Yahara River Streambank Erosion Assessment and Five-Year Plan

Village of Deforest

August 2022



Cardno

now

Stantec

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1 Overview

The Yahara River within the Village of Deforest is experiencing problems with streambank erosion and suspended sediment driven by land-use changes within its watershed. Increased flood peaks and water volumes have degraded streambanks throughout the reach over time. Sediment from bank erosion is also deposited within the channel reducing the channel's capacity and efficiency. In May of 2022, Cardno now Stantec completed a streambank erosion assessment of approximately 37,200 linear feet of the Yahara River in the Village of Deforest between East Yahara Road and Windsor Road (see Appendix A). This assessment included identification of areas of significant streambank erosion on both the left and right bank for the entire project area. Once identified, each area of significant erosion was assessed using the Bank Assessment for Non-Point Source Consequences of Sediment (BANCS) model. This model includes a Bank Erosion Hazard Index (BEHI) assessment, which evaluates the susceptibility of a streambank to erosion from multiple erosional processes and a Near Bank Stress (NBS) assessment, which approximates erosional forces on the identified study bank. Combined these assessments (BEHI & NBS) give an indication of erosion rates and root causes of instability as well as an approximate annual sediment load coming from a particular stretch of stream. This erosion data was then used to prioritize areas for future treatments and could support grant requests for funding to perform streambank restoration. An additional seven canoe launch areas were also inspected for potential upgrades and/or installation of new canoe launces as part of this assessment. The following report includes a five-year plan listing projects and project prioritization to guide the Village of Deforest in repairing areas of significant erosion along the Yahara River within the identified project area.

2 Stream Assessment

2.1 Streambank Erosion Assessment

Streambank erosion along the Yahara River in the Village of Deforest was assessed using the BANCS model which evaluates bank characteristics and flow distribution along river reaches. Multiple factors are evaluated during this assessment including bank height, rooting depth, root density, bank angle, surface protection, bank material and near bank stresses. Annual erosion rates can be estimated from this assessment and then multiplied by the bank height and corresponding bank length of a similar condition to provide an estimate of cubic yards and tons of sediment per year potentially contributed from these eroded streambanks to the channel.

For this assessment Cardno now Stantec completed streambank erosion assessments on both streambanks for approximately 37,200 linear feet of the Yahara River in the Village of Deforest between East Yahara Road and Windsor Road (Figure 1).

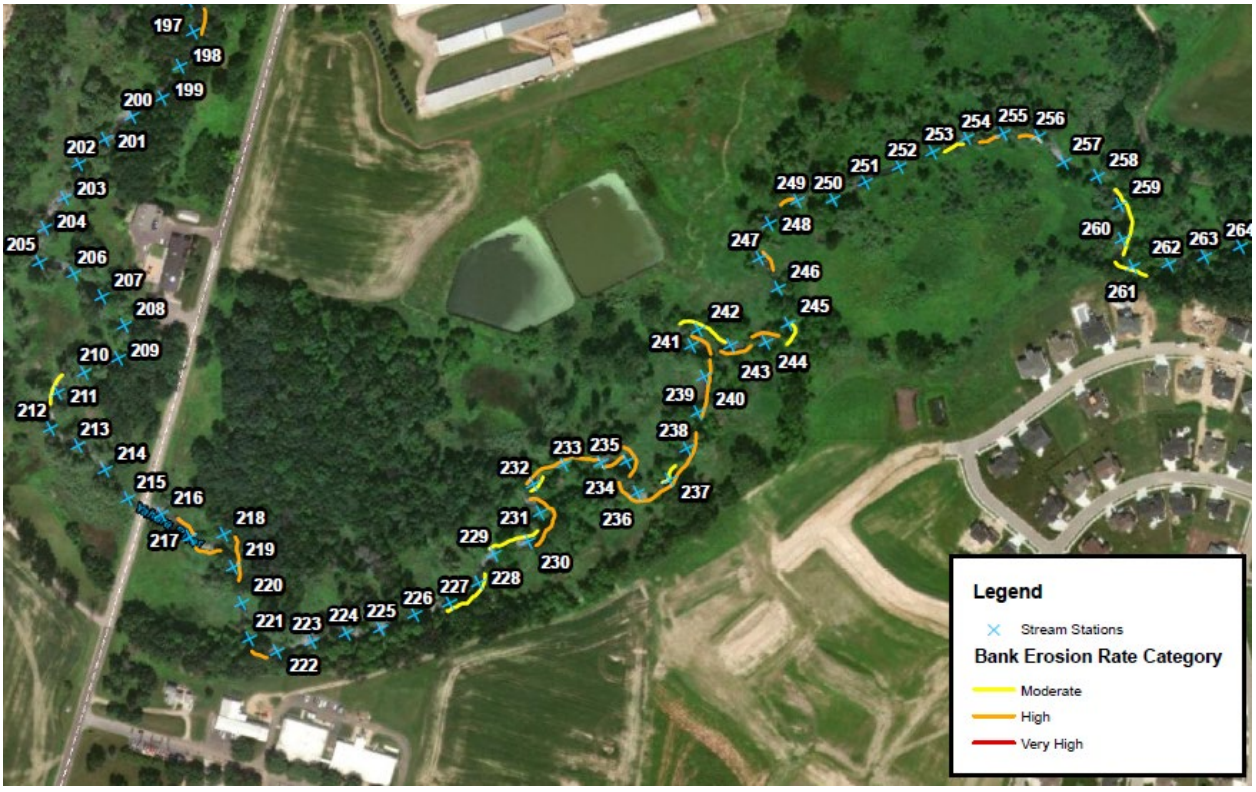


Figure 1:Example of Identified Areas of Streambank Erosion along the Yahara River in the project area.

Our team identified 112 areas of Moderate to Very High streambank erosion along over 74,400 linear feet of assessed streambanks (both sides of 37,200 linear feet of stream). The identified areas of erosion corresponded to approximately 14,440 linear feet of streambank or about 19% of the total area surveyed. None of the areas identified showed evidence of extreme bank erosion or fell into the category of high priority restoration areas that pose a risk to public safety. There were however 44 areas of Moderate erosion, 67 areas of High Erosion and 1 area of Very High streambank erosion identified with a total of approximately 949 tons of sediment per year contributed to the stream off of these streambanks (see Table 1 below).

Table 1: Streambank Erosion Risk Assessment for the Left and Right Bank of the Yahara River in the Village of Deforest

Assessed Streambank Erosion Category	Number of Identified Streambank Segments	Cumulative Linear Feet of Streambank	Cumulative Estimated Tons of Annual Sediment Loss from Identified Streambanks
Very High	1	194	22
High	67	8,826	723
Moderate	44	5,380	204
Totals	**112**	**14,440**	**949**

2.2 Canoe Launch Assessment

The Cardno Stantec team evaluated seven potential canoe launch locations within the Yahara River project area to assess viability of constructing a new canoe launch or performing upgrades to existing canoe launches to enhance public access to the river (Figure 2).

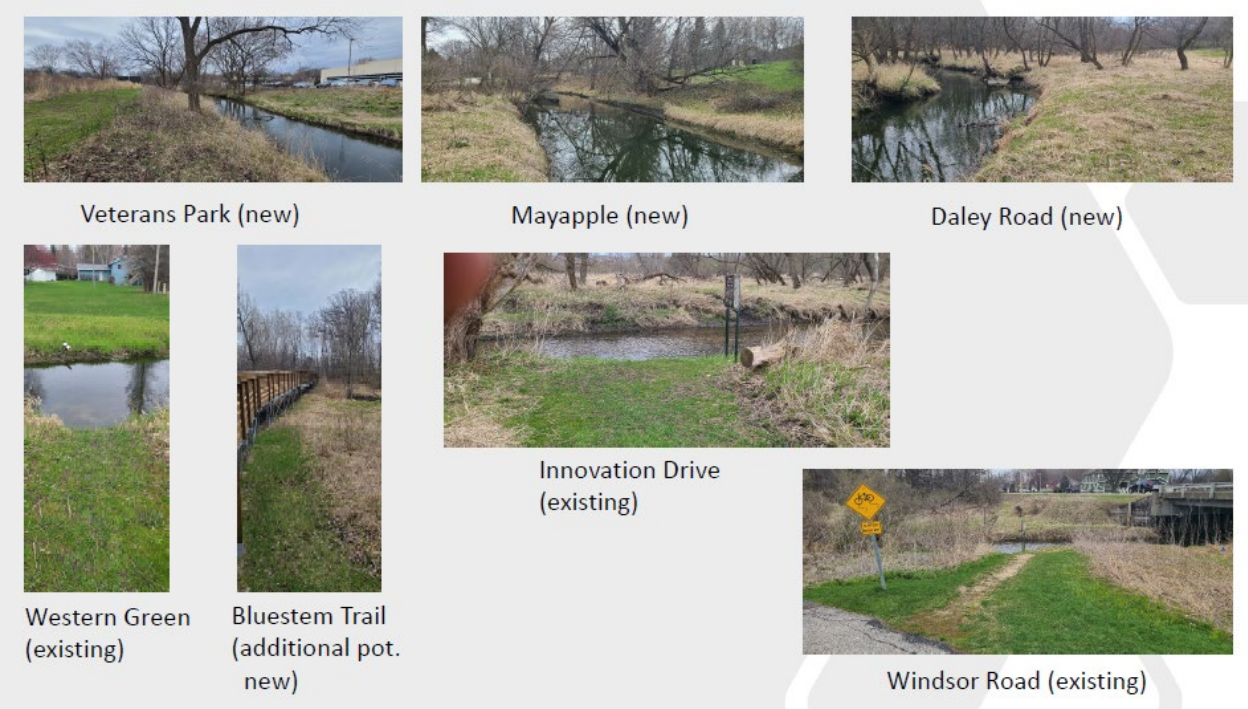


Figure 2: Photos of the seven potential canoe launch locations assessed by Cardno now Stantec

All seven canoe launch locations assessed would make valuable additions to the Village of Deforest to allow access to the Yahara River. The seven locations are spread throughout the Village allowing multiple canoe put-in/take-out points, giving residents options as to how long of canoe trip they would like to take. Both the existing and proposed canoe launch locations could also be upgraded to provide dedicated access to the stream at these locations (Figure 3).

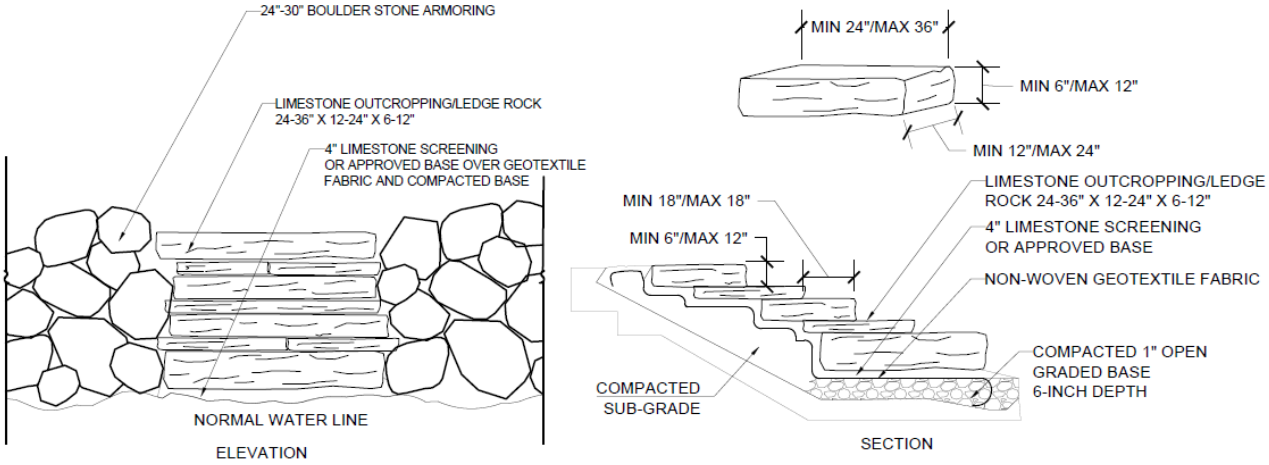


Figure 3: Example dedicated canoe launch detail

There are however currently obstructions to canoe travel within the Yahara River project area. These obstructions would need to be addressed in order to allow canoe passage on the Yahara River throughout the Village of Deforest (Figure 4).



Figure 4: Examples of identified channel canoe blockages on the Yahara River within the Village of Deforest

A map showing the locations of canoe launches and identified channel blockages can be found in Appendix B.

3 Recommendations

Approximately 80% of the cumulate estimate of sediment lost per year from the identified areas of streambank erosion on the Yahara River within the Village of Deforest project area comes from areas identified as High or Very High. In an effort to best utilize the Village of Deforest funds to restore sections of the Yahara River our team recommends focussing restoration efforts on the identified High and Very High areas of streambank erosion.

3.1 Streambank Restoration Techniques

Many of the eroded streambank sections identified along the Yahara River can be stabilized through toe protection with stone and bank grading to return streambanks to more stable angles while also allowing increased flood flow capacity through the corridor. There are trees that are currently beginning to collapse into the stream or that would need to be removed during bank grading operations in some of the identified streambank erosion areas. Many of these trees are shallow rooted tree species such as box elder (Acer negundo). These early successional or pioneering tree species have shallow root systems that do a poor job of stabilizing streambanks. Future restoration efforts in the Yahara River project area should take into consideration removing the down and damaged trees adjacent to the streambank to prevent damage in future flooding events. Trees removed during restoration activities can be stockpiled and re-used to stabilize banks and provide additional stream habitat through the use of integrated bank treatments including rootwads composites and toewood structures.

3.1.1 Rootwad Composite and Toewood Structures

Rootwad composite revetments and toewood structures are installed using a combination of rootwads, (the intact lower trunk and root mass of mature trees), branches and stone. These structures provide a biological streambank stabilization alternative that aids in dissipating energy and near-bank stress from stream flows, increasing channel roughness while avoiding accelerating flows downstream of where they are installed. They also promote scour in the near-bank area providing pool habitat which is currently lacking in the Yahara River project area due to the legacy of bank sediments found within the channel. Small spaces found within the rootwads and other wood installed provide cover for small fish, as well as reptiles and small mammals found in the riparian habitat. These structures also create a diversity of micro-flow conditions, due to their non-uniformity, which can enhance aquatic invertebrate diversity allowing benthic organisms to select specific positions within the geometry of the local flow conditions (Figure 5).

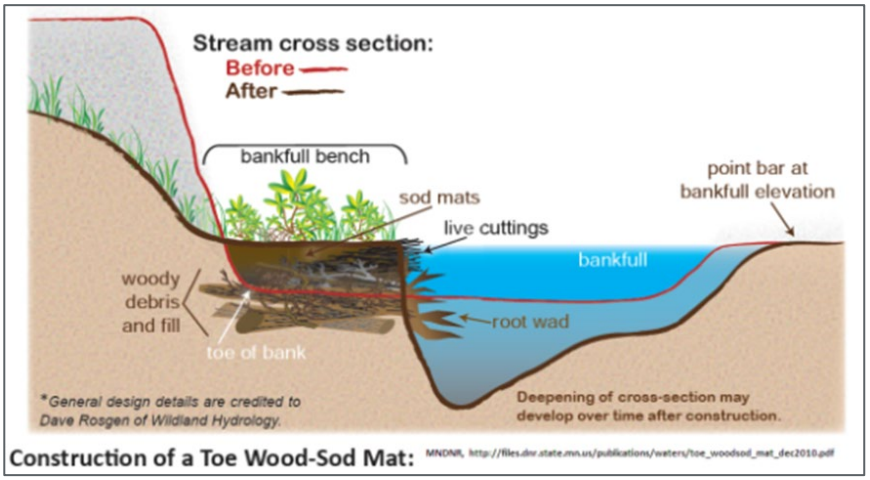


Figure 5: Example Cross Section of Toewood Structure

3.1.2 Flow Manipulation and Grade Control Structures

Flow manipulation and grade control structures such as single arm vanes and J-Hooks can be used to deflect stream flow away from the streambank toward the center of the channel mitigating back erosion at sites within the project area. Flow deflection structures (including single arm vanes, cross-vanes and J-Hooks) have been utilized under various channel conditions for over 30 years throughout most regions of the U.S. There is a large volume of technical information regarding field applications and hydraulic research related to these structures. Once installed, these structures induce deposition in near-bank areas while accelerating flows back toward the center of the channel creating scour pools essentially transforming areas of erosion into areas of deposition, further protecting the toe of the streambank. Trees procured during restoration activities could also be incorporated into the flow redirections structures to create additional in-stream and under-bank habitat (Figure 6).



Figure 6: Rootwad log vane J hook combo designed and installed by Cardno on the Knife River in 2016 (photo taken 6/26/17)

3.1.3 Native Vegetation

Establishing native vegetation on restored slopes and streambanks is recommended for restoration designs in the Yahara River project area. Once established, the deep dense roots of native grasses and forbs act to increase bank stability and trap bank sediments in place. Another benefit to using natives is, once stablished, only minimal management is needed. Maintenance on newly restored areas to limit encroachment of invasive species as well as early successional tree species is recommended for all restored areas for at least three years following construction activities.

3.1.4 Wisconsin DNR Urban Nonpoint Source (UNPS) Grants

The Urban Nonpoint Source Grant Program offers competitive grants to local governments for the control of pollution from diffuse urban sources that is carried by storm water runoff. Grants from the UNPS Program reimburse costs of construction projects controlling urban nonpoint source and storm water runoff pollution. Streambank restoration and stabilization projects such as the proposed work in the Yahara River project area are eligible for 50/50 grant match funding with the total state reimbursement

amount not to exceed $150,000 for construction and engineering during a given year. Applications for the Wisconsin DNR UNPS grants are due by April 15 each year.

3.2 Five-Year Plan

Our assessment of the Yahara River project area within the Village of Deforest identified approximately 9,020 linear feet of High to Very High eroding streambanks. Restoration of these eroded areas could be accomplished by breaking the eroded stream segments into five separate restoration projects. Working from upstream to downstream separate projects would spread out costs of implementation, with each of the five projects potentially receiving 50/50 grant match funding through the Wisconsin DNR UNPS grant program. The Cardno now Stantec team can apply for grants on behalf of the Village of Deforest and has been successful in obtaining numerous Wisconsin DNR UNPS grants for other communities for similar streambank restoration projects (see Table 2 below).

Table 2: Five-Year Plan for Restoration of High and Very High Eroded Streambanks in the Yahara River Project Area in the Village of Deforest

Project	Number of Identified Streambank Erosion Segments	Cumulative Linear Feet of Streambank	Cumulative Estimated Tons of Sediment Lost from Identified Streambanks
Year One - 2023 Station 0+00 thru 78+00	10	1,790	153
Year Two – 2024 Station 78+00 thru 172+25	13	1,970	163
Year Three – 2025 Station 172+25 thru 241+15	14	1,775	158
Year Four – 2026 Station 241+15 thru 309+90	18	1,774	123
Year Five – 2027 Station 309+90 thru 370+60	13	1,711	148
Totals	**68**	**9,020**	**745**

3.2.1 Five-Year Restoration Plan Costs

Cost estimates for the five streambank restoration projects outlined above as well as installation costs for the seven identified canoe launches can be found in Table 3 below. Streambank restoration projects recently completed by the Cardno now Stantec team of similar size and scope were used to create the associated cost estimates for each project. The following cost estimates are intended to aid Village of Deforest staff in the budgeting process, and more detailed construction cost estimates for each project would be available once project designs are completed.

Table 3: Five-Year Plan Cost Estimates for Restoration of High and Very High Eroded Streambanks in the Yahara River Project Area in the Village of Deforest

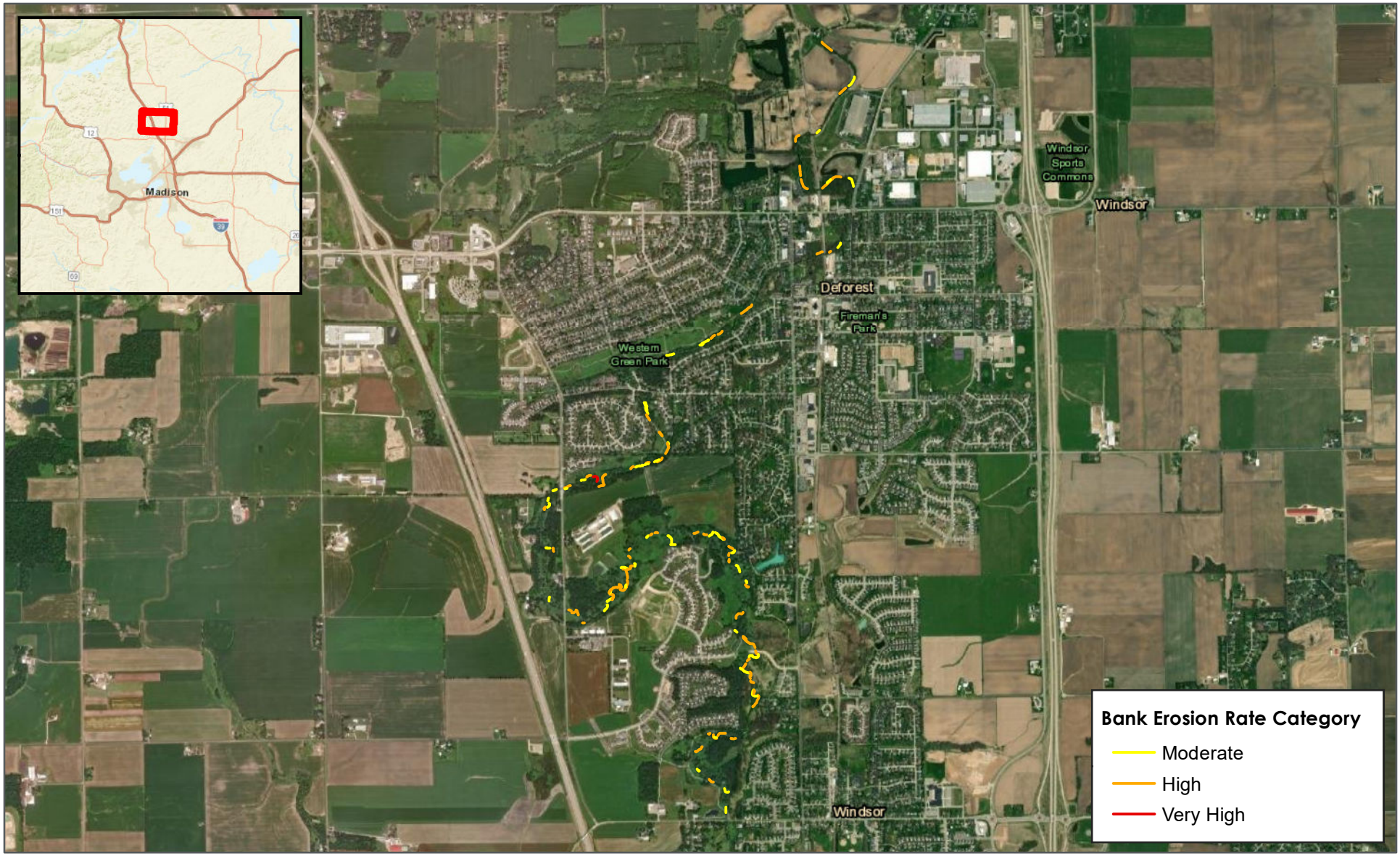
Year	Task	Village of Deforest Cost	Wisconsin DNR NPS Grant Reimbursement	Total Cost
2023	Wisconsin DNR NPS Grant Application Submission (due by April 15, 2023)	$4,400	NA	$4,400
	Design Costs (Site Surveys, Design, Permitting)	$17,500	$17,500	$35,000
	Streambank Restoration Construction Cost Estimate	$67,125	$67,125	$134,250
	Veteran's Park Canoe Launch Installation Cost	$6,500	NA	$6,500
2023 Total Project Costs		**$95,525**	**$84,625**	**$180,150**
2024	Wisconsin DNR NPS Grant Application Submission (due by April 15, 2023)	$4,400	NA	$4,400
	Design Costs (Site Surveys, Design, Permitting)	$17,500	$17,500	$35,000
	Streambank Restoration Construction Cost Estimate	$73,875	$73,875	$147,750
	Mayapple Canoe Launch Installation Cost	$6,500	NA	$6,500
	Western Green Canoe Launch Installation Cost	$6,500	NA	$6,500
2024 Total Project Costs		**$108,775**	**$91,375**	**$200,150**
2025	Wisconsin DNR NPS Grant Application Submission (due by April 15, 2023)	$4,400	NA	$4,400
	Design Costs (Site Surveys, Design, Permitting)	$17,500	$17,500	$35,000
	Streambank Restoration Construction Cost Estimate	$66,562	$66,562	$133,124
	Daley Road Canoe Launch Installation Cost	$6,500	NA	$6,500
2025 Total Project Costs		**$94,962**	**$84,062**	**$179,024**
2026	Wisconsin DNR NPS Grant Application Submission (due by April 15, 2023)	$4,400	NA	$4,400
	Design Costs (Site Surveys, Design, Permitting)	$17,500	$17,500	$35,000
	Streambank Restoration Construction Cost Estimate	$66,525	$66,525	$133,050
	Bluestem Trail Canoe Launch Installation Cost	$6,500	NA	$6,500

2026 Total Project Costs		**$94,925**	**$84,025**	**$178,950**
2027	Wisconsin DNR NPS Grant Application Submission (due by April 15, 2023)	$4,400	NA	$4,400
	Design Costs (Site Surveys, Design, Permitting)	$17,500	$17,500	$35,000
	Streambank Restoration Construction Cost Estimate	$64,163	$64,163	$128,326
	Innovation Drive Canoe Launch Installation Cost	$6,500	NA	$6,500
	Windsor Road Canoe Launch Installation Cost	$6,500	NA	$6,500
2027 Total Project Costs		**$99,063**	**$81,623**	**$180,726**
Five-Year Plan Total Project Costs		**$493,250**	**$425,750**	**$919,000**

Village of Deforest

APPENDIX A

YAHARA RIVER STREAMBANK EROSION ASSESSMENT



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Bank Erosion Survey Overview

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Dane County, Wisconsin

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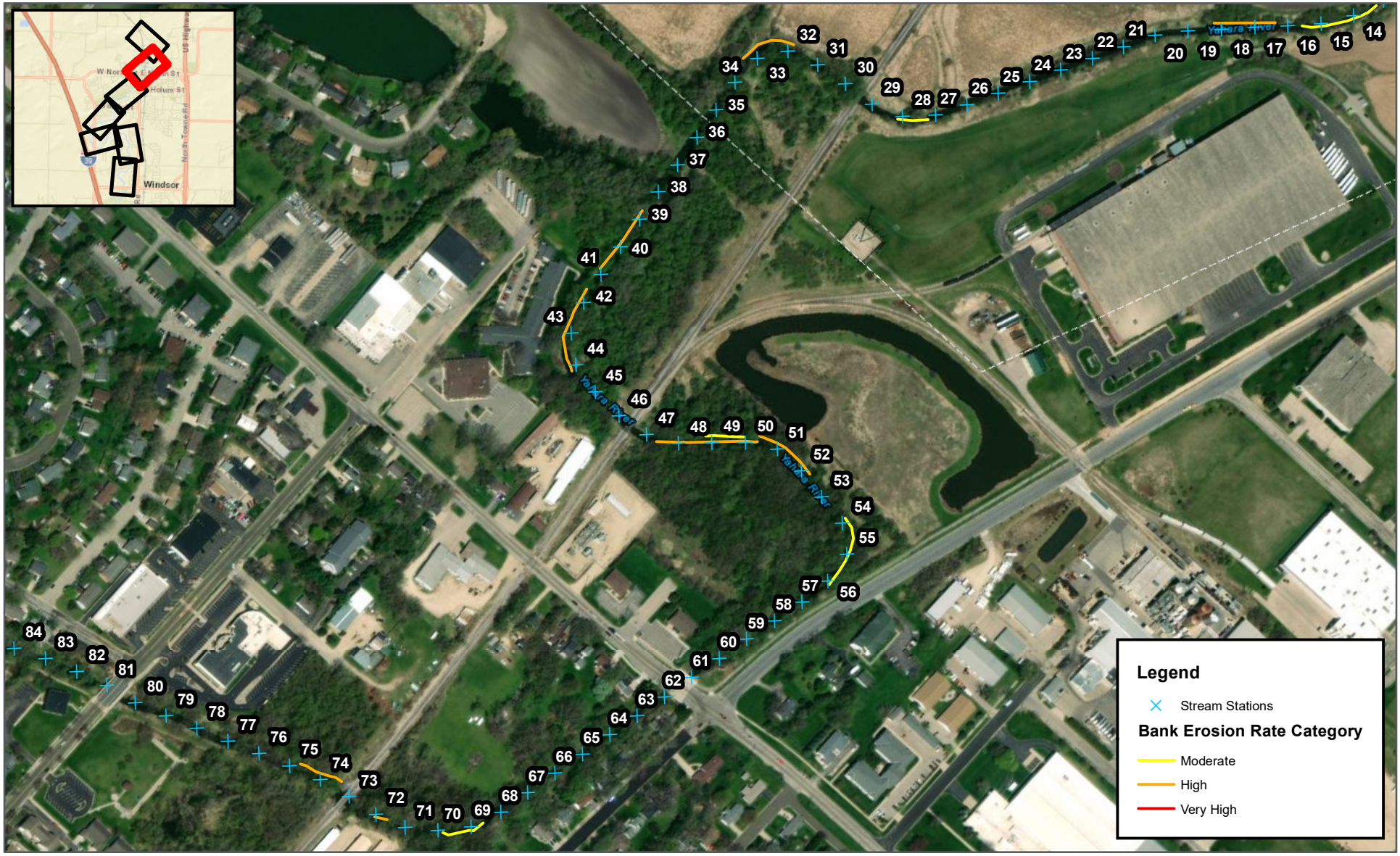
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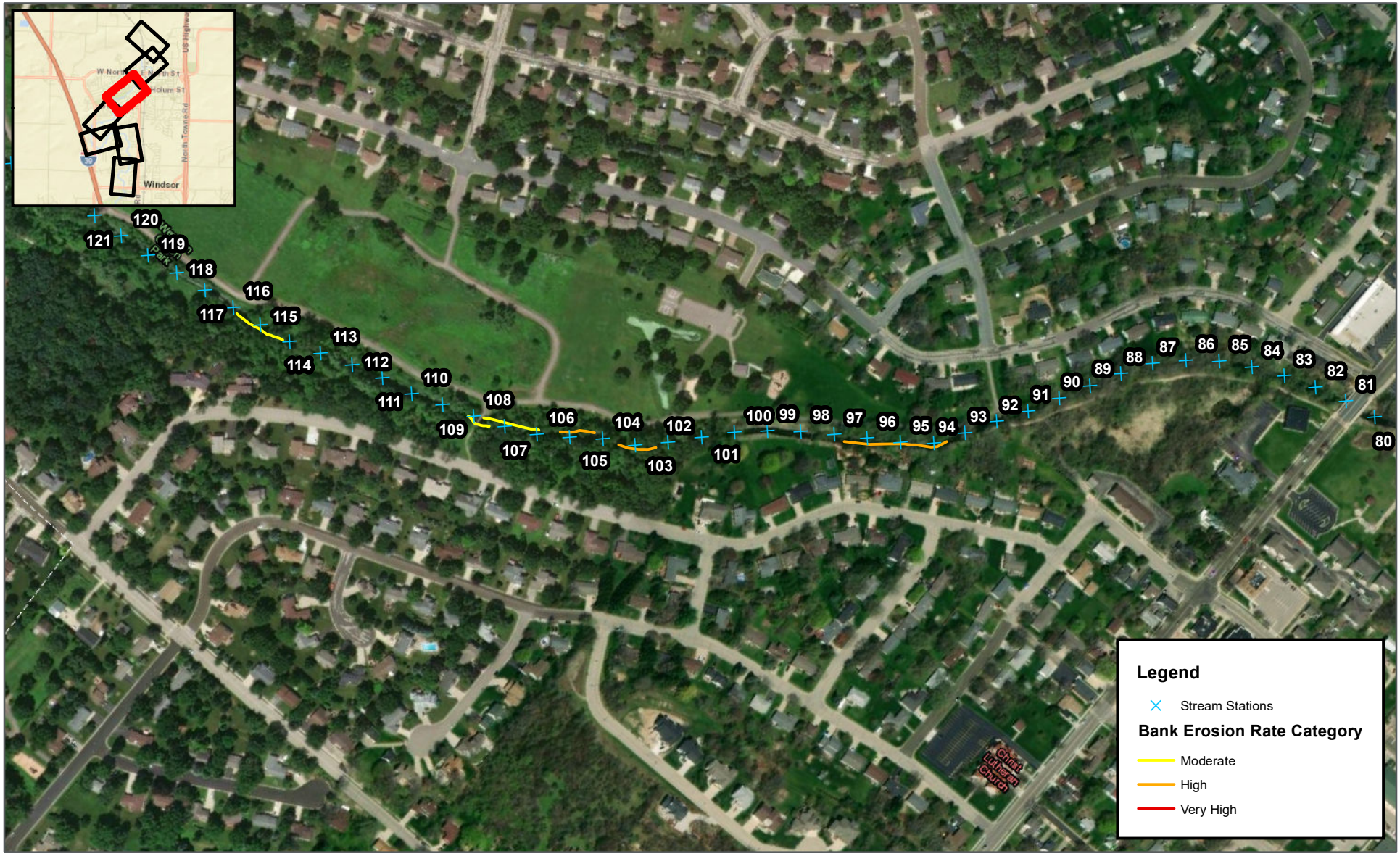
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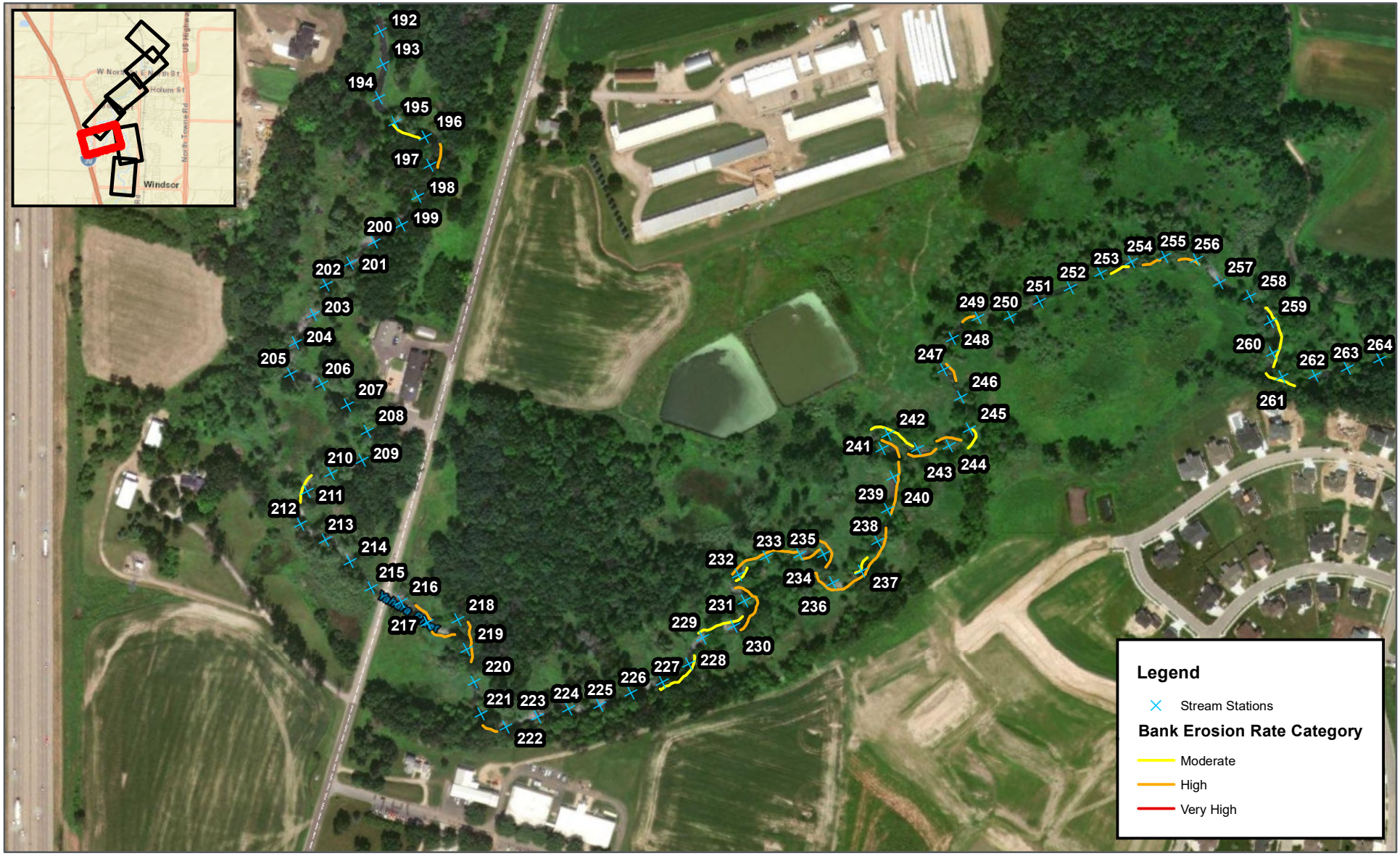
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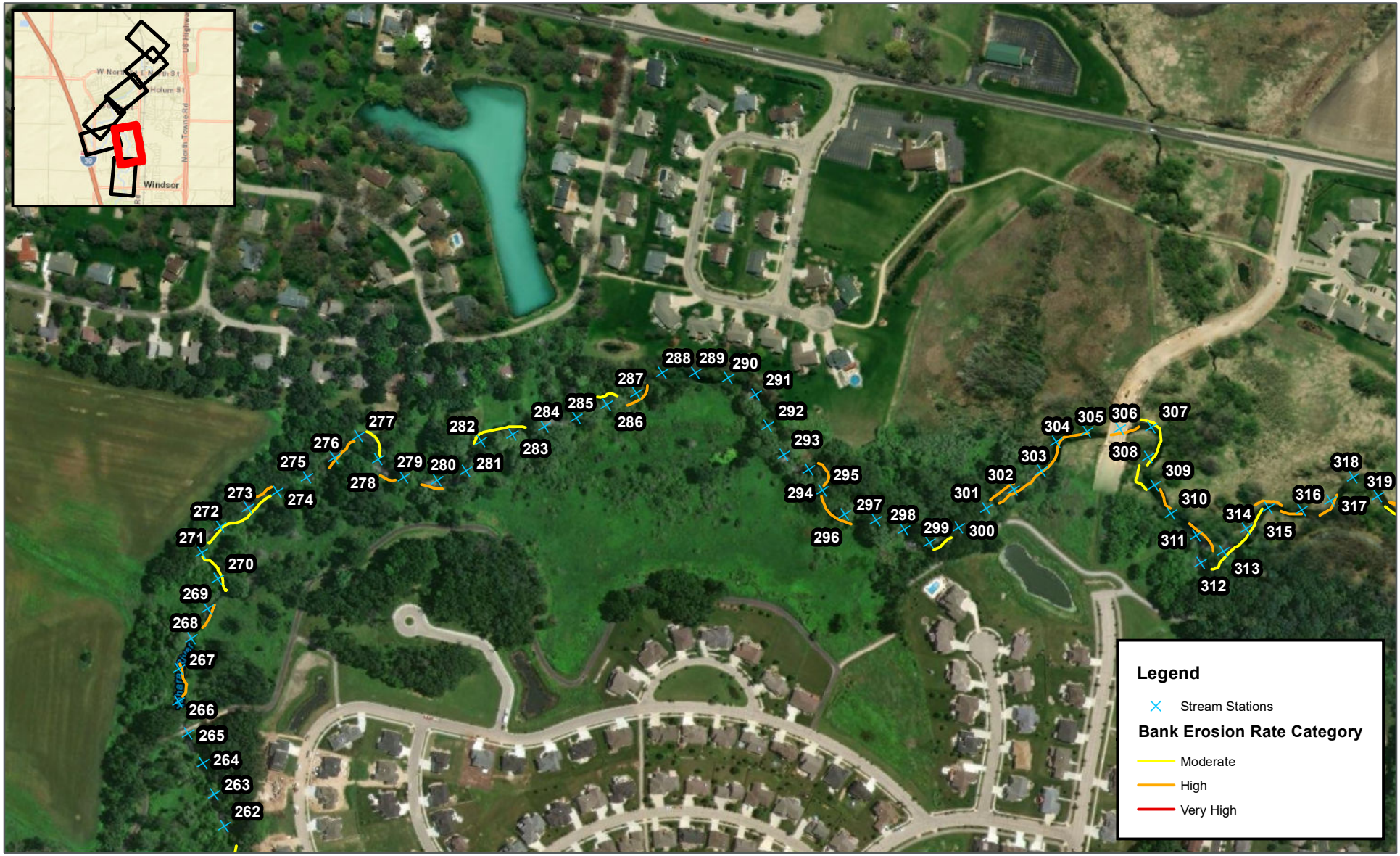
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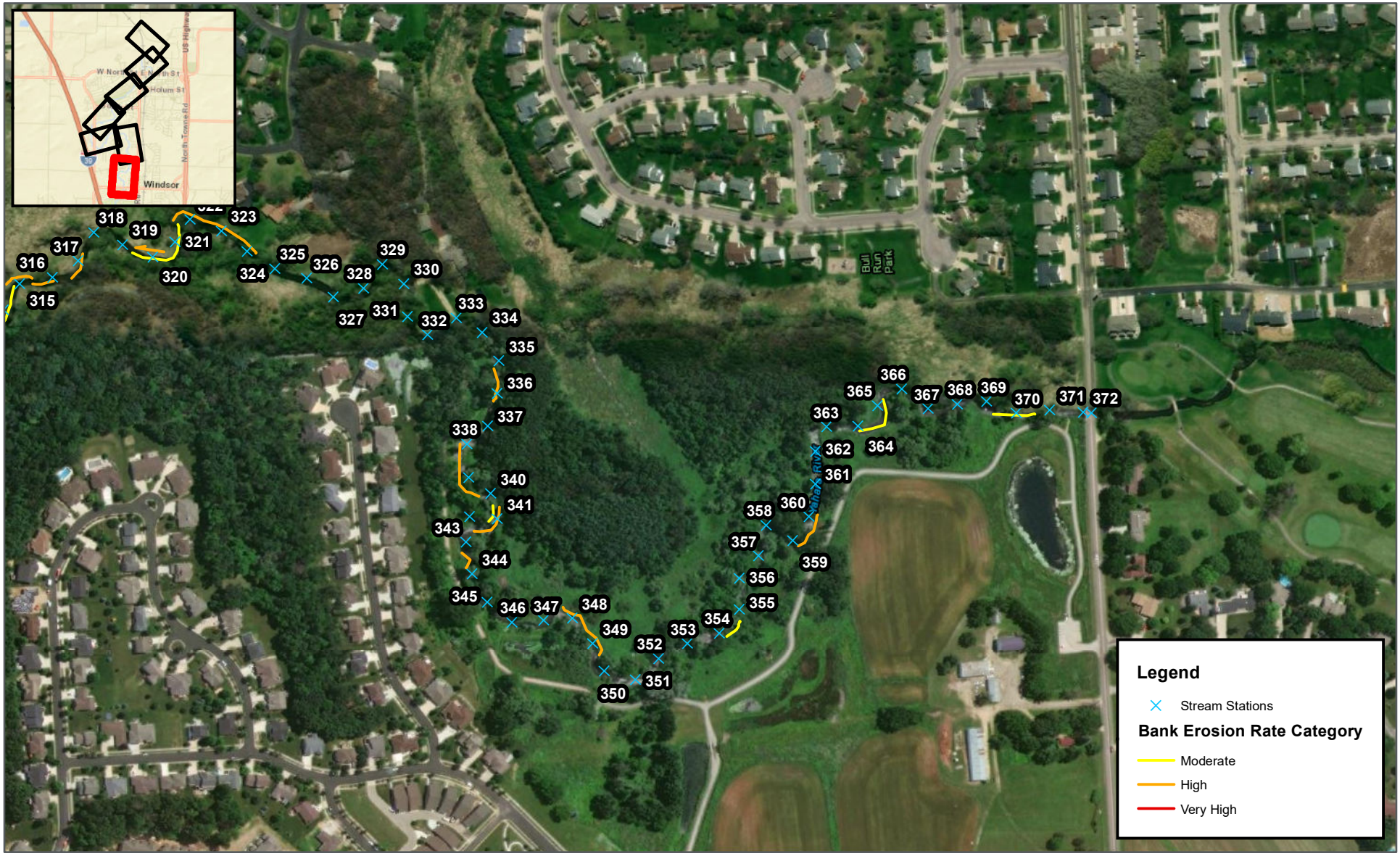
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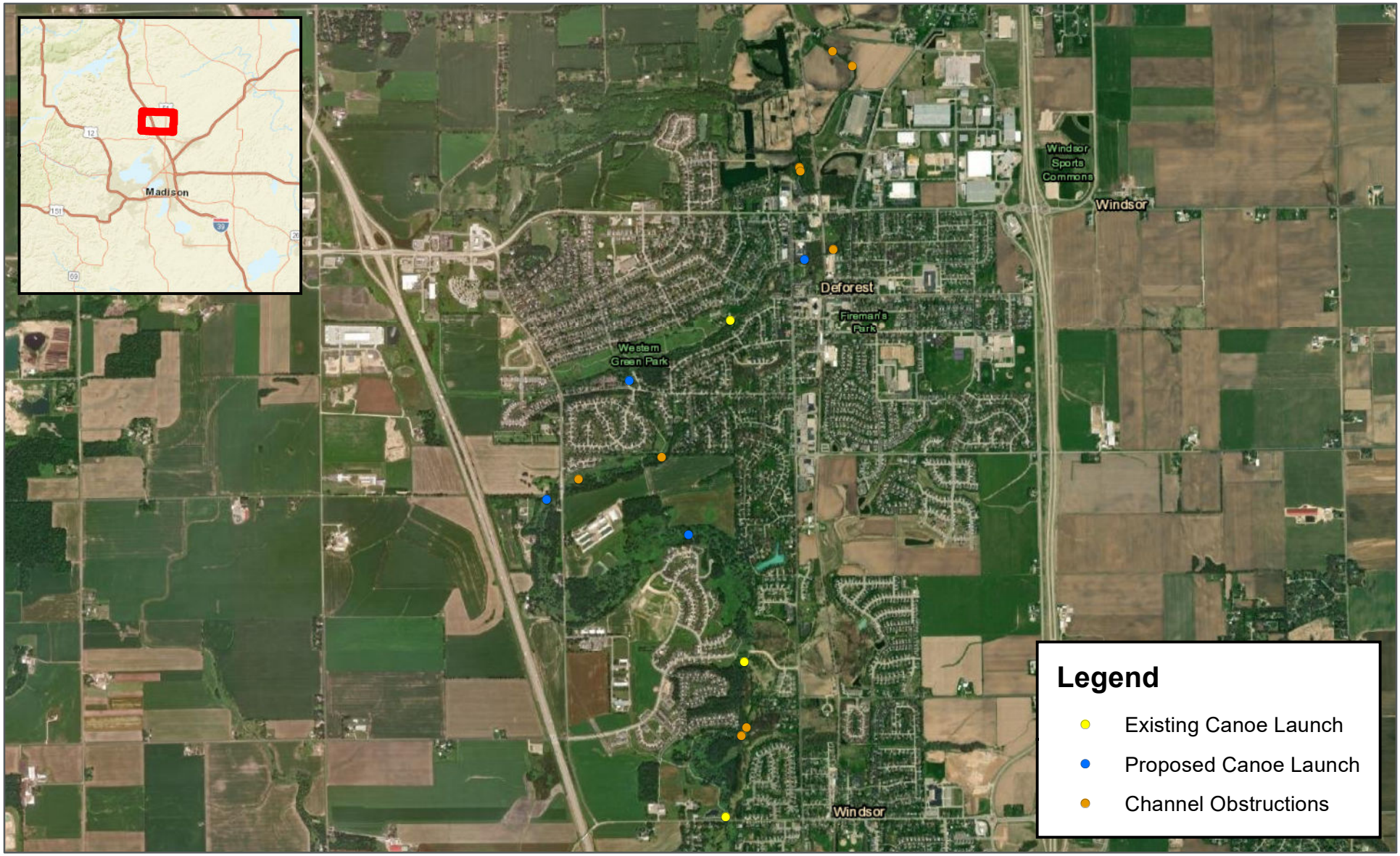
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Village of Deforest

APPENDIX B

YAHARA RIVER CANOE LAUNCH LOCATIONS AND OBSTRUCTIONS



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Canoe Launch Locations and Obstructions

Yahara River Bank Assessment
Dane County, Wisconsin

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Data Sources:
GIS Analyst: christopher.hong

TOGETHER we can do great things

Community

When we say community, we don't just mean the neighborhoods that people call home. We mean everyone and everything with a stake in the work that we do—from our Stantec and industry colleagues to the clients we collaborate with and the people and places we impact.

Whether creating, sustaining, or revitalizing a community, we help diverse cultures and perspectives work together toward shared successes.

Although our work helps to create physical communities, our ultimate goal is to create something far more meaningful—a sense of community.

Creativity

For us, creativity is driven by purpose. Knowing that transformation is truly possible inspires us to approach every situation with a fresh perspective.

Our inventive and collaborative approach to problem-solving helps bring big ideas to life through creative solutions.

Whether our contribution is a design that strikes the perfect balance between function and aesthetics, a feat of engineering that redefines what's possible, or a project management approach that delivers results, we strive for outcomes that transcend the challenges they solve and shape the communities we serve for the better.

Client Relationships

We're better together. This belief shapes how we collaborate with our clients, our partners, and our communities.

We listen so we can deeply understand our clients' needs, communicate with purpose so we maintain alignment, and remain open and flexible so we never miss an opportunity to strengthen a project and positively transform a community.

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