NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

Transportation Asset Management Plan

June 2019

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June 20, 2018

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FAST ACT COMPLIANT TRANSPORTATION ASSET MANAGEMENT PLAN

Enclosed, for your approval, is North Dakota Department of Transportation's (NDDOT) FAST Act Compliant Transportation Asset Management Plan (TAMP), as provided by the FAST Act and in compliance with the requirements of 23 CFR 515.11. Upon FHWA approval, this document will be published on NDDOT's website.

Please contact Jack Smith at (701) 328-2016 or jasmith@nd.gov with any questions, concerns, or comments.

RONALD J. HENKE, P.E., INTERIM DIRECTOR

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Enclosure

TRANSPORTATION ASSET MANAGEMENT PLAN

June 2019

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Executive Summary

The North Dakota Department of Transportation's (NDDOT) vision is that transportation asset management (TAM) fosters a culture of public dollar stewardship through data-supported, goal-oriented decisions. Based on the TransAction III initiative #1, the NDDOT TAM program has adopted the mission of strategically prioritizing the use of transportation resources and to define the levels of service to be provided and maintained as a method of reaching that vision.

This document is NDDOT's federally-required Transportation Asset Management Plan (TAMP), developed under the requirements of 23 CFR 515. This TAMP covers two asset classes, pavements and structures. It further describes the transportation system managed by the NDDOT, the method of managing transportation assets throughout their life cycles, the financial constraints in managing the system, and the processes for managing risk related to the transportation system and services. While federal regulations only require the TAMP to cover the National Highway System (NHS) pavements and structures (or bridges) in a state, NDDOT has chosen to manage all of its pavements and bridges using asset management principles and document those processes in this TAMP. The reason for this change is because NDDOT pavement and bridge models cover all of its pavement and bridges, not only the NHS.

In the NDDOT, robust transportation asset management, at its core, is the practice of using goal-oriented, data-supported decision-making processes to provide transportation infrastructure that *safely moves people and goods* at the lowest practical cost over the life of that infrastructure. It is critical to remember that asset management modeling is but one (albeit very important and influential) source of information in the decision-making processes. Therefore, NDDOT considers asset management to be a collaborative and multi-disciplinary process. The practical implementation of this core philosophy occurs through NDDOT's Investment Priorities Process, beginning with the establishment of long-range goals and culminating with the publication of the STIP, on a recurring basis. This process is summarized below and described in more detail throughout this document, especially in the Investment Priorities Process section, and can be thought of as the framework around which the details contained throughout this TAMP are built.

There are two major phases to the Investment Priorities Process: the long-term and short-term, but both are cyclical. The long-term phase begins with the long-range transportation plan (LRTP), currently called TransAction III, which is due to be updated. During the LRTP update long-term policy goals are established that guide all of the decision-making processes related to services provided.

After the last LRTP update, the policy goals were converted to measurable, long-term performance goals. Eleven such measures and goals were established with two of those relating to this TAMP, Pavement Management (System Average Ride – based on International Roughness Index or IRI) and Bridge Management (System Average Bridge Health Index). The long-term targets for these measures were established by the NDDOT Director, after a meeting in which various executive-requested funding-distribution scenarios (i.e., investment strategies) were reviewed using the NDDOT's Tradeoff Hub to provide live estimates of the system-level performance outcomes in each investment class. A sample of the output screen from the Tradeoff Hub (showing only the pavement and structure asset classes) is presented below. However, because this is a live tool, the presented figure is only a sample.

FIGURE 1 - SAMPLE TRADEOFF HUB INVESTMENT SCENARIO RESULTS.

The Tradeoff Hub estimates pavement management and bridge management model forecasts of performance outcomes for various investment levels in each class. The Hub is intended to be used to provide rapid information during a discussion to get an idea of the consequences of a potential decision option (or investment strategy). Because it is an estimator only, throughout the entire process, the results of the Hub are typically verified by the investment class managers, before a final decision is made using the performance forecasts.

The Director, ultimately, established challenging "stretch" goals that were beyond the funding limitations previously forecasted. However, this decision was made with the full knowledge, given the

Tradeoff Hub forecasts confirmed by the investment class managers, that NDDOT's systems and processes would be unable to reach these goals in the desired 20-year horizon. Thereby, NDDOT personnel were challenged to find process improvements that would make greater progress than was forecasted. These long-term goals thus became the benchmark against which short-term targets and performance are compared.

During development of this TAMP, the steering committee chose to recommend an update to those long-term performance goals for Pavements and Bridges, as described later. The newly recommended and fiscally constrained long-term performance goals are 111 in/mile and 84.33, at 2028, for Pavements and Bridges, respectively. To achieve these goals, approximately $10M/yr. is estimated to need to be shifted from Pavements to Bridges in a typical year. The exact annual funding distribution is, however, to be determined through the annual STIP development described in the following summary of the short-term phase of the Investment Priorities Process. Through approval of this TAMP, the NDDOT Director adopted the above-described updated long-term performance goals.

The short-term phase of the Investment Priorities Process begins with a detailed 5-year revenue forecast, extrapolated to a 20-year revenue forecast, and culminates, annually, with the publication of a final STIP containing the actual list of planned projects to be constructed. The first of many steps between these book ends is the development of the Obligational Authority (OA) Distribution Document, so titled because historically the funding shown consisted of the federal obligational authority provided to NDDOT and the required match. However, over time this document has often times contained significant local or state funding beyond these federal-program funds. The document is then provided to the Deputy Director for Engineering, who determines how the State program will be divided between the various infrastructure investment classes over the following five years. This decision is based on the OA Distribution Document and, if requested, another live use of the Tradeoff Hub to estimate 20-year performance outcomes from various constrained funding scenarios in the Pavement and Bridge management investment classes. These projected Pavement and Bridge performance outcomes are compared to the long-term goals established in the earlier phase of the Investment Priorities Process. While the desire is to make the greatest projected progress toward those long-term goals, other factors such as short-term mobility needs and other emphasis areas also influence the ultimate investment-class funding decision.

The next step in the Investment Priorities Process begins the actual project-selection stage. Various outputs and reports from the Pavement Management model (dTIMS CT) and/or the Bridge Management model (BrM), along with local knowledge of the system are used by the District Engineers and Bridge Division staff to develop lists of candidate projects (i.e., District and Bridge Priorities) for potential inclusion in the STIP. District Priorities are not completely fiscally constrained, but the Bridge Priorities are.

At this point in the Investment Priorities Process, the Programming Division, annually, prepares the Draft STIP for all projects to be funded over the next four-year period. With regard to Pavement Management projects, this prioritization process considers candidate projects from dTIMS and the District Priorities, noted above, using the various dTIMS outputs and goals emphasizing: the higher

level Highway Performance Classification System (HPCS) and Freight System roadways, balancing work types, geographic distribution of work, industry workloads, and stability in previously-planned projects, among other items. Typically, the Bridge Priorities are included in the STIP verbatim, given the fiscally-constrained nature and that these priorities already considered the other qualitative considerations, noted above.

As part of approval to publish the Draft STIP, dTIMS model forecasts of the Draft STIP system condition and performance impacts are compared to the long-term and short-term goals established in the earlier steps of this process. Additionally, a comparison of the projects programmed in the STIP to the dTIMS project recommendations is reviewed for consistency. In the future all of these same comparisons will be made using Bridge Management outputs. Following public comment, the pavement and bridge project lists are revised, as needed, for the Final STIP, and the modeling and meeting steps are repeated for final approval and adoption of the STIP.

As of this writing, the steps documented in the above paragraph are being revised to monitor the STIP impacts on the federally-required performance measures and targets for the National Highway System (NHS) structures and pavements. However, the NDDOT has chosen to continue to define "State of Good Repair" based on overall system performance, rather than managing based on only the impacts to the NHS.

In addition to and in support of the Investment Priorities Process, NDDOT manages risk using processes learned through the National Highway Institute (NHI) course *FHWA-NHI-136065 – Risk Management*, for which NDDOT was a pilot test state during the development of the course. Risk Management, at its core, is the practice of methodically and systematically addressing the impacts of uncertainty (positive and negative) affecting the ability to achieve one's goals. This practice includes predicting, evaluating, prioritizing, and responding to these uncertainties (i.e. risks). Responses may include: avoid, transfer, enhance, accept or mitigate the positive or negative risk. Ultimately, this process will result in information that includes probability and impact of the risks, as well as proposed response actions and a list of personnel responsible for those actions. If any of the response actions adjust procedures noted in this document, the TAMP will be updated, accordingly.

Introduction

The North Dakota Department of Transportation (NDDOT), in its continuing effort to ensure stewardship of public transportation funds, has adopted the goal-oriented and data-supported philosophy of Transportation Asset Management (TAM). This TAMP was prepared in order to document how the NDDOT will monitor and implement that TAM philosophy.

In short, TAM is a goal-oriented, data-supported way of managing transportation systems and their components such that system managers are provided the information they need to make decisions necessary to reach desired outcomes. TAM is able to assist NDDOT management in making decisions that cost effectively progress toward goals by measuring the current performance of an asset class and by projecting the effect that potential decisions will have on the various asset classes' long term performance into the future. As such, TAM will never truly be fully implemented. Rather, it is a

continuous, cyclical process that is repeated to leverage the latest advances. The process is described in the following diagram.

FIGURE 2 – THE FIVE STEP TAM PROCESS

TAM methods and philosophies can be applied to any asset class (or type) and even to non-physical asset investment classes providing service to the end system users (i.e., the customers). The NDDOT is currently using TAM principles to manage pavements and structures, among others. Therefore, in the future, additional investment classes have the potential to be added to NDDOT's TAMP. Another advantage of formal TAM is the ability to utilize a process called cross-asset analysis to quantify the impacts of investing in one asset class versus another to develop investment strategies that close as many performance gaps, as much as practical, throughout all of the managed investment classes. Finally, TAM, at its best, provides information that allows the public to understand, verify, and relate the transportation system to their needs and objectives.

The NDDOT's vision is that TAM fosters a culture of public dollar stewardship through data-supported, and goal-oriented decisions. Based on the TransAction III initiative #1, the NDDOT TAM program has adopted the mission of strategically prioritizing the use of transportation resources and to define the levels of service to be provided and maintained as a method of reaching that vision.

Definitions

"Bridge" and "structure" are used interchangeably, throughout this document generally, to mean bridges and culverts longer than 20 feet, measured parallel to the driving lanes. This does not apply where the words "bridge" and "culvert" appear in the same context; in these instances, bridges and culverts are treated independently.

Gap Analysis - Per 23 CFR Part 515.5 of the federal regulations, "*Performance gap means the gaps [or differences] between the current asset condition and State DOT targets for asset condition, and the gaps in system performance effectiveness that are best addressed by improving the physical assets.*" Therefore, gap analysis Identifies differences between current or projected conditions and desired conditions (i.e., long-range performance goals or short-range targets). If current or projected performance falls short of the desired performance, there is a gap. If current or projected performance exceeds the desired performance, there is a performance surplus.

Life Cycle Planning - Life Cycle Planning is a systematic way of operating, maintaining, and improving physical assets. Using system-wide engineering and economic analysis, a plan of actions taken over the life of the asset is developed. Obstacles or deficiencies hindering progress toward the state of good repair are evaluated during the life cycle planning process. This process is linked with both system level performance goal risk management and financial planning.

Life Cycle Plan (LCP) – A specific, long-term, policy level investment strategy that accounts for realistic financial estimates and includes a risk analysis.

State of Good Repair - The State of Good Repair for pavements and structures is a condition in which the assets, to an acceptable extent, (a) are functioning as designed and (b) are sustained through cyclical and condition-based preventative maintenance, rehabilitation and replacement activities.

Long Term Performance Goal – An aspirational goal, 10 to 20 years into the future, that may or may not be achievable with current resources and technologies. Short and mid-term decisions are made with an effort to reach the long term performance goal. For the asset classes covered in this TAMP, these goals are condition based.

Short Term Target - A target that The Department will attempt to reach in the short term (4 to 5 years) through its investments. This target attempts to push the Department toward its long term goals, but ultimately is fiscally constrained.

Asset Inventory

The NDDOT manages approximately 8,600 roadway miles of state highways within the state of North Dakota. There are 3,720 miles of roadway on the National Highway System (NHS), managed by all levels of government, as described in the section on Data Management. NDDOT's roadway system is comprised of many individual asset classes such as pavements, structures, safety appurtenances,

drainage structures, right of way, signs, lighting, and many other ancillary items. This document concentrates on the portion of the NDDOT's asset management program that manages pavements and structures on the NHS. These asset classes are further divided into the asset subgroups, shown below.

Pavement Type	Centerline Miles on NHS
Asphalt	2,844
Concrete	518
Composite	303
Local Owned NHS (Cities)	52
Local Owned NHS (Counties)	3
Total	3,720
Structure Type	**Number on NHS**
Concrete Slab	30
Concrete Tee Beam	53
Steel Stringer	129
Steel Girder Floor Bm	2
Steel Box Beam	2
Steel Truss	2
Prestressed Box	121
Prestressed I	53
Segmental Box	1
Steel Pipe Culvert	10
Reinforced Concrete Box Culvert	237
Total	637

NHS PAVEMENTS AND STRUCTURES INVENTORY SUMMARY.

However, locally-owned NHS pavements are listed, above, as separate subgroups. The amount of miles is small compared to the rest of the NHS (less than 1.5%); additionally, the design characteristics of local roads emphasize functions that are different from the rest of the NHS and do not influence how the overall NHS is managed. Projects on locally-owned NHS are prioritized with the assistance of NDDOT's Local Government Division, as described in the Local Government Manual linked at http://www.dot.nd.gov/manuals/localgov/localgovernmentmanual.pdf, and with District Engineer assistance if the project has impacts on state-owned roadways. In either case, the initial scope of the candidate project may be proposed by the local entity or NDDOT. Both entities must concur for a candidate project to move into the remainder of the Investment Priorities Process.

The Department is in the process of transitioning these locally own assets into its asset management models and its life cycle planning financial management and risk management processes. Formalizing TAM processes with local partners will continue to develop over the life of this TAMP and will be documented in future TAMPs. Since locally owned assets are a small percentage of the overall NHS, the life cycle plans in this document assume that local assets will trend with state owned assets in the

short term. Local projects are bid through the Department and significant departures from the Department's investment strategy have not been observed.

The NDDOT also recently began reporting system and service performance online. The most current system performance reports can be found at: http://www.dot.nd.gov/business/transactioniii/transactioniiiprogress.htm. The link includes the following asset related reports, among others:

> The NDDOT Performance Report, which covers 8 service areas including pavement and structures. The report shows past system wide pavement and structure condition.
>
> North Dakota's Federal Transportation Performance Report, which covers federal performance reporting and will include the NDDOT's required federal performance measure targets, as they come due or are updated.

NHS effectiveness independent of physical condition is monitored through the NDDOT Freight and Personal Mobility model and accompanying freight constraints map found at: http://www.dot.nd.gov/divisions/planning/freight/docs/NDFreightConstraintsMap.pdf. A sample of this map is presented below; however, the official version is published at the above link. These constraints (or "restrictions") are based on physical and operational characteristics of both roadways and structures that hinder the efficient movement of people and goods (i.e. "deficiencies"). Examples of such deficiencies include: load carrying capacity, width and height clearances, and/or traffic saturation levels that don't meet expected limits.

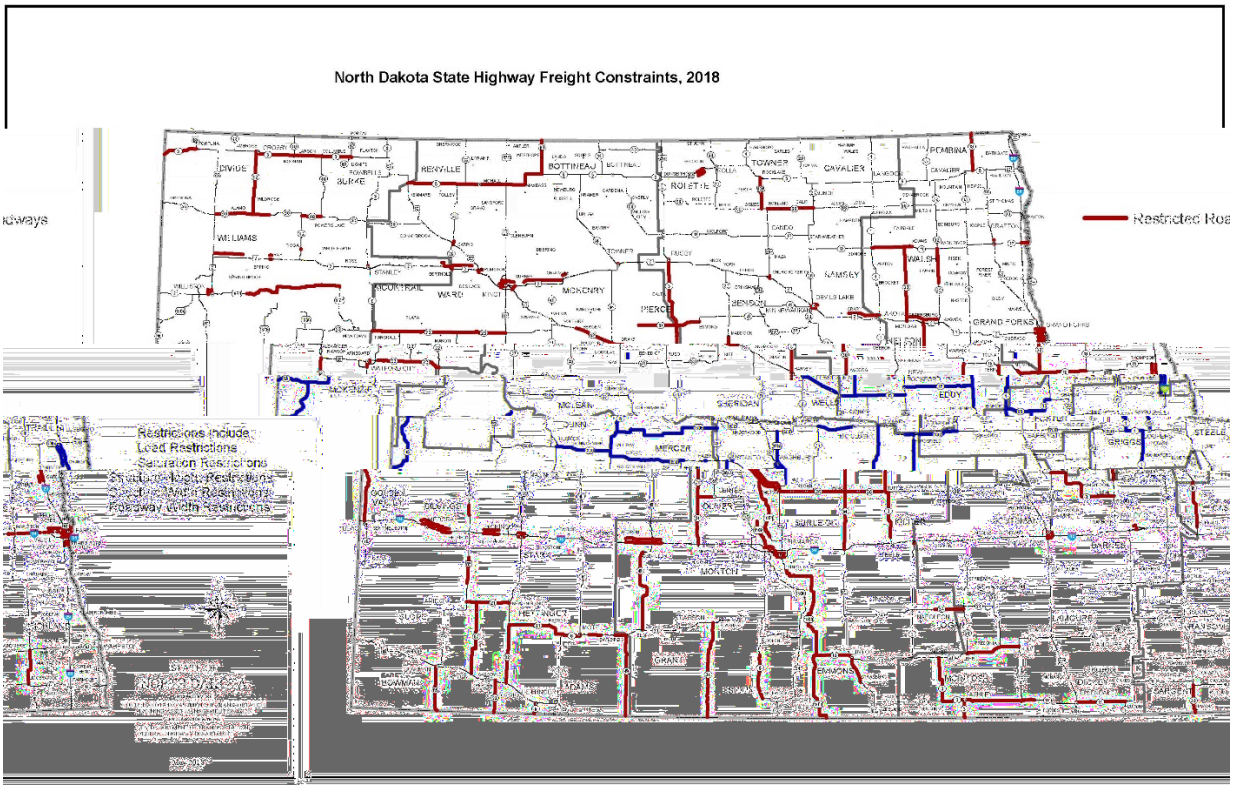


FIGURE 3 – SAMPLE FREIGHT CONSTRAINTS MAP.

This map is produced from the Freight and Personal Mobility model outputs, which show deficiencies to aid in identifying potential projects for closing performance gaps. The outputs of the model are considered, like the pavement model, during various stages of the Investment Priorities Process to help determine if an additional investment should be made to improve a non-condition deficiency.

To facilitate the efficient management of the many assets to meet the expected performance of the overall system, the North Dakota legislature and Governor endorsed the concept of a state-system roadway classification framework called the Highway Performance Classification System (HPCS) (N.D.C.C. §24-01-03.1). To define the expected functionality of these roadways, the NDDOT has adopted definitions for each of these classifications based on: reliability (i.e., will the roadway be available to travel as expected), types of movement (e.g. long distance versus local access), typical geometry (e.g. four-lane versus two lane), typical speeds, size and weight restrictions, pavement condition (e.g. ride quality and distress), risk tolerance, and expected overall safety.

The HPCS illustrates both quantitative and qualitative goals for system performance depending on how a roadway is used. A map of the current HPCS can be found at http://www.dot.nd.gov/divisions/planning/hwyclassification.htm. A sample of this map is presented below for convenience; however, the official version is published at the above link.

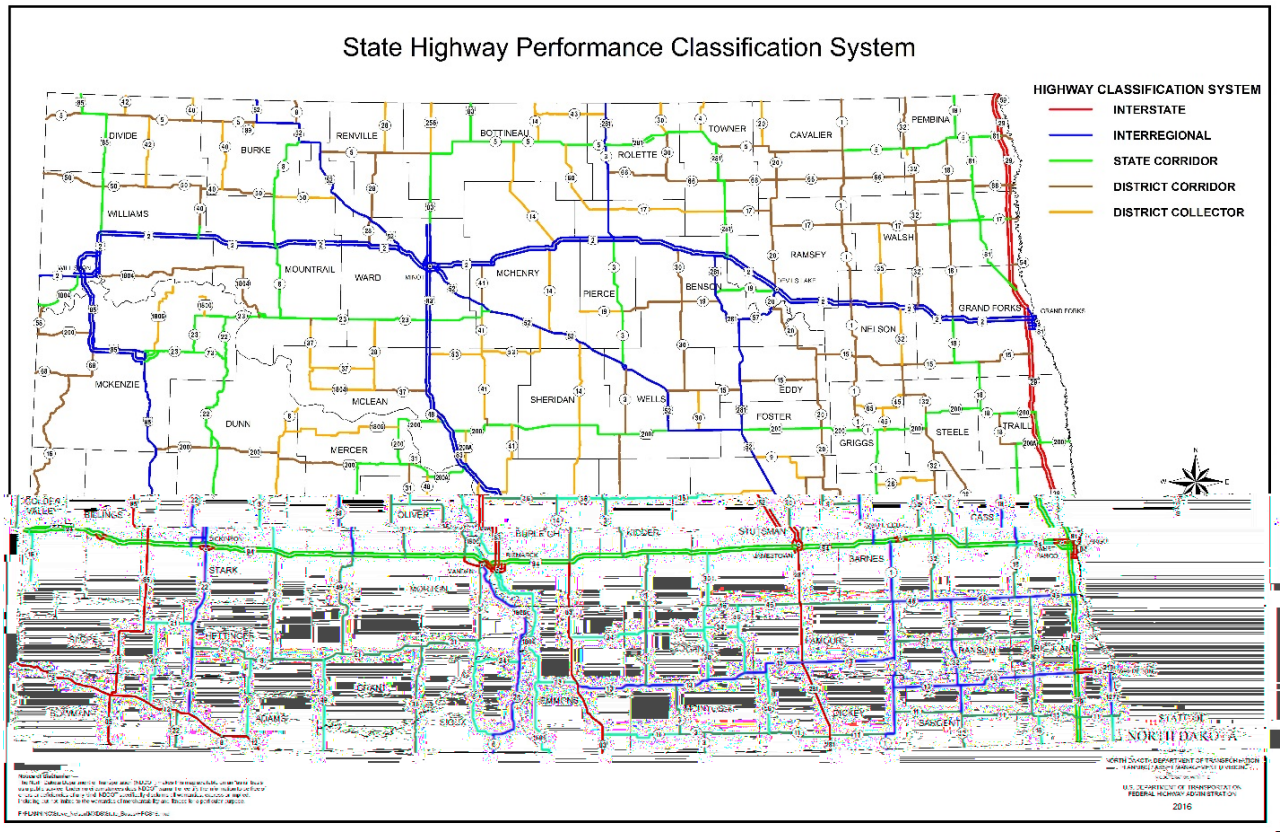


FIGURE 4 – SAMPLE HIGHWAY PERFORMANCE CLASSIFICATION SYSTEM MAP.

Currently, there are five classifications:

Interstate: Movements on the interstate system are primarily long-distance, interstate and intrastate traffic. Rural Interstates are multi-lane (usually four) roadway facilities and have full access control.

Interregional Corridor: Movements on Interregional highways are primarily long-distance, interstate and intrastate traffic. Interregional System highways are either two-lane or multi-lane facilities. Segments or specific locations may have partially controlled access.

State Corridor: State Corridors provide connectivity between lower and higher level roadways. Movements on these highways are primarily medium-distance intrastate traffic. State Corridors are typically two-lane facilities and have segments or locations with partially controlled access.

District Corridor: Movements on District Corridor highways are primarily short to medium distance intrastate traffic. District Corridors are two lane facilities.

District Collector: Highways classified as District Collectors are generally short routes that provide connectivity to the higher level road systems. Movements on these highways are primarily short distance, local, farm to market traffic. District Collectors are two lane facilities.

The HPCS sets the overall framework to guide the NDDOT in defining the state of good repair for individual corridors. The vast majority of NHS pavements are primarily the top three corridors (Interstate, Interregional, and State Corridors); so, NHS pavements and structures tend to have the highest expectations and priority for investing transportation funding. Because the NDDOT has robust models, and process for implementing life cycle planning, it also has the capability to monitor and model other performance trends to ensure that life cycle planning does not overlook something that should be considered in defining the state of good repair or that may impact performance gaps. Some of these capabilities are outlined below:

I. Pavement Analysis Capability

Pavement condition history and forecasts can be developed to answer system-level condition questions and support gap analyses. For most pavement condition monitoring activities, NDDOT uses ride (measured as IRI in inches per mile) to report performance. Often this is reported using metrics of Excellent (0-60 in/mi), Good (61-99), Fair (100-145), or Poor (>145). Ad hoc analyses can also be completed to check performance of subsets of the system or using various other measures. Some examples of ad hoc analyses include the following charts:

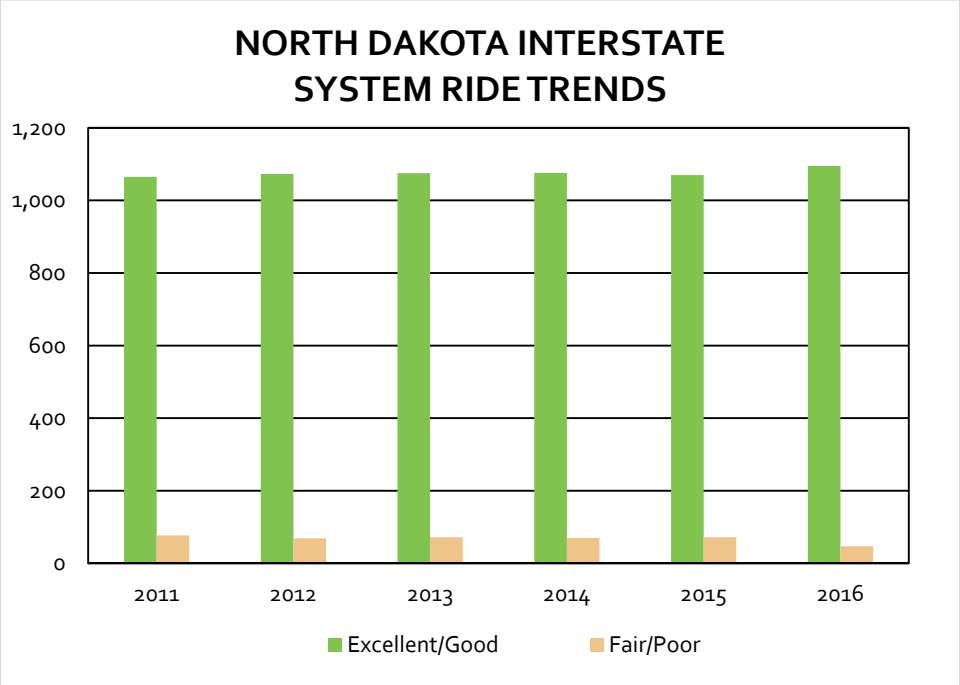


FIGURE 5 – AD HOC CHART SHOWING DECREASING FAIR AND POOR INTERSTATE PAVEMENT CONDITION.

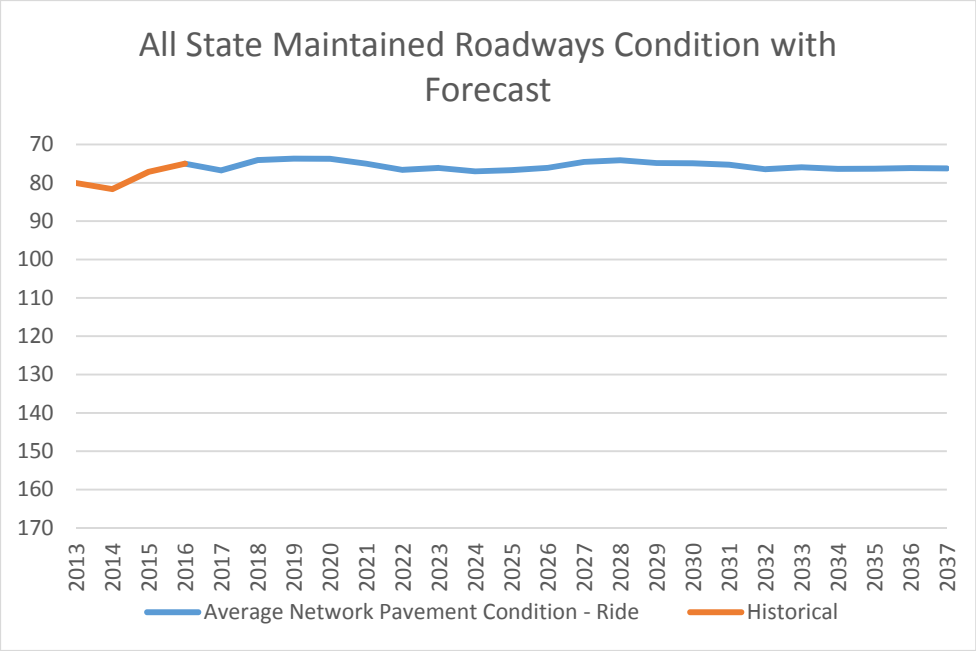


FIGURE 6 – GRAPH SHOWING HISTORICAL PERFORMANCE AND FORECASTED PERFORMANCE AT AN INVESTMENT LEVEL INCREASE OF 140% COMPARED TO PAST INVESTMENTS.

II. Structure Analysis Capability

The NDDOT state bridge system is comprised of 1,145 structures. There are 720 bridges with lengths greater than 20 feet, and 425 culverts that are greater than 20 feet as defined in the National Bridge Inventory (NBI). Of these, 637 are on the NHS including 390 bridges and 247 culverts.

NDDOT uses the FHWA definition of Good, Fair, and Poor for an inspection program that uses a supplemented Bridge Inspection Coding Guide. Using the NDDOT version of the Bridge Inspection Coding Guide, condition ratings are given to the deck, superstructure and substructure on bridges and the culvert rating for culverts. When the minimum condition rating of the three NBI items for a bridge (Deck, Superstructure, and Substructure) is 7, 8, or 9, the bridge is classified as Good. When the minimum condition rating of these three NBI items is either 5 or 6, the bridge is classified as Fair, and when the minimum condition rating of these three NBI items is 4 or below, the bridge is classified as Poor.

Similarly, when the condition rating of NBI item Culvert is 7, 8, or 9, the culvert is classified as Good. When the condition rating for this item is either 5 or 6, the culvert is classified as Fair and when the condition rating for this item is 4 or below, the culvert is classified as Poor.

Structure	Good (9,8,7)	Fair (6,5)	Poor (<=4)	Total
Bridges (NHS)	227	154	9	390
Culverts (NHS)	174	71	2	247
Total Structures (NHS)	401	225	11	637

Structure	% Deck Area Good (9,8,7)	% Deck Area Fair (6,5)	% Deck Area Poor (<=4)
Bridges NHS	64.1%	31.8%	4.1%
Culverts	75.5%	23.9%	0.6%
Total Structures (NHS)	64.9%	31.3%	3.9%

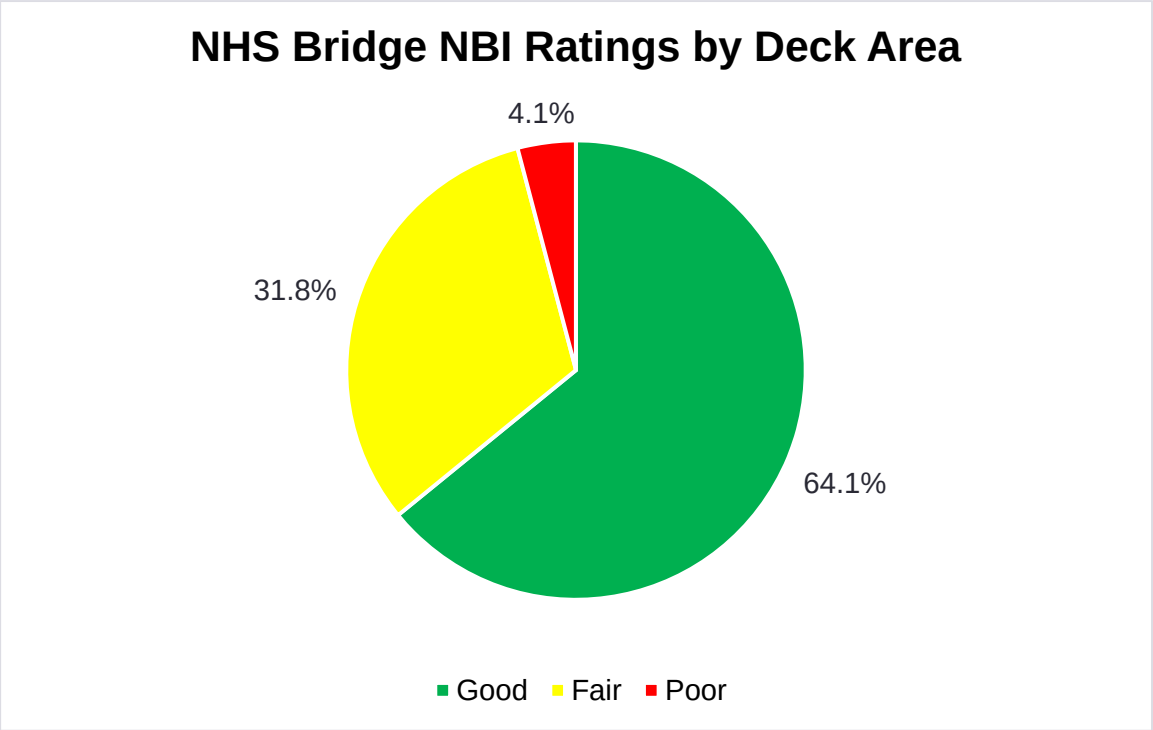


FIGURE 7 –CONDITION BY DECK AREA OF THE STATE OWNED NHS BRIDGES.

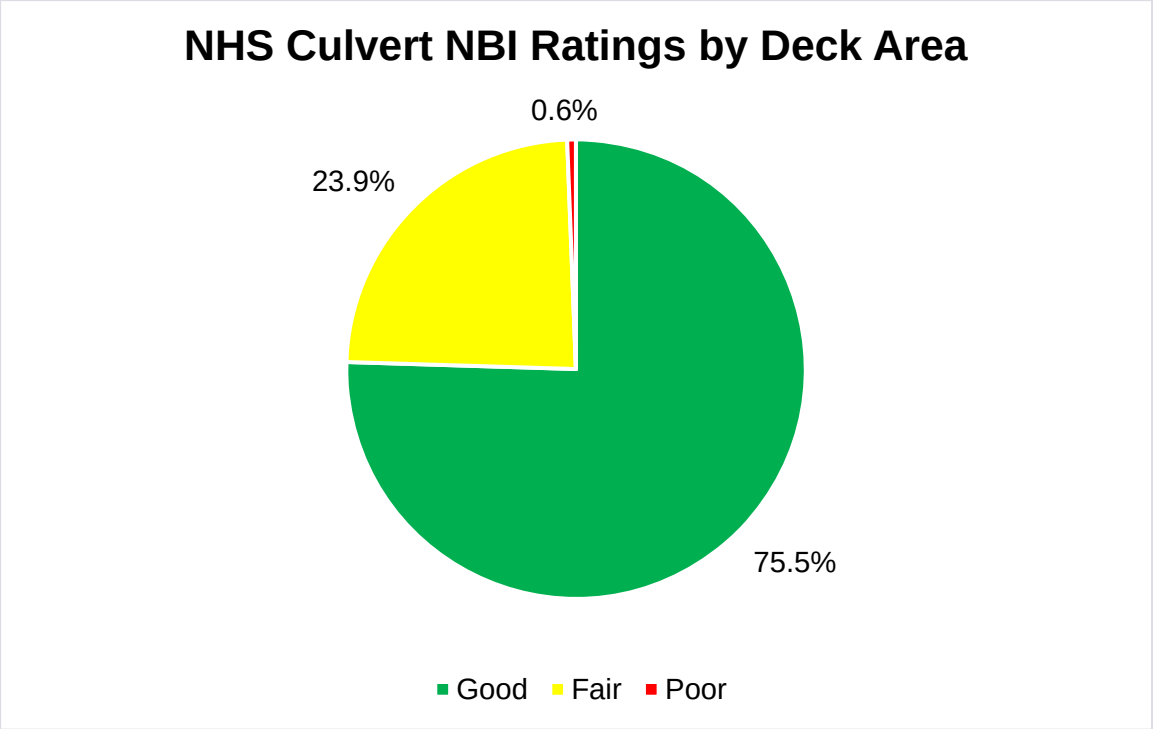


FIGURE 8 –CONDITION OF NHS CULVERTS BY DECK AREA.

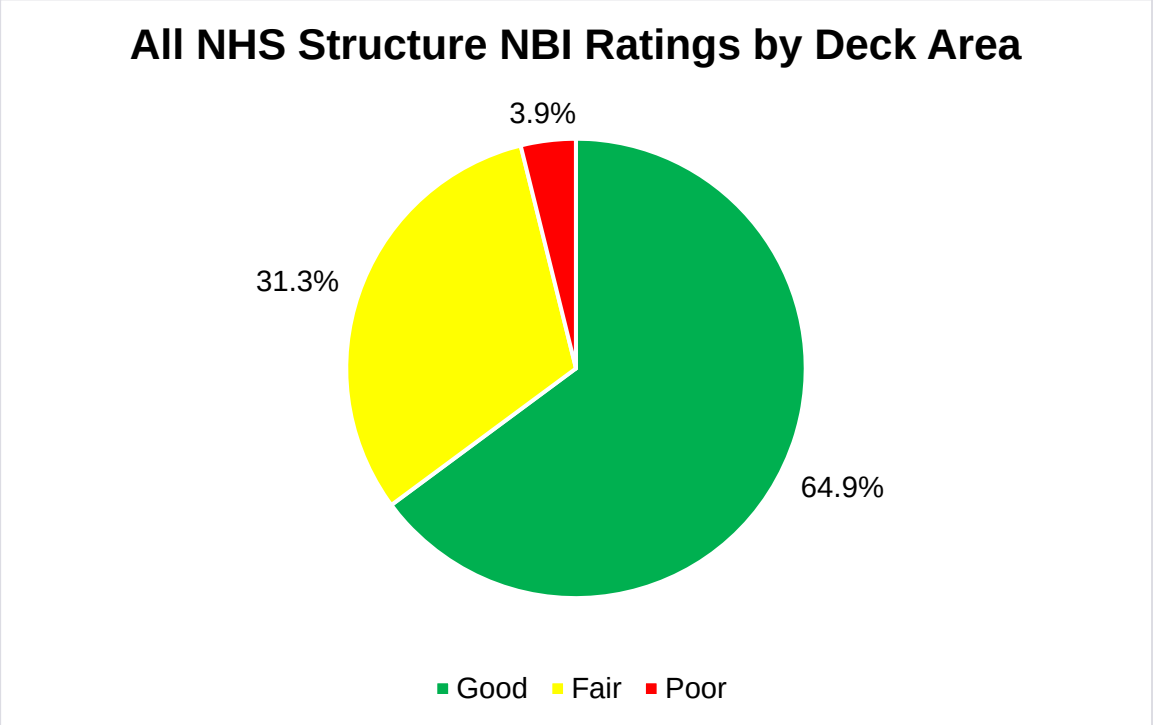


FIGURE 9 – CONDITION OF NHS CULVERTS AND BRIDGES COMBINED BY DECK AREA

Models are used to develop alternative risk-tolerant strategies for varying levels of funding, which is the primary obstacle (or "deficiency") toward the state of good repair in North Dakota. The NDDOT is also able to periodically evaluate how funding is allocated between service and asset classes using its Tradeoff Hub. This allows the Department to monitor the effect of its investments in closing the gap to the state of good repair. The implementation of the life cycle planning process occurs in the NDDOT's Investment Priorities Process, outlined in the following section.

Investment Priorities Process

Life Cycle Planning, Gap Analysis, and Financial Analysis are conducted simultaneously in the Department's Investment Priorities Process. The state of good repair is, also, defined through this process.

There are two major phases to the Investment Priorities Process: the long-term and short-term, but both are cyclical. The long-term phase begins with the long-range transportation plan (LRTP). The current LRTP is called TransAction III, which is due to be updated. During the LRTP update long-term policy goals are established that guide all of the decision-making processes related to services provided. These goals are high-level, philosophical descriptions for how the public wants the overall transportation system and services to function in the state of North Dakota. The LRTP and associated goals are typically updated approximately every five years. The LRTP is the top of the hierarchy of the Department's family of plans.

This NDDOT TAMP is intended to support TransAction III. Full details of which may be found at: http://www.dot.nd.gov/business/transactioniii/transactioniii.htm

This iteration of the NDDOT's TAMP focuses on three of the TransAction III values:

> *Safety and Security: Transportation safety and security is the state's number one priority. Reasonable efforts should be made to plan, design, build and operate a transportation system that allows travelers and freight to move safely and securely.*
>
> *Maintainable and Sustainable: The transportation system should be strategically developed considering long-term investment versus short-term demands. The use of transportation resources should be prioritized and levels of service to be provided should be defined. The system should not be over-built or under-built. Preserving and maintaining the system should be emphasized over new construction.*
>
> *Reliable and Predictable: Today's fast-paced lifestyles and globally integrated economy require a transportation system that is reliable and predictable. Technological advances, larger and more efficient equipment, the evolution of shuttle trains, and "just-in-time" manufacturing emphasize reliability and predictability of travel time and cost. Multiple modal options (highway/rail, rail/pipeline, etc.) should be promoted to improve reliability and predictability.*

After the last LRTP update, the policy goals were converted to measurable, long-term performance goals, based on the NDDOT's understanding of the public's desires. Eleven such measures and goals were established with two of those relating to this TAMP, Pavement Management (System Average Ride – based on International Roughness Index or IRI) and Bridge Management (System Average Bridge Health Index). The long-term performance goals for these measures were established by the NDDOT Director, after a meeting with the NDDOT executive team, including the Director, Deputy Directors, Engineering Office Holders, and select technical asset management support staff. During this meeting, the asset management staff entered executive-requested funding-distribution scenarios (i.e., investment strategies) into the NDDOT's Tradeoff Hub to provide estimates of the system-level performance outcomes in each investment class. A sample of the output screen of the Tradeoff Hub (showing only the pavement and structure asset classes) is presented below. However, because this is a live tool, the presented figure is only a sample.

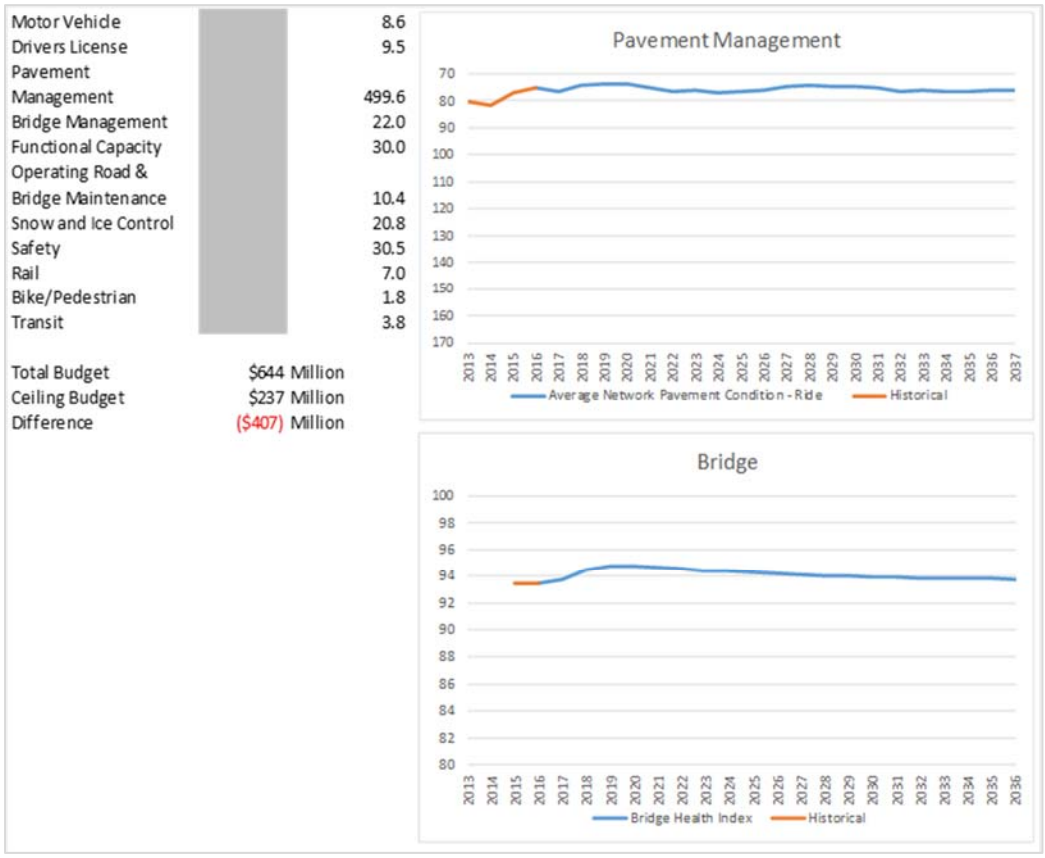


FIGURE 10 - SAMPLE TRADEOFF HUB INVESTMENT SCENARIO RESULTS.

The Tradeoff Hub uses an interpolation method to estimate what the pavement management and bridge management models would forecast as performance outcomes for a given investment level in each class. This tool is intended to be used to provide rapid information during a discussion to get an idea of the consequences of a potential decision option (or investment strategy). It does not provide analytics beyond a simple estimation of management system outputs for the single measure within each investment class. Once the Director reached a comfort level with the distribution of projected funding and the associated performance outcomes in each investment class, the estimated outcomes

were sent to the investment class managers to review for any technical corrections to the estimated projections. After the outcomes were confirmed, the Director held further one-on-one discussions with various personnel and, ultimately, established challenging "stretch" goals that were beyond the funding limitations previously forecasted. However, this decision was made with the full knowledge, given the Tradeoff Hub forecasts confirmed by the investment class managers, that NDDOT's systems and processes would be unable to reach these goals in the desired 20-year horizon, thus challenging Department personnel to find process improvements that would make greater progress than was forecasted. These long-term performance goals thus became the benchmark against which short-term targets and performance are compared.

During development of this TAMP, the steering committee chose to recommend an update to those long-term performance goals for Pavements and Bridges, as described later. The newly recommended and fiscally constrained long-term performance goas are 111 in/mile and 84.33, at 2028, for Pavements and Bridges, respectively. To achieve these goals, approximately $10M/yr. is estimated to need to be shifted from Pavements to Bridges in a typical year. The exact annual funding distribution is, however, to be determined through the annual STIP development described in the following summary of the short-term phase of the Investment Priorities Process. Through approval of this TAMP, the NDDOT Director adopted the above-described updated long-term performance goals.

The short-term phase of the Investment Priorities Process begins with a detailed 5-year revenue forecast and culminates, annually, with the publication of a final STIP containing the actual list of planned projects to be constructed. The first of many steps between these book ends is the development of the OA Distribution Document, so titled because historically the funding shown consisted of the federal obligational authority provided to NDDOT and the required match. However, over time this document has often times contained significant local or state funding beyond these federal-program funds. The draft OA Distribution Document is prepared by the Programming Division based on the federal apportionment noted in the current federal transportation bill and the State (or what NDDOT calls Rural), Urban, County programs funding-split policy (which is approximately 75%, 16.5%, and 8.5%, respectively). Because these programs borrow funds from each other, the exact split each year varies. An example OA Distribution Document showing how the funding is split is included in the financial plan section of this TAMP. Additionally, the draft OA Distribution Document is developed considering any one-time funding appropriated by the state biennial legislative process, estimated federal end-of-year redistribution, any carryover funding, and similar ad-hoc funding that may exist in a given year, and the results of the Risk Analysis of the generated Life Cycle Plans in this document. The Deputy Director determines how the State program will be divided between the various infrastructure investment classes over the following five years. This decision is based on the OA Distribution Document, and at the request of the Deputy Director, another live use of the Tradeoff Hub to estimate 20-year performance outcomes from various constrained funding scenarios in the Pavement and Bridge management investment classes. These projected Pavement and Bridge state of good repair outcomes are compared to the long-term goals established in the earlier phase of the Investment Priorities Process. While the desire is to make the greatest projected progress toward those long-term goals,

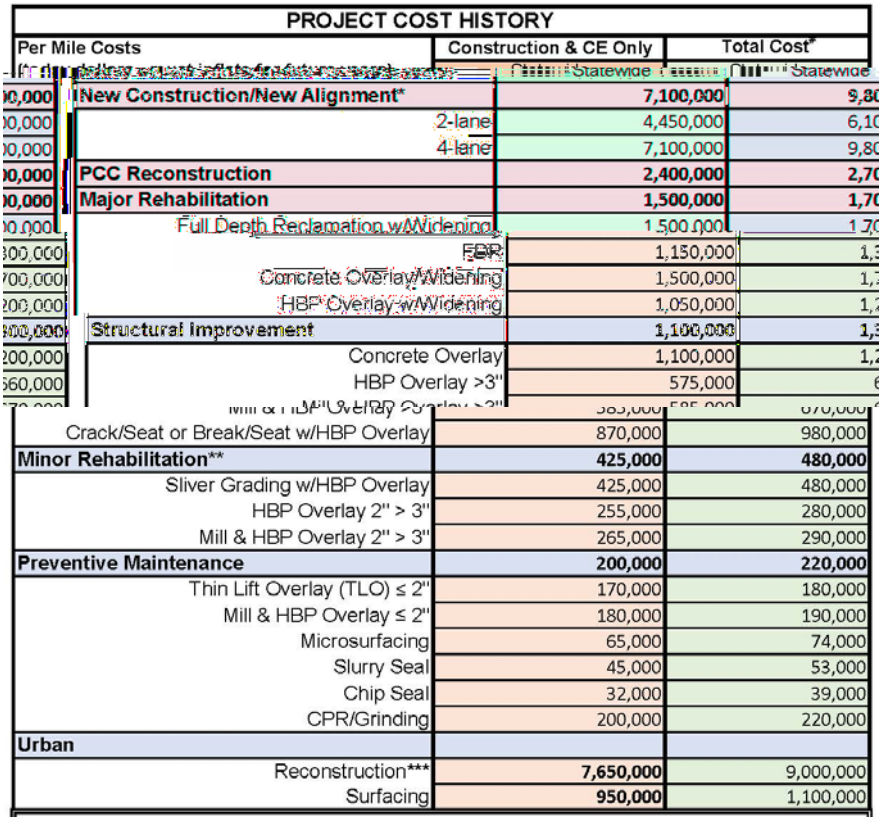
other factors such as short-term mobility needs and other emphasis areas also influence the ultimate investment-class funding decision.

Additional input from the NDDOT's Asset Management models occurs in the next steps of the Investment Priorities Process:

I. Pavements

The next step in the Investment Priorities Process begins the actual project-selection stage. The Pavement Management model (dTIMS CT) is run based on the above funding decision and an optimization algorithm that attempts to maximize the system condition (based on ride). An additional model run is performed using an unconstrained budget to determine the "optimum" treatment for each segment, if unlimited funding were available. The outputs from dTIMS consist of both system-level performance-outcome forecasts and a list of project recommendations for each pavement segment. Finally, these outputs are also compared to the candidate projects submitted by the District in the previous year (i.e. District Priorities). These various outputs and reports are provided to each of the District Engineers during an annual meeting, in each District, (the District Visits) with the Programming, Local Government, and Planning/Asset Management central office divisions. Based on the dTIMS recommendations, the other above reports, and their local knowledge of the system, each District submits a list of candidate pavement projects (i.e. District Priorities) to the Programming Division for consideration in the draft STIP development.

Currently, dTIMS serves as a planning and modeling tool that provides recommendations to decision makers, and feedback on the projected impacts of proposed decisions. Deterioration, traffic, HPCS level, and condition, among other criteria, are considered in the model. Preventative Maintenance, Minor Rehab, Structural Improvements, and Major Rehab/New/Reconstruction are work types that the software considers and optimizes for pavement management reports. Current costs for these work types are used in the NDDOT's models and may be found (along with costs of some treatments within them) on the Department's website at http://www.dot.nd.gov/manuals/design/designmanual/wordfiles_design/Project%20Cost%20History.pdf . The below figure is a sample of the results of this effort. However, these costs are updated annually by the Programming Division by analyzing actual project costs by treatment type from the previous year. Therefore, the official version of this chart is maintained at the above link.



PROJECT COST HISTORY

Per Mile Costs	Construction & CE Only	Total Cost*
	Statewide	Statewide
New Construction/New Alignment*	**7,100,000**	**9,80**
2-lane	4,450,000	6,10
4-lane	7,100,000	9,80
PCC Reconstruction	**2,400,000**	**2,70**
Major Rehabilitation	**1,500,000**	**1,70**
Full Depth Reclamation w/Widening	1,500,000	1,70
FDR	1,150,000	1,3
Concrete Overlay/Widening	1,500,000	1,7
HBP Overlay w/Widening	1,050,000	1,2
Structural Improvement	**1,100,000**	**1,3**
Concrete Overlay	1,100,000	1,2
HBP Overlay >3"	575,000	6
Mill & HBP Overlay >3"	585,000	670,000
Crack/Seat or Break/Seat w/HBP Overlay	870,000	980,000
Minor Rehabilitation**	**425,000**	**480,000**
Sliver Grading w/HBP Overlay	425,000	480,000
HBP Overlay 2" > 3"	255,000	280,000
Mill & HBP Overlay 2" > 3"	265,000	290,000
Preventive Maintenance	**200,000**	**220,000**
Thin Lift Overlay (TLO) ≤ 2"	170,000	180,000
Mill & HBP Overlay ≤ 2"	180,000	190,000
Microsurfacing	65,000	74,000
Slurry Seal	45,000	53,000
Chip Seal	32,000	39,000
CPR/Grinding	200,000	220,000
Urban		
Reconstruction***	**7,650,000**	9,000,000
Surfacing	**950,000**	1,100,000

FIGURE 11 – SAMPLE WORK TYPE COST SUMMARY USED IN THE PAVEMENT MODEL.

The following is an introductory summary of the pavement work type descriptions. For more detail see the NDDOT Design Guidelines section of the Design Manual (http://www.dot.nd.gov/manuals/design/designmanual/Chapter%201%20Section%206.pdf).

Preventative Maintenance – The intended purpose of this work type is to protect the pavement structure, slow the rate of pavement deterioration, and/or correct deficiencies in the pavement surface only; structural deficiencies cannot be corrected with this application. This work type often consists of thin-lift overlays, micro-surfacing, or small-scale concrete repair projects (less than 10% of the pavement surface area per mile), dowel bar retrofit (to restore ride and load transfer between adjacent concrete slabs), or Diamond Grinding (to restore ride and/or minor surface deformation such as restoring the roadway crown/cross slope). An overlay is considered to be Preventative Maintenance when the maximum thickness is two inches (with no additional asphalt allowance for rut filling). Preventative Maintenance falls under the FHWA Preservation work type.

Minor Rehabilitation –The primary aim of this work type is to correct the structural integrity of the pavement without necessarily changing the existing geometrics. It is intended to extend the useful life of a highway by restoring the pavement structure to its original load carrying capacity. The minor rehabilitation of roadways uses repair techniques designed to repair pavement distress areas primarily caused by the environment and by the daily wear

and tear of traffic. This work type often consists of asphalt overlays up to 3 inches thick (with additional asphalt for rut filling), distress area repairs (may include base and subbase spot repairs) and asphalt overlay, mill & asphalt overlay up to 3 inches, or sliver grading to correct ditch foreslope or re-establish the original traveled-way-plus-shoulders width (typically 2-foot added width or less). These techniques may be applied to either existing asphalt or concrete roadways. When an overlay is between two and three inches thick the investment is a Minor Rehabilitation project. Minor Rehab falls under the FHWA Rehabilitation work type.

Structural Improvement – This work type is intended to extend the useful life of a highway by restoring the pavement structure without necessarily improving existing geometrics. In addition, the load carrying capacity is generally increased to meet the HPCS guidelines. Examples of structural improvements may be white topping (i.e. concrete overlay), crack-and-seat or break-and-seat of existing concrete (i.e. the existing concrete is either cracked and rolled to establish a firm base or is broken and rolled) with asphalt overlay, or asphalt overlay in excess of 3 inches. This work type may be applied to either existing asphalt or concrete roadways. Structural improvement falls under the FHWA Rehabilitation work type.

Major Rehabilitation/New/Reconstruction – These work types are intended to be applied where extensive work is needed to extend the service life, completely replace an existing roadway, add capacity to an existing roadway, or build a new roadway where one didn't exist previously. This work type nearly always includes new surfacing (concrete or asphalt), major work to the underlying aggregate base, and, often, work on the underlying earthen subbase. Major Rehabilitation/New/Reconstruction falls under the FHWA Highway Reconstruction and Initial Construction work types.

Routine maintenance treatments such as crack sealing/pouring, depressed crack repair, scotch patching, spray injection patching, hot and cold mix asphalt patching, bituminous seal coats, and concrete joint sealing are also performed as needed, but these treatments are not modeled by the Pavement Management System. Guidance for routine maintenance may be found in the NDDOT Maintenance Operations Manual. Routine Maintenance falls under the FHWA Preventative Maintenance work type.

The NHS in North Dakota consists of concrete, asphalt, composite, and local road pavements. Composite pavements are pavements built with combinations of asphalt and concrete. The miles of each pavement type are shown in a chart in the Asset Inventory section of this report. The NDDOT manages composite pavements by the top layer, so an asphalt pavement on top of cracked and seated concrete is managed the same as other asphalt pavements. Typically, pavements deteriorate from the environment and not from loading in North Dakota. Since the oil boom, the entire system is monitored, on a segment basis, for Equivalent Single Axle Load (ESAL) life used to account for heavy truck traffic on certain segments. The NDDOT's pavement model decision trees consider the ESAL life

used, ride, load carrying capacity, and pavement distresses, among others, on a system-wide, segment-by-segment basis.

As can be seen from the above description, NDDOT does not manage the pavements based on a timing schedule of treatments, but rather based on a performance and condition decision tree set with specific interventions called by numerous variables working together. The actual investment strategy is determined, annually, based on the OA Distribution Document discussions and subsequent model runs that identify the optimum treatments to close the gap between current and desired condition and performance. These concepts are described in more detail throughout this TAMP.

At this point in the Investment Priorities Process, the Programming Division, annually, prepares the Draft STIP for all projects to be funded over the next four-year period. With regard to Pavement Management projects, this prioritization process considers candidate projects from dTIMS and the District Priorities, noted above, using the various dTIMS outputs and other goals emphasizing: the higher level Highway Performance Classification System (HPCS) and Freight System roadways, balancing work types, geographic distribution of work, industry workloads, and stability in previously-planned projects, among other items.

II. Structures

Similar to the Pavement Management investment class, the Bridge Division uses AASHTOWare BrM to model structure performance within the state, based on the above noted funding distribution decision from the OA Distribution Document portion of the process.

Based on a robust bridge inspection program, BrM is designed to support the structure preservation program, to utilize deterioration modeling for predicting future bridge condition in order to optimize the overall structure condition given funding constraints, and to assist with planning and programming structure projects. The data BrM uses is gathered in the field from NDDOT Bridge inspectors using visual inspection processes. Cyclical Maintenance, Condition-Base Maintenance, Rehabilitation, and Replacement are work types that the software considers and optimizes for structure management reports, all as further described below.

Cyclical maintenance – These activities are performed at pre-determined intervals to preserve and delay deterioration of bridge elements or components before rehabilitation or replacement becomes necessary. Cyclical maintenance generally includes activities as indicated in the table below. Cyclical Maintenance is falls under the FHWA Preventative Maintenance work type.

NBI Item	NBI Rating	Preservation/Cyclical Maintenance	Interval (Years)	Basic Work Description
58 Deck	≥ 5	Sweep, Flush Deck	1	Sweep and collect dirt, debris from winter snow/ice treatment, other debris; flush to remove chlorides
	≥ 5	Clean Expansion Joints, Drains	1	Remove dirt, debris from joints and drains to ensure proper function
	≥ 6	Crack Seal Deck	3	Apply epoxy crack sealer to individual cracks to seal out chlorides
	≥ 6	Apply Surface Treatment (Silane) to Deck, Splash Zone	6	Apply surface treatment to decks, curbs, barriers to minimize water, chloride ingress
59 Superstructure	≥ 5	Clean Beams, Bearings	1 to 2	Clean dirt, bird droppings from beams, bearings to minimize corrosion
	≥ 6	Lubricate Bearings	3	Lubricate bearings to maintain proper functionality
60 Substructure	≥ 6	Clean Abutment and Pier Tops	1 to 2	Clean debris and chlorides to prevent corrosion
	≥ 6	Apply Surface Treatment (Silane) to Abutment & Pier Tops	6	Apply surface treatment to concrete to minimize water, chloride ingress

Condition-Based Maintenance – These activities, identified through the inspection process, are performed on bridge components or elements in response to known defects to preserve and delay further deterioration of bridge elements or components before rehabilitation or replacement becomes necessary. Condition-based maintenance improves the condition of that portion of the element, but may or may not result in an increase in the component condition rating. Condition-based maintenance generally includes work activities as indicated in the following table. Condition based maintenance falls under the FHWA Preservation work type.

Bridge Component	Preservation/Condition-Based Maintenance	Basic Work Description
Deck	Repair Deck Drains	Repair broken drains; extend drains past bottom of beams
	Repair/Replace Joints	Repair joint seals, repair or replace backer rods, reapply pourable joint filler
	Repair/Patch Concrete on Deck	Repair concrete spalls, pot holes with appropriate concrete patching material
Deck	Repair/Patch Concrete on Barriers, Railing, Curbs	Repair concrete spalls with appropriate concrete patching material
Approach	Repair/Level Approach Slabs	Repair concrete; level approach slabs
	Repair Erosion/Correct Drainage issues	Repair erosion around approaches and abutments; remedy the cause to prevent future erosion
Superstructure	Repair/Reset Bearings	Repair bearings, reset into proper alignment
	Repair/Patch Concrete on Beams	Repair concrete with appropriate concrete patching material
	Spot/Full Painting on Steel Beams, Bearings	Paint/repaint areas on steel beams and bearings to protect against corrosion
Substructure	Repair Concrete on Piers, Abutments	Repair concrete with appropriate patching materials and methods
	Repair Slope Protection near Abutments	Fill joints, restore function of slope protection
Channel	Repair Erosion, Scour	Repair erosion, scour in channel; remedy cause
	Repair Riprap, Other Countermeasures	Repair riprap, other erosion or scour countermeasures or add new to prevent erosion, scour
	Remove Debris, Vegetation from Channel	Remove debris, including branches, logs, litter, from waterway and vegetation from bank areas to protect bridge structure and maintain proper channel function
Culvert	Fill Voids	Fill voids near joints or where eroded to protect roadway above and maintain culvert functionality
	Repair/Seal Joints	Repair, seal joints to protect from infiltration and protect above roadway

Rehabilitation – These activities involve major work required to restore structural integrity as well as work necessary to correct major safety defects. Bridge rehabilitation projects

provide complete or nearly complete restoration of bridge elements or components. Rehabilitation generally includes work activities as indicated in the following table. Rehabilitation falls under the FHWA Rehabilitation work type.

Bridge Component	Minor/Major Rehabilitation	Basic Work Description
Deck	Overlay Deck	Mill deck surface, repair areas of deteriorated concrete, overlay deck with low-slump concrete
	Replace Deck	Remove all concrete from deck, repair any corroded reinforcement, place new full-depth concrete deck
	Replace Joint	Remove and replace entire joint; typically done with deck overlay or replacement project
	Repair, Replace Bridge Railing	Repair or replace damaged or unsafe bridge railing
	Repair, Replace, Add Drains	Repair, replace or add drains to provide proper drainage on deck
Approach	Repair, Replace Approach Slabs	Replace entire approach slab; typically done with deck overlay or deck replacement projects
	Repair, Replace Approach Railings	Repair or replace damaged or unsafe approach railing
Superstructure	Paint Steel	Paint or repaint steel bridge components
	Repair or Replace Beam	Repair or replace beam due to deterioration or damage
	Replace Bearings	Replace bearings to provide proper functionality
Substructure	Replace or Reinforce Pier	Replace or reinforce cracked, damaged, or deteriorated piers, restore structural integrity
	Replace Abutment	Replace abutment to restore structural integrity
Culvert	Restore Flow Line	Repair damaged or deteriorated culvert invert to maintain or provide proper flow
	Restore Structural Integrity	Repair culvert to restore structural and functional (hydraulic) integrity, when feasible

Replacement – These activities involve the complete replacement of an existing structure with a new facility to meet current design standards for the types and volume of projected traffic over its design life. Replacement typically includes a nominal amount of approach work sufficient to connect the new facility to the existing roadway. Replacement falls under the FWHA Replacement work type.

Using BrM, Bridge Division prepares a list of structures with an NBI rating of 5 or less for internal review. Potential priorities are also submitted by the Districts for consideration in the development of investment priorities. Using the fiscally-constrained budget determined in the OA Distribution Document phase, quantitative and qualitative analysis is performed and a list of projects are submitted to Programming Division for incorporation into the Draft STIP. As part of the qualitative analysis, consideration is given to the Highway Performance Classification System (HPCS), Freight Levels, AADT, balancing work types, geographic distribution of work, project bundling, strategic initiatives, funding constraints, as well as other items.

As with pavements, at this point in the annual Investment Priorities Process, the Programming Division prepares the Draft STIP for all projects to be funded over the next four-year period. Generally, the Bridge project priorities are included in the Draft STIP, verbatim as received from the Bridge Division, because the qualitative considerations were addressed as noted above.

Later in the process, projects in the draft STIP are loaded into the dTIMS model, and the 20-year impact of the STIP is compared to the state of good repair. This allows the NDDOT to not only track its performance and ensure it is programing projects that move toward the long term state of good repair, but also to look at any projects that are being programmed that do not seem to follow model recommendations. Those projects can be reviewed to see if future model improvements need to be made or if the project should be programmed at all. Additionally, dTIMS is run with any updates to the budget, with no projects committed, to obtain a new optimized overall system condition. These two runs provide information about the impacts of the proposed Draft STIP on the overall system condition as compared to the "optimum" condition for the given budget. These are also compared to the long-term and short-term goals established in the earlier steps of this process. Additionally, a comparison of the projects programmed in the STIP to the dTIMS recommendations is made and a percentage match is determined (with a match consisting of the same work type programmed within two years either side of the recommended year; for the purpose of matching work types, minor rehabilitation and preventative maintenance work types are considered matches). All of this information, the Draft STIP itself, and other analysis reports are, then, presented at a meeting with all of the Engineering Division Directors and District Engineers to obtain their input, before this same information (revised, as needed, from the input) is presented to the executive team, consisting of the Deputy Director for Engineering and all three Engineering Office Holders for final approval to publish for public comment.

Since the STIP is a short term document, a short term prediction of the system performance resulting from the draft STIP is also produced by loading the draft STIP projects into the dTIMS model. This allows the NDDOT to see if the proposed STIP is moving current conditions toward or away from a short-term state of good repair. The results of these analyses are reported to the executives prior to their approval for advertising the draft STIP for public comment. Following public comment, the pavement and bridge project lists are revised, as needed, for the Final STIP, and the modeling and meeting steps are repeated for final approval and adoption of the STIP.

The current aspirational goals for pavements and structures are as follows:

Asset Class	Current Performance Measure Condition	Aspirational Long Term Performance Measure Condition at Year 20	Fiscally Constrained Long Term Goals at Year 10
Pavements – (Average IRI)	78.8	74.9	88
Structures – (Average Bridge Heath Index)	93.5	98.2	92

In addition to the above, federal regulations designate minimum system conditions for Interstate pavements and NHS structures. For bridges and culverts 20 feet or longer, no more than 10% of these NHS structures, as measured by deck area, are allowed to fall into a poor condition. For pavements, no more than 5% of the Interstate pavements may fall into poor condition. The NDDOT has set performance targets in accordance with the structure and pavement performance measures defined by MAP-21 and continued in the FAST Act to reflect investment strategies that work toward achieving a state of good repair over the life cycle of assets at a minimum practical cost. Currently, the NDDOT's structures and pavements on the NHS are typically in good condition. NHS structures are maintained at a higher condition level than the lower service tiers without sacrificing safety of the traveling public. The majority of the traffic uses the NHS roadways. Therefore, the level of service is expected to be greater than the average of the whole system.

The Department's two and four year infrastructure condition targets are in the following table. Per 23 CFR490.105(e)(7) 2-year interstate pavement targets are not needed for the first reporting period. The current 2018-2021 performance period is the first reporting period. All targets are percentages. The criteria for a pavement or bridge being considered good or poor are defined nationally by FHWA. The Department has higher standards for what is considered acceptable condition. As a result of this, current pavement and bridge conditions are better than all 2- and 4-year targets. Because of this, there is no gap between expected performance and existing performance in terms of the federal measures. The gaps the Department analyzes are in terms of the state's stricter metrics and higher expectations than the federal performance metrics. As more historical data for the federal measures is obtained, the Department may be able to set more aggressive federal targets if desired by the public. Strategies for addressing state gaps are in the form of varying condition treatments for pavements and bridges identified in the pavement and structure sections earlier in this document.

Federal Pavement Measures and NDDOT Defined Short-Term Targets		
Measure	Target	Current Condition
% Interstate Good 4-Year Target	75.6	80.2
% Interstate Poor 4-Year Target	3.0	0.1
% Non-Interstate NHS Good 2-Year Target	58.3	78.5
% Non-Interstate NHS Good 4-Year Target	58.3	
% Non-Interstate NHS Poor 2-Year Target	3.0	3.4
% Non-Interstate NHS Poor 4-Year Target	3.0	
Federal Bridge Measures and NDDOT Defined Short-Term Targets		
% Deck Area of NHS Bridges Good 2-Year Target	60.0	65.3
% Deck Area of NHS Bridges Good 4-Year Target	60.0	
% Deck Area NHS Bridges Poor 2-Year Target	4.0	3.8
% Deck Area NHS Bridges Poor 4-Year Target	4.0	

I. Sources of Gaps for Pavements

The primary obstacle or deficiency to achieving a state of good repair for the NHS is a lack of funding. Additionally, adding asphalt and concrete overlays to existing pavement sections narrows the roadway over time. This creates roadway width challenges as the pavement is maintained throughout its life cycle. Gap sources are reviewed for each identified Life Cycle Plan through the Risk Management process detailed later in this TAMP.

II. Sources of Gaps for Structures

In recent years, the NDDOT has been performing routine structure maintenance and preservation work across the state with continued emphasis on the importance of preservation and maintenance of our structures. Of the structures, nearly half are 50 years or older, and nearly 60% were built between the 1950's and 1970's, many as part of the Interstate system. A larger number of structures are near or beyond their design life with that number growing faster than they can be replaced. Increased funding and a rigorous maintenance program will be needed to maintain the NHS in good or fair condition. These issues, and others, are obstacles to maintaining the desired state of good repair and are considered through the Risk Management process.

The NDDOT has chosen to continue to define "State of Good Repair" based on overall system performance, as noted above, rather than managing based on only the impacts to the NHS. Considering the current condition of the NHS in North Dakota, as noted elsewhere in this document, it seems unlikely that unacceptable NHS conditions will occur in the near term. Therefore, NDDOT has determined that simple monitoring of those federal measures is all that is necessary, at this time, but will revisit that decision as may be needed.

Life Cycle Planning Outcomes

Currently, projecting **future** performance gaps is a highly uncertain (i.e., risk-filled) activity due to federal funding volatility and unpunctuality, meaning there is substantial risk that projected performance gaps will be incorrect due to inaccurate forecasts of available federal funding. Compounding this effect, current federal and state transportation revenues in North Dakota are insufficient to achieve the desired long-term condition and performance of the system; additionally, the state one-time supplemental revenues (from ad hoc, non-traditional transportation sources) have ranged from $0 to 100's of millions of dollars in a biennium since 2007, leaving no practical way for NDDOT to predict, with certainty, available future funding. Nonetheless, NDDOT computes current and projected performance gaps based on the best available information for reasonably expected revenues to be realized. A group of asset experts with input from local North Dakota Division FHWA staff generated the following life-cycle plan (LCP) strategies using the Department's trade off hub. These were all tied to realistic investment levels and were analyzed for risks as outlined in the risk section of the TAMP. The LCP's and their resulting system conditions are in the following tables:

Life Cycle Plan	LCP 1	LCP 2	LCP 3
Annual Investment	$206.5M	$206.5M	$283M
Pavement Management Investment Level	$186.5M	$176.5M	$223M
Bridge Management Investment Level	$20M	$30M	$60M
Projected Pavement System Condition Year 10 (International Roughness Index)	89.69 (Good)	91.41 (Good)	85.02 (Good)
Projected Bridge System Condition Year 10 (Bridge Health Index)	87.39 (Unacceptable)	87.99 (Acceptable)	89.56 (Acceptable)
Projected Pavement System Condition Year 20 (International Roughness Index)	108.49 (Fair)	111.00 (Fair)	100.52 (Fair)
Projected Bridge System Condition Year 20 (Bridge Health Index)	82.81 (Unacceptable)	84.33 (Unacceptable)	87.37 (Unacceptable)

These LCP's show how different investment levels that are financially realistic and analyzed for risks over a 10-year period can be used to develop shorter term investment strategies for the STIP using the OA Distribution Document. The OA distribution document can then be used to determine if the TAMP is being implemented.

Life Cycle Plan 1 is maintaining typical investments levels for pavements and bridges. This results in unacceptable bridge condition in year 10. Life Cycle Plan 2 shifts funding from pavements to bridges. This will allow bridges (≥88) due to rounding and pavements (<100 in/mi) to stay in acceptable condition at year 10 of the analysis period. Finally Life Cycle Plan 3 is an increase in overall investment in pavements and bridges. This would require additional outside revenue or shifting Department resources from services to infrastructure. Life Cycle Plan 3 results in year 20 outcomes that are close to acceptable for pavements and bridges. Each of the analyzed life cycle plans result in the Department meeting it's federal performance measure two and four year targets.

The Department also is in the process of refining its predictive model for pavements and its distress scoring methodology. This has not been completed and current models are the same as the Initial TAMP.

Financial Planning Outcome

First, it is important to understand the difference between revenue and budget. Asset management is not a budgeting exercise or activity; it focuses on the expected revenue, instead. Revenue is the actual money that comes in or is forecast to come in, while budget is the authority to spend that money. Both are needed in a government setting to expend funds. However, the timing of receipts impacts budgets independently of the practice of asset management. For example, the federal transportation program is a reimbursement program, meaning the NDDOT must spend the funds and then request, from the Federal Highway Administration (FHWA), the "replacement" cash, which is limited by federal fiscal year. Because the main construction season and the federal fiscal year are split by the North Dakota state fiscal year, it is common for expenditures to occur in one state fiscal year and the revenue to be realized in the next. This results in budget values that do not align with necessary asset management related revenue forecasts. In any given state fiscal year, a budget may contain authority to spend money that was received in a previous state fiscal year or is appropriated at the federal level to be received in the next state fiscal year. Regardless of this misalignment, asset management assumes the revenues will be realized in the "year" the project is planned. This assumption can be made because NDDOT regularly receives cash reimbursement for past project expenditures and has authority to borrow cash from the state-owned Bank of North Dakota to manage its cash flow, within the limits of known revenue streams.

NDDOT's revenue for preserving the NHS in and improving it to a state of good repair primarily comes through federal funds. During the recent oil boom of 2008-2016, large state general fund investments were made for transportation capital projects in the western part of the state, allowing federal funds to be shifted to the central and eastern parts of the state. Subsequent to the oil boom, transportation capital investments have been adjusted to be primarily federal funds, again. As described in more detail later in this section, nearly all revenues for routine maintenance of the NHS come from state sources.

As can be seen in the overall biennial budget charts for 2017-19 (see the next two pages for Enrolled Senate Bill 2012), roughly 50% of NDDOT's total budgeted revenues, for all purposes, comes from federal sources. The remaining 50% comes from state fuel taxes, drivers' license fees, motor vehicle registration fees, financial account interest, services to other state agencies (e.g. fleet rental), and miscellaneous other items. These revenues fund not only capital projects on the pavements, structures, and other highway assets, but routine maintenance activities and all other NDDOT operations and programs. While the included charts cover only the 2017-19 biennium, they represent the typical known funding sources upon which all revenue forecasts (regardless of timeframe) rely for the types of funding expected to be available.

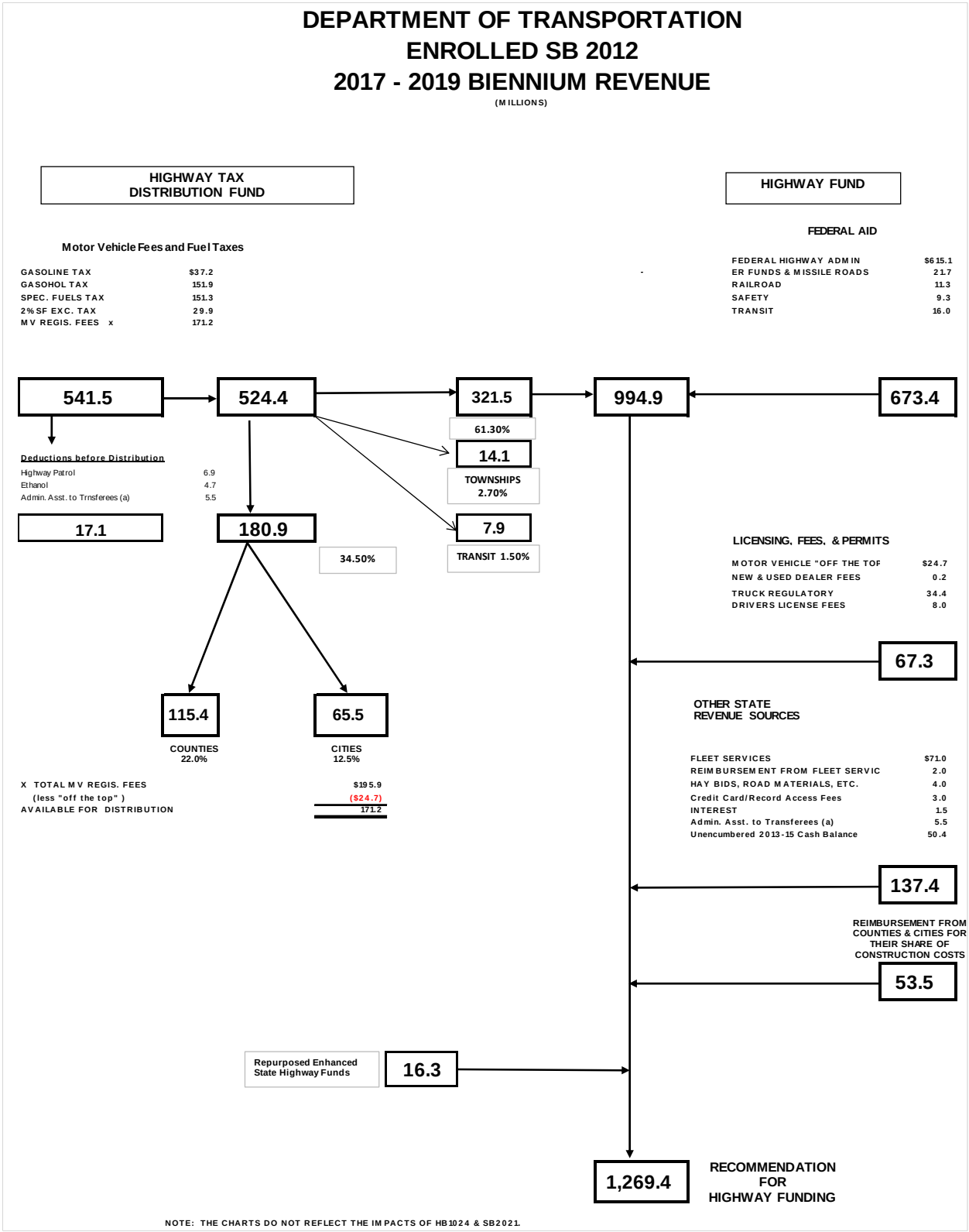


FIGURE 12 – SAMPLE REVENUES CHART, SUMMARIZING NDDOT BUDGET BILL FUNDING SOURCES.

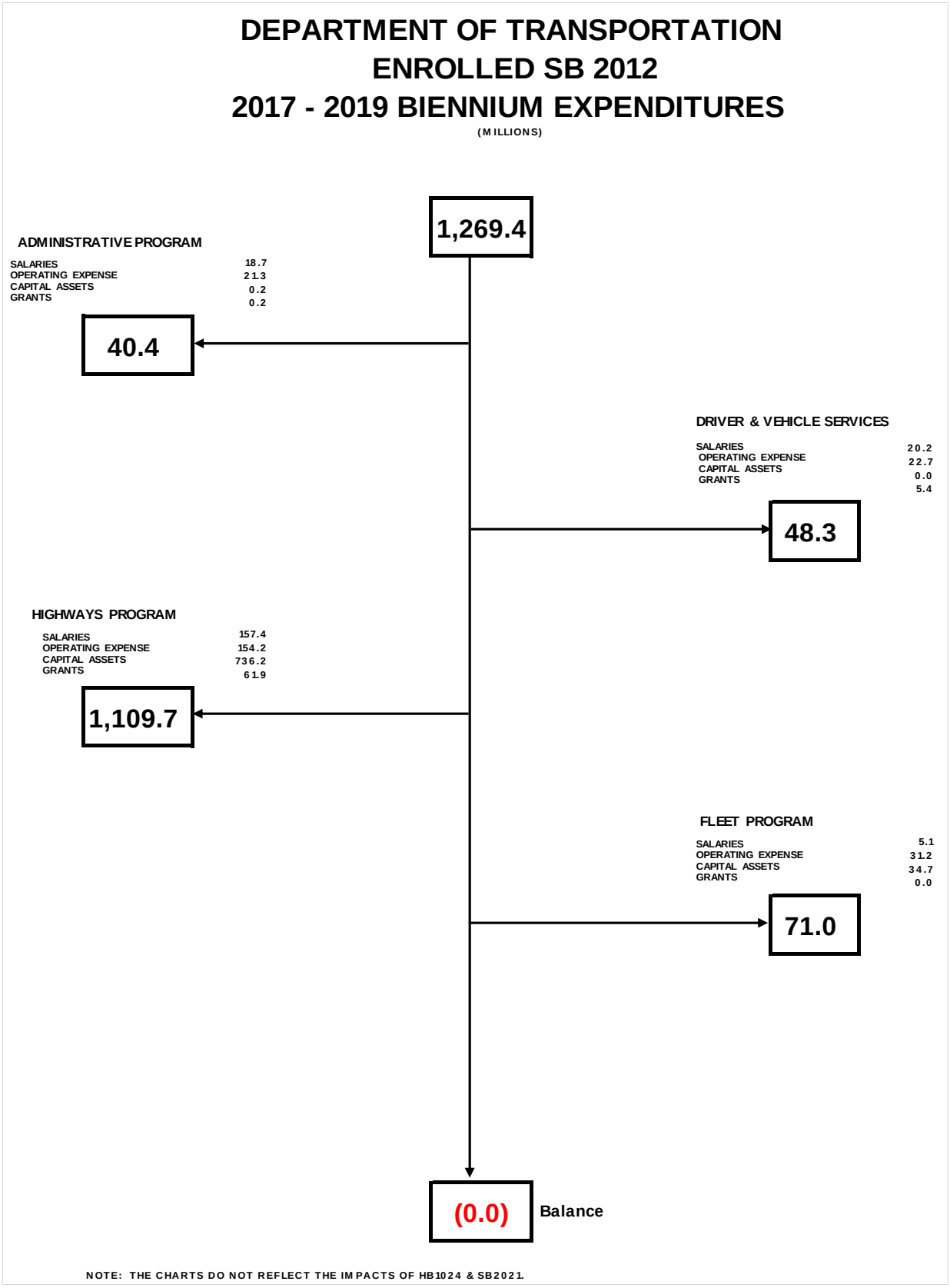


FIGURE 13 – SAMPLE EXPENDITURES CHART, SUMMARIZING NDDOT BUDGET BILL.

This TAMP focuses on the revenues and expenditures dedicated to highway assets (i.e., NHS pavements and structures).

The Financial Plan development in NDDOT starts with the OA Distribution Document development, noted in the Investment Priorities Process description. The draft OA Distribution Document is prepared by the Programming Division based on the federal apportionment noted in the current federal transportation bill, any known one-time funding appropriated by the state biennial legislative process, estimated federal end-of-year redistribution, any carryover funding, and similar ad-hoc funding that may exist in a given year. These revenues are, then, split into the major program areas (and investment classes) to generate the Draft OA Distribution Document, covering the subsequent 5-year period.

See the below figure for a sample OA Distribution Document that includes the comparison developed for the Draft STIP approval stage of the Investment Priorities Process. These grey comparison columns allow the executives to determine how closely their initial investment strategy was followed in the actual projects proposed for the Draft STIP being requested for approval.

DISTRIBUTION OF OBLIGATIONAL AUTHORITY (OA)

All Dollars are shown in Federal Funds (in thousands)

	2019	DRAFT STIP 2019	2020	DRAFT STIP 2020	2021	DRAFT STIP 2021	2022	DRAFT STIP 2022	2023
Total OA [1]	**$268,520**	***$300,162***	**$274,940**	***$297,912***	**$280,439**	***$295,272***	**$286,048**	***$305,959***	**$291,769**
Safety State [7][3]	$5,500	*$15,388*	$5,500	*$5,948*	$5,500	*$4,148*	$5,500	*$483*	$5,500
Safety LRSP [7][3]	$5,500	*$975*	$5,500	*$160*	$5,500	*$369*	$5,500	*$0*	$5,500
TAP to Urban Grant [10]	$1,660	*$1,660*	$1,660	*$1,660*	$1,660	*$1,660*	$1,660	*$1,660*	$1,660
Urban [2][9]	$38,296	*$35,836*	$39,539	*$42,430*	$40,374	*$39,388*	$41,227	*$42,281*	$42,097
Urban to Urban Grant [10]	*$2,000*	*$2,000*	*$2,000*	*$2,000*	*$2,000*	*$2,000*	*$2,000*	*$2,000*	*$2,000*
County [2][9][12]	$20,815	*$21,135*	$21,589	*$21,909*	$22,024	*$22,344*	$22,467	*$22,787*	$22,919
ND STREET [7]	$3,000	*$2,993*	$3,000	*$0*	$3,000	*$0*	$3,000	*$0*	$3,000
Rural to Urban Grant [10]	$1,000	*$1,000*	$1,000	*$1,000*	$1,000	*$1,000*	$1,000	*$1,000*	$1,000
PEP [5]	$28,082	$28,082	$27,929	$27,929	$28,173	$28,173	$28,016	$28,016	$28,262
Seals	$10,000	*$10,000*	$10,000	*$10,000*	$10,000	*$10,000*	$10,000	*$10,000*	$10,000
Mega Bridges [6]	$0	*$0*	$0	*$0*	$0	*$0*	$7,122	*$7,122*	$0
Bridges [7]	$9,000	*$9,216*	$9,000	*$10,493*	$9,000	*$8,696*	$9,000	*$6,687*	$9,000
Bonds	$4,301	*$4,301*	$4,300	*$4,300*	$0	*$0*	$0	*$0*	$0
State Discretion TAP [13]	$0	*$0*	$0	*$0*	$0	*$0*	$0	*$0*	$0
TAP [7][8]	$1,660	*$1,660*	$1,660	*$1,660*	$1,660	*$1,660*	$1,660	*$1,660*	$1,660
Rural OA	**$137,706**		**$142,264**		**$150,548**		**$147,896**		**$159,172**
Rural plus PEP & SEALS OA	**$175,788**		**$180,193**		**$188,721**		**$185,912**		**$197,434**
Rural $$ Over Programmed		**$28,210**		**$23,160**		**$22,286**		**$31,367**	
Rural % Over Programmed		**16.0%**		**12.9%**		**11.8%**		**16.9%**	

NOTES:

(1) 2016 at $252 M per FAST ACT, about 2% increase each year after per FAST ACT, but using actual from Schedule A. 2021, 2022 & 2023 are 2% increase upon the prior year.
(2) 14.7% (U) & 7.6% (C) for 2016; 14.8% (U) & 7.7% (C) for 2017; 15.0% (U) & 7.8% (C) for 2018; 15.1% (U) & 7.8% (C) for 2019; 15.2% (U) & 7.9% (C) for 2020 based on Schedule A. 2021 & beyond held at 2020 levels.
(3) The Districtwide SRSP for 2017/2018/2019 do include some LRSP items, but them are all included with the Safety State numbers.
(4) NA
(5) Rec Trails in the amount of $1,010 (90% of apportionment) included for each year based on ND 2009 FY App.
(6) Kennedy & Minot Viaducts in 2017, Washington Underpass in GF (2022) & Oslo in 2025 (TBD?).
(7) Amounts shown are the budget to be reserved.
(8) 57.57% for Urban, 42.43% for County; transfer of $1.6 OA to Urban Grant per 1/3/18 Dec Doc; Per FAST Act used $1.62 for 16 & 17 & $1.66 for 18-20.
(9) Urban and County does not include TA portion.
(10) Urban Grant Program per 1/3/18 Dec Doc. $1M Urban & Regional each, $1M Rural, $1.6M Tap Transfer. Starts in 2018/2019.
(11) NA
(12) County includes approximately $6 M per year for Bridges with the remainder for county roadways.
(13) Velva (FFY 2017) moved to (FFY 2018) and Brick Mine Bridge Rehabilitation (FFY 2016) per Decision Document (TAP funds transferred to STP).

FIGURE 14 – SAMPLE OA DISTRIBUTION DOCUMENT, INCLUDING STIP COMPARISON.

Although a 10-year forecast is required, the Department elects to extend that timeframe to 20 years in order to capture the long term impacts of investments. During the risk analysis of the LCP however, a 10-year planning horizon is considered for reasons described in the risk section. After the Draft OA Distribution document (without the STIP comparison columns) is developed, this information and the Tradeoff Hub results for 20-year projected system-level outcomes resulting from this investment strategy are presented to the Deputy Director for Engineering and other executive staff. At this stage, the Tradeoff Hub is typically based on the previous year's data (including 20-year funding estimate extrapolated from the previous OA Distribution document) and previous year's model runs. This must be done because the most recent condition-data collection isn't typically fully processed for either pavements or structures at this point, meaning new model runs aren't available. During this presentation meeting, the executives typically request to see the estimated 20-year performance results of investment strategy scenarios other than the one presented. Once the executives choose an investment strategy covering all state-owned pavements and structures (among other investment classes), the OA Distribution Document is finalized. These funding levels are, then, given to the investment class managers to be extrapolated for the necessary 20-year period (using a constant growth rate of 1-3% per year) and to be modeled when the newest condition data is available.

The following is a table with estimated revenue for pavements and bridges as well as the estimated costs for pavement preservation and bridge preservation work types only. These costs and funding predictions are used in the Department's models, which in turn are used to generate the Life Cycle Planning Scenarios by loading the results into the Trade-Off Hub.

Year	Estimated Revenue (in Millions)	Estimated Pavement Work Type Costs (in Millions)	Estimated Bridge Work Type Costs (in Millions)	Estimated Costs (in Millions) Pavements and Bridges Combined
2018	$196	$145	$25	$170
2019	$200	$148	$25	$173
2020	$204	$151	$26	$177
2021	$208	$154	$26	$180
2022	$212	$157	$27	$184
2023	$216	$160	$27	$188
2024	$221	$164	$28	$191
2025	$225	$167	$28	$195
2026	$230	$170	$29	$199
2027	$234	$174	$30	$203
2028	$239	$177	$30	$207
2029	$244	$181	$31	$211
2030	$249	$184	$31	$215
2031	$254	$188	$32	$220
2032	$259	$192	$33	$224
2033	$264	$195	$33	$229
2034	$269	$199	$34	$233
2035	$275	$203	$35	$238

Year	Estimated Revenue (in Millions)	Estimated Pavement Work Type Costs (in Millions)	Estimated Bridge Work Type Costs (in Millions)	Estimated Costs (in Millions) Pavements and Bridges Combined
2036	$280	$207	$35	$243
2037	$276	$212	$36	$248

The planning estimate in the chart below is the predicted cost of future planned pavement work by FHWA work type.

Year	Preservation ($Million)	Rehabilitation ($Million)	Initial Construction/Reconstruction ($Million)
2020	$30.4	$115.2	$2.5
2021	$49.5	$62.8	$35.6
2022	$33.9	$103.8	$10.3
2023	$33.8	$63.7	$50.6
2024	$60.3	$41.4	$30.2
2025	$58.4	$87.4	$2.2
2026	$81.1	$63.8	$2.9
2027	$94.3	$52.8	$0.9
2028	$120.4	$26.4	$1.3
2029	$84.0	$64.1	$0.0
2030	$114.2	$33.9	$0.0

The planning estimate in the chart below is the predicted cost of future planned bridge work by FHWA work type. The bridge investments are split 50/50 as the Department works to replace a backlog of older bridges.

Year	Replacement ($Million)	Rehab/Repair ($Million)
2020	$13	$13
2021	$13	$13
2022	$13.5	$13.5
2023	$13.5	$13.5
2024	$14	$14
2025	$14	$14
2026	$14.5	$14.5
2027	$15	$15
2028	$15	$15
2029	$15.5	$15.5
2030	$15.5	$15.5

The Department also tracks construction costs over time to project future costs. The current 10-year average inflation rate is an approximate 4% increase in costs per year.

Overall Construction Cost Index			
Construction Year	Adjusted to Base Year	Index	Year by Year Change %
2001*	-	100	-
2002	$77,645,225	110	10
2003	$77,953,406	110	0
2004	$75,503,275	107	-3
2005	$78,535,121	111	4
2006	$94,521,333	134	20
2007	$102,581,103	145	9
2008	$115,891,707	164	13
2009	$133,064,330	188	15
2010	$122,788,915	174	-8
2011	$151,097,368	214	23
2012	$162,297,310	229	7
2013	$189,106,646	267	17
2014	$203,683,730	288	8
2015	$203,761,457	288	0
2016	$173,479,381	241	-16
2017	$157,982,550	221	-8
2018	$163,430,121	231	4

The Department also tracks costs by treatment type within the bridge and pavement work types. This forecasting of work type costs is required by federal regulations.

Asphalt Pavements per Mile Costs In Thousands of Dollars						
Year	Preventative Maintenance Asphalt	Minor Rehabilitation Asphalt	Minor Sliver Grade	Structural Overlay	Structural Overlay Interstate Only	Major/Reconstruction
2019	$180	$265	$425	$850	$985	$1,500
2020	$187	$276	$442	$884	$1,024	$1,560
2021	$195	$287	$460	$919	$1,065	$1,622
2022	$202	$298	$478	$956	$1,108	$1,687
2023	$211	$310	$497	$994	$1,152	$1,755
2024	$219	$322	$517	$1,034	$1,198	$1,825
2025	$228	$335	$538	$1,076	$1,246	$1,898
2026	$237	$349	$559	$1,119	$1,296	$1,974
2027	$246	$363	$582	$1,163	$1,348	$2,053
2028	$256	$377	$605	$1,210	$1,402	$2,135
2029	$266	$392	$629	$1,258	$1,458	$2,220

Concrete Pavements per Mile Costs in Thousands of Dollars			
Year	Preventative Maintenance Concrete	Minor Rehabilitation Concrete	Major/Reconstruction and Interstate
2019	$100	$150	$2,400
2020	$102	$153	$2,448
2021	$104	$156	$2,497
2022	$106	$159	$2,547
2023	$108	$162	$2,598
2024	$110	$166	$2,650
2025	$113	$169	$2,703
2026	$115	$172	$2,757
2027	$117	$176	$2,812
2028	$120	$179	$2,868
2029	$122	$183	$2,926

Bridge Costs Per Square Foot of Deck Area in Dollars		
Year	Rehabilitation	Replacement
2019	$50	$500
2020	$52	$520
2021	$54	$541
2022	$56	$562
2023	$58	$585
2024	$61	$608
2025	$63	$633
2026	$66	$658
2027	$68	$684
2028	$71	$712
2029	$74	$740

The value of the NHS in North Dakota is approximately $8.4B although the cost to rebuild the NHS due to failure cannot be calculated with current methods. The Department intends to increase our asset valuation capabilities.

Risk Analysis Outcome

Risk Management, at its core, is the practice of methodically and systematically addressing the impacts of uncertainty (positive and negative) affecting the ability to achieve one's goals. This practice includes predicting, evaluating, prioritizing, and responding to these uncertainties (i.e. risks). Responses may include: Avoid, Transfer, Enhance, Accept or Mitigate. An example of a positive risk (uncertainty) might be the potential for aerial drones to reduce the truck volumes, resulting in slower pavement deterioration and fewer and/or lower-cost projects being required over a set evaluation period and, therefore, causing less funds being needed to reach the desired state of good repair. As can be seen through this example, the goal of risk management is to reduce uncertainty in managing and forecasting the system performance as they relate to achieving a goal. Stated more plainly, risk management seeks to analyze the systems, processes, and infrastructure to identify prioritized improvements that will aid in predicting NDDOT's ability to achieve its goals.

Historically, the NDDOT conducted risk reviews periodically with FHWA and internally on major program areas, on an ad hoc basis. The NDDOT-lead risk reviews were tied to Departmental risks, which can affect the condition and performance of the NHS. Recent NDDOT risk reviews included reviews of the risks toward department revenue, risks toward implementing an urban grant program, and risks related to implementing longer inspection intervals for culverts. In the past, when risks were identified, the NDDOT would develop a process to minimize or eliminate a negative risk if possible.

NDDOT risk reviews are now conducted using FHWA Publication No. FHWA-NHI-17-004 – *Participant Workbook* processes learned through the National Highway Institute (NHI) course *FHWA-NHI-136065 – Risk Management*, for which NDDOT was a pilot test state during the development of the course. The

process is summarized on the following page, reprinted from FHWA-NHI-17-004 Appendix A. The method results in a risk register where likelihood, impact and responses are documented. Risks that rank high on the register (high likelihood and impact) are typically addressed first. Additionally, facilities repeatedly impacted by emergency events were analyzed following the process outlined in the next section of the TAMP.

APPENDIX A - RISK MANAGEMENT PROCESS – OVERVIEW, QUESTIONS, TOOLS, OUTPUTS

Steps: What do I do?	Tools and Techniques: What are the questions and what tools can I use to answer them?		Output: What is the product of this step?
Communication and Consultation occur at each step	Who needs to be involved? How will we communicate and consult with them?	FMFIA Risk Profile, Stewardship Agreement	Meetings, verbal or written reports, surveys, teams, leadership activities
Identify the Context	What program or other objective areas will we assess? What are the things to consider when we assess them? What criteria will we use to assess our risks? Who will do the assessment?	FMFIA Risk Profile, Program Areas, Strategic Plan, SIP, Unit Plan	An understanding of the risk context and the objectives against which risk will be managed
Identify the Risks	What events could happen that would affect my program areas or objectives? What are the corresponding impacts? What are my If...then… statements?	Brainstorming Strengths, Weaknesses, Opportunities and Threats (SWOT) Subject matter experts Surveys	A list of risk statements
Analyze the Risks	What is the severity of this impact according to my criteria?	Impact Criteria	A risk register, with risk events, likelihood of occurrence, and impact levels. Draft response strategies may be included.
Assess Impact			
Assess Likelihood	What is the likelihood that this risk event will occur?	Likelihood Criteria	
Prioritize Risks	How do the risks compare? What is the relative ranking of each risk statement? Which risks does leadership consider the "key risks?" Which risks will require a response?	Heat Map Rank Order Risk Tolerance Leadership Validation Consultation	A prioritized risk register. Key risks are selected for response and reporting at the national level.
Plan and Execute Risk Response Strategies	What actions will we take to mitigate, avoid, accept, transfer, or enhance our risks? Are there ongoing actions to continue? What actions are important to take now? Who is accountable, when will they start, and when will it be done?	Response Context Corporate, Unit, and Individual Performance Plans	Risk response strategies are developed and included in agency, unit, and individual plans
Monitor, evaluate, and adjust	What is the status of our response actions? Are they completed, in progress, not started, or has the action been deferred? Did the action have the desired effect? What is the residual risk and how should we respond?	Risk Tracker Roll up, Dashboards, Monitoring, Response level	A risk register, with current status of response strategies. Risk Tracker - Leadership Team Dashboard

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FIGURE 15 – PUBLICATION NO. FHWA-NHI-17-004, APPENDIX A; RISK MANAGEMENT PROCESS FLOW USED BY NDDOT.

In the future, the NDDOT will conduct risk assessments during performance based planning document updates (e.g. TAMP, LRTP, Freight Plan, etc.). The assessments of condition and performance risk to NHS pavements and structures will include extreme weather, the below described repeated damage

analysis, budget uncertainty, operational risks such as asset failure, and strategic risks such as regulatory compliance, among others. The results of these assessments, which include likelihood and impact of the risks as well as proposed response actions will be presented to the public during the plan public outreach. Risks and responses will be finalized by expert task groups in each risk subject, utilizing the group's professional judgement determined through various consensus-building techniques. When the risk and responses are finalized, they will be documented in a mitigation plan document and individuals will be assigned risk monitoring duties, which include periodic reports. Reporting frequency will be outlined in the risk mitigation plan. The individual monitoring actions for each assigned risk will be assigned to a NDDOT employee with expertise in the risk. Risks to NHS structures will typically be monitored by the Bridge Division and risks to NHS pavements will typically be monitored by the Planning/Asset Management Division. A summary of identified risks found during this TAMP's update is included in the appendix.

Many of the risks identified during this plan update had low risk ratings. This was either due to low probably or low impact. All risks in this plan used a 10-year planning horizon, meaning the probability and impact had to be realized within the next 10 years. The further into the future the planning horizon examines, the probability of a risk being realized increases. Utilizing a 10-year horizon allows the Department to prioritize the risks it manages.

This TAMP addresses three prioritized risks, one for each LCP identified during the Investment Priorities Process. All other risks that were analyzed are in appendix A. Therefore, during the next TAMP update, they can be reconsidered along with any new risks.

LCP 1 (Maintain Current Investment Strategy) –

Risk: If the Department invests at our current levels in bridges, then by 2030 our models predict that more than 10% of our structures by deck area will be in poor condition, resulting in a loss of ability to properly manage all non-NHS bridges.

Response: *Mitigate by monitoring condition and reallocating funds as needed, Planning/Asset Management Division to monitor and report annually.*

LCP 2 (Shift $10M in Pavement Preservation investments to Bridge Preservation) –

Risk: If the Department does not adjust the funding distribution between pavements and bridges to this level, then modeled system pavement IRI remains under 100 and modeled system bridge health index falls below the 88 for the 10-year forecast, resulting in reduced acceptable service from bridges.

Response: *Avoid by monitoring investment levels, Planning/Asset Management Division to monitor and report annually.*

LCP 3 (Increase Overall Investment by $76.5M Annually Above Current Investment Levels)-

Risk: If transportation investments increase by $76.5M, then there may be increased external influence and/or control of investment decisions, resulting in the reduced ability of the Department to implement the TAMP with the potential to reduce federal share on projects (i.e. increased local match).

Response: *Mitigate by monitoring and informing key external partners, Planning/Asset Management Division to monitor and report annually.*

Overall, NDDOT's goal is to take a multi-disciplinary, prioritized, and systemic view of risk management, generally not a project-level view for the purposes of influencing asset and investment management decisions. As an example, if the above noted risk analysis process were to indicate that flood damage is a high-priority risk to the infrastructure and the services provided, one possible mitigation strategy may be to develop a program and invest class for identifying and prioritizing flood mitigation investments. Regardless, the above-noted risks and responses identification process may influence individual, project-level decisions or segment-level identification, depending on the specific items identified. Ultimately, this will be determined through the response analyses discussed above. Such responses may include changes to policy or procedure related to any phase of the overall investment process, including goal setting, work type selection or definition, and project scoping, among others. If such changes adjust procedures noted in this document, the TAMP will be updated, accordingly. Additionally, it should be noted that NDDOT already mitigates the risk of assets deteriorating faster than expected, through its inspection programs and the ability of the districts to submit any segment or bridge for consideration in the Investment Priorities Process.

One area in which NDDOT has utilized risk analysis is the development of a longer inspection cycle for reinforced concrete box culverts in good condition. With permission from FHWA and as outlined in 23 CFR Part 650 – BRIDGE, STRUCTURES, AND HYDRAULICS the Department changed the inspection cycle of these types of structures from 24 month to 48 months when they meet the agreed upon criteria.

Facilities Repeatedly Impacted By Emergency Events

In accordance with 23 CFR 667, NDDOT conducted statewide evaluations where applicable on facilities that were repeatedly damaged on two or more occasions due to ER events. NDDOT took reasonable actions to determine the locations and corrective actions that occurred at each location based on available data. NDDOT also received data from the ND FHWA Division office in determining past authorization of Emergency Relief projects within the state.

23 CFR 667 requires states to evaluate ER sites beginning from January 1, 1997. Data prior to 2009 related to the exact damage and location is very limited to NDDOT. NDDOT used an existing database and information provided by the ND FHWA Division office in compiling this information.

NDDOT determined there has been 15 locations where facilities on the NHS were repeatedly damaged by two or more emergency events. NDDOT mapped these locations based on the data available and grouped sites in close proximity to each other. Locations that were fairly close or overlapped based on the permanent repairs that were completed, were considered "a location or group" where an evaluation was considered necessary.

Based on the evaluations conducted related to the NHS sites, NDDOT has either mitigated or minimized the chance of damage reoccurring again at these locations. NDDOT has prepared a report of these locations. The report is included in appendix B.

Data Management

The Tradeoff Hub can generate investment strategies for varying funding levels, on the fly, as it approximates the results of the more robust pavement and structure models. The pavement model, for example, can take several hours to produce results after being given a specific funding scenario. Therefore, the model is run with multiple budgets prior to meeting with the executives. The results of those runs (i.e., 20-year, annual-condition projections) are loaded into the Tradeoff Hub. As an example, the dTIMS pavement model was most recently given 16 different funding levels ranging from $40 Million to $500 Million at regular intervals. The model optimizes the treatments for each funding level and produces a 20-year projection of the performance resulting from each of the scenarios in terms of the model's and long-range goal's performance measure (i.e., IRI for pavements). The same process is used for the Bridge Model to feed the Hub. If the executives wish to review an investment level that does not match one of the pre-selected investment levels, the Hub interpolates the projections between the next investment level higher and lower than the selected investment level. Changes between funding levels are not necessarily linear (as can be seen in the figure below); so, the selected investment level must be checked with the more robust pavement and structure models. However, the Tradeoff Hub essentially allows the executive team to generate and react to as many investment strategies, in real time, as they see fit. Since the Tradeoff Hub is loaded with outputs from the more robust models, it benefits from the data QC/QA for those models, as well.

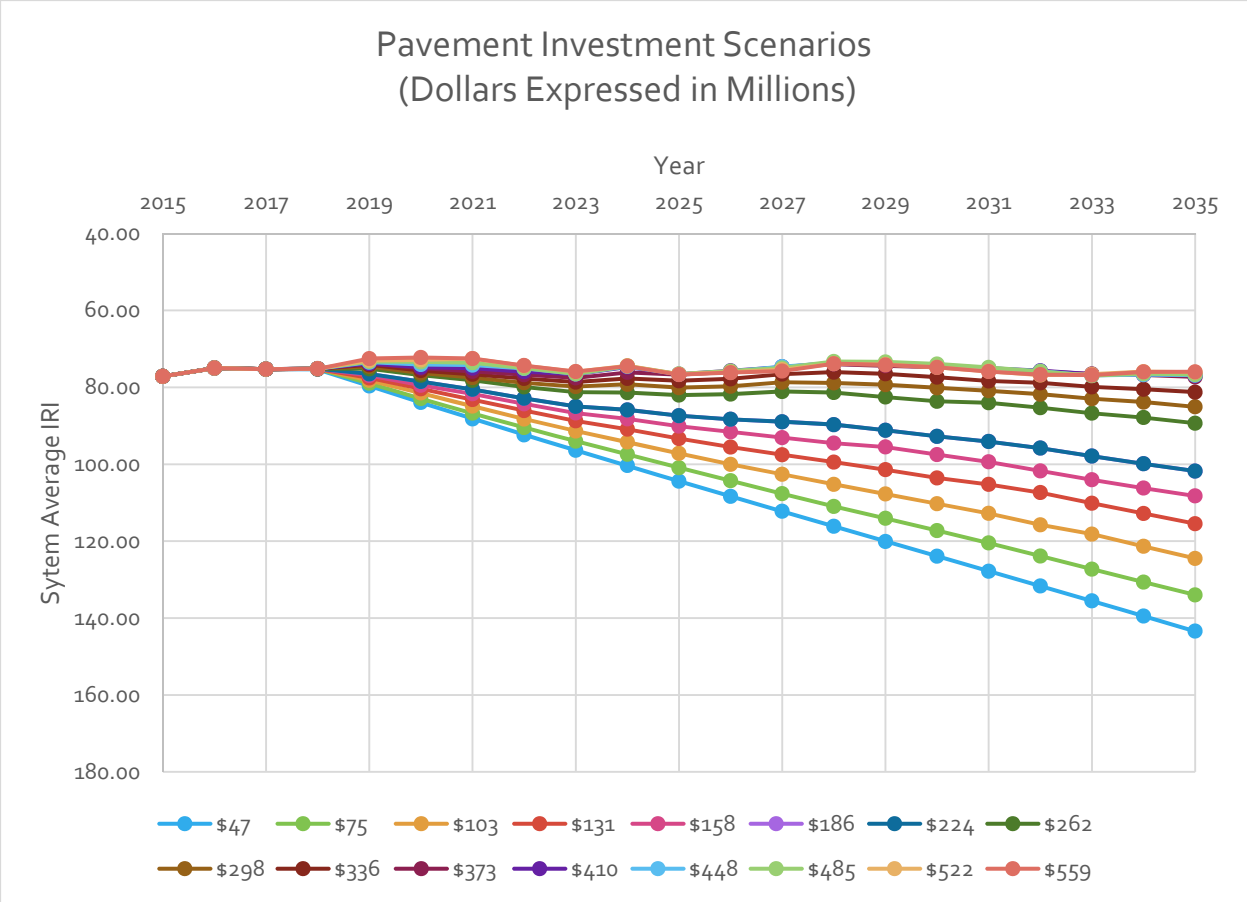


FIGURE 16 – SAMPLE PAVEMENT MODEL RESULTS THAT FEED THE TRADEOFF HUB.

As noted in the Risk Management section, risk responses may include changes to policy or procedure related to any phase of the overall Investment Priorities Process, including goal setting, investment strategy selection, work type selection or definition, model parameters, and project scoping, among others that may influence the process noted above. If such changes adjust procedures noted in this document, the TAMP will be updated, accordingly.

The vast majority of the NHS is owned and maintained by the NDDOT. A summary of the NHS ownership by jurisdiction is included in the following table:

Owner	NHS Pavements		NHS Bridges		NHS Culverts (Longer than 20 ft.)	
	Miles (Centerline)	Percent of Total	Number	Percent of Total	Number	Percent of Total
State	3,665	98.52%	390	100%	247	100%
County	3	0.08%	0	0%	0	0%
City	52	1.40%	0	0%	0	0%
Totals	3,720	100%	390	100%	247	100%

Though NDDOT is phasing in locally owned pavements into its Life Cycle analysis, it still monitors condition of the entire NHS. The NDDOT has also expanded its pavement data collection efforts (outlined in the next section of this document) to include NHS pavements it does not own. The local NHS owners will be notified when this data is processed and will be provided with it, upon request. Additionally, twice annually, NDDOT's Local Government, Programming, and Planning/Asset Management Divisions meet with the directors of the three metropolitan planning organizations (MPOs) in North Dakota. At one of these meetings, the above data coordination process was discussed, with all four entities concluding this course of action to be prudent. The NDDOT will be developing processes to obtain financial data from local entities, but since it currently looks at system wide management, the small amounts of financial contribution from local entities in the NHS does not impact the LCP analysis.

Data that is used in NDDOT's bridge and pavement management systems is collected with federally required data definitions for the NBI and Highway Performance Monitoring System (HPMS).

I. Pavement Data

The NDDOT collects pavement condition data on the entire NHS annually, as detailed in its federally-approved (per 23 CFR 490.319 (c)) Pavement Data Quality Management Plan and summarized below. Both directions are collected on interstates and multi-lane highways (driving lane only). One direction is collected for two-lane highways, alternating direction each year. Data collected as part of the network-level pavement condition data is reported for every 0.100 mile of the surveyed length for the Highway Performance Monitoring System (HPMS) and reported by NDDOT segment length for the NDDOT's Pavement Management System (PMS). Data is collected in both wheel paths of travel. The collected data is shown in the following table:

General Data	Asphalt and Composite Pavements	Jointed Concrete Pavements and Concrete Overlays	Continuously Reinforced Concrete Pavements
• Location (highway, MP, offset, length, latitude & longitude determined by GPS coordinates) • Roadway events (bridges, railroad crossings, rumble	• IRI • Bleeding • Longitudinal Cracking • Transverse Cracking • Block Cracking	• IRI • Corner Breaks • Longitudinal Cracking • Transverse Cracking • Corner Breaks • D Cracking	• IRI • Longitudinal Cracking • Transverse Cracking • D Cracking • Longitudinal Joint Spalling

General Data	Asphalt and Composite Pavements	Jointed Concrete Pavements and Concrete Overlays	Continuously Reinforced Concrete Pavements
strips, construction) • Perspective and ROW Images • Optional Geometric Data (horizontal and vertical curves, cross-slope, super-elevation)	• Alligator Cracking • Raveling/ Weathering • Bituminous Patching • Rutting	• Longitudinal Joint Spalling • Transverse Joint Spalling • Broken Slabs • Bituminous Patching • Concrete Patch Deterioration • Faulting	• Transverse Joint Spalling • Blow-Up Repairs • Bituminous Patching • Concrete Patch Deterioration

TABLE 3 – NETWORK LEVEL CONDITION DATA ITEMS COLLECTED.

The key deliverables, protocols used for collection, and associated quality standards are described below. Quality standards define, when applicable, the resolution, accuracy, and repeatability or other standards used to determine the minimum characteristics of each deliverable.

Deliverable	Protocols	Resolution	Accuracy (compared to reference value)	Repeatability (for three repeat runs)
Longitudinal Profile	AASHTO M 328-10, AASHTO PP 70-14, AASHTO R 56-14, AASHTO R 57-14, ASTM E950	0.002 inch	+/- 5%	+/- 5%
IRI (left, right, and average)	AASHTO M 328-14, AASHTO R 43-13, AASHTO R 57-14, ASTM E1926	1 in/mile	+/- 5%	+/- 5%
Rut Depth (average and maximum)	AASHTO PP 69-10, AASHTO PP 69-14 (Automated), AASHTO PP 70-14	0.01 inch	+/- 0.019 inch	0.06 inch

Deliverable	Protocols	Resolution	Accuracy (compared to reference value)	Repeatability (for three repeat runs)
	(Automated), AASHTO R 48-10			
Faulting (average)	AASHTO R 36-13	0.01 inch	0 .06 inch	0.06 inch
Distress Identification and Rating	AASHTO PP 67-10, AASHTO PP 67-14 (Automated), AASHTO PP 68-10, AASHTO PP 68-14 (Automated), AASHTO R 55-10 (Manual), ASTM E1656-11, LTPP Distress Identification Manual, NDDOT Distress Scoring Guide	Varies	+/- 20 percent	N/A
GPS (latitude and longitude)	N/A	Submeter (static)	Submeter (static)	N/A
Perspective and ROW Images	N/A	2500 X 2000 per camera	Signs legible, proper exposure and color balance	N/A
Pavement Images	N/A	N/A	2 mm cracking visible and detected	N/A

The pavement data the NDDOT collects is checked with Quality Control Activities. The activities conducted for each deliverable are outlined in the following table:

Deliverable	Quality Expectations	QC Activity	Frequency/Interval
IRI, DMI	95 Percent Compliance With Standards	Initial Equipment Configuration, Calibration, Verification	Pre-Collection (Annually)
		Daily Equipment Checks and Monitor Real-Time	Daily
		Control, Blind, or Verification Testing	Weekly
		Inspect Uploaded Data Samples	Weekly
		Inspect Processed Data	During Manual QC
		Final Data Review	Prior to RIMS Upload
Rut Depth, Faulting, GPS Coordinates, Longitudinal Grade	95 Percent Compliance With Standards	Initial Equipment Configuration, Calibration, Verification	Pre-Collection (Calibration at time of equipment purchase)
		Daily Equipment Checks and Monitor Real-Time	Daily
		Control, Blind, or Verification Testing	Weekly
		Inspect Uploaded Data Samples	Weekly
		Inspect Processed Data	During Manual QC
		Final Data Review	Prior to RIMS Upload
Distress Rating	80 Percent Match: Manual vs Automated	Initial Rater Training	Pre-Collection (as needed)
		Intra-rater Checks	During Manual QC
		Final Data Review	Prior to RIMS Upload
Perspective, ROW and Pavement Images	98 Percent Compliance With Standards of Each Control Section and Not More Than 5 Consecutive Images Failing to Meet Criteria	Startup Checks, Real-Time Monitoring, and Field Review	Daily
		Uploaded Samples Review	Weekly
		Final Review	Prior to Processing

Although the Department has many checks and protocols involving pavement data, the physical equipment that is used by the Department to collect data must also be calibrated and periodically certified to ensure quality data is obtained. Prior to 2019, NDDOT's pavement condition data collection vehicle was taken to MnROAD's facility, annually before collection begins, for IRI calibration and certification on both asphalt and concrete pavement. The DMI was also calibrated at this time. This was done in the spring before roadway collection begins. MnROAD's certification process is in accordance to AASHTO R56. Before going to MnROAD the bounce test and block test were performed on the pavement condition data collection vehicle by NDDOT employees. The block test is used to calibrate the wheel path lasers, and the bounce test is used to verify the proper function of the accelerometers with relation to the wheel path lasers.

After the 2018 calibration MnROAD informed us NDDOT it would no longer offer calibration services to those not affiliated with MNDOT. Calibration is planned to be done in South Dakota for 2019 and potential calibration sites in North Dakota are being investigated.

Throughout the data collection season, weekly verification is done on the pavement condition data collection vehicle to ensure it stays in compliance. The verification is performed at the beginning of the week before collection begins. The verification site is 1,000 feet long on asphalt pavement that is not scheduled for construction or maintenance so the condition stays reasonably constant during the collection cycle. The verification site is used to verify the DMI, IRI and Rut. In addition, the block and bounce tests are conducted whenever the air pressure in the tires is changed, the vehicle is realigned, or any other work is done on the vehicle that may affect the wheel path laser.

The collected data is checked weekly and before final yearly acceptance to ensure the highest quality data is being used in the NDDOT's Pavement Management Model.

II. Structure Data

Data obtained from the bridge inspection process is the foundation of the bridge management system. Information obtained during the inspection is used not only for determining the safety to the traveling public but also for determining needed maintenance and repairs, for prioritizing rehabilitation and replacement projects, for allocating resources, and for evaluating and improving designs for new structures. The accuracy and consistency of inspection and documentation is vital because not only does it impact programming and funding appropriations, but also, and even more importantly, public safety and public confidence. The NDDOT addresses this need with Quality Control and Quality Assurance procedures. The use of Quality Control and Quality Assurance procedures are also required by 23 CFR 650.313(g).

The NDDOT has an approved QC/QA plan that identifies various items that are completed each year to verify the quality of the inspections and the recorded data within BrM. Part of

the plan is to ensure that the bridge inspector qualification standards are met. To do this, the Structural Management Engineer and the Internal Review Technician maintain a roster and organizational chart of the inspection personnel. The roster is used to track and help monitor NBIS and NDDOT requirements for certification, training, refresher training and experience. The Structural Management Engineer and the Internal Review Technician spot check incoming inspection reports to ensure that the inspector of record meets the specified qualifications for experience and training. The spot checks are documented in a log. A summary of this activity is included in the approved Annual Statewide QA Summary Report that is created at the end of each calendar year.

Routine inspections involve a visual inspection of all components of a structure. Normally a two person team performs the routine inspection with at least one team member being a team leader. Team leader qualifications are identified in the 23 CFR Part 650.309(b) which identifies minimum education and experience required to lead a bridge inspection.

Existing conditions are compared to historical photos and written descriptions of any defects or issues with the structures. Changes are noted and the records are updated to keep the data in the BrM current with the actual structure conditions. If the various elements of the bridge cannot be readily be observed from the ground or with ladders etc., the NDDOT has an under-bridge inspection unit (snooper) that can gain access to all areas of the structures. Periodic underwater inspections are performed on structures where the substructures cannot be readily inspected by wading or probing methods. The inspectors then submit the current information via an application developed in-house that allows the new data to be reviewed by the Structural Management Engineer or the Internal Review Technician prior to updating into the BrM. Any questions on the inspection conditions are resolved prior to updating the data.

Once a year the Structural Management Engineer submits to four of the eight districts the names of an independent inspection team that will perform a Quality Control Review in the district and a list of eight bridges per district that will receive this review. The inspection team consists of members from the NDDOT central office. The independent inspection team visits the bridge sites to determine condition and appraisal ratings, compare the results with the latest inspection reports, enter comments and site locations in a Quality Control log, and review comments and observations with the original bridge inspection team in a timely manner. Upon completion of the independent review, all Quality Control logs and correspondence pertaining to the review are submitted to the Structural Management Engineer. The Structural Management Engineer reviews the Quality Control log and any associated correspondence to determine if the reviews, individually or collectively, suggest that additional training, instruction clarification, or another response is necessary. A summary of the District Quality Control Reviews is then made by the Structural Management Engineer and included in the Annual Statewide QA Summary Report.

Annually, the Structural Management Engineer performs quality control actions, the review of the bridge files in Bridge Division is necessary to ensure that information needed for bridge inspection is readily available and that the files are complete and accurate. The Structural Management Engineer reviews the files of approximately 5% of the bridges inspected during the past year for completeness, timeliness, and accuracy. Next, the Structural Management Engineer reviews the posted bridge list and the files of 5% of these bridges to assure that the file documentation is sufficient and agrees with the posting, and the rating is current with the latest inspection findings. A summary of the Quality Control of Bridge Record Keeping is then made by the Structural Management Engineer and included in the Annual Statewide QA Summary Report.

The purpose of the NDDOT's Bridge Inspection QA Program is to measure the accuracy and consistency of the Department's bridge inspections and bridge load ratings. It is not the intent of the Quality Assurance Program to update individual inspection items or load ratings.

The findings from this program are used to enhance or emphasize training needs and to address any bridge inspection or load rating anomalies. The NDDOT's Statewide Bridge Inspection Quality Assurance Program consists of independently re-inspecting 8 bridges in each of four of the eight districts on an annual basis. The 8 bridges are to include two state owned and six locally owned bridges, have an ADT between 0 and 5000, and be between 20 feet and 350 feet long. The parameters are established to provide a sample of North Dakota bridges while containing the cost of re-inspection and the overall cost of the Program. The structures are randomly selected by the Structural Management Engineer and inspected by the Structural Management Engineer's Team (QA Team). The QA Team may include personnel from the Bridge Division, districts and FHWA and may differ from year to year. On each bridge the ratings from the QA inspection are compared to the ratings from the most recent routine inspection. The ratings and appraisals are considered to be in disagreement if any rating or appraisal varies by more than one or if more than four ratings or appraisals differ. All disagreements are documented in the QA Close-Out Report. The number and type of disagreements will, at the judgment of the Structural Management Engineer, determine the recommendations for specific instruction or additional training. The results of the QA inspections are used to emphasize training requirements, improve inspection techniques, and initiate needed changes to the bridge inspection program. The results of the QA Inspections are summarized by the Structural Management Engineer and included in the Annual Statewide QA Summary Report. Copies are be distributed to the districts and the office holders. This compilation gives an indication of statewide trends in bridge inspection. Any consistent problems are identified and corrected by revising procedures and manuals; providing Bridge Inspection and Refresher Training Courses and providing other bridge inspection related courses.

The field inspection data review includes a complete review of NBIS inspection data by the Structural Management Engineer of all selected structures in the QC sample and includes

verifying and identifying the structure, verifying inventory data, performing independent condition/appraisal ratings, and preparing or amending field sketches for scour conditions. A summary of the QA Review of Field Inspection Data is made by the Structural Management Engineer and included in the Annual Statewide QA Summary Report.

The record keeping review by the Structural Management Engineer includes verifying that the inspection forms are complete, reviewing criteria used in load rating structures to ensure that the appropriate methodologies are in place, and performing a review of the load rating analysis. A summary of the QA Review of Bridge Record Keeping is made by the Structural Management Engineer and included in the Annual Statewide QA Summary Report.

An Annual Statewide QA Summary Report, due September 1 of each year, is written by the Structural Management Engineer for submittal to the Bridge Division Engineer. The report summarizes all QC and QA activities for the fiscal year and inspection cycle. Part of the report may include recommendations for quality improvements to the bridge inspection program in a decision document for action by the Bridge Division Engineer.

Conclusion

TAM is a goal-oriented, data-supported way of managing transportation systems and their components such that system managers are provided the information they need to make decisions necessary to reach desired outcomes. TAM is able to assist NDDOT management in making decisions that cost effectively progress toward goals by measuring the current performance of an asset class and by projecting the effect that potential decisions will have on the various asset classes' long term performance into the future.

The NDDOT's vision is that TAM fosters a culture of public dollar stewardship through data-supported, and goal-oriented decisions.

Appendix A –Risk Management Risk Statements and Risk Register

LCP 1 – Continue with Existing Investment Strategy:

1) If the Department invests at our current levels in bridges, then by 2030 our models predict that more than 10% of our structures by deck area will be in poor condition, resulting in a loss of ability to properly manage all Non-NHS bridges. *Mitigate by monitoring condition and reallocating funds as needed.*

2) If the Department invests at our current levels in pavements, and the interstate starts to approach 5% poor conditions, then funding would be redirected from non NHS and non-Interstate NHS to the interstate, resulting in decreased condition of those tiers.

3) If the Department invests at current overall levels, then the public will not be asked for additional funding, resulting in decreased transportation services, but allowing for funds to be allocated to other areas.

LCP 2 – Move $10M from Pavement Preservation to Bridges Preservation:

4) If the Department adjusts the funding distribution between pavements and bridges to this level, then modeled system pavement IRI remains under 100 and modeled system bridge health index remains above 88 for the 10 year forecast, resulting in prolonged acceptable service from bridges. *Avoid by monitoring investment outcomes.*

5) If the Department invests at this level, then the bridge model does not fall below the minimum federal condition threshold of 10% poor until 2033, delaying potential loss of funding flexibility.

6) If the Department reduces the investment in pavements, then the average condition of our pavements will decrease, resulting in increased public complaints above current levels.

LCP 3 –Increasing the Program by $76.5M:

7) If additional funding were available for infrastructure, then there would be more opportunity to provide safer transportation for all users, resulting in fewer fatalities on rural roads.

8) If funding is moved from other service areas to increase pavement and bridge funding, then other service areas would see a decrease in funding, resulting in diminished services in those areas.

9) If bridge staffing isn't replaced as positions become open, then a program of this size may not be able to be delivered, resulting in loss of public trust.

10) If design staffing isn't replaced as positions become open, then a program of this size may not be able to be delivered, resulting in loss of public trust.

11) If bridge staffing isn't replaced as positions become open, then a program of this size may not be able to be delivered, resulting in federal aid not being utilized in the proper biennium.

12) If design staffing isn't replaced as positions become open, then a program of this size may not be able to be delivered, resulting in federal aid not being utilized in the proper biennium.

13) If transportation investments increase by $76.5M, then the contracting industry would need to adapt to a larger construction program, resulting in less bid competition and temporary inflation of bid prices.

14) If transportation investments increase by $76.5M, then the contracting industry would need to adapt to a larger program, resulting in increasing contractor claims.

15) If transportation investments increase by $76.5M, then there may be increased external influence and/or control of investment decisions, resulting in the reduced ability of the Department to implement the TAMP with the potential to reduce federal share on projects (i.e. increased local match). *Mitigate by monitoring and informing key external partners.*

16) If transportation investments increase by $76.5M, then in the short term the Department may be forced to choose projects that are easier to deliver in a short amount of time, resulting in less than optimal geographic project selection.

17) If transportation investments increase by $76.5M, then in the short term the Department may be forced to choose projects that are easier to deliver in a short amount of time, resulting in public perception that the Department is not making cost effective investments.

18) If transportation investments increase by $76.5M, then in the short term delivering the correct projects may be difficult, resulting in loss of trust in the Department's delivery of projects.

19) If the TAMP doesn't include the $100M, $200M, $300M, and $400M/biennium-increase scenarios presented to the Governor, then the elected officials may view these amounts as unnecessary even though they are all short of the funding needed to maintain the current levels of service, resulting in potentially lower overall funding and service to the public.

Title	Risk Statement Number (NR = Not Rated)																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Bridge Engr.	20	6	NR	5	15	8	12	8	16	8	12	6	8	8	12	10	10	12	NR
Asst. Bridge Engr.	16	12	NR	NR	9	12	NR	12	16	12	12	9	12	12	12	8	8	12	16
Pavement Mgmt Engr.	16	8	8	16	16	16	12	16	9	9	9	9	12	12	9	12	16	12	NR
Asst. Planning/Asset Mgmt	16	16	9	9	9	12	9	12	6	6	6	6	9	9	6	9	9	9	9
FWHA Division Structures	12	6	4	6	12	8	9	8	16	9	16	12	9	6	4	4	4	3	6
FHWA Planning Lead	12	12	9	6	9	12	12	6	9	9	12	12	8	9	16	9	9	9	9
Asst. Programming Engr.	8	4	3	8	5	4	2	9	6	1	1	1	1	3	2	8	8	12	6
FHWA Operations Engr	16	4	6	3	3	4	4	4	9	9	9	9	4	4	4	6	6	3	9
Programming Engineer	6	6	4	4	2	6	9	9	9	6	1	1	4	4	6	9	9	9	NR
Planning/Asset Mgmt Engr.	16	12	4	12	10	6	12	5	3	3	12	3	6	9	12	6	4	4	6
Local Government Engr	12	12	12	2	8	6	2	8	3	6	12	12	3	6	2	6	2	3	NR
Asst. Planning/Asset Mgmt	16	12	6	10	16	12	12	8	4	4	12	4	8	10	8	10	4	10	8
Asst. Finance Director	8	6	12	12	6	8	12	12	15	15	15	15	8	8	12	12	12	12	NR
Bridge Management Eng.r	12	4	6	6	6	4	12	9	12	9	12	9	4	6	8	9	6	6	NR
Chief Financial Officer	16	3	12	9	9	6	12	9	9	9	9	9	12	12	6	12	9	12	NR
Average	13	8	7	8	9	8	9	9	9	8	10	8	7	8	8	9	8	9	9

Appendix B – Facilities Repeatedly Damaged by Emergency Events Report

Facilities Repeatedly Damaged by an Emergency Event Report

NHS Sites

Evaluations Conducted November 2018

Conducted by:
Maintenance Division
Local Government Division

Group Site Name: Hwy 13 - Lehr

Highway: ND 13

Location (RP, LAT/LON, or SEC/TWP/R): ND 13, west of Lehr, in McIntosh County, RP 240 to 242.5

Owner: State

NHS (yes/no): Yes

Event Years: 1999, 2010

Description of damage:
1999: Erosion due to high water and wave action.

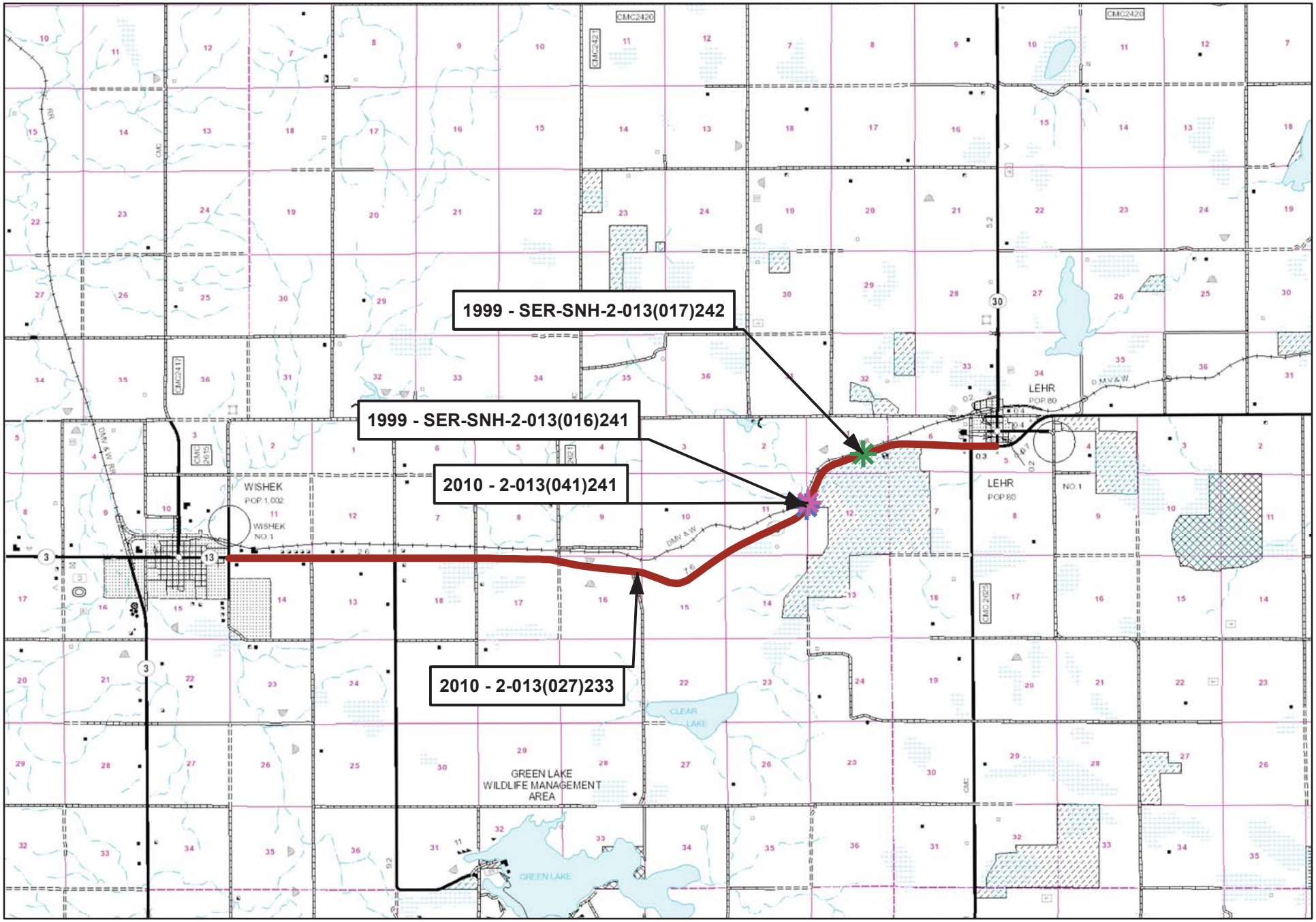
2010: During planned reconstruction project, substantial rise in water elevation overtopped the roadway in the closed basin.

Completed Permanent Repairs:
1999: SER-SNH-2-013(016)241: Riprap placed to prevent further erosion from wave action.
1999: SER-SNH-2-013(017)242: Riprap placed to prevent further erosion from wave action.

2010: 2-013(027)233: A grade raise was completed above 25-year event in a closed drainage basin and flatten inslopes to prevent erosion.
2010: 2-013(041)241: Hot bituminous surfacing for the temporary gravel grade raise project SER-2-013(040)241 that was constructed earlier in the year.

Evaluation:
The grade raise and pavement projects increased roadway profile above the 25-year event in this closed basin. Therefore, in accordance with 23 CFR 667, NDDOT partially or fully mitigated the damage from re-occurring at this time.

Hwy 13 - Lehr


1999 - SER-SNH-2-013(017)242
1999 - SER-SNH-2-013(016)241
2010 - 2-013(041)241
2010 - 2-013(027)233
WISHEK
POP 1,002
WISHEK
NO 1
LEHR
POP 80
LEHR
POP 80
NO 1
GREEN LAKE
WILDLIFE MANAGEMENT
AREA
CLEAR
LAKE
GREEN LAKE
CMC2420
CMC2421
CMC2417
CMC2616
CMC2624
DMV&W
13
3
30

Group Site Name: Hwy 200, Hurdsfield E

Highway: ND 200

Location (RP, LAT/LON, or SEC/TWP/R): ND 200, east of Hurdsfield, Wells County, RP 254 to 256

Owner: State

NHS (yes/no): Yes

Event Years: 1997, 2011

Description of damage:
1997: Erosion due to high water and wave action.

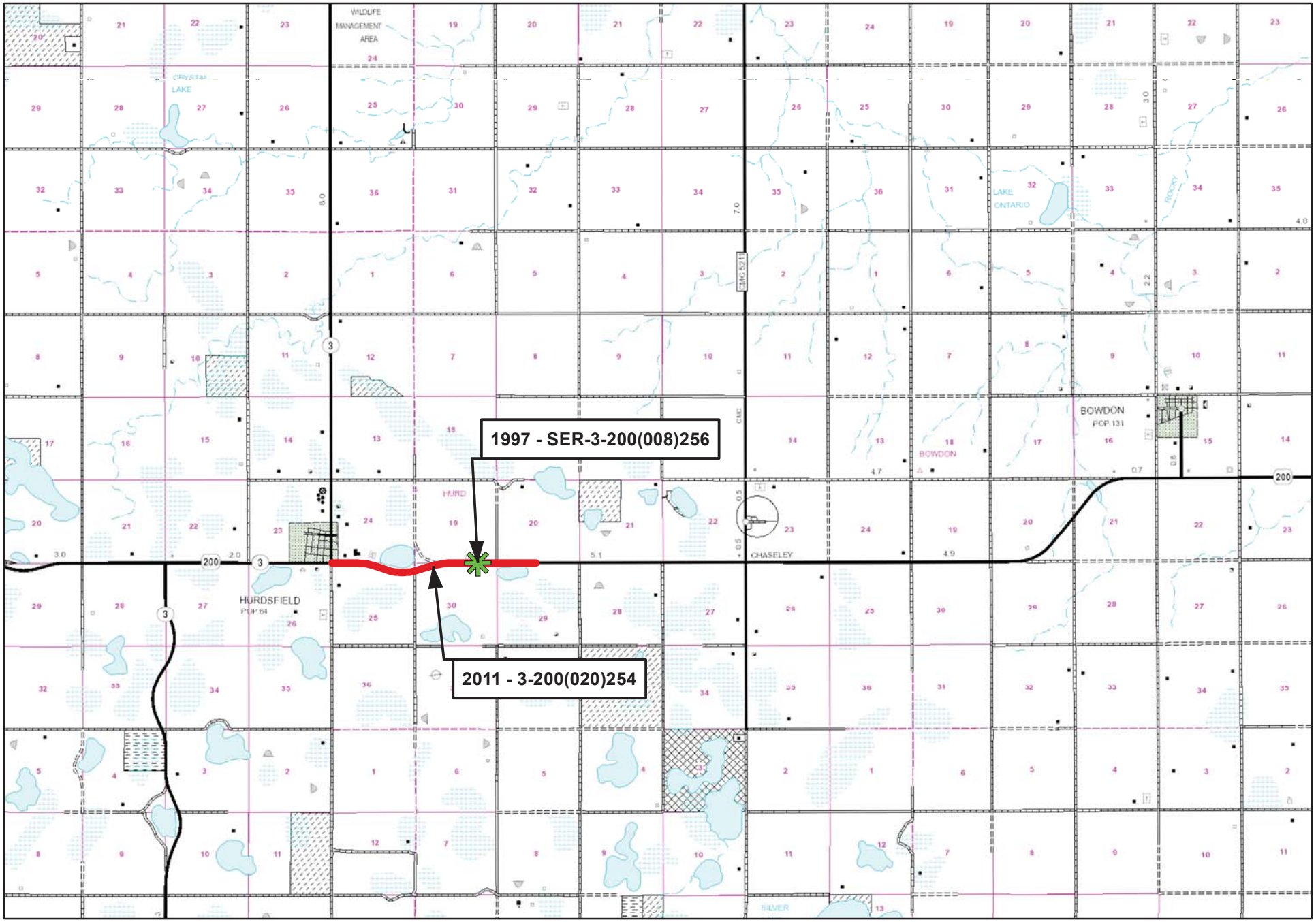
2011: Due to the significant amount of spring runoff and rainfall, ND 200 was inundated near RP 254 and 256, east of Hurdsfield. Road was closed due to the depth of water. Sites were affected by several slowly draining basins. The water levels did not go down, requiring a permanent grade raise.

Completed Permanent Repairs:
1997: SER-3-200(008)256: Riprap placed to prevent further erosion from wave action.

2011: 3-200(020)254: Completed permanent grade raise to elevation above natural outlet of the closed drainage basins and installation of erosion control measures.

Evaluation:
The grade raise increased roadway profile above the natural outlet of the closed basins and erosion control measures were installed prevent further damage. Therefore, in accordance with 23 CFR 667, NDDOT partially or fully mitigated the damage from re-occurring at this time.

Hwy 200, Hurdsfield E



Group Site Name: Hwy 200, W of Chaseley

Highway: ND 200

Location (RP, LAT/LON, or SEC/TWP/R): ND 200, west of Chaseley, Wells County, RP 257 to 258

Owner: State

NHS (yes/no): Yes

Event Years: 1997, 2001, 2013

Description of damage:
1997: Erosion due to high water and wave action.

2001: Erosion due to high water and wave action. Roadway inundated by high water in a closed drainage basin.

2013: Heavy rainfalls increased the water levels of the closed drainage basin west of Chaseley. The water surface overtopped the centerline of ND 200. The highway was determined to be unsafe for the public and was closed due to rising water levels and significant wave action.

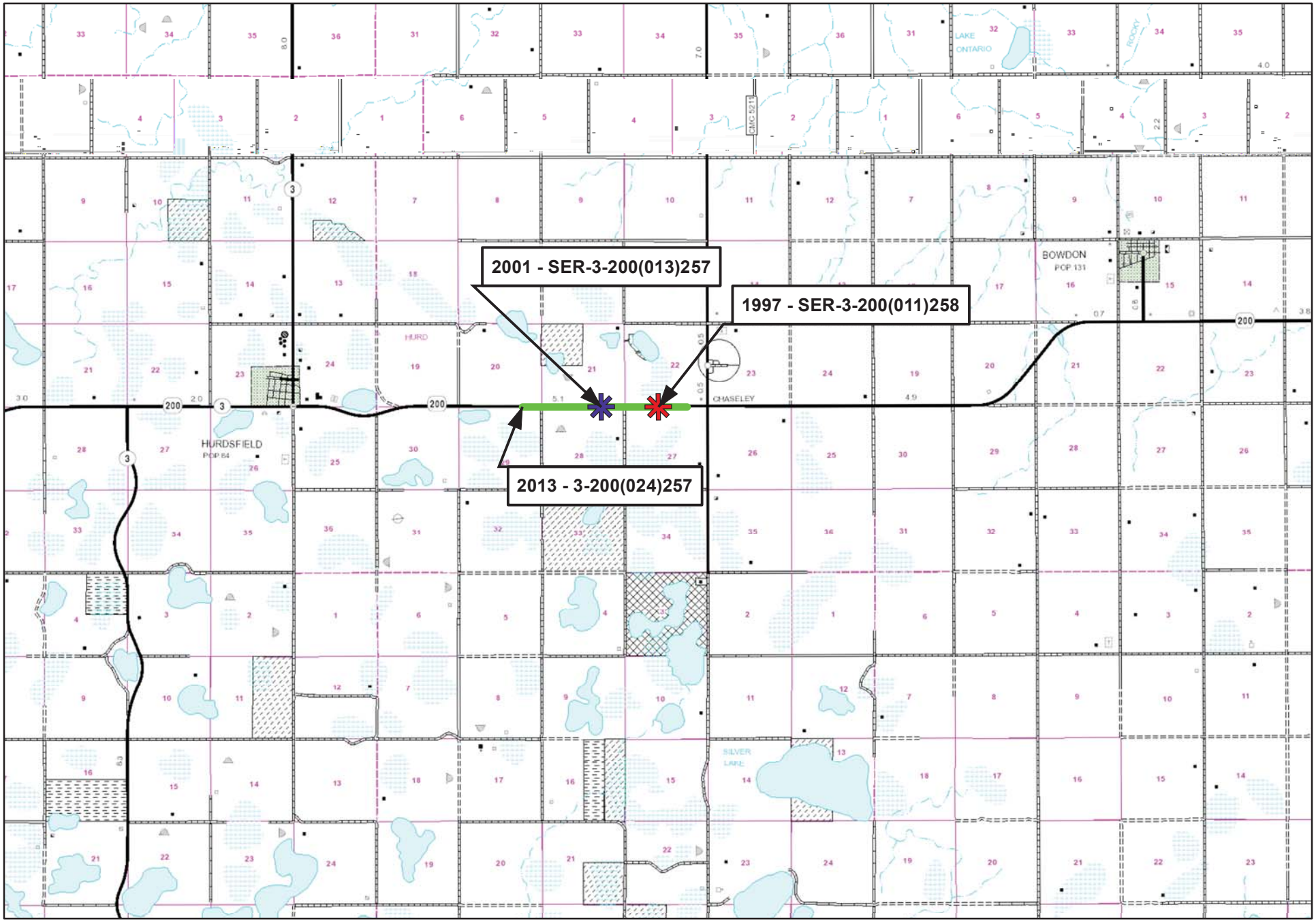
Completed Permanent Repairs:
1997: SER-3-200(011)258: Erosion repairs and hot bituminous surfacing.

2001: SER-3-200(013)257: Raised roadway profile above the existing standing high water. Repairs included preventative erosion control measures and permanent surfacing.

2013: 3-200(024)257: A permanent grade raise restored safe travelling conditions, provided adequate clear zone, and protected the roadway from further damage. A hydraulic analysis determined that the grade be raised to an elevation sufficient to provide two feet of freeboard above the outlet elevation.

Evaluation:
The grade raise increased roadway profile above the natural outlet of the closed basin and erosion control measures were installed to prevent further damage. Therefore, in accordance with 23 CFR 667, NDDOT partially or fully mitigated the damage from re-occurring at this time.

Hwy 200, W of Chaseley



Group Site Name: ND 3, W of Hurdsfield

Highway: ND 3

Location (RP, LAT/LON, or SEC/TWP/R): ND 3, west of Hurdsfield, Wells County, RP 135

Owner: State

NHS (yes/no): Yes

Event Years: 2010, 2011

Description of damage:
2010: Unforeseen high water and high winds created wave action that washed away riprap and eroded the south inslope.

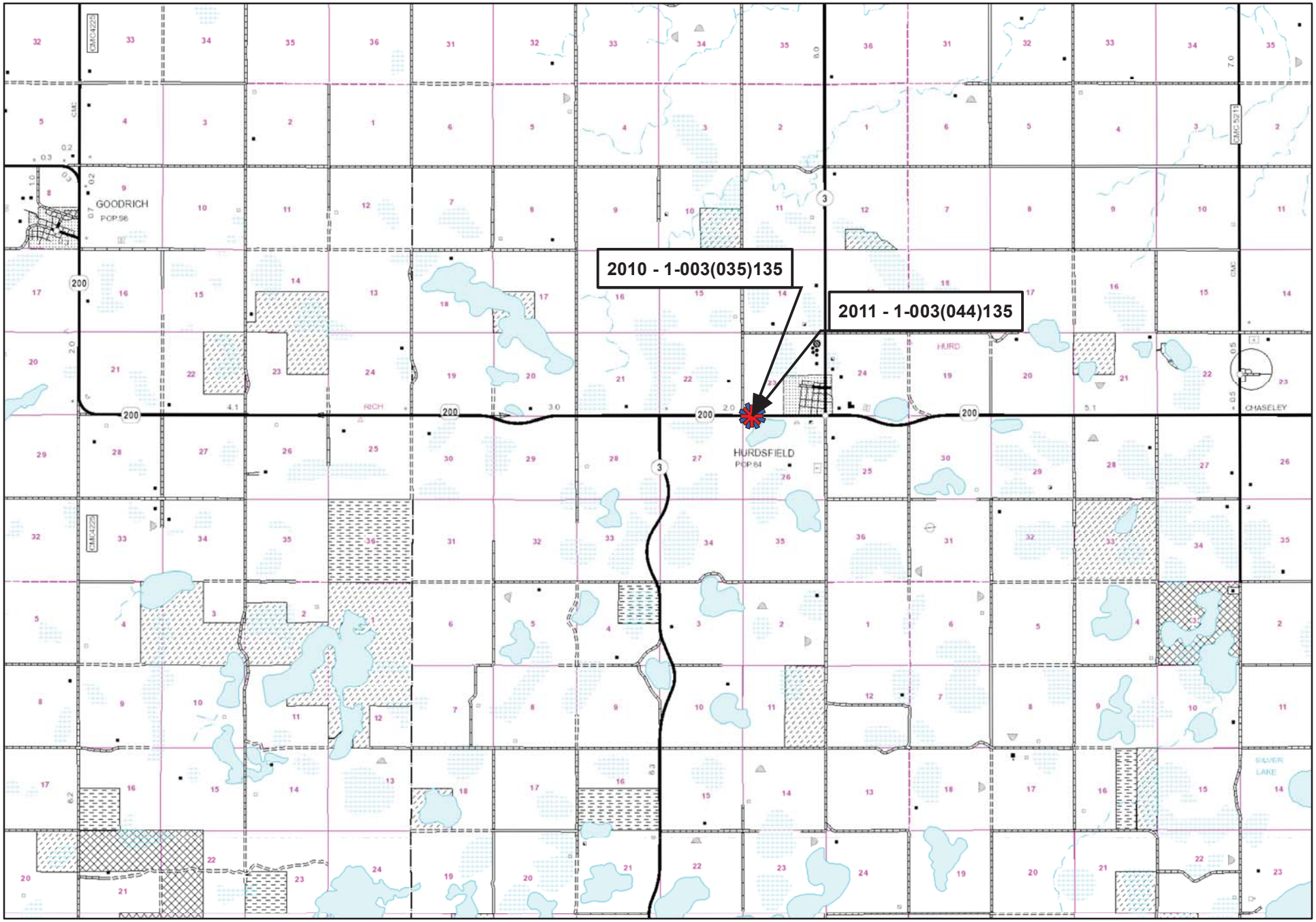
2011: Roadway inundated by water in closed basin.

Completed Permanent Repairs:
2010: 1-003(035)135: Embankment stabilization and riprap to prevent further damage.

2011: SER-1-003(044)135: A permanent grade was constructed to provide sufficient freeboard to accommodate riprap to be placed two feet above the outlet elevation at the edge of the clear zone.

Evaluation:
The grade raise increased roadway profile above the natural outlet of the closed basin and the erosion control measures prevent further damage. Therefore, in accordance with 23 CFR 667, NDDOT partially or fully mitigated the damage from re-occurring at this time.

Hwy 3, W of Hurdsfield



Group Site Name: Hwy 200, W of Hwy 3

Highway: ND 200

Location (RP, LAT/LON, or SEC/TWP/R): ND 200, west of Hurdsfield, Wells County, RP 250

Owner: State

NHS (yes/no): Yes

Event Years: 1997, 2013

Description of damage:
1997: Erosion due to high water and wave action.

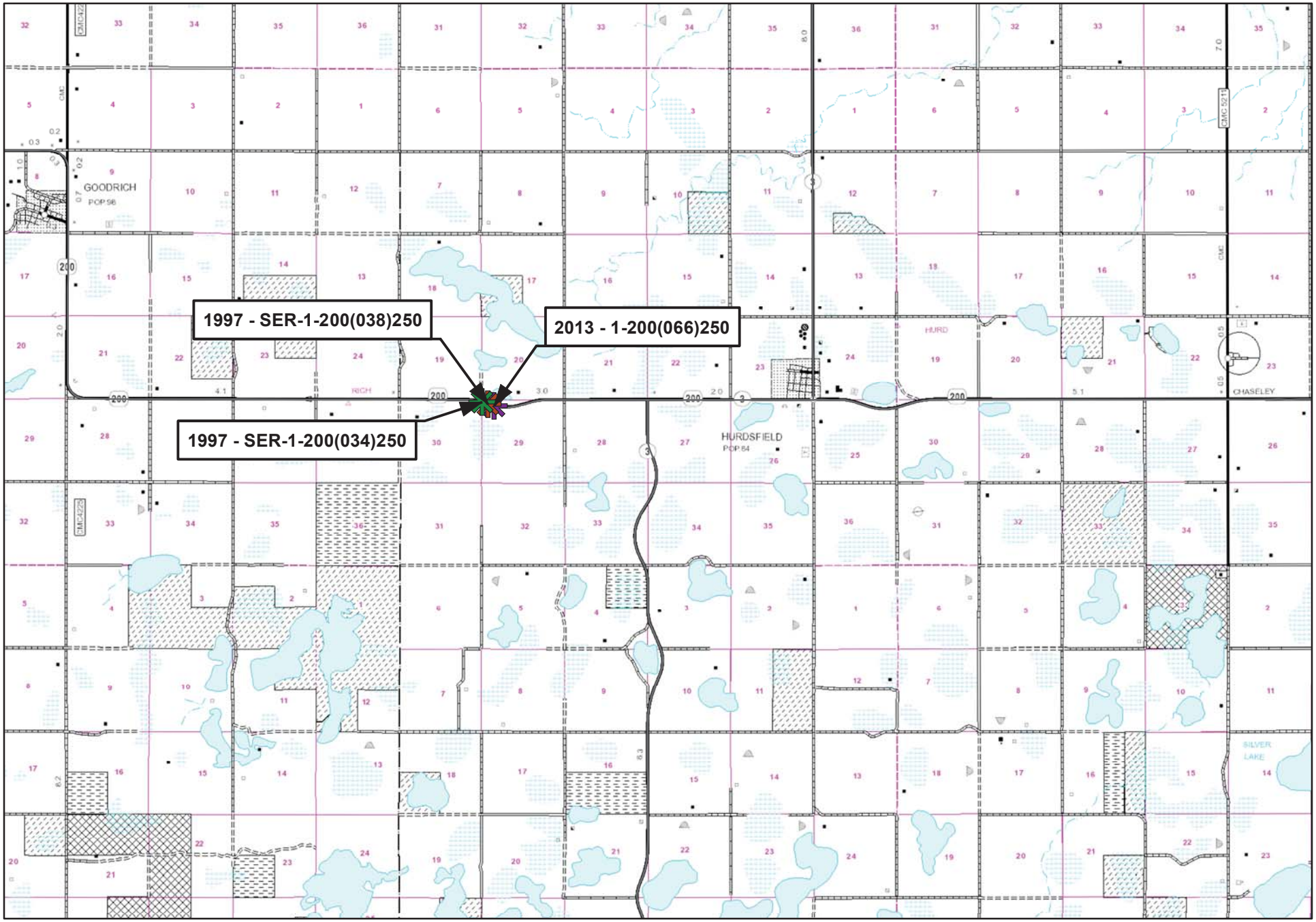
2013: Roadway was inundated by water in a closed basin. Heavy rains increased the water levels of the enclosed drainage basin. The water surface encroached on the shoulder of the westbound lane, which is the low side of the super-elevated curve.

Completed Permanent Repairs:
1997: SER-1-200(034)250: Pumping of the closed drainage basin and erosion control measures to prevent further damage.
1997: SER-1-200(038)250: Erosion control measures to prevent further damage.

2013: SER-1-200(066)250: The roadway grade was raised to an elevation sufficient to provide two feet of freeboard above the outlet elevation. The existing horizontal alignment was maintained.

Evaluation:
The grade raise increased roadway profile above the natural outlet of the closed basin and erosion control measures were installed to prevent further damage. Therefore, in accordance with 23 CFR 667, NDDOT partially or fully mitigated the damage from re-occurring at this time.

Hwy 200, W of Hwy 3



Group Site Name: Hwy 3, S of Hwy 200

Highway: ND 3

Location (RP, LAT/LON, or SEC/TWP/R): ND 3, south of ND 200 junction, Wells County, RP 132 to 133

Owner: State

NHS (yes/no): Yes

Event Years: 1997, 2011

Description of damage:
1997: Roadway inundated with water in a closed basin. High water and wave action eroded inslopes.

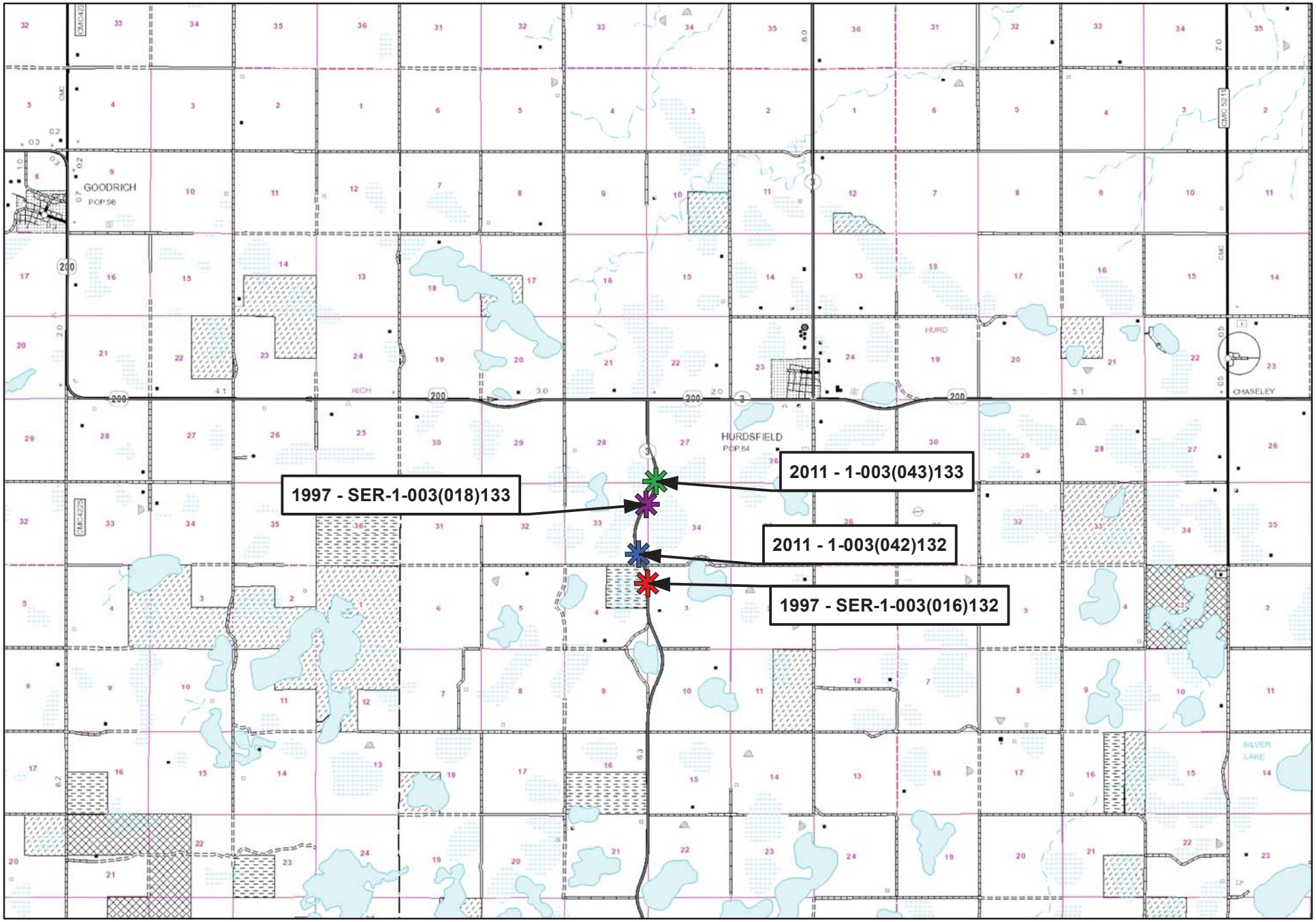
2011: ND 3 was closed due to water inundating the roadway. There was approximately 3 feet of water over the centerline by the time the rising water slowed.

Completed Permanent Repairs:
1997: SER-1-003(016)132: A dike was constructed to prevent water from damaging roadway. Water was pumped from diked area. The dike was later removed.
1997: SER-1-003(018)133: Water was pumped from closed basin and erosion control measures were installed to prevent future erosion from high water.

2011: SER-1-003(042)132: ND 3 was realigned around the closed basin at similar costs as raising grades, but with less environmental impacts and more resiliency to future basin flooding.
2011: SER-1-003(043)133: ND 3 was realigned around the closed basin in a tied project to the RP 132 site. Realignment was found to be more cost effective. Also, at RP 133 a grade raise would have only provided an estimated 3 years of storage while a realignment would protect the road to the ultimate outlet elevation.

Evaluation:
The realignment of ND 3 will prevent future closed basin flood waters from damaging the roadway. The realignment followed a profile higher than the natural outlet elevation of the closed adjacent drainage basins. Therefore, in accordance with 23 CFR 667, NDDOT partially or fully mitigated the damage from re-occurring at this time.

Hwy 3, S of Hwy 200



Group Site Name: I-29

Highway: I-29

Location (RP, LAT/LON, or SEC/TWP/R): I-29, Grand Forks County, Walsh County, RP 158 to 172

Owner: State

NHS (yes/no): Yes

Event Years: 1997, 2009, 2011

Description of damage:
1997: High water damage right of way fence along I-29.

2009: Due to high water and sheet ice flow, numerous right of way fence was destroyed. Some ditch blocks and median blocks were damaged. There were large debris deposits within I-29 right of way.

2011: Debris from the recent flood were deposited within the I-29 right of way. The debris consists of timber, branches, grass & field organic materials, and other man made materials.

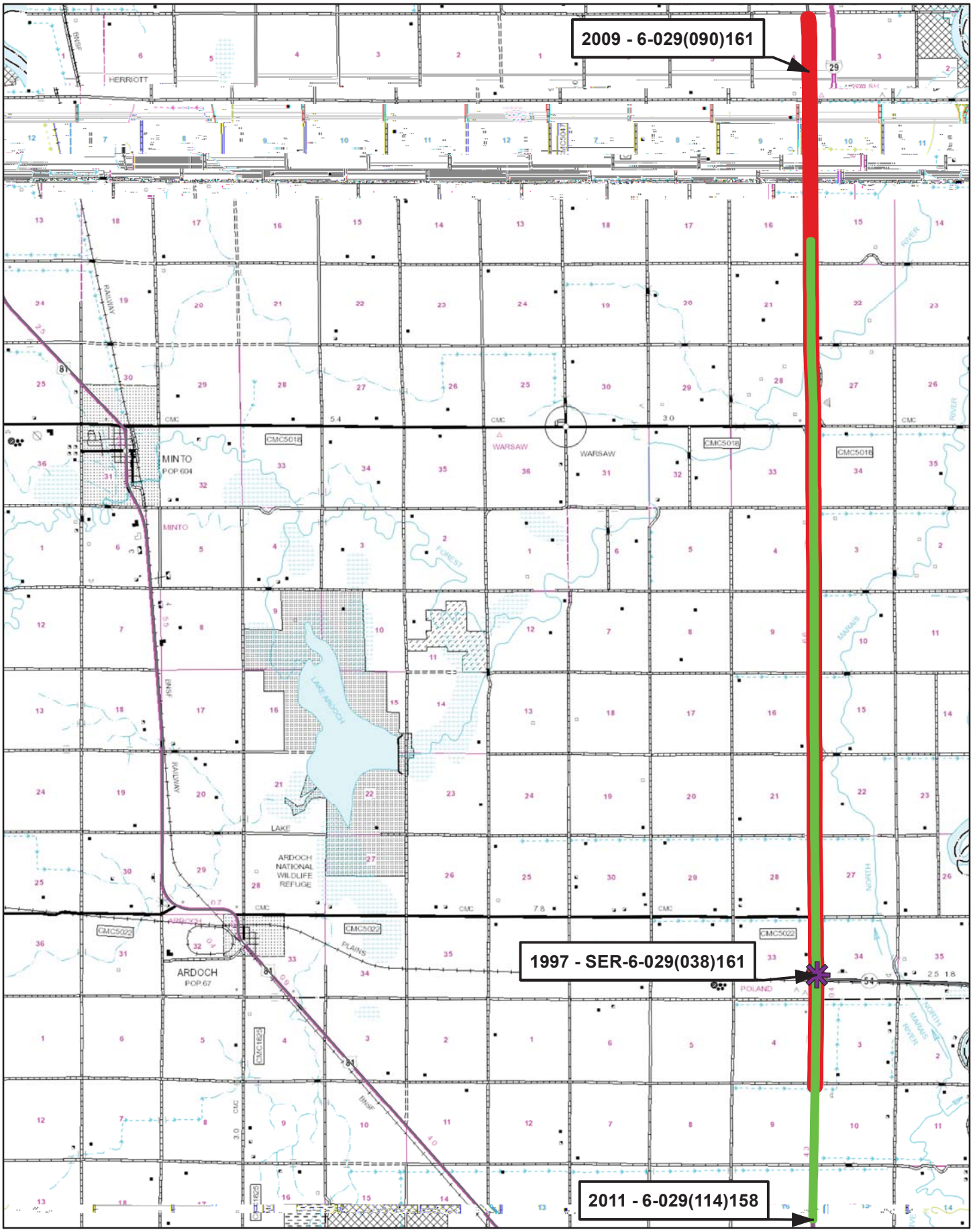
Completed Permanent Repairs:
1997: SER-6-029(038)161: Repair and replace right of way fence.

2009: SER-6-029(090)161: Repair and replace right of way fence. Clear debris from clear zones and right of way. Restoration of ditch blocks and median blocks to maintain positive drainage within the right of way.

2011: SER-6-029(114)158: For safety of mowing and the traveling public, the debris shall be removed from within the limits of the right-of-way and any easements. The debris removal will include materials caught by the right-of-way fencing that runs along Interstate.

Evaluation:
Because of the geography of this area, much of the farmland adjacent to I-29 is inundated with flood water when the Red River floods. Debris and ice sheets become tangled in the right of way fence and deposited within the I-29 right of way. Damage to the roadway is generally considered minor, but fencing repairs and debris clean up would be required with major flooding events. I-29 is located within a floodway and replacing fencing is cost effective compared to raising this corridor. As this corridor is located in floodway, raising the corridor would increased localized flooding resulting in additional damage to other facilities or communities adjacent to this corridor.

I-29


2009 - 6-029(090)161
1997 - SER-6-029(038)161
2011 - 6-029(114)158
MINTO
POP 604
ARDOCH
POP 67
WARSAW
ARDOCH NATIONAL WILDLIFE REFUGE
LAKE ARDOCH
HERRIOTT
POLAND
CMC5018
CMC5022
CMC1825
BNSF
RAILWAY
PLAINS
FOREST
RIVER
MARAIS
NORTH

Group Site Name: ND 19

Highway: ND 19

Location (RP, LAT/LON, or SEC/TWP/R): ND 19, west of Devils Lake, Ramsey County, RP 152, Devils Lake Creel Bay

Owner: State

NHS (yes/no): Yes

Event Years: 1997, 1999, 2001, 2010,

Description of damage:
1997: High water and wave action damaged the roadway surface.

1999: High water inundated roadway.

2001: High water and wave action damaged the roadway surface.

2010: High water inundated roadway.

Completed Permanent Repairs:
1997: SER-3-019(024)152: Resurfaced damaged roadway.
1997: SER-3-019(025)139: Resurfaced damaged roadway.

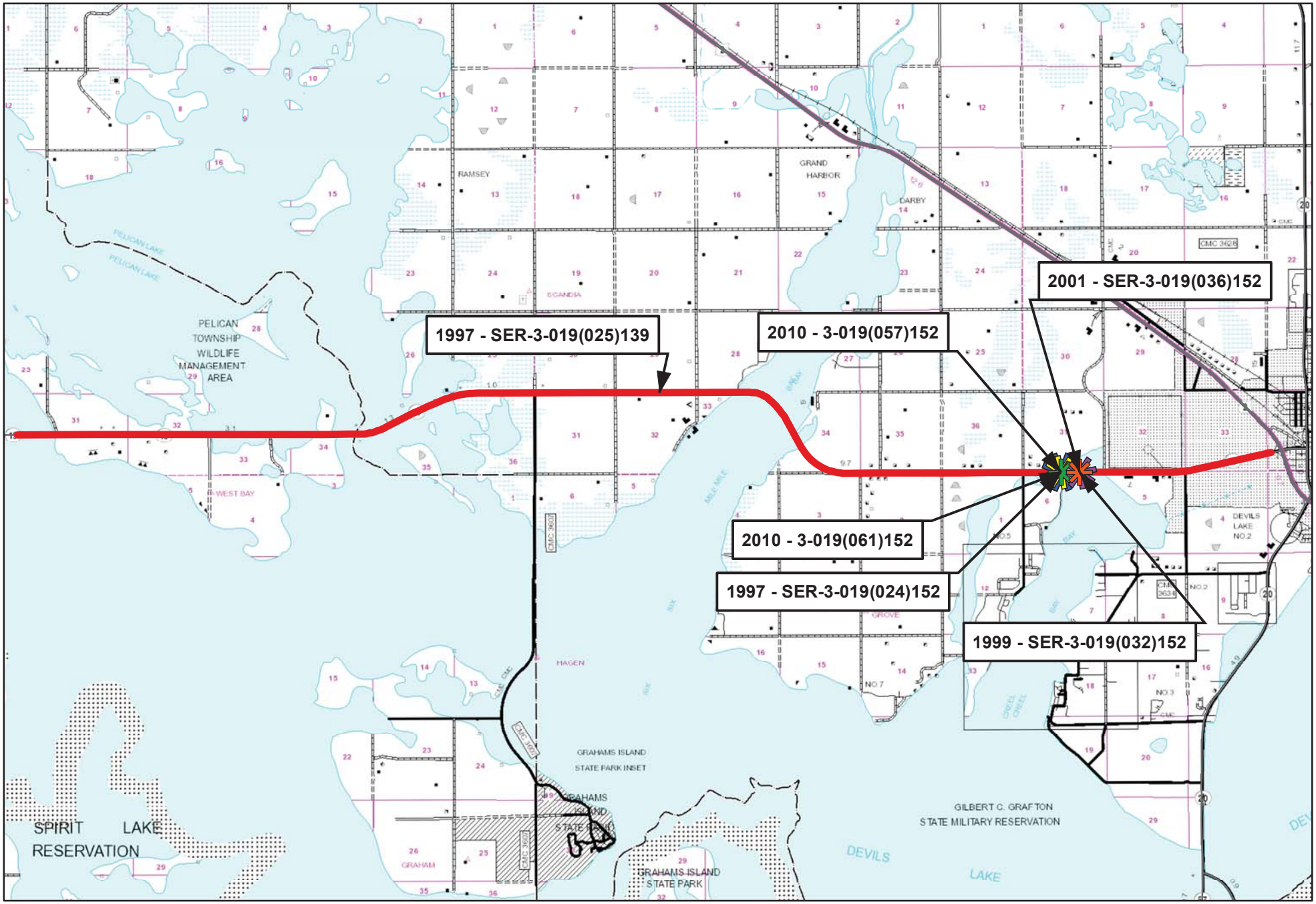
1999: SER-3-019(032)152: Raised the grade to elevation above water levels.

2001: SER-3-019(036)152: Resurfaced damaged roadway.

2010: SER-3-019(057)152: Grade raise to bring roadway elevation to 1461'. Revised DDIR to account for additional work to raise the road over an elevation of 1465'. As of May 2011, The Devils Lake 2011 50% probability elevation was 1454.7'. Based on the probable elevation and the status of current projects, raising the grade still met the three-foot eligibility criteria to a pavement elevation of 1465'.
2010: SER-3-019(061)152: Grade raise to bring roadway elevation to 1461'. Revised DDIR to account for additional work to raise the road over an elevation of 1465'. As of May 2011, The Devils Lake 2011 50% probability elevation was 1454.7'. Based on the probable elevation and the status of current projects, raising the grade still met the three-foot eligibility criteria to a pavement elevation of 1465'.
-These two 2010 SER projects were combined into SER-3-019(055)137 (PCN 18740) to raise grade to ultimate elevation.

Evaluation:
The grade raise increased the roadway profile above the natural outlet of the closed basin and erosion control measures were installed to prevent further damage. The ND State Water Commission also installed a permanent pumping station on Devils Lake to reduce lake elevations over time. Therefore, in accordance with 23 CFR 667, NDDOT partially or fully mitigated the damage from re-occurring at this time.

ND 19


1997 - SER-3-019(025)139
2010 - 3-019(057)152
2001 - SER-3-019(036)152
2010 - 3-019(061)152
1997 - SER-3-019(024)152
1999 - SER-3-019(032)152
PELICAN TOWNSHIP WILDLIFE MANAGEMENT AREA
RAMSEY
GRAND HARBOR
DARBY
SCANDIA
WEST BAY
HAGEN
GRAHAMS ISLAND STATE PARK INSET
GRAHAMS ISLAND STATE PARK
SPIRIT LAKE RESERVATION
GILBERT C. GRAFTON STATE MILITARY RESERVATION
DEVILS LAKE
DEVILS LAKE NO.2
CMC 3628
CMC 3603
CMC 3607
CMC 3634

Group Site Name: ND 57 - 1

Highway: ND 57

Location (RP, LAT/LON, or SEC/TWP/R): ND 57, east of Fort Totten, Benson County, RP 6 to 13, Spirit Lake Nation

Owner: State

NHS (yes/no): Yes

Event Years: 1997, 2001

Description of damage:
1997: High water in Devils Lake threatened to erode ND 57 in two areas of RP 7.

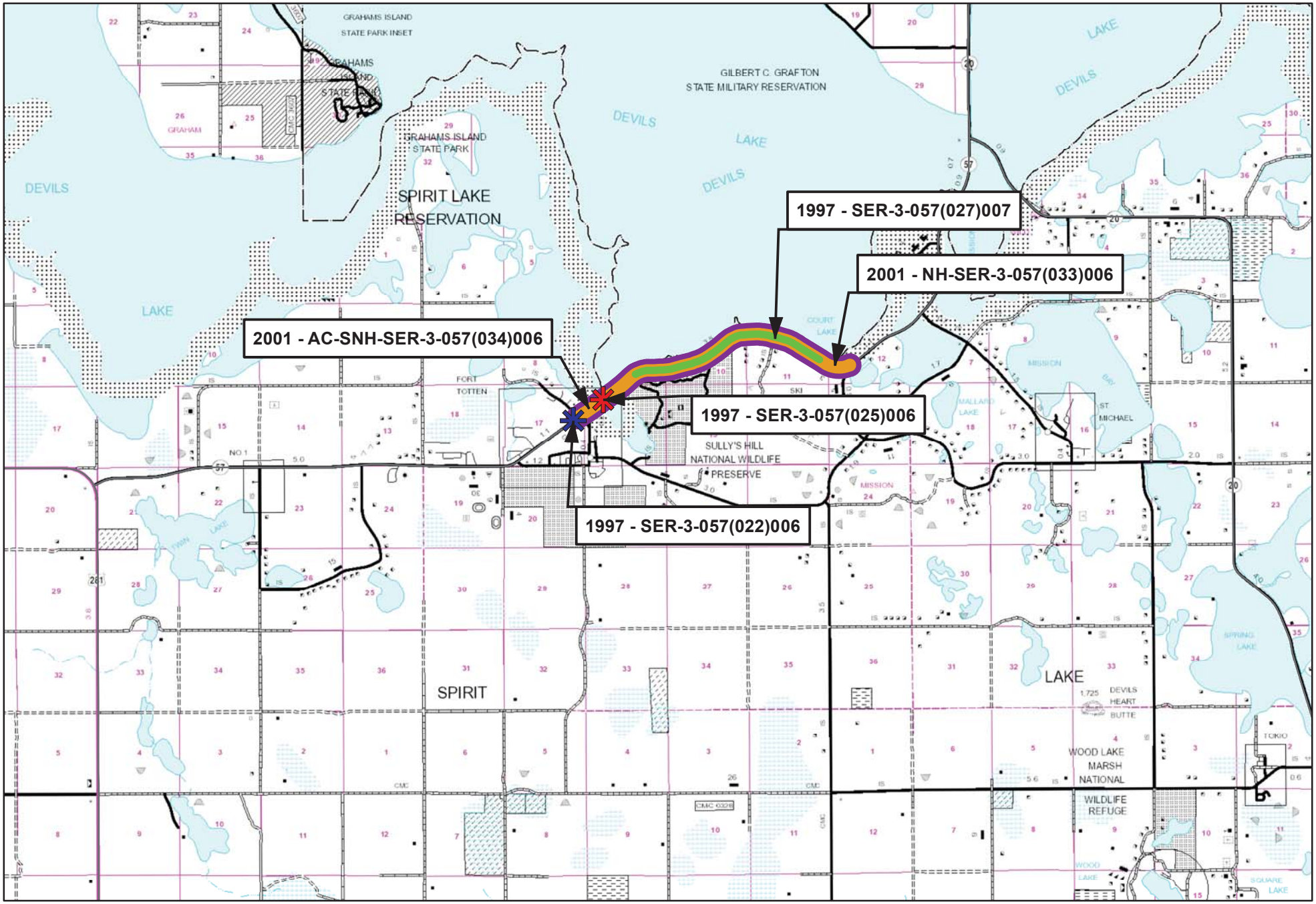
2001: Devils Lake continued to rise causing erosion to high water and wave action.

Completed Permanent Repairs:
1997: SER-3-057(022)006: Grading, surfacing, and incidentals.
1997: SER-3-057(025)006: Grading, fabric, and riprap.
1997: SER-3-057(027)007: Added riprap to prevent erosion.

2001: NH-SER-3-057(033)006: Grade raise, aggregate surfacing, and incidentals.
2001: AC-SNH-SER-3-057(034)006: Hot bituminous surfacing

Evaluation:
The grade raise increased roadway profile and erosion control measures were installed to prevent further damage. The ND State Water Commission also installed a permanent pumping station on Devils Lake to reduce lake elevations over time. Therefore, in accordance with 23 CFR 667, NDDOT partially or fully mitigated the damage from re-occurring at this time.

ND 57-1


1997 - SER-3-057(027)007
2001 - NH-SER-3-057(033)006
2001 - AC-SNH-SER-3-057(034)006
1997 - SER-3-057(025)006
1997 - SER-3-057(022)006
GRAHAMS ISLAND STATE PARK INSET
GRAHAMS ISLAND STATE PARK
GILBERT C. GRAFTON STATE MILITARY RESERVATION
SPIRIT LAKE RESERVATION
DEVILS LAKE
FORT TOTTEN
SULLY'S HILL NATIONAL WILDLIFE PRESERVE
MISSION
ST MICHAEL
SPIRIT LAKE
DEVILS HEART BUTTE
WOOD LAKE MARSH NATIONAL WILDLIFE REFUGE
TOKIO
SQUARE LAKE

Group Site Name: ND 57 - 2

Highway: ND 57

Location (RP, LAT/LON, or SEC/TWP/R): ND 57, east of Fort Totten, Benson and Ramsey Counties, RP 11 to 13, Devils Lake, The Narrows

Owner: State

NHS (yes/no): Yes

Event Years: 1997, 2009, 2011

Description of damage:
1997: High water and wave action damaged the roadway surface.

2009: Severe erosion due to high water and wave action.

2011: Rise of water in the Devils Lake Basin threatened to severely damage ND 57.

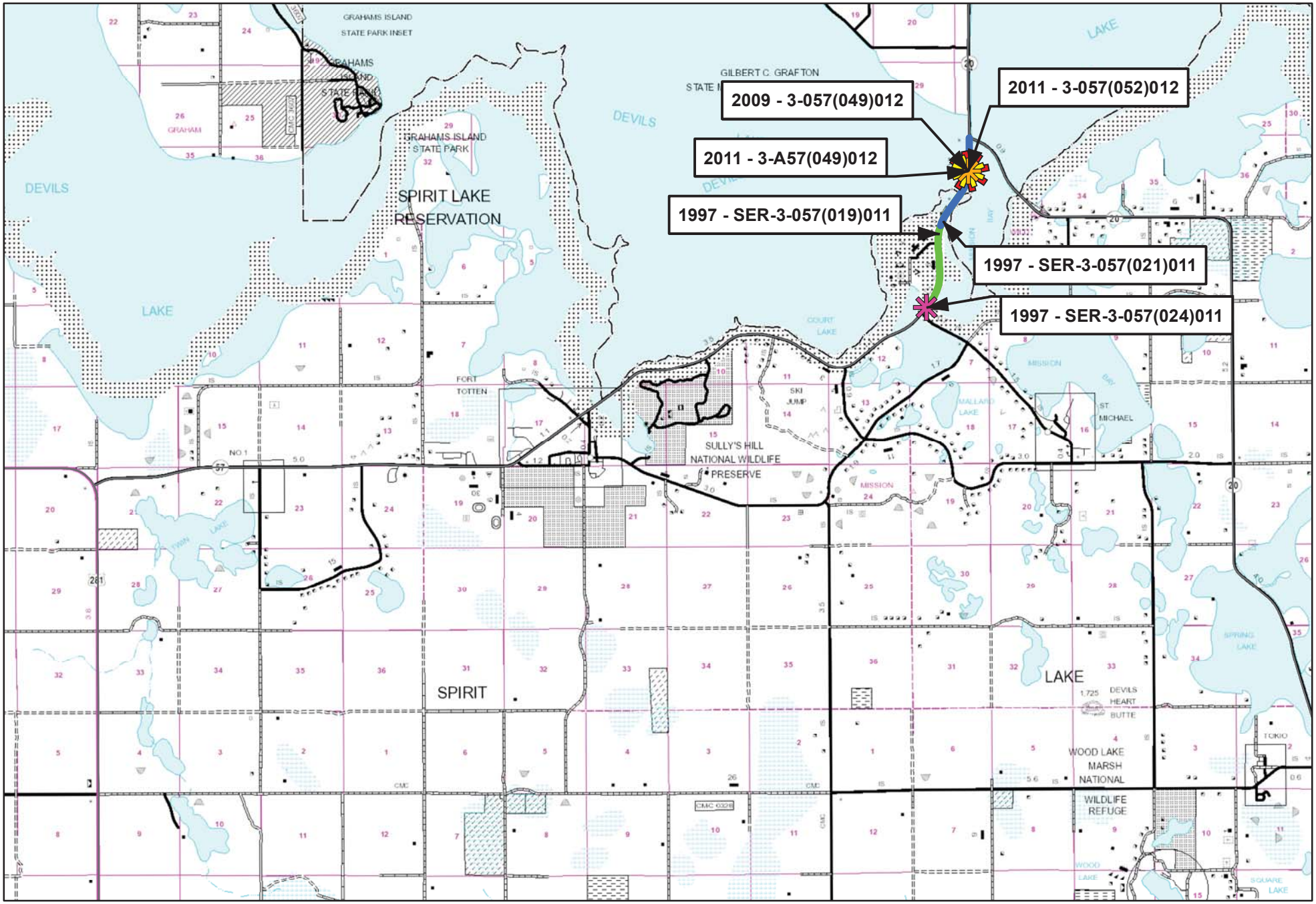
Completed Permanent Repairs:
1997: SER-3-057(019)011: Grading, riprap, structure repair, and aggregate surfacing.
1997: SER-3-057(021)011: Hot bituminous surfacing.
1997: SER-3-057(024)011: Grade, aggregate surface, riprap, and incidentals.

2009: 3-057(049)012: Rip rap berm was installed to protect the inslope from wave action damage before this project permanently raised the grade five feet, as per ER standards at the time.

2011: 3-057(049)012: Grade raise to final elevation of 1465'.
2011: 3-057(052)012: Subgrade repair, paving, and incidentals to finish the grade raise project.

Evaluation:
The grade raise increased roadway profile and erosion control measures were installed to prevent further damage. The ND State Water Commission also installed a permanent pumping station on Devils Lake to reduce lake elevations over time. Therefore, in accordance with 23 CFR 667, NDDOT partially or fully mitigated the damage from re-occurring at this time.

ND 57-2


2011 - 3-057(052)012
2009 - 3-057(049)012
2011 - 3-A57(049)012
1997 - SER-3-057(019)011
1997 - SER-3-057(021)011
1997 - SER-3-057(024)011
GRAHAMS ISLAND
STATE PARK INSET
GRAHAMS ISLAND STATE PARK
SPIRIT LAKE RESERVATION
GILBERT C. GRAFTON
DEVILS
LAKE
FORT TOTTEN
SULLY'S HILL NATIONAL WILDLIFE PRESERVE
SKI JUMP
MISSION
ST MICHAEL
SPIRIT
LAKE
DEVILS HEART BUTTE
WOOD LAKE MARSH NATIONAL WILDLIFE REFUGE
TOKIO
SQUARE LAKE

Group Site Name: ND 20

Highway: ND 20

Location (RP, LAT/LON, or SEC/TWP/R): ND 20, south of Devils Lake, Ramsey County, RP 98 to 101, Devils Lake, Acorn Ridge

Owner: State

NHS (yes/no): Yes

Event Years: 1997, 2001, 2004, 2006, 2009, 2010, 2011

Description of damage:
1997: High water and wave action damaged the roadway surface.

2001: Devils Lake continued to rise causing erosion to high water and wave action.

2004: High water and wave action damaged the roadway surface.

2006: High water and wave action damaged the roadway surface.

2009: Rise of water in the Devils Lake Basin. High water and strong winds causing wave action to erode inslope above current riprap elevation.

2010: Due to high water and high winds, the inslope rapidly eroded away.

2011: Rise of water in Devils Lake Basin.

Completed Permanent Repairs:
1997: SER-3-020(046)098: Hot bituminous pavement wearing course to accommodate traffic through the winter.
1997: SER-3-020(051)098: Change order, added riprap erosion control to protect inslope.

2001: SER-3-020(070)098: Roads Acting As Dams, seepage berm along dry side of inslope toe, plug culvert, and incidentals.

2004: SER-3-020(065)099: Erosion control measures installed to prevent the inslope from eroding.

2006: 3-020(082)098: Grading, aggregate base, hot bituminous pavement, signing, marking, and Incidentals

2009: 3-020(090)096: Grade raise to elevation 1460'; change order to 1465'.
2009: 3-020(094)097: Riprap placement to prevent further inslope erosion before grade raise work began.
2009: 3-020(097)098: Riprap placement to prevent further inslope erosion before grade raise work began.

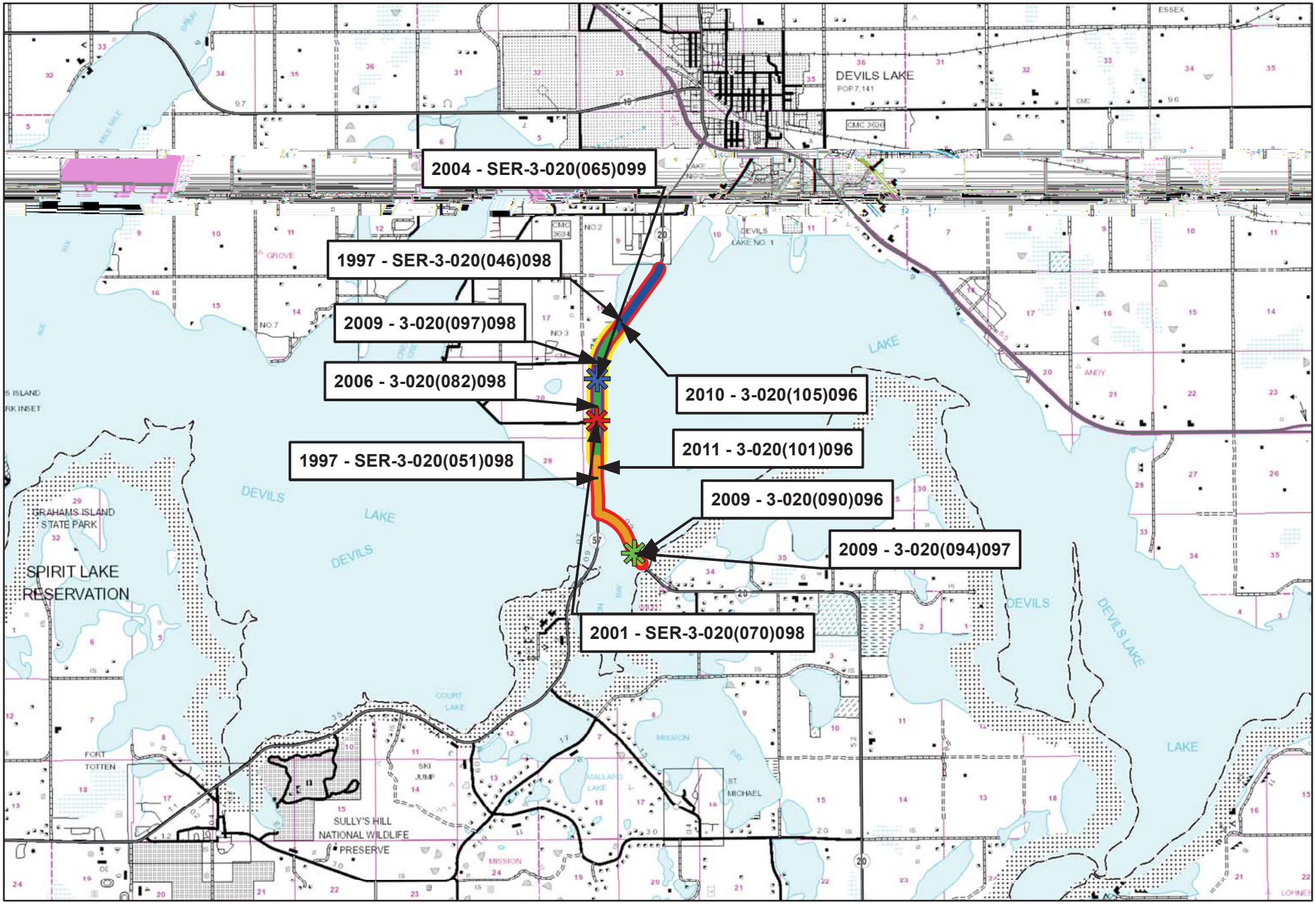
2010: 3-020(105)096: Filled erosion holes, added more protection, and relocated existing riprap.

2011: SER-3-020(101)096: As of May 2011, the Devils Lake 2011 50% probability elevation was 1454.7'. Based on the probable elevation and the status of the current projects, raising the current projects identified in 2009 and 2010 ER events would still meet the 2011 3-foot eligibility criteria of 1465 feet. This project completed paving for previous 1465' grade raise project SER-3-020(090)096. PCN 18175

Evaluation:

The grade raise increased roadway profile and erosion control measures were installed to prevent further damage. The ND State Water Commission also installed a permanent pumping station on Devils Lake to reduce lake elevations over time. Therefore, in accordance with 23 CFR 667, NDDOT partially or fully mitigated the damage from re-occurring at this time.

ND 20


2004 - SER-3-020(065)099
1997 - SER-3-020(046)098
2009 - 3-020(097)098
2006 - 3-020(082)098
2010 - 3-020(105)096
1997 - SER-3-020(051)098
2011 - 3-020(101)096
2009 - 3-020(090)096
2009 - 3-020(094)097
2001 - SER-3-020(070)098
DEVILS LAKE
POP 7,141
GRAHAMS ISLAND
STATE PARK
SPIRIT LAKE
RESERVATION
FORT
TOTTEN
SULLY'S HILL
NATIONAL WILDLIFE
PRESERVE
ST
MICHAEL
DEVILS
LAKE

Group Site Name: US 2 Channel A

Highway: US 2

Location (RP, LAT/LON, or SEC/TWP/R): US 2, west of Devils Lake, Ramsey County, RP 262, Channel A into Six Mile Bay

Owner: State

NHS (yes/no): Yes

Event Years: 1997, 2004

Description of damage:
1997: High water damaged roadway inslope around box culvert, threatened to erode box culvert structure.

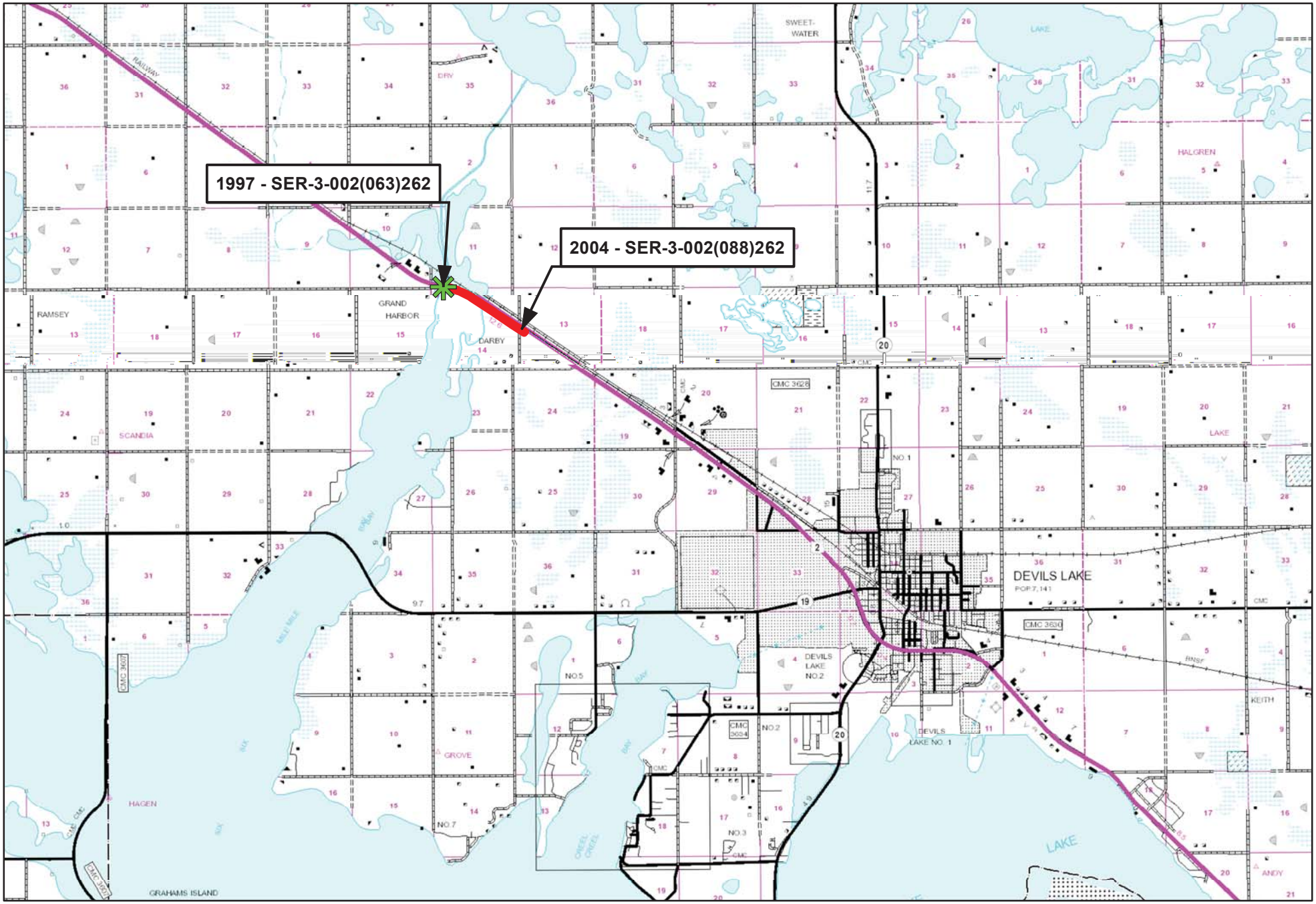
2004: Rising waters of Devils Lake threatened to inundate US 2.

Completed Permanent Repairs:
1997: SER-3-002(063)262: Placed riprap at the outlet of box culvert.

2004: SER-3-002(088)262: 18-inch grade raise, hot bituminous pavement, two new single span bridges, both eastbound and westbound roadways.

Evaluation:
The grade raise increased roadway profile and erosion control measures were installed to prevent further damage. The new structures allow changing water elevations to flow better (increased flow capacity) than the previous box culvert. The ND State Water Commission also installed a permanent pumping station on Devils Lake to reduce lake elevations over time. Therefore, in accordance with 23 CFR 667, NDDOT partially or fully mitigated the damage from re-occurring at this time.

US 2 Channel A



Group Site Name: US 281 - 1

Highway: US 281

Location (RP, LAT/LON, or SEC/TWP/R): US 281, west of ND 57 junction, Benson County, RP 150

Owner: State

NHS (yes/no): Yes

Event Years: 1997, 1998

Description of damage:
1997: Rising water levels in a closed basin damaged inslope.

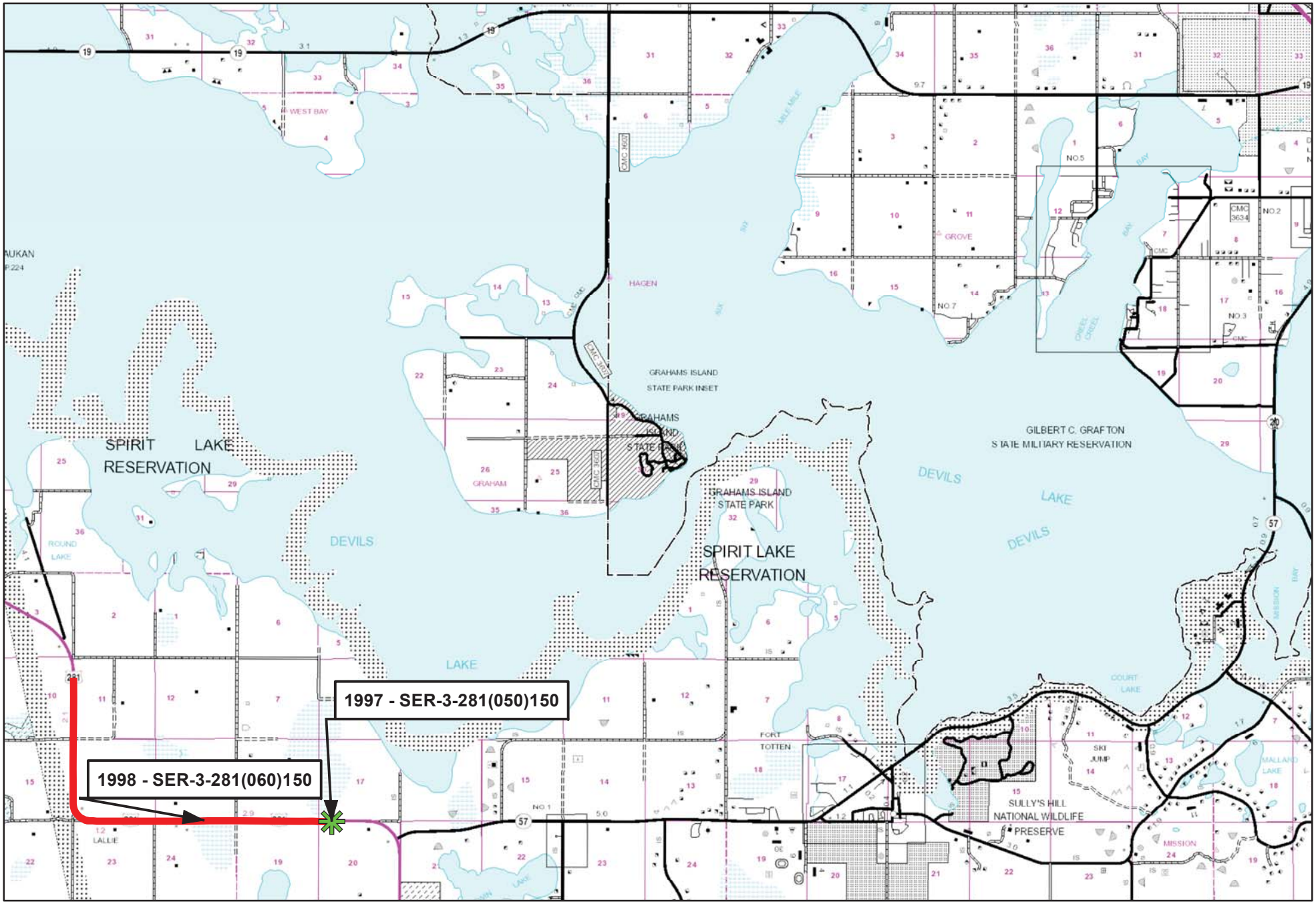
1998: Rising water levels in a closed basin damaged inslope.

Completed Permanent Repairs:
1997: SER-3-281(050)150: Placed concrete erosion control blankets to prevent further damage to roadway.

1998: SER-3-281(060)150: Surfacing.

Evaluation:
The waters in this closed basin have stabilized. Appropriate erosion protection was installed to protect the embankment from wave action damage. Therefore, in accordance with 23 CFR 667, NDDOT partially or fully mitigated the damage from re-occurring at this time.

US 281-1


1997 - SER-3-281(050)150
1998 - SER-3-281(060)150
SPIRIT LAKE RESERVATION
DEVILS LAKE
GRAHAMS ISLAND STATE PARK INSET
GRAHAMS ISLAND STATE PARK
GILBERT C. GRAFTON STATE MILITARY RESERVATION
SULLY'S HILL NATIONAL WILDLIFE PRESERVE
FORT TOTTEN
HAGEN
WEST BAY
LALLIE
ROUND LAKE
SKI JUMP
MISSION
COURT LAKE
MALLARD LAKE

Group Site Name: US 281 - 2

Highway: US 281

Location (RP, LAT/LON, or SEC/TWP/R): US 281, south of Minnewaukan, Benson County, RP 157

Owner: State

NHS (yes/no): Yes

Event Years: 1997, 2001

Description of damage:
1997: Rising water levels in Devils Lake damaged roadway.

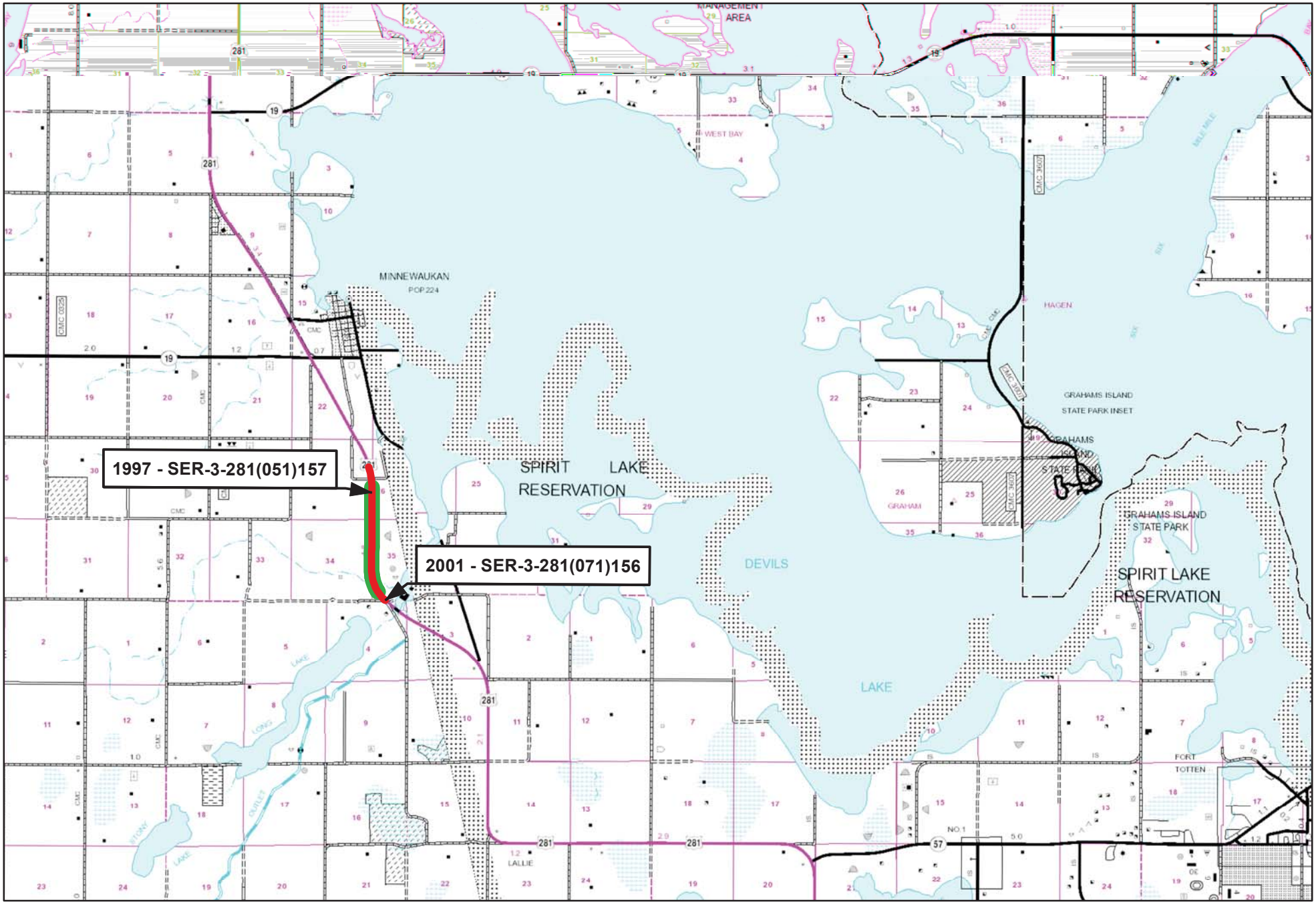
2001: Area around roadway was impacted by the rising waters of Devils Lake.

Completed Permanent Repairs:
1997: SER-3-281(051)157: Hot bituminous surfacing.

2001: SER-3-281(071)156: Realignment and reconstruction of US 281 south of Minnewauken. This project rerouted US 281 to the west of Devils Lake. The previous alignment was abandoned and flooded by the rising lake waters.

Evaluation:
The realignment of US 281 moved the roadway west from the shores of Devils Lake inland. The roadway is not expected to be impacted by rising lake levels on the current alignment. Therefore, in accordance with 23 CFR 667, NDDOT partially or fully mitigated the damage from re-occurring at this time.

US 281-2


1997 - SER-3-281(051)157
2001 - SER-3-281(071)156
MINNEWAUKAN
POP 224
SPIRIT LAKE RESERVATION
DEVILS LAKE
SPIRIT LAKE RESERVATION
GRAHAMS ISLAND STATE PARK INSET
GRAHAMS ISLAND STATE PARK
HAGEN
WEST BAY
LALLIE
FORT TOTTEN
281
19
57

Group Site Name: US 281 - 3

Highway: US 281

Location (RP, LAT/LON, or SEC/TWP/R): US 281, north of ND 19 junction, Benson County, north of Minnewaukan

Owner: State

NHS (yes/no): Yes

Event Years: 1997, 2001

Description of damage:
1997: Rising water levels in Devils Lake damaged roadway.

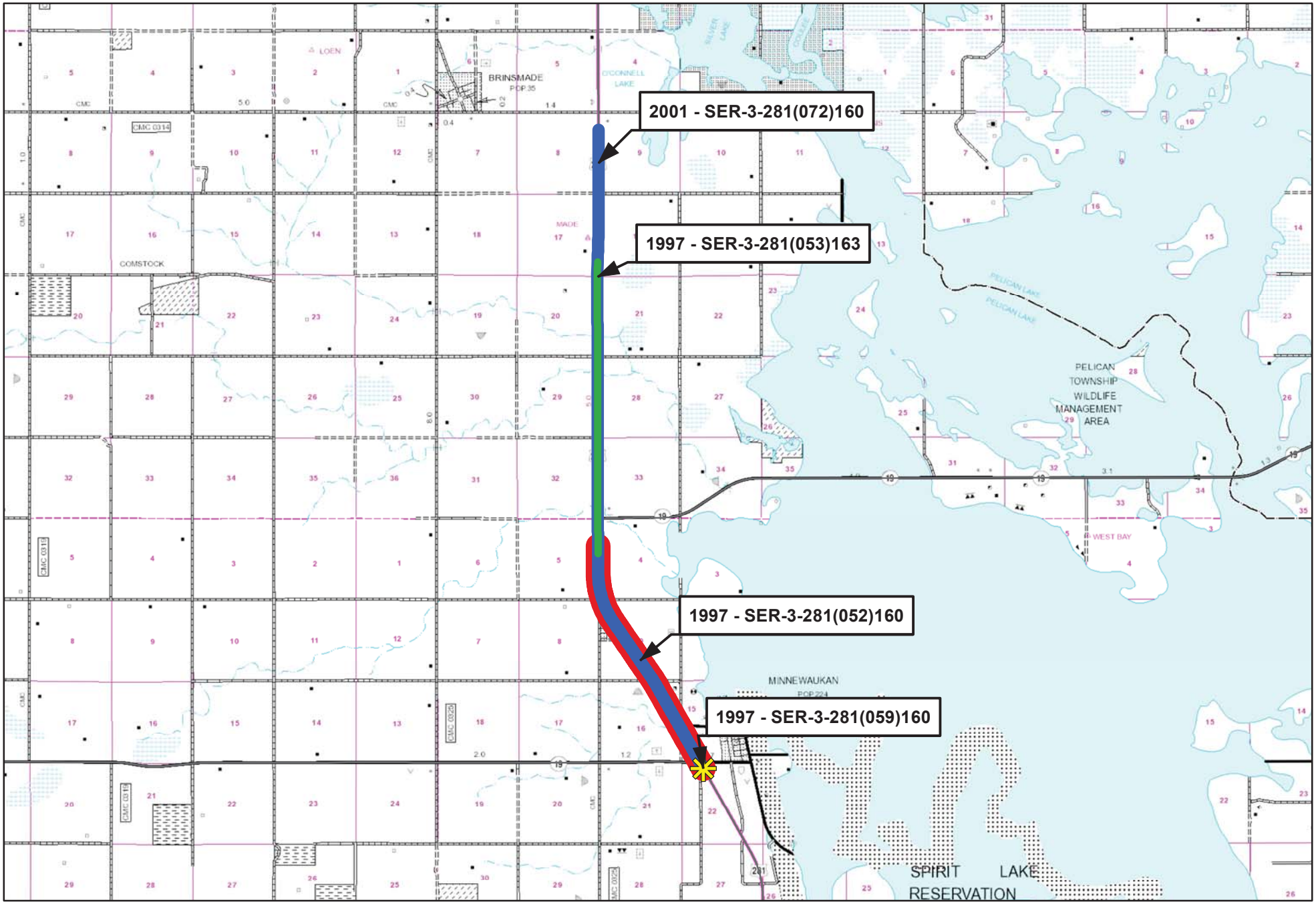
2001: Area around roadway was impacted by the rising waters of Devils Lake.

Completed Permanent Repairs:
1997: SER-3-281(052)160: Hot bituminous surfacing.
1997: SER-3-281(053)163: Hot bituminous surfacing.
1997: SER-3-281(059)160: Riprap erosion control.

2001: SER-3-281(072)160: Realignment and reconstruction of US 281 south of Minnewaukan. This project rerouted US 281 to the west of Devils Lake. The previous alignment was abandoned and flooded by the rising lake waters.

Evaluation:
The realignment of US 281 moved the roadway west from the shores of Devils Lake inland. The roadway is not expected to be impacted by rising lake levels on the current alignment. Therefore, in accordance with 23 CFR 667, NDDOT partially or fully mitigated the damage from re-occurring at this time.

US 281-3


2001 - SER-3-281(072)160
1997 - SER-3-281(053)163
1997 - SER-3-281(052)160
1997 - SER-3-281(059)160
BRINSMADE
POP 35
COMSTOCK
LOEN
O'CONNELL LAKE
PELICAN LAKE
PELICAN TOWNSHIP WILDLIFE MANAGEMENT AREA
WEST BAY
MINNEWAUKAN
POP 224
SPIRIT LAKE RESERVATION