Mounds Lake Reservoir Phase II Study

ARCHITECTURE • ENGINEERING • PLANNING
SURVEYING • CONSTRUCTION SERVICES

Anderson Corporation for Economic Development

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Executive Summary

The Anderson Corporation for Economic Development (ACED) and its partners have commissioned DLZ Indiana, LLC (DLZ) to complete the next planning phase (Phase II) regarding the feasibility of constructing a dam on the West Fork of the White River in Anderson, Indiana. This would create the proposed reservoir for the primary purpose of drinking water supply as well as secondary purposes of flood control, alternative energy and potential economic development.

Like the Phase I study, this evaluation continued the investigation of many issues related to the reservoir's design and construction. These included:

1. **Yield Analysis:** During this phase of the project, it was determined that the proposed dam could provide a firm yield of 60 million gallons per day (MGD) at a normal pool elevation of 876.0 feet when the most severe drought conditions on record, the years of 1940-1941, are considered. Models indicate that this results in a drop of 31 feet within the reservoir. The resulting depth in the reservoir at its deepest point under these conditions is approximately 20 feet. During all less severe drought conditions after 1945, maintaining a minimum depth of 20 feet, results in an increase in the reservoir firm yield to 78 MGD. During a more moderate drought such as the one experienced in 1988, the reservoir would drop only an estimated 6 feet at the 60 MGD yield value. Future analysis will focus on demonstrating the value of the reservoir to protect against drought vulnerability for the Central Indiana region.

2. **Social, Environmental, and Regulatory Investigation, Coordination**: The goal of this section included reviews of a wide range of features related to potential changes to land conditions/uses, water quality, habitat and social issues. A feasibility study level review of existing conditions and potential changes once the reservoir is constructed are examined in this section.

   Social, Economic, and Environmental Resource Investigations. To advance this effort, early coordination was performed with all relevant state and federal agencies regarding social, economic, and environmental (SEE) issues. This included the level necessary to allow for more detailed scoping of future phase resource investigations for the project, as well as determining the lead agency for future National Environmental Policy Act (NEPA) investigations. This includes evaluating the reservoir's effects on various SEE issues, including land cover, farmlands, wildlife habitat, wetlands, recreation, parks, noise, rights-of-way, relocations, socioeconomic conditions, visual changes, land use, water resources, threatened or endangered species, and temporary construction impacts. In each case, the existing conditions, potential impacts, mitigation, and possible NEPA phase investigations were evaluated. This also included impacts to the storm water system, including county drains within the project area, and the transportation impacts to local roads, bridges and the Anderson Airport.

   Archaeology. Through the Applied Anthropology Laboratories (AAL) of Ball State University, a preliminary review of the location of known cultural resource sites and structures within the project area that may be impacted, including a records search and characterization of known sites, as well as discussion regarding the level of investigation effort required for each site at a later phase. This also included potential impacts on the ceremonial grounds at Mounds State Park and early coordination with the State Historic Preservation Office (SHPO) to determine future NEPA clearance phase requirements.

Mounds State Park. The protection and preservation of the pre-historic mound constructions at Mounds Park is of the utmost importance. A review of the area elevations indicates that all park buildings, campsites and the pre-historic Mounds are located well above the highest projected flood stage of Mounds Lake. Mounds State Park has historically flooded in the lower lands on the average of three events per year. These fast current flood events have played a major role in creating the current river valley. It can be expected that once Mounds Lake is established, erosion of the side walls of the valley would greatly diminish. Additional studies of the soil type in this area will need to be performed to determine if any erosion protection is needed for this area.

Environmental Justice. This included a preliminary review of the 2010 census data and any existing socio-economic mapping for potential environmental justice concerns to determine where populations of minority and/or low income persons may be concentrated and evaluate the impact on these neighborhoods for the various flood height scenarios.

Next Steps. Based upon this review, there are a number of impacts to the social, economic and environmental resources within the project area. Preliminary mitigation requirements for each impacted resource have been identified and initial discussions with regulatory agencies have been conducted. Anticipated future NEPA phase requirements have been identified. Upon a review of the findings of this report with the affected resource agencies, next steps will include negotiating the mitigation requirements should the project proceed to the NEPA clearance and/or permitting phase as well as further development for the NEPA phase, including the preparation of the Environmental Impact Statement (EIS).

3. **<u>Geotechnical (Borings at Proposed Dam Site/ Reservoir Pool Site):</u>** As a continuation of the Phase I study, a better understanding of the subsurface conditions that will influence the proposed dam design, construction and operation required additional geotechnical work. This included six test borings - three along the proposed dam centerline at the bottom of the existing valley, and three at the bottom of the existing valley in the area to be inundated by the reservoir pool. Final boring logs were prepared to begin to define the subsurface stratigraphy and a preliminary evaluation of seepage through the foundation of the proposed dam was performed to help determine if a foundation cutoff wall will be needed. In addition geotechnical reports performed for past bridge projects within the proposed reservoir footprint have been reviewed as part of this study.

   At this stage of the investigation, there appear to be no major geotechnical issues that should prevent this project from continuing on to the next stage. Soils and bedrock beneath the proposed dam are capable of supporting the proposed dam structure and spillway. However, underseepage through the granular soils in the river valley beneath the dam and at the abutments will need to be addressed. Also, additional field analysis and possible geotechnical borings will be performed to identify and evaluate areas of high permeability within the proposed reservoir footprint.

4. **<u>I-69 over White River Bridge Raising/ Replacement Feasibility:</u>** Increasing the pool level of the proposed reservoir has a substantial impact on its overall water availability. An increase of approximately 5 feet adds over 3 billion gallons of available water. However, this increase would require the current I-69 bridges over the White River to be replaced at a higher elevation to protect the bridges.

   A preliminary evaluation for raising the grade of I-69 over the White River in the headwater area was performed to provide for at least 1-foot of freeboard over the 100-year flood elevation in the headwater pool of the dam. This included a preliminary alignment and profile grade along I-69 that maximizes the grade change at the bridges over the White River. A review of the existing alignments and profiles for the SR 67 and SR 32 interchange ramps required no grade changes to match the new alignment for I-69.

   Preliminary costs for the roadway reconstruction work were estimated to be $6.2 million. The bridge portion of this review investigated the worst case scenario of the complete replacement of the existing bridges with new structures on the same alignment. Preliminary costs of the updated 5-span bridge were calculated to

be $14.2 million. Adding the upgraded roadway costs to this resulted in a total preliminary project cost of $20.4 million.

5. **<u>Evaluate the effect of the Mounds Lake Reservoir on the Chesterfield and Yorktown Wastewater Treatment Plants:</u>** In this section the effect of the new pool heights on the Chesterfield and Yorktown wastewater treatment plants (WWTP) was evaluated. This included the effect on the NPDES permits of each WWTP, based on a review of the relevant Indiana regulations and meetings with IDEM, as well as the impacts of new flood elevations on the WWTP operations.

   Using the new proposed pool elevation of 876.0 and the new 100-year floodplain elevation of 878.6, it is clear that there will be no impact to the Yorktown WWTP's structures and minimal potential impacts to operations. The Chesterfield WWTP operation and structures will be impacted by the new pool level. Options to address impacts to the WWTP structures and operations will be evaluated in close coordination with Town of Chesterfield officials. Initial review of the WWTP treatment process indicates that the existing equipment is adequate to meet the more stringent water quality permit conditions anticipated due to discharging to a lake.

6. **<u>Dam Flood Routing:</u>** The hydraulic routing of the Probable Maximum Flood (PMF) event through the reservoir and dam for two pool levels was evaluated and the spillway/dam configurations required for these pool levels was estimated. This included completing preliminary estimates of construction costs for the dam/spillway for these two pool levels.

   Preliminary calculations showed that a combination of 250 feet of uncontrolled spillway at crest elevation 876.0 and 280 feet of gated spillway at crest elevation 860.0 would be required to achieve a PMF elevation below the top of dam elevation and to provide enough clearance under the raised I-69 bridge so as to not raise discharges downstream. This was a significant improvement over the previous gated spillway model because more realistic geometries of the radial gate spillways were used. These results show that there is no overtopping of the dam during the PMF event and that there are decreases in the peak flow values downstream of the dam. This also allows for substantial clearance under the I-69 bridge during the 100-year event.

7. **<u>Opinions of Probable Cost:</u>** A feasibility level cost analysis for the Mounds Lake project has been performed as part of this study. The cost analysis includes all items that are likely to be part of the final project. The total probable cost of construction for the Mounds Lake reservoir is $428,000,000 in 2015 dollars.

   The cost to construct a new water treatment plant to treat water from Mounds Lake was also examined as part of this feasibility study. By building a water treatment plant, the community would have the ability to sell treated water to a wide range of utilities in the Central Indiana region. Analysis indicates that Mounds Lake has the capacity to produce 40 MGD of water for sale, while maintaining several billion gallons of water in storage to be used in the event of a long term drought. The probable cost to permit, design and construct the conveyance pipe, intake and water treatment plant is estimated to be $120,000,000. A discussion regarding the overall financial feasibility of selling processed water is discussed in the Phase II Financial Feasibility Report.

   Next steps are to review each probable cost area in more detail to refine the projected total costs for Mounds Lake and constructing an intake, conveyance pipe and water treatment plant for the purpose of selling treated water.

8. **Conclusions and Recommendations:** This report concludes that there are no engineering related issues that preclude the Mounds Lake project from advancing to the next phase of development.

- A firm yield of 60 MGD is available from the proposed reservoir, even during the most severe drought of record, with this dependable yield increasing substantially to 78 MGD during all other moderate drought periods.
- Initial social, environmental and regulatory investigations yielded impacts to a number of historically and archeologically sensitive sites within the project area, so future project steps should include additional research and coordination with key stakeholders to determine the appropriate mitigation methods to preserve and/or protect these important assets.
- There appear to be no major geotechnical issues affecting this project that should prevent this project from continuing on to the next stage. Raising the existing I-69 bridges will add approximately $20 million to the overall project cost but will also allow the increased pool level to add over 3 billion gallons of capacity to the reservoir.
- The impacts on the Yorktown wastewater treatment facility are minimal, while the impacts on the Chesterfield wastewater treatment facility can be mitigated with little disruption to the existing structures and plant operation.
- The use of a combination of a 250 feet uncontrolled spillway and a 280 feet gated spillway would achieve a PMF elevation below the top of dam elevation while providing sufficient bridge clearance during the 100-year flood.

Based on these results, the NEPA and preliminary design phase (Phase 3) of this project is warranted based on the analysis within the scope of this study.

Analysis / Subject Matter

1. Yield Analysis
2. Social, Environmental, Regulatory
3. Geotechnical/Foundation Analysis
4. I-69 over White River Bridge Raising/Replacement Feasibility
5. Effect on Chesterfield and Yorktown WWTPs
6. Dam Flood Routing and Cost Options
7. Opinions of Probable Cost
8. Conclusions and Recommendations

1. Yield Analysis

Goal: **The intent of this section of the study is to address additional pool level effects on the yield and reservoir level fluctuations for specific pool levels (evaluating 2-3 levels) and to evaluate the impacts of a specific daily demand requirement (up to two). This study includes additional analysis to refine the yield of the reservoir, including no loss in storage due to sedimentation, and adds statistics related to yield and reservoir elevations.**

Summary: **At a reservoir pool elevation of 876 feet, the firm yield is 60 MGD with no sedimentation factors and meeting the historical multiyear drought of 1940-1941. This would result in a reservoir level drop of 31 feet. Under these same conditions, restricting the water withdrawal rate to 40 MGD or 50 MGD will result in reservoir level decreases of 5 feet to 9 feet, respectively. Maintaining withdrawal rates at these levels will minimize impacts to the overall reservoir levels and the available yields.**

During all less severe drought conditions after 1945, the firm yield of the reservoir increases to 78 MGD over a two year period. During the driest post 1945 period the 78 MGD yield results in a reservoir drop of 31 feet.

Next Steps: **Perform additional engineering analysis to determine the value of the reservoir as a resource to protect against drought vulnerability for the Central Indiana region. Investigate the water needs of Central Indiana communities for various time frames and drought scenarios.**

Background

In the Mounds Lake Dam Feasibility Study dated December 8, 2011, the hydraulic analysis calculated a firm yield of the proposed reservoir of 88 cubic feet per second (cfs) or 57 MGD at a pool elevation of 875 feet This did not include any losses in the receiving stream at the point of withdrawal. This analysis also accounted for storage depletion due to sedimentation, as well as other factors impacting storage.

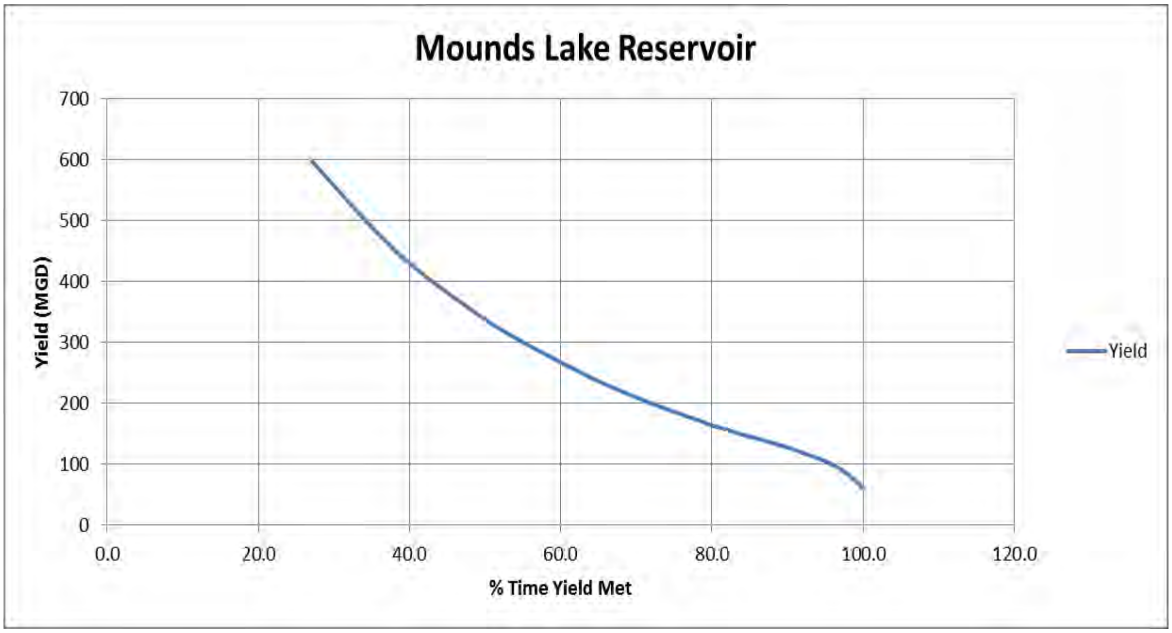
The current study includes additional analysis using a pool elevation of 876 feet and assumes no loss in storage due to sedimentation, and adds statistics related to yield and reservoir elevations.

Analysis

At a reservoir pool elevation of 876 feet, with no sedimentation loss, the firm yield of the reservoir is projected to be 60 MGD. This analysis includes using daily stream flow data from October 1, 1933 through September 30, 1993. This represents the best contiguous data source for the calculations since data from 1994 through 2006 is not available due to USGS gauging data being unavailable for this period. The analysis was used to determine the percentage of time that higher water withdrawal rates could be met, as shown in **Figure 2.1**.

It should be noted that the minimum yield and the yield characteristics shown in **Figure 2.1** are strongly influenced by the "dust bowl" years in the 1930's and the severe drought from 1940 through 1942. To illustrate these impacts, additional analysis was conducted, which included the non-contiguous data from October 1, 2006 through September 30, 2013 to compensate for the shorter data availability. These results are shown in **Figure 2.2**. By excluding the extreme dry periods in the 1930's and 1940's, the yield calculations increase by 18 MGD to 78 MGD for the reservoir assuming a minimum reservoir level of 845 feet.

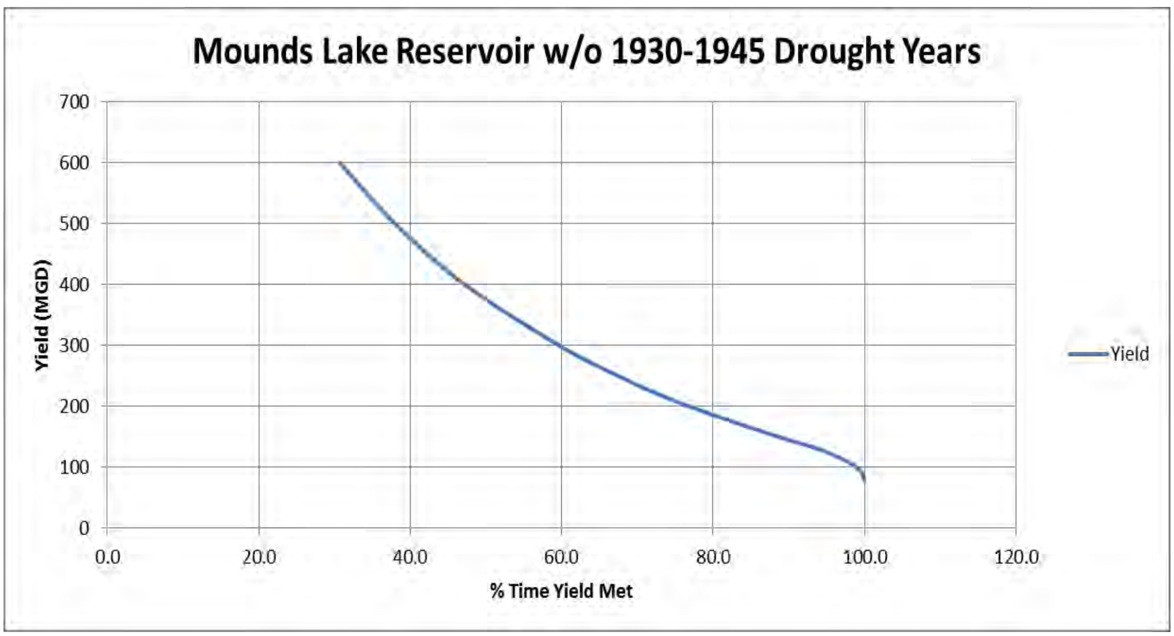
This extended data set was used to analyze the impact of water withdrawals on the reservoir levels, as shown in **Figure 2.3**. This analysis shows that a water withdrawal rate equal to the firm yield of 60 MGD will cause the reservoir level to fall to the target minimum level of 845 feet. This is the level that corresponds with the 1941-1942 drought years. If the withdrawal rate is lowered to 50



Notes:
Sedimentation not included
Pool El = 876 ft
Min Pool = 845 ft

Min Yield = 60 MGD

Figure 2.1 Yield Characteristics of Mounds Lake Reservoir



Notes:
Sedimentation not included
Pool El = 876 ft
Min Pool = 845 ft

Min Yield = 78 MGD

Figure 2.2 Yield Characteristics of Mounds Lake Reservoir (Excluding 1930-1945)

MGD, the minimum reservoir level rises to 867 feet, or a drawdown of 9 feet from the normal pool level. At an even lower rate of withdrawal of 40 MGD, the minimum reservoir level is 871 feet. or a drawdown of 5 feet.

Plots were generated to simulate reservoir level variations during specific calendar years: 1940, 1941, 1942, 1988, and 2012. The years of 1940-1942 were significant drought years, with a persistent drought stretching over 2-3 years. The moderate drought of 1988 was included as well as 2012, which was a recent high irrigation year, resulting in mandatory restrictions in the Indianapolis metropolitan area.

An analysis of these plots provided useful results. The 1940-1942 plots matched the historical pattern of the drought beginning in the summer/fall of 1940, with the reservoir levels never fully recovering during the spring/ summer of 1941. February 1942 was the lowest level identified, after which the spring rains allowed the

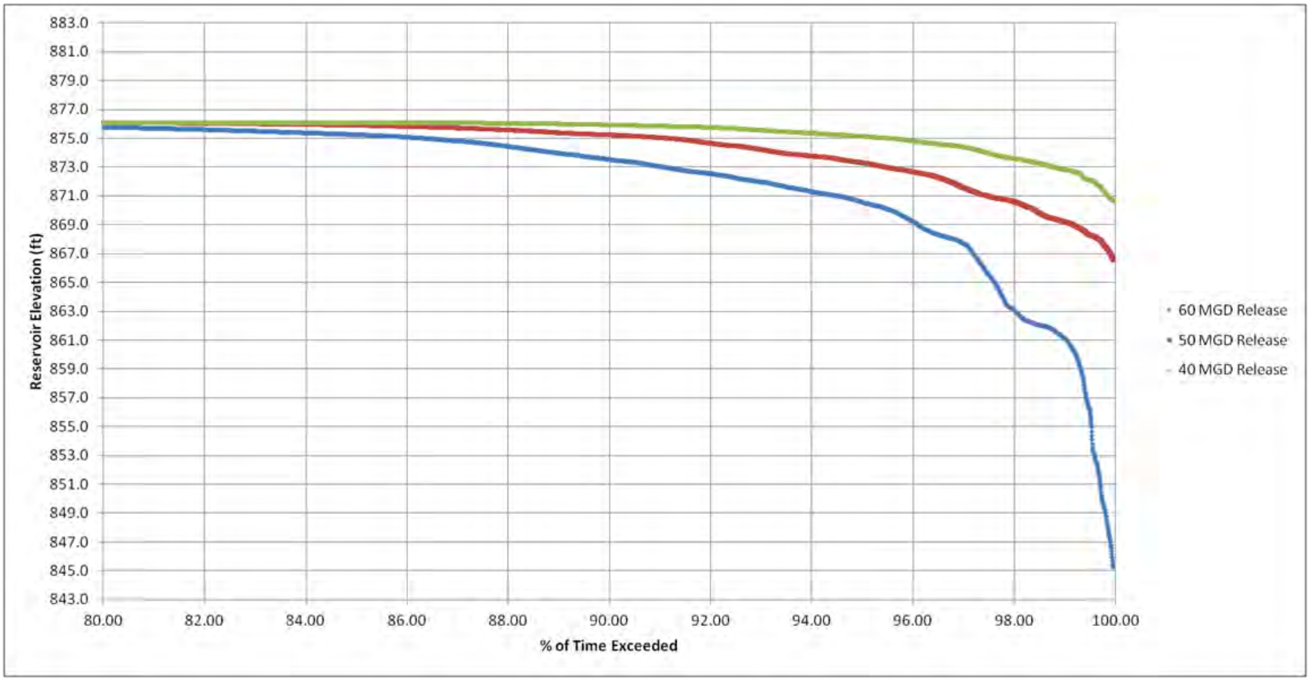


Figure 2.3 Reservoir Levels for Various Withdrawal Rates

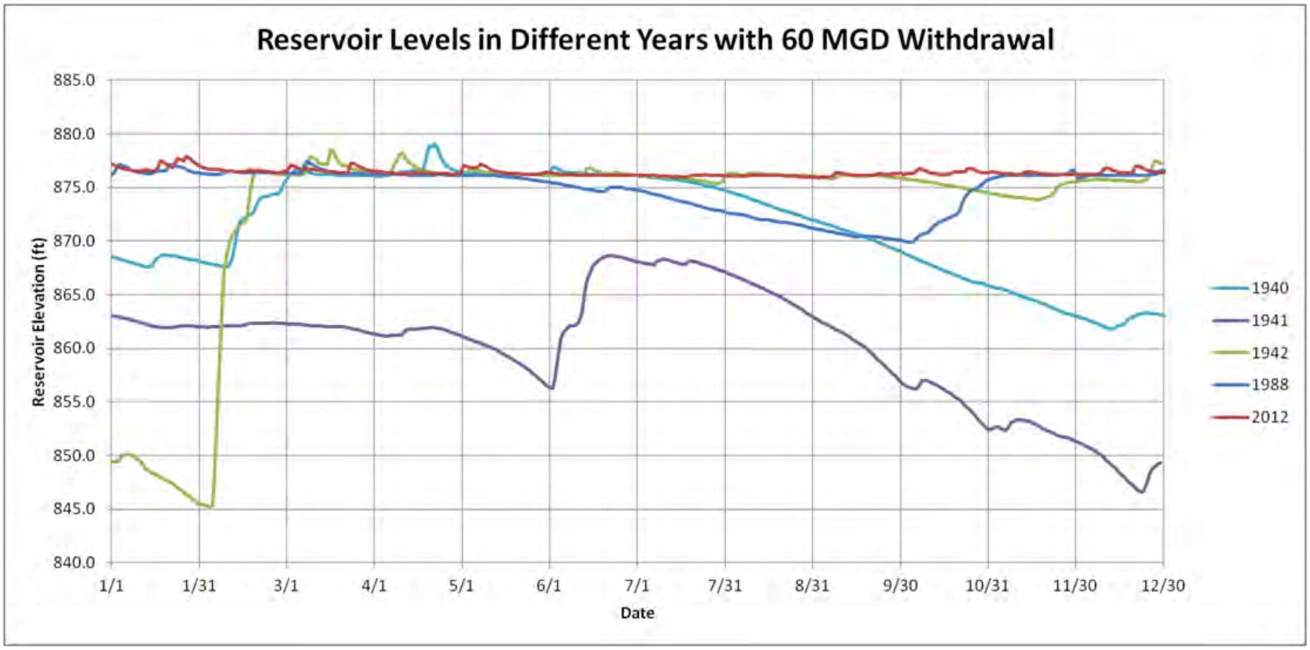


Figure 2.4 Reservoir Levels with 60 MGD Withdrawal Rates

reservoir levels to recover later in the year. Historically, this "back-to-back" drought scenario has not reoccurred. Similar plots for 1988 dropped the level by 6 feet, while the 2012 simulation resulted in a reservoir level drop of 0.2 feet, assuming a 60 MGD withdrawal in the 1988 and 2012 simulations.

Yield Restrictions

The analysis assumes that the yield would be released to the White River at the dam. If the yield were to be withdrawn at the reservoir itself, careful consideration would need to be given to downstream water needs. A minimum flow release rate to the White River would be established in the permitting phase.

SUMMARY

In summary, the reservoir firm yield is 60 MGD with no sedimentation factors and meeting the historical multiyear drought of 1940-1941. This would result in a reservoir level drop of 31 feet. During less severe drought conditions after 1945, the yield of the reservoir increases to 78 MGD. Restricting the water withdrawal rate to 40-50 MGD range resulted in reservoir level decreases of only 5-9 feet even during the worst drought on record. Maintaining withdrawal rates at these lower levels will minimize impacts to the overall reservoir levels and the available yields. This will provide a regional drought preparedness resource in the event of a future major drought event, such as the multiyear drought experienced from 1940-1941.

2. Social, Environmental, Regulatory

Goal: The goal of this section included reviews of a wide range of features related to potential changes to land conditions/uses, water quality, habitat and social issues. A feasibility study level review of existing conditions and potential changes once the reservoir is constructed are examined in this section.

Social, Economic, and Environmental Resource Investigations. To advance this effort, early coordination was performed with all relevant state and federal agencies regarding social, economic, and environmental (SEE) issues. This included the level necessary to allow for more detailed scoping of future phase resource investigations for the project as well as determining the lead agency for future National Environmental Policy Act (NEPA) investigations. This includes evaluating the reservoir's effects on various SEE issues, including land cover, farmlands, wildlife habitat, wetlands, recreation, parks, noise, rights-of-way, relocations, socioeconomic conditions, visual changes, land use, water resources, threatened or endangered species, and temporary construction impacts. In each case, the existing conditions, potential impacts, mitigation, and possible NEPA phase investigations were evaluated. This also included impacts to the storm water system, including county drains within the project area, and the transportation impacts to local roads, bridges and the Anderson Airport.

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Summary: Based upon this review, there are a number of impacts to the social, economic and environmental resources within the project area. Preliminary mitigation requirements for each impacted resource have been identified and initial discussions with regulatory agencies have been conducted. Anticipated future NEPA phase requirements have been identified.

Next Steps: Upon a review of the findings of this report with the affected resource agencies, next steps will include negotiating the mitigation requirements should the project proceed to the NEPA clearance and/or permitting phase as well as further development for the NEPA phase, including the preparation of the EIS.

INTRODUCTION

This section of the report identifies the main Social, Economic, and Environmental (SEE) resources within the project area that may be potentially impacted by the proposed reservoir alternatives. For each SEE resource:

1. Existing conditions are described,
2. Potential impacts are identified,
3. Possible mitigation to consider or which may be required is presented, and
4. NEPA phase investigations required to adequately assess existing conditions and probable impacts are identified.

The existing conditions for each SEE resource were obtained from research through literature sources, site review, aerial photography, mapping, and coordination with relevant agencies. Potential impacts were identified by preliminary resource specific analysis or investigations, agency contacts, professional opinion based on existing data, and/or from outcomes in similar projects. Mitigation for some resources is based on existing regulatory requirements; however, most of the required mitigation will not be known until the project enters the NEPA phase, more detailed investigations are undertaken, and additional coordination occurs with regulatory agencies with jurisdiction. The NEPA phase investigations (e.g., hydrology, traffic, floodplain, etc.) present the likely next steps and investigations/analysis that will be required to conduct an Environmental Impact Statement (EIS) and to obtain NEPA clearance.

AGENCY COORDINATION – PROCESS AND RESULTS

As part of the SEE investigations, early agency coordination letters were mailed to federal, state, and local agencies in March 2014. These letters informed the agencies that the project was underway and requested that they:

1. Identify issues of concern based on their expertise or regulatory jurisdiction,
2. Identify mitigation or permitting requirements that may be necessary for project implementation based on project information presented, and
3. Identify available technical information regarding the various SEE issues.

Agency representatives were also invited to an agency stakeholder meeting that was held in Indianapolis on June 3, 2014. Agencies were encouraged to submit their comments in writing, especially if a representative was not able to be present at the meeting. **Appendix A** contains responses to early coordination requests, the agency stakeholder meeting attendee list, and a summary of the discussion from the agency stakeholder meeting.

BASIN CHARACTERISTICS – PHYSIOGRAPHY, TOPOGRAPHY, GEOLOGY, SOILS AND CLIMATE

Existing Conditions

The West Fork of the White River (WFWR) is part of the Upper White River Watershed. The United States Geological Survey (USGS) subdivides the United States into successively smaller hydrologic units, called hydrologic unit codes (HUC), which are classified into four levels: regions, sub-regions, accounting units, and cataloging units consisting of two to eight digits. The Upper White River Watershed, located in central Indiana, is a HUC 8 watershed (05120201) and consists of 17 smaller HUC 10 subwatersheds. The project area is within the HUC 10 subwatershed Killbuck Creek – White River (Killbuck Creek). The Upper White River watershed drains approximately 2,720 square miles.

The White River basin cuts across various topographic and physiographic regions in Indiana ranging from broad, flat uplands in the upstream portion of the basin, to high hills with uneven ridges and canyon-like gorges, to flat-bottom valleys in the central section, and finally to wide meandering floodplain bottomlands in the lower section. Elevations vary between 500 and 1,500 feet above mean sea level. Topography in this part of the WFWR watershed is a result of continental glaciation during the most recent ice age and has low topographic relief.

The project area is within the eco-region of the Eastern Corn Belt Plains, a generally flat and featureless plain with low gradient streams that were laid down during the Wisconsin glaciations (USGS 1998). The project area lies on the more specific loamy, high lime till plains materials. Eco-regions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources, including abiotic and biotic factors such as geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology (USEPA

2011). The White River Basin can be divided into six regions that have similar characteristics on the basis of geologic, geomorphologic, and hydrologic factors (USGS 2001). Three of the regions, the till plain, glacial lowland, and fluvial deposits, are defined primarily by glacial deposits while the remaining three, the bedrock upland, bedrock lowland and plain, and karst plain, are defined primarily by bedrock geology (USGS 2001).

Soil survey information was obtained from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Web Soil Survey. The soils that are predominant in the project area include: Brookston, Wawaka, Celina, Crosby, Genesee, Fox, Hennepin, Sloan and Miami silt loams, Ross loam, and urban land on the Wawaka-Miami complex (**Figure 2.5**). Slopes are primarily 0 to 2 percent. The till plains are typically covered by 100 to 200 feet of silty-clay till interspersed with thin (5 to 10 feet) layers of sand and gravel and are areas of low topographic relief. The relatively impervious till limits infiltration and promotes surface runoff; tile drains are common in the till plain (USGS 2001). It is estimated that 86,066 acres (63.8%) of the Killbuck Creek-White River subwatershed is potentially tile drained (Tedesco et al. 2011).

Central Indiana is located in a humid-continental climate characterized by well-defined summer and winter seasons, large ranges in annual temperature, and variable weather patterns (Schnoebelen 1999). Average monthly temperatures for the area range from 26 °F to 74 °F. Average monthly precipitation ranges from 2 inches in the winter to 4.28 inches in the summer. Average annual precipitation is about 40 inches and is generally distributed evenly throughout the year. In this portion of the White River basin, mean annual runoff is about 12 inches and expressed as a percentage of mean annual precipitation; mean annual runoff is about 30 percent (Schnoebelen 1999).

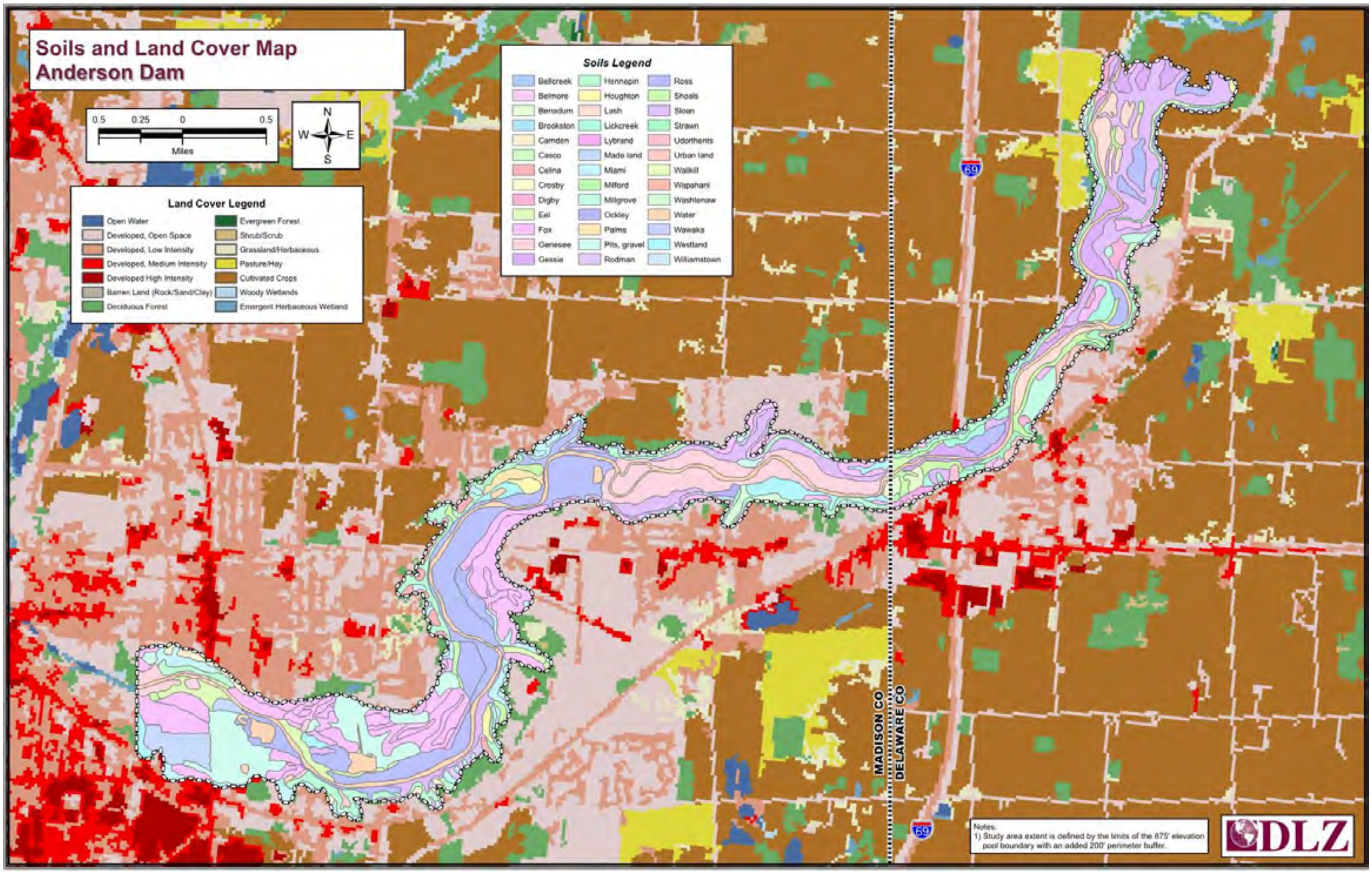


Figure 2.5 Soils and Land Cover Map

Land Cover

Existing Conditions

Land cover types (physical and biological) within the project area include low, medium, and high density development, developed open space, water, woody and emergent herbaceous wetlands, deciduous forest, shrub/ scrub, pasture/hay, grassland, and cultivated crops (**Figure 2.6**). The predominant cover types within the project area include developed open space (29%), deciduous forests (28%), and cultivated crops (20%). Habitat types present in or nearby the project area include agriculture, aquatic systems, urban grasslands, barren lands, developed lands, forest lands, and wetlands. Forest lands and wetlands are primarily concentrated along the WFWR throughout the project area.

Wetlands buffer 8.5 miles of stream in the Killbuck Creek-White River sub-watershed and account for the highest percentage of wetland cover, more than any other sub-watershed in the Upper White River (average is 0.09%) (Tedesco et al. 2011).

Over 150 acres of land have been set aside through the Conservation Reserve Program (CREP) in the Killbuck Creek subwatershed (Tedesco et al. 2011). The most common CREP conservation practices implemented have been filter strips, bottomland trees establishment, and riparian forest buffers.

Potential Impacts

The amount of open water cover will increase within the Killbuck Creek sub-watershed, impacting agricultural, herbaceous, forest, urban, and wetland land covers. The agricultural land cover will also likely further decrease as those areas with drain tiles are reverted back to wetland for water quality improvement purposes (as a result of project activities) and for potential wetland mitigation. The type of wetland cover will also change (see discussion in Wetlands section). Much of the project area lies within

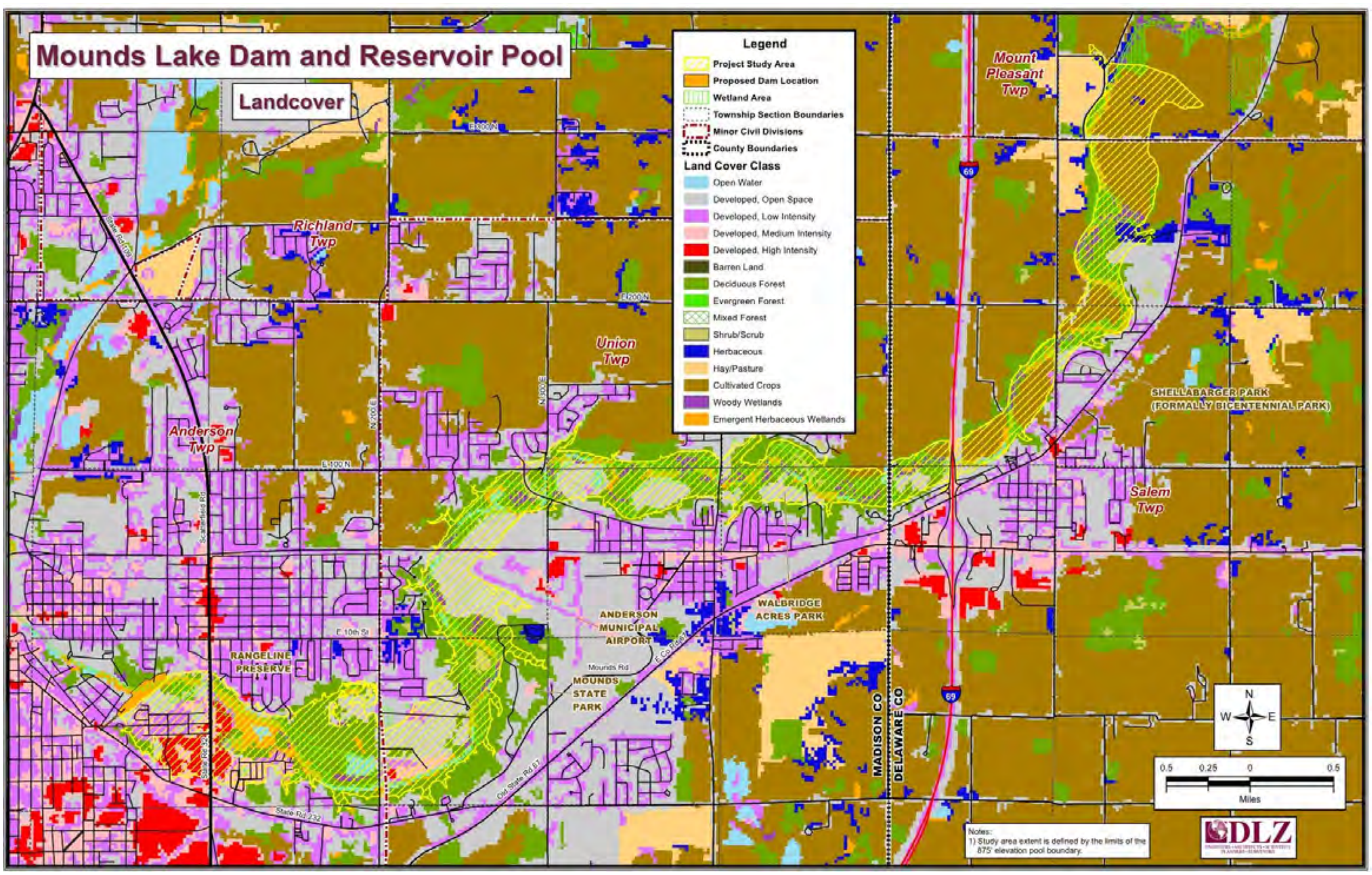


Figure 2.6 Land Cover Map

those areas being zoned for conservation areas. CREP practices could be continued and new ones implemented as water quality improvements for the project. Of the 614 acres of urban land cover within the project area, 201 acres, in the categories of low to high density urban development, will be inundated.

Mitigation

Mitigation for wetlands and farmlands are discussed in more detail in sections to follow. Forest cover, as it relates to wildlife habitat, is discussed in that section of the report.

NEPA Phase Investigations

Potential NEPA phase investigations for wetlands, farmlands, and forests are discussed in more detail in sections to follow.

FARMLANDS

Existing Conditions

The project area is within the ecoregion of the Eastern Corn Belt Plains, more specifically the loamy, high lime till plains. The most intensively farmed regions in the White River Basin are the till plain, glacial lowland, and fluvial deposits.

Land that has the best combination of physical and chemical characteristics for the production of crops is considered Prime Farmland. This land has the soil quality, growing season, and moisture supply needed to produce sustained high yields of crops when treated and managed. The project area lies within prime farmland with the following soil complexes: Houghton-Adrian-Carlisle, Fox-Ockley-Westland, Crosby-Treaty-Miami and Miami-Crosby -Treaty (**Figure 2.7**).

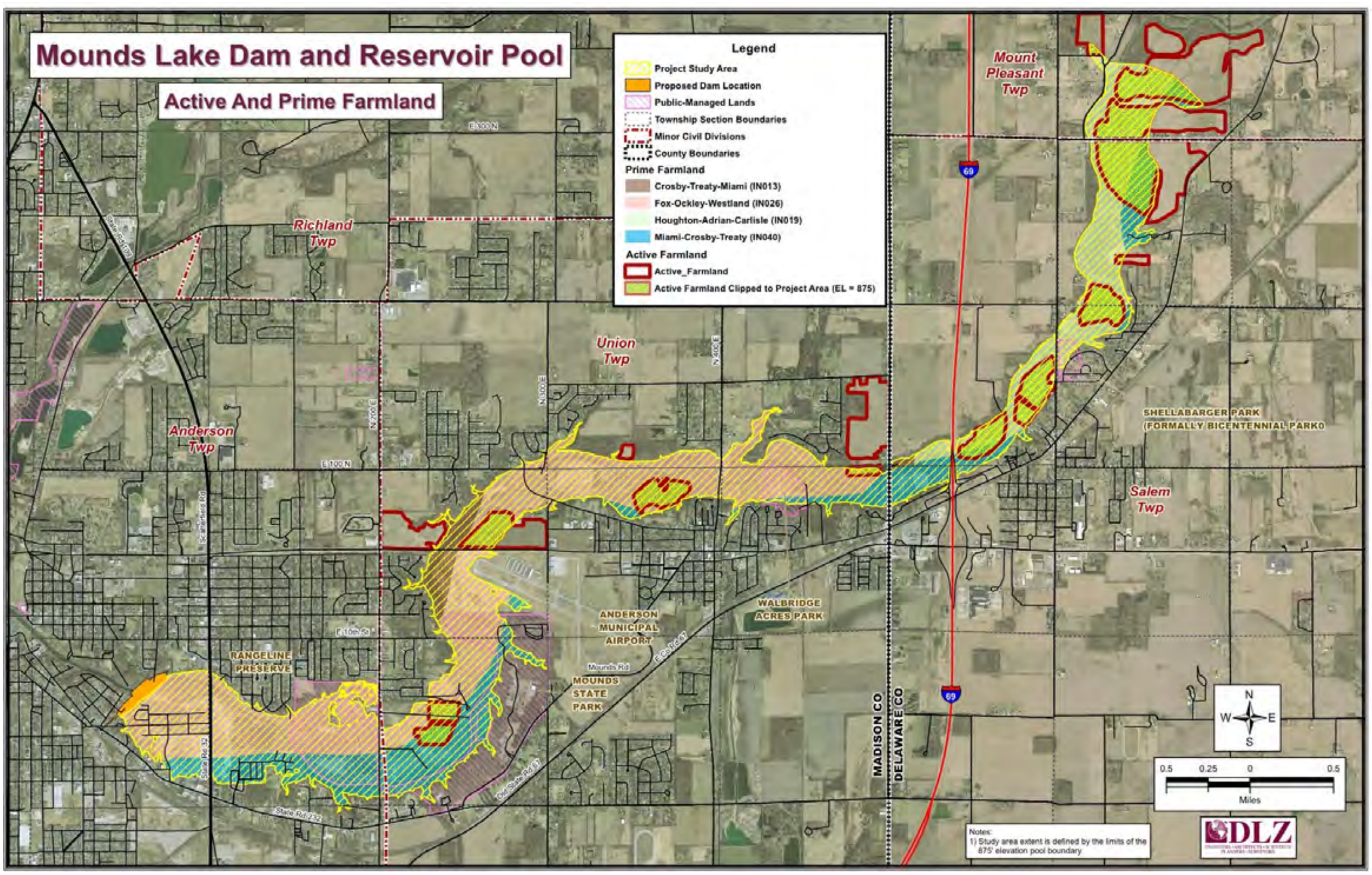


Figure 2.7 Prime and Active Farmland

Potential Impacts

The potential impacts of the reservoir pool to active farmlands are depicted in **Figure 2.7**. Approximately 1,900 acres of prime farmland soils are located within the project area. Approximately 330 acres of active farmland could be impacted within the proposed project area, all of which are located on prime farmland soils.

Mitigation

Although no formal mitigation is anticipated, farmers impacted by these changes would be compensated for their land following state and federal applicable policies and laws.

NEPA Phase Investigations

This project would have to comply with the Farmland Protection Policy Act (FPPA), 7 U.S.C. 4201, since it involves a federal action. Congress enacted the FPPA as a subtitle of the 1981 Farm Bill. The purpose of the law is to minimize the loss of prime farmland and unique farmlands as a result of federal actions by converting these lands to non-agricultural uses. The FPPA also stipulates that federal programs be compatible with state, local, and private efforts to protect farmland. For the purposes of the law, federal programs include construction projects - such as highways, airports, dams and buildings—sponsored or financed in whole or part by the federal government, and the management of federal lands. The NRCS is charged with oversight of the FPPA.

The NRCS uses a land evaluation and site assessment (LESA) system to establish a farmland conversion impact rating score on proposed sites of federally funded and assisted projects. The assessment is completed via Form AD-1006, Farmland Conversion Impact Rating. This score is used as an indicator for the project sponsor to consider alternative sites if the potential adverse impacts on the farmland exceed the recommended allowable level. FPPA does not, however, require federal agencies to alter projects to avoid or minimize farmland conversion. Contacting and coordinating with the local office of the NRCS or USDA Service Center and filling out form AD-1006 is required during the NEPA phase.

Wildlife Habitat

Existing Conditions

The stretch of the WFWR along the project area is predominately bordered by a wooded buffer consisting of mature hardwood trees and shrubs. Habitat for migratory birds may be present which includes stream corridors and wetlands. There are several bald eagle nests along the WFWR, but no nests are present within the project area at this time (USFWS 2014b).

A mesic upland forest is present at Mounds State Park, designated by IDNR as a high quality natural area. Mesic upland forests are found throughout the state, but are most common in hilly regions where slopes are protected from excessive evaporation and fire. Sugar maple, American beech, red oak, and basswood are the typical dominant trees in a mesic upland forest with an understory of shade-tolerant species. A variety of common amphibians, reptiles, mammals, and birds are commonly found in this community type.

The Central Indiana Land Trust (CILTI) is a non-profit organization that has been working on a regional green infrastructure project to identify key areas to target for conservation. A green infrastructure network can be used as a skeleton to guide growth and development decisions, as well as land protection initiatives. Five habitat types and six species served as the basis for the project. The five studied habitat types were forested wetland, emergent wetland, aquatics, glaciated forest, and unglaciated forest. These areas were chosen because of the needs of key species to survive. Within each of these habitat types, specific species were the focus. The six species were Indiana bat (Myotis sodalis), king rail (Rallus elegans), river otter (Lontra canadensis), mussels, wood thrush (Hylocichla mustelina), and ovenbird (Seiurus aurocapillus). Within the Killbuck Creek subwatershed, the WFWR near Chesterfield has been identified as a green infrastructure network (see Figure 5.24 in Tedesco et al. 2011).

Potential Impacts

The actual extent of project impacts will not be known until detailed resource investigations are performed; however, based on GIS forest cover mapping estimates, approximately 405 acres of deciduous forest and 12 acres of wooded wetlands could potentially be impacted. The creation of the reservoir will also have benefits to various wildlife species, providing opportunities for species that utilize open water and the bay or cove areas likely to form by creation of the reservoir. Aquatic and semi-aquatic wildlife would benefit most from this new habitat.

Mitigation

IDNR-Division of Fish & Wildlife (2014b) stated in a letter that "It is not clear what types of mitigation could be performed to address the wide range of impacts …" but that "mitigation should focus on restoring in-kind resources". The Natural Resources Commission (NRC) Information Bulletin (IB) No. 17 (NRC 2012) states that "the level of mitigation for removing trees from a non-wetland, riparian area depends on the size of the area impacted, the number and size of trees being removed, and the type and quality of the overall habitat being impacted." Projects that remove at least one acre of non-wetland trees from riparian area would typically result in a minimum mitigation ratio of 2:1 (NRC 2012). Types of mitigation could include riparian restoration or augmenting existing buffers. In early successional habitats, the mitigation ratio is typically 1:1, and a native herbaceous riparian seed mixture including native woody species, if present, is planted (NRC 2012). Forested wetlands are mitigated at a 4:1 ratio (see full discussion in Wetlands section). Mitigation in the form of planting of trees, shrubs, and herbaceous vegetation is likely, with the primary focus areas for plantings being located along the reservoir and in upstream locations or along other small watercourses within the watershed.

NEPA Phase Investigations

USFWS requested that extensive wildlife surveys be conducted during the future phases, including habitat assessments, avian surveys, and stream surveys. Conducting surveys for wildlife is being recommended by IDNR-DFW to determine the extent of the fauna in the project area.

WETLANDS

Existing Conditions

The wetlands within the project area are located primarily adjacent to the WFWR. Lacustrine, palustrine emergent, farmed, scrub-shrub, freshwater ponds, and riverine wetland types are present. Wetland information was obtained from U.S. Fish & Wildlife Service (USFWS) National Wetland Inventory (NWI) maps, which are not considered to be completely accurate and should not be relied upon to make determinations of wetland locations, presence, size, or type without field verification. NWI information also does not provide information about the quality of the wetlands.

Potential Impacts

Creation of the reservoir will inundate a number of wetlands along and near the WFWR. A summary of potential wetland impacts is presented below in **Table 2.1**.

Wetland Type	Approximate Acres*	Mitigation Ratio
Palustrine Emergent	53	2:1
Palustrine Forested	344	4:1
Palustrine Scrub-Shrub	11	3:1
Freshwater Pond	46	2:1
Riverine	151	2:1

**Based on NWI mapping*

Table 2.1 Potential Wetland Impacts by Type

Avoidance of these wetland impacts is not feasible if the reservoir is created, since many of the wetlands are within the floodplain of the river. A wetland fen is documented in the Mounds Fen Nature Preserve. There is no way to avoid impacting the fen because the Nature Preserve sits at a land elevation of 855 feet, approximately 20 feet below the proposed water surface of the reservoir. The construction of the reservoir will create new wetlands at the mouth of the various small tributaries that enter the reservoir and a large wetland is planned at the headwaters waters of the reservoir to act as a sink to trap nutrients and sediment before they enter the open water area of the reservoir.

Mitigation

Per U.S. Army Corps of Engineers (USACE) regulations, wetland mitigation is needed for impacts of 0.1 acre or greater. Guidance on mitigation ratios and plans is provided in NRC-IB No. 17 (NRC 2012); wetland types and typical ratios are summarized in **Table 2.1**. Mitigation areas to be considered will focus on those with soils that are classified as hydric and that may be tile drained. Restoring wetlands on these soils (provided wetland hydrology is present) will improve water quality in areas of known high contribution of nutrients and other dissolved loads.

NEPA Phase Investigations

Field verification of wetland location, boundaries, classification, and quality within the project area and impacts would need to be made in the next phase of the project. A review of functions and values of impacted wetlands would also be performed to ensure that mitigation replaces these functions and values to the extent possible. Wetlands and potential impacts would be identified via wetland delineations per USACE and IDEM guidelines. Mitigation requirements would be verified via coordination with USACE and IDEM.

RECREATION

Existing Conditions

Five parks are located within the project area (see **Figure 2.8**). These parks include:

- Mounds State Park – Located on the southern shore of the WFWR at 4306 Mounds Road (Madison County). Established in 1930, Mounds State Park contains 10 unique earthworks built by prehistoric Indians known as the Adena-Hopewell people. The largest earthwork, the Great Mound, is believed to have been constructed around 160 B.C. Archaeological surveys indicate the mounds were used as gathering places for religious ceremonies from where astronomical alignments could be viewed (see Cultural Resources section for additional information). The park also includes the homestead of the Bronnenberg family, circa 1840. The Mounds Fen Nature Preserve, which was designated as a recognized preserve in the 1980s and is managed by Indiana State Parks and Reservoirs, is also located within the Mounds State Park. Additional information about Mounds State Park can be found at http://www.in.gov/dnr/parklake/2977.htm.
- Walbridge Acres Park –In 1890, the State Spiritualist Association purchased 30 acres of land north of Chesterfield for a campground. This park is now

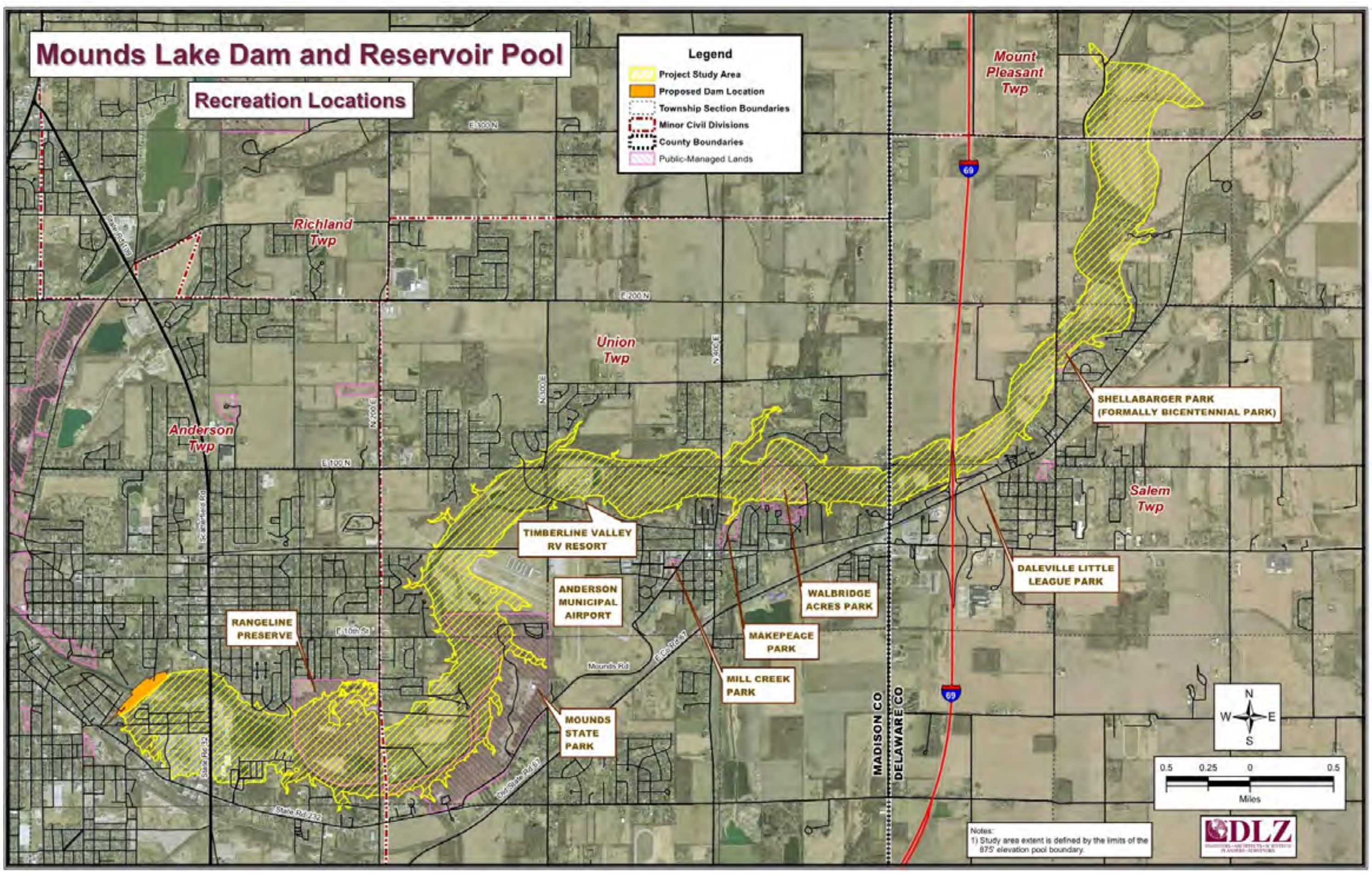


Figure 2.8 Recreational Areas

named Walbridge Acres Park and is located off SR 32 in Chesterfield (Madison County). The park features several baseball diamonds and has an active Little League program.

- Rangeline Preserve – Located at the former Vulcan Materials gravel pit on the northern shore of the WFWR at 1200 S. Rangeline Road (Madison County). The 180 acre nature area includes a range of vegetation, topography, and water amenities and has several mountain bike trails.
- Makepeace Park – Located in Union Township (Madison County) off SR 32 and is part of the Chesterfield Parks system. The park contains ball diamonds and a basketball court.
- Shellabarger (formally Bicentennial) Park – Located north of Daleville (Delaware County) off of West Hilltop Circle adjacent to a residential neighborhood. The park contains a playground.

The 80-acre Timberline Valley RV Resort is also present within the project boundaries; it is located off North Street just east of Airport Road in Union Township. Canoe liveries offer trips on the WFWR above, within, and below the proposed reservoir. Other boating opportunities on the WFWR are limited.

Potential Impacts

Significant land acquisition impacts will occur to all five existing parks (see **Figure 2.8**) and at the RV Park as a result of the reservoir pool (inundation). The majority of Rangeline Preserve and Walbridge Acres Park would be inundated. Mounds State Park, Makepeace Park, and Shellabarger Park would be at least partially inundated. All of the Mounds Fen Nature Preserve and Timberline Valley RV Resort would be inundated. Modification to the two impacted canoe liveries would be necessary to continue operations at their current locations.

It is anticipated that significant recreational opportunities will exist on the proposed reservoir, including boating, fishing, bird watching and trail access. Public access to the newly created lake and new recreational opportunities will be considered, including trails around the lake, relocating the Rangeline Nature Preserve to the north for mountain biking, and a hiking trail that would be connected at Shadyside Park.

Mitigation

Impacts to the local parks would likely be mitigated by creating new parks of similar size and with the same activities along the reservoir. The acquisition of park property in which Land and Water Conservation Funds (LWCF) were used would need to be mitigated with an equal or greater sized parcel of property. The value of the acreage would need to be taken into account so that the replacement value would be equal to or greater than the current value of the property. See the Land and Water Conservation Fund section below for mitigation requirements for those parks that received LWCF grants.

NEPA Phase Investigations

Coordination with the various local, county, and state park representatives will be necessary. An assessment of the level of impacts to the recreational areas and investigation of potential mitigation sites will be required as part of this coordination.

Land and Water Conservation Fund Act (Section 6[F][3] Lands)

Existing Conditions

The Land and Water Conservation Fund Act establishes funding to assist local, state, and federal agencies in meeting the demand for present and future outdoor recreation sites. This is done through grants for land acquisition, park amenities, and other park development costs. A search on the NPS database and correspondence with IDNR, Division of Outdoor Recreation, has identified four parks within the project area that have received LWCF funding.

Potential Impacts

Mounds State Park has received several LWCF grants for various developments within the park that encumbers the park with Section 6(f) protection (pers. comm. Bronson 2014). The Delaware County Bicentennial Park (now known as Shellabarger Park) received funding in 1976. The Walbridge Acres Park received a grant to develop baseball fields, restrooms, tennis courts, an archery range, and canoe launch in 1985. The Anderson Riverwalk received funding for an extension and is located west of State Road 32.

Mitigation

Section 6(f)(3) of the LWCF Act contains provisions to protect Federal investments and the quality of assisted resources. Provisions of Section 6(f)(3) state that "no property acquired or developed with assistance under this section shall, without the approval of the Secretary, be converted to other than public outdoor recreation uses. The Secretary shall approve such conversion only if he finds it to be in accord with the then existing comprehensive statewide outdoor recreation plan and only upon such conditions as he deems necessary to assure the substitution of other recreation properties of at least equal fair market value and of reasonably equivalent usefulness and location". If Section 6(f) funds have been used, the land or park appurtenances cannot be eliminated or acquired without coordination with the NPS and mitigation that replaces the eliminated items. The mitigation must be at least at a ratio of 1:1, for both quality (reasonably equivalent usefulness and location) and quantity. Suitable properties will exist to provide this mitigation.

NEPA Phase Investigations

A letter was sent to the National Park Service (NPS) during this phase of the project but a response has not been received. It is recommended that additional contact with the NPS and IDNR State Parks grant coordinator during the next phase of the project as part of the early coordination efforts will help to coordinate mitigation requirements. Properties that are deemed to meet these requirements will be proposed for consideration by these agencies.

LAND USE

Existing Resource

The predominant land cover types within the project area include developed open space (29%), deciduous forests (28%), and cultivated crops (20%). Projections of future land use east of Anderson show increases in residential land and conservation areas replacing current agricultural land (see Figure 5.11 in Tedesco et al. 2011). Currently there are five parks located along the river corridor. There are transportation improvements being planned along with the increase in residential use and commercial growth planned along major roadways (Tedesco et al. 2011).

Potential Impacts

The proposed project is not anticipated to impact the land use surrounding the project area that is currently residential or commercial. There is likely to be a change to agricultural land. The recreational use associated with the river would be repurposed to reservoir-based recreational activities. It is anticipated that an authority would be created to regulate and protect the new lake shore. As a part of the lake authority, new recreational uses would be proposed along the lakeshore, the details of which are not currently known. The unique resource the reservoir will provide for recreation is likely to induce new types of commercial businesses.

Mitigation

See the 6(f) section for proposed mitigation measures regarding recreational/park impacts.

NEPA Phase Investigations

During the NEPA phase, more detailed investigation would be conducted to determine potential land uses being impacted and located along the lake shore.

FLOODPLAINS

Existing Resource

The existing WFWR floodplain has been determined by FEMA and is shown on **Figure 2.9**. Extensive portions of the project area fall within the 100-year floodway or 100-year floodplain.

Potential Impacts

The majority of the existing 100-year floodplain associated with the WFWR would be inundated by the proposed project. A new 100-year floodplain would be created as part of the proposed project. This would likely result in approximately a five percent reduction in the 100-year peak flow downstream with the uncontrolled spillway as a result of the storage effects associated with the pool. If a gated spillway structure were to be used, with flood control as a specific operational objective, there would likely be significant reductions in the 100-year peak flow downstream.

NEPA Phase Investigations

During the EIS, a more detailed hydrology and hydraulic study would be conducted once the dam alternatives have been clearly defined and to determine the optimum gate

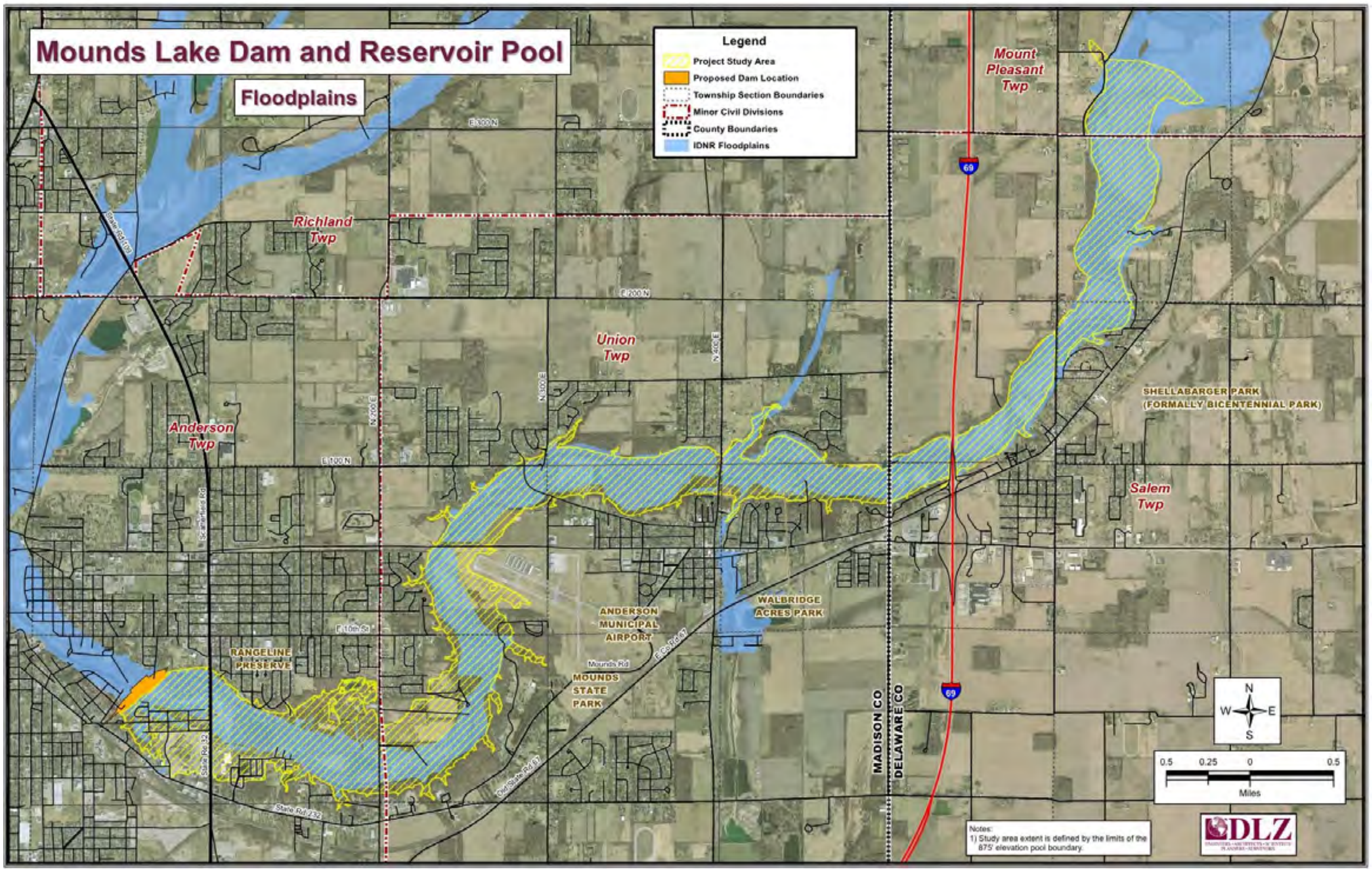


Figure 2.9 Floodplains

operations. A determination of the new floodplain and amendments to Flood Insurance Rate Maps prepared by the Federal Emergency Management Agency (FEMA) would be completed.

Aquatic Resources

Existing Conditions

The WFWR within the project area is a meandering watercourse that is relatively undisturbed. It has what would be considered a normal channel width that does not appear to be significantly impacted by the development within the watershed. Much of the riparian area includes hillsides that are vegetated, often by large trees that provide shading and detritus into the river. The Muncie Bureau of Water Quality has evaluated stream habitat quality at a site near W 300 S Street using the Qualitative Habitat Evaluation Index (QHEI). The site is located in the northern portion of the proposed reservoir. The QHEI is a physical habitat index that scores various attributes of the in-stream habitat and the surrounding land which provides an indication of the stream's ability to support fish and macroinvertebrate communities (OEPA 2006, see IDEM 2006 for specifics on calculating the index). The maximum possible QHEI score is 100 and represents undisturbed habitats. The site was given a QHEI score of 68, which is classified as good. Sites with stream reaches having QHEI scores greater than 60 are generally expected to sustain fish and macroinvertebrate communities, indicative of Warm Water Habitats (WWH).

Fish

The WFWR varies in width and depth through the project area. The diversity of habitat in the river enhances the diverse fishery; a fairly intact forested riparian corridor, scattered wetland assemblages, pool-riffle sequences, and undercut banks are among those habitat features. IDNR has sampled portions of the White River upstream of Indianapolis. The primary purpose was to evaluate the recovery of the fishery following a fish kill in 1999 caused by a chemical spill that is thought to have virtually eliminated all aquatic life for nearly 50 miles. Surveys by IDNR in the fall of 2011 between Anderson and Indianapolis collected over 7,000 fish from 57 species. Two of the sites surveyed are control sites, one of which is located at Mounds State Park. At the Mounds Lake site, the common game fish include largemouth (Micropterus salmoides), smallmouth (M. dolomieu), and spotted bass (M. punctulatus), rock bass (Ambloplites rupestris), and a variety of sunfish (Lepomis spp.). Other common fish species include shiners (Notropis spp.), northern hogsucker (Hypentelium nigricans), central stoneroller (Campostoma anomalum), bluntnose minnow (Pimephales notatus), darters (Etheostoma spp.), mottled sculpin (Cottus bairdii), and black redhorse (Moxostoma duquesni) (IDNR 2012). A copy of the survey results can be found in **Appendix A.**

A previous survey by IDNR taken further upstream included portions of the upper area of the reservoir and upstream of the fish kill. The most common fish in this area included carp (Cyprinus carpio), longear sunfish (Lepomis megalotis) and various other sunfish, suckers (Catastomidae family), minnows (Cyprinidae family), white crappie (Pomoxis annularis), and largemouth bass.

Fisheries surveys taken by Muncie Bureau of Water Quality in the river near W 300 S Street resulted in capture of black crappie (P. nigromaculatus), black redhorse, blackside darter (Percina maculata), sunfish species including bluegill (L. macrochirus), bluntnose minnow, brook silverside (Labidesthes sicculus), central stoneroller, golden redhorse (M. erythrurum), grass pickerel (Esox americanus), darters species, largemouth bass, logperch (Percina caprodes), mottled sculpin, northern hog sucker, rock bass, and several shiners. Survey locations and information, including bottom substrate maps, can be found at their website http://www.munciesanitary.org/clientuploads/biologymapweb/index.html.

Benthic Community

Benthic macroinvertebrates are bottom dwelling aquatic invertebrates that serve as an important forage base for fish and other fauna. They also serve as good indicators of the health of our waters. This is because they live in the water for all or most of their life cycle, differ in their tolerance to amount and types of pollution, have limited mobility, and are indicators of environmental condition (EPA 2007). Organisms such as some mollusks, mayflies, stoneflies, and caddisflies are pollution-sensitive organisms and act as indicators of the absence of pollutants. Pollution-tolerant organisms, such as midges and worms, are less susceptible to changes in physical and chemical parameters in a stream and are an indirect measure of pollution.

Benthic invertebrate surveys are taken by Muncie Bureau of Water Quality in the river near the upper extent of the project area at W 300 S Street. Several mayfly, stonefly, and caddisfly species were found at this sampling location (see **Appendix A** for species list), along with a variety of other aquatic invertebrate species such as water striders, dragonflies, amphipods, and copepods. See Muncie site for benthic data at http://www.munciesanitary.org/clientuploads/biologymapweb/index.html.

Potential Impacts

The project will convert approximately seven miles of riverine habitat into a lake habitat. Some of the fish species found in the WFWR would adapt to the lacustrine (lake) habitat, including largemouth bass, sunfish species, crappie, grass pickerel, carp, and golden redhorse. Other riverine species, such as the darters, some minnows, central stoneroller, black redhorse, and suckers, are adapted to fast moving currents and cobble/gravel substrates for feeding and spawning. The habitat for these species would still be present above and below the reservoir. Movement of fish within the river would likely be blocked by the dam and the large area of the reservoir.

Many of the benthic macroinvertebrates found in the river would be able to adapt to the new habitat type since they do not have a narrow habitat requirement and can inhabit either lotic (moving) or lentic (still) environments. For species adapted to only lotic habitats (e.g. caddisflies, stoneflies) significant impacts would not be expected as populations of these species likely already exist in downstream and upstream sections of the river.

Mitigation

It is not known at this time what mitigation measures would be required by federal and state agencies. Additional coordination with USEPA, USFWS, IDEM and IDNR will be necessary to make this determination.

NEPA Phase Investigations

USFWS requested that extensive wildlife surveys be conducted, including habitat assessments and stream surveys. Additional surveys will need to be performed prior to any project work taking place to determine species presence within the river segment of the proposed project. The survey plans will need to be reviewed by USFWS and IDNR prior to final plan being implemented. An investigation of the need for fish passage past the dam and fish passage options will also be explored.

Threatened and/or Endangered Species

Existing Resource

During Phase I, a request was made to the Indiana Natural Heritage Data Center for information on the endangered, threatened, or rare species documented within the project area. At that time no specific project area boundaries were provided. During the current phase, this information was collected directly from federal and state resource agencies. No known state or federally endangered or threatened species are present in the immediate project area (IDNR 2014). However, several species were identified as being potentially present and are discussed below.

Mollusks

No federally listed mollusks have been documented within the project area; however, their presence cannot be ruled out due to the presence of suitable habitat (USFWS 2014). The clubshell (Pleurobema clava) and the Northern riffleshell (Epioblasma torulosa rangiana), both federally endangered, have been collected as weathered-dead (shells of dead mollusks that have been in the river for an extended time period and show signs of weathering) within this reach of the river (IDEM 2011) (**Appendix A**). Surveys were performed by IDNR biologists at two locations within the project reach, a station at Mounds State Park and a station at the Delaware/Madison County line. Only two live species and two fresh dead species were found at these locations. Several state species listed as endangered or special concern could potentially be within the project boundaries including sheepnose (Plethobasus cyphyus), rabbitsfoot (Quadrula cylindrica cylindrica), kidneyshell (Ptychobranchus fasciolaris), and purple lilliput (Toxolasma lividus).

Bats

Both the federally endangered Indiana bat (Myotis sodalis) and the proposed endangered Northern long-eared bat (NLEB, M. septentrionalis) have ranges that include the project area. Although no records of the bats exist near the project area, suitable summer habitat (wooded stream corridors and bottomland and upland forests and woods) is present within the project area for these species (USFWS 2014).

Typical characteristics for summer maternity colony or primary roost trees for Indiana bats include trees that have peeling or exfoliating bark. Primary roosts usually are in trees that are in early to mid-stages of decay. Average diameter of roost trees is 13 inches but can be as small as 6-8 inches. Primary roost trees usually receive direct sunlight for more than half the day. Roost trees are typically within canopy gaps in a forest, fence lines, or along a wooded edge or within 50 feet of a forest edge (USFWS 2007).

During summer, NLEBs roost singly or in colonies underneath bark, in cavities, or in crevices of both live and dead trees (as small as 3 inches in diameter). Males and non-reproductive females may also roost in cooler places, like caves and mines. NLEBs appear to be opportunistic in selecting roosts, using tree species based on suitability to retain bark or provide cavities or crevices. Occasionally, they have been found roosting in structures like bat houses, barns, and sheds. Isolated trees are considered suitable habitat when they exhibit the characteristics of a suitable roost tree and are less than 1000 feet from the next nearest suitable roost tree within a woodlot or wooded fencerow (USFWS 2014a).

Birds

The loggerhead shrike (Lanius ludovicianus) is a state endangered species that may potentially be present within the project area. This bird inhabits open country areas with short vegetation and well-spaced shrubs or low trees, particularly those with spines or thorns. They frequent agricultural fields, pastures, old orchards, riparian areas, golf courses, and cemeteries and are often seen along mowed roadsides with access to fence lines and utility poles (Cornell Lab of Ornithology 2014).

Dragonflies

Of the state listed species, three dragonflies are potentially within the project area; all three can be found at Mounds State Park within the Mounds Fen Nature Preserve (IDNR 2011). These species include the endangered brown spiketail (Cordulegaster bilineata) and the rare clamp-tipped emerald (Somatochlora tenebrosa) and gray petaltail (Tachopteryx thoreyi). See **Table 2.2**.

Species	Common Name	Status	Preferred Habitat	Habit
Cordulegaster bilineata	Brown Spiketail	Endangered	Lotic- depositional, sandy & silt (seeps)	Burrowers
Somatochlora tene-brosa	Clamp-tipped Emerald	Rare	Lentic-littoral (bogs); lotic–depositional (springs)	Sprawlers
Tachopteryx thoreyi	Gray Petaltail	Rare	Lotic-depositional; lentic-littoral (bogs)	Sprawlers

Table 2.2 State Listed Dragonfly Species Potentially Within Project Area

Plants

The remaining state listed species are plant species, and a plant survey would need to be performed to determine if they are present in the project area. Rare plants associated with Mounds Fen Nature Preserve include the state rare tufted hairgrass (Deschampsia cespitosa) and shining ladies'-tresses (Spiranthes lucida). Species on the state watch list include the butternut (Juglans cinerea) and meadow spike-moss (Selaginella apoda).

High Quality Areas

A wetland fen is documented in the Mounds Fen Nature Preserve (a list of plant species present in the fen can be found in the Mounds State Park Interpretative Master Plan, IDNR 2011) and is discussed in further detail in the Wetlands section. A mesic upland forest is also present at Mounds State Park and is discussed in further detail in Wildlife Habitat section.

Potential Impacts

The negative effects of river impoundments on mussels have been documented (Vaughn and Taylor 1999, Watters 1996 and 1998) and include impeding distribution because of water quality changes and interference with host movements and migrations. Impacts to Indiana bat and NLEB would not be expected to be significant if they are found within the project area as much of their preferred habitat is available only for a short period of time (until the bark falls off dying trees or the snag falls). The flooding of the existing riparian forest is likely to provide an abundance of new habitat trees in the years after the project is completed as these trees succumb to the flooding. Impacts to the loggerhead shrike are not expected as their preferred habitat is much more abundant outside of the project area than within.

The flooding of the Mounds Fen Nature Preserve would eliminate the habitat for some of the listed dragonfly and plant species and inundate the entire wetland fen. A portion of the mesic upland forest would also be inundated.

Mitigation

It is not known at this time what mitigation measures would be required for listed species. Additional coordination with USEPA, USFWS, IDEM and IDNR will be necessary to make this determination.

NEPA Phase Investigations

Section 7 of the Endangered Species Act (ESA) directs all Federal agencies to work to conserve endangered and threatened species and to use their authorities to further the purposes of the Act. The Act ensures that Federal agency actions, including those they fund or authorize (includes permitting), do not jeopardize the existence of any listed species (USFWS 2014). During the NEPA phase of the project, consultation with the USFWS will take place to determine what species are present in the project area and what effect the proposed action may have on those species.

Extensive aquatic and terrestrial surveys for wildlife are being recommended by USFWS and IDNR-DFW. During the NEPA phase avian surveys and plant surveys will need to be performed to confirm species presence. Habitat assessments, including forest cover, river quality assessments (QHEI), and fisheries surveys, would likely be conducted. Additional mussel surveys may be performed to determine species present within the river segment of the proposed project. The mussel survey plan will need to be reviewed by USFWS and IDNR prior to final plan being implemented. No known surveys for bats have been performed in the project area and will be required. Surveys for the bat species would be performed according the most current protocols of USFWS. Significant aquatic and terrestrial surveys have been requested by USFWS and IDNR-DFW to determine the faunal extent within the project area.

Surface Water and Water Quality

Existing Resource

The White River Basin is part of the Mississippi River system and drains 11,350 square miles of central and southern Indiana. Major streams of the basin include the East Fork of the White River, WFWR, Eel River, and an extensive network of tributary streams and ditches. The White River basin enters the Wabash River, then the Ohio and Mississippi Rivers, and eventually reaches the Gulf of Mexico. Stream flow variation is seasonal and moderate (highest in spring and lowest in late summer and fall).

The WFWR originates in Randolph County and travels westward through Indianapolis and converges with the East Fork of the White River. The WFWR drainage area at Anderson (USGS gage station #03348000; RM 293.27) is 406 square miles. This portion of the WFWR is located within the Killbuck Creek-White River subwatershed (HUC: 0512020103). Within the project area 10 regulated drains converge with the river – East Anderson Drain, Mary A. Cromer Ditch, Chesterfield Drain, James M. Donnely Ditch, Ollie Pittsford Drain, Henry Bronnenberg Ditch, Turkey Creek, Laura Heath Drain, Pate Shoemaker Drain, and Dona Van Ditch (**Figure 2.10**). Other smaller drains will potentially connect to the reservoir once it reaches its design elevation.

Flows in the WFWR are typically the greatest during spring rains and snowmelt and lowest in the late summer and early fall. Flood stage is ten feet at the Anderson gage; the highest recorded peak stage was 26.3 feet in March 1913 (USGS 2011). At least 17 flooding events have occurred in the City of Anderson since 2000; flooding in the streets occurs at a flood stage of 12 feet.

The Clean Water Act (CWA) and U.S. Environmental Protection Agency (USEPA) regulations require that states develop Total Maximum Daily Loads (TMDL) for all waters on the Section 303(d) lists. A TMDL is the sum of the allowable amount of a single pollutant that a water body

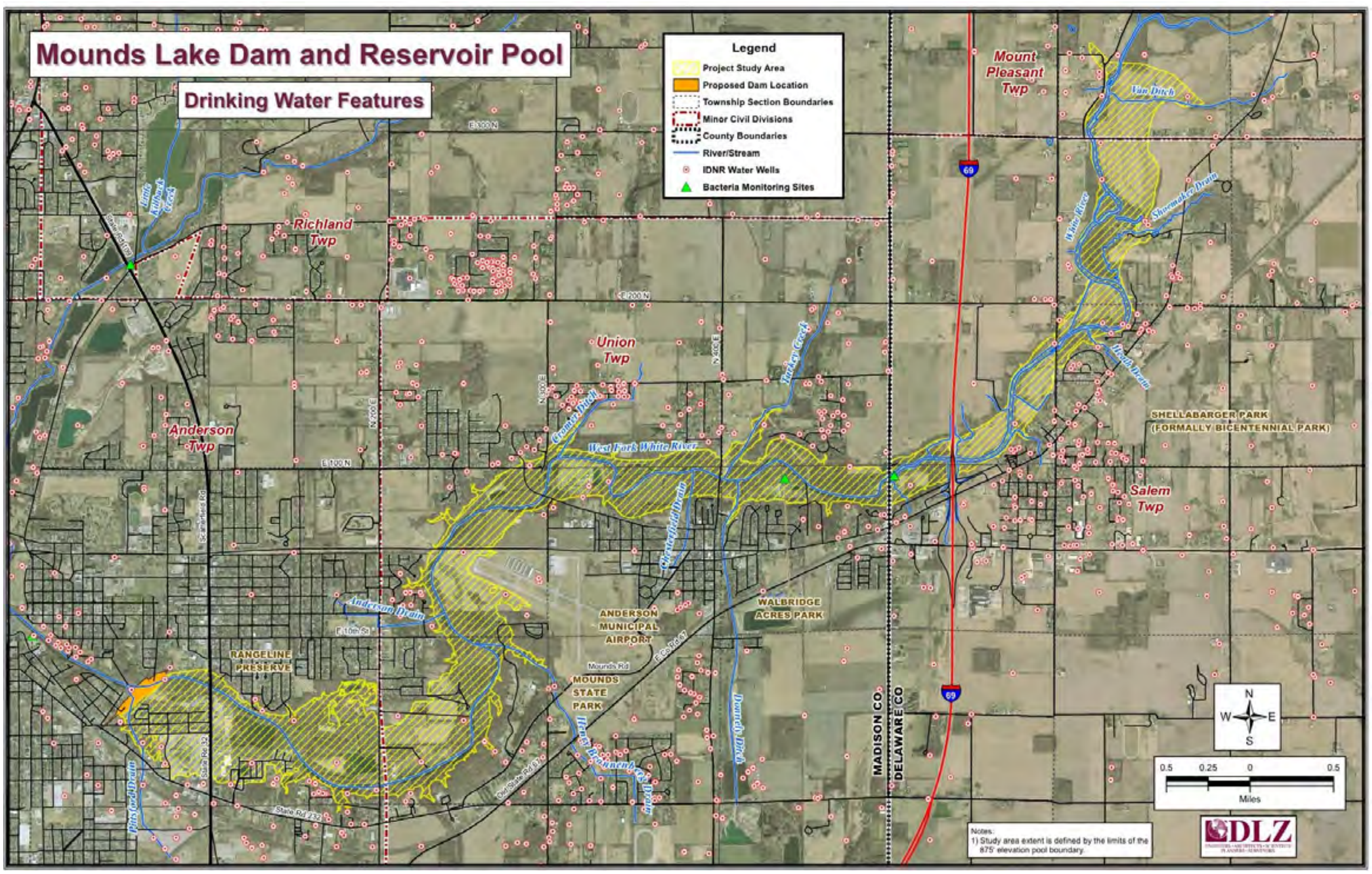


Figure 2.10 Drinking Water Features

can receive from all contributing point and non-point sources and still support its designated uses. The stretch of the WFWR that flows through the project area does appear on Indiana's Section 303(d) list as impaired water in three designated use groups: failing to fully support the state's recreation use, aquatic life harvesting, and fish, shellfish, and wildlife protection and propagation. The project site is within two sections: INW0132_T1014 Chesterfield to upstream and INW0132_T1015 Chesterfield to Anderson. The Killbuck Creek subwatershed has 90% of its stream miles listed as impaired. Turbidity in this subwatershed is the highest of all the Upper White River Watersheds with stormwater downcutting streams and inadequate buffers being part of the cause.

Violations of the Escherichia coli standard were identified during surveys collected by IDEM in 1996, 2001, and 2004. A TMDL for E. coli was established in 2004. E. coli is a bacterium that indicates the presence of human sewage and/or animal manure. It can enter rivers through direct permitted discharges, combined sewer overflows (CSOs), illicit and failing septic systems, and storm runoff carrying wastes from wildlife, domestic, and agricultural animals. Bacteria monitoring data is available for two locations in the WFWR within the project area. The stations and the monitoring data are available from the USEPA Storage and Retrieval of US Waters Parametric Data (STORET). This portion of the river is covered under the TMDLs West Fork White River, Muncie to Hamilton-Marion County Line (Tetra Tech 2004).

In 2008 and 2010, another cause of impairment in both stretches of the river was for polychlorinated biphenyls (PCBs) in fish tissue. The probable source for this impairment is unknown. A TMDL is still needed to address this current impairment.

As authorized by the CWA, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Only one NPDES facility is located within the project area, the Chesterfield Wastewater Treatment Plant (WWTP) which is located west of Chesterfield (see Section 5 for further information on potential impacts). Active NPDES permits near the project area include an outfall for the Anderson Municipal Sewage Treatment Plant (located at the Chesterfield lift station), an outfall for the Chesterfield Combined Sewer System (CSS) (located at Mill Creek and Plum Street), and the Yorktown WWTP located upstream of the project area (see Section 5 for further details). Both Anderson and Chesterfield have CSSs and are Combined Sewer Overflow (CSO) communities. CSSs are designed to overflow occasionally and discharge excess wastewater directly to nearby streams, rivers, or other water bodies. These CSOs can contain not only stormwater but also untreated wastewater. There are no Confined Feeding Operations (CFO) present within the project area.

Under Phase II of the NPDES storm water program, rules have been developed to regulate most Municipal Separate Storm Sewer Systems (MS4s) entities (cities, towns, universities, colleges, correctional facilities, hospitals, conservancy districts, homeowner's associations, and military bases) located within mapped urbanized areas or for those areas serving an urban population greater than 7,000 people. The following entities within the WFWR watershed located near the project area fall under the Phase II guidelines:

- Anderson
- Muncie
- Madison County
- Delaware County

Potential Impacts

The potential impacts to each drain are summarized in **Table 2.3**. Stormwater impacts could be addressed by land use and ordinances, while nutrient loading and sediment are watershed impacts and more difficult to address. Design considerations may be able to address some of these issues through the use of constructed wetlands and filter strips. Septic system impacts could be less of an issue and mitigated through proper abandonment procedures if within the pool; otherwise, these could be replaced as sewers become available per regulations. All the tributaries within the project area are regulated drains by either the Madison County or Delaware County Surveyors Offices. There is an expressed desire to ensure that the reservoir water quality is a primary consideration during the design phase. By decreasing the length of drainages and increasing the buffers along them, the water quality could be improved. A detailed analysis has been performed for hydrology impacts of the reservoir and is described in other sections and reports. It is generally understood that the reservoir

NAME	Total_Length
Anderson Drain	342.21
Chesterfield Drain	846.91
Cromer Ditch	1001.82
Donnely Ditch	1009.73
Heath Drain	967.91
Henry Bronnenberg Drain	2144.78
Pittsford Drain	1523.54
Shoemaker Drain #103	3983.56
Turkey Creek	2371.50
Unknown	9436.04
Van Ditch #200	3033.05

Table 2.3 Potential Drain Impacts

would likely mitigate the impact of flooding downstream by providing storage of floodwaters and controlled release by the dam.

An additional water quality study that evaluates the White River corridor upstream of the reservoir may be performed in the next phase of the project. Impacts of the Chesterfield and Yorktown WWTP discharges, as well as, county legal drains and other storm water discharges would be part of this more comprehensive water quality evaluation. This study would examine various sources of nutrients and bacteria and explore options to minimize impacts to the water quality of the proposed reservoir.

Mitigation

Water quality improvements, such as expanding buffer areas and in-stream habitat within drains, would not address the "linear feet" loss of tributaries within the watershed. Mitigation of this loss would likely have to be performed in upstream locations or on other small watercourses within the watershed. Creation of buffer areas within the watershed and construction of wetlands could aid in improving the quality of water entering the various drains and other watercourses, which would inevitably enter the reservoir. The design of the reservoir is likely to include an innovative maintenance plan with an expansive headwater wetland at the upper end of the reservoir that would allow for sediments to be trapped and nutrients to be filtered by the vegetation. Maintenance of this area would be needed when sediment accumulations prevent the area from functioning as designed.

NEPA Phase Investigations

A review of existing conditions of watercourses to be impacted will be performed, including county drains. Collection of water quality data will be useful information to identify potential sources of undesired inputs into the reservoir and allow for investigation of sources and ways to reduce the inputs. County drains can be vacated or the maintenance restrictions lifted by the County Drainage Board. Coordination with the Board and County Surveyor will be needed to ensure that there would not be an impact to drainage. A review of land uses and identification of potential locations where inputs into the drains could be reduced or otherwise improved would be undertaken. The design will need to consider options to reduce nutrient and sediment inputs into the reservoir.

Scenic Rivers

Existing Conditions

The WFWR is not a federally-designated scenic river but is classified as an outstanding river within the reach of the project area (designated segment is from the Town of Farmland to the Wabash River confluence). In 1993, the Indiana Natural Resources Commission adopted its "Outstanding Rivers List for Indiana" and the listing was published in the Indiana Register as Information Bulletin #4 (16 IR 1677). Except where incorporated into a statute or rule (e.g., utility line crossings within floodways and general permits for logjam removals), the listing is intended to provide guidance rather than to have regulatory application (Indiana General Assembly 1993). The WFWR qualified because it is a state-designated canoe trail and the river has been identified by natural heritage programs as having outstanding ecological importance. The segment was also identified in the Nationwide Rivers Inventory by the National Park Service as being qualified for inclusion in the National Wild and Scenic Rivers System (NWSRS). The WFWR is not designated by the state of Indiana as part of the Natural, Scenic, and Recreational River System.

Potential Impacts

This project could have an impact on the designated canoe trail and the classification of outstanding river that qualify it for inclusion into the NWSRS within the project area. There would be no change above or below the reservoir.

Mitigation
It is not known at this time what mitigation measures would be required by federal and state agencies. However, it is anticipated that structures / pathways will be constructed to facilitate canoe portage around the proposed dam to facilitate passage.

NEPA Phase Investigations
During the NEPA Phase, coordination would be conducted with IDEM to determine if any additional studies need to be conducted or what mitigation measures would be required by federal and state agencies.

Groundwater

Existing Resource
Characteristics of groundwater in the project area are discussed in detail in the Geotechnical section of this report.

Sole Source Aquifer
The project area is not located within a Sole Source Aquifer (SSA); currently the only SSA present in Indiana is the St. Joseph system in the northern part of the state.

Wellhead Protection Areas
IDEM confirmed in March 2014 that the project area is not located within a Wellhead Protection Area (WPA). Both Chesterfield and Daleville drinking water wells are located considerably outside the project limits.

Potential Impacts
No impacts are expected to sole source aquifers or wellhead protection areas since there are none within the project area vicinity. Additional impacts related to the groundwater resources are discussed in the Geotechnical section of this report.

Mitigation
No mitigation is anticipated to be required.

NEPA Phase Investigations
Additional coordination and verification of groundwater information will be completed during the NEPA phase.

Drinking Water

Existing Resource
The City of Anderson obtains its public water supply from groundwater wells. The wells draw from the aquifer in the Indian Creek area in Lafayette Township and the White River and Killbuck Creek area. Daleville Water Department supplies water to the residents of Daleville from groundwater wells located on the east side of town. The Town of Chesterfield obtains its drinking water from municipal groundwater wells located south of town. Numerous groundwater wells are also present that supply domestic water for individual properties within the project area (**Figure 2.10**).

Indiana American Water is the public water system serving Muncie and surrounding communities. This public water system relies on the surface waters from White River and Prairie Creek Reservoir. Groundwater sources are obtained from one well field with three wells.

Potential Impacts
There are 33 drinking water wells that could potentially be impacted by this project (**see Figure 2.10**). The properties currently served by these wells would be inundated so the wells will need to be abandoned and closed. No impacts are expected to individual wells outside of the reservoir and no impact to municipal wells are expected either. One of the purposes of this project is to provide a reliable source of clean drinking water for the region and, as such, the overall impact to the drinking water supply could be positive.

Mitigation
Closure of wells would be performed consistent with local and state standards.

NEPA Phase Investigations
Additional field review and verification of the location of wells and well records will occur to ensure that all wells are identified and properly closed.

Cultural Resources

Existing Resource
Cultural resources include above ground structures that are 50 years old or have other historical significance and archaeological sites that are eligible for listing or listed on

the National Register of Historic Places (NRHP). Eligibility for the NRHP for projects requiring a federal action is determined by the project sponsor in consultation with the State Historic Preservation Officer (SHPO). Section 106 of the National Historic Preservation Act of 1966 (NHPA) requires federal agencies to take into account the effects of their undertakings on historic properties, and afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment.

Applied Archaeology Laboratories (AAL) of Ball State University was contracted to undertake initial investigations (pre-NEPA) of historic and cultural resources that may be affected within the project area. The Area of Potential Effect (APE) was assumed to be the reservoir pool at 880 feet plus a 200 foot buffer outside of this contour. Two separate studies, the Historic Resources Assessment, Mounds Lake "Pre-NEPA" Study, Madison and Delaware Counties, Indiana (McCarthy 2014) and Archaeological Resource Assessment, Mounds Lake "Pre-NEPA" Study, Madison and Delaware Counties, Indiana (Nolan 2014) were conducted. Due to the sensitivity of the information that the two reports may contain, only a summary of the findings of each report is presented below.

Archaeological Resources

According to the AAL report, the proposed pool at 880.0 feet encompasses 80 officially recorded archaeological sites and includes a proliferation of lithic (relating to stone tools) scatters, and a preponderance of unidentified prehistoric sites (Nolan 2014). Additionally, a large number of sites are predicted to potentially exist within the project area and would need to be discovered and/or reinvestigated as part of further investigations (Nolan 2014). About one-third of these sites may be recommended as potentially eligible for the NRHP and would require additional investigation to assess eligibility and mitigation.

Historic Properties (Section 106)

Two properties listed on the NRHP are likely to be affected by the project: Mounds State Park and Chesterfield Spiritualist Camp District. Three previously surveyed resources are NRHP eligible; the Carol Bronnenberg House, the CR 300S Iron Truss Bridge, and the Mt. Pleasant Church and Cemetery. Seven other resources were identified as potentially eligible: the Bronnenberg Children's Home, the Lemon Drop Drive In, Bronnenberg Cemetery, Daleville Historic District, a Daleville farm complex, a Yorktown farm complex, and Gale Farm.

Mounds State Park

The protection and preservation of the pre-historic mound constructions at Mounds Park is of the utmost importance. A review of the area elevations indicates that all park buildings, campsites and the pre-historic Mounds are located well above the highest projected flood stage of Mounds Lake. **Figure 2.11** illustrates the location of three accompanying elevation cross sections. The lowest mound construction is located approximately 30 feet above Mounds Lake. Mounds Park has historically flooded in the lower lands on the average of three events per year. These fast current flood events have played a major role in creating the current river valley. It can be expected that once Mounds Lake is established, erosion of the side walls of the valley would greatly diminish. Additional studies of the soil type in this area will need to be performed to determine if any erosion protection is needed for this area.

Potential Impacts

The project could impact numerous archaeological sites, two historic properties, and ten potentially NRHP eligible properties. The project could also substantially impact the NRHP sites identified in Mounds State Park and may pose a threat to the preservation of these resources in the future.

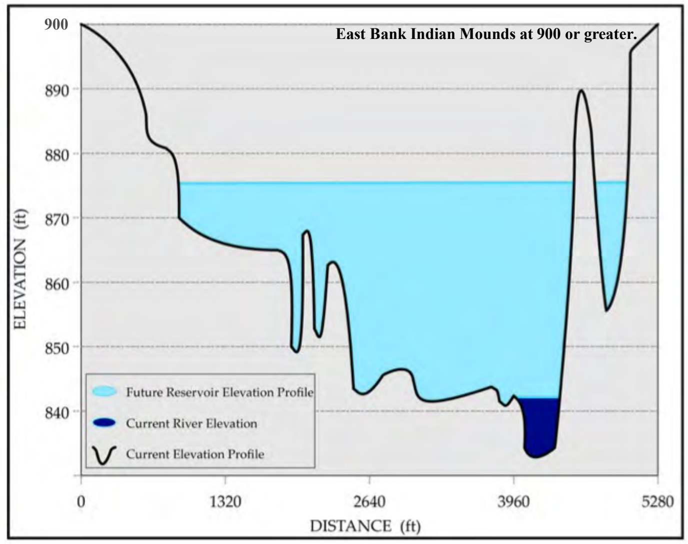
Mitigation

Mitigation for the above ground resources could include preservation, relocation, or recordation of the site, property, and/or buildings. Mitigation for the archaeological resources could include excavation, preservation, relocation, and/or documentation of the archaeological resources. Preservation of resources of constructed mounds within Mounds State Park, which are located 30 to 35 feet above the proposed pool height, may need to be protected by an engineered barrier to address long-term erosion concerns and ensure that erosion does not encroach on the mounds.

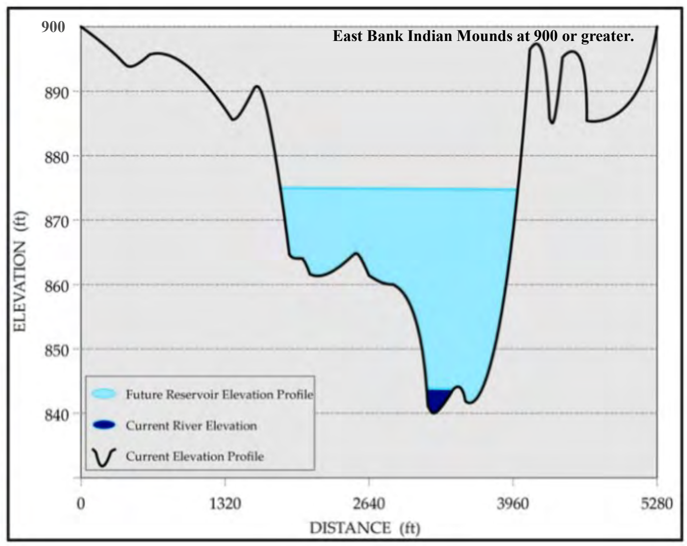
NEPA Phase Investigations

Additional surveys for both historic and archaeological resources would be conducted during the NEPA phase to further identify protected resources, determine the eligibility of above ground resources, and determine impacts within the project area. Coordination with IDNR's

Cross-Section #3: West of Rangeline Road



Cross-Section #4: Mounds State Park



Cross-Section #5: North of State Road 32

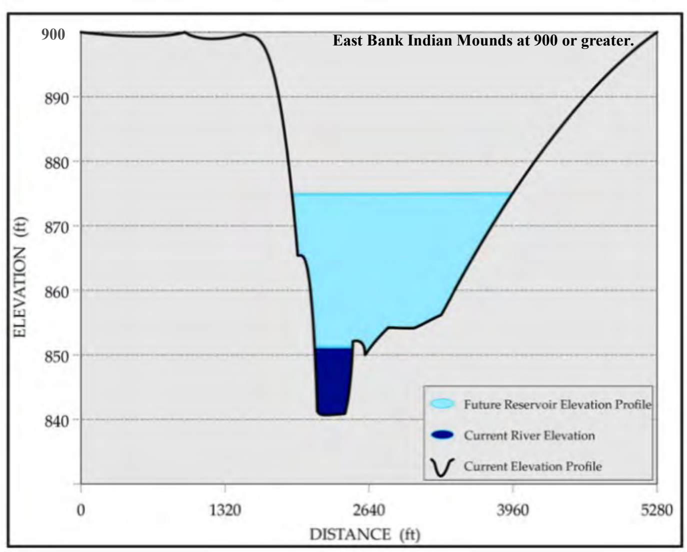


Figure 2.11 Mounds State Park Elevation Cross Sections

Department of Historic Preservation & Archaeology (DHPA, which is the SHPO) will be required to determine the level and intensity of surveys, with a detailed work plan developed for consideration and approval prior to beginning the work. Investigations during the NEPA phase would also include identification of consulting parties, including recognized Native American groups with ancestral relationships to the region that would be coordinated with during the project. Coordination with SHPO will also be undertaken.

If the project is within 100 feet of the Mt. Pleasant Cemetery, a Cemetery Management Plan will need to be developed with DHPA, in accordance with Indiana law. Consultation with federally-recognized tribes with respect to the indirect effects on the prehistoric mounds at Mounds State Park will need to take place on a "nation-to-nation" basis.

SOCIOECONOMIC CONDITIONS

Existing Conditions

The median income for a household in Madison County in 2010 was $38,772, and the median income for a family was $52,319. About 13% of families and 18.5% of the population were below the poverty line in 2010, including 31.5% of those under age 18 and 9.4% for those aged 65 or over (U.S. Census Bureau). The median income for a household in Delaware County in 2009 was $35,935. Economic figures for city, county, and state residents are presented in **Table 2.4**. The most prominent industry for employment in both counties and the City of Anderson is healthcare and social assistance, followed by retail trade, manufacturing, and accommodation and food services.

Currently the project area consists of mainly single family residential neighborhoods (medium to low density), farmland, and some commercial development located near the State Road 32 and State Road 232 intersection. No community facilities, such as, cemeteries, libraries, fire services, emergency services, or school transportation are known to be in the project area.

The population within Madison County is 131,642 and within Delaware County is 117,671 (2010 data; U.S. Census Bureau). The two major population centers within the project area are the City of Anderson and the town of Chesterfield. Anderson is the county seat of Madison County with a population of 56,129. Chesterfield is in Union Township with a population of 2,547. The town of Daleville, located in Salem Township, Delaware County, and has a population of 1,647. Population statistics are presented in **Table 2.5**.

Potential Impacts

The project would likely impact several neighborhoods and five parks. Additionally, it could result in moderate changes to local access (i.e., changes that alter travel patterns) by closing roads and bridges. Rerouted roads and bridge closures could result in longer emergency

	Median Household Income (2008-2012 American Community Survey 5-yr Estimates)
Indiana	$48,374
Madison County	$44,245
Delaware County	$38,215
City of Anderson	$35,232
Data obtained from U.S. Census Bureau	

Table 2.4 - Economic Data for the Project Area

	2010 Population	2012 Estimate (% change from 2010)	Persons per sq mi (2010)
State of Indiana	6,483,802	6,537,334 (+8.3%)	178.0
Madison County	131,636	130,348 (-3.1%)	290.6
Delaware County	117,671	117,364 (-0.3%)	297.2
City of Anderson	56,129	55,554 (-1.0%)	1353.2
Data obtained from the US Census Bureau website & USA.com			

Table 2.5 - Population Data for the Project Area.

vehicle response times, local traffic disruption, and longer school bus routes.

The proposed project may impact the perceived quality of life of some residents living within the project area. Specifically, residents living adjacent to the project area would experience impacts such as construction delays, changes to visual conditions, loss of river related activities within the project area portion of the river, longer drive times, relocated routes, etc. Some residents would perceive an increase in the quality of life as the result of newly created lake front property and recreational opportunities provided by the lake.

During construction, residents of the project area could experience a temporary decrease in their quality of life due to access restrictions, travel delays, and construction noise.

Mitigation

No mitigation anticipated.

	Minority % (2008-2013 Estimates)	Persons Below Poverty Level (2008-2013 Estimates)
Indiana	13.9	14.7
Madison County	12.3	16.4
Delaware County	10.9	21.0
City of Anderson	21.3	24.4
US Census 2010 data		

Table 2.7- Census tract information for minority and low income populations within project area.

NEPA Phase Investigations

As part of the EIS, additional analysis would need to be conducted to determine potential economic, neighborhood, social cohesion, school boundary, population, and tax base impacts.

Environmental Justice

Existing Resource

Executive Order (EO) 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations", was signed on February 11, 1994. The order requires Federal agencies to promote "nondiscrimination in Federal programs substantially affecting human health and the environment." In response to this EO, Federal agencies must identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations.

A review of census information was undertaken to determine the presence of minority and/or low income populations within the project area. The following census tracts are located within the project area limits, with demographic information included for each (**Table 2.6 and 2.7; see Figures 2.112 and 2.13**).

Potential Impacts

Potential environmental justice impacts to populations are typically evaluated by locating minority and low-income populations in and near a project area, calculating their percentage in the area relative to a reference population, and determining whether there will be a disproportionate adverse impact to them. The reference community is typically a county, city, or town and is called the community of comparison (COC). The community that

Tract ID	Location	Minority %	% Below Poverty Level
18035002401	Delaware County north of E 300 N Street.	2.62	7.12
18035002302	Delaware County south of E 300 N Street.	4.61	3.17
18095011300	Madison County north of E 100 S and south of the White River.	3.92	14.58
18095011200	Madison County east of N 200 E and south of E 250 N.	4.77	2.90
18095001200	Madison County north of the White River and east of Scatterfield Road.	10.68	11.03
18095001100	Madison County north of the White River and west of Scatterfield Road.	15.78	42.56
18095001000	Madison County south of the White River and west of SR 32.	21.24	29.44

Table 2.6 Census Tract Information for Minority and Low Income Populations within Project Area with Location

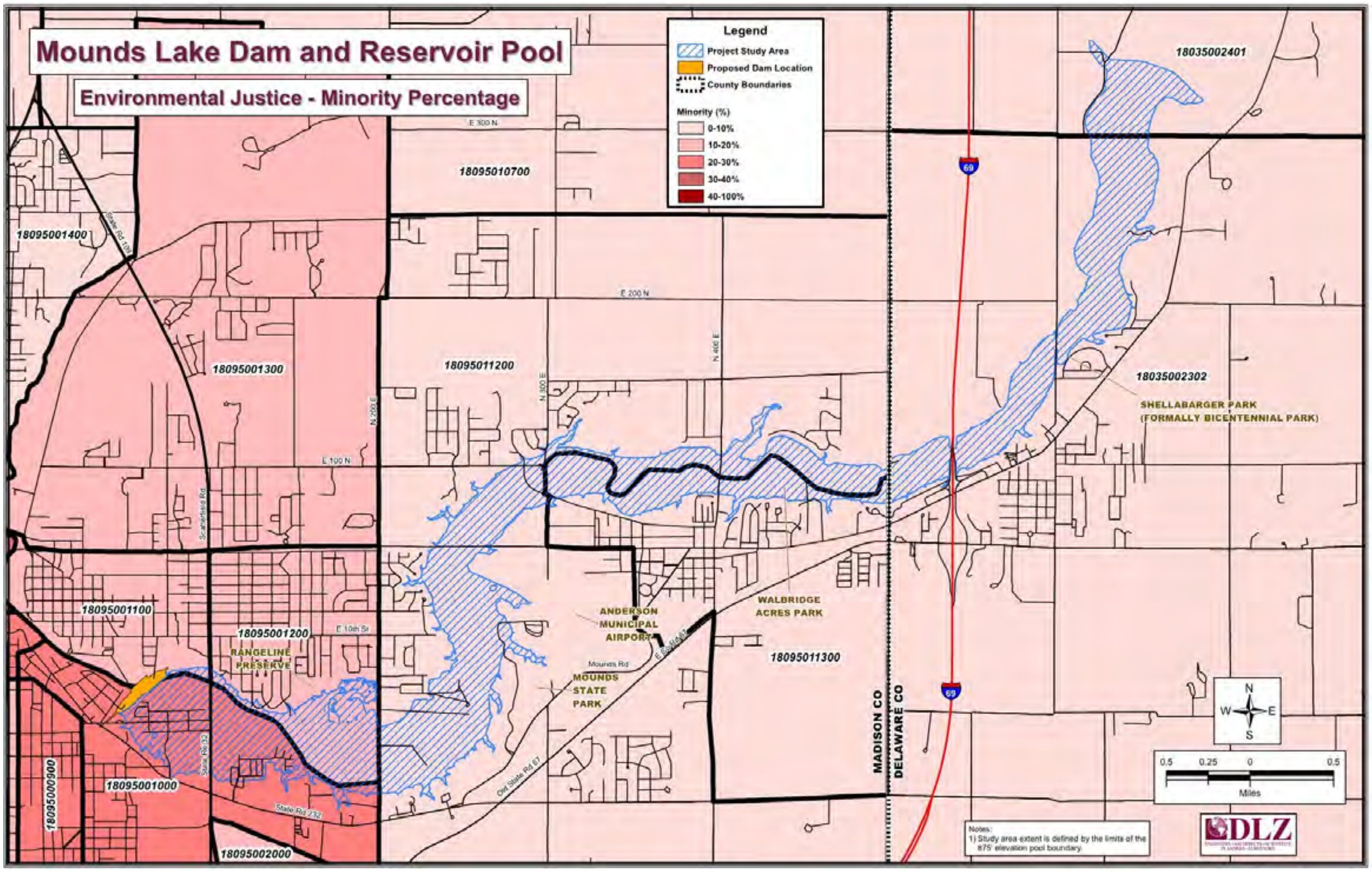


Figure 2.12 Environmental Justice—Minority Percentage

overlaps the project limits is called the affected community (AC). The AC needs to be contained within the COC. An AC has a population of concern for environmental justice if the population is more than 50 percent minority or low-income or if the percentage of low-income population or minority population in the AC is 25 percent higher than the percentage of low-income or minority population in the COC (US EPA's "Toolkit for Assessing Potential Allegations of Environmental Injustice").

Census tract locations of minority and/or low income populations were gathered and evaluated for the proposed flooding scenarios to determine initial impacts. Areas of concern are based on the high percentage (greater than 50%) of minority populations and/or the percentage of people below poverty (USEPA 2014). According to the census tract data there are no areas with environmental justice populations within the project area. It should be noted that the minority populations for census tract 18095001100 (42.56%) is approximately 18 percent higher than the minority population for the City of Anderson.

Mitigation

Although it is not anticipated that there will be any formal mitigation requirements, efforts will be made to work with local agencies, organizations, and private groups to offer a range of housing options to impacted low income residents.

NEPA Phase Investigations

Throughout the NEPA phase, public involvement/outreach will be conducted to gather community input and identify any potentially affected environmental justice populations within the project area. Updated socio-economic information will be reviewed, as additional details may be available from the 2010 census.

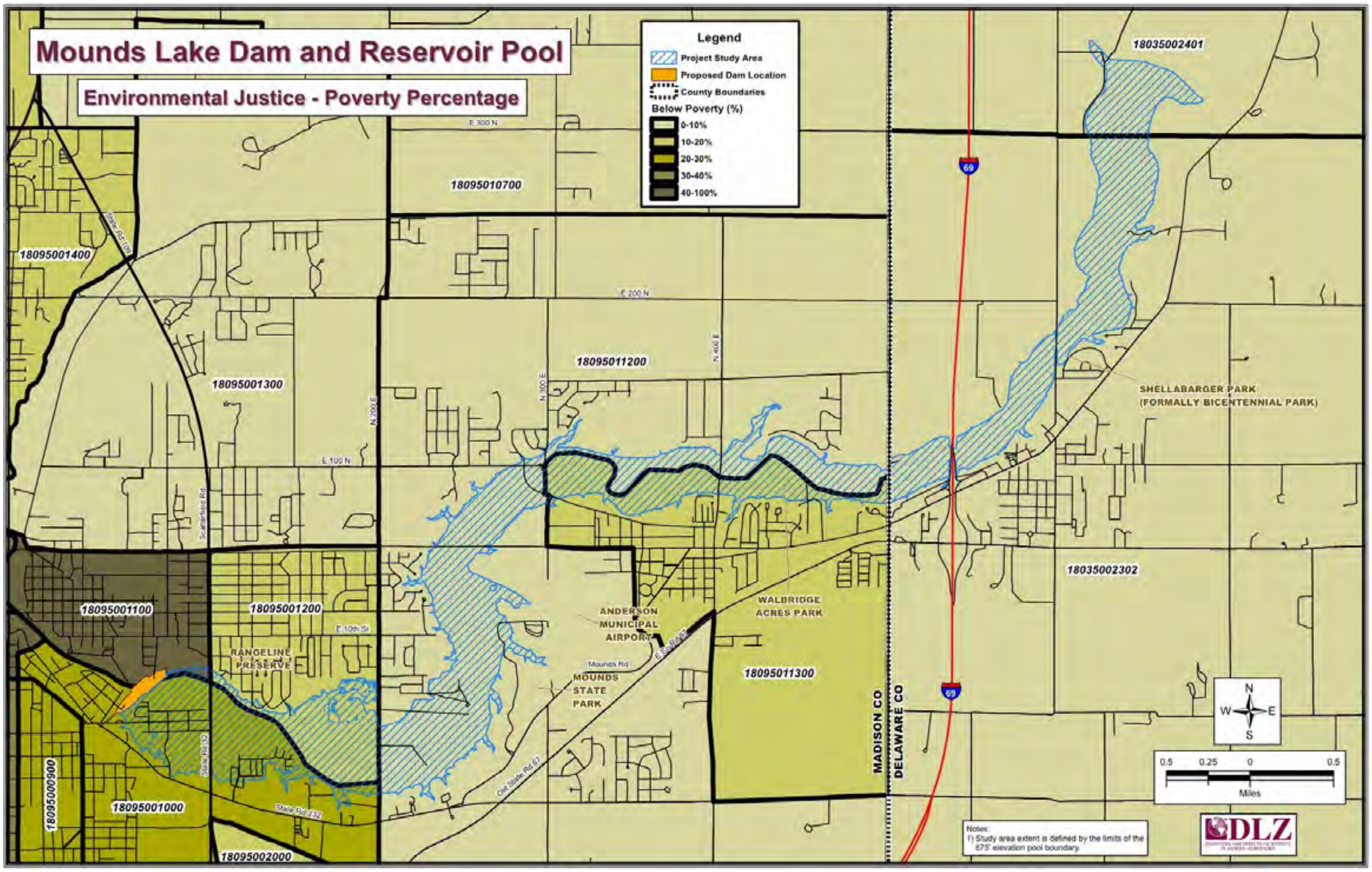


Figure 2.13 Environmental Justice—Poverty Percentage

TRANSPORTATION

Existing Resource

Interstate 69 runs through the middle to eastern portion of the project area (**Figure 2.14**) just east of the Madison County/Delaware County boundary. A Conrail railroad line runs at the southern portion of the project area south of Anderson. Mounds Road also runs along the southern end just north of the railroad, and County Road (CR) 67 runs south to east through Daleville. State Route (SR) 32 (Main St.) crosses the WFWR west of Chesterfield and continues east through Daleville. A number of local streets are present throughout parts of the project area. The Anderson Municipal Airport is located off SR 32 east of the WFWR between Anderson and Chesterfield. Both the Indiana Department of Transportation (INDOT) and the Federal Aviation Administration (FAA) have been notified of the project and representatives from both agencies attended the early coordination meeting.

Potential Impacts

Impoundment of the WFWR would result in changes to the transportation network in the area. Roads may be abandoned and closed, dead end at the reservoir, or be relocated to tie into a different roadway for the purpose of maintaining connectivity. Several existing bridges will be impacted also as they are below the reservoir pool elevation. These bridges will need to be abandoned, raised and possibly extended, or new bridges constructed that would span across the reservoir. These changes would result in traffic pattern shifts, changes in travel times, and changes in local access.

If berms are not implemented as a mitigation measure at the airport, the reservoir pool would encroach onto airport property, which may impact the Runway Safety Area (RSA) and Runway Protection Zone (RPZ). The proximity of open water to the airport was also noted by FAA representatives that attended the agency coordination meeting to be a wildlife hazard, due to the fact that birds could be attracted.

Mitigation

Transportation mitigation may include road relocations, new roadways, modified and new bridges, roadway widening, or intersection and/or signal improvements to account for the shifts in traffic patterns and provide a road network that can adequately serve projected traffic volumes.

Mitigation measures for the airport could include construction of a berm to protect the RSA and RPZ. Other mitigation options are much more costly and could include significant changes to the runway and associated protected areas. Future efforts to address transportation needs and changes will certainly involve direct engagement with the impacted communities and completion of a thorough traffic study.

NEPA Phase Investigations

A traffic network analysis could be completed to develop a plan for determining which roads would be closed, roads that would be relocated or connected to other roadways for connectivity, other improvements needed to accommodate changes in traffic patterns, determine bridges that can be removed and not replaced, bridges that need to be could be raised and possibly lengthened, and which roadways are essential to construct new bridges on to allow passage across the reservoir. Coordination with all transportation agencies and local governments would be required to determine relocations, removals, and closures.

Coordination with the FAA and airport will be undertaken to review impacts and assess options to minimize and mitigate impacts. A review of the Airport Layout Plan (ALP), which is the master plan for the airport, will also be performed and may need to be reassessed to consider the feasibility of the various mitigation options.

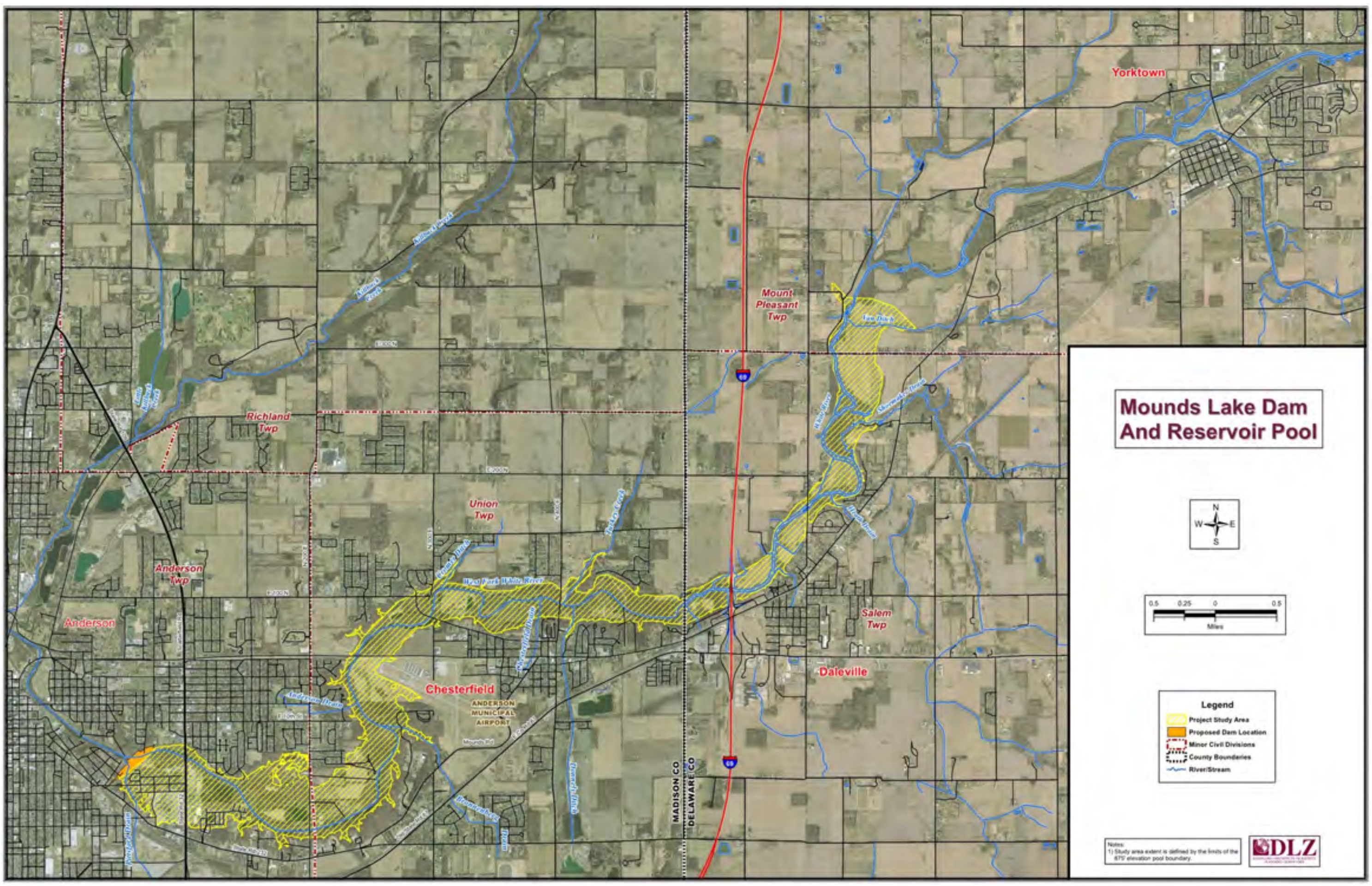


Figure 2.14 Mounds Lake Dam and Reservoir Pool

AIR QUALITY

Existing Resource

Both Madison and Delaware Counties are attainment areas under the Clean Air Act, meaning that concentrations of one or more criteria pollutants did not exceed Federal air quality standards. Monitoring is conducted to assure compliance of those standards. The two closest stations to the project area are located in Anderson and Muncie. Both cities had the majority of Air Quality Index (AQI; national standard for reporting air quality) days in the good quality in 2012.

Potential Impacts

No issues have been identified; the proposed dam should not have an effect on the air quality for this area.

Mitigation

No mitigation is anticipated.

NEPA Phase Investigations

If the proposed project results in significant changes to the local roadway network and traffic patterns, a carbon monoxide hotspot analysis may be needed.

NOISE

Existing Resource

Noise-sensitive receivers are those locations where activities occur that could be affected by increased traffic noise levels (e.g., residences, motels, churches, schools, parks, libraries, cemeteries, etc.). Noise sensitive receivers in the project area mainly consist of single family homes and residential neighborhoods located along the White River. Other noise-sensitive receivers within the project area include five parks (See **Figure 2.8**) and the Timberline Valley RV Resort. In addition to these noise-sensitive receivers, there are several historic or potentially historic properties that may also be considered noise-sensitive receivers. These include the Mounds State Park (NRHP listed), Chesterfield Spiritualist Camp District (NRHP listed), the Carol Bronnenberg House (NRHP eligible), and the Mt. Pleasant Church and Cemetery (NRHP eligible). Potentially historic properties include the Bronnenberg Children's Home, the Lemon Drop In Drive In, Bronnenberg Cemetery, Daleville Historic District, a Daleville farm complex, a Yorktown farm complex, and the Gale Farm.

Potential Impacts

Noise sources within the project could include motor vehicles, construction, watercraft, and aircraft. It should be noted that the addition of water turbines at the dam to generate hydro-electric power could be considered potential noise sources and should be designed to mitigate this issue. It should also be noted that some sensitive receivers are located within the proposed pool and would be impacted as part of the relocation efforts in lieu of noise mitigation.

Potential impacts to sensitive receivers related to motor vehicle or aircraft noise could occur if, as a result of the proposed project, the following projects occurred:

- Realignment/relocation of the airport runway,
- Substantial horizontal or vertical alteration of the existing roadways,
- Addition of through-traffic lane or auxiliary lane (except turn lanes),
- Addition or relocation of interchange ramps, and
- Restriping for the purposes of adding a traffic through -lane or auxiliary lane.

As defined by INDOT guidelines, a traffic noise impact occurs when noise levels reach within 1.0 dB(A) of the appropriate noise abatement category (NAC) or a substantial noise increase (15.0 dB(A) or greater) occurs as related to noise-sensitive receiver within 500 feet of the proposed improvements.

The Federal Aviation Administration (FAA) has determined that a "significant" noise impact occurs if analysis shows that preferred alternative would cause noise sensitive receivers to reach noise levels of 65 dB (DNL) or greater. A noise impact also occurs if noise sensitive areas experience an increase in noise of 1.5 dB (DNL) or more as a result of the preferred alternative when they are already within the 65 dB (DNL) noise contour for the no build conditions.

No guidelines have been set for watercraft or turbine noise.

Mitigation

If noise impacts are identified as a result of the preferred alternative, possible mitigation options could include modification of flight tracks, jet blast barriers, noise barriers, use of earthen berms, reduction of speed limits, restriction of truck traffic to specific times of the day, total prohibition of trucks, alteration of horizontal and vertical alignments, property acquisition for construction of noise barriers or berms, acquisition of property to create buffer zones to prevent development that could be adversely impacted, and/or noise insulation.

NEPA Phase Investigations

If the proposed project requires any of the roadway or airport modifications noted above, noise studies following the US Environmental Protection Agency (US EPA) Noise Control Act of 1972, FHWA 23 CFR 772, July 13, 2010, *Indiana Department of Transportation Traffic Noise Analysis Procedure (2011)* FAA Order 5050.4B, *Environmental Desk Reference for Airport Actions* (FAA Office of Airports, October 2007), and FAA Order 1051.1E, *Policies and Procedures for Considering Environmental Impacts* (FAA June 8, 2004) would likely be conducted.

No federal or state guidelines exist for measuring watercraft or water turbine noise. As part of the EIS, a qualitative analysis would be conducted for these noise sources.

Relocations/Right-of-way

Potential Impacts

A pool elevation of 876.0 is estimated to impact approximately 628 parcels that have a total assessed value of $86,500,000. Of the estimated 628 parcels, 552 parcels (400 residential/agricultural parcels and 152 commercial parcels) are located in Madison County. An additional 76 parcels (74 residential/agricultural parcels and 2 commercial parcels) are located in Delaware County.

Mitigation

Full and fair compensation for fee purchase of property required as part of the proposed project would be provided to affected parties in compliance with applicable federal and/or state regulations.

NEPA Phase Investigations

As part of the EIS, property assessments will be conducted for all properties to be purchased as part of the proposed project. Property assessments would be conducted to determine fair market value per federal and state regulations.

Visual/Aesthetics

Existing Resource

The project area includes urban, residential, rural/agricultural and limited amount of commercial uses. Natural features within the project area include the river, wetlands, and forests. Terrain in the project area is relatively flat with higher bluffs on the perimeter. Key viewpoints are from river users, the motorists' perspective along project area roads, from homes, and sidewalks for pedestrians. Panoramic views are not present in the project area due to buildings, trees, and the lack of major elevation changes. Therefore, most views are limited to the immediate foreground (within 0.25 mile), with mid-ground views (0.25 to 4 miles) only occurring when looking down project area roads and other very limited areas.

Potential Impacts

The proposed project would change the project area views from the existing meandering river valley into an open water reservoir. River views would be replaced by open water views along the roadways and for residential areas adjacent to the reservoir. The existing forests would be partially cleared, with the remaining forest and wetlands being inundated. Impacts to both resources would be mitigated.

The proposed dam would be observable from the neighborhoods adjacent to the proposed dam location (E. Lynn Street, Miller Avenue, Johnson Avenue, Riverside Drive, and Columbus Avenue). The dam will be primarily viewed from State Road 32 and State Road 232. During leaf-off periods, views of the dam may be extended to neighborhoods to the north off of 10th Street. The reservoir pool would be visible from the majority of roads and residential areas within the project area throughout the year.

While the proposed project would change visual characteristics of the project area, views of the reservoir pool may be perceived to be positive.

Mitigation

Mitigation measures may be considered as part of the proposed project. Mitigation could include landscaping, green buffer strips, re-vegetation, tree/shrub planting, etc.

NEPA Phase Investigations

During the NEPA phase, more detailed investigations would be conducted to determine potential impacts to visual/aesthetic resources and potential mitigation measures.

Construction

Potential Impacts

Construction of the proposed project could result in short-term impacts to air quality, vegetation/tree removal, noise levels, water quality/aquatic habitat, and traffic maintenance. The short-term impacts are expected to be minor and minimized by adhering to applicable federal and state standard specifications. Minor, short-term temporary impacts to fire, police, and emergency medical response times could also occur during the project construction.

Mitigation

Mitigation strategies could potentially include: screening of the construction site, protection and management of native vegetation within and adjacent to the construction area and re-vegetation of areas impacted by construction. Any road improvements will be designed to minimize traffic delays within the project area. A maintenance of traffic (MOT) plan will be implemented during construction to ensure continuous, uninterrupted traffic flow by staging construction and utilizing detours. Access to existing businesses impacted by the project will be maintained during construction to the extent possible. Signs will be used to direct motorists through the project area during construction. Local media will be notified of any changes to road closures so motorists can plan alternate routes and accommodate any delays in advance. Local police and emergency responders will be notified in advance of any construction related activities to allow for planning of alternate emergency routes.

NEPA Phase Investigations

More detailed construction impacts would be investigated as part of the EIS.

3. Geotechnical/Foundation Analysis

Goal: **The intent of this section of the study is to address issues related to the structural soils and bedrock and geotechnical information surrounding the dam itself, and within the reservoir area. The investigation was also intended to determine if there were any obvious geotechnical problems associated with the project area that would preclude the site's use for the proposed dam or impoundment area upstream of the dam and if there are any major issues that will need to be taken into account during design that could add significant costs to the project.**

Summary: **At this stage in the feasibility investigation, there appear to be no major geotechnical issues that should prevent this project from continuing on to the next stage. Soils and bedrock beneath the proposed dam are capable of supporting the proposed dam structure and spillway. The potential presence of granular soils beneath the dam throughout the pool will require additional studies and may result in additional design and construction considerations.**

Next Steps: **The next steps include expanding on the geotechnical information by completing additional borings in the field. Additional test borings and laboratory testing of soil samples will be needed to develop more detailed information on the subsurface strata and the soil engineering parameters needed to prepare a preliminary dam design. These borings will verify soil and bedrock conditions beneath the proposed dam footprint. Additional borings will also be completed to assess conditions beneath the proposed impoundment to evaluate leakage potential and also identify potential borrow areas.**

Mounds Lake Geotechnical Investigation

The preliminary geotechnical study of the proposed Mounds Lake area was conducted to obtain a basic understanding of the subsurface conditions and correlate that information to existing documentation of subsurface conditions in the area. The investigation also identified any obvious geotechnical problems associated with the project area that would preclude the sites use for the proposed dam and impoundment upstream of the dam.

Geology

As part of the preliminary investigation, DLZ conducted a literature review of published geological information and other data that would provide insight into the existing conditions. This information included mapping, aerial imagery, and records from the State of Indiana Department of Transportation (INDOT), Indiana Geological Survey, United States Geological Survey (USGS), and other published documents available for the study area. Existing field observations, aerial photographs, historic mapping, water well records, borings from previous investigations, and other information was reviewed to provide insight into the subsurface and geologic conditions in the local area of the proposed dam and reservoir.

Bedrock and Soils

In general, the information reviewed shows that the valley of the West Fork White River exists in a post-glacial river valley. Preglacial and glacial drainageways are also present in the region. The most significant of these preglacial valleys is located north of the City of Anderson. Generally, bedrock is sloped towards this preglacial valley, which typically lies in an easterly or northerly direction within the study area, depending on location with respect to the buried bedrock valley. The West Fork White River crosses this buried bedrock valley in Section 9 of Township 19 North, Range 8 East, near the north end of the Anderson Municipal Airport. The bedrock slopes in a more westerly direction east of this bedrock valley. **Figure 2.15** on the next page presents the bedrock geology and surface topography of the inundation area of the dam.

Bedrock within the study area is deepest within the preglacial valley at an approximate elevation of 650 feet. The areas with the highest bedrock elevation within the study area are located east of the county line near Daleville and west of State Route 9 on the north side of the West Fork White River. The bedrock surface within these areas is expected to be near elevation 800 to 810.

In the area of the proposed dam the approximate bedrock surface elevation is anticipated to vary between elevations 750 and 810. It is noted that this preglacial valley is not expressed in the surface topography, which is the result of the thick layers of glacially deposited material that overlie the region. Most surface topography is the result of post-glacial dissection of the region by modern streams, including the White River. The difference in topography of the bedrock and the overlying soil results in soil thicknesses of approximately 40 to 250 feet within the study area.

Several bedrock units are located in the study area but are not exposed at the surface and are overlain by thick layers of soil. Bedrock, from shallowest/youngest in age to deepest/oldest in age, in the study area include: the Silurian Age Pleasant Mills Formation that consists of dolomite, limestone, and argillaceous dolomite; the lower portion of the Bainbridge group, which includes the Louisville Limestone, the Waldron Shale, and the Salamonie Dolomite; and the Brassfield Limestone. In the preglacial valley, the top of the Ordovician Age Maquoketa Group is the upper most bedrock unit, which underlies the younger Silurian units. The uppermost bedrock unit of the Maquoketa Group is the White Water Limestone Formation. It is unknown if the erosion in the preglacial valley has exposed deeper/older units including the Dillsboro formation, which consist of equal parts of argillaceous limestone and calcareous shale.

The present-day valley, which contains the West Fork White River in the study area, consists of Wisconsinan Age undifferentiated outwash. This material was deposited by glacial melt water. Erosion by the outflow of the melt water resulted in the creation of the West Fork White River valley in this region, as well as the valley of the Killbuck Creek to the northwest of the proposed dam site. These outwash deposits are depicted on **Figure 2.16**. These deposits rapidly give way to glacial till and glacial drift deposits away from the White River and Killbuck

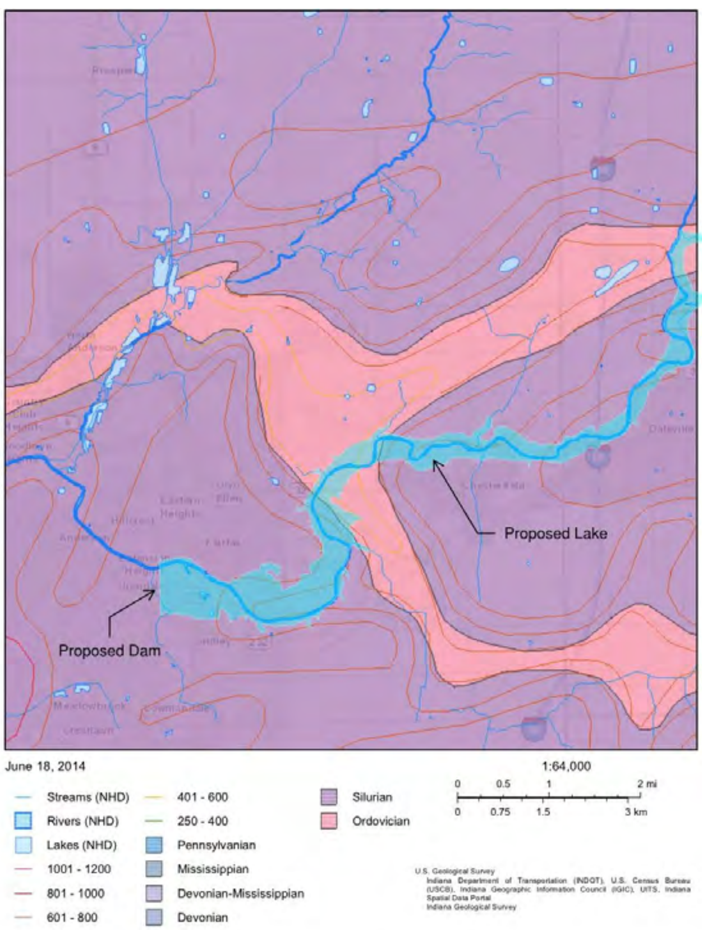


Figure 2.15 Bedrock Geology and Topography

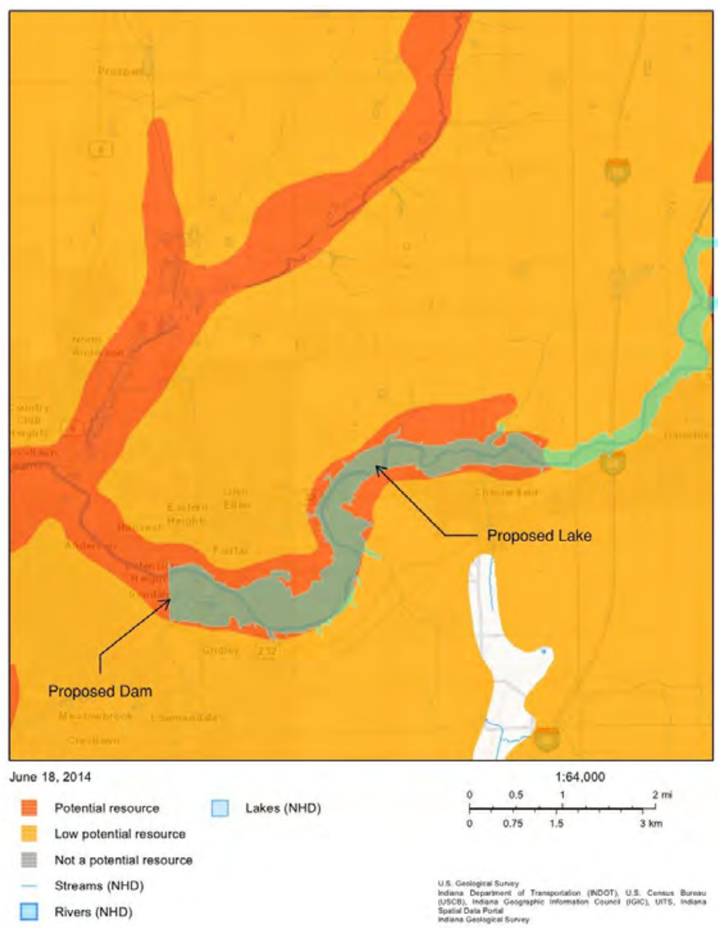


Figure 2.16 Anderson Sand and Gravel Resources

Creek Valleys. Soils derived from the glacial till and glacial drift deposits typically consist of a loam till formed in the Wisconsinan Age Huron-Erie Glacial Lobe that extended southwest across Madison County from Lake Erie. The valley of the West Fork White River has been quarried for sand and gravel resources. State of Indiana mineral resource mapping indicates that these deposits are limited to the river valleys of the White River and Killbuck Creek. Extensive, wide spread gravel deposits are not identified in the areas away from the documented outwash deposits in these valleys.

Groundwater

Groundwater resources in the area are typically obtained from the two major types of aquifers, the unconsolidated aquifer, where water is obtained from the soils and the consolidated or bedrock aquifer that underlies the soils.

The unconsolidated aquifer system in the study area contains several different units. These aquifer units include the White River and Tributaries Outwash Aquifer System, the Bluffton / New Castle / Tipton Complex Aquifer System, and Bluffton / New Castle / Tipton Till Aquifer System. As the name suggests, the White River and Tributaries Outwash Aquifer System is located within the valley of the West Fork of the White River. This aquifer is developed in the sands and gravels of the glacial outwash deposits that fill the valley. This unit is capable of producing sufficient water for residential, commercial, and industrial use. Typical domestic yields of between 10 to 40 gallons per minute (gpm) are common for the aquifer. High capacity wells in this aquifer can yield up to 1,139 gpm. The unit primarily receives its recharge from the river and other surface water sources. The Bluffton / New Castle / Tipton Complex Aquifer System is located north of the West Fork White River valley and to the east of the Mounds State Park. Water from this aquifer is obtained from inter-till sand and gravel deposits that are overlain by thick layers of till. The aquifer is reportedly highly variable in depth, thickness, and lateral extent. Well completion information suggests that the aquifer system is a confined aquifer with static water levels above the reported well completion depths. Domestic well yields from this system are reported to be up to 50 gpm. Substantially higher yields, from 75 to 2,847 gpm, are reportedly available from high capacity wells used for municipal, commercial, or industrial use. The Bluffton / New Castle / Tipton Till Aquifer System is similar to the Bluffton / New Castle / Tipton Aquifer System but the presence of water bearing zones in this till aquifer are less prevalent, thinner, and discontinuous in nature. Groundwater resources from this aquifer are derived from inter-till sand and gravel layers within the thick clayey till deposits. Domestic water supplies are reported to be between 10 to 40 gpm in the aquifer. High capacity wells are capable of yielding up to 1,000 gpm.

GEOHAZARDS

Karst

Bedrock underlying this area consists of Silurian age limestones, dolomites, and calcareous shales. Additionally, Ordovician age carbonates and shales are reportedly present in a deep preglacial valley which bisects the West Fork White River Valley. Carbonate rocks are susceptible to dissolution by acidic groundwater referred to as karstification. Purer limestones and gypsum are more susceptible to formation of karst. Impurities in the rock, such as quartz, shale, siltstone, and other minerals, including magnesium, which replace calcium in limestone to form dolomite, decrease the solubility of the rock and reduces the potential to form karst.

Karstification occurs as acidic groundwater drains through existing rock fractures. Chemical reactions between the rock and the water result in the dissolution, or dissolving, of the rock. As the dissolution occurs the existing fractures widen and can result in the formation of sinkholes, caves, and underground drainage systems.

Karsts in Indiana are most prevalently found in the rock formations in the southern part of the state where sinkholes, caves, sinking streams, and underground drainage systems are common, as shown in **Figure 2.17**. These formations are generally associated with the Mitchell Plateau, which is underlain by limestone and dolomitic rocks of the Mississippian age Sanders and Blue River Groups, with some of these rocks being highly susceptible to dissolution. As indicated previously, limestones and dolomites are present within the study area; however, the bedrock in the formation at the proposed project site is not known to be as susceptible to dissolution as those rock types found in the southern portion of the state. Existing fractures and bedding plane surfaces with minor dissolution have been observed in bedrock cores from this investigation. This fracturing and limited dissolutioning contributed to the formation of the

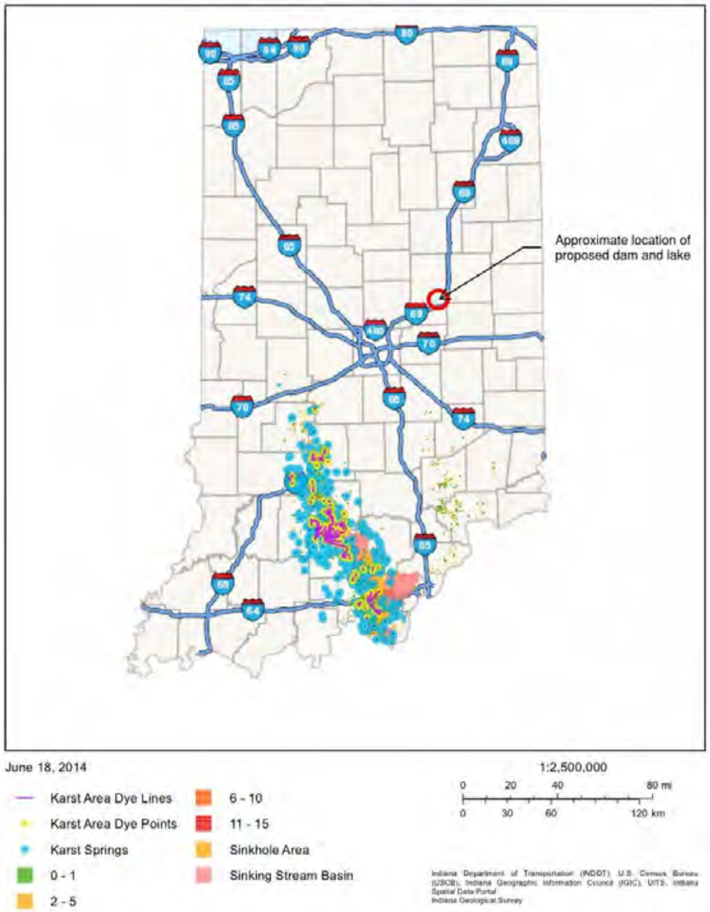


Figure 2.17 Indiana Karst Map

carbonate aquifers which underlies this region. Sinkholes, caves, sinking streams, and underground drainage systems are not identified with the rock formations at the subject site. Additionally, these formations are typically covered with a thick layer of glacial soils, which slows infiltrations rates and buffers acidic groundwater, thus resisting the formation of karst features in the rock.

Mineral Resource Quarrying

As indicated in the section above describing the geologic conditions the West Fork White River flows in a valley containing glacial outwash. The outwash deposits, typically consisting of sand and gravel, were deposited by glacial melt water flowing in the valley. Mineral resource mapping of the area from the State of Indiana indicates that the river valley from Chesterfield westward is a potential sand and gravel resource area. The locations of the mineral resources are depicted on **Figure 2.16**. Historical plat maps from 1954 were obtained from www.historicalmapworks.com. These maps indicated that property owners along the river, upstream of the proposed dam, included the Stillwell Sand and Gravel Company and the Western Indiana Gravel Company. Each of these companies owned large land tracts adjacent to the river. Historical aerial photographs from the state of Indiana have indicated that these resources have been mined during the last century, as several open pit sand and gravel quarries were opened in the valley. These historical maps and aerial photographs also indicate that these activities resulted in the relocation of the river channel in a northward direction east of Scatterfield Road sometime between 1939 and 1950 as shown on **Figure 2.18**. Many of the areas immediately upstream of the proposed dam appear to have been quarried for sand and gravel. The full extent and depth of these quarry activities has not been determined. Historic aerial photographs suggest that the quarry activities consisted mostly of dredging near-surface deposits. On the basis of historical mapping and aerial photographs, quarrying does not

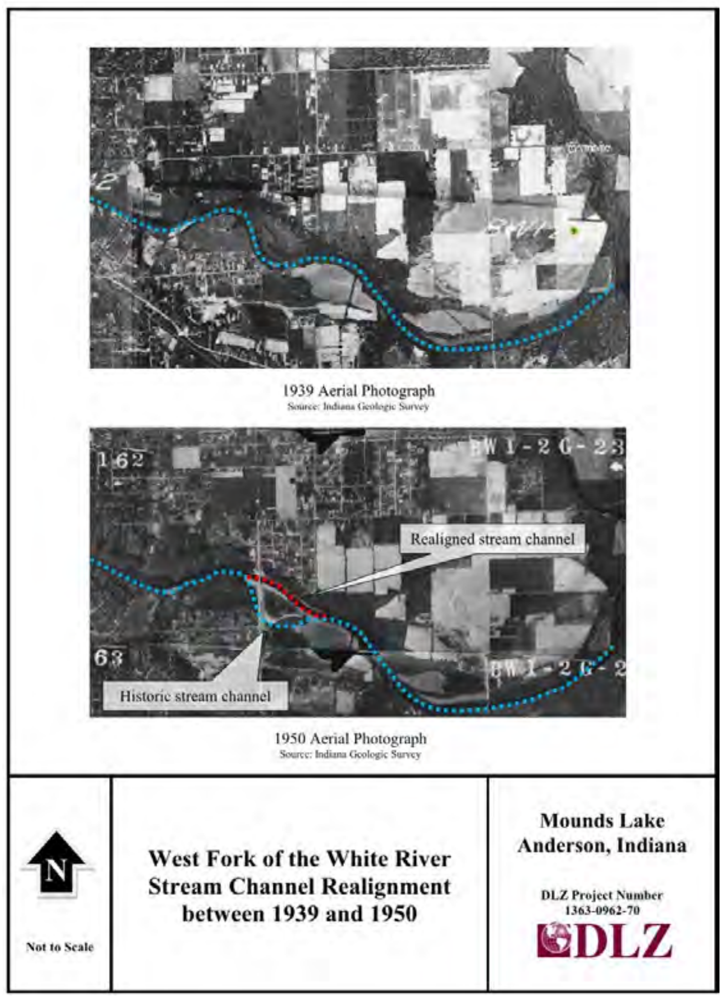


Figure 2.18 Historical Map/Aerial Map of Scatterfield Road

appear to have occurred within the footprint of the proposed dam.

EXPLORATION

The preliminary subsurface investigation for the proposed Mounds Lake and Dam was conducted between February 25 and April 22, 2014. The investigation was conducted using a CME 750X drill rig mounted on a tracked, all-terrain carrier and a truck mounted CME 75 drill rig. Six borings were drilled to a depth of 84 to 130 feet below ground surface, depending on the location and the presence of bedrock. All borings were advanced with flush joint casing and mud rotary methods to the completion depth of the borehole or the top of bedrock. Three borings, B-001-14, B-002-14, and B-003-14, were drilled into bedrock. Three borings were drilled in the vicinity of the proposed dam and three others were drilled in areas that would be within the inundation area upstream of the proposed dam. The three borings in the dam area, B-001-14, B-002-14, and B-003-14, were drilled on the south end of the proposed dam, adjacent to the river near the deepest portion of the valley along the proposed dam alignment, and on the north end of the proposed dam, respectively. Boring B-005-14 was drilled just north of the river off S. Rangeline Road. Boring B-006-14 was drilled near the west end of the Anderson Municipal Airport runway near the river. Boring B-007-14 was drilled adjacent to the river in Walbridge Acres Park in the town of Chesterfield. The boring locations were selected and field located by DLZ engineers and the respective location and ground surface elevation was measured using handheld GPS. The locations of these borings are depicted on the Plan of Borings and the ground surface elevations at the boring locations are listed on the individual boring logs, which are included in **Appendix B.**

The results of historic soil borings performed for four bridge projects in the proposed inundation area were also available and considered as part of this exploration. The historic borings were for the following bridges over the West Fork White River:

- Madison SR 109/SR 9 (Bridge File: 109-48-3727A);
- Madison SR 32 (Bridge File: 32-Gg ,4513);
- Madison CR 500 E/County Line Road (Bridge File: Madison 10442); and
- I-69 (Bridge File: I-69-32-4741 & 4741J).

The results of four to ten borings were available for each of the bridge structures with boring depths ranging from approximately 16 to 52 feet below the ground surface. Historic plan sheets presenting the individual historic boring logs and approximate boring locations, copies of the boring logs and plans for all of these structures are included in **Appendix B.**

DISCUSSION

The West Fork White River flows within a glacial stream valley that was formed during the Wisconsinan Ice Age as melt water flowed away from the retreating glacial margin. Topographic mapping of the area indicated the glacial valley is substantially wider than the existing stream channel in which the river currently flows. Highlands and bluffs along the valley were used to identify the margins of the ancient stream channel. The existing river meanders within this existing ancient stream channel. Soil types vary across the area, but, in general, soils in the valley of the West Fork White River are derived from glacial outwash parent materials. The near surface soils away from the valley are formed from glacial till and glacial drift deposits. Published information, borings from previous investigations, and borings from this investigation report the presence of stratified sands and gravels in the subsurface, which is consistent with the depositional environment of glacial outwash deposits. Sufficiently thick near-surface deposits of sand and gravel were quarried during the previous century. Historical aerial photographs and maps indicate that the area upstream of the proposed dam was extensively quarried. These maps and photographs also indicated the suspected man-made movement of the river channel east of N. Scatterfield Road as a result of the quarrying of these aggregate resources and resulted in the straightening of the river in this area.

Published surface topographic information and bedrock surface contour data indicate that the soils are relatively thick in the study area. The thinnest overburden (i.e., soil) thickness is located in the vicinity of Daleville, the easternmost extent of the study area, and in the river valley at the toe of the proposed dam. These soils are around 40 to 50 feet in thickness. The greatest soil thickness is anticipated along the preglacial valley that bisects the project area near the northwest end of the airport runway. Soils in this area are anticipated to be over 200 feet thick. The soils in the study area consist of both cohesive soils (i.e., clay and plastic silt) and granular soils (i.e., gravel, sand, and non-plastic silt). Cohesive soils are generally low permeability soils that resist the migration of groundwater through the soils, and granular soils consisting of sand and gravel are typically significantly more permeable than cohesive soils. In general, the soils in the area that are classified as granular soil contain fine grained components, such as clay and silt, that reduce the permeability of the predominantly granular soil matrix.

Generally, bedrock in the area varies in depth, from approximately 80 feet in depth to over 200 feet below the ground surface. Geologic mapping across the region indicates the surface of the bedrock is not flat and that preglacial drainageways and other features have been carved into the surface of the bedrock. These bedrock features were covered by glacial and other soil deposits. Due to the thickness of the overburden, these bedrock features are not expressed at the surface. Geologic mapping indicates that a deep drainageway or ancient river channel cuts a perpendicular path across the West Fork White River north of the Anderson Municipal Airport. Bedrock in this area is anticipated to be over 200 feet below the ground surface; however, due to the thickness of the overburden, there is no expression of this significant subsurface feature at the surface.

The bedrock formations anticipated in the area are from the Bainbridge Group and the Maquoketa Group. These formations consist mostly of carbonate bedrock that primarily consists of dolomite with lesser amounts of limestone, shale, and argillaceous limestone/dolomite. These bedrock formations also make up the extensive bedrock aquifer that underlies most of the region. The Silurian Age Bainbridge Group is the upper most bedrock unit within the area of the proposed dam and lake. The upper portion of the Ordovician Age Maquoketa Group is reportedly the upper most bedrock unit in the area where preglacial erosion has cut through the Bainbridge Group and into the deeper bedrock.

SUMMARY OF GEOTECHNICAL CONSIDERATIONS

Published data and information from previous investigations were reviewed for this preliminary investigation. In addition, borings were drilled at several locations to assess the subsurface conditions at the proposed dam and upstream areas. Generally, the information reviewed indicates that the underlying dense and hard soils, as well as hard, competent bedrock, offer suitable support for the proposed dam and associated structures. Soils within the proposed inundation area upstream of the dam consist of both cohesive and granular soils. The presence of clayey soils with silty granular soils reported in the borings from this investigation, as well as other borings for structures in the area, indicates that the soils are capable of supporting the proposed impoundment. Conditions encountered suggest that water losses through leakage will occur in areas where soils with higher granular content are present. The soils with the highest granular content identified thus far have been in or adjacent to the West Fork White River. The extent of these granular soils has yet to be determined upstream of the proposed dam. The presence of artesian groundwater conditions encountered in historical and current borings indicate the presence of confining layers in the subsurface that limit the vertical migration of groundwater and surface water in the valley.

A number of existing site conditions were assessed as part of this investigation. A few of these were identified as items that could present engineering challenges and add additional cost and or extend the schedule for construction of the project; however, no items were identified by this investigation that preclude the site as geotechnically unfeasible. The following paragraphs address those items that were determined to have the greatest potential geotechnical engineering related impact to the project.

Dam structural stability: The proposed dam structure will cross the existing West Fork White River Channel and the preexisting, wider, glacial outwash channel in which it flows. On the basis of the preliminary boring results drilled across the proposed dam alignment, the existing and ancient channels contain deposits of dense, compact granular soils (i.e., sand, gravel, and non-plastic silt) and layers of hard cohesive soils (i.e., clay and plastic silt). These soils are underlain by hard dolomitic bedrock. It is anticipated that the soils and bedrock at this site will provide suitable support for the anticipated concrete gate structure, concrete spillway, and earthen embankments. Additionally, the soil density/hardness across the base of the proposed alignment appears to be relatively uniform and the thickness of the overburden appears to vary relatively gradually (approximately 3 percent slope in the bedrock surface based on the three borings performed along the alignment). Therefore, differential settlement from uneven settling of the soils beneath the structure is anticipated to be within tolerable limits. Additional investigations will be necessary to assess in more detail the subsurface conditions in the dam area prior to making final design recommendations.

Dam under-seepage: Although the granular soils in the existing and ancient channels are dense, granular soils by nature are permeable and prone to seepage. Therefore, the mitigation of seepage beneath the proposed structure will be required to construct the dam. Typically this is accomplished through the construction of a cutoff wall, grout curtain, soil improvement/mixing, or other methodology to limit the seepage of water beneath the dam. Additional investigations beneath the proposed dam and adjacent areas will be needed to determine the best methodologies to accomplish the cutoff of seepage.

Reservoir leakage: Reservoir leakage or the ability to maintain the reservoir pool with normal inflows is also related to seepage. As indicated above, seepage related to the sand and gravel deposits in the valley are a potential challenge to maintaining the reservoir pool. These deposits are anticipated to be present beneath most, if not all, of the proposed impoundment. This valley is contained within a larger, regional, glacial drift deposit that consists of clayey soils. These clayey glacial drift deposits tend to act as boundaries to the horizontal and vertical migration of water in the subsurface. This glacial drift deposit also contains layers of water-bearing sand and gravel, as well as the clayey layers. Since artesian groundwater conditions were encountered during the historical drilling of borings for bridge crossings, as well as this current investigation, their presence indicates that some of these saturated sand and gravel layers are confined, or isolated, by the clayey glacial till layers. The confining of these saturated layers result in the excess water pressures that produce artesian flow. These artesian conditions indicate that the clayey till is acting as a boundary to the migration of water in the subsurface, at least in some areas.

Historic surface mining: Quarrying of sand and gravel resources are known to have occurred historically in the areas of the proposed dam and impoundment area. It is also known that sand and gravel resources are documented to be present from Chesterfield west along the ancient river channel in which the West Fork White River flows. Currently no active quarrying is occurring in the area of the proposed project. The disruption of subsurface conditions by these quarrying activities was a concern, specifically in the area beneath the proposed dam structure. This included the possible rechannelization of the river beneath the dam. Based on historical information, maps, and aerial photographs, it appears that quarrying in the valley occurred east of Scatterfield Road where the river was dechannelized. This quarrying did not appear to extend into the area of the proposed dam. Additionally, the quarrying activities appeared to be restricted to the readily accessible, near surface deposits. Potential disruption of the soils beneath the dam by unknown quarrying activities and/or subsequent backfilling with uncontrolled fill materials should be explored and identified during subsequent investigations for underseepage and structural assessment investigations.

Cobbles and Boulders: Glacial till and glacial outwash deposits are present across the study area. Both deposits characteristically contain cobbles and boulders which can impede construction excavation activities such as cutoff trench installation or temporary earth retention structure installation. Clusters of cobbles and boulders can also present potential for zones of increased permeability of groundwater. Hard igneous and metamorphic cobbles and boulders were not identified in the limited number of borings conducted for this current investigation. However, hard carbonate gravel has been encountered in the dense sand and gravel outwash. Although boulder fields within the till layers or outwash have not been identified by the borings, it is anticipated that cobbles and boulders suspended in the till, known as glacial erratics, will be less common than in the outwash or in the discontinuous layers of sand and gravel within the till deposits. Additional borings are planned as part of the next phase of investigation and may identify areas that contain higher concentrations of cobbles or boulders.

RECOMMENDATIONS

Based on the findings of the current investigation, the existing soils beneath the proposed dam alignment consist of predominantly dense to very dense granular soils and hard cohesive soils overlying hard dolomite bedrock. These existing foundation soils should provide suitable support for the proposed earthen dam with typical side slopes of 3(H) to 1(V). Zoned embankment construction is recommended utilizing a clay core and granular shell material, in order to optimize usage of the available materials as well as providing seepage and stability performance of the embankment. A key trench should be constructed along the dam alignment and extend into the cohesive glacial till soils located in the upland areas. An extended under-seepage cutoff wall is recommended beneath the portion of the dam located within the glacial valley due to the predominantly granular soils encountered in this area.

Additional Investigations

Additional borings, monitoring wells, and laboratory testing of soil and rock samples will be needed to develop more detailed information on the subsurface stratigraphy and the geotechnical engineering parameters. The additional information derived from the borings and monitoring wells will be used to determine the following:

1. Extent of under-seepage cutoff, type of cutoff wall, depth and lateral extent;
2. Need for any soil treatment or overexcavation needed for foundation support of the dam embankment and spillway;
3. Location of a borrow source for construction of the dam embankment;
4. Strength, compressibility, and permeability of the foundation soils and borrow material to be used in the earth embankment, including identification of materials disturbed by or replaced after quarrying activities;
5. Depth and condition of potentially karstic limestone bedrock;
6. Extent of cobbles and boulders for impact on excavation of cutoff wall, temporary earth retention structures, and underseepage; and
7. Permeability of the soils in the inundation area to evaluate leakage potential of the reservoir.

4. I-69 over White River Bridge Raising/ Replacement Feasibility

Goal: **The intent of this section of the study is to perform a preliminary evaluation for the feasibility of raising the grade of I-69 over the White River in Delaware County to create the largest potential headwater area possible at the bridge structures. This will include a preliminary alignment and profile grade along I-69 that maximizes the grade change at the river, as well as any grade changes for the ramps for SR 67 and SR 32. The study will include evaluations of alternate span configurations to minimize the superstructure depth and an "order of magnitude" cost for the resulting bridge square footage area.**

Summary: **The profile developed included roadway reconstruction over a 2,400 linear-foot section. The proposed elevation difference at the SR 32 interchange ramps would be minimal (maintaining the required SR 32 bridge clearance) so minimal work will be required to tie the existing ramps into the new roadway grade. Preliminary costs for the roadway reconstruction work were calculated to be $6.2 million ($5.6 – $6.7 million). The bridge portion of this review investigated the worst case scenario of the complete replacement of the existing bridges with new structures on the same alignment. Preliminary costs of the updated 5-span bridge were calculated to be $14.2 million. Adding the upgraded roadway costs to this resulted in a total preliminary project cost of $20.4 million.**

Next Steps: **The next steps include performing coordination with INDOT and preliminary engineering of the I-69 bridge crossing over the White River to determine the best design parameters to follow during the final design. This review would include a comparison of a 4-span and 5-span option, final bridge elevations and required underclearance, and cost comparison of options to allow for selection of a preferred alternative. As an alternative, a 4-span configuration was developed and compared to the existing 5-span configuration. Although 4-span structures may be more economical, the construction depth is approximately 6-inches greater. Economic justification for this change would require the development of more detailed costs and final elevations.**

Description

As part of the reservoir project, a preliminary evaluation was conducted regarding the feasibility of raising the grade of I-69 over the White River to increase the potential headwater elevation at the structures. The proposed reservoir dam will result in the I-69 twin bridges over the White River to be within the headwater area of the reservoir, so the proposed profile grade of I-69 raised the elevation to provide for 1-foot of freeboard over the 100-year flood elevation in the headwater area of the reservoir. This change results in raising the low chord of the bridges a minimum of 5 feet.

Roadway

To increase the profile grade, a preliminary alignment was developed along I-69 that raised the grade of bridge crossings 5-feet above the existing elevation. This new profile was developed using the construction plans for the existing bridges, Contract Number R-21607. No additional field survey was performed for this study. Preliminary alignments and profiles were not developed for the required grade changes affecting the SR 67 and SR 32 interchange ramps. The existing alignments of I-69 between Stations 870+00 and 905+00 were maintained as part of this evaluation to minimize the impacts of the changes.

Several constraints were identified as part of raising the proposed roadway profile:

1. The existing geometrics of the bridges had to be maintained – for example, the elevations of the bridges were raised while keeping the structures parallel to the existing ones. Since there is a vertical curve on the structures at Station 894+55, this was maintained and another vertical curve in the same direction was added to match the existing grades.

2. The vertical clearance at the SR 32 Bridge at Station 880+00 over I-69 was maintained.

Based on these constraints, the proposed profile was developed with the raised bridge structures, as shown in **Figure 2.19**. This includes roadway reconstruction within the limits of Station 879+50 to Sta. 903+50, or 2,400 linear -feet. Since the proposed elevation difference at the SR 32 interchange ramps is minimal (maintaining the required SR 32 bridge clearance), it is anticipated that minimal work will be required to tie the existing ramps into the new roadway grade. Preliminary costs for the roadway reconstruction work were calculated to be $6.2 million ($5.6 – $6.7 million).

Bridges

The bridge portion of this review investigated the worst case scenario of the complete replacement of the existing bridges with new structures on the same alignment. The replacement structures will have the same lane configuration as those existing, while the shoulder widths will be upgraded to the current Indiana Design Manual standards. The length of the proposed structures was calculated using the existing structure length and increasing that length by extending the existing 2:1 spillslopes. No additional hydraulic or economic analysis was performed.

Cost

Preliminary costs of the updated 5-span bridge were calculated to be $14.2 million. Adding the upgraded roadway costs to this resulted in a total preliminary project cost of $20.4 million.

Alternative Span Configuration

As an alternative, a 4-span configuration was developed and compared to the existing 5-span configuration. Although 4-span structures may be more economical, the construction depth is approximately 6-inches greater. Economic justification for this change would require the development of more detailed costs and final elevations.

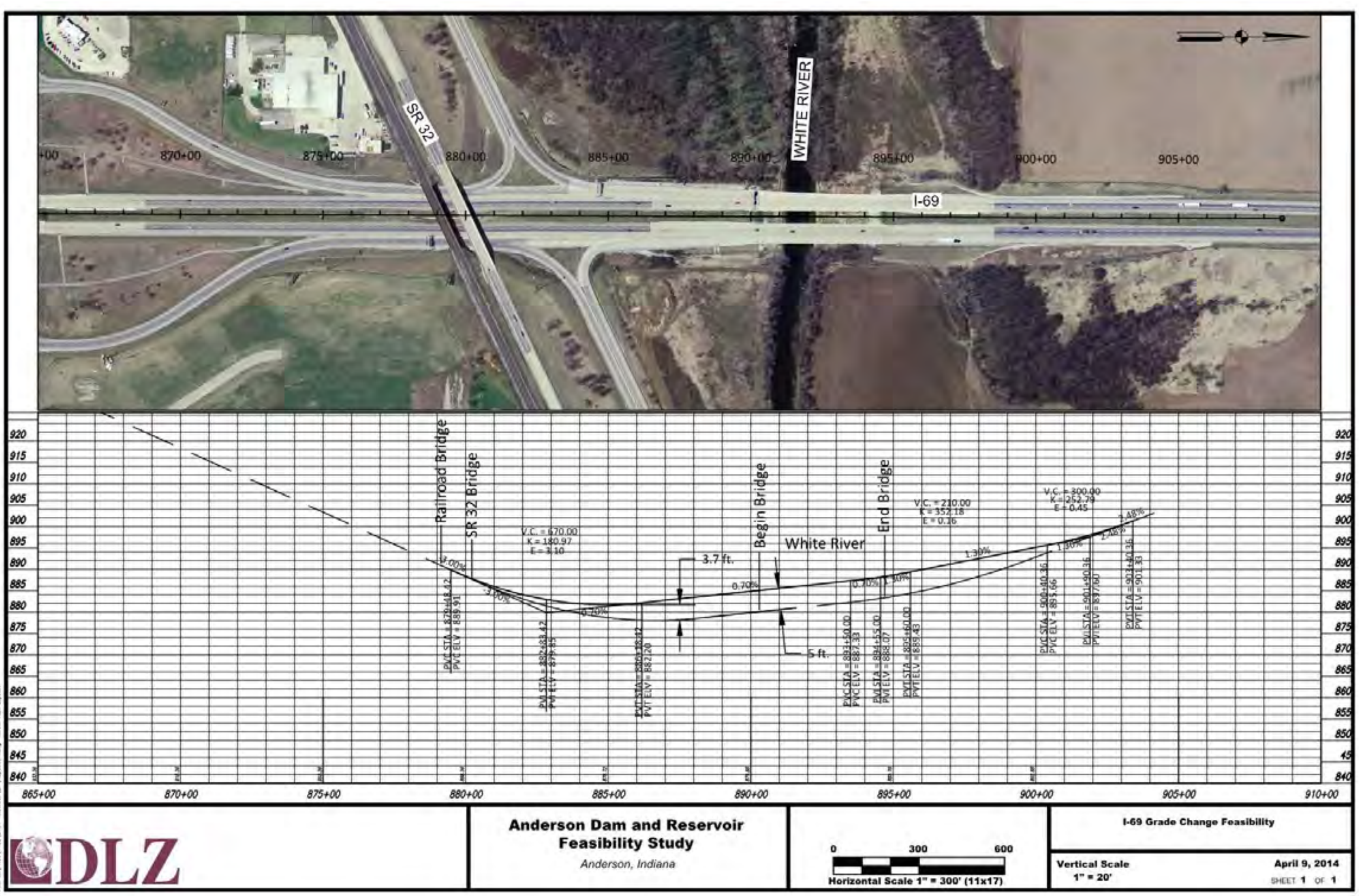


Figure 2.19 Proposed Profile

5. Effect of Reservoir on the Chesterfield and Yorktown WWTPs

Goal: **The intent of this section of the study is to determine the effect of the reservoir on the Chesterfield and Yorktown wastewater treatment plants (WWTP), as shown in Figure 2.20. This includes evaluating the new pool heights on these plants along the new shoreline and the impacts of not discharging into a riverine water body. This also includes evaluating the impacts on the NPDES permits for the plants based on meetings with officials from IDEM and reviewing the new flood elevations and impact on the plants' operations.**

Summary: **Using the new proposed pool elevation of 876 feet and the new 100-year floodplain elevation of 878.6 feet, investigations indicate that there will be no impacts to the Yorktown WWTP's operation or structures. Conversely, the Chesterfield WWTP operation and structures will be impacted by the new pool level. To meet its NPDES permit requirement of the 25-year floodplain elevation, additional site improvements will be required. Possible improvements to protect the WWTP include construction of a flood control levee or elevation of structures and processes. The existing treatment processes are adequate to meet the more stringent water quality permit conditions anticipated due to a lake discharge.**

Next Steps: **Discussions with Chesterfield officials regarding impacts of the reservoir to the WWTP will continue as part of the next phase of the project. Specifically, the options to protect the WWTP will be evaluated with local officials.**

Feasibility Study and Analysis

The intent of this study is to determine the potential effects of the proposed dam's new water pool elevation of 876.00 feet on the existing Chesterfield and Yorktown Wastewater Treatment Plants (**Figure 2.20**). The primary impact anticipated is due to changes in the current discharge point becoming a lake shoreline discharge rather than discharging into a tributary of the White River for the Chesterfield plant. This study will also evaluate the ability of the plants to meet their proposed new water quality standards and the impact of this new water pool elevation on their protection against the 100-year floodplain elevation.

Yorktown Wastewater Treatment Plant

Assessment

The existing Yorktown Wastewater Treatment Plant's discharge is 3.3 miles upstream of the highest reaches of the proposed dam's normal pool elevation (**see Figure 2.20**). Per 327 IAC 5-10-4, Section 4(a), the current water quality standards will not change since this plant's discharge will still be greater than 2 miles upstream of the new reservoir.

Chesterfield Wastewater Treatment Plant

Assessment

The existing Chesterfield Wastewater Treatment Plant, as shown in **Figure 2.21**, is a 1.0 MGD extended aeration treatment facility permitted to discharge under NPDES Permit IN 0063983.

Flow metering is present for both the influent and effluent flows. Sludge dewatering is accomplished through a Twin Blue River Technologies System, with dewatered sludge disposal in a landfill. Please see **Exhibit 2.21** for more details and the overall plant layout.

The current Chesterfield plant will be impacted by this new dam's water pool elevation of 876.00. Not only will this existing plant's water quality discharge limits change as a result of a direct lake discharge, but there will be a new 100-year floodplain elevation of 878.60 that will impact all of its existing structures at the plant **(see Figure 2.22).**

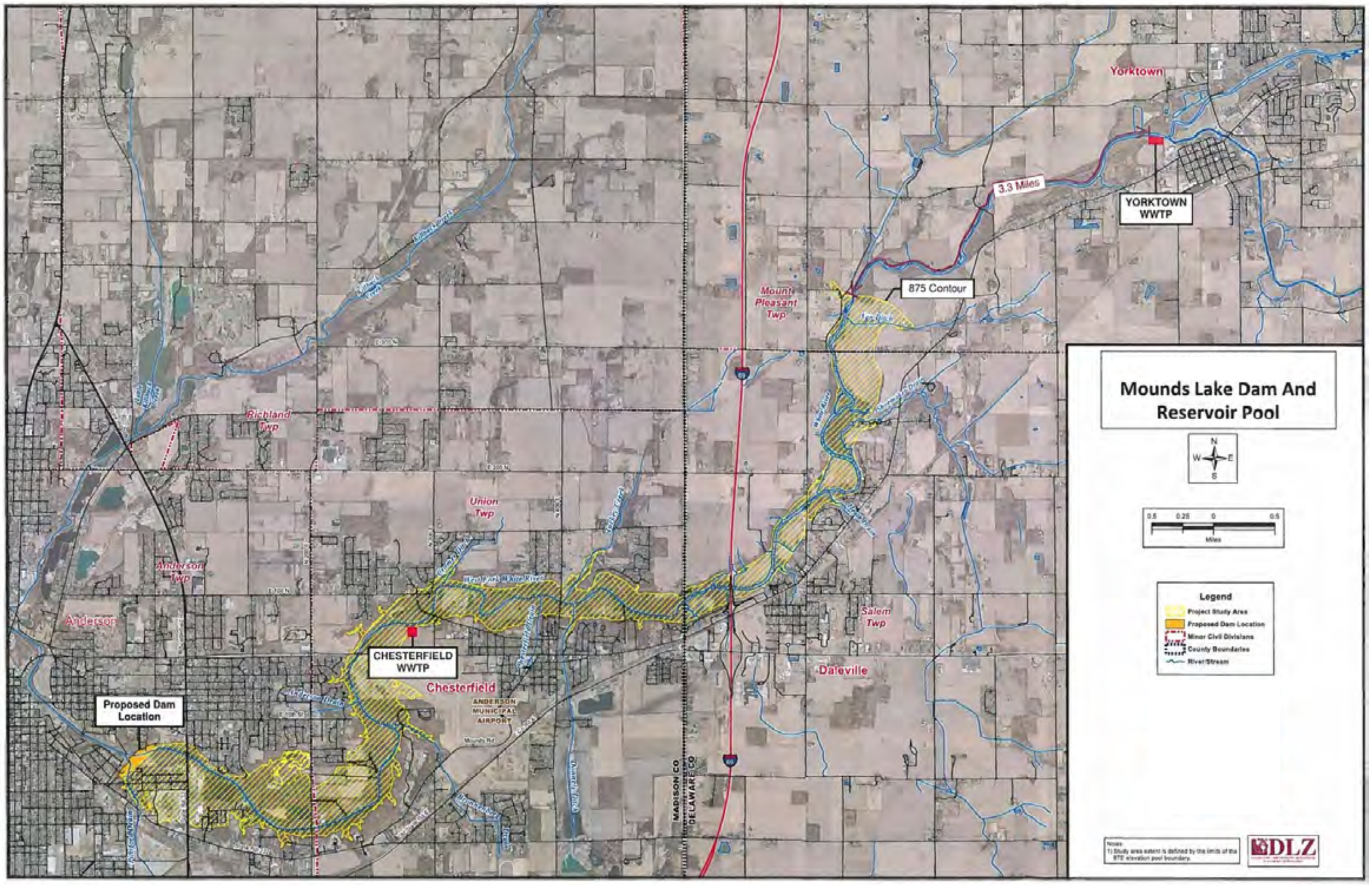


Figure 2.20 Existing Chesterfield and Yorktown Wastewater Treatment Plants

Water Quality Impacts

The impact of changing the water quality limits to those related to direct discharge into a lake is shown in the **Table 2.8.** Per 327 IAC 5-10-4, Section 4(a), lake and sinkhole dischargers must meet those stated in **Table 2.8.**

As can be seen from the comparison table, the only changes to the plant's current water quality discharge standards is the addition of a 1 mg/L phosphorous limit and year-round disinfection. The existing wastewater plant was originally designed with a similar anticipated phosphorous limit. Accordingly, the current plant has the capability to achieve phosphorous removal to the 1 mg/L level utilizing the "luxury uptake" potential of the plant's biomass. This can be accomplished with the present anoxic zones that already exist at the beginning of each of the plant's existing operational trains. To achieve this, submersible mixers would need to be installed in both influents' tanks. This would help provide the correct mixing requirements for the biomass without oxygen additions. There may also need to be minor changes in the plant's current operations to help remove the phosphorous to the new limits. The existing plant uses ultraviolet disinfection from April 1 to October 31 each year for disinfection compliance. Complying with year-round disinfection would require that this process be maintained throughout the entire operational year (**see Figure 2.22**). This would increase the plant's operational budget and disinfection system maintenance needs, but no new equipment would be required to meet this requirement.

Flooding Impacts

The proposed dam pool elevation of 876.00 will have a major impact on the Chesterfield plant's structures. As shown in **Figure 2.22**, the dam's pool elevation and the new 100-year flood elevation of 878.60 feet are imposed on the existing topographic site plan. **Figure 2.23** shows the impacts to the plant's hydraulic profile. The major plant's operational components impacted are the plant's

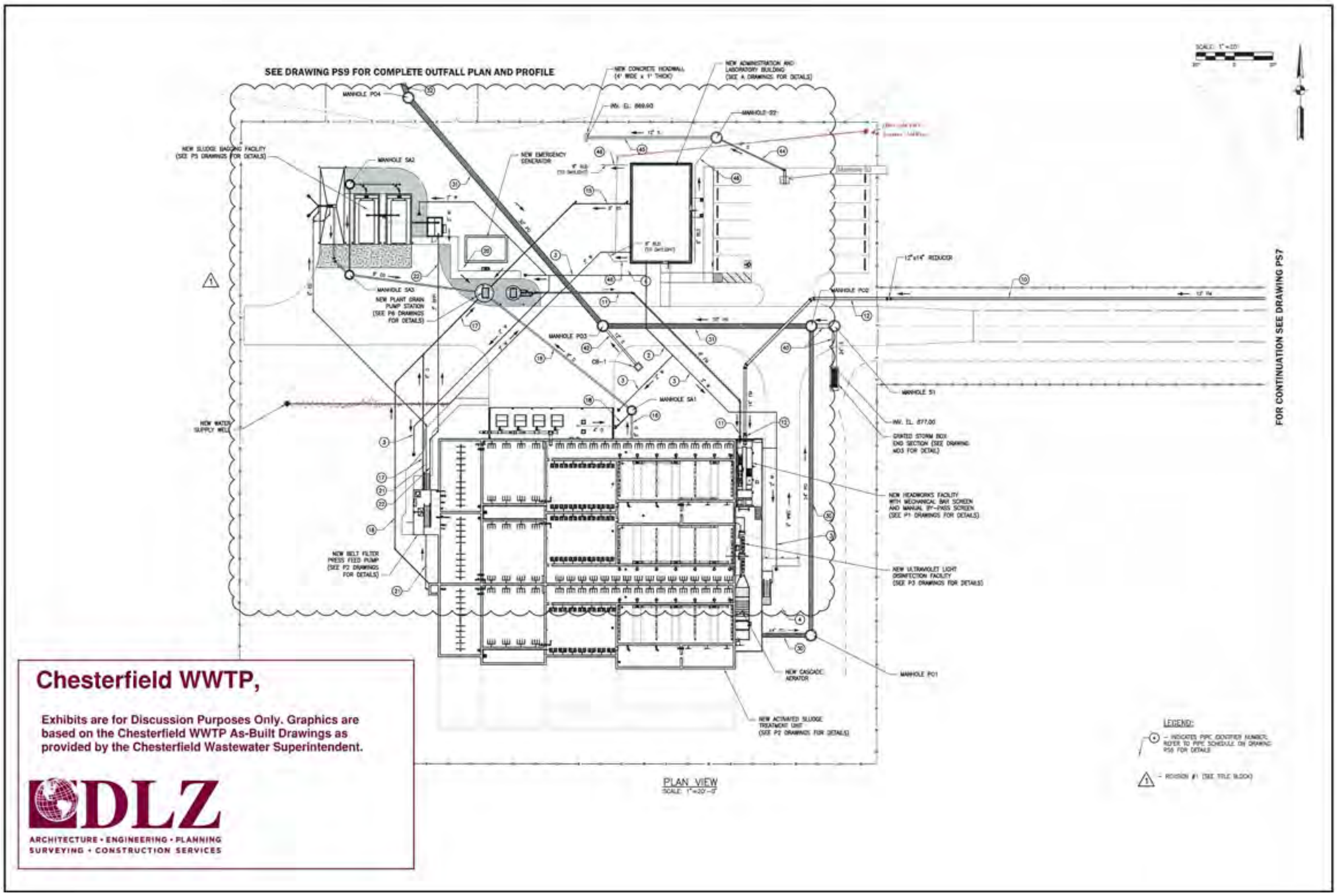


Figure 2.21 Overall Existing Chesterfield Wastewater Treatment Plant Layout

	Existing NPDES Permit NPDES #IN0063983		Proposed New Lake Shoreline Dis-charge	
Pollutant	**Monthly Average Concentration (mg/l)**	**Weekly Average Concentration (mg/l)**	**Monthly Average Concentration (mg/l)**	**Weekly Average Concentration (mg/l)**
CBOD5	10	15	10	15
Total Suspended Solids (TSS)	12	18	12	18
Total Ammonia, as N	-	-	-	-
Summer (May - November)	1.1	1.6	1.1	1.6
Winter (December – April)	1.6	2.4	1.6	2.4
Dissolved Oxygen	6.0		6.0	
Phosphorus †	None	None	1.0	
Disinfection ‡ E. Coli	125 cfu/100 ml (April 1 - October 31)	235 cfu/100 ml (April 1 - October 31)	Year Around	Year Around

† Added Compliance Limit for Phosphorous.
‡ The existing plant uses Ultra Violet Disinfection. Added Disinfection Limits.

Table 2.8 Chesterfield Wastewater Treatment Plant's Discharge Limits discharge piping network, sludge dewatering process, standby generator, dewatering pump station, cascade post aeration process, and the plant's office building (**see Figure 2.23**). The remaining parts of the plant lie above the 876.00 elevation and will not be impacted by new pool level. The 100-year floodplain elevation of 878.60 feet will impact all the unit processes previously mentioned, as well as the new laboratory building and the new blower building structure.

In order for the plant to meet its NPDES permit requirement of the 25-year floodplain elevation, additional site improvements will be required.

REGULATOR DISCUSSIONS

The existing Yorktown and Chesterfield wastewater treatment plants were both evaluated regarding the potential impact of the proposed dam's water pool surface of 876.00 feet and the 100-year flood elevation of 878.60 feet. During this evaluation, **Figure 2.23** was developed to show the entire potential impact of the new dam and the corresponding pool.

DLZ presented this preliminary information to representatives from IDEM's Permits and Construction Departments in a meeting on June 11, 2014. The meeting including discussions regarding impacts of the new dam's water pool surface and the new 100-year flood elevations on these two wastewater treatment plants. DLZ presented **Figures 2.20-2.23** to help illustrate these impacts and explained that the water pool elevation would not have any effect on the existing Yorktown Wastewater Treatment Plant's operations or current structures.

DLZ also presented the effect that this new dam's water surface would have on the existing Chesterfield Wastewater Treatment Plant's operations and current

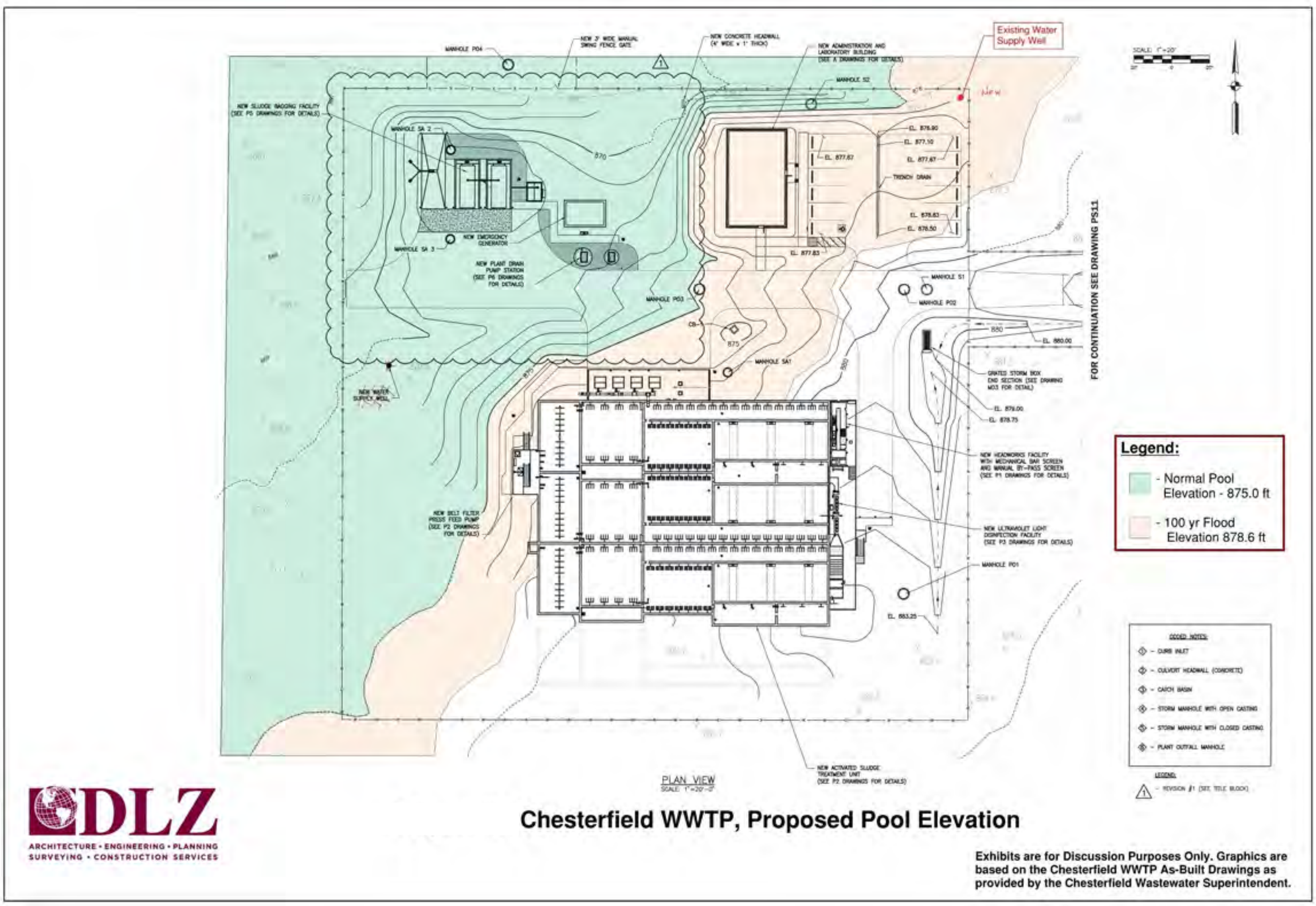


Figure 2.22 Chesterfield WWTP Proposed Pool Elevation

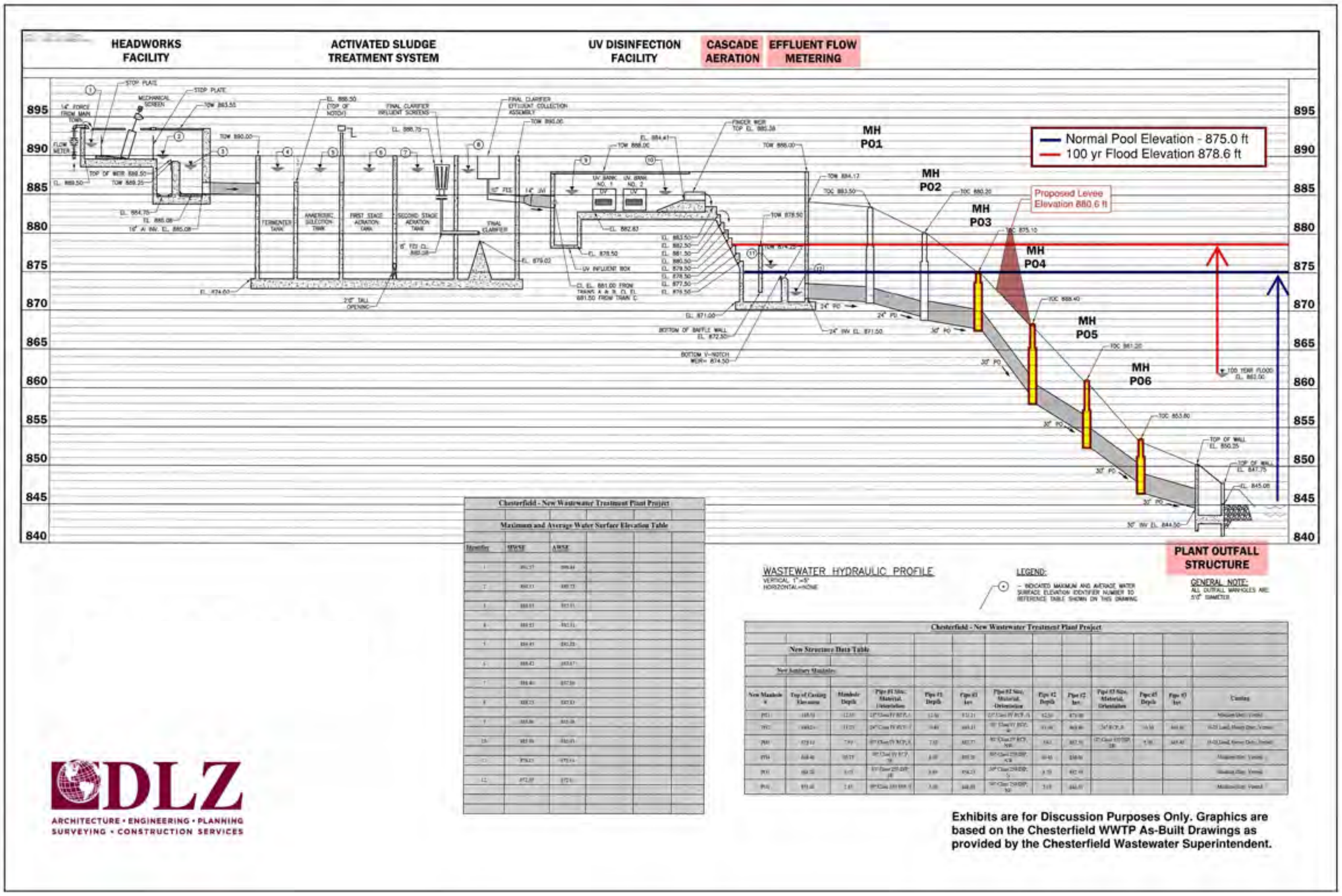


Figure 2.23 Impacts to Chesterfield Hydraulic Profile and Plant Operational Components

structures. IDEM officials noted that the current water quality limits for the Chesterfield Plant are very restrictive and that the current plant should have no issues meeting the lake discharge requirements. They also noted that there would be an operation impact with disinfection compliance for the entire year. At the conclusion, IDEM personnel asked DLZ to discuss results of this evaluation with representatives from both communities.

SUMMARY

As shown in **Figure 2.20,** the existing Yorktown Wastewater Treatment Plant is approximately 3.3 miles upstream from the headwaters of Mounds Lake. It is also noted that the current 100-year floodplain elevation for this plant will also not be affected. Therefore, there will be no impact on the existing Yorktown Wastewater Treatment Plant from the construction of this proposed dam.

The existing Chesterfield Wastewater Treatment Plant will be impacted by the new dam's water pool surface and the new 100-year flood elevation. The existing wastewater treatment process is capable of meeting the current water quality effluent and permit conditions, and these are very similar to what will be required for a new NPDES Permit for a lake discharge. Therefore, it is anticipated that very few improvements will be necessary at the existing plant in order to meet more stringent water quality permit conditions.

The existing wastewater treatment plant site will need to be protected from the dam's water pool elevation and the floodplain elevation. There are various methods to protect the Chesterfield WWTP, these options will be discussed and evaluated in conjunction with Town of Chesterfield officials.

In the course of evaluating the impacts to the Chesterfield and Yorktown treatment facilities, additional analysis will be required, including a modified Streeter-Phelps oxygen sag curve analysis to determine what impacts each plant's effluent and any runoff nutrients will have on the new stream flows.

6. Dam Flood Routing and Cost Estimates

Goal: **The intent of this section of the study is to perform hydraulic routing of the Probable Maximum Flood (PMF) event through the reservoir and dam for the selected pool level of 876 feet and to estimate the spillway/dam configuration required. This also includes completing preliminary estimates of construction costs for the dam/spillway.**

Summary: **The most recent updated calculations show that a combination of 250 feet of uncontrolled spillway at crest elevation 876 feet and 280 feet of gated spillway at crest elevation 860 feet would be required. This will achieve a PMF event elevation below the top of dam elevation. This is a significant improvement over the previous spillway model due to the use of mixed type spillways and more realistic geometries of the radial gate spillways. These results show that there is no overtopping of the dam during the PMF event and that there are decreases in the peak flow values downstream of the dam. This also allows for proper clearance under the I-69 Bridge during the 100-yr event.**

Next Steps: **The next steps include detailed studies to determine the optimal reservoir operational parameters for long-term policy development. There will also be a need to develop a more accurate HEC-RAS model in the future that incorporates all of the bridge crossings, detailed sensitivity analysis using a range of Manning's n values, better cross-section locations and geometry, and more accurate stream centerline alignment.**

Background

In the Mounds Lake Dam Feasibility Study dated December 8, 2011, flood routing was accomplished using the USACOE HEC-HMS program, assuming the use of either a fixed crest weir or a gated spillway. For a pool elevation of 876 feet, it was determined that a crested spillway of at least 1,100 feet in length was required to prevent overtopping an earthen embankment with a top elevation of 890 feet Using similar calculation, a gated spillway needed to be at least 530 feet so as not to overtop the dam. In both cases, these were chute-type spillways. After preliminary investigations and limited borings showed that the foundation materials would support more robust structures, ogee-shaped spillways were included since they are up to 30% more efficient in flow conveyance.

Flood Routing Analysis

To obtain a more accurate flood routing process in this review, a HEC-RAS model was developed along the reach of the White River where the proposed dam and reservoir are located. Cross sections along river were cut from the 2 foot LIDAR mapping data for the area using the HEC-GeoRAS extension in ArcGIS. Since the depth of water behind the dam under normal pool conditions would be significantly greater than with the 100-yr flood, to the use the FIS cross sections and even the stream centerline in the existing DFIRM data is not valid. Also, because of the significant depth of water along the stream due to the dam, the Manning's roughness values in the pool area of the dam would be relatively low and was adopted as 0.03 for the entire reach. Initial water surface elevations just below the dam location were calculated using normal flow conditions. None of the bridge crossings were considered to impact the model since they are likely to be raised, relocated or removed. Future routings are planned to account for any proposed crossings. A screen shot of the cross section locations are shown in **Figure 2.24**.

Flow hydrographs for the PMF and the 100-yr events were obtained from the HEC-HMS model developed in the previous study. These hydrographs are shown in **Figure 2.25**.

For the dam structure, a combination of a fixed crest spillway and gated spillways is proposed. The fixed crest spillway is good for maintaining a permanent pool without the constant operation of gates, while a gated spillway is useful for controlling reservoir levels during periods of

Figure 2.24 Cross Section Locations in HEC-RAS Model

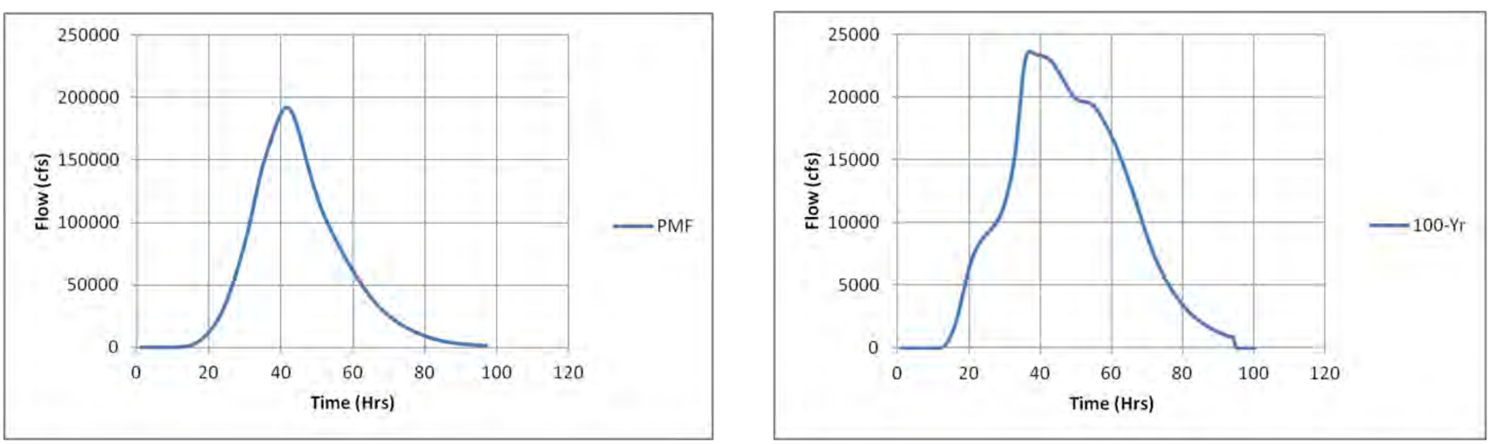


Figure 2.25 Inflow Hydrographs

Parameter	PMF Event	100-yr Event
Peak Inflow Discharge	191,695 cfs	23,616 cfs
Peak Outflow Discharge	174,319 cfs	23,411 cfs
Peak Elevation at Dam	889.1 ft	876.5 ft
Peak Elevation at Airport	889.3 ft	876.5 ft
Peak Elevation at I-69 Bridge	890.7 ft	876.8 ft

Table 2.9: Results of Flood Routing

moderate to high inflow. Using a combination of spillway types generates operational complexity in terms of arriving at an optimal control or gate operation policy. This is balanced against the significant operational flexibility provided, which will improve as experience and knowledge is gained with this combination.

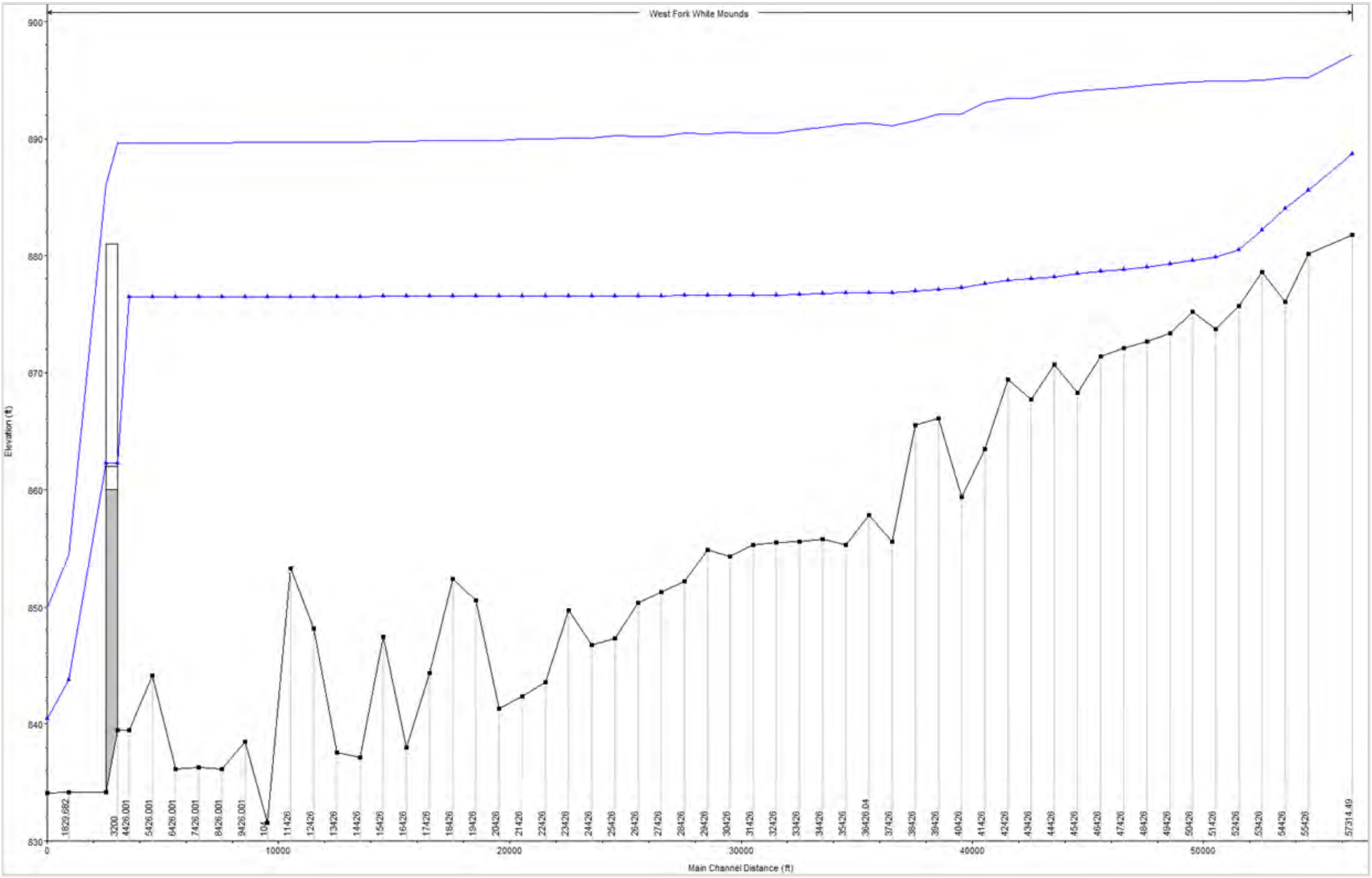
A significant constraint in setting the pool elevation (and any future gate control policies) is the clearance and freeboard requirement under the modified I-69 Bridge crossing upstream of the dam. Preliminary evaluations indicate that the water level at the I-69 Bridge location would have to be below 879.6 feet to obtain an average of 1 foot clearance under a raised bridge for the 100-yr event.

Preliminary calculations with an initial pool elevation of 876 feet showed that a combination of 250 feet of uncontrolled spillway at crest elevation 876 feet and 280 feet of gated spillway at crest elevation 860 feet would be required to achieve a PMF elevation below the top of dam elevation and to provide enough clearance under the raised I-69 Bridge For the 100-yr event. The current model is a significant improvement over the previous spillway model due to the use of uncontrolled and gated spillways, and more realistic geometries of the gated spillways. It is anticipated that the maximum opening through the radial gates would be smaller than the difference between the spillway crest and the top of dam (which supports a roadway for maintenance and operations). Other significant model parameters were the elevations at which the gated spillway was set to open and the rate of gate openings. For this study, conservative parameter values were used, with the elevation at which the gated spillway would open set at 876.5 feet at a relatively slow rate of 1 foot per 30 minutes. Future detailed studies will determine the optimal reservoir operational parameters for long-term policy development. A more accurate HEC-RAS model will also need to be modeled in the future that incorporates all of the bridge crossings, more sensitivity analysis using a range of Manning's n values, better cross-section locations and geometry, and more accurate stream centerline alignment.

The principal results of the analysis are shown in **Table 2.9**.

These results show that there is no overtopping of the dam during the PMF event and that there are decreases in the peak flow values downstream of the dam. This also allows for substantial clearance under the I-69 Bridge during the 100-yr event.

Profile plots of the HEC-RAS runs are shown in **Figure 2.26**



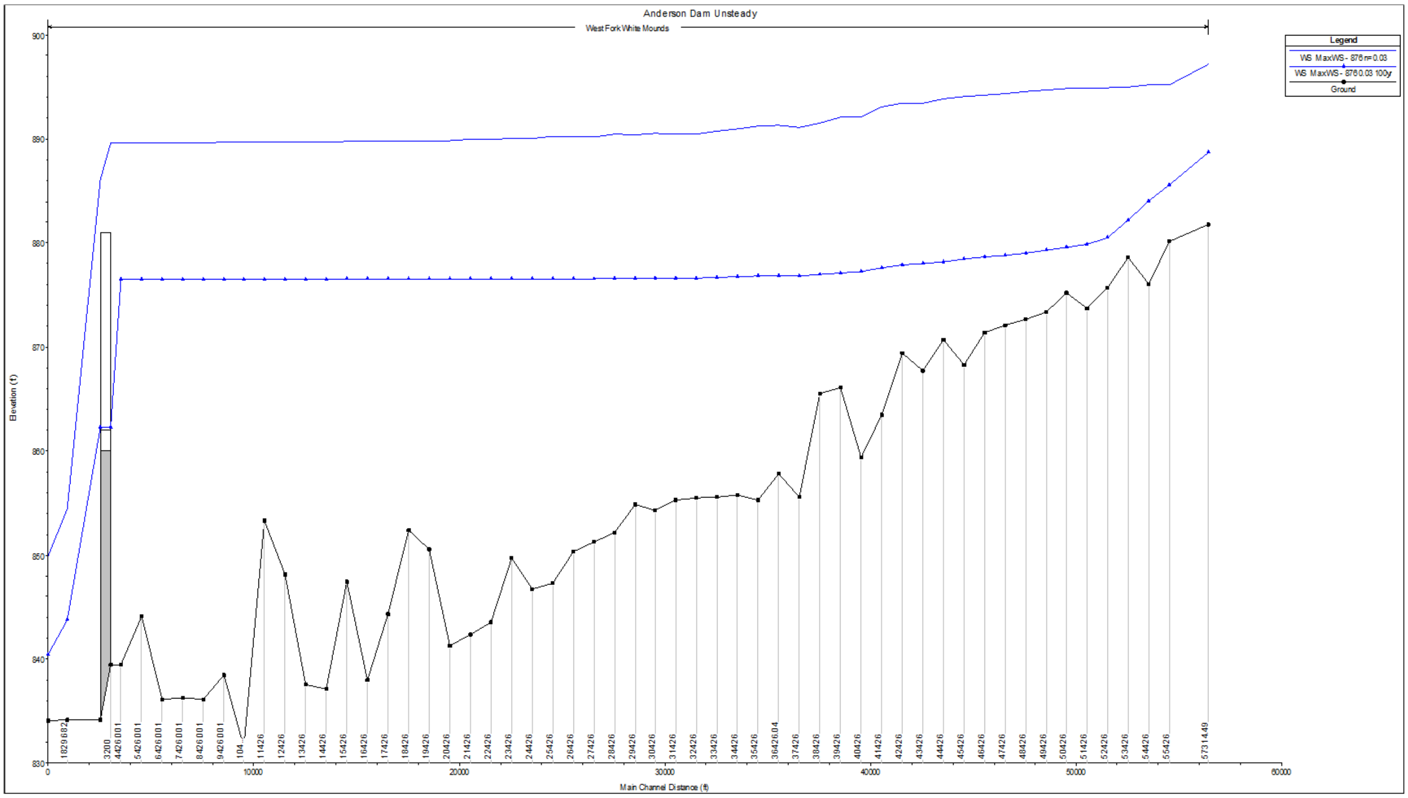


Figure 2.26 Water Surface Profiles

7. Opinions of Probable Cost

Goal: **The purpose of this section is to estimate the probable costs of the Mounds Lake project. Additionally, the cost to construct a water treatment plant to process water from Mounds Lake has also been considered as part of the Phase II Feasibility Study.**

Summary: **A feasibility level cost analysis for the Mounds Lake project has been performed as a part of this study. The cost analysis includes all items that are likely to be a part of the final project. The total probable cost of construction for the Mounds Lake reservoir is $440,000,000 in 2014 dollars.**

The cost to construct a new water treatment plant to process water from Mounds Lake was also examined as part of this feasibility study. By developing a water treatment plant, the community would have the ability to sell treated water to a wide range of utilities in the Central Indiana region. Analysis indicates that Mounds Lake has the capacity to produce 40 million gallons per day of water for sale, while maintaining several billions of gallons of water in storage to be used in the event of a long term drought. The probable cost to build the water treatment plant and associated infrastructure is $120,000,000. A discussion regarding the overall financial feasibility of selling processed water is discussed in the Phase II Financial Feasibility Report.

Next Steps: **Next steps are to review each probable cost area of the project in more detail and refine cost projections during Phase III, the permit and preliminary design phase. This would include, but is not limited to, additional field investigations, engineering reviews, coordination of multiple projects, as well as, cost and risk sensitivity analysis.**

Cost Analysis

As part of the Phase II Feasibility Study, an Engineer's Opinion of Probable Costs was prepared to provide a total project cost based on the costs of various project components. Cost estimates were provided from a wide range of engineers and other professionals to complete various infrastructure upgrades and to address environmental concerns. Estimates for the valuation of properties that would need to be acquired to construct Mounds Lake were obtained from publicly available information from Madison and Delaware Counties. All of these various costs have been included in the Mounds Lake cost estimates. The cost estimates have been divided into two categories, costs to construct Mounds Lake and the costs to construct the optional water treatment plant.

Mounds Lake Project Components

The probable cost estimates for Mounds Lake have been divided into five categories. This includes all necessary activities, within the footprint of Mounds Lake and all related infrastructure adjacent to the proposed reservoir. The categories include:

Real Estate Acquisition: $ 95,000,000.

Real Estate Acquisition includes the land needed to build Mounds Lake, relocation cost for impacted business, homes, and rental properties.

Dam Construction / Earth Work: $120,000,000.

Dam cost include design and construction of the primary dam, as well as, the low head dam located on the eastern end of the project that is to be used for sediment capture and maintenance of water depth. Also included is all earth work needed for the preparation of the lake basin, such as shaping shallower areas to assure minimum functioning depth.

Utility Installation / Relocation: $ 60,000,000.

Redesign, rerouting and relocation of sewer, water, natural gas, electric, and telecommunication services will be necessary during the construction phase of the Mounds Lake project.

Bridges and Roads: $ 85,000,000.

A thorough evaluation of all roads and bridges will need to be conducted in the next phase of the project. The traffic study and community input will be used to determine how transportation systems will function and how Bridges and Roads funding will be allocated. If the decision is made to remove certain bridges, area roads will need to be improved to handle increased traffic flows. The potential replacement of all nine bridges encompassed within the project area has been included in the cost estimate.

Environmental: $ 80,000,000.

$35 million dollars has been budgeted for environmental remediation to address any potential subsurface concerns that may be present within the project area. $45 million dollars has been allocated for mitigation required for woodland, wetland and cultural impacts.

***Total Mounds Lake Project Cost*: $440,000,000.**

Water Treatment Facility Option

As part of the comprehensive Phase II Feasibility Study, an option to fund the construction a drinking water treatment facility was considered. Analysis indicates that Mounds Lake has the capacity to produce 40 million gallons of water per day for sale, while maintaining several billion gallons of water in storage to be used in the event of a long term region drought. The probable cost to build the water treatment plant and all associated infrastructure is $120,000,000.

8. Conclusions and Recommendations

As stated previously, the goal of this report was to continue the investigations of the next planning phase (Phase II) regarding the feasibility of constructing a dam on the West Fork of the White River in Anderson, Indiana, to create the proposed reservoir for the primary purpose of drinking water supply. Other secondary impacts of the reservoir may include flood control, alternative energy, and potential economic development. As described in the summaries and recommendations below, there appear to be no substantial issues that should prevent this project from continuing to the next phase.

1. **Yield Analysis:** During this phase of the project, it was determined that the proposed dam could provide a firm yield of 60 million gallons per day (MGD) with a normal pool elevation of 876.0 feet, when the most severe drought conditions of 1940-1941 are considered. This results in a drop of 31 feet within the reservoir. The resulting depth in the reservoir under these conditions is approximately 20 feet. During all less severe drought conditions after 1945, maintaining a minimum depth of 20 feet, results in an increase in the reservoir firm yield to 78 MGD. During a more moderate drought such as the one experienced in 1988, the reservoir would drop only an estimated 6 feet at the 60 MGD yield value. Future analysis will focus on demonstrating the value of the reservoir to protect against drought vulnerability for the Central Indiana region and investigating the water needs of Central Indiana communities for various time frames and drought scenarios.

2. **Social, Economic, and Environmental Resources:** Based upon this review, there are a number of impacts to the social, economic, and environmental resources within the project area. These range from little to no impact for resources such as air quality to considerable impacts to aquatic resources, transportation, socioeconomic factors, and cultural resources. Preliminary mitigation plans for each area of impact have been identified and initial discussions with regulatory agencies have been conducted. Anticipated future NEPA phase requirements have been identified. In the next phase (Phase III), formal consultation with all resource agencies will occur as part of the coordination required during preparation of an Environmental Impact Statement. This consultation will result in formal comments from agencies with jurisdiction on all relevant topics and establish permitting and mitigation requirements.

3. **Geotechnical (Borings at Proposed Dam Site/ Reservoir Pool Site):** There appears to be no major geotechnical issues that should prevent this project from continuing on to the next stage. Soils and bedrock beneath the proposed dam are capable of supporting the proposed dam structure and spillway based on preliminary data. Underseepage through the granular soils in the river valley beneath the dam and at the abutments may add additional cost to the project. In the next phase of the project, additional geotechnical work could include expanding on the geotechnical information by completing additional test borings to develop more detailed information on the subsurface strata and the soil engineering parameters needed to prepare a preliminary dam design. Additional field evaluation and potentially additional borings will be performed throughout the proposed reservoir footprint. These will verify soil and bedrock conditions beneath the proposed dam footprint and the proposed impoundment to evaluate leakage potential and also identify potential borrow areas.

4. **I-69 over White River Bridge Raising/Replacement Feasibility:** Increasing the pool level of the proposed reservoir has a substantial impact on its overall water availability. The intent of this section of the study was to perform a preliminary evaluation for the feasibility of raising the grade of I-69 over the White River in Delaware County to create the largest potential headwater possible at the bridge structures, including a preliminary alignment and profile grade along I-69 that maximizes the grade change at the river as well as any grade changes for the ramps for SR 67 and SR 32. The proposed elevation difference at the SR 32 interchange ramps is minimal (maintaining the required SR 32 bridge clearance) so minimal work will be required to tie the existing ramps into the new roadway grade. Preliminary costs for the roadway reconstruction work were calculated to be $6.2 million ($5.6 – $6.7 million). The bridge portion of this

review investigated the worst case scenario of the complete replacement of the existing bridges with new structures on the same alignment. Preliminary costs of the updated 5-span bridge were calculated to be $14.2 million. Adding the upgraded roadway costs to this resulted in a total preliminary project cost of $20.4 million. As an alternative, a 4-span configuration was developed and compared to the existing 5-span configuration. Economic justification for this change would require the development of more detailed costs and final elevations.

5. **Evaluate the effect of the Mounds Lake Reservoir on the Chesterfield and Yorktown Wastewater Treatment Plants:** Using the new proposed pool elevation of 876 feet and the new 100-year floodplain elevation of 878.6 feet, investigations indicate that there will be no impacts to the Yorktown WWTP's operation or structures. Conversely, the Chesterfield WWTP operation and structures will be impacted by the new pool level. To meet its NPDES permit requirement of the 25-year floodplain elevation, additional site improvements will be required. Possible improvements to protect the WWTP include construction of a flood control levee or elevation of structures and processes. The existing treatment processes are adequate to meet the more stringent water quality permit conditions anticipated due to a lake discharge. Discussions with Chesterfield officials regarding impacts of the reservoir to the WWTP will continue as part of the next phase of the project. Specifically, the options to protect the WWTP will be evaluated with local officials.

6. **Dam Flood Routing:** Preliminary calculations showed that a combination of 250 feet of uncontrolled spillway at crest elevation 876.0 and 280 feet of gated spillway at crest elevation 860.0 would be required to achieve a PMF elevation below the top of dam elevation and to provide enough clearance under the raised I-69 bridge so as to not raise discharges downstream. This was a significant improvement over the previous gated spillway model due to more realistic geometries of the radial gate spillways that were used. These results show that there is no overtopping of the dam during the PMF event and that there are decreases in the peak flow values downstream of the dam. This also allows for substantial clearance under the I-69 bridge during the 100-year event. Future detailed studies will be needed to determine the optimal reservoir operational parameters for long-term policy development. A more accurate HEC-RAS model will also need to be modeled in the future that incorporates all of the bridge crossings, more sensitivity analysis using a range of Manning's n values, better cross-section locations and geometry, and more accurate stream centerline alignment.

Based on the findings of the Phase I Conceptual Evaluation and the Phase II Feasibility Analysis, at this time DLZ finds no basis for the Mounds Lake Project not to proceed to the NEPA evaluation and preliminary design phase, Phase III of the Mounds Lake process.

Appendix A

Social, Environmental, Regulatory

Responses to Early Coordination Requests

DNR Indiana Department of Natural Resources

Michael R. Pence, Governor
Cameron F. Clark, Director

Environmental Unit
Division of Fish and Wildlife
402 W. Washington Street
Room W273
Indianapolis, IN 46204
Phone (317) 232-4080
Fax (317) 232-8150
www.in.gov/dnr/fishwild/

June 18, 2014

Jon LaTurner
DLZ, Inc.
157 East Maryland St.
Indianapolis, IN 46204

Re: initial comments regarding the proposed Mounds Lake

Dear Mr. LaTurner:

This letter is a follow-up to the Early Coordination Agency Meeting held June 3, 2014, at the Indiana Government Center, Indianapolis, regarding the proposed Mounds Lake in Madison and Delaware Counties. The following comments are meant to reflect concerns of the Department of Natural Resources (DNR), Division of Fish and Wildlife and address some of the broad concepts that have been provided to date.

The proposed dam would result in significant impacts to fish, wildlife, and botanical resources, with additional impacts that would be an issue during the NEPA phase. A permit from DNR would be required under the Flood Control Act, and mitigation would be required as a part of that permit. In terms of permitting, the DNR would look at impacts within the footprint of the dam, all of the impounded area, and impacts downstream when determining mitigation. Details regarding the DNR mitigation process can be found online at http://www.in.gov/legislative/iac/20120801-IR-312120434NRA.xml.pdf. It is not clear what types of mitigation could be performed to address the wide range of impacts, including conversion of river to impoundment, flooding of forested riparian areas and wetlands (including a fen), and creating a barrier to fish and wildlife passage both upstream and downstream as well as across the river. Mitigation should focus on restoring in-kind resources. Creating storm water control features, trails, separation of combined sewer outfalls, providing an additional source for water supply, and other similar features should not be considered as mitigation options, but should be evaluated as measures to protect the water quality of the impoundment.

Fish passage is a critical issue. There are a variety of passage options, from ladders to bypasses. Information regarding fishway passage designs is available from various resources, including the document "Fisheries Handbook of Engineering Requirements and Biological Criteria," Milo C. Bell, second edition (1986) or third edition (1990). In accordance with state law in IC 14-22-9-9, fish ladders must be considered and in fact may be made a requirement to partially address impacts upon fish and wildlife resources. That same regulation also discusses maintaining sufficient flow past the dam to sustain aquatic systems. Based on experiences at other dams, low and fluctuating flows can have serious negative impacts upon downstream resources. The DNR recommends a run of the river design, where the outfall properly equates to the inflow at the dam. It may be necessary to do considerable gaging before any construction occurs in order to develop a model of what the actual run of the river flows are based on flows upstream and downstream. The U.S. Fish and Wildlife Service recently conducted work of a similar manner in order to develop a run of the river plan at an existing dam in Indiana.

At this time, the Division of Fish and Wildlife is not aware of any State or federally endangered or threatened animals in the immediate project vicinity. However, this does not mean that none are present, or that species not currently listed but within the area of potential effect may not become endangered in the future. Significant aquatic and terrestrial surveys should be conducted in order to determine the fullest extent of the fauna throughout the project area.

The construction of dams often results in water quality issues in the impoundment and downstream. Land use around any impoundment often dictates the major water quality issues. Minimizing development and maintaining a natural shoreline with large buffers are some of the basic measures that can reduce degradation of the impoundment. In many instances, an impoundment can prevent some pollutants from moving downstream but only through the detriment of the impoundment. Downstream impacts not only include changes in flow amounts, duration, and timing, but also erosion and incising. Though the impoundment would trap considerable amounts of sediment, one of the basic functions of the river is sediment transport. The river will claim new sediment as bed load through erosive forces downstream of the dam. This can lead to erosion and incision that can extend a considerable distance downstream.

Coordination among all the various regulatory agencies is critical. The comments provided are only from the Division of Fish and Wildlife. Several other DNR Divisions, as well as other federal, state, and local agencies may also have concerns that have not been fully expressed to date. The comments provided by the US EPA and US Fish and Wildlife Service should also be considered if this project moves forward. If the project proceeds to the NEPA phase, the development and evaluation of a purpose and need statement and alternatives are critically important.

Please contact me at (317) 233-4666 if we can be of further assistance.

Sincerely,

Matt Buffington
Environmental Supervisor
Division of Fish and Wildlife

cc:
Elizabeth Pelloso, US EPA
Marissa Reed, US Fish and Wildlife Service
Greg McKay, US Army Corps of Engineers
Randy Braun, Indiana Department of Environmental Management
Mike Neyer, DNR, Division of Water

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

APR 14 2014

REPLY TO THE ATTENTION OF:
E-19J

Rob Sparks
Anderson/Madison County Corporation for Economic Development
2701 Enterprise Dr., Suite 100
Anderson, Indiana 46013

RE: Early Coordination/Scoping for an Environmental Impact Statement: Mounds Lake Dam/Reservoir – Madison and Delaware Counties, Indiana

Dear Mr. Sparks:

The U.S. Environmental Protection Agency has reviewed your correspondence dated March 10, 2014, regarding a Phase II study on the feasibility of constructing a dam on the West Fork of the White River to create Mounds Lake, a proposed reservoir in Madison and Delaware Counties, Indiana. In addition to your correspondence, EPA has reviewed the Phase I Feasibility Study documents[1] referenced in your letter. We assume that Federal funds and permits will be tied to this project in the future, requiring an Environmental Impact Statement (EIS) for this project as provided in the National Environmental Policy Act (NEPA). This letter provides early coordination comments pursuant to NEPA, the Council on Environmental Quality's NEPA Implementing Regulations (40 CFR 1500-1508), and Section 309 of the Clean Air Act.

According to the Phase I Feasibility Study Executive Summary, "*The impetus for a proposed dam is the potential to increase economic development and investment in the area*" and "*the primary purpose is economic development*." At this time, the dam is proposed to be located on the eastern side of Anderson approximately 2,000 feet west of State Road (SR) 9, creating a pool depth of approximately 50 feet at the dam and 30 feet at the midpoint of the reservoir. The dimensions of the reservoir will vary, but will be approximately 7 miles in length with an overall surface area of approximately 2,000 acres, draining approximately 400 square miles of land.

In contradiction to the proposed purpose noted in all of the Phase I Feasibility study documents, the statement made in your March 10, 2014, correspondence states that the project purpose is "*to provide a source of drinking water to central Indiana, while mitigating drought and flood impacts and providing economic development in the region.*" To help you prepare going forward, EPA would like to emphasize the role and importance of the statement of purpose and need that will be required in any EIS for this project. The purpose and need statement should be specific enough that the range of alternatives can be evaluated in terms of how well they address purpose and need, but not so narrow that they pre-select a single alternative. Furthermore, a project's purpose and need must justify the impacts associated with a Proposed Project.

[1] Phase I Feasibility study documents prepared by the Anderson/Madison County Corporation for Economic Development (CED) - available online at: http://moundslake.com/studies-and-reports/

Proposing the construction of a dam and reservoir at this point appears to skip the important step of developing a range of alternatives (including a No Build alternative) to meet a specific project purpose and need. In particular, project alternatives meeting the broad purpose of economic development could include, but are not limited to, those that support transportation infrastructure and community and business growth/development.[2] The purpose of providing a drinking water source should also study additional alternatives, especially implementation of effective utility management practices, including infrastructure sustainability, and implementation of conservation measures to restructure local water use to meet part or all of existing and future demand needs. EPA's efforts to promote and maintain sustainable water systems are anchored in two widely accepted management frameworks – the Effective Utility Management Initiative and the Safe Drinking Water Act's Capacity Development Program[3]. Additional alternatives should include continued use of existing regional reservoirs, including Geist, Morse, and Eagle Creek; use of groundwater supplies as a drinking water source; and construction of one or more off-line reservoirs (not in-stream). All reasonable alternatives should be identified and studied, regardless of whether or not they are within the jurisdiction of the lead Federal agency (once designated).

Inclusion of regional flood attenuation as an element of the purpose and need will require documentation to verify. However, it is expected that an EIS would study alternatives to construction of a dam and reservoir for flood control, including land use changes, floodplain restoration activities, or more traditional activities such as levee and floodwall construction. Consideration of flood management should account for the expected impact of climate change, including more extreme storm events, when evaluating the long-term sustainability of possible flood control solutions.

In addition, the significant impacts to aquatic resources and wetlands from a proposed dam and reservoir would require issuance of an Individual Clean Water Act Section 404 permit from the U.S. Army Corps of Engineers (USACE) for proposed discharges of dredged or fill materials to Waters of the United States. Issuance of a Section 404 permit approval is contingent upon a project complying with Clean Water Act Section 404(b)(1) guidelines. These guidelines are summarized as follows:

- **Least Environmentally Damaging Practicable Alternative** – There must be no practicable alternative to the proposed discharge (impacts) which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences;
- **No Violation of Other Laws** – The proposed project must not cause or contribute to violation of state water quality standards or toxic effluent standards, and must not jeopardize the continued existence of federally-listed endangered or threatened species or their critical habitat(s);
- **No Significant Degradation** – The project must not cause or contribute to significant degradation of Waters of the United States; and
- **Minimization and Mitigation of Adverse Impacts** – The project must include appropriate and practicable steps to avoid impacts to regulated Waters of the United States. Where impacts are unavoidable, a project must demonstrate how impacts have been minimized. Compensatory aquatic resource mitigation is required to offset unavoidable, minimized impacts to aquatic ecosystems.

[2] Including, but not limited to (if applicable): Metropolitan Transportation Plans, Comprehensive Transportation Plans, County and/or Municipal Visioning Documents, Land Development Plans, Resolutions of Individual Developments, Non-Governmental Entities (including Development Commissions and Chambers of Commerce), and Capital Improvement Programs.

[3] More information on Managing for Sustainable Water Systems can be found on EPA's website at: http://water.epa.gov/infrastructure/sustain/sustainable_systems.cfm

Based on the information that has been provided so far, it appears unlikely that proposal of a dam and reservoir would be determined to be the Least Environmentally Damaging Practicable Alternative (LEDPA).

If this project proceeds under NEPA, environmental impacts and costs for all viable alternatives to be carried forward should be thoroughly analyzed in a Draft Environmental Impact Statement. Project costs as proposed in Phase I Feasibility Study documents did not include estimated costs of mitigation, including mitigation siting, preparation of mitigation plans, land and easement acquisition, mitigation construction costs, and monitoring and adaptive management plans. Environmental impacts associated with a new dam and reservoir are expected to be substantial, with significant impacts to aquatic resources[4], wetlands, wellhead protection areas, public lands (including Mounds State Park), historic properties and archaeological resources/sites, Federally-listed endangered species, prime farmland, and residences and businesses expected, including the potential for environmental justice impacts. Significant secondary impacts, including land use changes, and impacts due to inundation, particularly on public lands (including the Rangeline Preserve and Mounds State Park) and the Anderson Municipal Airport would also be expected.

At this time, selecting the construction of a new dam and reservoir to meet a proposed purpose of economic development in the greater Anderson area appears to be premature. We are available to discuss our comments with you in further detail if requested. We request that you include our agency in planning meetings as they are developed. If you have any questions or comments regarding the content of this letter, please contact Ms. Liz Pelloso, PWS, of my staff at 312-886-7425 or via email at pelloso.elizabeth@epa.gov.

Sincerely,

Kenneth A. Westlake, Chief
NEPA Implementation Section
Office of Enforcement and Compliance Assurance

cc: Laban Lindley, USACE-Louisville (Indy Field Office)
Greg McKay, USACE-Louisville
Marissa Reid, USFWS-Bloomington
Heather Parsons, IDEM-401 WQC
Jim McGoff, IFA
Bill Harkins, IFA
Matt Buffington, IDNR-DFW
Andrea Gromeaux-Schnaith, IDNR-DOW
Ken Smith, IDNR-DOW
George Crosby, IDNR-DOW
John Bacone, IDNR-DNP
Dan Bortner, IDNR-State Parks/Reservoirs
Mitch Zoll, Indiana SHPO
Ted Tapp, Mounds State Park
Jon LaTurner, DLZ
Steve Metzer, DLZ

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[4] Phase I Feasibility study information noted that this stretch of the West Fork White River is designated as an outstanding state resource water, having outstanding ecological importance and state-designated canoe and boating trails.

Survey Results

STATION: 1, Mounds

NAME OF STREAM: West Fork White River

NAME, NUMBER, PERCENTAGE, SIZE, AND WEIGHT OF FISHES COLLECTED

COMMON NAME	NUMBER	PERCENTAGE	SIZE RANGE (INCHES)	TOTAL WEIGHT (POUNDS)	PERCENTAGE
Sand shiner	296	27.92	2.5-13.8	1.15	2.17
Central stoneroller	153	14.43	2.0-5.8	1.24	2.34
Northern hog sucker	132	12.45	2.5-13.8	29.79	56.31
Spotfin shiner	128	12.08	1.1-3.9	1.15	2.17
Bluntnose minnow	83	7.83	1.0-3.2	0.30	0.57
Bluegill	35	3.30	2.6-4.1	0.88	1.66
Smallmouth bass	29	2.74	3.0-11.2	3.38	6.39
Creek chub	26	2.45	1.7-3.0	0.12	0.23
Mottled sculpin	21	1.98	1.7-3.2	0.27	0.51
Greenside darter	19	1.79	2.0-3.4	0.10	0.19
Rosyface shiner	19	1.79	2.0-3.5	0.16	0.30
Longear sunfish	17	1.60	1.3-5.6	0.52	0.98
Green sunfish	16	1.51	1.1-5.0	0.63	1.19
Rock bass	15	1.42	1.6-8.7	1.85	3.50
Black redhorse	12	1.13	2.7-14.7	8.03	15.18
Rainbow darter	12	1.13	1.7-2.4	0.04	0.08
Silverjaw minnow	9	0.85	2.0-3.2	0.02	0.04
Striped shiner	9	0.85	2.5-5.7	0.31	0.59
Silver shiner	7	0.66	4.1-4.7	0.09	0.17
Golden redhorse	6	0.57	2.1-16.7	2.71	5.12
Blacknose dace	3	0.28	1.7-2.0	0.01	0.02
Largemouth bass	3	0.28	2.8-4.0	0.06	0.11
River chub	3	0.28	2.1-5.0	0.03	0.06
Brook silverside	2	0.19	1.7-2.5	0.01	0.02
Johnny darter	1	0.09	2.2	0.01	0.02
Orangethroat darter	1	0.09	1.6	0.01	0.02
Redfin shiner	1	0.09	2.2	0.01	0.02
Stonecat	1	0.09	3.0	0.01	0.02
Yellow bullhead	1	0.09	2	0.01	0.02
Total - 29 Species	1,060			52.90	

Macroinvertebrates Species List

List of benthic macroinvertebrates found at station W 300 S Street.
(Data from Muncie Bureau of Water Quality)

Amphipoda
Ancyronyx variegata
Argia spp.
Baetis spp.
Berosus spp. JUV
Bidessus spp. (=Bidessonotus)
Caenis spp.
Calopteryx spp.
Cambaridae
Cheumatopsyche spp.
Chironomidae
Copepoda
Corbicula fluminea
Corixidae
Enallagma spp.
Ferrissia spp.
Gomphus spp.
Goniobasis spp.
Hetaerina spp.
Hyallela azteca
Hydropsychidae
Macronychus glabratus
Nectopsyche spp.
Nilotanypus spp.
Nyctiophylax spp.
Oecetis spp.
Optioservus fastiditus
Paratanytarsus spp.
Peltodytes spp.
Physa spp.
Pleurocera spp.
Podocopa=Ostracoda
Potamanthus spp.
Psephenus herricki
Rhagovelia spp.
Rheotanytarsus spp.
Stenonema spp.
Tanypodinae
Tanytarsini
Thienemanniella spp.
Trichocorixa spp.
Trichoptera
Tricorythodes spp.

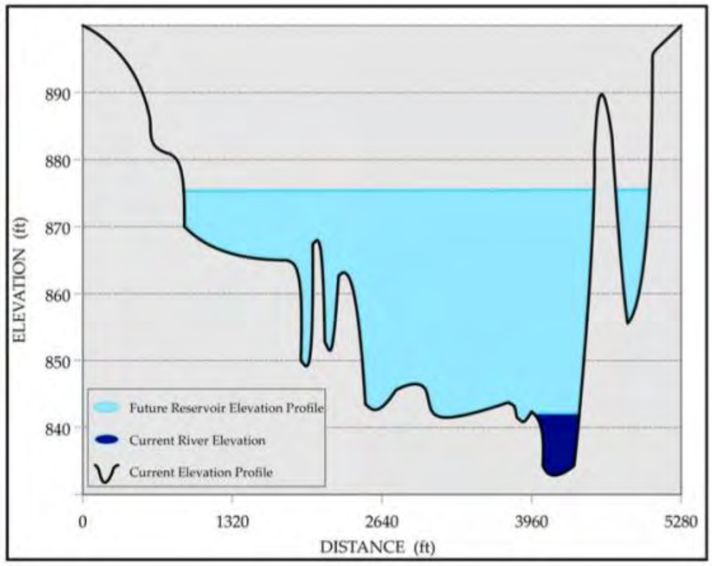
Mollusks List

Freshwater Mussels of the mainstem West Fork White River

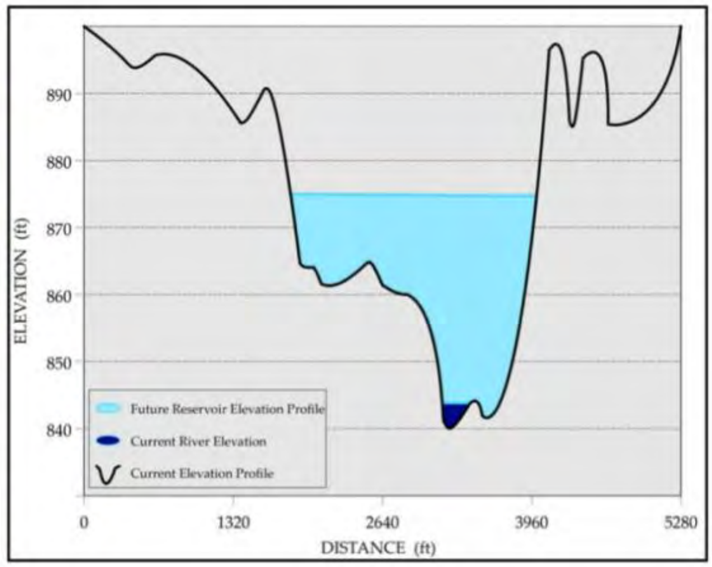
Genus	*Species*	Best Condition	u/s Indianapolis	d/s Indianapolis
Actinonaias	*ligamentina*	L	L	
Alasmidonta	*marginata*	L	L	
Alasmidonta	*viridis*	L	L	
Anodontoides	*ferussacianus*	L	L	
Elliptio	*dilatata*	L	L	
Fusconaia	*flava*	L	L	
Lampsilis	*fasciola*	L	L	
Lampsilis	*siliquoidea*	L	L	
Lasmigona	*compressa*	L	L	
Lasmigona	*costata*	L	L	
Pleurobema	*sintoxia*	L	L	
Strophitus	*undulatus*	L	L	
Villosa	*iris*	L	L	
Lampsilis	*cardium*	L	L	L
Lasmigona	*complanata*	L	L	L
Pyganodon	*grandis*	L	L	L
Amblema	*plicata*	L	L	FD
Utterbackia	*imbecillis*	L	L	FD
Ptychobranchus	*fasciolaris*	FD	FD	
Anodonta	*suborbiculata*	FD		FD
Quadrula	*nodulata*	FD		FD
Tritogonia	*verrucosa*	FD		FD
Arcidens	*confragosus*	L		L
Lampsilis	*teres*	L		L
Leptodea	*fragilis*	L		L
Obliquaria	*reflexa*	L		L
Obovaria	*olivaria*	L		L
Potamilus	*alatus*	L		L
Potamilus	*ohiensis*	L		L
Quadrula	*pustulosa pustulosa*	L		L
Quadrula	*quadrula*	L		L
Truncilla	*donaciformis*	L		L
Truncilla	*truncata*	L		L
Cyclonaias	*tuberculata*	WD		
Cyprogenia	*stegaria*	WD		
Ellipsaria	*lineolata*	SF		
Elliptio	*crassidens*	WD		
Epioblasma	*obliquata perobliqua*	WD		
Epioblasma	*propinqua*	WD		
Epioblasma	*torulosa rangiana*	WD		
Epioblasma	*torulosa torulosa*	WD		
Epioblasma	*triquetra*	WD		
Fusconaia	*ebena*	WD		
Fusconaia	*subrotunda*	WD		
Hemistena	*lata*	SF		
Lampsilis	*abrupta*	SF		
Lampsilis	*ovata*	WD		
Ligumia	*recta*	WD		
Ligumia	*subrostrata*	WD		
Megalonaias	*nervosa*	WD		
Obovaria	*retusa*	WD		
Obovaria	*subrotunda*	WD		
Plethobasus	*cyphyus*	WD		
Pleurobema	*clava*	WD		
Pleurobema	*cordatum*	WD		
Pleurobema	*plenum*	WD		
Pleurobema	*rubrum*	WD		
Potamilus	*capax*	WD		
Quadrula	*cylindrica cylindrica*	WD		
Quadrula	*metanevra*	WD		
Toxolasma	*lividus*	WD		
Toxolasma	*parvus*	WD		
Villosa	*fabalis*	WD		
Villosa	*lienosa*	WD		
Corbicula	*fluminea*	L	L	L
	Total Native Species Live/FD:	33	19 (12)	19 (14)
	Total Native Species WD/SF:	31		
	Total Native Species:	64		

Mounds State Park Elevation Cross Sections

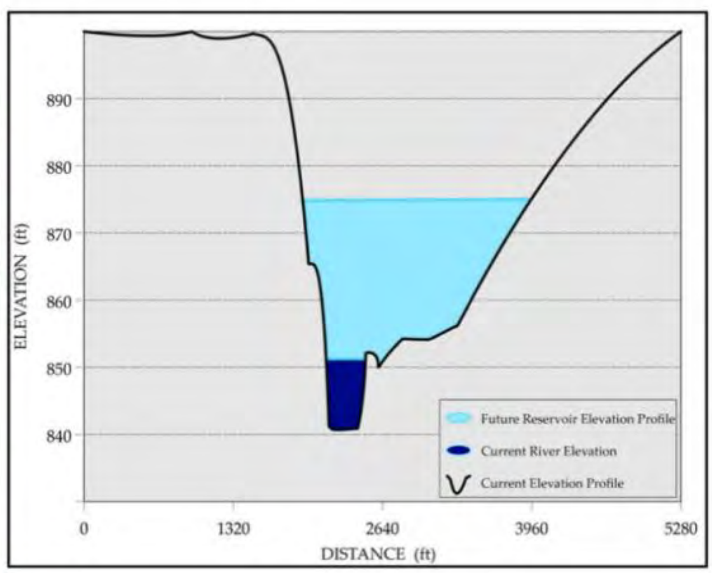
Cross-Section #3: West of Rangeline Road



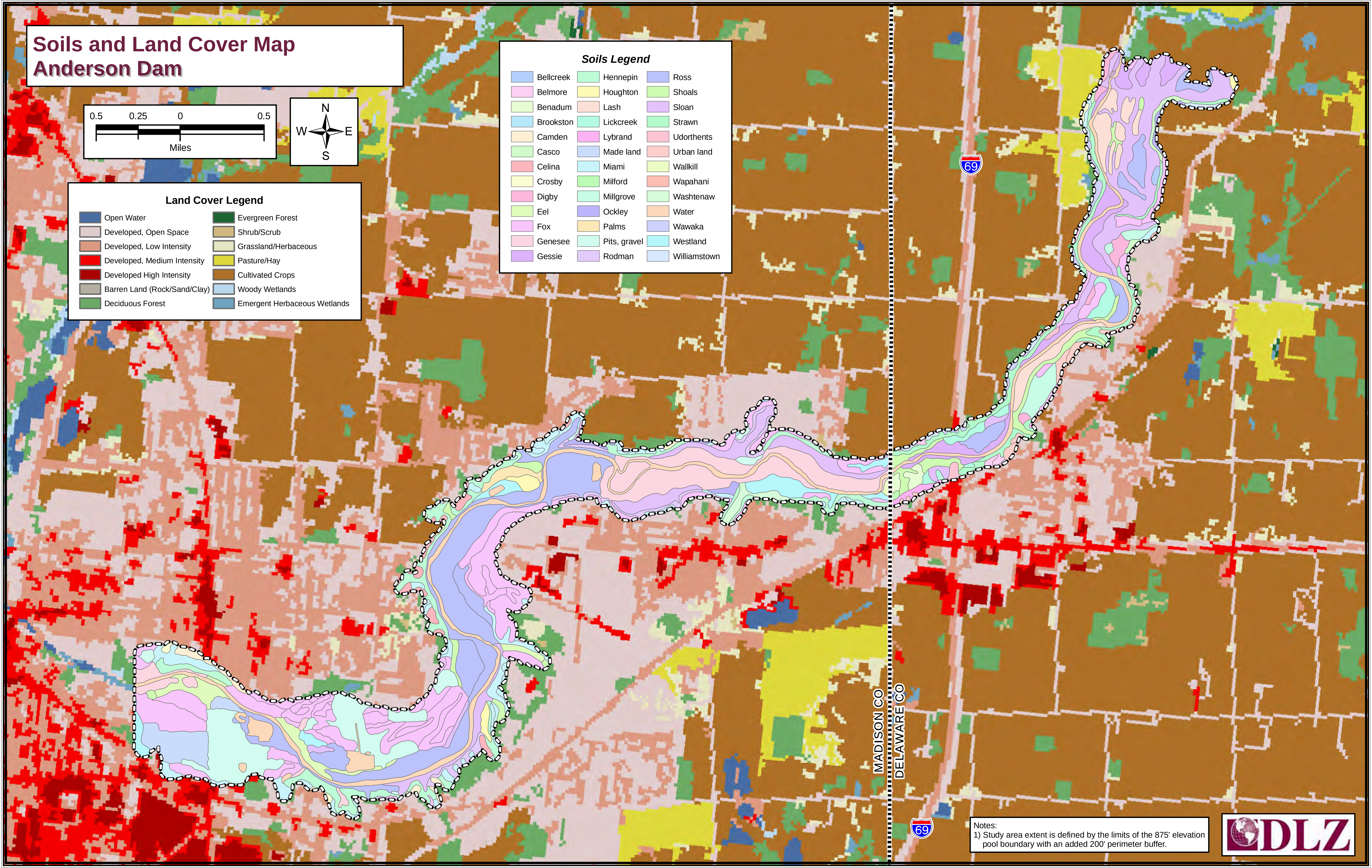
Cross-Section #4: Mounds State Park

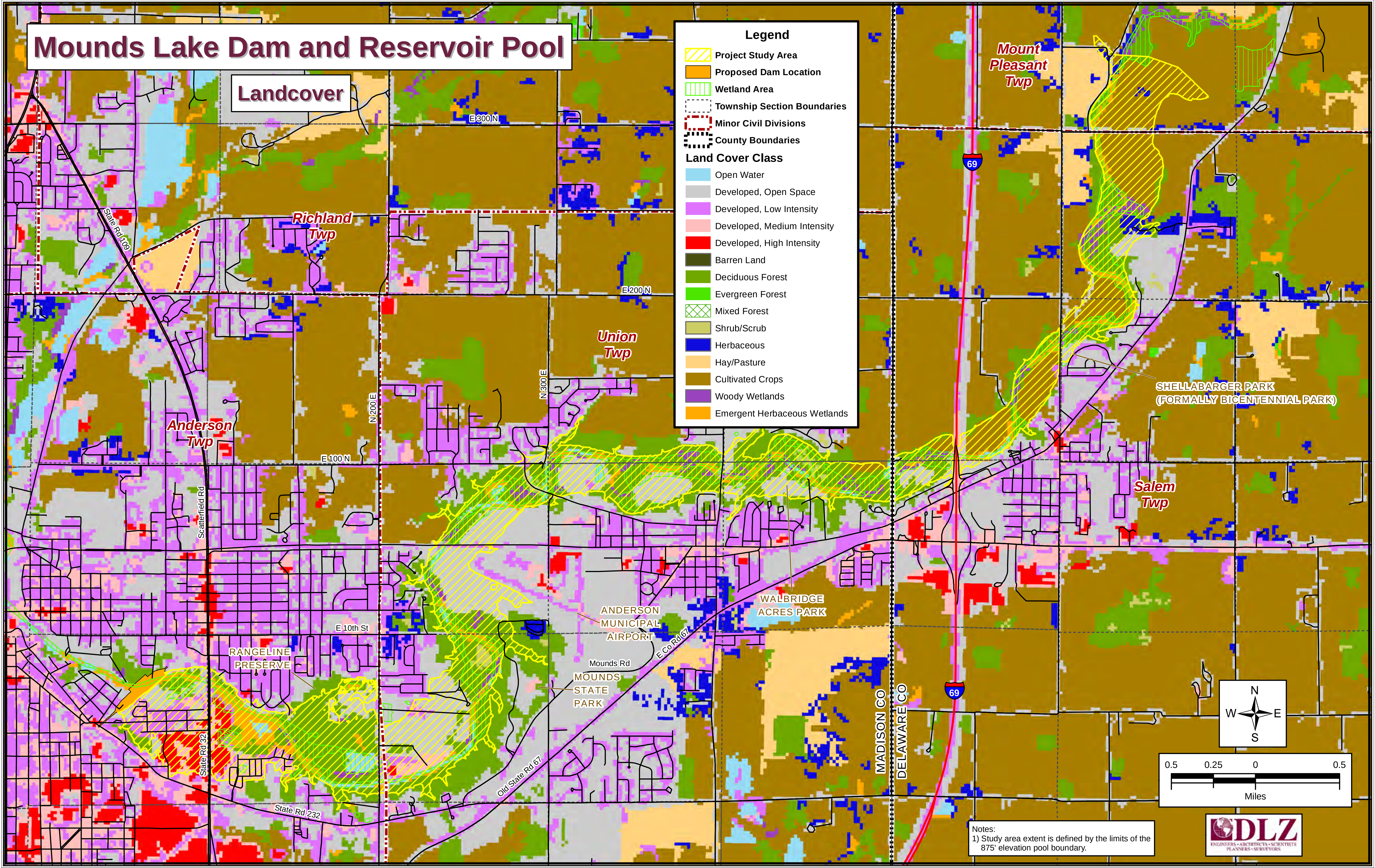


Cross-Section #5: North of State Road 32

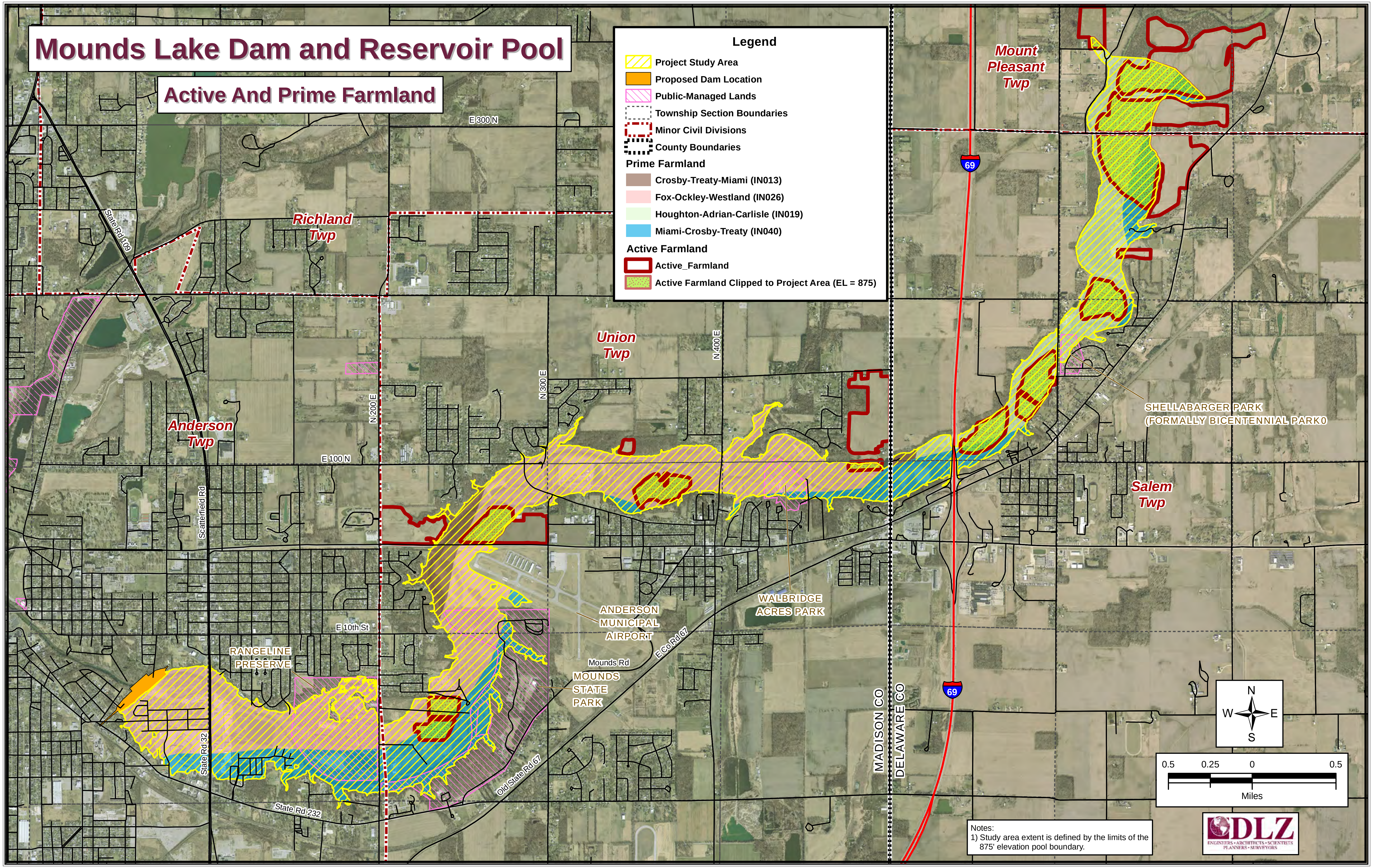


Maps


Soils and Land Cover Map
Anderson Dam
0.5 0.25 0 0.5
Miles
N
W
E
S
Land Cover Legend
Open Water
Developed, Open Space
Developed, Low Intensity
Developed, Medium Intensity
Developed High Intensity
Barren Land (Rock/Sand/Clay)
Deciduous Forest
Evergreen Forest
Shrub/Scrub
Grassland/Herbaceous
Pasture/Hay
Cultivated Crops
Woody Wetlands
Emergent Herbaceous Wetlands
Soils Legend
Bellcreek
Belmore
Benadum
Brookston
Camden
Casco
Celina
Crosby
Digby
Eel
Fox
Genesee
Gessie
Hennepin
Houghton
Lash
Lickcreek
Lybrand
Made land
Miami
Milford
Millgrove
Ockley
Palms
Pits, gravel
Rodman
Ross
Shoals
Sloan
Strawn
Udorthents
Urban land
Wallkill
Wapahani
Washtenaw
Water
Wawaka
Westland
Williamstown
69
69
MADISON CO
DELAWARE CO
Notes:
1) Study area extent is defined by the limits of the 875' elevation pool boundary with an added 200' perimeter buffer.
DLZ



Mounds Lake Dam and Reservoir Pool
Landcover
Legend
Project Study Area
Proposed Dam Location
Wetland Area
Township Section Boundaries
Minor Civil Divisions
County Boundaries
Land Cover Class
Open Water
Developed, Open Space
Developed, Low Intensity
Developed, Medium Intensity
Developed, High Intensity
Barren Land
Deciduous Forest
Evergreen Forest
Mixed Forest
Shrub/Scrub
Herbaceous
Hay/Pasture
Cultivated Crops
Woody Wetlands
Emergent Herbaceous Wetlands
Richland Twp
Union Twp
Anderson Twp
Mount Pleasant Twp
Salem Twp
E 300 N
E 200 N
E 100 N
E 10th St
N 200 E
N 300 E
State Rd 109
Scatterfield Rd
State Rd 32
State Rd 232
Old State Rd 67
E Co Rd 67
Mounds Rd
69
SHELLABARGER PARK (FORMALLY BICENTENNIAL PARK)
WALBRIDGE ACRES PARK
ANDERSON MUNICIPAL AIRPORT
RANGELINE PRESERVE
MOUNDS STATE PARK
MADISON CO
DELAWARE CO
N
W
E
S
0.5
0.25
0
0.5
Miles
Notes:
1) Study area extent is defined by the limits of the 875' elevation pool boundary.
DLZ
ENGINEERS • ARCHITECTS • SCIENTISTS PLANNERS • SURVEYORS



Mounds Lake Dam and Reservoir Pool
Active And Prime Farmland
Legend
Project Study Area
Proposed Dam Location
Public-Managed Lands
Township Section Boundaries
Minor Civil Divisions
County Boundaries
Prime Farmland
Crosby-Treaty-Miami (IN013)
Fox-Ockley-Westland (IN026)
Houghton-Adrian-Carlisle (IN019)
Miami-Crosby-Treaty (IN040)
Active Farmland
Active_Farmland
Active Farmland Clipped to Project Area (EL = 875)
Richland Twp
Union Twp
Anderson Twp
Mount Pleasant Twp
Salem Twp
E 300 N
E 100 N
E 10th St
State Rd 109
State Rd 32
State Rd 232
Old State Rd 67
E Co Rd 67
Scatterfield Rd
N 200 E
N 300 E
N 400 E
Mounds Rd
69
SHELLABARGER PARK
(FORMALLY BICENTENNIAL PARK0
ANDERSON MUNICIPAL AIRPORT
RANGELINE PRESERVE
MOUNDS STATE PARK
WALBRIDGE ACRES PARK
MADISON CO
DELAWARE CO
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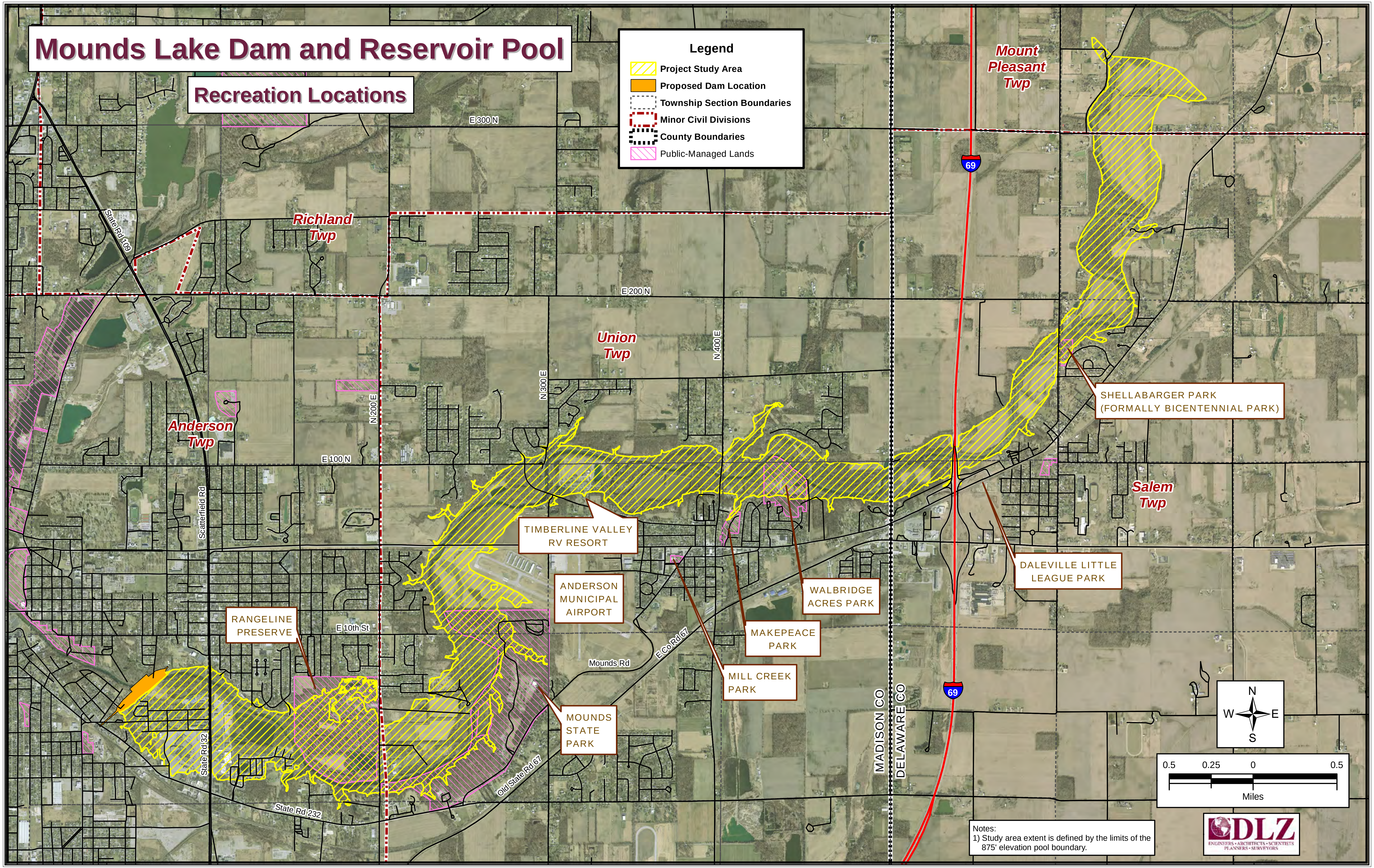
0.5
Miles
Notes:
1) Study area extent is defined by the limits of the 875' elevation pool boundary.
DLZ
ENGINEERS • ARCHITECTS • SCIENTISTS
PLANNERS • SURVEYORS


Mounds Lake Dam and Reservoir Pool
Recreation Locations
Legend
Project Study Area
Proposed Dam Location
Township Section Boundaries
Minor Civil Divisions
County Boundaries
Public-Managed Lands
Richland Twp
Union Twp
Anderson Twp
Mount Pleasant Twp
Salem Twp
E 300 N
E 200 N
E 100 N
E 10th St
N 200 E
N 300 E
N 400 E
State Rd 100
Scatterfield Rd
State Rd 32
State Rd 232
Old State Rd 67
E Co Rd 67
Mounds Rd
69
MADISON CO
DELAWARE CO
SHELLABARGER PARK
(FORMALLY BICENTENNIAL PARK)
TIMBERLINE VALLEY
RV RESORT
ANDERSON
MUNICIPAL
AIRPORT
RANGELINE
PRESERVE
WALBRIDGE
ACRES PARK
DALEVILLE LITTLE
LEAGUE PARK
MAKEPEACE
PARK
MILL CREEK
PARK
MOUNDS
STATE
PARK
N
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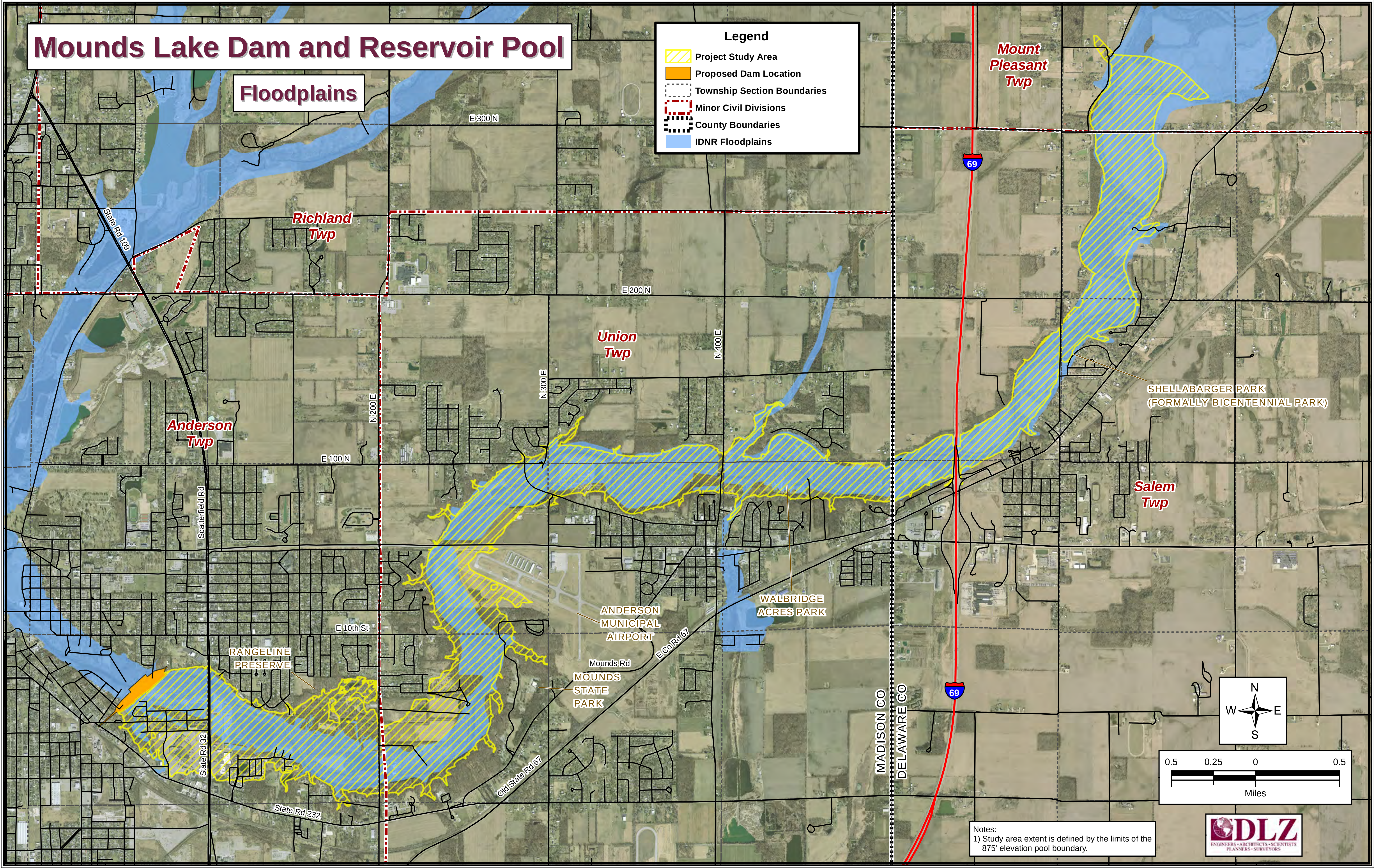
E
S
0.5
0.25
0
0.5
Miles
Notes:
1) Study area extent is defined by the limits of the 875' elevation pool boundary.
DLZ
ENGINEERS • ARCHITECTS • SCIENTISTS
PLANNERS • SURVEYORS


Mounds Lake Dam and Reservoir Pool
Floodplains
Legend
Project Study Area
Proposed Dam Location
Township Section Boundaries
Minor Civil Divisions
County Boundaries
IDNR Floodplains
Mount Pleasant Twp
Richland Twp
Union Twp
Anderson Twp
Salem Twp
E 300 N
E 200 N
E 100 N
E 10th St
State Rd 109
N 200 E
N 300 E
N 400 E
Scatterfield Rd
State Rd 32
State Rd 232
Old State Rd 67
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Mounds Rd
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SHELLABARGER PARK
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ANDERSON MUNICIPAL AIRPORT
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MOUNDS STATE PARK
MADISON CO
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0.5
0.25
0
0.5
Miles
Notes:
1) Study area extent is defined by the limits of the 875' elevation pool boundary.
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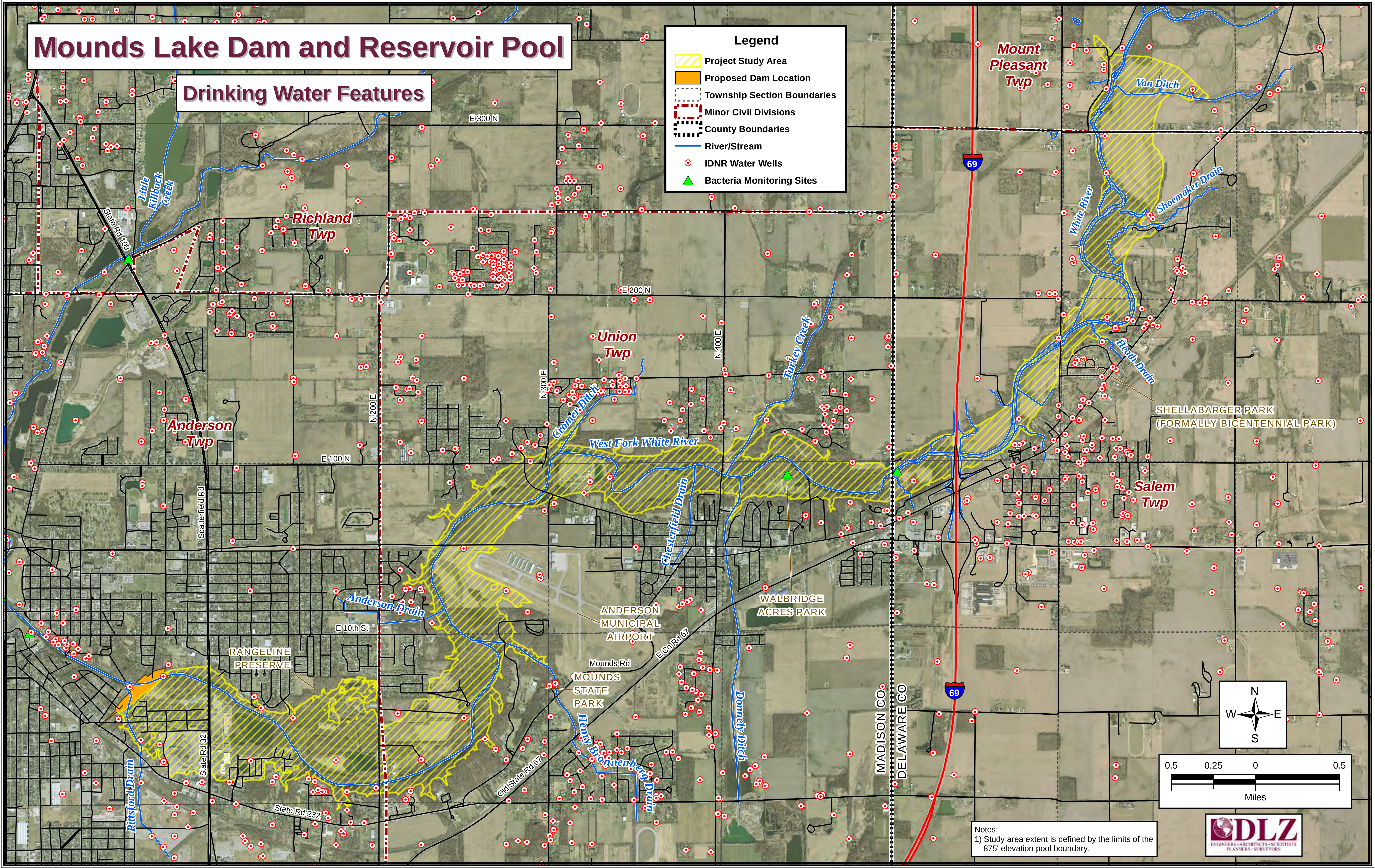
Mounds Lake Dam and Reservoir Pool
Drinking Water Features
Legend
Project Study Area
Proposed Dam Location
Township Section Boundaries
Minor Civil Divisions
County Boundaries
River/Stream
IDNR Water Wells
Bacteria Monitoring Sites
Richland Twp
Union Twp
Anderson Twp
Mount Pleasant Twp
Salem Twp
Little Killbuck Creek
State Rd 109
E 300 N
E 200 N
E 100 N
N 200 E
N 300 E
N 400 E
E 10th St
Scatterfield Rd
State Rd 32
State Rd 232
Old State Rd 67
E Co Rd 67
Mounds Rd
Turkey Creek
Cromer Ditch
West Fork White River
Chesterfield Drain
Anderson Drain
Pittsford Drain
Henry Bronnenberg Drain
Donnelly Ditch
White River
Van Ditch
Shoemaker Drain
Heath Drain
69
RANGELINE PRESERVE
ANDERSON MUNICIPAL AIRPORT
MOUNDS STATE PARK
WALBRIDGE ACRES PARK
SHELLABARGER PARK (FORMALLY BICENTENNIAL PARK)
MADISON CO
DELAWARE CO
N
W
E
S
0.5
0.25
0
0.5
Miles
Notes:
1) Study area extent is defined by the limits of the 875' elevation pool boundary.
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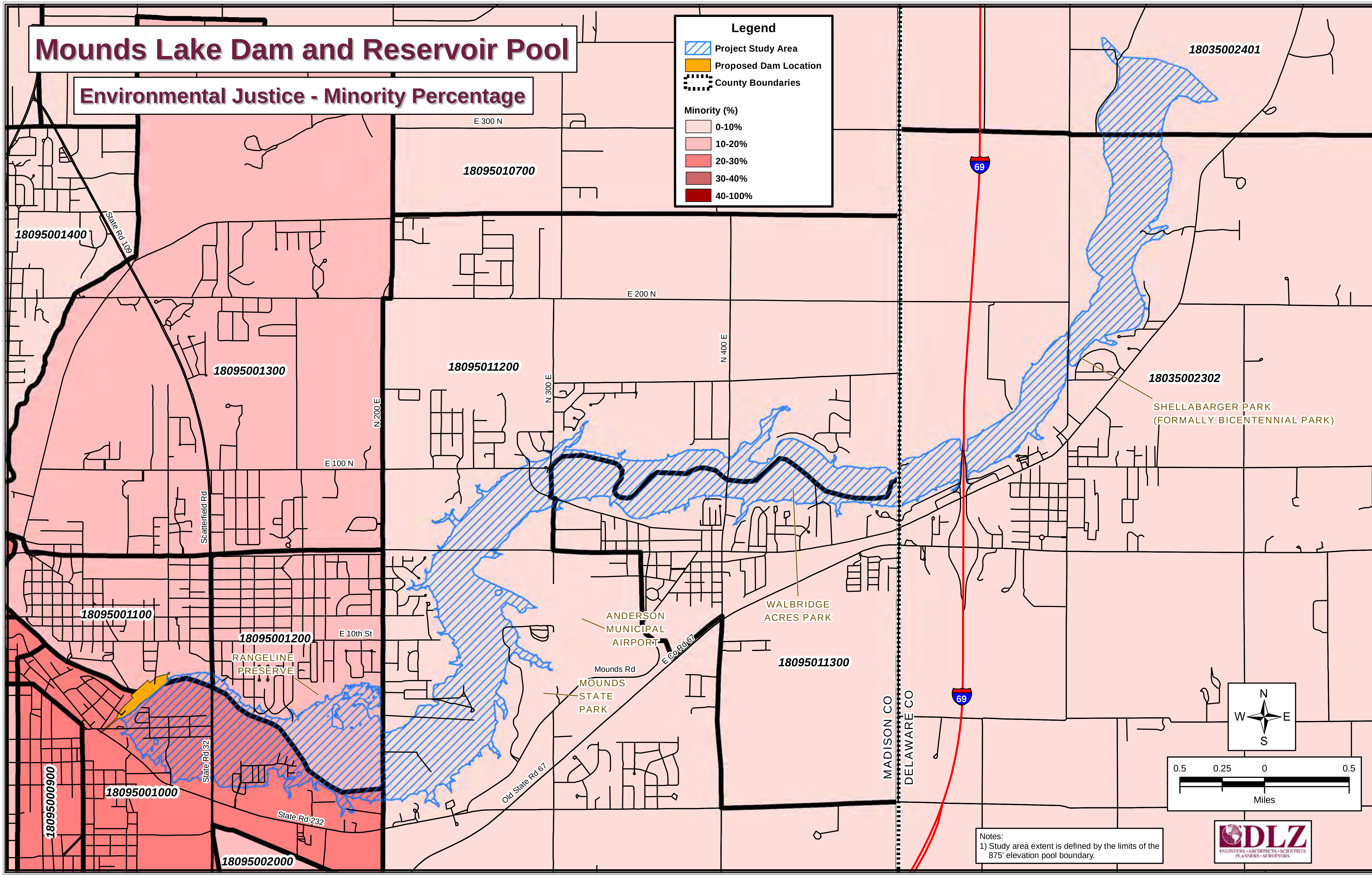

Mounds Lake Dam and Reservoir Pool
Environmental Justice - Minority Percentage
Legend
Project Study Area
Proposed Dam Location
County Boundaries
Minority (%)
0-10%
10-20%
20-30%
30-40%
40-100%
18035002401
18095010700
18095001400
18095001300
18095011200
18035002302
SHELLABARGER PARK
(FORMALLY BICENTENNIAL PARK)
18095001100
18095001200
RANGELINE
PRESERVE
ANDERSON
MUNICIPAL
AIRPORT
WALBRIDGE
ACRES PARK
MOUNDS
STATE
PARK
18095011300
18095000900
18095001000
18095002000
E 300 N
E 200 N
E 100 N
E 10th St
N 400 E
N 300 E
N 200 E
State Rd 109
Scatterfield Rd
State Rd 32
State Rd 232
Old State Rd 67
E Co Rd 67
Mounds Rd
69
MADISON CO
DELAWARE CO
N
W
E
S
0.5
0.25
0
0.5
Miles
Notes:
1) Study area extent is defined by the limits of the 875' elevation pool boundary.
DLZ
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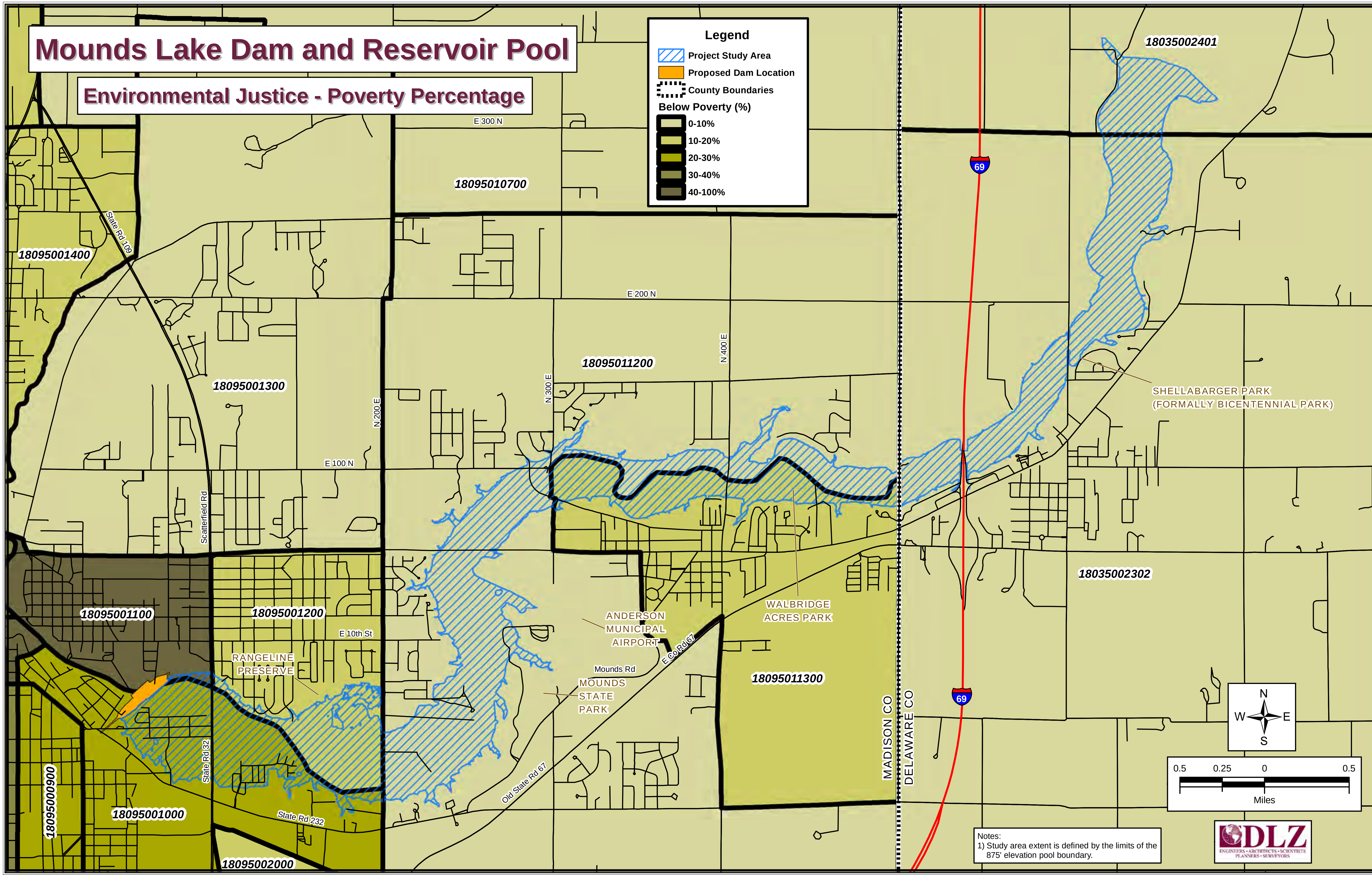
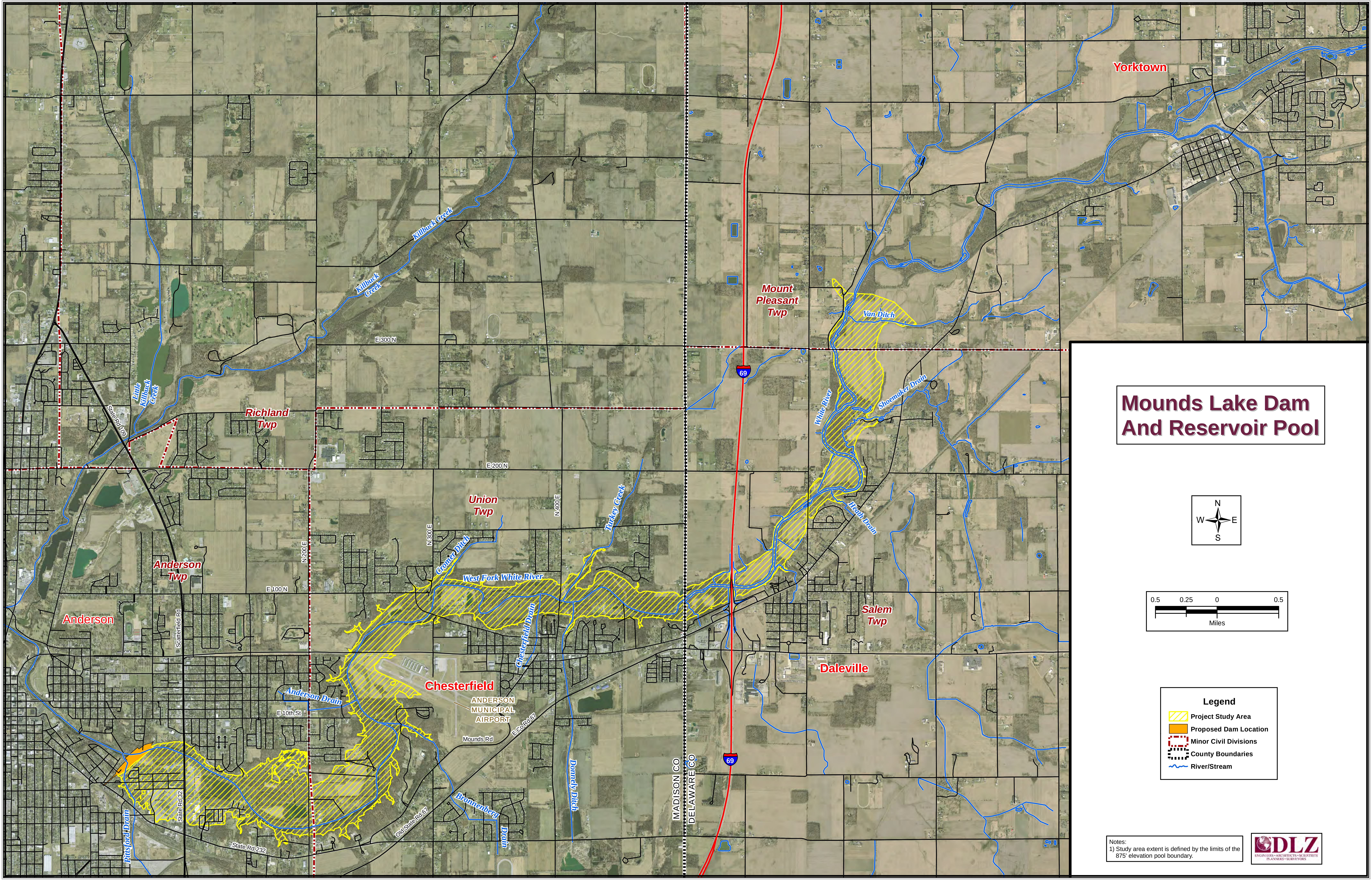
PLANNERS • SURVEYORS



Mounds Lake Dam and Reservoir Pool
Environmental Justice - Poverty Percentage
Legend
Project Study Area
Proposed Dam Location
County Boundaries
Below Poverty (%)
0-10%
10-20%
20-30%
30-40%
40-100%
18095010700
18095001400
18095001300
18095011200
18035002401
18035002302
18095001100
18095001200
18095001000
18095000900
18095002000
18095011300
E 300 N
E 200 N
E 100 N
E 10th St
State Rd 109
Scatterfield Rd
N 200 E
N 300 E
N 400 E
State Rd 32
State Rd 232
Old State Rd 67
E Co Rd 67
Mounds Rd
69
SHELLABARGER PARK
(FORMALLY BICENTENNIAL PARK)
WALBRIDGE
ACRES PARK
ANDERSON
MUNICIPAL
AIRPORT
MOUNDS
STATE
PARK
RANGELINE
PRESERVE
MADISON CO
DELAWARE CO
N
W
E
S
0.5
0.25
0
0.5
Miles
Notes:
1) Study area extent is defined by the limits of the 875' elevation pool boundary.
DLZ

Mounds Lake Dam And Reservoir Pool



Appendix B

Geotechnical/Foundation Analysis

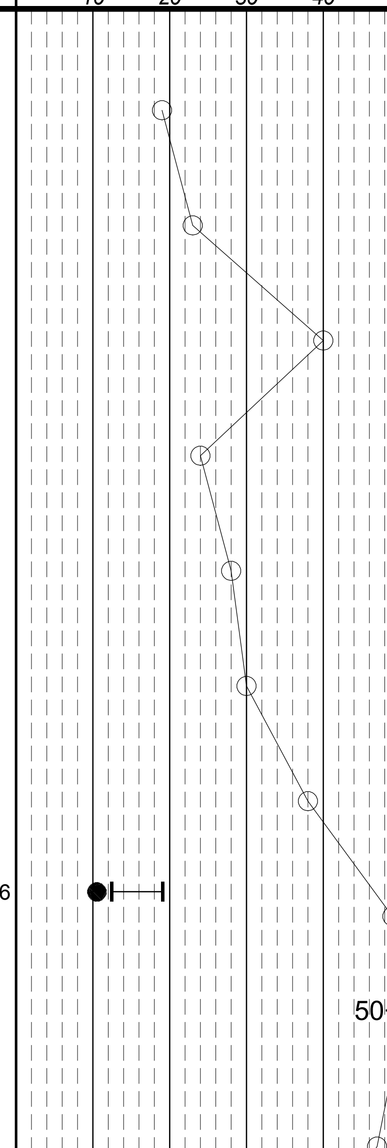
Boring Logs and Plans

Client: Anderson Corp. for Econ. Dev.	Project: Mounds Lake	Job No. 1363-0962.70
LOG OF: Boring B-001-14	Location: As per plan	Date Drilled: 2/25/2014 to 2/27/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft) 865.4	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.9	864.5						Topsoil - 11"						
3.5	861.9	4 6 9	12	1			Medium dense brown GRAVEL with silt with sand (GP-GM); damp.						
		7 9 9	13	2			Medium dense to dense brown SAND with silt with gravel (SP-SM); damp.						
8.5	856.9	8 14 17	7	3									
11.0	854.4	4 10 9	14	4		2.25	Very stiff brown sandy LEAN CLAY (CL); moist.						
13.5	851.9	8 10 12	12	5		4.5	Hard brown LEAN CLAY with sand (CL); moist.						
16.0	849.4	6 11 12	0	6			Very stiff brown sandy LEAN CLAY (CL); wet. @ 13.5'-15.0', SPT sample pressed to retreive 0 recovery driven SPT sample.						
		11 13 17	17	7		4.5	Hard brown sandy SILTY CLAY (CL-ML); damp to moist.						
		22 19 19	14	8		4.5		2	4	9	25	34	26
		50/5	0	9		4.5	@ 21.0'-22.5', drove possible cobble, SPT sample pressed to retreive 0 recovery driven SPT sample.						
25	840.4	18 19 18	13	10		4.5							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL LL
Blows per foot - ○ / Non-Plastic - NP



Client: Anderson Corp. for Econ. Dev.	Project: Mounds Lake	Job No. 1363-0962.70
LOG OF: Boring B-001-14	Location: As per plan	Date Drilled: 2/25/2014 to 2/27/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60)
	840.4						Hard brown sandy SILTY CLAY (CL-ML); damp to moist.							
26.0	839.4	10 12 16	18	11		2.25	Very stiff greenish gray SILTY CLAY (CL-ML); moist.							
28.5	836.9	16 26 30	17	12		4.5	Hard grayish brown sandy LEAN CLAY (CL); damp.							72
30		16 35 41	14	13		4.5								98
		13 34 37	14	14		4.5	@ 34.1'-34.4', sand seam.							91
35		25 50/5	11	15		4.5								50+
		27 50/5	11	16		4.5		7	2	11	26	35	19	50+
40		50/4	4	17		4.5	@ 41.0'-41.4', encountered granite cobble or boulder.							50+
44.0	821.4	24 50/5	8	18A 18B		4.5	Very dense brownish gray sandy SILT (ML); moist.							50+
45														
46.0	819.4						Hard gray sandy LEAN CLAY (CL); damp.							
47.0	818.4	33 50 50/5	16	19A 19B		4.5	Very dense brownish gray sandy SILT (ML); moist.							50+
48.5	816.9	35 50 50	14	20			Very dense gray SILTY SAND (SM); wet.	3	3	29	52	--13--		128
50	815.4													

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

Client: Anderson Corp. for Econ. Dev.	Project: Mounds Lake	Job No. 1363-0962.70
LOG OF: Boring B-001-14	Location: As per plan	Date Drilled: 2/25/2014 to 2/27/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft) 815.4	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60)
							Very dense gray SILTY SAND (SM); wet.							
		29 50/5	0	21										50+
55							@ 55.0'-70.0', difficult drilling hard/very dense soils.							
58.5	806.9	50/5	3	22			Very dense gray fine to medium clayey SAND (SC); damp.							50+
60														
63.5	801.9	22 37 50	15	23		4.25	Hard brown LEAN CLAY with sand (CL); damp.	11	2	5	16	38	28	112
65														
70		22 32 50/2	14	24		4.5								50+
71.0	794.4	50 50/5	11	25			Very dense brown silty SAND (SM); moist to wet.							50+
73.5	791.9	18 34 35	17	26			Hard brown LEAN CLAY with sand (CL); contains fine sand lamination between clay layers; damp.							89
75	790.4													

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: Anderson Corp. for Econ. Dev. | Project: Mounds Lake | Job No. 1363-0962.70

LOG OF: Boring B-001-14 | Location: As per plan | Date Drilled: 2/25/2014 to 2/27/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft) 790.4	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60)
							Hard brown LEAN CLAY with sand (CL); contains fine sand lamination between clay layers; damp.							
78.5	786.9	15 29 32	18	27		4.5	Hard brown LEAN CLAY with sand (CL); damp to moist.							78
83.5	781.9	50/3	3	28			Hard brown LEAN CLAY with gravel (CL); damp.							50+
88.5	776.9	50/5	3	29		4.5	Very dense brown clayey GRAVEL with sand (GC); damp.							50+
		42 50/2	7	30			@ 93.5'-108.5', preboring with tricone required to advance casing.	33	3	7	14	22	21	50+
		50/0		31										50+
100	765.4													

Depth scale: 80, 85, 90, 95, 100

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL — LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

Client: Anderson Corp. for Econ. Dev. | *Project:* Mounds Lake | *Job No.* 1363-0962.70

LOG OF: Boring B-001-14 | *Location:* As per plan | *Date Drilled:* 2/25/2014 to 2/27/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft) 765.4	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢—⊣ LL Blows per foot - ○ / Non-Plastic - NP (10, 20, 30, 40)
							Very dense brown clayey GRAVEL with sand (GC); damp.								
105		50/0		32											50+
108.5	756.9	50/0 Core 18"	Rec 18"	33 RQD 83%	R-1		Hard gray and light brown mottled DOLOMITE; very fine grained, moderately weathered, very thinly bedded to thinly bedded, moderately fractured, nodularly bedded with seperations and solutioning along undulatiing bedding surfaces.								50+
110		Core 60"	Rec 60"	RQD 90%	R-2										
115.3 (115)	750.1	Core 120"	Rec 120"	RQD 85%	R-3		Hard light brownish gray DOLOMITE; very fine grained, slightly to moderately weathered, thickly bedded to massive, moderately to highly fractured, contains pinhole size vugs throughout. @ 115.3'-116.3', high angle fractures. @ 116.7'-117.9', high angle fracture with solutionion facees. @ 117.2', decomposed iron stone band 1/8". @ 118.8'-118.9', greenish gray. @ 118.9'-119.1', hard carbonacious zone.								
120															
125	740.4						@ 123.9'-124.2',124.5'-125.0', high angle fractures.								

Client: Anderson Corp. for Econ. Dev.	Project: Mounds Lake	Job No. 1363-0962.70
LOG OF: Boring B-001-14	Location: As per plan	Date Drilled: 2/25/2014 to 2/27/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft) 740.4	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢—⊣ LL Blows per foot - ○ / Non-Plastic - NP 10 20 30 40
125.2	740.2	Core 60"	Rec 60"	RQD 100%	R-4		Hard gray DOLOMITE; very fine grained, slightly weathered, argillaceous, medium bedded, unfractured. @ 125.2'-127.3', contains pin hole vugs. @ 127.3'-130.0', thinly laminated to laminated.								
130.0	735.4						Bottom of Boring - 130.0'								

130
135
140
145
150

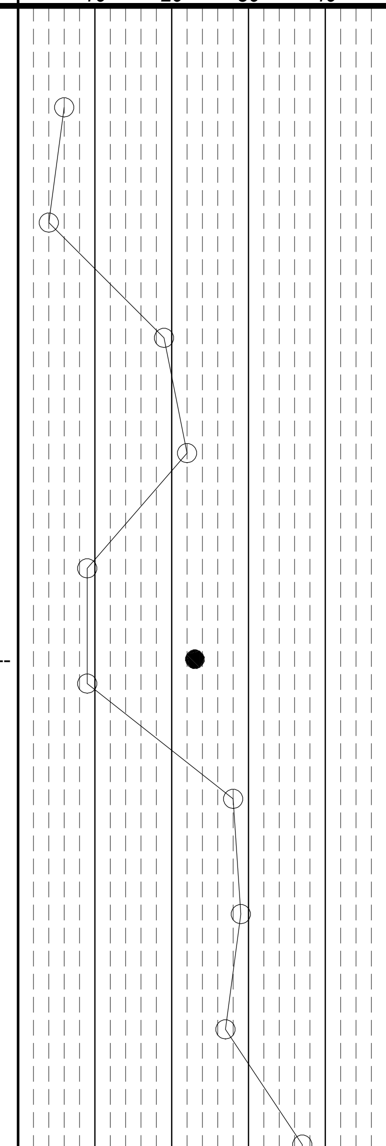
Client: Anderson Corp. for Econ. Dev. | *Project:* Mounds Lake | *Job No.* 1363-0962.70

LOG OF: Boring B-002-14 | *Location:* As per plan | *Date Drilled:* 4/15/2014 to 4/16/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:
@ 13.5', encountered ~1.5' sand heave - triconed/washed out.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	835.8												
1.0	834.8						Topsoil - 12"						
		2 3 2	8	1			Medium stiff to stiff brown to dark brown LEAN CLAY with sand (CL); moist.						
5		2 2 2	7	2									
6.0	829.8												
		4 8 9	9	3			Medium dense grayish brown to light brown GRAVEL with silt (GP-GM); contains rock fragments and broken gravel; wet.						
10		6 9 11	0	4			@ 8.5', drove 3" Split spoon to recover sample.						
11.0	824.8												
		2 4 4	10	5			Loose light brown silty SAND (SM); wet.						
15		3 3 5	16	6				0	3	67	12	--18--	
		8 12 13	12	7			@ 16.0'-18.5', medium dense.						
18.5	817.3												
20		11 12 14	18	8			Medium dense brown fine to coarse SAND (SP); wet.						
		9 13 11	13	9									
23.5	812.3												
25	810.8	15 17 16	14	10			Medium dense brown fine to coarse SAND with silt (SP-SM); wet.						

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP



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Client: Anderson Corp. for Econ. Dev. | **Project:** Mounds Lake | **Job No.** 1363-0962.70

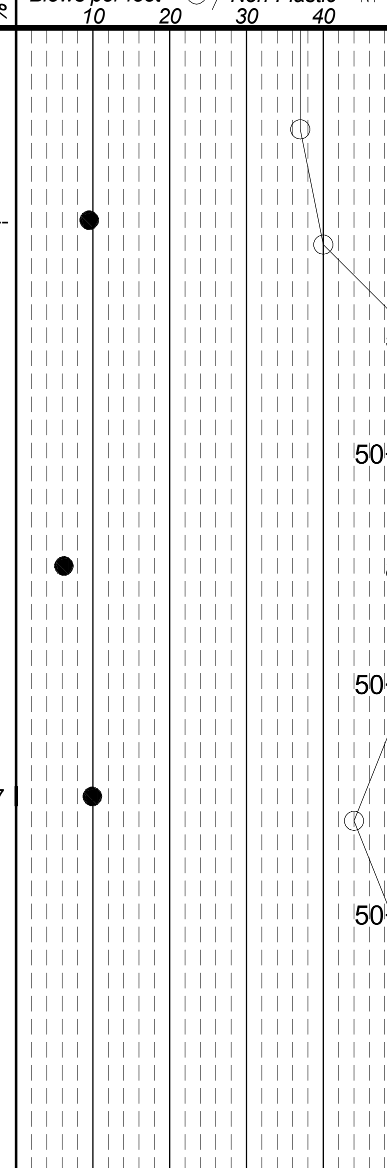
LOG OF: Boring B-002-14 | **Location:** As per plan | **Date Drilled:** 4/15/2014 to 4/16/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:

FIELD NOTES:
@ 13.5', encountered ~1.5' sand heave - triconed/washed out.

Depth (ft)	Elev. (ft) 810.8	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
		9 17 16	12	11			Medium dense brown fine to coarse SAND with silt (SP-SM); wet. @ 26.0', brownish gray.						
28.5	807.3	14 20 16	10	12			Dense brown GRAVEL with silt with sand (GP-GM); wet.	55	12	14	8	--11--	
30		9 19 30	10	13									
33.5	802.3	8 50/3	0	14			Very dense brown GRAVEL with silt (GP-GM); contains rock fragments and broken gravel; wet.						
35													
36.0	799.8	31 48 30	18	15			Very dense brown fine GRAVEL with silt (GP-GM); wet.	58	6	7	21	--8--	
40		16 49 50/5	7	16									
41.0	794.8	11 18 21	18	17			Dense gray silty SAND (SM); damp to moist.	10	14	18	22	29	7
43.5	792.3	50/3	2	18			Soft to medium hard brownish gray DOLOMITE; very fine grained, highly weathered to decomposed.						
44.0	791.8	c:"	r:60"	q:93%	R-1		Hard gray DOLOMITE; very fine grained, slightly to moderately weathered, thinly bedded to thickly bedded, slightly fractured, ocasional turbidic beds.						
45													
50	785.8	c:"	r:60"	q:90%	R-2								

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP



Client: Anderson Corp. for Econ. Dev. | Project: Mounds Lake | Job No. 1363-0962.70

LOG OF: Boring B-002-14 | Location: As per plan | Date Drilled: 4/15/2014 to 4/16/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:

FIELD NOTES:
@ 13.5', encountered ~1.5' sand heave - triconed/washed out.

Depth (ft)	Elev. (ft) 785.8	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢⊣ LL Blows per foot - ○ / Non-Plastic - NP 10 20 30 40
51.9	783.9														
54.3	781.5	c:"	r:120"	q:99%			Hard gray to dark gray DOLOMITE; very fine grained, slightly weathered, slightly carbonaceous, thinly bedded to thickly bedded, slightly fractured, contains small vugs. @ 53.4'-54.3', light gray bed.								
55							Hard gray to dark gray DOLOMITE; very fine grained, slightly weathered, slightly carbonaceous, laminated to thinly bedded, slightly fractured, nodular bedding; somewhat regular dark gray beds. @ 55.4'-56.4',57.7'-59.6',62.0'-64.0', gray to light gray beds.								
60															
65		c:"	r:120"	q:100%	R-3										
							@ 66.3'-66.9', light gray bed; thinly laminated to very thinly bedded.								
70					R-4										
71.8	764.0														
75	760.8	c:"	r:120"	q:100%	R-5		Hard gray to light gray DOLOMITE; very fine grained, slightly weathered, very thinly bedded to thinly bedded, unfractured, slightly vuggy; slightly fossiliferous. @ 73.0'-74.0', thinly laminated to very thinly bedded.								

Client: Anderson Corp. for Econ. Dev. | Project: Mounds Lake | Job No. 1363-0962.70

LOG OF: Boring B-002-14 | Location: As per plan | Date Drilled: 4/15/2014 to 4/16/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:

FIELD NOTES:
@ 13.5', encountered ~1.5' sand heave - triconed/washed out.

Depth (ft)	Elev. (ft) 760.8	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - ● / PL — LL / Blows per foot - ○ / Non-Plastic - NP
							Hard gray to light gray DOLOMITE; very fine grained, slightly weathered, very thinly bedded to thinly bedded, unfractured, slightly vuggy; slightly fossiliferous. @ 76.3'-76.5', thinly laminated.								
79.8	756.0						Hard gray to dark gray DOLOMITE; very fine grained, slightly weathered, thickly bedded, slightly fractured, bioturbatedvuggy, styolitic with carbonized surfaces.								
84.0	751.8						Bottom of Boring - 84.0'								

Depth scale: 80, 85, 90, 95, 100

Blows per foot scale: 10, 20, 30, 40

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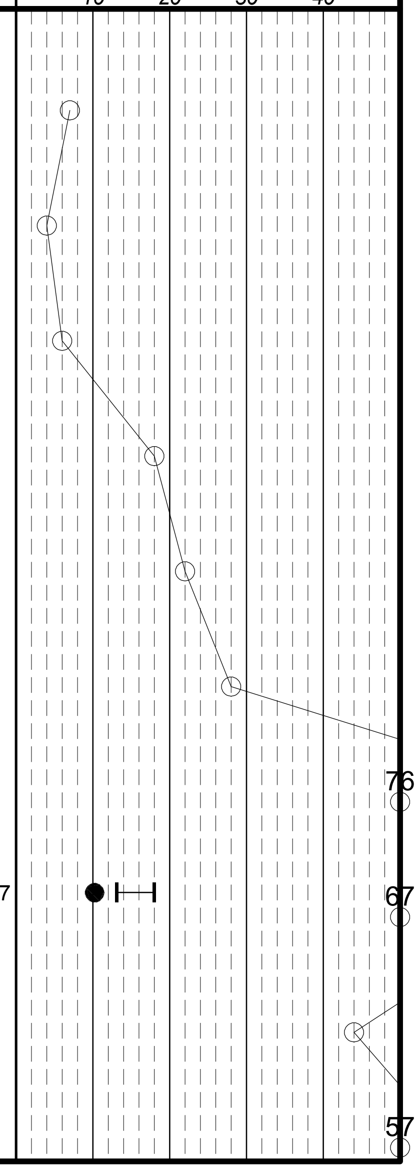
Client: Anderson Corp. for Econ. Dev.	Project: Mounds Lake	Job No. 1363-0962.70
LOG OF: Boring B-003-14	Location: As per plan	Date Drilled: 4/18/2014 to 4/22/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:

FIELD NOTES:
Samples S-1 & S-2 were taken from offset boring 12' SW (B-003A-14) Driller did not sample 0-5' at this location. Changed to mud rotary @ 11.0'

Depth (ft)	Elev. (ft) 898.3	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.4	897.9						Topsoil - 5"						
		3 3 3	14	1		1.0	Medium stiff to stiff brown LEAN CLAY (CL); damp.						
5		2 2 2	15	2		1.5							
		1 2 3	14	3		0.5							
8.5	889.8												
10		2 8 8	8	4			Medium dense brown fine to coarse SAND with silt (SW-SM); damp.						
11.0	887.3												
		9 11 9	8	5			Medium dense brown fine to coarse SAND with silt (SW-SM); wet.						
15		4 8 17	10	6									
16.0	882.3												
		33 30 38	18	7		2	Dense to very dense brown silty, clayey SAND (SC-SM); damp.						
20		28 30 30	18	8		2.5		4	9	16	24	30	17
		17 18 21	18	9		1.75							
25	873.3	25 28 23	18	10		2.0	@ 23.5', gray.						

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL |—| LL
Blows per foot - ○ / Non-Plastic - NP



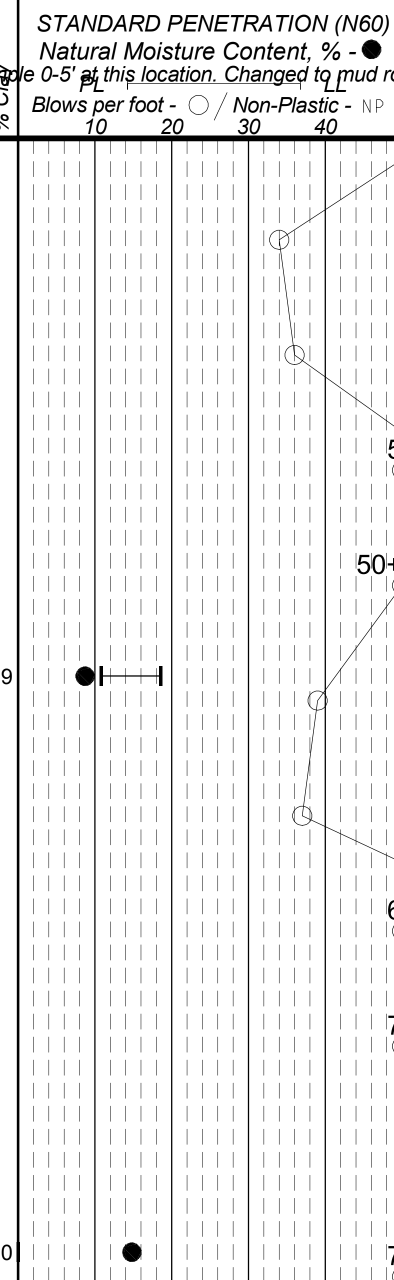
Client: Anderson Corp. for Econ. Dev. | *Project:* Mounds Lake | *Job No.* 1363-0962.70

LOG OF: Boring B-003-14 | *Location:* As per plan | *Date Drilled:* 4/18/2014 to 4/22/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:

FIELD NOTES:
Samples S-1 & S-2 were taken from offset boring 12' SW (B-003A-14). Driller did not sample 0-5' at this location. Changed to mud rotary @ 11.0'

Depth (ft)	Elev. (ft) 873.3	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
26.0	872.3						Dense to very dense gray clayey SAND (SC); damp.							
		12 16 14	18	11		3.75								
		26 15 17	9	12		3.75								
		16 24 27	9	13		3.5								
		33 50/5	10	14		3.75								
		8 17 18	13	15		4.0	@ 36.0', hard.		8	6	16	24	28	19
		15 14 19	16	16		4.0								
		23 36 26	13	17		4.0								
43.5	854.8	17 26 37	17	18		4.0	Dense light brown silty SAND (SM); contains brown clay seams; damp.							
48.5	849.8	27 31 39	8	19		4.0	Dense brown fine silty SAND (SM); damp.		1	0	5	55	29	10
50	848.3													



Client: Anderson Corp. for Econ. Dev. | *Project:* Mounds Lake | *Job No.* 1363-0962.70

LOG OF: Boring B-003-14 | *Location:* As per plan | *Date Drilled:* 4/18/2014 to 4/22/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:

FIELD NOTES:
Samples S-1 & S-2 were taken from offset boring 12' SW (B-003A-14). Driller did not sample 0-5' at this location. Changed to mud rotary @ 11.0'

Depth (ft)	Elev. (ft) 848.3	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60)
							Dense brown fine silty SAND (SM); damp.							
53.5	844.8													
55		27 33 36	14	20		4.0	Very dense gray clayey SAND (SC); damp.							77
60		47 15 31	18	21		4.0	@ 58.5'-60.0', wet.							51
		45 50/5	11	22		4.0								50+
65		37 50/2	8	23		4.0		8	8	14	25	32	13	50+
		50/5	6	24		3.75								50+
70		35 50/3	9	25		4.0								50+
		26 50/3	8	26		4.0								50+
75	823.3	25 38 45	17	27		4.0								93

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢ ⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

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Client: Anderson Corp. for Econ. Dev.	Project: Mounds Lake	Job No. 1363-0962.70
LOG OF: Boring B-003-14	Location: As per plan	Date Drilled: 4/18/2014 to 4/22/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:

FIELD NOTES:
Samples S-1 & S-2 were taken from offset boring 12' SW (B-003A-14). Driller did not sample 0-5' at this location. Changed to mud rotary @ 11.0'

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL LL
Blows per foot - ○ / Non-Plastic - NP

Depth (ft)	Elev. (ft) 823.3	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	N60
76.0	822.3													
		31 35 47	18	28			Dense to very dense gray fine to medium SAND with silt (SP-SM); wet.							92
80		17 19 23	15	29				1	1	41	46	--11--		
81.0	817.3	21 22 35	12	30			Very soft gray DOLOMITE; very fine to fine grained, decomposed.							64
83.5	814.8	50/3	3	31			Soft to medium hard gray DOLOMITE; very fine to fine grained, highly weathered to decomposed.							50+
85.0	813.3	Core 120"	Rec 115"	RQD 95%	R-1		Hard gray and light brown mottled DOLOMITE; very fine grained, moderately weathered, very thinly bedded to thinly bedded, moderately fractured, nodularly bedded with seperations and solutioning along undulatiing bedding surfaces. @ 86.9',82.9', clay filled fracture. @ 88.5'-88.8', high angle fracture.							
93.8	804.5	Core 120"	Rec 117"	RQD 98%	R-2		Hard gray DOLOMITE; very fine grained, slightly weathered, argillaceous, medium bedded, unfractured.							
100	798.3													

Client: Anderson Corp. for Econ. Dev.	Project: Mounds Lake	Job No. 1363-0962.70
LOG OF: Boring B-003-14	Location: As per plan	Date Drilled: 4/18/2014 to 4/22/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:

FIELD NOTES:
Samples S-1 & S-2 were taken from offset boring 12' SW (B-003A-14). Driller did not sample 0-5' at this location. Changed to mud rotary @ 11.0'

Depth (ft)	Elev. (ft) 798.3	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL LL Blows per foot - ○ / Non-Plastic - NP 10 20 30 40
		Core 120"	Rec 117"	RQD 98%	R-2		Hard gray DOLOMITE; very fine grained, slightly weathered, argillaceous, medium bedded, unfractured. @ 102.5'-102.8', high angle fracture.								
105.0	793.3														
							Bottom of Boring - 105.0'								

Depth scale: 105, 110, 115, 120, 125

Client: Anderson Corp. for Econ. Dev.	*Project:* Mounds Lake	*Job No.* 1363-0962.70
LOG OF: Boring B-004-14	*Location:* As per plan	*Date Drilled:*

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetro-meter (tsf)	WATER OBSERVATIONS: Water seepage at: Water level at completion: FIELD NOTES: DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢⊣ LL Blows per foot - ○ / Non-Plastic - NP 10 20 30 40
5															
10															
15															
20															
25															

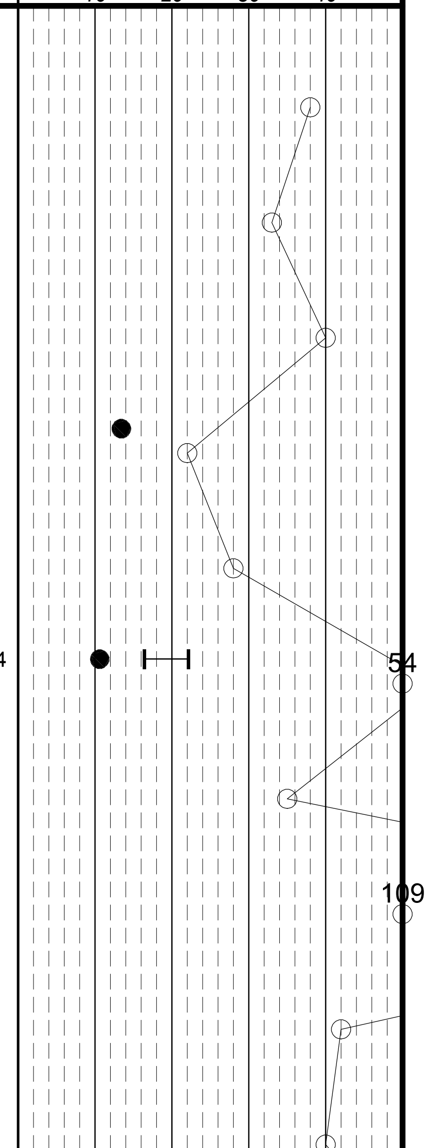
Client: Anderson Corp. for Econ. Dev. | *Project:* Mounds Lake | *Job No.* 1363-0962.70

LOG OF: Boring B-005-14 | *Location:* As per plan | *Date Drilled:* 2/27/2014 to 3/5/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft) 847.2	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	846.9						Aggregate - 4"						
		4 / 15 / 15	14	1			Medium dense brown SAND with silt with gravel (SP-SM); damp. @ 3.0', contains broken gravel.						
		8 / 12 / 14	13	2									
6.0	841.2	24 / 18 / 13	5	3			Medium dense brown GRAVEL with silt with sand (GP-GM); contains broken large gravel fragments; wet.						
8.5	838.7	9 / 10 / 7	8	4			Medium dense brown SAND with silt with gravel (SP-SM); wet.	16	28	39	8	--9--	
11.0	836.2	9 / 10 / 12	11	5			Medium dense brown SAND with clay with gravel (SW-SC); wet.						
		44 / 20 / 22	15	6				45	14	24	7	6	4
		10 / 15 / 12	12	7									
18.5	828.7	17 / 37 / 48	5	8			Very dense brown clayey GRAVEL with sand (GC); moist.						
21.0	826.2	13 / 14 / 19	9	9		4.5	Hard brown LEAN CLAY with gravel (CL); damp.						
23.5	823.7	8 / 11 / 20	13	10		4.5	Hard brown LEAN CLAY with sand (CL); damp.						
25	822.2												

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: Anderson Corp. for Econ. Dev. | **Project:** Mounds Lake | **Job No.** 1363-0962.70

LOG OF: Boring B-005-14 | **Location:** As per plan | **Date Drilled:** 2/27/2014 to 3/5/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft) 822.2	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Blows per foot
							Hard brown LEAN CLAY with sand (CL); damp.								
		15 19 22	18	11		4.5			2	1	8	20	34	35	53
30		8 16 20	15	12		4.5									
		20 21 50/5	14	13		3.75	@ 31.0', very stiff.								50+
33.5	813.7														
35		18 25 29	14	14			Very dense gray SAND with silt (SP-SM); wet.								69
36.0	811.2														
		24 41 18	18	15			Very dense gray fine to medium silty SAND (SM); moist.								76
38.5	808.7														
40		11 16 18	16	16		4.5	Hard gray LEAN CLAY with sand (CL); damp.								
45		8 16 20	14	17		4.5			2	1	7	20	36	35	
							@ 45.0', started loosing drilling mud into formation.								
		18 24 26	16	18		4.5									64
49.1	798.1	11 26 41	18	19A 19B		4.5	Very dense gray SILT with sand (ML); moist.								86
50	797.2														

Natural Moisture Content, % - ● ; PL ├──┤ LL ; Blows per foot - ○ / Non-Plastic - NP ; 10 20 30 40

Client: Anderson Corp. for Econ. Dev. | *Project:* Mounds Lake | *Job No.* 1363-0962.70

LOG OF: Boring B-005-14 | *Location:* As per plan | *Date Drilled:* 2/27/2014 to 3/5/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft) 797.2	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60)
51.0	796.2	11 23 29	18	20		4.0	Hard gray LEAN CLAY with sand (CL); damp.							67
		50/4	0	21										50+
58.5	788.7	19 38 50/5	10	22		3.75	Very stiff bluish gray to gray LEAN CLAY (CL); moist.							50+
63.5	783.7	50/5	4	23			Very dense gray clayey SAND with gravel (SC); moist.							50+
68.5	778.7	7 20 27	18	24		4.5	Hard brown LEAN CLAY with gravel (CL); moist.							60
73.5	773.7	13 22 24	18	25		4.5	Hard brown sandy LEAN CLAY (CL); damp.	4	2	8	24	31	31	59
75	772.2													

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

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Client: Anderson Corp. for Econ. Dev. | Project: Mounds Lake | Job No. 1363-0962.70

LOG OF: Boring B-005-14 | Location: As per plan | Date Drilled: 2/27/2014 to 3/5/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft) 772.2	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60)
							Hard brown sandy LEAN CLAY (CL); damp.								
78.5	768.7	8 13 38	18	26			Dense grayish brown fine SAND with silt (SP-SM); wet.								65
83.5	763.7	20 26 50/3	15	27A 27B		4.5	Hard brown LEAN CLAY (CL); damp to moist. @ 83.5', artesian conditions water flowing out of surface casing.								50+
84.6	762.6						Medium hard bluish gray SHALE; very fine grained, moderately to highly weathered, thinly laminated to laminated.								
		50/1	1	28											50+
93.5	753.7	50/3	3	29			Hard yellowish brown LEAN CLAY (CL); possible decomposed shale; damp.								50+
94.0	753.2						@ 94.0', casing refusal. Bottom of Boring - 94.0'								

Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

Depth scale: 80, 85, 90, 95, 100

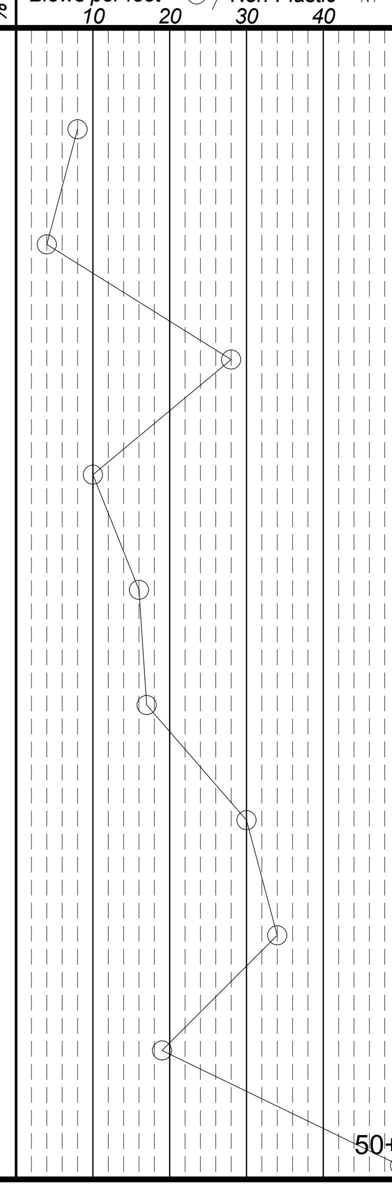
Client: Anderson Corp. for Econ. Dev. | Project: Mounds Lake | Job No. 1363-0962.70

LOG OF: Boring B-006-14 | Location: As per plan | Date Drilled:

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetro-meter (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.4							Topsoil - 5"							
		2 4 3	15	1			Loose dark brown fine silty SAND (SM); organic; topsoil like; damp.							
3.5		2 2 2	13	2		1.0	Loose brown fine silty SAND (SM); damp to moist.							
6.0		6 12 13	8	3			Loose to medium dense brown fine to coarse SAND with silt (SP-SM); wet.							
		10 4 5	13	4										
		4 4 10		5										
13.5		4 5 10		6			Medium dense brown GRAVEL with silt (GP-GM); wet.							
		11 14 13	7	7										
18.5		2 14 16	14	8		2.5	Very stiff brown sandy LEAN CLAY (CL); damp to moist.							
21.0		4 7 10	6	9		2.0	Stiff to very stiff gray sandy SILTY CLAY (CL-ML); wet.							
23.5		35 50/5	11	10A			Very dense gray GRAVEL with silt (GP-GM); moist.							
				10B			@ 23.5'-23.8', drove and fragmented large gravel or cobbel.							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP



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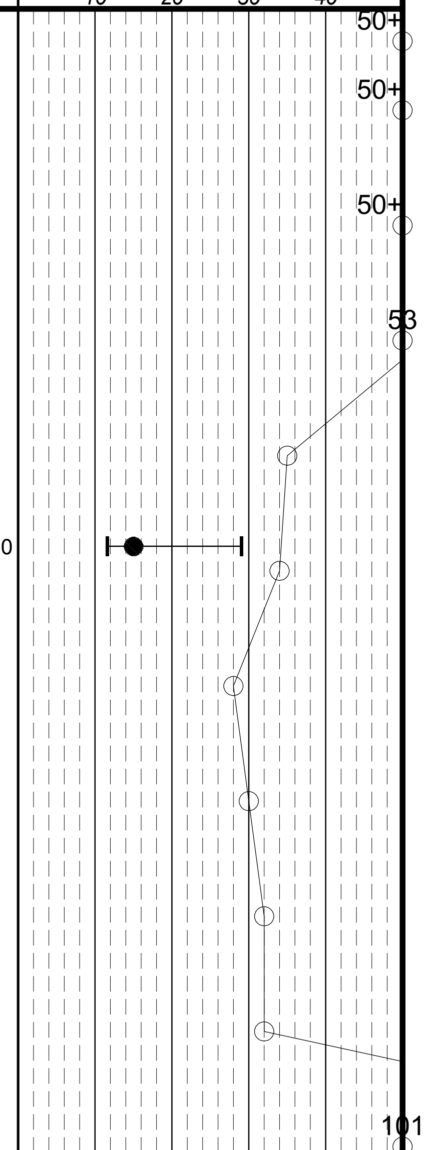
Client: Anderson Corp. for Econ. Dev. | *Project:* Mounds Lake | *Job No.* 1363-0962.70

LOG OF: Boring B-006-14 | *Location:* As per plan | *Date Drilled:*

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
		50/4	3	11									
30		50/2	0	12									
31.0		27 22 25	0	13		3.0	Very stiff gray sandy SILTY CLAY (CL-ML); wet.						
33.5 / 35		12 13 18	13	14		4.0	Hard gray LEAN CLAY with sand (CL); moist.						
		10 12 18	18	15		4.0		0	2	7	18	32	40
40		10 11 14	12	16		4.0							
		8 12 15	15	17		4.0							
45		12 14 15	18	18		3.5							
46.0		11 14 15	18	19			Medium dense to dense gray fine to medium SAND with silt (SP-SM); moist to wet.						
48.5 / 50		12 40 50	18	20			Medium dense to dense gray fine silty SAND (SM); moist to wet.						

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



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Client: Anderson Corp. for Econ. Dev. | *Project:* Mounds Lake | *Job No.* 1363-0962.70

LOG OF: Boring B-006-14 | *Location:* As per plan | *Date Drilled:*

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60)
		35 34 32	13	21		4.0	Medium dense to dense gray fine silty SAND (SM); moist to wet.	4	7	45	26	--18--		74
53.5														
55		10 14 21	18	22		4.0	Hard gray sandy LEAN CLAY (CL); moist.							
		13 15 18	18	23		4.0		3	2	8	22	35	30	
60		10 16 23	18	24		3.75	@ 58.5'-61.0', very stiff, moist.							
61.0														
		9 19 22	18	25		3.5	Hard gray sandy SILTY CLAY (CL-ML); moist.							
63.5														
65		13 21 24	16	26			Hard reddish brown LEAN CLAY (CL); contains silt laminations; damp.							
66.0														
		22 35 33	17	27			Very dense gray sandy SILT (ML); wet.	0	0	0	33	--67--		76
70		25 33 31	18	28										72
73.5														
75		21 25 22	18	29		4.0	Hard reddish brown LEAN CLAY (CL); damp.	0	0	1	9	47	43	53

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

Client: Anderson Corp. for Econ. Dev. | Project: Mounds Lake | Job No. 1363-0962.70

LOG OF: Boring B-006-14 | Location: As per plan | Date Drilled:

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - ● / PL–LL / Blows per foot - ○ / Non-Plastic - NP
							Hard reddish brown LEAN CLAY (CL); damp.								
80		21 23 34	18	30		4.0									64
83.5		20 26 22	18	31		4.0	Hard reddish brown sandy LEAN CLAY (CL); damp.								54
85															
88.5		42 50/5	11	32		2.5	Very dense reddish brown silty SAND (SM); damp.		3	2	6	48	--41--		50+
90															
93.5		31 35 40	10	33			Very dense gray fine to medium SAND with silt (SP-SM); wet.								84
95															
98.5		24 50/3	8	34			Very stiff gray LEAN CLAY with sand (CL); damp.								50+
100															

Chart scale: 10, 20, 30, 40

Client: Anderson Corp. for Econ. Dev. | Project: Mounds Lake | Job No. 1363-0962.70

LOG OF: Boring B-006-14 | Location: As per plan | Date Drilled:

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL LL Blows per foot - ○ / Non-Plastic - NP 10 20 30 40
							Very stiff gray LEAN CLAY with sand (CL); damp.								
103.5		30 30 27	6	35			Dense gray fine to medium SAND with silt (SP-SM); wet.								64
105.0	105						Bottom of Boring - 105.0'								

110

115

120

125

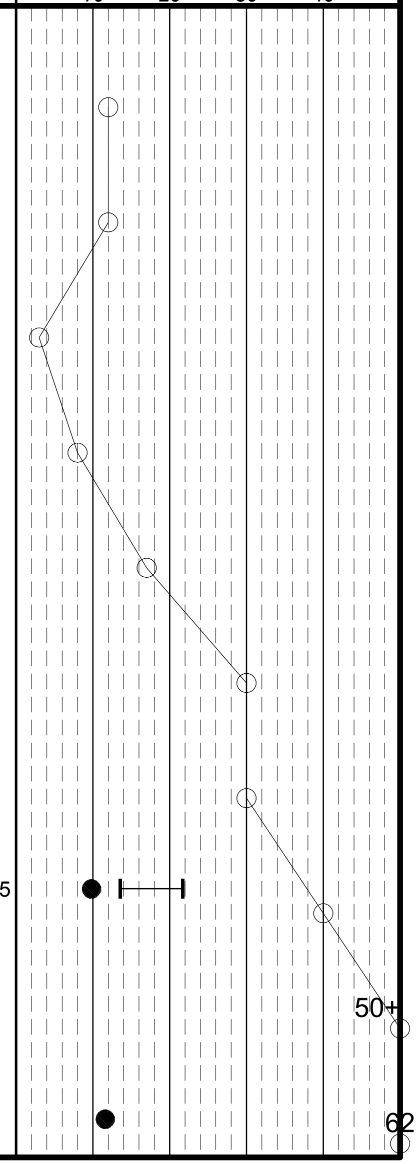
Client: Anderson Corp. for Econ. Dev. | **Project:** Mounds Lake | **Job No.** 1363-0962.70

LOG OF: Boring B-007-14 | **Location:** As per plan | **Date Drilled:** 3/5/2014 to 3/7/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft) 860.0	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	859.7						Asphalt Concrete Pavement - 3" Aggregate Base - 1"							
		6 4 5	16	1			Stiff dark brown SILTY CLAY with sand (CL-ML); possible topsoil; damp.							
3.5	856.5													
4.3	855.7	4 5 4	13	2A 2B			Soft brown SILTY CLAY with sand (CL-ML); damp.							
5							Loose brown silty SAND with gravel (SM); damp.							
6.0	854.0	1 1 1	15	3		0.25	Very soft brown LEAN CLAY (CL); moist to wet.							
8.5	851.5	6 4 2	8	4		0.75	Soft gray LEAN CLAY with sand (CL); contains organic material; moist to wet.							
10														
11.0	849.0	17 8 5	11	5A 5B		0.5	Medium dense brown GRAVEL with silt with sand (GP-GM); wet.							
11.5	848.5						Medium dense gray SAND with silt (SP-SM); wet.							
13.7	846.3	8 11 12	9	6A 6B		.75	Medium dense gray SAND with silt (SP-SM); wet.							
15														
16.0	844.0	5 11 12	14	7		4.5	Hard gray sandy LEAN CLAY (CL); damp.							
		5 14 17	17	8		4.5			2	3	10	25	35	25
20														
		50/5	0	9			@ 21.0', boulder encountered.							
25	835.0	14 25 23	14	10		4.5								

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

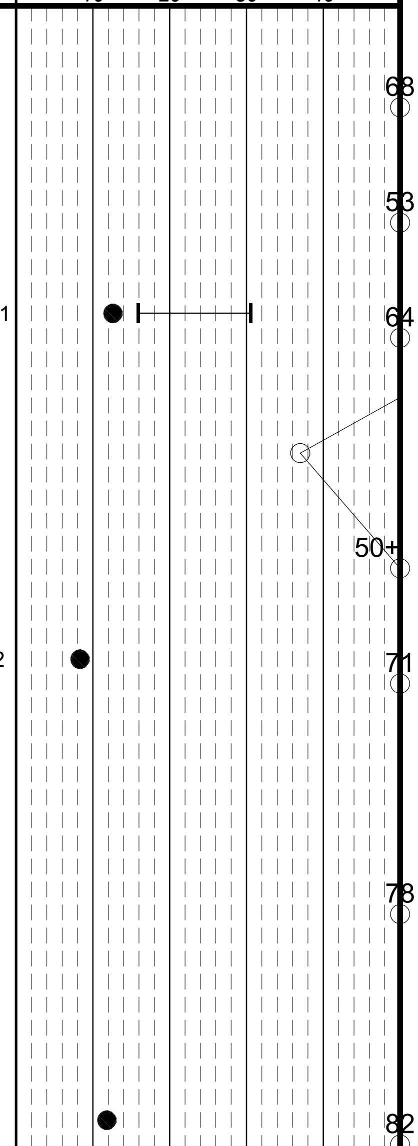
Client: Anderson Corp. for Econ. Dev. | Project: Mounds Lake | Job No. 1363-0962.70

LOG OF: Boring B-007-14 | Location: As per plan | Date Drilled: 3/5/2014 to 3/7/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft) 835.0	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
		22 23 30	18	11		4.5	Hard gray sandy LEAN CLAY (CL); damp.						
30		12 19 22	18	12		4.5							
		11 20 30	18	13		4.5		1	2	8	20	38	31
35		8 12 17	18	14		4.5							
36.0	824.0	50/5	5	15			Very dense gray GRAVEL with silt with sand (GW-GM); wet. @ 36.0', artesian conditions encountered, est. 30 gpm.						
40		20 28 27	12	16			@ 38.5'-42.0', chatter while advancing casing.	52	13	21	8	4	2
43.5	816.5	16 36 25	15	17			Very dense gray SAND with silt with gravel (SP-SM); wet.						
45													
50	810.0	28 29 35	18	18				22	20	23	26	--9--	

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○ / Non-Plastic - NP



Client: Anderson Corp. for Econ. Dev.	Project: Mounds Lake	Job No. 1363-0962.70
LOG OF: Boring B-007-14	Location: As per plan	Date Drilled: 3/5/2014 to 3/7/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft) 810.0	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60)
							Very dense gray SAND with silt with gravel (SP-SM); wet.								
53.5	806.5														
55		8 21 30	18	19		4.5	Very stiff to hard gray sandy LEAN CLAY (CL); damp to moist.		1	6	10	25	33	25	65
60		12 19 30	2	20		3.5									63
63.5	796.5														
65		15 23 36	18	21			Very dense gray fine silty SAND (SM); moist. @ 63.5',68.5', heaving sands encountered.								76
68.5	791.5														
70		10 16 32	8	22			Dense gray GRAVEL with silt with sand (GP-GM); wet. @ 68.5'-78.5', chatter while advancing casing.								62
73.5	786.5														
74.5	785.5	10 20 22	18	23A 23B		4.5	Dense gray fine silty SAND (SM); moist to wet.								54
75	785.0														

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

Client: Anderson Corp. for Econ. Dev. | *Project:* Mounds Lake | *Job No.* 1363-0962.70

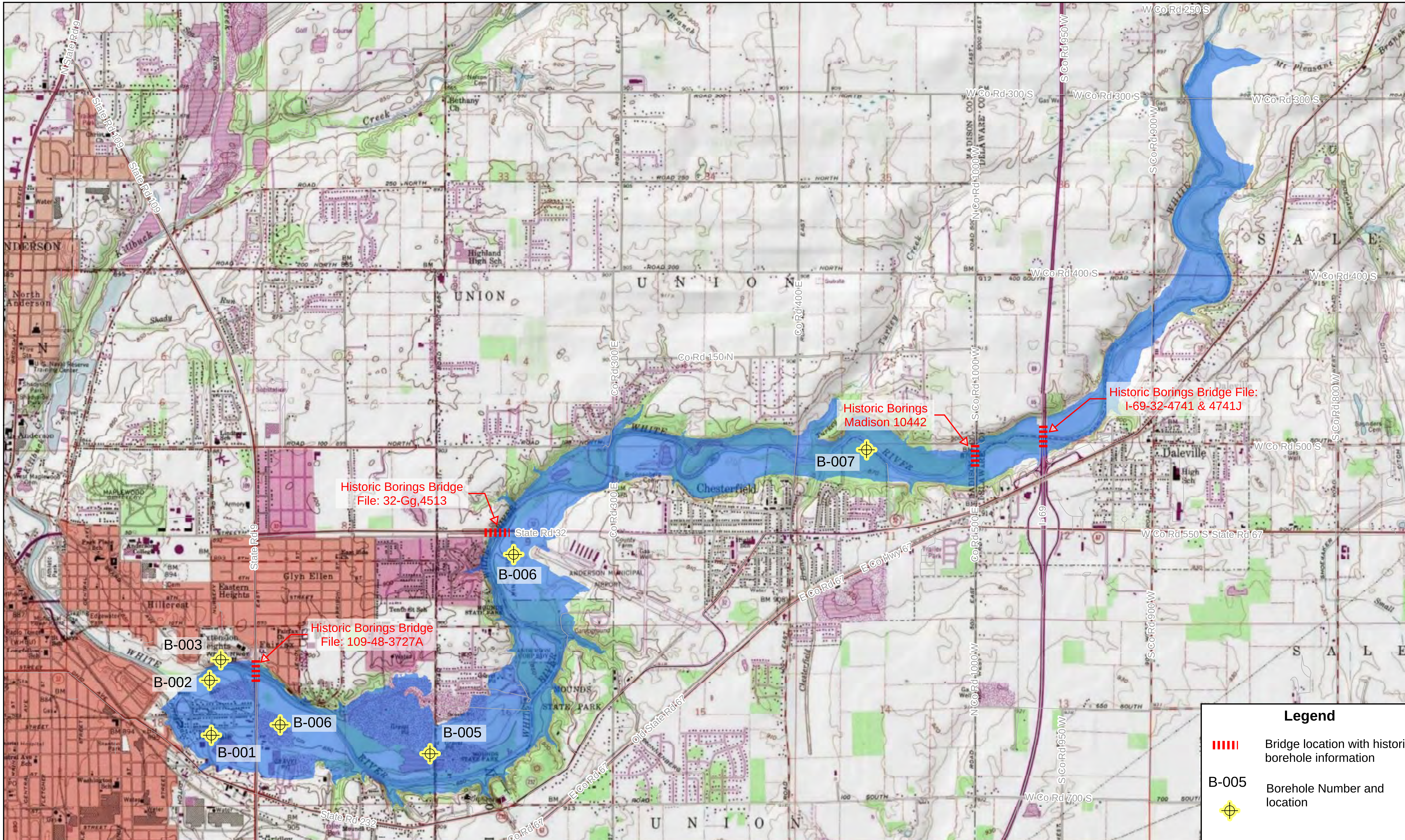
LOG OF: Boring B-007-14 | *Location:* As per plan | *Date Drilled:* 3/5/2014 to 3/7/2014

WATER OBSERVATIONS:
Water seepage at:
Water level at completion:
FIELD NOTES:

Depth (ft)	Elev. (ft) 785.0	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60)
							Very stiff to hard sandy brownish gray LEAN CLAY (CL); damp.							
80		20 36 46	18	24		4.5	@ 78.5', heaving sands encountered.	10	5	12	22	34	17	105
83.5	776.5													
83.9	776.1	50/4	0	25			Soft yellowish gray LIMESTONE; very fine grained, highly weathered to decomposed. @ 83.5'-88.5', preboring with tricone required to advance casing.							50+
84.6	775.4	c:"	r:12"	q:0%			Very soft to soft orangish red LIMESTONE (Terra Rosa completely decomposed limestone/dolomite soil residium.)							
88.6	771.4	50/1	1	26	R-1		Soft gray LIMESTONE; very fine grained, highly weathered to decomposed.							50+
							Bottom of Boring - 88.6'							

Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

Depth scale: 80, 85, 90, 95, 100



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Anderson Dam - Mounds Lake
Proposed Boring Location Plan Overview

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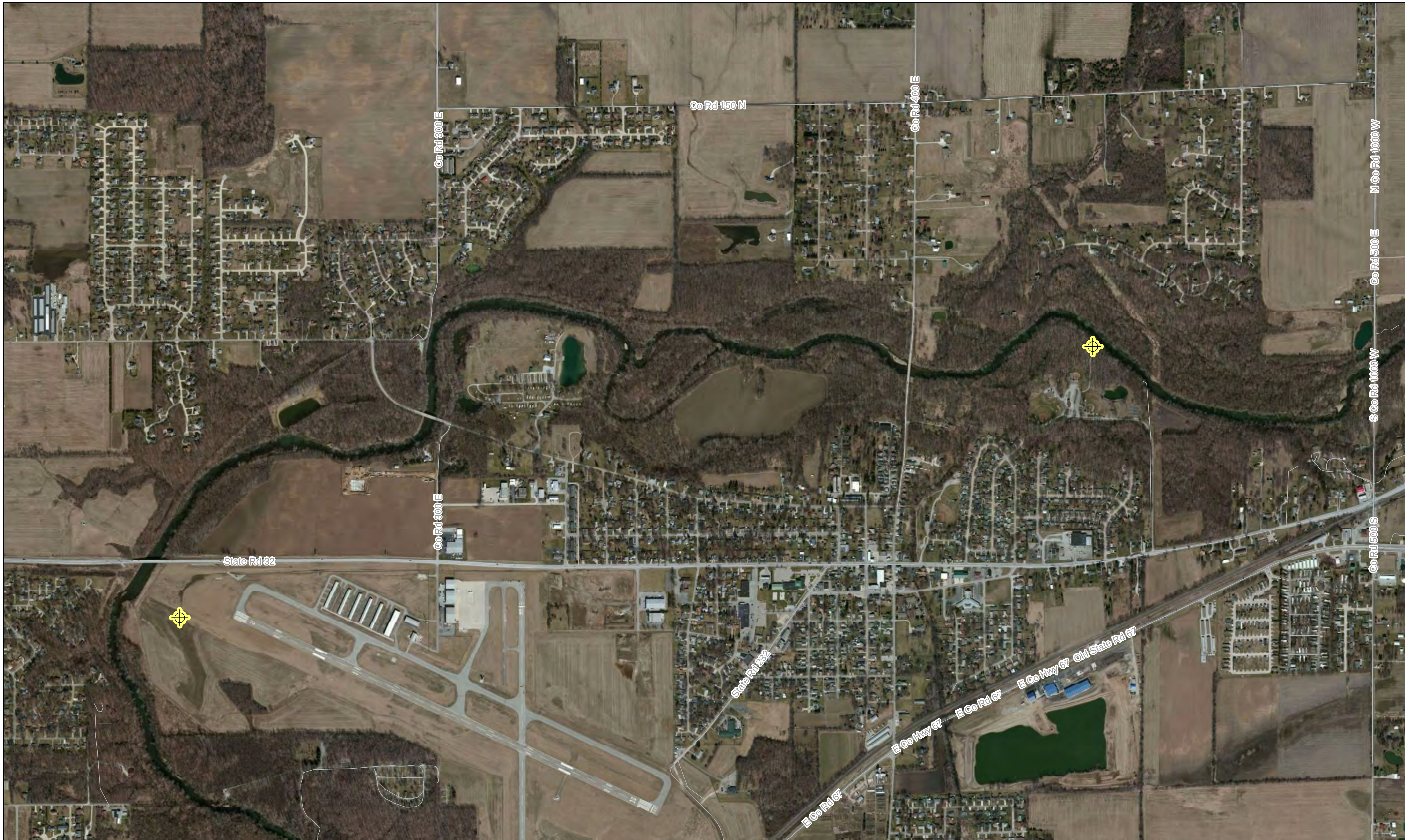
Anderson Dam - Mounds Lake
Proposed Boring Location Plan 1/2



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Anderson Dam - Mounds Lake
Proposed Boring Location Plan 2/2

0 500 1,000
Feet

N

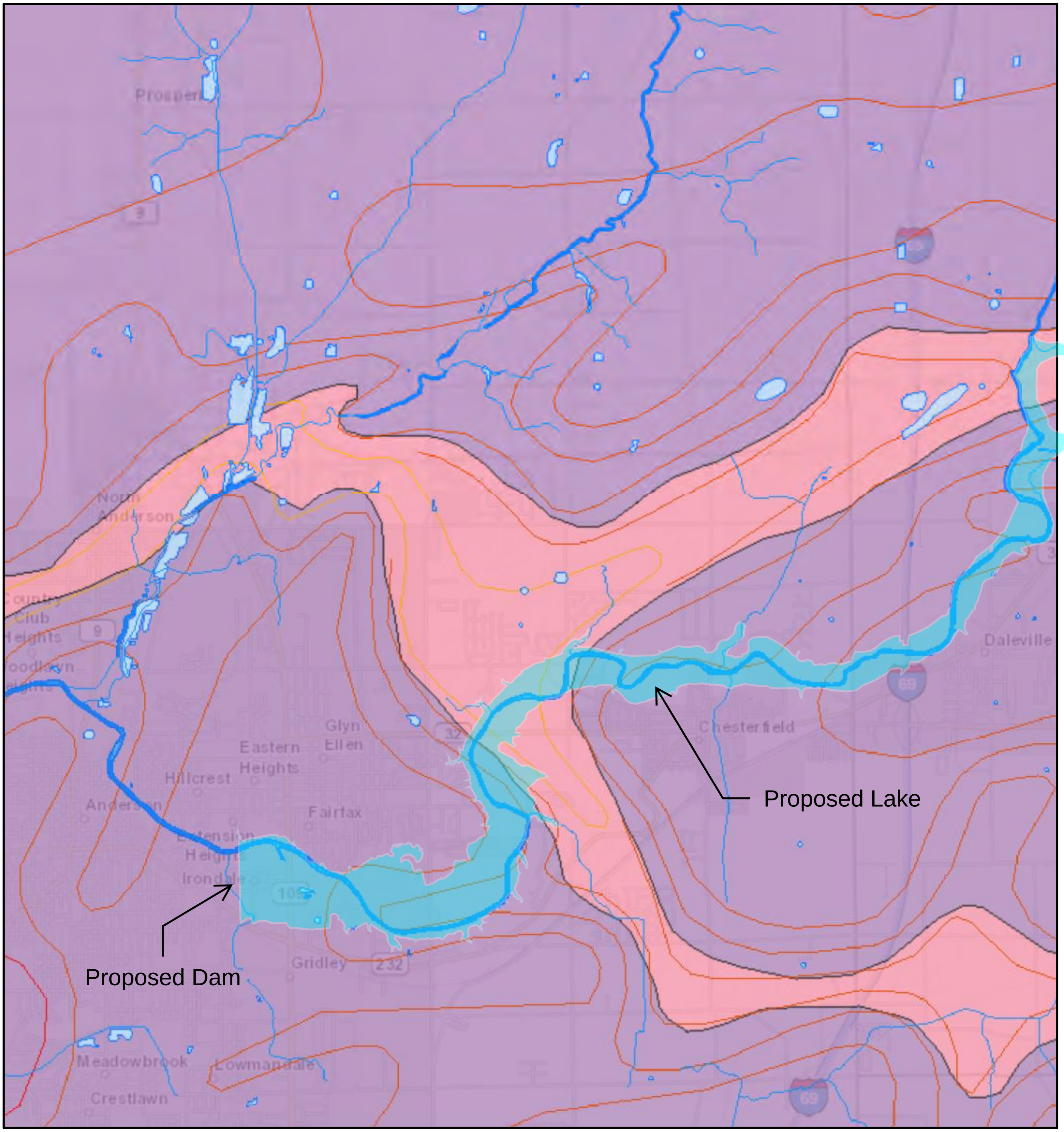
DLZ

Anderson Dam - Mounds Lake
Proposed Boring Location Plan with 1953 Aerial

0 300 600
Feet

Maps

Bedrock Geology and Topography



June 18, 2014

1:64,000

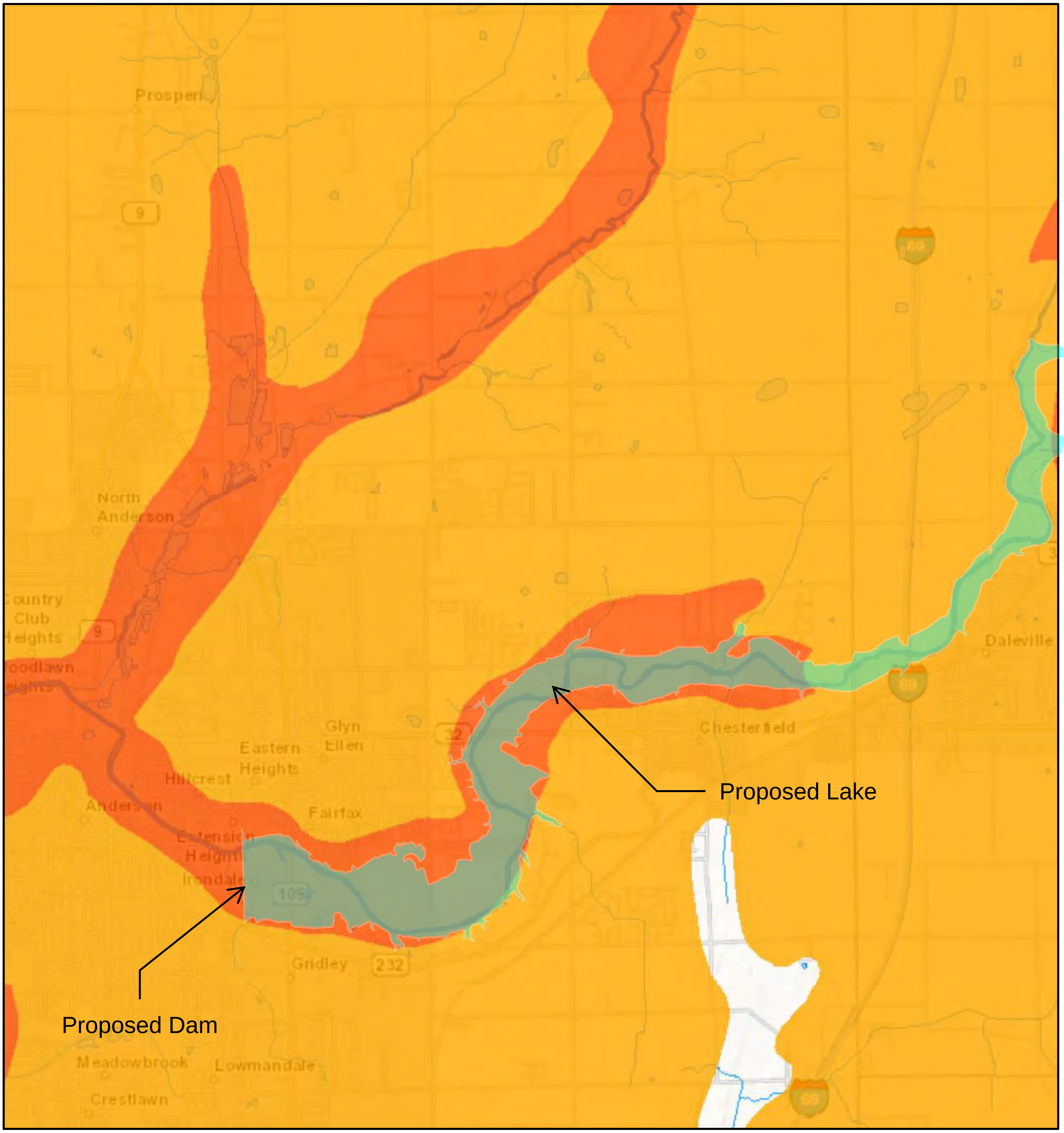
0 0.5 1 2 mi

0 0.75 1.5 3 km

- Streams (NHD)
- Rivers (NHD)
- Lakes (NHD)
- 1001 - 1200
- 801 - 1000
- 601 - 800
- 401 - 600
- 250 - 400
- Pennsylvanian
- Mississippian
- Devonian-Mississippian
- Devonian
- Silurian
- Ordovician

U.S. Geological Survey
Indiana Department of Transportation (INDOT), U.S. Census Bureau (USCB), Indiana Geographic Information Council (IGIC), UITS, Indiana Spatial Data Portal
Indiana Geological Survey

Anderson Sand and Gravel Resources



June 18, 2014

1:64,000

0 0.5 1 2 mi

0 0.75 1.5 3 km

Potential resource

Low potential resource

Not a potential resource

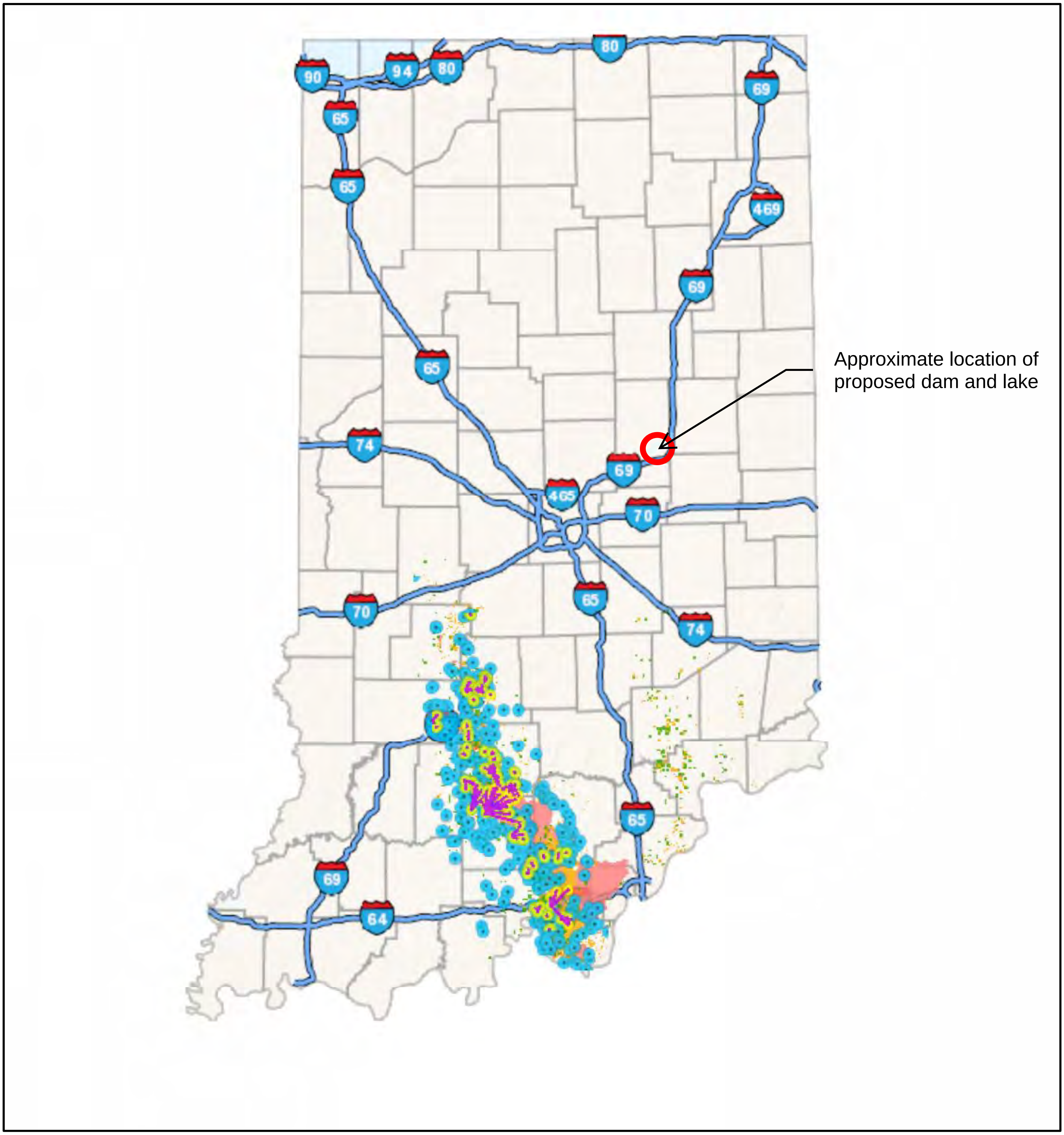
Streams (NHD)

Rivers (NHD)

Lakes (NHD)

U.S. Geological Survey
Indiana Department of Transportation (INDOT), U.S. Census Bureau (USCB), Indiana Geographic Information Council (IGIC), UITS, Indiana Spatial Data Portal
Indiana Geological Survey

Indiana Karst Map



June 18, 2014

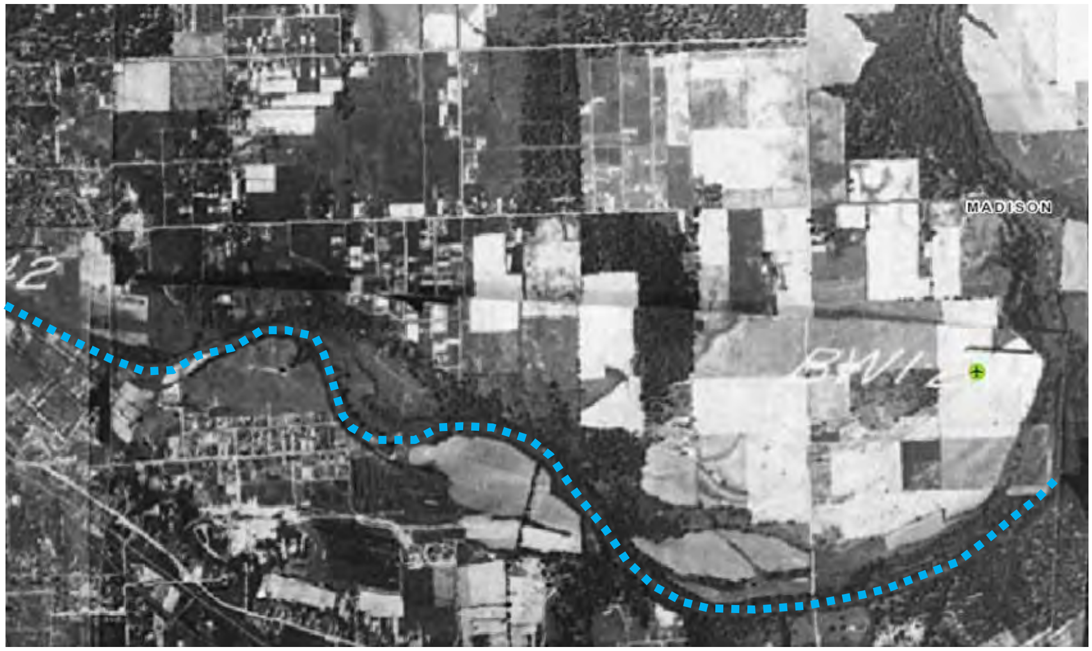
	Karst Area Dye Lines		6 - 10
	Karst Area Dye Points		11 - 15
	Karst Springs		Sinkhole Area
	0 - 1		Sinking Stream Basin
	2 - 5		

1:2,500,000

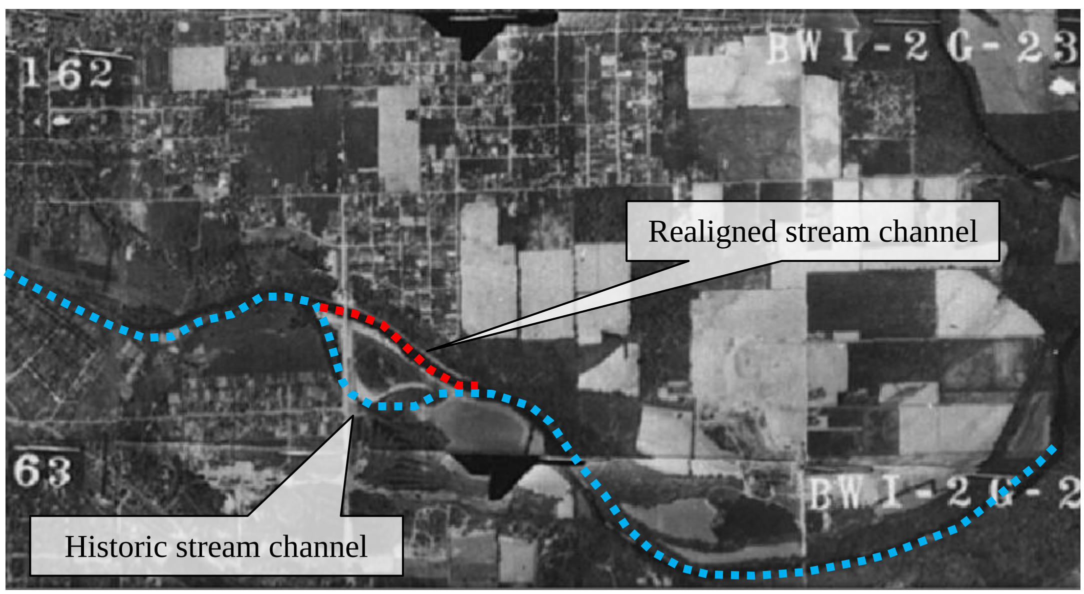
0 20 40 80 mi

0 30 60 120 km

Indiana Department of Transportation (INDOT), U.S. Census Bureau (USCB), Indiana Geographic Information Council (IGIC), UITS, Indiana Spatial Data Portal
Indiana Geological Survey



1939 Aerial Photograph
Source: Indiana Geologic Survey



1950 Aerial Photograph
Source: Indiana Geologic Survey

N

Not to Scale

West Fork of the White River Stream Channel Realignment between 1939 and 1950

Mounds Lake
Anderson, Indiana

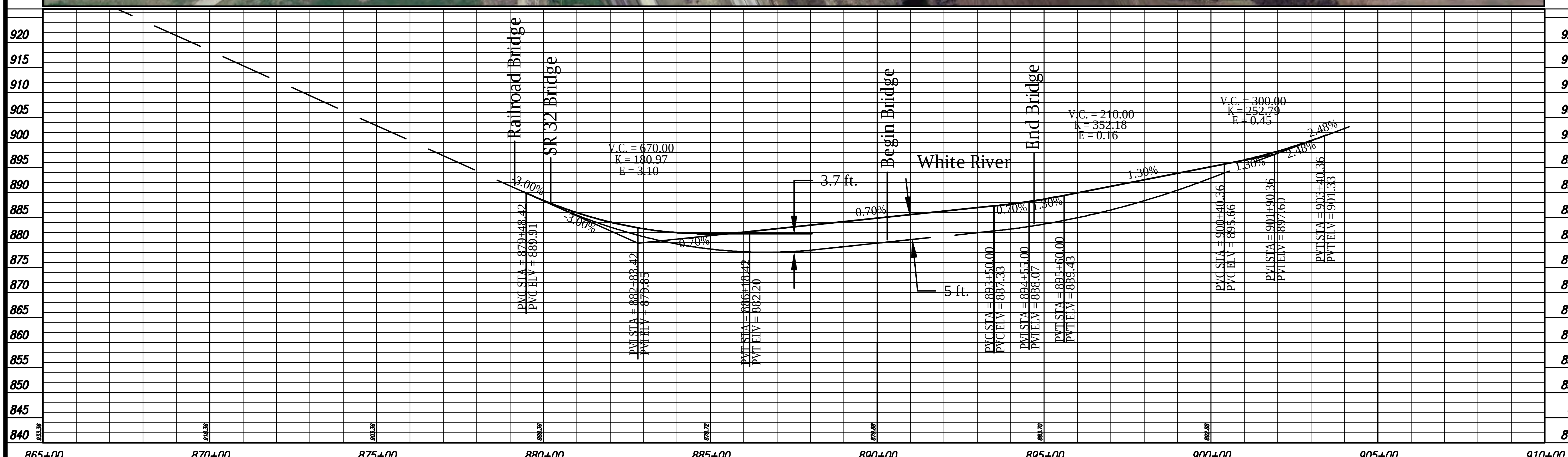
DLZ Project Number
1363-0962-70

DLZ

Appendix C

I-69 over White River Bridge Raising / Replacement Feasibility

Maps



Date: Apr 09, 2014, 4:44pm User ID: cgonsoski
File: M:\PROJ\1163\0791-Anderson\EP\RCp03001.dwg Model Tab: Layout1

DLZ

Anderson Dam and Reservoir
Feasibility Study
Anderson, Indiana

0 300 600
Horizontal Scale 1" = 300' (11x17)

I-69 Grade Change Feasibility

Vertical Scale
1" = 20'

April 9, 2014

SHEET 1 OF 1