of the Endangered Species Act (ESA), in the event of a positive listing decision under the ESA. Table 1 of the CR provides a list of conservation practice standards covered by the Conference Report. Table 1 is much more extensive than the list provided in the Monarch WHEG. The CR identifies 645 as the Umbrella practice, and designates all other practices as either Core or Supporting. A Core practice can stand alone, while a supporting practice most commonly is implemented in support of a Core Practice.

[3] Conservation Practice Standards can be used to support monarch habitat by creating new habitat, or as a management tool to improved conditions of existing habitat.

[4] This WHEG uses 3 practice categories:

Practice Categories:

1. Umbrella: Serves as the foundation for the conservation planning process for the monarch butterfly. Though required in the conservation plan, the umbrella practice is not required in a financial assistance contract.
2. Core: Can be planned and implemented as a standalone practice.
3. Supporting: Are not a standalone practice, but rather are used to support a core practice.

Riparian Herbaceous Cover	390	Core	Establishment
Upland Wildlife Habitat Mgmt.	645	Umbrella	Management
Wetland Enhancement	659	Supporting	Management
Wetland Restoration	657	Supporting	Management
Wetland Wildlife Habitat Mgmt.	644	Supporting	Management

XERCES SOCIETY
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Rusty Patched Bumble Bee Habitat

Assessment Form & Guide

May 2017

The Xerces Society for
Invertebrate Conservation

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Cover Photographs

Cover main: A wooded bluff and streamside prairie in the Driftless Area of Wisconsin (photograph by Susan Carpenter, UW-Madison Arboretum); left: *Bombus affinis* (rusty patched bumble bee) on joe pye weed, *Eutrochium purpureum* (photograph by Rich Hatfield, The Xerces Society); right: eastern woodland with pollinator-friendly understory (photograph by Jennifer Hopwood, The Xerces Society).

Photographs

We are grateful to the photographers for allowing us to use their wonderful photographs. Susan Carpenter, UW-Madison Arboretum: 2, 3, 10a, 10c. Sarah Foltz Jordan, the Xerces Society: 7a, 7b. Eric Lee-Mäder, The Xerces Society: 7c, 7d. Johanna James: 9. Dustin Blakey, Flickr: 10b. Jennifer Hopwood, The Xerces Society: 10d. Scott Seigfreid: 12. The copyright for all photographs is retained by the photographers. None of the photographs may be reproduced without permission from the photographer. If you wish to contact a photographer, please contact the Xerces Society at the address below.

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The Xerces Society for Invertebrate Conservation is a nonprofit organization that protects wildlife through the conservation of invertebrates and their habitat. Established in 1971, the Society is at the forefront of invertebrate protection, harnessing the knowledge of scientists and enthusiasm of citizens to implement conservation programs worldwide. The Society uses advocacy, education, and applied research to promote invertebrate conservation.

Rusty Patched Bumble Bee Conservation

Habitat Assessment Form and Guide

Purpose

The rusty patched bumble bee (*Bombus affinis*) is listed as an endangered species by the U.S. Fish and Wildlife Service. This species has specific habitat requirements, including high quality foraging resources, nesting sites, overwintering sites, and protection from pesticides, introduced diseases, and other disturbances. This tool is meant to help educate conservation planners and landowners, prioritize conservation actions, and quantify habitat or land management improvements for the rusty patched bumble bee on a single site. As existing conditions and degree of habitat management at any given site are different the goal of this tool is not to compare one site with another. Rather, it is intended to help incorporate conservation efforts for the rusty patched bumble bee into a landscape management plan and then identify specific actions for habitat improvement and/or management practices to help protect the rusty patched bumble bee from potential threats. As with any tool of this nature, the evaluation and scoring practice is a subjective process, and the usefulness of the tool is dependent upon the consistency and skills of the evaluator. While the goal is to implement changes that will result in improved habitat, there may not always be a viable treatment for individual variables. The scoring goals outlined in the instructions are general guidelines, but the capacity to reach or exceed these goals varies widely in different landscapes and may be refined by conservation planners for a more regionally specific pollinator habitat assessment guide. This guide was developed with the purpose of assessing sites where the rusty patched bumble bee has been recently detected, but can also be employed by anyone seeking to improve their land for bumble bees.

Instructions

- This rusty patched bumble bee habitat assessment guide is designed for natural areas on public and private lands. If you are working in a farm landscape, please consider using our *Pollinator Habitat Assessment Form and Guide: Farms and Agricultural Landscapes* (available as a free download at: www.xerces.org/habitat-assessment-guides/; Note: this assessment form is not specific to the rusty patched bumble bee).
- The accompanying photos and notes will help you identify and assess some specific habitat features.
- An assessment would ideally be done twice, once during the habitat evaluation process (before project implementation) and once after any changes have been implemented.
- Each item in the assessment should be given a score of 0 if not present or the appropriate value from the "Score" column.
- If you are conducting an assessment for the USFWS, obtain the 10 x 10 km grid ID and sighting ID directly from the Service (contact your local field office: https://www.fws.gov/midwest/es/fld_off.html). Use the 10 x 10 km grid cell to address question 1a.
- If this is not an official USFWS assessment, address question 1a using an online mapping program with a satellite view. Assess the habitat within a 5 km radius of your location.
- Prior to conducting an assessment, print aerial photos to help with site and landscape questions.
- Add up the scores to calculate a subtotal for each subsection.
- Next, add up subsection subtotals to get a total for each section. Transfer these figures into the summary table on page 3 to generate the overall score for each assessment.
- Ideally, landowners/managers should strive to achieve an overall score of at least 100, and an improvement of at least 40 points. If this is not possible for your region or land management plan, talk to your area biologist, regional ecologist, or planner for guidance.

A southern Wisconsin planting of diverse native prairie forbs that provides floral resources throughout the growing season.

Site Summary

Obtain the Grid ID and RPBB sighting ID from the USFWS. If this is not an official assessment leave blank.

Owner/ Operator:		Planner:
10 km x 10 km Grid ID:		Associated RPBB sighting ID:
Survey locality/address:		
Dates	Existing condition assessment:	
	Assessment after implementation:	
Define and describe the project area (attach annotated maps; include Ecological Classification System information, if known):		

Total Score for Habitat Assessment

The figures entered into this summary table will be calculated during completion of the assessment.

	BEFORE	AFTER
Section 1: Regional and Landscape Features *(max score 20)*		
Section 2: Site Features *(max score 35)*		
Section 3: Foraging Habitat *(max score 50)*		
Section 4: Nesting and Overwintering Habitat *(max score 30)*		
Section 5a: Pesticide Practices *(max score 40)*		
Section 5b: Management Practices *(max score 40)*		
OVERALL SCORE		

Section 1: Regional and Landscape Features

The characteristics of regional and landscape features have a significant impact on the rusty patched bumble bee and its ability to successfully find a mate and reproduce. The landscape characteristics at this scale may not be changeable, but will help determine the scale at which local habitat management matters.

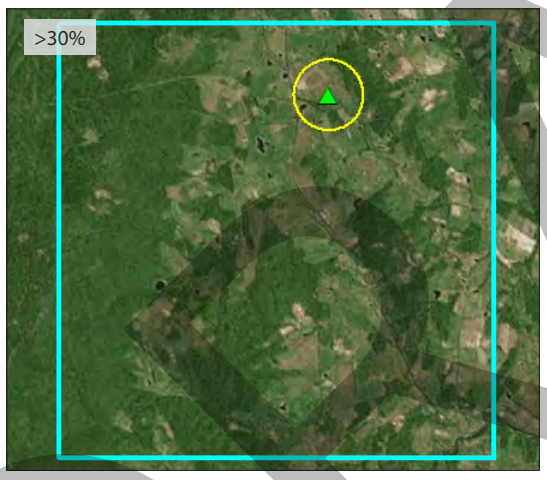
1a. Percentage of the grid cell that is natural habitat. This land use cover includes prairie, shrub lands, woodlands, grasslands, riparian habitat, wetlands, and non-invasive weedy areas. It does NOT include lawn grass, cropland, or overgrazed pasture. Using the 10 x 10 km grid cells provided by the USFWS, or area within a 5 km radius of your location, analyze the proportion of the habitat that is natural. See photos below for guidance (blue area is at the scale of 10 x 10 km).

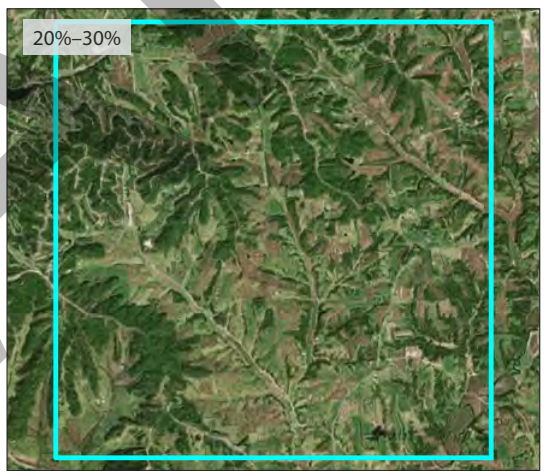
Max score of 10.

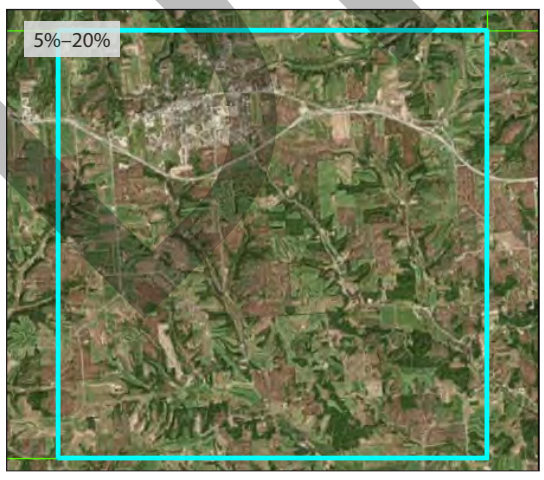
SELECT ONLY ONE	Score	Existing Condition
>30%	10	
20%–30%	7	
5%–20%	3	
<5%	0	
Subtotal (1a)		

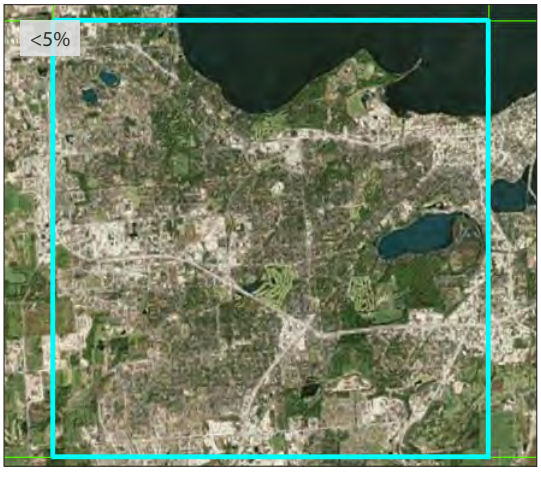
(1a)

The photos below illustrate the different percent covers.









Continue here

1b. The assessment area is defined by the unit of land on which management can be implemented to improve habitat for the rusty patched bumble bee. With that in mind, what is the dominant vegetation within ½ mile of assessment area including the assessment area itself. *Max score of 10.*

SELECT ONLY ONE	Score	Before	After	Treatment to increase score (no treatment if off-site)
Native plants	10			
Mix of native and naturalized (non-invasive) plants	7			
Naturalized flowering species (e.g., alfalfa)	5			
Mix of native, naturalized, and weedy/invasive species	3			
Invasive flowering weeds, crops and/or sod-forming grasses	0			
Subtotal (1b)				

(1a)

(1b)

(1a + 1b)

Section 2: Site Features

On-site natural areas and other features have a significant influence on bumble bee abundance and diversity.

2a. Percentage of site that is in natural or semi-natural habitat.
Max score of 10.

SELECT ONLY ONE	Score	Before	After	Treatment to increase score
>75%	10			
50%–75%	7			
25%–49%	5			
10%–24%	3			
<10%	0			
Subtotal (2a)				

(2a)

2b. Additional site features that are present.
Max score of 25.

SCORE ALL OPTIONS THAT APPLY	Score	Before	After	Treatment to increase score
Permanent meadows or open areas with diverse native wildflowers allowed to bloom	10			
Pasture or hayed land with >30% non-invasive, bee-friendly forage legumes (e.g., red clover, alfalfa, etc.) allowed to bloom	5			
Wooded or wetland areas with diverse flowering trees, shrubs, and/or wildflowers (e.g., maples, basswood, willows, wild plum, spring blooming woodland ephemerals)	5			
Buffers: 2 points for every 20% of area within 25' of water features that is flowered, 1 point for every 20% of area that is grass, 0 points for no buffers	0–5			
Subtotal (2b)				

(2b)

Site Features Total

(2a + 2b)

Section 2: Site Features

3a. Percentage of vegetative cover that is comprised of forbs, flowering shrubs, or pollinator-friendly trees on site. *This does not include invasive or noxious species (e.g., Canada thistle, spotted knapweed, purple loosestrife, crown vetch, buckthorn, etc.).* *Max score of 10.*

SELECT ONLY ONE	Score	Before	After	Treatment to increase score
>50% cover	10			
30%–50% cover	7			
20%–30% cover	5			
10%–20% cover	3			
<10% cover	1			
Subtotal (3a)				

(3a)

The photos below illustrate some categories. *See page 12 for lists of preferred pollinator plants and other information.*

Continue here

3b. Number of species of forbs, flowering shrubs, or pollinator-friendly trees on site that bloom in **spring** and support bees. *This includes fruit trees and some flowering weeds like dandelions, but does not include invasive or noxious species (see https://plants.usda.gov/java/noxiousDriver for examples).*

Max score of 10.

SELECT ONLY ONE	Score	Before	After	Treatment to increase score
10+ species	10			
5–9 species	5			
1–4 species	3			
0 species	0			
Subtotal (3b)				

(3b)

(3a)

3c. Number of species of forbs, flowering shrubs, or pollinator-friendly trees on site that bloom in **summer** and support bees. *This includes some flowering non-native plants, such as red clover, but does not include invasive or noxious species (see https://plants.usda.gov/java/noxiousDriver for examples).*

Max score of 10.

SELECT ONLY ONE	Score	Before	After	Treatment to increase score
18+ species	10			
10–17 species	7			
1–9 species	3			
0 species	0			
Subtotal (3c)				

(3c)

3d. Number of species of forbs, flowering shrubs, or pollinator-friendly trees on site that bloom in **fall** and support bees. *This includes some flowering non-native plants, such as red clover, but does not include invasive or noxious species (see https://plants.usda.gov/java/noxiousDriver for examples).*

Max score of 10.

SELECT ONLY ONE	Score	Before	After	Treatment to increase score
10+ species	10			
5–9 species	7			
1–4 species	5			
0 species	0			
Subtotal (3d)				

(3d)

Continue here

3e. Rusty patched bumble bee superfoods. The rusty patched bumble bee has been observed most commonly on the following plants. How many of these plants are present on site? Note that some of these species may not be appropriate for every region/site.

Wild bergamot (*Monarda fistulosa*), prairie clover (*Dalea* spp.), hyssop (*Agastache* spp.), goldenrod (*Solidago* spp.), joe pye weed (*Eutrochium* spp.), coneflowers (*Echinacea* spp.), native thistles (*Cirsium* spp.), asters (*Symphyotrichum* spp.), leadplant (*Amorpha canescens*), jewelweed (*Impatiens capensis*), mountain mint (*Pycanthemum* spp.), native spiraea (*Spiraea* spp.), and wild cranberry (*Vaccinum* spp.).

Max score of 7.

SELECT ONLY ONE (how many species of bumble bee superfoods are present on site?)	Score	Before	After	Treatment
9–13 species	7			
5–8 species	5			
1–4 species	2			
0 species	0			
Subtotal (3e)				

(3e)

3f. In addition to plants that are known to be attractive to the rusty patched bumble bee, the following plants are known to help build bumble bee immune systems. How many of these plants are present on site? Note that some of these species may not be appropriate for every region/site.

Wild bergamot (*Monarda fistulosa*), sunflowers (*Helianthus* spp.), white turtlehead (*Chelone glabra*), penstemon (*Penstemon* spp.), and wild blueberry/cranberry (*Vaccinium* sp.).

Max score of 3.

SCORE THIS OPTION	Score	Before	After	Treatment
Score 1 point, up to 3 for each species present	0–3			
Subtotal (3f)				

(3f)

(3a + 3b + 3c + 3d + 3e + 3f)

(3a-d)

The rusty patched bumble bee (*Bombus affinis)* nectars on monarda.

Section 4: Nesting and Overwintering Habitat

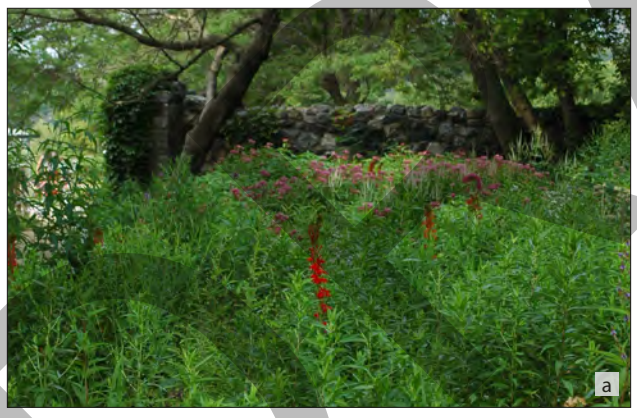
Bumble bee colony success is often limited by the availability of suitable nesting and overwintering sites. Diverse habitat features will increase the likelihood of nesting and overwintering success.

4. Bumble bee nesting preferences vary by species and local habitat conditions. Generally, bumble bees nest under ground, often in abandoned rodent nests. They are also known to nest in dry cavities above ground, such as in rock walls or under clump-forming bunch grasses. The nests are often found under woody plants, tall grasses, or hidden among vegetation or plant materials, and can be difficult to detect. Bumble bees often overwinter underneath leaf litter, in the duff layer of forests, or under loose soils.

Max score of 30.

SCORE ALL OPTIONS THAT APPLY	Score	Before	After	Treatment to increase score
Areas of undisturbed (for example, ungrazed) native bunch grasses (clump-forming)	>20% = 5 ~20% = 3 <5% = 1			
Areas with loose soil with evidence of rodent activity (holes, surface tunnels, etc.) (compacted or hard packed bare ground does not count toward the total)	>20% = 5 ~20% = 3 <5% = 1			
1 point for every 10% of area that is unmowed, ungrazed, and not subject to controlled burning	0–10			
Areas of site with woody cover, or other sheltered areas where bumble bees could build their nest or overwinter (downed wood, rock walls, brush piles, forest duff layer, etc.)	>20% = 5 ~20% = 3 <5% = 1			
Leaf litter left on site in the fall and through the spring (for overwintering queens)	5			
Nesting and Overwintering Habitat Total				

The photos below illustrate some typical nesting and overwintering habitat.



Section 5: Management and Pesticide Practices

Management practices in and adjacent to habitat areas have a significant influence on bumble bee populations.

SCORE ALL OPTIONS THAT APPLY	Score	Before	After	Treatment to increase score
Invasive weed control, if any, carried out with targeted herbicide applications, rather than broadcast (also score 5 if herbicides are not used)	5			
No use of insecticides on site and no suspected use on adjacent lands (If yes, score points and continue to 5b)	35			
No use of fungicides on site (5 pts). The only fungicides used on site are part of an IPM program that specifically addresses pollinator protection, and each use has a documented need to manage an economic or public health pest (2 pts)	0-5			
If any insecticides are used on site they are part of an IPM program that specifically addresses pollinator protection, and are for the management of economic or public health pests (e.g., emerald ash borer or disease transmitting mosquitoes). Also score points if no insecticides are used on site.	8			
Pollinator habitat on site is adequately buffered from insecticide applications including: • Min. 125' buffer from any neonicotinoid use on and/or adjacent to site (including seed treatment) (2 pts) • No aerial (helicopter/airplane) applications on and/or adjacent to site (2 pts) • Min. 60' spatial buffer from any airblast applications of other (non-neonicotinoid) insecticides on and/or adjacent to site (1 pt) • Min. 40' spatial buffer from any non-airblast ground applications of insecticides on and/or adjacent to site (1 pt) • Vegetative buffers, even if they do not meet the distance minimums listed above, include the use of larger-stature non-pollinator attractive vegetation (e.g., coniferous hedge rather than mowed grass) (2 pts)	Score points for each bullet point met			
If insecticides are used spray drift is carefully controlled and spray equipment is calibrated annually, as per state regulations. Also score points if no insecticides are used on site.	2			

5b. Land management techniques used on the site or in adjacent area. *These questions pertain to ongoing site management as opposed to site preparation. Note 'n/a' if option is not applicable to the site.*

Max score of 40.

SCORE ALL OPTIONS THAT APPLY (M = Management Matches Description, S = Somewhat Matches, N = No Match, N/A = Doesn't apply	Score	Before	After	Treatment to increase score
If mowing or haying occurs, then entire disturbed area is limited to ⅓ of habitat per year. Haying or mowing is done patchily, at reduced speeds (<8 mph), with high mower height (12–16"), and in late summer (after peak bloom).	M = 10 S = 5 N = 0 N/A			
If site is grazed, then conservation grazing plan is in place and includes prescribed grazing practices that encourage wildflower diversity/abundance, such as low intensity grazing, or short duration grazing with long recovery periods.	M = 10 S = 5 N = 0 N/A			
If burning occurs, then entire disturbed area is limited to ⅓ of habitat per year, and a patchy burn approach is used leaving numerous skips and unburned patches. A 3–10 year burn rotation period is used, and the time of year when burning occurs is varied. Rare invertebrate species and their specific needs are considered.	M = 10 S = 5 N = 0 N/A			
Managed bees (both honey bees, and commercial bumble bees) are known to both compete with native bumble bees, and have been shown to transmit diseases to wild bumble bees. When the rusty patched bumble bee is near, it is best to avoid the use of managed bees, and honey bees. If honey bees are used they should be kept at low densities. (no managed bees = M, <0.5 Honey bee hive/acre = S, >0.5 Honey bee hive/acre and/or commercial bumble bees present = N).	M = 10 S = 5 N = 0			
Management Practices Total				

Habitat Assessment Reference Materials

General Pollinator Conservation

Protecting Habitat From Pesticide Contamination
This guidance document was designed to help land managers safeguard pollinator habitat from harmful pesticide contamination. It includes information on selecting habitat sites, as well as ways to maintain clean habitat by limiting and carefully managing pesticide use.
http://www.xerces.org/wp-content/uploads/2016/10/ProtectingHabitatFromPesticideContamination_oct2016-02.pdf

Pollinator Conservation Resource Center
The Pollinator Conservation Resource Center includes regional information on plants for pollinator habitat enhancement, habitat conservation guides, nest management instructions, bee identification and monitoring resources, and directories of native pollinator plant nurseries.
www.xerces.org/pollinator-resource-center/

Attracting Native Pollinators
A complete guide to the fascinating lives of these vital creatures. The book includes detailed profiles of over 30 commonly encountered bee genera and more than 50 pages of fully-illustrated plant lists that enable you to choose the best plants for your region.
http://xerces.org/announcing-the-publication-of-attracting-native-pollinators/

Upper Midwest Citizen Science Monitoring Guide: Native Bees
Developed by the Xerces Society, this guide provides instructions for assessing pollinator habitat quality and diversity in the Upper Midwest by monitoring native bees. It was developed for conservationists, farmers, land managers, and restoration professionals to document how native bee communities change over time in pollinator habitats.
http://xerces.org/wp-content/uploads/2016/05/UpperMidwestBeeCSMG_May2016_web.pdf

Pollinator Habitat Installation Guides
These regional guidelines provide in-depth practical guidance on how to install and maintain foraging and nesting habitat for pollinators in wildflower meadow plantings or linear rows of native flowering shrubs. Region-specific seed mixes and plant recommendations are included in the appendices of each guide.
http://xerces.org/pollinator-conservation/agriculture/pollinator-habitat-installation-guides/

Pollinators in Natural Areas: A Management Primer
A fact sheet discussing the importance of pollinators in natural areas, as well as their habitat needs. An extensive list of references is also provided.
http://www.xerces.org/wp-content/uploads/2008/11/pollinators_in_natural_areas_xerces_society.pdf

Inside Agroforestry–Windbreaks
An article about using windbreaks to provide pollinator habitat or to capture pesticide drift.
http://nac.unl.edu/documents/insideagroforestry/vol20issue1.pdf

Introduced, Invasive, and Noxious Plants
Federal and state noxious weed lists, invasive plant lists, and introduced plant lists, with links to more information.
https://plants.usda.gov/java/noxiousDriver

An overview of the potential impacts of honey bees to native bees, plant communities, and ecosystems in wild landscapes: Recommendations for land managers
A review of the potential threats that managed bees may pose to native bees, including the rusty patched bumble bee.
http://www.xerces.org/wp-content/uploads/2016/09/Xerces_policy_statement_HB_Final.pdf

Bumble Bee Conservation

Conserving Bumble Bees: Guidelines for Creating and Managing Habitat for America's Declining Pollinators
A publication to help landowners and managers create, protect, and restore habitat for bumble bee populations.
www.xerces.org/wp-content/uploads/2012/06/conserving_bb.pdf

Bumble Bee Watch
A collaborative citizen science effort to track and conserve North America's bumble bees.
www.bumblebeewatch.org

Bumble Bee Pocket Identification Guides
Pocket identification guides are available for the following species: the rusty patched bumble bee (*Bombus affinis*), the western bumble bee (*Bombus occidentalis*), and the yellowbanded bumble bee (*Bombus terricol*a).
http://xerces.org/identification-guides/bumble-bee-pocket-id/

Lady Bird Johnson and Xerces Society Plant Database for Bumble Bees
The Xerces Society partnered with the Lady Bird Johnson Wildflower Center to generate a list of plants that are of special value to bumble bees.
www.xerces.org/lbj

This mesic prairie provides both forage and nesting habitat with a mix of native wildflowers and bunch grasses.

Rusty Patched Bumble Bee Midwest Plant Guide

Photo by: Susan Day, UW– Madison Arboretum

Midwest includes IA, IL, IN, MI, MN, MO, OH, and WI
* = superfood plants with nectar rich in amino acids
! = known immune building plants for bumble bees
◯ = Full sun ◐ = Part shade/sun ● = Shade
For more information: https://go.usa.gov/xNNWn

Bloom Period	Common Name	Scientific Name	Shade	Habitat type
Forbs/Wildflowers				
EARLY (March April)	Anemones	*Anemone* spp.	◐ ●	Species dependent
	Ground plum	*Astragalus crassicarpus*	◯	Dry prairies
	Virginia bluebells	*Mertensia virginica*	◐ ●	Moist woods, wooded edges
	Shooting star	*Primula* spp.	◯ ◐	Savanna, open woods
	Wild geranium	*Geranium maculatum*	◐ ●	Woodlands, open woods
	Virginia waterleaf	*Hydrophyllum virginianum*	◐ ●	Moist woodlands
	Wild lupine	*Lupinus perennis*	◯ ◐	Savanna, open woods
	Wood betony	*Pedicularis canadensis*	◯ ◐	Prairies, open woods
MID (May August)	Native giant hyssop* ***1***	*Agastache* spp.	◯ ◐	Fields to deciduous woods
	Milkweed ***2***	*Asclepias* spp.	◯ ◐	Species dependent
	Wild white indigo or cream indigo	*Baptisia* spp.	◯ ◐	Prairie, open woodland
	White and purple prairie clover *	*Dalea candida* and *purpurea*	◯	Prairies, dry fields
	Coneflower* ***3***	*Echinacea* spp.	◯	Dry prairies
	Joe pye weed* ***4***	*Eutrochium* spp.	◯	Wet meadows, open woods
	Jewelweed	*Impatiens capensis*	◯ ◐	Moist thickets, forested edges
	Blazing-star	*Liatris* spp.	◯ ◐	Prairies
	Bee balm/wild bergamot*! ***5***	*Monarda fistulosa*	◯ ◐	Dry fields, prairies
	Penstemon spp.	*Penstemon* spp.	◯ ◐	Prairie, fields, wooded edges
	Mountain mint	*Pycanthemum virginianum*	◯ ◐	Fields, prairies, fens
	Culver's root ***6***	*Veronicastrum virginicum*	◯ ◐	Fields, prairie, wooded edges
LATE (Sept. October)	Native field thistle	*Cirsium discolor*	◯	Fields, open woods
	Native swamp thistle	*Cirsium muticum*	◯ ◐	Swamps, wet meadows
	Gentian	*Gentiana* spp.	◯ ◐	Moist fields, wooded edges
	Showy goldenrod* **(also MID in IA, MN, MO)** ***7***	*Solidago speciosa*	◯	Fields, prairies, savannas
	Goldenrod* **(also MID in IA, MN, MO)**	*Solidago* spp.	◯ ◐ ●	Species dependent
	New England aster* **(also MID in IA, MN, MO)** ***8***	*Symphyotrichum novae-angliae*	◯ ◐	Moist fields, wooded edges
	White turtlehead!	*Chelone glabra*	◯ ◐	Wet meadows, wetlands
Trees and Shrubs				
EARLY (March April)	Serviceberry	*Amelanchier* spp.	◯ ◐	Forest understory, woods edge
	Plums and cherries	*Prunus* spp.	◯ ◐	Species dependent
	Gooseberry and currants	*Ribes* spp.	◯ ◐	Species dependent
	Willows	*Salix* spp.	◯ ◐	Meadows, wetlands
MID (May August)	Leadplant *	*Amorpha canescens*	◯	Dry prairie, open woods
	New Jersey tea	*Ceanothus americanus*	◯ ◐	Fields, prairies, open woods
	Buttonbush	*Cephalanthus occidentalis*	◯ ◐	Riverbanks, marshes, shores
	Dwarf bush honeysuckle	*Diervilla lonicera*	◐	Woodland edges, thickets
	Wild roses	*Rosa* spp.	◯ ◐	Prairies, wooded edges
	American basswood	*Tilia americana*	◯ ◐	Deciduous forest
	Large cranberry!	*Vaccinium macrocarpon*	◯	Wetlands

APPENDIX A: PHASE 1 HABITAT ASSESSMENTS

Summer habitat and potential hibernacula assessments are Step 2 of Phase 1- Initial Project Screening. The information below is provided to assist applicants, consultants, and/or project proponents (hereinafter termed the "applicant") in establishing whether surveys for IBAT and/or NLEB should be conducted. As a reminder, the first step for determining presence of IBAT and/or NLEB at a given site is to determine whether there is any existing occurrence data available for the vicinity of the project from the local USFWS FO. This step can be conducted remotely via a desktop analysis (e.g., use of aerial photography to assess the potential presence of suitable summer habitat). The applicant is responsible for developing and providing sufficient information as to whether suitable summer habitat and/or potential hibernacula exist within a proposed project area. If suitable habitat is present, the applicant should calculate the amount and submit this to the USFWS FO(s) and determine the need for any presence/absence surveys (Phase 2). **NOTE**: if IBAT and/or NLEB are present or assumed to be present during any phase, more detailed habitat information may be necessary to adequately assess the potential for impacts (see attached example Bat Habitat Assessment Datasheet). If no suitable habitat is present or it is determined through discussions with USFWS FO(s) that no adverse effects are anticipated from the proposed project, no surveys are recommended to assess risk during the summer. Habitat assessments for IBAT and/or NLEB can be completed any time of year and applicants are encouraged to submit results and proposed Phase 2 study plans well in advance of the summer survey season.

PERSONNEL

Habitat assessments should be completed by individuals with a natural resource degree or equivalent work experience.

DEFINITION FOR POTENTIALLY SUITABLE INDIANA BAT SUMMER HABITAT

Suitable summer habitat for IBAT consists of a wide variety of forested/wooded habitats where they roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats[27] such as emergent wetlands and adjacent edges of agricultural fields, old fields and pastures. This includes forests and woodlots containing potential roosts (i.e., live trees and/or snags ≥5 inches dbh[28] (12.7 centimeter) that have exfoliating bark, cracks, crevices, and/or hollows), as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure. Individual trees may be considered suitable habitat when they exhibit the characteristics of a potential roost tree and are located within 1,000 feet (305 meters) of other forested/wooded habitat.

[27] Non-forested habitats typically should be excluded from acreages used to establish a minimum level of survey effort for Phase 2 surveys.

[28] While trees <5 inches (<12.7 cm) dbh that have exfoliating bark, cracks, crevices, and/or hollows may have some potential to be male IBAT summer roosting habitat, the USFWS does not consider early successional, even-aged stands of trees <5 inches dbh to be suitable roosting habitat for the purposes of this guidance. Suitable *roosting* habitat is defined as forest patches with trees of 5-inch (12.7 cm) dbh or larger. However, early successional habitat with small diameter trees may be used as foraging habitat by IBATs. Therefore, a project that would remove or otherwise adversely affect ≥20 acres of early successional habitat containing trees between 3 and 5 inches (7.6-12.7 cm) dbh would require coordination/consultation with the USFWS FO to ensure that associated impacts would not rise to the level of take. The USFWS may request P/A surveys if >20 acres of early successional habitat were proposed for removal.

Indiana bats have also been observed roosting in human-made structures, such as bridges and bat houses (artificial roost structures); therefore, these structures should also be considered potential summer habitat[29]. We recommend that project proponents or their representatives coordinate with the appropriate USFWS Field Office to more clearly define suitable habitat for their region as some differences in state/regional suitability criteria may be warranted (e.g., high-elevation areas may be excluded as suitable habitat in some states).

Examples of unsuitable habitat:

- Individual trees that are greater than 1,000 feet from forested/wooded areas;
- Trees found in highly developed urban areas (e.g., street trees, downtown areas); and
- A pure stand of less than 3-inch dbh[30] trees that are not mixed with larger trees.

DEFINITION FOR POTENTIALLY SUITABLE NORTHERN LONG-EARED BAT SUMMER HABITAT

Suitable summer habitat for the NLEB consists of a wide variety of forested/wooded habitats where they roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats such as emergent wetlands and adjacent edges of agricultural fields, old fields and pastures. This includes forests and woodlots containing potential roosts (i.e., live trees and/or snags ≥3 inches dbh that have exfoliating bark, cracks, crevices, and/or cavities), as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure. NLEBs are nocturnal foragers and use hawking (catching insects in flight) and gleaning (picking insects from surfaces) behaviors in conjunction with passive acoustic cues (Nagorsen and Brigham 1993, p. 88; Ratcliffe and Dawson 2003, p. 851). NLEB seem to prefer intact mixed-type forests with small gaps (i.e., forest trails, small roads, or forest-covered creeks) in forest with sparse or medium vegetation for foraging and commuting rather than fragmented habitat or areas that have been clear cut (USFWS 2015, p. 17992). Individual trees may be considered suitable habitat when they exhibit characteristics of suitable roost trees and are within 1,000 feet of other forested/wooded habitat[31]. The NLEB has also been observed roosting in human-made structures, such as buildings, barns, bridges, and bat houses; therefore, these structures should also be considered potential summer habitat[32]. NLEBs typically

[29] If human-made structures are present within your project area and are proposed to be removed or modified, see Appendix E (Emergence Surveys) and then coordinate with the local USFWS FO(s) regarding how to determine presence/absence.

[30] Suitable *roosting* habitat is defined as forest patches with trees of 5-inch (12.7 cm) dbh or larger. However, early successional habitat with small diameter trees may be used as foraging habitat by IBAT. Therefore, a project that would remove or otherwise adversely affect ≥20 acres of early successional habitat containing trees between 3 and 5 inches (7.6-12.7 cm) dbh would require coordination/consultation with the USFWS FO to ensure that associated impacts would not rise to the level of take. The USFWS may request P/A surveys if >20 acres of early successional habitat were proposed for removal.

[31] This number is based on observations of bat behavior indicating that such an isolated tree (i.e., ≥1000 feet) would be extremely unlikely to be used as a roost. This distance has also been evaluated and vetted for use for the NLEB. See the "Indiana bat Section 7 and Section 10 Guidance for wind Energy Projects," question 33, found on the USFWS website provided in the intro.

[32] Trees found in highly-developed urban areas (e.g., street trees, downtown areas) are extremely unlikely to be suitable habitat.

occupy their summer habitat from mid-May through mid-August each year[33] and the species may arrive or leave some time before or after this period.

Examples of unsuitable habitat:

- Individual trees that are greater than 1,000 feet from forested/wooded areas;
- Trees found in highly-developed urban areas (e.g., street trees, downtown areas); and
- A pure stand of less than 3-inch dbh trees that are not mixed with larger trees.

[33] Exact dates vary by location., with NLEBs typically being found earlier in spring at lower latitudes

Appendix H

ENVIRONMENTAL ENGINEERING DOCUMENTATION

INTRODUCTION

In order to better understand the issues facing the Nahant Marsh Education Center (NMEC), various investigative measures were conducted during the PAS Study. Limited data existed prior to development of the PAS Study regarding sedimentation, elevations of the bed of the open water marsh area (main marsh), elevations of certain structures, types and nature of sediments present, and water quality. As such, survey transects across the marsh were conducted, soil borings were installed, soil samples collected, and elevations of structures were collected. In addition, NMEC staff had collected water quality data at various points on the NMEC property, which were utilized by the Corps to develop an understanding of marsh water quality parameters. Due to the goal of the NMEC to support migratory waterfowl, water level management is a critical issue and further development of options was required.

MARSH SURVEY TRANSECTS

To ascertain elevations and structure of the main marsh, nine transects were surveyed the week of December 6, 2021. Transects were set to run perpendicular to flow in the marsh and were roughly 250 to 300 feet apart. See Attachment E-1 for a site plan indicating the locations and orientation of the transects. The transects indicate that in the area of the upstream trench, bed elevations are approximately 551 feet MSL (NAVD88 Geoid 18). Further downstream in the main open water area bed elevations range from 550 to 551 feet MSL. Shoreline elevations are approximately 552 feet MSL. Bed elevations are fairly uniform, with very little topographic diversity or variation within the marsh.

Elevations were also taken at a 10-foot by 10-foot box culvert under the Interstate 280 embankment located downstream of the marsh. NMEC staff raised questions about the elevations of the floor of the conduit and the impact of those elevations on the flow of water into and out of the main marsh. Survey indicated the invert elevation of the upstream (northeast) end of the culvert is 549.73 feet MSL, and the invert elevation of the downstream (southwest) end of the culvert is 548.79 feet MSL. The elevations indicate that the culvert will allow flow to propagate downstream accordingly. Table H-1 indicates elevations and coordinates of features that were surveyed in 2021.

Table H-1. 2021 Survey Elevations

Location Description	Elevation (NAVD 88 US Survey Feet)
I-280 Box Culvert East Side Invert Elevation	549.73
I-280 Box Culvert East Side Top Elevation	561.73
I-280 Box Culvert West Side Invert Elevation	548.79
I-280 Box Culvert West Side Top Elevation	560.78
Sediment Monument NM-22-02	555.16
Sediment Monument NM-22-07	554.96
Sediment Monument NM-22-08	556.44
Survey Monument 714	553.51

Survey Monument 758	562.73
Survey Monument 727	557.60
Staff Gage at Wapello	Gage 0 = 550.59

WATER QUALITY

Water quality parameters were collected by NMEC staff periodically from 2016 to the present date. These parameters include water temperature, pH, nitrate/nitrite, dissolved oxygen (DO), ortho-phosphate, chloride, total suspended solids (TSS), and transparency. Field test kits and equipment were utilized primarily, although on some occasions samples were sent for laboratory analysis for nitrate/nitrite, TSS and ortho-phosphate. For the purposes of this assessment, water quality data was reviewed for the time period of summer 2018 to summer 2021. Samples were collected over many different flow regimes and weather situations, such as the 2019 flood event, and drought in summer 2020.

Sites selected for sampling were on the upstream drainage ditch (Sites J and K), the main marsh (Site C), the marsh outlet at Wapello Avenue (Site B) and the ultimate outlet of the marsh water on Concord Street (Site G). Please see Figure H-1 for site locations (also included as Attachment E-2).

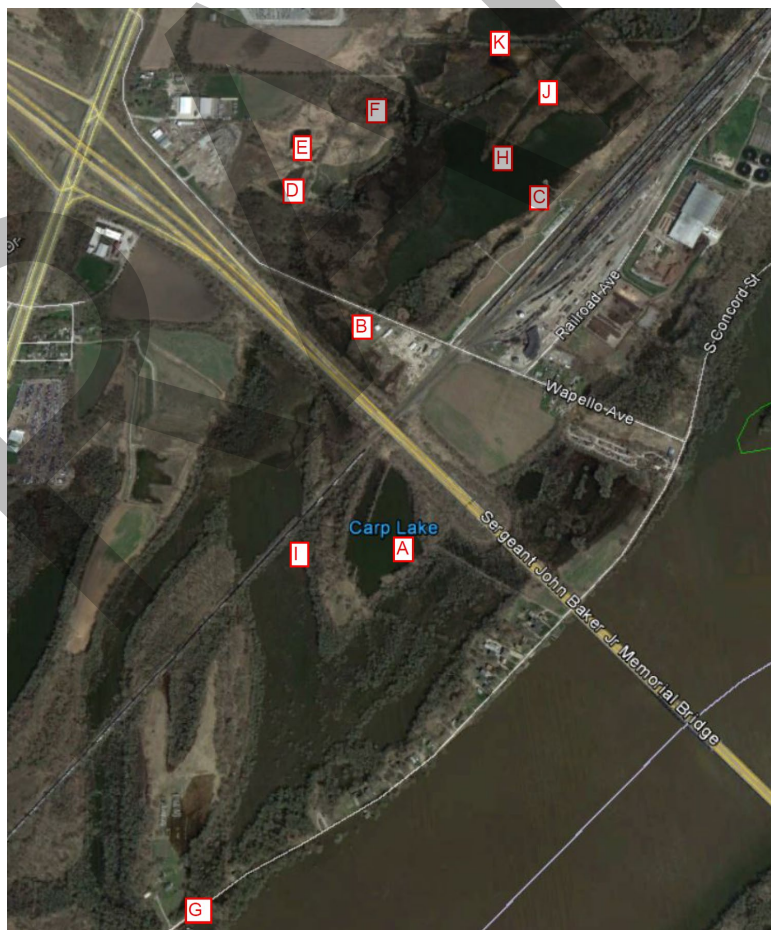


Figure H-1. Water Quality Sample Site Locations.

At a stage reading of 12 feet on the Mississippi River at Lock and Dam 15 gage, it has been observed that floodwater reverses normal downstream flow in the main marsh, and water enters the marsh from the Wapello Avenue water control structure. At that point it can be inferred that water from the Mississippi River is having some influence on the water quality parameters in the main marsh. For the purposes of this

assessment, water quality parameters were reviewed as an entire data set over the time period, during normal flow conditions (Lock and Dam 15 gage stage <12 feet) and backflow conditions (Lock and Dam 15 gage stage >12 feet).

Regarding water temperature and pH, no concerns were observed. Water temperature readings were in line with ambient weather conditions and time of day/year. In general pH values were within the range desired for aquatic wildlife (pH values between 6.5 and 9). There were observations of pH values of 5 or 6, but these appear to be isolated events, and did not reflect typical conditions.

For transparency, chloride, DO, nitrate and orthophosphate, mean values were determined for Sites B, C, J, K and G for the entire sample period, for normal flow conditions and backflow conditions. In addition, precipitation for the 48-hour period prior to sample collection was determined for comparisons.

Transparency

Transparency is an indication of how turbid the water is and is measured in the field with a Secchi Tube. There is no regulated standard for the transparency standard, though a general rule of thumb is a reading of 30 centimeters (cm) or below is an indication of turbid conditions.

Mean values for all sites except Site G were in the mid to upper 40 cm range and were relatively close. Site G mean value was 26 cm, not unexpected as it is located right next to the Mississippi River, where more suspended sediments are present and lower transparency values accordingly. Very similar mean values were indicated during normal flow conditions. Mean values during backflow conditions were generally lower than normal flow conditions, except Site K and Site G.

There appears to be a weak correlation between precipitation and lower transparency values during normal flow conditions. The greatest correlation occurs at Site K. During backflow conditions, transparency is the lowest at Site G, and appears to increase moving upstream.

Overall, the data suggests that backflow conditions may be a greater influence on reducing the transparency values in the marsh than precipitation during normal flow conditions. However, the mean values between normal and backflow conditions are quite similar at sites J and K. This is likely indicating that the turbid water being brought in during backflow conditions is not affecting the upper ditch as much as the marsh. There are also indications that water from precipitation events under normal flow conditions is disturbing sediments within the ditch, reducing transparency as it moves into the marsh.

Chloride

Chloride is an indicator of a salt presence, that may be from various sources such as road deicing activities, human/animal waste, industrial discharge or septic/sanitary sewer systems. The Iowa DNR has standards for protection of aquatic wildlife of 389 mg/L (parts per million) for chronic exposure and 629 mg/L for acute exposure. No values measured at the Marsh exceeded these standards, although a general rule of thumb is concentrations over 100 mg/L may indicate abnormal conditions are occurring.

Chloride mean values were higher at all sites during the normal flow conditions. The sites in the upstream ditch had higher overall and normal flow mean values, with many individual readings over 100 mg/L. These high values were observed with and without previous precipitation events.

Backflow mean values were significantly less than normal flow conditions at all sites.

Overall, chloride values at all sites and flow regimes (except Site G backflow conditions) seem abnormally high given the time of year that the samples were collected. It appears that upstream sources may be influencing chloride concentrations in the marsh more than backflow conditions.

Nitrate

Nitrate is a form of nitrogen that is easily utilized by aquatic plants, and is considered a primary nutrient, that in excess concentrations, can lead to an overabundance of aquatic vegetation and low dissolved oxygen conditions. The Iowa DNR water quality standard for nitrate is 10 mg/L, but this relates to protection of drinking water, not prevention of eutrophic conditions.

Mean values for nitrate for the entire sample period increase from upstream to downstream sites, with Site K mean of 0.04 mg/L and Site G mean of 1.15 mg/L. Means during backflow conditions were higher than normal flow conditions at sites B, C and G. The mean values for all conditions however are quite low, with many individual values of non-detection.

There appears to be a weak correlation of precipitation and nitrate detections during normal flow conditions, and some correlation of precipitation and nitrate detections during backflow conditions.

Overall, the nitrate load in the marsh appears low, which may be due to use by aquatic plants leading to excess vegetation conditions that have been observed. Based on mean values, backflow conditions appear to be a greater influence on nitrate conditions than normal flow conditions.

Orthophosphate

Orthophosphate is the dissolved phase of phosphorus which is readily available to aquatic wildlife. It is considered a primary nutrient that, in excess concentrations, can lead to eutrophic conditions. No water quality standard exists in Iowa to prevent eutrophic conditions, but a general guide is a value greater than 0.1 mg/L can lead to the production of excess vegetation.

All mean values for the sites exceeded the 0.1 mg/L threshold, regardless of flow conditions. The mean values for the entire sample period were highest at Sites B and C, followed by Site G, and then Sites J and K. Mean values during normal flow conditions were higher than backflow conditions at Sites B, C and G.

Some correlation between orthophosphate concentrations and precipitation was observed during normal flow conditions. In addition, there is some correlation between higher orthophosphate concentrations and low DO values.

*include header title (e.g. assessment, recommendations, etc)

Determining a likely source for orthophosphate is not clear. In the marsh, higher concentrations were observed at Sites B and C during normal flow conditions. Both upstream and downstream sites have mean concentrations in all flow regimes lower than the marsh mean concentrations. There are indications that the combination of low DO time periods and phosphorus rich sediments (see Sedimentation Section) lead to accelerated release of phosphorus in the form of orthophosphate into the water column. It is likely that upstream and downstream sources are contributing to the orthophosphate load, but also internal loading due to low DO conditions.

Dissolved Oxygen

Dissolved Oxygen (DO) is a critical parameter for aquatic wildlife. Any value of DO below 5 mg/L is considered detrimental. Means for DO for all sites during the entire sample period ranged from 5 to 6 mg/L. During normal flow conditions, means were similar, with Site C exhibiting slightly lower DO on average just under 5 mg/L. Similar conditions were observed during backflow conditions, though Site B had an average just under 5 mg/L.

Concentrations of DO at the sites ranged from 1 to 12 mg/L, and there does not appear to be any correlation between DO concentration and flow conditions or precipitation.

DO values and means are consistent with a shallow water body such as the marsh, as well as the ditch area and the stream sample location at Site G. Sites B and C had the lowest mean concentrations, and in light of the orthophosphate concentrations at those locations, lends credence to the probability of phosphorus leaching in anoxic conditions.

SEDIMENTATION

There is no historic sedimentation data at the main marsh to utilize to determine a sedimentation rate. Based on staff observations, sedimentation has occurred, particularly in the upstream ditch and ditch outfall area into the main marsh. To obtain data for future use, three methods of investigation were utilized. The aforementioned survey transects were conducted in fall 2021 to ascertain current main marsh bed elevations. In January 2022 three sedimentation monuments were installed at various locations at the main marsh. These monuments are permanent structures to which the bed of marsh can be measured, to determine any changes in bed elevation over time. Also, at the same time of the monument installation, eight soil borings were hand driven at various locations. Further details on the borings and the boring logs are included in the Geotechnical Appendix. These borings were utilized to determine the lithology and stratigraphy of the materials in the main marsh. Refer to Appendix I for additional information on the sedimentation monuments.

The borings indicate that in general the main marsh bed is composed of flocculant, organic, unconsolidated, massive, dark brown/dark gray silty clay, varying between 3 to 5 feet in depth. Underlying this silty clay is a more indurated and firmer, massive brown/black/gray silt/clay. In some locations shell fragments are present. In two borings, below the firmer clay bed, rounded to subrounded lithic gravels with clay matrix are present. These materials are consistent with backwater alluvial depositional environments, and the uppermost flocculant silty clay materials are consistent with low velocity depositional environments such as the marsh.

In 1999, excavation of lead contaminated sediments was conducted as part of a Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) remedial activity at the marsh. The depth of the excavation varied, but in general did not exceed three feet. Two of the borings completed in January 2022, NM-22-01 and NM-22-06 were installed within the excavation area. The data in these borings was utilized to estimate a sediment rate. Boring NM-22-01 indicated 3.2 feet of organic silty clay overlying an oxidized dark gray clay. Boring NM-22-06 indicated 3.45 feet of organic silty clay overlying light gray clay with trace gravel and shell fragments. It is inferred that the oxidized clay is the former bottom of the lead excavation area, and therefore any sediment present above the oxidized clay layer has been deposited since 1999. Utilizing the 23-year time period for sedimentation rate gives a rate of 0.13 feet/year (1.7 inches/year) at NM-22-01 and 0.15 feet/year (1.8 inches/year) at NM-22-06. These estimated sedimentation rates are considered within reason given the multiple sources of sediment and low velocity depositional environment encountered at the marsh. Further investigation into sedimentation rates can use data from the sediment monuments, future survey transects and bathymetric measurements (if available) and will determine if the rates from the borings are accurate.

SEDIMENT ANALYSIS

Soil samples were collected from the top 6 inches of material from each boring. The materials were sent to a laboratory for analysis of nitrate, total lead, and total phosphorus. Table H-2 displays the concentrations of each parameter at each boring.

Table H-2. Laboratory Analyses

Location	Date	Nitrate (mg/kg)	Total Phosphorus (mg/kg)	Total Lead (mg/kg)	Percent Moisture (%)
NM-22-01	3/11/2022	<16.2	630	46.1	40.3
NM-22-02	3/11/2022	<17.7	1300	52.5	44.7
NM-22-02	3/11/2022	<20.2	821	42.1	50.5
NM-22-04	3/11/2022	<18.0	1220	29.8	45.2
NM-22-05	3/11/2022	<20.6	681	49.2	51.5
NM-22-06	3/11/2022	<17.9	551	27.7	46.1
NM-22-07	3/11/2022	<16.1	659	52.4	39.8
NM-22-08	3/11/2022	<18.8	456	48.2	49.6

Nitrate concentrations were below laboratory detection limits and are in line with what is expected in marsh sediments. Total phosphorus concentrations are considered moderate to high and indicate a phosphorous load in sediments that could potentially be released from sediments in the right conditions. Total lead concentrations appear to be in line with regional background concentrations and indicate there are likely not residual lead “hotspots” remaining from previous shooting range activities at the marsh.

*include header title (e.g. assessment, recommendations, etc)

WATER LEVEL MANAGEMENT

General descriptions of water level management options are presented below, with further details on each option provided in Attachment E-3.

Exterior Berms, Interior Berms, and Overflow Spillways

Two general design criteria for this feature are to construct a reliable embankment system that provides adequate flood protection to meet NMEC's seasonal and/or annual management goals and locate borrow sites in areas that improve the suitable habitat for migratory birds.

Pump Stations and Wells

Water can be introduced or removed from a moist soil management unit or backwater lake through the use of a pump station, portable pumps, wells or a water control structure. Pumps can obtain either surface water, typically from a river, or groundwater.

Stoplog Structures

Stoplogs can be placed in various types of structures to meet the sizing requirements for raising or lowering water levels. Additionally, the design of the stoplogs themselves can vary widely. Using stoplog structures can be an advantage because they are relatively inexpensive and require low maintenance.

Gated Structures

The primary purpose of a gated structure is to provide gravity drainage from the MSMU. It may be desirable to have at least one gated structure installed within each cell. A gated structure may also be used to enhance MSMU filling operations. If high water events were to occur during the late summer and fall, the gated structure could be opened to help capture water, thereby decreasing the pumping requirements. In addition, the gated structure may serve as an additional opening for water to enter the MSMU prior to overtopping events.

CARP LAKE

Carp Lake is a former sand quarry located immediately southwest of the Interstate 280 embankment. NMEC owns the property on which Carp Lake sits. NMEC purchased the property in 2002, and it appears that slag from an unverified source was dumped there prior to purchase. The slag pile rests adjacent to Carp Lake between the lake and the I-280 embankment. Due to concerns over potential contaminants, Nahant Marsh, in combination with Western Illinois University, led a series of investigations as part of master's and PhD studies for WIU students. A formal Phase I Environmental Site Assessment and Phase II Limited Site Investigation have been conducted. The data collected thus far indicates that heavy metals (cadmium, lead, nickel, copper and zinc) are present at levels that exceed Iowa DNR Statewide standards for soil, sediment, surface water and groundwater. The contamination does not rise to the level of hazardous waste but does exceed various exposure routes that are for protection of human health and the environment. Based on Nahant Board of Directors and the Iowa DNR direction, the Carp Lake site is only accessible to NMEC staff and not the general public.

*include header title (e.g. assessment, recommendations, etc)

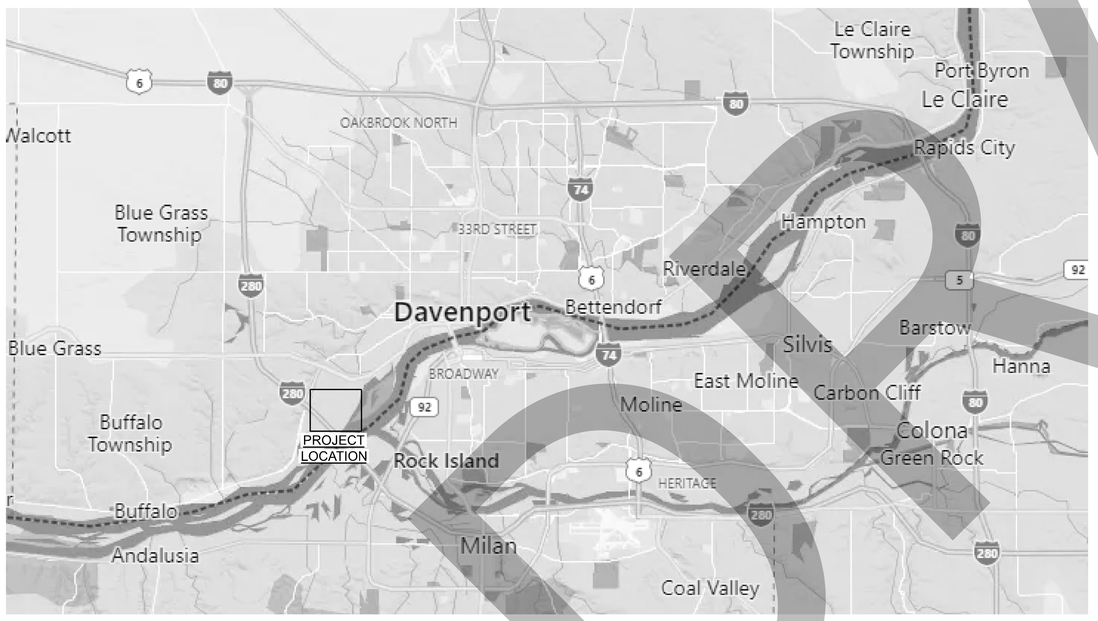
NMEC has been in communication with the Iowa DNR for concurrence with the findings, and, as a nonprofit, for assistance with possible remedial actions. There are currently no state or federal programs that appear to be applicable for remedial assistance. A bid has been secured to remove the slag pile. This slag would be transported to a local cement processing facility to be used as an additive. NMEC has not been able to procure funds for removal of the slag as of this time.

US Army Corps of Engineers®

ROCK ISLAND DISTRICT

MISSISSIPPI RIVER BASIN
DAVENPORT, IA
SCOTT COUNTY, IA
NAHANT MARSH

INDEX	
SHEET ID	**SHEET TITLE**
	GENERAL
G-001	COVER SHEET
	SURVEY
V-101	PLAN - SURVEY CONTROL
	CIVIL
C-101	SITE PLAN
C-301	TRANSECTS
C-302	TRANSECTS



ISSUE DATE: MAY 2022

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: S. GUSTAFSON
DRAWN BY: C. CUTKOMP
CHECKED BY:
ISSUE DATE:
SOLICITATION NO.:
CONTRACT/T.O. NO.:
PROJECT CODE: BSMRPRO2202003
SUBMITTED BY: A. ZEDDLESTEIN
SIZE: ANSI D
MATOC/IDIQ CONTRACT NO.:

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS 61201

MISSISSIPPI RIVER BASIN
DAVENPORT, IA
SCOTT COUNTY, IA
NAHANT MARSH

COVER SHEET

SHEET ID
G-001

REVIEW

SURVEY CONTROL POINTS

POINT NAME	NORTHING	EASTING	ELEVATION	DESCRIPTION
714	555545.050	2424371.445	553.51	5/8" REBAR WITH CAP "NAH7-2021"
758	556746.369	2424255.229	552.73	5/8" REBAR WITH CAP "NAH14-2021"
727	556762.690	2425787.994	557.60	5/8" REBAR WITH CAP "NAH19-2021"

GENERAL NOTES

1. FIELD SURVEY WAS COMPLETED FEBRUARY 9, 2022.
2. PROJECT DATUM:
   NAD83 (2011) STATE PLANE IOWA SOUTH
   NAVD88 GEOID 18 US SURVEY FEET

758
727
714
MARSH
NAHANT MARSH EDUCATION CENTER
ACCESS TO NAHANT MARSH EDUCATION CENTER
CANADIAN PACIFIC RAILWAY NAHANT YARD
RAILROAD AVENUE
WAPELLO AVENUE
10' X 10' BOX CULVERT
INV EL 549.73
TOP EL 561.73
10' X 10' BOX CULVERT
INV EL 548.79
TOP EL 560.78
RAILROAD
INTERSTATE 280
280
CREDIT ISLAND
MISSISSIPPI RIVER
FLOW

PLAN NORTH

0 300' 600'

A1 PLAN - SURVEY CONTROL
SCALE: 1" = 300'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: E. SELFE	ISSUE DATE: 2022/03/18		
DRAWN BY: E. SELFE	SOLICITATION NO.:		
CHECKED BY: M. MANTERNACH	CONTRACT/T.O. NO.:		
SUBMITTED BY: J. RIGELOW	PROJECT CODE: BSMRPRO420202003		
SIZE: ANSI D	MATOC/IDIQ CONTRACT NO.:		

U.S. ARMY CORPS OF ENGINEERS
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ROCK ISLAND, ILLINOIS 61201

MISSISSIPPI RIVER BASIN
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SCOTT COUNTY, IA
NAHANT MARSH

PLAN
SURVEY CONTROL

SHEET ID
V-101

REVIEW

A1 SITE PLAN

SCALE: 1" = 200'

PLAN NORTH

0 200' 400'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: S. GUSTAFSON
DRAWN BY: C. CUTKOMP
CHECKED BY:
SUBMITTED BY: A. HEDDLESTEN
SIZE: ANSI D

ISSUE DATE:
SOLICITATION NO.:
CONTRACT/T.O. NO.:
PROJECT CODE: B5MRPROJ202003
MATOC/IDIQ CONTRACT NO.:

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS 61201

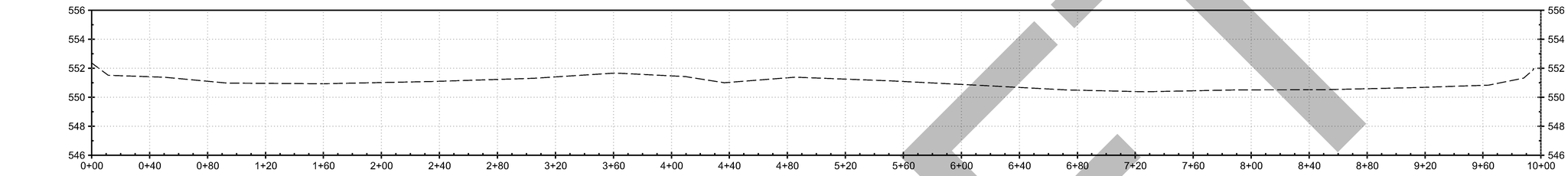
MISSISSIPPI RIVER BASIN
DAVENPORT, IA
SCOTT COUNTY, IA
NAHANT MARSH

SITE PLAN

SHEET ID

C-101

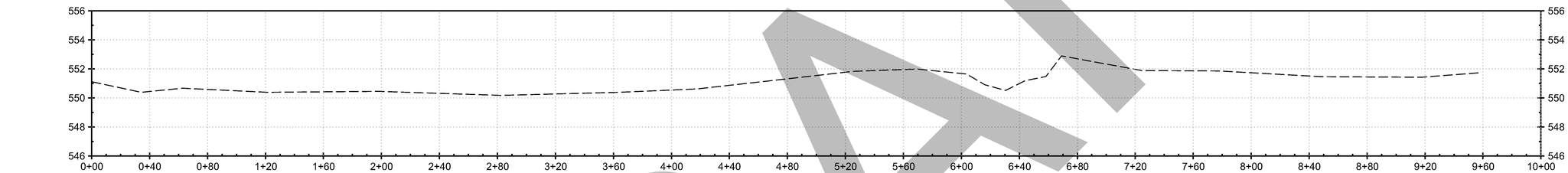
REVIEW



K1 TRANSECT 4

SCALE: VERTICAL: 1/4" = 1' HORIZONTAL: 1" = 40'

0 2' 4' 8' 0 40' 80'



G1 TRANSECT 3

SCALE: VERTICAL: 1/4" = 1' HORIZONTAL: 1" = 40'

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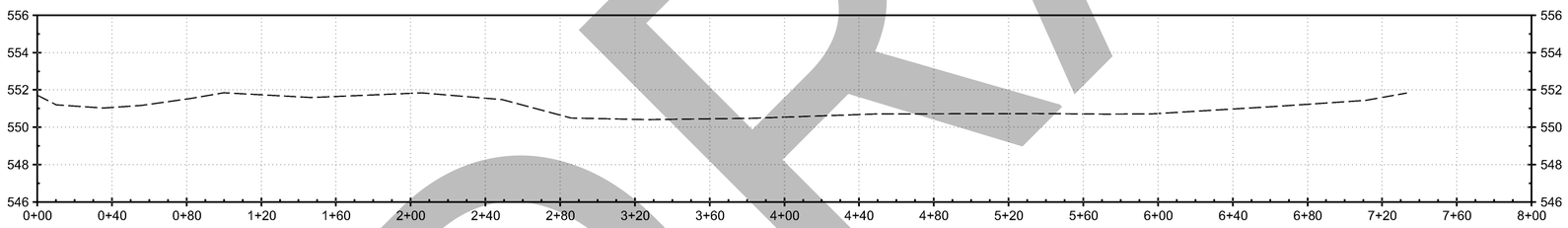

D1 TRANSECT 2

SCALE: VERTICAL: 1/4" = 1' HORIZONTAL: 1" = 40'

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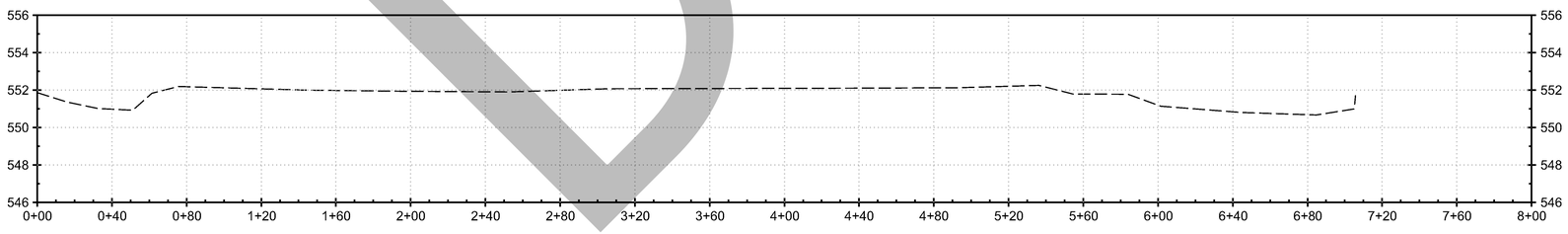

A1 TRANSECT 1

SCALE: VERTICAL: 1/4" = 1' HORIZONTAL: 1" = 40'

0 2' 4' 8' 0 40' 80'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: S. GUSTAFSON
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CHECKED BY:

ISSUE DATE:
SOLICITATION NO.:
CONTRACT/T.O. NO.:

SUBMITTED BY: A. HEDDLESTEN
SIZE: ANSI D

PROJECT CODE: BSMRPRO42020003
MATOC/IDIQ CONTRACT NO.:

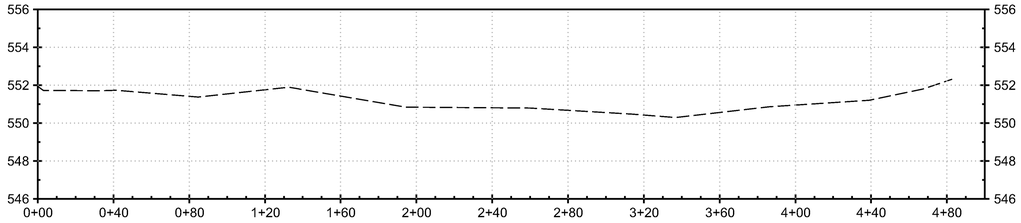
U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS 61201

MISSISSIPPI RIVER BASIN
DAVENPORT, IA
SCOTT COUNTY, IA
NAHANT MARSH

TYPICAL SECTIONS
TRANSECTS

SHEET ID
C-301

REVIEW



K1 TRANSECT 8

SCALE: VERTICAL: 1/4" = 1' HORIZONTAL: 1" = 40'

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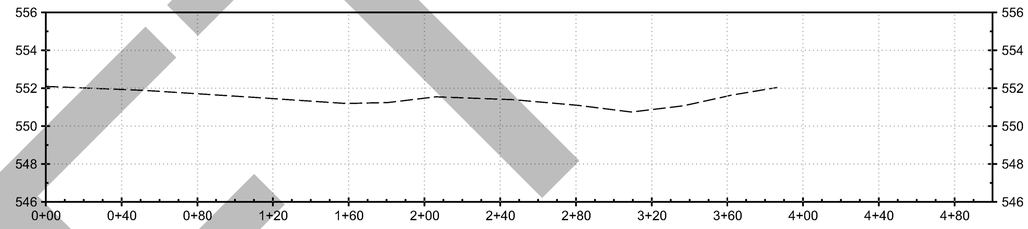

K11 TRANSECT 9

SCALE: VERTICAL: 1/4" = 1' HORIZONTAL: 1" = 40'

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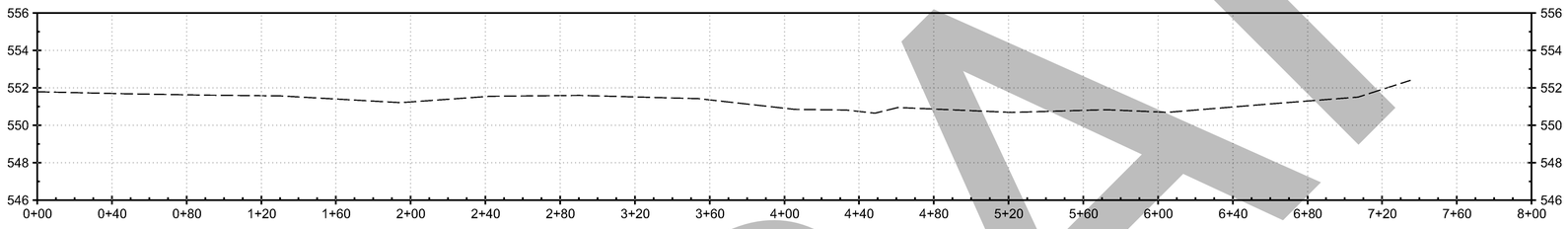

G1 TRANSECT 7

SCALE: VERTICAL: 1/4" = 1' HORIZONTAL: 1" = 40'

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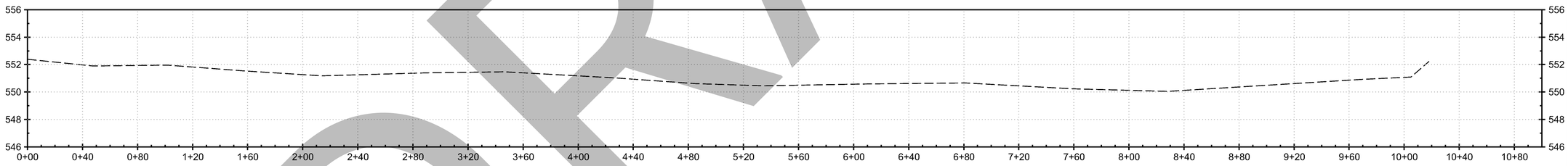

D1 TRANSECT 6

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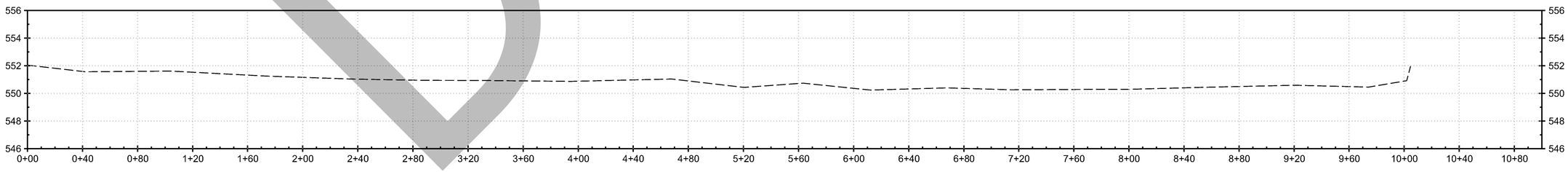

A1 TRANSECT 5

SCALE: VERTICAL: 1/4" = 1' HORIZONTAL: 1" = 40'

0 2' 4' 8' 0 40' 80'

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MARK	DESCRIPTION	DATE

DESIGNED BY: S. GUSTAFSON
DRAWN BY: C. CUTKOMP
CHECKED BY:

ISSUE DATE:
SOLICITATION NO.:
CONTRACT/T.O. NO.:

SUBMITTED BY: A. HEDDLESTEN
SIZE: ANSI D

PROJECT CODE: BSMRPRO42002003
MATOC/IDIQ CONTRACT NO.:

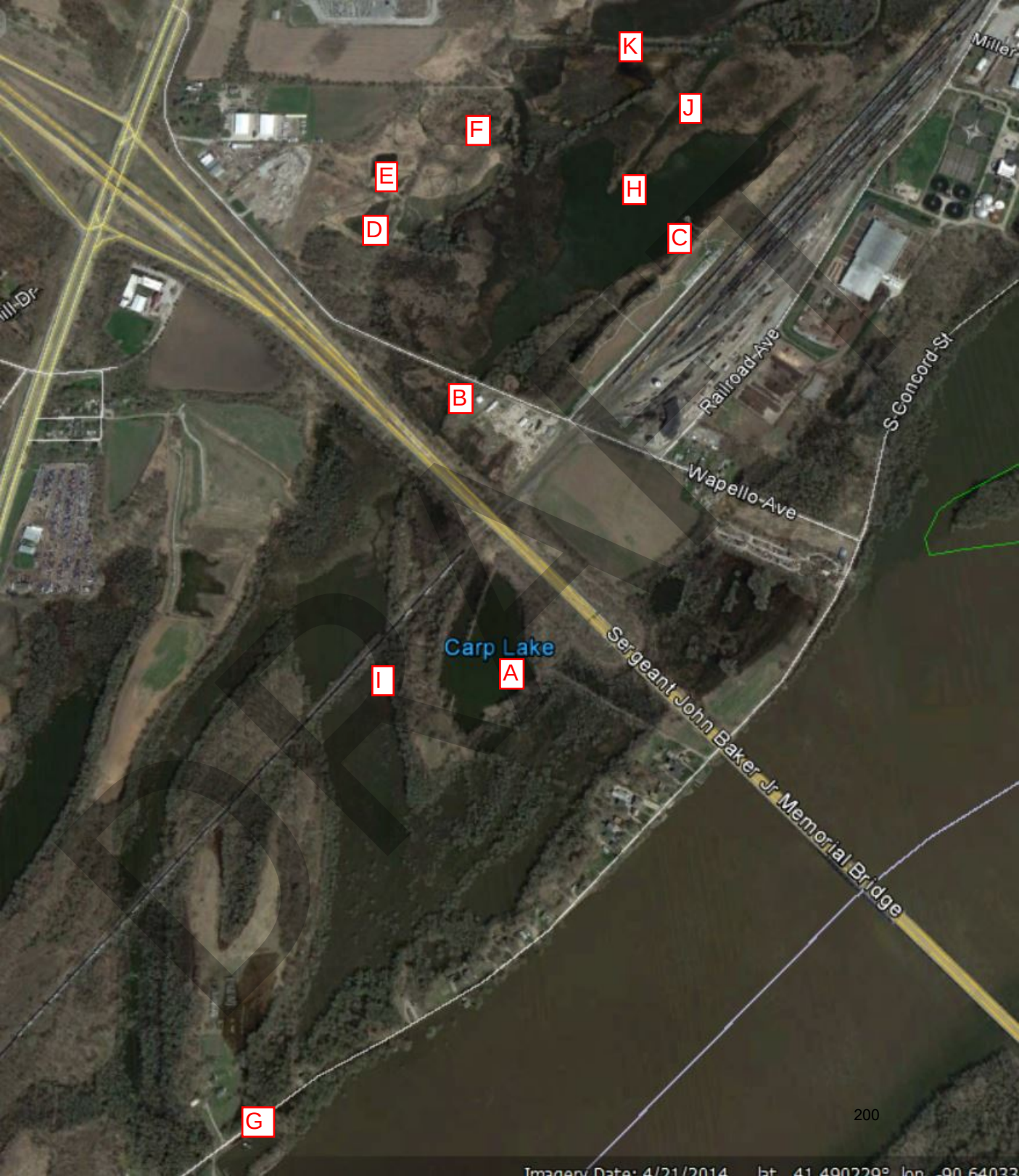
U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS 61201

MISSISSIPPI RIVER BASIN
DAVENPORT, IA
SCOTT COUNTY - IA
NAHANT MARSH

TYPICAL SECTIONS
TRANSECTS

SHEET ID
C-302

REVIEW


K
J
F
E
H
D
C
B
Railroad Ave
S Concord St
Wapello Ave
Carp Lake
A
I
Sergeant John Baker Jr Memorial Bridge
G
200
Imagery Date: 4/21/2014 lat 41.490229° lon -90.640333

Site B, Wapello Ave

Date	H2O Temp (F)	pH	Nitrite (mg/L)	Nitrate (mg/L)	DO (mg/L)	Ortho-Phosphate (mg/L)	Chloride (mg/L)	Transparency (cm)	Total Suspended Solids (mg/L)
6/22/2016	24.1	7	nt	1	NA	NA	111	60	nt
6/29/2016	24.1	8	nt	2.71	102.40%	NA	122	NA	nt
7/6/2016	26.3	7	nt	2.9	104.80%	NA	72	12	nt
7/13/2016	29.9	7	nt	4	102.55%	0.4	81	55	nt
7/20/2016	22	7	nt	9.10	88.50%	1	50	9	nt
7/27/2016	28.1	7	nt	9	103%	1	64	60	nt
7/5/2017	82	9	0	0	4	2		nt	nt
7/12/2017	nt	7	0	0	2	2	56	nt	nt
7/19/2017	nt	9	0	0	3	3	56	nt	nt
7/31/2017	nt	8	0	0	8	0.8		nt	nt
8/18/2017	85	8	0.15	1	6	4	56	10	nt
8/23/2017	67	8	0	0	3	3	56	9	nt
9/2/2017	68	8	0	0	6	4	90	21	nt
10/21/2017	63	7	0	0	5	0.6	64	60	nt
5/18/2018	nt	7.50	nt	0	4.77	0.3	38	nt	nt
5/25/2018	25	7.37	nt	1	1.36	2.0	54	nt	nt
6/1/2018	24.1	7.41	nt	1	1.02	2.0	69	nt	nt
6/15/2018	20.6	7.43	nt	1	1.28	0.6	54	nt	nt
6/29/2018	27.2	7.68	nt	2	3.35	0.6	24	nt	nt
7/6/2018	26.3	7.26	nt	1	0.75	0.6	24	nt	nt
7/13/2018	27.3	7.20	nt	1	0.22	1.0	39	nt	nt
7/20/2018	22.2	7.69	nt	1	0.40	1.0	54	nt	nt
8/27/2018	nt	8.5	0	<0.1	9	0.1	75	30	22
9/5/2018	nt	7	0.15	0	3	1	27	43	nt
9/12/2018	nt	8	0	0	1	1	27	0	nt
9/19/2018	nt	7	0	0	1	1	40	46	nt
9/24/2018	nt	7	0	0.199	1	0.131	38	60	5.7
10/3/2018	nt	9	0	0	1	0.3	40	60	nt
10/17/2018	nt	7	0	0	5	0.1	27	60	nt
10/26/2018	nt	7	0	0	6	0.1		55	nt
4/22/2019	62	7	0	<0.1	8	0.1	30	52	7.7
5/6/2019	60	9	0	0	12	0.1	23	38	nt
5/28/2019	69	8	0	2.19	8	0.1	13	50	28.3
6/17/2019	67	7	0	0	2	1	13	60	nt
6/24/2019	72	7	0	0	4	1	40	60	nt
7/1/2019	78	7	0	0	6	0.1	56	40	nt
7/8/2019	78	7	0	0	5	1	70	42	nt
7/15/2019	81	8	0	0	8	0.1	56	25	nt
7/22/2019	77	8	0	0	10	0	147	60	nt
8/5/2019	79	8	0	0	6	0	75	35	nt
8/16/2019	69	7	0	0	10	0	139	60	nt
8/27/2019	65	7	0	<0.1	12	0.1	102	60	5
9/9/2019	60	7	0.15	0	6	0.1	126	60	nt
9/30/2019	66	8	0	<0.1	8	0.1	20	53	19.3
10/14/2019	52	7	0	0	10	0	22	60	nt
10/28/2019	44	6	0	0	5	0	34	60	nt
4/20/2020	52	7	0	0	10	0.1	27	24	nt
4/28/2020	63	8	0	<0.1	4	0.1	34	50	18.5
5/11/2020	56	7	0	0	8	0	76	30	nt
5/15/2020	70	nt	0	0	-	-	-	19	nt
5/26/2020	77	8	0	<0.1	6	0.1	53	25	13.3
6/8/2020	78	8	0	0	4	0.6	47	59	nt
6/22/2020	78	9	0	0	10	0.6	61	56	nt
6/29/2020	82	8	0	<0.1	6	0.149	76	46	11
7/6/2020	81	8	0	0	4	3	95	37	nt
7/20/2020	81	9	0	0	10	2	68	43	nt
7/27/2020	82	8	0	<0.1	1	0.212	115	36	17.3
8/3/2020	71	8	0	0	2	0.6	106	17	nt
8/24/2020	71	7	0	0	1	0.8	115	29	nt
8/31/2020	67	7	<0.1	<0.1	1	0.1	187	26	36.5
9/14/2020	65	8	0	0	5	0.8	46	60	nt
9/28/2020	60	7	<0.1	<0.1	3	0.119	103	50	13
10/19/2020	41	6	0	0	5	0.1	116	45	nt
10/28/2020	36	6	0	0	6	0.1	79	55	nt
4/12/2021	49	6	0	0	8	0	69	28	nt
4/26/2021	54	7	0	<0.1	10	0.1	78	40	12
5/10/2021	56	7	0	0	8	0	78	45	nt
5/24/2021	74	8	0	<0.1	3	0.1	78	60	<5
6/7/2021	74	7	0	0	5	0.6	69	60	nt
6/21/2021	70	7	0	0	3	1	78	55	nt
6/28/2021	73	8	0	<0.1	2	0.1	78	60	<5
7/12/2021	66	6	0	0	2	0.3	78	48	nt

nt: not tested

blue highlight indicates laboratory analysis

Site C, Marsh Dock

Date	H2O Temp (F)	pH	Nitrite (mg/L)	Nitrate (mg/L)	DO (mg/L)	Ortho-Phosphate (mg/L)	Chloride (mg/L)	Transparency (cm)	Total Suspended Solids (mg/L)
3/31/2017	nt	7	nt	1	9	nt	nt	32	nt
4/7/2017	nt	6.5	nt	0	9	nt	56	11	nt
7/5/2017	82	9	0	0	8	0.8	nt	nt	nt
7/12/2017	nt	8	0	0	4	0.4	80	nt	nt
7/19/2017	nt	8	0	0		1	nt	nt	nt
7/31/2017	nt	9	0	0	3	0.4	nt	nt	nt
8/17/2017	78	8	0	0	3	3	29	nt	nt
8/23/2017	70	7	0	0	1	4	29	40	nt
9/2/2017	74	9	0	1	12	2	64	41	nt
10/21/2017	67	7	0.3	0	10	0.8	35	60	nt
5/18/2018	nt	7.60	nt	0.0	4.77	0.6	24	nt	nt
5/25/2018	24.8	7.77	nt	0.0	9.05	1.0	46	nt	nt
6/1/2018	25.7	9.33	nt	1.0	1.65	2.0	46	nt	nt
6/15/2018	24.5	7.63	nt	1.0	1.75	2.0	87.0	nt	nt
6/29/2018	25.6	7.63	nt	2.0	3.42	0.6	24.0	nt	nt
7/6/2018	27.0	7.34	nt	1.0	0.56	0.3	33.0	nt	nt
7/13/2018	24.8	7.38	nt	1.0	0.33	0.4	33.0	nt	nt
7/20/2018	22.2	7.92	nt	1.0	2.35	2.0	61.0	nt	nt
8/27/2018	nt	7	0	0	1	3	56	30	nt
9/5/2018	nt	nt	0	1	4	1	47	55	nt
9/12/2018	nt	8	0	0	8	2	27	33	nt
9/19/2018	nt	9	0	1	2	2	34	60	nt
9/24/2018	nt	7	1	<0.1	5	<0.1	45	37	20
10/3/2018	nt	9	0	0	5	0.1	55	47	nt
10/17/2018	nt	8	0.15	2	5	0.2	27	60	nt
10/26/2018	nt	7	0	0	4	0.2	27	60	nt
10/31/2018	nt	6	0	0	4	0.8	30	60	nt
4/22/2019	61	7	0	<0.1	10	<0.1	30	47	9
5/6/2019	60	9	0	0	10	0.1	23	49	nt
5/28/2019	69	8	0	0.463	6	<0.1	13	60	5
6/17/2019	67	7	0	0	4	1	20	60	nt
6/24/2019	72	7	0	0	3	1	20	43	nt
7/1/2019	82	9	0	0	10	0	40	27	nt
7/8/2019	80	7	0	0	4	1	40	47	nt
7/15/2019	85	9	0	0	10	0.1	28	24	nt
7/22/2019	78	8	0	0	4	0	40	55	nt
8/5/2019	80	8	0	0	6	0	48	60	nt
8/16/2019	77	9	0	0	10	0.1	41	60	nt
8/27/2019	68	7	0	<0.1	2	<0.1	56	41	5
9/9/2019	64	7	0	0	2	0.1	80	60	nt
9/30/2019	65	8	0	<0.1	3	<0.1	27	60	5
10/14/2019	50	7	0	0	10	0.1	22	60	nt
10/28/2019	47	7	0	0	8	0	13	60	nt
4/20/2020	52	6	0	0	8	0.1	27	35	nt
4/28/2020	62	8	0	<0.1	4	<0.1	41	43	11
5/11/2020	54	6	0	0	8	0	68	36	nt
5/26/2020	76	8	0	<0.1	6	<0.1	47	40	11
6/8/2020	77	8	0	0	8	0.8	53	60	nt
6/22/2020	76	8	0	0	2	2	47	60	nt
6/29/2020	77	7	0	<0.1	2	0.413	47	58	14.5
7/6/2020	76	8	0	0	1	3	47	39	nt
7/20/2020	79	8	0	0	1	4	22	35	nt
7/27/2020	78	8	0	<0.1	1	0.701	37	45	27.3
8/3/2020	66	7	0	0	1	1	60	46	nt
8/24/2020	72	7	0	0	1	3	41	25	nt
8/31/2020	67	8	<0.1	<0.1	2	0.367	46	31	820
9/14/2020	65	7	0	0	1	0.4	11	60	nt
9/28/2020	57	6	<0.1	<0.1	2	<0.1	46	50	7
10/19/2020	39	9	0	0	8	0.1	103	60	nt
10/28/2020	34	5	0	0	12	0	79	56	nt
4/12/2021	49	6	0	0	8	0	67	20	nt
4/26/2021	53	7	0	<0.1	8	<0.1	69	51	8.3
5/10/2021	53	7	0	0	6	0	60	48	nt
5/24/2021	75	8	0	<0.1	6	<0.1	69	43	14.7
6/7/2021	80	8	0	0	6	0.6	69	47	nt
6/21/2021	72	7	0	0	6	0.6	60	56	nt
6/28/2021	76	7	0	<0.1	6	<0.1	60	60	<5
7/12/2021	67	7	0	0	3	0.4	69	57	nt

nt: not tested

blue highlight indicates laboratory analysis

G, Concord near Miss Rvr

Date	H2O Temp (F)	pH	Nitrite (mg/L)	Nitrate (mg/L)	DO (mg/L)	Ortho-Phosphate (mg/L)	Chloride (mg/L)	Transparency (cm)	Total Suspended Solids (mg/L)
3/31/17	7.2	6.67	nt	0	11.65	nt	nt	27	nt
4/7/17	9.9	7.64	nt	0	13.1	nt	64	36	nt
4/14/17	14.8	7.15	nt	0	9.77	nt	56	20	nt
6/22/2016	24	7	nt	NA	41.40%	NA	100	35	nt
6/29/2016	25.8	7	nt	2.3	96.50%	NA	35	30	nt
7/6/2016	23.8	6	nt	2.2	36.60%	NA	88	35	nt
7/13/2016	26.2	7	nt	0.8	57%	1	64	40	nt
7/20/2016	22.9	6	nt	2.3	77.20%	1	57	18.6	nt
7/27/2016	28	8	nt	7.5	87.56%	0.3	31	23	nt
8/18/2017	71	8	0	0	3	2	64	27	nt
8/23/2017	74	8	0	0	6	0.8	72	22	nt
9/2/2017	63	8	0	0	5	1	63	31	nt
10/21/2017	60	7	0	0	6	2	29	25	nt
5/25/2018	25.4	7.47	nt	1	2.36	1	46	nt	nt
6/1/2018	22.1	7.38	nt	2	3.89	2	24	nt	nt
6/15/2018	24.2	7.64	nt	2	3.33	0.6	24	nt	nt
7/13/2018	26.7	7.43	nt	1	0.7	1	33	nt	nt
7/20/2018	23.1	7.7	nt	1	0.36	2	33	nt	nt
8/27/2018	nt	8.5	0	<0.1	1	<0.1	65	38	32
9/5/2018	nt	8	0.3	2	6	1	27	nt	nt
9/24/2018	nt	6	0	2.42	6	0.129	17	7	88
10/3/2018	nt	9	0.15	5	8	1	27	10	nt
10/31/2018	nt	7	0	0	6	0.8	30	16	nt
6/24/2019	67	7	0	2	8	1	6	16	nt
7/1/2019	73	8	0	1	6	0	16	12	nt
7/8/2019	78	9	0	5	10	1	44	15	nt
7/15/2019	83	8	0.15	2	8	0	16	11	nt
7/22/2019	76	8	0	3	6	0.1	16	25	nt
8/5/2019	73	7	0	0	4	0.1	28	52	nt
8/16/2019	79	9	0	0	8	0	27	22	nt
8/27/2019	68	8	0	<0.1	6	<0.1	60	25	28
9/9/2019	61	7	0	0	4	0.6	114	15	nt
4/28/2020	60	9	1	0.783	10	<0.1	6	27	29
5/11/2020	56	6	0	0	8	0.1	41	25	nt
5/26/2020	70	8	2	2.5	10	<0.1	16	19	113
6/8/2020	76	8	2	0	8	0.1	16	24	nt
6/22/2020	79	8	0	0	8	0.3	47	25	nt
6/29/2020	80	8	2	4.01	8	0.11	16	16	36.7
7/6/2020	85	8	1	0	6	0.2	35	35	nt
7/20/2020	82	8	2	0	8	0.2	16	30	nt
7/27/2020	84	8	0	0.17	1	0.175	58	30	18.7
8/3/2020	78	7	2	0	6	0.1	30	28	nt
8/24/2020	80	9	0	0	8	0.3	47	10	nt
8/31/2020	69	8	<0.1	<0.5	3	<0.1	30	25	24.7
9/14/2020	61	8	0	0	6	0.8	46	40	nt
9/28/2020	56	7	<0.1	<0.1	6	<0.1	79	37	20.5
10/19/2020	43	7	0	0	8	0	79	31	nt
10/28/2020	37	6	0	0	8	0	46	31	nt
4/12/2021	50	7	0	0	8	0.1	103	29	nt
4/26/2021	55	8	0	<0.1	8	<0.1	60	20	71.3
5/10/2021	55	7	0	0	10	0.1	121	48	nt
5/24/2021	75	8	0	<0.1	6	<0.1	78	49	29
6/7/2021	75	8	0	0	10	2	69	21	nt
6/21/2021	65	8	0	0	8	2	53	14	nt
6/28/2021	63	7	0	<0.1	4	<0.1	53	21	36.7
7/12/2021	65	7	0	0	6	1	53	122	nt

nt: not tested

blue highlight indicates laboratory analysis

Site J, Ditch

Date	H2O Temp (F)	pH	Nitrite (mg/L)	Nitrate (mg/L)	DO (mg/L)	Ortho-Phosphate (mg/L)	Chloride (mg/L)	Transparency (cm)	Total Suspended Solids (mg/L)
5/18/2018	nt	7.47	nt	0	2.61	0.6	61	nt	nt
5/25/2018	23.4	7.35	nt	1	2.23	0.8	106	nt	nt
6/1/2018	26.7	7.39	nt	1	12.6	0.4	139	nt	nt
6/15/2018	32.7	7.62	nt	1	13.44	0.1	139	nt	nt
6/29/2018	29.9	7.82	nt	2	5.53	0.4	39	nt	nt
7/6/2018	28	7.20	nt	1	0.77	0.6	151	nt	nt
8/27/2018	nt	7	0	1.79	4	<0.1	61	25	11
9/12/2018	nt	8	0	0	5	0.6	55	55	nt
9/19/2018	nt	7	0	0	6	1	119	26	nt
9/24/2018	nt	9	0	0.241	2	<0.1	142	60	18.3
10/3/2018	nt	9	0	0	1	0.1	142	60	nt
10/17/2018	nt	8	0	0	5	0.1	27	60	nt
10/26/2018	nt	7	0	0	6	0.2	34	60	nt
11/2/2018	nt	8	0.15	2	2	0.3	126	nt	nt
4/22/2019	62	7	0	<0.1	8	<0.1	30	52	12.7
5/6/2019	60	9	0	0	12	0.1	23	38	nt
5/28/2019	69	8	0	0.24	8	<0.1	13	50	6
6/17/2019	67	7	0	0	2	1	13	60	nt
6/24/2019	72	7	0	0	4	1	40	60	nt
7/1/2019	78	7	0	0	6	0.1	56	40	nt
7/8/2019	78	7	0	0	5	1	70	42	nt
7/15/2019	81	8	0	0	8	nt	56	25	nt
7/22/2019	77	8	0	0	10	0	147	60	nt
8/5/2019	79	8	0	0	6	0	75	35	nt
8/16/2019	69	7	0	0	10	0	139	60	nt
8/27/2019	65	7	0	<0.1	12	<0.1	102	60	8
9/9/2019	60	7	0.15	0	6	0.1	126	60	nt
9/30/2019	66	8	0	<0.1	8	0.165	20	53	85
10/14/2019	52	7	0	0	10	0	22	60	nt
10/28/2019	44	6	0	0	5	0	34	60	nt
4/20/2020	56	6	0	0	10	0	27	20	nt
4/28/2020	63	8	0	0.175	6	<0.1	80	32	12.7
5/11/2020	54	7	0	0	10	0.1	139	29	nt
5/15/2020	64	nt	0	0	-	-	-	7	nt
5/26/2020	72	7	0	0.154	8	<0.1	105	40	17.3
6/8/2020	77	8	0	0	4	1	95	50	nt
6/22/2020	74	8	0	0	6	0.2	139	36	nt
4/12/2021	49	6	0	0	6	0.1	46	59	nt
4/26/2021	49	7	0	0.18	8	<0.1	116	23	20.7
5/10/2021	51	6	2	0	5	0.3	88	28	nt
5/24/2021	72	7	0	<0.1	1	0.215	88	60	<5
6/7/2021	80	8	0	0	6	0.4	60	53	nt
6/21/2021	70	7	0	0	5	0.8	133	37	nt
6/28/2021	73	7	0	0.567	10	<0.1	88	60	<5
7/12/2021	66	7	0	0	1	0.6	133	44	nt

nt: not tested

blue highlight indicates laboratory analysis

Site K, Upper Ditch

Date	H2O Temp (F)	pH	Nitrite (mg/L)	Nitrate (mg/L)	DO (mg/L)	Ortho-Phosphate (mg/L)	Chloride (mg/L)	Transparency (cm)	Total Suspended Solids (mg/L)
8/27/2018	nt	8	0	<0.1	5	0.108	134	60	190
9/12/2018	nt	7	0	0	8	0.6	27	42	nt
9/19/2018	nt	7	0	0	1	1	142	37	nt
9/24/2018	nt	9	0	<0.1	6	<0.1.	121	45	26.7
10/3/2018	nt	9	0	0	5	0.3	130	60	nt
10/17/2018	nt	7	0	0	5	0.3	34	60	nt
10/26/2018	nt	7	0	0	4	0.8	34	60	nt
11/2/2018	nt	8	0	0	2	1	68	51	nt
4/22/2019	61	7	0	<0.1	8	<0.1	30	49	8
5/6/2019	60	9	0	0	12	0.1	23	45	nt
5/28/2019	69	8	0	0.547	6	<0.1	13	60	6
6/17/2019	66	7	0	0	4	1	6	60	nt
6/24/2019	72	7	0	0	3	1	37	60	nt
7/1/2019	85	9	0	0	12	0	40	20	nt
7/8/2019	79	7	0	0	8	1	40	31	nt
7/15/2019	83	8	0	0	6	0.1	28	31	nt
7/22/2019	76	8	0	0	8	0.1	85	40	nt
8/5/2019	80	9	0	0	10	0.1	147	60	nt
8/16/2019	71	7	0	0	6	0	65	44	nt
8/27/2019	67	7	0	<0.1	6	<0.1	91	60	10.3
9/9/2019	63	7	0	0	5	0.1	165	60	nt
9/30/2019	66	8	0	<0.1	5	0.102	41	60	8
10/14/2019	52	7	0	0	12	0	16	60	nt
10/28/2019	44	6	0	0	8	0.1	28	60	nt
4/20/2020	54	8	0	0	8	0.1	27	36	nt
4/28/2020	63	7	0	<0.1	6	<0.1	34	33	10.3
5/11/2020	56	6	0	0	6	0.1	85	49	nt
5/15/2020	64	nt	0	0	nt	nt	-	7	nt
5/26/2020	74	8	0	<0.1	6	<0.1	61	40	24.7
6/8/2020	78	7	0	0	4	2	61	43	nt
6/22/2020	74	8	0	0	5	3	85	nt	nt
6/29/2020	85	7	0	<0.1	4	<0.1	127	nt	1480
7/27/2020	77	8	0	<0.1	3	<0.1	115	37	24.7
9/14/2020	61	7	0	0	5	0.6	46	51	
9/28/2020	56	7	<0.1	0.19	5	0.137	91	48	34
10/19/2020	39	6	0	0	4	0.1	172	10	nt
10/28/2020	35	6	0	0	4	0	103	9	nt
4/12/2021	48	6	0	0	6	0	33	57	nt
4/26/2021	50	7	0	<0.1	8	<0.1	67	51	11.3
5/10/2021	52	7	0	0	5	0.1	78	60	nt
5/24/2021	75	7	0	<0.1	3	0.175	69	60	5
6/7/2021	78	7	0	0	5	0.6	98	47	nt
6/21/2021	73	7	0	0	3	0.6	78	60	nt
6/28/2021	75	7	0	<0.1	6	<0.1	69	60	<5
7/12/2021	67	7	0	0	4	0.3	78	60	nt

nt: not tested

blue highlight indicates laboratory analysis

Upper Mississippi River Restoration Environmental Management Program

US Army Corps of Engineers®

Environmental Design Handbook

December 2012

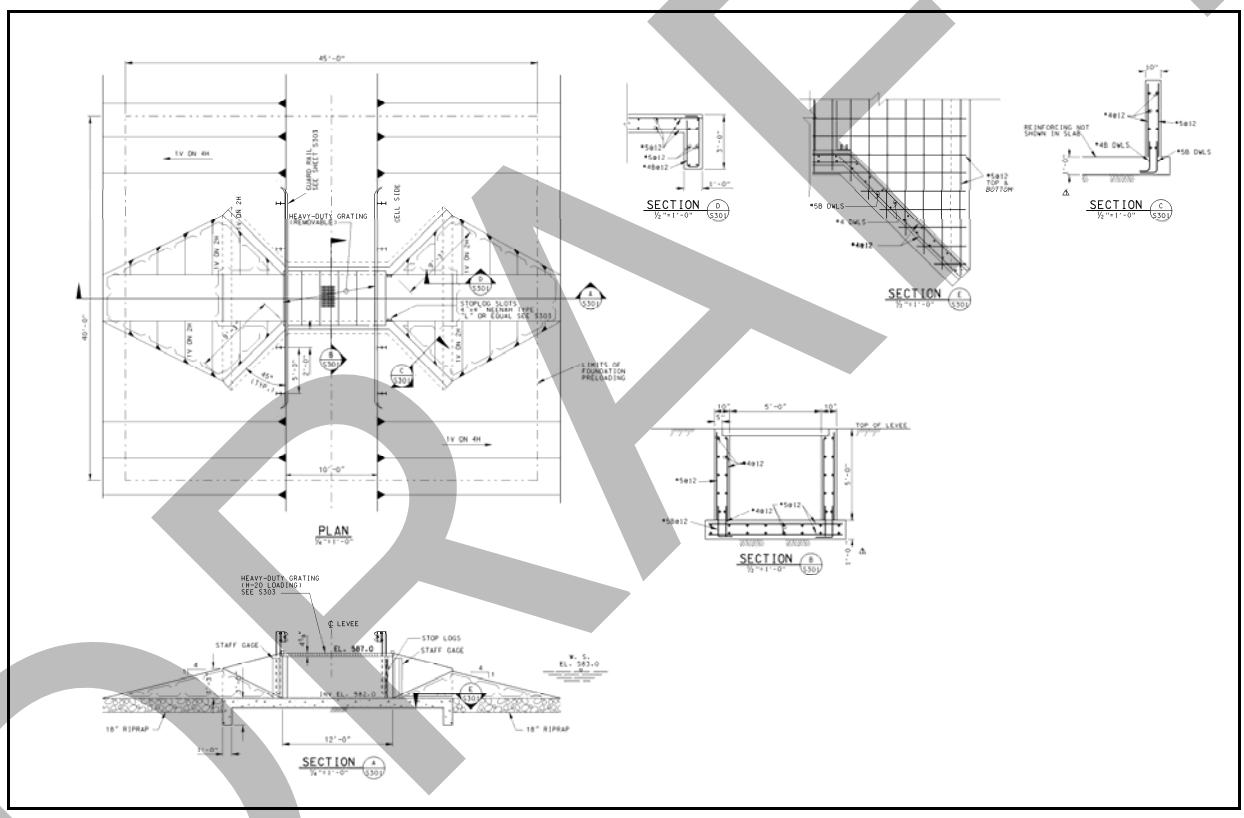
Localized Water Level Management

Chapter 5

UPPER MISSISSIPPI RIVER RESTORATION ENVIRONMENTAL MANAGEMENT PROGRAM ENVIRONMENTAL DESIGN HANDBOOK

CHAPTER 5

LOCALIZED WATER LEVEL MANAGEMENT



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CHAPTER 5

LOCALIZED WATER LEVEL MANAGEMENT

TABLES

PHOTOGRAPHS

UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
ENVIRONMENTAL DESIGN HANDBOOK

CHAPTER 5

LOCALIZED WATER LEVEL MANAGEMENT

A. RESOURCE PROBLEM AND OPPORTUNITIES

1. Pre-Inundation Conditions. Large river ecosystems such as the Upper Mississippi River System (UMRS) are characterized by seasonal cycles of flood and drought (or low flow). A variety of ecological functions and processes are linked to this cycle. Development of water resources for hydropower or navigation typically alters and disrupts these natural cycles. Fortunately in the UMRS, the flood stage of the hydrograph is relatively unaltered, but low stages have been eliminated to support commercial navigation.

2. Resource Problems. Much of the flora and fauna native to the Upper Mississippi River (UMR) region is adapted to the wide variations in water level that characterized the river and its floodplain prior to establishment of the lock and dam system. Since the implementation of the 9-Foot Channel Project, however, these variations have been truncated and the low river stage portion of the hydrograph has been increased to support commercial navigation. This water level control, coupled with other cumulative effects, has degraded ecosystem conditions, mainly the loss of backwater depth and aquatic plants in many areas.

3. Resource Opportunities. Numerous (27 as of 2005) Environmental Management Program (EMP) habitat projects have attempted to recreate this variability in specific areas to benefit such species. Several responses to water level management projects have been demonstrated since the 1997 Report to Congress. For example, Lake Chautauqua on the Illinois River near Havana, Illinois has been managed as a National Wildlife Refuge (NWR) since 1936, but wetland management capabilities and habitat quality had degraded over the years. Improved water level management capabilities in the southern pool completed in 1999 resulted in phenomenal wetland plant response, which, in turn, was met with the highest waterfowl use since the 1970s. Submersed aquatic vegetation and marsh plants colonized almost 1,400 acres after project completion. Fish response monitoring indicates the site can produce and export hundreds of millions of larval fish to the Illinois River.

B. HABITAT REHABILITATION AND ENHANCEMENT PROJECT (HREP) OBJECTIVES [1]

Recent evaluations of habitat objectives and opportunities through pool planning and the UMR-Illinois Waterway (IWW) Navigation Feasibility Study are revealing that water level management may be the only reliable mechanism in some instances to counteract the impacts of impoundment and floodplain development and thus achieve the desired habitat conditions. Evidence from EMP and other water level management projects indicates these projects can be effectively operated for multiple management objectives, including waterfowl, shorebirds, wading birds, reptiles, amphibians, and fisheries. However, water level management projects that include embankments, pumps, and control structures are more costly to build, maintain, and operate relative to other types of HREPs.

1. Hydraulics and Hydrology. Water level management is the direct manipulation of hydrology in a specific area with the purpose of eliciting a physical and biological response. Water level management is typically used on the river to restore the low-water portion of the natural seasonal hydrology, which was removed with the completion of the locks and dams. However, water level management strategies also include the active flooding of higher ground, as is the case with moist soil management techniques.

2. Geomorphology. Water level management can be used to influence geomorphology, though habitat and biological categories are more typically the focus. Water level management can be used to lower water levels to dry out and consolidate sediment. This can help stabilize sediment, reduce erosion and also counter the effects of past sedimentation. These effects can help meet bathymetric diversity objectives.

3. Biogeochemistry. Water level management can indirectly address biogeochemistry objectives through effects to vegetation. Lowering water levels during the growing season typically leads to a favorable response by aquatic and emergent vegetation, which can improve nutrient cycling and dissolved oxygen levels. Improved vegetation will also reduce sediment resuspension, leading to improved water quality.

4. Habitat. Water level management techniques are used to address habitat objectives by restoring hydrology to improve vegetation and/or the use of habitat by wildlife such as shorebirds and waterfowl. Drawdown in backwaters has been shown to help restore diverse and abundant native aquatic vegetation communities through the restoration of a more natural seasonal hydrograph. Moist soil management units (MSMU) can create important wetland habitat within the floodplain that serve waterfowl and shorebirds.

5. Biota. Water level management (and most features used in HREPs) indirectly affect biota through other effects to hydrology, geomorphology, biogeochemistry, and habitat. The effects to biota are seldom measurable in a manner that can clearly prove a cause and effect relationship with project features, so they are often assumed to correlate with physical habitat objectives.

[1] For a detailed explanation of the overall EMP vision, goals, and objectives, see Chapter 2, *Habitat Rehabilitation and Enhancement Projects.*

C. TYPES OF WATER LEVEL MANAGEMENT

Water level management features are named differently depending on the type of habitat improvements and other considerations. For the purpose of this report, they are divided into two categories, MSMUs and backwater lakes. The features which can control water levels will apply regardless of which name is chosen for the habitat.

1. Moist Soil Management Units

a. General Overview. The basic operating plan for an MSMU is to keep water out in the late spring and summer and to gradually flood the area in the fall. In a multiple cell system, it is best to be able to control water levels independently. One way to accomplish this independent filling is to have the pump discharge into a water control structure along an interior berm. This structure would be designed to have structures at both ends to control flow to either cell. A gate structure would be installed within each cell to allow independent gravity drainage. Table 5-1 represents a typical annual management plan for an MSMU.

Table 5-1. Typical MSMU Annual Management Plan

Month	Action	Purpose
Jul to Sep	Maintain water levels to minimum extent possible	Expose and maintain mudflats to allow vegetation growth
Oct to Nov	Gradually increase water levels	Provide access to aquatic food plants for migratory waterfowl
Dec to Apr	Maintain water levels to maximum extent possible	Maintain winter furbearer habitat
May to Jun	Gradually decrease water levels	Prepare for aquatic plant germination

Moist Soil Management Units are typically designed to include water containment, water supply, and water control structures. Water containment is provided by construction of exterior berms, interior berms, and overflow spillways; which are used to impound water during seasonal waterfowl migrations or keep water out of the impounded area. Water supply may be provided by either river water or ground water through the use of a pump station or well, respectively. Water control structures are utilized to maintain desired water elevations throughout the year. There are many types of water control structures such as stoplog, gated, overflow weir, and fuse plug. The water control structures typically used for HREP projects include stoplog, gated or other measures.

Moist Soil Management Units are part of the HREPs listed here. The design features for MSMUs are described in Section D.

Andalusia Refuge HREP, Pool 16, UMR RM 462.0-463.0, Rock Island Co., IL, MVR
Batchtown HREP, Pool 25, UMR RM 242.5-246.0, Calhoun Co., IL, MVS
Bay Island HREP, Pool 22, UMR RM 311.0-312.0, Marion Co., MO, MVR
Calhoun Point HREP, Pool 26, UMR RM 221.0-221.0, Calhoun Co., IL, MVS
Clarksville Refuge HREP, Pool 24, UMR RM 275.0-275.0, Pike Co., MO, MVS
Dresser Island HREP, Pool 26, UMR RM 206.0-209.0, St. Charles Co., MO, MVS
Guttenberg Waterfowl Ponds HREP, Pool 11, UMR RM 614.0-615.0, Grant Co., WI, MVP
Pleasant Creek HREP, Pool 13, UMR RM 548.7-552.8, Jackson Co., IA, MVR
Pool Slough HREP, Pool 9, UMR RM 673.0-673.0, Allamakee Co., IA MVP
Potters Marsh HREP, Pool 13, UMR RM 522.5-526.0, Carroll Co. and Whiteside Co., IL, MVR
Princeton Refuge HREP, Pool 14, UMR RM 504.0-506.4, Scott Co., IA, MVR
Rice Lake HREP, LaGrange Pool, IWW RM 132.0-138.0, Fulton Co., IL, MVR
Spring Lake HREP, Pool 13, UMR RM 532.5-536.0, Carroll Co., IL, MVR
Stump Lake HREP, Alton Pool, IWW RM 7.2-12.7, Jersey Co., IL, MVS
Swan Lake HREP, Alton Pool, IWW RM 5.0-13.0, Calhoun Co., IL, MVS
Trempealeau NWR HREP, Pool 6, UMR RM 718.0-724.0, Trempealeau Co., WI, MVP

MVR – Rock Island District; MVS – St. Louis District; MVP – St. Paul District

b. Biota and Habitat Considerations. Generally, the goal of an MSMU is wetland habitat enhancement with the objective of providing suitable habitat for waterfowl. Moist Soil Management Units are typically managed to include annual draw-downs. This technique is well accepted for wetland management and has been considered necessary for rejuvenating older, unproductive impoundments (Kadlec 1962). Stabilizing water levels, particularly at high levels, can be detrimental; and periodic drying and flooding is beneficial for establishment of desired aquatic vegetation (Weller 1978, 1981:70). The need for seasonal instability should not be equated with erratic water level changes at any time of the year (Weller 1981:70). Wildlife productivity will likely increase as wetlands experience a regular flooding cycle (Mitsch and Gosselink 1986:430).

2. Backwater Lakes With Water Level Management

a. General Overview. Prior to construction of the navigation system, water levels typically dropped during the summer months allowing backwater lakes to consolidate. This drying effect encouraged emergent aquatic plants, such as bulrush and arrowhead to grow. With the more stable water levels created by the navigation pools, this low-water effect and drying of sediments no longer occurs. Plant beds that depend on this drying process have decreased in extent or disappeared entirely. Stands of perennial emergent aquatic plants are important to fish and wildlife populations because they provide food, shelter, and dissolved oxygen. Hence, a backwater lake with water level management may be implemented to help improve conditions for the growth of aquatic vegetation.

Similar to MSMUs, backwater lakes with water level management are typically designed to include water containment, water supply, and water control structures. These are similar to those described for MSMUs. Backwater lakes with water level management are listed below. The design features for a backwater lake with water level management are described in Section D.

Batchtown HREP, Pool 25, UMR RM 242.5-246.0, Calhoun Co., IL, MVS
Banner Marsh HREP, LaGrange Pool, IWW RM 138.0-144.0, Fulton Co. and Peoria Co., IL, MVR
Bay Island HREP, Pool 22, UMR RM 311.0-312.0, Marion Co., MO, MVR
Bussey Lake HREP, Pool 10, UMR, Clayton Co., IA, MVP
Calhoun Point HREP, Pool 26, UMR RM 221.0-221.0, Calhoun Co., IL, MVS
Clarksville Refuge HREP, Pool 24, UMR RM 275.0-275.0, Pike Co., MO, MVS
Finger Lakes HREP, Pool 5, UMR, Wabasha Co., MN, MVP
Fox Island HREP, Pool 20, UMR RM 353.5-358.5, Clark Co., MO, MVR
Lake Chautauqua HREP, LaGrange Pool, IWW RM 124.0-129.5, Mason Co., IL, MVR
Lake Odessa HREP, Pools 17-18, UMR RM 435.0-440.0, Louisa Co., IA, MVR
Long Meadow Lake HREP, Minnesota River, Hennepin Co., MN, MVP
Peoria Lake HREP, Peoria Pool, IWW RM 162.0-181.0, Peoria Co. and Woodford Co., IL, MVR
Princeton Refuge HREP, Pool 14, UMR RM 504.0-506.4, Scott Co., IA, MVR
Rice Lake HREP, LaGrange Pool, IWW RM 132.0-138.0, Fulton Co., IL, MVR
Rice Lake HREP, Minnesota River RM 15.0-17.5, Scott Co. and Hennepin Co., MN, MVP
Small Scale Drawdown HREP, Pool 5, UMR RM 746.0-746.0, Buffalo Co., WI, MVP
Stump Lake HREP, Alton Pool, IWW RM 7.2-12.7, Jersey Co., IL, MVS
Swan Lake HREP, Alton Pool, IWW RM 5.0-13.0, Calhoun Co., IL, MVS
Trempealeau NWR HREP, Pool 6, UMR RM 718.0-724.0, Trempealeau Co., WI, MVP

MVR – Rock Island District; MVS – St. Louis District; MVP – St. Paul District

b. Biota and Habitat Considerations. Generally, the goal of a backwater lake with water level management is aquatic habitat restoration with the objective of providing suitable habitat for waterfowl and fisheries. Water level management of a backwater lake consists of a temporary seasonal increase or decrease in water elevations to mimic natural hydrologic regimes in order to improve large areas of shallow aquatic habitat.

D. DESIGN FEATURES COMMON FOR WATER LEVEL MANAGEMENT

Water level management projects, to include MSMUs and backwater lakes, have several similar design features important to the proper operation and maintenance of these systems. These features are described in the following sections.

1. Exterior Berms, Interior Berms, and Overflow Spillways

a Design Considerations. Two general design criteria for this project feature are to construct a reliable embankment system that provides adequate flood protection to meet the sponsor's seasonal and/or annual management goals and locate borrow sites in areas that improve the suitable habitat for migratory birds.

b. Embankment Height. When designing the height of the embankment system, it is important to minimize interior sedimentation and to provide protection against frequent flooding for reliable water level management but on the other hand, it can also be important to maintain connectivity with the river. In addition, the desired operating levels of the system also need to be considered. Therefore, the embankment height needs to be carefully evaluated. One approach for determining the embankment height is to consider various flood elevations (2- year, 5-year, 10-year, 15-year, 20-year, 25-year, etc.) and determine how many times each flood elevation has been exceeded based on the data available. Then evaluate the additional cost of raising the embankment system to a higher flood elevation versus the decrease in the exceedance rate. The approximate embankment heights for some HREPs are listed in the table 5-2.

Table 5-2. HREP Embankment Height

Project	Feature	Embankment Height (Flood Level)
Andalusia	Levee	2 year
Banner Marsh	Levee	50 year
Bay Island	Levee	2 year
Clarksville	Levee	20 year
Lake Odessa	Levee	varies
	Upper Spillway	17 year
	Lower Spillway	10 year
Princeton	Levee	15 year
Rice Lake	Spillway	2 year
Spring Lake	Levee	50 year
	Cross Dike (Interior Berm)	5 year
Stump Lake	Levee	3 to 4 year

c. Embankment Slopes. If the exterior berm is located adjacent to a major river, its profile parallel to that river may be sloped upstream to allow for gradual overtopping during flood events, which could minimize damage potential. Top widths for exterior and interior berms are typically a minimum of 10 feet, especially for those embankment systems that are also used for access. (At times the top of the berms are used as a roadway for embankment inspections or maintenance.) Side slopes are typically a minimum of 3H:1V. Flatter side slopes can be desired to minimize rodent damage and to minimize erosion caused by overtopping. If site conditions vary, consider multiple design cross section templates as a single design cross section template doesn't always fit the actual field conditions

encountered during construction. Design cross section templates should be applicable to all field conditions.

d. Cells. A MSMU may have a single exterior berm (1-celled) or consist of multiple cells through the construction of interior berms. When determining whether the embankment system should be single or multiple celled, consider the existing site topography. If the site is relatively flat, a single cell may be adequate. If the site varies in elevation, multiple cells may be desired to maximize the acreage of ideal water depth. In addition, large MSMUs may be portioned into multiple cells for management purposes. On the other hand, it can also be desired to minimize the number of cells to increase connectivity and create larger contiguous areas required by some species. The top elevation of an interior berm is typically set to provide a minimum freeboard of 2 feet during the highest ponding scenario.

e. Spillways. To provide controlled overtopping of an embankment system, overflow spillways are constructed, typically at the downstream end of the site, at an elevation lower than the exterior berm. This elevation provides for overtopping during a lesser flood event. During a flood event, the overflow spillway allows rapid filling of the MSMU interior prior to overtopping of the exterior berm. The spillway provides a defined location for filling the cells that can be adequately armored and protected against erosion. An overtopping analysis should be conducted to determine the elevation difference between the exterior berm and the overflow spillway.

f. Embankment Material. When considering options for borrow material for the embankment system, it may be beneficial to use on-site material that is suitable. The utilization of interior borrow areas offers additional habitat benefit by converting existing cropland to non-forested wetland. Ideally, these areas would be developed as large and shallow, which would not only maximize habitat benefits but may also yield the most suitable impervious borrow material. Essentially, these borrow areas may be considered potholes. Dredged material from within or outside the embankments may also be used to construct the berms. Using dredged material may provide additional aquatic habitat for the HREP.

g. Embankment Protection. HREPs that include moist soil units typically hold water for extended periods of time. To the greatest extent possible provide bank stabilization methods above and below the design operating water levels. Typically, vegetative bank stabilization is often planted on embankments to help prevent scouring. Stone protection may also be required in some instances. For embankments that will be exposed to frequent recreational traffic, consider establishing slow-no-wake zones to help minimize erosion, especially if the embankment is constructed of clay material and is not protected with riprap.

h. Maintenance. Maintenance of the exterior berms, interior berms, and overflow spillways should include project inspections on an annual basis (ideally after the area is drained) in addition to immediately following a high water event. Project inspections should determine if the following conditions exist:

- settlement, slough, or loss of section
- wave wash and scouring
- overtopping erosion
- inadequate vegetative cover (too much or not enough)
- unauthorized grazing or traffic

- encroachments
- unfavorable tree/shrub growth
- seepage distress

Corrective action should be taken upon discovery of any adverse conditions.

i. Case Studies. Constructed HREPs with an embankment feature are listed here.

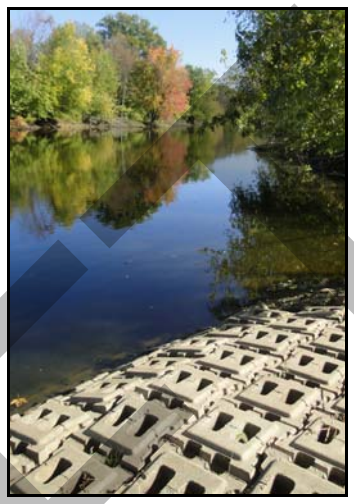
Andalusia Refuge HREP, Pool 16, UMR RM 462.0-463.0, Rock Island Co., IL, MVR
Banner Marsh HREP, LaGrange Pool, IWW RM 138.0-144.0, Fulton Co. and Peoria Co., IL, MVR
Bay Island HREP, Pool 22, UMR RM 311.0-312.0, Marion Co., MO, MVR
Clarksville Refuge HREP, Pool 24, UMR RM 275.0-275.0, Pike Co., MO, MVS
Guttenberg Waterfowl Ponds HREP, Pool 11, UMR RM 614.0-615.0, Grant Co., WI, MVP
Lake Chautauqua HREP, LaGrange Pool, IWW RM 124.0-129.5, Mason Co., IL, MVR
Lake Odessa HREP, Pools 17-18, UMR RM 435.0-440.0, Louisa Co., IA, MVR
Pharrs Island HREP, Pool 24, UMR, Pike Co., MO, MVS
Pool Slough HREP, Pool 9, UMR RM 673.0-673.0, Allamakee Co., IA MVP
Princeton Refuge HREP, Pool 14, UMR RM 504.0-506.4, Scott Co., IA, MVR
Rice Lake HREP, LaGrange Pool, IWW RM 132.0-138.0, Fulton Co., IL, MVR
Rice Lake HREP, Minnesota River RM 15.0-17.5, Scott Co. and Hennepin Co., MN, MVP
Spring Lake HREP, Pool 13, UMR RM 532.5-536.0, Carroll Co., IL, MVR
Stump Lake HREP, Alton Pool, IWW RM 7.2-12.7, Jersey Co., IL, MVS
Swan Lake HREP, Alton Pool, IWW RM 5.0-13.0, Calhoun Co., IL, MVS
Trempealeau NWR HREP, Pool 6, UMR RM 718.0-724.0, Trempealeau Co., WI, MVP

MVR – Rock Island District; MVS – St. Louis District; MVP – St. Paul District

j. Photographs. Constructed HREPs with berms and/or spillways are shown here.

Photographs 5-1a and b. Andalusia Refuge HREP, Pool 16, UMR RM 462.0-463.0, Rock Island Co., IL, MVR

Photograph 5-2. Princeton Refuge HREP, Pool 14, UMR RM 504.0-506.4, Scott Co., IA, MVR



Photographs 5-3a and b. Lake Odessa HREP, Pools 17-18, UMR RM 435.0-440.0, Louisa Co., IA, MVR

k. References

EM 1110-2-1603, Engineering and Design - Hydraulic Design of Spillways, CECW-ED-H, 16 Jan 1990 (original) 31 Aug 1992 (errata #1)

EM 1110-2-1913, Engineering and Design - Design and Construction of Levees, CECW-EG, 30 Apr 2000

EP 415-1-261 (Volume 2), Construction - Quality Assurance Representative's Guide - Pile Driving, Dams, Levees and Related Items, CEMP-CE, 31 Mar 1992

2. Pump Stations and Wells

a. Design Considerations. Water can be introduced or removed from a MSMU or backwater lake through the use of a pump station, portable pumps, wells or a water control structure. Pumps can obtain either surface water, typically from a river, or groundwater.

b. Surface Water. When evaluating a pump station versus a well (i.e. surface water versus ground water), keep in mind that reuse of surface water is desired where practicable. Surface water is often used as a source due to its abundance and ease of access. When surface water is used, it can remove sediment from its source, and add potentially nutrient rich sediment to the MSMU or backwater lake. Additionally, the use of surface water can remove nitrogen and phosphorous from the river system, with the nutrients eventually being uptaken by plant organisms within the MSMU.

Inlet and/or outlet channels from the source of surface water to the pump stations if needed have routinely had sedimentation challenges. To the greatest extent possible, locate pump stations adjacent to the river or as close to the river as possible to minimize channel lengths.

c. Groundwater. The volume of water required will generally dictate whether a groundwater well can be feasibly constructed. Groundwater wells are limited in capacity due to available well yield from the aquifer, construction limitations, commercially available well pump size, and availability of utility power. There is also a potential of encountering poor groundwater quality such as high sulfur, etc. It may be necessary to incorporate provisions into the design to deal with situations where testing of groundwater quality reveals problems.

d. Pump Housing. Pump stations can be designed to have the intake sump and pumps with associated equipment all in one structure or they can be separate. The equipment for both pump stations and wells is required to be at or above certain flood elevations and will depend on where the project is located. Pumping stations can either be a permanent station or be mobile, including floating type pumping plants.

e. Water Direction. Pump stations can be designed to pump from the river to the MSMU, from the MSMU to the river, or be multi-directional to pump to multiple MSMU's as well as either way. Extra flexibility may be desired by the project sponsor, although water control could be obtained through the use of various closure structures if so designed.

f. Pump Size. When determining the size of the pumps for a pump station or well, a minimum of three variables need to be considered; the evaporation rate, the seepage rate, and the desired fill rate.

g. Access Hatches. Design hatches and grating to have locking mechanisms when open so that the hatches to do not close unexpectedly causing a safety hazard.

h. Power Source. Pumps may be electric or diesel driven depending upon the availability of utility power and user needs. Electric driven pump stations have the advantage of being quieter to operate (little vibration), easier automation, and less routine maintenance. They may also be submerged and require less labor time to operate. Some of the disadvantages are that the electrical equipment must be protected from flooding, available utility power can limit capacity, high demand charge, and usually larger more elaborate structures are required to house electrical equipment. Since

electrical equipment is subject to damage from high water, ensure that it is placed above the 500 year (or higher if possible) flood elevation.

Diesel driven pump stations have the advantage of being ideally suited where utility power in unavailable, they have a large capacity, can be permanently mounted pumps with submersible gear drives, can be mounted vertically or angle mounted, can be made trailer mounted to reduce the threat of flooding, and the drive arrangements afford flexibility (direct, belt, hydraulic). Disadvantages to diesel driven pumps are they are noisy to operate, require more routine maintenance, capacity and availability of on-site fuel supply can be restrictive, and are difficult to automate.

i. Equipment Testing. Ensure the contract specifications include testing for all pump station equipment to include pumps, floats, surge protectors, humidity devices, etc. All pump station equipment should be checked, inspected, and verified after installation by the Contractor before finally acceptance.

j. Maintenance. Maintenance of a pump station or well should include project inspections on an annual basis (ideally after the area is drained) in addition to immediately following a high water event. Pump station inspections should be documented using the pump station rating guidelines for continuing eligibility inspections to include the following items as a minimum where applicable:

- structural steel
- structural concrete
- displaced/missing riprap
- electrical lighting/standby generator
- discharge pipe
- sump
- hydraulic pump
- stoplogs

Corrective action should be taken upon discovery of any deficiencies found during the inspection.

k. Case Studies. Constructed HREPs with pump stations and wells are as follows:

Andalusia Refuge HREP, Pool 16, UMR RM 462.0-463.0, Rock Island Co., IL, MVR
Banner Marsh HREP, LaGrange Pool, IWW RM 138.0-144.0, Fulton Co. and Peoria Co., IL, MVR
Batchtown HREP, Pool 25, UMR RM 242.5-246.0, Calhoun Co., IL, MVS
Bay Island HREP, Pool 22, UMR RM 311.0-312.0, Marion Co., MO, MVR
Calhoun Point HREP, Pool 26, at the confluence of IWW and UMR RM 220.0, Calhoun Co., IL, MVS
Clarksville Refuge HREP, Pool 24, UMR RM 275.0-275.0, Pike Co., MO, MVS
Cuivre Island HREP, Pool 26, UMR RM 233.0-239.0, Lincoln Co. and St. Charles Co., MO, MVS
Lake Chautauqua HREP, LaGrange Pool, IWW RM 124.0-129.5, Mason Co., IL, MVR
Lake Odessa HREP, Pools 17-18, UMR RM 435.0-440.0, Louisa Co., IA, MVR
Peoria Lake HREP, Peoria Pool, IWW RM 162.0-181.0, Peoria Co. and Woodford Co., IL, MVR
Princeton Refuge HREP, Pool 14, UMR RM 504.0-506.4, Scott Co., IA, MVR
Rice Lake HREP, LaGrange Pool, IWW RM 132.0-138.0, Fulton Co., IL, MVR
Spring Lake HREP, Pool 13, UMR RM 532.5-536.0, Carroll Co., IL, MVR

Stump Lake HREP, Pool 26, IWW RM 7.0-13.0, Jersey Co., IL, MVS
Swan Lake HREP, Alton Pool, IWW RM 5.0-13.0, Calhoun Co., IL, MVS
Trempealeau NWR HREP, Pool 6, UMR RM 718.0-724.0, Trempealeau Co., WI, MVP

MVR – Rock Island District; MVS – St. Louis District; MVP – St. Paul District

l. Photographs. Constructed HREPs with pump stations are shown here.

Photographs 5-4a and b. Andalusia Refuge HREP, Pool 16, UMR RM 462.0-463.0, Rock Island Co., IL, MVR

Photograph 5-5. Portable Pump-Lake Odessa HREP, Pools 17-18, UMR RM 435.0-440.0, Louisa Co., IA, MVR

m. References

EM 1110-2-3104, Engineering and Design - Structural and Architectural Design of Pumping Stations, CECW-ED, 30 Jun 1989

ER 1110-2-100, Engineering and Design - Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures, CECW-EP, 15 Feb 1995

3. Stoplog Structures

a. Design Considerations. A general design criterion for this project feature is to construct a structure with operational flexibility that provides the site manager with the capability to meet seasonal and/or annual management goals. Stoplogs can be placed in various types of structures to meet the sizing requirements for raising or lowering water levels. Additionally, the design of the stoplogs themselves can vary widely. Using stoplog structures can be an advantage because they are relatively inexpensive and require low maintenance. Some disadvantages include the following:

- Removing a stoplog can, in some cases, require more than one-person to operate.
- When the head over the stoplogs is high, removal can become nearly impossible.
- Stoplogs with eyes at top are difficult to remove and are often hard to hook, which can also cause problems with sealing properly.

b. Structure Material. Stoplog structures may be constructed of various materials, such as concrete, corrugated metal pipe (CMP), combination concrete and CMP, PVC, or steel.

c. Concrete stoplog structures may have single or multiple bays. The concrete structure may be cast-in-place or precast. Additionally, the structure may or may not have footings. Dewatered versus in the wet construction methods should be considered, especially if control of construction costs are critical.

d. CMP stoplog structures generally consist of a 5-foot diameter riser pipe.

e. PVC stoplog structures have not been used extensively for HREP projects but have proven to be successful on other Corps projects so they should be considered for future HREP projects (http://www.agridrain.com/watercontrolproductsinline.asp). Stoplog structures may also be designed to have a combination of both stoplogs and sluice gates. The ability to resist deflection and warping must be considered. Protection against damage from ultraviolet radiation is important because the breakdown of the outer surface can expose glass fibers.

f. Sheet pile cells may be incorporated into stoplog structures as abutments (Batchtown, Swan Lake and Calhoun Point) or stoplog structures may incorporate internally tied-back Z-shaped sheet pile wing and face walls (Calhoun Point). Concrete footing structures at the top of each abutment support access bridges and stoplog support framing. These footings may be soil-founded (Batchtown) or pile-founded within the retained embankment (Calhoun Point) as local conditions require.

g. Structure Location. Inlet and/or outlet channels from the main channel to the stoplog structures if needed have routinely had sedimentation challenges. To the greatest extent possible, locate stoplog structures adjacent to the river or as close to the river as possible to minimize side channel lengths. Soil borings are recommended at the proposed location of structures to include groundwater elevations. The soils should be evaluated to determine if they are suitable for the structure foundation and if not, what kind of working platform is needed. Ground water elevations can help identify the need for a cofferdam and/or dewatering system during construction.

h. Structure Height. Structures can vary in height to meet customer requirements. At Swan Lake, a number of both one-foot-high and six-foot-high stoplogs are being provided for flexibility in

operation. At Calhoun Point, one-foot-high stoplogs that can be ganged together in the field are being provided. In general, the structure should be located and designed to allow for appropriate drainage or flooding of the site, and to ensure that there is adequate height to maintain water levels upstream of the structure.

i. Structure Top Width. For larger structures, if vehicular access across a structure is required, the weight and width of the equipment must be considered.

j. Structure Safety. If operator access is required, appropriate safety measures for guardrails, steps, etc. must be included. Additionally, operator safety should be considered in developing structure features. Non-skid grating and guardrails should be provided on catwalks, etc. Safety features for access to the smaller structures must be considered such as locking devices for hinged hatches.

k. Structure Protection. Ensure that sufficient riprap/bank stabilization is placed around inlet/outlet of gated structures, even if erosion is not a concern. This will prevent wildlife from burrowing next to the structure, which has been a maintenance issue at a few constructed projects. The tendency is to keep the stabilization to a minimum when going for the maximum is usually the better approach.

l. Stoplog Material

Aluminum stoplogs generally weigh less but cost more. While the material weight for aluminum stoplogs is less than wood, hollow stoplogs can accumulate internal silt and thus additional lifting weight over time. Aluminum stoplogs have been designed to have rubber stripping along the bottom and sides to provide a tighter seal. Options for aluminum stoplogs include extruded cross-sections (for individual 1-foot stoplogs) or fabricated cross sections of skin plates and connecting members (for 1-foot or higher stoplogs). Aluminum stoplogs are also subject to being stolen when aluminum recycling costs are high.

Wood stoplogs are buoyant and require ballasting or some type of mechanism to prevent from floating. Wood stoplogs may have a tendency to seal better as wood will swell when saturated. To help with sealing, wood stoplogs have been designed to have grooves so that they "interlock;" when installed, however, this is not always the case, such as at Swan Lake.

m. Stoplog Bay Widths. A stoplog structure can involve a series of bays. The stoplog bay width depends on local user requirements. In Rock Island District, a five foot bay is often used. At Batchtown (in St. Louis District), several structures are across channels where duck blind access is required. A clear width in each bay of ten feet between stoplog supports, and head clearance of five feet between the maximum water level and the low surface of the access bridge, is provided. At Swan Lake, where such access is not required, the clear opening in each bay is only four feet. If a number of similar structures are anticipated at a project site, using similar bay widths, and therefore similar stoplogs throughout, can provide interoperability.

n. Stoplog Storage. Stoplogs may be stored either off site or on-site, such as in a pump house. If stored on-site, keep stoplogs at the highest elevation possible. It is important to establish storage capabilities of the site managers during the design process.

o. Stoplog Protection. Stoplog structures need to be protected from vandalism, theft, and unauthorized use. This can be accomplished through use of padlocks and locking bars. The safety of stoplog structures can be provided through use of inlet/outlet guards, ladders, guardrails, and other such devices.

p. Stoplog Lifting Devices. A stoplog lifting hook is typically furnished for the installation and removal of the stoplogs. Lifting devices should be designed for easy transportation and use, especially during high flows. Stop log hoists may be used to manipulate the structure. Lifting devices can be manual or power-assisted. Electric or hydraulic hoists can be used for raising and lowering stoplogs. The lifting equipment can be supported on a trolley beam running across all bays or on a jib crane. The support requirements for a trolley beam or job crane will determine to some extent the layout of the supporting structures at the sides of the channel to be controlled. Jib crane manufacturers can provide anchor bolt patterns and minimum footing requirements to be used in support structure layout. The design of the lifting device should take into consideration the equipment and/or machinery that the owner has on hand or is readily available to them. Keep in mind when designing a stoplog structure that some site managers may prefer a one-person operation when installing and removing stoplogs. This can become difficult when the head is too high over the stoplogs, the stoplogs are too heavy, and/or the lifting devices are too bulky.

q. Operation. Stoplog structures should be operated so that when the MSMU is in use or the river water levels are expected to rise, the stoplogs should be installed and are to remain in place until one of the following occurs:

- flood waters recedes,
- project no longer in use, or
- overtopping of the exterior berm is anticipated

r. Maintenance. Maintenance of stoplog structures should include project inspections on an annual basis (ideally after the area is drained) in addition to immediately following a high water event. Project inspections should ensure the following:

- stoplogs, slots, keepers, staff gages, and lifting hooks are in good condition
- steel rails, posts, grating, and fasteners are in good condition
- concrete is in good condition
- inlet and outlet channels are open
- trash, debris, and sediment are not accumulating in and around the structure
- erosion, seepage, and encroachments are not occurring adjacent to the structure which might endanger its function
- riprap is not displaced or missing

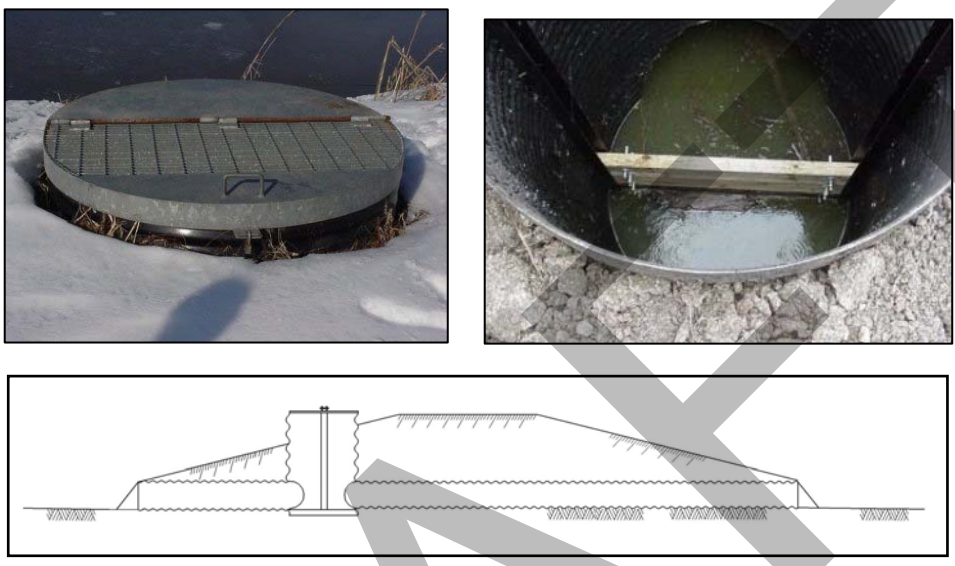
Corrective action should be taken upon discovery of any adverse conditions at the structures.

s. Case Studies. Constructed HREPs with stoplog include the following:

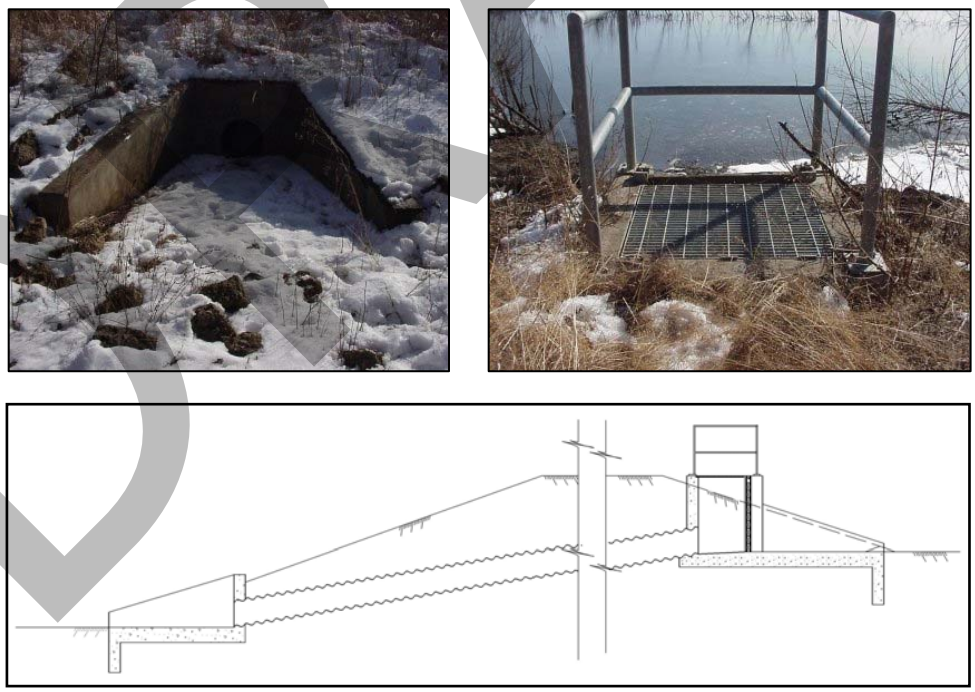
Ambrough Slough HREP, Pool 10, UMR, Crawford Co., WI, MVP
Banner Marsh HREP, LaGrange Pool, IWW RM 138.0-144.0, Fulton Co. and Peoria Co., IL, MVR
Batchtown HREP, Pool 25, UMR RM 242.5-246.0, Calhoun Co., IL, MVS
Bay Island HREP, Pool 22, UMR RM 311.0-312.0, Marion Co., MO, MVR
Calhoun Point HREP, Pool 26, UMR RM 221.0-221.0, Calhoun Co., IL, MVS
Cuivre Island HREP, Pool 26, UMR RM 233.0-239.0, Lincoln Co. and St. Charles Co., MO, MVS
Fox Island HREP, Pool 20, UMR RM 353.5-358.5, Clark Co., MO, MVR
Guttenberg Waterfowl Ponds HREP, Pool 11, UMR RM 614.0-615.0, Grant Co., WI, MVP
Lake Chautauqua HREP, LaGrange Pool, IWW RM 124.0-129.5, Mason Co., IL, MVR
Lake Odessa HREP, Pools 17-18, UMR RM 435.0-440.0, Louisa Co., IA, MVR
Long Meadow Lake HREP, Minnesota River, Hennepin Co., MN, MVP
Peoria Lake HREP, Peoria Pool, IWW RM 162.0-181.0, Peoria Co. and Woodford Co., IL, MVR
Pleasant Creek HREP, Pool 13, UMR RM 548.7-552.8, Jackson Co., IA, MVR
Pool Slough HREP, Pool 9, UMR RM 673.0-673.0, Allamakee Co., IA MVP
Potters Marsh HREP, Pool 13, UMR RM 522.5-526.0, Carroll Co. and Whiteside Co., IL, MVR
Princeton Refuge HREP, Pool 14, UMR RM 504.0-506.4, Scott Co., IA, MVR
Rice Lake HREP, LaGrange Pool, IWW RM 132.0-138.0, Fulton Co., IL, MVR
Rice Lake HREP, Minnesota River RM 15.0-17.5, Scott Co. and Hennepin Co., MN, MVP
Spring Lake HREP, Pool 13, UMR RM 532.5-536.0, Carroll Co., IL, MVR
Stump Lake HREP, Alton Pool, IWW RM 7.2-12.7, Jersey Co., IL, MVS
Swan Lake HREP, Pool 26, IWW RM 5.0-13.0, Calhoun Co., IL, MVS

MVR – Rock Island District; MVS – St. Louis District; MVP – St. Paul District

t. Photographs and Figures. Constructed HREPs with stoplog structures are shown in the following photographs:



Photographs 5-6a, b, and c. Banner Marsh HREP, LaGrange Pool, IWW RM 138.0-144.0, Fulton and Peoria Counties, IL, MVR



Photographs 5-7a, b, and c. Potters Marsh HREP, Pool 13, UMR RM 522.5-526.0, Carroll and Whiteside Counties, IL, MVR

Photographs 5-8a and b. Bay Island HREP, Pool 22, UMR RM 311.0-312.0, Marion Co., MO, MVR

Photographs 5-9a and b. Princeton Refuge HREP, Pool 14, UMR RM 504.0-506.4, Scott Co., IA, MVR

Photographs 5-10a and b. Spring Lake HREP, Pool 13, UMR RM 532.5-536.0, Carroll Co., IL, MVR

u. References

EM 1110-2-2705, Engineering and Design - Structural Design of Closure Structures for Local Flood Protection Projects, CECW-ED, 31 Mar 1994

Agri Drain Corporation, Inline Water Level Control Structures, http://wwwagridraincom/watercontrolproductsinlineasp

Agri Drain Corporation, Inlet Water Level Control Structures, http://wwwagridraincom/watercontrolproductsinletasp

EM 385-1-1, Safety – Safety and Health Requirements, CESO-ZA, 03 Nov 2003

EM 1110-2-2100, Stability Analysis of Concrete Structures, CECW-CE, 01 Dec 2005

EM 1110-2-2102, Engineering and Design – Waterstops and Other Preformed Joint Materials for Civil Works Structures, CECW-EG, 30 Sep 2005

EM 1110-2-2104, Engineering and Design – Strength Design for Reinforced Concrete Hydraulic Structures, CECW-ED, 30 Jun 1992 (original), 20 Aug 2003 (Change 1)

EM 1110-2-2105, Engineering and Design – Design of Hydraulic Steel Structures, CECW-ED, 31 Mar 1993 (Original), 31 May 1994 (Change 1)

EM 1110-2-2503, Engineering and Design – Design of Sheet Pile Cellular Structures, Cofferdams and Retaining Structures, CECW-EP, 20 Sep 1989 (Original), 11 Jun 1990 (Errata sheet)

EM 1110-2-2504, Engineering and Design – Design of Sheet Pile Walls, CECW-ED, 31 Mar 1994

EM 1110-2-2906, Engineering and Design – Design of Pile Foundations, CECW-ED, 15 Jan 1991

4. Gated Structures

a. Design Considerations. The primary purpose of a gated structure is to provide gravity drainage from the MSMU. It may be desirable to have at least one gated structure installed within each cell. A gated structure may also be used to enhance MSMU filling operations. If high water events were to occur during the late summer and fall, the gated structure could be opened to help capture water, thereby decreasing the pumping requirements. In addition, the gated structure may serve as an additional opening for water to enter the MSMU prior to overtopping events.

A secondary goal of a gated structure may be to increase dissolved oxygen (DO) levels. Gated structures can be used to help control and maintain water quality in backwaters. If increased DO levels are desired, the size of the gated structure should consider the amount of water needed to provide adequate dissolved oxygen during critical times of the year.

Concrete gated structures may be cast-in-place or precast with the piping being precast reinforced concrete pipe. In some cases, this might be specified as the Contractor's option. Weight and size limitations might restrict this choice. Gated structures may be constructed of CMP. The inverts may be reinforced with riprap. Desired level of durability and dewatering requirements during construction will influence the choice of structure. It is important to consider the expected life of a CMP structure when designing this type of feature. In addition to material type, another factor to consider in the design of a gated structure is whether or not fish passage is desired.
The type of gate that may be installed depends on the type of structure. Sluice gates requiring a flat back for installation require a concrete structure. Other types of gates (for example, gates which can be installed on the end of a pipe) are not as dependent upon the type of structure. The structure must provide an operating platform from which the gate may be manipulated and which supports any equipment required to do so. This platform can be steel or fiberglass grating. Guardrails should be provided where required by the safety manual. In addition, even if erosion is not a concern, sufficient riprap/bank stabilization will need to be placed around the inlet/outlet of a gated structure. This will prevent wildlife from burrowing next to the structure, which has been an issue at a few constructed projects. The tendency is to keep the stabilization to a minimum when actually, the maximum is usually the better approach.

Inlet and/or outlet channels from the main channel to the gated structures have routinely raised sedimentation challenges. To the greatest extent possible, locate gated structures adjacent to the river, or as close as possible, to minimize side channel lengths. Soil borings are recommended at locations of structures with groundwater elevations. The soils should be evaluated to determine if they are suitable for the structure foundation and if not, determine what kind of working platform is needed. Ground water elevations can help identify the need for a cofferdam and/or dewatering system. Controlling and maintaining debris is a primary consideration in designing the inlet to these structures. Trash racks, flap gates, wooden piles, sheep and cattle fencing, and a number of other techniques have been used to prevent debris from plugging these structures. Debris can be large (trees and logs) or small (floating vegetation). In some situations small debris can be flushed from the conduit entrance or outlet by increasing discharge levels and velocities in the system.

b. Case Studies. Constructed HREPs with gated structures are listed below.

Andalusia Refuge HREP, Pool 16, UMR RM 462.0-463.0, Rock Island Co., IL, MVR
Batchtown HREP, Pool 25, UMR RM 242.5-246.0, Calhoun Co., IL, MVS
Brown's Lake HREP, Pool 13, UMR RM 545.8, Jackson Co., IA, MVR
Bussey Lake HREP, Pool 10, UMR, Clayton Co., IA, MVP
Calhoun Point HREP, Pool 26, UMR RM 221.0-221.0, Calhoun Co., IL, MVS
Clarksville Refuge HREP, Pool 24, UMR RM 275.0-275.0, Pike Co., MO, MVS
Cuivre Island HREP Pool 26, UMR RM 233.0-239.0, Lincoln Co. and St. Charles Co., MO., MVS
Dresser Island HREP, Pool 26, UMR RM 206.0-209.0, St. Charles Co., MO, MVS
Finger Lakes HREP, Pool 5, UMR, Wabasha Co., MN, MVP
Guttenberg Waterfowl Ponds HREP, Pool 11, UMR RM 614.0-615.0, Grant Co., WI, MVP
Island 42 HREP, Pool 5, UMR, Wabasha Co., MN, MVP
Lake Chautauqua HREP, LaGrange Pool, IWW RM 124.0-129.5, Mason Co., IL, MVR
Lake Odessa HREP, Pools 17-18, UMR RM 435.0-440.0, Louisa Co., IA, MVR
Long Lake HREP, Pool 7, UMR, Trempealeau Co. and La Crosse Co., WI, MVP
Long Meadow Lake HREP, Minnesota River, Hennepin Co., MN, MVP
Pharrs Island HREP, Pool 24, UMR, Pike Co., MO, MVS
Princeton Refuge HREP, Pool 14, UMR RM 504.0-506.4, Scott Co., IA, MVR
Spring Lake HREP, Pool 13, UMR RM 532.5-536.0, Carroll Co., IL, MVR
Stump Lake HREP, Alton Pool, IWW RM 7.2-12.7, Jersey Co., IL, MVS
Swan Lake HREP, Alton Pool, IWW RM 5.0-13.0, Calhoun Co., IL, MVS
Trempealeau NWR HREP, Pool 6, UMR RM 718.0-724.0, Trempealeau Co., WI, MVP

c. Photographs. Constructed HREPs with gated structures are shown below.

Photograph 5-11. Andalusia Refuge HREP, Pool 16, UMR RM 462.0-463.0, Rock Island Co., IL, MVR

Photograph 5-12. Princeton Refuge HREP, Pool 14, UMR RM 504.0-506.4, Scott Co., IA, MVR

Photograph 5-13. Guttenberg Waterfowl Ponds HREP, Pool 11, UMR RM 614.0-615.0, Grant Co., WI, MVP

d. Reference

EM 1110-2-3104, Engineering and Design - Structural and Architectural Design of Pumping Stations, Appendix C, CECW-ED, 30 Jun 1989

5. Sheet Pile Cells

a. Design Considerations. Sheet pile cells are fabricated from flat PS-series steel sheets. The number of sheets required for a particular radius cell is standard for a particular width sheet and can be ascertained from manufacturers' handbooks. A cutoff wall of Z-shaped steel sheet piles is driven between the two cells and capped with a sill beam (cast-in-place or precast and grouted onto the cells). Fabricated piles are used to create the connection between the cells and the cutoff wall.

Because the Government is required to purchase American steel, the sources for sheet piling and cross-section profiles allowed are limited. This requirement must be considered in the design stage of a project so the correct cross-sections can be included in the Plans and Specifications. PS- and Z-profile sheets are rolled in this country by Chaparral Steel (http://www.chapusa.com/), which distributes through L.B. Foster (http://www.lbfoster.com/). Additional information on these products is available at http://www.sheet-piling.com/main. Another American supplier of these products is Nucor-Yamato steel (http://www.nucoryamato.com/).

Where sheet pile cells are used as abutments for water control structures, the cells are assumed to be stable within a plane parallel to the axis of the berm (i.e., if the end of the berm is stable in itself, a cell situated within the end of the berm will be stable). Stability in a plane transverse to the axis of the berm is checked, based on the depth of the sheet piling and the internal pressures and external pressures on the cell. The internal pressures will be influenced by the method with which the cell fill is placed.

The need for dewatering of the site prior to placement of the cells must also be considered, because it affects means of construction as well as cost.

Developing a clearly-defined construction sequence is critical for proper installation of the cells. Placement of the cells relative to each other in the field should consider the "bulge" the cells may experience after fill is placed. The resulting clear distance between cells must be considered with regard to installation of footings on top of the cells and stoplog support appurtenances.

Special connection details (e.g., bent plates above the sill analogous to the cutoff wall fabricated piles below the sill) are necessary to provide watertight closure between the cells and the stoplog supports. Selecting steel details that will accommodate the final disposition of the cells, and allowing extra distance between the driven cells to account for bulge, can assist in successful erection of appurtenant details.

Sheet pile cells have provided an opportunity for recycling steel sheet piling originally used for temporary purposes (e.g., sheet piling that had been used in the Melvin Price Locks and Dam cofferdam has since been utilized in cell abutments at EMP projects). If recycled sheet piling is being considered, the condition of the piling needs to be evaluated to include a inspection of the interlocks and tips as well as damage to the sheeting itself.

Concrete footings installed on top of the cells support structural/mechanical features such as access bridges, jib cranes, etc. The sheet piling can be used as part of the formwork for these footings. The footings may be supported on the cell fill alone or on foundation piles driven through the fill, as conditions warrant.

Placement of a concrete slab on top of the cell will prevent loss of cell fill in the event a cell is overtopped. Provision of plugged holes in the slab will allow grouting beneath the slab if excessive fill settlement should occur.

Guardrail should be installed around the tops of cells in accordance with the safety manual. In lieu of installing a toeboard, the sheet piling may be cut off four inches above the top of the cell fill/slab. Fiberglass-reinforced plastic guardrails have been used at some locations (Swan Lake); however, because of ultraviolet deterioration and difficulty in making repairs should these items be damaged during floods, wire rope guardrails are an appropriate alternative (Batchtown, replacement of guardrails at Swan Lake).

b. Case Studies. Constructed HREPs with sheet pile cells include the following:

Lake Chautauqua HREP, LaGrange Pool, IWW RM 124.0-129.5, Mason Co., IL, MVR

Swan Lake HREP, Alton Pool, IWW RM 5.0-13.0, Calhoun Co., IL, MVS

MVR – Rock Island District; MVS – St. Louis District; MVP – St. Paul District

c. References

EM 385-1-1, Safety – Safety and Health Requirements, CESO-ZA, 03 Nov 2003

EM 1110-2-2100, Stability Analysis of Concrete Structures, CECW-CE, 01 Dec 2005

EM 1110-2-2104, Engineering and Design – Strength Design for Reinforced Concrete Hydraulic Structures, CECW-ED, 30 Jun 1992 (original), 20 Aug 2003 (Change 1)

E. LESSONS LEARNED (location is in the MVR unless otherwise specified)

Topic	Location	Lesson Learned
Botulism	Lake Chautauqua	Chautauqua experienced botulism deaths of many migratory waterfowl (waterfowl mortalities in 1997 through 2000 were 8,000, 2,500, 250 and 900). Sick birds generally appear in late August when there are low water levels (2 to 10"), low precipitation, and high temperatures for extended periods. These conditions set the stage for the botulism organisms to start reproducing. Birds pick up the toxin and die. Flies lay eggs on the carcasses and the maggots concentrate the toxin to the point where only 3 maggots will kill a duck. The botulism problem usually subsides after the first killing frost. Drying the lake bottom would force the birds to go elsewhere and therefore, avoid the botulism toxins. Therefore, the lower lake dewatering channels were extended from the pump station to the stoplog structure. This required dredging a shallow channel 35' wide and approximately 11,000' long. The extended channel allows the area to be dewatered completely. This removes the habitat for waterfowl and shorebird use and allows the Site Manager to do complete searches of any remaining small wet areas. If dewatered early enough, the area will produce moist soil plant foods that can be used by waterfowl and other wildlife when re-flooded in the fall. It will also allow the bottom to dry to the point where equipment can be brought into the area to control invasive vegetation such as willow.
Cell Operation	Andalusia Refuge	For HREPs with water control structures requiring operation during inclement weather, granular surfacing should be provided along the perimeter levee to strengthen the surface under adverse conditions.
Cell Operation	Bay Island	The MSMU was not designed to allow independent operation of the cells. The existing water supply berm was raised and a new gatewell structure was installed in the water supply berm. This added height to the water supply berm in combination with the new gatewell structure now allows independent operation of the cells.
Cell Operation	Princeton Refuge	The concrete stoplog structure did not allow for complete drainage of the north cell into the south cell. As a result, 2 CMP stoplog structures were installed along the cross dike to provide water level management between the cells at lower elevations by gravity flow.
Contract Changes	Lake Chautauqua	The first contract (Stage I) was typical low bid and was below the government estimate. The contractor started on the access road. The contract measured fill only for payment. The first problem was the material disappeared into a large soft spot. Following the first problem, the 1993 weather pattern kept river water levels high and delayed the project more than a year. Following the initial flood, there were several follow-on floods that overtopped levees and caused flood related damages and time extensions. As a result, the contractor got into a routine of not doing very much when the weather and river was cooperating. He did collect flood damages and time extensions after several flood events. The contractor was not used to working in the flood plain and had equipment that was not suitable to the material. In 1996, the Government terminated the contract and developed Stage II. Designers formulated the Stage II contract so that the work could be done quickly, under flood conditions, and at minimal risk to the government. Incentives to speed up work included a shorter contract duration, intermediate completion dates, and structured payment clauses so that payment was not made until a feature was stable. For example, levees had to be constructed in sections and progress payments not made until they were seeded and mulched. In addition, the contractor was responsible for incomplete and exposed work and the contract defined a flood as being water above a certain elevation. Everything below that level would not result in a time extension.

Topic	Location	Lesson Learned
Erosion Protection: Levees	Bay Island	Severe erosion along the northwestern edge of the perimeter levee was evident after the Flood of 1993. Approximately 1,070' of the perimeter levee toe eroded due to Clear Creek. Clear Creek is a meandering stream that runs along this portion of the levee. The erosion created a 2 to 3-ft vertical cut into the levee toe. The levee slope was re-graded and riprap was placed from the base of the levee toe to 6' from the edge of the levee crown.
Erosion Protection: Levees	Peoria Lake	The erosion control mats and seeding for erosion control along the levees of Cells B and C were not successful with water level fluctuations, resulting in bank erosion. Traditional riprap was installed in place of these mats at various locations.
Erosion Protection: Pump Station	Andalusia Refuge	Riprap was found to be missing in several areas at the water control structure. However, it was determined that the lack of riprap was not causing any problems.
Erosion Protection: Pump Station	Peoria Lake	Erosion occurred around the concrete pad at the pump station outlet. The Site Manager installed riprap around the concrete pad to help reduce the erosive effects around the pump station outlet.
Erosion Protection: Wells	Potters Marsh	The well outlet was provided with a splash pad; however, following testing of the well, it was evident that additional erosion protection would be necessary. To remedy the erosion, a mixture of slush concrete and riprap was placed around the splash pad.
Gatewell	Spring Lake	The gate position was difficult to read. The Site Manager painted the top of the gate stem bright orange to make its position easier to read. Stoplogs are used in the gated inlet structure during maintenance of the structure. The stoplogs are difficult to remove with a high head against them. To ease removal of the stoplogs, the gate is closed temporarily to allow water levels to equalize on either side of the stoplogs.
Gated Structures	Finger Lakes (St. Paul District)	Design for a wide range of flow conditions if increasing dissolved oxygen levels is desired. The gated conduits that were used at this site were sized to provide up to 50 cubic feet per second (cfs) to each of the downstream Finger Lakes. A Biological Response study that was conducted after the project was constructed indicated that the required winter flow was on the order of 5 cfs or less, about 1/10th the capacity of the conduits. However, recommended summer discharges are on the order of 40 cfs, which is near the maximum flow of the conduit. Furthermore, the Fish and Wildlife Service often flushes the pipes by using their full capacity to clear out small debris from the entrance and outlet channels.
Gated Structure	Lake Chautauqua	Ensure the contract specifications address the responsibility of structure operation during construction. At Chautauqua, nobody (owner/sponsor, USACE or contractor) wanted to take responsibility for gate openings on a water control structure from the ILWW to the upper lake and eventually that indecision was at least in part cause to a complete loss of that existing structure and construction of a new structure.
Guardrails	Swan Lake (St. Paul District)	Fiberglass-reinforced plastic guardrails have been used at some locations (Swan Lake); however, because of ultraviolet deterioration and difficulty in making repairs should these items be damaged during floods, wire rope guardrails are an appropriate alternative (Batchtown, replacement of guardrails at Swan Lake).
High Water Action Plan	Banner Marsh and Lake Chautauqua	Since HREPs are constructed in typically wet and potentially flooded areas, ensure that the hydraulic conditions at the site are clear in the contract specifications so that bidders are fully aware of "normal" conditions. Ensure that the contract specifications include a submittal for a detailed high water action plan. The plan should include procedures for rising high water and for dewatering after a high water event.

Topic	Location	Lesson Learned
Levee Construction	Swan Lake St. Louis District	The perimeter levee was constructed 1995 and 1996 with large (8 cy) clamshell bucket using lake bottom silts and clays. Portions of the berm have settled more than expected, especially in areas were the berm alignment was across lower elevational areas, such as sloughs. A 5 to 10% design overbuild of berms were to account for anticipated settlement. Some of these areas have now settled below the overflow spillway grade, now making them the low point in the system. The project has experienced overtopping at these low areas and has resulted in higher maintenance caused by washing road stone off of the top of the berm. The low spots of the berms are expected to be brought back up to grade in 2006, subject to funding availability.
Levees: Rodent and ATV Control	Andalusia Refuge	Settlement of the levee was discovered due to animal burrowing, unauthorized vehicle use, and scouring and erosion. Trapping has resolved the settlement due to burrowing animals. Unauthorized vehicle use from ATVs and snowmobiles no longer seems to be a problem. The settlement from scouring and erosion also appeared to be corrected.
Levees: Rodents	Spring Lake	Since construction has been completed, muskrat burrowing has caused severe erosion on the side slopes and large sinkholes on the levee crown. As a result, water is flowing between the units. This has caused the refuge manger to be unable to manipulate water levels within individual cells as desired. The problem has also become a safety hazard to vehicles traveling on the levee crowns. Annual inspection and maintenance will continue to assess the muskrat damage. One possible solution would be to lay chain link fence fabric on the levee slope, providing a physical barrier to the muskrats. Another possible solution would be to establish an aggressive eradication program, such as trapping. Some site managers claim that having flatter side slopes, such as 10:1 vertical to horizontal, can help prevent muskrat burrowing.
Level of Protection	Bay Island	The perimeter levee provides a 2-year level of protection. This level of protection should be used only at sites where impacts of frequent flooding are acceptable for project O&M. It was recommended that perimeter levees provide at least a 5-year level of protection. A higher level of protection will decrease the rate of sedimentation within the MSMU, increase controlled management opportunities, and decrease the risk of prolonged flooding when trying to establish desired vegetation.
Level of Protection	Spring Lake	A 2-year level of protection, as provided by the interior levees (or cross dikes) in Upper Spring Lake, should only be used at HREPs where impacts of frequent flooding are acceptable for project operation and maintenance. Flooding in the spring of 1997 caused damage to some of the embankment materials. The 50-year perimeter levee was not overtopped during the floods of 1997, 1999, or 2001, and is considered an appropriate level of protection.
Pump Cavitation	Banner Marsh	The existing pump station structure was modified as part of the HREP to install a new 48" submersible pump. The existing sump was modified and an anti-vortexing plate was installed prior to pump installation. The pump was factory tested but not to the low sump elevation level as specified. After installation, the pump developed a cavitation noise in the sump level operating range during operation of the pump, which has led to complete failure. As a result, heavy rains have caused localized flooding within the MSMU. It may also cause accelerated wear of pump components, thus shortening the expected service life of the pump. The pump was pulled for inspection and measurements with no conclusive findings. The pump was reinstalled with the cavitation noise present and a spare impeller was purchased for replacement in the future. The recommendation has been to continue using the pump as normal. Under normal operation, the 48" submersible pump is a backup that only turns on when the 24" service pump is unable to keep up. The 24" service pump can handle about 90% of the annual MSMU pumping requirements.
Pump Controller Valve	Banner Marsh	The 48" pump controller failed twice. The first failure was due to condensation in the pump controller cabinet, which caused a component in the soft start drive to fail. The condensation was caused when the power was turned off to the entire pump station by opening the main breaker. This made it impossible for the pump controller cabinet heater to function and condensation resulted. The Site Manager was instructed to not turn off the main breaker anymore. No O&M Manual was available at the time to provide instruction for pump operation. The second failure was a different component in the soft start drive, which is believed to have failed due to stress caused from the first failure. Both problems were corrected by replacing the faulty components. If further components of the soft start drive fail, it has been recommended replacing the entire drive, which is only one part of the pump controller.

Topic	Location	Lesson Learned
Pump Inspections	Spring Lake	Since the project did not include a system for pump removal, the Site Manager had to add a jib hoist and crane to the pump station to facilitate removal of the pumps for inspections.
Pump Operation	Banner Marsh	A light was installed on the outside of the pump building so that the Site Manager can verify that the pump is running from his house rather than having to drive out to the pump station.
Pump Size and O&M	Lake Chautauqua	Configuration: Lake Chautauqua pump station is a single submersible turbine that pumps from a lower level pump station to the upper level. It is located at the junction of 2 lakes and the river. It is gate controlled and capable of pumping into or out of any of the 3 water bodies or is capable of gravity flow into or out of any of the 3 water bodies. This configuration greatly increases its versatility and also simplifies pump controls. Pump Size: When the pump station was designed, the pump criterion was to dewater the lower lake in 30 days (allows sufficient time for moist soil production). This resulted in a 41,000 GPM pump. Multiple smaller pumps were ruled out as being too expensive. The design criteria were flawed in the following respect: The pump station has never been used to dewater the entire lake within the 30 day timeframe. The cost to run the pump and pay the demand charges is too costly. The FWS refuge staff would rather wait for the river to drop before dewatering mostly by gravity. In fact, waiting is usually faster. (The pump can pump down a full lake by about 0.10' per day). The pump is more than adequate to pump remnants out of the lake and to maintain the lake in a dewatered condition. For these purposes a smaller pump would also work. It would have resulted in less demand and electric charges as well as less submergence requirement and a less expensive pump station. Maintenance and/or repair of pump station components requires the dewatering of the pump station sump area. Pump station component maintenance and repair should be examined for user friendliness.
Pump Station	Andalusia Refuge	When the pump was turned on in the fall of 1994 to fill the MSMU, the trash rack clogged with vegetation and cut off the water supply. Subsequently, a chain link fence was installed 6' from the pump intake, and an outer mesh fence was installed 100' from the pump intake. The outer mesh fence was subjected to damage from ice during the winter of 1995 to 1996. The Site Manager stated that the fences were not working as intended and had been destroyed by ice, and that the vegetation had filled back in from shore to shore. The trash rack fence system had been designed for those years when there was an excess of floating (or dead) vegetation, river levels were low, and fall pumping was required, which didn't meet the needs of the site manager. It was decided that the outer mesh fence could be removed, leaving the posts in place, and re-installed when needed. Otherwise, if the outer mesh fence remains in place, annual maintenance would be necessary prior to ice-over of the refuge.
Pump Station	Swan Lake (lower compartment); Calhoun Point and Stump Lake - MVS	There are permanent pump stations in which the pump is installed in a slanted intake tube supported in the water on the supply side by a system of piles and cross-beams. The discharge pipe passes through the berm (an embankment created between parallel rows of cross-tied sheet piles) and discharges through a duckbill. The pile support system for the pump allows installation without creating a dewatered location for building a sump. The pump support system must accommodate removal of the pump for maintenance.
Pump Station in Cold Weather	Banner Marsh	The pump floatation system would freeze up, so the Site Manager purchased a bubbler system to prevent floats from freezing.
Pump Station Inlet	Princeton Refuge	The river grating on the pump station inlet box has been a challenge. It will plug with debris and create a vortex during pumping operations. It is recommended that a secondary fence be installed between the ends of the wingwalls. This fence would then extend along the top of the wingwalls up to the top of the inlet box to keep debris out during flood events.
Pump Station Inlet	Princeton Refuge	The grating on top of the pump station inlet box is heavy and removing and replacing it for maintenance is dangerous to the operator and hazardous to the public if left off. The grating on top of the pump station inlet box was designed to be heavy for safety reasons and to prevent vandalism. If the grating is replaced with a lighter, hinged section, a padlock should be installed.
Pump Station Location	Princeton Refuge	During construction, the existing pump station was relocated from the downstream end to the middle of the perimeter levee. However, the existing pump station only consisted of a single pump. As a result, a portable pump with a diesel engine mounted on a highway trailer was supplied following construction.

Topic	Location	Lesson Learned
Pump Station Materials	Spring Lake	The door to the pump station rusted on the inside due to moisture. All metal should be galvanized to help prevent rust damage.
Pump Station Siltation	Bay Island	The pump station had a continuous problem with the pumping chamber and intake structure filling in with 2 to 3' of silt. The silt enveloped the pump impellers, thus making the pump station inoperable until the pumping chamber was cleaned out. In addition, removal of the silt in the pumping chamber had been labor intensive and difficult to complete without easy access to the pumping chamber and intake structure. Silt accumulation in the pumping chamber and around the pump impellers created different power demands on the pump motor. Fluctuation in the pump motor loads or possibly incoming power supply had been throwing the phase converter out of balance. The services of an electrical contractor to recalibrate the phase converter had been needed about twice annually since the pump station had been in service. A sluice gate was installed on the outside of the pump station intake structure and that a platform structure was constructed in the pumping chamber. The sluice gate was placed at the intake of the pump station near the existing trash rack. This gate is closed during non-pumping times to prevent the buildup of silt in the pumping chamber. A platform structure with a ladder was installed to facilitate cleaning out of any silt that collects inside the pumping chamber.
Pump Station Stoplogs	Andalusia Refuge	The pump station stop logs would not seal due to the presence of construction debris in the channels. Therefore, the stop log channels had to be cleaned out. Additionally, the stop logs were difficult to remove because of their close proximity to the trash rack. As a result, the pump station trash rack was relocated and a hoist installed.
Pumps and Fishing Lines	Princeton Refuge	Fishing line has been a challenge with the seals around the pump impeller head. A trash rack cleaning apparatus could be utilized to help with the fishing line. This apparatus would have to be used on a regular basis and could be stored in the pump station engine building.
Sheetpile Cells	Lake Chautauqua	The project constructed 4 each 74-ft diameter sheet pile cells. The sheet pile was driven to bedrock and filled with stone. The 4 large cells were connected with arc cells to a lower elevation that would allow complete dewatering of the lake. The arc cells were filled with stone and capped with an H pile supported concrete cap that supported a flood wall and a 10-ft by 10-ft heavy duty sluice gate. The main cells included bridges to span the arc cells and provide access to open and close the gates. The bridge abutments were supported on H-piles driven within the main cells. The gates had back-up bulkheads and aluminum stop logs. **BACKGROUND:** The upper lake at Lake Chautauqua had a 60 year old water control structure consisting or 4 radial gates 12' wide. The gate had not been used for over 30 years. During a flood event, the structure washed out, leaving a large scour hole in the levee system. A flood damage report analyzed various closure alternatives to allow rapid inflow before an over-top event could damage the levee. Other desirable design features were maintaining a consistent water level and increasing the ability to dewater the lake. Analysis showed that another gated concrete structure would be very expensive. Other alternatives included spillways, fuse plug spillway, culverts with gate control, and the selected alternative described below. This design worked well to close the breach in the levee, meet all functional purposes, minimize maintenance, and ease operation. Downstream scour is not a concern and the cost of a stilling basin was eliminated. Used sheet pile was utilized from St Louis District saving additional money. Hydraulics developed an operating plan for when to open the gates. To date the gate plan has worked well and has been used twice. During construction, Engineering used State Plane Coordinates to locate the next main cell after the first cell was constructed and surveyed. Cell spacing was critical so that the gates and floodwall would fit properly. During the gate construction contract, the contractor was required to work up to a designated flood level. He was able to do this by leaving the arc cells extended to the flood elevation and providing interior supports. This worked well and allowed construction within the arc cells during relatively high river levels.
Spillway	Princeton Refuge	During the Flood of 2001, the granular surfacing along the overflow spillway was washed to the downstream slope and the geotextile fabric beneath the granular surfacing had been shifted to the downstream shoulder. Despite the disturbance to the granular surfacing and geotextile fabric, the overflow spillway slopes were still intact with most of the vegetation remaining. It appeared that the geotextile fabric had acted as a slippage plane during the flood event for the granular surfacing to "peel" off the overflow spillway. Therefore, the geotextile fabric was not replaced when the overflow spillway was lowered 8".

Topic	Location	Lesson Learned
Spillway	Princeton Refuge	The design for the overflow spillway was to be 2' lower than the north perimeter levee to allow for rapid filling of the MSMU interior water surfaces prior to overtopping of the perimeter levee. The as-built construction drawings show the final grade of the north perimeter levee at elevation 582.3' msl and the overflow spillway at elevation 580.3' msl, which provides the required 2-ft difference. However, 8" (minimum) of granular surfacing was then placed on the overflow spillway. This would place the top of the overflow spillway at approximately elevation 581' msl. A land survey verified that this was indeed the case. The average top elevation of the north perimeter levee was found to be 582.45' msl, while the overflow spillway showed an average top elevation of 581.05' msl. The result was a 1.4-ft difference between the 2 ends rather than the required 2-ft difference. This discrepancy may have contributed to a large breach in the north perimeter levee during the Flood of 2001. During the flood event, the Site Manager observed that the north perimeter levee and overflow spillway overtopped at the same time, rather than the latter first. As a result, the overflow spillway was lowered 8".
Spillway	Stump Lake St. Louis District	The exterior perimeter berm (levee) was designed with a 200 ft long overflow spillway on the downstream portion of the project. The riprap stone was graded stone C (400 lb top size). Severe erosion to the spillway and adjacent berm occurred during an overtopping event in 1997. In 1998, the spillway capacity was reanalyzed and redesigned with larger riprap stone (1,200 lb top size) and 500' additional length. To date the spillway has been overtopped numerous times and has maintained its integrity.
Spillway vs Stoplogs	Bay Island	Overflow spillways were constructed within each cell to allow the MSMU to flood at a set elevation. The overflow spillways help remove the burden of constantly monitoring the river for rising elevations and the need to access the site for removal of all the stoplogs. After the overflow spillways were installed, it was noted that the transition from the perimeter levee crest down to the overflow spillway crest, a 1-ft vertical drop, may be too abrupt at a 10% slope.
Stoplog Materials	Banner Marsh	One of the stoplog structures is starting to rust due to the high acidity of the water in the project area or it may be a natural occurrence. The Site Manager may need to repaint this structure.
Stoplog Operation	Banner Marsh	The stoplog structures have been difficult to operate. The Site Manager has recommended that the stoplog structures have a sluice gate installed to stop flow. This would facilitate placement and removal of stoplogs.
Stoplog Operation	Banner Marsh	In the other stoplog structure, the stoplogs have a tendency to float. The Site Manager has wedged objects between the C-frame and the end of the stoplogs as a remedial effort to keep the stoplogs from floating. It has been recommended that the stoplog structures have locking mechanisms installed to prevent the stoplogs from floating or the procedure for installing the stoplogs needs to be changed.
Stoplog Operation	Bay Island	The water control structures were designed and constructed with the intention of one person removing and replacing the stoplogs. Stoplogs were constructed out of pressure treated Spruce-Pine with a dimensional size of 5'-2½" x 5½" x 2½". However, removal of the wood stoplogs has proven to be more than a one person operation and can often be a struggle for two persons. It was recommended that the wood stoplogs be replaced with aluminum stoplogs, which are lighter. It was also recommended that one of the bays at each structure be converted to a sluice gate, thereby eliminating some of the stoplogs.
Stoplog Operation	Peoria Lake	The Site Manager has expressed the inability to independently operate the 3 cells, which is undesirable. In addition, there have been challenges in operating the stoplog structures due to the weight of the wood stoplogs. Using solid plates or aluminum stoplogs in lieu of wood stoplogs has been discussed.
Stoplog Operation	Spring Lake	Removal of the stoplogs underwater had been difficult. Locating the lifting lugs with the lifting device was a hit-and-miss operation. Therefore, the stoplog lifting device was modified by the Site Manager to make locating the lifting lugs easier. In addition, the stoplogs do not seal well, allowing seepage between cells. The stoplogs will eventually seal after several days due to fine sediment build-up between the gaps. It has been recommended that the stoplog settings not be changed frequently to avoid breaking this seal. If a more immediate seal is needed, it has been suggested to utilize cinders on the upstream side of the stoplogs.

Topic	Location	Lesson Learned
Vegetation Control (interior)	Andalusia Refuge	An abundance of woody vegetation was also reported on several islands in the MSMU. In 1996, the ILDNR Site Manager aerially sprayed the MSMU to control bulrush, lotus, and willow growth. The islands were also burned in 1997 and 1998 to control undesirable vegetation. A beaver dam was found across the main channel. A continual problem in the MSMU is the erosion of the island banks.
Vegetation Control (levees)	Andalusia Refuge	In 1997 and 1998, thick woody vegetation was noted as growing among the riprap on the perimeter of the levee. The vegetation was removed and the riprap was sprayed with Round-Up. This process has since been repeated several times.
Vegetation Response on Berms	Andalusia Refuge	The perimeter levee was originally seeded with a mixture which was predominantly Indian grass. Initial establishment was successful, however, there was no post-Flood of 1993 re-establishment of the Indian grass on the side slopes of the perimeter levee, nor was the perimeter levee re-seeded. Reed canary grass is now the predominant species. As reed canary grass is very invasive, spraying or controlled burns in the MSMU may be necessary to limit it to the perimeter levee only.
Wells	Fox Island	Test bore holes for new well construction failed to identify large cobble and rocks at approximately the 30-ft depth at both new well locations approximately 1 RM apart. Cost and time escalation was realized and well installation methods were changed dramatically upon the discovery of the cobble.

Appendix I

GEOTECHNICAL REPORT

The Corps conducted a subsurface investigation at NMEC on January 12th, 2022. The primary purpose of the investigation was to determine the amount of accumulated sediment on the main marsh floor, but the soil samples collected were used for environmental and cultural assessments.

The investigation included performing eight borings at locations NM-21-01 through NM-21-08, as shown in Figure I-1 . Refer to Table I-1 for approximate depths and coordinates. The borings were collected using 2-inch diameter stainless steel tubes. The tubes were first-hand pushed until the material became firm, then hammer driven with a post drive to the full length or rejection. Measurements were recorded for hand-drive lengths and final depths. After extraction, the tubes were capped at both ends and transported back to the Corps Rock Island Geotechnical laboratory. The samples were frozen and stored for approximately two months before testing and classification.

Figure I-1. Overview of Nahant Marsh Boring Locations

Table I-1. Nahant Marsh Borings

Boring ID	Depth	Boring Type	Latitudinal	Longitudinal
NM-21-01	6 ft	Push Tube	41°29'26.41"N	90°38'11.06"W
NM-21-02	6 ft	Push Tube	41°29'20.00"N	90°38'23.35"W
NM-21-03	7 ft	Push Tube	41°29'31.45"N	90°38'12.69"W
NM-21-04	5 ft	Push Tube	41°29'40.14"N	90°38'4.04"W
NM-21-05	7.5 ft	Push Tube	41°29'24.99"N	90°38'15.98"W
NM-21-06	5.75 ft	Push Tube	41°29'28.47"N	90°38'7.58"W
NM-21-07	5.5 ft	Push Tube	41°29'32.37"N	90°38'3.16"W
NM-21-08	6.5 ft	Push Tube	41°29'28.26"N	90°38'17.45"W

The laboratory analysis included soil classification and estimations of approximate sediment layer thicknesses. A typical cross-section of the marsh subsurface has a top layer of dark gray silty clay with high organics content and traces of shells, a thin transition layer (approximately 1 or 2 inches), and a bottom light gray clay layer, which is assumed to be native soil, as shown in Figure I-2. In all cases, the exact sedimentation thickness could not be determined directly from the lab measurements as the Corps found that the total lengths of the samples measured in the lab were approximately 28-56% of the field recorded lengths, as shown in Table I-2. This discrepancy was partiality due to compression and settling caused by freezing, thawing, and compression during sampling.

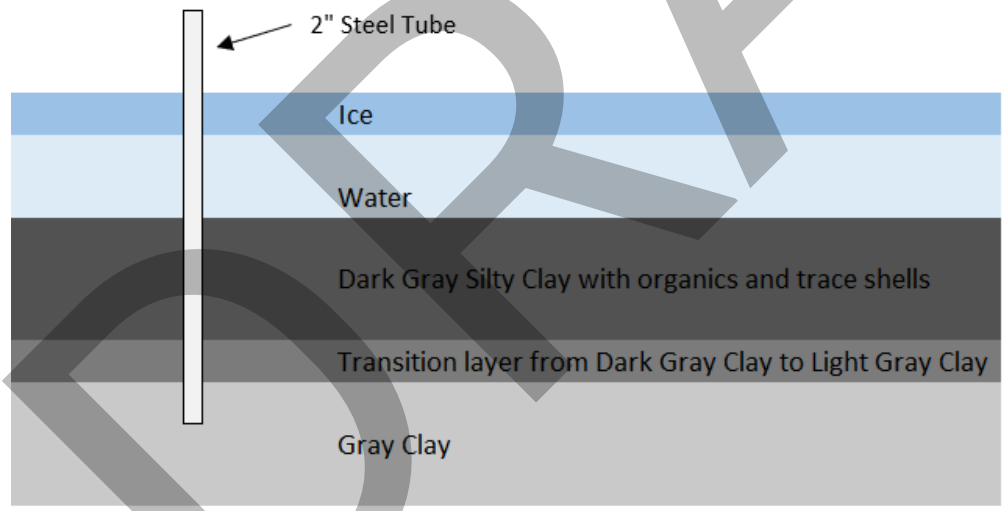


Figure I-2. Typical Marsh Cross-Section

Table I-2. Variability in Lab and Field Measurements

Boring No.	Recovered Soil Length Measure in Lab	Recovered Soil thickness from Field Logs	Lab/Field
NM-21-01	28	50	56%
NM-21-02	19	53	36%
NM-21-03	30.5	71	43%
NM-21-04	24	50	48%
NM-21-05	18.5	67	28%
NM-21-06	13	47	28%
NM-21-07	24	46	52%
NM-21-08	25	61	41%

As an alternative analysis method, the Corps compared field recordings with lab measurements to estimate ranges for sediment thickness A low value was calculated using lab measurements. The Corps assumes that native material was least affected by compression, so subtracting the bottom material thickness with the depth of water and ice from the total boring depth can provide a low value. Then a high value was calculated using the hand and hammer drive measurements. The native material is assumed to be at depths where material became firm during hand driving. So, the hand drive depth minus the depth of water and ice shows the field estimated sediment thickness. Refer to Table I-3 for a summary of the estimated sediment layer thicknesses.

Table I-3. Approximate Range for Sediment Layer Thickness at Each Boring Location

Boring No.	High Value (Lab Estimate)	Low Value (Field Estimate)
NM-21-01	3'8"	Unknown
NM-21-02	4'3"	3'5"
NM-21-03	5'1"	4'11"
NM-21-04	3'2"	2'8"
NM-21-05	5'6"	4'1"
NM-21-06	3'5"	3'2"
NM-21-07	2'10"	Unknown
NM-21-08	4'1"	Unknown

Sediment Monuments

The Corps installed three observation monuments in the marsh to monitor future sediment build-up. Monument locations are shown in Figure I-3. The monuments consist of steel pipes driven vertically into the marsh floor. The pipes are used as reference points to spot-check sedimentation elevations. The sedimentation elevations near the monuments may be determined by subtracting by the distance between the top of water to the top of the marsh floor. To compare past recordings, adjust water depth

to relative elevations using the staff gage located on the south end of the main marsh. Initial measurements are shown in Table I-4.

Figure I-3. Sediment Monument Locations

Table I-4. Initial Sediment Monument Readings

Date:	1/12/2022
Staff gage Reading:	1.65 ft
Monument	Depth from top of ice/water to top of Sediment
NM-21-02	1'5"
NM-21-05	1'10"
NM-21-08	1'5"

Appendix J

HYDRAULICS AND HYDROLOGY REPORT

SCOPE OF WORK

This report summarizes the hydraulic and hydrologic state of the main marsh. The goal of this work was to establish what information and data is already available, find data gaps and how to fill in those gaps, determine runoff/flow paths to the main marsh, and create a set of alert guidelines for NMEC staff when the Mississippi River is forecasted to rapidly rise.

STUDY AREA

The main marsh is located on the Iowa side of the Mississippi River at River Mile 477.8 (Figure J-1). The main marsh hydraulically connects with the Mississippi River just downstream of Interstate-280. Additionally, water enters the main marsh through runoff from surrounding agricultural and industrial areas. There is a water control structure at Wapello Avenue that can be used at times of high or low water depending on the season and environmental/ecological needs of the main marsh.

Figure J-1. Nahant Marsh and surrounding area

*include header title (e.g. assessment, recommendations, etc)

DATUM INFORMATION

Mapping and modeling for this work used the North American Vertical Datum of 1988 (NAVD 88) for vertical control and USA Contiguous Albers Equal Area Conic USGS version (US Feet) for horizontal control. Project units were U.S. Customary. Iowa Green LiDAR (combined topography and bathymetry) data from 2017 was obtained in the horizontal control Illinois State Plane West, NAD 83 and projected to the project datum using ArcGIS Pro. Vertical control for the Green LiDAR was NAVD 88.

GAGE DATA

No historic stream gage data is available within the main marsh watershed. Gage data is available for the Mississippi River at Lock and Dam 15 (Rock Island, IL) gage (https://rivergages.mvr.usace.army.mil/WaterControl/stationinfo2.cfm?sid=MI15&fid=RCKI2&dt=S). This gage is located at Mississippi River mile 482.9 and is 5.1 river miles upstream of the Marsh. Gage zero is 542.50 feet MSL1912 or 541.8 feet NAVD88. Additionally, the junction of the Rock River and Mississippi River is 1.2 river miles upstream of the main marsh. Gage data is available for the Rock River at Moline, IL gage (https://rivergages.mvr.usace.army.mil/WaterControl/stationinfo2.cfm?sid=MLII2&fid=MLII2&dt=S). This gage is located at Rock River mile 7.2. Gage zero is 551.34 feet NGVD29 or 551.1 feet NAVD88.

To supplement the available upstream gage data, a staff gage was installed at the main marsh in February 2022. The gage needs to be monitored regularly, on a daily basis at a minimum. During times of rising waters and flood conditions, this frequency would ideally be increased up to an hourly basis as long as staffing and safety considerations allow.

2004 FLOW FREQUENCY STUDY WSE

Flow frequency analysis of the Mississippi River in the Marsh area was conducted for the 2004 report, “Upper Mississippi River System Flow Frequency Study” (USACE 2004). Water surface elevations at the main marsh for River Mile 477.9 are shown in the table below. Figure J-2 shows the flow frequency profiles and exceedance duration profiles for Mississippi River Pool 16.

Table J-1. 2004 Flow Frequency Study Water Surface Elevations (WSE) for Nahant Marsh at RM 477.9

Annual Exceedance Probability	Mississippi River WSE, feet NAVD88
0.5	553.70
0.2	556.60
0.1	558.30
0.04	560.40
0.02	562.00
0.01	563.40
0.005	564.60
0.002	565.90

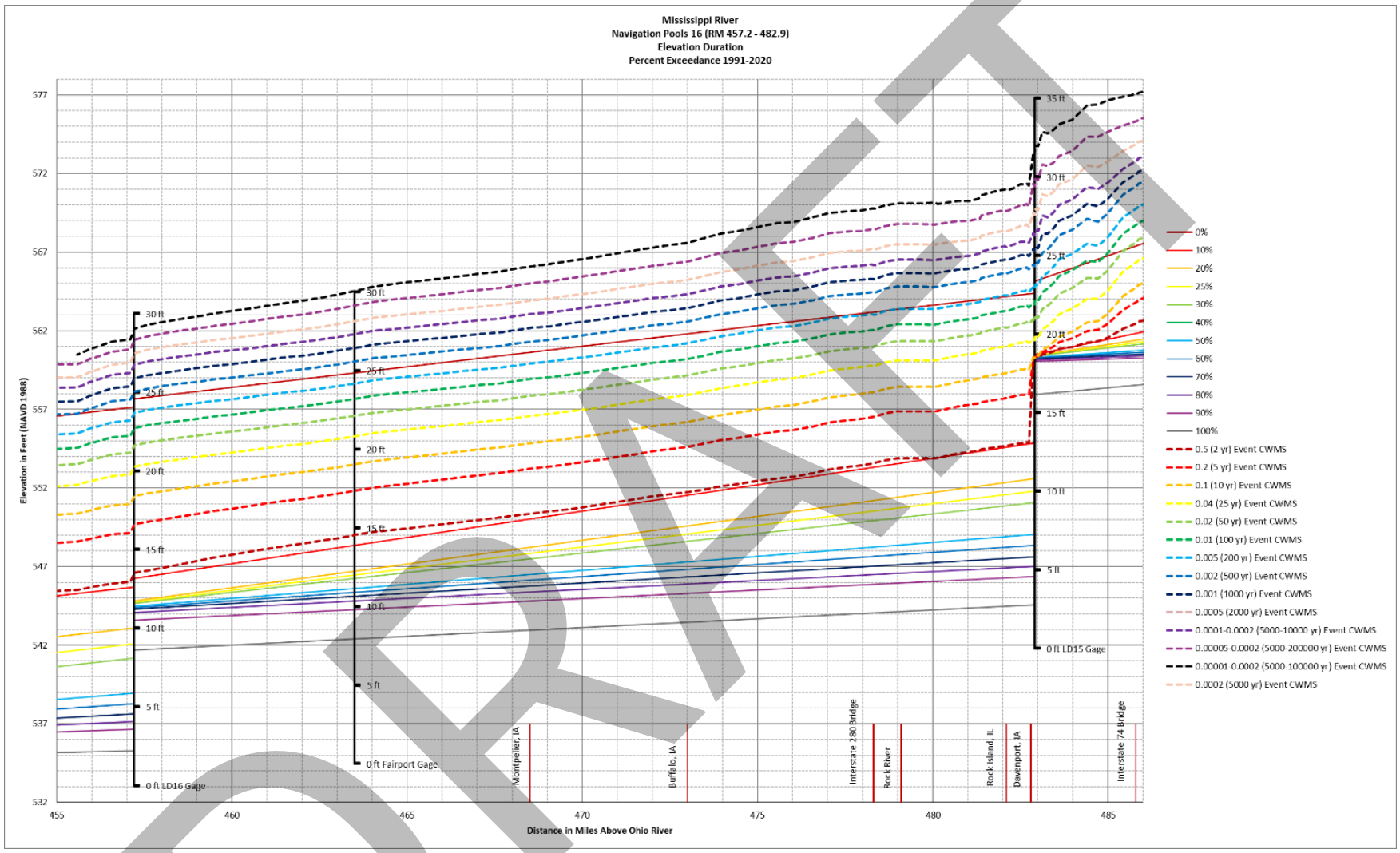


Figure J-2. Flow Frequency and Exceedance Duration Profiles for Mississippi River Pool 16. Nahant Marsh is located at River Mile 477.9

FLOW LINES TO MARSH

NMEC staff were interested in finding potential areas for contaminant entry to the main marsh beyond the obvious drainage ditch and entry from the Wapello Avenue gate. Using the Iowa Green LiDAR from 2017, the terrain and bathymetry were first visually inspected in ArcGIS Pro for connected, low lying areas that would be indicative of flow paths. These results are displayed in Figure J-3.

After the ArcGIS Pro analysis, a 2D HEC-RAS model was developed in the project datum to get a more detailed view on flow patterns in the surrounding marsh area. Since little flow/stage data is available, the main marsh is being modeled with precipitation filling up an empty, dry main marsh. This allows us to be able to see how the main marsh responds to runoff without influence of the Mississippi or Rock Rivers. Rainfall was set to an NRCS Type II rainfall distribution for a 24-hr period for 1 inch, 3 inch, and 6 inch events.

Two versions of the geometry were tested. In the first model, no water is exiting the main marsh to the Mississippi River, the main marsh is simply filling up like a bathtub. Results from the last timestep of the simulation are shown in Figure J-4. In the second geometry, the culverts below Wapello Avenue are included and release water to the Mississippi River. Results from the last timestep of the simulation are shown in Figure J-5. Videos of the full simulations are available upon request/at a different location outside of this report.

Seeing the video results of the 2D HEC-RAS modeling confirm the flow paths from the ArcGIS Pro analysis. This is easiest to see for the 6 inch rain event since the large amount of water fills in depressions in the ground more quickly than the smaller rainfall events.

Figure J-3. Flow paths to the Marsh as determined by visual inspection of Green LiDAR data

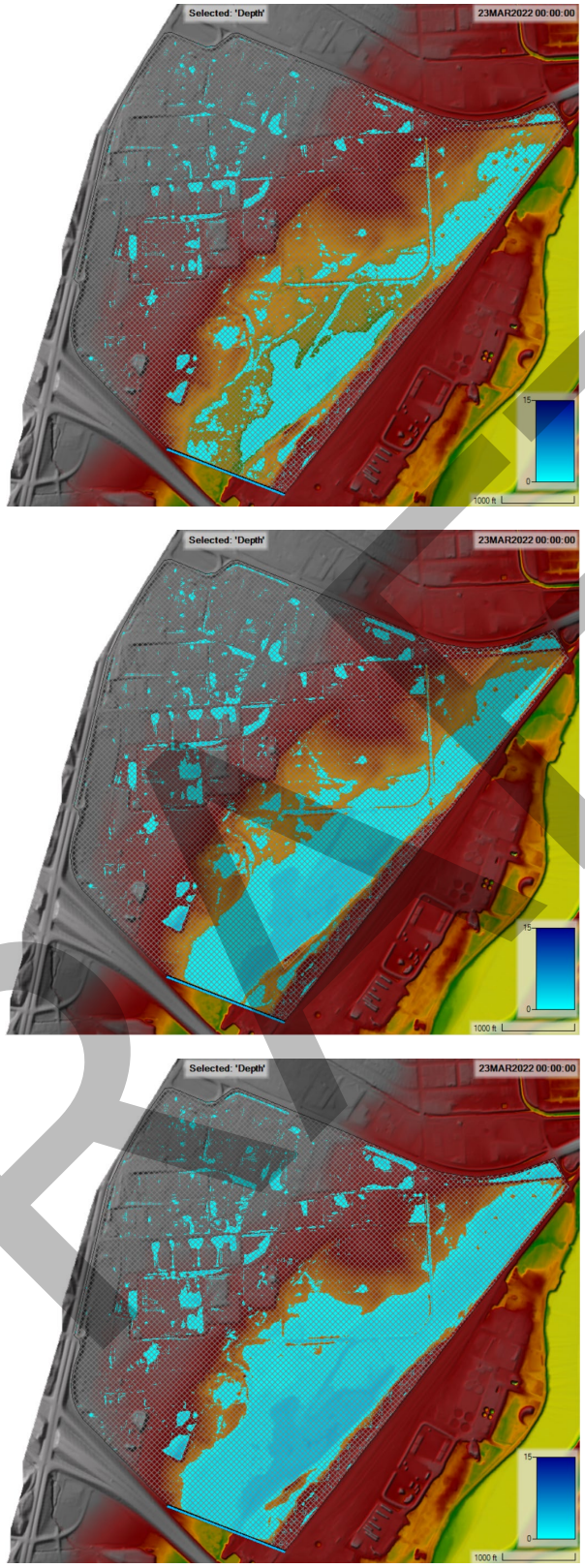


Figure J-4. Results from the last timestep of the 2D HEC-RAS model of the main marsh with no outlet to the Mississippi River. From top to bottom the events are 1 inch, 3 inches, and 6 inches.

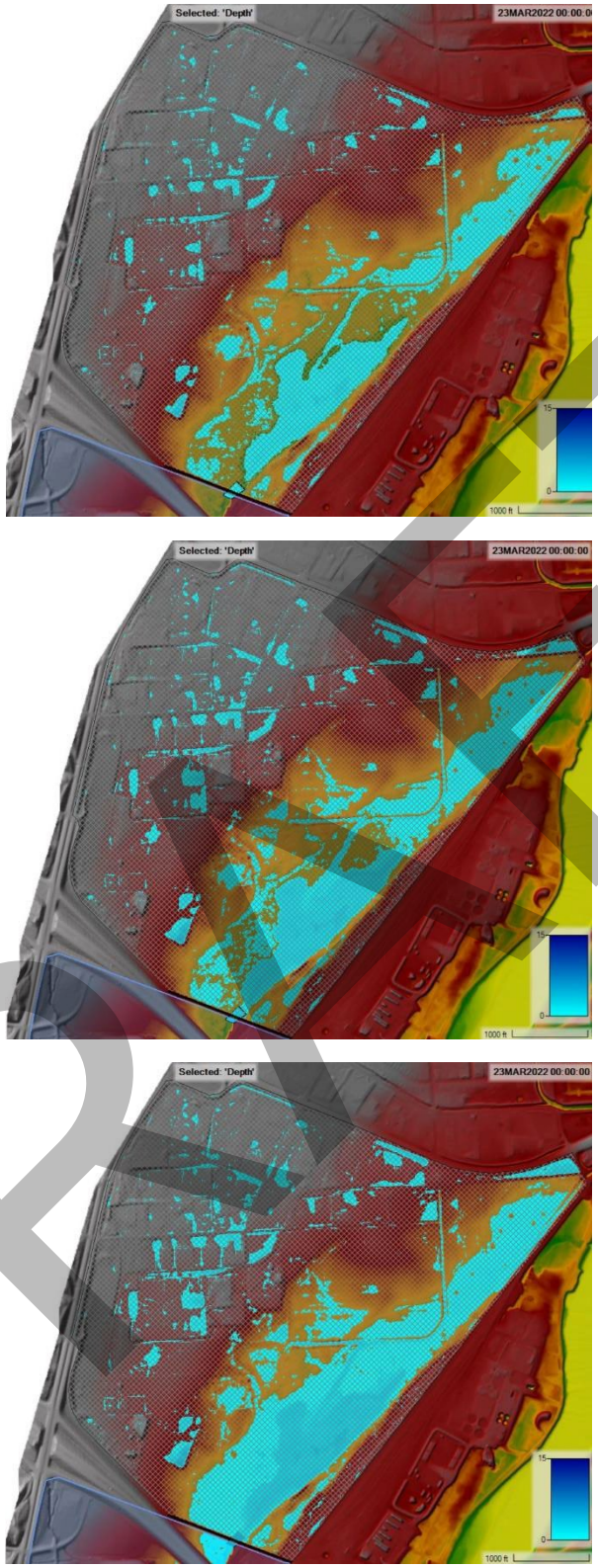


Figure J-5. Results from the last timestep of the 2D HEC-RAS model of the main marsh with culverts releasing water to the Mississippi River. From top to bottom the events are 1 inch, 3 inches, and 6 inches.

Survey crews were able to go to the main marsh and take measurements of the bathymetry. Eleven transects total were taken and are seen in Figure J-5. With these points, cross sections were constructed with the survey elevations themselves (Figure J-6) and with the Iowa Green LiDAR topobathy (Figure J-7). These slices help visualize the state of the main marsh currently and can be used in the future with new survey data to do estimations of sedimentation in the main marsh.

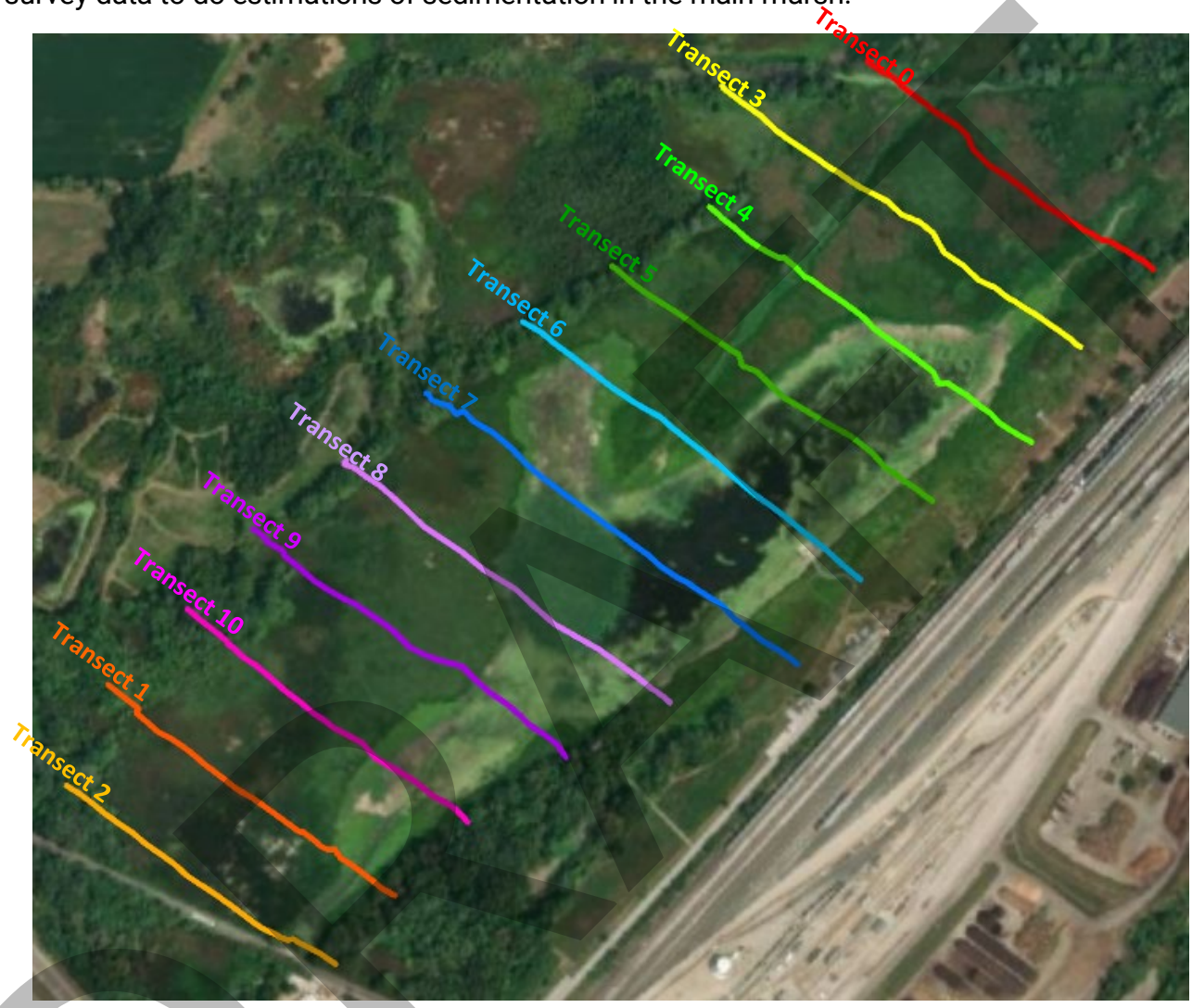


Figure J-6. Aerial view of the main marsh transects done by the survey crew

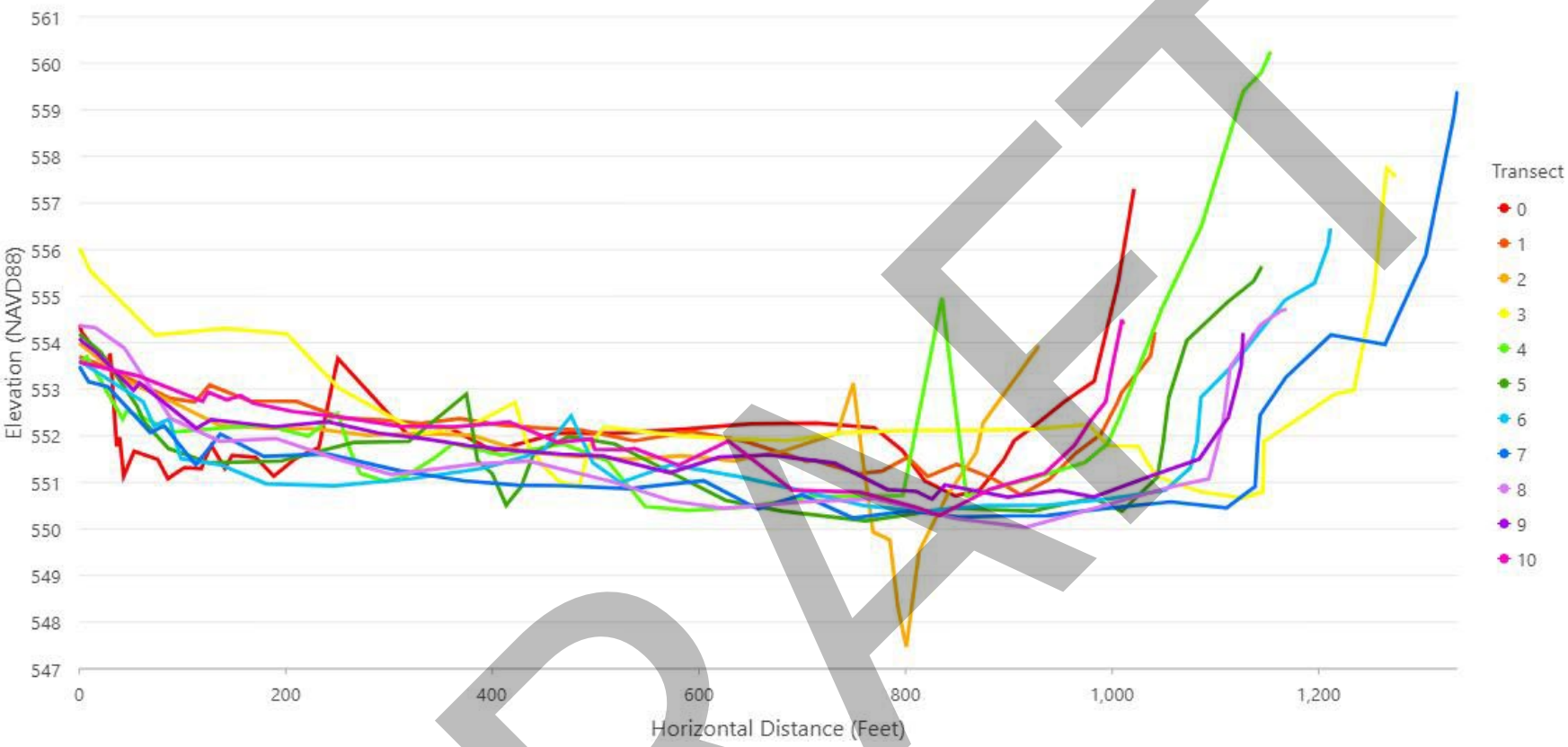


Figure J-7. Cross sections of the main marsh with survey elevations

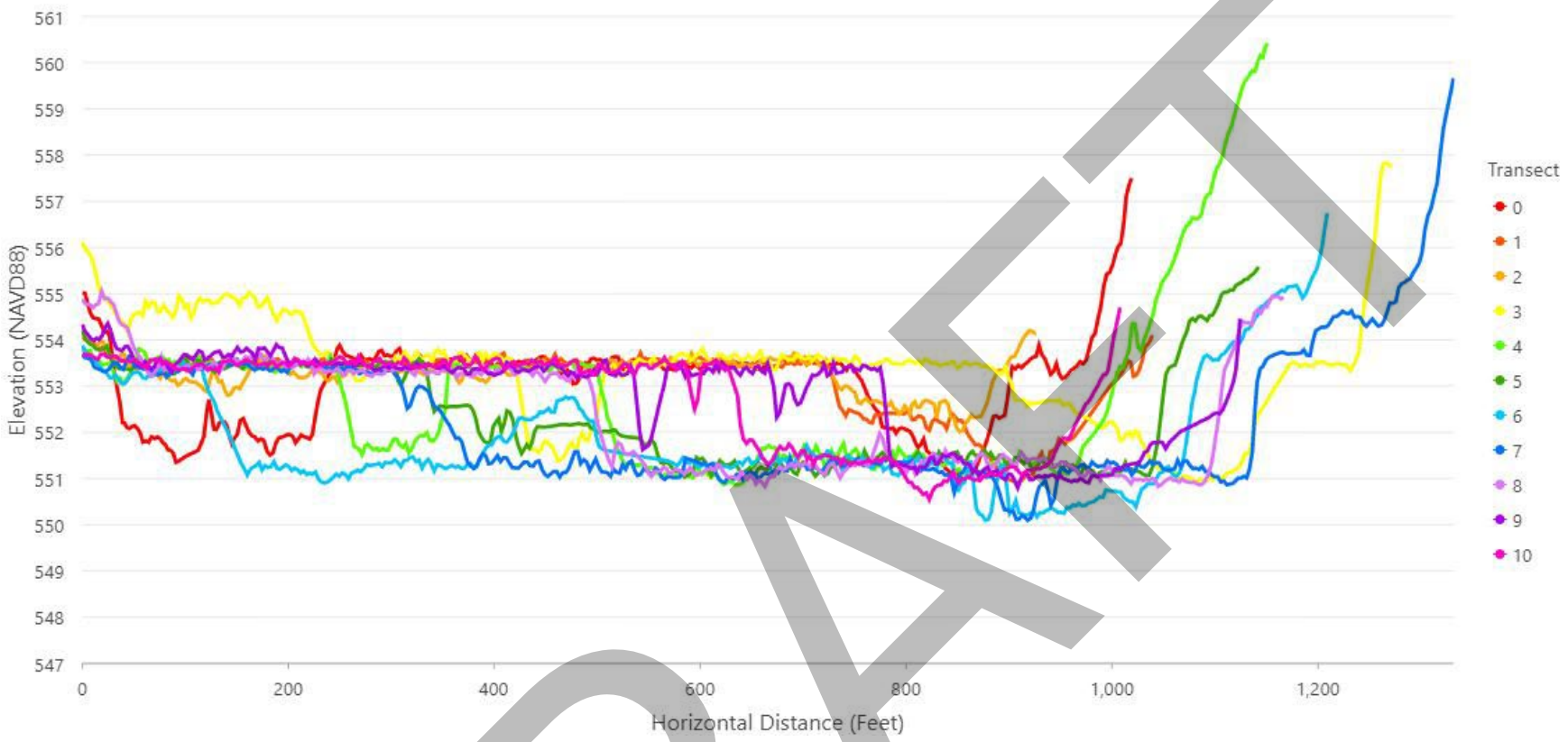


Figure J-8. Cross sections of the main marsh with Iowa Green LiDAR topobathy elevation

FLOOD ALERT GUIDELINES

NMEC staff has locations of interest that may be impacted by high water (Figure J-8). Since automated gage measurements are not available, a table with alert stages from the Lock and Dam 15 (LD15) gage can be used to provide approximately 24 hours of warning time before the point of interest is inundated (Table J-2). For example, NMEC staff may want to sandbag the back classroom door before the building is inundated. Looking at the table provided, when the stage at LD15 reaches 20 feet, there is approximately 24 hours of time until water reaches the back classroom door. This allows NMEC staff to have time to plan and act accordingly to protect their property.

This table was developed using GPS elevations from NMEC staff and the 2004 Flow Frequency Study Profiles. Discussions with the Corps Water Control section determined that a warning of 3 feet provides roughly 24 hours of lead time before the river crests.

CRITICAL NOTE These are only guidelines and should not be used alone. The values in the Alert table are to be used in conjunction with current observations and river forecasts from the National Weather Service as every high-water event is different and the table was developed with information from the Mississippi River only and does not consider flows from the Rock River. Rising hydrographs can peak much more quickly or slowly than 24 hours. When high water is expected, monitor forecasts frequently to aid in decision making.

Table J-2. Flood alert stages for main marsh points of interest using Mississippi River Gage Lock & Dam 15

Point of Interest	WSE at Marsh (ft NAVD88)	WSE at LD15 (ft NAVD88)	Stage at LD15 (ft)	Alert Elevation at LD15 (ft NAVD88)	Alert Stage at LD15 (ft)
East Trail Culvert	553.64	555.00	13.20	552.00	10.20
Survey Pin in Woods	554.01	555.75	13.95	552.75	10.95
Carp Lake Gate	554.28	556.00	14.20	553.00	11.20
Survey Pin by Dock	556.15	557.90	16.10	554.90	13.10
Bird Blind Boardwalk	559.12	561.25	19.45	558.25	16.45
Culvert under Wapello Avenue	560.25	562.10	20.30	559.10	17.30
Nahant Sign by Benches	561.18	563.00	21.20	560.00	18.20
Viewing Platform	562.10	564.00	22.20	561.00	19.20
Back Classroom Door	563.04	564.80	23.00	561.80	20.00
Front Parking Lot Gate	563.26	565.00	23.20	562.00	20.20

*include header title (e.g. assessment, recommendations, etc)

If additional points wish to be added to table, follow the steps outlined below to estimate the alert stage at LD15:

1. Obtain the elevation for the point of interest, ideally obtain the elevation in NAVD88, otherwise it can be converted using the following conversions:

To convert elevations in MSL1912 to NGVD1929 subtract	To convert elevations in NGVD1929 to NAVD1988 subtract	To convert elevations in MSL1912 to NAVD1988 subtract
(feet)	(feet)	(feet)
0.51	0.207	0.717

2. Add 1.78 feet to the elevation. This is the water surface elevation at LD15.
3. Subtract 541.8 feet from results in step 2. This is the stage at LD15.
4. Subtract 3 feet from results found in step 3. This is the roughly 24-hour alert stage at LD15.

Figure J-9. Points of interest for the main marsh associated with the Flood Warnings

HYDROLOGY SUMMARY AND FUTURE RECOMMENDATIONS

The main marsh is in a hydrologically complex area. Waters from the mainstem of the Mississippi River as well as the junction of the Rock River, located immediately upstream have flashy rises. Discerning where river flows/impacts are coming from is extremely challenging. While there is data upstream for both rivers, there is little information for the main marsh itself. With the installation of the staff gage and regular data collection, there will be additional data for future studies and efforts at the main marsh. Withe the identification of flow paths and 2D modeling available, it is now possible to learn where non-obvious points of entry to the main marsh occur. Water surface elevation profiles from available Mississippi River Flow Frequency Studies allow for estimation of flood alert stages so NMEC staff can take action when points of interest are forecasted to be inundated.

*include header title (e.g. assessment, recommendations, etc)

From a hydraulic and hydrologic standpoint, it is recommended that NMEC staff continue to collect data from their staff gage at the finest frequency possible. In the future, it would be best to find ways to automate data collection. With sufficient data collection there is potential to perform regression or other analyses to determine flow relationships from both the Mississippi and Rock rivers and how those relationships affect stages at the main marsh. This information can supplement and refine the flood alert system developed using information from the Mississippi River only.