Multi-Purpose Drainage Management Plan

County Ditch No. 13

Isanti County, Minnesota

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Multi-Purpose Drainage Management Plan

Prior to this report, the Agricultural Conservation Planning Framework (ACPF) GIS tools were used along with aerial drone videos to site and prioritize BMPs within the CD 13 watershed. The data sets developed were the starting point for identifying practical and feasible practices to prioritize for implementation. Additional practices were added that may be outside the scope of siting through the GIS tools but would be feasible based upon on-site conditions such as topography, field boundaries, and aerial review. It is important to note that this study was completed through desktop analysis and on-site investigation is needed to verify project feasibility. Multi-purpose drainage management incorporates Best Management Practices (BMPs) which utilize effective measures aimed at reducing sediment and nutrient loading and improving water quality. These BMPs are divided into Preventive, Control, and Treatment measures.

Preventative Measures

Preventative measures that can be applied throughout the watershed include crop rotation, cover crops, residue management, and nutrient management. These measures are aimed at controlling sediment, minimizing erosion and nutrient loss, and sustaining the soil's health, all without dramatically changing the current land use of the landscape. ISG performed a runoff risk assessment throughout the CD 13 watershed. An ACPF "runoff risk assessment" utilizes a matrix for only agricultural fields and is used to classify a given field according to its risk of direct runoff contribution to stream channels in the watershed. The matrix utilizes cross-classification of slope steepness and proximity to stream. A sediment delivery ratio (SDR) is used as proxy for stream proximity. A slope steepness and SDR value is found for each agricultural field based on the ACPF field boundaries classification and converted to a rank (high, medium, or low) for each field. ACPF field boundaries indicate whether the land use type is agricultural or not. Within this ACPF process, distance to the stream from the field edge is estimated using the minimum distance to stream value found from each field. This minimum distance value is translated to a SDR for each field. It is important to note that fields within 10 feet of the stream are considered to border the stream resulting in an SDR value of 1. Additionally, field slope is represented by the steepest 25% of the field, defined by the 75th percentile (or 3rd quartile slope value) of the field. Fields that contain an area where 25% of the total field area has slopes greater than 5% will be classified as "high" risk. Fields that contain an area where 25% of the total field area has slopes less than 2% will be classified as "low" risk. Fields that contain an area where 25% of the total field area has slopes between 5% and 2% will be classified as "medium" risk. The ACPF tool will utilize both input parameters and each agricultural field will receive a runoff risk classification of: A (very high), B (high), C (moderate), or D (low). A "low" classification does not mean that a runoff-control conservation practice would not benefit a given field, but rather, indicates that other fields have a greater potential to deliver sediment and phosphorus to the stream via surface runoff. From this assessment, ISG was able to identify areas of high potential for sediment and nutrient loaded runoff. These areas give a good idea of where to implement the preventative measures discussed previously.

Control Measures

Control measures are practices aimed at improving water quality directly associated with the flow of water by reducing peak flow and providing in-stream storage, sedimentation, and nutrient uptake. Examples of control measures include alternative tile intakes, grassed waterways, two stage ditches, water control structures, and controlled subsurface drainage. These practices are directly linked to the conveyance of subsurface tile water or open channel ditch flow. ISG identified several areas in which contour buffer strips two-stage ditches, controlled drainage, and woodchip bioreactors have a high potential for constituent reduction.

Contour Buffer Strips

Contour Buffer Strips are strips of perennial vegetation planted along topographic contours, which may be alternated with wider cultivated strips that are farmed on the contour. Contour buffer strips are in-field runoff control practices that use permanent vegetation to decrease the length of slopes along which runoff accumulates and thereby reduce sheet and rill erosion. Additionally, contour buffer strips reduce water quality degradation from the transport of sediment and other water-borne contaminants down slope. Contour buffer strips are placed along topographic contours to intercept flows. No grassed waterways were produced through the ACPF process. Grassed waterways are a shaped or graded channel established with suitable vegetation to convey surface water at a nonerosive velocity. Grassed waterways are constructed to convey runoff from concentrated-flow areas running parallel to the slope of an agricultural field. Waterways are mainly used to control gully erosion. Contour buffer strips slow runoff, trap sediment, and reduce erosion. Contour buffer strips are established laterally along undulating to rolling topography. It is likely that through ACPF processes, no grass waterways were located as the risk of high velocity, parallel, concentrated flow is not high based on topography, land use, and CD 13 watershed characteristics. Conversely, based on the same factors, ACPF processes found that contour buffer strips intercepting lateral overland flow is an applicable BMP. It is important to note that grassed waterways and contour buffer strips may be alternatives for the same practice sites, and more investigation will proceed to identify additional sites with drone footage.

Controlled Drainage

Controlled Drainage is the process of managing the drainage volume and water table elevation by regulating the flow from a surface or subsurface agricultural drainage system. This practice is used to reduce nutrient, pathogen, and pesticide loading from drainage systems into downstream receiving waters. Additionally, controlled drainage improves productivity, health, and vigor of plants along with reducing the oxidation of organic matter in soils. This practice is applicable to agricultural lands with surface or subsurface drainage systems that can be adapted or partially adapted to allow management of drainage volume and the water table by changing the water level elevation at the outlets. This practice applies where a high natural water table exists or has existed, and the topography is relatively smooth, uniform, and flat to very gently sloping.

Two-Stage Ditch

Two-Stage Ditches are drainage ditches that are modified by adding benches that serve as floodplains within the overall channel. The ditch consists of a low-flow channel and provides storage via vegetated benches during higher flows. The vegetation also provides flow velocity reduction. Because of this velocity reduction, sediments and other particulate material may settle out more effectively. This practice is applicable for ditches that are experiencing bank erosion or are undersized. Additionally, two-stage ditches can provide an increase in nutrient cycling. The Two-Stage Ditch ACPF tool evaluates riparian settings within each riparian catchment which were data sets produced from earlier run ACPF tools. Additional inputs are elevation data, soil classification, field slopes, and land use types within each riparian catchment. ACPF utilizes a recommended drainage area between 1 and 10 square miles to identify areas where two-stage ditch implementation is best suited. Bank height was an additional input parameter to allow for installation of floodplain benches, in contrast, the practice may become cost-prohibitive where ditches are too steep and large amounts of land would need to be taken out of production. Default minimum and maximum bank heights are set at 4 feet and 12 feet, respectively. Sandier soils may not be well-suited for this practice unless vegetation can be established quickly. ACPF identifies areas to be best suited for two-stage ditches where the channel has a grade less than 2 percent. Finally, ACPF uses field topography and land use type parameters. Two-stage ditches are best suited adjacent to fields that are flat with subsurface drainage installed. A default of 35% of each riparian zone (within 90 meters of the stream) must consist of slopes greater than 5%. Agricultural land must exist within 90 meters of the stream (either cropland or pasture land) within each riparian zone for ACPF to identify a suitable area for a two-stage ditch. ISG identified several areas in which two-stage ditches could be implemented, but further investigation should be pursued to verify site conditions.

Treatment Measures

The function of treatment measures is to improve water quality by directly removing sediment and nutrients from the subsurface or surface water flow throughout a watershed. Examples of treatment measures include surge basins (storage ponds), filter/buffer strips, constructed and/or restored wetlands, woodchip bioreactors, and water and sediment control basins (WASCOBs). These practices may be incorporated into either the public or private drainage systems.

Saturated Buffers

Saturated buffers employ a lateral distribution line within a riparian buffer and a diversion gate that intercepts a tile above its outlet to a stream. The diversion gate comprises a control structure that diverts outflow portion of the tile flow to the distribution line and raises the water table within the buffer, which enhances the buffer’s ability to naturally remove nutrients conveyed by tile drainage. Saturated buffers reduce nitrate loading from subsurface drain outlets through vegetative uptake and denitrification. Additionally, they enhance or restore saturated soil conditions in riverine, lacustrine fringe, slope, or depression wetland hydrogeomorphic classes.

This practice is applicable to lands with a subsurface drainage system adaptable to discharge in a vegetated area.

Denitrifying Bioreactors

Bioreactors typically comprise a buried bed of woodchips that receive a portion of tile drainage flows from an adjoining field. The wood chips provide a carbon source, which combined with the reducing (oxygen limiting) conditions in the saturated subsurface environment, encourage naturally occurring bacteria to reduce nitrate to di-nitrogen gas in a stepwise process (denitrification). This practice applies to sites where there is a need to reduce the concentration of nitrate nitrogen in the flow from subsurface drainage systems.

Constructed Treatment Wetlands

Constructed treatment wetlands are generally located in low-lying areas that would otherwise be saturated during rain events. Constructed wetlands use embankments such as berms or overflow weirs to hold agricultural drainage water to be treated. Constructed wetlands benefits include reduced peak flow rates, sedimentation, nutrient reductions, wildlife enhancement, and overall improved water quality. There are many programs available for constructed treatment wetlands and include wetland banking, RIM-WRP, CREP, and various NRCS programs. ISG identified multiple areas in which constructed wetlands could be implemented. Further investigation of identified locations should be pursued, as factors such as maintained water level, wetland size, drainage area, outlet structure, costs, etc. are variable. The scope of this MDM plan is to provide general potential constructed wetlands locations and cost effectiveness values using estimated parameters that may change if a constructed wetland BMP is pursued.

Wetland Enhancements

Wetland Enhancements are implemented to enhance existing wetland areas. Wetland enhancements include but are not limited to increasing wetland storage by adding additional hydrology to the site, expanding the wetland footprint, or allowing agricultural drainage water treatment. By enhancing the wetland, it can add additional water quality benefits including increased sedimentation, nutrient reduction, and reduced peak flows.

Several potential wetland areas were located throughout the CD 13 watershed. Much of the CD 13 watershed consists of depressional slough areas. Compared to constructed wetlands, wetlands enhancements generally cost less as they require less construction. These potential wetlands are generally located in areas that have a large upstream drainage area to maximize sediment and nutrient capture. ISG identified several areas in which wetland restorations could be implemented. Further investigation of identified locations should be pursued, as factors such as maintained water level, wetland size, drainage area, outlet structure, costs, etc. are variable. The scope of this MDM plan is to provide general potential wetland restoration locations and cost effectiveness values using estimated parameters that may change if a wetland restoration BMP is pursued.

Data Analysis

Loading Rate

To obtain the data required to rank the investigated BMPs, constituent loading rates needed to be determined. The loading rates for Total Suspended Solids (TSS), Total Nitrogen (TN), and Total Phosphorous (TP), are typically determined from the Hydrologic Simulation Program – FORTRAN, Scenario Application Manager (HSPF-SAM). HSPF is a comprehensive watershed model that integrates runoff processes and in-stream processes to simulate pollutant runoff and watershed fate and transport of the modeled pollutant constituents. HSPF-SAM is a graphical interface that allows users to obtain modeled outputs from HSPF and develop management scenarios simulating the adoption of various BMPs and land use changes.

The previously discussed constituent loading rates were determined within HSPF based on watershed data provided. It is important to note that HSPF did not contain a comprehensive watershed model, or any data, for CD 13 in the Lower St. Croix River basin. HSPF did contain a comprehensive watershed model for the Rum River watershed, which is an adjacent basin to the Lower St. Croix River basin. ISG utilized a bordering watershed to CD 13, A413 in the Rum River basin, to use as a basis for determining CD 13 loading rates.

The data type selected was the A413 Basin Source Load Rate, which is the sum of the constituent loads at the outlet of each unique subbasin aggregated by the land use source and divided by the area (acres). This produced the total local loading rate per acre coming from each unique combination of land use source and basin for several different land use types. HSPF-SAM produced a Basin Source Loading Rate for every land use type for TSS (ton/acre/yr), TN (lb./acre/yr), and TP (lb./acre/yr). It is important to note that Basin Source Load Rate results are only available for nonpoint land-area sources and generally will not include point sources, boundary conditions, or direct inflows. To relate the Basin Source Load Rates from HSPF's Rum River A413 watershed to CD 13, a relationship needed to be developed, and the loading rates needed to be calibrated.

Calibration

The MPCA's Simple Estimator tool was utilized to complete this calibration for TP and TSS, while USGS SPARROW was used for the calibration of TN. The MPCA's Simple Estimator is a spreadsheet-based approach to compute pollutant loading based on Event Mean Concentrations (EMCs) and runoff coefficients for each land use category. The USGS's SPARROW model is a non-linear regression model that estimates watershed pollutant runoff based on land use characteristics and downstream monitored values. ISG's calibration process consisted of running these more simplistic modeling tools for both the A413 and CD 13 watersheds to establish a relationship between the two adjacent watersheds to compare pollutant loading rates using the same modeling approach. This comparison established a multiplier factor for each pollutant parameter to scale the results from the HSPF A413 watershed to the CD 13 watershed. The Engineer selected this approach versus using the results of the more simplified models due to the fact HSPF is a more robust modeling approach and it is believed to provide more accurate results due to the similarities in terrain and land use between the two adjacent watersheds.

Within the MPCA's Simple Estimator, inputs for A413's and CD 13's, land use types, land use areas, TSS EMCs, TP EMCs, basin annual precipitation, and runoff coefficients for each land use type, were entered. These inputs were determined using the Minnesota Stormwater Manual and Minnesota Department of Natural Resources Climate Trend Data. These inputs were entered for both A413 and CD 13. The MPCA's Simple Estimator then calculated the A413 and CD 13 loading rates for TSS and TP. Resulting from this calibration, a relationship between A413's and CD 13's, TP and TSS loading rates were determined, and a multiplier was developed. Based on the calibration, CD 13 should have a loading rate 1.3 times higher and 1.1 times higher than A413, for TP and TSS, respectively. These multipliers were then applied to the A413 land use weighted, average loading rates, which were previously calculated. It is important to note that "Feedlot" loading rates, provided from HSPF, was not included in these weighted average calculations. In the Minnesota Geospatial Commons, one feedlot location was sited in A413, and one feedlot was sited in CD 20, a bordering watershed that outlets into the downstream end of CD 13. The Engineer believes that these sited feedlot locations will have negligible impacts to the loading rates utilized as they are sited in areas believed to contribute negligible TSS, TN, and TP quantities to A413 and CD 13. It is important to note that the MPCA's Simple Estimator does not include calculations for TN, so the USGS SPARROW model was utilized. TN loading rate values were obtained using the USGS's online mapper tool and were obtained at the HUC8 scale for the Rum River Watershed and Lower St.Croix watersheds. The evaluation of this relationship resulted in a multiplier of 1.2, which was used for TN.

As a result of the calibration approach and assumptions outlined within this section, it is assumed that there is a slight underestimation of loading reaching the BMPs. As a result, the BMP performance may be underestimating the true reduction potential but presents a conservative approach.

These newly calibrated TSS, TN, and TP loading rates, for CD 13, could be utilized in ISG's constituent reduction calculations and cost analysis.

Base Capture Efficiency

The next required parameters are TSS, TN, and TP, base capture efficiencies. These capture efficiencies are based on individually selected BMPs within the HSPF-SAM database. By selecting the desired BMP, the base capture efficiency was provided over a specific reference term and flow type for TSS, TN, and TP. HSPF-SAM simulates the separation of runoff from surface, interflow, and base-flow pathways at the outlet of the lumped segment based on parameter calibration and watershed characteristics. Efficiencies were developed to be applied as different values for each of these flow pathways simulated by HSPF-SAM and represent the percent reduction of TSS, TN, and TP achieved from BMP implementation. Efficiencies are also dependent on selected reference terms. The reference term options were 0-5 years, 5-10 years, or 10-20 years. The selected reference term for this multi-purpose drainage management plan was 0-5 years and the flow type was chosen appropriately based on the corresponding BMP. The provided BMP base capture efficiencies were utilized in ISG's constituent reduction calculations and cost analysis.

Modified Capture Efficiency

HSPF-SAM utilizes efficiency reduction factors to simulate BMP implementation in a model application. These efficiency reduction factors reduce uncertainty in representing the impacts of BMPs within the model. To determine if a modified capture efficiency should be utilized, the base capture efficiency was normalized by the total treated area (acres) for each individual BMP for TSS, TN, and TP. HSPF-SAM provided "Impact to Implementation Area Factors" to determine suitable acres available for each individual BMP and aid in determining if a modified capture efficiency should be utilized. ISG determined that if the base capture efficiency multiplied by an "Impact to Implementation Area Factor" and divided by the total treated area (acres) was greater than the base capture efficiency, then the base capture efficiency should be utilized. Conversely, if the base capture efficiency multiplied by an "Impact to Implementation Area Factor" and divided by the total treated area (acres) was less than the base capture efficiency, the modified capture efficiency would be used in lieu of the base capture efficiency. For constructed wetlands and wetland enhancement BMPs, the watershed to wetland ratio was utilized in determining modified capture efficiency, opposed to total treated acres. Additionally, HSPF-SAM did not contain any "Impact to Implementation Area Factors" for two-stage ditch BMPs, so the base capture efficiency was utilized.

BMP Costs and Cost Effectiveness

This multi-purpose drainage management plan is focused on prioritizing BMP locations within the CD 13 watershed and utilizes generalized costs specific to the BMP type, to determine cost effectiveness. Individualized BMP specific factors such as BMP length, surface area, treatment area, and life span were utilized in generalized costs and cost effectiveness calculations. GIS data was used to assist in estimating these BMP specific quantities. Costs can vary by BMP type, size, location, etc. When calculating costs, the individualized BMP specific factors previously discussed were utilized when applicable, but each type of BMP utilized the same unit costs. Unit costs associated with each BMP were determined based on other MDM plans within Isanti County. It is important to note that these generalized unit costs and BMP parameters are variable. The purpose of this MDM plan is to prioritize BMPs based on location and cost effectiveness, and following further investigation and BMP selection, these generalized costs and cost effectiveness estimates can be determined more effectively and accurately.

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Rank of Potential Practices Based on Total Phosphorous Cost Effectivness

Unique ID	BMP Number	TSS Load (T/year)	TN Load (lb/year)	TP Load (lb/year)	Base TSS Capture Efficiency	Base TN Capture Efficiency	Base TP Capture Efficiency	Modified TSS Capture Efficiency	Modified TN Capture Efficiency	Modified TP Capture Efficiency	TSS Reductions (T/yr)	TN Reductions (lb/yr)	TP Reductions (lb/yr)	Estimated Total Cost	Life Span (yr)	TSS Cost Effectiveness ($/T/yr)	TSS Cost Effectiveness ($/lb/yr)	TN Cost Effectiveness ($/lb/yr)	TP Effectiveness ($/lb/yr)	Rank (TP Focus)
ControlledDrainage1	24	2.76	217.06	14.79	0.00	0.43	0.43	0.00	0.43	0.43	0.00	93.34	6.36	$ 8,264.95	40	$ -	$ -	$ 2.21	$ 32.48	1
ControlledDrainage2	25	2.78	218.66	14.90	0.00	0.43	0.43	0.00	0.43	0.43	0.00	94.03	6.41	$ 8,326.05	40	$ -	$ -	$ 2.21	$ 32.48	2
ControlledDrainage3	26	3.24	255.08	17.39	0.00	0.43	0.43	0.00	0.43	0.43	0.00	109.68	7.48	$ 9,712.55	40	$ -	$ -	$ 2.21	$ 32.48	3
TwoStageDitch1	40	186.56	14681.63	1000.67	0.35	0.15	0.35	0.35	0.15	0.35	65.30	2202.24	350.23	$ 1,748,730.97	50	$ 535.63	$ 0.27	$ 15.88	$ 99.86	4
TwoStageDitch2	41	113.52	8933.52	608.89	0.35	0.15	0.35	0.35	0.15	0.35	39.73	1340.03	213.11	$ 1,110,867.52	50	$ 559.18	$ 0.28	$ 16.58	$ 104.25	5
ContourBufferStrip6	21	0.30	23.51	1.60	0.84	0.66	0.67	0.84	0.66	0.67	0.25	15.52	1.07	$ 4,631.82	40	$ 461.35	$ 0.23	$ 7.46	$ 107.84	6
ConstructedWetland7	33	84.36	6639.12	452.51	0.75	0.52	0.43	0.71	0.49	0.41	59.61	3252.59	183.32	$ 1,214,132.36	50	$ 407.34	$ 0.20	$ 7.47	$ 132.46	7
ContourBufferStrip4	19	0.18	13.89	0.95	0.84	0.66	0.67	0.84	0.66	0.67	0.15	9.17	0.63	$ 3,395.07	40	$ 572.63	$ 0.29	$ 9.26	$ 133.85	8
ConstructedWetland10	36	105.94	8336.90	568.22	0.75	0.52	0.43	0.75	0.52	0.43	79.45	4335.19	244.34	$ 1,693,904.32	50	$ 426.39	$ 0.21	$ 7.81	$ 138.65	9
SaturatedBuffer1	7	0.51	40.30	2.75	0.74	0.31	0.27	0.74	0.31	0.27	0.38	12.49	0.74	$ 4,810.00	40	$ 317.31	$ 0.16	$ 9.63	$ 162.14	10
ContourBufferStrip8	23	0.40	31.72	2.16	0.84	0.66	0.67	0.84	0.66	0.67	0.34	20.94	1.45	$ 9,850.02	40	$ 727.24	$ 0.36	$ 11.76	$ 169.99	11
SaturatedBuffer6	12	0.44	34.62	2.36	0.74	0.31	0.27	0.74	0.31	0.27	0.33	10.73	0.64	$ 4,810.00	40	$ 369.35	$ 0.18	$ 11.20	$ 188.73	12
ContourBufferStrip7	22	0.20	15.68	1.07	0.84	0.66	0.67	0.84	0.66	0.67	0.17	10.35	0.72	$ 5,982.68	40	$ 893.85	$ 0.45	$ 14.46	$ 208.93	13
WetlandEnhancement12	38	577.68	45460.68	3098.49	0.75	0.52	0.43	0.09	0.06	0.05	49.92	2723.78	153.52	$ 1,907,696.19	50	$ 764.29	$ 0.38	$ 14.01	$ 248.53	14
WetlandEnhancement9	35	66.83	5259.06	358.45	0.75	0.52	0.43	0.39	0.27	0.22	25.88	1411.94	79.58	$ 994,922.06	50	$ 768.95	$ 0.38	$ 14.09	$ 250.05	15
WetlandEnhancement8	34	55.97	4404.52	300.20	0.75	0.52	0.43	0.40	0.28	0.23	22.35	1219.52	68.73	$ 861,040.40	50	$ 770.47	$ 0.39	$ 14.12	$ 250.54	16
WetlandEnhancement6	32	160.65	12642.73	861.70	0.75	0.52	0.43	0.10	0.07	0.06	16.05	875.72	49.36	$ 621,822.98	50	$ 774.86	$ 0.39	$ 14.20	$ 251.97	17
WetlandEnhancement13	39	329.74	25948.93	1768.62	0.75	0.52	0.43	0.03	0.02	0.02	10.80	589.39	33.22	$ 422,593.63	50	$ 782.43	$ 0.39	$ 14.34	$ 254.43	18
WetlandEnhancement5	31	114.48	9008.94	614.03	0.75	0.52	0.43	0.07	0.05	0.04	8.41	458.91	25.86	$ 331,806.50	50	$ 789.01	$ 0.39	$ 14.46	$ 256.57	19
WetlandEnhancement4	30	186.47	14674.35	1000.17	0.75	0.52	0.43	0.04	0.02	0.02	6.62	361.22	20.36	$ 263,838.35	50	$ 797.05	$ 0.40	$ 14.61	$ 259.19	20
WetlandEnhancement3	29	26.56	2089.81	142.44	0.75	0.52	0.43	0.25	0.17	0.14	6.54	356.92	20.12	$ 260,843.84	50	$ 797.50	$ 0.40	$ 14.62	$ 259.33	21
SaturatedBuffer3	9	0.31	24.69	1.68	0.74	0.31	0.27	0.74	0.31	0.27	0.23	7.65	0.45	$ 4,810.00	40	$ 518.01	$ 0.26	$ 15.71	$ 264.69	22
WetlandEnhancement2	28	325.00	25576.34	1743.22	0.75	0.52	0.43	0.01	0.01	0.01	3.03	165.31	9.32	$ 127,521.95	50	$ 841.80	$ 0.42	$ 15.43	$ 273.74	23
WetlandEnhancement1	27	70.93	5581.53	380.42	0.75	0.52	0.43	0.04	0.03	0.02	2.91	158.51	8.93	$ 122,793.30	50	$ 845.34	$ 0.42	$ 15.49	$ 274.89	24
ContourBufferStrip2	17	0.07	5.86	0.40	0.84	0.66	0.67	0.84	0.66	0.67	0.06	3.87	0.27	$ 3,173.23	40	$ 1,267.60	$ 0.63	$ 20.50	$ 296.29	25
SaturatedBuffer4	10	0.25	20.00	1.36	0.74	0.31	0.27	0.74	0.31	0.27	0.19	6.20	0.37	$ 4,810.00	40	$ 639.52	$ 0.32	$ 19.40	$ 326.78	26
ContourBufferStrip5	20	0.08	5.92	0.40	0.84	0.66	0.67	0.84	0.66	0.67	0.06	3.91	0.27	$ 4,162.06	40	$ 1,645.29	$ 0.82	$ 26.61	$ 384.57	27
ContourBufferStrip3	18	0.05	4.01	0.27	0.84	0.66	0.67	0.84	0.66	0.67	0.04	2.65	0.18	$ 3,209.77	40	$ 1,873.99	$ 0.94	$ 30.31	$ 438.03	28
SaturatedBuffer8	14	0.19	14.87	1.01	0.74	0.31	0.27	0.74	0.31	0.27	0.14	4.61	0.27	$ 4,810.00	40	$ 859.77	$ 0.43	$ 26.08	$ 439.32	29
ContourBufferStrip1	16	0.04	3.21	0.22	0.84	0.66	0.67	0.84	0.66	0.67	0.03	2.12	0.15	$ 2,608.21	40	$ 1,903.46	$ 0.95	$ 30.78	$ 444.92	30
SaturatedBuffer2	8	0.18	14.32	0.98	0.74	0.31	0.27	0.74	0.31	0.27	0.13	4.44	0.26	$ 4,810.00	40	$ 893.12	$ 0.45	$ 27.09	$ 456.36	31
SaturatedBuffer5	11	0.15	11.42	0.78	0.74	0.31	0.27	0.74	0.31	0.27	0.11	3.54	0.21	$ 4,810.00	40	$ 1,120.02	$ 0.56	$ 33.97	$ 572.31	32
SaturatedBuffer9	15	0.12	9.63	0.66	0.74	0.31	0.27	0.74	0.31	0.27	0.09	2.98	0.18	$ 4,810.00	40	$ 1,328.23	$ 0.66	$ 40.29	$ 678.70	33
SaturatedBuffer7	13	0.12	9.20	0.63	0.74	0.31	0.27	0.74	0.31	0.27	0.09	2.85	0.17	$ 4,810.00	40	$ 1,390.63	$ 0.70	$ 42.18	$ 710.58	34
WetlandEnhancement11	37	10.53	828.80	56.49	0.75	0.52	0.43	0.75	0.52	0.43	7.90	430.98	24.29	$ 1,057,779.50	50	$ 2,678.33	$ 1.34	$ 49.09	$ 870.95	35
Bioreactor6	6	4.69	369.38	25.18	0.00	0.22	0.00	0.00	0.22	0.00	0.00	81.26	0.00	$ 13,000.00	15	$ -	$ -	$ 10.66	$ -	36
Bioreactor3	3	1.68	132.08	9.00	0.00	0.22	0.00	0.00	0.22	0.00	0.00	29.06	0.00	$ 13,000.00	15	$ -	$ -	$ 29.83	$ -	37
Bioreactor2	2	1.52	119.30	8.13	0.00	0.22	0.00	0.00	0.22	0.00	0.00	26.25	0.00	$ 13,000.00	15	$ -	$ -	$ 33.02	$ -	38
Bioreactor4	4	0.50	39.01	2.66	0.00	0.22	0.00	0.00	0.22	0.00	0.00	8.58	0.00	$ 13,000.00	15	$ -	$ -	$ 101.00	$ -	39
Bioreactor5	5	0.37	28.76	1.96	0.00	0.22	0.00	0.00	0.22	0.00	0.00	6.33	0.00	$ 13,000.00	15	$ -	$ -	$ 136.97	$ -	40
Bioreactor1	1	0.25	19.69	1.34	0.00	0.22	0.00	0.00	0.22	0.00	0.00	4.33	0.00	$ 13,000.00	15	$ -	$ -	$ 200.09	$ -	41

Notes	
*Modified Capture Efficiency is utilized if it is less than the Base Capture Efficiency	*"BMP Number" Column Corresponds to BMP Labels on the Attached MDM Map

ISANTI COUNTY
COUNTY DITCH NO. 13

Bioreactors

Average Installation Cost	$10,000.00	EA
Technical Assistance (10%)	$1,000.00	EA
Administration (5%)	$500.00	EA
Subtotal	$11,500.00	EA
Contingency (10%)	$1,000.00	EA
Mobilization (5%)	$500.00	EA
Total per Bioreactor	$13,000.00	EA

Saturated Buffers

Average Installation Cost	$3,700.00	EA
Technical Assistance (10%)	$370.00	EA
Administration (5%)	$185.00	EA
Subtotal	$4,255.00	EA
Contingency (10%)	$370.00	EA
Mobilization (5%)	$185.00	EA
Total per Saturated Buffer	$4,810.00	EA

Contour Buffer Strips

Seeding	$1.94	LF
Earthwork	$10.00	LF
Subtotal	$11.94	LF
Technical Assistance (10%)	$1.19	EA
Administration (5%)	$0.60	EA
Contingency (10%)	$1.19	EA
Mobilization (5%)	$0.60	EA
Total per Linear Foot	$15.52	LF

Controlled Drainage

Average Installation Cost	$	85.00	AC
Control Structure(s)	$	150.00	AC
Subtotal	$	235.00	AC
Other (20%)			
Technical Assistance (10%)			
Administration(5%)			
Contingency (10%)			
Mobilization (5%)			

Constructed Wetlands

Earthwork	$9.00	CY
Berms	$10.00	LF
Seeding	$4,000.00	AC
Outlet Structure	$25,000.00	EA
Riprap	$125.00	CY
Land Acquisition	$4,500.00	AC
Temporary Damages	$650.00	AC

Other (20%)
Technical Assistance (20%)
Adminstration (10%)
Contingency (10%)
Mobiliation (5%)

Wetland Enhancement

Earthwork	$9.00	CY
Seeding	$4,000.00	AC
Riprap	$125.00	CY
Land Acquisition	$4,500.00	AC
Temporary Damages	$650.00	AC

Other (20%)
Technical Assistance (20%)
Adminstration (10%)
Contingency (10%)
Mobiliation (5%)

Two Stage Ditch

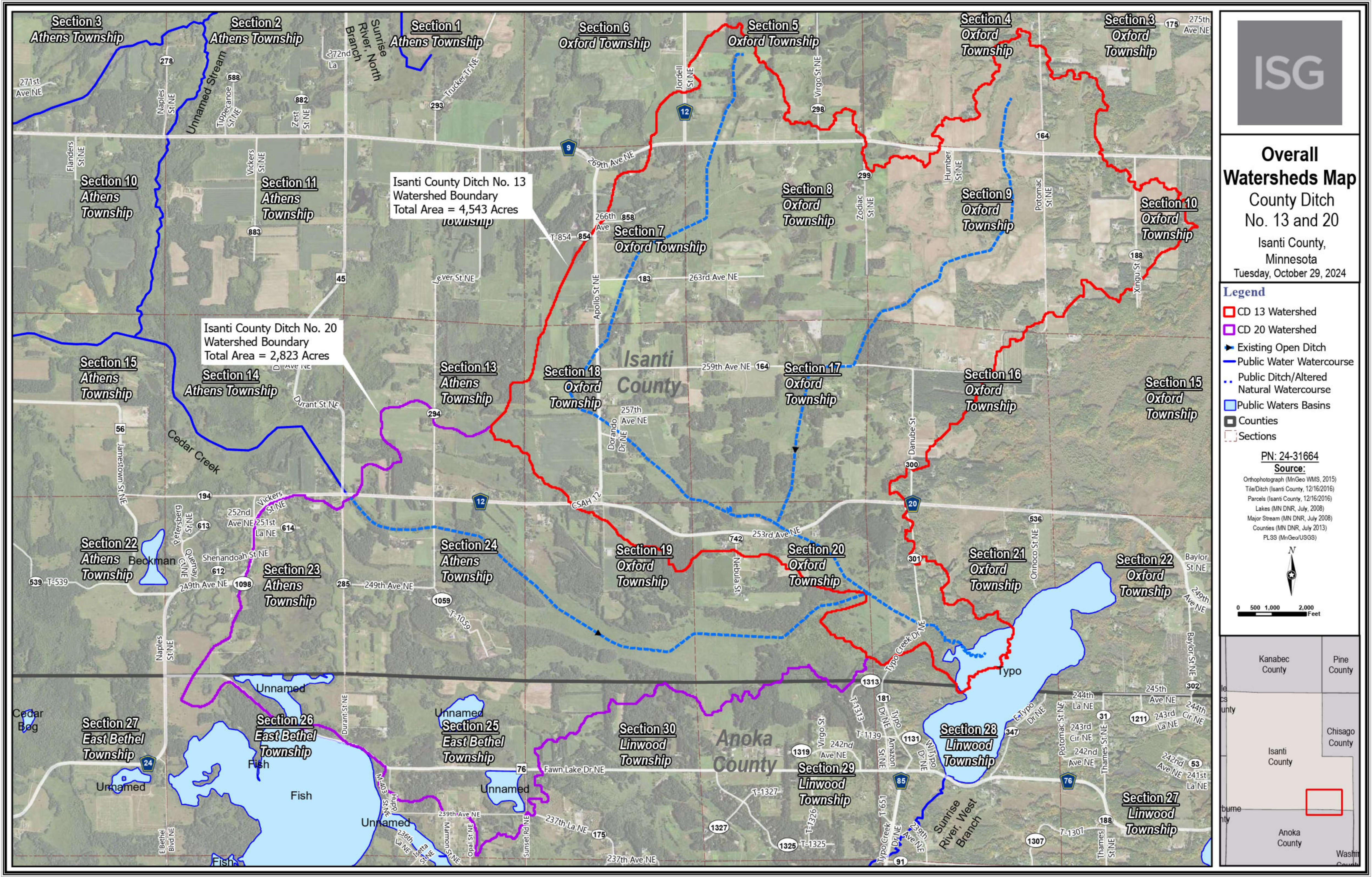
Earthwork	$9.00	CY
Spoil Placement	$3.50	CY
Topsoil Redress	$2.50	CY
Seeding	$3,500.00	AC
Outlet Structure	$25,000.00	EA
Riprap	$125.00	CY
Land Acquisition	$4,500.00	AC
Temporary Damages	$650.00	AC

Other (20%)
Technical Assistance (20%)
Adminstration (10%)
Contingency (10%)
Mobiliation (5%)

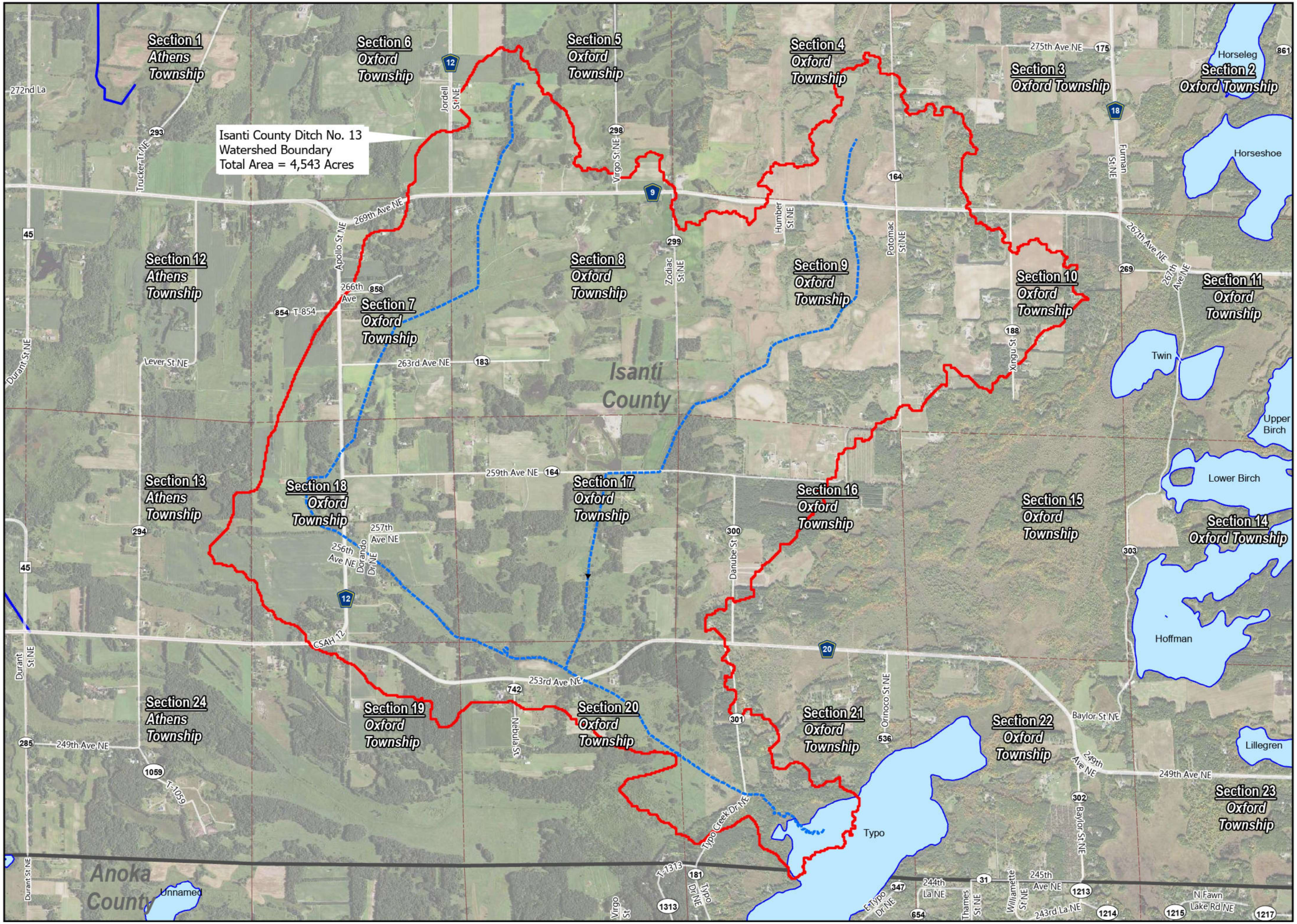
Additional Wetland Notes

Unique ID	BMP Number	TP Effectiveness ($/lb/yr)	Rank (TP Focus)	Additional Notes
ConstructedWetland7	33	$ 132.46	7	Outlet Structure, 375' Berm, Average 2' Earthwork Across Wetland Area, Tree Removal, Protect Road/Farm Site
ConstructedWetland10	36	$ 138.65	9	Outlet Structure, 480' Berm, Average 2' Earthwork Across Wetland Area
WetlandEnhancement12	38	$ 248.53	14	Average 1' Earthwork Across Wetland Area, Tree Removal, Protect Road
WetlandEnhancement9	35	$ 250.05	15	Average 1' Earthwork Across Wetland Area, Tree Removal, Protect Road
WetlandEnhancement8	34	$ 250.54	16	Average 1' Earthwork Across Wetland Area
WetlandEnhancement6	32	$ 251.97	17	Average 1' Earthwork Across Wetland Area, Minimal Tree Removal
WetlandEnhancement13	39	$ 254.43	18	Average 1' Earthwork Across Wetland Area, Minimal Tree Removal
WetlandEnhancement5	31	$ 256.57	19	Average 1' Earthwork Across Wetland Area Earthwork, Minimal Tree Removal
WetlandEnhancement4	30	$ 259.19	20	Average 1' Earthwork Across Wetland Area, Tree Removal
WetlandEnhancement3	29	$ 259.33	21	Average 1' Earthwork Across Wetland Area, Protect Road
WetlandEnhancement2	28	$ 273.74	23	Average 1' Earthwork Across Wetland Area, Minimal Tree Removal, Protect Road
WetlandEnhancement1	27	$ 274.89	24	Average 1' Earthwork Across Wetland Area, Minimal Tree Removal
WetlandEnhancement11	37	$ 870.95	35	Average 1' Earthwork Across Wetland Area, Protect Road

Notes
*"BMP Number" Column Corresponds to BMP Labels on the Attached "Wetland Map"



ISG
Overall Watersheds Map
County Ditch No. 13 and 20
Isanti County, Minnesota
Tuesday, October 29, 2024
Legend
CD 13 Watershed
CD 20 Watershed
Existing Open Ditch
Public Water Watercourse
Public Ditch/Altered Natural Watercourse
Public Waters Basins
Counties
Sections
PN: 24-31664
Source:
Orthophotograph (MnGeo WMS, 2015)
Tile/Ditch (Isanti County, 12/16/2016)
Parcels (Isanti County, 12/16/2016)
Lakes (MN DNR, July, 2008)
Major Stream (MN DNR, July 2008)
Counties (MN DNR, July 2013)
PLSS (MnGeo/USGS)
N
0 500 1,000 2,000 Feet
Kanabec County
Pine County
Isanti County
Chisago County
Anoka County
Isanti County Ditch No. 13 Watershed Boundary Total Area = 4,543 Acres
Isanti County Ditch No. 20 Watershed Boundary Total Area = 2,823 Acres
Isanti County
Anoka County
Section 3 Athens Township
Section 2 Athens Township
Section 1 Athens Township
Section 6 Oxford Township
Section 5 Oxford Township
Section 4 Oxford Township
Section 3 Oxford Township
Section 10 Athens Township
Section 11 Athens Township
Section 7 Oxford Township
Section 8 Oxford Township
Section 9 Oxford Township
Section 10 Oxford Township
Section 15 Athens Township
Section 14 Athens Township
Section 13 Athens Township
Section 18 Oxford Township
Section 17 Oxford Township
Section 16 Oxford Township
Section 15 Oxford Township
Section 22 Athens Township
Section 23 Athens Township
Section 24 Athens Township
Section 19 Oxford Township
Section 20 Oxford Township
Section 21 Oxford Township
Section 22 Oxford Township
Section 27 East Bethel Township
Section 26 East Bethel Township
Section 25 East Bethel Township
Section 30 Linwood Township
Section 29 Linwood Township
Section 28 Linwood Township
Section 27 Linwood Township
Unnamed Stream
Sunrise River, North Branch
Cedar Creek
Sunrise River, West Branch
Beckman
Typo
Fish
Cedar Bog
Unnamed
269th Ave NE
263rd Ave NE
259th Ave NE
257th Ave NE
253rd Ave NE
249th Ave NE
Fawn Lake Dr NE
237th Ave NE
CSAH 12
Apollo St NE
Durant St NE
Jamestown St NE
Naples St NE
Danube St NE
Typo Creek Dr NE



Watershed Map

County Ditch No 13

Isanti County, Minnesota

Tuesday, October 29, 2024

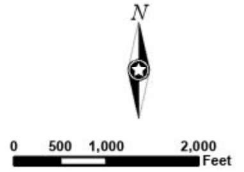
Legend

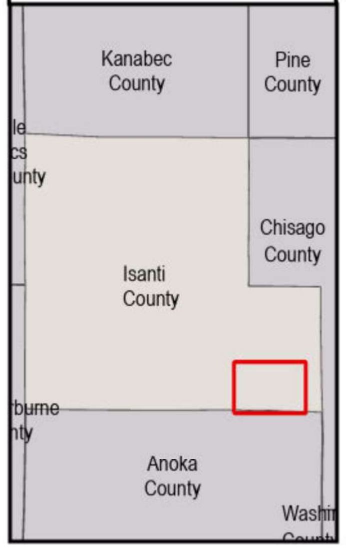
- CD 13 Watershed
- Existing Open Ditch
- Public Water Watercourse
- Public Ditch/Altered Natural Watercourse
- Public Waters Basins
- Counties
- Sections

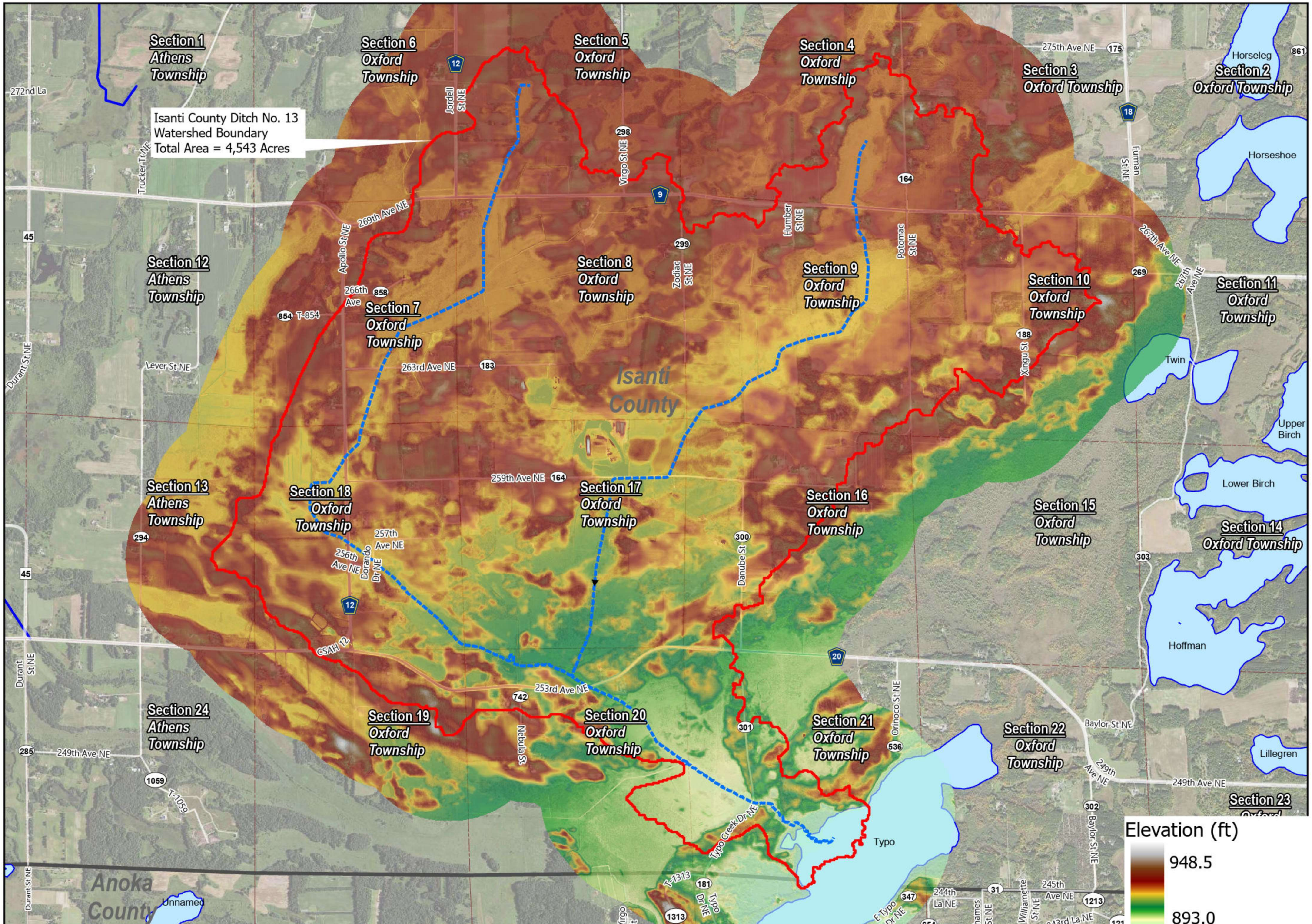
PN: 24-31664

Source:

Orthophotograph (MnGeo WMS, 2015)
Tile/Ditch (Isanti County, 12/16/2016)
Parcels (Isanti County, 12/16/2016)
Lakes (MN DNR, July, 2008)
Major Stream (MN DNR, July 2008)
Counties (MN DNR, July 2013)
PLSS (MnGeo/USGS)







Elevation Map

County Ditch No 13
Isanti County, Minnesota
Tuesday, October 29, 2024

Legend

- CD 13 Watershed
- Existing Open Ditch
- Public Water Watercourse
- Public Ditch/Altered Natural Watercourse
- Public Waters Basins

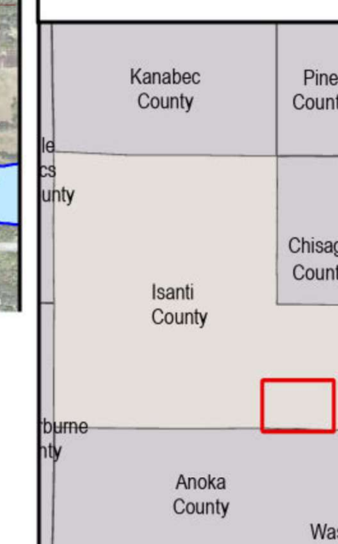
PN: 24-31664

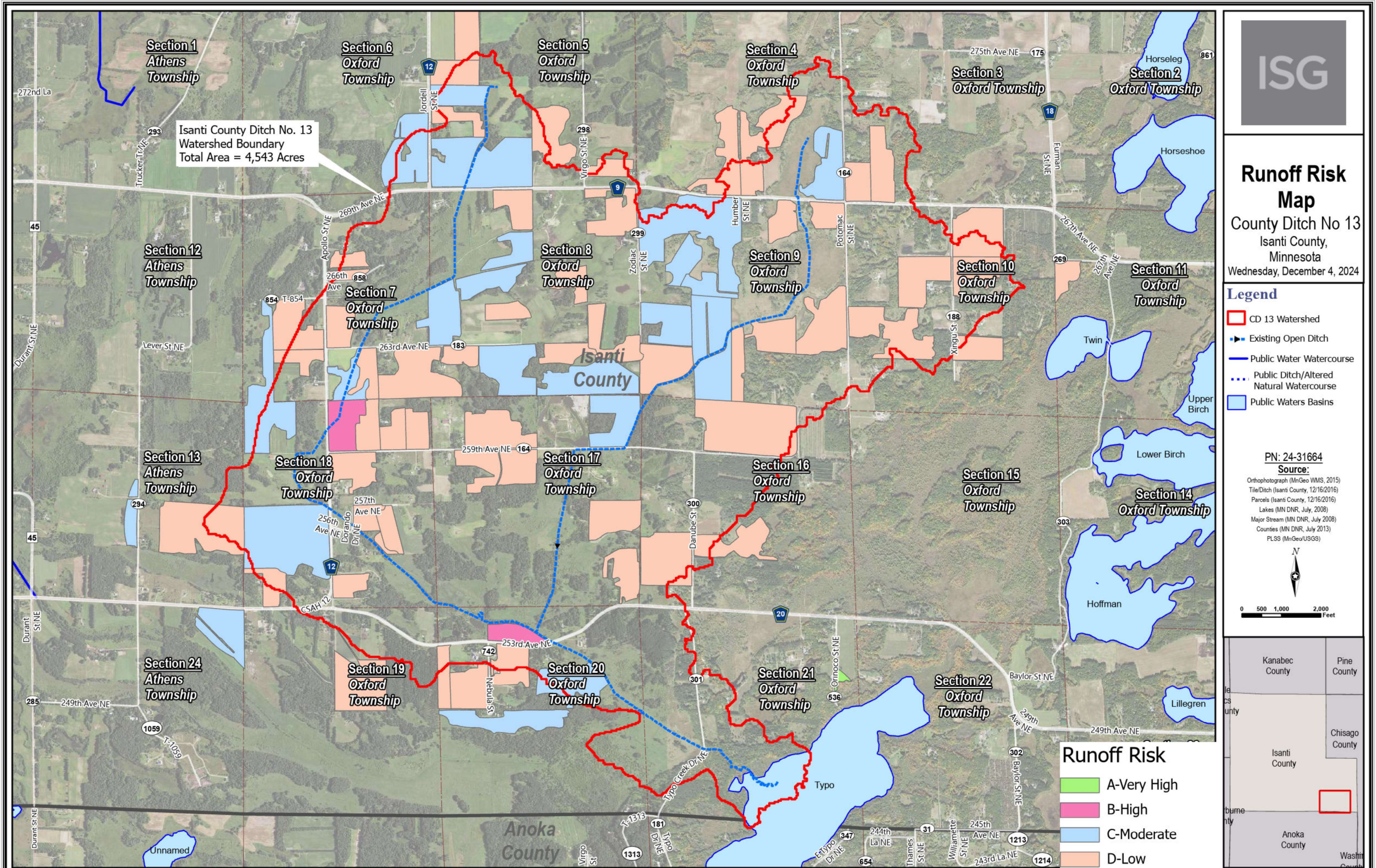
Source:

Orthophotograph (MnGeo WMS, 2015)
Tile/Ditch (Isanti County, 12/16/2016)
Parcels (Isanti County, 12/16/2016)
Lakes (MN DNR, July, 2008)
Major Stream (MN DNR, July 2008)
Counties (MN DNR, July 2013)
PLSS (MnGeo/USGS)

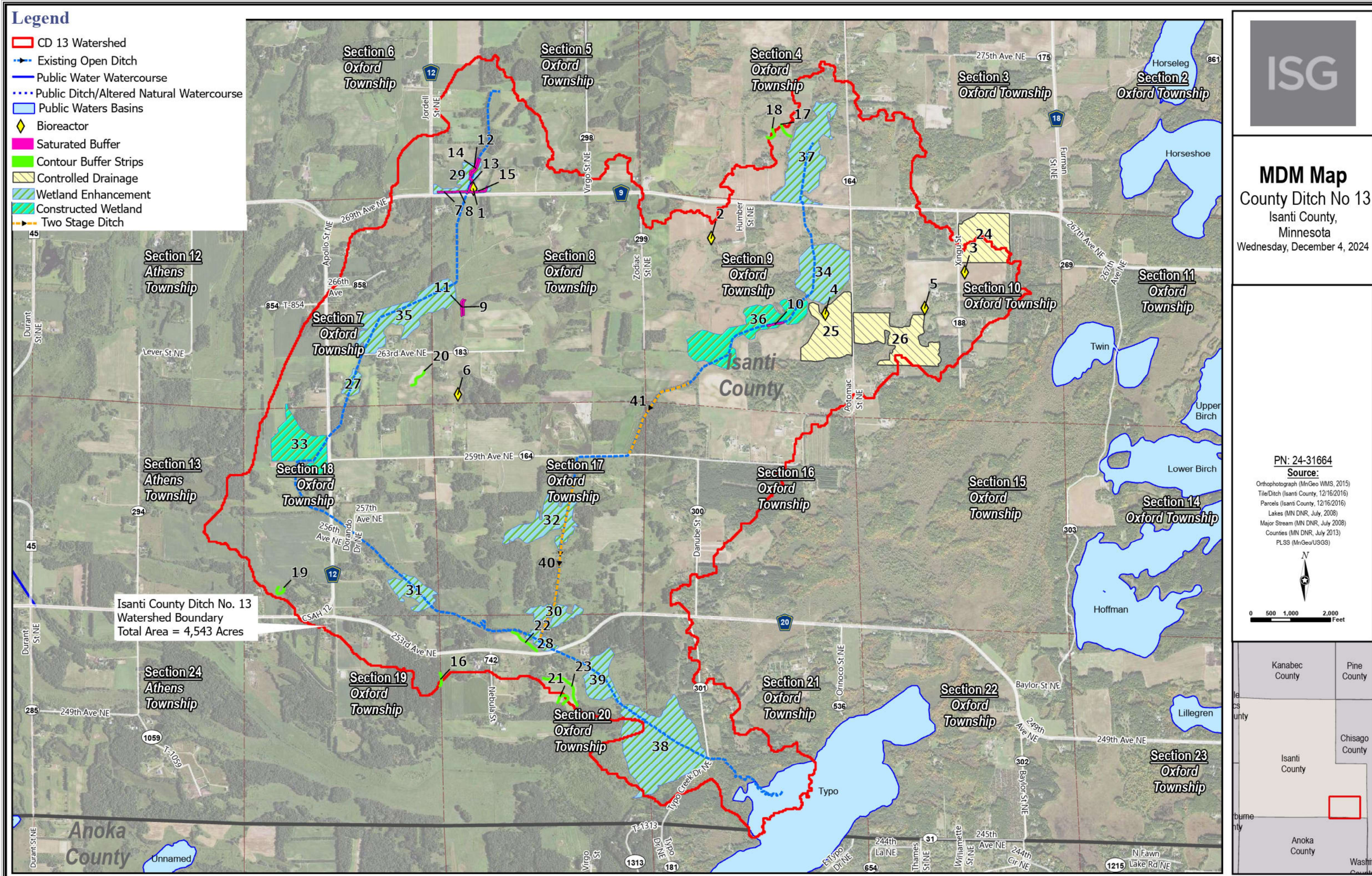
N

0 500 1,000 2,000 Feet





Runoff Risk Map
County Ditch No 13
Isanti County, Minnesota
Wednesday, December 4, 2024
Legend
CD 13 Watershed
Existing Open Ditch
Public Water Watercourse
Public Ditch/Altered Natural Watercourse
Public Waters Basins
PN: 24-31664
Source:
Orthophotograph (MnGeo WMS, 2015)
Tile/Ditch (Isanti County, 12/16/2016)
Parcels (Isanti County, 12/16/2016)
Lakes (MN DNR, July, 2008)
Major Stream (MN DNR, July 2008)
Counties (MN DNR, July 2013)
PLSS (MnGeo/USGS)
N
0 500 1,000 2,000 Feet
Runoff Risk
A-Very High
B-High
C-Moderate
D-Low
Isanti County Ditch No. 13
Watershed Boundary
Total Area = 4,543 Acres
Isanti County
Anoka County
Section 1 Athens Township
Section 6 Oxford Township
Section 5 Oxford Township
Section 4 Oxford Township
Section 3 Oxford Township
Section 2 Oxford Township
Section 12 Athens Township
Section 7 Oxford Township
Section 8 Oxford Township
Section 9 Oxford Township
Section 10 Oxford Township
Section 11 Oxford Township
Section 13 Athens Township
Section 18 Oxford Township
Section 17 Oxford Township
Section 16 Oxford Township
Section 15 Oxford Township
Section 14 Oxford Township
Section 24 Athens Township
Section 19 Oxford Township
Section 20 Oxford Township
Section 21 Oxford Township
Section 22 Oxford Township
Horseleg
Horseshoe
Twin
Upper Birch
Lower Birch
Hoffman
Lillegren
Typo
Unnamed
Kanabec County
Pine County
Chisago County
Isanti County
Anoka County


Legend
CD 13 Watershed
Existing Open Ditch
Public Water Watercourse
Public Ditch/Altered Natural Watercourse
Public Waters Basins
Bioreactor
Saturated Buffer
Contour Buffer Strips
Controlled Drainage
Wetland Enhancement
Constructed Wetland
Two Stage Ditch
ISG
MDM Map
County Ditch No 13
Isanti County,
Minnesota
Wednesday, December 4, 2024
PN: 24-31664
Source:
Orthophotograph (MnGeo WMS, 2015)
Tile/Ditch (Isanti County, 12/16/2016)
Parcels (Isanti County, 12/16/2016)
Lakes (MN DNR, July, 2008)
Major Stream (MN DNR, July 2008)
Counties (MN DNR, July 2013)
PLSS (MnGeo/USGS)
N
0 500 1,000 2,000 Feet
Kanabec County
Pine County
Isanti County
Chisago County
Anoka County
Isanti County Ditch No. 13
Watershed Boundary
Total Area = 4,543 Acres
Section 6 Oxford Township
Section 5 Oxford Township
Section 4 Oxford Township
Section 3 Oxford Township
Section 2 Oxford Township
Section 12 Athens Township
Section 8 Oxford Township
Section 9 Oxford Township
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Section 18 Oxford Township
Section 17 Oxford Township
Section 16 Oxford Township
Section 15 Oxford Township
Section 14 Oxford Township
Section 24 Athens Township
Section 19 Oxford Township
Section 20 Oxford Township
Section 21 Oxford Township
Section 22 Oxford Township
Section 23 Oxford Township
Isanti County
Anoka County
Horseleg
Horseshoe
Twin
Upper Birch
Lower Birch
Hoffman
Lillegren
Typo
Unnamed
275th Ave NE
269th Ave NE
267th Ave NE
266th Ave
263rd Ave NE
259th Ave NE
257th Ave NE
256th Ave NE
253rd Ave NE
249th Ave NE
245th Ave NE
244th La NE
244th Cir NE
Jordell St NE
Virgo St NE
Zodiac St NE
Humber St NE
Xingu St
Furman St NE
Apollo St NE
Durant St NE
Lever St NE
Dorando Dr NE
Danube St NE
Potomac St NE
Orinoco St NE
Nebula St
Baylor St NE
Typo Creek Dr NE
Typo Dr NE
E Typo Dr NE
Thames St NE
Williamette St NE
N Fawn Lake Rd NE
CSAH 12
T-854
T-1059
T-1313
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742
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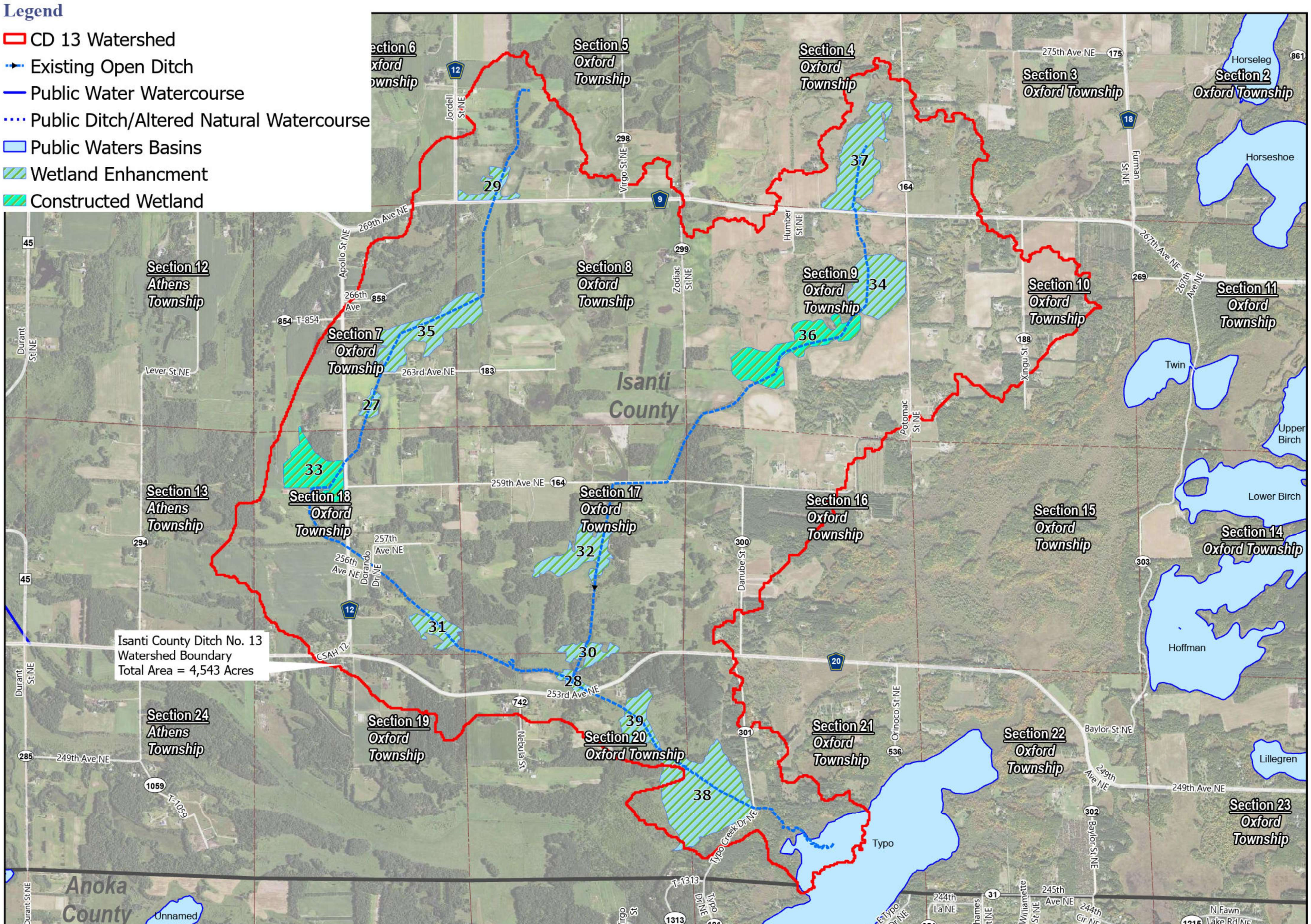

ISG

Wetland Map

County Ditch No 13

Isanti County, Minnesota

Monday, December 23, 2024

PN: 24-31664

Source:

Orthophotograph (MnGeo WMS, 2015)
Tile/Ditch (Isanti County, 12/16/2016)
Parcels (Isanti County, 12/16/2016)
Lakes (MN DNR, July, 2008)
Major Stream (MN DNR, July 2008)
Counties (MN DNR, July 2013)
PLSS (MnGeo/USGS)

N

0 500 1,000 2,000 Feet