Remote Controlled Hydrographic Survey System

SP&R Part II, 775 Project# RB13-015

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Design Bureau

Project

An Evaluation of Advanced Remote Hydrographic Survey System for Applications in Subsurface Topographic Engineering Surveys for use by the Iowa Department of Transportation in the Development of Transportation Improvement Projects.

Iowa DOT Report Author

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Project Summary

The purpose of this project was to investigate the potential for collecting and using engineering survey accurate data from a remote controlled (unmanned) platform equipped with a system of advanced survey technologies for hydrographic and bridge scour evaluations. The primary interests in investigating this hydrographic scanning technology is to obtain; a significantly improved representation of the underwater surface as compared to traditional methods, the presence of scour at bridge elements and to minimize the exposure of field surveyors and bridge inspectors to the dangers of working in water, from boats and gathering data from bridges. Additional benefits to explore were cost savings and reducing the time required to gather and produce the subsurface information.

The remote hydrographic survey system needs to incorporate the following integrated field capable (ruggedized) technologies:

- Real Time Kinematic (RTK) Global Navigation Satellite System (GNSS) Receiver: This receiver uses satellite navigation in real time from a system of satellites that provide autonomous geo-spatial positioning with global coverage. This allows the receiver to determine the location (longitude, latitude, and altitude) to high precision using time signals transmitted along a line of sight from satellites. The signals also allow the electronic

receivers to calculate the current local time to high precision, which allows time synchronization.

- GNSS Antenna: The antenna boosts the reception signal to a GNSS receiver.
- Single Beam Echosounder: An echosounder capable of recording high resolution full water column acoustic envelope which will result in a highly detailed representation of the bottom of a body of water.
- Radio Modem: Real-time data transfer provided by a radio modem with multiple channel wireless communications over long distances allowing instrument data to be logged by computer on shore. Wireless connectivity allows for a link with external hardware as a tablet PC.
- Hydrographic Data Acquisition Software
- Remote Controlled Boat and Dual Motors

The remote hydrographic survey system generates a detailed 3-dimensional electronic map (also referred to as bathymetry in the study of the "floor" of a body of water, including rivers, streams, and lakes) accurately defining the depths and shapes of underwater terrain. In the same way that topographic maps represent the 3-dimensional features of terrain, hydrographic survey maps illustrate the 'land' that lies underwater. The variations in floor relief of a body of water may be depicted by color and contour lines called depth contours or isobaths. At the Iowa DOT, this information will be used in a format referred to as a triangular irregular network (TIN). The data represented in the TIN is readily consumed by engineers and designers who leverage the data to provide high accuracy design proposals.

Literature Search

"Hydrographic survey methods for determining reservoir volume"

Jordan Furnans, Environmental Modelling & Software,

Volume 23, Issue 2, February 2008, Pages 139–146

Abstract: Since the creation of the Texas Water Development Board (TWDB) hydrographic survey program in 1991, over 100 bathymetric surveys of Texas reservoirs have been conducted. From these surveys, reservoir volumes and surface areas for corresponding reservoir stages can be estimated, thus providing engineers, managers, and regulators with accurate knowledge of water availability. Volume differences derived from multiple surveys of individual reservoirs also provide estimates of capacity loss over time due to sedimentation. Completing each survey requires extensive field data collection and precise data analysis, which often limit the frequency with which surveys may be conducted. This paper serves to document the innovative survey methods used by the TWDB hydrographic survey group, including a presentation of the in-house Hydro Edit software, which increases survey accuracy while drastically reducing the time required for data processing.

"Efficient Hydrographic Surveying of EEZ with New Multibeam Echosounder Technology for Shallow and Deep Water"

Dennis A. Ardus, and Michael A. Champ, Ocean Resources

Abstract: The Multibeam Echosounder ATLAS HYDROSWEEP is designed for efficient hydrographic survey in shallow and deep water sea areas, and for the real-time display and recording of the topographical structures as colored areas and isolines. The special features of ATLAS HYDROSWEEP are the large coverage of 2 x 45° and the shallow and deep water survey capability from 10 m to >10,000 m. With the aid of 59 PFB's (preformed beams), a swath width equal to twice the depth of the water is covered on the sea bed. This greatly increases the economy of ship operations for survey purposes, compared to previous systems. A comparison of HYDROSWEEP data with comparable SEABEAM measurements along almost identical track lines proves the high data quality and the superior efficiency of the HYDROSWEEP.

http://dx.doi.org/10.1007/978-94-009-2131-3_6

"**International Hydrographic Survey Standards**"

Gerald B. Mills, NOAA, Office of Coast Survey, Hydrographic Surveys Division

http://www.searchmesh.info/PDF/GMHM2_IHO_survey_standards.pdf

"Hydrographic Survey Techniques."

NOAA 200th: Top Tens: Breakthroughs: 2015.

http://celebrating200years.noaa.gov/breakthroughs/hydro_survey/welcome.html

"Hydrographic Survey Management Guidelines"

Canadian Hydrographic Service - Fisheries and Oceans Canada, Second Edition, June 2013

Abstract: The advent of satellite positioning, multi-transducer and multibeam echo sounding systems and sophisticated data processing tools have drastically modified the way hydrographic surveys are conducted. Management tools such as ISO 9001:2000 have also had an impact on the methods used to ensure quality assurance. The Canadian Hydrographic Service (CHS) Survey Standing Orders, as they were written in the 1980's and 1990's, no longer reflect the standards and the methods of work required to properly conduct a hydrographic survey. After review, the requirements for the completion of a hydrographic survey have been divided into three separate documents. The CHS Standards for Hydrographic Surveys is the document that specifies the requirements for hydrographic surveys in order that hydrographic data is collected according to specific standards. This document quantifies the accuracies required, depending on the use of the data.
http://www.charts.gc.ca/data-gestion/hydrographic/sd-ld-eng.asp

"Hydrographic Survey Using Real Time Kinematic Method for River Deepening"

Nor Aklima Bte Che Awang and En. Rusli Othman
Department of Geomatic Engineering, Faculty of Geo-information Science and Engineering, University, Malaysia

Abstract: There are many survey method in hydrographic surveying due to development of technologies. The latest development in technologies for example Global Positioning System (GPS) gives new challenges in surveying field. Surveyors use GPS technology for simple tasks or complex tasks. In hydrographic survey, the important data required are position, tidal reading and depth value. Normally, tidal reading is obtained at tidal station established near to survey area by using instrument like automatic or self-recording tide gauge. Depth of seabed is measured by using single beam or multi beam echo sounder without add up tidal value at the same time. The latest technique of getting position and depth simultaneously is by using RTK method.
http://eprints.utm.my/27793/1/NorAklimaBteCheAwang2011_HydrographicSurveyUsingReal.pdf

"Good Practice for Hydrographic Surveys"

Russell Kilvington, Director of Maritime Safety

New Zealand Ports & Harbours

Abstract: This document outlines the basic "good practice" guidelines that should be considered in the planning, execution and management of hydrographic surveys used to support the safe navigation of vessels in New Zealand ports and harbours. These guidelines have been endorsed by the National Hydrographic Authority, Land Information New Zealand (LINZ).

https://www.maritimenz.govt.nz/Publications-and-forms/Commercial-operations/Ports-and-harbours/Hydrographic-surveys-guidelines.pdf

"Hydrographic Survey of Heyburn Lake"

State of Oklahoma - Oklahoma Water Resources Board

December 27, 2004

Abstract: The Oklahoma Water Resources Board (OWRB) conducted a hydrographic survey of Heyburn Lake in May and June of 2004. The purpose of the study was to collect hydrographic data of Heyburn Lake and convert this information into an area-elevation volume table at the conservation pool elevation. The information produced will serve as a base to establish the location and rate of sedimentation in the conservation pool for future surveys. The United States Army Corps of Engineers (USACE) reservoir elevation gauge at Heyburn Dam is reported in National Geodetic Vertical Datum 29 (NGVD 29). All vertical elevations referenced are reported as NGVD 29. Heyburn Lake is located on Polecat Creek, a tributary of the Arkansas River in Creek County, approximately eleven miles southwest of Sapulpa, Oklahoma.

https://www.owrb.ok.gov/studies/reports/reports_pdf/Heyburn_Hydrographic_Survey.pdf

"Bathymetric Surveys (Bridge Scour Investigation) at Highway Bridges Crossing the Missouri and Mississippi Rivers near St. Louis, Missouri, 2010"

Huizinga, R.J., 2011, U.S. Geological Survey Scientific Investigations Report 2011–5170, 75 p.

Abstract: Bathymetric surveys were conducted by the U.S. Geological Survey, in cooperation with the Missouri Department of Transportation, on the Missouri and Mississippi Rivers in the vicinity of 12 bridges at 7 highway crossings near St. Louis, Missouri, in October 2010. A multi-beam echo sounder mapping system was used to obtain channel-bed elevations for river reaches ranging from 3,280 to 4,590 feet long and extending across the active channel of the Missouri and Mississippi Rivers. These bathymetric scans provide a snapshot of the channel conditions at

the time of the surveys and provide characteristics of scour holes that may be useful in the development of predictive guidelines or equations for scour holes. These data also may be used by the Missouri Department of Transportation to assess the bridges for stability and integrity issues with respect to bridge scour. Bathymetric data were collected around every pier that was in water, except those at the edge of water or in extremely shallow water, and one pier that was surrounded by a large debris raft. Scour holes were present at most piers for which bathymetry could be obtained, and ranged from 0 to 16 feet deep except at piers on channel banks or those near or embedded in rock dikes. Scour holes observed at the surveyed bridges were examined with respect to frontal slope and shape, and scour holes near railroad bridges in the vicinity of the highway bridges also were examined. Although exposure of parts of foundational support elements was observed at several piers, the exposure likely can be considered minimal compared to the overall substructure that remains buried at these piers. At piers with well-defined scour holes, the frontal slopes of the holes ranged from 1.70 to 2.94 feet per foot (computed as run over rise), which were similar to recommended values in the literature (generally ranging from 1.0 to 2.0), and the shapes of the scour holes were not substantially affected by the movement of sand waves into the holes. Spur dikes near several of the piers caused localized flow disturbances that caused the resultant scour holes to display characteristics of skewed approach flow. The channel bed in the 2010 surveys was as much as 16 feet lower than the channel bed at the time of construction at the two oldest surveyed bridges, and the range varied with age of the structure, indicating the channel-bed elevations have lowered with time. However, other research has indicated the extremely dynamic nature of the channel bed on the Mississippi River.
http://pubs.usgs.gov/sir/2011/5170/

"Channel Scour at Bridges in the United States"

M. Landers and D. Mueller

U.S. Geological Survey and Federal Highway Administration

FHWA-RD-95-184, 3D3C1-212, September 3, 1996

Abstract: Scour of the channel bed around bridge foundations is the leading cause of failure among more than 487,000 bridges over water in the United States. Field measurements of scour at bridges are needed to improve the understanding of scour processes and the ability to predict scour depths accurately. This report documents methods to measure and interpret bridge scour

data, presents an extensive pier scour measurement data base, evaluates scour processes in an analysis of these data, and compares observed and predicted scour depths for several scour prediction equations. More than 380 measurements of local scour around bridge piers have been compiled from 56 bridges in 14 States in a cooperative investigation of the U.S. Geological Survey and the Federal Highway Administration. The data are stored in an interactive bridge scour data base management system developed in this study. Improved planning for scour measurements during floods and advances in scour measurement instrumentation and techniques have improved the quantity and quality of measured scour data. Consistent and representative methods are used to interpret scour measurement data that were compiled from several investigations. The relation of scour depth to several explanatory variables, including effective pier width, flow depth, flow intensity, and sediment parameters, is investigated. The data distributions of individual scour variables are typically right skewed. The effective pier width generally has the greatest influence on scour depth. Flow depth has a positive relation with scour depth over the range of measured data; but the influence of flow depth decreases with increasing scour. The positive relation of flow intensity to scour depth is apparent when bed-load transport is negligible, but appears insignificant for active bed-load transport conditions. The influence of sediment size and gradation on local scour depth is inconclusive on the basis of this analysis. Selected local scour prediction equations are evaluated and compared based on the field data. None of the selected equations accurately predict the depth of scour for all the measured conditions. Several equations did better than others when evaluated as design equations. The information in this report is provided to contribute to the improved design and evaluation of bridges, and to the safety of the traveling public.
http://trid.trb.org/view.aspx?id=460821

Depth Measurement Equipment Discussion:
Depth measurement is normally achieved using either Single Beam (SBES) or Multibeam (MBES) echosounders. SBES are the most common tool used in hydrographic surveys since they provide good results without significant initial purchase funding and regular maintenance expenditures. Unless the initial cost and operating costs reduce significantly, it is unlikely that MBES will be a recommend alternate for the Iowa DOT. The use of MBES as a hydrographic survey tool has significant advantages over SBES in the capability to detect small objects and

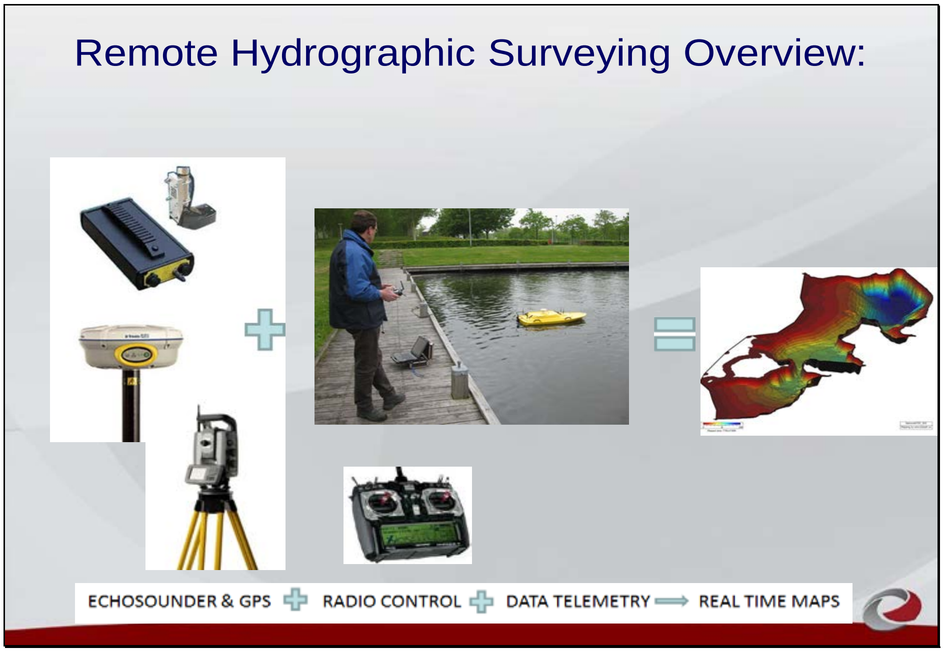
achieve full bottom coverage. MBES require key ancillary equipment such as an appropriate motion sensor and gyro, which must be correctly integrated for correct operation. The ability to measure sound velocity profiles through the water column is also required to correct for the refraction of beams, particularly when using wide swathe widths. Users should be aware of the expected performance of the system and employ robust methodology to prove this before accepting the system as operational. Careful calibration of MBES is required at regular intervals. Inherent with the increased detail and coverage achieved with MBES is the ability to clearly see errors associated with incorrect vessel offsets, SV or excessive vessel motion. The ability to "smooth" out such errors in subsequent processing is potentially misleading and should be avoided unless the magnitude of the change from the raw to the smoothed record is clearly stated. In short, a MBES is not the appropriate tool for the Iowa DOT.

Evaluation Procedure

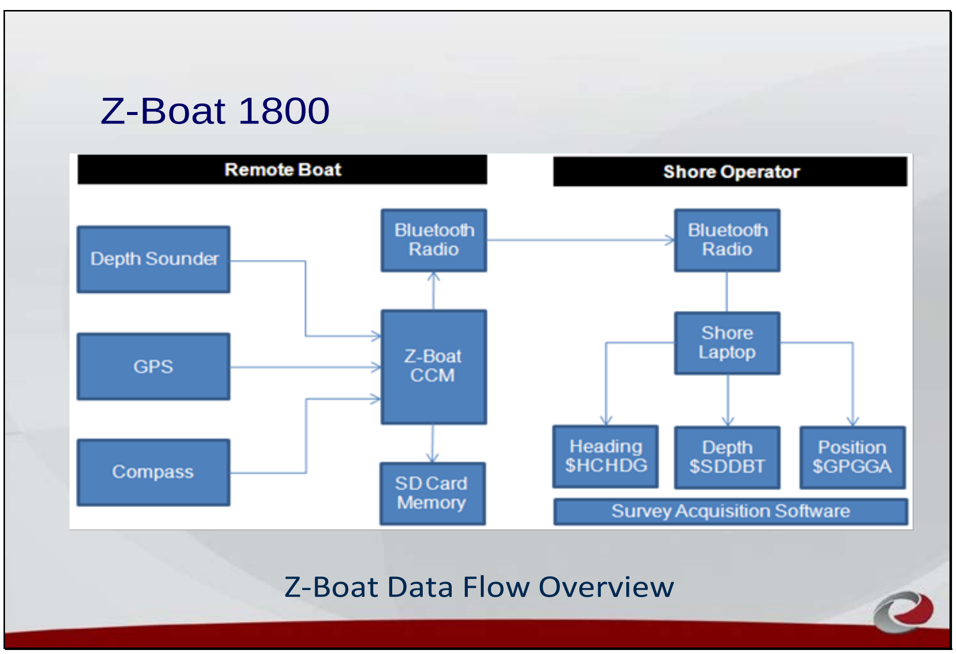
The Survey Section of the Iowa DOT's Office of Design has over the years performed many surveys on ponds, partial lakes, streams and rivers bottoms in support of transportation improvement projects. These efforts have typically been conducted by staff wading into the water or using a small boat to collect the data. This method is slow, does not capture many data points on the bottom of the body of water and has some risk to the safety of the survey staff conducting the work. In 2013 and 2014, an internet search was conducted to see how hydrographic surveys are being addresses by other organizations. That search indicated that there are several large boat systems in operation for significant bodies of water, but that only one fully integrated hydrographic system for addressing bodies of water typically encountered on highway system. Teledyne Oceanscience produces such a system called a Z-Boat which integrates a remote-controlled boat and motors with an RTK GNSS receiver, a GPS antenna, an echo sounder and radio communications. The purpose of this study was to determine if this system can provide hydrographic data in a quick, data dense and safe manner. This system produces electronic data for use in various reports and to create MicroStation/GEOPAK (civil design platform and software) triangular irregular network (TIN) files representing the 3-dimensional surface of the bottom of the body of water.

Remote Controlled Hydrographic Survey System Overview

- Echosunder (single beam) + GPS (DGPS or RTK tidal corrected) or Robotic Total Station
- RC (Remote Control) + data link
- Product = Bathymetric map



Data and Communications Overview:



Hydrographic Survey System Equipment Specifications:

Z-Boat 1800

Physical:	
Hull Length	5.09ft
Hull Width	2.9ft
Weight	66lbs.
Payload	55lbs.
Hull Material	UV Resistant ABS
Motor	High Speed Dual Brushless 24V DC Outdrives
Remote:	
Navigation Remote Control Unit	Hitec with vessel telemetry
Navigation Remote Control Unit Frequency	2.4GHz FHSS
Navigation Remote Control Range	4920 ft
Performance:	
Typical Survey Speed	5 - 6.5 ft/sec
Top Speed	16 ft/sec
Battery Endurance	Up to 150 min.
Battery Pack	1 x 12V 30 Ah

Echosounder (Single Beam)

Physical:	
Dimensions	11.81" x 9.84" x 5.43" (L x W x D)
Display	420 x 272 touch screen color LCD
Weight	7.7 lbs.
Connectors	LEMO 1K & 2K series, Industrial USB
Environmental:	
Operating temperature	32°F – 122°F
Humidity	95% non-condensing
Power:	
Power consumption	6.8 watts (approximate operating time 8+ hours)
Internal battery	Rechargeable high capacity NiMH battery 10Ah
External power supply	Nominal 12.0 VDC @ 2A (9-24 VDC range)
Data Logging:	
Internal Memory	16 GB & 32 GB optional
Echosounder:	
Mode	Automatic and Manual
Frequency	High band: 190 kHz – 210 kHz Low band: 30 kHz – 36 kHz (optional)
Accuracy	0.01 m +/- 0.1% of depth @ 200 kHz 0.10 m +/- 0.1% of depth @ 33 kHz (optional)
Depth range	0.2 – 200 m (0.6 – 328 ft) @ 200 kHz
Sound velocity	1350 – 1750 m/s
Ping rate	1-20 Hertz

GNSS

The Z-Boat can accommodate any GNSS receiver and antenna specified by the Iowa DOT.

The system arrived with some assembly required. IDOT survey staff prepared the system for the first day of testing at Ada Hayden Park north of Ames, Iowa.

Z-Boat Remote Operation Overview

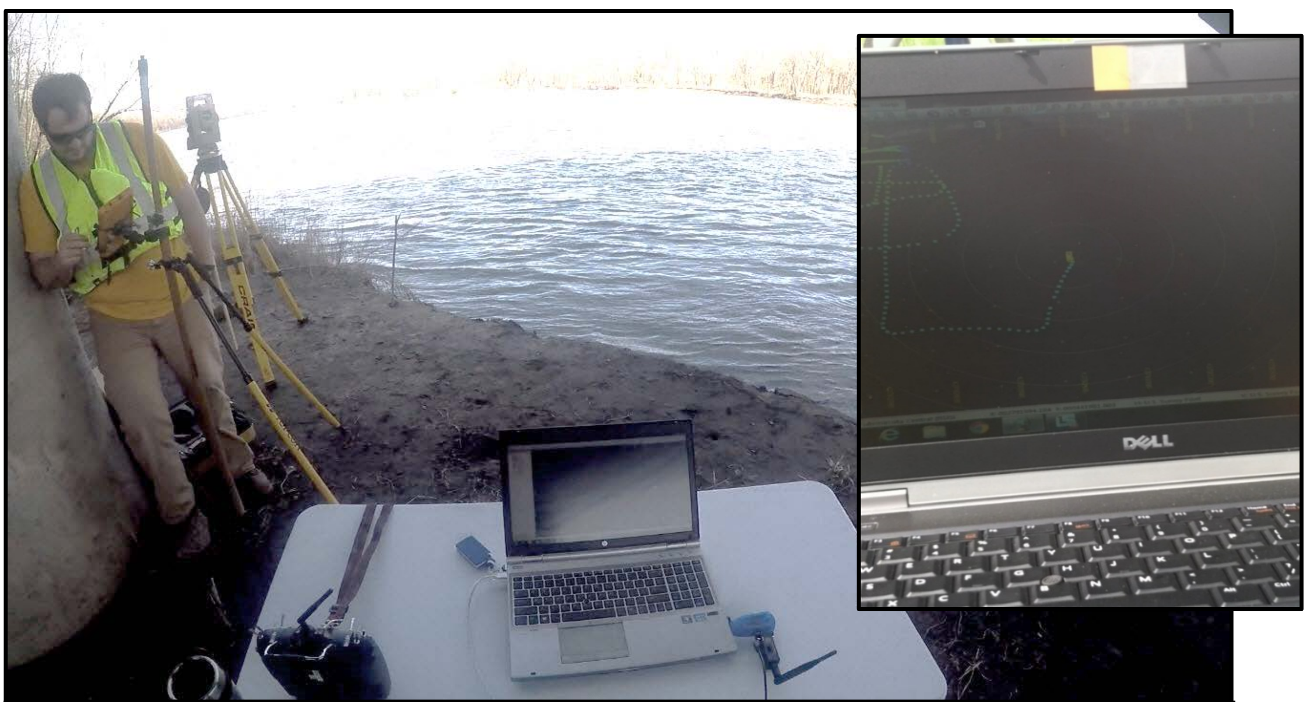
The Z-Boat uses a radio connection to the remote-control unit. It can motor away from the remote unit far enough where the boat appears as a dot in the water and still be controlled (approximately 3500'). A low battery warning alarm is sounded at the remote-control unit when there is 10 to 15 minutes of operation time left. This appears to be ample time to motor the boat to shore. The batteries held enough charge to perform the test survey without needing to be recharged. Maneuvering around the bridge pier columns was conducted with relative ease. The echo sounder is a narrow beam that is best suited to bore to a depth that is solid. It was discussed that a body of water with brush and weeds can cause navigation problems. A good practice has been to limit underwater vegetation conflicts by intentionally doing most of their surveying early in the season before undergrowth is fully established. When using the echo sounder and GNSS combination a roadway/bridge site can be surveyed in 30 minutes to an hour. If site conditions do not allow for GNSS, a total station survey instrument can be used to locate the Z-Boat, but this doubles or triples the collection time. However, the time to perform the hydrographic survey with the Z-Boat is a fraction of the time required to put surveyors in or on the water and safety issues are increased.

The following images show the typical transportation and deployment of the system as well as the field-office.

Iowa DOT vehicle fitted with locking topper and roll-out storage platform.

The system requires a two-person lift due to the overall weight of approximately 65 lbs.

Personal floatation devices are required for work near water.



"Field Office." The surveyor can visualize on the laptop (insert) the current location of the boat as well as what area has been covered to ensure that the proper area and density of data is collected before leaving the site.

Collection Methods

The most efficient use of the system appears to require two individuals. One navigates the boat and the other monitors the logging progress on a laptop. The system software plots a dot on a map in real-time as the survey proceeds. This allows the operators to visually verify that all the coverage area is collected while still in the field. The map can have an aerial image background, so the paths of the boat are mapped real-time on the imagery which makes monitoring coverage easy.

The system can collect data with two different control methods depending on conditions within the project site. We tested both methods with success. The first method is when the GPS antenna on top of the boat is unobstructed by overhead features (bridges or trees) and the second methods is used under features that block the GPS signal from reaching the antenna. Both methods are briefly discussed below.

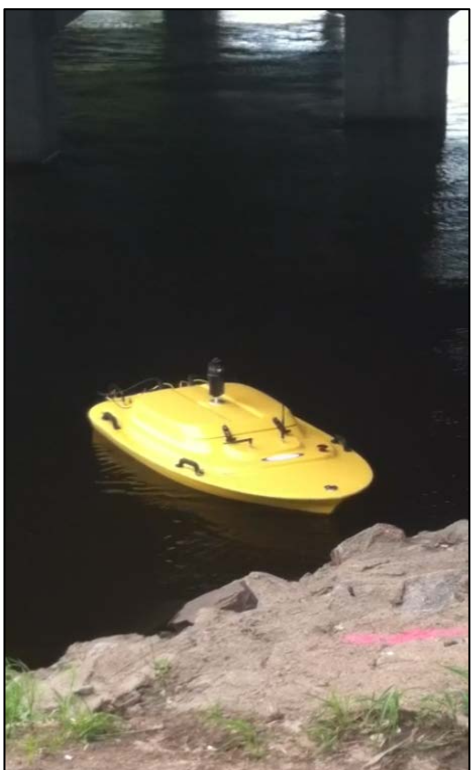
Method 1: GNSS Data Collection

GNSS is used for most surveying tasks accomplished by the survey boat. The exception is where open sky above the boat is very limited or completely obstructed, such as beneath a bridge. While the system is configured to log a location at 2 second intervals it can be configured to log automatically at any time or distance interval. An important feature is that when the GNSS receiver loses a fixed solution (a loss of contact with the satellites) the logging instantly ceases. When a fixed satellite solution is regained, then logging also resumes. This greatly reduces the chance that non-survey quality positions will be logged and included in the final 3-dimensional representation of the bottom of the body of water. The system has a capability to log data while the GNSS signal is lost. If the boat stays on a bearing the locations between where the GNSS signal is lost and where it is regained can be interpolated by the software. This option would allow the boat to pass under a bridge on a straight bearing and the depths would be accurate while the horizontal locations would be approximate.

Method 2: Total Station Data Collection


GNSS data collection is appropriate when the system has a clear view to the sky, but not when the sky is obstructed such as under a bridge.

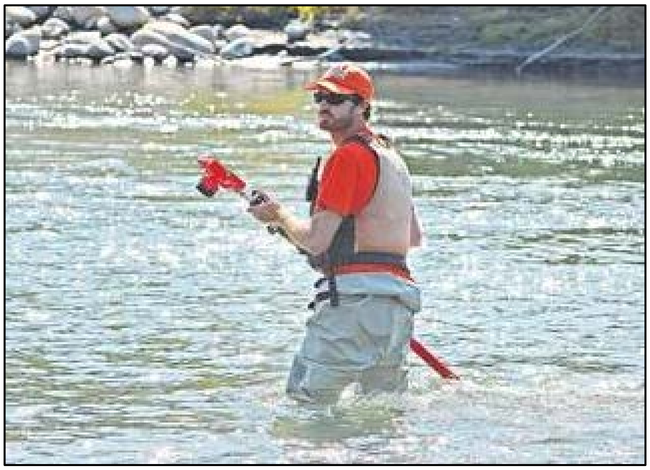
The system can also be operated with a total station during data collection in situations where survey accurate GNSS observations are not possible due to the presence of a feature that does not allow for an unobstructed view of the sky. The system is designed to be readily switched from GNSS locating to total station locating. It takes about 5 minutes to reconfigure the data stream collection. The system must be called back to shore and the connections are changed inside the boat, the GNSS antenna is removed and a reflective prism sensor is added to the mast. After the connection has been validated the boat is launched. Control must be used to establish a position of the total station. After the total station is oriented to project control the data logging process continues much the same as with GNSS.


Z-Boat with the GNSS Antenna Replaced with a Reflective Prism


Total Station Collecting Positional Data

Safety

A remotely controlled hydrographic survey system allows all field staff to gather the needed data from a position adjacent to the body of water which reduces the possibility of a water related accidents.   The following images show survey practices that we want to stop using.



Current survey methods require field staff to enter the water to collect the required data. This has been traditionally done using a total station and a prism pole and more recently with GPS equipment as shown in the following images. One of the objectives of this investigation is to identify and implement as hydrographic system that eliminates the need for survey staff to enter a body of water to gather

When the body of water is too deep to wade into or the water is moving too fast, then a boat has been used in the collection process (as shown in the following images). However, the use of a boat also exposes field staff to risk that can be avoided with the remotely controlled hydrographic survey system. The following images show survey practices that we want to stop using.

Test Sites

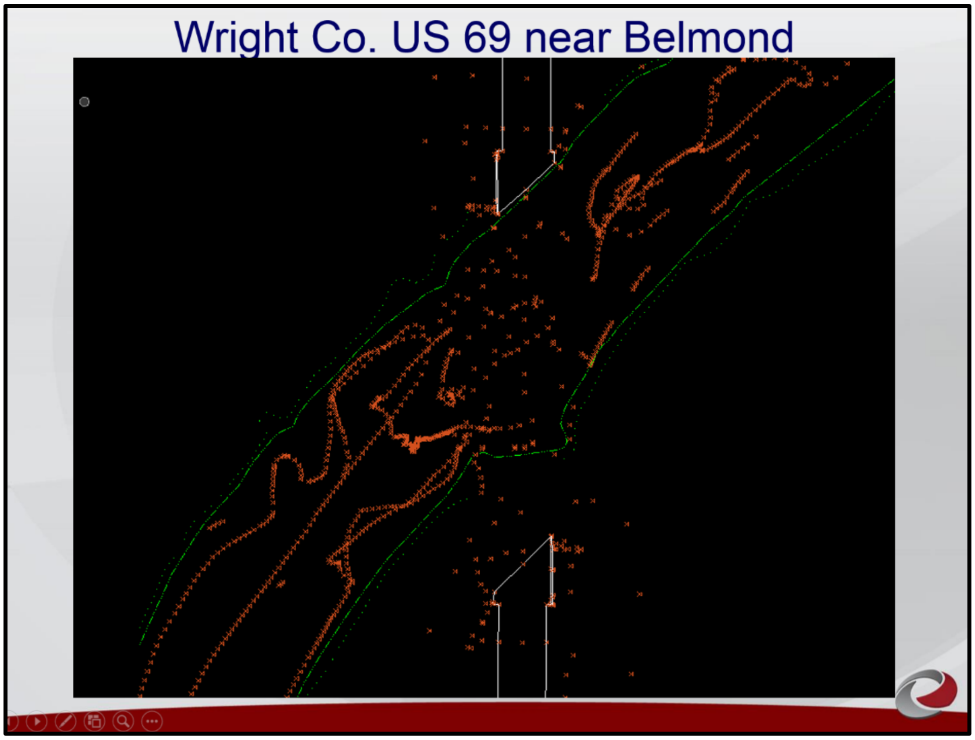
The following are the 4 sites used in this study. These sites are typical of the projects that will need hydrographic surveys in the future. These projects required an extensive river survey that would prove very challenging with traditional survey methods.

Site #1

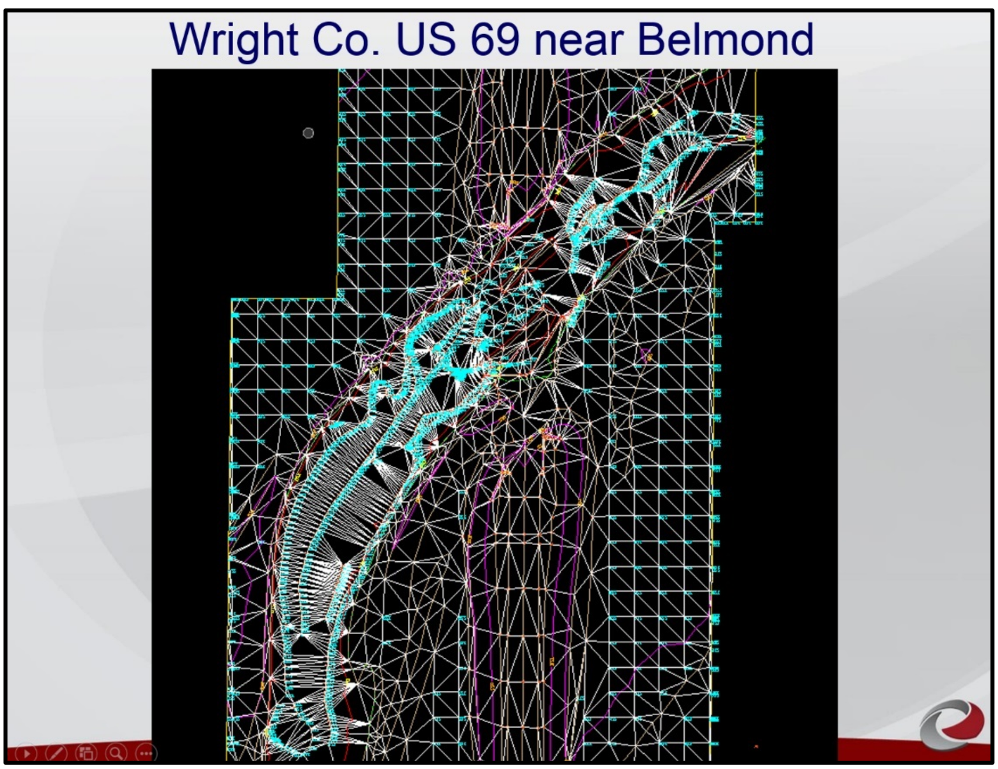
Wright County

Project Number: BRFN-69-7(30)--39-99

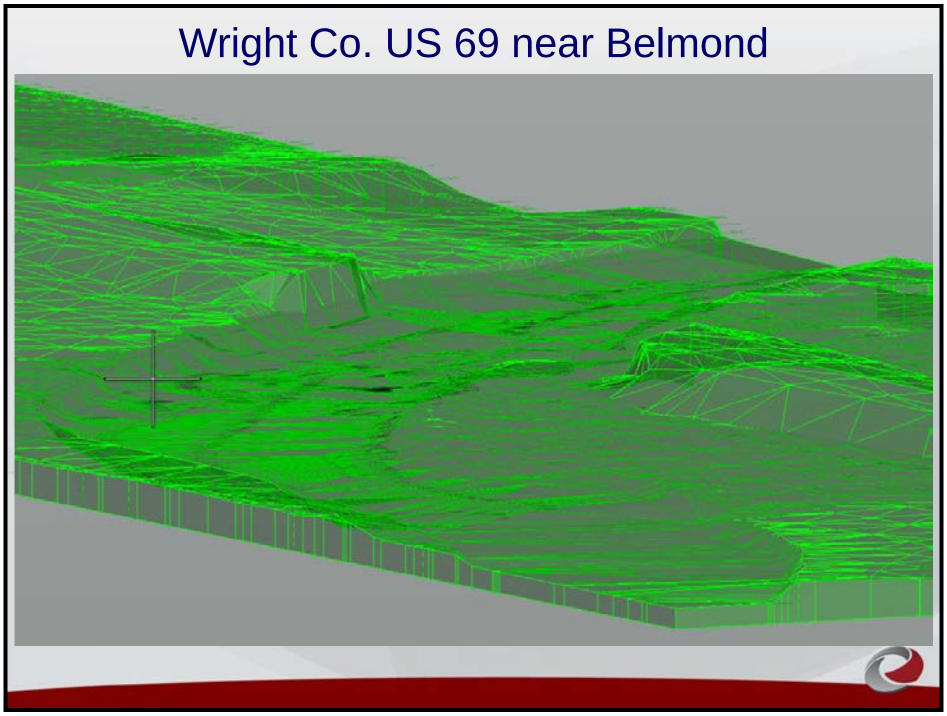
This project on US 69 over the Iowa River 5.3 miles north of the north US 69 and IA 3 junction was to replace the existing bridge and adjacent roadway.



The red dots indicate locations where 3D data was collected within the stream.



The wire frame view of the stream survey and ground survey combined for use by the engineers and designers.



The oblique view of the shaded 3D model has the 3D wire mesh over laid on it to better depict the final product.

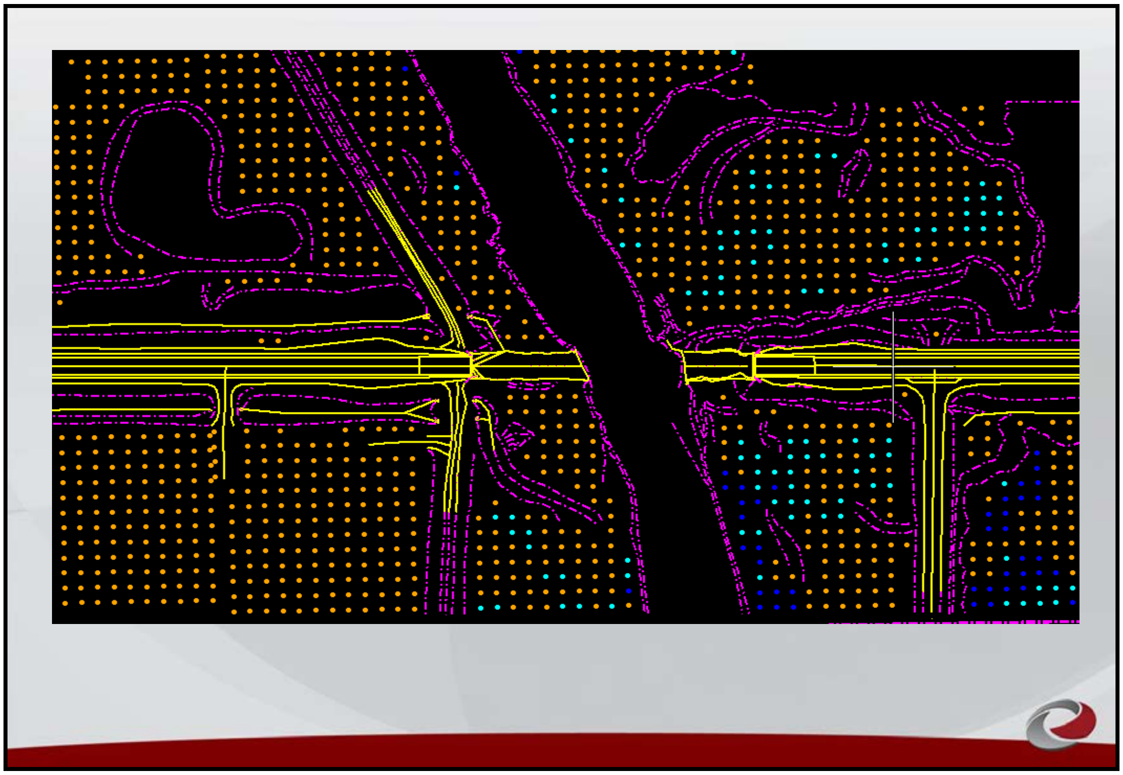
Site #2

Butler County

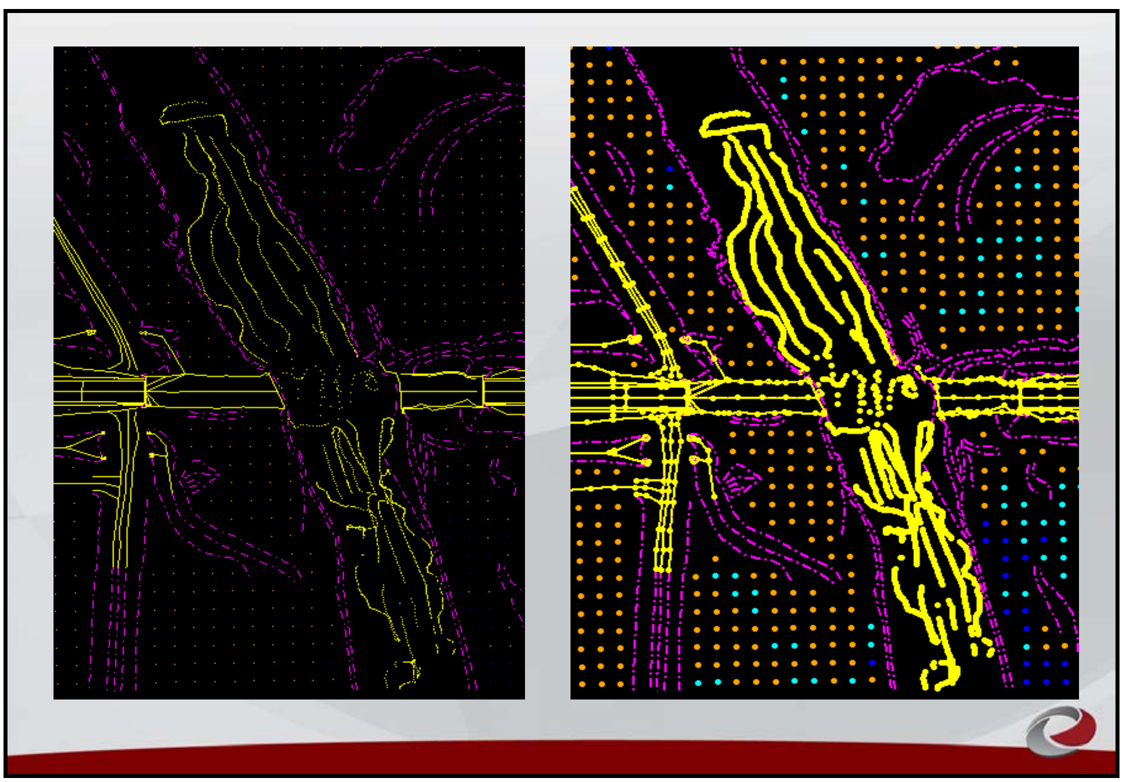
Project Number:

BRF-003-5(77)--38-12

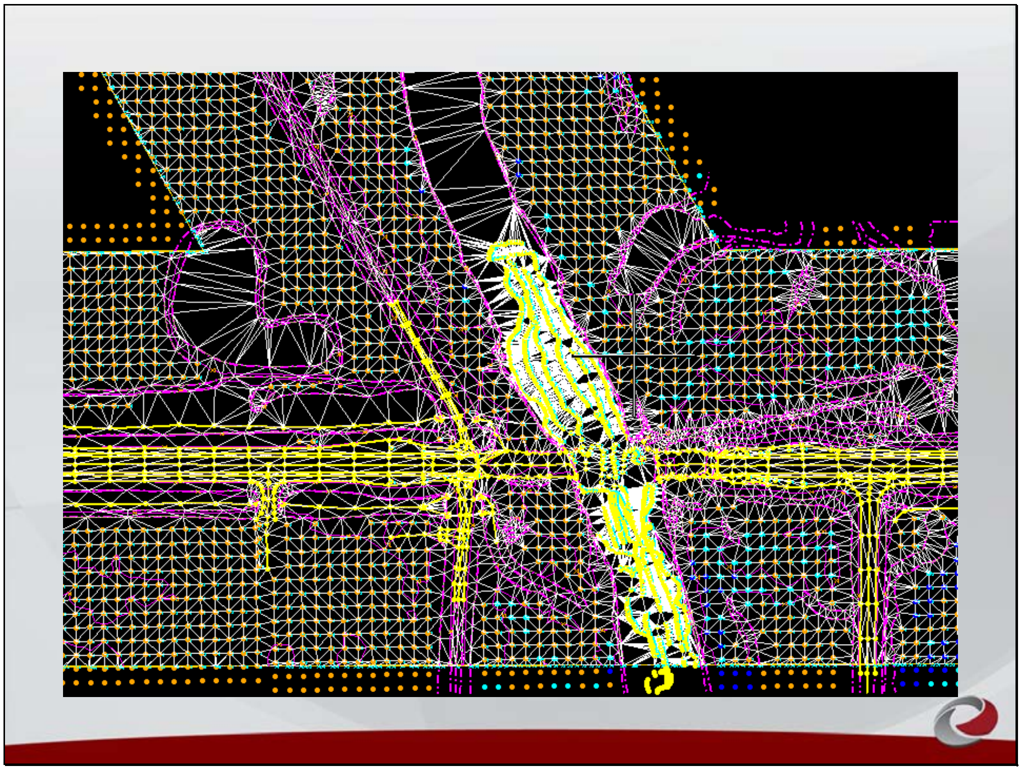
This project on IA 3 over the West Fork of the Cedar River 0.8 mi east of County Road T16 was to replace the existing bridge and adjacent roadway.



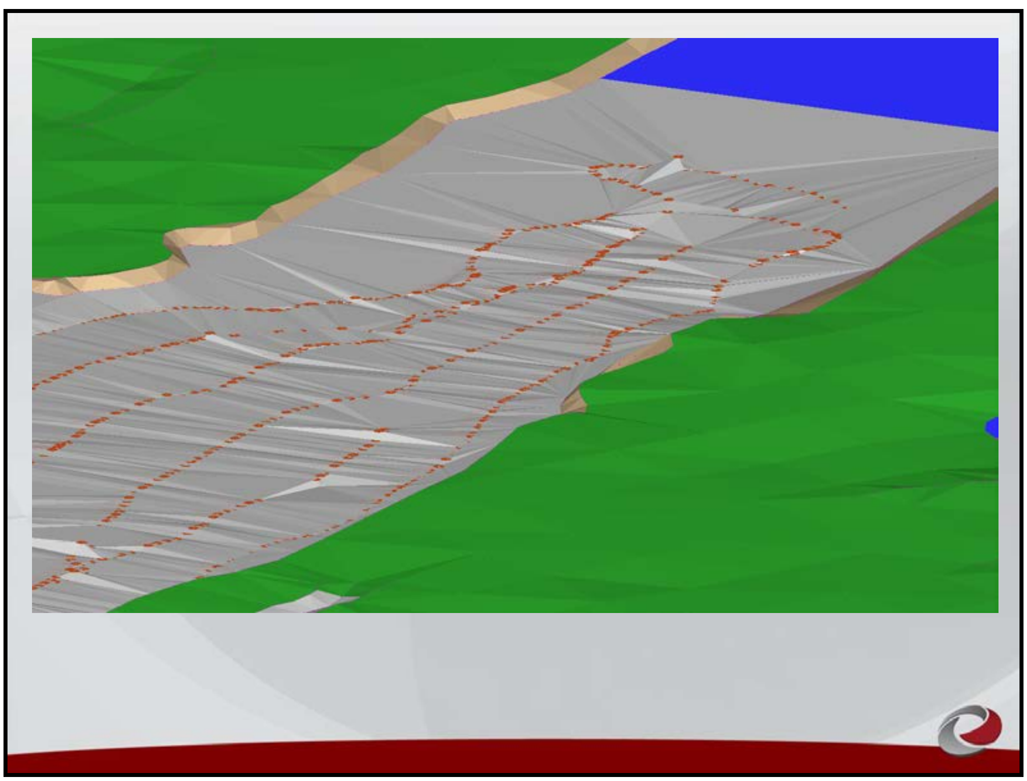
Site 2: Showing the extent of river survey needed.



Site 2: 3D points survey on the river bottom.



Site 2: The wire frame view of the stream survey and ground survey combined for use by the engineers and designers.



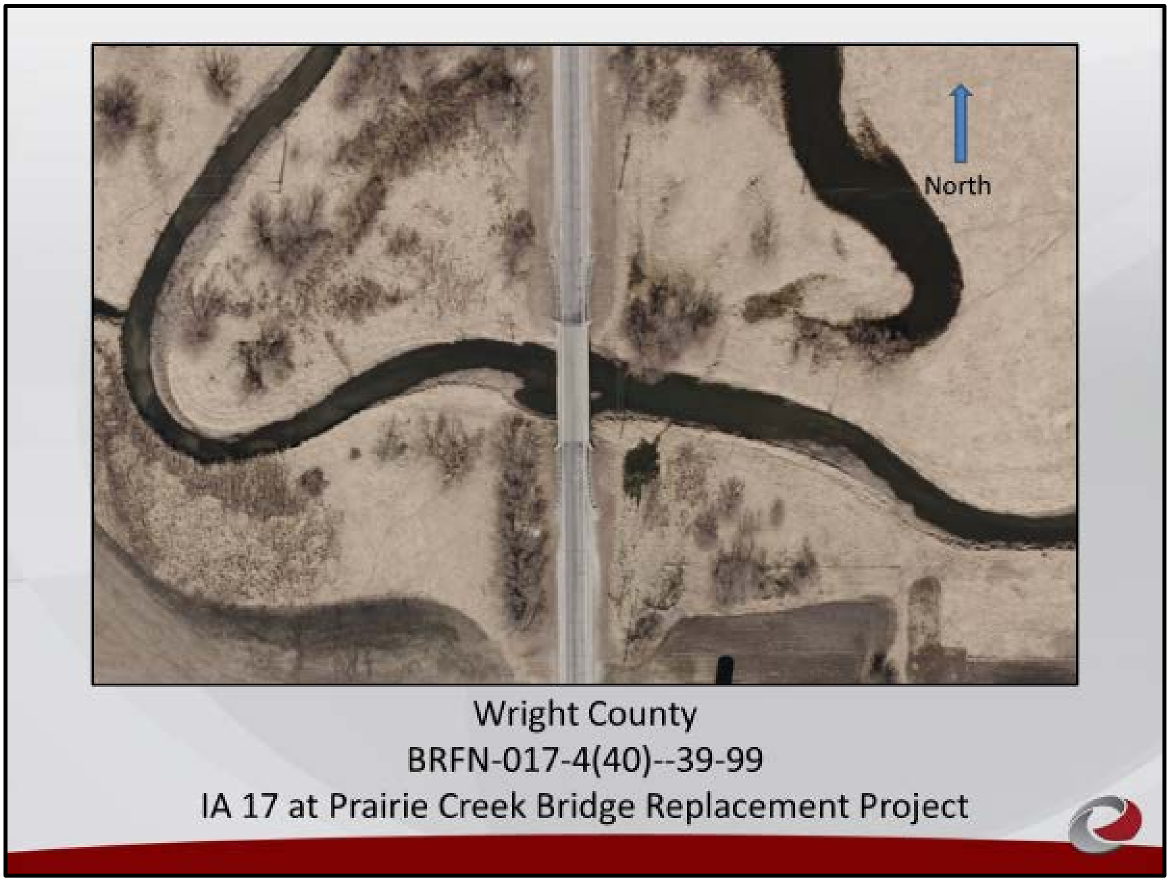
The oblique view of the shaded 3D model including the river bottom survey data points.

Site #3

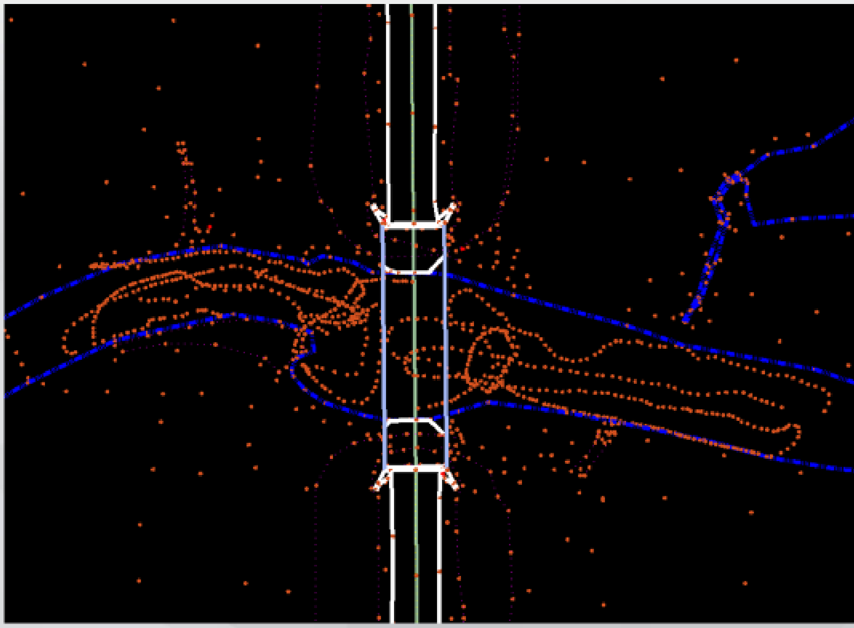
Wright County

Project Number: BRFN-17-4(40)--39-99

This project on IA 17 over Prairie Creek was to replace the existing bridge and adjacent roadway.



The survey boat on the test site #3



The data collect path of the boat can be clearly seen in this image which is similar to what the operator would see on the computer screen in the field.

Site #4

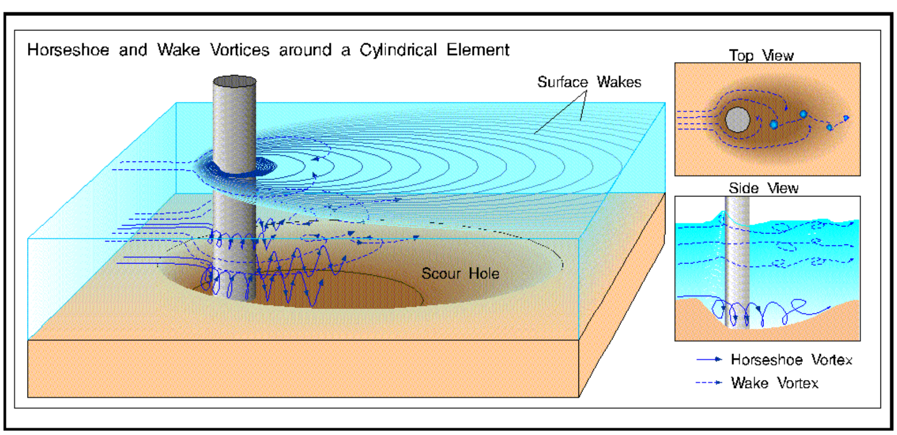
Jackson County

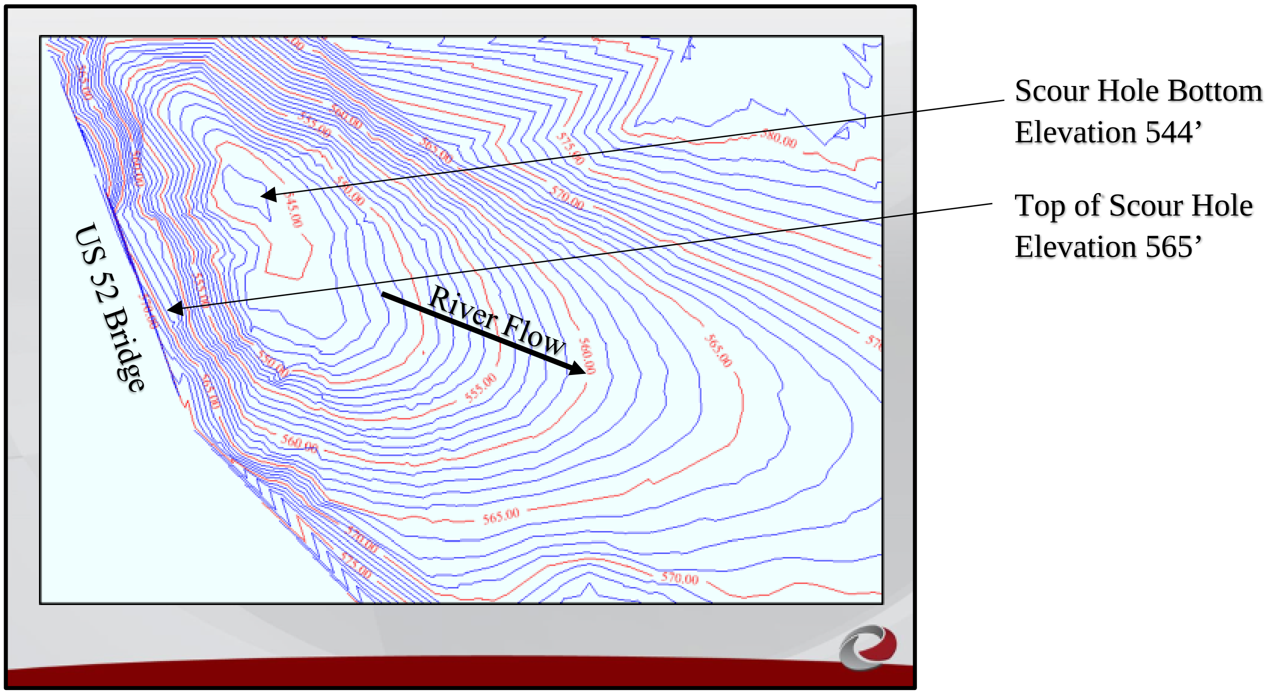
Project Number: STPN-52-1(113)—2J-49

This project is at the US 52 bridge over the Mississippi River overflow channel north of Sabula.

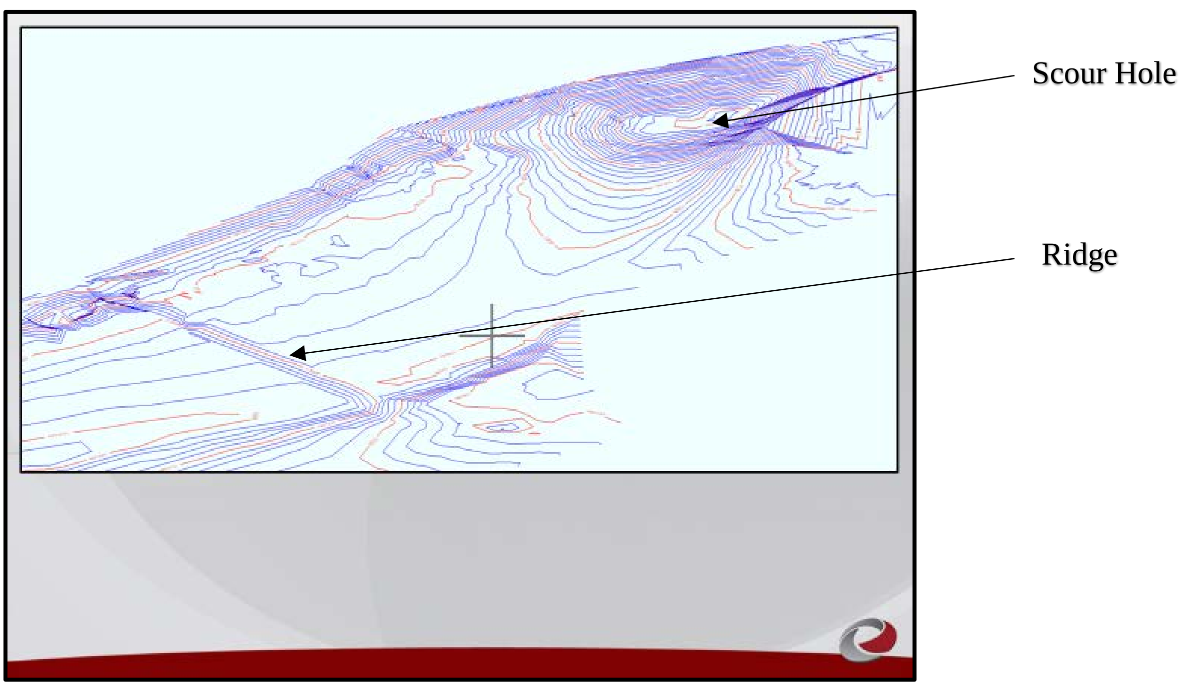
Site 4: The perimeter of this project is approximately 5400' and covers approximately 22.5 acres. This large of an area could not reasonably been surveyed using traditional survey methods.

Project site #4 provided the opportunity to understand the capabilities of the system to locate and measure scour that can occur at bridges due to the increased velocity of the water removing material from the bed of the waterway. This turned out to be an excellent example of scouring and the system performed very well at measuring the scour hole. Being able to identify and monitor bridge scour is a significant issue and responsibility for the Iowa DOT. This system will allow for the rapid and accurate identification of such condition and the numerous scour-critical structures in Iowa. This image shows the cause and result of scour.





Site #4: The completed survey revealed a scour hole approximately 21’ deep downstream of the US 52 bridge.



Site #4: This oblique view of the 3D model shows the scour hole and an unanticipated ridge that was located downstream of the bridge.

Results

Survey Time Comparison:

It was estimated that if the 4 test site survey projects had been conducted by a 2-person survey crew using traditional survey methods and a boat that it would have taken approximately 15 hours to complete. The same area was surveyed by the same 2-person survey crew using the hydrographic survey system took approximately 2 to 3 hours to complete.

Survey Data Density:

The challenges associated with tradition survey methods in gathering lake/river bottom data have resulted in sparse data points representing the bottom surface. This lack of data can lead to an inaccurate representation of the actual conditions. The hydrographic survey system investigated allows for extensive data collection for use by a designer in analyzing site conditions. It is not unrealistic to assume that sites like the four test projects could readily be represented by approximately 2000 unique points collected on average as compared to approximately 50 to 200 points that could be realistically collected using traditional survey methods.

Data Processing and Management:

The processing of hydrographic data involves the removal of invalid data and the selection of a "cleaned" data set for further processing or for the generation of required products (TIN surface file) for subsequent use in the design/analysis activities. Data processing should be done using dedicated hydrographic processing software that offers almost complete flexibility and the potential to edit data. Surveyors should refer to the manufacturers' instructions accompanying survey processing software and develop a series of standard operating procedures for the processing of data. Data collected during survey operations should be monitored closely to ensure the required standard and the desired extent of coverage is being met; however, it is not possible to fully assess the overall quality until all data can be viewed together or in suitably sized blocks. Cross-line comparisons and various other consistency checks are undertaken at this time. Areas requiring re-running, either because of gaps in coverage or due to suspect data, can be readily identified while in the field at the project site.

Hydrographic data can be rendered in several formats and styles, depending on its intended purpose. At the Iowa DOT, the most helpful format will be a contour map produced from the TIN file. The underlying principle that should be observed in compiling records of any survey is that they must be entirely intelligible to any person having a sound knowledge of the type of survey concerned, but who was not involved in the survey. For the Iowa DOT, a large proportion of hydrographic surveys will be repeat surveys at bridge scour sites to monitor that situation. This type of repeatability and comparison is well suited for this type of system. Computing and storage requirements needed for the type of project described above is not considered to be significant and is consistent with typical current requirements for engineering survey process. The typical finished products from hydrographic survey (combined with above water data) are the typical CAD design files and TIN file. The CAD files typically produced are indistinguishable from conventionally derived products. The horizontal datum and vertical datum will be established at the beginning of a survey project so that all data collected on ‘dry-ground’, from photogrammetric methods and from the hydrographic survey process can be easily and accurately combined into a complete 3-dimension surface for use by highway planners and designers. The data accuracy acquired through the hydrographic survey process meets the Iowa DOT specifications for engineering survey.

Recommendations and Implementation

The hydrographic survey system can collect 3-dimensional under water surface data significantly faster, at a greater density, at an accuracy that meets the needs on the Iowa DOT and in way that is safer than traditional survey methods used to collect data within a body of water. The four survey test site surveys were accomplished in a small fraction of the time as compared to traditional methods. The site #4 investigation resulted in the discovery of a subsurface ridge that was unanticipated and would have likely not be as clearly observed, if at all, using traditional collection methods. The safety benefits of having personnel on dry land rather than in or on the water are significant. All future bathymetric survey needs at the Iowa DOT will be conducted using the hydrographic system. The system will be used approximately 40 to 50 applications that require an underwater surface per year including the emergency response projects that arise due to flooding conditions that require immediate action.