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Unmanned Aerial Vehicle Bridge Inspection Demonstration Project

Barritt Lovelace, Principal Investigator
Collins Engineers, Inc.

July 2015

Research Project
Final Report 2015-40

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16. Abstract (Limit: 250 words)

The increasing costs of bridge inspections are a concern for the Minnesota Department of Transportation (MnDOT). The use of Unmanned Aerial Vehicles (UAV) may help alleviate these costs and improve the quality of bridge inspections.

The overall goal of the UAV Bridge Inspection Demonstration Project was to study the effectiveness of utilizing UAV technology as it could apply to bridge safety inspections. The project team investigated the technology on four bridges located throughout Minnesota. The project team evaluated the UAVs effectiveness as it could apply to bridge inspections based on UAV field results. Various UAV capabilities were utilized to evaluate current technologies as they relate to use in bridge inspections. This study details the advantages and challenges of potentially using UAVs to aid in bridge inspection, an analysis of current and future UAV technologies as they relate to bridge inspection, and an analysis describing how current and future technologies adhere to the National Bridge Inspection Standards.

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Unmanned Aerial Vehicle Bridge Inspection Demonstration Project
Final Report

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EXECUTIVE SUMMARY

An Unmanned Aerial Vehicle (UAV) is defined by the FAA as an aircraft flown with no pilot on board. UAVs are sometimes referred to as drones and the name can be used interchangeably. Unmanned Aerial System (UAS) is also a term that is commonly used. The vehicle is controlled either autonomously or with the use of a remote control by a pilot from the ground and can carry a wide range of imaging technologies including still, video and infrared sensors. UAVs are an emerging technology with many potential applications in the civil engineering field. One application that is routinely mentioned is the area of bridge inspection due to the logistical challenges to efficiently and effectively visually inspect a wide variety of structure types in challenging locations. However, to date an organized study on this application has not been performed. Seeing the potential of UAVs to aid in bridge inspections, the Minnesota Department of Transportation and Collins Engineers developed a demonstration project to evaluate the technology, safety and effectiveness as a tool for bridge inspection.

This demonstration project involved using UAV technology to view four bridges at various locations throughout Minnesota. The project investigated the technology's effectiveness as compared to other access methods, for improving inspections, and use as a tool for interim and special inspections. Current and proposed Federal Aviation Administration (FAA) rules were investigated to determine how they relate to bridge safety inspection use. Different UAV technologies were investigated to evaluate current and future capabilities as they relate to bridge inspection.

Four bridges of varying sizes and types were selected throughout Minnesota, and the bridges were studied using a UAV after a detailed field work plan was prepared for each bridge. The plan addressed safety, FAA rules, and inspection methods. Several imaging devices were tested including still image, video and infrared cameras. Various data were collected in the field including still images, video, infrared images, site maps and 3D models of bridge elements.

Based on our observations in the field and extensive literature research, the following conclusions were made:

- UAVs can be used in the field during bridge inspections safely. Based on the UAVs size, weight, controllability and built-in fail safes, the risk to inspection personnel and public is very low.
- UAVs are more suitable as a tool for inspections of larger bridges, but there can also be some advantages for smaller bridge inspections. (i.e. short span bridges and culverts)
- UAVs themselves cannot perform inspections independently but can be used as a tool for bridge inspectors to view and assess bridge element conditions in accordance with the National Bridge Inspection Standard as detailed in Chapter 3.
- Defects can be identified and viewed with a level of detail equivalent to a close-up photo.
- Measurements can be estimated from images, but tactile functions (e.g., cleaning, sounding, measuring, and testing) equivalent to a hands-on inspection cannot be replicated using UAVs.
- Current FAA rules are onerous when the application is bridge safety inspections. The Section 333 Exemption and Certificate of Authorization process is slowing the adoption of UAVs for bridge safety inspections. While these rules do not prevent the use of UAVs

for bridge inspections the increased time required to obtain approvals is significant and cost prohibitive for as a tool for bridge inspection. However, proposed FAA rules will remove many or all of these obstacles to widespread adoption. Recently the FAA Deputy Administrator Michael Whitaker told lawmakers, "The rule will be in place within a year" and "Hopefully before June 17, 2016."

- UAVs with the ability to direct cameras upward and the ability to fly without a GPS signal are important features when using this technology as an inspection tool.
- UAV technology is evolving rapidly and inspection-specific UAV features are just coming into the marketplace that will increase their effectiveness as it relates to bridge safety inspection. These new technologies should be included as a Phase II of this study.
- In some types of inspections, a UAV has the capabilities to be used in lieu of an under-bridge inspection vehicle and would provide significant savings. These savings would come in the form of reduced or eliminated traffic control and reduced use of under bridge inspection vehicles and lifts.
- UAVs can provide a cost effective way to obtain detailed information that may not normally be obtained during routine inspections.
- Infrared images of bridge decks and elements are already a common and accepted way to obtain information on concrete delaminations. UAVs can provide a very efficient way to collect infrared images of bridge decks and elements as they can be equipped with an infrared camera.
- Safety risks associated traffic control, working at height and in traffic could be minimized with the use of UAVs.
- UAVs can be utilized as an effective method to determine stream or river bank conditions upstream or downstream of the bridge as well as capture large overall aerial maps of dynamic bank erosion and lateral scour conditions.
- UAVs can provide important pre-inspection information for planning large-scale inspections. Information such as clearances, rope access anchor points and general conditions can easily be obtained with a UAV and would aid in the planning of an inspection.

Based on the information presented in this report, the following recommendations are made:

- The use of UAVs to aid bridge inspection should be considered as a tool to a qualified Team Leader when a hands-on inspection is not required. (A Team Leader is an individual certified by MnDOT to conduct inspections of in-service bridges in Minnesota)
- The use of UAVs to aid bridge inspections should be considered for routine inspections to improve the quality of the inspection by obtaining information and detail that may not be readily obtained without expensive access methods. They should also be considered where they can increase safety for inspection personnel and the traveling public.
- Due to the schedule and funding limitations in this initial phase of the demonstration project, an additional study phase should be considered. Topics for investigations in a future phase include:
    - Cost comparison with Aerial Work Platforms and traffic control.
    - Explore inspection-specific UAV technology including the Sensfly eXom. Information on the eXom can be found in Appendix B.

    - Compile a best practices document.
    - Incorporate UAV technology into an actual inspection.
    - Explore the use of a UAV in the planning of an inspection.
    - Use a secondary display for bridge inspector Team Leader.
    - Deck surveys with zoom camera.
    - Explore using UAV technology to perform culvert inspections which does not require FAA approval since culverts are an enclosed space.
    - Explore using UAV technology to perform box girder inspections which does not require FAA approval since culverts are an enclosed space.
    - Use a UAV with infrared (IR) to inspect a bridge with known deck delaminations at dawn.
    - Use a UAV to conduct a paint assessment of an existing bridge.

- A set of best practices and safety guidelines should be prepared and added to the *MnDOT Bridge and Structure Inspection Program Manual* as the technology becomes more prevalent. This could be added as a separate chapter or added to the current chapter titled MnDOT Inspection Vehicle Policy Manual.

CHAPTER 1: INTRODUCTION

1.1 Background

An Unmanned Aerial Vehicle (UAV) is defined by the FAA as an aircraft flown with no pilot on board. UAVs are sometimes referred to as drones and the name can be used interchangeably. Unmanned Aerial System (UAS) is also a term that is commonly used. The vehicle is controlled either autonomously or with the use of a remote control by a pilot from the ground and can carry a wide range of imaging technologies including still, video and infrared sensors. UAVs are an emerging technology with many potential applications in the civil engineering field. One application that is routinely mentioned is the area of bridge inspection due to the logistical challenges to efficiently and effectively visually inspect a wide variety of structure types in challenging locations. However, to date an organized study on this application has not been performed. Seeing the potential of UAVs to aid in bridge inspections, the Minnesota Department of Transportation and Collins Engineers developed a demonstration project to evaluate the technology, safety and effectiveness as a tool for bridge inspection.

This demonstration project involved using UAV technology to view four bridges at various locations throughout Minnesota. The project investigated the technology's effectiveness as compared to other access methods, for improving inspections, and use as a tool for interim and special inspections. Current and proposed Federal Aviation Administration (FAA) rules were investigated to determine how they relate to bridge safety inspection use. Different UAV technologies were investigated to evaluate current and future capabilities as they relate to bridge inspection.

Four bridges of varying sizes and types were selected throughout Minnesota, and the bridges were studied using a UAV after a detailed field work plan was prepared for each bridge. The plan addressed safety, FAA rules, and inspection methods. Several imaging devices were tested including still image, video and infrared cameras. Various data were collected in the field including still images, video, infrared images, site maps and 3D models of bridge elements.

1.1.1 Bridges

Four bridges were selected based on the following factors:

- Cooperation of Local Agency
- Safety
- Varied bridge types and sizes
- Location
- Requirements of FAA

The following bridges were selected for the study after extensive coordination and evaluation:

1. Bridge 13509, Chisago County, MN – Prestressed Beam Bridge

2. Bridge 448, Oronoco, MN – Concrete Arch
3. Bridge 49553, Little Falls, MN - Pedestrian Steel Deck Truss
4. Arcola RR Bridge, Stillwater, MN – High Steel Arch Railroad Bridge
   Alternate:
   Bridge 6544, Duluth, MN – Oliver Bridge Steel Truss and Plate Girders

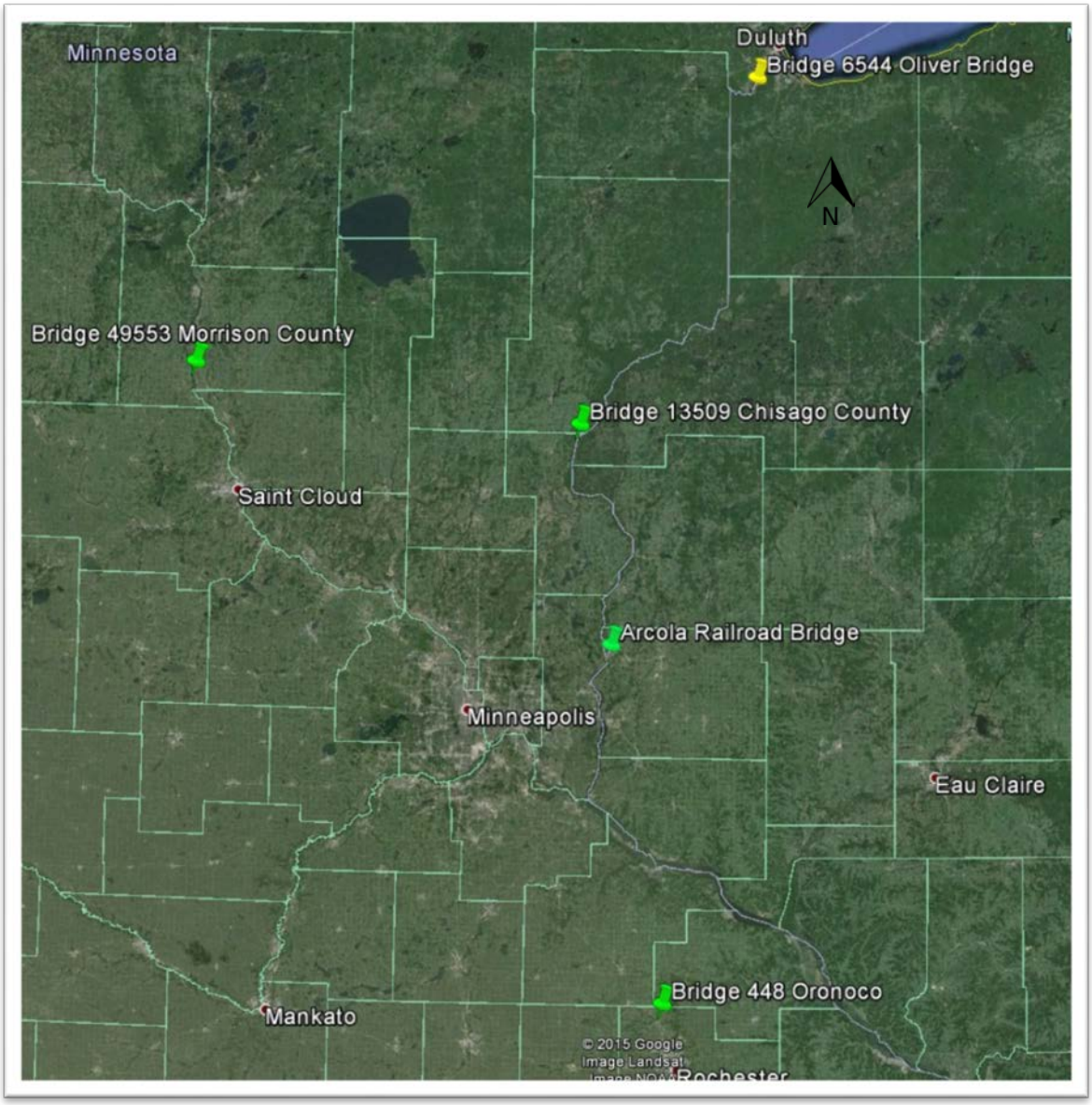

Figure 1-1 Overall Location Map of the Four Investigated Bridges in Minnesota.

CHAPTER 2: FAA RULES

2.1 Current Federal Aviation Administration (FAA) Rules

2.1.1 Commercial Use

Current FAA regulations are differentiated between hobbyists and commercial use. Rules for the hobby use of UAVs have some limited restrictions. However, when UAVs are used for commercial purposes, the rules become restrictive and include the following core rules:

- All aircraft must be certified and registered by the FAA.
- A licensed pilot is required to operate the UAV.
- The UAV must be operated within line of sight.
- The UAV must not be operated within 5 miles of an airport unless prior authorization from the airport operator and the airport air traffic control tower is received.

2.1.2 Section 333 Exception

In order to operate a UAV for commercial purposes, a "Section 333 Exemption" is required from the FAA. These exemptions are provided on a case by case basis and can take several months to receive FAA approval. An approved exemption defines additional restrictions for the use of the UAV. For this study, an exemption was obtained by Collins' sub-consultant, Unmanned Experts, for the use of the Aeyron Skyranger. Exemptions for additional UAVs were submitted prior to the beginning of the study but were not approved by the FAA in time for the fieldwork portion of the project. The most significant additional requirement in the exemption included maintaining a minimum UAV distance of 500 feet from any non-participants.

2.1.3 Certificate of Authorization (COA)

In March 2015, the FAA granted a blanket COA for flights below 200 feet provided the aircraft was less than 55 pounds, operations were conducted during daytime Visual Flight Rules (VFR) conditions, maintaining Visual Line of Sight (VLOS) of the pilot, and the required minimum distance away from airports or heliports. A certificate of authorization is required if a UAV is operated outside of criteria for the blanket COA.

2.1.4 MnDOT Aeronautics

Our team worked in close coordination with the MnDOT Office of Aeronautics to plan the project and obtain the necessary approvals. The Aeronautics Office recently published an official policy for the use of UAVs. The policy is detailed at the following website:

http://www.dot.state.mn.us/policy/operations/op006.html

2.2 Proposed FAA Rules

2.2.1 Commercial Use

On February 15, 2015 the FAA proposed a new set of rules governing the use of small UAVs (under 55lbs). The proposed set of rules would allow the commercial use of UAVs under less restrictions and would remove the need for a Section 333 Exemption and COA. The proposed rule also includes extensive discussion for an additional more flexible framework for "micro" UAVs, weighing under 4.4 pounds. UAVs suitable for inspection would likely fall into this micro UAV category. The proposed rules will undergo a review and comment period with adoption expected sometime in early 2017.

CHAPTER 3: ASSESSMENT OF CURRENT PRACTICES

3.1 Bridge Inspection Access Methods

Bridge inspections are performed using a variety of methods to access areas of bridges that are inaccessible from the ground or bridge deck. Different methods work well in different conditions and with different bridge types. The following discussion details some of the more traditional access methods utilized.

3.1.1 Aerial Work Platforms (AWP)

AWP is defined in the Code of Federal Regulations and includes a variety of equipment commonly referred to as under bridge inspection vehicles, snoopers, lifts, bucket-trucks. This equipment is the most common method for accessing difficult to reach areas of a bridge. Some of the advantages and disadvantages are listed below:

AWP Advantages:

- Ability for inspector to be within arm's reach of bridge components.
- Availability
- Reliability
- Versatility

AWP Disadvantages:

- High Capitol and Maintenance Costs
- Safety of Inspector and Public
- Bridge Weight Restrictions
- May Require Lane Closures
- Mobilization Time and Cost
- Qualified Operator Required (Typically Additional Staff Member on Site)

Figure 3-1 Example of a Under Bridge Inspection Vehicle.

3.1.2 Rope Access

Rope access is another accepted form of access for bridge inspections. This method involves specially trained and certified rope access professionals using ropes and climbing equipment to access portions of the bridge which are inaccessible from the ground or the bridge deck.

Advantages:

- Ability for inspector to be within arm's reach of bridge components.
- Low equipment cost
- Lane closures not required

Disadvantages:

- Availability
- Mobilization costs
- Training Requirements

Figure 3-2 Example of a Rope Access Inspection.

3.2 Evaluation of National Bridge Inspection Standard (NBIS) and MnDOT Standards

The minimum standards for bridge inspections are defined by the NBIS and are further detailed by the MnDOT Bridge and Structure Inspection Program Manual for bridges in Minnesota. The NBIS defines several different types of inspections including initial, routine, in-depth, fracture critical, damage, special and underwater. The minimum level of detail required varies according to the structure's type, size, design complexity, existing conditions and location. Some bridge elements require a hands-on inspection as specified in the NBIS. A list of these elements is included in the MnDOT Bridge and Structure Inspection Program Manual as part of Section A.5.2 and can be viewed here http://www.dot.state.mn.us/bridge/inspection.html. In general, fracture critical members and elements in poor condition require a hands-on inspection which is not possible with the use of a UAV. For members not requiring a hands-on inspection, a UAV can be used as a tool to assist an inspector in gathering better information than would normally be obtained. An example would be the ability to observe the conditions at the bearings or connections that may normally only be observed from some distance much greater than arm's length.

Figure 3-3 Example of the Detail Obtained at a Difficult to Access Bearing Location.

CHAPTER 4: ASSESSMENT OF CURRENT AND FUTURE UAV TECHNOLOGY

An Unmanned Aerial Vehicle (UAV) is defined by the FAA as an aircraft flown with no pilot on board. UAVs are sometimes referred to as drones and the name can be used interchangeably. Unmanned Aerial System (UAS) is also a term that is commonly used. The vehicle is controlled either autonomously or with the use of a remote control by a pilot from the ground. UAV Technology has been around for many years, but the technology has advanced rapidly as it has become affordable and available for commercial and hobby use. Another factor contributing to the rapid acceleration of civilian UAVs is the ability to carry payloads that collect data including imaging devices. Current technologies for commercial use include both fixed wing and rotor aircraft. This study is limited to rotor aircraft as this type of UAV is more suitable for bridge safety inspections.

4.1 Current Technology

There are numerous UAVs on the market that are potentially suitable for inspection work. While technologies and capabilities differ, the most common UAVs share these general features:

- Powered by rechargeable batteries.
- Controlled either autonomously or with a remote control device.
- Contain 4-8 rotors.
- Have the ability to use GPS to track location.
- Contain fail safes such as return to home technology.
- Includes a camera with both video and still image capabilities.

4.1.1 Aeyron Skyranger

For this study, an Aeyron Skyranger UAV (Skyranger) was used. Information on this model can be found in Appendix B. This aircraft was designed with military, public safety and commercial use in mind. The Skyranger is a very robust and capable unit and offered several advantages for this study. The all-weather ability allowed us to work in the rain which occurred within the first two days of field work. The Skyranger has the ability to change payloads to utilize a standard camera, an optical zoom camera, and an infrared camera. The Skyranger also has a very long battery life at around 50 minutes. While the Skyranger met many of the requirements for for collecting inspection data, it did not have the ability to look upward. Therefore, a 360 degree video camera was installed on top of the Skyranger, but due to Wi-Fi signal interference it did not perform correctly. In addition, the Skyranger did not have the ability to fly under the bridge decks because the loss of Global Positioning System (GPS) signal would cause the aircraft to fly vertically and return to the launch point; which was problematic with a bridge deck overhead. The purchase cost for the Skyranger unit is approximately $140,000.

4.1.2 Unmanned Experts

For this study sub-consultant Unmanned Experts provided the equipment and expertise to fly the UAV. They also provided the licensed pilots as required by the FAA and were instrumental in helping our team obtain all the required certifications and approvals.

Figure 4-1 Photograph of the Aeyron Skyranger UAV Next to Bridge.

4.1.3 Additional UAV Models

The original field work plan included utilizing different UAV models as a comparison between technologies. Although exemptions for several models were submitted to the FAA, none were approved in time for the field work portion of this project phase. There are many UAVs currently on the market with GPS and imaging capability starting at around $1000. The wide range in price is attributed to features and length of battery life. A lower cost UAVs battery may only last 10-20 minutes, where a higher end UAV will typically last close to 60 minutes. Lower end models typically lack post processing software, fail safe modes, and have lower material and build quality making them less suitable as a tool for bridge inspection. The costs and features available on UAVs is changing rapidly as the technology advances.

4.2 Future Technology

As UAV technology advances, the market for inspection specific vehicles has increased. There are several models coming into the market to fill this niche. One model is the Sensfly eXom. This model is expected to be on the market in July 2015. Our team met with Sensefly as part of this study, but was unable to use the aircraft at a bridge site because the FAA had not yet approved the exemption. Inspection specific UAVs such as the eXom include the ability to look directly up, fly under bridge decks, use infrared thermography and utilize ultrasonic proximity sensors to avoid objects. These technological advances will provide added benefits and advantages when using UAVs for bridge inspections. Information on the eXom model can be found in Appendix B, and the cost for this model is anticipated to be $45,000.

4.3 Safety Analysis

UAVs have come under scrutiny for privacy and safety concerns. This study provided an opportunity to evaluate the safety of UAVs for both an inspection team and for the traveling public. Most UAVs, including the Skyranger have safety features to reduce the risk involved. The first is the lightweight design. In order to have a longer battery life, all the components are designed to be as light weight as possible. The Skyranger weighs approximately 5 pounds which reduces the damage potential if there were a collision. There are also several fail safes built into the device including a return to home function if communication with the remote is ever lost. The propeller motors are also programmed to stop running if an object is struck. Throughout the study, confidence was gained that operating the vehicle using safety protocols presents a low risk to inspection personnel and to the public. When compared to other inspection methods where traffic control and large equipment is required, the risk is likely much lower.

All FAA's 333 Exemptions contain the following requirement: "Any incident, accident, or flight operation that transgresses the lateral or vertical boundaries of the operational area as defined by the applicable COA must be reported to the FAA's UAS Integration Office (AFS-80) within 24 hours. Accidents must be reported to the National Transportation Safety Board (NTSB) per instructions contained on the NTSB Web site: www.ntsb.gov."

The FAA incident and accident preliminary reports are compiled here:

http://www.asias.faa.gov/pls/apex/f?p=100:446:0::NO:446

A review of the information contained in the reports reveals that no fatalities or injuries have been reported to the FAA in the years 2010 – 2014 in regards to UAVs. No data is available for 2015. In addition, no property damage was reported other than to the UAVs themselves.

The NTSB also provided their UAS data to our team in spreadsheet format. The NTSB's reporting criteria is more selective and only accidents are reported. They have received 20 reports of accidents or incidents with no fatalities or injuries reported. The NTSB has received one report of an accident during a television filming that involved a UAV flying near a steel bridge and losing its compass reading that resulted in a crash. There were no injuries or property damage reported and it is unclear if any fail safes were utilized during the flight as little detail is

included on the incident. Two of the study bridges for this project were large steel structures and no compass problems were encountered during the field work.

Overall the FAA and NTSB data suggest a very low risk for UAVs flying for commercial purposes. Using fail safes and strict safety guidelines ensures the risk will remain low for both inspection personnel and the public.

CHAPTER 5: BRIDGE INVESTIGATION METHODS AND RESULTS

The following describes the investigative methods and results for each bridge in the study. The location, structure description, access methods, investigation methods, site specific safety analysis and imagery results are detailed for each bridge.

5.1 Bridge 13509 – Chisago County

5.1.1 Location

Bridge 13509 is located in Rusheba Township, Minnesota, and it carries CSAH 5 over Rock Creek.

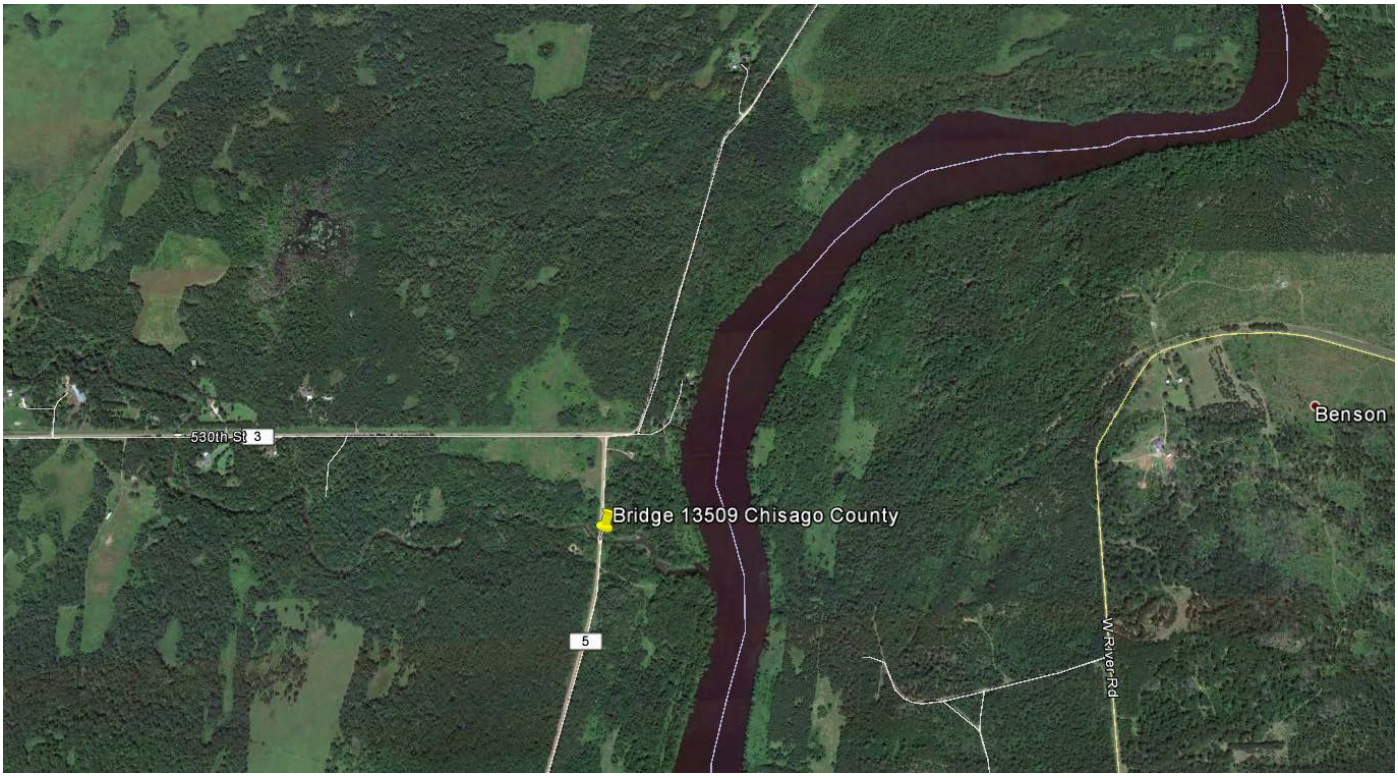

Figure 5-1 Bridge 13509 Site Map.

5.1.2 Structure Description

Bridge 13509 was constructed in 1976 and is an 80-foot long single span prestressed concrete bridge located in a very rural area of Chisago County. The inventory and inspection report can be found in Appendix A as part of the Bridge Investigation and Safety Plan.

Figure 5-2 Bridge 13509 Overall View of Inspection.

5.1.3 Access Methods

The bridge was accessed from both the river banks and from the top of deck. Each fascia of the bridge was flown from one end to the other to investigate the bridge. The bridge was unable to be flown from underneath because of the low clearance and the inability to obtain a GPS signal under the deck. The top of the bridge was flown to investigate the top of deck. The immediate bridge area (upstream and downstream) was also flown to create a map of that shows features adjacent to the bridge including stream banks, topography and site features.

5.1.4 Investigation Methods

The bridge was viewed with the use of the Skyranger UAV to determine its effectiveness as a tool for bridge safety inspection. Using the previous report as a reference, previously identified deficiencies were investigated to determine if those deficiencies could reasonably be identified with the use of a UAV.

5.1.5 Site Specific Safety

The bridge accommodates roadway traffic, and the UAV was flown in accordance with Unmanned Experts Operations Manual and the FAA Section 333 Exemption. Because of its rural location, the traffic volume on the bridge was minimal allowing the team almost unrestricted access. Roadway traffic was monitored and when vehicles were approaching the UAV was moved behind a barrier or distance greater than 500 feet from non-participants to ensure the requirements of the FAA Exemption are met.

5.1.6 Investigation Results

Bridge 13509 represented a local bridge in the study. Because of its smaller size, this bridge may not be an ideal candidate for using a UAV as an inspection tool. The level of detail needed to detect defects was provided by the UAV, but the inability to maneuver underneath the bridge was a limiting factor. Future technologies include the ability to fly under bridge decks which has the potential to improve the effectiveness of UAVs for small bridge inspections. The table below details each bridge element in the previous inspection report and give details on whether the condition could be discerned from the data collected from the UAV.

Table 5-1 Bridge 13509 Inspection Element Table

Bridge Element	Condition State	Previous Inspection Note	Discernable from UAV Video/Photo/IR Image
012 Top of Concrete Deck	2852 FT^2 CS 1	25 % of Deck	Yes, gravel is clearly visible in photos, now at 50%.
109 Prestressed Concrete Girder or Beam	312 FT CS 1	None	Yes, (fascia's only)
215 Reinforced Concrete Abutment	72 FT CS 1	None	No, unable to fly under deck.
311 Expansion Bearing	4 EA CS 1	Three anchor bolt nuts missing.	No, unable to fly under deck.
313 Fixed Bearing	4 EA CS 1	Five anchor bolt nuts missing.	No, unable to fly under deck.
331 Reinforced Concrete Bridge Railing	129 FT CS 1 32 FT CS2	Minor shrinkage cracks.	Yes
361 Scour Smart Flag	1 EA CS 1	None	Yes
380 Secondary Structural Elements	1 EA CS 1	Steel Diaphragms	No, unable to fly under deck.
387 Reinforced Concrete Wingwall	4 EA CS 1	None	Yes

To view video of the Chisago County Bridge Investigation visit the following link:

https://youtu.be/kmvEfKNPOBI

One of the highlights of this investigation was the infrared camera function. The image below shows a still IR image of the deck clearly showing the thermal gradient at the beam locations. While this deck did not have any delamination's that were observed it can be assumed that delamination's could be seen with the IR camera if they were present. The beams are clearly visible in Figure 4.1.3 showing the temperature variations present at the time of inspection. The images could also be dimensionally calibrated to provide repair quantity estimates. Significant research has been performed on the use of IR for evaluating concrete defects, and IR use is an accepted practice in non-destructive evaluation.

Figure 5-3 Bridge 13509 IR Image of Bridge Deck.

Another highlight was the mapping function that was performed by the UAV of the immediate bridge area. The image below is a result of flying the site in a “lawn mower” pattern while taking overlying still photos and stitching a series of still photographs together using software. This flight was preprogrammed and flown autonomously.

Figure 5-4 Bridge 13509 Orthographic Map.

Figure 5-5 Overall View of Personnel and UAV at Bridge.

5.2 Bridge 448 – Oronoco Bridge

5.2.1 Location

Bridge 448 is located in Oronoco, Minnesota, and it carries Minnesota Avenue over the Middle Fork of the Zumbro River.

5.2.2 Structure Description

Bridge 448 is a 296-foot long open spandrel concrete arch bridge that was constructed in 1918. The inventory and inspection report can be found in Appendix A as part of the Bridge Investigation and Safety Plan.

Figure 5-7 Bridge 448 Overall View.

5.2.3 Access Methods

The bridge was accessed from the river bank near the north end of the bridge. Each fascia of the bridge was flown from one end to the other to investigate the sides of the bridge. The bridge was also flown near the underside with a zoom lens to investigate the underside of deck, substructures and the bottom of the concrete spandrels. The top of deck was not flown due to traffic on the bridge.

5.2.4 Investigation Methods

The bridge was viewed with the use of UAV technology to determine its effectiveness as a tool for bridge safety inspection. Using the previous report as a reference, previously identified deficiencies were investigated to determine if those deficiencies could reasonably be identified with the use of a UAV.

5.2.5 Site Specific Safety

The bridge accommodates roadway and pedestrian traffic and the UAV was flown in accordance with Unmanned Experts Operations Manual and the FAA Section 333 Exemption. Pedestrian traffic was monitored in order to ensure the safety of the public. Radios were used to communicate the presence of approaching pedestrians to the UAV operator to avoid conflicts.

The area under the bridge was used by fisherman and our team had to ask some of them to leave the area during the inspection to maintain the 500-foot buffer.

5.2.6 Investigation Results

Bridge 448 represented a medium-sized concrete arch bridge in our study. Concrete arch bridges are common in Minnesota and can be difficult to access during bridge inspections. The level of detail needed to detect defects was provided by the UAV but the inability to maneuver underneath the bridge was a limiting factor. The zoom lens provided reasonable visibility under the bridge and many of the underdeck elements were able to be viewed. Future UAV technology that is coming to market includes the ability to fly under bridge decks. This technology will have the potential to improve the effectiveness of UAVs for this type of bridge. The table below details each bridge element in the previous inspection report and give details on whether the condition could be discerned from the data collected from the UAV.

Table 5-2 Bridge 448 Inspection Element Table

Bridge Element	Condition State	Previous Inspection Note	Discernable from UAV Video/Photo/IR Image
26 Top of Concrete Deck - EPX	14521 FT^2 CS 1	Deck was chained and no delamination was found.	No, FAA requirements only allowed flight under the level barrier.
300 Strip Seal Joint	92 FT CS 1	South end: West side 1 7/8" East side 2". North end: West side 1 1/2", East side 1 3/8" at 30 deg.	No, FAA requirements only allowed flight under the level barrier.
333 Railing	520 FT CS 1 71 CS 2	Minor vertical 0.013" cracks in concrete both sides of bridge. The galvanizing on the rail is fading.|	Yes
109 P/S Concrete Girder	409 FT CS 1 1 FT CS 2	North approach span east fascia beam bottom flange has a patched area on the east side of the beam 8' from the north abutment.	Yes
144 Concrete Arch	229 FT CS 1 188 FT CS 2	Spalls were repaired by MnDOT in July 2014, See history file attachment and photos and notes below.	Yes
155 Concrete Floorbeam	883 FT CS 1 9 FT CS2	There is a small delamination and crack in the north side of the center floorbeam against the east arch. The south end of the center floorbeam has small cracks against the arch.	Yes

Bridge Element	Condition State	Previous Inspection Note	Discernable from UAV Video/Photo/IR Image
385 Conc Spandrel Column	32 EA CS 1 3 EA CS 2	Spalls on columns were repaired by MNDOT July 2014.	Yes
310 Elastomeric Bearing	1 EA CS 1	Abutment bearing pads are cast into the concrete end diaphragm and partially concealed. No deterioration noted.	No
313 Fixed Bearing	10 EA CS 1	No deterioration noted.	Yes
205 Concrete Column	16 EA CS 1 16 EA CS 2	Spalls on column have been repaired by MNDOT in July 2014. See history file attachment and photos.|	Yes
215 Concrete Abutment	89 LF CS 1 9 LF CS 2	North abutment-Minor cracks in face of abutment walls. There is a 4" x 8" spall in the top of the bridge seat west end of the north abutment. South abutment-The bridge seat is stained from water leaking through the joint above.	Mostly, better views possible with ability to fly under deck.
234 Concrete Cap	98 LF CS 1	There are superficial vertical 0.010"cracks in both faces of the cap.	Yes
387 Concrete Wingwall	3 EA CS 1 1 EA CS 2	0.010" vertical crack in SE. wingwall. Cork material missing between wingwall	Yes

Bridge Element	Condition State	Previous Inspection Note	Discernable from UAV Video/Photo/IR Image
		and parapet wall on all four corners.	
358 Conc Deck Cracking	1 EA CS 2	Several longitudinal and traverse unsealed deck cracks (approximately 2000 linear feet	No, FAA requirements only allowed flight under the level of the barrier.
359 Concrete Deck Underside	1 EA CS 2	Scattered cracks with efflorescence throughout. Diagonal cracks in the NE and NW corners of deck.	No, UAV was not able to fly directly under deck.
361 Scour	1 EA CS 2	Scour at the corner of S. arch footing was repaired by Mn/Dot and County personnel according to the plan from Ron Benson from Erickson Engineering in 2006. On the east side of the repair, it is undermining which extends from two feet up to six feet past end of apron. Riprap was placed at south protection slab and along south wall. Plan, pictures and procedure are in bridge file.	No
981 Signing	1 EA CS 1	Clearance markers W. side only.	Yes
982 Guardrail	1 EA CS 1	Plate beam attached SW. corner.	No, FAA requirements only allowed flight under the level of the

Bridge Element	Condition State	Previous Inspection Note	Discernable from UAV Video/Photo/IR Image
			barrier.
985 Slopes	1 EA CS 1	New riprap was placed on north abutment in 2012. Riprap was placed in behind south protection walls. Slope in front south abutment has settled three to four feet as shown by the most recent concrete surface finish line.	Yes

To view video of the Oronoco Bridge Investigation visit the following link:

https://youtu.be/CR-tQnntFxI

The figures below show the level of detail obtained from the UAV for both a normal image and also an IR image.

Figure 5-8 Photograph of Bridge 448 Detail Near Top of Arch.

Figure 5-9 Bridge 448 IR View of Arch.

5.3 Bridge 49553 –Morrison County Pedestrian Bridge

5.3.1 Location

Bridge 49553 is part of the Soo Line Trail and crosses the Mississippi River just downstream of the Blanchard Dam. Blanchard Dam is a hydroelectric station owned and operated by Minnesota Power. The bridge is located in Swan River Township in Morrison County.

Figure 5-10 Bridge 49553 Overall Map.

5.3.2 Structure Description

Bridge 49553 was originally constructed in 1908, and it is a five-span steel underdeck truss bridge with cast-in-place concrete piers and abutments. The bridge carried railway trains for most of its life but the bridge was repurposed for pedestrians in 2006 as part of the Soo Line Recreational Trail Project. The inventory and inspection report can be found in Appendix A as part of the Bridge Investigation and Safety Plan.

Figure 5-11 Bridge 49553 Overall View.

5.3.3 Access Methods

The bridge was accessed from the top of deck. Each fascia of the bridge was flown from one end to the other to investigate the exterior of the truss. The bridge was also flown near the underside to investigate the bridge chords, substructures and the interior truss members. The top of deck was flown to investigate the condition of the timber deck.

5.3.4 Investigation Methods

The bridge was viewed with the use of UAV technology to determine its effectiveness as a tool for bridge safety inspection. Using the previous inspection report as a reference, previously identified deficiencies were investigated to determine if those deficiencies could reasonably be identified with the use of a UAV.

Figure 5-12 Bridge 49553 Access from Top of Deck.

5.3.5 Site Specific Safety

The bridge accommodates pedestrian traffic and the UAVs were flown in accordance with Unmanned Experts Operations Manual and the FAA Section 333 Exemption. Pedestrian traffic was monitored in order to ensure the safety of the public. Radios were used to communicate the presence of approaching pedestrians to the operator to avoid conflicts.

5.3.6 Investigation Results

Bridge 49553 represented a large steel truss bridge in our study. This bridge has been inspected in the past with an under bridge inspection vehicle, but because of the fence height and load capacity of the timber deck some areas are difficult to access even with the under bridge inspection vehicle. The level of detail needed to detect defects was provided by the UAV, and elements that are difficult to access were readily visible using the UAV with very good detail. The zoom lens provided very good detail without having to position the UAV too close to the bridge.

The table below details each bridge element in the previous inspection report and give details on whether the condition could be discerned from the data collected from the UAV.

Table 5-3 Bridge 49553 Inspection Element Table

Bridge Element	Condition State	Previous Inspection Note	Discernable from UAV Video/Photo/IR Image
31 Timber Deck	8450 FT^2 CS 2	Constructed 13' wide x 4" thick x 650' treated timber deck and replaced 33 RR ties. Also placed 2" treated timber wear course.	Yes
407 Bituminous Approach	2 EA CS 1	Paved 2" bituminous in November, 2006. 8/28/13 - West approach failure repaired by MCHD. Good condition. Erosion on East approach repaired w/ quarry run riprap.	Yes
334 Metal Rail Coated	1299 FT CS 1	Placed 1,300' of coated chain link fence in November, 2006. 8/27/12 - Missing (1) end cap on East end.	Yes
117 Timber Stringer	3251 FT CS 1	Constructed 5- 4"x 8" treated timber stringers.	Yes, partially
131 Painted Stl Deck Truss	351 FT CS 2 299 FT CS 2	10/4/04 - All steel corroding & in need of rehab.	Yes
311 Expansion Bearing	1 EA CS 1 8 EA CS 2 1 EA CS 3	10/11/05 - Bearings show movement is possible. Significant corrosion is present, but bearings appear functional. 8/27/12 - Extensive crack in lower portion of bearing on South bearing on East abutment. 8/28/13 - Changed quantity to	Yes

Bridge Element	Condition State	Previous Inspection Note	Discernable from UAV Video/Photo/IR Image
		each. Additional cracked bearing on pier 2 noted in 7/30/13 inspection.	
313 Fixed Bearing	10 EA CS 2	8/28/13 - Added element.	Yes
210 Concrete Pier Wall	102 FT CS 3	7/30/13 - Changed L.F. to correct dimensions. All walls have extensive cracking, spalling and delamination.	Yes
215 Concrete Abutment	33 FT CS 3	All pier footings are extremely Spalled (up to 1.0'). Much rebar corroding. 10/13/08 - Pier footing #1 has had partial repairs with grout filled bags. 10/2/14 - Pier #1 on top of exposed footing has advanced spalling taking place. Since last inspection, footing has lost approx. 1.0' of concrete on S.W. end of footing.	Yes
234 Concrete Cap	102 FT CS 3	10/4/04 - Pier caps are in poor condition. Extreme spalling. 10/11/2005 - All pier as have significant Surface spalls. No determination on integrity of remainder of concrete soundness is made. 9/23/10 - Concrete caps continue to deteriorate.	Yes
387 Concrete Wingwall	4 EA CS 3	10/4/04 - NW wing has (1) - 1" crack full height-and depth. SW wing has broken off.	Yes

Bridge Element	Condition State	Previous Inspection Note	Discernable from UAV Video/Photo/IR Image
		Severe spalls. 10/2/14 - Concrete on lower portion of S.W. wingwall is spalled. One void detected beneath wingwall is 3'x 1.5'x 1'.|	
982 Guardrail	1 EA CS 1	10/15/07 - Constructed split rail guardrail in November, 2006.	Yes

To view video of the Morrison County Bridge Investigation visit the following link:

https://youtu.be/oy6FFsNRFSE

The figures below demonstrates the level of detail obtained from the UAV.

Figure 5-13 Photograph of Bridge 49553 Top Chord.

Figure 5-14 Photograph of Bridge 49553 Bearings and Truss Panel Point.

Figure 5-15 Photograph of Bridge 49553 Pier Cap Concrete Deterioration.

5.4 Arcola Railroad Bridge

5.4.1 Location

The Arcola Bridge is located north of downtown Stillwater, Minnesota and carries the CN Railway across the St. Croix River.

Figure 5-16 Arcola Bridge Overall Map.

5.4.2 Structure Description

The Arcola Railway Bridge was constructed in 1909, and is 2,682 feet long and located approximately 185 feet above the St. Croix River. The bridge consists of five truss arch spans each 350 feet long. There are seven steel bents on the west approach and four steel bents on the east approach.

Figure 5-17 Arcola Bridge Overall View.

5.4.3 Access Methods

The bridge was accessed from the river by boat under the first arch span on the west side of the bridge. Each fascia of the arch span was flown from one end to the other to investigate the sides of the steel members. The bridge was also flown from the underside to investigate the substructures and the bottom of the steel members. The top of the bridge was be flown at a distance of 10 feet laterally from the track to meet CN requirements. CN Railway had a representative on site providing track clearance for the duration of the inspection.

5.4.4 Investigation Methods

The bridge was viewed with the use of UAV technology to determine its effectiveness as a tool for bridge safety inspection. A previous inspection report was not available at the time of inspection. Without a previous inspection report, this site provided an opportunity for a fresh perspective without prior knowledge of any defects.

5.4.5 Site Specific Safety

The bridge accommodates railway train traffic, and the UAV was be flown in accordance with Unmanned Experts Operations Manual and the FAA Section 333 Exemption. Maritime traffic

under the bridge was monitored in order to ensure the safety of the public. Spotters were used to communicate the presence of boaters to the operator to avoid conflicts.

5.4.6 Investigation Results

The Arcola Bridge represented a large complex steel bridge in our study. This bridge is typically inspected using rope access because of the 185 foot height. The level of detail needed to detect defects was provided by the UAV. The elements that were traditionally difficult to access were readily visible using the UAV with very good detail. The zoom lens provided quality detail without having to position the UAV too close to the bridge. This bridge is an ideal candidate for a UAV technology when arm's length inspection is not required.

To view video of the Arcola Bridge Investigation visit the following link:

https://youtu.be/T5Y7On-yWWw

The figures below show the level of detail obtained from the UAV.

Figure 5-18 Photograph of Arcola Bridge Pin Detail Photo 1.

Figure 5-19 Photograph of Arcola Bridge Pin Detail Photo 2.

Figure 5-20 Photograph of Arcola Bridge Pin Detail Photo 3.

Figure 5-21 Close up Photograph of Arcola Bridge Pin Detail Photo 4.

5.4.7 Three Dimensional Mapping

3D rendering of bridge components was explored using the UAV. Images were taken as the UAV is flown around the bridge foundation. These images are then processed using software to create a 3D model of the foundation. This model is "coordinate correct" and contains a point cloud generated from the photographs and telemetry data. This feature can be enhanced with a variety of additional sensor if deflections or other movement needs to be monitored.

Figure 5-22 Photograph of Arcola Bridge 3D Modeling Flight.

Figure 5-23 3D Orthographic Model of Bridge Foundation.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

Based on our observations in the field and extensive literature research, the following conclusions were made:

- UAVs can be used in the field during bridge inspections safely. Based on the UAVs size, weight, controllability and built-in fail safes, the risk to inspection personnel and public is very low.
- UAVs are more suitable as a tool for inspections of larger bridges, but there can also be some advantages for smaller bridge inspections. (i.e. short span bridges and culverts)
- UAVs themselves cannot perform inspections independently but can be used as a tool for bridge inspectors to view and assess bridge element conditions in accordance with the National Bridge Inspection Standard as detailed in Chapter 3.
- Defects can be identified and viewed with a level of detail equivalent to a close-up photo.
- Measurements can be estimated from images, but tactile functions (e.g., cleaning, sounding, measuring, and testing) equivalent to a hands-on inspection cannot be replicated using UAVs.
- Current FAA rules are onerous when the application is bridge safety inspections. The Section 333 Exemption and Certificate of Authorization process is slowing the adoption of UAVs for bridge safety inspections. While these rules do not prevent the use of UAVs for bridge inspections the increased time required to obtain approvals is significant and cost prohibitive for as a tool for bridge inspection. However, proposed FAA rules will remove many or all of these obstacles to widespread adoption. Recently the FAA Deputy Administrator Michael Whitaker told lawmakers, “The rule will be in place within a year” and “Hopefully before June 17, 2016.”
- UAVs with the ability to direct cameras upward and the ability to fly without a GPS signal are important features when using this technology as an inspection tool.
- UAV technology is evolving rapidly and inspection-specific UAV features are just coming into the marketplace that will increase their effectiveness as it relates to bridge safety inspection. These new technologies should be included as a Phase II of this study.
- In some types of inspections, a UAV has the capabilities to be used in lieu of an under-bridge inspection vehicle and would provide significant savings. These savings would come in the form of reduced or eliminated traffic control and reduced use of under bridge inspection vehicles and lifts.
- UAVs can provide a cost effective way to obtain detailed information that may not normally be obtained during routine inspections.
- Infrared images of bridge decks and elements are already a common and accepted way to obtain information on concrete delaminations. UAVs can provide a very efficient way to collect infrared images of bridge decks and elements as they can be equipped with an infrared camera.
- Safety risks associated traffic control, working at height and in traffic could be minimized with the use of UAVs.
- UAVs can be utilized as an effective method to determine stream or river bank conditions upstream or downstream of the bridge as well as capture large overall aerial maps of dynamic bank erosion and lateral scour conditions.

- UAVs can provide important pre-inspection information for planning large-scale inspections. Information such as clearances, rope access anchor points and general conditions can easily be obtained with a UAV and would aid in the planning of an inspection.

Based on the information presented in this report, the following recommendations are made:

- The use of UAVs to aid bridge inspection should be considered as a tool to a qualified Team Leader when a hands-on inspection is not required.
- The use of UAVs to aid bridge inspections should be considered for routine inspections to improve the quality of the inspection by obtaining information and detail that may not be readily obtained without expensive access methods. They should also be considered where they can increase safety for inspection personnel and the traveling public.
- Due to the schedule and funding limitations in this initial phase of the demonstration project, an additional study phase should be considered. Topics for investigations in a future phase include:
    - Cost comparison with Aerial Work Platforms and traffic control.
    - Explore inspection-specific UAV technology including the Sensfly eXom. Information on the eXom can be found in Appendix B.
    - Compile a best practices document.
    - Incorporate UAV technology into an actual inspection.
    - Explore the use of a UAV in the planning of an inspection.
    - Use a secondary display for bridge inspector Team Leader.
    - Deck surveys with zoom camera.
    - Explore using UAV technology to perform culvert inspections which does not require FAA approval since culverts are an enclosed space.
    - Explore using UAV technology to perform box girder inspections which does not require FAA approval since culverts are an enclosed space.
    - Use a UAV with infrared (IR) to inspect a bridge with known deck delaminations at dawn.
    - Use a UAV to conduct a paint assessment of an existing bridge.

- A set of best practices and safety guidelines should be prepared and added to the *MnDOT Bridge and Structure Inspection Program Manual* as the technology becomes more prevalent. This could be added as a separate chapter or added to the current chapter titled MnDOT Inspection Vehicle Policy Manual.

REFERENCES

Federal Highway Administration, *National Bridge Inspection Standards*, 23 CFR 650, FHWA, Washington, DC.

U.S. Department of Transportation (2012), *Bridge Inspector's Reference Manual*, Federal Highway Administration, Washington, DC.

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J. Koonce, T. Demski, M. Rowe, N. Morris (2011) "Bridge Inspection Access to Minimize Operational Impacts", American Railway Engineering and Maintenance of Way Association, 2011 Annual Conference, October 2011, Collins Engineers, Inc., Chicago, IL.

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APPENDIX A
Bridge Investigation and Safety Plan



Unmanned Aerial Vehicle Bridge Inspection Demonstration Project

Investigation and Safety Plan

5/20/15

Prepared for:

MINNESOTA DEPARTMENT OF TRANSPORTATION

Prepared by:

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PROJECT SUMMARY

Project: Unmanned Aerial Vehicle Bridge Inspection Demonstration Project

Purpose of Project: The overall goal of the Unmanned Aerial Vehicle (UAV) Bridge Inspection Demonstration Project is to study the effectiveness of UAV technology when applied to bridge safety inspections.

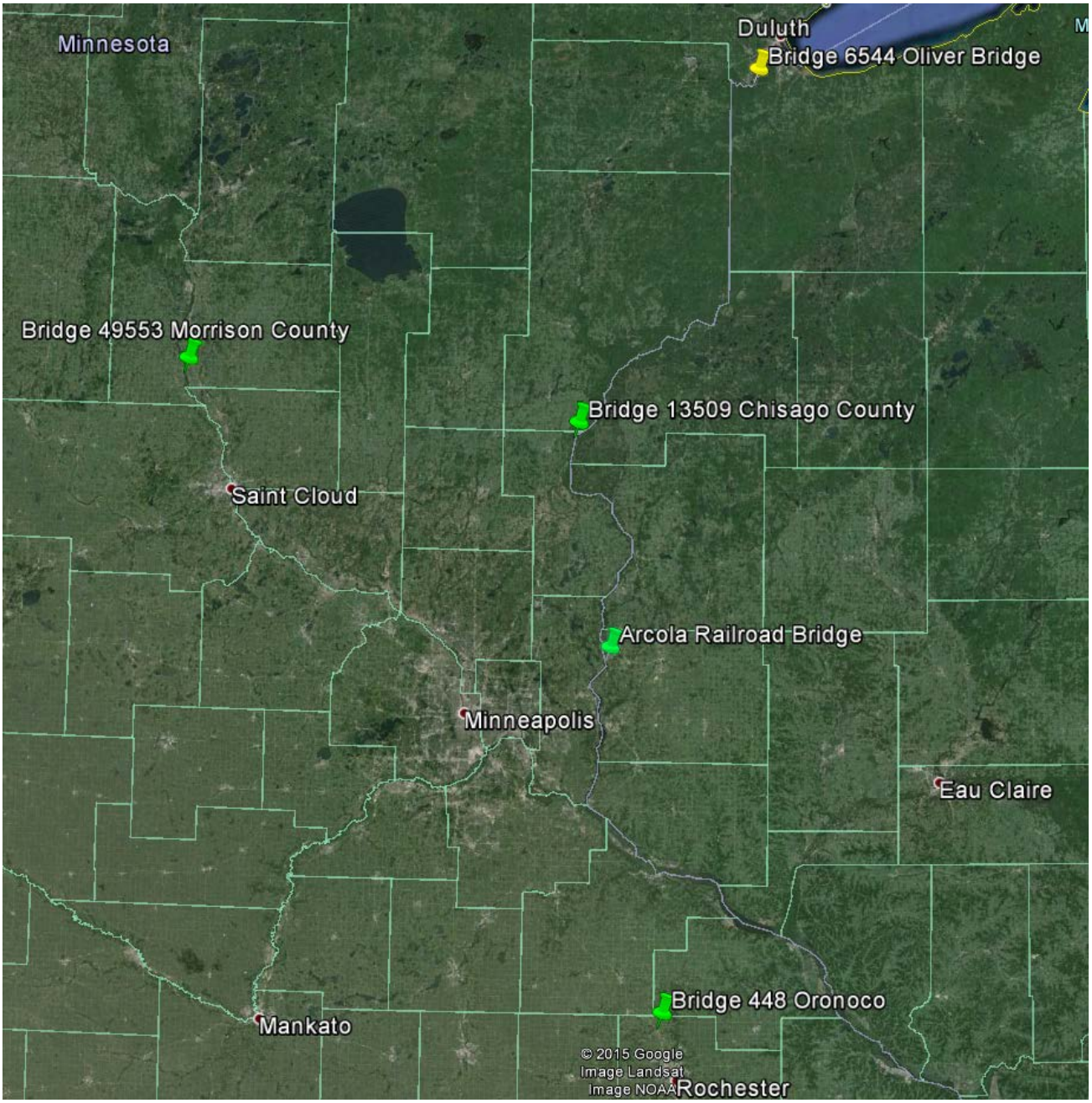
Field Team: Jennifer Zink - MnDOT Project Manager
Barritt Lovelace - Project Manager, Quality Mangement
Bruce Holdhusen - MnDOT Research Coordinator
Dave Prall - UAV Lead
Keven Gambold – UAV Administrator
Beverly Farraher - Project Champion

Field Date(s): May 25th – 29th, 2015, Working Hours 7 am – 7 pm

Tentative Schedule				
Monday 25th	Tuesday 26th	Wednesday 27th	Thursday 28th	Friday 29th
Bridge 13509	Bridge 448	Bridge 49553	Arcola	Alternate/ Weather Day/Media

Project Locations: Bridge 13509, Chisago County, MN – Prestressed Beam Bridge
Bridge 448, Oronoco, MN – Concrete Arch
Bridge 49553, Little Falls, MN - Pedestrian Steel Deck Truss
Arcola RR Bridge, Stillwater, MN – High Steel Arch Railroad Bridge
Alternate:
Bridge 6544, Duluth, MN – Oliver Bridge Steel Truss and Plate Girders

Map: Google Map of Bridges
https://www.google.com/maps/d/edit?mid=zWY1TJfvKcUc.kl6gZT_TtTAo



Overall Bridge Location Map

1.0 INTRODUCTION

1.1 Project Overview

Increasing bridge maintenance and inspection costs are a concern for existing bridges in Minnesota. These additional costs could be minimized and the quality of inspections could be improved by utilizing Unmanned Aerial Vehicles.

The overall goal of the Unmanned Aerial Vehicle (UAV) Bridge Inspection Demonstration Project is to study the effectiveness of UAV technology as it applies to Bridge Safety Inspections. The project will involve utilize UAV technology to inspect approximately four bridges. The project will investigate their effectiveness in improving inspections and their use as a tool for interim inspections. Different UAV models and technologies will be utilized to evaluate current technologies as they relate to bridge inspection. The study will culminate in a report detailing the advantages and challenges of using UAV's for bridge inspection, an analysis on current UAV technologies as they relate to bridge inspection, and an analysis describing how current and future technology fit within the National Bridge Inspection Standards.

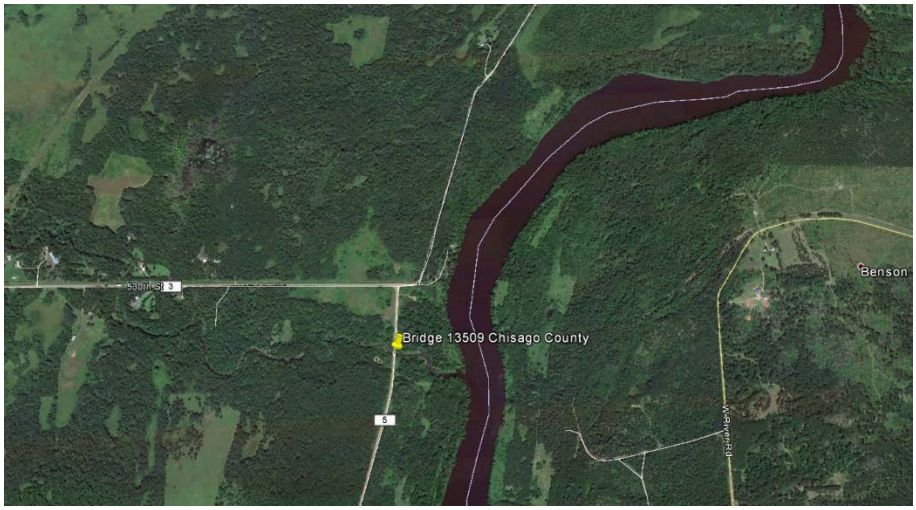
2.0 INVESTIGATION PLAN

The following describes the inspection plan for each bridge. The location, structure description, access methods, investigation methods and a site specific safety analysis are detailed for each bridge.

2.1 Bridge 13509 – Chisago County

2.1.1 Location

Bridge 13509 is located in Rusheba Township, Minnesota and carries CSAH 5 over Rock Creek.



2.1.2 Structure Description

Bridge 13509 is an 80 foot long single span prestressed concrete bridge located in a very rural area of Chisago County. The inventory and inspection report can be found in Appendix B.

2.1.3 Access Methods

The bridge will be accessed from both the river banks and from the top of deck. Each fascia of the bridge will be flown from one end to the other to investigate the sides of the bridge. The bridge will also be flown from underneath to investigate the

underside of deck, substructures and the prestressed beams. The top of the bridge will be flown to investigate the top of deck.

2.1.4 Investigation Methods

The bridge will be inspected with the use of UAV technology to determine its effectiveness as a tool for bridge safety inspection. Using the previous reports as a reference, previously identified deficiencies will be investigated to determine if those deficiencies could reasonably be identified with the use of a UAV. Any additional deficiencies discovered will be noted as well.

2.1.5 Site Specific Safety

2.1.5.1 Airspace safety is addressed in the Pre Site Survey Brief prepared by Unmanned Experts located in Appendix D.

2.1.5.2 The bridge accommodates roadway traffic and the UAV will be flown in accordance with Unmanned Experts Operations Manual and the FAA Section 333 Exemption. Because of its very rural location the traffic on the bridge is very limited which will give almost unrestricted access. Roadway traffic will be monitored in order to ensure the safety of the public. Radios will be used to communicate the presence of approaching vehicles to the operators to avoid conflicts.

2.2 Bridge 448 – Oronoco Bridge

2.2.1 Location

Bridge 448 is located in Oronoco, Minnesota and carries Minnesota Avenue over the Middle Fork of the Zumbro River.

2.2.2 Structure Description

Bridge 448 is a 296 foot long open spandrel concrete arch bridge that was constructed in 1918. The inventory and inspection report can be found in Appendix B.

2.2.3 Access Methods

The bridge will be accessed from the river bank near the north end of the bridge. Each fascia of the bridge will be flown from one end to the other to investigate the sides of the bridge. The bridge will also be flown from the underside to investigate the underside of deck, substructures and the bottom of the concrete spandrels. The top of deck will be flown to investigate the condition of the concrete deck.

2.2.4 Investigation Methods

The bridge will be inspected with the use of UAV technology to determine its effectiveness as a tool for bridge safety inspection. Using the previous reports as a reference, previously identified deficiencies will be investigated to determine if those deficiencies could reasonably be identified with the use of a UAV. Any additional deficiencies discovered will be noted as well.

2.2.5 Site Specific Safety

2.2.5.1 Airspace safety is addressed in the Pre Site Survey Brief prepared by Unmanned Experts located in Appendix D.

2.2.5.2 The bridge accommodates roadway and pedestrian traffic and the UAV will be flown in accordance with Unmanned Experts Operations Manual and the FAA Section 333 Exemption. Pedestrian traffic will be monitored in order to ensure the safety of the public. Radios will be used to communicate the presence of pedestrians to the operators to avoid conflicts. In order to inspect the top of deck the UAV may have to be positioned such that it leaves nonparticipating persons unprotected by barriers or structures. In this case the UAV will maintain a 500 foot buffer from the nonparticipants if possible. If this is not possible the top of deck inspection will not be included.

2.3 Bridge 49553 –Morrison County Pedestrian Bridge

2.3.1 Location

Bridge 49553 is part of the Soo Line Trail and crosses the Mississippi River just downstream of the Blanchard Dam. Blanchard Dam is a hydroelectric station owned and operated by Minnesota Power. The bridge is located in Swan River Township in Morrison County. The inventory and inspection report can be found in Appendix B.

2.3.2 Structure Description

Bridge 49553 was originally constructed in 1908 and is a five span steel underdeck truss bridge with cast in place concrete piers and abutments. The bridge carried

trains for most of its life but the bridge was repurposed for pedestrians in 2006 as part of the Soo Line Recreational Trail Project. The inventory and inspection report can be found in Appendix B.

2.3.3 Access Methods

The bridge will be accessed from the river banks at both the east and west sides of the river. The bridge may also be accessed from the top of deck. Each fascia of the bridge will be flown from one end to the other to investigate the exterior of the truss. The bridge will also be flown from the underside to investigate the underside of deck, substructures and the interior of the truss members. The top of deck will be flown to investigate the condition of the concrete deck.

2.3.4 Investigation Methods

The bridge will be inspected with the use of UAV technology to determine its effectiveness as a tool for bridge safety inspection. Using the previous reports as a reference, previously identified deficiencies will be investigated to determine if those deficiencies could reasonably be identified with the use of a UAV. Any additional deficiencies discovered will be noted as well.

2.3.5 Site Specific Safety

2.3.5.1 Airspace safety is addressed in the Pre Site Survey Brief prepared by Unmanned Experts located in Appendix D.

2.3.5.2 The bridge accommodates pedestrian traffic and the UAV's will be flown in accordance with Unmanned Experts Operations Manual and to the FAA Section 333 Exemption. Pedestrian traffic will be monitored in order to ensure the safety of the public. Radios will be used to communicate the presence of pedestrians to the operators to avoid conflicts.

2.4 Arcola Railroad Bridge

2.4.1 Location

The Arcola Bridge is located north of downtown Stillwater, Minnesota and carries the CN Railway across the St. Croix River.

2.4.2 Structure Description

The Arcola Railway Bridge was constructed in 1909 and is 2,682 feet long and approximately 185 feet above the ground line. The bridge consists of five truss arch spans each 350 feet long. There are seven steel bents on the west approach and four steel bents on the east approach.

2.4.3 Access Methods

The bridge will be accessed from the river by boat and the island area near the middle of the bridge. Each fascia of the bridge will be flown from one end to the other to investigate the sides of the steel members. The bridge will also be flown from the underside to investigate the substructures and the bottom of the steel members. The top of the bridge will be flown at a distance of 10 feet laterally from the track to meet CN requirements. Permission from CN has been granted for the inspection of this bridge for our study.

2.4.4 Investigation Methods

The bridge will be inspected with the use of UAV technology to determine its effectiveness as a tool for bridge safety inspection. Using the previous reports as a reference, previously identified deficiencies will be investigated to determine if those deficiencies could reasonably be identified with the use of a UAV. Any additional deficiencies discovered will be noted as well.

2.4.5 Site Specific Safety

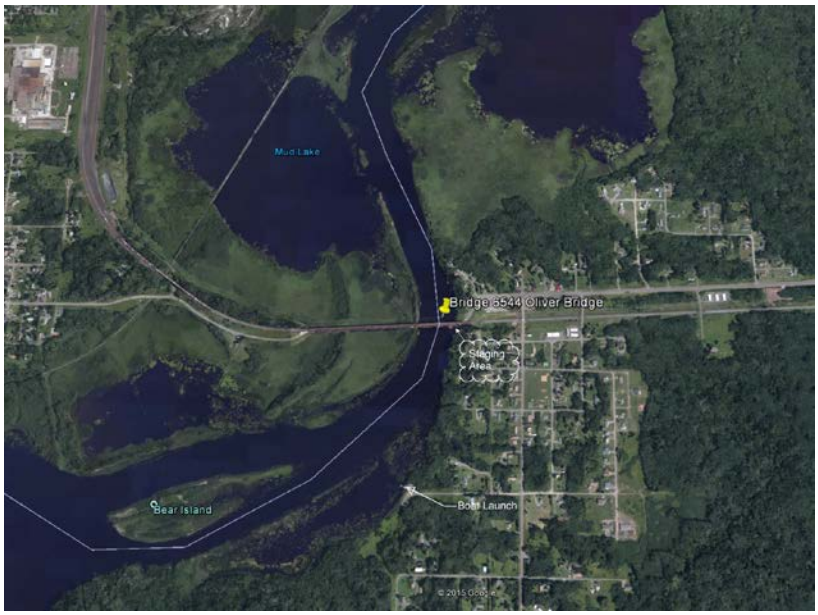
2.4.5.1 Airspace safety is addressed in the Pre Site Survey Brief prepared by Unmanned Experts located in Appendix D.

2.4.5.2 The bridge accommodates train traffic and the UAV will be flown in accordance with Unmanned Experts Operations Manual and the FAA Section 333 Exemption. Boat traffic under the bridge will be monitored in order to ensure the safety of the public. Radios will be used to communicate the presence of boaters to the operators to avoid conflicts. At no time shall the tracks be fouled nor shall the UAV be flown in the path of rail traffic. The UAV should remain a minimum of three feet from the edge of ties and shall not fly over the bridge. When flying above the top of deck the UAV should remain a minimum of 25 feet from the edge of ties. If rail traffic is approaching the UAV should immediately be moved a significant distance away from the bridge or returned to the landing area.

2.5 Bridge 6544 – Oliver Bridge

2.5.1 Location

Bridge 6544 is south of Duluth, Minnesota and carries MN 39 and CN Railway over the St. Louis River into Wisconsin.



2.5.2 Structure Description

The Oliver Bridge was originally built in 1916. The bridge supports a single rail line on the top level of the structure and two lanes of highway traffic below. The bridge is approximately 1,935 feet long and consists of a 32 span steel viaduct. At the south

end of the bridge, there is a new abutment and steel beam span constructed in 1985 to support the track. At the main channel a 301 foot deck truss is supported on a central concrete pier. The other spans consist of 30 foot and 70 foot steel plate girder spans supported by steel bents. At every 30 foot span a pair of bents are framed together to create a single tower structure. Although the bridge was originally constructed to support double track with a swing span, only one track currently operates and the swing span is not operational and thus acts as a deck truss with a fixed support mid-span. The inventory and inspection report can be found in Appendix B.

2.5.3 Access Methods

The bridge will be accessed from the river bank near the east end of the bridge. Each fascia of the bridge will be flown from one end to the other to investigate the sides of the truss and plate girder spans. Due to the length of the bridge our study will focus only on the first few spans including the truss span. The bridge will also be flown from the underside to investigate the underside of deck, substructures and the bottom of the truss members. The top of the bridge will be flown to investigate the top of truss.

2.5.4 Investigation Methods

The bridge will be inspected with the use of UAV technology to determine its effectiveness as a tool for bridge safety inspection. Using the previous reports as a reference, previously identified deficiencies will be investigated to determine if those deficiencies could reasonably be identified with the use of a UAV. Any additional deficiencies discovered will be noted as well.

2.5.5 Site Specific Safety

2.5.5.1 Airspace safety is addressed in the Pre Site Survey Brief prepared by Unmanned Experts located in Appendix D.

2.5.5.2 The bridge accommodates roadway and pedestrian traffic and the UAV will be flown in accordance with Unmanned Experts Operations Manual and the FAA Section 333 Exemption. Roadway and rail traffic will be monitored in order to ensure the safety of the public. The UAV will be flown in accordance with Unmanned Experts Operations Manual and the FAA Section 333 Exemption. Boat traffic under the bridge will be monitored in order to ensure the safety of the public. Radios will be used to communicate the presence of boaters to the operators to avoid conflicts. At no time shall the tracks be fouled nor shall the UAV be flown in the path of rail traffic. The UAV should remain a minimum of three feet from the edge of ties and shall not fly over the bridge. When flying above the top of deck the UAV should remain a minimum of 25 feet from the edge of ties. If rail traffic is approaching the UAV should immediately be moved a significant distance away from the bridge or returned to the landing area.

Respectfully Submitted,
COLLINS ENGINEERS, INC.

Barritt Lovelace, P.E., Regional Manager

Appendix A

Job Hazard Analysis

COLLINS ENGINEERS JOB SAFETY ANALYSIS

BRIDGE INSPECTION

Submit to Project Manager / Supervisor for approval prior to commencing work if necessary.

PROJECT INFORMATION:

Collins Project Number:	9029	Date:	5/12/2015
Client:	MnDOT	Prepared By:	Barritt Lovelace
Inspection Team Leader:	Barritt Lovelace	For Date(s):	May 25th - 30th
General Work Location:	Oliver Bridge, Duluth, MN	Expected Work Duration:	May 25th - 30th

REQUIRED SAFETY EQUIPMENT FOR INSPECTION CHECK LIST:

(Check if in Possession; obtain all applicable and required equipment prior to commencing work)

Personal Protective Equipment (PPE)		General Equipment		First Aid / Other:	
Hard Hat:		Project Work Plan:	X	First Aid Kit:	X
Safety Glasses:	X	GPS/Atlas/Maps:	X	Sunscreen:	X
Steel Toe Boots:	X	Harness:		Insect Repellent:	X
Gloves:		Stress Release Straps for Harness:		Drinking Water:	X
Hearing Protection:		Lanyards:	X	Strobe Lights:	X
Reflective Vests:	X	Tethers for Climbing Tools:		Two-Way Radios:	X
Reflective Pants (night work):		Personal Floatation Device:		Mobile Phone:	X
Rope Access Equipment:		:		:	
:		:		:	

WORK LOCATIONS / EMERGENCY CONTACT INFORMATION:

If information is located in field books, work plan, or elsewhere, ensure inspection team is aware and can readily locate.

Mobile phone or other means of contacting emergency personnel must be on site prior to starting inspection.

List complete location information for work in case of need for emergency response. List multiple if required.

Work Location	Nearest Intersection	Route/Dir./Milepost	Nearest Municipality (Name of City, Village, etc.)
Bridge 49553	Hillton Road and 305	Pedestrian Path	Little Falls, MN
Nearest Hospital Location:	St. Gabriel's Hospital 815 2nd St SE Little Falls, MN 56345		
Nearest Police / Fire Phone Numbers:	911		
Work Location	Nearest Intersection	Route/Dir./Milepost	Nearest Municipality (Name of City, Village, etc.)
Bridge 448	MN Ave and 2nd St SW	Minnesota Avene	Oronoco, MN
Nearest Hospital Location:	Mayo Clinic 200 1st St SW, Rochester, MN		
Nearest Police / Fire Phone Numbers:	911		
Work Location	Nearest Intersection	Route/Dir./Milepost	Nearest Municipality (Name of City, Village, etc.)
Arcola Bridge	Highway 36 and Water Street		Stillwater, MN
Nearest Hospital Location:	Lakeview Hospital, 927 Churchill St W, Stillwater MN		
Nearest Police / Fire Phone Numbers:	911		
Work Location	Nearest Intersection	Route/Dir./Milepost	Nearest Municipality (Name of City, Village, etc.)
Bridge 13509	River Road and CR 3		Rush City, MN
Nearest Hospital Location:	Fairview Clinics, 760 W 4th St, Rush City, MN 55069		
Nearest Police / Fire Phone Numbers:	911		

COLLINS ENGINEERS JOB SAFETY ANALYSIS

BRIDGE INSPECTION (Continued)

SAFETY ANALYSIS

Job Step	Specific Hazards	Corrective Action & Safe Work Practices	Responsible Party / Team Lead
Assess Site Conditions	Weather Conditions:		
	Rain, lightening, extreme temp. or wind, ice, other	Check forecast to be aware of possible inclement weather. Wait for improved conditions (at least 30 minutes after last lightening strike) or limit access to structure. Ensure inspection team is properly clothed and equipped (cold weather clothes, rain gear, etc.)	
	Traffic Conditions:		
	Vehicular traffic	Avoid high volume, high speed areas under construction or otherwise temporarily impeded (accidents, etc.) Wear proper reflective clothing and stay alert and vigilant. Coordinate with local authorities and inform them of our presence. Coordinate with Safety Signs for flagging and lane closure. Park vehicle near lift vehicle.	
	Rail traffic	Coordinate with proper jurisdiction if necessary, and arrange for flagman if required.	
	Boat traffic	Coordinate with proper jurisdiction if necessary, and stay alert for boat traffic and floating debris.	
Access Site	Vehicular Traffic:		
	Traffic at site	Park vehicle in safe location 10 foot from roadway edge, or off of roadway when possible.	
	Obstructions:		
	Obstructions (fences, retaining walls, vegetation, water, etc.)	Review previous inspection report, bridge file, and plans prior to inspection. Survey area for safest point of entry.	
	Traffic Control:		
	Traffic control setup	Traffic control should be setup in accordance with jurisdiction standard specifications (State/City/County etc.) or MUTCD. If roadway constraints do not allow for standard setup, competent person(s) should design proper traffic control.	
	Work zone check (traffic control)	Drive through work zone to ensure compliance with work zone standards (proper signage, configuration, etc.). Ensure traffic is flowing through work zone, and not encroaching on work zone.	
Inspection	General Inspection:		
	Insects, rodents, reptiles, other animals, poison ivy/oak, sunburn	Perform visual inspection of site prior to beginning work. Contact animal control or client if needed. Use wasp/hornet killer as needed. Wear proper PPE. Wear insect repellent clothing and sunscreen.	
	Sharp objects (rust, galvanizing drips, bolts, edges of plates, angles, etc.)	Visually inspect site for dangers. Wear proper PPE.	
	Slips, trips, and falls	Identify and avoid hazards if possible, guardrails, barriers, steep embankments, grade changes, etc. Wear proper PPE.	
	Vehicular Traffic:		
	Crossing lanes of traffic	Do not attempt to cross lanes of traffic in high volume conditions, low visibility condition, or high speed conditions. Do not cross traffic if traffic can not see you.	
	Traffic encroaching on work zone	Observe erratic drivers and avoid. Position yourself in safe place out of way of traffic when possible (behind guardrail or barrier, well off the road, etc.)	
	Aerial Lifts:* * Ensure all team members are properly trained and qualified to operate lift.		
	Fall from height greater than 6 feet	Wear fall protection. Follow Collins fall protection and rescue plan. Report any incidents to team leader immediately.	
	Overhead hazards (electrical lines, bridge beams, etc.). Aerial lifts over water: Proper PPE including PFD, Marine Radio	Visually inspect site for dangers prior to entering lift. Wear proper PPE. Stay a least 10 feet from power lines at all times.	
	Over/Near Water	Wear proper PPE including PFD. Marine Radio to be at site. Throwable life ring to be on site.	

COLLINS ENGINEERS JOB SAFETY ANALYSIS

BRIDGE INSPECTION (Continued)

SAFETY ANALYSIS (Continued)

Job Step	Specific Hazards	Corrective Action & Safe Work Practices	Responsible Party / Team Lead
Inspection (continued)	**Wading**		
	Enter water (slips /falls)	Visually inspect site prior to entering water. Survey area around bridge for best point of entry. Probe ahead of path with rod as entering. All team members aware of inspection POA. When working adjacent to water, you must wear a Personal Flotation Device.	
	Wade inspection / boat traffic / fast current	Stay alert for boat traffic, floating debris and swift currents. Probe ahead of path with rod when moving.	
	Exit water (slips/falls)	All team members assist each other when exiting the water.	
	UAV Concerns	Review and follow operations manual and use radios to communicate with operators to ensure public safety	
	Environmental Concerns	Stay alert for environmental factors.	
Post Inspection	**General**		
	Health and safety of inspector after inspection	Check inspectors health/condition after inspection. Inform the Team Leader of any inspection related injuries.	
	Work zone break down / vehicular traffic	Follow standards for work zone breakdown. Use proper MOT devices, vehicle with warning lights as needed to breakdown closure in reverse order.	

By signing this JSA, you confirm that each listed hazard has been reviewed during the safety briefing and you fully understand the work and safety procedures that can be utilized to mitigate these potential hazards. Inspectors are to report any physical problems before, during, or after the inspection. All incidents are to be reported to team leader as soon as possible.
Team leader shall complete an incident report and submit to Structural Inspection Program Manager and their respective Regional Manager.

Name / Signature / Date

Team Leader: _____ Inspector: _____

Inspector: _____ Inspector: _____

Inspector: _____ Inspector: _____

Appendix B

Bridge Inventory and Inspection Reports

2014 ROUTINE
BRIDGE INSPECTION REPORT

BRIDGE # 13509
CSAH 5 over ROCK CREEK

DISTRICT: Metro COUNTY: Chisago CITY/TOWNSHIP: RUSHSEBA

Date(s) of Inspection: 09/29/2014
Equipment Used:

Owner: County Highway Agency

Inspected By: Lovelace, Barritt

Report Written By: Barritt Lovelace
Report Reviewed By: Barritt Lovelace
Final Report Date: 11/07/2014

MnDOT Bridge Office
3485 Hadley Avenue North
Oakdale, MN 55128

Table of Contents

MnDOT Structure Inventory Report

Bridge ID: 13509 CSAH 5 over ROCK CREEK Date: 11/07/2014

GENERAL

Agency Br. No.
District Metro
Maint. Area Crew
County 013 - Chisago
City
Township 13007 - RUSHSEBA
Desc. Loc. 0.2 MI S OF JCT CSAH 3
Sect., Twp., Range 8 - 037N - 20W
Latitude Deg 45 Min 42 Sec 49.87
Longitude Deg 92 Min 52 Sec 23.65
Custodian 02 - County Highway Agency
Owner 02 - County Highway Agency
BMU Agreement
Year Built 1976
MN Year Reconstructed
FHWA Year Reconstructed
MN Temporary Status
Bridge Plan Location 3 - COUNTY
Date Opened to Traffic
On-Off System 0 - OFF
Legislative District 17B

STRUCTURE

Service On 1 - Highway
Service Under 5 - Waterway
Main Span Type
5 - Prestress or Precast 01 - Beam Span
Main Span Detail
Appr. Span Type
Appr. Span Detail
Skew 0
Culvert Type
Barrel Length ft.
Cantilever ID

NUMBER OF SPANS

MAIN: 1 APPR: 0 TOTAL: 1
Main Span Length 77.0 ft.
Structure Length 79.6 ft.
Deck Width (Out-to-Out) 35.8 ft.
Deck Material 1 - Concrete Cast-in-Place
Wear Surf Type 1 - Monolithlic Concrete (concr
Wear Surf Install Year
Wear Course/Fill Depth 0.00 ft.
Deck Membrane 0 - None
Deck Rebars N - Not Applicable (no deck)
Deck Rebars Install Year
Structure Area (Out-to-Out) 2850 sq. ft.
Roadway Area (Curb-to-Curb) 2551 sq. ft.
Sidewalk Width Lt 0.00 ft. Rt 0.00 ft.
Curb Height Lt 0.00 ft. Rt 0.00 ft.
Rail Type Lt 08 Rt 08

ROADWAY

Bridge Match ID (TIS) 0
Roadway O/U Key Route On Structure
Route Sys 04 - CSAH Number 5
Roadway Name or Description
CSAH 5
Level of Service 1 - MAINLINE
Roadway Type 2 - 2-way traffic
Control Section (TH Only)
Reference Point 006+00.850
Detour Length 8.0 mi
Lanes On 2 Under 0
ADT 117 Year 2008
HCADT 0 ADTT 0 %
Functional Class 08 - Rural - Minor Collector

RDWY DIMENSIONS

If Divided	NB-EB	SB-WB
Roadway Width	32.00 ft.	ft.
Vertical Clearance	ft.	ft.
Max. Vert. Clear.	ft.	ft.
Horizontal Clear.	ft.	ft.
Lateral Clearance	ft.	ft.

Appr. Surface Width 32.0 ft.
Bridge Roadway Width 32.0 ft.
Median Width On Bridge ft.

MISC. BRIDGE DATA

Structure Flared 0 - No flare
Parallel Structure N - No parallel structure
Field Conn. ID
Abutment Foundation 1 - CONC
(Material/Type) 0 - UNKNOWN
Pier Foundation N - N/A
(Material/Type) N - N/A
Historic Status 5 - Not eligible

PAINT

Year Painted
Unsound Paint %
Painted Area sq. ft.
Primer Type
Finish Type

BRIDGE SIGNS

Posted Load 0 - Not Required
Traffic 0 - Not Required
Horizontal 1 - Object Markers
Vertical N - Not Applicable

INSPECTION

Userkey 53
Unofficial Structurally Deficient N
Unofficial Functionally Obsolete N
Unofficial Sufficiency Rating 96.9
Routine Inspection Date 09/29/2014
Routine Inspection Frequency 24
Inspector Name Collins Eng
Status A - Open

NBI CONDITION RATINGS

Deck 8 - Very Good Condition
Unsound Deck %
Superstructure 8 - Very Good Condition
Substructure 8 - Very Good Condition
Channel 5 - Bank eroded; Major damage
Culvert N - Not Applicable

NBI APPRAISAL RATINGS

Structure Evaluation 8
Deck Geometry 7
Underclearances N
Water Adequacy 8 - Bridge Above Approache
Approach Alignment 8 - Equal to present desirabl

SAFETY FEATURES

Bridge Railing 0 - SUBSTANDARD
GR Transition 0 - SUBSTANDARD
Appr. Guardrail 0 - SUBSTANDARD
GR Termini 0 - SUBSTANDARD

IN DEPTH INSP.

	Y/N	Freq	Date
Frac. Critical			
Underwater			
Pinned Asbly.			
Spec. Feat.			

WATERWAY

Drainage Area (sq. mi.) 48.5
Waterway Opening 100 sq. ft.
Navigation Control 0 - No nav. control on waterw
Pier Protection
Nav. Clr. (ft.) Vert. ft. Horiz. ft.
Nav. Vert. Lift Bridge Clear. (ft.)
MN Scour Code I - LOW RISK Year 2006

CAPACITY RATINGS

Design Load 5 - HS 20
Operating Rating 2 - AS HS 42.1
Inventory Rating 2 - AS HS 23.4
Posting VEH: SEMI: DBL:
Rating Date 01/20/1985
MnDOT Permit Codes
A: N - N/A
B: N - N/A
C: N - N/A

11/07/2014

Inspector: Collins Eng

BRIDGE 13509 CSAH 5 OVER ROCK CREEK ROUTINE INSP. DATE: 09/29/2014

County: Chisago
City:
Township: 13007 - RUSHSEBA
Section: 8 Township: 037N Range: 20W
Span Type: 5 - Prestressed Concrete 02 - Stringer/Multi-beam or Girder
List:
NBI Deck: 8 Super: 8 Sub: 8 Chan: 5

Location: 0.2 MI S OF JCT CSAH 3
Route: 04 - CSAH 5 Ref. Pt.: 006+00.850
Control Section:
Maint. Area:
Local Agency Bridge Nbr.:
Culv: N
Open, Posted, Closed: A - Open
MN Scour Code: I - LOW RISK

Length: 79.6 ft.
Deck Width: 35.8 ft.
Rdwy. Area/ Pct. Unsnd: 2551 sq. ft. / %
Paint Area/ Pct. Unsnd: sq. ft. / %
Culvert: N/A
Postings:

Appraisal Ratings - Approach: 8 Waterway: 8
Required Bridge Signs - Load Posting: 0 - Not Required Traffic: 0 - Not Required
Horizntal: 1 - Object Markers Vertical: N - Not Applicable

Unofficial Structurally Deficient N
Unofficial Functionally Obsolete N
Unofficial Sufficiency Rating 96.9

Structure Unit:

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
012	Top of Concrete Deck (No Overlay - Uncoated Rebar)	2	Routine	09/29/2014	2852 SF	2852	0	0	0	0
			Routine	11/19/2012	2852 SF	2852	0	0	0	0
	☐Requires Monitoring		☐Monitored							
	Notes: [2014] 25% of deck covered with gravel up to 1/2 IN deep.									
109	Prestressed Concrete Girder or Beam	2	Routine	09/29/2014	312 LF	312	0	0	0	N/A
			Routine	11/19/2012	312 LF	312	0	0	0	N/A
	☐Requires Monitoring		☐Monitored							
	Notes:									
215	Reinforced Concrete Abutment	2	Routine	09/29/2014	72 LF	72	0	0	0	N/A
			Routine	11/19/2012	72 LF	72	0	0	0	N/A
	☐Requires Monitoring		☐Monitored							
	Notes:									
311	Expansion Bearing	2	Routine	09/29/2014	4 EA	4	0	0	N/A	N/A
			Routine	11/19/2012	4 EA	4	0	0	N/A	N/A
	☐Requires Monitoring		☐Monitored							
	Notes: 2012- Three anchor bolt nuts missing at north abutment and five anchor bolt nuts missing at south abutment.									

Structure Unit:

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
313	Fixed Bearing	2	Routine	09/29/2014	4 EA	4	0	0	N/A	N/A
			Routine	11/19/2012	4 EA	4	0	0	N/A	N/A
	☐Requires Monitoring		☐Monitored							
	Notes: [2012 - 2014] Three anchor bolt nuts missing at north abutment and five anchor bolt nuts missing at south abutment.									
331	Reinforced Concrete Bridge Railing	2	Routine	09/29/2014	161 LF	129	32	0	0	N/A
			Routine	11/19/2012	161 LF	129	32	0	0	N/A
	☐Requires Monitoring		☐Monitored							
	Notes: [2012 - 2014] Minor shrinkage cracks.									
361	Scour Smart Flag	2	Routine	09/29/2014	1 EA	1	0	0	N/A	N/A
			Routine	11/19/2012	1 EA	1	0	0	N/A	N/A
	☐Requires Monitoring		☐Monitored							
	Notes:									
380	Secondary Structural Elements	1	Routine	09/29/2014	1 EA	1	0	0	0	N/A
			Routine	11/19/2012	1 EA	1	0	0	0	N/A
	☐Requires Monitoring		☐Monitored							
	Notes: [2010] Steel Diaph.									
387	Reinforced Concrete Wingwall	2	Routine	09/29/2014	4 EA	4	0	0	0	N/A
			Routine	11/19/2012	4 EA	4	0	0	0	N/A
	☐Requires Monitoring		☐Monitored							
	Notes:									
964	Critical Finding Smart Flag	2	Routine	09/29/2014	1 EA	1	0	N/A	N/A	N/A
			Routine	11/19/2012	1 EA	1	0	N/A	N/A	N/A
	☐Requires Monitoring		☐Monitored							
	Notes: DO NOT DELETE THIS CRITICAL FINDING SMART FLAG.									

Structure Unit:

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
981	Signing	1	Routine	09/29/2014	4 EA	3	0	0	0	1
			Routine	11/19/2012	4 EA	3	0	0	0	1

☐ Requires Monitoring ☐ Monitored

Notes: [2014] One delineator missing.

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
985	Slopes & Slope Protection	2	Routine	09/29/2014	2 EA	2	0	0	N/A	N/A
			Routine	11/19/2012	2 EA	2	0	0	N/A	N/A

☐ Requires Monitoring ☐ Monitored

Notes: 2012 - Heavy brush growing near and under the bridge. Rip-rap missing near north abutment.

General Notes: [2012 - 2014] Maintenance:
Remove gravel from deck as part of regular maintenance.
Replace three anchor bolt nuts at north abutment and 5 anchor bolt nuts at south abutment.
Replace missing rip-rap at north abutment slope.

58. Deck NBI:

36A. Brdg Railings NBI:

36B. Transitions NBI:

36C. Appr Guardrail NBI:

36D. Appr Guardrail Terminal NBI:

59. Superstructure NBI:

60. Substructure NBI:

61. Channel NBI:

62. Culvert NBI:

71. Waterway Adeq NBI:

72. Appr Roadway Alignment NBI:

Inventory Notes:

Barritt Lovelace
Inspector's Signature

Barritt Lovelace
Reviewer's Signature

Pictures

Photo 1 - Top of Deck Looking South

Photo 2 - Upstream Channel Looking West

Pictures

Photo 3 - Downstream Channel Looking East

Photo 4 - East Fascia Looking Southwest

Pictures

Photo 5 - West Fascia Looking South

Photo 6 - Underside of Bridge Looking North

MnDOT Structure Inventory Report

Bridge ID: 448 CSAH 18 over MID FK ZUMBRO RIVER Date: 02/10/2015

GENERAL

Agency Br. No.
District District 6
Maint. Area Crew
County 055 - Olmsted
City Oronoco
Township
Desc. Loc. 0.6 MI N OF JCT TH 52
Sect., Twp., Range 17 - 108N - 14W
Latitude Deg 44 Min 9 Sec 44.79
Longitude Deg 92 Min 32 Sec 5.21
Custodian 02 - County Highway Agency
Owner 02 - County Highway Agency
BMU Agreement
Year Built 1918
MN Year Reconstructed 1987
FHWA Year Reconstructed 1986
MN Temporary Status
Bridge Plan Location 3 - COUNTY
Date Opened to Traffic 9/1/1987
On-Off System 1 - ON
Legislative District 29A

STRUCTURE

Service On 5 - Highway-pedestrian
Service Under 5 - Waterway
Main Span Type
1 - Concrete 12 - Arch
Main Span Detail V - OPEN SPANDREL ARCH
Appr. Span Type
5 - Prestress or Precast 01 - Beam Span
Appr. Span Detail
Skew 0
Culvert Type
Barrel Length ft.
Cantilever ID

NUMBER OF SPANS

MAIN: 1 APPR: 2 TOTAL: 3
Main Span Length 208.2 ft.
Structure Length 295.8 ft.
Deck Width (Out-to-Out) 49.1 ft.
Deck Material 1 - Concrete Cast-in-Place
Wear Surf Type 1 - Monolithlic Concrete (concr
Wear Surf Install Year 1987
Wear Course/Fill Depth 0.00 ft.
Deck Membrane 0 - None
Deck Rebars 1 - Epoxy Coated Reinforcing
Deck Rebars Install Year 1987
Structure Area (Out-to-Out) 14524 sq. ft.
Roadway Area (Curb-to-Curb) sq. ft.
Sidewalk Width Lt 0.00 ft. Rt 6.00 ft.
Curb Height Lt 0.50 ft. Rt 0.83 ft.
Rail Type Lt 17 Rt 17

ROADWAY

Bridge Match ID (TIS) 0
Roadway O/U Key Route On Structure
Route Sys 04 - CSAH Number 18
Roadway Name or Description
CSAH 18
Level of Service 1 - MAINLINE
Roadway Type 2 - 2-way traffic
Control Section (TH Only)
Reference Point 001+00.926
Detour Length 3.0 mi
Lanes On 2 Under 0
ADT 2000 Year 2006
HCADT 0 ADTT 0 %
Functional Class 07 - Rural - Major Collector

RDWY DIMENSIONS

If Divided	NB-EB	SB-WB
Roadway Width	40.00 ft.	ft.
Vertical Clearance	ft.	ft.
Max. Vert. Clear.	ft.	ft.
Horizontal Clear.	39.9 ft.	ft.
Lateral Clearance	ft.	ft.

Appr. Surface Width 40.0 ft.
Bridge Roadway Width 40.0 ft.
Median Width On Bridge ft.

MISC. BRIDGE DATA

Structure Flared 0 - No flare
Parallel Structure N - No parallel structure
Field Conn. ID
Abutment Foundation 1 - CONC
(Material/Type) 3 - FTG PILE
Pier Foundation 1 - CONC
(Material/Type) 2 - SPRD ROCK
Historic Status 2 - Eligible for National Register

PAINT

Year Painted
Unsound Paint %
Painted Area sq. ft.
Primer Type
Finish Type

BRIDGE SIGNS

Posted Load 0 - Not Required
Traffic 0 - Not Required
Horizontal 1 - Object Markers
Vertical N - Not Applicable

INSPECTION

Userkey 95
Unofficial Structurally Deficient N
Unofficial Functionally Obsolete N
Unofficial Sufficiency Rating 99.5
Routine Inspection Date 10/15/2014
Routine Inspection Frequency 24
Inspector Name County, Olmsted
Status A - Open

NBI CONDITION RATINGS

Deck 7 - Good Condition
Unsound Deck %
Superstructure 6 - Satisfactory Condition
Substructure 7 - Good Condition
Channel 6 - Bank slump; minor damage
Culvert N - Not Applicable

NBI APPRAISAL RATINGS

Structure Evaluation 6
Deck Geometry 7
Underclearances N
Water Adequacy 9 - Bridge Above Flood Wat
Approach Alignment 8 - Equal to present desirabl

SAFETY FEATURES

Bridge Railing 1 - MEETS STANDARDS
GR Transition 1 - MEETS STANDARDS
Appr. Guardrail 1 - MEETS STANDARDS
GR Termini 1 - MEETS STANDARDS

IN DEPTH INSP.

	Y/N	Freq	Date
Frac. Critical			
Underwater			
Pinned Asbly.			
Spec. Feat.			

WATERWAY

Drainage Area (sq. mi.) 425.0
Waterway Opening 10000 sq. ft.
Navigation Control 0 - No nav. control on waterw
Pier Protection
Nav. Clr. (ft.) Vert. ft. Horiz. ft.
Nav. Vert. Lift Bridge Clear. (ft.)
MN Scour Code O - STBL - ACT F Year 1995

CAPACITY RATINGS

Design Load 5 - HS 20
Operating Rating 2 - AS HS 38.1
Inventory Rating 2 - AS HS 25.5
Posting VEH: SEMI: DBL:
Rating Date 2/1/1988
MnDOT Permit Codes
A: N - N/A
B: N - N/A
C: N - N/A

02/10/2015

Inspector: County, Olmsted

BRIDGE 448 CSAH 18 OVER MID FK ZUMBRO RIVER ROUTINE INSP. DATE: 10/15/2014

County: Olmsted
City: Oronoco
Township:
Section: 17 Township: 108N Range: 14W
Span Type: 1 - Concrete 11 - Arch - Deck
List:
NBI Deck: 7 Super: 6 Sub: 7 Chan: 6

Location: 0.6 MI N OF JCT TH 52
Route: 04 - CSAH 18 Ref. Pt.: 001+00.926
Control Section:
Maint. Area:
Local Agency Bridge Nbr.:
Culv: N
Open, Posted, Closed: A - Open
MN Scour Code: O - STBL - ACT REQD

Length: 295.8 ft.
Deck Width: 49.1 ft.
Rdwy. Area/ Pct. Unsnd: sq. ft. / %
Paint Area/ Pct. Unsnd: sq. ft. / %
Culvert: N/A
Postings:

Appraisal Ratings - Approach: 8 Waterway: 9
Required Bridge Signs - Load Posting: 0 - Not Required Traffic: 0 - Not Required
Horizntal: 1 - Object Markers Vertical: N - Not Applicable

Unofficial Structurally Deficient N
Unofficial Functionally Obsolete N
Unofficial Sufficiency Rating 99.5

Structure Unit:

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
026	Top of Concrete Deck (No Overlay - Epoxy Rebar)	2	Routine	10/15/2014	14521 SF	14521	0	0	0	0
			Routine	11/25/2013	14521 SF	14521	0	0	0	0

☐Requires Monitoring ☐Monitored

Notes: [2014] Deck was chained and no delamination was found. [2011-13] A small amount of deck cracks which need to be sealed again, some new cracks to seal also. There is an area of exposed aggregate in both driving lanes of the deck just north of the strip seal.

109	Prestressed Concrete Girder or Beam	2	Routine	10/15/2014	410 LF	409	1	0	0	N/A
			Routine	11/25/2013	410 LF	409	1	0	0	N/A

☐Requires Monitoring ☐Monitored

Notes: [2011-13] North approach span east fascia beam bottom flange has a patched area on the east side of the beam 8' from the north abutment.

144	Reinforced Concrete Arch	2	Routine	10/15/2014	417 LF	229	188	0	0	N/A
			Routine	11/25/2013	417 LF	229	188	0	0	N/A

☐Requires Monitoring ☐Monitored

Notes: [2014] Spalls were repaired by MNdot in July 2014, See history file attachmnet and photos and notes below.

155	Reinforced Concrete Floorbeam	2	Routine	10/15/2014	892 LF	883	9	0	0	N/A
			Routine	11/25/2013	892 LF	883	9	0	0	N/A

☐Requires Monitoring ☐Monitored

Notes: [2011-14] There is a small delamination and crack in the north side of the center floorbeam against the east arch. The south end of the center floorbeam has small cracks against the arch.

Structure Unit:

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
205	Reinforced Concrete Column	2	Routine	10/15/2014	16 EA	8	8	0	0	N/A
			Routine	11/25/2013	16 EA	4	8	4	0	N/A

☐Requires Monitoring ☐Monitored

Notes: [2014] Spalls on column have been repaired by MNDOT in July 2014. See history file attachemant and photos.

215	Reinforced Concrete Abutment	2	Routine	10/15/2014	98 LF	89	9	0	0	N/A
			Routine	11/25/2013	98 LF	89	9	0	0	N/A

☐Requires Monitoring ☐Monitored

Notes: [2011-14] North abutment-Minor cracks in face of abutment walls. There is a 4" x 8" spall in the top of the bridge seat west end of the north abutment. South abutment-The bridge seat is stained from water leaking through the joint above.

234	Reinforced Concrete Pier Cap	2	Routine	10/15/2014	98 LF	98	0	0	0	N/A
			Routine	11/25/2013	98 LF	98	0	0	0	N/A

☐Requires Monitoring ☐Monitored

Notes: [2011-14] There are superficial vertical 0.010"cracks in both faces of the cap.

300	Strip Seal Deck Joint	2	Routine	10/15/2014	92 LF	92	0	0	N/A	N/A
			Routine	11/25/2013	92 LF	87	5	0	N/A	N/A

☐Requires Monitoring ☐Monitored

Notes: [2014] South end: West side 1 7/8" East side 2". North end: West side 1 1/2", East side 1 3/8" at 30 deg.
[2011-13] South end-The strip seal is full of dirt and debris. Joint openings measurements at the gutter line at 30 degrees was 1 5/8" east side and 2" at west side. North end the strip seal is full of dirt and debris Joint opening measurements at the gutterline at 30 degrees was 2" east side and 2 1/8" at west side.

310	Elastomeric (Expansion) Bearing	2	Routine	10/15/2014	10 EA	10	0	0	N/A	N/A
			Routine	11/25/2013	10 EA	10	0	0	N/A	N/A

☐Requires Monitoring ☐Monitored

Notes: [2014] Abutment bearing pads are cast into the concrete end diaphragm and partially concealed. No deterioration noted.

313	Fixed Bearing	2	Routine	10/15/2014	10 EA	10	0	0	N/A	N/A
			Routine	11/25/2013	10 EA	10	0	0	N/A	N/A

☐Requires Monitoring ☐Monitored

Notes: [2014] No deterioration noted.
Located at end of piers.

Structure Unit:

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
333	Masonry, Other or Combination Material Railing	2	Routine	10/15/2014	591 LF	520	71	0	N/A	N/A
			Routine	11/25/2013	591 LF	520	71	0	N/A	N/A

☐Requires Monitoring ☐Monitored

Notes: [2011-14] Minor vertical 0.013" cracks in concrete both sides of bridge. The galvanizing on the rail is fading.

358	Concrete Deck Cracking Smart Flag	2	Routine	10/15/2014	1 EA	0	1	0	0	N/A
			Routine	11/25/2013	1 EA	0	1	0	0	N/A

☐Requires Monitoring ☐Monitored

Notes: [2011-14] Several longitudinal and traverse unsealed deck cracks (approximately 2000 linear feet).

359	Underside of Concrete Deck Smart Flag	2	Routine	10/15/2014	1 EA	0	1	0	0	0
			Routine	11/25/2013	1 EA	0	1	0	0	0

☐Requires Monitoring ☐Monitored

Notes: [2011-14] Scattered cracks with efflorescence throughout. Diagonal cracks in the NE and NW corners of deck.

361	Scour Smart Flag	2	Routine	10/15/2014	1 EA	0	1	0	N/A	N/A
			Routine	11/25/2013	1 EA	0	1	0	N/A	N/A

☐Requires Monitoring ☐Monitored

Notes: [2011-14] Scour at the corner of S. arch footing was repaired by Mn/Dot and County personnel according to the plan from Ron Benson from Erickson Engineering in 2006. On the east side of the repair, it is undermining which extends from two feet up to six feet past end of apron. Riprap was placed at south protection slab and along south wall. Plan, pictures and procedure are in bridge file.

385	Reinforced Concrete Arch Spandrel Column	2	Routine	10/15/2014	32 EA	29	0	3	0	N/A
			Routine	11/25/2013	32 EA	29	0	3	0	N/A

☐Requires Monitoring ☐Monitored

Notes: [2014] spalls on columns were repaired by MNDOT July 2014. [2011-13] Some arch columns at north end near north pier have spalls with exposed rebar. Large corner spall on one arch column near south pier, spall is 5 ft. long with some minor section loss on vertical reinforcement. Graffitti on the lower part of the columns.

387	Reinforced Concrete Wingwall	2	Routine	10/15/2014	4 EA	3	1	0	0	N/A
			Routine	11/25/2013	4 EA	3	1	0	0	N/A

☐Requires Monitoring ☐Monitored

Notes: [2011-14] 0.010" vertical crack in SE. wingwall. Cork material missing between wingwall and parapet wall on all four corners.

Structure Unit:

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
407	Bituminous Approach Roadway	2	Routine	10/15/2014	2 EA	2	0	0	0	N/A
			Routine	11/25/2013	2 EA	2	0	0	0	N/A

☐Requires Monitoring ☐Monitored

Notes: [2014] New bituminous approachs on both sides in 2013.

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
964	Critical Finding Smart Flag	2	Routine	10/15/2014	1 EA	1	0	N/A	N/A	N/A
			Routine	11/25/2013	1 EA	1	0	N/A	N/A	N/A

☐Requires Monitoring ☐Monitored

Notes: [2011-14] No critical findings observed.

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
981	Signing	2	Routine	10/15/2014	1 EA	1	0	0	0	0
			Routine	11/25/2013	1 EA	1	0	0	0	0

☐Requires Monitoring ☐Monitored

Notes: [2011-14] Clearance markers W. side only.

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
982	Approach Guardrail	2	Routine	10/15/2014	1 EA	1	0	0	N/A	N/A
			Routine	11/25/2013	1 EA	1	0	0	N/A	N/A

☐Requires Monitoring ☐Monitored

Notes: [2011-14] Plate beam attached SW. corner.

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
984	Deck & Approach Drainage	2	Routine	10/15/2014	1 EA	1	0	0	N/A	N/A
			Routine	11/25/2013	1 EA	1	0	0	N/A	N/A

☐Requires Monitoring ☐Monitored

Notes: [2011-14] Two catch basins on each side of the North approach

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
985	Slopes & Slope Protection	2	Routine	10/15/2014	1 EA	1	0	0	N/A	N/A
			Routine	11/25/2013	1 EA	1	0	0	N/A	N/A

☐Requires Monitoring ☐Monitored

Notes: [2011-14] New riprap was placed on north abutment in 2012. Riprap was placed in behind south protection walls. Slope in front south abutment has settled three to four feet as shown by the most recent concrete surface finish line.

Structure Unit:

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
986	Curb & Sidewalk	2	Routine	10/15/2014	1 EA	1	0	0	N/A	N/A
			Routine	11/25/2013	1 EA	1	0	0	N/A	N/A

☐Requires Monitoring ☐Monitored

Notes: [2011-14] South end of sidewalk east side has settled. Approximately 250' of unsealed cracks in walk. Eighty feet of new approach sidewalk on east side north end.

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
988	Miscellaneous Items	1	Routine	10/15/2014	1 EA	1	0	0	N/A	N/A
			Routine	11/25/2013	1 EA	1	0	0	N/A	N/A

☐Requires Monitoring ☐Monitored

Notes: [2011-14] There is a new 80' small diameter pipe rail along the north end approach sidewalk. The rail has failed paint with light corrosion and is not firmly attached. 2 light poles along east side of deck.

General Notes: CHANNEL: There is bank erosion on both sides on the downstream side.

On 9-23-2010 flood, fill washed out from behind north arch footing. Repair work done was new block poured behind footing that was doweled and keyed into rock for lateral support.

During flood of 9-23-2010 fill was completely washed out from north abutment. New H pile Columns were installed on top of new footing and in between cassians to fortify north abutment. Shot rock and 1" rock was used to backfill. New riprap was placed on slope.

On 12-20-2010 Mn/Dot completed a snooper inspection on bridge 448. Findings were the north approach beam ends over the pier were in good condition. No movement at the bearings, no cracking of the pier at the bearings indicating any improper movement, all anchor rods were either in the vertical position or were leaning south and overall the north approach beam ends over the pier appear to be in the same conditon as they were prior to the flood. Arch is in the same condition as previously reported. South approach no change in condition. Measurements were taken of the gap at the north strip seal for verticality at the north abutment and will be used as a baseline for future inspections.

Ron Benson P.E. from Bonestroo was included in the inspection with Mn/Dot in the snooper and concludes the same findings and recommends the bridge to be reopened. Bridge was reopened 12-22-2010. Rons report is in bridge file.

Bridge was inspected by Mn/Dot on 10/15/14 as requested by Olmsted County and this report reflects their findings and is in bridge file.

B.M. 988.97

West arch- South end has cracks and delaminated concrete on the west face last 30'. North end has scattered vertical and horizontal cracks both faces of arch. North of the arch mid point is a small transverse crack in the bottom of the arch. Approximately 15' north of this crack is a 9' long longitudinal crack. West face of the arch from the bottom up to column 2, the top portion of the west face is cracked, delaminated and spalled. West face between columns 3 & 4 there is an 8" wide by 4" deep spall. There is a horizontal crack that extends the entire distance between the columns. Directly under column 1 there is a vertical crack that runs the entire thickness of the arch 8" into the bottom of the arch. At column 5 there is a horizontal crack that runs a distance of 28" At column 6 there is a horizontal crack that runs a distance of 30".
East arch- Scattered vertical and horizontal cracks both faces of the arch. 30' up from the south end of the arch is a crack with heavy efflorescence. Twenty feet up from the north end on the East face of the arch there are horizontal and random cracks that extend for a distance of ten feet. Some of these cracks extend into the bottom of the arch. On the South end of the arch starting approximately 3' from the bottom of the arch at the center point there is a 20' long crack that runs parallel with the arch. East face between columns 1 & 2 there is a horizontal map cracked area with delaminated concrete. East face between columns 15 & 16 the entire area between the columns is map cracked and delaminated. The top of the arch 24" in from the east face between columns 2 & 3, there is a horizontal crack that runs the entire length between the columns. At the bottom of arch east side between columns 14 to 16 there is a horizontal crack that starts north of column 14 and extends up to column 16. The bottom of the arch is map cracked up to column 1.

58. Deck NBI: [2014] Minor cracking

36A. Brdg Railings NBI:

36B. Transitions NBI:

36C. Appr Guardrail NBI:

Structure Unit:

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5

36D. Appr Guardrail Terminal NBI:

59. Superstructure NBI:

60. Substructure NBI: [2014] Minor delamination and spalling.

61. Channel NBI: [2011-14] There is bank erosion on both sides on the downstream side. Dam doors were opened all the way up and not letting any water backing up forming a lake.

62. Culvert NBI:

71. Waterway Adeq NBI:

72. Appr Roadway Alignment NBI:

Inventory Notes:

Jeffery Busch
Inspector's Signature

Kaye Bieniek
Reviewer's Signature

Pictures

Photo 1 - New sidewalk and curbs at North abutment.

Photo 2 - New Rip rap at North abutment.

Pictures

Photo 3 - North Columns spalls

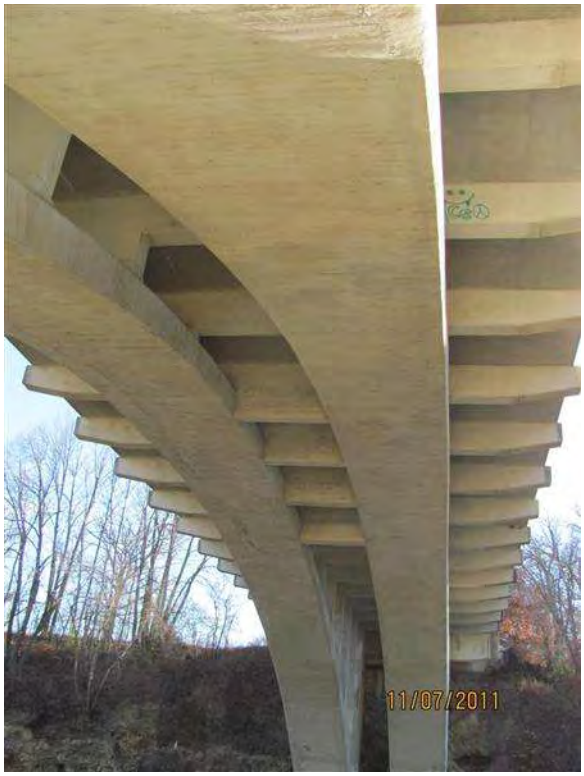


Photo 4 - Under side of archs

Pictures

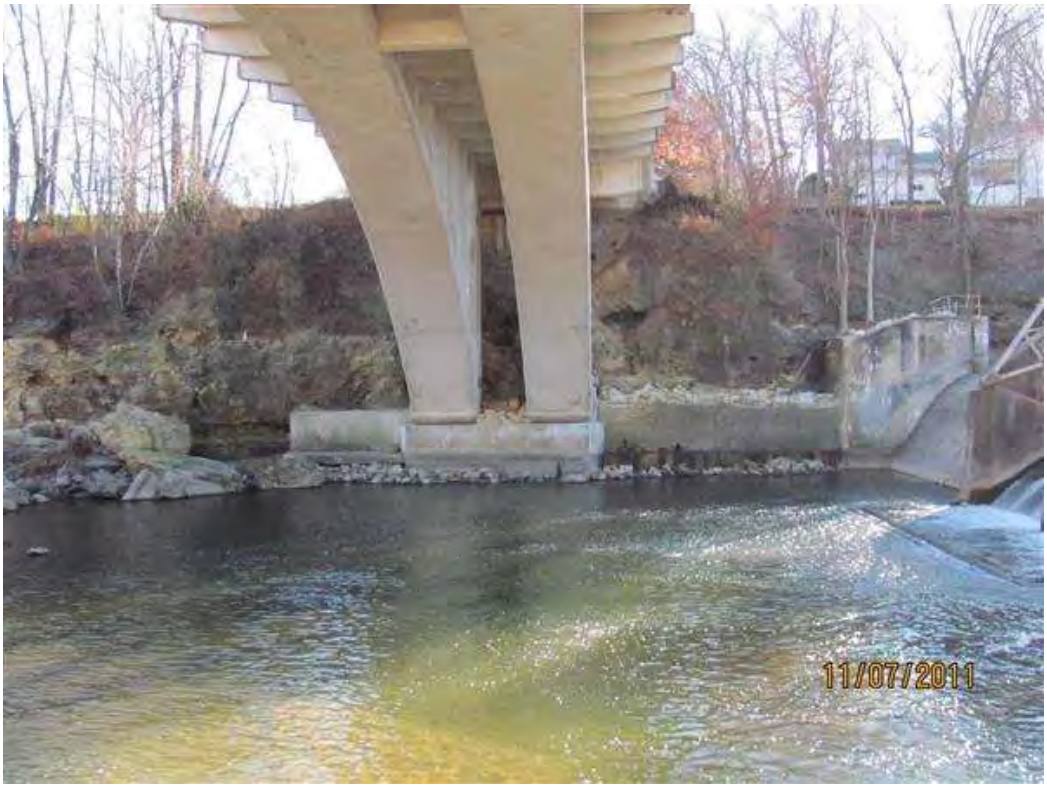


Photo 5 - South abutment

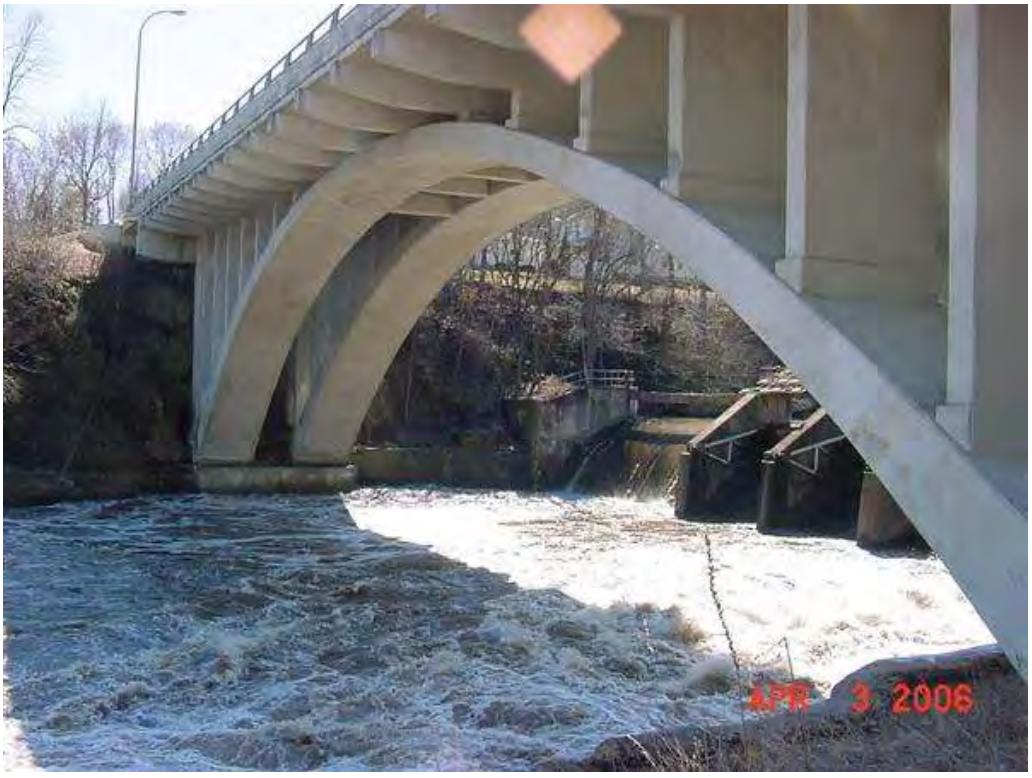


Photo 6 -

Pictures

Photo 7 - 2010 Flood

Photo 8 - 2010 Flood

Pictures

Photo 9 -

Photo 10 - Timber debris at dam.

Pictures

Photo 11 - Looking North

Photo 12 - Repaired Northwest side of Arch ftg.

Pictures

Photo 13 - Repaired columns at NW corner.

Photo 14 - Repaired Northeast side of the arch.

Pictures

Photo 15 - SE corner of the arch repaired

Photo 16 -

Pictures

Photo 17 - Column repairs at north base of arch.

BRIDGE INSPECTION REPORT

Bridge Number: BR-448 Olmsted County

Location: CSAH 18 over the Mid Fork of the Zumbro River

Inspected By: Eric Evens, Steve Miller, Robert Pyfferoen & Rick Peterson

Date of Inspection: June 1, 2011

Date of Report: January 26, 2012

Report Prepared By: Eric C. Evens

Inspection Findings:
Refer to page 6 for the column numbering system and the arch face designations. The spandrel columns were numbered from the south.

East Arch South End Columns
Column 2 southeast corner 15'8" up from the arch, there is a 3' long x 13" wide spall with exposed reinforcement (Photo 1). Southwest corner directly beneath the horizontal strut there is a 4' long x 11" wide spall with exposed reinforcement (Photo 2). Northwest corner 18'2" up from the arch, there is a 6' long x 22" wide spall with exposed reinforcement (Photo 3). Extending down from this spall is a vertical crack that is 38" long. Section loss to the exposed reinforcement at all of these spalls would be considered incidental at this time.

Columns 1, 3, and 4 have minor cracking, scattered minor areas of concrete deterioration and scattered small delamination.

East Arch North End Columns
Column 1 south face of the column there is a horizontal spall with exposed reinforcement 24" up from the arch that is 24" long x 5" wide (Photo 4). Below the horizontal spall is a 3" x 6" vertical spall with exposed reinforcement (Photo 4). Directly below the horizontal strut southwest corner, there is a 6'2" long x 21" wide spall with exposed reinforcement (Photo 5). There are four additional horizontal spalls with exposed reinforcement on the south face of the column. The top spall is 2' x 2' in size, the next spall down is 15" x 5", the third spall is 13" x 5" and the fourth is 13" x 6" (Photo 5). On the southeast corner there is a 3'3" x 18" spall with exposed reinforcement 9'6" up from the arch (Photos 6 & 7). Section loss to the exposed reinforcement at all of these spalls would be considered incidental at this time.

Columns 2, 3, and 4 have minor cracking, scattered minor areas of delamination and deterioration. There are small spalls with exposed reinforcement on Columns 2 and 4.

West Arch South End Columns
Column 4 has a 12" wide x 3" long area of delaminated concrete 2' above the arch on the north face of the column.

Columns 1, 2, and 3 have moderate concrete deterioration.

West Arch North End Columns

Column 1 at the bottom south side there is a 17" long x 10" wide x 4" deep spall (Photos 8 & 21). The entire south face of the column is cracked and has scattered delaminated areas. On the north side of the same column there is an 8" x 3" spall with exposed reinforcement.

Column 2 on the west side there is a 10" diameter spall with no exposed reinforcement.

Column 3 has a 30" x 20" spall with exposed reinforcement along the southeast edge 10'6" up from the bottom of the column (Photo 9). There is a 50" x 16" spall with exposed reinforcement in the south face of the column directly below the horizontal strut (Photos 10 & 11).

Column 4 has minor concrete deterioration.

East Arch East Face

There is cracked and delaminated concrete starting at the bottom of the arch extending to spandrel column 2 (Photos 13, 14, & 15). There is an 8" x 20" spall with no exposed reinforcement 58" up from the bottom of the arch top edge (Photo 13). Around this spall there is a large area of cracked and delaminated concrete. Directly beneath spandrel column 2, there is a 12" x 28" spall with no exposed reinforcement (Photo 14). Directly beneath spandrel column 1 bottom edge, there is a 6" x 30" spall with no exposed reinforcement (Photo 15). There is cracked and delaminated concrete around this spall. On the top edge starting just north of spandrel column 3 and extending 8' towards spandrel column 2, there is cracked, delaminated and spalled concrete. Starting north of spandrel column 5 extending towards spandrel column 4 there is a 10'6" area of cracked and delaminated concrete along the top edge down to the middle of the arch. There are scattered vertical cracks that extend the entire thickness of the arch 7" deep as seen from the top of the arch. These cracks are located between spandrel columns 9 & 10, 10 & 11, 11 & 12, and 12 & 13. There is a 6" x 16" spall with no exposed reinforcement 4' north of spandrel column 13 (Photo 16). Starting south of spandrel column16 extending to spandrel column15 there is an area of horizontal and random cracking and scattered small delamination's (Photo 17). This cracking extends into the bottom face of the arch 2'6".

East Arch West Face

Directly under spandrel column 2 there is a 4" x 12" spall with no exposed reinforcement on the top edge. Under spandrel column 3 there is a 22" long vertical crack. Between spandrel columns 13 and 14 there are two form line cracks. There is a 4" x 16"x 28" cracked and delaminated area along the top edge 10" north of spandrel column 14. There is a 6" x 19" cracked and delaminated area along the top edge 44" north of spandrel column 15. There is a vertical crack that extends down from this delaminated area. There is a 10' long horizontal crack in the mid-point of the west face 4' from the north end. There is a vertical crack that runs the entire thickness of the west face 3' south of spandrel column 1. This crack branches out at the mid-point.

East Arch Bottom Face

Starting from the north end of the arch 34" in from the west face, there is an 18'6" long longitudinal hairline crack. This crack starts and terminates as a horizontal crack. From the bottom north end there is an 8"long x 5" wide x 6" deep spall that extends up the west face (Photo 18). There was no exposed reinforcement in this spall. Starting from the

bottom south end of the arch 30" in from the east face extending up to spandrel column 3, there is an area of longitudinal and random cracking. This area corresponds to a repair patch completed in the past. The south end thrust block east side is cracked, spalled and delaminated (Photo 13 & 20).

East Arch Top Face
There are no significant spalls or cracks in the top face of the arch.

West Arch East Face
Directly below spandrel column 1 there is a 6" wide x 7" deep x 5" high spall with no exposed reinforcement. At the bottom of the arch south end there is a 5' long horizontal crack. Directly under spandrel column 16 there is a full thickness vertical crack with map cracking.

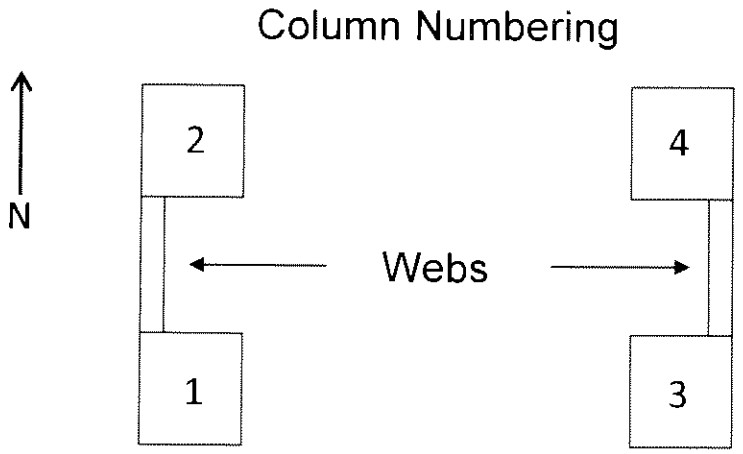
West Arch West Face
There is a hairline horizontal crack that runs between spandrel columns 1 and 2. South of spandrel column 1 there is a 16" wide x 50" long area of cracked and delaminated concrete. Directly under spandrel column 2 top edge extending to the south there is a 6' long x 10" wide x 6" deep spall (Photo 22). Directly under spandrel column 3 extending to the south along the bottom edge there is a 36"x 6"x 7" deep patched area that is cracked and delaminated. There is a 36" long x 8" deep spall along the top edge 40" north of spandrel column 3 (Photo 23). Under spandrel column 5 there is a 33" long x 12" wide x 4" deep top edge spall (Photo 24). There is a hairline horizontal crack that extends the entire distance between spandrel columns 4 and 5. Under spandrel column 6 there is a 26" x 4" area of cracked and delaminated concrete top edge. Directly under spandrel column 11 there is a full height hairline vertical crack. Just south of spandrel column 12 there is a 4" x 10" top edge spall that is adjacent to an 18" cracked and delaminated area. Between spandrel columns 14 and 15 there is an 8' long mid-point horizontal crack. There are seven hairline vertical cracks scattered between the north end of the arch and spandrel column 15.

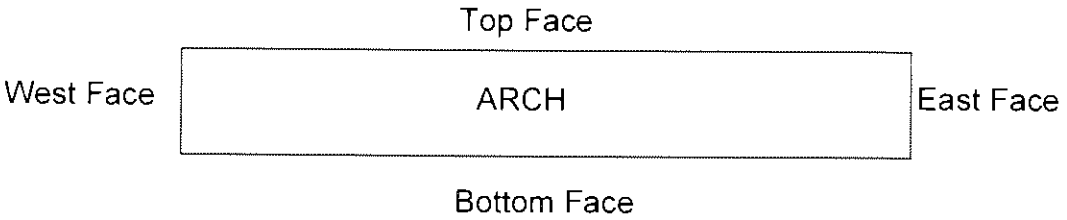
West Arch Bottom Face
The bottom south end of the arch is spalled, cracked and delaminated (Photo 25). Starting 34" up from the bottom south end of the arch west edge there is a 56" long x 18" wide spalled, cracked and delaminated area (Photo 25). Directly above the bottom south end of the arch 24" in from the west edge there is a 4' long x 22" wide area of spalled, cracked and delaminated concrete (Photo 26). There is a hairline transverse crack 33" from spandrel column 2. This crack runs across the entire bottom of the arch and up 6" vertically into the east face. There is a 9" x 14" x 7" deep spall at the north end of the arch west corner (Photo 27). South of spandrel column 2 and 16" in from the west face there is a 15" x 45" area of cracked and delaminated concrete with no spalls.

West Arch Top Face
There is an area of cracked and deteriorated concrete top west side of the arch between spandrel columns 1 and 2 (Photo 28). These cracks are rust stained. The remaining top face of the arch has no significant spalls or cracks.

Miscellaneous:
North approach span east fascia beam bottom flange has a patched area on the east side of the beam 8' from the north abutment (Photo 29).

The apron that was added to the east side of the south end of the arch is undermining (Photos 30 & 31). The undermining extends from 2' up to 6' past the end of the apron (Photo 32).


Column Numbering
N
2
4
Webs
1
3


Top Face
West Face
ARCH
East Face
Bottom Face

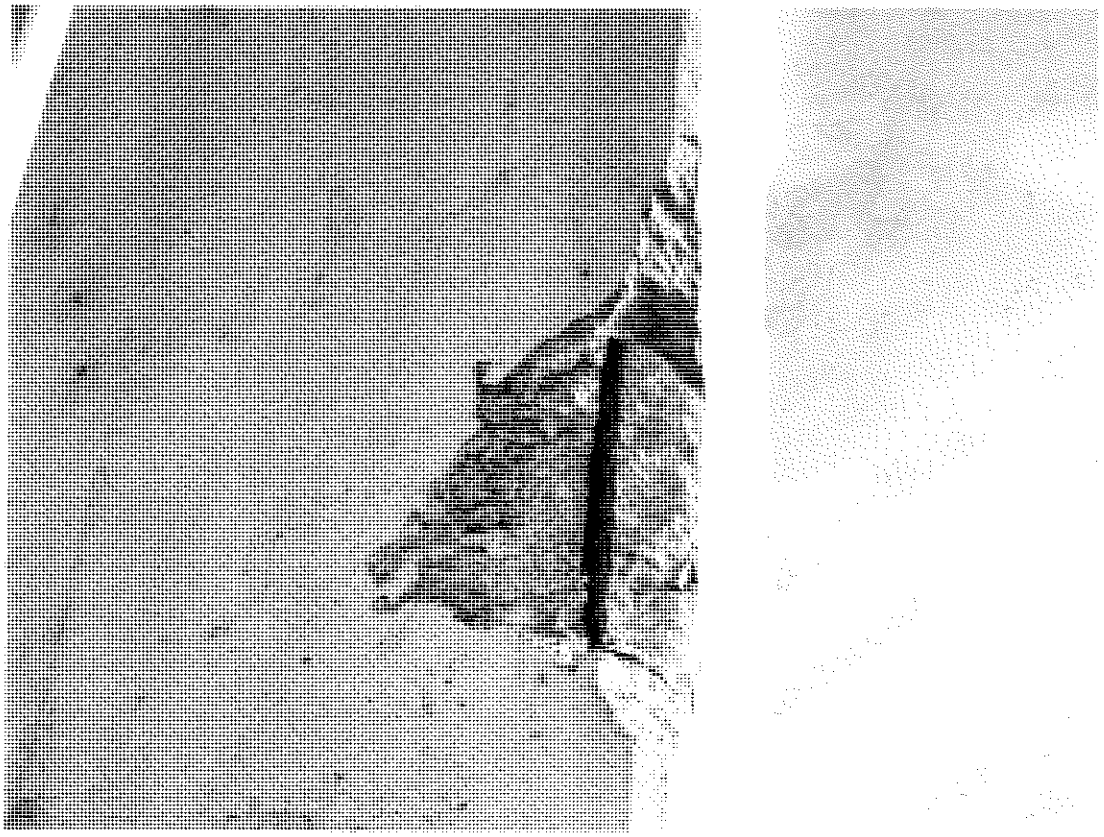


Photo 1 - East Arch Column 2 South End (54)

Photo 2 - East Arch Column 2 South End

Photo 3 - East Arch Column 2 South End

Photo 4 - East Arch Column 1 North End

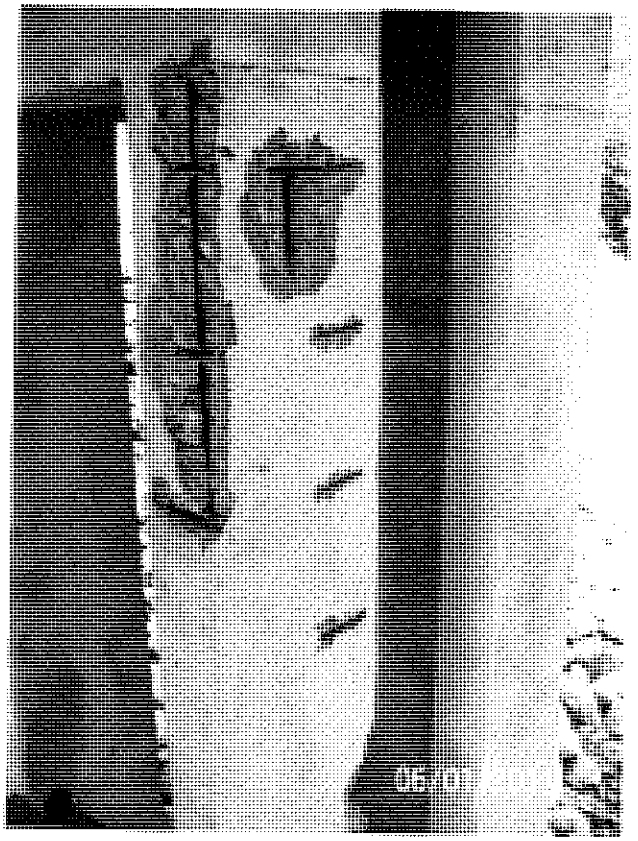


Photo 5 - East Arch Column 1 North End

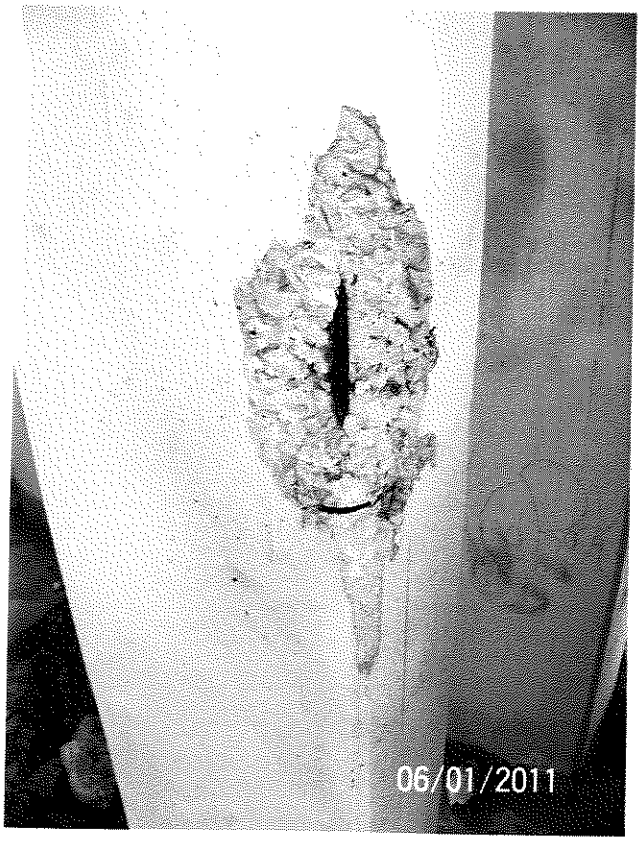


Photo 6 - East Arch Column 1 North End

Photo 7 - East Arch Column 1 North End

Photo 8 - West Arch Column 1 North End

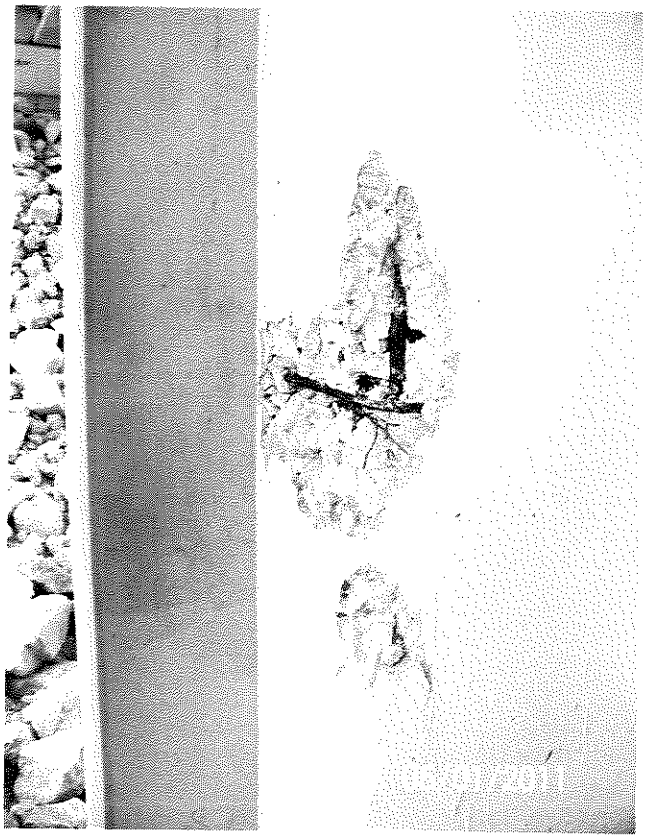


Photo 9 - West Arch Column 3 North End

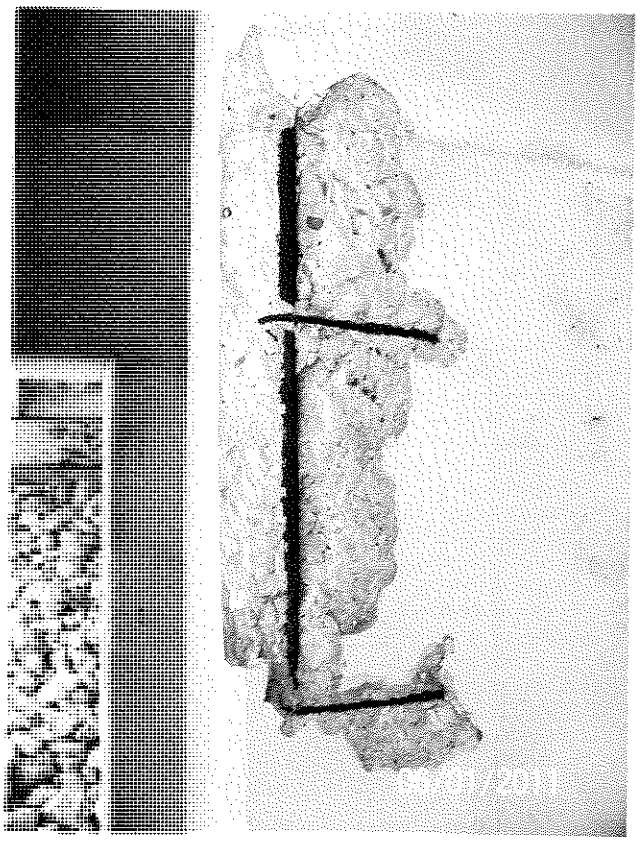


Photo 10 - West Arch Column 3 North End

Photo 11 - West Arch Column 3 North End

Photo 12 - West Arch Column 1 North End

Photo 13 - East Arch South End Thrust Block

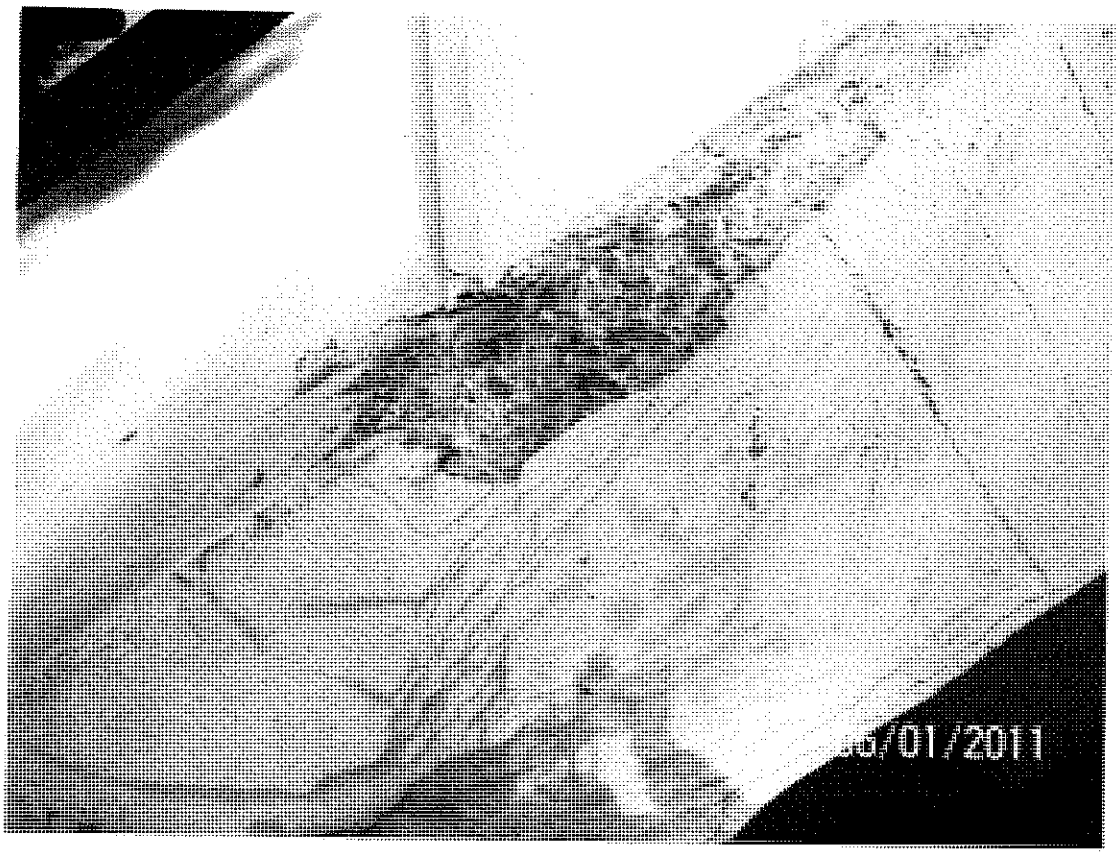


Photo 14 - East Arch South End @ Spandrel Column 2

Photo 15 - East Arch South End @ Spandrel Column 1

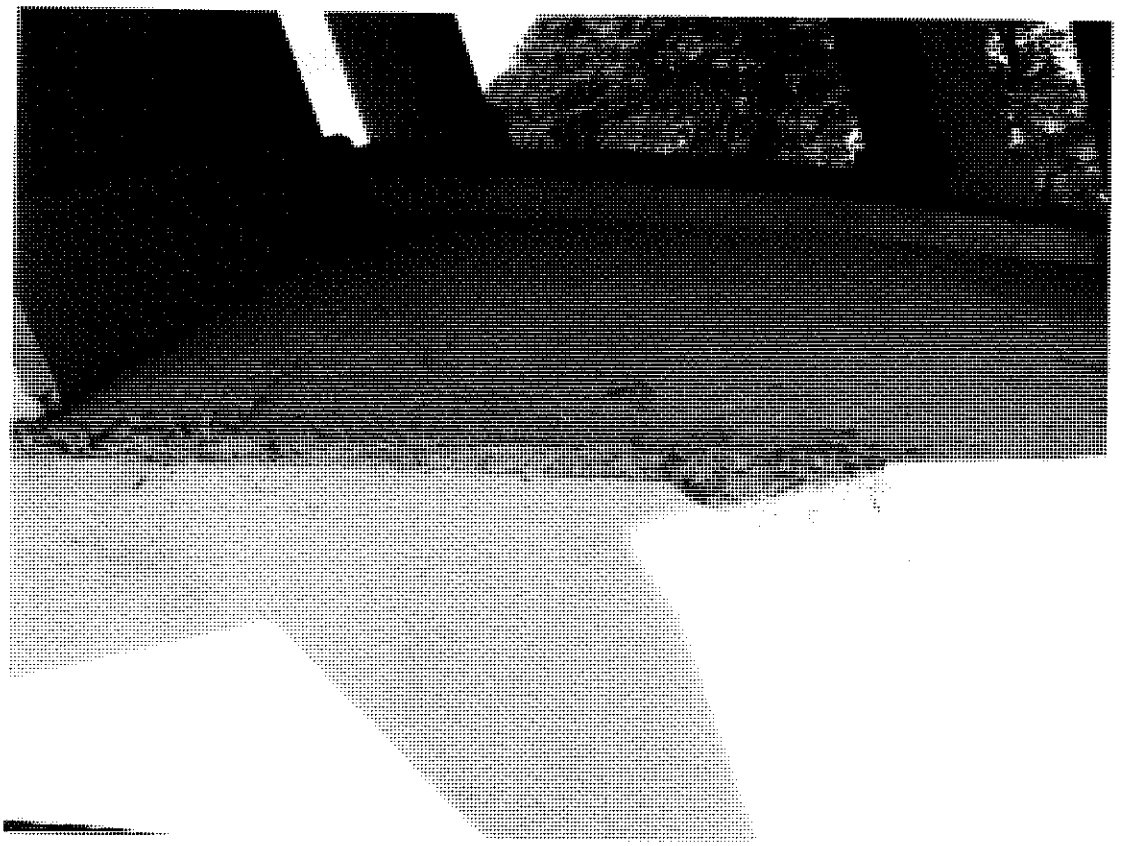


Photo 16 - East Arch South End North of Spandrel Column 13

Photo 17 - East Arch Between Spandrel Columns 15 & 16

Photo 18 - East Arch North End West Face

Photo 19 - East Arch West Face @ Spandrel Column

Photo 20 - East Arch East Face @ Thrust Block

Photo 21 - West Arch North End South Side Column 1

Photo 22 - West Arch West Face @ Spandrel Column 2

Photo 23 - West Arch West Face North of Spandrel Column 3

Photo 24 - West Arch West Face Spandrel Column 5

Photo 25 - West Arch Bottom South End

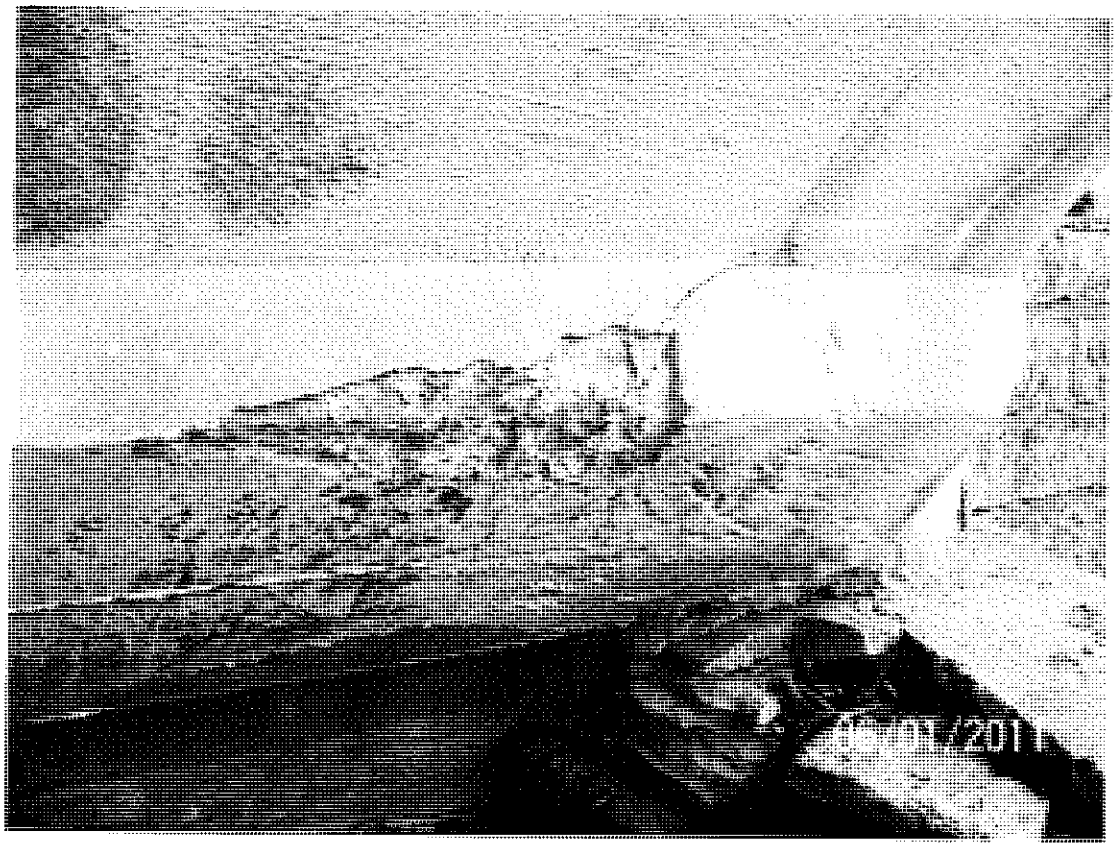


Photo 26 - West Arch South End

Photo 27 - West Arch North End West Corner

Photo 28 - West Arch Between Spandrel Columns 1 & 2

Photo 29 - North End Approach East Fascia Beam

Photo 30 - South End of Arch East Footing

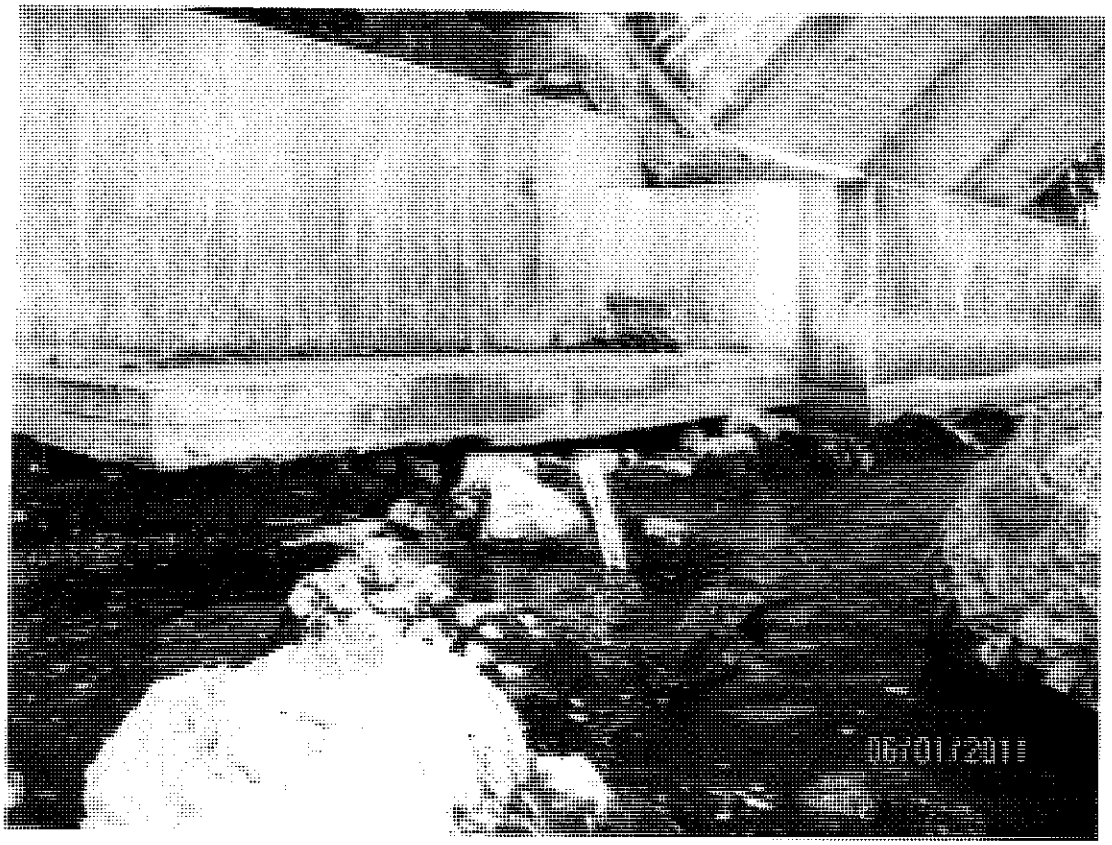


Photo 31 - South End of Arch East Footing

Photo 32 - South End of Arch East Footing

South Abutment footing

South Abutment footing

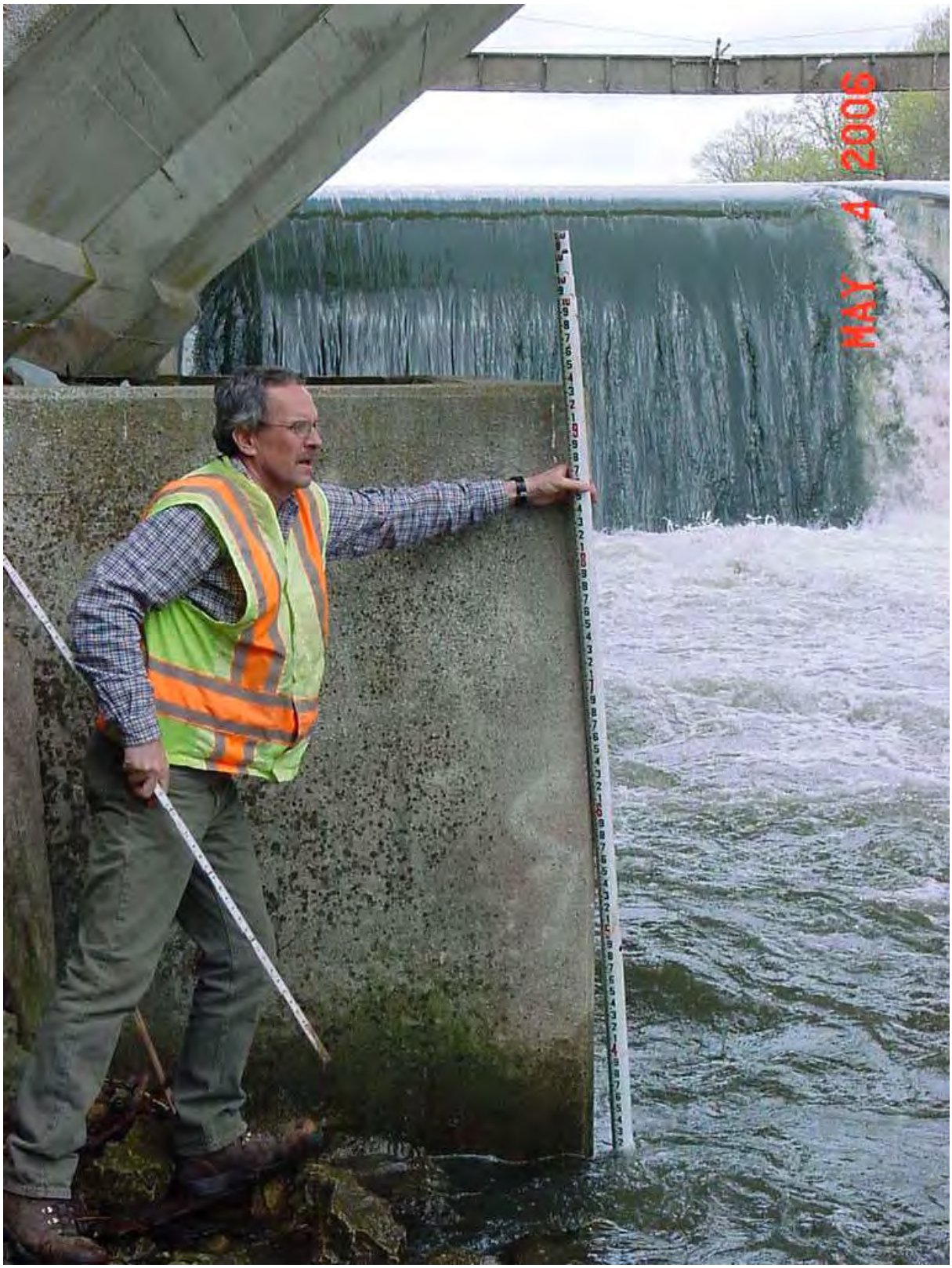

APR 3 2006


MAY 4 2006


MAY 4 2006

The survey rod is 25’


MAY 4 2006


MAY 4 2006


MAY 4 2006

BR 448
South Arch Footing

BR 448
South Arch Footing

OLMSTED COUNTY
BRIDGE SCOUR ACTION PLAN

Bridge Number 448

Route	CSAH 18	Location	0 6 MI S of JCT CSAH 12
Stream	Mid FK of Zumbro River	Township	Oronoco

Scour Code **O – Scour Stable, Action Required**
Prepared by Jeff Busch Date 8/24/12
Approved by Michael T Sheehan County Engineer
Michael T Sheehan

HISTORY

BR 448 was built in 1918 then widened and remodeled in 1987 There is a dam about 50' up stream the created Lake Shady The main span is a concrete arch spanning 200' across the Zumbro River The arch footings are concrete keyed into the limestone Both footings are protected from normal canal flows by concrete walls The south abutment had some scour on the down stream side from a high water event The scour was repaired in the fall of 2006 with a concrete wall tied into the limestone The approach span on each side of the arch, have abutments on caissons

On September 23, 2010 a major flood event occurred, the upstream dam failed and flood waters were focus toward the North arch footing and North abutment Abutment fill was washed away and the road was washed out Additional foundation supports were added and slopes were rip-raped The dam's gates are now wide open, and plans are made to remove the dam

RECOMMENDED ACTION

The bridge has been determined to be stable for predicted damage to the structure However, there is a possibility during large floods that the protection wall and arch footing could be undermined resulting in possible loss of foundation support. The bridge should be inspected during routine inspection and after large floods that over-top the walls If fill behind protection walls is washed away or damage to the walls is imminent, immediately notify the County Engineer

BM 988 97 SE wingwall

Structure	Top of Curb Elevation	Bottom of Footing Elevation	Average Bottom of Piling Elevation	Critical Scour Elevation
North Arch Footing	983 6	935 0	None	935 0
North Wall	984 2	929 0	None	929 0
South Wall	989 1	292 8	None	292 8
South Arch Footing	989 4	935 0	None	935 0

OLMSTED COUNTY
BRIDGE SCOUR ACTION PLAN

Bridge Number 55507

Route	CSAH 15	Location	0 2 MI S of JCT CR 126
Stream	S FK of Zumbro River	Township	Rock Dell

Scour Code **O – Scour Stable, Action Required**
Prepared by Jeff Busch Date 8/24/12
Approved by Michael T Sheehan County Engineer
Michael T Sheehan

HISTORY

BR 55507 was built in 1962 The Piers are on spread footing with timber piling below channel bottom The abutments are also on timber piling and are elevated above the waterline During flooding the water over tops the road 500' to the south first

RECOMMENDED ACTION

The bridge has been determined to be stable for predicted damage to the structure during flooding However there is a possibility during large floods that the abutment footings could be undermined resulting in possible loss of the approach embankment fill The bridge should be inspected during routine inspections and before reopening the road after it has overtopped during major floods events Take channel elevations across the bridge opening When critical scour elevation is reached or washout of approaches is imminent, immediately notify the County Engineer

BM 1111 65 SE Wingwall

Structure	Top of Curb Elevation	Bottom of Footing Elevation	Average Bottom of Piling Elevation	Critical Scour Elevation
South Abutment	1116 7	1103 1	1067 6	1097 2
Pier 1	1116 9	1089 2	1067 2	1078 5
Pier 2	1117 5	1089 8	1067 8	1078 5
North Abutment	1117 7	1104 2	1068 7	1098 8

Bridge Scour Monitoring Form

Bridge No 55507 Bench Mark 1111 65 SE wingwall

Location CSAH 15 0 2 MI S of CR 126 on the S FK of Zumbro River

	Water Surface		South Abutment		Pier 1 (South)		Pier 2 (North)		North Abutment	
Date / Time	Drop	Elev	Depth	Elev	Depth	Elev	Depth	Elev	Depth	Elev
Top of railing				1116 7		1116 9		1117 5		1117 7
Critical Elev			19 5	1097 2	38 4	1078 5	39	1078 5	18 9	1098 8
Baseline 6/2/09 Downstream		1098				1097 4		1097 7		

Mn/DOT Structure Inventory Report

Bridge ID: 6544 **MN 39; RR over ST LOUIS RIVER** Date: 05/12/2015

+ GENERAL +

Agency Br. No. SL13-C
District 1 **Maint. Area** 1A
County 69 - ST LOUIS
City DULUTH
Township
Desc. Loc. 0.9 MI E OF JCT TH 23
Sect., Twp., Range 11 - 048NN - 15W
Latitude 46d 39m 24.00s
Longitude 92d 12m 06.00s
Custodian RAILROAD
Owner RAILROAD
Inspection By OTHER
BMU Agreement
Year Built 1916
Year Fed Rehab 1970
Year Remodeled 2001
Temp
Plan Avail. DISTRICT

+ STRUCTURE +

Service On HWY;RR
Service Under STREAM
Main Span Type STEEL MOVEABLE
Main Span Detail
Appr. Span Type STEEL BM SPAN
Appr. Span Detail
Skew
Culvert Type
Barrel Length
Number of Spans
MAIN: 2 APPR: 32 TOTAL: 34
Main Span Length 150.0 ft
Structure Length 1,888.7 ft
Deck Width 25.0 ft
Deck Material C-I-P CONCRETE
Wear Surf Type MONOLITHIC CONC
Wear Surf Install Year
Wear Course/Fill Depth
Deck Membrane NONE
Deck Protect. EPOXY COATED REBAR
Deck Install Year
Structure Area 47,218 sq ft
Roadway Area 43,066 sq ft
Sidewalk Width - L/R
Curb Height - L/R
Rail Codes - L/R 22 22

+ ROADWAY +

Bridge Match ID (TIS) 1
Roadway O/U Key 1-ON
Route Sys/Nbr MNTH 39
Roadway Name or Description
MN 39
Roadway Function MAINLINE
Roadway Type 2 WAY TRAF
Control Section (TH Only) 6942
Ref. Point (TH Only) 001+00.079
Date Opened to Traffic 12-03-2001
Detour Length 12 mi.
Lanes 2 Lanes ON Bridge
ADT (YEAR) 2,150 (2008)
HCADT 344
Functional Class. URB/MINOR ART

+ RDWY DIMENSIONS +

If Divided	NB-EB	SB-WB
Roadway Width	22.8 ft	
Vertical Clearance	14.1 ft	
Max. Vert. Clear.	15.7 ft	
Horizontal Clear.	22.7 ft	
Lateral Clr. - Lt/Rt		
Appr. Surface Width	31.0 ft	
Roadway Width	22.8 ft	
Median Width		

+ MISC. BRIDGE DATA +

Structure Flared NO
Parallel Structure NONE
Field Conn. ID RIVETED
Cantilever ID
Foundations
Abut. CONC - FTG PILE
Pier DIFF - FTG PILE
Historic Status ELIGIBLE
On - Off System ON

+ PAINT +

Year Painted 1940 **Pct. Unsound** 50 %
Painted Area
Primer Type LEAD
Finish Type ENAMEL

+ BRIDGE SIGNS +

Posted Load NOT REQUIRED
Traffic NOT REQUIRED
Horizontal OBJECT MARKERS
Vertical ROADWAY RESTRICTION

+ INSPECTION +

Deficient Status F.O.
Sufficiency Rating 57.8
Last Inspection Date 11-06-2014
Inspection Frequency 12
Inspector Name DISTRICT1
Structure A-OPEN

+ NBI CONDITION RATINGS +

Deck	8
Superstructure	5
Substructure	6
Channel	8
Culvert	N

+ NBI APPRAISAL RATINGS +

Structure Evaluation	5
Deck Geometry	2
Underclearances	N
Waterway Adequacy	8
Approach Alignment	3

+ SAFETY FEATURES +

Bridge Railing	1-MEETS STANDARDS
GR Transition	1-MEETS STANDARDS
Appr. Guardrail	1-MEETS STANDARDS
GR Termini	1-MEETS STANDARDS

+ IN DEPTH INSP. +

Frac. Critical Y 24 mo 11/2014
Underwater Y 60 mo 08/2008
Pinned Asbly.
Spec. Feat.

+ WATERWAY +

Drainage Area
Waterway Opening 99999 sq ft
Navigation Control PERMIT REQD
Pier Protection NOT REQUIRED
Nav. Vert./Horz. Clr. 50 ft 250.0 ft
Nav. Vert. Lift Bridge Clear.
MN Scour Code I-LOW RISK
Scour Evaluation Year 2009

+ CAPACITY RATINGS +

Design Load HS20
Operating Rating HS 33.00
Inventory Rating HS 20.00
Posting
Rating Date 08-25-2000
Mn/DOT Permit Codes
A: X B: X C: X

BRIDGE INVENTORY REPORT.RPT

Mn/DOT BRIDGE INSPECTION REPORT

Inspected by: OTHER

BRIDGE 6544 **MN 39; RR over ST LOUIS RIVER** **INSP. DATE: 11-06-2014**

County: ST LOUIS
City: DULUTH
Township:
Section: 11 Township: 048NN Range: 15W
Span Type: STEEL MOVEABLE
NBI Deck: 8 Super: 5 Sub: 6 Chan: 8 Culv: N

Location: 0.9 MI E OF JCT TH 23
Route: MNTH 39 Ref. Pt.: 001+00.079
Control Section: 6942 Maint. Area: 1A
Local Agency Bridge Nbr: SL13-C

Length: 1,888.7 ft
Deck Width: 25.0 ft
Rdwy. Area / Pct. Unsnd: 43,066 sq ft
Paint Area/ Pct. Unsnd: 50 %
Culvert N/A

Open, Posted, Closed: OPEN

Appraisal Ratings - Approach: 3 Waterway: 8
MN Scour Code: I-LOW RISK
Def. Stat: F.O. Suff. Rate: 57.8

Required Bridge Signs - Load Posting: NOT REQUIRED
Traffic: NOT REQUIRED
Horizontal: OBJECT MARKERS
Vertical: ROADWAY RESTRICTION

STRUCTURE UNIT: 0

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
26	TOP OF CONC DECK-EPX	2	11-06-2014	47,584 SF	47,584	0	0	0	0
			09-24-2013	47,584 SF	47,584	0	0	0	0

Notes: |2014 - No significant changes (applies to roadway girders only). Refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
2013 - No significant change.
2012 - Minor deficiencies were observed in the lower (roadway) concrete deck. Typical transverse cracking in the 70 foot spans through underside of deck was noted [2011] Taconite pellets continue to accumulate on shoulders and in expansion joints. Consider use of vacuum truck to remove periodically.
|

401	BALLAST PLATE DECK	1	11-06-2014	32,946 SF	0	0	32,946	0	0
			09-24-2013	32,946 SF	0	0	32,946	0	0

Notes: |2014 - No significant changes. Refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element. Only viewed from underside since access was not available to top side.
2013 - Significant rust and through rust in deck plate at numerous locations (see Photo 5). Railroad deck beam supporting deck plate at railroad south side of Bent 31 is cracked through bottom flange and full height of web (see Photo 6). Although all the square footage for this element must be entered under one condition state, an estimated 20% (6,589 sq. ft.) would fall in the guildlines of Condition State 4. Steel plate railroad level deck, including walkways. Deck plate cracked at weld locations throughout bridge. Cantilevered channel support beams for walkway are cracked at fillet where web of channel was coped for connection (east railroad approach span). Should be monitored and repaired by 2006. Other locations need to be inspected (not accessible at this time).
|

300	STRIP SEAL JOINT	2	11-06-2014	367 LF	367	0	0	N/A	N/A
			09-24-2013	367 LF	367	0	0	N/A	N/A

Notes: |2014 - Anchor screw at slotted hole in cover plate at expansion joints missing at Bent 4 North, Bent 15 North, Bent 21 South, Bent 23 North and Bent 27 South.
2012 - Most expansion joints are filled with pellet debris. 2007 LHB Note: Possible leak at north end of joint @ bent 7. Monitor during future inspections.
|

321	CONC APPROACH SLAB	2	11-06-2014	2 EA	1	1	0	0	N/A
			09-24-2013	2 EA	1	1	0	0	N/A

Notes: |2014 - One panel moved to CS 2 to account for minor settlement. Refer to Photo No. 14 and to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
2013 - Bituminous pavement settled 1" to 1 1/2" at concrete approach on the Minnesota end. Minnesota end concrete approach panel diagonally cracked in the southeast corner of approach panel from end block to rail barrier (approx. 4'-6" in length). Bituminous pavement settled 1/2" to 1" at concrete approach on the Wisconsin end.
Rather large hump in pavement at east end of bituminous approach tie-in.
|

331	CONCRETE RAILING	2	11-06-2014	3,832 LF	0	3,832	0	0	N/A
			09-24-2013	3,832 LF	0	3,832	0	0	N/A

Notes: |2014 - No significant changes. Refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
2013 - The modified "F" railing is map cracked on the east and west sides. Areas of scratches, gouges and spalls around deflection joints are present in various locations.
2012 - The modified "F" railing on the north side map cracked in various areas.
|

Mn/DOT BRIDGE INSPECTION REPORT

Inspected by: OTHER

BRIDGE 6544 **MN 39; RR over ST LOUIS RIVER** **INSP. DATE: 11-06-2014**

STRUCTURE UNIT: 0

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
334	METAL RAIL-COATED	1	11-06-2014	3,876 LF	3,876	0	0	0	0
			09-24-2013	3,876 LF	3,876	0	0	0	0

Notes: |2014 - No significant changes.
South handrail could use additional wire ties to secure fencing material.
|

107	PAINTED STEEL GIRDER	3	11-06-2014	3,874 LF	0	0	1,900	1,900	74
			09-24-2013	3,874 LF	0	0	1,900	1,900	74

Notes: |This element applies to the railroad level girders under active track on east side of bridge.
2014 - A potential defect was noted in the top flange of the east beam in Span 23. See Photo No. 19. 74 feet added in CS 5 due to loss of section in excess of 10% on the top flanges of the 30' tower span girders. Refer to Photo No. 9 and Photo No. 110 and to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
2013 - Bent 26 - The east girder connection angle of the east interior girder and the west girder connection angle of the east fascia girder are displaced 1/4" from the floorbeam web due to pack rust in the upper portions of the connection angles (see Photo 1).
[2012] Significant pitting with pack rust at bottom flange at bearing locations. Minor loss of section in each leg of bottom flange angles. Loss (estimate at 1/8" to 1/4") in inboard bottom flange fillet and top of inboard horizontal leg behind horizontal gusset plate present at almost every lateral/wind bracing connection (see Photo 5). Top flange angles have minor to moderate deterioration with 5/32" loss of section (original 3/8") in inboard horizontal leg at mid-span of towar span being observed max (see Photo 6).
2007 LHB Notes: Cracks found in the vertical clip angles connecting 30' (short span) girders to floor beams. Cracked locations:
Bent 1 - North Interior Beam (NIB) - 2" long crack, N side of connection; Bent 1 - NIB - 14.5" long crack, S side of connection; Bent 2 - North Fascia Beam (NFB) - 1.5" long crack, S side of connection; Bent 26 - NIB - 39.5" long crack, S side of connection; Bent 26 - NIB - 7.25" long crack, N side of connection; Bent 26 - NFB - 6.25" long crack, S side of connection; Bent 26 - NFB - 5" long crack, N side of connection; Bent 30 - NFB - 11" long crack, S side of connection; Bent 30 - NIB - 6" long crack, N side of connection; Bent 30 - NIB - 16" long cr

107	PAINTED STEEL GIRDER	2	11-06-2014	6,310 LF	6,310	0	0	0	0
			09-24-2013	6,310 LF	6,310	0	0	0	0

Notes: |This element applies to the roadway deck level girders.
2014 - No significant changes. Refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
2013 - No significant change.
2012 - Represents roadway level beams. Good condition; replaced in 2001.
|

113	PAINT STEEL STRINGER	2	11-06-2014	1,200 LF	600	600	0	0	0
			09-24-2013	1,200 LF	600	600	0	0	0

Notes: |2014 - No significant changes. Refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
2013 - Main truss upper stringers - minor to moderate section loss to the top and bottom flanges in various locations. Maximum observed loss was up to 1/4" in bottom flange and up to 5/16" in top flange between U5-U6 on the east fascia girder.
2012 - Main truss upper stringers - good condition; general pitting and minor section loss in top and bottom flanges in various locations.
|

Mn/DOT BRIDGE INSPECTION REPORT

Inspected by: OTHER

BRIDGE 6544 **MN 39; RR over ST LOUIS RIVER** **INSP. DATE: 11-06-2014**

STRUCTURE UNIT: 0

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
121	P/STL THRU TRUSS/BOT	3	11-06-2014	600 LF	0	580	20	0	0
			09-24-2013	600 LF	0	580	20	0	0

Notes: |2014 - Section loss noted in the top flange of bottom chord and lower portion of gusset plate on the inboard side of L0. See Photo No. 5. Through-hole rust in batten plate, west truss. See Photo No. 6. Refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
2013 - South inboard vertical angle of vertical post (L1-U1 of West truss) has a 2" crack and an estimated 1/4" loss of section at/along the top of the bottom chord and the north inboard vertical angle has a 5" crack and an estimated 5/16" loss of section in the same location. This condition is similar at (L3-U3 of West truss) except the south inboard vertical angle has a 2 3/4" crack and the north inboard vertical angle has a 4" crack along with significant section loss. Likewise, at (L1-U1 of East Truss) the south inboard vertical angle has a 1 1/2" crack and the north inboard vertical angle has a 3 1/4" crack along with an estimated 5/16" of section loss.
[2012] Various locations of minor to moderate section loss and pitting, mainly in the horizontal legs of the top and bottom inboard angles near the end of the web splice plates and the top splice plates at the gusset/diagonal panel points. The loss was estimated to be 5/8" (original angle thickness 3/4") in these locations (see Photo 3). 2007 LHB note: Loss of section noted at various locations along top of bottom chord. Areas have been painted and loss has been arrested.
|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
126	P/STL THRU TRUSS/TOP	3	11-06-2014	600 LF	0	93	507	0	0
			09-24-2013	600 LF	0	93	507	0	0

Notes: |2014 - No significant changes. Refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
2013 - No significant changes. Refer to written report.
2012 - Few areas of noted section loss - refer to LHB 2012 FC inspection notes. Truss diagonals have minor pitting on the various stay plates which comprise the memeber. A few angles are cracked along the top of the bottom chord/bottom of floor beam that make up the vertical posts (see Photo 1). The main vertical members have moderate to significant section loss noted at the end of the inboard and outboard vertical angles at the bottom chord connection (see Photo 2). Truss was repainted with lead free paint to 6 ft. above roadway surface in 2001. Local buckling of top chord of main truss span was noted in panels 3 and 5 from the east end and panel 4 from the west end of truss. Defect is about 1/2 to 1 inch out of plane. Unclear if from erection or subsequent damage etc. Monitor. A crack 7 to 8in long was noted in the web of the upper floor beam on the north side of the truss at U1(second upper node from the west end of the truss.) Upon a more detailed inspection, it was determined that there is not a crack in the floor beam web . It was rust staining. 2007 LHB note: Distortion of top chord noted in previous inspection appears to be the result of cable hook or other pulling/impact damage and is not likely related to top chord compression loading.
|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
152	PAINT STL FLOORBEAM	2	11-06-2014	2,150 LF	1,075	0	1,075	0	0
			09-24-2013	2,150 LF	1,075	0	1,075	0	0

Notes: |2014 - Ongoing and previously documented pitting in floor beam web along toe of clip angle connection to the main beams, see Photo No. 8. Refer to Photo No. 2, Photo No. 7 and to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
2013 - No significant change. Refer to written report.
2012 - Main truss upper floorbeams - significan loss of section in the top flange between east fascia stringer and east interior stringer; estimated between 1/2" and 5/8" (original 3/4"). Minor loss observed on bottom flange around intermediate stiffener angles. Intermediate stiffener angles show moderate to signifcant section loss in the top and bottom one to three inches. Non-truss upper floorbeams - moderate pitting and loss of section in tops of the bottom flange angles and cover plate and and adjacent to interior web stiffener locations. Several web stiffeners show moderate to significant section loss in top and bottom one to three inches (see Photo 4). Non-truss lower floorbeams - good condition; replaced in 2001. Possible crack in top flange of new floor beam on Bent 12 . This possible crack is short and runs parallel to the long axis of the beam near the top of the flange. Due to the presence of the stringer bearing assembly, the top side of the floor beam flange was not accessible . It is located just below the 1st interior stringer support on the south side of the bridge. This area should be further investigated and monitored, but is not considered a critical finding. See photograph submitted with 2003 report. 2007: Deleted Element 231 & added it's 775 LF to this element per LHB.
2007 LHB note - Several cracks in the upper floor beams of the truss span were observed. These cracks are located in the the beam webs outside (north of) the north fascia beams. All had arresting holes drilled in them to prevent propagation unless noted otherwise. Locations are

Mn/DOT BRIDGE INSPECTION REPORT

Inspected by: OTHER

BRIDGE 6544 **MN 39; RR over ST LOUIS RIVER** **INSP. DATE: 11-06-2014**

STRUCTURE UNIT: 0

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
423	GUSSET PLATE (PAINT)	2	11-06-2014	26 EA	14	0	12	0	0
			09-24-2013	26 EA	14	0	12	0	0

Notes: |2014 - No significant changes. Refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
2013 - Gusset plate quantity consists of an inboard and outboard plate in 26 locations. Inboard gusset plates on the East truss at L2, L4 & L10 and on the West truss at L6 & L10 have localized section loss up to 3/8" along the floorbeam connection angles and/or above top flange of the floorbeam (see Photo 7). Other truss inboard gusset plates, not listed above, have minor section loss in the same localized area. This gusset plate deterioration is most likely caused by snow containing salt being trapped between the vertical member and the concrete rail barrier, then melting and dripping on the gusset plates below. The lower truss gusset plates should be programmed to be repainted. Paint system failed on upper level gusset plates.
|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
380	SECONDARY ELEMENTS	2	11-06-2014	1 EA	0	1	0	0	N/A
			09-24-2013	1 EA	0	1	0	0	N/A

Notes: |2014 - No significant changes. Refer to Photo No. 4, 11 & 17 and to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
2013 - Localized areas of paint failure (less than 2 sq. ft. per location) were noted on the lower column transverse and longitudinal bracing members. Localized paint failure on web of column transverse cross bracing at Bent 8. Size of failure is about 1ft-0 in X 4ft- 0 in. Likely due to contamination of primer surface prior to intermediate/finish coat application.
2007/2012 LHB note: Due to the wide variety in both condition and location of the various secondary members (bracing and bracing connection plates), refer to the specific condition descriptions contained in the CNRR Bridge Inspection Report - 2007/2012 (see Photo 7). (this report not yet rec'd from CNRR/LHB - Comment by P Huston 3/18/2008).
|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
310	ELASTOMERIC BEARING	2	11-06-2014	140 EA	136	0	4	N/A	N/A
			09-24-2013	140 EA	136	0	4	N/A	N/A

Notes: |2014 - No significant changes. 2014 condition is similar to 2012 description. Refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
2012 - 4 Elastomeric bearings at Bent 5 are fully/overextended 2" to the south (see Photo 8).
|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
311	EXPANSION BEARING	2	11-06-2014	52 EA	0	12	40	N/A	N/A
			09-24-2013	52 EA	0	12	40	N/A	N/A

Notes: |2014 - Elastomeric bearings (roadway deck) are overextended at Bent 5. This condition was documented in previous inspections. See Photo No. 12 . Refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
2013 - No significant change.
2012 - Minor to moderate section loss in the rivets but bearings generally appear to be adequate. Moderate to severe pack rust with associated section loss was observed at railroad level abutment bearings. Rocker bearings at old railroad abutment on east end of bridge appear to have shifted about 7/8 inch to the north along their pins. Monitor. North hemispherical bearing at railroad span 2 is shifted out from seat about 7/8 inch at top and 1 inch at base. Monitor and reset if movement continues.
|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
313	FIXED BEARING	2	11-06-2014	6 EA	0	6	0	N/A	N/A
			09-24-2013	6 EA	0	6	0	N/A	N/A

Notes: |2014 - No significant changes. Refer to Photo No. 13 and to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
2013 - Girders are pushed into backwall at railroad North abutment (long term condition).
Railroad level at abutments. Most girders are framed directly into floor beam webs and do not have bearings.
|

Mn/DOT BRIDGE INSPECTION REPORT

Inspected by: OTHER

BRIDGE 6544 **MN 39; RR over ST LOUIS RIVER** **INSP. DATE: 11-06-2014**

STRUCTURE UNIT: 0

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
202	PAINT STL COLUMN	2	11-06-2014	56 EA	0	17	15	24	0
			09-24-2013	56 EA	0	17	15	24	0

Notes: |2014 - Condition similar to previous inspections. See Photos 16 and 18 and refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
2013 - Many of the column base plates have at least two deteriorated anchor bolts. The west column at Bent 10, the outer 3" of the 4" leg of the southwest outboard vertical angle and the outer 1 1/2" of the southeast outboard vertical angle are 100% deteriorated for a height of 2" at interface with interior concrete fill (see Photo 2). The east column at Bent 2, the outer 3" of the 4" leg of the northeast outboard vertical angle is 100% deteriorated for a height of 1" at interface with interior concrete fill. The south east outbaord vertical angle has a 2" diameter hole just above interior concrete fill (see Photo 3). The vertical outboard angles of other columns are cracked and/or have section loss but not as severe as noted at Bents 10 & 2. These angles are located at: Bent 13 - West column - N.W. angle, Bent 18 - West column - S.W., S.E. & N.E., Bent 19 - West column - S.E., Bent 20 - East column - S.W., Bent 22 - West column - N.E., Bent 24 - West column - N.E., Bent 25 - West column - N.W., Bent 27 - East Column - S.E. and Bent 28 - East Column - S.W. & S.E.
[2012] A few of the tower column bearing plate castings are cracked in the corners with the worse case at the west column of Bent 26 where all four corners are completely cracked off inside the anchors and the bearing plate has settled into the concrete pedestal about 1/2" (see Photo 9).
[2011] RR support columns above portion painted w/non-lead paint. Built-up columns are trapping water inside voided areas at bottoms of columns. Most have concrete fill to prevent water from accumulating. Those that do not should be filled with concrete/grout. Localized paint failure was identified at the north column of Bent 1. This occurs at the field welded connection of

210	CONCRETE PIER WALL	2	11-06-2014	100 LF	70	0	30	0	N/A
			09-24-2013	100 LF	70	0	30	0	N/A

Notes: |2014 - Condition of Bent 1 is similar to previous inspections. See Photo No. 15 and refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
2007: The following note was moved from Element 387 as per 2007 LHB inspection: "Large vertical crack in old RR abutment on east end of bridge. anecdotal information from RR personnel indicates that crack has increased in width to where daylight is now visible. Install crack guage and monitor. See Elem 311 for related symptoms."
2007 LHB note: The original concrete abutment at Bent 31 was converted to a pier years ago. Backwall cold joint and the north edge of Span 32 girder support area should be monitored. Also, a large vertical crack through the abutment (south of south girder) should be continue to be monitored. Discussion with CNRR Structural Engineer indicates no evidence of further movement in vertical crack in recent years.
|

215	CONCRETE ABUTMENT	3	11-06-2014	100 LF	75	0	25	0	N/A
			09-24-2013	100 LF	75	0	25	0	N/A

Notes: |2014 - Refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
Total element quantity = 50 LF highway + 50 LF railroad
|

220	CONCRETE FOOTING	2	11-06-2014	57 EA	10	6	41	0	N/A
			09-24-2013	57 EA	10	6	41	0	N/A

Notes: |2014 - Refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
2013 - Column concrete footings that were encased during the 2001 rehabilitation are in good condition. Remaining pedestals show some signs of deterioration and scaling (see Photo 4 for typical column footing deterioration at Bent 9).
Center river pier: On August 15, 2011 Smith Lasalle completed an underwater inspection of this bridge for CN Railway. In Smith Lasalle's report for this inspection, the following is stated in the Executive Summary;
"The damage above the waterline on the Draw Pier should be repaired in the next 12-18 months by having the unsound concrete removed, dowels installed and a new collar poured." Resolution of this finding is the responsibility of CN Railway. (ECE)
|

234	CONCRETE CAP	2	11-06-2014	58 LF	58	0	0	0	N/A
			09-24-2013	58 LF	58	0	0	0	N/A

Notes: |2014 - No significant changes.
2013 - No issues.
Bent 1A & 30A
|

Mn/DOT BRIDGE INSPECTION REPORT

Inspected by: OTHER

BRIDGE 6544 **MN 39; RR over ST LOUIS RIVER** **INSP. DATE: 11-06-2014**

STRUCTURE UNIT: 0

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
382	CAST-IN-PLACE PILING	2	11-06-2014	8 EA	8	0	0	0	N/A
			09-24-2013	8 EA	8	0	0	0	N/A
	Notes: |2014 - Condition is good. |								
387	CONCRETE WINGWALL	2	11-06-2014	6 EA	2	2	2	0	N/A
			09-24-2013	6 EA	2	2	2	0	N/A
	Notes: |2014 - Condition is similar to previous. Refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element. Large vertical crack in north railroad abutment continues to be monitored. Little movement has been noted. 2007: A portion of the old note under this element was moved to element 210 as suggested by LHB. |								
357	PACK RUST	2	11-06-2014	1 EA	0	0	1	0	N/A
			09-24-2013	1 EA	0	0	1	0	N/A
	Notes: |2014 - CS 3 for this element still appropriate. Refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element. Confined to RR portion after 2001 rehab. |								
358	CONC DECK CRACKING	2	11-06-2014	1 EA	1	0	0	0	N/A
			09-24-2013	1 EA	1	0	0	0	N/A
	Notes:								
359	CONC DECK UNDERSIDE	2	11-06-2014	1 EA	1	0	0	0	0
			09-24-2013	1 EA	1	0	0	0	0
	Notes:								
361	SCOUR	2	11-06-2014	1 EA	1	0	0	N/A	N/A
			09-24-2013	1 EA	1	0	0	N/A	N/A
	Notes: | < none > |								
363	SECTION LOSS	2	11-06-2014	1 EA	0	0	1	0	N/A
			09-24-2013	1 EA	0	0	1	0	N/A
	Notes: |2014 - CS 3 still appropriate for this element. Will consider revising to 4 if bridge owner engineering staff determines that analysis is warranted where noted. Refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element. |								
964	CRITICAL FINDING	2	11-06-2014	1 EA	1	0	N/A	N/A	N/A
			09-24-2013	1 EA	1	0	N/A	N/A	N/A
	Notes: |DO NOT DELETE THIS CRITICAL FINDING SMART FLAG.|								
966	FRACTURE CRITICAL	2	11-06-2014	1 EA	1	0	0	N/A	N/A
			09-24-2013	1 EA	1	0	0	N/A	N/A
	Notes: |Do Not Remove. See in-depth report for location of F/C members. 2014 - Refer to the attached 2014 Fracture Critical Report dated January 9, 2015 for full discussion of all relevant elements including potential for engineering analysis. 2008-12-22: Full FC report received from LHB. Report is dated Nov. 5 - 9, 2007 and is in the District bridge file. Copy sent to Wis/DOT Al Bjorklund. The CNRR has completed repairs to the upper level bridge. I have requested and inventory of the repairs from Joel Reed (CNRR Proctor). Note entered by Pat Huston. |								

Mn/DOT BRIDGE INSPECTION REPORT

Inspected by: OTHER

BRIDGE 6544 **MN 39; RR over ST LOUIS RIVER** **INSP. DATE: 11-06-2014**

STRUCTURE UNIT: 0

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
981	SIGNING	2	11-06-2014	1 EA	1	0	0	0	0
			09-24-2013	1 EA	1	0	0	0	0

Notes: |2014 - All signs appear to be properly in place.
[2013] 25 m.p.h. speed limit sign missing from sign post at north approach. 25 m.p.h. speed limit sign missing top bolt and is currently hanging upside down at Bent 28.
Signs Required: Vertical Clearance Horizontal Clearance
|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
982	GUARDRAIL	2	11-06-2014	1 EA	1	0	0	N/A	N/A
			09-24-2013	1 EA	1	0	0	N/A	N/A

Notes: |2014 - Traffic barrier in good condition.
2013 - Traffic barrier end treatment on the Minnesota end is detached from the last timber post.
2007 LHB note: End timber posts damaged (both sides) at Wisconsin end approach.
|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
984	DRAINAGE	2	11-06-2014	1 EA	1	0	0	N/A	N/A
			09-24-2013	1 EA	1	0	0	N/A	N/A

Notes: |2014 - No significant changes.
2013 - Manhole/catch basin is clear of debris.
Manhole/catch basin just east of east roadway approach abutment is covered with sand and debris. Appears to be caused by erosion of approach roadway. Consider stabilizing roadway embankment.
|

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
985	SLOPES	2	11-06-2014	1 EA	1	0	0	N/A	N/A
			09-24-2013	1 EA	1	0	0	N/A	N/A

Notes: |< none > |

Mn/DOT BRIDGE INSPECTION REPORT

Inspected by: OTHER

BRIDGE 6544 **MN 39; RR over ST LOUIS RIVER** **INSP. DATE: 11-06-2014**

STRUCTURE UNIT: 0

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
967	GUSSET DISTORTION	2	11-06-2014	1 EA	0	1	0	0	N/A
			09-24-2013	1 EA	0	1	0	0	N/A

Notes: |2014 - No significant changes. Refer to Photo No. 3 and to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of this element.
Some minor distortion noted in 2012 FC inspection.
|

General Notes: Inspections of this privately owned bridge are the responsibility of the owner (Canadian National RR). The roadway portion of this bridge was reconstructed in 2001 under contract awarded to Johnson Brothers Corporation by DM&IR RY. Construction administration and inspection by LHB Engineers. Opened to traffic 12/3/2001.
The construction and maintenance agreement for this bridge is #78755 and a scanned copy is on the D1 file server.

2014 Notes:
In depth F/C inspection performed in conjunction with routine inspection in November of 2014. Typical and ongoing deficiencies were again noted in the most recent inspection, mostly related to corrosion and section loss in the railroad supporting elements. Refer to the written Fracture Critical Bridge Inspection Report (attached) for complete documentation of the bridge elements.
2013 Notes:
Rail deck beam at railroad south side of Bent 31 is cracked through the bottom flange and full height of the web. Railroad has benn notified and taking action. In span 17, a top diagonal lateral bracing angle (just north of Bent 16) is split in half.

2012 Notes:
F/C inspection conducted 8/13/12 to 8/16/12. Significant repairs were completed to the railroad level structure since previous F/C inspection in 2008. Deteriorated secondary members were repaired/replaced. Refer to the 2012 F/C report for inspection findings/reports.

2011 Notes;
Underwater inspection completed by Smith Lasalle on August 15, 2011.
CN Railway Bridge Inspectors Scott Beatty and Peter Kaz completed an annual bridge inspection of the bridge on August 12, 2011. No NBI ratings were assigned to the bridge from this inspection. MnDOT's Bridge Inspection Field Manual was not followed during this inspection. AASHTO CoRe elements for the deck, superstructure and substructure were not followed. Efforts are underway to discuss this with CN Railway before the next inspection cycle to determine best course of action in obtaining NBIS & Minnesota inspection pr

Inspector's Signature

Reviewer's Signature / Date

Mn/DOT Structure Inventory Report

Bridge ID: 49553 **SOO LINE REC TRAIL over MISSISSIPPI RIVER** Date: 05/13/2015

+ GENERAL +

Agency Br. No.
District 3 **Maint. Area**
County 49 - MORRISON
City
Township SWAN RIVER
Desc. Loc. 0.2 MI E OF CSAH 52
Sect., Twp., Range 32 - 128NN - 29W
Latitude 45d 51m 37.46s
Longitude 94d 21m 33.56s
Custodian COUNTY
Owner COUNTY
Inspection By MORRISON COUNTY
BMU Agreement
Year Built
Year Fed Rehab
Year Remodeled
Temp
Plan Avail. NO PLAN

+ STRUCTURE +

Service On PED-BICYCLE
Service Under STREAM
Main Span Type STEEL DECK TRUSS
Main Span Detail
Appr. Span Type
Appr. Span Detail
Skew
Culvert Type
Barrel Length

Number of Spans

MAIN: 5 APPR: 0 TOTAL: 5

Main Span Length 130.0 ft
Structure Length 650.0 ft
Deck Width 10.0 ft
Deck Material TIMBER
Wear Surf Type TIMBER
Wear Surf Install Year
Wear Course/Fill Depth
Deck Membrane NONE
Deck Protect. NONE
Deck Install Year
Structure Area 6,500 sq ft
Roadway Area
Sidewalk Width - L/R
Curb Height - L/R
Rail Codes - L/R NN NN

+ ROADWAY +

Bridge Match ID (TIS) 1
Roadway O/U Key 1-ON
Route Sys/Nbr UNKN -1

Roadway Name or Description

Roadway Function N/A
Roadway Type NOT APPLI
Control Section (TH Only)
Ref. Point (TH Only)
Date Opened to Traffic
Detour Length 0 mi.
Lanes -1 Lanes ON Bridge
ADT (YEAR) 1 (2009)
HCADT
Functional Class.

+ RDWY DIMENSIONS +

If Divided	NB-EB	SB-WB
Roadway Width		
Vertical Clearance		
Max. Vert. Clear.		
Horizontal Clear.		
Lateral Clr. - Lt/Rt		
Appr. Surface Width		
Roadway Width		
Median Width		

+ MISC. BRIDGE DATA +

Structure Flared NO
Parallel Structure NONE
Field Conn. ID
Cantilever ID

Foundations

Abut. CONC - FTG PILE
Pier CONC - FTG PILE
Historic Status NOT ELIGIBLE
On - Off System OFF

+ PAINT +

Year Painted **Pct. Unsound**
Painted Area
Primer Type
Finish Type

+ BRIDGE SIGNS +

Posted Load NOT REQUIRED
Traffic NOT REQUIRED
Horizontal NOT REQUIRED
Vertical NOT APPLICABLE

+ INSPECTION +

Deficient Status N/A
Sufficiency Rating N/A
Last Inspection Date 10-02-2014
Inspection Frequency 12
Inspector Name PONTIS
Structure A-OPEN

+ NBI CONDITION RATINGS +

Deck	7
Superstructure	7
Substructure	4
Channel	7
Culvert	N

+ NBI APPRAISAL RATINGS +

Structure Evaluation	3
Deck Geometry	N
Underclearances	N
Waterway Adequacy	7
Approach Alignment	8

+ SAFETY FEATURES +

Bridge Railing 1-MEETS STANDARDS
GR Transition N-NOT REQUIRED
Appr. Guardrail N-NOT REQUIRED
GR Termini N-NOT REQUIRED

+ IN DEPTH INSP. +

Frac. Critical
Underwater
Pinned Asbly.
Spec. Feat.

+ WATERWAY +

Drainage Area
Waterway Opening 9999 sq ft
Navigation Control NO PRMT REQD
Pier Protection DETERIORATING
Nav. Vert./Horz. Clr.
Nav. Vert. Lift Bridge Clear.
MN Scour Code F-EVAL REQD
Scour Evaluation Year

+ CAPACITY RATINGS +

Design Load PED
Operating Rating PED
Inventory Rating PED
Posting
Rating Date

Mn/DOT Permit Codes

A: N B: N C: N

BRIDGE INVENTORY REPORT.RPT

Mn/DOT BRIDGE INSPECTION REPORT

Inspected by: MORRISON COUNTY

BRIDGE 49553 SOO LINE REC TRAIL over MISSISSIPPI RIVER INSP. DATE: 10-02-2014

County: MORRISON
City:
Township: SWAN RIVER
Section: 32 Township: 128NN Range: 29W
Span Type: STEEL DECK TRUSS
NBI Deck: 7 Super: 7 Sub: 4 Chan: 7 Culv: N

Location: 0.2 MI E OF CSAH 52
Route: UNKN -1 Ref. Pt.:
Control Section: Maint. Area:
Local Agency Bridge Nbr:

Length: 650.0 ft
Deck Width: 10.0 ft
Rdwy. Area / Pct. Unsnd:
Paint Area/ Pct. Unsnd:
Culvert N/A

Open, Posted, Closed: OPEN

Appraisal Ratings - Approach: 8 Waterway: 7
MN Scour Code: F-EVAL REQD Def. Stat: N/A Suff. Rate: N/A
Required Bridge Signs - Load Posting: NOT REQUIRED Traffic: NOT REQUIRED
Horizontal: NOT REQUIRED Vertical: NOT APPLICABLE

STRUCTURE UNIT: 1

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
31	TIMBER DECK	2	10-02-2014	8,450 SF	0	8,450	0	0	N/A
			08-27-2012	8,450 SF	0	8,450	0	0	N/A
	Notes: |11/1/06 - Constructed 13' wide x 4" thick x 650' treated timber deck and replaced 33 RxR ties.Also placed 2" treated timber wear course. 9/23/10 - All timber deck planks have cupped.|								
407	BITUMINOUS APPROACH	1	10-02-2014	2 EA	2	0	0	0	N/A
			08-27-2012	2 EA	2	0	0	0	N/A
	Notes: |10/15/07 - Paved 2" bituminous in November, 2006. 8/28/13 - West approach failure repaired by MCHD. Good condition. Erosion on East approach repaired w/ quarry run riprap.|								
334	METAL RAIL-COATED	1	10-02-2014	1,299 LF	1,299	0	0	0	0
			08-27-2012	1,299 LF	1,299	0	0	0	0
	Notes: |10/15/07 - Placed 1,300' of coated chain link fence in November, 2006. 8/27/12 - Missing (1) end cap on East end.|								
117	TIMBER STRINGER	2	10-02-2014	3,251 LF	3,251	0	0	0	N/A
			08-27-2012	3,251 LF	3,251	0	0	0	N/A
	Notes: |11/1/06 - Constructed 5- 4"x 8" treated timber stringers.|								
131	PAINT STL DECK TRUSS	2	10-02-2014	650 LF	0	351	299	0	0
			08-27-2012	650 LF	0	351	299	0	0
	Notes: |10/4/04 - All steel corroding & in need of rehab.|								
311	EXPANSION BEARING	1	10-02-2014	10 EA	1	8	1	N/A	N/A
			08-27-2012	10 EA	1	8	1	N/A	N/A
	Notes: |10/11/05 - Bearings show movement is possible. Significant corrosion is present, but bearings appear functional. 8/27/12 - Extensive crack in lower portion of bearing on South bearing on East abutment. 8/28/13 - Changed quantity to each. Additional cracked bearing on pier 2 noted in 7/30/13 inspection.|								
313	FIXED BEARING	2	10-02-2014	10 EA	0	10	0	N/A	N/A
			08-27-2012	10 EA	0	10	0	N/A	N/A
	Notes: |8/28/13 - Added element.|								
210	CONCRETE PIER WALL	2	10-02-2014	102 LF	0	0	102	0	N/A
			08-27-2012	102 LF	0	0	102	0	N/A
	Notes: |7/30/13 - Changed L.F. to correct dimensions. All walls have extensive cracking, spalling and delamination. |								
215	CONCRETE ABUTMENT	2	10-02-2014	33 LF	0	0	33	0	N/A
			08-27-2012	33 LF	0	0	33	0	N/A
	Notes: |10/13/08 - Both abutments have extensive spalls and cracks.|								
220	CONCRETE FOOTING	2	10-02-2014	4 EA	0	0	4	0	N/A
			08-27-2012	4 EA	0	0	4	0	N/A
	Notes: |All pier footings are extremely Spalled (up to 1.0'). Much rebar corroding. 10/13/08 - Pier footing #1 has had partial repairs with grout filled bags. 10/2/14 - Pier #1 on top of exposed footing has advanced spalling taking place. Since last inspection, footing has lost approx. 1.0' of concrete on S.W. end of footing.|								

Mn/DOT BRIDGE INSPECTION REPORT

Inspected by: MORRISON COUNTY

BRIDGE 49553 SOO LINE REC TRAIL over MISSISSIPPI RIVER INSP. DATE: 10-02-2014

STRUCTURE UNIT: 1

ELEM NBR	ELEMENT NAME	ENV	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
234	CONCRETE CAP	2	10-02-2014	102 LF	0	0	102	0	N/A
			08-27-2012	102 LF	0	0	102	0	N/A
	Notes: |10/4/04 - Pier caps are in poor condition. Extreme spalling. 10/11/2005 - All pier as have significant Surface spalls. No determination on integrity of remainder of concrete soundness is made. 9/23/10 - Concrete caps continue to deteriorate.|								
387	CONCRETE WINGWALL	2	10-02-2014	4 EA	0	0	4	0	N/A
			08-27-2012	4 EA	0	0	4	0	N/A
	Notes: |10/4/04 - NW wing has (1) - 1" crack full height-and depth. SW wing has broken off. Severe spalls. 10/2/14 - Concrete on lower portion of S.W. wingwall is spalled. One void detected beneath wingwall is 3'x 1.5'x 1'.|								
964	CRITICAL FINDING	2	10-02-2014	1 EA	1	0	N/A	N/A	N/A
			08-27-2012	1 EA	1	0	N/A	N/A	N/A
	Notes: |< none >|								
982	GUARDRAIL	1	10-02-2014	1 EA	1	0	0	N/A	N/A
			08-27-2012	1 EA	1	0	0	N/A	N/A
	Notes: |.10/15/07 - Constructed splitrail guardrail in November, 2006.|								
986	CURB & SIDEWALK	2	10-02-2014	2 EA	2	0	0	N/A	N/A
			08-27-2012	2 EA	2	0	0	N/A	N/A
	Notes: |11/1/06 - Constructed 1300' of 6"x6" treated timber curb.|								

General Notes: 7/30/13 - Inspected by Barritt Lovelace, PE, and Ashley Slominski, PE from WSB & Associates. See detailed inspection report in bridge file.

Inspector's Signature

Reviewer's Signature / Date

Appendix C

FAA COA

U.S. Department
of Transportation
**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, D.C. 20591

April 17, 2015

Exemption No. 11375
Regulatory Docket No. FAA–2015-0090

Mr. Mr. Drew A. Jurkofsky
Unmanned Experts, Inc.
720 South Colorado Boulevard
Penthouse North
Denver, CO 80246

Dear Mr. Jurkofsky:

This letter is to inform you that we have granted your request for exemption. It transmits our decision, explains its basis, and gives you the conditions and limitations of the exemption, including the date it ends.

The Basis for Our Decision

By letter dated January 15, 2015, you petitioned the Federal Aviation Administration (FAA) on behalf of Unmanned Experts, Inc. (hereinafter petitioner or operator) for an exemption. The exemption would allow the petitioner to operate an unmanned aircraft system (UAS) to conduct precision aerial surveying.

See Appendix A for the petition submitted to the FAA describing the proposed operations and the regulations that the petitioner seeks an exemption.

The FAA has determined that good cause exists for not publishing a summary of the petition in the Federal Register because the requested exemption would not set a precedent, and any delay in acting on this petition would be detrimental to the petitioner.

Airworthiness Certification

The UAS proposed by the petitioner is an Aeryon SkyRanger.

The petitioner requested relief from 14 CFR part 21, *Certification procedures for products and parts, Subpart H—Airworthiness Certificates*. In accordance with the statutory criteria provided in Section 333 of Public Law 112−95 in reference to 49 U.S.C. § 44704, and in consideration of the size, weight, speed, and limited operating area associated with the aircraft and its operation, the Secretary of Transportation has determined that this aircraft meets the conditions of Section 333. Therefore, the FAA finds that the requested relief from 14 CFR part 21, *Certification procedures for products and parts, Subpart H—Airworthiness Certificates*, and any associated noise certification and testing requirements of part 36, is not necessary.

The Basis for Our Decision

You have requested to use a UAS for aerial data collection. The FAA has issued grants of exemption in circumstances similar in all material respects to those presented in your petition. In Grants of Exemption Nos. 11062 to Astraeus Aerial (*see* Docket No. FAA−2014−0352), 11109 to Clayco, Inc. (*see* Docket No. FAA−2014−0507), 11112 to VDOS Global, LLC (*see* Docket No. FAA−2014−0382), and 11213 to Aeryon Labs, Inc. (*see* Docket No. FAA−2014−0642), the FAA found that the enhanced safety achieved using an unmanned aircraft (UA) with the specifications described by the petitioner and carrying no passengers or crew, rather than a manned aircraft of significantly greater proportions, carrying crew in addition to flammable fuel, gives the FAA good cause to find that the UAS operation enabled by this exemption is in the public interest.

Having reviewed your reasons for requesting an exemption, I find that—

- They are similar in all material respects to relief previously requested in Grant of Exemption Nos. 11062, 11109, 11112, and 11213;
- The reasons stated by the FAA for granting Exemption Nos. 11062, 11109, 11112, and 11213 also apply to the situation you present; and
- A grant of exemption is in the public interest.

Our Decision

In consideration of the foregoing, I find that a grant of exemption is in the public interest. Therefore, pursuant to the authority contained in 49 U.S.C. 106(f), 40113, and 44701, delegated to me by the Administrator, Unmanned Experts, Inc. is granted an exemption from 14 CFR §§ 61.23(a) and (c), 61.101(e)(4) and (5), 61.113(a), 61.315(a), 91.7(a), 91.119(c), 91.121, 91.151(a)(1), 91.405(a), 91.407(a)(1), 91.409(a)(1) and (2), and 91.417(a) and (b), to the extent necessary to allow the petitioner to operate a UAS to perform aerial data collection. This exemption is subject to the conditions and limitations listed below.

Conditions and Limitations

In this grant of exemption, Unmanned Experts, Inc. is hereafter referred to as the operator.

Failure to comply with any of the conditions and limitations of this grant of exemption will be grounds for the immediate suspension or rescission of this exemption.

1. Operations authorized by this grant of exemption are limited to the Aeryon SkyRanger when weighing less than 55 pounds including payload. Proposed operations of any other aircraft will require a new petition or a petition to amend this exemption.

2. Operations for the purpose of closed-set motion picture and television filming are not permitted.

3. The UA may not be operated at a speed exceeding 87 knots (100 miles per hour). The exemption holder may use either groundspeed or calibrated airspeed to determine compliance with the 87 knot speed restriction. In no case will the UA be operated at airspeeds greater than the maximum UA operating airspeed recommended by the aircraft manufacturer.

4. The UA must be operated at an altitude of no more than 400 feet above ground level (AGL). Altitude must be reported in feet AGL.

5. The UA must be operated within visual line of sight (VLOS) of the PIC at all times. This requires the PIC to be able to use human vision unaided by any device other than corrective lenses, as specified on the PIC's FAA-issued airman medical certificate or U.S. driver's license.

6. All operations must utilize a visual observer (VO). The UA must be operated within the visual line of sight (VLOS) of the PIC and VO at all times. The VO may be used to satisfy the VLOS requirement as long as the PIC always maintains VLOS capability. The VO and PIC must be able to communicate verbally at all times; electronic messaging or texting is not permitted during flight operations. The PIC must be designated before the flight and cannot transfer his or her designation for the duration of the flight. The PIC must ensure that the VO can perform the duties required of the VO.

7. This exemption and all documents needed to operate the UAS and conduct its operations in accordance with the conditions and limitations stated in this grant of exemption, are hereinafter referred to as the operating documents. The operating documents must be accessible during UAS operations and made available to the Administrator upon request. If a discrepancy exists between the conditions and limitations in this exemption and the procedures outlined in the operating documents, the conditions and limitations herein take precedence and must be followed.

Otherwise, the operator must follow the procedures as outlined in its operating documents. The operator may update or revise its operating documents. It is the operator's responsibility to track such revisions and present updated and revised documents to the Administrator or any law enforcement official upon request. The operator must also present updated and revised documents if it petitions for extension or amendment to this grant of exemption. If the operator determines that any update or revision would affect the basis upon which the FAA granted this exemption, then the operator must petition for an amendment to its grant of exemption. The FAA's UAS Integration Office (AFS−80) may be contacted if questions arise regarding updates or revisions to the operating documents.

8. Any UAS that has undergone maintenance or alterations that affect the UAS operation or flight characteristics, e.g., replacement of a flight critical component, must undergo a functional test flight prior to conducting further operations under this exemption. Functional test flights may only be conducted by a PIC with a VO and must remain at least 500 feet from other people. The functional test flight must be conducted in such a manner so as to not pose an undue hazard to persons and property.

9. The operator is responsible for maintaining and inspecting the UAS to ensure that it is in a condition for safe operation.

10. Prior to each flight, the PIC must conduct a pre-flight inspection and determine the UAS is in a condition for safe flight. The pre-flight inspection must account for all potential discrepancies, e.g., inoperable components, items, or equipment. If the inspection reveals a condition that affects the safe operation of the UAS, the aircraft is prohibited from operating until the necessary maintenance has been performed and the UAS is found to be in a condition for safe flight.

11. The operator must follow the UAS manufacturer's maintenance, overhaul, replacement, inspection, and life limit requirements for the aircraft and aircraft components.

12. Each UAS operated under this exemption must comply with all manufacturer safety bulletins.

13. Under this grant of exemption, a PIC must hold either an airline transport, commercial, private, recreational, or sport pilot certificate. The PIC must also hold a current FAA airman medical certificate or a valid U.S. driver's license issued by a state, the District of Columbia, Puerto Rico, a territory, a possession, or the Federal government. The PIC must also meet the flight review requirements specified in 14 CFR § 61.56 in an aircraft in which the PIC is rated on his or her pilot certificate.

14. The operator may not permit any PIC to operate unless the PIC demonstrates the ability to safely operate the UAS in a manner consistent with how the UAS will be

operated under this exemption, including evasive and emergency maneuvers and maintaining appropriate distances from persons, vessels, vehicles and structures. PIC qualification flight hours and currency must be logged in a manner consistent with 14 CFR § 61.51(b). Flights for the purposes of training the operator's PICs and VOs (training, proficiency, and experience-building) and determining the PIC's ability to safely operate the UAS in a manner consistent with how the UAS will be operated under this exemption are permitted under the terms of this exemption. However, training operations may only be conducted during dedicated training sessions. During training, proficiency, and experience-building flights, all persons not essential for flight operations are considered nonparticipants, and the PIC must operate the UA with appropriate distance from nonparticipants in accordance with 14 CFR § 91.119.

15. UAS operations may not be conducted during night, as defined in 14 CFR § 1.1. All operations must be conducted under visual meteorological conditions (VMC). Flights under special visual flight rules (SVFR) are not authorized.

16. The UA may not operate within 5 nautical miles of an airport reference point (ARP) as denoted in the current FAA Airport/Facility Directory (AFD) or for airports not denoted with an ARP, the center of the airport symbol as denoted on the current FAA-published aeronautical chart, unless a letter of agreement with that airport's management is obtained or otherwise permitted by a COA issued to the exemption holder. The letter of agreement with the airport management must be made available to the Administrator or any law enforcement official upon request.

17. The UA may not be operated less than 500 feet below or less than 2,000 feet horizontally from a cloud or when visibility is less than 3 statute miles from the PIC.

18. If the UAS loses communications or loses its GPS signal, the UA must return to a pre-determined location within the private or controlled-access property.

19. The PIC must abort the flight in the event of unpredicted obstacles or emergencies.

20. The PIC is prohibited from beginning a flight unless (considering wind and forecast weather conditions) there is enough available power for the UA to conduct the intended operation and to operate after that for at least five minutes or with the reserve power recommended by the manufacturer if greater.

21. Air Traffic Organization (ATO) Certificate of Waiver or Authorization (COA). All operations shall be conducted in accordance with an ATO-issued COA. The exemption holder may apply for a new or amended COA if it intends to conduct operations that cannot be conducted under the terms of the attached COA.

22. All aircraft operated in accordance with this exemption must be identified by serial number, registered in accordance with 14 CFR part 47, and have identification

(N−Number) markings in accordance with 14 CFR part 45, Subpart C. Markings must be as large as practicable.

23. Documents used by the operator to ensure the safe operation and flight of the UAS and any documents required under 14 CFR §§ 91.9 and 91.203 must be available to the PIC at the Ground Control Station of the UAS any time the aircraft is operating. These documents must be made available to the Administrator or any law enforcement official upon request.

24. The UA must remain clear and give way to all manned aviation operations and activities at all times.

25. The UAS may not be operated by the PIC from any moving device or vehicle.

26. All Flight operations must be conducted at least 500 feet from all nonparticipating persons, vessels, vehicles, and structures unless:
    a. Barriers or structures are present that sufficiently protect nonparticipating persons from the UA and/or debris in the event of an accident. The operator must ensure that nonparticipating persons remain under such protection. If a situation arises where nonparticipating persons leave such protection and are within 500 feet of the UA, flight operations must cease immediately in a manner ensuring the safety of nonparticipating persons; and
    b. The owner/controller of any vessels, vehicles or structures has granted permission for operating closer to those objects and the PIC has made a safety assessment of the risk of operating closer to those objects and determined that it does not present an undue hazard.

    The PIC, VO, operator trainees or essential persons are not considered nonparticipating persons under this exemption.

27. All operations shall be conducted over private or controlled-access property with permission from the property owner/controller or authorized representative. Permission from property owner/controller or authorized representative will be obtained for each flight to be conducted.

28. Any incident, accident, or flight operation that transgresses the lateral or vertical boundaries of the operational area as defined by the applicable COA must be reported to the FAA's UAS Integration Office (AFS−80) within 24 hours. Accidents must be reported to the National Transportation Safety Board (NTSB) per instructions contained on the NTSB Web site: www.ntsb.gov.

If this exemption permits operations for the purpose of closed-set motion picture and television filming and production, the following additional conditions and limitations apply.

29. The operator must have a motion picture and television operations manual (MPTOM) as documented in this grant of exemption.

30. At least 3 days before aerial filming, the operator of the UAS affected by this exemption must submit a written Plan of Activities to the local Flight Standards District Office (FSDO) with jurisdiction over the area of proposed filming. The 3-day notification may be waived with the concurrence of the FSDO. The plan of activities must include at least the following:
    a. Dates and times for all flights;
    b. Name and phone number of the operator for the UAS aerial filming conducted under this grant of exemption;
    c. Name and phone number of the person responsible for the on-scene operation of the UAS;
    d. Make, model, and serial or N−Number of UAS to be used;
    e. Name and certificate number of UAS PICs involved in the aerial filming;
    f. A statement that the operator has obtained permission from property owners and/or local officials to conduct the filming production event; the list of those who gave permission must be made available to the inspector upon request;
    g. Signature of exemption holder or representative; and
    h. A description of the flight activity, including maps or diagrams of any area, city, town, county, and/or state over which filming will be conducted and the altitudes essential to accomplish the operation.

31. Flight operations may be conducted closer than 500 feet from participating persons consenting to be involved and necessary for the filming production, as specified in the exemption holder's MPTOM.

Unless otherwise specified in this grant of exemption, the UAS, the UAS PIC, and the UAS operations must comply with all applicable parts of 14 CFR including, but not limited to, parts 45, 47, 61, and 91.
This exemption terminates on April 30, 2017, unless sooner superseded or rescinded.

Sincerely,

/s/
John S. Duncan
Director, Flight Standards Service

UNMANNED EXPERTS

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January 15, 2015
U.S. Department of Transportation
Docket Management System
1200 New Jersey Ave., SE
Washington, DC 20590

Dear Sir or Madam:

Pursuant to Section 333 of the FAA Modernization and Reform Act of 2012 (herein referred to as Reform Act) and 14 CFR Part 11, Unmanned Experts, a small Unmanned Aircraft System (sUAS) consultancy and training firm, hereby applies for an exemption from the listed Federal Aviation Regulations (FARs) to allow commercial operation of sUAS for precision aerial surveying, so long as such operations are conducted within and under the conditions outlined herein or as may be established by the FAA as required by Section 333.

As detailed in this document and the attached **Aeryon SkyRanger** User Guide (herein referred to as User Guide), the requested exemption would permit the operation of sUAS under controlled conditions in airspace that is 1) limited, 2) predetermined, 3) controlled as to access and 4) would provide safety enhancements to the already best practices safety protocols followed by Unmanned Experts. Approval of this exemption would thereby enhance safety and fulfill the Secretary of Transportation's responsibilities to "…establish requirements for the safe operation of such aircraft systems in the national airspace system." Section 333(c) Reform Act.

The name and address of the applicant is:

Unmanned Experts, Inc.
Drew A. Jurkofsky
720 S. Colorado Boulevard, Penthouse North
Denver, CO 80246
970-237-1902
drew.j@unmannedexperts.com

Regulations from which the exemption is requested:

14 CFR Part 21
14 CFR 45.23(b)
14 CFR 61.113(a) & (b)
14 CFR 91.7(a)
14 CFR 91.9(b)(2)
14 CFR 91.103

14 CFR 91.109
14 CFR 91.119
14 CFR 91.121
14 CFR 91.151(a)
14 CFR 91.203(a) & (b)
14 CFR 91.405(a)
14 CFR 407(a)(1)
14 CFR 409(a)(2)
14 CFR 417(a) & (b)

AUTHORITY FOR EXEMPTIONS

The Federal Aviation Act expressly grants the FAA authority to issue exemptions. This statutory authority includes exempting civil aircraft, as the term is defined under §40101 of the Act, including sUASs, from the requirement that all civil aircraft must have a current airworthiness certificate.

The Administrator may grant an exemption from a requirement of a regulation prescribed under subsection (a) or (b) of this section or any sections §44702-44716 of this title if the Administrator finds the exemption in the public interest. 49 USC §44701(f). See also 49 USC §44711(a); 49 USC §44704; 14 CFR 91.203(a)(1).

Section 333(b) of the Reform Act assist the Secretary in determining whether sUASs may operate in the national airspace system without creating a hazard to the user, the public, or a threat to national security. In making this determination, the Secretary must consider:

- The sUAS' size, weight, speed and operational capability;
- Whether the sUAS operates within the visual line of sight of the operator;
- Whether the sUAS operates outside of highly populated areas and away from close proximity to airports.

Reform Act 333(a). If the Secretary determines that a sUAS "may operate safely in the national airspace system, the Secretary shall establish requirements for the safe operation of such aircraft in the national airspace system." *Id*. 333(c).

The Aeryon SkyRanger is a multirotor aircraft weighing 6.5 pounds, including payload. It has the ability to operate under normal conditions at a speed of no more than 30 knots and has the capability to hover and move in the vertical and horizontal plane simultaneously. The sUAS will operate only in the pilot's or visual observer's visual line of sight at all times. Such operations will insure that the sUAS will "not create a hazard to users of the national airspace system or the public." Reform Act Section 333(b).

Given the small size of the sUAS involved and the restricted environment within which they will operate, our application falls squarely within the zone of safety (an equivalent level of safety) in which Congress envisioned that the FAA must, by exemption, allow commercial operations of sUASs to commence immediately. Also due to the small size of the UAS and the low altitudes in which our sUAS will operate, approval of the application presents no national security issue.

DESCRIPTION OF SPECIFIC REGULATIONS

14 CFR Part 21, Subpart H: Airworthiness certificates

Subpart H, establishes the procedural requirements for the issuance of airworthiness certificates as required by FAR §91.203(a)(1). Given the size and limited operating area associated with the aircraft to be utilized by Unmanned Experts, an exemption from Part 21 Subpart H meets the requirements of an equivalent level of safety under Part 11 and Section 333 of the Reform Act. The Federal Aviation Act (49 USC §44701(f)) and Section 333 of the Reform Act both authorize the FAA to exempt aircraft from the requirement for an airworthiness certificate, upon consideration of the size, weight, speed, operational capability and proximity to airports and populated areas of the particular sUAS. In all cases, an analysis of these criteria demonstrates that the sUAS operated without an airworthiness certificate, in the restricted environment and under the conditions proposed, will be at least as safe, or safer, than a conventional aircraft operating with an airworthiness certificate without the restrictions and conditions proposed.

14 CFR 45.23(b): Marking of the aircraft

This regulation requires that certain experimental, provisionally certified aircraft, or light-sport category aircraft to be marked with letters between 2 inches and 6 inches high “limited”, “restricted,” “light-sport,” “experimental,” or “provisional,” near each entrance to a cabin, cockpit or pilot station.

Even though the UAS will have no airworthiness certificate, an exemption may be needed as the sUAS will have no entrance to the cabin, cockpit or pilot station on which the word “Experimental” can be placed. Given the size of the sUAS, 2 inch lettering will be impossible. Unmanned Experts will mark the sUAS with the organization’s name and address. An insurance barcode attached to the aircraft will also be linked to Unmanned Experts.

14 CFR 61.113(a) & (b): Private pilot privileges and limitations: Pilot in command

Sections 61.113(a) and (b) limit private pilots to non-commercial operations. Because the sUAS will not carry a pilot or passengers, the proposed operations can achieve the equivalent level of safety of current operations by requiring the pilot operating the aircraft to have completed a UAS flight training course of 100 hours before flying a sUAS. Unlike a conventional aircraft that carries the pilot and passengers, the sUAS is remotely controlled with no living thing or cargo on board. The area of operation is controlled and restricted, and all flights are planned and coordinated in advance as set forth in the User Guide. The risks associated with the operation of the small UAS are so diminished from the level of risk associated with commercial operations contemplated by Part 61 when drafted, that allowing operations of the sUAS as requested exceeds the present level of safety achieved by 14 CFR 61.113(a) and (b).

14 CFR 91.7(a): Civil aircraft airworthiness

The regulation requires that no person may operate a civil aircraft unless it is in airworthy condition. As there will be no airworthiness certificate issued for the aircraft, should this exemption be granted, no FAA regulatory standard will exist for determining airworthiness. Given the size of the aircraft and the requirements contained in the User Guide for maintenance and use of safety checklists prior to each flight an equivalent level of safety will be provided.

14 CFR 91.9(b)(2): Civil aircraft flight manual, marking and placard requirements

The sUAS, given its size and configuration has no ability or place to carry such a flight manual on the aircraft, not only because there is no pilot on board, but because there is no room or capacity to carry such an item on the aircraft.

The equivalent level of safety will be maintained by keeping the User Manual at the ground control point where the pilot flying the sUAS will have immediate access to it.

14 CFR 91.103: Preflight action

This regulation requires each pilot in command take certain actions before flight to ensure the safety of flight. An exemption is needed from this requirement as the pilot will take separate preflight actions, including checking for weather conditions, checking flight battery requirements, checking takeoff and landing distances, and all other actions in the User Guide and safety checklists. These actions will provide an equivalent level of safety.

14 CFR 91.109: Flight instruction

Section 91.103 provides that no person may operate a civil aircraft (except a manned free balloon) that is being used for flight instruction unless that aircraft has fully functioning dual controls.

By design, sUASs and remotely piloted aircraft do not have fully functional dual controls. Flight control is accomplished through the use of a control box that communicates with the aircraft via radio communications. The equivalent level of safety is provided by the fact that neither a pilot nor passengers will be carried in the aircraft, the ability to control the sUAS via radio signals from the controller and by the size and speed of the aircraft.

14 CFR 91.119: Minimum safe altitudes

Section 91.119 establishes safe altitudes for operation of civil aircraft. Section 91.119(d) allows helicopters to be operated at less than the minimums prescribed, provided the person operating the helicopter complies with any route or altitudes prescribed for helicopters by the FAA. This exemption is for a multirotor craft that flies similarly to a helicopter, with vertical takeoff and vertical landing, which will typically operate at altitudes of 200 feet above ground level (AGL), so an exemption may be needed to allow such operations. The sUAS will never operate at altitude higher than 400 AGL and all operations will occur during daylight hours under Visual Meteorological Conditions (VMC) only.

The equivalent level of safety will be achieved given the size, weight and speed of the sUAS as well as the location where it is operated. No flight will be taken without the permission of the property owner or local officials. Because advance notice to the property owner and any onsite personnel, as well as the precautions outlined below, all affected individuals will be aware of the planned flight operations.

Flight operations will be conducted at least 500 feet from all non-participating persons (persons other than the pilot in command (PIC) or visual observer (VO)), vessels, vehicles and structures, unless:

1. Barriers or structures are present that sufficiently protect non-participating persons from debris in the event of an accident. The PIC will ensure that non-participating persons remain under such protection. If a situation arises where non-participating persons leave such

protection and are within 500 feet of the sUAS, flight operations will cease immediately and/or;

2. The aircraft is operated near vessels, vehicles or structures where the land owner/controller has granted permission and the PIC has made a safety assessment of the risk of operating closer to those objects and;

3. Operations near the PIC or VO do not present an undue hazard to the PIC or VO, per 14 CFR 91.119(a).

The sUAS will remain within visual line of sight of the PIC or VO. Flight operations will be conducted at least 5 miles from an airport and at least 3 miles from any city or densely populated area. The PIC or VO will provide notification to the local Flight Standards District Office and airport controller of all operations within 5 miles of an airport. The FAA will have advance notice of all operations through the filing of notices-to-airmen.

Compared to flight operations with aircraft or rotorcraft weighing far more than the sUAS proposed herein and carrying flammable fuel, any risk associated with our operations is far less than those presently presented with helicopters and other conventional aircraft operating at or below 500 feet AGL. In addition, the low-altitude operations of the sUAS will ensure separation between these UAS operations and the operations of conventional aircraft that must comply with Section 91.119.

14 CFR 91.121: Altimeter Settings

This regulation requires each person operating the aircraft to maintain cruising altitude by reference to an altimeter that is set "…to the elevation of the departure airport or an appropriate altimeter setting available before departure." As the sUAS may not have a barometric altimeter, but instead a GPS altitude read out, an exemption may be needed. An equivalent level of safety will be achieved by the PIC confirming the altitude of the launch site shown on the GPS altitude indicator before flight.

14 CFR 91.151(a): Fuel requirements for flight in VFR conditions

Section 91.151(a) outlines fuel requirements for beginning a flight in VFR conditions. Our sUAS is limited to operations in controlled environments and has a limited flight time which require an exemption from 14 CFR 91.151(a).

The battery powering the sUAS provides approximately 50 minutes of powered flight. To meet the 30 minute reserve requirement in 14 CFR 91.151, sUAS flights would be limited to approximately 20 minutes in length. Given the limitations on the sUAS's proposed flight area and the location of its proposed operations within a predetermined area, a longer time frame for flight in daylight VFR conditions is reasonable.

An equivalent level of safety can be achieved by limiting flights to 40 minutes, or enough battery reserve to ensure that the sUAS lands at the ground station with at least 20% of battery

power (as determined by the onboard monitoring system and the PIC), whichever happens first. This restriction would be more than adequate to return the sUAS to its planned landing zone from anywhere in its limited operating area.

14 CFR 91.203(a) & (b): Carrying civil aircraft certification and registration

The sUAS has no cabin, cockpit or pilot station and is operated without an onboard pilot. Therefore, there is no ability or place to carry certification and registration documents or to display them on the sUAS.

An equivalent level of safety will be achieved by keeping these documents at the ground control point where the pilot flying the sUAS will have immediate access to them, to the extent they are applicable to the sUAS.

14 CFR 91.405(a); 407(a)(1); 409(a)(2); 417(a) & (b): Maintenance inspections

These regulations require that an aircraft operator or owner "shall have that aircraft inspected as prescribed in subpart E of this part and shall between required inspections, except as provided in paragraph (c) of this section, have discrepancies repaired as prescribed in part 43 of this chapter…," and others shall inspect or maintain the aircraft in compliance with Part 43.

Given that these sections and Part 43 apply only to aircraft with an airworthiness certificate, these sections will not apply to Unmanned Experts. Maintenance will be accomplished by the operator pursuant to the User Guide. An equivalent level of safety will be achieved because these sUASs are very limited in size and will carry a small payload and operate only in restricted areas for limited periods of time. If mechanical issues arise, the sUAS can land immediately and will be operating from no higher than 400 feet AGL. As provided in the User Guide, the operator will ensure that the sUAS is in working order prior to initiating flight, perform required maintenance and keep a log of any maintenance performed. Moreover, the operator is the person most familiar with the aircraft and best suited to maintain the aircraft in an airworthy condition to provide the equivalent level of safety.

PUBLIC INTEREST

Approval of exemptions allowing commercial operations of sUASs for precision aerial surveys enhances safety while reducing risk. Manned aircraft monitoring and surveying creates a greater risk because the craft are much larger, have combustible fuel, and carry an onboard human pilot. In contrast, a sUAS weighing 6.5 pounds and powered by batteries eliminates virtually all of that risk given the reduced mass and lack of combustible fuel carried on board. The sUAS will carry no passengers or crew and, therefore, will not expose them to the risks associated with manned aircraft flights.

Conducting aerial surveys with the Aeryon SkyRanger, instead of manned aircraft, will greatly benefit the public by drastically reducing the levels of air and noise pollution generated during traditional aerial survey flight operations. By using battery power and electric motors, the

SkyRanger produces no air pollution and is a viable, environmentally conscious alternative to the cabin class, six cylinder internal combustion twin engine aircraft that are typically utilized for aerial surveys, while burning approximately 20-30 gallons per hour of leaded aviation fuel. The SkyRanger, while reducing the carbon footprint of aerial surveys, also reduces noise pollution as the sUAS is propelled by battery powered electric motors rather than an internal combustion engine.

EQUIVALENT LEVEL OF SAFETY

Unmanned Experts proposes that the exemption requested herein apply to civil aircraft that have the characteristics and that operate within the limitations listed herein. These limitations provide for at least an equivalent or even higher level of safety to operations under the current regulatory structure because the proposed operations represent a safety enhancement to the already safe protocols followed by aerial survey operations conducted with helicopters and other conventional aircraft.

Unmanned Experts will be bound by the following limitations when conducting its sUAS operations under an FAA issued exemption:

1. The sUAS will weigh less than 6.5 pounds.
2. Flights will be operated within line of sight of a pilot and/or observer.
3. Maximum total flight time for each operational flight will be 40 minutes. Flights will be terminated at 20% battery power reserve should that occur prior to the 40 minute limit.
4. Flights will be operated at an altitude of no more than 400 feet AGL.
5. Flight operations will be conducted 5 miles from an airport and at least 3 miles from any city or densely populated area, which are depicted in yellow on VFR sectional charts.
6. Flight operations within 5 miles of an airport require notification and approval from the local Flight Standards District Office and airport controller.
7. Flight operations will occur during daylight hours and under visual meteorological conditions only.
8. The FAA will have advance notice of all operations through the filing of notices-to-airmen.
9. Minimum crew for each operation will consist of the sUAS pilot and visual observer.
10. The sUAS pilot will be an FAA licensed airman with at least a private pilot's certificate and third class medical.
11. The pilot and visual observer will have been trained in the operation of the sUAS.
12. The pilot and visual observer will at all times be able to communicate by voice and/or text.
13. Written and/or oral permission from the relevant property holders will be obtained.
14. Flight operations will be conducted at least 500 feet from all non-participating persons, vessels, vehicles and structures unless:
    a. Barriers or structures are present that sufficiently protect non-participating persons from debris in the event of an accident. The pilot will ensure that non-participating persons remain under such protection. If a situation arises where non-participating

persons leave such protection and are within 500 feet of the sUAS, flight operations will cease immediately and/or;

b. The aircraft is operated near vessels, vehicles or structures where the land owner/controller has granted permission and the PIC has made a safety assessment of the risk of operating closer to those objects and;
c. Operations near the pilot or visual observer do not present an undue hazard to the pilot or visual observer.

15. If the sUAS loses communication or loses its GPS signal, the sUAS will have the capability to return to a safe, pre-determined location and land.
16. The sUAS will have the capability to abort flight in case of unpredicted obstacles or emergencies.

PRIVACY

All flights will occur over private or controlled access property with the property owner's prior consent and knowledge. Images taken will be of individuals who have also consented to being filmed or otherwise have agreed to be in the area where aerial photography will take place.

Federal Register Summary

Mr. Drew A. Jurkofsky, Aerial Photogrammetrist and Mapping Specialist, Unmanned Experts, Inc., 720 S. Colorado Boulevard, Penthouse North, Denver, Colorado 80246, petitioned the FAA on behalf of Unmanned Experts, Inc. (Unmanned Experts) for an exemption from part 21 and §§ 45.23(b), 61.113(a) and (b), 91.7(a), 91.9(b)(2), 91.103, 91.109, 91.119, 91.121, 91.151(a), 91.203(a) and (b), 91.405(a), 407(a)(1), 409(a)(2), 417(a) and (b) of Title 14, Code of the Federal Regulations (14 CFR). The exemption would allow commercial operation of Aeryon SkyRanger small Unmanned Aircraft Systems (sUASs) for precision aerial surveys.

****

Satisfaction of the criteria provided in Section 333 of the Reform Act of 2012 – size, weight, speed, operating capabilities, proximity to airports and populated areas and operation within visual line of sight and national security – provide more than adequate justification for the grant of the requested exemptions allowing commercial operation of Unmanned Experts' sUAS for precision aerial surveys.

Sincerely,

Drew A. Jurkofsky
Unmanned Experts, Inc.
Aerial Photogrammetrist and Mapping Specialist

Appendix D

Pre Site Survey Brief

Unmanned Experts Inc.

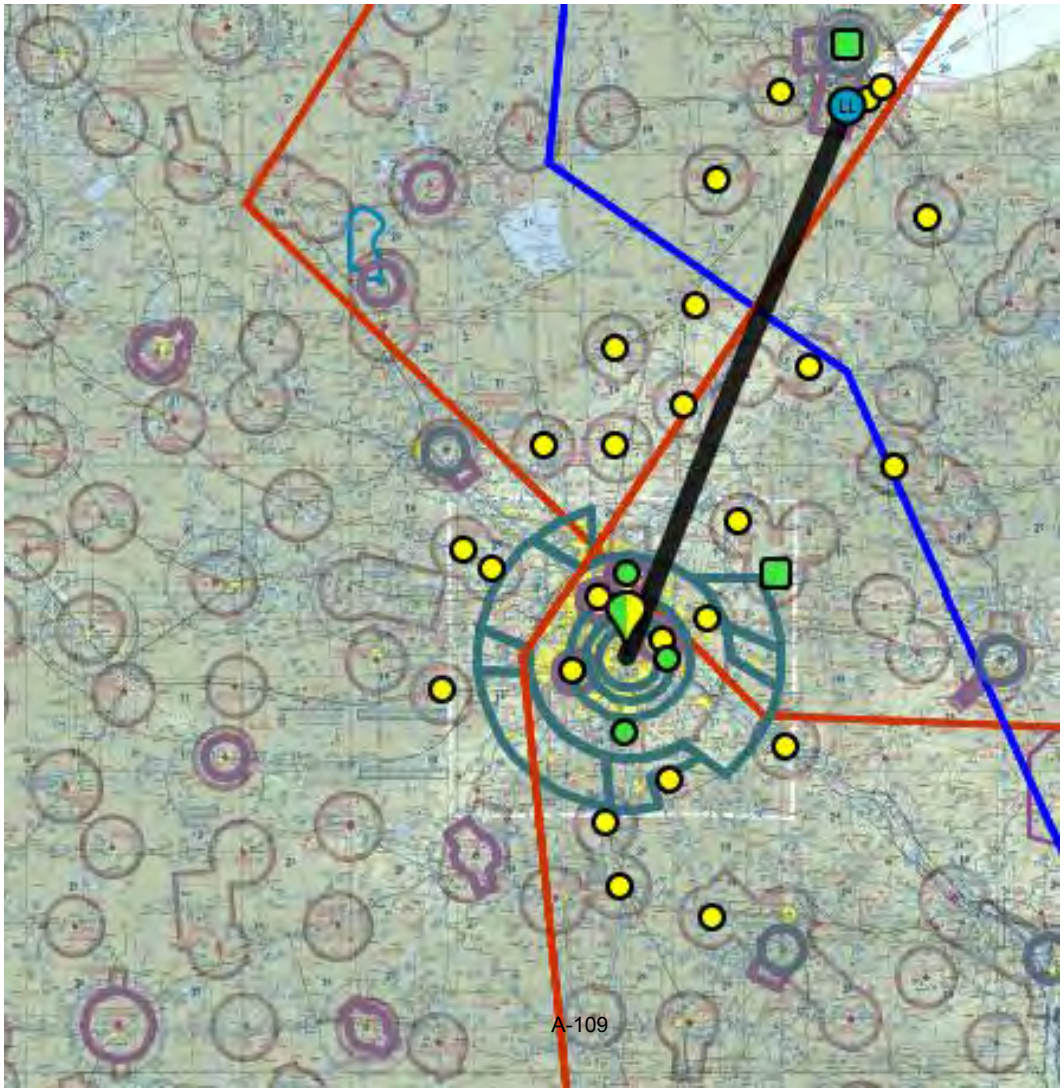
Minnesota DOT

Bridge Inspection Pilot

PRE SITE SURVEY BRIEF

UNMANNED EXPERTS

Airspace Overview



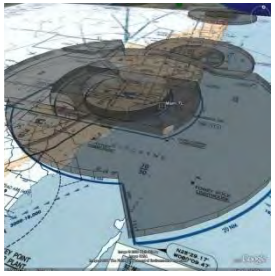
Area Overview & Sites

Google Earth

UNMANNED EXPERTS

Chisago County Bridge

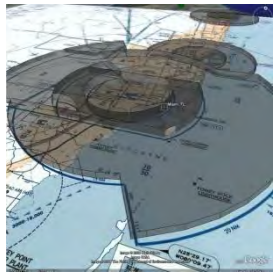
13509

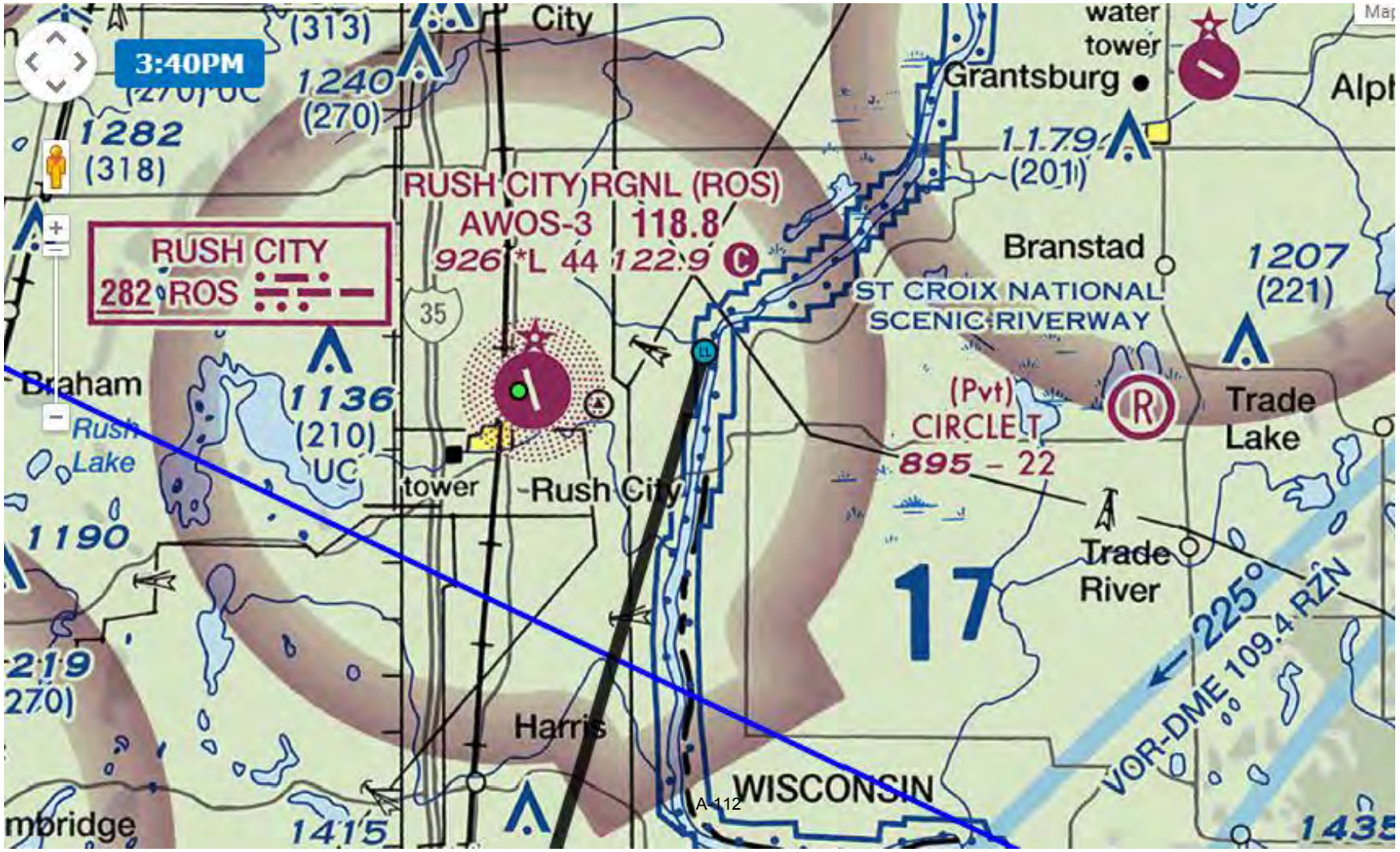


UNMANNED EXPERTS

Chisago County Bridge

13509





UNMANNED EXPERTS

Chisago County Bridge

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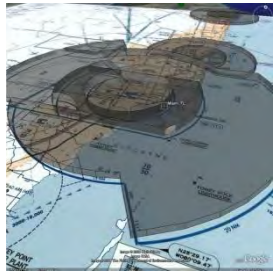
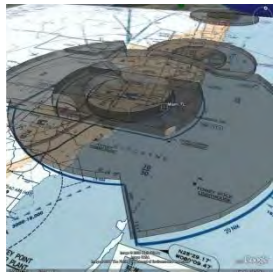


UNMANNED EXPERTS

Assessment Form

Chisago County Bridge



	Color	New 333 COA regs	COA?
• Airspace:		E (Rush City) 3NM W	
• ATC:		Rush City (118.8)	
• Terrain:		Narrow River, Wooded	
• Hazards:		Elec Tx lines E, N and W	
• Restrictions:		WI border 1 NM E	
• Sensitivities:		UNK	
• RF Issues:		UNK	
• People:		Light Road traffic	
• Livestock:		UNK	
• Rights of Way:		MNDOT / NPS	
• Cordons:		Possible	
• Permissions:		ATC LOA/ NPS	
• Alternates:		NOTAM, Time, Location, Handhelds	

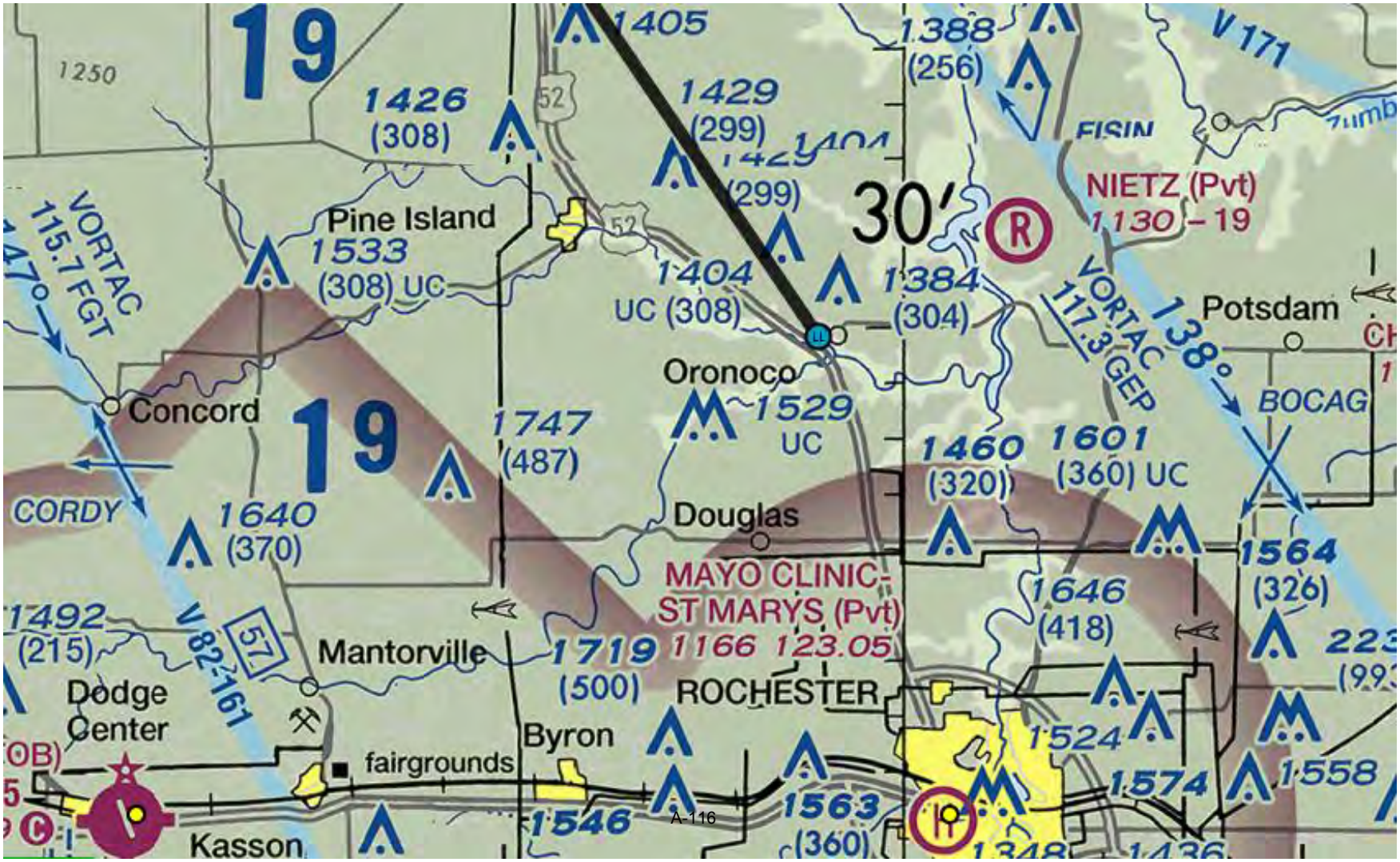
UNMANNED EXPERTS

Oronoco Bridge

448

UNMANNED EXPERTS

Oronoco Bridge



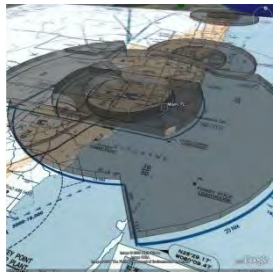
UNMANNED EXPERTS

Oronoco Bridge

UNMANNED EXPERTS

Assessment Form

Orinoco Bridge, MN

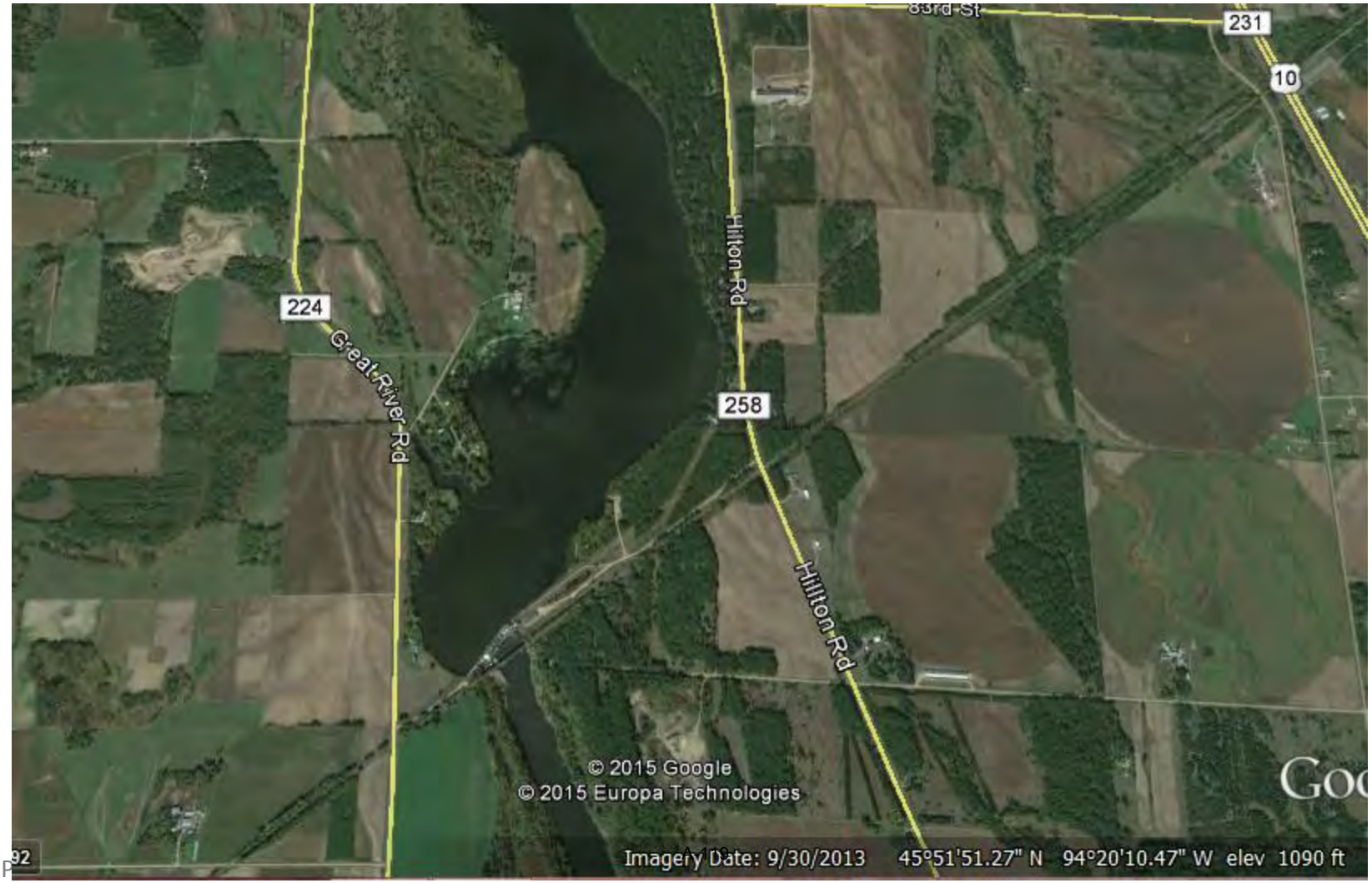


	Color	New 333 COA regs	COA?
• Airspace:		G with E (Rochester) 2NM Sth	
• ATC:		Nietz (Pvt) 3NM NE, Rochester 8NM Sth	
• Terrain:		1000’ and in Valley	
• Hazards:		Power lines to East, trees	
• Restrictions:		Nil	
• Sensitivities:		Local Populace	
• RF Issues:		UNK	
• People:		Houses, Fishermen	
• Livestock:		UNK	
• Rights of Way:		DOT?	
• Cordons:		Likely	
• Permissions:		MNDOT	
• Alternates:		Boat, Landing to NW	

UNMANNED EXPERTS

Little Falls Bridge

49553



UNMANNED EXPERTS

Little Falls Bridge

49553

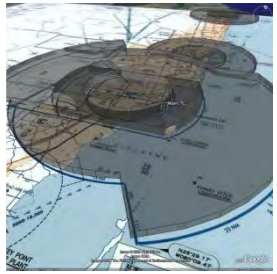
UNMANNED EXPERTS

Little Falls Bridge

49553

Assessment Form

Little Falls Bridge

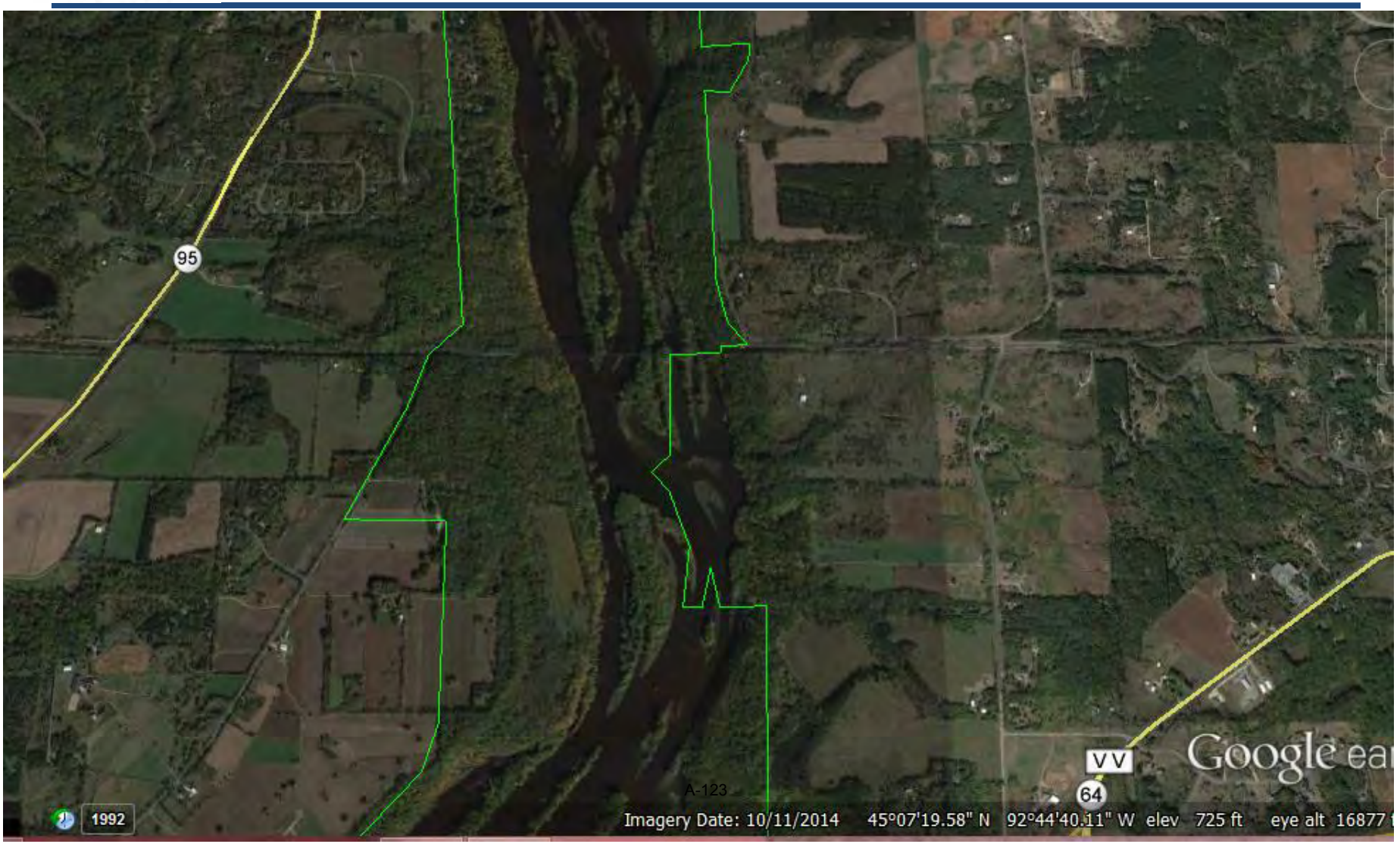


	Color	New 333 COA regs	COA?
• Airspace:		E (Little Falls) 3NM N	
• ATC:		Little Falls (119.45) and Fussy (Pvt) 2NM S	
• Terrain:		River, Dam, Wooded	
• Hazards:		Elec Tx lines	
• Restrictions:		Substation?	
• Sensitivities:		UNK	
• RF Issues:		UNK	
• People:		Fishermen, Dam workers?	
• Livestock:		UNK	
• Rights of Way:		Power company?	
• Cordons:		Possible	
• Permissions:		ATC, Power Company	
• Alternates:		Risk Mitigate, Time, Location, Handheld, Boats?	

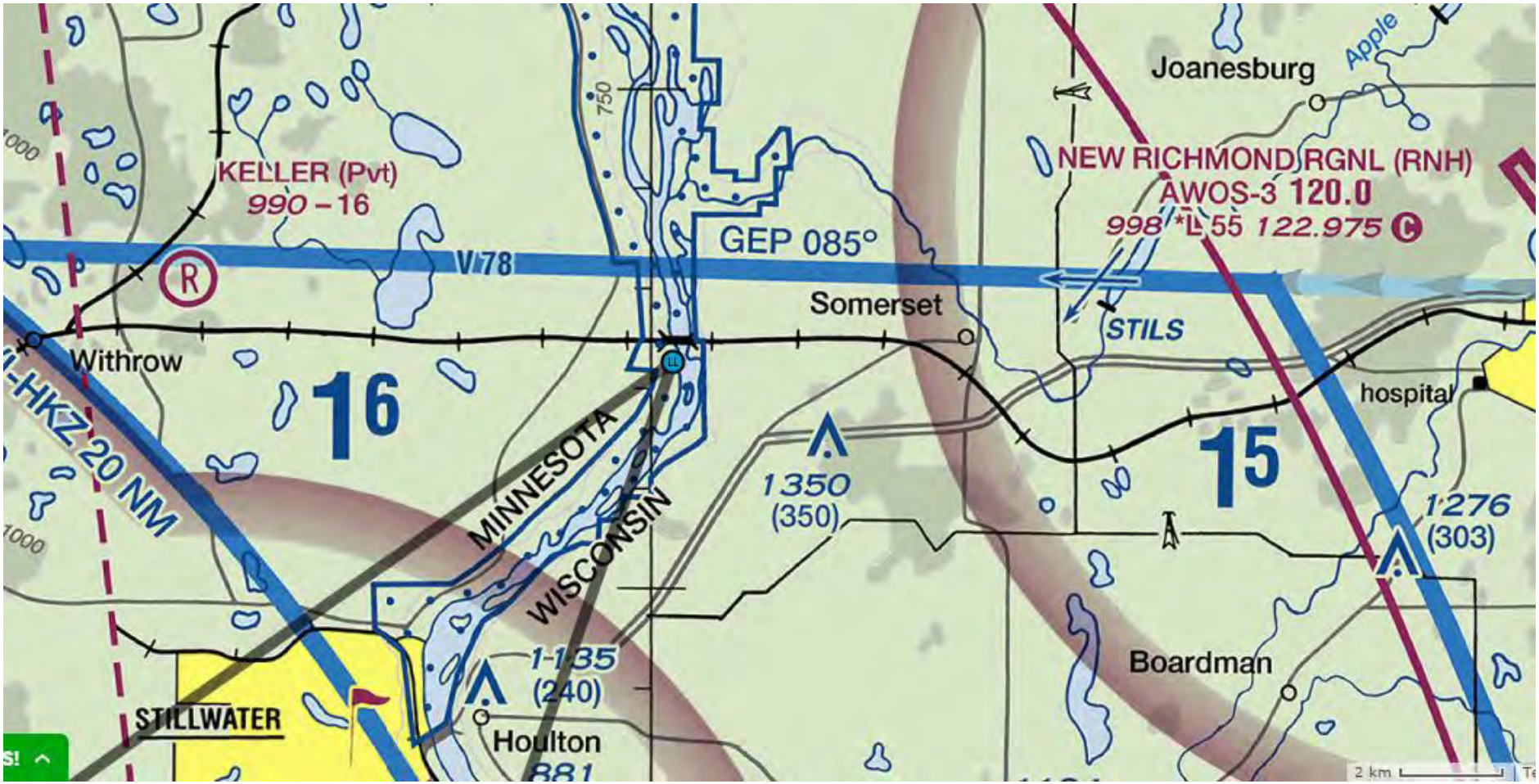
UNMANNED EXPERTS

Arcola RR Bridge

Nr Stillwater / Somerset



Arcola RR Bridge



UNMANNED EXPERTS

RR Bridge

Arcola

Assessment Form

Arcola RR Bridge, MN

	Color	New 333 COA regs	COA?
• Airspace:		G but E (New Richmd) 3NM E / E (Lake Elmo) 3NM SW	
• ATC:		V78 - 1 NM North? / Keller airfield (pvt) 5NM W	
• Terrain:		150’ river gorge and wooded (old imagery)	
• Hazards:		Nil	
• Restrictions:		WI border mid river / NPS land	
• Sensitivities:		UNK	
• RF Issues:		UNK	
• People:		Fishermen?	
• Livestock:		UNK	
• Rights of Way:		Railroad / NPS	
• Cordons:		Unlikely	
• Permissions:		CN Railway Inspection Mgr / NPS	
• Alternates:		Boat, on bridge? Train schedule?	

UNMANNED EXPERTS

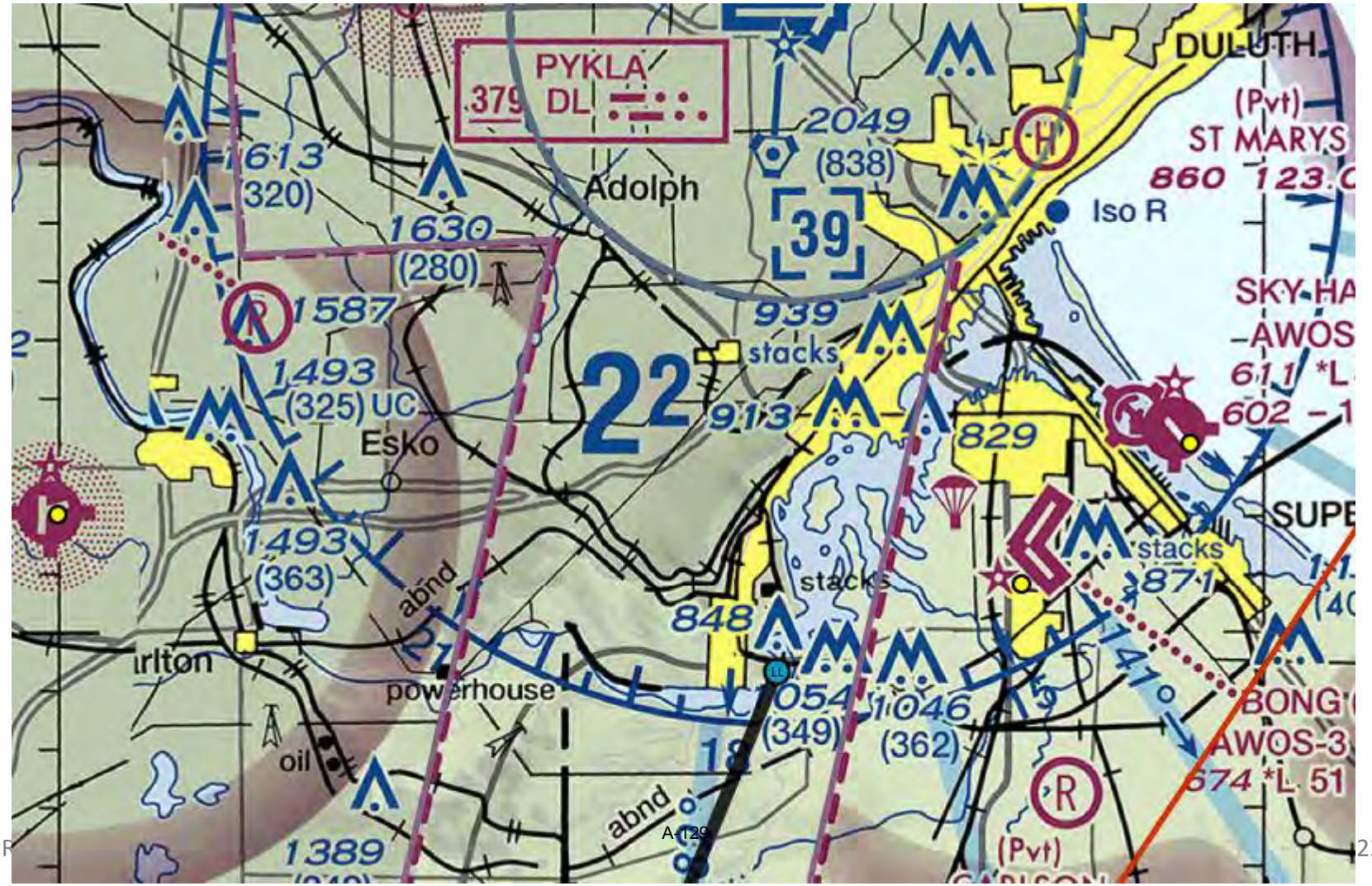
Oliver Bridge

UNMANNED EXPERTS

Oliver Bridge, Duluth

UNMANNED EXPERTS

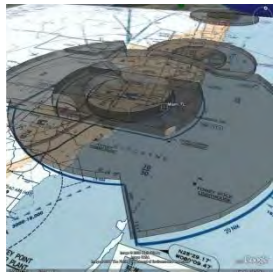
Oliver Bridge



UNMANNED EXPERTS

Assessment Form

Oliver Bridge, Duluth



	Color	New 333 COA regs	COA?
• Airspace:		Class E (Duluth) also close to Bong (SUW): need LOAs	
• ATC:		DLH 9NM Nth (Twr 118.3), Bong + Para 4NM NE (120.35)	
• Terrain:		Swamp to W (MN). 150m River (80m to WI border)	
• Hazards:		Pylons to N and E (400')	
• Restrictions:		WI Border, checking with NPS	
• Sensitivities:		Houses on E bank	
• RF Issues:		UNK	
• People:		Old maps so UNK on W bank, fishermen?	
• Livestock:		UNK	
• Rights of Way:		UNK	
• Cordons:		Heavy road traffic, but covered bridge	
• Permissions:		ATC LOAs	
• Alternates:		Stand-off, under bridge	

Suggestions

- Chisago Co Bridge
  - ATC LOA (Rush City)
- Arcola RR Bridge
  - ATC LOA (Lake Elmo)
  - RR Permit
- Oronoco
- Little Falls County
  - ATC LOA (little Falls)
- Oliver Bridge
  - ATC LOA (Duluth)

Likely Issues

- As Assessed

End of Brief

Contact Us

Contact us via any of the media below.

Our UAV consultants are available and will immediately begin helping you define your UAS/RPAS requirements and start to fulfill them.

Telephone: +1 (334) 578 2900

Fax: +1 (334) 460 8111

operations@unmannedexperts.com

www.unmannedexperts.com

We look forward to working with you.

This a time of great opportunity in the unmanned sector, let us help you seize it.

APPENDIX B
UAV Product Information

Aeryon SkyRanger™

THE BENCHMARK IN VTOL sUAS FLIGHT PERFORMANCE, RELIABILITY AND EASE-OF-USE

Field-tested and battle-proven, Aeryon small UAS set the standard for immediate aerial intelligence gathering by **ANYONE**, **ANYWHERE**, at **ANYTIME**:

+ Intuitive touchscreen interface and advanced features, minimal user training
+ Single operator transport and deployment, no launch or recovery equipment
+ Reliable flight performance even in the most demanding weather conditions, when other systems cannot fly

The **Aeryon SkyRanger™** introduces a new airframe and integrated system design to the Aeryon sUAS platform, based on thousands of hours of flight time and successful customer exercises and missions around the world. Designed to military and government specifications, **SkyRanger™** extends industry-leading performance and system capabilities.

Intuitive interface and autonomous capabilities – no joysticks required

+ Point-and-click touchscreen navigation and camera control
+ Dynamic flight plans including Follow-Me™ protection and AutoGrid™ mapping modes

Pre-assembled deployment – airborne in seconds

+ Folding design protects payload & includes battery for powered standby
+ Payload, battery, arms and legs are easily replaced in the field without tools

Advanced optics and networking – smart imagery and seamless integration

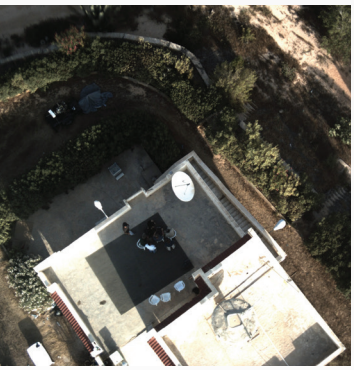
+ Stabilized, simultaneously-streaming dual EO/IR high resolution cameras
  - EO: 1080p24 HD H.264 video, 15MP still images
  - IR: 640x480 H.264 video and still images, white-hot and black-hot modes
+ Low-latency all-digital network – 256bit AES encrypted streaming video to multiple devices, embedded geotags and metadata
+ Beyond line-of-sight range – 1.9 mi (3 km) integrated capability, extensible beyond 3.1 mi (5 km)

Rugged, reliable and capable – dependable in extreme environments

+ Up to 50-minute endurance with payload, continuous operation model
+ High wind tolerance
  - 40 mph (65 kph) sustained
  - 55 mph (90 kph) gusts
+ Ruggedized and weather-sealed
+ Environmental temperature range -22°F to 122°F (-30°C to 50°C)

Aeryon Labs Inc.

MILITARY & GOVERNMENT APPLICATIONS



The Aeryon sUAS platform brings secure, real-time and simultaneous tactical situational awareness to ground forces and remote command. Advanced autonomous capabilities and simple touchscreen controls require minimal training for soldier, squad, or platoon-level deployment.

Unlike fixed-wing systems, the **Aeryon SkyRanger™** is a Vertical Take-Off and Landing (VTOL) sUAS – ideal for providing continuous eyes-on-target for situational awareness, operations in confined environments, and low-risk launch and retrieval without peripheral equipment. **SkyRanger™** is ideally suited for both land and maritime military use including covert ISR, convoy and compound security, and ship boarding operations.

Immediate deployment, small size, quiet operation and specialized imaging payloads make **SkyRanger™** the ideal platform for a wide range of missions in any conditions, including:

+ Tactical situational awareness & targeting
+ Perimeter & convoy security
+ Covert Intelligence, Surveillance and Reconnaissance (ISR)
+ Anti-piracy, tactical ship boarding
+ De-mining
+ Emergency & disaster response
+ HAZMAT/CBRNE management

For information about Aeryon sUAS solutions, contact your Aeryon Sales Representative:

Call +1-519-489-6726 ext: 320 or email sales@aeryon.com
www.aeryon.com | @aeryonlabs

TECHNICAL **SPECIFICATIONS:**

ENDURANCE:
- Up to 50-minute flight time (with payload)

WIND TOLERANCE:
- 40 mph (65 kph) sustained
- 55 mph (90 kph) gusts

ENVIRONMENTAL TEMPERATURE RANGE:
- -22°F to –122°F (-30°C to 50°C)

BEYOND LINE-OF-SIGHT RANGE:
- 1.9 mi (3 km) integrated capability
- Extensible beyond 3.1 mi (5 km)

ALTITUDE:
- 1500 ft. (450 m) AGL, 15000 ft. (4500 m) MSL

LAUNCH & RECOVERY METHOD:
- Vertical Take-Off and Landing (VTOL)

DIMENSIONS:
- **Deployed**: 40 in. (102 cm) diameter, 9.3 in. (24 cm) height
- **Folded**: 20 in. (50 cm) length, 10 in. (25 cm) width

WEIGHT (WITHOUT PAYLOAD):
- 5.3 lbs (2.4 kg)

ADDITIONAL PAYLOADS:
- 3-axis stabilized high resolution EO camera
- Custom payload development

NAVIGATION LEDS:
- Red/Green and Red/NIR

RADIO FREQUENCIES:
- 900 mhz, 2.4 GHz, custom

CONTROL AND DATA LINK:
- Low-latency all-digital network

SECURITY:
- Secure network pairing, AES 256 bit encryption

eXom

senseFly

The intelligent **mapping**
& **inspection** drone

B-3

3 reasons to choose eXom

- **1 flight, 3 types of imagery**

  eXom can capture and geotag video, still and thermal imagery, all during the same flight, without landing to change cameras.

- **Advanced situational awareness**

  Five dual sensor modules, positioned around the drone, enable eXom to get safely up close to structures and surfaces in order to achieve sub-millimetre image resolutions.

- **Choose your flight mode**

  eXom offers full flight mode flexibility. Choose between an autonomous, GPS-guided mission or a live-streaming interactive flight, or start in autonomous mode and 'go live' on demand.

Choose the flight mode that suits your project

Fully autonomous mode

Already know the specific structure or site you want to map?

- Specify your area/object of interest in eXom's eMotion software
- eMotion automatically creates a GPS waypoint-based flight plan
- eXom takes off, flies, acquires imagery & lands itself
- View eXom's live video stream during flight
- Imagery is stored on eXom's SD card for further post-flight analysis
- Use Postflight Terra 3D software (supplied) to create highly accurate 2D maps & 3D models

Interactive ScreenFly mode

Need to perform a live inspection?

· Take-off in interactive mode (or switch into this during an autonomous flight)

· 'See what eXom sees' on-screen via its multiple live video feeds

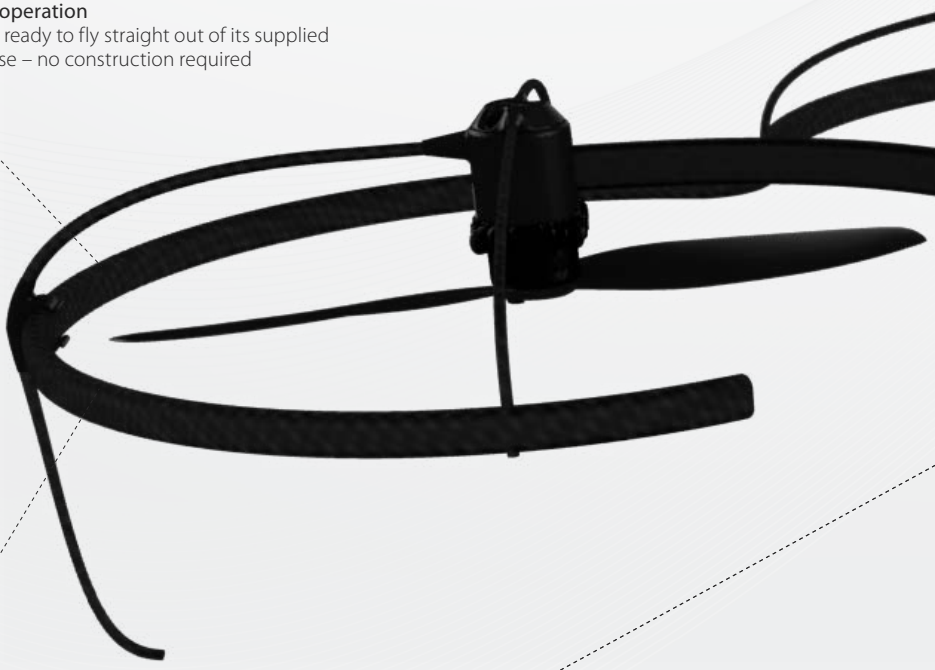
· Centre eXom's cameras on a target

· Capture high-res still images on demand

TripleView sensor head
This fully stabilised unit provides three distinct types of imagery: HD video, thermal video/stills, and high-resolution still images.

- Thermal camera
- Main camera (HD video/high-res still camera)
- Headlamp
- Head navcam (Wide-angle video camera)
- Ultrasonic transmitter
- Ultrasonic receiver

Instant operation
eXom is ready to fly straight out of its supplied carry case – no construction required



Safety smart
Numerous self-monitoring & automated failsafe procedures reduce the risk of inflight issues, minimising potential danger to structures, people & the eXom airframe

Close-object operation
Advanced situational awareness, obstacle avoidance & flight stabilisation enabled by:
· 5 ultrasonic sensors
· 5 navcams (visual sensors)

Onboard eXom

eXom is a sensor-rich system with the widest payload breadth of any civilian drone. Its stabilised TripleView sensor head allows you to examine high-definition video and thermal video imagery, live during your flight, and capture high-resolution still images on demand. All saved and accessible post-flight, and all without landing to change payloads.

Electric powered
Low noise, no pollution, and easy battery swapping for prolonged use

Live feedback
See what eXom sees via its front-facing wide-angle navcam

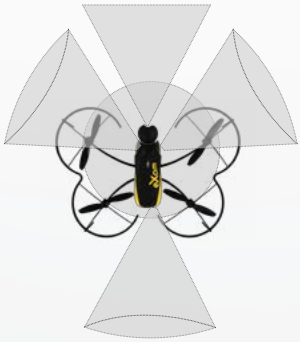
Leading autopilot technology
The artificial intelligence built into the senseFly autopilot analyses a raft of data to optimise every aspect of your flight

Safety smart
eXom's shock-absorbent carbon fibre shrouding fully protects the drone in case of surface contact

Multi-directional sensor intelligence

Navcams

Ultrasonic sensors

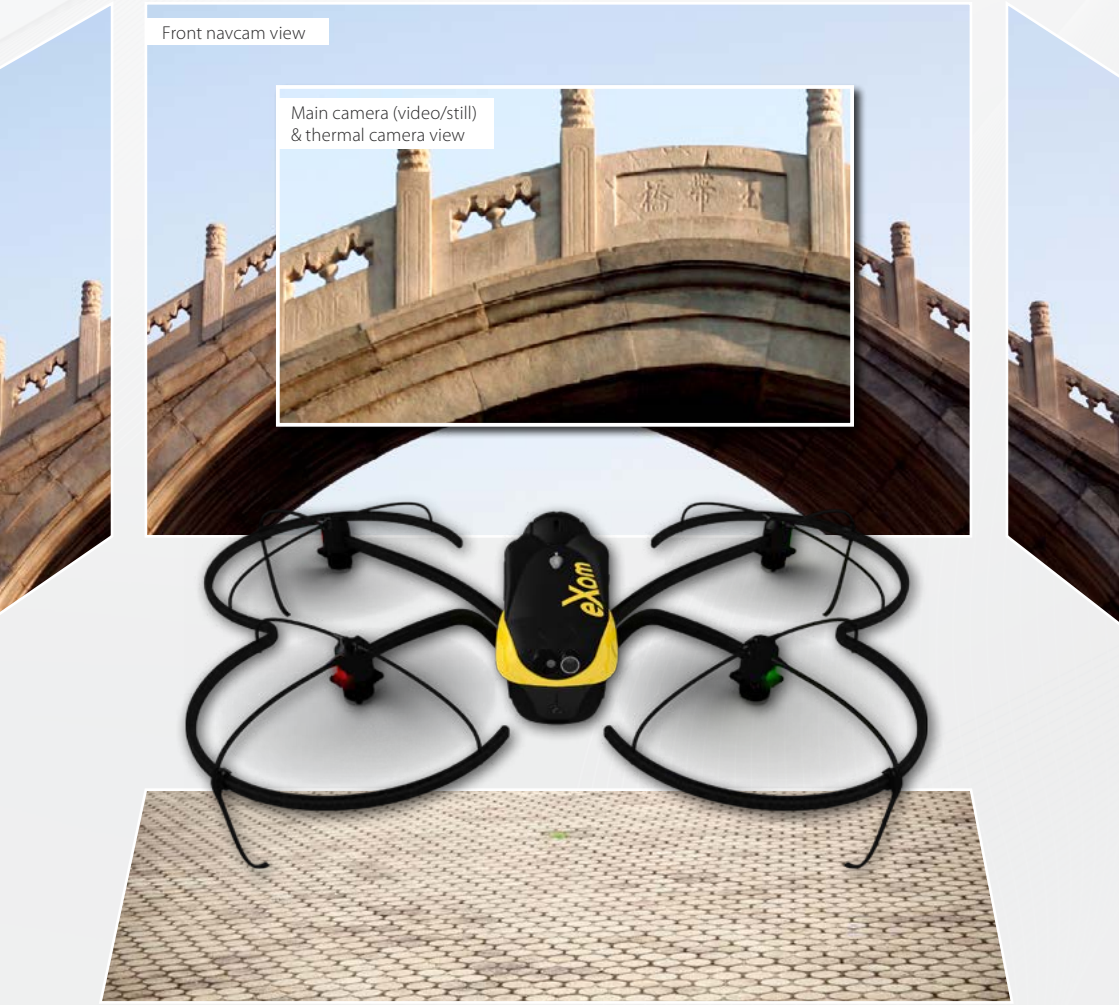


Head position	Navigate, avoid obstacles, see what eXom sees
Left/Right	Navigate, avoid obstacles, see side views
Bottom	Navigate, avoid obstacles, land autonomously
Rear	Navigate, avoid obstacles, backup safely

Advanced situational awareness

eXom is designed from the ground up to permit the safe inspection of buildings and other structures. The drone's five sensor modules, positioned around the aircraft, each feature a navcam and an ultrasonic sensor.

These sensors feed cutting-edge computer vision algorithms, which provide the situational awareness and object avoidance intelligence eXom needs to make every project a success.



Inspection

Examine and document surfaces and objects in high-resolution, in real-time

3D modelling

Capture high-resolution aerial imagery you can transform into full 3D and thermal models of buildings and small/medium-sized infrastructure

High-resolution mapping

Create high-resolution 2D and 3D maps, or complement fixed-wing drone data by mapping a site's highly inclined and vertical surfaces

Plus…

Crack/defect detection

Pipe & wind turbine inspection

3D modelling of structures/buildings

Agricultural & archaeological mapping

Aerial surveillance

Plant inspection & documentation

Heat distribution mapping

Solar field thermography

First responder assessment

Construction monitoring

Stockpile assessment

Conservation & environmental management

… and much more.

Flight system

Type	V-shaped quadcopter
Dimensions (incl. shrouding)	56 x 80 x 17 cm (22 x 32 x 7 in)
Engines	4 electric brushless motors
Propellers	4
Take-off weight	1.7 kg (3.7 lb) incl. battery, payload & shrouding
Flight time (full system)	Up to 22 min
Max. climb rate	7 m/s (15 mph)
Max. airspeed	Automatic flight: 8 m/s (18 mph) Manual flight:12 m/s (27 mph)
Wind resistance	Automatic: up to 8 m/s (18 mph) Manual: up to 10 m/s (22 mph)
Autopilot & control	IMU, magnetometer, barometer & GPS
Materials	Composite body, moulded carbon fibre arms and legs, precision-molded magnesium frame, precision-molded injected plastic
Operating temperature	-10 to 40º C (14º-104º F)

Wireless communication

Main communication link

Type	Digital, dual omnidirectional antennas, dual band, encrypted
Frequency	2.4 GHz & 5 GHz ISM bands (country dependent)
Data transmitted	Commands, main camera stream, navcam stream, sensor data, etc.
Range	Up to 2 km (1.2 mi)

RC (Remote control)

Type	Digital
Frequency	2.4 GHz
Range	Up to 800 m (0.5 mi)

System power

Technology	Smart battery
Type	LiPo, 3 cell, 8500 mAh
Power level display	LED display on battery, on-screen information
Charging time	1 - 1.5 h

Integrated payloads

TripleView head

Main camera

Still images	38 MP, mechanical shutter DNG (RAW image with correction metadata) Ground sampling distance (GSD): - 1 mm/pixel at 6 m - 1 cm/pixel at 60 m Recorded on board Geo-referenced (position & orientation)
Video	HD (1280 x 720 pixels) Recorded on board or streamed
Horizontal field of view	63 degrees
Digital zoom	6x

Thermal camera

Still images/video	Thermal (80 x 60 pixels) overlaid on main camera stream
Horizontal field of view	50 degrees
Edge enhancement	Yes

Head navcam (visual sensor)

Video	VGA (640 x 480 pixels)
Video live streaming range	Up to 2 km (1.24 miles)
Horizontal field of view	100 degrees

Lights

Headlamp	Yes, used for video
Flash	Yes (not active upon release)

Additional navcams (visual sensors)

Number	4 navcams
Positions	Left, right, rear, bottom
Video	VGA (640 x 480 pixels)
Horizontal field of view	100 degrees
Availability	One navcam at a time
Operational use	Side views (w/o turning main camera) & parallel flight along objects Back-up safely & control in tight environments Landing & ground proximity

Flight modes

Types	Automatic Interactive ScreenFly Manual (RC)
Availability	Switch between modes at any time

Automatic

Control interface	Mouse, keyboard or touchscreen
Mission planning	Drag-and-drop mission blocks
Types of mission blocks	Horizontal mapping Around point of interest User-defined route
In-flight mission changes	Yes: manual waypoint changes and updates possible at any time

Interactive ScreenFly

Primary control interface	Screen-based actions & USB joypad
Flight assistance (depending on the flight phase)	Cruise control Distance lock Obstacle avoidance

Manual (RC)

Primary control interface	RC (remote control)

On-board computing

Type	4 on-board CPUs
Quad-core processor	Principal autopilot & artificial intelligence
Dual-core processor	Video co-processing
Single-core processor	Low-level autopilot (safety fallback) and motor control
Single-core processor	Communication link management

Situational awareness & assistance

Multidirectional video feed

Source	Navcams (visual sensor)
Number	5
Video	VGA (640 x 480 pixels)
Horizontal field of view	100 degrees
Availability	One navcam at a time

Object & range detection

Sensor	Ultrasonic
Number	5
Range	Up to 6 m (20 ft)
Feedback	Audio and visual object warning

Operational safety

Shrouding

Material	Carbon fibre
Function	Defines propeller rotation area Protects from damage at low speed

Signalisation lights

Navigation lights	2 green on the right, 2 red on the left
Anti-collision lights	1 top strobe, 1 bottom strobe

Ground proximity detection

Avoidance procedure	Automatic stop (can be deactivated)
Warning signals	Audio & visual

Flight assistance features (Interactive mode)

Cruise control	Maintains (low) constant speed in a given direction
Distance lock	Keeps distance to frontal objects 3 - 5 m (9.8 – 16 ft)
Obstacle avoidance	Depending on flight phase

Safety procedures

Automated failsafe behaviours	Geofencing, return home, emergency stop, emergency landing
Operator triggered	Hold position, return home, go land, land now, emergency motor cut-off

Autopilot fallback

Type	Independent low-level autopilot (backup for main autopilot)
Manual RC control	Independent RC controller (take manual control at any time)

Ground station software

Software application	senseFly eMotion X (supplied)
Mission planning	Intuitive 3D user interface Click and drag to set mission blocks Automatic 3D flight planning Edit mission plans during flight
Flying	Automated system checks Automated take-off & landing Real-time flight status Main camera video feed integration Thermal video feed integration Navcam video feed integration Fully automatic flight Interactive ScreenFly Manual flight (with assistance functions) In-flight switch between flight modes Black-box recording of all flight & mission parameters
After your flight	Project & data management Seamless interface to Postflight Terra 3D DNG to JPEG conversion

Image processing

Software application	Postflight Terra 3D (supplied)
Processing	Rapid Check processing Quality Report Automatic Aerial Triangulation (AAT) and Bundle Block Adjustment (BBA) Automatic point cloud classification and DTM extraction Point cloud filtering and smoothing Automatic brightness and colour correction
rayCloud Editor	Point cloud viewing & editing Polyline, surface & stockpile measurement Digitisation tools/vector object editing Fly-through animation
Mosaic Editor	Seamline editing Planar/ortho projection selection Mosaic colour/brightness editing
Output results	2D and 3D (orthoimage, point cloud, vector data, etc.) Optimised camera position, external orientation and internal parameters, undistorted images

senseFly
a Parrot company

About senseFly: At senseFly we develop and produce aerial imaging drones for professional applications. Safe, light and easy to use, these tools are employed by customers around the world in fields such as surveying, agriculture, GIS, industrial inspection, mining and more.

How to order your eXom? Visit www.sensefly.com/about/where-to-buy to locate your nearest distributor.

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APPENDIX C
NTSB UAS Events Spreadsheet

This list will be periodically updated, it should contain all NTSB numbered events. There are many UAS events that we know about but are not NTSB investigations for various reasons - usually because they are either military or hobby/recreational (ostensibly). I will add them and more details as appropriate.

Date	Location	Operator	Type	Case #	Level of Invest	Main circumstances	Notes
4/24/2006	Nogales, AZ	CBP	MQ-9	CHI06MA121	Major, board meeting	Lost link, console lock up	Numerous recommendations to CBP and FAA
8/24/2007	Whetstone AZ	Raytheon	Cobra	SEA07IA237	Limited	Mode confusion in landing pattern	Reclass to IA following 2010 reg change
7/28/2008	Colorado Springs	Raytheon	Cobra	DEN08IA130	Limited	Collision with object during demo	Reclass to IA following 2010 reg change
9/24/2008	Whetstone , Az	Raytheon	Cobra	DEN08IA160	Limited	Engine failure	Reclass to IA following 2010 reg change
11/6/2008	Sierra Vista, AZ	CBP	MQ-9	DCA09FA009	Field	Hard landing during training	
2/19/2009	Sierra Vista, AZ	CBP	MQ-9	DCA09FA028	Field	Hard landing during training	
12/14/2010	El Paso, TX	Mexican Fed Police	Orbiter	DCA11SA012	Limited	Lost GPS, parachute deployed, crossed border	Security sensitive
12/19/2011	McMurdo, ANT	Univ of Kansas	Meridian	DCA12CA023	Limited	Mode confusion in landing pattern	Large fixed wing aircraft, no COAs
5/10/2013	Cocoa Beach, Fl	CBP	MQ-9	DCA13CA088	C-case	Hard landing	Same aircraft as DCA09FA009 following Mariner conversion
7/26/2013	Oliktok, AK	NASA	SIERRA	DCA13CA172	C-case	Carb icing, mission pressure	Full mishap report by NASA. >300lbs

8/24/2013	Dinwiddie, VA	Scott Hansen	DJI	DCA13SA139	Data gathering	Battery exhaustion	"Running of the Bulls" crash into crowd, probably illegal commercial operation. Injuries minor.
8/26/2013	Watts Bridge, QN	Insitu	Scan Eagle	DCA13SA140	None	Engine failure	Plan to **drop file** as it was found to be operating as contract under **foreign military**
9/13/2013	Chuchki, AK	Conoco/Insitu (EXP)	Scan Eagle	DCA13SA151	Data gathering	Engine failure	Misc incident due to "First commercial approval" second flight
9/15/2013	Key West, FL	NOAA (PAO)	Puma	DCA13NA152	Notification	Servo failure	Notification due flight control system malf - minimal data gathered
1/27/2014	Point Loma, CA	CBP	MQ-9	DCA14CA043	C-case	Intentional ditching following generator failure	Full CBP report in docket
4/25/2014	Lake Conroe, TX	Montgomery Co Sheriff	Shadow Hawk	DCA14SA091	Factual report	Rotor blade delamination	Hobby grade components on mil-grade hdwe, no airworthiness programs, ac destroyed but <300lbs so not accident. 830.5 rotor blade
9/5/2014	Chuchki, AK	Univ of Alaska	Scan Eagle/ Nanook	DCA14SA158	Misc data	Fuel exhaustion	Highly modified aircraft, AK test site. Not accident, not 830.5 - miscellaneous incident
12/17/2014	Van Nuys, CA	Pictorvision (333)	DJI S1000	None	Misc data	Pilot error led to too-low RTH	Followed up media report indicating possible "fly away". Data shows not so, and **no 830.5 reportables.**
5/1/2015	Otto, NM	Titan (EXP)	Solara 50	DCA15CA117	C-form	Structural failure	Test and development flight, scaled proof of concept for Google project. Accident because >300lbs.

5/9/2015	Los Angeles	Wild Rabbit (333)	Allied Chaos/A2	DCA15SA119	Notification	FC malf	Bad compass msg, flying near steel bridge structure, RTL hit bridge