IN THE MATTER OF THE APPLICATION OF XCEL ENERGY

FOR A SITE PERMIT

FOR THE UP TO 250 MW SHERCO 3 SOLAR ENERGY GENERATING SYSTEM

IN SHERBURNE COUNTY, MINNESOTA

MINNESOTA PUBLIC UTILITIES COMMISSION

COMMISSION DOCKET NO. E-002/GS-23-217

OAH DOCKET NO.: 24-2500-39813

DIRECT TESTIMONY OF ELLEN HEINE

APRIL 30, 2024

I. INTRODUCTION AND QUALIFICATIONS

Q. Please state your name and business address.

A. My name is Ellen Heine, and my business address is 414 Nicollet Mall, Minneapolis, Minnesota 55401.

Q. By whom are you employed and in what capacity?

A. I am employed as a Principal Siting and Permitting Agent by Xcel Energy Services Inc., the service company for Xcel Energy Inc. ("Xcel Energy" or the "Company").

Q. Please describe your educational background and professional experience.

A. I have a Bachelor of Arts degree in Biology and Chemistry from the University of Minnesota-Morris, and a Masters Degree in Urban and Regional Planning from the University of Minnesota. Earlier in my career, I was employed by Minnehaha Creek Watershed District as a Land Conservation Specialist and by the Metropolitan Council of the Twin Cities as a GIS Technician. I have been employed by Xcel Energy since 2011, first as a Compliance/Permitting Analyst, and, starting in 2013, in my current position. My job duties include coordinating with team members, agency staff, consultants and construction managers and crews on permitting and compliance issues for projects; acquiring federal and state permits for wetlands, water and land crossings and transmission line routes; and managing compliance filings and tasks related to permitted projects.

Q. For whom are you testifying?

A. I am testifying on behalf of Northern State Power Company, doing business as Xcel Energy, in support of its Application for a Site Permit for the up to 250 MW Sherco 3 Solar Energy Generating System ("Application")

Q. What is your role in the Project?

A. I am a responsible for Project specifics and environmental aspects of the proposed Sherco 3 solar project including environmental site studies, site permit application development, coordination and management of Project consultants, and communication with regulatory and resource agency staff.

II. OVERVIEW

Q. What is the purpose of your Direct Testimony?

A. The purpose of my testimony is to provide a general description of the Sherco 3 Solar Energy Generating System Project ("Project") and to introduce the other witness who is providing direct testimony in support of the Application. I will also provide an update on the Project and construction schedule. In addition, I will discuss water quality concerns, visual impacts, and heat island concerns raised by local stakeholders.

Q. What attachments are attached to your Direct Testimony?

A. The following attachments are attached to my Direct Testimony:

- Attachment A: Curriculum Vitae
- Attachment B: Updated Site Map
- Attachment C: Westwood Sherco 3 Ordinance Stormwater Memorandum
- Attachment D: TCLP Testing Results

Q. Are you also sponsoring the Application?

A. Yes, I am sponsoring the entire Application.

III. PROJECT OVERVIEW

Q. Please provide a summary of the Project.

A. The Project includes an up to 250-megawatt ("MW") alternative current ("AC") solar project in Sherburne County, Minnesota. The Project is proposed to partially replace energy production of the approximately 700 MW Sherco Generating Plant Unit 2 ("Sherco Generating Plant"), a coal-powered facility. In 2016, the Commission approved the Company's plan to retire Unit 2 of the Sherco Generating Plant, which was completed in 2023. The Project would be located within agricultural fields between U.S. Highway 10 and the Mississippi River.

Q. Who is developing the project?

A. Xcel Energy will construct, own, and operate the Project.

Q. Why has Xcel Energy proposed the Project?

A. The Project is being proposed to reuse transmission interconnection rights that have become available due to ceasing operations of Unit 2 of the Sherco Generating Plant in 2023. Upon cessation, existing interconnection capacity must be repowered within three years or retired by Xcel Energy under the Midcontinent Independent System Operator ("MISO") generating facility replacement process. The Project will replace a portion of the nearly 700 MW of capacity generated by the Sherco Generating Plant and represents a key milestone step in Xcel Energy's clean energy transition, which targets 100 percent carbon free electricity by 2050 and 80 percent less carbon by 2030.

In addition, the Project is part of a set of investments Xcel Energy proposed in response to a request from the Commission to identify projects that could create jobs and assist the clean energy transition while also keeping bills low for its customers. The construction of the Project will provide an estimated $115 million in wages from nearly 900 union construction jobs.

Q. Is a certificate of need required for the Project?

A. No. Although I am not an attorney, I understand that typically, a certificate of need is required for a "large energy facility", which includes an electric power generating plant with a capacity of 50,000 kilowatts or more. However, there are several exemptions to this requirement. I understand that this Project is exempt from certificate of need requirements pursuant to Minn. Stat. § 216B.2422 subd. 5, which provides an exemption from the certificate of need statute (Minn. Stat. § 216B.243) for resources selected through a competitive bidding acquisition process approved or established by the Commission, such as the Modified Track 2 process used by Xcel Energy to select the Project. The Commission determined that the Project qualifies for this exemption because it was selected using Xcel Energy's Modified Track 2 bidding process.

Q. Please describe the Solar Project in further detail.

A. The Project will be located in the city of Clear Lake and Clear Lake Township in Sherburne County. The Project will connect to the previously permitted Sherco Solar West Substation, which will connect to the existing Sherburne County Substation. Combined, the Lease Area and Collection Corridors comprise the Project Area and encompass approximately 1,780 acres. At present, the Project Area is comprised primarily of agricultural fields. After photovoltaic (PV) solar panels are installed and construction of the Project is completed, areas that will not contain permanent Project facilities, including area under the panels, laydown yards, and stormwater basins, if any, will be re-vegetated with perennial native vegetation consistent with the Vegetation Management Plan (VMP).

IV. PROJECT UPDATE

Q. Do you have any updates to provide concerning the Project's layout?

A. Yes. As reflected in Attachment B and as described and depicted in the Application, Unit 4 will not host Project infrastructure due to siting constraints posed by existing transmission lines that cross Unit 4. The Project's solar panels must be setback from existing transmission lines to accommodate the existing easement rights and to ensure the solar panels are not shaded by the transmission lines. The imposition of adequate setbacks in this unit meant that we couldn't feasibly fit panels in Unit 4. Xcel Energy can meet its power production target for the existing layout without placing panels in this Unit. In order to allow continued use of Unit 3, a new easement corridor was recently secured between Units 3 and 7 via a voluntary easement agreement. The collector easement corridor will allow the installation of underground electrical collection and communication cables to connect Units 3 and 7. The electrical collector and communication lines will be installed in this collector easement corridor via underground directional boring. Because the cabling will be installed via directional boring across this collector corridor easement parcel, no environmental impacts are anticipated in this area.

Q. Do you have any other updates concerning the Project?

A. Yes. Due to timing of site permitting activities, some activities are now scheduled to begin after the crops are harvested this fall. Because the permit approval is likely to come later this summer, Xcel told landowners they could plant crops this year to take advantage of this growing season. Accordingly, Xcel will wait until crops are harvested and a cover crop is planted before beginning land preparation activities.

V. WATER QUALITY

Q. What are the existing conditions at the Project Area?

A. The Project is comprised mostly of agricultural land, currently consisting primarily of row crops. The topography of the Project Area is generally flat with slopes becoming steeper near the waterbodies and is scattered with numerous existing depressions. The soil primarily consists of 'poorly graded' sand, which has a high infiltration rate. With the high infiltration rates the existing depressions generally do not retain water for a significant amount of time following rainfall events.

Q. What will the conditions at the Project Area be like once the Project is completed?

A. The Project Area will be revegetated with a native prairie mix that will include native grasses and wildflowers that will provide beneficial habitat. This will achieve Xcel's goal of operating a habitat-friendly solar facility by providing native perennial vegetation and foraging habitat beneficial for game birds, songbirds, and pollinators.

Q. What impact will the conversion from row crops to native perennial vegetation have on area water quality?

A. Xcel Energy expects the conversion of the Project Area from row crops to native perennial vegetation will improve area water quality. Nitrogen fertilizer is commonly used in row crop agriculture, including at the Project site. As the Minnesota Department of Agriculture (MDA) acknowledges, "an extensive body of research document[s] that nitrate from nitrogen fertilizer can leach below the root zone and migrate to groundwater." Nitrate causes widespread water degradation in Minnesota. According to the Minnesota Pollution Control Agency, "[n]itrate . . . commonly exceeds the levels established to protect drinking water, especially in wells located below sandy soils and shallow soils above fractured bedrock. Nitrate levels are high enough to harm the food chain for fish in some rivers and streams fed by groundwater and drainage ditches."

Groundwater in and around the Project Area is polluted with nitrates. The MDA maintains a "Vulnerable Groundwater Area Map," which documents areas where nitrate can move easily through soil and into groundwater. Clear Lake and Clear Lake Township both fall in vulnerable groundwater areas. The map also reveals that the downstream Becker Drinking Water Supply Management Area (DWSMA) exceeds the current Nitrate-Nitrogen drinking water standard of 5.4 mg/L, which is a health-based threshold that applies to public wells. In 2020, the city of Clear Lake received a $1.3 million loan from the state to address nitrate pollution by digging a new public well. Data about private wells can be more difficult to find. But according to a January 2018 MDA Report, in 2014–2016, more than 1 in 10 private wells in the Clear Lake area exceeded the previous Nitrate-Nitrogen drinking water standard of 10 mg/L—nearly double the current threshold.

By converting row crop area to native perennial vegetation in the Project Area, the Project is expected to improve water quality in and around the Project Area. A 2019 Iowa State study of changes to soil health after participation in the Conservation Reserve Program (CRP) found that perennial vegetation has a higher potential to retain nitrogen than cropland, which will reduce nitrogen leaching and improve soil health. *See* Mriganka De et al., *Soil health recovery after grassland reestablishment on cropland: The effects of time and topographic position*, 84 Soil & Water Management and Conservation 2 (Dec. 12, 2019) https://doi.org/10.1002/saj2.20007. Xcel anticipates that the perennial vegetation at the Project will similarly retain nitrogen better than row crops, which will reduce nitrogen leaching and improve soil health in the Project Area. Moreover, the Project will not require the application of nitrogen to the soil during the Project's operation. Retiring the Project Area from crop production and its associated nitrogen applications will reduce the amount of nitrogen that may enter groundwater and area surface waters.

Q. Are there any other environmental benefits from converting row crops to native perennial vegetation?

A. Yes. As mentioned previously, converting the Project Area from row crops to native perennial vegetation is expected to improve soil quality.

There will likely also be climate benefits from improved soil quality. Native perennial vegetation is expected to sequester and retain more carbon than annual row crops. As discussed in Chapter 10: Grasslands of the Second State of the Carbon Cycle Report (SOCCR2), which was published by the U.S. Global Change Research Program, mature native grasslands like the native prairie mix that will be established at the Project Area have the potential to sequester significant amounts of carbon for extended periods of time. (Available at https://doi.org/10.7930/SOCCR2.2018.Ch10). In fact, a 2018 study by Pawlok Dass *et al.*, at the University of California – Davis, found that grasslands are the *only* viable net carbon sink ecosystem in the next century because they are best equipped to withstand unpredictable weather resulting from climate change.

Native perennial vegetation serves as a particularly effective carbon sink because of its extensive and durable root systems. According to the Minnesota Board of Water and Soil Resources (BWSR), "Prairie systems contain much more soil organic carbon than other ecosystems due to rooting characteristics of the vegetation that grows there." These deep root systems deposit carbon deep in soil layers, which increases the rate of carbon sequestration because the rate of sequestration increases with soil depth. The deep root systems of the native perennial vegetation at the Project site will sequester more carbon than the previous annual row crops, improving soil quality and climate resilience.

Q. How does a solar facility, such as the Project, differ from other types of development?

A. A solar facility like the Project is different from other types of commercial or residential developments that would otherwise be allowed in this area. Traditional commercial or residential developments consist of extensive impervious surfaces where water cannot infiltrate into the soil and instead runs off the land into stormwater ponds. On the contrary, when constructed, the Facility will include solar panels mounted above the finished ground in rows, at-grade aggregate access roads, and other ground-mounted electrical equipment. Most ground cover conditions during operations of the Facility will be of a constant vegetated state that will consist of perennial native vegetation in accordance with the final Vegetation Management Plan. The area between and beneath the panels will be vegetated, along with the area between the panels and the access roads, and the area between the access roads and the security fence. The extensive vegetated condition of the land, combined with the sandy soils, within the Project will allow for significant water infiltration and less runoff than traditional commercial or residential developments.

Q. We have discussed general research regarding water contamination from solar facilities, how did Xcel review the review the effects of the proposed Facility on waterbodies in and around the Facility Project Area?

A. Xcel Energy engaged its contractor, Blattner Construction, and its consultant, Westwood Professional Services, to assess the runoff potential from the Project during its construction and operation (See Attachment C). The Stormwater Management Plan includes comprehensive hydrologic runoff calculations to assess the runoff conditions from the Project Area before and after construction of the Project. These calculations rely on modeling software that is commonly used in Minnesota and that is based on Technical Release 55 from the United States Department of Agriculture. The model uses curve numbers to estimate runoff volumes, based on numerous factors including soil types and area landcover. The model showed that the existing conditions (i.e., row crops) will produce a higher runoff volume compared to perennial vegetation. As discussed, perennial vegetation will be in place year-round in the Project Area, and has more robust root structure than row crops to reduce the amount of stormwater runoff from the land, providing greater opportunity for the water and other nutrients to infiltrate into the soil before leaving the Project Area.

Q. Did Blattner and Westwood reach any conclusions about how the Project will impact runoff and leachate at the Project site?

A. Yes. As noted in Attachment C, the conversion of existing row crop to perennial vegetation to the Project will reduce the volume and velocity of runoff from the site. The Facility will allow for additional infiltration and reduction of runoff released from the portions of the Facility into the neighboring land and waterbodies. Additionally, the natural depressions within the Facility's boundaries will provide additional onsite infiltration for stormwater runoff. The combined infiltration from the change in land cover, naturally sandy soil and natural depressions will serve as an effective onsite treatment system that is anticipated to reduce sedimentation and reduce nutrient loads to surrounding land and waterbodies and the groundwater as compared to the current land use. Moreover, as discussed, the conversion of the land from agricultural uses to perennial native vegetation will result in the termination of application of nitrogen and other agricultural chemicals and fertilizers on the land, which will lead to less nitrogen and other chemicals reaching the area's nitrogen imperiled groundwater.

Q. Can you address any concerns members of the public may have regarding the potential for photovoltaic (PV) panels to release hazardous materials?

A. Yes. PV solar panels are nearly entirely encapsulated in glass and aluminum, which are not hazardous materials. The PV solar panels do, however, contain small amounts of metals that are, by themselves, characterized as hazardous materials by the United States Environmental Protection Agency (EPA). When panels are disposed of at recycling facilities or landfills, the characteristics of those elements and the likelihood that they will leach from the PV solar panels into the environment must be determined and reported. Many manufacturers of PV solar panels are taking proactive actions to determine the potential for the metals contained in PV solar panels to leach from the panels during operation of the panel or if it is broken into pieces. The EPA-approved method for determining whether a hazardous substance is likely to leach from a manufactured product into the ground and ground water is the Toxicity Characteristic Leaching Procedure (TCLP). The PV solar panels that will be used for the Project have undergone TCLP testing as part of the product development process, and all passed TCLP testing (See Attachment D). In other words, no hazardous materials (including arsenic, barium, cadmium, chromium, lead, mercury, selenium or silver) leached from the tested products resulting in leachate concentrations above the EPA's regulatory thresholds. In light of the panels being fully encapsulated, unlikely to shatter and not expected to leach hazardous materials into the environment, the risk to the environment from the contents of the PV solar panels will be minimal. If a PV solar panel is broken at the Project, the broken pieces and the remainder of the panel will be recycled or disposed of and replaced, thereby further reducing the risk for hazardous materials contained in the PV solar panels to leach into the environment.

VI. HEAT ISLAND

Q. Are you familiar with the term "heat island"?

A. Yes.

Q. What is a heat island?

A. "Heat island" is a term used to describe large, concentrated urban areas with lots of dark-colored impervious surfaces like concrete or asphalt. The EPA defines "heat islands" as "urbanized areas that experience higher temperatures than outlying areas." Heat islands experience higher temperatures than outlying areas because structures, including buildings, roads, and other infrastructure, absorb and re-emit the sun's heat more than vegetation and water bodies.

Q. Are heat islands associated with solar facilities like this?

A. No. Solar facilities like the Project have 15 to 20 feet between panels which allows for heat to dissipate. Moreover, most of the land surface within the Project Area will be vegetated and the interior access roads will be gravel, which absorbs and dissipates heat more effectively than the structures and road infrastructure in urban areas.

Studies of solar facilities consistently show that heat from the panels rises and quickly dissipates—heat does not last far from the panels. For example, a 2019 study of utility-scale solar in a desert climate (Broadbent *et al.*) found no significant impacts on air temperature as close as 5 feet above the solar panels, and less than 1.5-degree Fahrenheit difference at the same height during the day. And field studies at solar sites situated in cropland (e.g. V. Fthenakis and Y. Yu, 2013) show temperature increases of 3.4°F (1.8°C) 2 feet above the array height, decreasing quickly at the edge of the array. The same study showed that in an agricultural environment, like the Project, temperatures reach ambient air temperature as close as 9 feet above the solar panels, and within approximately 300 yards of the edge of the facility.

Q. There are other solar facilities in the Midwest. Have those facilities caused heat-related impacts on surrounding cropland?

A. No. There are more than 2,500 MW of solar installed in Minnesota alone, with no reports of decreased crop yields, weather or climate impacts due to proximity to solar panels. In fact, according to the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy, over 2.8 GW of solar facilities in the United States are being used for agrivoltaics, which is the colocation of solar energy installations and agriculture beneath or between rows of photovoltaic panels, indicating the compatibility of agriculture and solar facilities. Michelle Boyd, *The Potential of Agrivoltaics for the U.S. Solar Industry, Farmers, and Communities*, U.S. Dep't of Energy Office of Energy Efficiency & Renewable Energy (Apr. 17, 2023).

VII. CONCLUSION

Q. Does this conclude your Direct Testimony?

A. Yes.

414 Nicollet Mall
Minneapolis, MN 55401

Ellen L. Heine

Work Experience

Xcel Energy
Principal Siting and Permitting Agent, 2022 – Present
Sr. Siting and Permitting Agent, 2014 – 2022
Permitting and Compliance Analyst, 2011-2014

- Lead agent on multiple transmission and renewable energy projects
- Collaborate with internal and contract project team members and agency staff to plan, permit and execute projects
- Develop training materials for Company compliance efforts
- Assign, manage and direct consultant activities for capital projects
- Coordinate with team members, agency staff, consultants and construction managers and crews on permitting and compliance issues for projects
- Manage compliance filings and tasks related to permitted transmission projects
- Acquire federal and state permits for wetlands, water and land crossings
- Mentor Permitting Interns in roles within the Permitting group

GIS Technician, 2010-2011
Metropolitan Council

- Updated the 2010 Land Use data for the Twin Cities Metropolitan Area using aerial imagery, parcel data, and community planning documents, and online resources
- Expanded my knowledge of databases and statistical analysis through assistance of other team members working with census data for forecasts and employment modeling

Independent Contractor, 2010-2011

- Conducted phone interviews with school staff and contractors to prepare case studies on K-12 schools with renewable energy projects
- GIS analysis and mapping of senior housing locations in the Twin Cities
- Collected and summarized transportation and housing research data for Grand Rapids comprehensive plan update

Land Conservation Specialist/Planner, 2006 – 2010
Minnehaha Creek Watershed District (MCWD), Deephaven, Minnesota.

- Conducted erosion control permit site inspections for MCWD and Pollution Control Agency permitted projects and worked with contractors on compliance issues
- Coordinated with city planning and public works staff as well as surveyors, realtors and real estate attorneys on land conservation development and restoration projects
- Presented development plans to Planning Commissions and City Councils for conservation development
- Created maps and analyses for baseline documentation, wetland delineation and project reporting
- Evaluated properties for conservation potential and coordinated meetings with a Technical Advisory Team to review conservation opportunities

Project Experience

Sherco Solar, Co-lead Site and Route permitting effort for 460 MW solar facility in Sherburne County, Xcel Energy's first utility scale solar development project. Responsibilities include regulatory requirements evaluation, coordination and consultation with state regulatory agencies, collaboration with the development partner on development of permit applications and supporting documentation, and evaluation of EPC contractors.

Bayfield Second Circuit Transmission Line, Lead permitting effort on a challenging project with significant community involvement and opposition, multiple approvals required from local, state and federal agencies, and multiple project changes requiring coordination with the Project team, contractors and agency staff.

Nelson to Mississippi River Rebuild, Collaborated with federal agency regulators and the project team to develop a successful plan for rebuild of the transmission line through the Mississippi River National Wildlife Refuge while complying with DNR, Corps of Engineers and FWS requirements which included significant timeframe and access constraints.

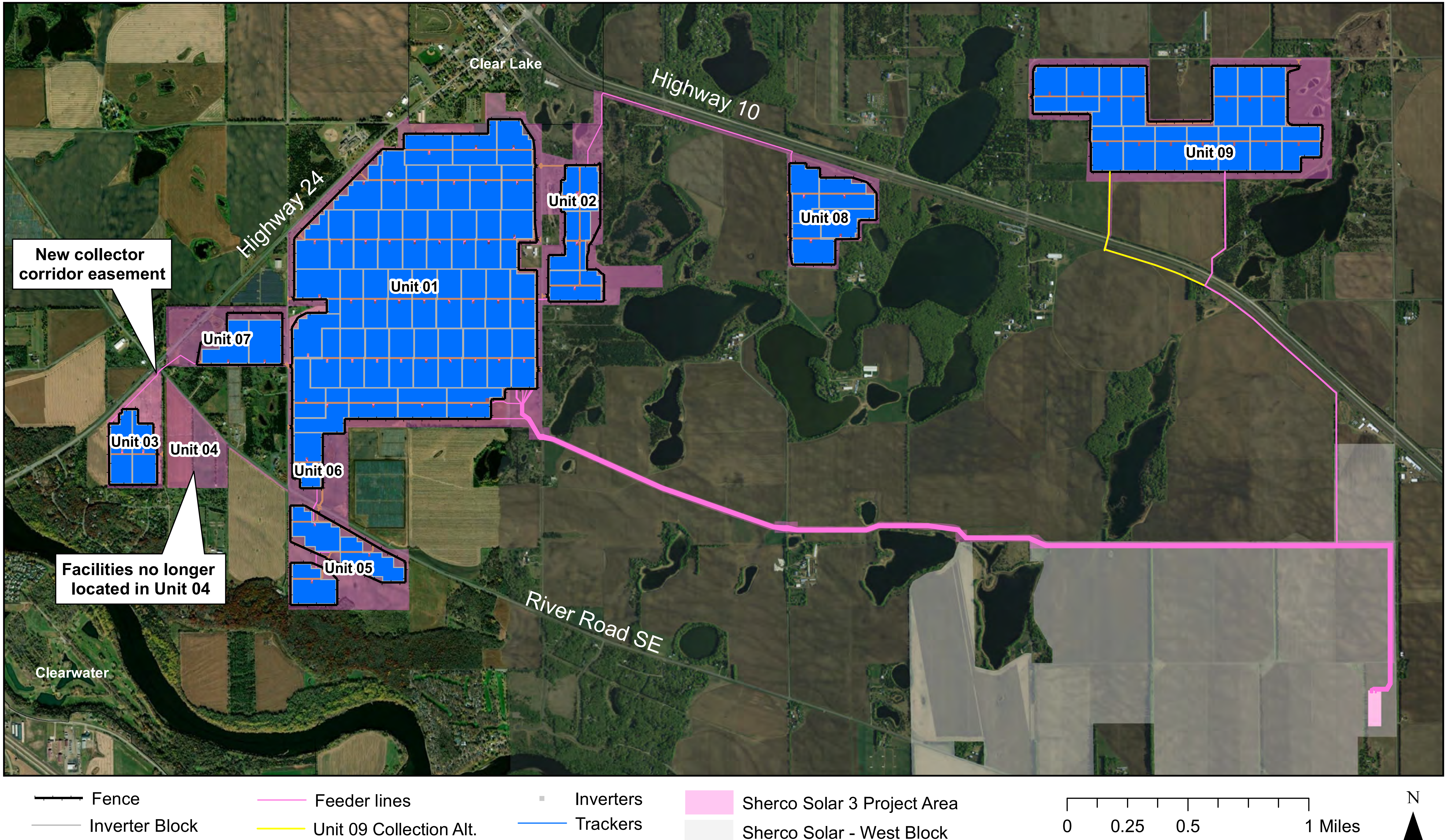
CapX Hampton to Rochester to La Crosse, Coordinated with the internal project team as well as agency representatives, consultants and members of the public to acquire state and federal permits, train crews on permit requirements, implement the project, and track and report on compliance with permit requirements throughout the life of the project.

Hiring of Permitting Interns, Worked with SLR team members on multiple rounds of intern hiring including updating job descriptions, reviewing resumes, and conducting interviews for our group

Education

Master of Urban and Regional Planning, University of Minnesota,
Emphasis: Environmental Planning and Geographic Information Systems

Bachelor of Arts, University of Minnesota-Morris,
Major: Biology, Minor: Chemistry



Sherco Solar 3 Sherburne County, Minnesota

Xcel Energy®

Attachment C

Westwood

12701 Whitewater Drive, Suite 300
Minnetonka, MN 55343

main (952) 937-5150
fax (952) 937-5822

MEMORANDUM

Date: April 15, 2024

Re: Sherco 3 Ordinance Stormwater Memo
File: R0036476.00

This memo was prepared to review the effects of the proposed Sherco 3 Solar Facility (Facility) on waterbodies located within and adjacent to the Facility project area. The memo also reviews the effects of locations within the Sherburne County Shoreland Ordinance. The memo specifically looks at the calculated existing water quantity and water quality and how the proposed Facility will impact those conditions.

Background

The proposed Facility is located mainly south of the town of Clear Lake with a block to the east and southeast in Sherburne County (Exhibit 1). Portions of Unit 2 are within the Sherburne County Shoreland Overlay District for Jones Lake and an unnamed water body to the north; Unit 8 is minimally within the Shoreland Overlay District for Mosford Lake and the unnamed water body between Mosford Lake and Crescent Lake; and the portions of Unit 9 are within the Shoreland overlay District for Prairie Lake, Camp Lake, and unnamed waterbody to the northeast of Prairie Lake. To analyze the potential impact the Facility may have on the lakes and wetlands within the Shoreland Overlay District, the Facility's overall impact and runoff rates were analyzed. Not all areas of the Facility drain to waters within the Shoreland Overlay District. Approximately 450 acres of contributing land within the fenced portion of the Facility drain to bodies of water in the Shoreland Overlay District (see Exhibit 2). There are 760 acres of land that does not drain to waters in the Shoreland Overlay District, and therefore any runoff generated in these watersheds will not contribute or flow to these waterbodies.

Under the current existing conditions, the Facility's project area is comprised mostly of agricultural operations consisting of row crops. The topography of the watersheds is generally flat with slopes becoming steeper near the waterbodies and is scattered with numerous existing depressions. The soil composition primarily consists of poorly graded sand, which has a high infiltration rate. With the high infiltration rates the existing depressions generally do not retain water for a significant amount of time following rainfall events.

A typical solar project, such as the Facility, differs greatly from other types of commercial or residential developments that would otherwise be allowed in the Shoreland Overlay District. When constructed, the Facility will include solar panels mounted above the finished ground in rows, at-grade aggregate access roads, and other ground-mounted electrical equipment. Most ground cover conditions during operations of the Facility will be of a constant vegetated state that will consist of perennial native vegetation in accordance with the final Vegetation Management Plan developed for the Facility. These vegetated areas include the area beneath the access roads, and the area up to the security fence. As the area between and beneath the panels will be vegetated, runoff from the panels will infiltrate into the soil as it passes underneath the downstream panel. While the project requires some grading onsite, it is relatively minimal and the grading is designed to maintain the existing drainage patterns. Access roads are typically installed at grade and allow for on-site runoff to flow freely throughout the Facility. The proposed perennial vegetation groundcover provides treatment and reduction in runoff by reducing the velocity of the runoff, allowing for increased infiltration into the ground.

Water Quantity

Stormwater Permitting required by the Minnesota Pollution Control Agency (MPCA) for the Facility will require that the operational Facility does not increase runoff from that which exists in existing row crop conditions.

A detailed Stormwater Management Plan was prepared for the Facility that includes comprehensive hydrologic runoff calculations of both existing and proposed conditions (Appendix A). Those calculations utilized modeling software commonly used within the State of Minnesota that is based on Technical Release 55 (TR-55) from the United States Department of Agriculture. TR-55 uses curve numbers to estimate runoff volumes. Curve numbers are values that represent a specific land use type that converts mass rainfall to mass runoff. A higher curve number represents a higher runoff value. A curve number is determined based on numerous factors, but the major factors are soil types and the landcover in the area. Soil Types are classified as a Hydrologic Soil Group (HSG) and are used to efficiently correspond soil types to an overall classification. For example, site conditions that consist of row crops have a larger curve number compared to sites consisting of perennial vegetation due to the temporary nature of crops over the course of a year and the shallower root structure of row crops (See Table 1 below). Therefore, the existing conditions (i.e., row crops) will produce a higher runoff volume as compared to perennial vegetation, which will be in place year-round with more robust root structure to reduce the amount of stormwater runoff from the land.

Other land uses that are permitted within the Shoreland Overlay District would also increase runoff curve values as compared the Facility. For example, the Sherburne County Shoreland Overlay District allows gravel mining operations, confined animal feedlots, commercial uses, and industrial uses. Any of those alternative uses, including row crop agriculture have more runoff and less infiltration than the Facility.

TABLE 1: CURVE NUMBERS USED IN ANALYSIS

Land Cover	HSG A	HSG B	HSG C	HSG D
Existing Row Crop	67	78	85	89
Future Perennial Vegetation	39	58	71	78
Gravel Mining Operations	96	96	96	96
Confined Animal Feedlots (65% Impervious)	77	85	90	92
Commercial Uses (85% Impervious)	89	92	94	95

The following table is a summary of the runoff rates in cubic feet per second (cfs) for the existing conditions as compared to the proposed Facility at the external boundaries across the Project Site. These values have been taken directly from the attached draft stormwater report (Appendix A).

TABLE 2: RUNOFF RATE SUMMARY

External Boundary	Existing 100-Year Runoff (cfs)	Proposed 100-Year runoff (cfs)
Jones Lake West	37.9	11.9
Jones Lake East	0.5	0.3
90th Ave	48.4	4.5
Mosford Lake Surface Overflow	3.1	0.6
Mosford Lake Basin	21.6	4.8
NE Overflow	3.0	1.0
N Overflow	7.8	4.3
63rd Ave	24.0	12.9
S Surface Overflow	43.0	11.4
S Channel Overflow	0.2	0.1
SE Surface Overflow	4.3	2.6
SE Basin Overflow	6.0	3.8
SE Wetland Overflow	13.8	0.1
80th Ave	1.5	1.9
NE Wetland Overflow	0	0.6
S Overflow	3.3	0.1
Prairie Lake S	47.6	11.9
Wetland S Overflow	0.7	0.1

External Boundary	Existing 100-Year Runoff (cfs)	Proposed 100-Year runoff (cfs)
Wetland W Overflow	6.9	0.7
SW Overflow	0.2	0.1
Camp Lake Overflow	3.3	0.1
Total	277.1	73.8

As can be seen from the calculations the Facility will significantly reduce the amount of runoff flowing from the site compared to the existing conditions in the area. For more details on calculation methods, refer to appendix A.

Water Quality

While runoff curves show that infiltration will increase across the Facility area with the conversion to a solar facility, the MPCA has developed solar specific water quality requirements for runoff treatment of solar facilities. An MPCA approved treatment method for stormwater runoff is onsite infiltration. Since the Facility has soils conducive to infiltration the water quality requirements will be met through infiltration. The MPCA has developed a solar specific calculator to calculate the volume of water to be treated onsite. These volumes must be treated, and the use of infiltration either through existing depressions or constructed infiltration basins is an approved method of treatment.

The stormwater management plan developed for the Facility calculated the required water quality volumes. Based on these calculations, the plan utilized existing depressions when possible, and found that the water quality volume is more than accounted for with the existing infiltrating natural depressions onsite. Table 3 values were taken from the draft stormwater report (Appendix A).

TABLE 3: REQUIRED WATER QUALITY VOLUME

Required Water Quality Volume (ac-ft)	Existing Natural Depressions (ac-ft)
3.78	>60

Conclusion

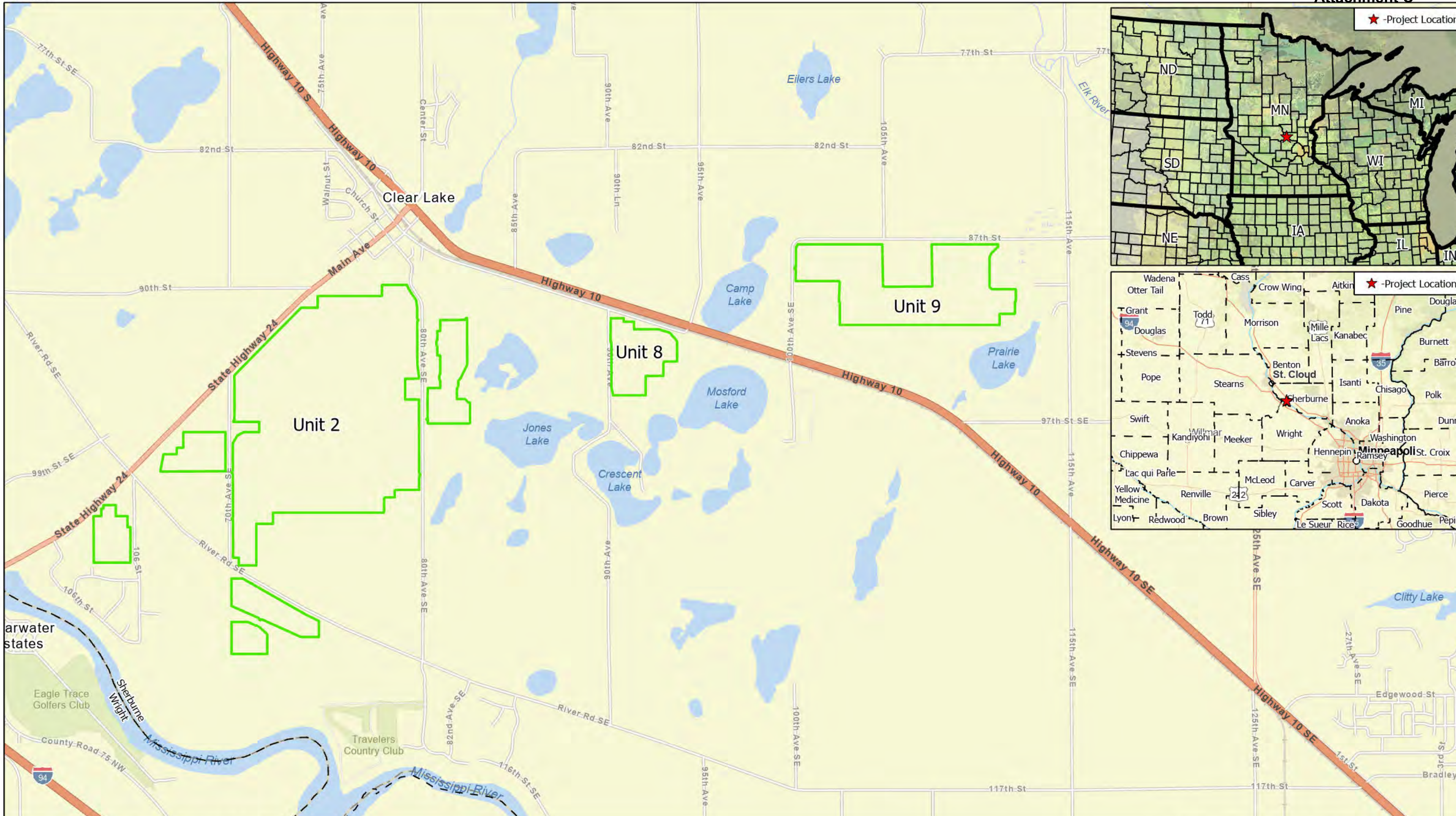
With the conversion of existing row crop to perennial vegetation with minimal impervious cover, the volume and velocity of runoff generated onsite will be reduced. The Facility will allow for additional infiltration and reduction of runoff released from the portions of the Facility within the Shoreland Overlay District into the neighboring waterbodies. Additionally, the Facility's infiltration basins will provide additional onsite infiltration for stormwater runoff. The runoff reduction from conversion to perennial vegetation and onsite infiltration basins will significantly reduce runoff to the adjacent waterbodies. The combined infiltration from the change in land cover and additional onsite basins will serve as an effective onsite treatment system that is anticipated to reduce sedimentation and reduce nutrient loads as compared to the current land use.

Exhibits

Appendices

Exhibits

Attachment C



Data Source(s): Westwood (2024); Esri WMS Basemap Imagery (Accessed 2024); USGS (2024); FEMA (2024); USDA (2024)

Legend

- County Boundary
- Proposed Fence Boundary

N

0 — 0.5 Miles

Sherco 3 Solar Project

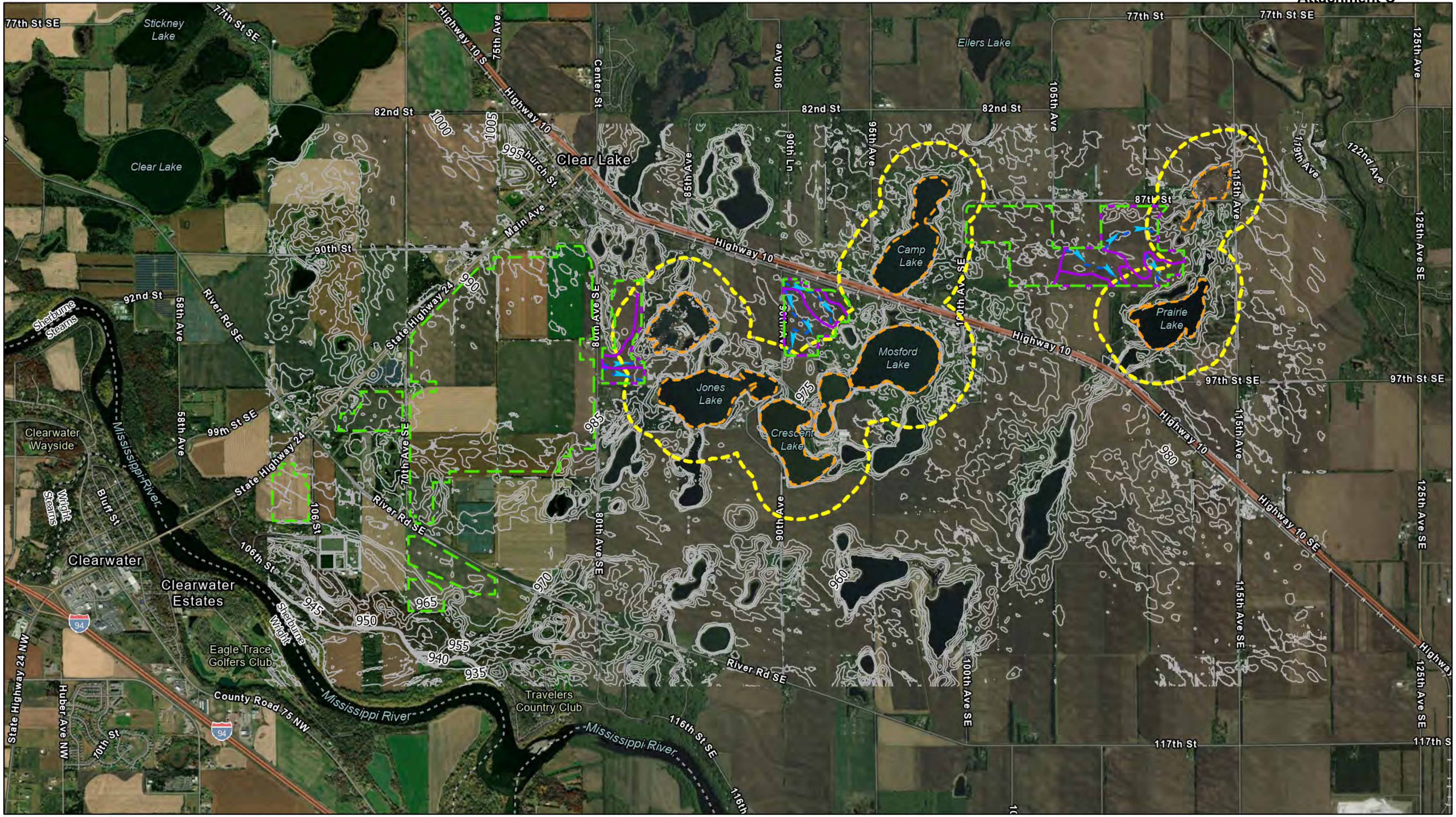
Sherburne County, Minnesota

Exhibit 1: Location Map

April 15, 2024

Westwood
Toll Free (888) 937-5150 westwoodps.com

Attachment C



Data Source(s): Westwood (2024); Esri WMS Basemap Imagery (Accessed 2024); USGS (2024); FEMA (2024); USDA (2024)

Westwood

Toll Free (888) 937-5150 westwoodps.com

Legend

- County Boundary
- Proposed Fence Boundary
- Onsite Drainage Areas
- Waterbodies Subject to Shoreland District
- Sherburne County Shoreland District
- Proposed Flow Path
- 5' Contours

N

0 0.5 Miles

Sherco 3 Solar Project

Sherburne County, Minnesota

Exhibit 2: Proposed Drainage Area Map

April 15, 2024

Appendix A

Draft Stormwater Management Report

Attachment C

DRAFT
STORMWATER REPORT

SHERCO III SOLAR PROJECT

SHERBURNE COUNTY, MINNESOTA

Rev A, September 19, 2023
Rev B, November 27, 2023
Rev C, March 27, 2024

Prepared for:
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WSB PROJECT NO. 023176-000

Table of Contents

Executive Summary

The purpose of this report is to summarize the existing and proposed stormwater conditions of the Sherco III Solar Development project and define the hydrology and surface runoff within the project area.

The proposed project site is approximately six miles west of the existing Sherburne County Generating Plant. The project consists of 1,414 acres of buildable area, located south and east of Clear Lake in Clear Lake Township, Minnesota. With offsite flow areas, the drainage area covers a total of 2,266 acres and two HUC-12 watersheds.

Data Sources

Data	Source	Date	Use
County LiDAR Elevation	Sherburne County Elevation Data Geodatabase	2011	Offsite HEC-RAS terrain and drainage area delineation
Sherco Site LiDAR Elevation	WSB LiDAR Survey	2023	Onsite HEC-RAS terrain and drainage area delineation
Offsite Soils	USDA/NRCS Web Soil Survey	2023	Weighted CN values
Onsite Soils	Sherco III Geotechnical Engineering Report	2023	Weighted CN values
Precipitation Depth and Intensity	NOAA Atlas 14 Precipitation Frequency Data Server (PFDS)	2023	Design storms
HUC-12 Drainage Boundaries	USDA Natural Resources Conservation Service Geospatial Data Gateway	2023	Planning Hydrologic & Hydraulic (H/H) models
Project Boundaries	Blattner Energy	2023	Planning H/H models
FEMA Flood Zones	FEMA National Flood Hazard Layer (NFHL) Viewer	2023	Floodplain location
Manning Values	NRCS-Kansas 2016 and HEC-RAS 2D Manual	2016	2D hydraulic calculations
Curve Numbers	TR-55 Manual Tables 2-2a through 2-2c	1986	Hydrologic calculations
Geocell Permissible Shear	Colorado State University Geoweb Performance Testing	Not given	Low water crossing reinforcement parameter

1 - General Location & Description

1.1 Site Location

The project area for Sherco III is in Clear Lake Township and Sherburne County, Minnesota. The site is roughly bounded by 87th Street SE to the north, 115th Avenue SE to the east, 106th Street SE to the south, and MN State Highway 24 to the west. Per the project Basis of Design, the Sherco III property is approximately 1,781 acres, with 1,414 acres of buildable area after setbacks are applied for roads, wetlands, and Natural Environment Lakes. Five bodies of water south and west of the site are shown as DNR Public Water Wetlands 71012400W, 71012500W, 71012700W, 71012900W (Jones Lake), and 71013000W and as Sherburne County Natural Environment Lakes. See **Appendix 1, Figure 1.**

1.2 Description of Property

The project site is very flat, with elevations varying from 957' to 992', generally decreasing from north to south and lowest around the public waters wetlands. The site is roughly broken into three areas, the largest is south of the Clear Lake city limits, the smallest is south of the Clear Lake Airport across US Highway 10, and the final one is bounded to the west by 100th Avenue SE and north by 87th Street SE. Most of the existing land cover, 77 percent, within the modeled drainage area is cultivated crops. The remainder of the drainage area land cover is made up of deciduous forest, evergreen forest, shrub/scrub, grassland/herbaceous, pasture/hay, emergent herbaceous wetlands, roadway, open space developed land, and open water. There is no mapped FEMA floodplain within project extents as shown in **Appendix 3**.

2 – Hydrology Existing Conditions

2.1 HUC-12 Catchment

The northern and eastern portion of the Sherco III drainage area is within the Elk Lake – Elk River HUC-12 catchment (#070102030503). The western portion is within the Fish Creek – Mississippi River HUC-12 catchment (#070102030601). **Appendix 1, Figure 2** shows these catchment areas.

2.2 Hydrologic Analysis Method

Hydrologic analyses for this project follow the United States Department of Agriculture Natural Resources Conservation Service National Engineering Handbook - Hydrology (NEH Part 630). The hydrologic calculations for this project were completed with HEC-HMS 4.10 modeling software. HEC-HMS was used to generate excess runoff precipitation values at 5-minute intervals for input as rain on grid simulation in HEC-RAS 2D modeling.

Input parameters for the HEC-HMS of Sherco East include:

Basin Models: Area (sq. miles), Curve Number, Impervious %, and Lag Time (minutes) with Standard (PRF-484) graph type.

Meteorological Models: Frequency Storm Precipitation with Duration - Depth values from NOAA Atlas 14. No Area Reduction applied.

Control Specifications: 1 day with 5-minute time interval.

The resulting precipitation hyetographs for the project have been used in the corresponding HEC-RAS model. See **Appendix 4** for additional HEC-HMS parameters.

2.3 Drainage Area Delineation

Due to the geographic separation between project areas, Sherco III was modeled as two drainage areas, main and northeast. The broader drainage areas were delineated such that outflow points are well defined and accurately reflect how water leaves the site. The drainage areas were extended beyond the project buildable area where topography indicated offsite flows might contribute to site hydraulics in order to fully understand what the expected flow depths and velocities may be onsite. These drainage areas are shown in **Appendix 1, Figure 2**.

2.4 Rainfall Distribution and Depths

A NOAA precipitation frequency report was developed for Sherco III. The precipitation data from this report was processed in HEC-HMS and then imported to HEC-RAS as rain on grid modeling. The NOAA report is available in **Appendix 2**.

2.5 Soils

The preliminary geotechnical engineering report prepared by Terracon in September 2023 was used to inform soil conditions onsite. Based on results from 14 borings across the Sherco III property extents, the site is dominated by SP subgrade soils, reflecting Hydrologic Soil Group (HSG) A runoff characteristics. As such, all surfaces were modeled with curve numbers based on HSG A soils and the respective land cover.

For offsite soil characteristics, the USDA Web Soil Survey was used to estimate HSG class. As with onsite soils, all offsite soils showed HSG A characteristics. Additionally, the Web Soil Survey also confirmed HSG A characteristics onsite. There are some HSG D soils reported from the Web Soil Survey, but these are shown under open water surfaces and therefore don't impact runoff as the water surface is already modeled as impervious.

2.6 Curve Number

Weighted curve numbers (CN) have been computed for the project drainage area using TR-55 Tables 2-2a, b, and c. As the hydrologic modeling was completed for the entire drainage area, both onsite and offsite land covers were used in determining the weighted CN. Land use was delineated manually based on aerial imagery and classified based on the standard National Land Cover Database (NLCD) classes to provide higher resolution land cover data.

The relationship between land cover and CN is summarized below. These values are all for HSG A soils with the exception of emergent herbaceous wetlands which overlapped with HSG D soils.

Table 1: Existing NLCD CN Values

NLCD Class	Land Cover Description	CN
11	Open Water	100
21	Developed, Open Space	30
41	Deciduous Forest	45
42	Evergreen Forest	40
52	Shrub/Scrub	35
71	Grassland/Herbaceous	30
81	Pasture/Hay	39
82	Cultivated Crops	67
95	Emergent Herbaceous Wetlands	84

The dominant existing CN value within the study area is cultivated crops, reflecting the current primary agricultural land use. See **Appendix 1, Figure 4** for mapped existing CN values.

2.7 Manning's n Values

Manning's n surface roughness coefficients have been assigned to each existing land cover type per NRCS standards defined in the data sources table at the beginning of this report. One exception to these standards is delineated roadway surface which was given a roughness appropriate for asphalt.

Table 2: Existing NLCD Manning's n Values

NLCD Class	Land Cover Description	Manning's n
11	Open Water	0.04
21	Developed, Open Space	0.04
41	Deciduous Forest	0.16
42	Evergreen Forest	0.16
52	Shrub/Scrub	0.1
71	Grassland/Herbaceous	0.035
81	Pasture/Hay	0.03
82	Cultivated Crops	0.035
95	Emergent Herbaceous Wetlands	0.07
	Roadway	0.013

See **Appendix 1, Figure 5** for mapped existing Manning's n values.

2.8 Lag Time Method

The watershed lag method was used in determining the lag time for the site drainage area. Land slope percentage and flow length were obtained using Sherburne County LiDAR elevation data contours. Lag time computations are provided in **Appendix 4.**

3 – Hydraulics Existing Conditions

3.1 Hydraulic Analysis Methods

The hydraulic calculations for this project were performed using HEC-RAS 6.4.1. HEC-RAS 2D modeling was used to evaluate:

- Project inundation areas.
- Flow depths and velocities across the site.
- Discharges at project outlet areas.

Input parameters for the HEC-RAS model include:

Geometry:

- Combined terrain data from the project survey LiDAR and Sherburne County LiDAR elevations.
- Manually delineated NLCD landcover areas.

- Storage Area 2D (SA/2D) connections for existing roadway culverts.
- Break lines following existing site topographic high points and roads.
- Computational mesh set to 20' x 20' grid cells.

Unsteady state flow data:

- Rain on grid precipitation based on runoff values generated from HEC-HMS.
- Normal depth external boundary conditions based on outflow point topography.

Unsteady flow analysis:

- Computation interval set to 5 seconds, mapping output set to 1 minute, model time of 16 hours.

A computation summary from the HEC-RAS 2D model has been provided in **Appendix 5**. This summary provides percent error, boundary flux, and precipitation excess data.

3.2 Existing Culvert Hydraulics

As part of the HEC-RAS geometry inputs, existing culverts have been modeled using SA/2D connections. These connections are modeled based on the surveyed inverts, sizes, and pipe materials.

To prevent errors in 2D modeling, 20' circular terrain modifications were made where the pipe invert was below the ground surface. These modifications consisted of adjusting the inlet/outlet ground elevation to be below the pipe invert by within 0.1'. Based on site flows and topography, these terrain modifications have a minimal impact on flow through the culvert.

Project Culvert 1 was not modeled as the crossing does not contribute flows to the project area and would not have an impact on model results.

Locations of culverts are noted on **Appendix 1, Figure 2**. Summaries of these culverts and their modeled results are shown in **Table 3**.

Table 3: Existing Culvert Summary

Culvert ID	Dimensions	Road Overtopped?
2	12" CMP	No
3	16" CPP	No
4	18" CMP	No

3.3 Existing Site Outflow Rates

At the low points of the project boundary, external boundary conditions were modeled to understand how water leaves the site. These boundary conditions were modeled with a normal depth condition, where the friction slope is used to determine how water flows through the boundary. This friction slope was taken to be the same as the topographic slope based on the terrain data. A comparison of existing and proposed outflow rates can be found in Section 5.6 of this report.

4 – Hydrology Proposed Conditions

4.1 Hydrologic Analysis Method

Hydrologic analysis methods were unchanged between existing and proposed conditions. However, the input data for curve numbers and impervious percentage differed based on proposed land cover changes. See **Appendix 6** for additional HEC-HMS parameters.

4.2 Drainage Area Delineation

The delineated drainage area remained unchanged from existing to proposed conditions.

4.3 Rainfall Distribution and Depths

As there was no change in drainage area location, rainfall distributions remained unchanged from existing to proposed conditions.

4.4 Soils

Soils are anticipated to remain relatively unchanged from existing to proposed conditions. For high vehicle traffic areas and site low points, scarification of soils will be used to ensure no loss of infiltration capacity due to compaction. In addition, silt fence is proposed around major ponding areas onsite to reduce sediment buildup at these low points during construction and maintain their infiltration capacity.

4.5 Curve Number

There is a significant anticipated change in CN from existing to proposed conditions. As currently proposed, all pervious surfaces within the project buildable area will be reseeded with prairie grasses and maintained to achieve a prairie landcover around and under the panels. Prairie landcover, in conjunction with the high infiltration capacity of the soils, promotes a high degree of initial abstraction of rainfall.

While the solar panels function as impervious surfaces, runoff from them can infiltrate in both the permeable area between and under the panels, acting as a disconnected impervious surface. Therefore, a prairie land cover curve number was used in areas with proposed solar panels.

Prairie land cover was taken to be roughly equivalent to the NLCD grassland/herbaceous CN, even though this may be somewhat conservative considering the additional infiltration capacity due to the deep root structures of prairie grass. From existing to proposed, 1,376 acres of new grassland/prairie landcover will be created on Sherco III. Much of this new land cover is being converted from row crops, whose CN of 67 is over double the CN of prairie at 30.

The weighted CN of the project drops considerably from existing to proposed conditions due to the factors described above. As a result, the excess rainfall modeled in HEC-HMS is much lower in proposed conditions, a drop in total runoff depth of 68 percent for Sherco III. This leads to decreased flow rates and volumes in proposed conditions.

Proposed maintenance roads were considered impervious for hydrology analysis. The impervious percentage slightly increased from existing to proposed conditions, 3.41 percent to 4.75 percent of total drainage area. However, the increase in weighted CN due to these proposed impervious surfaces is offset by the widespread conversion to prairie landcover**. Appendix 6, Figure 1** shows proposed land cover CN values. These proposed surface CN values are summarized below.

Table 4: Proposed Surface CN Values

Land Cover Description	CN
Prairie (with and without solar panels)	30
Maintenance roads	98

4.6 Manning's n Values

The proposed new land covers will also have an impact on Manning's n roughness across the site. The proposed prairie land cover was assumed to have the same n value as the grassland/herbaceous NLCD class and the proposed maintenance roads have an n value appropriate for an aggregate roadway.

Appendix 6, Figure 2 shows proposed land cover Manning's n values. These proposed values are summarized below.

Table 5: Proposed Surface Manning's n Values

Land Cover Description	Manning's n
Prairie (with and without solar panels)	0.035
Maintenance roads	0.033

4.7 Time of Concentration / Lag Time Method

Lag times in HEC-HMS were not changed from existing to proposed conditions. While there are changes to site topography in proposed conditions, they are relatively minor when measured across the entire drainage area, having a small impact on calculated lag times. In addition, lag time primarily controls peak timing of excess rainfall values, which doesn't change the ultimate depths or flows in hydraulic modeling, just when they occur.

5 – Hydraulics Proposed Conditions

5.1 Hydraulic Analysis Methods

The general methodology for hydraulic analysis is unchanged from existing to proposed conditions. However, there are changes necessitated as a result of proposed conditions. 2D modeled terrains, break lines, and land cover layers changed as a result of the proposed conditions across the sites. The rain on grid inputs were also changed due to the large reduction in excess rainfall from the existing to proposed land cover. Model parameters such as computational mesh sizing, external boundary conditions, existing culverts, and computation timing remained unchanged.

A computation summary from the HEC-RAS 2D model has been provided in **Appendix 7**. This summary provides percent error, boundary flux, and precipitation excess data.

5.2 Proposed Culvert Hydraulics

Existing culverts are not proposed to be modified as part of this project. As such, they remained unchanged in the HEC-RAS modeling, including the required terrain modifications to prevent errors in modeling. There are no proposed internal culverts within the site, surface low water crossings of project roads will be used in their place.

Due to the decreased runoff volumes in proposed conditions, none of the existing culverts that had resulted in roads overtopping in existing conditions overtop in the proposed modeling.

There are proposed 12", 15", and 18" corrugated metal pipe culverts where the maintenance roads intersect with offsite roads. See the project culvert plan sheets in **Appendix 8** for locations and profiles of these culverts. They are proposed to ensure conveyance along the existing roadside ditches is not lost with this project. This is a conservative design since conveyance in these ditches is likely minor in existing conditions. Due to the flat site topography and permeable soils, these ditches have low conveyance and instead function more like ponding areas that draw down via infiltration. In addition, various crossings of these ditches currently exist without any identified culverts, segmenting the ditch runs alongside the roadway. Based on the factors discussed above, the 6 modeled culverts do not convey a significant flow rate, however, they were incorporated to better understand flows adjacent to the access roads. Furthermore, the proposed culverts had minimal impact on the flow depths and velocities of the panel locations as they are within the property line setbacks and are hydraulically connected primarily to the roadside ditch.

5.3 Proposed Low Water Crossings (LWX)

As part of the project, several miles of maintenance roads will be constructed within the site. Due to the proposed topography of the site, water will cross and pool at numerous low points along these roads. For many of these LWXs, the water will be moving such that erosion is not a concern for the aggregate roadway or adjacent vegetation and due to the high infiltration capacity of the soils any ponded water is expected to draw down within a few days.

However, for some select LWXs shear forces above the erosive threshold for aggregate roads, 0.4 lb/sf, are expected and require reinforcement across the roadways. Reinforcement at these locations will consist of EnviroGrid Geocell products, where a honeycomb structure of HDPE cells is filled with aggregate to provide increased protection against erosive forces. These cells will be used across the entire width of the proposed roadway and along the entire stretch of road that is exposed to crossing water. These LWXs are summarized in the following table.

Table 6: Proposed LWX Reinforcement

LWX ID	Reinforcement Type	Reinforcement Length (ft)
LWX-1L4	EnviroGrid EGA20	120
LWX-1L5	EnviroGrid EGA20	190
LWX-1L8	EnviroGrid EGA20	92
LWX-3L1-N	EnviroGrid EGA20	80

Per client specifications, all LWXs must be designed to handle flows from the 100-year event. EnviroGrid EGA20 was found to be sufficient for all LWXs based on the modeled 100-year flow velocities and rates. Allowable velocities and shear stresses are over 16 ft/s and 9 lb/ft^2 based on performance testing for similar cellular reinforcement products, far above the anticipated flows at project LWXs**. Appendix 7** has results of this LWX analysis. See the project LWX plan sheets in **Appendix 8** for locations of each LWX.

5.5 Inundation and Scour Analysis

Local scour at each solar tracker pile had to be considered due to the impacts erosion could have on structural stability of the system. Inundation and scour depths were calculated across the entire site and are used in the design of the tracker support piles. The inundation and scour depths were determined based on HEC-RAS 2D modeling results, where scour depth is a function of water depth and velocity.

Maximum water depth and velocity were determined using the “Max” functionality of HEC-RAS results reporting. This is a conservative analysis as often the maximum depth and velocity varies across time and location, but the “Max” function reports it independent of time. As a result, the maximum calculated scour may be greater than the actual potential scour as maximum velocities may occur at a different time than maximum depths. Points with no modeled depth or velocity were considered to have no potential scour.

For the 93,235 piles across Sherco III, scour was calculated based on HEC-18 equations. Equation 7.1 as shown below was used at each pile.

$$\frac{y_s}{y_1} = 2.0\, K_1\, K_2\, K_3 \left(\frac{a}{y_1}\right)^{0.65} Fr_1^{0.43} \qquad (7.1)$$

With input variables calculated as shown below:

y_s = Scour depth, ft

y_1 = Flow depth directly upstream of the pier, ft

K_1 = Correction factor for pier nose shape from **Figure 7.3** and **Table 7.1**

K_2 = Correction factor for angle of attack of flow from **Table 7.2** or Equation 7.4

V_1 = Mean velocity of flow directly upstream of the pier, ft/s

Vc = Critical velocity for initiation of erosion of the cohesive material, ft/s.

g = Acceleration due to gravity

The pile shapes used in this project will be H-shaped and were assumed to act as square nose piers for scour calculations **Figure 7.3 & Table 7.1**. An attack angle of 0° **Table 7.2** and clear water scour **Table 7.3** were also assumed, therefore K_1, K_2, and K_3 were determined to be 1.1, 1.0, and 1.1, respectively. A pier width of 8.27 inches (0.69 ft) was used.

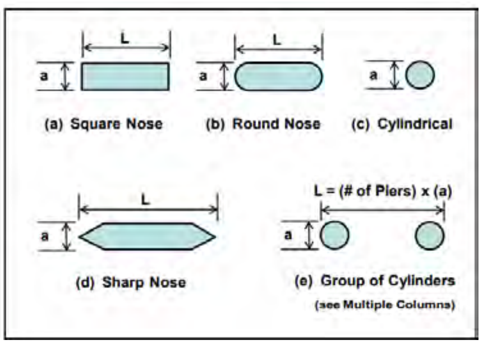


Fig 7.3

Table 7.1. Correction Factor, K_1, for Pier Nose Shape.	
Shape of Pier Nose	K_1
(a) Square nose	1.1
(b) Round nose	1.0
(c) Circular cylinder	1.0
(d) Group of cylinders	1.0
(e) Sharp nose	0.9

Table 7.3 Increase in Equilibrium Pier Scour Depth, K_3, for Bed Conditions		
Bed Condition	Dune Height, ft	K_3
Clear-Water Scour	N/A	1.1

Table 7.2. Correction Factor, K_2, for Angle of Attack, θ, of the Flow.			
Angle	L/a=4	L/a=8	L/a=12
0	1.0	1.0	1.0
15	1.5	2.0	2.5
30	2.0	2.75	3.5
45	2.3	3.3	4.3
90	2.5	3.9	5.0
Angle = skew angle of flow L = length of pier			

Scour depths are shown across the site in **Appendix 7, Figure 3**. Inundation and scour depth results are summarized below:

Table 7: Inundation Depth Results

Inundation Depth	Number of Piles East Phase
0 – 12”	92,816
12 – 18”	341
18 – 24”	78
>24”	0

Table 8: Scour Depth Results

Scour Depth	Number of Piles East Phase
0 – 12”	93,235
12 – 14”	0
>14”	0

5.6 Rate Control

At the low points of project boundaries, external boundary conditions were modeled to understand how water leaves the sites. These boundary conditions were modeled with a normal depth condition, where the friction slope is used to determine how water flows through the boundary. This friction slope was taken to be the same as the topographic slope based on the terrain data.

Sherco III has 21 external boundaries across the main and northeast models. The peak flows through these boundaries were determined in both existing and proposed conditions to ensure net rates offsite are not increasing. These existing and proposed flows for the 100-year event are given in the tables below and shown in **Appendix 7, Figure 3**.

Table 9: Offsite Rate Comparison

External Boundary	Existing Peak Rate (cfs)	Proposed Peak Rate (cfs)
Jones Lake West	37.9	11.9
Jones Lake East	0.5	0.3
90th Ave	48.4	4.5
Mosford Lake Surface Overflow	3.1	0.6
Mosford Lake Basin	21.6	4.8
NE Overflow	3.0	1.0
N Overflow	7.8	4.3
63rd Ave	24.0	12.9
S Surface Overflow	43.0	11.4
S Channel Overflow	0.2	0.1
SE Surface Overflow	4.3	2.6
SE Basin Overflow	6.0	3.8
SE Wetland Overflow	13.8	0.1
80th Ave	1.5	1.9
NE Wetland Overflow	0	0.6
S Overflow	3.3	0.1
Prairie Lake S	47.6	11.9
Wetland S Overflow	0.7	0.1
Wetland W Overflow	6.9	0.7
SW Overflow	0.2	0.1
Camp Lake Overflow	3.3	0.1
Total:	**277.1**	**73.6**

5.7 Water Quality Treatment

Per MPCA NPDES construction permit requirements, the water quality volume needing treatment for new development is 1" off new impervious surface. This 1" requirement is directly applied to the roadway, substation pad, and inverter pad impervious surface. However, for the disconnected impervious surface of the proposed panel area, the MPCA allows water quality credit to be taken for infiltration between and under the panels.

This solar panel credit is determined using a spreadsheet calculator from the Minnesota Stormwater Manual. Inputs include panel sizing, spacing and soil type. The spreadsheet outputs a remaining water quality volume per panel after the infiltration volume credit is applied, 0.59 ft^3 for this project. This volume was multiplied by the total number of panels across the entire project to determine the required water quality volume for the proposed panels. The inputs and result of this spreadsheet can be found in **Appendix 7**. The table below summarizes the water quality volume across the entire project.

Table 10: Water Quality Volume

Surface	Calculation	Water Quality Volume (ac-ft)
Road Impervious	30.2 ac * 1/12' * 1"	2.52
Panel Impervious	0.591 ft^3 * 93,235 panels / 43560	1.26
	Total:	**3.78**

As proposed, 3.78 ac-ft of water quality treatment volume must be provided for the site. The Stormwater Manual states "natural depressions on the landscape that infiltrate" may be counted towards this water quality volume. Analysis of this site indicates there is over 60 ac-ft of storage in the larger existing depressions alone. These depressions would draw down within 48 hours based on typical infiltration rates for HSG A soils. The water quality volume provided by these infiltrating depressions far exceeds the required water quality volume off the proposed impervious and solar panels. Therefore, it is assumed no water quality basins will need to be constructed to meet NPDES water quality standards.

6 – Conclusions

6.1 Proposed Land Cover Change

One of the major changes from existing to proposed conditions is the transition from row crop land cover to prairie cover. This prairie will be established and maintained within the entire project buildable area. As a result, the net curve number of the project site drops, corresponding to a 68 percent decrease in excess precipitation and runoff rates from the site.

6.2 Rate Control

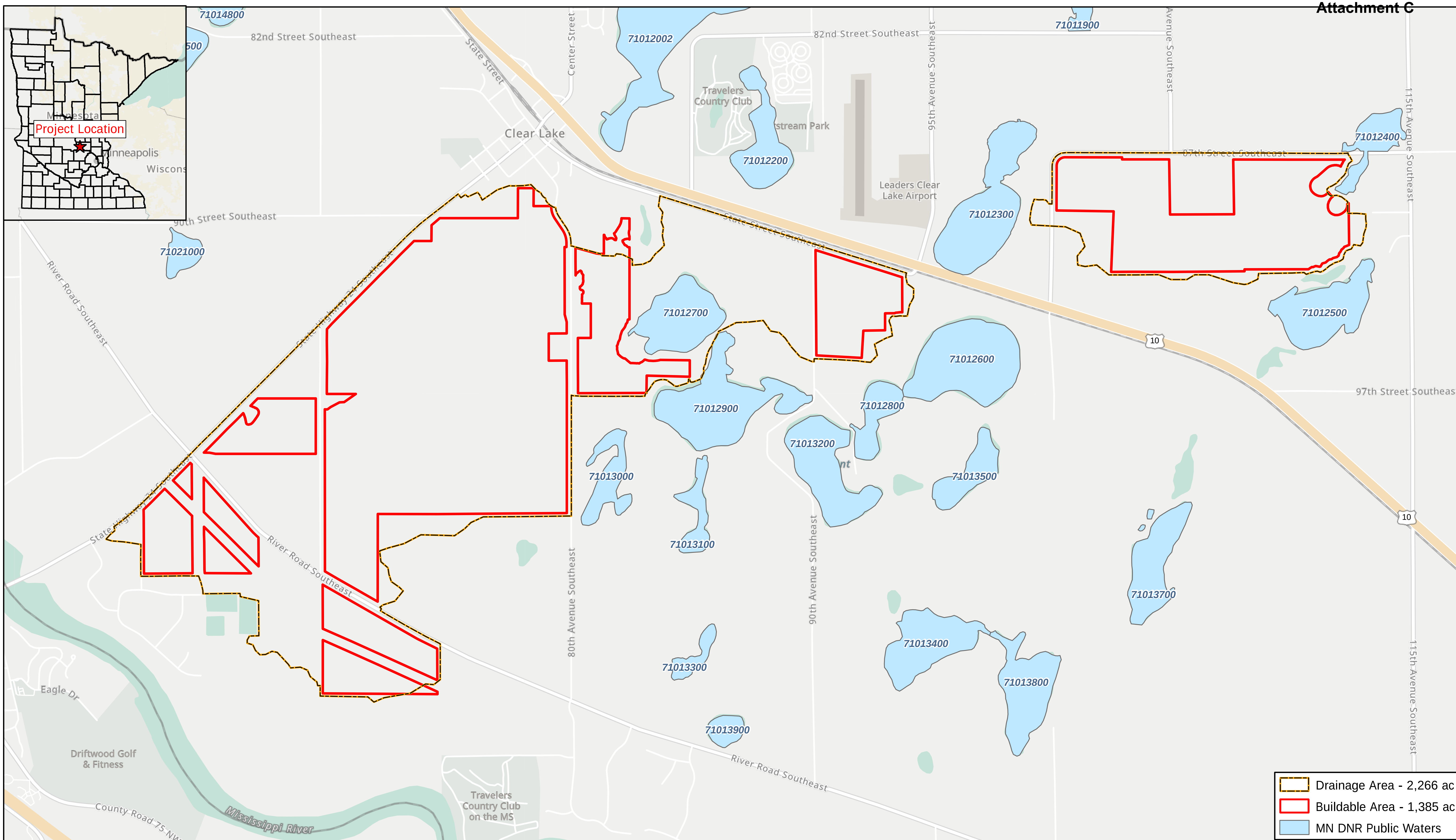
As demonstrated in **Table 9**, there is a 73 percent reduction in flows offsite going from existing to proposed conditions. Therefore, the likelihood of negative downgradient impacts is very low as a result of this project.

6.3 Water Quality

The proposed developments as part of this project include the creation of impervious area, as solar panels, roadways, substation pads, and inverter pads. Per NPDES requirements, these require treatment to ensure water quality is not degraded due to runoff from these surfaces. Using the calculator and assumptions provided for solar projects from the MN Stormwater Manual, the water quality volume for this project is more than accounted for with the existing infiltrating natural depressions onsite.

Appendix 1: General Project Figures

Attachment C



BLATTNER ENERGY

Figure 1: Sherco III Location Map

Sherco III Solar Development
Blattner Energy

0 2,000 Feet
1 inch = 2,000 feet

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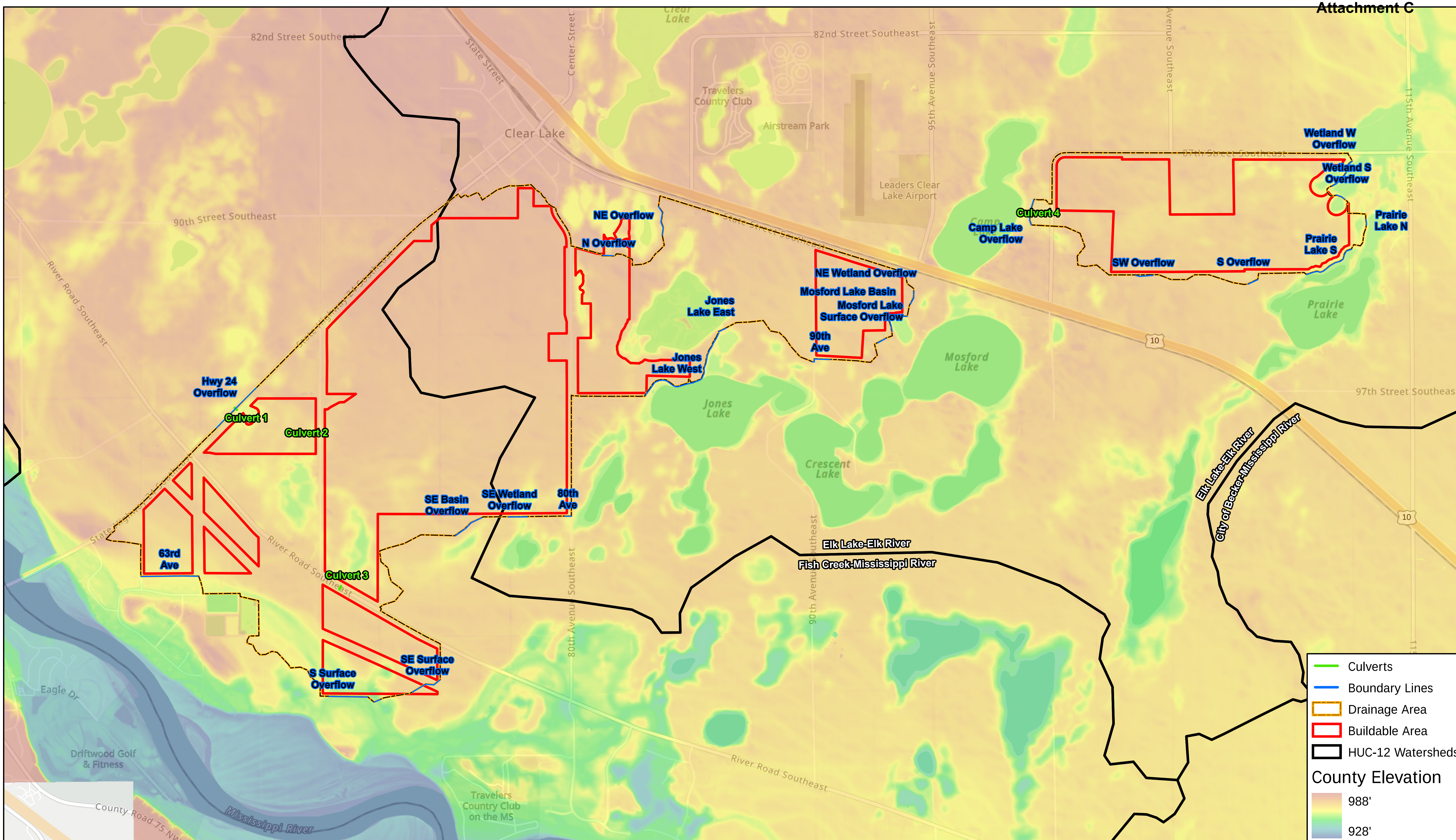

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BLATTNER ENERGY

Figure 2: Sherco III Drainage

Sherco III Solar Development
Blattner Energy

0 2,000 Feet
1 inch = 2,000 feet

wsb

Attachment C

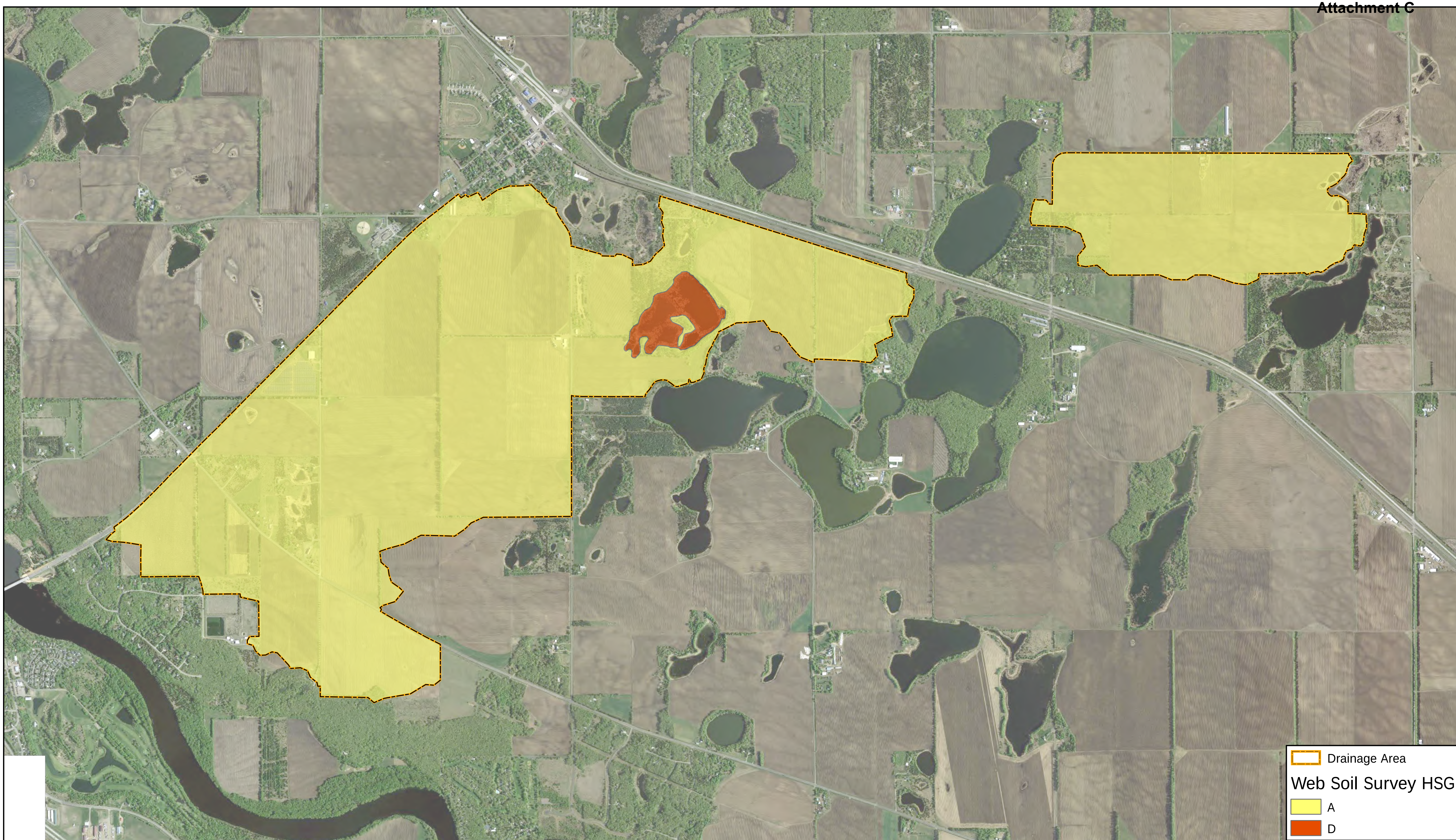

Figure 3: Sherco III HSG Classes

Sherco III Solar Development
Blattner Energy

BLATTNER ENERGY

wsb

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Figure 4: Sherco III Existing Curve Numbers

Sherco III Solar Development
Blattner Energy

0 2,000 Feet
1 inch = 2,000 feet

BLATTNER ENERGY

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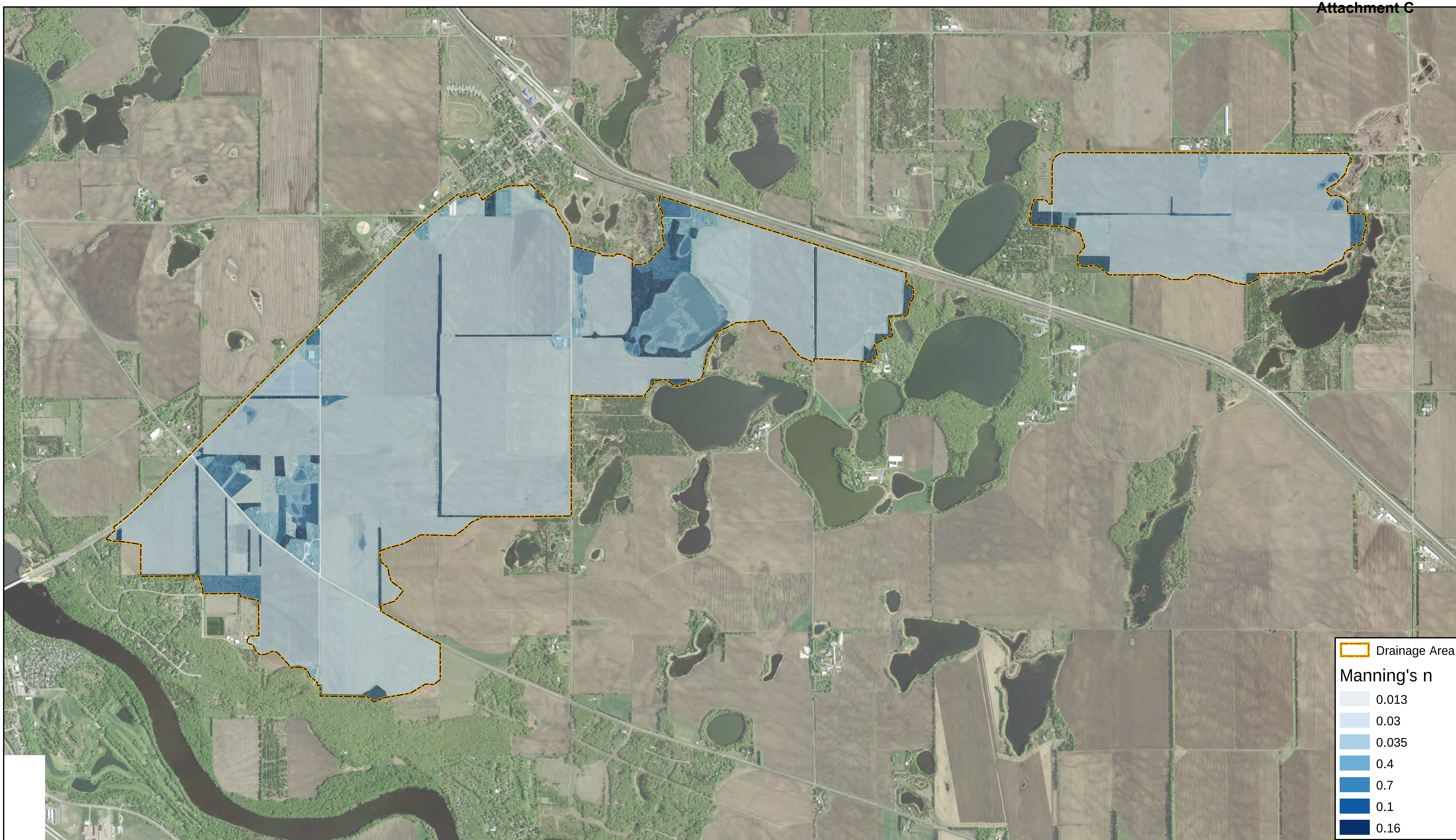

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BLATTNER ENERGY

Figure 5: Sherco III Existing Manning's n Values

Sherco III Solar Development
Blattner Energy

0 2,000
Feet
1 inch = 2,000 feet

wsb

Appendix 2: NOAA Atlas 14 Rainfall Data

Attachment C

NOAA Atlas 14, Volume 8, Version 2
Location name: Clear Lake, Minnesota, USA*
Latitude: 45.4271°, Longitude: -94.0059°
Elevation: 986 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffrey Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.364** (0.307-0.431)	**0.428** (0.361-0.508)	**0.535** (0.450-0.636)	**0.625** (0.522-0.746)	**0.751** (0.603-0.926)	**0.850** (0.665-1.06)	**0.951** (0.714-1.22)	**1.06** (0.755-1.38)	**1.20** (0.817-1.61)	**1.30** (0.864-1.78)
10-min	**0.532** (0.450-0.631)	**0.626** (0.529-0.743)	**0.783** (0.658-0.931)	**0.915** (0.764-1.09)	**1.10** (0.883-1.36)	**1.24** (0.973-1.55)	**1.39** (1.05-1.78)	**1.54** (1.10-2.02)	**1.75** (1.20-2.35)	**1.91** (1.27-2.60)
15-min	**0.649** (0.549-0.770)	**0.764** (0.645-0.906)	**0.955** (0.803-1.14)	**1.12** (0.932-1.33)	**1.34** (1.08-1.65)	**1.52** (1.19-1.90)	**1.70** (1.28-2.17)	**1.88** (1.35-2.47)	**2.13** (1.46-2.87)	**2.33** (1.54-3.17)
30-min	**0.896** (0.758-1.06)	**1.06** (0.894-1.26)	**1.33** (1.12-1.58)	**1.55** (1.30-1.85)	**1.86** (1.50-2.29)	**2.11** (1.65-2.63)	**2.35** (1.77-3.00)	**2.61** (1.86-3.41)	**2.94** (2.01-3.96)	**3.20** (2.13-4.37)
60-min	**1.14** (0.960-1.35)	**1.36** (1.15-1.61)	**1.73** (1.46-2.06)	**2.04** (1.70-2.44)	**2.47** (1.98-3.04)	**2.80** (2.19-3.50)	**3.14** (2.36-4.01)	**3.49** (2.49-4.57)	**3.95** (2.70-5.31)	**4.30** (2.86-5.87)
2-hr	**1.37** (1.17-1.62)	**1.66** (1.41-1.96)	**2.13** (1.80-2.52)	**2.53** (2.12-3.00)	**3.08** (2.48-3.76)	**3.50** (2.75-4.34)	**3.93** (2.97-4.98)	**4.37** (3.14-5.68)	**4.96** (3.41-6.62)	**5.40** (3.61-7.32)
3-hr	**1.52** (1.29-1.78)	**1.84** (1.57-2.16)	**2.38** (2.02-2.80)	**2.83** (2.39-3.35)	**3.47** (2.81-4.23)	**3.96** (3.13-4.90)	**4.47** (3.39-5.65)	**4.98** (3.60-6.46)	**5.68** (3.92-7.56)	**6.21** (4.17-8.39)
6-hr	**1.78** (1.53-2.07)	**2.14** (1.84-2.50)	**2.76** (2.35-3.22)	**3.29** (2.79-3.85)	**4.04** (3.30-4.92)	**4.65** (3.70-5.72)	**5.28** (4.03-6.64)	**5.93** (4.32-7.66)	**6.83** (4.76-9.05)	**7.53** (5.09-10.1)
12-hr	**2.08** (1.80-2.41)	**2.44** (2.10-2.82)	**3.07** (2.64-3.56)	**3.63** (3.10-4.23)	**4.46** (3.69-5.42)	**5.16** (4.14-6.33)	**5.89** (4.54-7.40)	**6.68** (4.91-8.60)	**7.78** (5.47-10.3)	**8.66** (5.89-11.5)
24-hr	**2.36** (2.05-2.71)	**2.75** (2.39-3.16)	**3.44** (2.97-3.96)	**4.05** (3.48-4.68)	**4.96** (4.13-5.99)	**5.72** (4.62-6.98)	**6.53** (5.07-8.15)	**7.40** (5.48-9.47)	**8.62** (6.10-11.3)	**9.60** (6.58-12.7)
2-day	**2.65** (2.31-3.02)	**3.12** (2.72-3.56)	**3.93** (3.42-4.49)	**4.63** (4.00-5.32)	**5.64** (4.70-6.72)	**6.45** (5.23-7.78)	**7.30** (5.69-9.00)	**8.18** (6.08-10.4)	**9.40** (6.69-12.2)	**10.4** (7.14-13.6)
3-day	**2.94** (2.57-3.33)	**3.41** (2.98-3.87)	**4.21** (3.67-4.80)	**4.92** (4.26-5.62)	**5.93** (4.96-7.04)	**6.76** (5.50-8.11)	**7.61** (5.96-9.35)	**8.52** (6.36-10.7)	**9.76** (6.98-12.6)	**10.8** (7.44-14.1)
4-day	**3.18** (2.79-3.60)	**3.65** (3.20-4.13)	**4.45** (3.89-5.05)	**5.16** (4.48-5.88)	**6.19** (5.20-7.32)	**7.02** (5.74-8.41)	**7.90** (6.20-9.68)	**8.83** (6.61-11.1)	**10.1** (7.25-13.1)	**11.1** (7.74-14.6)
7-day	**3.73** (3.29-4.20)	**4.25** (3.75-4.78)	**5.14** (4.52-5.80)	**5.92** (5.17-6.71)	**7.05** (5.95-8.28)	**7.96** (6.54-9.47)	**8.91** (7.04-10.9)	**9.92** (7.47-12.4)	**11.3** (8.15-14.5)	**12.4** (8.67-16.1)
10-day	**4.23** (3.75-4.74)	**4.80** (4.25-5.38)	**5.77** (5.08-6.48)	**6.60** (5.78-7.46)	**7.80** (6.60-9.12)	**8.77** (7.22-10.4)	**9.76** (7.73-11.8)	**10.8** (8.16-13.4)	**12.2** (8.85-15.6)	**13.4** (9.37-17.3)
20-day	**5.81** (5.17-6.46)	**6.47** (5.76-7.20)	**7.57** (6.71-8.44)	**8.50** (7.48-9.52)	**9.79** (8.31-11.3)	**10.8** (8.94-12.6)	**11.8** (9.42-14.2)	**12.9** (9.79-15.9)	**14.3** (10.4-18.1)	**15.4** (10.9-19.8)
30-day	**7.15** (6.39-7.92)	**7.93** (7.08-8.79)	**9.20** (8.18-10.2)	**10.2** (9.05-11.4)	**11.7** (9.91-13.3)	**12.7** (10.6-14.8)	**13.8** (11.0-16.4)	**14.9** (11.3-18.2)	**16.3** (11.9-20.4)	**17.3** (12.3-22.2)
45-day	**8.84** (7.94-9.75)	**9.85** (8.82-10.9)	**11.4** (10.2-12.6)	**12.7** (11.3-14.1)	**14.4** (12.2-16.3)	**15.6** (13.0-18.0)	**16.8** (13.4-19.8)	**17.9** (13.7-21.7)	**19.3** (14.1-24.1)	**20.3** (14.5-25.9)
60-day	**10.3** (9.24-11.3)	**11.5** (10.4-12.7)	**13.5** (12.1-14.8)	**15.0** (13.3-16.6)	**16.9** (14.4-19.1)	**18.3** (15.3-21.0)	**19.6** (15.7-23.1)	**20.9** (15.9-25.2)	**22.3** (16.3-27.7)	**23.3** (16.7-29.6)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

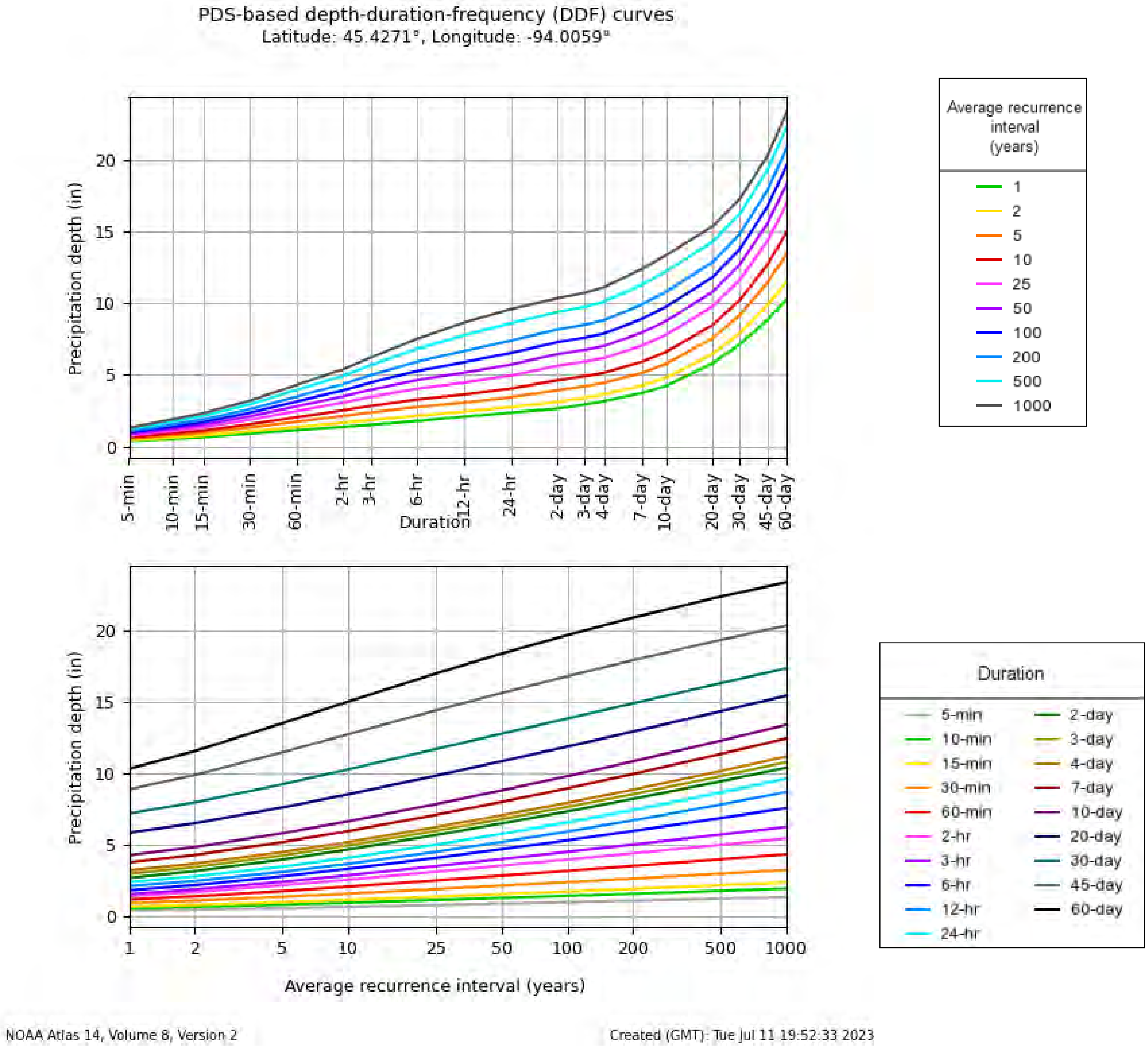
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

Attachment C

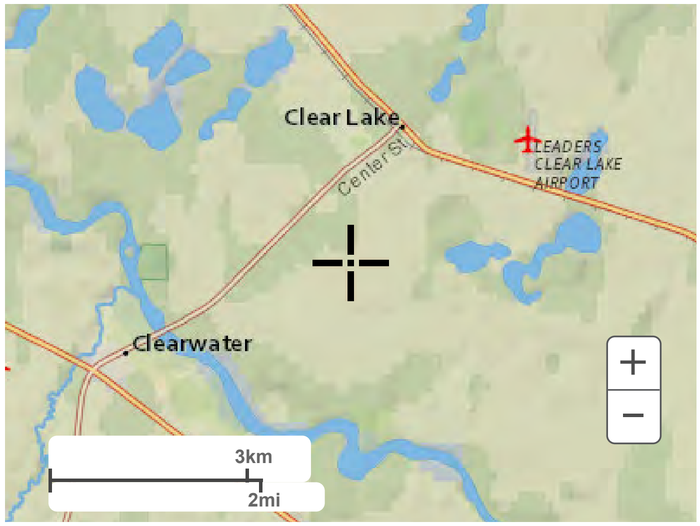


Back to Top

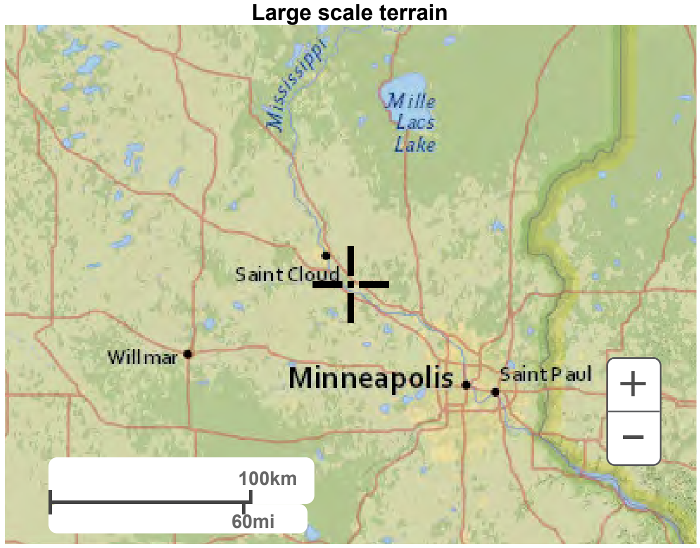
Maps & aerials

Small scale terrain

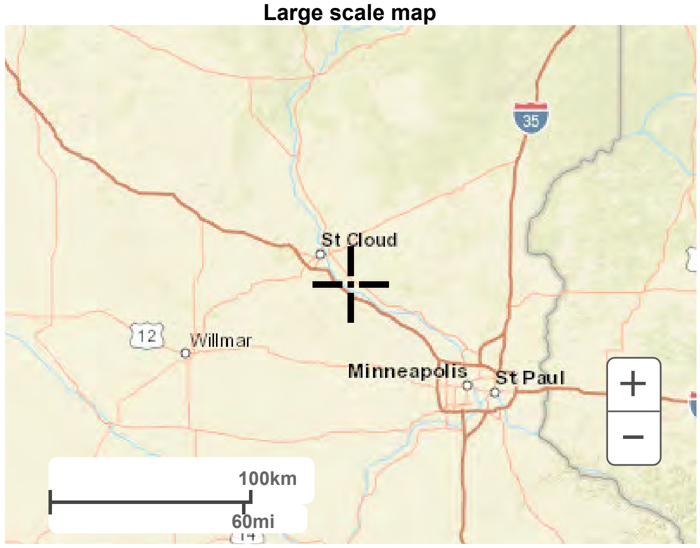
Attachment C



Large scale terrain

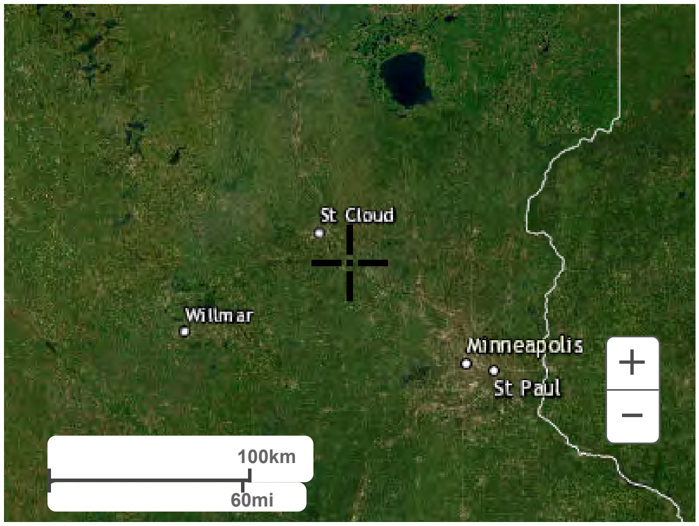


Large scale map



Large scale aerial

Attachment C



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Appendix 3: FEMA Maps

Attachment C

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) Report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS Report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study Report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study Report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study Report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 15. The **horizontal datum** was NAD 83, GRS 1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713- 3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was derived from multiple sources. Water features were obtained from the Minnesota Department of Natural Resources at a scale of 1:24,000, dated 2003. Transportation features, Political Boundaries, and Public Land Survey System features were provided by the Sherburne County Public Works Department at a scale of 1:1000, dated 2004.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables for multiple streams in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

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For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have **questions about this map,** how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at **1-877-FEMA-MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

Approximate buildable area shown in red

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% Annual Chance Floodplain Boundary

0.2% Annual Chance Floodplain Boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.

513 — Base Flood Elevation line and value; elevation in feet*

(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A — A Cross section line

23 - - - - - - 23 Transect line

45° 02' 08", 93° 02' 12" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere

$^{49}89^{000m}$ N 1000-meter Universal Transverse Mercator grid values, zone 15

DX5510 × Bench mark (see explanation in Notes to Users section of this FIRM panel)

• M1.5 River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
May 4, 2000

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
November 16, 2011 - to add Base Flood Elevations, to add Special Flood Hazard Areas, to decrease Base Flood Elevations, to update corporate limits, to add roads and road names, to increase Base Flood Elevations, to change Special Flood Hazard Areas and to change zone designations.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

N

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0185F

FIRM

FLOOD INSURANCE RATE MAP

SHERBURNE COUNTY, MINNESOTA
(AND INCORPORATED AREAS)

PANEL 185 OF 410
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CLEAR LAKE, CITY OF	270664	0185	F
SHERBURNE COUNTY	270435	0185	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
27141C0185F

MAP REVISED
NOVEMBER 16, 2011

Federal Emergency Management Agency

NOTES TO USERS

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National Geodetic Survey
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(301) 713-3242

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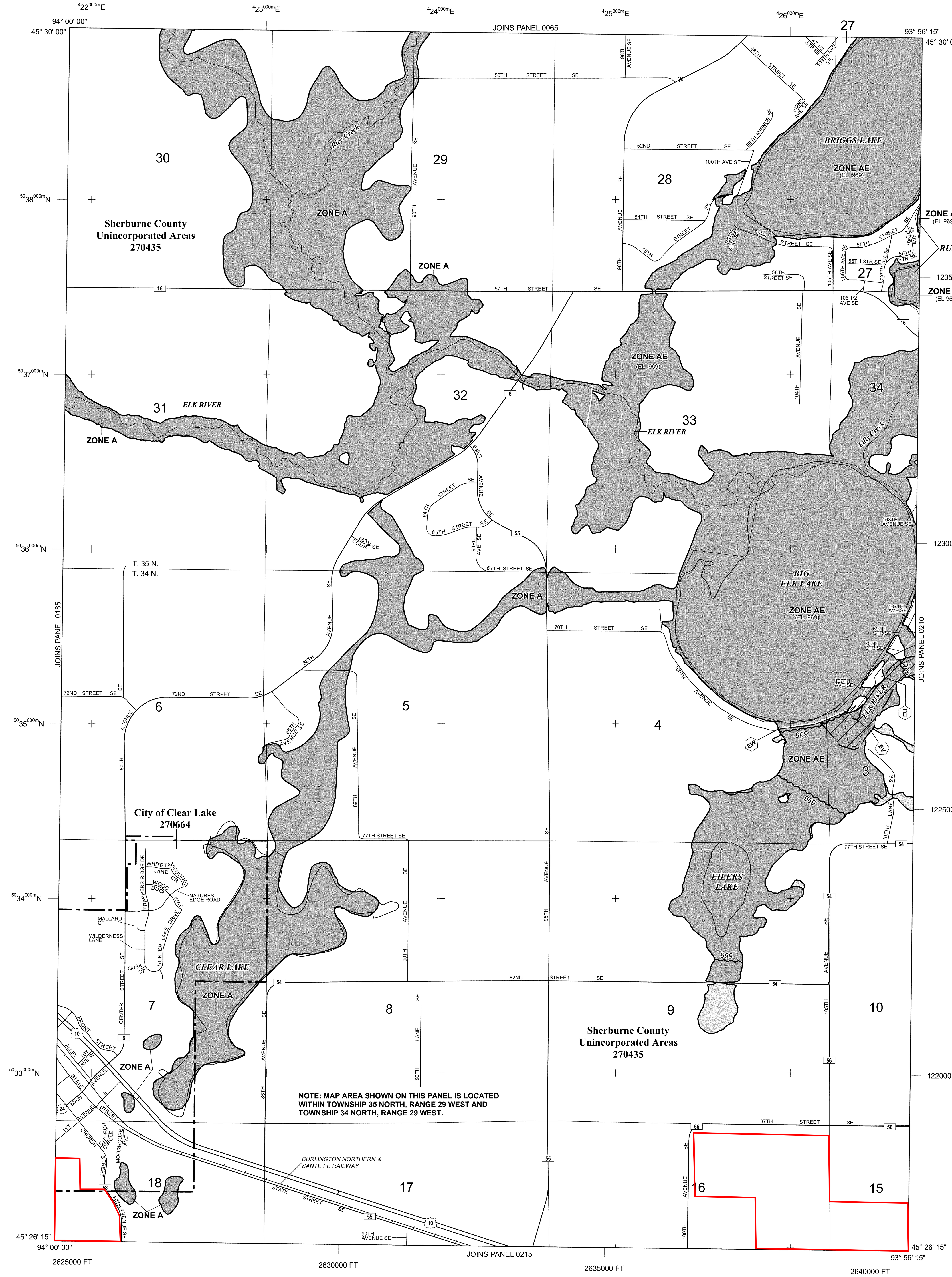

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LEGEND

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ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% Annual Chance Floodplain Boundary
0.2% Annual Chance Floodplain Boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A — A	Cross section line
23 - - - - - - 23	Transect line
45° 02' 08", 93° 02' 12"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
$^{49}89^{000m}$ N	1000-meter Universal Transverse Mercator grid values, zone 15
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
May 4, 2000

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
November 16, 2011 - to add Base Flood Elevations, to add Special Flood Hazard Areas, to decrease Base Flood Elevations, to update corporate limits, to add roads and road names, to increase Base Flood Elevations, to change Special Flood Hazard Areas and to change zone designations.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

N

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0205F

FIRM
FLOOD INSURANCE RATE MAP
SHERBURNE COUNTY, MINNESOTA
(AND INCORPORATED AREAS)

PANEL 205 OF 410
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CLEAR LAKE, CITY OF	270664	0205	F
SHERBURNE COUNTY	270435	0205	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER 27141C0205F

MAP REVISED NOVEMBER 16, 2011

Federal Emergency Management Agency

Attachment C

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

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Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study Report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study Report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study Report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 15. The **horizontal datum** was NAD 83, GRS 1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

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Base map information shown on this FIRM was derived from multiple sources. Water features were obtained from the Minnesota Department of Natural Resources at a scale of 1:24,000, dated 2003. Transportation features, Political Boundaries, and Public Land Survey System features were provided by the Sherburne County Public Works Department at a scale of 1:1000, dated 2004.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables for multiple streams in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

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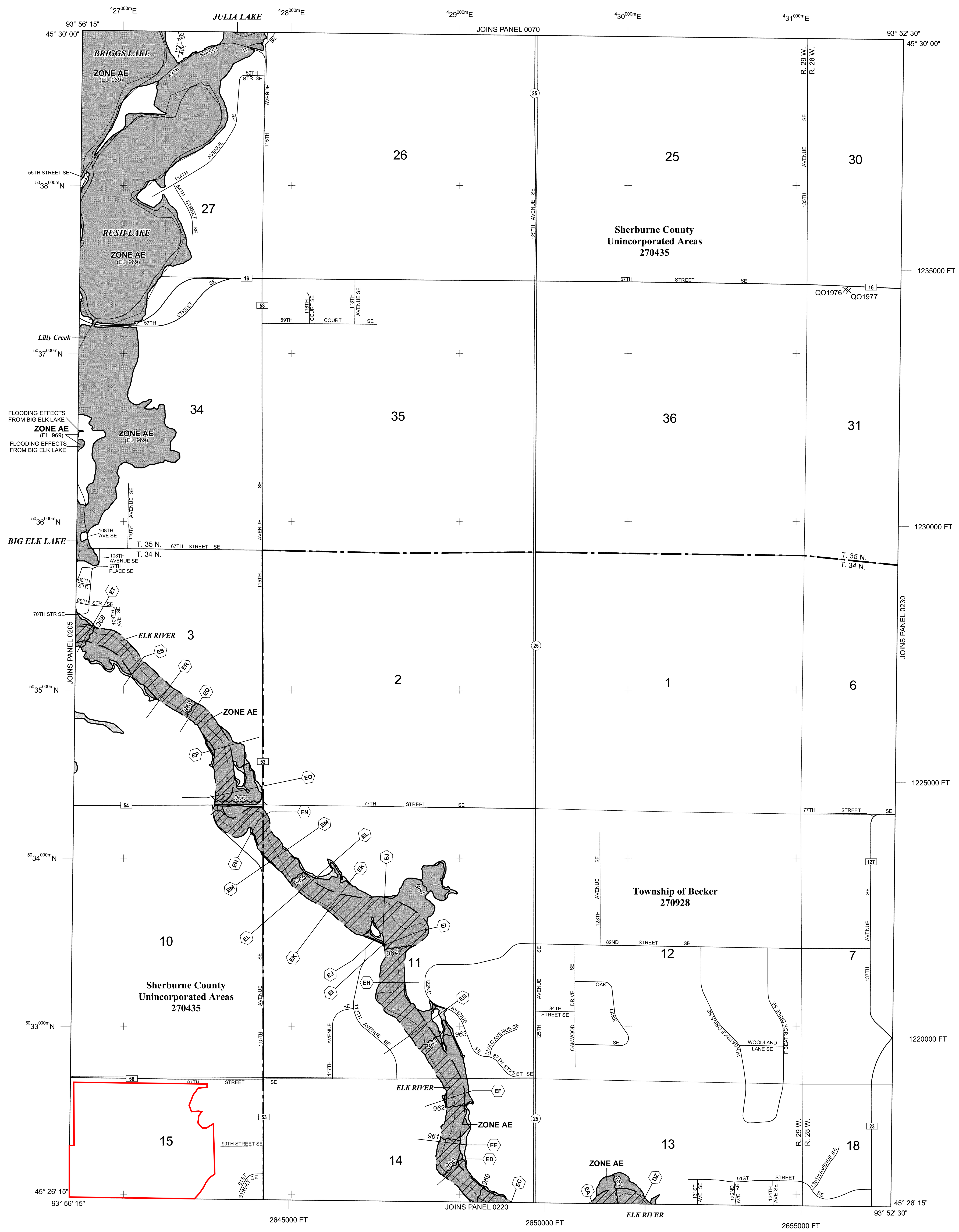
Approximate buildable area shown in red



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% Annual Chance Floodplain Boundary

0.2% Annual Chance Floodplain Boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.

513 — Base Flood Elevation line and value; elevation in feet*

(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A — A Cross section line

23 - - - - - - 23 Transect line

45° 02' 08", 93° 02' 12" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere

$^{49}89^{000m}$ N 1000-meter Universal Transverse Mercator grid values, zone 15

DX5510 × Bench mark (see explanation in Notes to Users section of this FIRM panel)

• M1.5 River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
May 4, 2000

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
November 16, 2011 - to add Base Flood Elevations, to add Special Flood Hazard Areas, to decrease Base Flood Elevations, to increase Base Flood Elevations, to update corporate limits, to add roads and road names, to change Special Flood Hazard Areas and to change zone designations.

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MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0210F

FIRM

FLOOD INSURANCE RATE MAP

SHERBURNE COUNTY, MINNESOTA
(AND INCORPORATED AREAS)

PANEL 210 OF 410
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
BECKER, TOWNSHIP OF	270928	0210	F
SHERBURNE COUNTY	270435	0210	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
27141C0210F

MAP REVISED
NOVEMBER 16, 2011

Federal Emergency Management Agency

Attachment C

NOTES TO USERS

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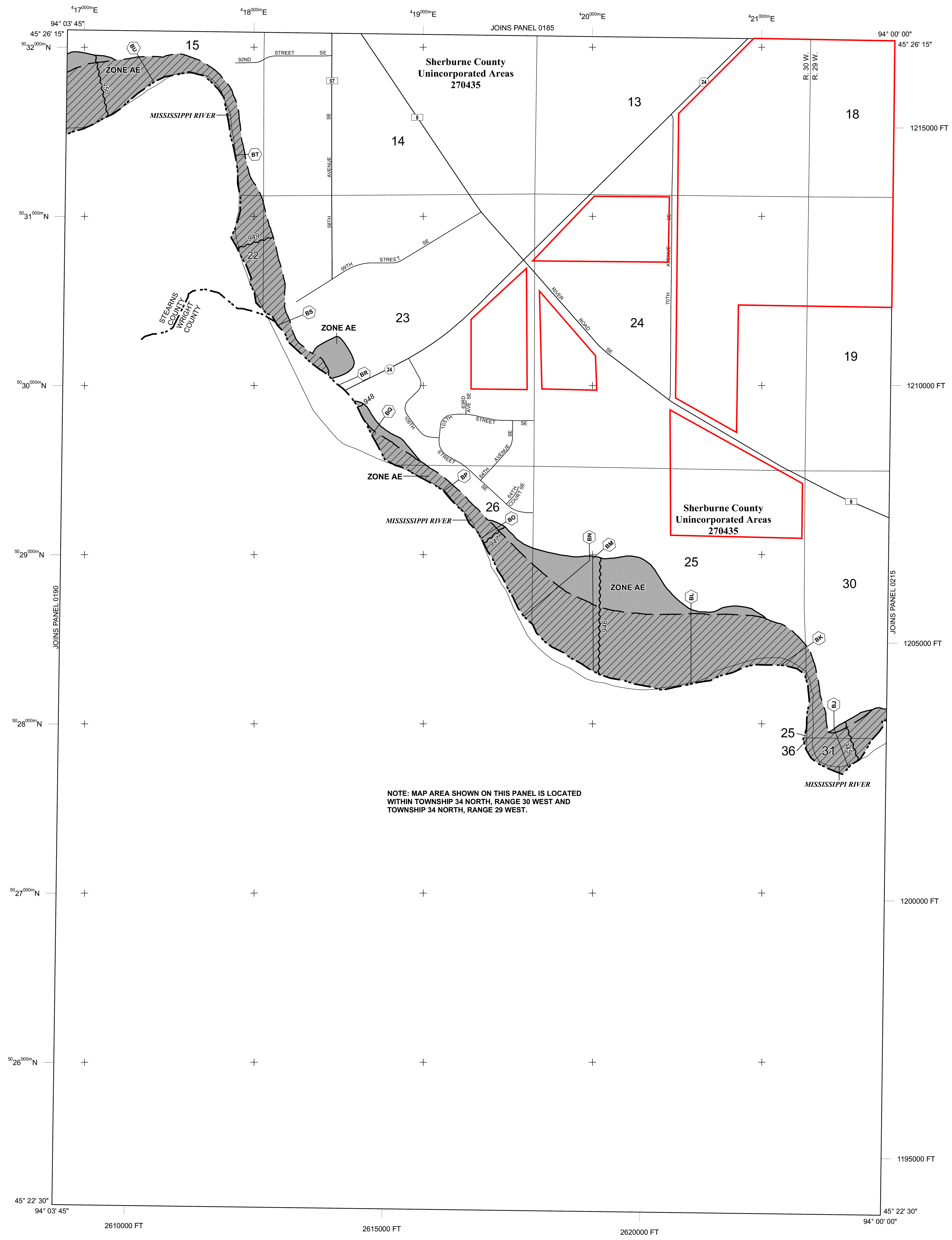
Approximate buildable area shown in red



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% Annual Chance Floodplain Boundary

0.2% Annual Chance Floodplain Boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
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*Referenced to the North American Vertical Datum of 1988

A — A	Cross section line
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$^{49}89^{000m}$ N	1000-meter Universal Transverse Mercator grid values, zone 15
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
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MAP REPOSITORIES
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EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
May 4, 2000

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
November 16, 2011 - to add Special Flood Hazard Areas, to decrease Base Flood Elevations, to increase Base Flood Elevations, to update corporate limits, to add roads and road names, to add Base Flood Elevations, to change Special Flood Hazard Areas and to change zone designations.

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MAP SCALE 1" = 1000'

500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0195F

FIRM
FLOOD INSURANCE RATE MAP

SHERBURNE COUNTY, MINNESOTA
(AND INCORPORATED AREAS)

PANEL 195 OF 410
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
SHERBURNE COUNTY	270435	0195	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
27141C0195F

MAP REVISED
NOVEMBER 16, 2011

Federal Emergency Management Agency

Attachment C

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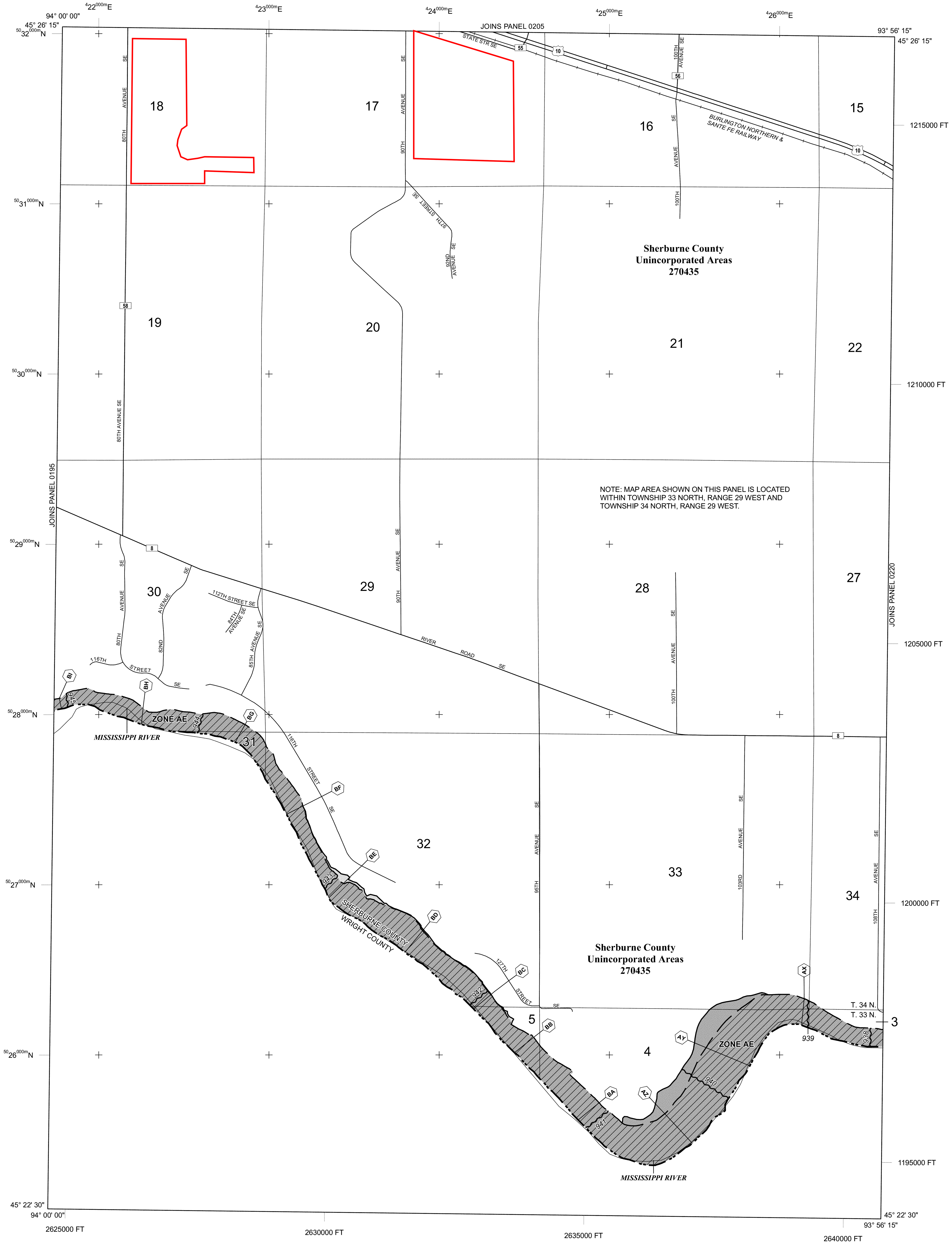

LEGEND

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FLOODWAY AREAS IN ZONE AE

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OTHER FLOOD AREAS

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1% Annual Chance Floodplain Boundary

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Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A — A	Cross section line
23 - - - - - 23	Transect line
45° 02' 08", 93° 02' 12"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
$^{49}89^{000m}$ N	1000-meter Universal Transverse Mercator grid values, zone 15
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
May 4, 2000

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
November 16, 2011 - to add Base Flood Elevations, to add Special Flood Hazard Areas, to decrease Base Flood Elevations, to update corporate limits, to add roads and road names, to increase Base Flood Elevations, to change Special Flood Hazard Areas and to change zone designations.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0215F

FIRM
FLOOD INSURANCE RATE MAP
SHERBURNE COUNTY, MINNESOTA
(AND INCORPORATED AREAS)

PANEL 215 OF 410
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
SHERBURNE COUNTY	270435	0215	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
27141C0215F

MAP REVISED
NOVEMBER 16, 2011

Federal Emergency Management Agency

Appendix 4: Existing Conditions Hydrologic Calculations

Attachment C

SCS CN Runoff Value Calculations

Used for HEC-HMS Calculations

CN values from Table 2-2a to 2-2c of TR-55 manual

Date: 9/15/2023
By: Henry Meeker

Sherco III - Main

Cover Type	NLCD Code	Area (ac)	CN	% of Total	Area Weighted CN
Open Water	11	50.338	100	2.7%	2.69
Developed, Open Space	21	58.477	46	3.1%	1.44
Deciduous Forest	41	86.420	45	4.6%	2.08
Evergreen Forest	42	2.400	40	0.1%	0.05
Shrub/Scrub	52	61.984	35	3.3%	1.16
Grassland/Herbaceous	71	150.682	30	8.1%	2.42
Pasture/Hay	81	5.658	39	0.3%	0.12
Cultivated Crops	82	1410.525	67	75.4%	50.52
Emergent Herbaceous Wetlands	95	19.909	84	1.1%	0.52
Impervious Roadway	N/A	24.201	100	1.3%	1.29
	Total:	1870.595		Composite CN:	62.3

Sherco III - NE

Cover Type	NLCD Code	Area (ac)	CN	% of Total	Area Weighted CN
Developed, Open Space	21	4.162	30	1.1%	0.32
Deciduous Forest	41	9.350	45	2.4%	1.08
Shrub/Scrub	52	7.907	35	2.0%	0.71
Grassland/Herbaceous	71	21.494	30	5.5%	1.65
Cultivated Crops	82	339.932	67	87.2%	58.43
Emergent Herbaceous Wetlands	95	4.347	84	1.1%	0.94
Impervious Roadway	N/A	2.609	100	0.7%	0.67
	Total:	389.800		Composite CN:	63.8

Time of Concentration

Used for HEC-HMS Calculations

Date: 9/15/2023

By: Henry Meeker

NRCS Hydrology Manual Chapter 6

Section 630.1502: Methods for Estimating Time of Concentration

(a) Watershed Lag Method

$$L = \frac{\ell^{0.8}(S+1)^{0.7}}{1{,}900Y^{0.5}} \qquad \text{(eq. 15–4a)}$$

Applying equation 15–3, $L=0.6T_c$, yields:

$$T_c = \frac{\ell^{0.8}(S+1)^{0.7}}{1{,}140Y^{0.5}} \qquad \text{(eq. 15–4b)}$$

where:

L = lag, h

T_c = time of concentration, h

ℓ = flow length, ft

Y = average watershed land slope, %

S = maximum potential retention, in

$$= \frac{1{,}000}{cn'} - 10$$

where:

cn' = the retardance factor

$$Y = \frac{100(CI)}{A} \qquad \text{(eq. 15–6)}$$

where:

Y = average land slope, %

C = summation of the length of the contour lines that pass through the watershed drainage area on the quad sheet, ft

I = contour interval used, ft

A = drainage area, ft^2 (1 acre = 43,560 ft^2)

Watershed Lag Equation Limitations

Developed using data from 24 watersheds ranging in size from 1.3 acres to 9.2 square miles (Mockus 1961)

	l	cn'	S	C	I	A	Y	L_t
Drainage Area	**Flow Length (ft)**	**Curve Number**	**Max Potential Retention (in)**	**Sum of contour Lengths (ft)**	**Contour Interval (ft)**	**Drainage Area (sf)**	**Avg. Land Slope (%)**	**Lag Time (min)**
Sherco III - Main	19201	41.2	14.3	814523	2	81483101	2.00	234
Sherco III - NE	7493	63.8	5.7	182024	2	16979674	2.14	103

HEC-HMS Basin Input Summary

Used for HEC-HMS Calculations

Date: 9/15/2023
By: Henry Meeker

Site Condition:	Sherco III - Main

Area (mi²):	2.923
Discretization Method:	None
Canopy Method:	None
Snow Method:	None
Surface Method:	None
Loss Method:	SCS Curve Number
Transform Method:	SCS Unit Hydrograph
Baseflow Method:	None

Initial Abstraction:	0
Curve Number:	62.3
Impervious (%):	3.98

Graph Type:	Standard (PRF 484)
Lag Time (min):	234

Frequency Storm	
Duration	**Depth (in)**
5 minutes	0.951
15 minutes	1.7
1 hour	3.14
2 hours	3.93
3 hours	4.47
6 hours	5.28
12 hours	5.89
1 day	6.53

Site Condition:	Sherco III - NE

Area (mi²):	0.609
Discretization Method:	None
Canopy Method:	None
Snow Method:	None
Surface Method:	None
Loss Method:	SCS Curve Number
Transform Method:	SCS Unit Hydrograph
Baseflow Method:	None

Initial Abstraction:	0
Curve Number:	63.8
Impervious (%):	0.67

Graph Type:	Standard (PRF 484)
Lag Time (min):	103

Frequency Storm	
Duration	**Depth (in)**
5 minutes	0.951
15 minutes	1.7
1 hour	3.14
2 hours	3.93
3 hours	4.47
6 hours	5.28
12 hours	5.89
1 day	6.53

Appendix 5: Existing Conditions Hydraulic Figures & Calculations