UPPER MISSISSIPPI RIVER RESTORATION FEASIBILITY REPORT WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

GREEN ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER
RIVER MILES 545.9 THROUGH 548.7
JACKSON COUNTY, IOWA

APPENDIX E
ENGINEERING

ATTACHMENT B
CIVIL AND ENVIRONMENTAL ENGINEERING

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1. CIVIL DESIGN CONSIDERATIONS

1.14 Submerged Aquatic Vegetation A major objective of this project is the preservation and enhancement of the species of submerged aquatic vegetation (SAV), such as Coontails (Ceratophyllum demersum), Waterweeds (Elodea), Sago Pondweed (Stuckenia pectinate), Northern Watermilfoil (Myriophyllum sibiricum), and Star Duckweed (Lemna trisculca). These (SAV) can be seen in Photographs 1-5. The SAV needs to be fully submerged to survive. The sponsor will maintain the water levels on site to allow for SAV to be always submerged. The Channel bottom elevation for the Lakes is 576.82, providing 8 feet below Winter Pool for SAV survivability. See main feasibility report for more information.

Photograph 1. Coontail

Photograph 2. Sago Pondweed

Photograph 3. Waterweed

Photograph 4. Northern Watermilfoil

Photograph 5. Star Duckweed

1.15 Wind Driven Wave Reduction Wind fetch is defined as the unobstructed distance that wind can travel over water in a constant direction. Fetch is an important characteristic of open water because longer fetch can result in larger wind-generated waves.

One goal of this project is to reduce wind fetch across the Green Island pools, therefore reducing the size of wind-generated waves. This, in turn, will reduce the total suspended solids/turbidity of the water. USACE has designed projects in the past aimed to achieve similar goals including Pool 8 Islands HREP and Pool 9 Harpers Slough HREP.

The addition of wind-fetch reduction berms will be of value to reduce or break down wind driven waves. Increased wind grows larger waves, which circulate and resuspend the sediment (Photograph 6, Photograph 7, Photograph 8, Photograph 9, Photograph 10, and Photograph 11). This causes an increase in turbidity which is detrimental to future SAV growth. The SAV itself can serve to break up waves, and filter excess turbidity, and in general water is clearer within submerged vegetation beds. However, if the turbidity is too high, these beds will not be able to get established, and overall, the future of the beds continues to diminish over time. H&H gathered wind rose plots from Iowa State University's Iowa Environmental Mesonet to summarize the characteristics of the wind over the year and determined the most significant sources and direction of wind waves. The PDT met with the sponsor and discussed the strategic placement of the berms based on the data provided by H&H and existing conditions from the Sponsor where wind wave erosion was observed. More information on wind analysis is included in Attachment A, *Hydraulics and Hydrology.*

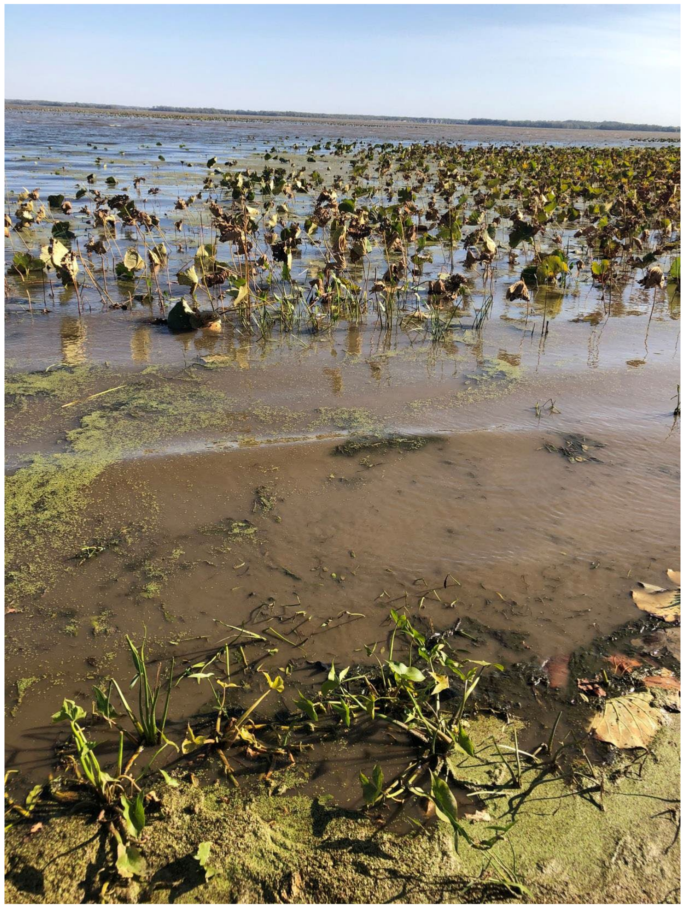
Photograph 6. Resuspended Sediment on High Wind Days Lower Pool 13.
This was at the north tip of the Thompson Causeway Campground. (IADNR Photo Credits).

25 mph out of the NW. (10/12/2020)

Photograph 7. Views from Bulgers Hollow October 2020

Photograph 8. Vantage 1, 10/5/20 – 17 mph S wind – Bad Day (IA DNR)

Photograph 9. Vantage 1, 10/8/20– 6 mph E wind – Good Day (IA DNR)



Photograph 10. Vantage 2, 10/5/20 – 17 mph S wind – Bad Day (IA DNR)

Photograph 11. Vantage 2, 10/8/20– 6 mph E wind – Good Day (IA DNR)

1.16 Overwintering Habitat. A major objective of this project is to provide overwintering habitat for the backwater fishery including the bluegill and other centrarchids. Palesh and Anderson identify the optimum winter bluegill habitat on the Upper Mississippi River system to have depths of greater than 4 feet (1.21 m), DO levels of greater than 5 mg/L, water temperature of 4 degrees Celsius, and no current. While no velocity is ideal, the closer to 0 the project gets the better it is for the habitat. It was determined that fish would leave water that has higher dissolved oxygen for lower flows. The study also showed that temperatures greater than 4 degrees C had anoxic or supersaturated water which can cause fish kills.

Four feet of water was met or exceeded during winter sampling runs in 100% of depth readings at site W-M546.1J, 66.7% of depth readings at site W-M546.8K, and 77.8% of depth readings at site W-M547.7H. Site W-M546.8K is not shown on the box plots because it was only sampled for one season. Though the sites met optimum depth requirements in a high percentage of measurements, depth at monitoring sites may not be representative of depth throughout the project, as the monitoring sites were chosen specifically for their depth.

With respect to temperature, across all winter monitoring, all three sites were below 4 C for a majority of measurements. Percent of measurements under 4 C was calculated as 63.4% at site W-M546.1J, 80.9% at site W-M546.8K, and 72.2% at site W-M547.7H. Breaking this down further, the majority of measurements below 4 C were between 4 and 2 C at all sites, with the percent of measurements in this temperature range calculated as 49.6% for site W-M546.1J, 59.6% for site W-M546.8K, and 50.5% for site W-M547.7H. No site had more than 22% of the winter temperature measurements below 2 C. Because Green Island is sheltered from the main channel of the Mississippi by levees, there is little risk of supercooled water from the main channel being introduced into overwintering fish habitat.

Winter DO was the parameter most variable, year to year, and site to site. Overall, DO levels were above the 5 mg/L threshold in 42.3% of measurements over two years of monitoring at site W-M546.1J, 85.4% of measurements over one year of monitoring at site W-M546.8K, and 63.6% of measurements over three years of monitoring at site W-M547.7H. These values also varied year to year, with site W-M547.7H as an extreme example. In winter of 2019-2020, DO sonde data from Site W-M547.7H was above 5 mg/L in 100% of the DO readings, with a minimum of 8.71 mg/L. However, in winter 2020-2021, 60.2% of sonde DO readings from site W-M547.7H were below 5 mg/L, and 50% of total readings were below 1.5 mg/L. In both cases, grab samples of DO corroborate the sonde readings.

Though none of the Green Island sites met the 0 cm/s current requirement for velocity, both sites W-M546.1J and W-M547.7H had median velocity measurements of just over 0.5cm/sec. The higher velocity measurements at both of these sites tended to occur towards the end of the winter monitoring season after ice melt, during the months of March or April.

More information on overwintering for design considerations is included in Attachment D, *Water Quality.*

2. Site Selection.

Berm and channel locations were selected using a variety of water quality data, bathymetry, historic aerial photos, existing feature locations, existing aquatic vegetation beds, and avoidance of areas that experienced historic activities, and areas where resuspension of sediments from wind driven waves was most likely to occur. Final locations were selected across the project area.

Water control structure locations were already existing and were left in the same locations.

Locations of features were developed during feasibility phase using information to include sponsor input and recommendations, water depths, water quality data, vegetation monitoring information, habitat suitability index, velocity, wind wave modeling, sediment evaluation, historic aerial photography, recreational boating impacts, floodplain impacts, hazardous toxic and radioactive waste assessments, cultural and historic sites, and real estate boundaries.

2.14 Sponsor Recommendations. Project priority areas were identified by the project sponsors at a workshop in December 2019. In February 2020, the team discussed various feature locations identified by all agencies. A virtual site visit in April 2020 confirmed the general locations of the features. In June 2020, the PDT selected the optimum locations for all features. For more information on sponsor coordination please see Appendix D – *Coordination and Public Involvement*.

2.14.1 USFWS. U.S. Fish and Wildlife Service (USFWS) is a key partner in the UMRR Program. The USFWS would ensure the TSP is compatible with the goals and objectives of the refuge. A small parcel of the land within the Green Island study area is within the Upper Mississippi River National Wildlife and Fish Refuge (UMR NWFR). These are a list of overarching goals from USFWS:

- Management practices will restore or mimic natural ecosystem processes or functions to promote a diversity of habitat.
- The aesthetics of projects in context of visual impacts to the landscape should be considered in project design.
- Bottomland forests will be developed consistent with the bottomland forest objectives contained in the Habitat Management Plan (HMP), which includes targets for species composition, canopy cover, regeneration, herbaceous cover, and invasive species.

2.14.2 IADNR. At the December 2019 workshop, the IADNR established several objectives for the Green Island Wildlife Management Area:

- Promote abundant, diverse, high quality waterfowl habitat to produce, attract, and harvest waterfowl.
- Create and maintain diverse aquatic vegetation communities for the benefit of diverse aquatic wildlife, maintaining diverse and healthy forest communities for the benefit of forest associated wildlife, and supporting viable native fish communities.

2.15 Water Depths. Based on the design criteria developed, water depths are an important parameter to consider ensuring that SAV has sufficient light breaking through the water surface and overwintering capabilities for fish species present. Depths that are too great may not be able to create the light penetration required for annual growth of SAV. According to Palesh and Anderson optimum winter bluegill habitat on the Upper Mississippi River system is identified as having depths of greater than 4 feet. The project design included a depth of 8 feet below winter pool, assuming 2 feet for ice, 4 feet of water, and 2 feet of sedimentation over 50 years. For more information on existing water depth conditions information is available in Attachment D: *Water Quality*

2.16 Water Quality Monitoring.

2.16.1 Water Quality Monitoring (LTRM). Water quality monitoring in the pool is accomplished with a combination of Fixed Site Sampling (FSS) and Stratified Random Sampling (SRS). For FSS, a relatively small number of nonrandomly-selected fixed sites are monitored repeatedly at intervals ranging from once every two weeks to once every two months. Water quality SRS occurs at a larger number of randomly selected locations at seasonal (quarterly) intervals. Some of the data available for review include *in situ* measurements, water clarity, water chemistry including nutrient parameters, and chlorophyll.

2.16.2 Water Quality Monitoring (USACE). Information collected to date is available in Attachment D: *Water Quality* and the location of water quality monitoring sites can be found in *Appendix L: Plates.* Turbidity evaluation and sources is also summarized in Attachment D: *Water Quality.*

2.17 Vegetation Monitoring. Vegetation monitoring will be conducted during PED phase using Long Term Resource Monitoring (LTRM) SRS protocol. Data will be collected on distribution, frequency of occurrence, and relative abundance of aquatic vegetation within Green Island, including the following aquatic vegetation types: submersed, rooted, floating-leaf, emergent, algae, and duckweeds. Vegetation maps will utilize SRS summer vegetation sampling data. Each sampling site will have six subsamples around the boat and each subsample will be assigned a value between Trace-5 (rake values). Photograph 12 depicts vegetation sampling using a rake.

Photograph 12. Vegetation Sampling Using a Rake

Water quality and vegetation data are available for download at https://umesc.usgs.gov/ltrm-home.html.

2.18 Velocity. To address the matter of optimum velocity, it was determined that structures would need to be constructed to reduce velocity in areas with the appropriate depths for typical turbidity in the pool. The PDT selected berms for the structures at Green Island to accomplish the velocity reduction. Channel depths were determined based on feature purpose, with overwintering habitat at 8 feet below winter pool and conveyance channels at 6 feet below the lowest pools. More information on hydraulic modeling to support the site selection is included in Attachment A, *Hydraulics and Hydrology.*

2.19 Wind Wave Modeling. An analysis of wind fetch was conducted by H&H to support placement of islands within the Green Island impounded areas to reduce wave-impacted erosion and sediment-resuspension. The time of year and accompanying wind direction during that time, the sponsors goals per season for each Pool, and sponsor input were used to determine some of the placement locations for the berms.

Annually, the greatest proportion of wind speeds are attributed to winds from the north-northwest and south-southeast directions. The TSP includes strategic placement of dredge material to create wind-wave mitigation structures in both Pools A & B.

In Pool A, the Ridge and Swale feature will be used to effectively reduce fetch length. The 3rd Ditch and Fish Lake berms were requested by the sponsor to reduce wind fetch due to existing erosion patterns they believed to be from wind waves.

In Pool B, the 4th Ditch Road Berm and the 5th Ditch Berm will have a North-South orientation. Densmore Lake, Sawmill Lake and Blake's Lake berms will have a more East-West orientation.

The PDT incorporated berms, shown in yellow in Figure 1, in all four directions in both Pools to assist with the directionality of the wind and the existing locations on site that have consistently shown wind wave erosion. Side casting of material was chosen for ease of use and cost reduction, wherever possible.

More information on these modeling efforts is included in Attachment A, *Hydraulics and Hydrology*.

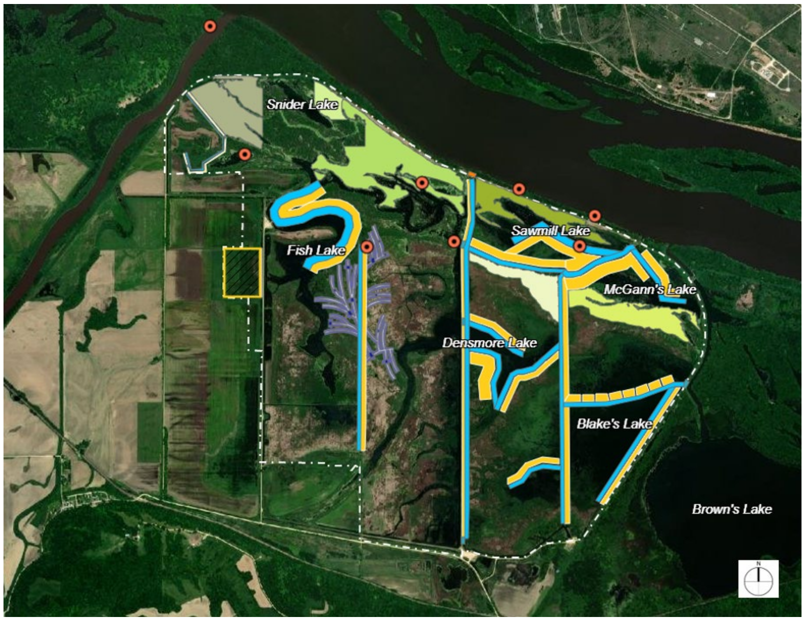


Figure 1. TSP

2.20 Sediment Evaluation. Substrate is another important parameter to consider in the placement or construction of features that will encourage SAV. Geotechnical borings were not fully obtained during the feasibility level of design but will be required during the design phase of this project. However, water clarity monitoring, and water erosion prediction tools were conducted to determine what materials may be better suited for SAV in lower Green Island.

2.20.1 Water Clarity Monitoring. Baseline water quality monitoring was initiated in order to determine pre-Project conditions and assist with selecting and locating alternatives for habitat rehabilitation and enhancement. This monitoring also supports future evaluation of the Project's goals of providing suitable summer and winter fish refuges and increasing the coverage of aquatic vegetation for waterfowl habitat. For more information see *Attachment D – Water Quality.*

2.20.2 Estimated Sediment Evaluation. Estimated sediment deposition rates within the Green Island HREP were used to compute habitat benefits under future without project conditions as well as to inform dredge cut design to support benefits over the 50-year project life. The sediment assessment documented in *Attachment A – Hydrology and Hydraulics* describes significant sources of sediment to the Project, provides estimates of contributions from these sources where possible and an estimated sediment deposition rate under both with and without project conditions.

Hillslope soil loss from two contributing watersheds, (Mooney Hollow and Smith Creek), suspended sediment from the Maquoketa River flowing into Mooney Hollow Ditch, suspended sediment from fall pumping of Mississippi River water into the Project, and perimeter levee overtopping were the primary sources of sediment deposition identified for Green Island.

2.20.3 Summary: Sediment Evaluation. Water clarity measurements suggest that Mooney Hollow Creek is not a constant source of sediment into the project, only contributing quantities of sediment during high rainfall events. Both the Pump House Inflow and the Downstream Gate inflow had lower water clarity readings and may contribute to sedimentation in the northern portion of the project. The Smith Creek inflow was only operated for a short timeframe in the fall, and water clarity readings were drastically different from year to year.

A sediment deposition rate for the Project was estimated to support dredge cut design and habitat benefit calculations under with and without-project conditions for the 50-year life of the project. Smith Creek and Mooney Hollow hillslope loss and fall pumping sediment sources were explicitly estimated. Consideration was given to the sediment deposition processes that result in increased deposition in deeper areas, project features including Mooney Hollow sediment trap and berm features that provide reduced wind fetch, and published backwater sedimentation rates. The resulting without-project sediment deposition rate for the Green Island Project Area was estimated as three feet over 50-years. The resulting with-project sediment deposition rate for the Green Island Project Area was estimated as two feet over 50-years.

2.21 Historic Maps and Photographs.

2.21.1 Historic Aerial Maps. This imagery was reviewed to observe changes over time, to help identify any construction constraints for the placement of features, and to determine the most efficient method and location for dredging and placing in historical channels or historical high ground. (Figure 2 to 12). Based on PDT meetings and sponsor input, locations for desired channels and berms were created taking specific note to areas of wind fetch concerns and an initial layout was provided for cut and placement locations. These images were used to discern the natural pathways for water migration through the site and areas where material seems to be depositing over time. The initial layouts were modified to better represent normal pathways for water flow for the dredge locations and indicate better locations for adjacent berms to find the most natural location for berm placement that would also meet the project feature goals for wind wave reduction.

Figure 2. 1936 Aerial Photo

Figure 3. 1952 Aerial Photo

Figure 4. 1964 Aerial Photo

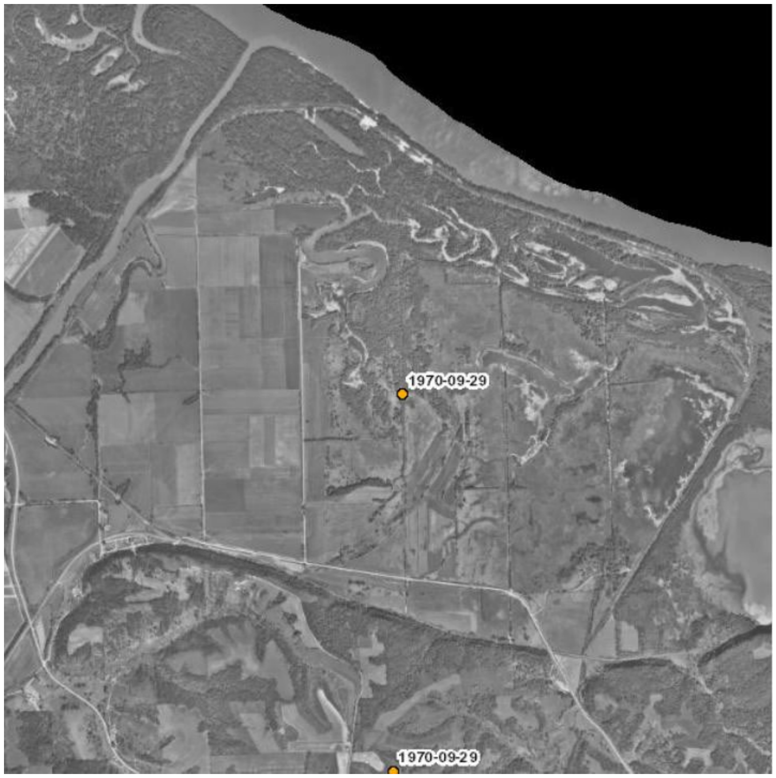


Figure 5. 1970 Aerial Photo

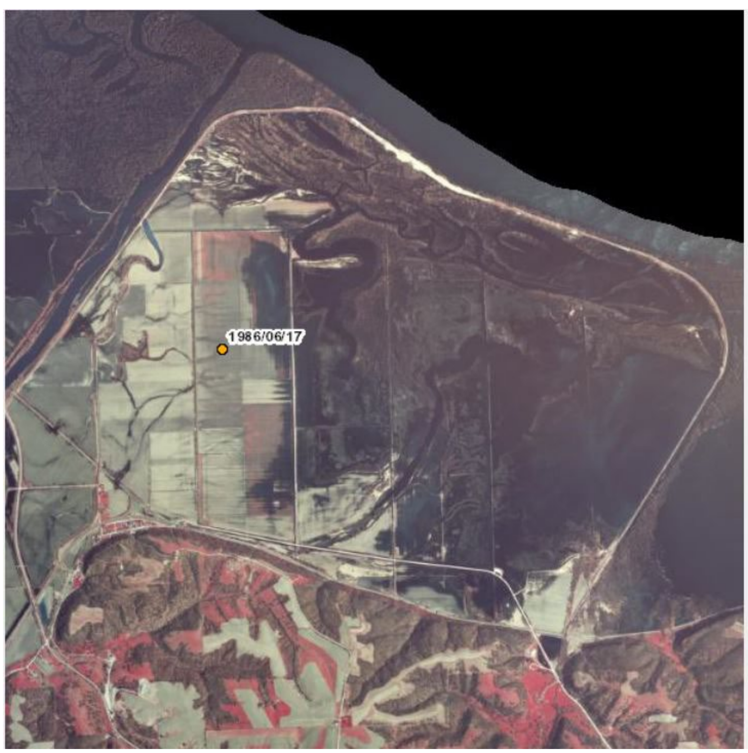


Figure 6. 1986 Aerial Photo

Figure 7. 1994 Aerial Photo

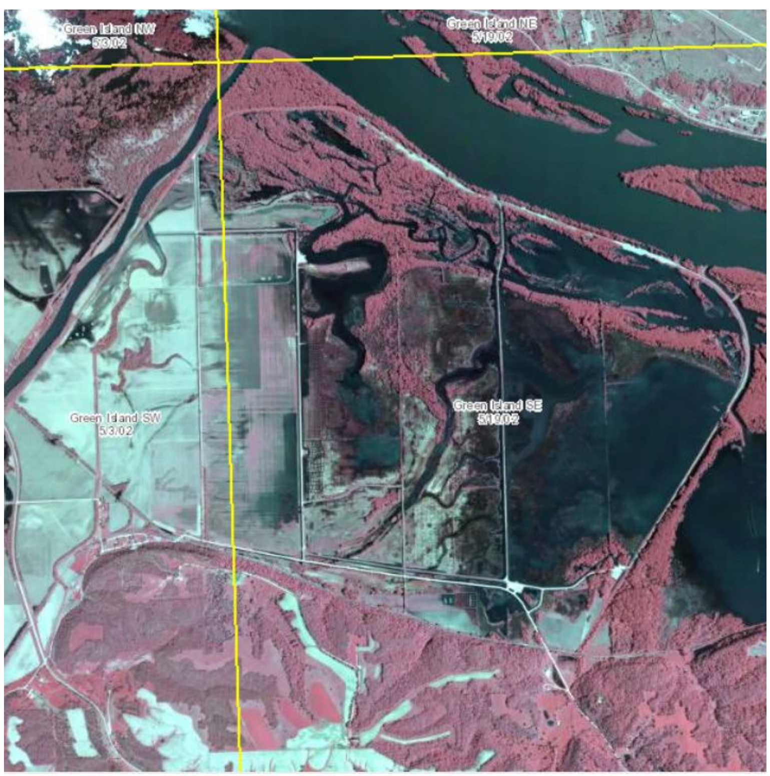


Figure 8. 2002 Aerial Photo

Figure 9. 2004 Aerial Photo

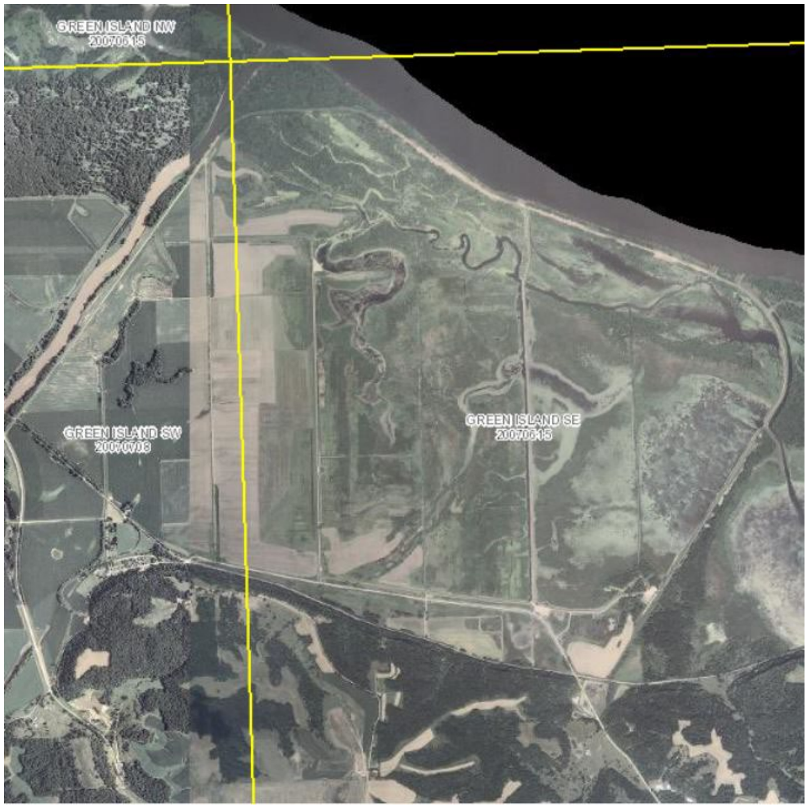


Figure 1. 2007 Aerial Photo

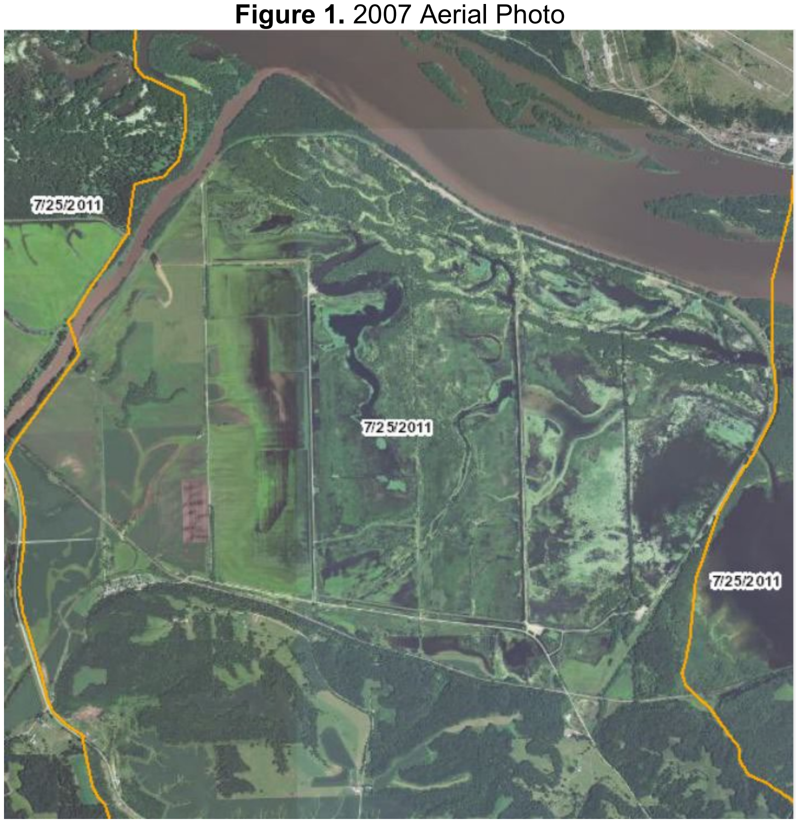


Figure 11. 2011 Aerial Photo

Figure 12. 2014 Aerial Photo

2.21.2 Current Imagery. Current imagery is utilized in the GIS web server and in Appendix L on the plates. (Figures 13,14). The web viewer for this project is located at https://usace-mvr.maps.arcgis.com/apps/webappviewer/index.html?id=c9d1105d12054f55a892129ff79cda9e.

Figure 13. 2019 Aerial Photo

Figure 14. Current TSP Aerial Photo

2.22 Navigation Impacts. Project features are situated within the Green Island Wildlife Management Area behind a levee which will ensure that there are no adverse impacts to navigation.

2.23 Recreational Boating Impacts. Green Island is not used by recreational boaters, but by boaters for recreational fishing and waterfowl hunting. There is a public access boat ramp at Fish Lake. There is a boat ramp accessing Pool A in the parking lot located at the sound end of 4th Ditch, there is also a boat ramp accessing Pool B at this same parking lot. There is a boat ramp accessing Pool B at another parking lot East of the main parking lot. Throughout most of the year when in non-frozen conditions fishermen and hunters will use these boat ramps and navigate existing channels. Channelization of areas like Fish Lake may attract more boaters to the area.

2.24 Floodplain Impacts. Feature sizes and locations were analyzed to ensure that there would no negative impact to the Floodplain. Further information on this analysis is in Attachment A, *Hydraulics and Hydrology.*

2.25 Hazardous, Toxic and Radioactive Waste. A site visit was conducted by USACE representative on July 27, 2021. No indications of recognized environmental conditions (REC's) were observed in the Site Reconnaissance phase.
More information is available in Attachment H, *Hazardous, Toxic and Radioactive Waste*.

2.26 Surveying, Mapping, and Other Geospatial Data Requirements. Project datum information is summarized below:

- Horizontal: NAD 83 State Plane Iowa North
- Vertical: NAVD88
- Geoid 18 (CONUS)
- Units: US Survey Feet
- Conversion: MSL12-0.68 feet = NAVD88

EC-TS Performed Topographic and Hydrographic Survey and provided precise data for a local elevation conversion of the feasibility area. EGIS supplemented the topographic data with Lidar Imagery from publicly available data. More details on method of survey and control points are included in Attachment E, Survey, Mapping, and Geospatial Data.

2.27 Utilities. Utility relocations are not required for this Project. There are no existing utilities onsite. As a part of the feasibility project, the PDT and sponsor considered the options for bringing 3 phase electrical utilities on site. A combination of overhead and underground methods were chosen to run the power to the new pump station. The electric company is willing to place fiberoptic cable at the same time as the 3 phase conductors for future monitoring use. Those details will be confirmed during the design phase. More information on the electrical analysis is included in Engineering Appendix E, 3.7 Electrical and Mechanical Requirements.

2.28 Cultural and Historic Sites. Feature layouts were situated to avoid all cultural and historic sites within the study area. Seven prior surveys were conducted on site and 2 archeological sites were identified. Not all of the project area has been surveyed to date. Areas that have not yet been surveyed were avoided to minimize impacts in locations near prior finds based on Cultural recommendations. More information is available in the Main Report under Section III, Paragraph C.5.a. under existing Cultural Resources.

2.29 Real Estate Boundaries. Features and their impacts are all located within Federal property limits (Figure 15). All project work is located on Federal property. The electrical utilities will need to be brought onto project lands from the adjacent IADNR office. More information is available in Appendix C, *Real Estate*.

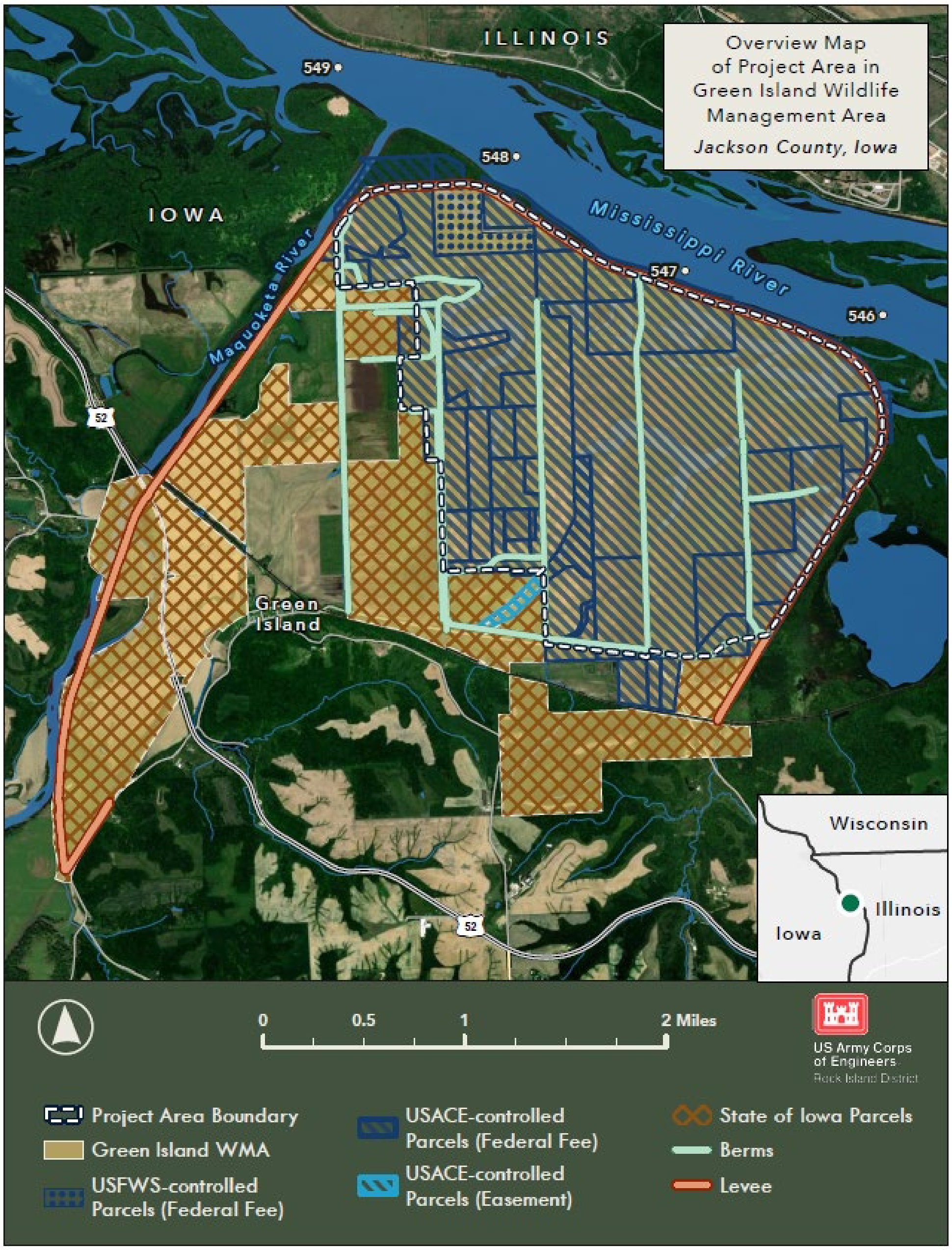


Figure 15. Real Estate Parcels

3. REAL ESTATE AND RELOCATIONS (C-6.2 AND C-6.3)

Information regarding real estate needs is included in the main report and Appendix C, *Real Estate*.

4. C-5. ENVIRONMENTAL ENGINEERING

The following environmental engineering factors shall be incorporated into each aspect of the project.

4.1 C-5.1. Use of environmentally renewable materials.

Materials used for this project will consist of dredged material.

4.2 C-5.2. Design of positive environmental attributes into the project.

This ecosystem restoration project will have a positive influence on the environment.

4.3 C-5.3. Inclusion of environmentally beneficial operations and management for the project.

4.4 C-5.4. Beneficial uses of spoil or other project refuse during construction and operation.

Material excavated for dredging will be placed at a site in a manner to support habitat restoration.

4.5 C-5.5. Energy savings features of the design.

The design will be completed in a manner to reduce the amount of rework required to construct all features, creating an overall energy savings by not have to perform rework.

4.6 C-5.6. Maintenance of the ecological continuity in the project with the surrounding area and within the region.

This ecosystem restoration project will improve the ecological needs of the area and is consistent with the sponsors restoration and refuge goals. More information is available in the main report.

4.7 C-5.7. Consideration of indirect environmental costs and benefits.

Habitat benefits were determined as described in the main report. NEPA compliance addresses ecological impacts.

4.8 C-5.8. Integration of environmental sensitivity into all aspects of the project.

4.9 C-5.9. The perusal of the Environmental Review Guide for Operations (ERGO) with respect to environmental problems that have become evident at similar existing projects

and, through foresight during this design stage, have been mitigated/addressed in the project design.

4.10 C-5.10. Incorporation of environmental compliance measures into the project design