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St. Croix National Scenic Riverway

Ruins of a Forgotten Highway: Survey and Documentation of Historic Water Control Features

Submerged Resources Center Technical Report No. 36

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ST. CROIX NATIONAL SCENIC RIVERWAY

Ruins of a Forgotten Highway: Survey and Documentation of Historic Water Control Features

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A product of the National
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Executive Summary

The National Park Service's Submerged Resources Center and Midwest Archeological Center collaborated with St. Croix National Scenic Riverway to document the extensive United States Army Corps of Engineers improvements along the St. Croix River below St. Croix Falls. From 1879 to 1900 the Corps built 3.6 miles of wing dams, closing dams, jetties, revetments, and shoreline rip-rap to regulate the river and make it a predictable commercial highway for steamboats and log drives. Through investigation and documentation of the remnants and extent of these cultural resources, this 2015 study provides an opportunity to share this story and its results with the park and public in hopes of provoking visitors' appreciation of the complexity of past and present human interaction with nature. The findings will be used in concert with historical research as the basis for a National Register nomination of the structures as a nationally significant historic district, and become integrated into SACN's planning documentation and interpretive program. Taken together, the numerous water control features likely qualify as a National Register Eligible District under Criterion C.

Introduction

The following summarizes the work conducted at St. Croix National Scenic Riverway (SACN) from June 1 through June 30, 2015 by the National Park Service Submerged Resources Center (SRC), Midwest Archeological Center (MWAC), and members of the SACN staff and volunteers.

This project's three primary goals related to the identification and documentation of historic water control features created or maintained by the United States Army Corps of Engineers (USACE) within SACN boundaries. The three project goals were 1) the development of a comprehensive GIS database for water control features; 2) the detailed documentation of typologically unique and/or representative water control structures; and 3) a synthesis of the archeological data into an existing research database in order to augment other National Register nomination materials already in the park's possession. These goals were accomplished in collaboration with park historians, historical research, and on-water investigations utilizing side scan sonar and ground-truthing methods. The work was completed pursuant to Section 110 of the National Historic Preservation Act, which charges managing agencies with the identification, evaluation, nomination to the National Register, and protection of historic properties under their jurisdiction.

This document reviews the project's results by separating the St. Croix River into 20 sections, north to south, between Taylors Falls and Catfish Bar at Afton, MN. Originally, the survey planned to extend downriver to Prescott, WI; however, based on time constraints and limited historical evidence for remaining historic water control features, the survey investigation ended at Afton. One of the main historical references used during the project is a 1937 U.S. Army Corps of Engineers (USACE) river survey map. This map depicts 18 out of the 20 designated river sections and is included here both individually and as an overlay over a modern aerial image. GPS targets indicating original historical dam locations, actual identified water control features, and site extents, retrieved both in person and via sonar, are also noted on the map overlay and are identified in the GPS, GIS, and Excel files located on the hard drive provided. The final section of this report briefly reviews information collected per the request of the Minnesota SHPO around the Stillwater Boom Grounds relating to future investigations, projects, and grant funding.

Field operations were coordinated through Jean Scheappi-Anderson, Julie Galonska, Dan Ott, and Park Dive Officer Bryon Karns, who provided logistical guidance, the use of SACN watercraft (both boats and kayaks), and SACN cylinders for diving. SACN volunteer Bob Whaley provided daily support as the boat captain and river guide. SRC project personnel included Dave Conlin, Bert Ho, Jessica Keller, Jim Koza, Susanna Pershern, and Jeneva Wright. MWAC personnel included Erin Dempsey and Nora Greiman.

Project Methodology

Historical Research

Project methodology began with the acquisition of data necessary to accomplish the three main objectives: the development of a comprehensive GIS database for cataloging historic water control features, the creation of a detailed documentation of typologically unique and/or representative archeological feature types, and a synthesis of the archeological field data for a National Register nomination. To that end, historic research and discussions with SACN park staff provided an overview of the types of historic water control features that might be encountered, as well as general locations to begin sonar survey investigations.

In 2014, a special study contracted by the National Park Service was conducted on the St. Croix River and part of the Namekagon River detailing the historical modifications to the rivers and their banks by the USACE between the years of 1870-1975 (Godfrey 2015). This report provided crucial information and acts as the foundation for this current project. It remains the most complete historical documentation of the activities of the USACE in this area.

Other historical documents were collected and reviewed in addition to this special report. Contacts from USACE's St. Paul District Office and Library provided helpful insight and information, and additional documents were reviewed from the Minnesota Digital Library. All of the collected and referenced sketches, maps, and detailed reports were compared to each other and to modern river maps, though water control feature locations and geological formations listed in the later 1800s and early 1900s vary from the modern river locations and common names. A Report on Preliminary Examination of St. Croix River Basin Minnesota and Wisconsin was completed in 1946 by the United States Engineer's Office of St. Paul, Minnesota in accordance with Section 6 of the Rivers and Harbors Act. Though this report did not detail the exact locations or types of water control features, it did present an overview of the St. Croix area, utilizing data related to water flow, climate, and drainage, as well as a specific river issues such as water power and desired channel depths of a 3 foot, 6 foot, and 9 foot channel. This 1946 report may be a useful supporting document for the nomination to the National Register.

Survey Operations

The St. Croix River is a dynamic environment in a constant state of change. Shifts in water levels, current, debris, and sedimentation present both modern and historic navigational hazards, along with challenges for effective survey and investigation. In 2007, a low water year, NPS staff investigated a number of historic water control features- mainly wing dams that were visible and caught the interest of the park. Using the locations and images collected in 2007, in 2014/2015 SACN, in concert with external contractors, created a database to log the locations and identification of other features along the river.

This database, archival research, and local knowledge formed the foundation for the areas with possible features relating to the navigational improvements initiated by the USACE between 1879 and 1900. One week before the beginning of the project, a detailed 1937 USACE map of the river was found. This map showed a number of dams along the river and was the first of its kind identified by historians. The map was georectified by SRC over the target areas, creating a modern map (Figures 1 and 2) which provided a real-time guide into the past. The SRC survey team identified 130 target areas on the 26-mile stretch from Taylors Falls to Prescott, with a majority of the targets above Stillwater and two below: one at Catfish Bar and one at Hudson's Swing Bridge. These targets are indicated throughout the report as orange dots (on historical maps) and red dots (on sonar imagery).

From June 3 through June 16, SRC completed a combination of side scan sonar survey and in-person investigations. Initially SRC was given the SACN Rescue 1 boat for operations, but after the first day it was apparent that the boat was too small for all required equipment. The rest of the project utilized the SACN dive pontoon boat, as it had ample space and still could reach the shallow sections of the river. SRC used a Klein 3000H dual frequency high definition side scan sonar to survey the target locations, collecting both high and low frequency data. This data was acquired with Klein's SonarPro 13.0 data acquisition program running off an SRC Toughbook laptop. All remote sensing data was positioned with Differential GPS data supplied by a Hemisphere Power Max DGPS receiver with sub-meter accuracy. Datum NAD83 was used throughout all data collection and post processing for surveys in UTM Zone 15N, which covered all of SACN. Sonar imagery was acquired as close to the water control features as possible, while maintaining safe vessel operations and adequate altitude for the towfish. Multiple passes of the targets were completed with the sonar to achieve good images. Side scan sonar was attempted on 103 of the 130 original targets. A small number of these targets were too shallow to image clearly, and several of the other targets resulted in recording bottom contours only or no findings.

SRC was also able to document a section of the river around the historic boom grounds per the request of the Minnesota SHPO. SRC will be able to create a mosaic of this sonar section and any potential target coordinates in the area was given to the park for future investigations by the SACN dive team.

FIGURES 1 and 2. GIS maps of Folsom and Boom Islands with layers of GPS targets (yellow dots) and the rectified 1937 USACE map.

Anomaly Investigation

Review of the side scan sonar data resulted in the identification of targets requiring additional investigation. The locations of anomalies, unusual, or potential features were obtained and transferred to a handheld GPS unit. These anomaly and ground-truthing operations were conducted via kayaks, searching in-water with probes in shallow areas, and using open circuit scuba for deeper targets. Over the course of target investigation, other targets were added to the overall GPS anomaly list to include new sites or site extents. All GPS points are recorded in an Excel spreadsheet and as an Expert GPS file, which can easily be transferred to other hand-held GPS units.

All in-water operations were either live-boated or the boat was safely beached on the riverbank. A dive flag was displayed on the boat during dive operations. At times, a weighted buoy was dropped on the GPS target location as the center for underwater circle searches. Some locations had swift current conditions, which prevented the acquisition of GPS points for site extents.

Site Documentation

Specific water control features were documented utilizing a variety of methods. Typologically representative features were documented in detail using a combination of traditional mapping (measured plan and profile drawings), photography, and total station point data collection. Additional sites—those determined to be typologically redundant—will be notated with GPS/total station positions and integrated as point or shape features into the project's GIS database. Plan and profile drawings completed in the field were finalized after the project in ink and are presented in this report.

Historical Background

Logging on the St. Croix River began quietly in the late 1830s, but by the late 1840s, businesses were rapidly growing, and with that growth came an intensification of logging operations. In order to move logs down the river, companies like the St. Croix Boom Company built their own dams and booms along the river. The dams changed the river flow, and at times, logjams blocked up miles of the river, impeding flow, riverine commerce, and communication. It was not until 1870 that the USACE was able to begin preliminary surveys of the St. Croix River in an effort to increase navigation and river flow. Three years passed before another survey was completed on the St. Croix River. This 1873 navigational survey was the first to suggest building dams and other water control features to focus and streamline water flow. By June 1878, the first funds from Congress had been appropriated, though the amount was less than half what was requested (Godfrey 2015:21).

A majority of the work completed by the USACE on the St. Croix River occurred between 1878-1896, with the latter years primarily focused on repairing existing dams and dredging sandbars (Godfrey 2015). The USACE considered the project along the St. Croix River complete by 1900, though the last reference to building dams occurred in 1917 (Jean Schaeppi-Anderson 2015, pers. comm.). During this time, the USACE built, maintained, or removed a variety of water control structures intended to alter or strengthen the river flow. In 1897, for example, 60-70 dams were present on the St. Croix River (Godfrey 2015:94). The ability of the USACE to construct water control features was enhanced by the passage of the Rivers and Harbors Act of 1890, which provided authority to the USACE to control the construction of any structure on a navigable waterway (Godfrey 2015:58).

One of the most commonly referenced structures built on the river was a wing dam.

> The Corps of Engineers preferred wings dams because of their cheapness of construction, facility of repairing, and durability in managing streams with shifting sandbars, like the Saint Croix River. Brush and stone were the normal construction material used by the USACE in building wing dams. The dams were usually built two to three feet higher than the low stage of water, and in general, work was done from the bank outward (Godfrey 2015:27).

Wing dams were built from the bank stretching into the river and were designed to concentrate the river flow in order to guide logs past potential obstructions (McMahan and Karamenski 2002). These dams were constructed from a combination of materials such as brush (sometimes called fascines), timber, and rock. At times, the wing dam was referred to by the construction materials, including brush (brushwood), stone and brush, and log and stone dams. Also, construction methods for building a wing dam varied due to time and materials available. Wing dams were also synonymous with jetties, dikes, and spurs. The size of a wing dam was dependent upon the location, position, and purpose.

> As regards the position of a wing-dam, or jetty, with reference to the current of the stream, considerable diversity of opinion exists. It would seem that no especial rule can be strictly followed. Dams projected in a direction normal to the shoreline being shortest, require less material. Dams inclined downstream are subject to scour along the upstream face, besides protecting the shore just below their junction with it, less than those do which are inclined upstream. Dams inclined upstream, however, are subject to scour along the lower face. All three types must resist effect of overfall and scour around their heads (Allen 1880:1666-1667).

Other water control features built or monitored by the USACE included boom grounds, closing dams, and revetments (Figure 3). A boom was a line of large logs chained end to end, that were anchored to piles (logs or cut pieces of timber) driven into the riverbed to form a floating fence. A series of booms, also known as boom grounds or boom piers, acted as a conduit, leading milled logs to holding

pens (McMahan and Karamenski 2002). The USACE did not build any booms along the river; rather, they monitored and removed booms previously built by logging companies that were hazardous to navigation.

Piles could also be used in dam construction; their use in SACN was particularly noted in the construction of the Hudson Bridge closing dam (Figure 4). Closing dams were typically built between two islands, or pieces of land, closing off a channel and thereby focusing river flow. At least two different construction methods of closing dams were used in SACN: pile driven and brush/stone (Figure 5) (Godfrey 2015).

Revetments were sloping structures placed along riverbanks to absorb the energy of incoming water, intended to protect existing riverbanks from erosion (USACE 2015). Revetments, also referred to as revet or revetted, had varied construction methods. Appendix A contains a quick reference guide to historic water control feature definitions and descriptions.

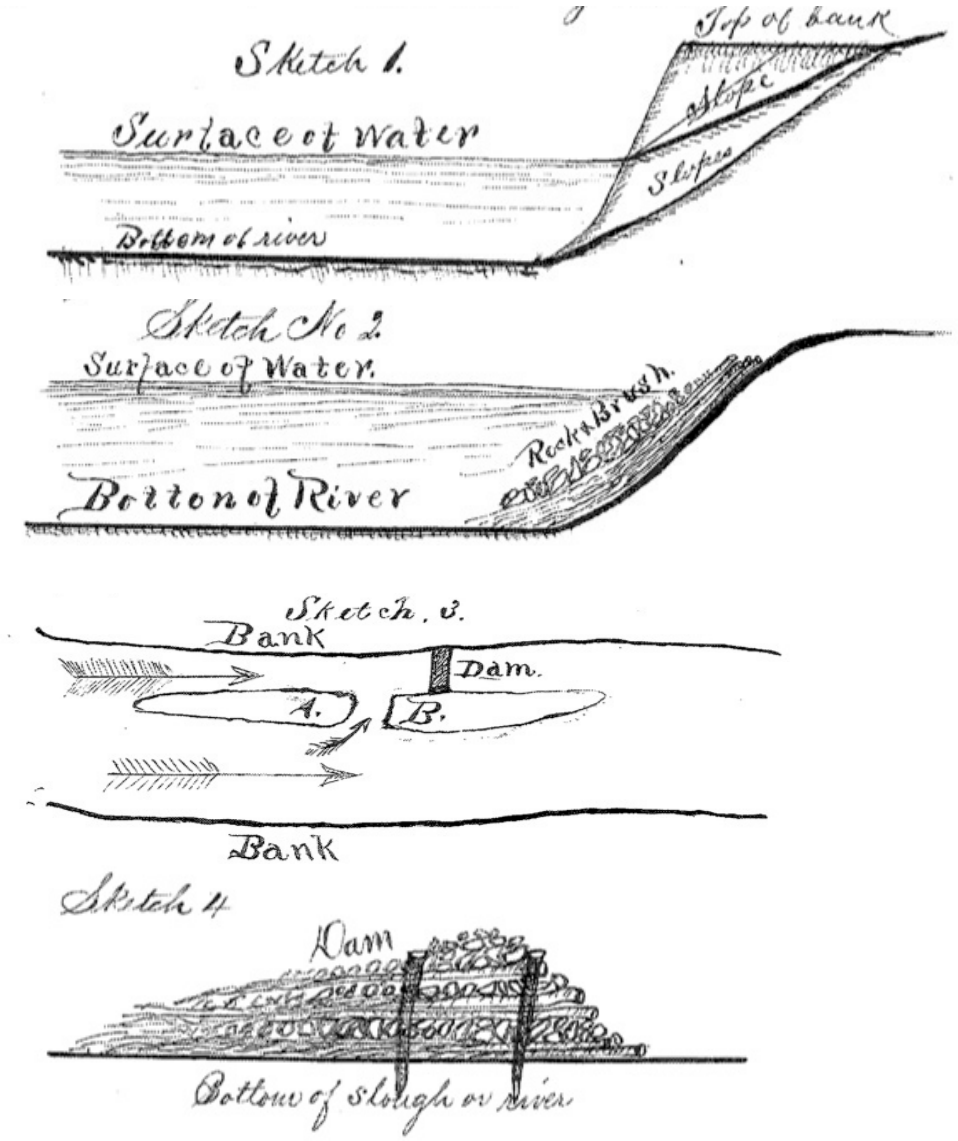


FIGURE 3. The Cedar Bend dam sketches by Captain Charles J. Allen in 1878. (Godfrey 2015:24-25).

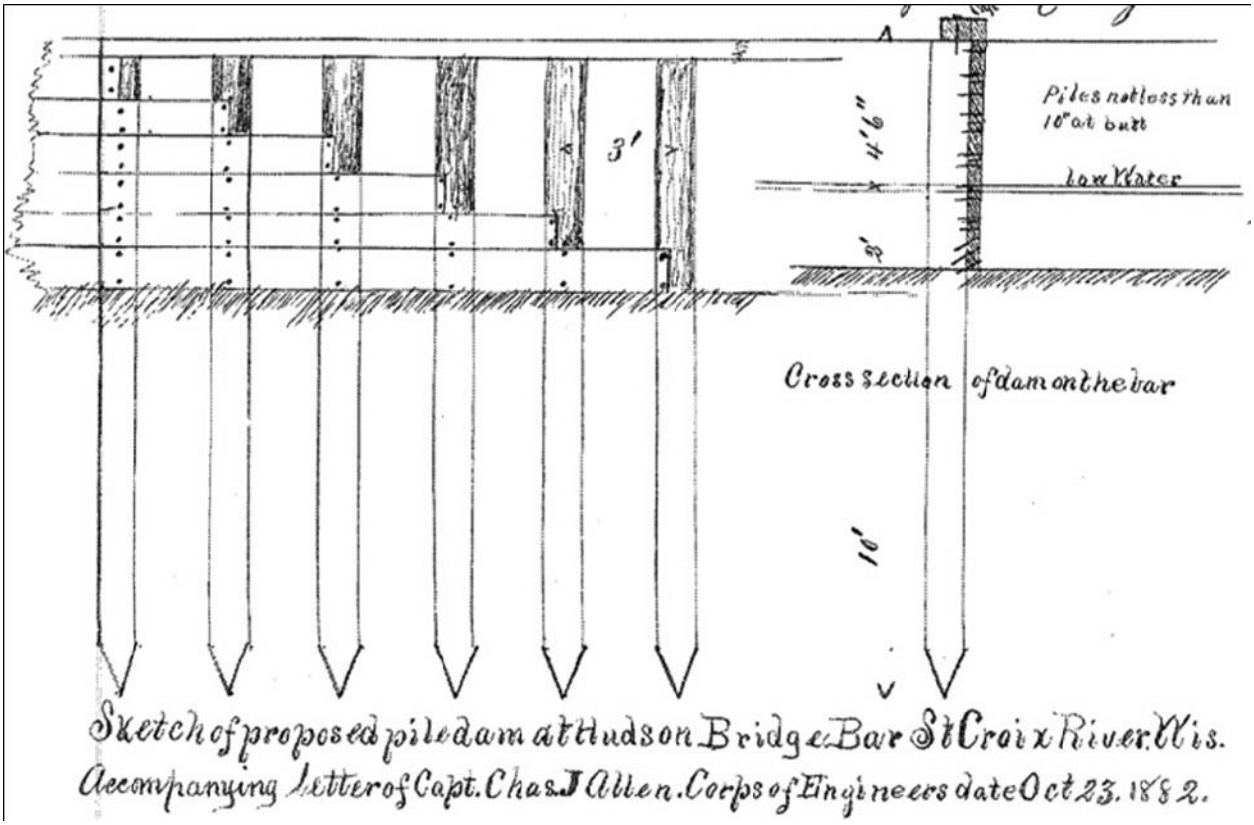
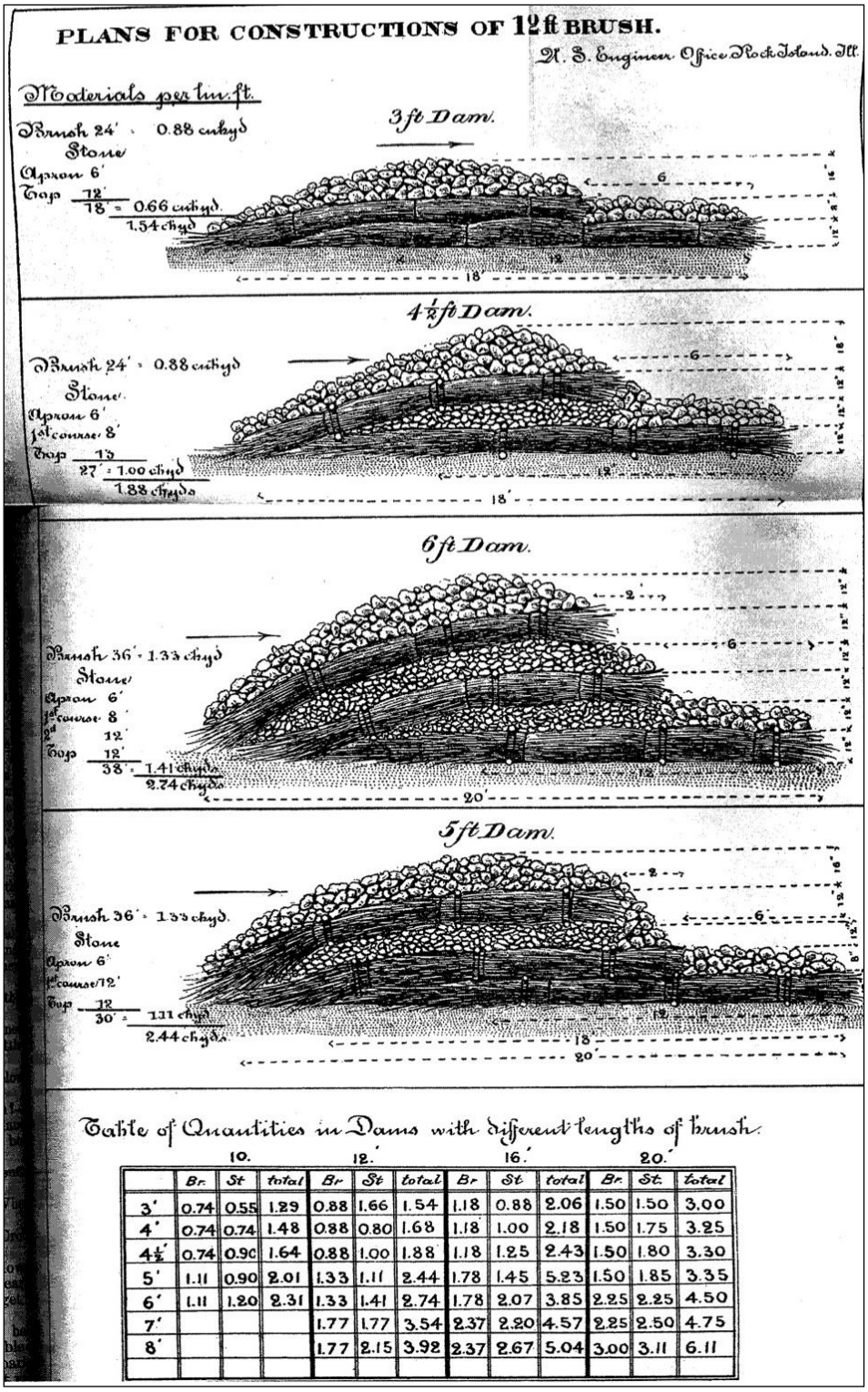


FIGURE 4. Charles J. Allen's sketch of the proposed Hudson Bridge closing dam pilings in 1882. (Godfrey 2015:37).



	10.			12.			16.			20.		
	Br.	St	total	Br	St	total	Br	St.	total	Br.	St.	total
3'	0.74	0.55	1.29	0.88	1.66	1.54	1.18	0.88	2.06	1.50	1.50	3.00
4'	0.74	0.74	1.48	0.88	0.80	1.68	1.18	1.00	2.18	1.50	1.75	3.25
4½'	0.74	0.90	1.64	0.88	1.00	1.88	1.18	1.25	2.43	1.50	1.80	3.30
5'	1.11	0.90	2.01	1.33	1.11	2.44	1.78	1.45	5.23	1.50	1.85	3.35
6'	1.11	1.20	2.31	1.33	1.41	2.74	1.78	2.07	3.85	2.25	2.25	4.50
7'				1.77	1.77	3.54	2.37	2.20	4.57	2.25	2.50	4.75
8'				1.77	2.15	3.92	2.37	2.67	5.04	3.00	3.11	6.11

FIGURE 5. USACE stone and brush dam construction chart. Drawing taken from *Mississippi River Floods: Testimony Taken Before Subcommittee of Senate Committee on Commerce, Senate Resolution No. 76,* 56th Congress, 1st Session, 1897, page 21. (Godfrey 2015:73).

Results Overview

Despite the dynamic and constantly changing environment of the St. Croix River, a number of submerged cultural resources were found and identified. This fieldwork served as archeological support for district nomination to the National Register of Historic Places. Out of the 130 original targets identified via reference to historic documents, 49 areas contain remains of dams (closing and wing), rock piles, cribs, and revetments. Two targets identified from side scan sonar imagery revealed the possible remains of old bridge supports at Osceola; although historic, these two targets were not included in the noted 49 targets, as they are not related to the work completed by the USACE. Only two original targets were not investigated due to location, and four were invalid targets based upon discrepancies between modern and historic maps. Finally, 73 out of 130 targets resulted in no findings. Overall, the number of identified historic water control features exceeded our expectations and together form an interesting part of the larger river history.

Per park request, the river was split into four sections for documentation purposes, with one representative site from each of the four sections identified and mapped for historic preservation and interpretation. The sections were Taylors Falls to Osceola, Osceola to Arcola, Arcola to Stillwater, and Stillwater to Prescott. Sadly, two sites in the fourth area, Stillwater to Prescott, were present, but completely silted in. Neither of these two sites, both constructed with pile driven logs, could be hand mapped. The Catfish dam or dyke was only submerged in a few inches of water. It is possible that this site could be imaged in the future with ground penetrating radar (GPR) techniques during a low water year.

The three northern sections contained sites that were conducive to in-depth documentation. From Taylors Falls to Osceola, a rock wing dam south of Franconia Landing was the first site that was documented. Both MWAC and SRC were able to map the site using each of their specialized methods: GPS with a total station and hand mapping, respectively.

Two sites were chosen for mapping in the Osceola to Arcola section: a rare brush and rock closing dam at Log House Landing and a crib and rock wing dam at Marine on St. Croix. The selection of two sites in this area was based both on the inability to map below Stillwater, and the heavy historical use of this section of river. Upon investigation and documentation, both sites represented different construction methods and aligned with the project's goal of detailing unique types of water control features. Also, both of these sites were shallow and could easily present an opportunity for visitor interpretation in the future.

The mapping of the Log House Landing brush and rock closing dam was particularly important; due to the deterioration of organics during wet/dry cycles caused by varying river levels, it was surprising to locate a dam with existing brush or brush mats still in relatively good condition. The Marine on St. Croix dam was the only shallow cribbing with log structure that was located. A rock wing dam extended from shore just south of the cribbing out into the river. The spatial relationship between these two creates an interesting visual for interpretation and one that visitors should be able to see at normal river levels.

The final site documented and the one within the section of Arcola to Stillwater was the Kelly's Slough closing dam. The majority of the targets in this section, especially around the sloughs, no longer existed upon investigation. This rock closing dam was one of the few sites in good condition, and it also represented a distinct mode of construction.

In total, two rock wing dams, a brush and rock closing dam, cribbing, and a rock closing dam were documented in detail during this project. We recommend that the maps drawn during this project be used for future interpretation projects and outreach. Side scan sonar was only used around the target

areas due to limited project duration. At this time, we do not feel that completing an entire river survey with the sonar will strengthen the nomination for the National Register, as 49 locations is a strong representative number, though possibilities to further investigate the river remain. Finally, we see no issue with the release of the information regarding the location of these historic water control features. Unlike shipwrecks where the potential for looting is often high, we feel that these features have a low risk for looting, but a high value to the community, which will encourage preservation and visitor engagement.

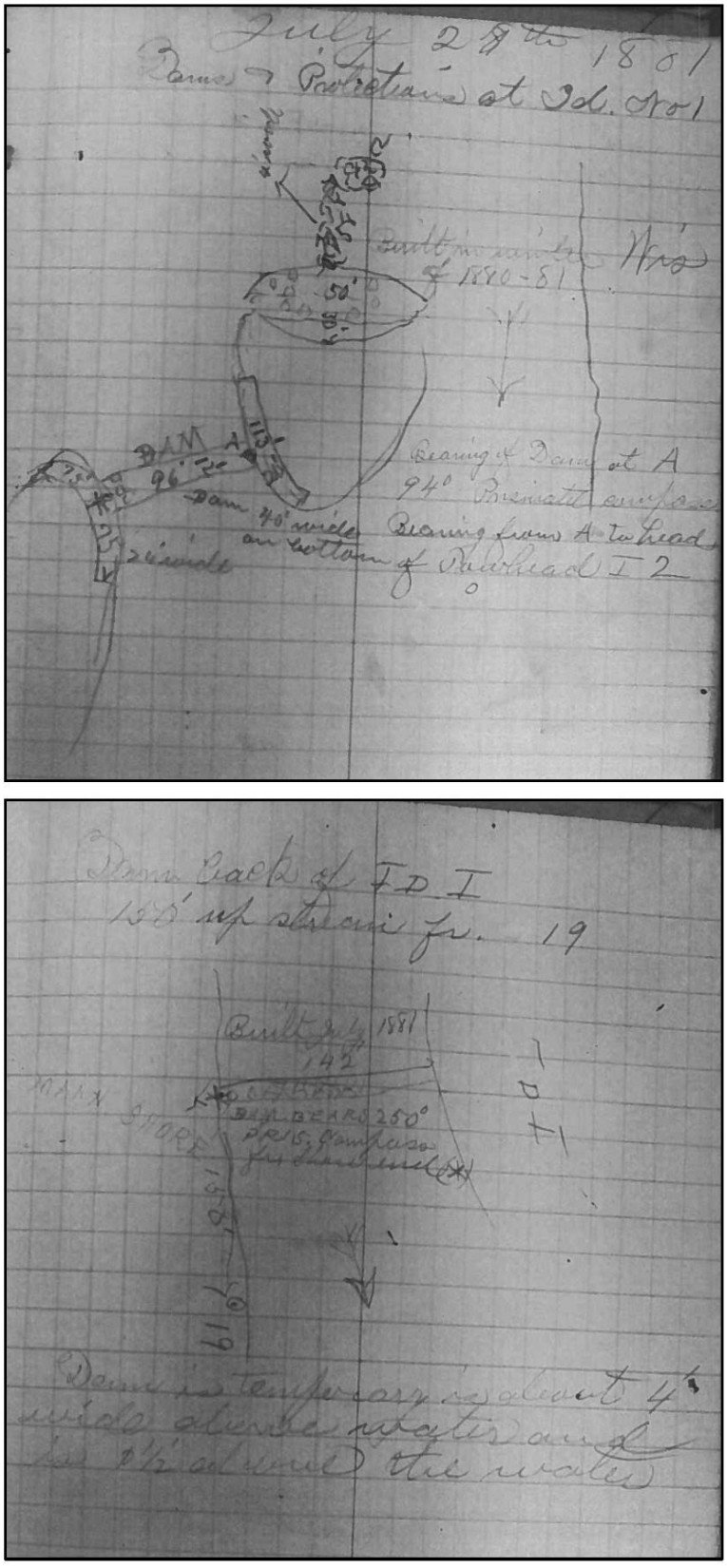
Folsom Island

Historical research and side scan survey investigations around Folsom or Falsom (historically spelled) Island revealed six features relating to river modifications (Figures 6 and 7). Features on the northern end of the island were depicted in sketches from July 1881 by assistant engineer JB Parkinson and October 1883 by John H. Darling who worked on the river with USACE in the construction and planning of river improvements (Figures 8-10). These sketches detail a large closing dam on the southern end of the island, and other modifications, including a possible small closing dam, revetments, cribs, and a possible jetty.

In the 1884 Annual Report to the Chief of Engineers, the USACE listed work completed at a nonspecific wing dam at Folsom. In 1898, two dams, Folsom Island Dams No. 2 and 3 were listed in the Annual Report to the Chief of Engineers as being repaired. Unfortunately, there were no specific locations mentioned for the dams in either report (Figure 11).

The largest feature on the northern tip of the main island was identified as the remains of a closing dam (Figure 12). The 1937 USACE river survey referenced this dam as an existing structure, also shown on the overlay aerial map in Figure 7. The second closing dam at the southern end of the island also appears on the 1937 USACE map. Sonar survey found two rock piles in this area, but they were not as linear and coherent as the northern closing dam (Figure 13). Nonetheless, we believe the rock piles are remnants of the closing dam depicted in the historical documents. Both original and actual GPS locations for the southern features remain on the maps below, but are also identified in detail in the GPS files, GIS attribute table, and Excel findings spreadsheet.

FIGURES 6 and 7. USACE Map, Folsom Island 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI aerial map with USACE map, Folsom Island 1937 overlay.



FIGURES 8 and 9. Folsom map sketches by Parkinson in 1881. (Courtesy of SACN 2015 and Chicago NRA).

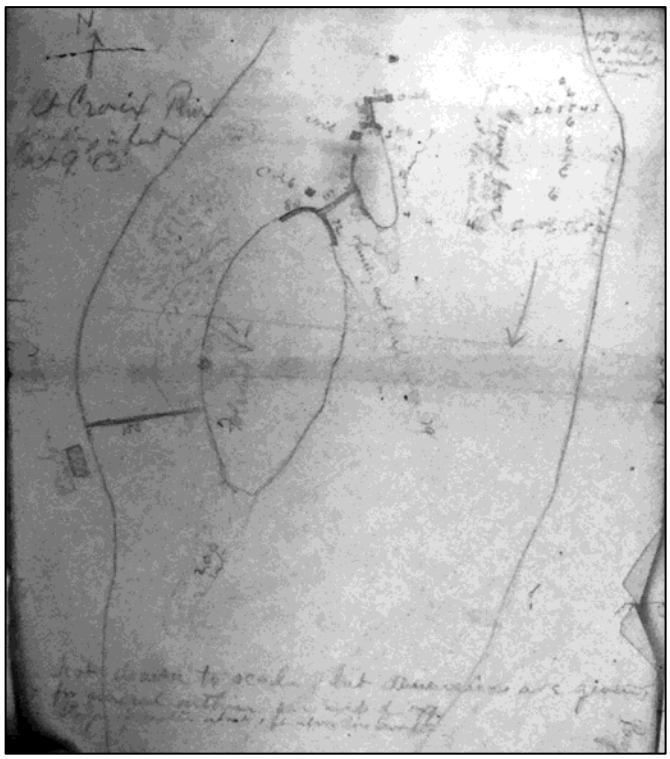


FIGURE 10. Folsom map sketch by Darling in 1883. (Courtesy of SACN 2015).

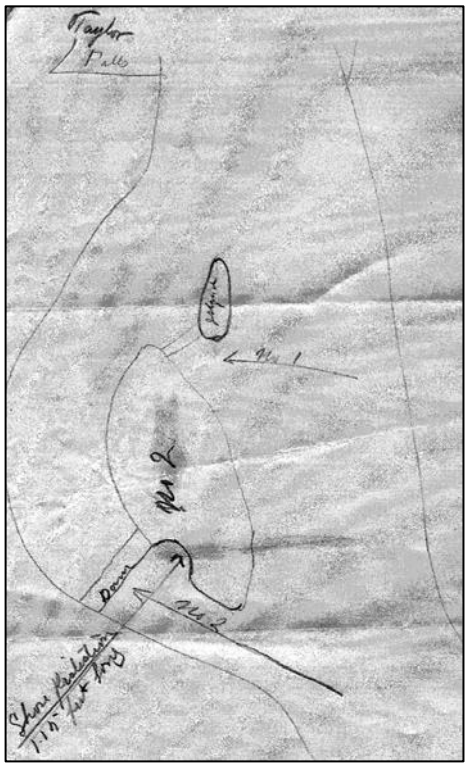


FIGURE 11. Folsom map sketch from 1897. (F.N. Truax to F.V. Abbot, 7 November 1897, Box 51, Entry 1604, Letters Received, 1889-1898, Mississippi River Above Falls of Saint Anthony–Saint Croix River, RG 77, Kansas City, Missouri; Godfrey 2015:74).

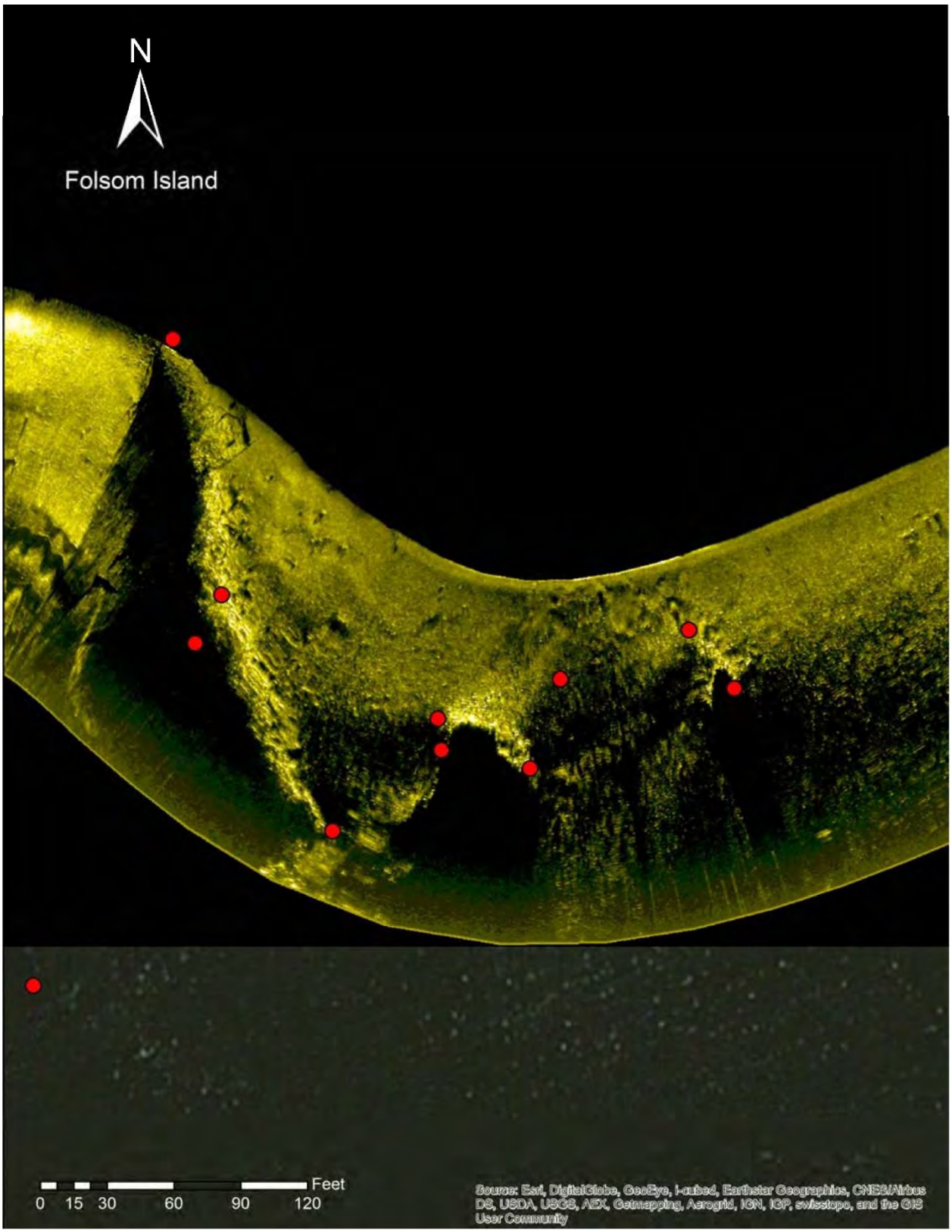


FIGURE 12. Side scan image of the northern section of Folsom Island taken in 2015.

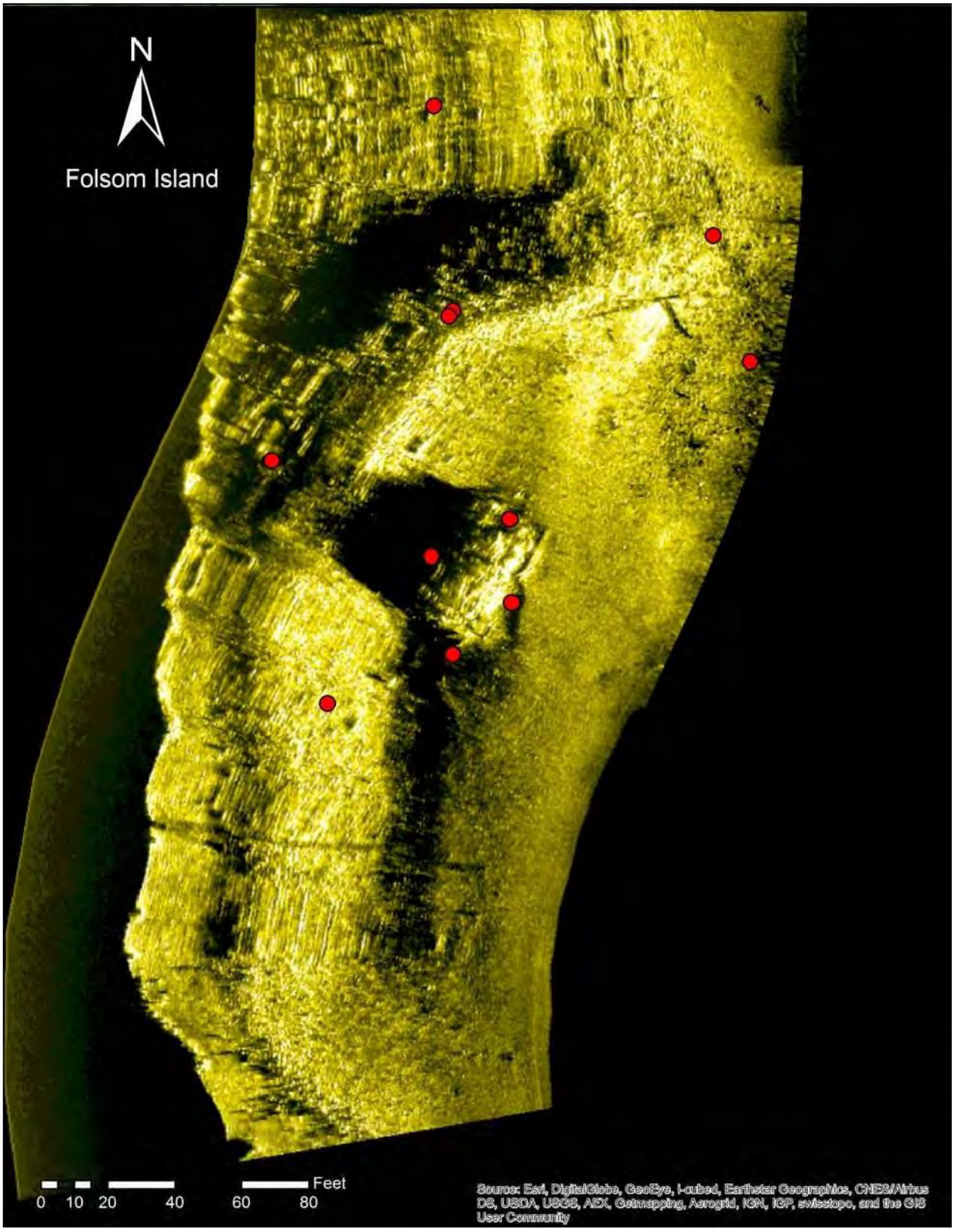


FIGURE 13. Side scan image of the southern section of Folsom Island taken in 2015.

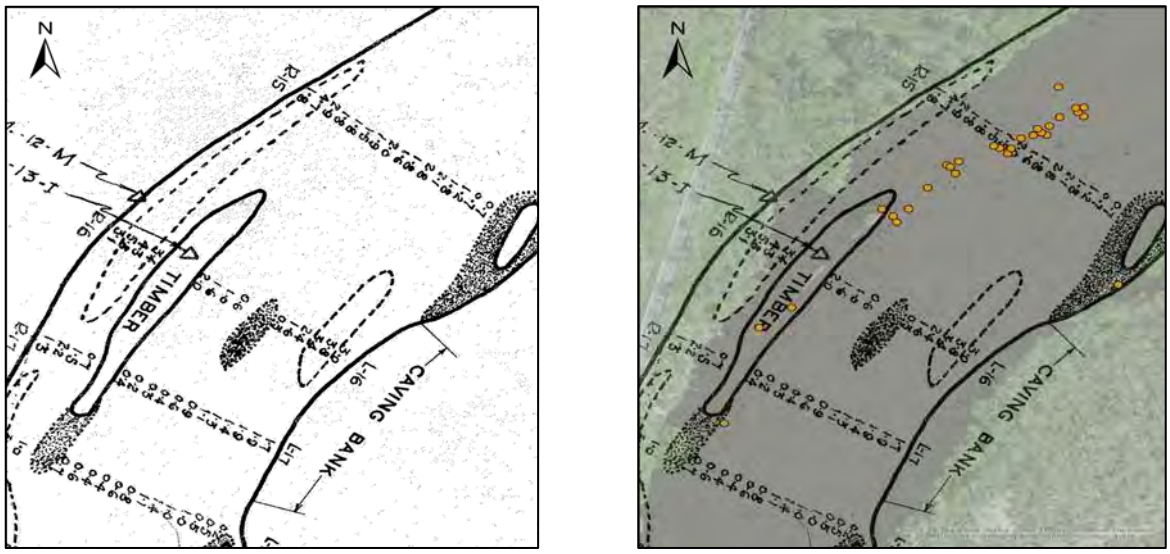
Clark Island

Investigations at Clark Island revealed six individual features. GPS points were taken on each feature's extents to document their size and location (Figures 14 and 15). The first four features were very shallow, but their imagery was captured by side scan sonar (Figure 16). Based upon historical sketches from 1881 and 1883, it appears these four rock piles once formed a continuous line of river modifications at the northern tip of the island (Figures 17 and 18). The Annual Report of Chief of Engineers (1880:1663) reported that Clark Island or Clark Slough had old cribs, a wing dam at the upper end of the island, and a revetment on the right bank of the island. This report also recommended the addition of a "small dam between island and tow-head, and, probably, about 200 feet brush and stone wall at lower end of island [sic]."

Another dam, roughly 850 feet in length, was also recommended to close off a chute between Island 1 (Folsom) and Island 2 (Clark) (Annual Report of the Chief of Engineers 1880:1663). However, in 1884, Clark Island was reported to have a series of revetment bars (Godfrey 2015:40) with no other mention of river modifications near the island. Perhaps the four rock piles identified by this survey were the remains of the revetment bars instead of cribbing or wing dams. The final mention of work completed at Clark was in 1900, relating to channel dredging and wing dams, but with no specific location around the island listed (Godfrey 2015:89).

Towards the end of the project, water levels dropped and sections of the rock piles above the island broke the river's surface (Figures 19 and 20). A fifth rock pile was identified, and appeared to be associated with the other four, though the placement of its rocks differed from the other piles (possibly due to original construction or modern visitor manipulation). Nevertheless, its location and size were documented. These features may have been constructed out of a foundation from an old local French fort, though we noted no evidence of this on the site (Jean Schaeppi-Anderson 2015, pers. comm.).

The final feature identified was a very large wing dam, approximately 400 feet in length, located at the southern tip of the island and extending to the east (Figure 21). Historical records indicate the dam was constructed on the west side of the island, but due to the island's erosion and position shift over the years, the feature now rests in the main river channel. The structure appears to be very stable and poses a navigational hazard to boaters.



FIGURES 14 and 15. USACE Map, Clark Island 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI Aerial Map with USACE Map, Clark Island 1937 overlay.

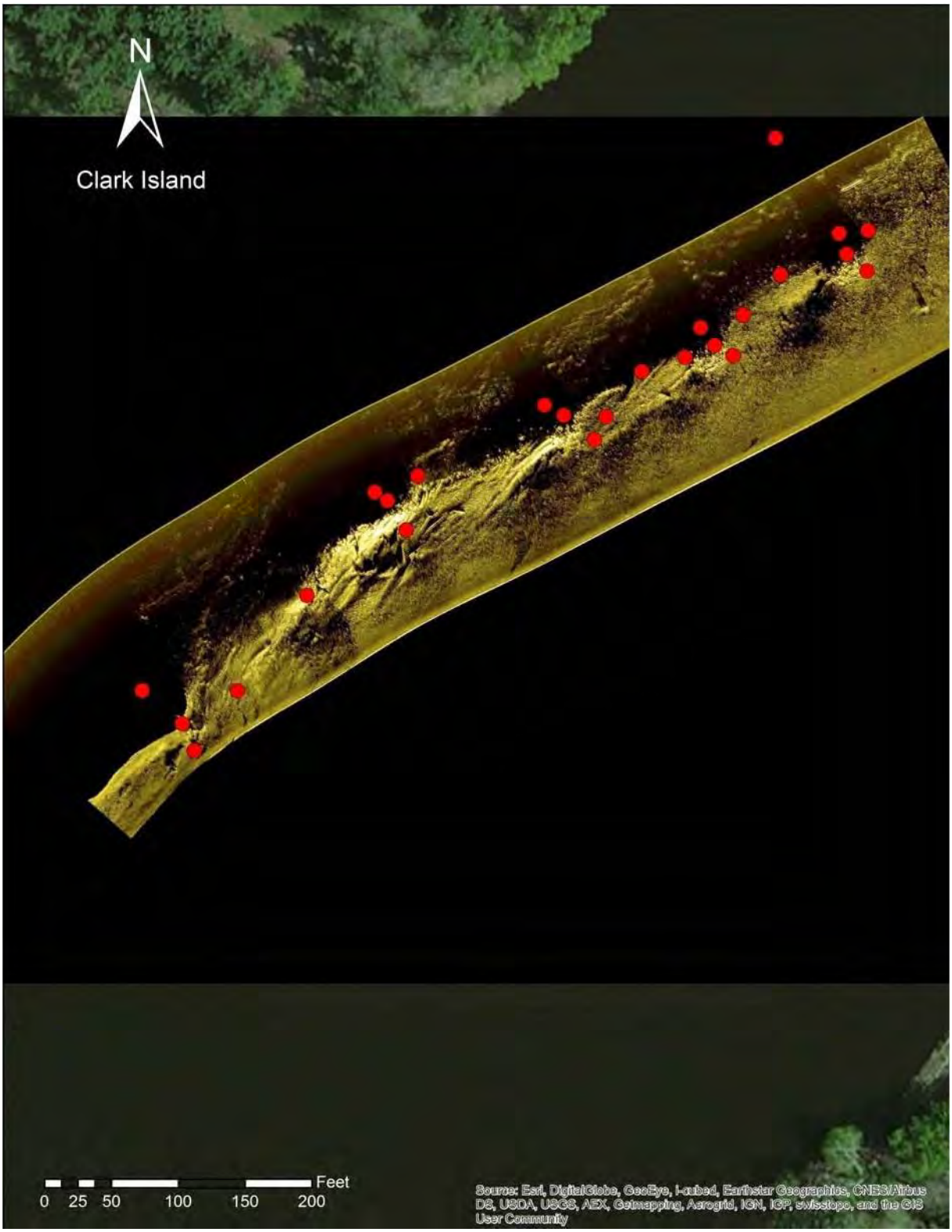


FIGURE 16. Sonar imagery of the northern section of Clark Island taken in 2015.

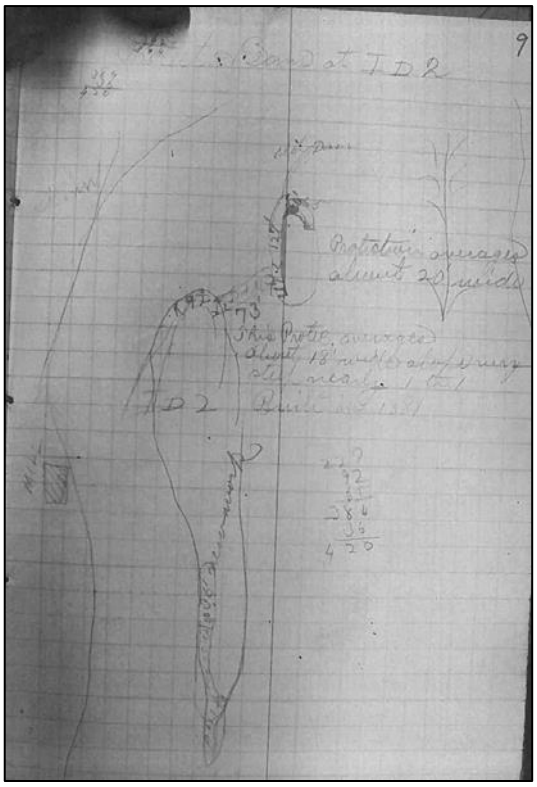


FIGURE 17. Clark Island sketch by Parkinson in 1881. (Courtesy of SACN 2015 and Chicago NRA).

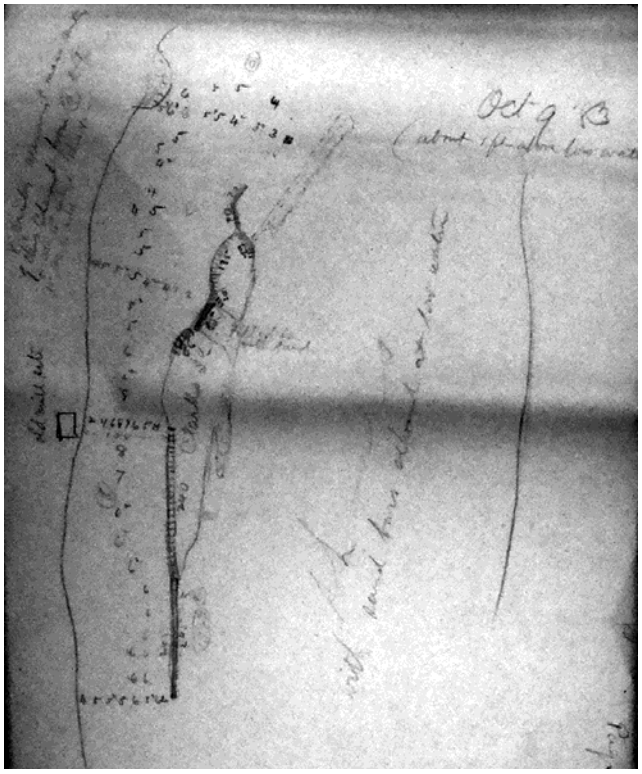


FIGURE 18. Clark Island sketch by Darling in 1883. (Courtesy of SACN 2015).

FIGURES 19 and 20. Clark Island field photos.

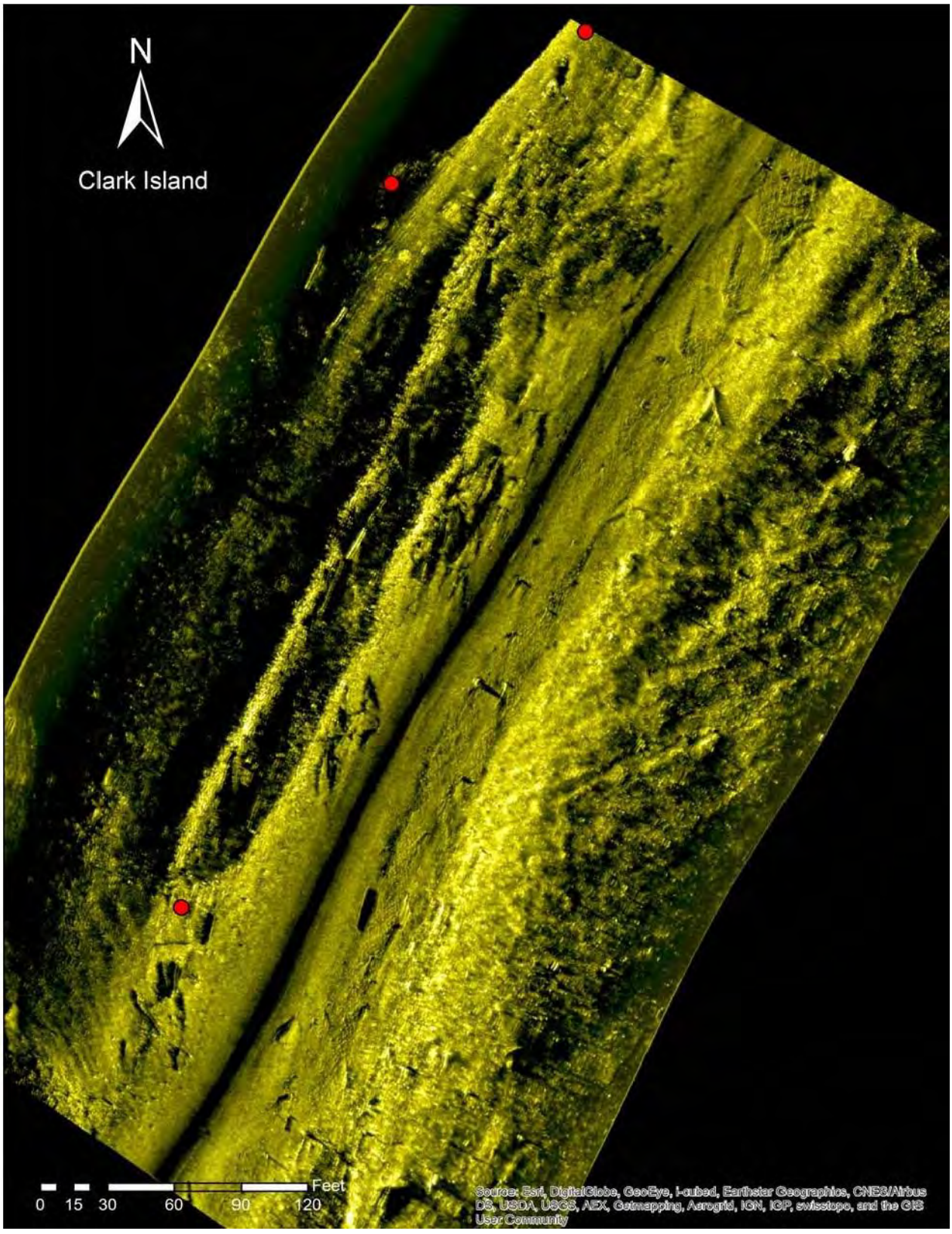
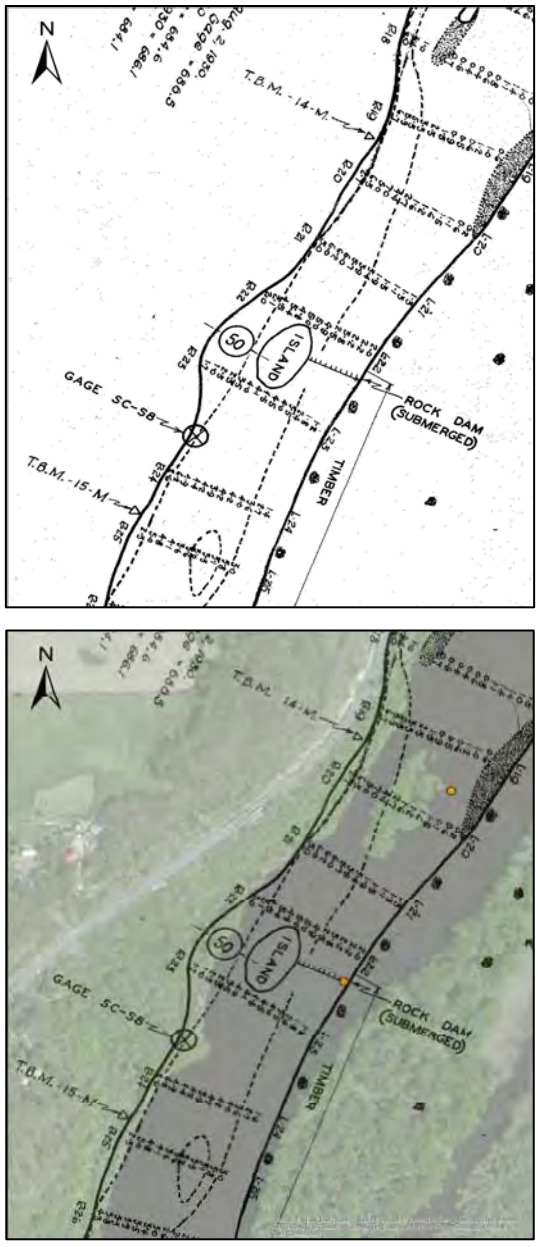


FIGURE 21. Sonar imagery of the southern section of Clark Island showing a large dam.

Blast Island

Blast Island is unique, as the island appears on the 1937 USACE map, but not on a 1926 USACE map (Figures 22-24). The island is a result of a rock collapse during road construction in 1931 above the area (Godfrey 2015:123). The island's location on the 1937 map, when compared to the rest of the river survey, varies greatly to modern day (Figure 23). GPS target points were placed at both the physical location of the island and the georectified 1937 map location. The side scan sonar revealed a linear rock pile (Figure 25), similar to the rock dam on the 1937 map, at the physical location of the island. GPS targets were extracted from sonar data and placed on the imagery to show the site extents. The current was moving swiftly at the time of investigation and it was determined unsafe to dive given the distinct feature in the sonar image.



FIGURES 22 and 23. USACE Map, Blast Island 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI aerial map with USACE map, Blast Island 1937 overlay.

FIGURE 24. USACE Survey Map from 1926. (Minnesota Digital Library: Minnesota Reflections http://reflections.mndigital.org/cdm/singleitem/collection/ p15160coll7/id/37.; Godfrey 2015:121).

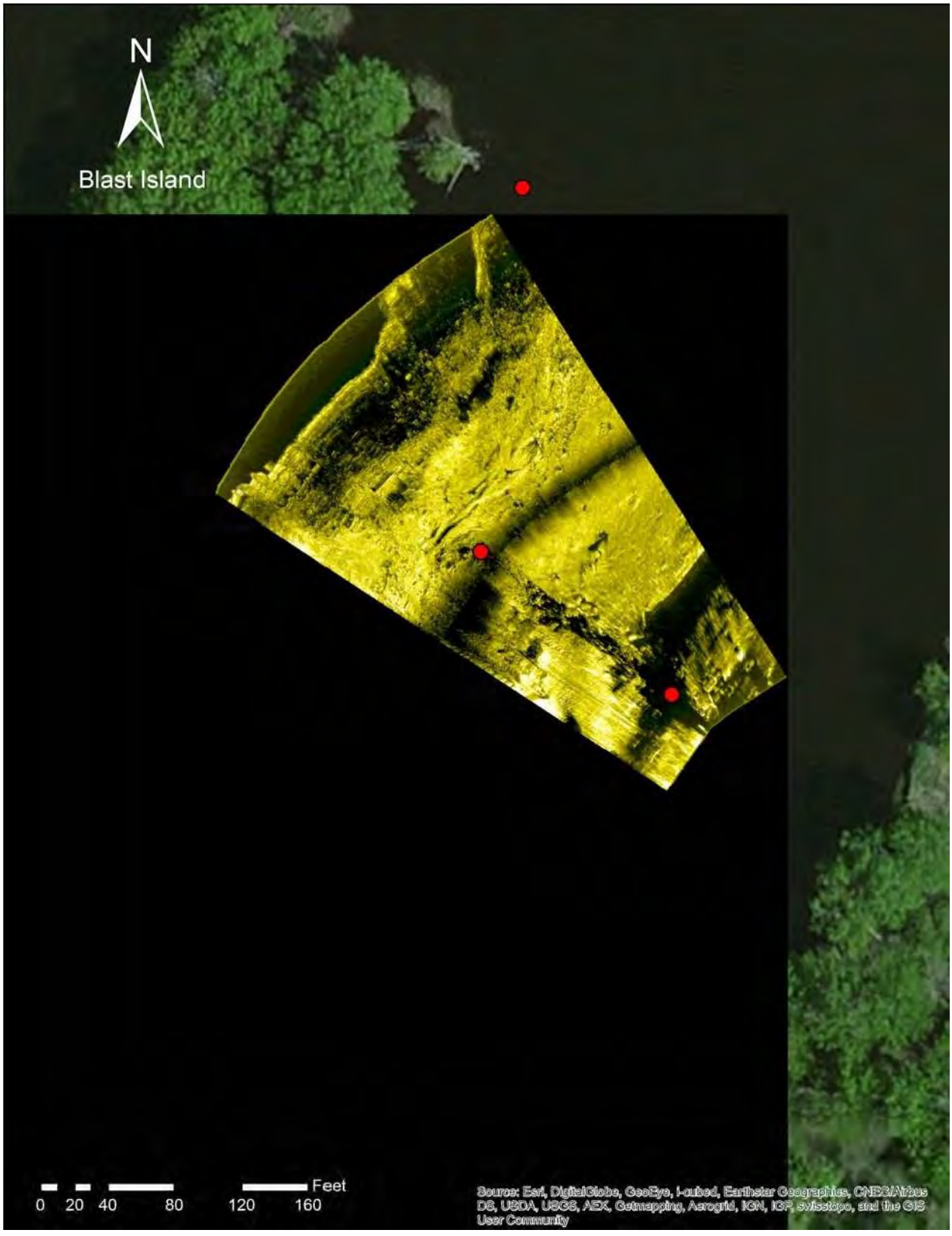
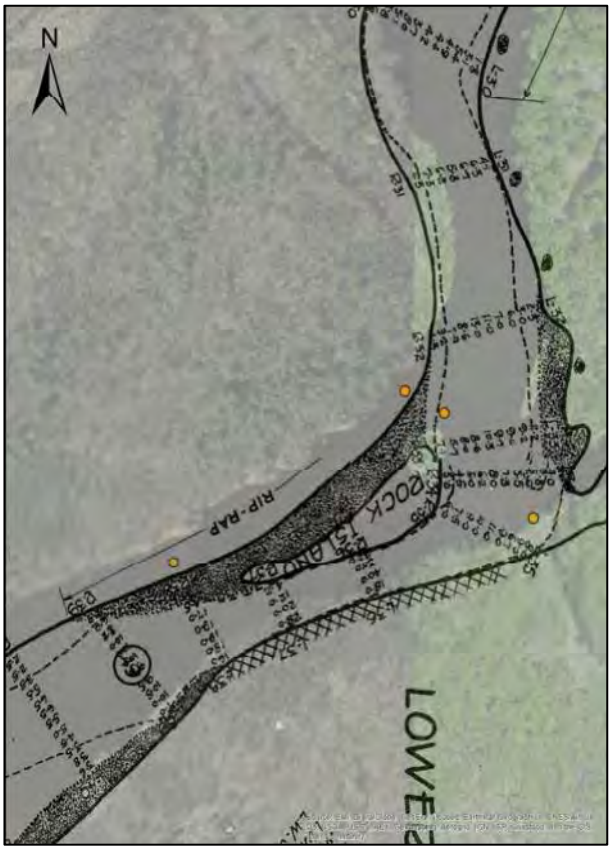
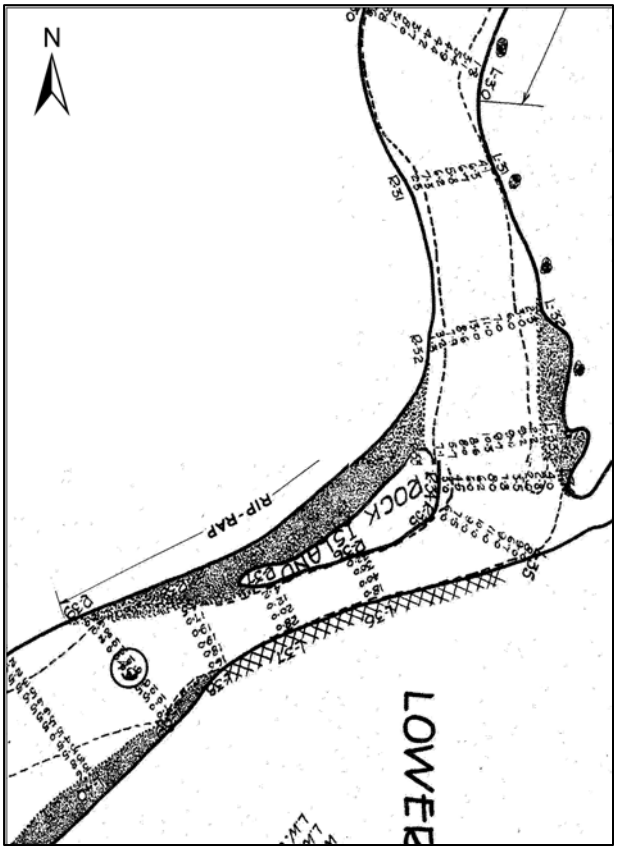


FIGURE 25. Sonar imagery of Blast Island revealing linear rock dam.

Rock Island

Rock Island is believed to have historically been referred to as Island 3, as referenced in the 1880 Annual Report to the Chief of Engineers. The report cites an accompanying map of the river with the islands numbered as a reference; however, the map has not been located. Assuming Rock Island is Island 3, a 600 foot jetty was proposed (Annual Report to the Chief of Engineers 1880:1663). No other references to this jetty's construction or maintenance were found, but Figures 26-28 below show that in 1926, the western portion of the river was open, while in the 1937, it was filled in with sediment. Side scan sonar and personal investigation of the western side around Rock Island were conducted and resulted in the identification of natural rock outcroppings (Figures 29 and 30). Also, the area to the north of the island has been heavily disturbed with the placement of a pipeline.





FIGURES 26 and 27. USACE Map, Rock Island 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI aerial map with USACE map, Rock Island 1937 overlay.

FIGURE 28. USACE Survey Map from 1926. (Minnesota Digital Library: Minnesota Reflections http://reflections.mndigital.org/cdm/singleitem/collection/p15160coll7/ id/37.; Godfrey 2015:121).

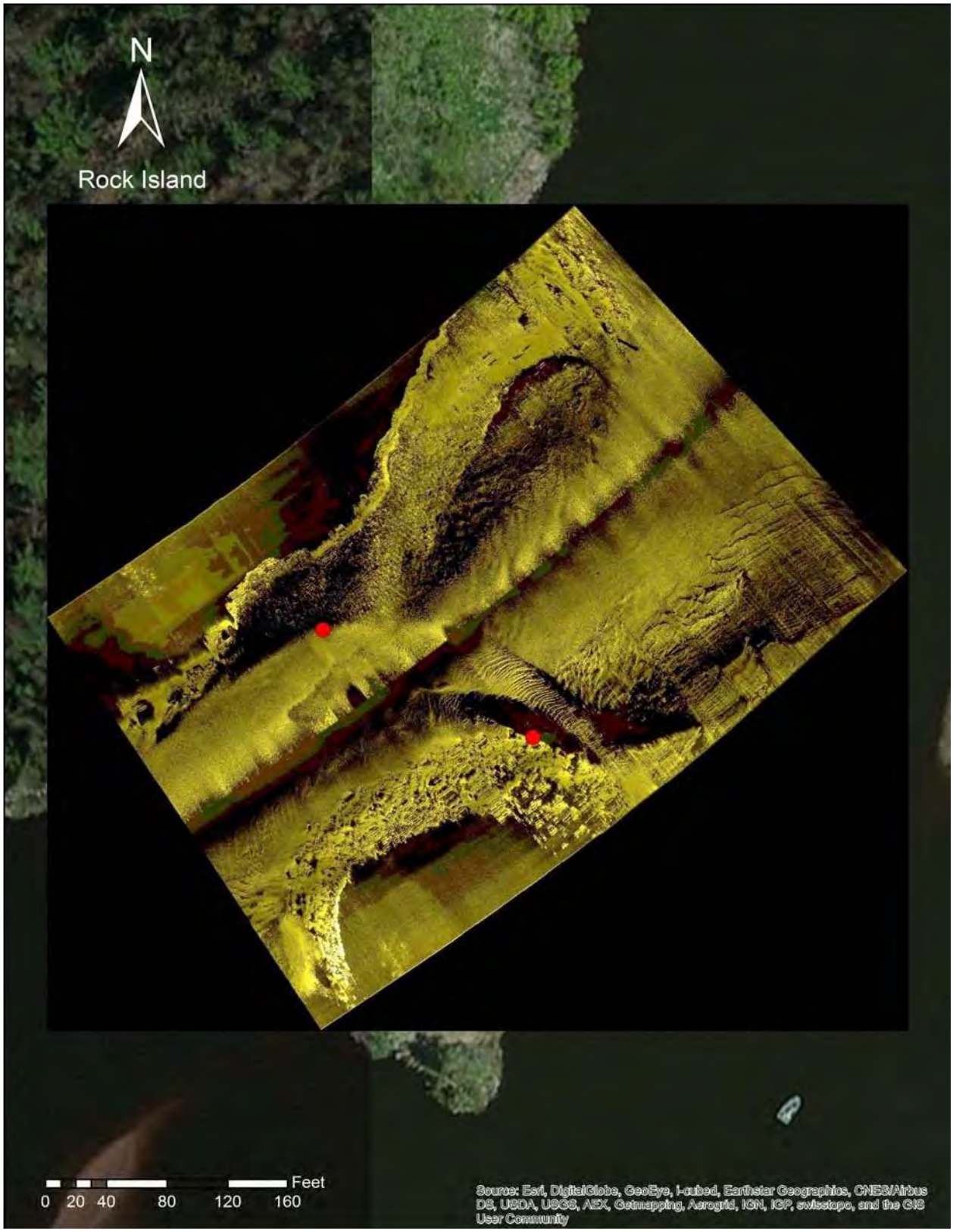


FIGURE 29. Sonar imagery around Rock Island identified as natural rock outcroppings.

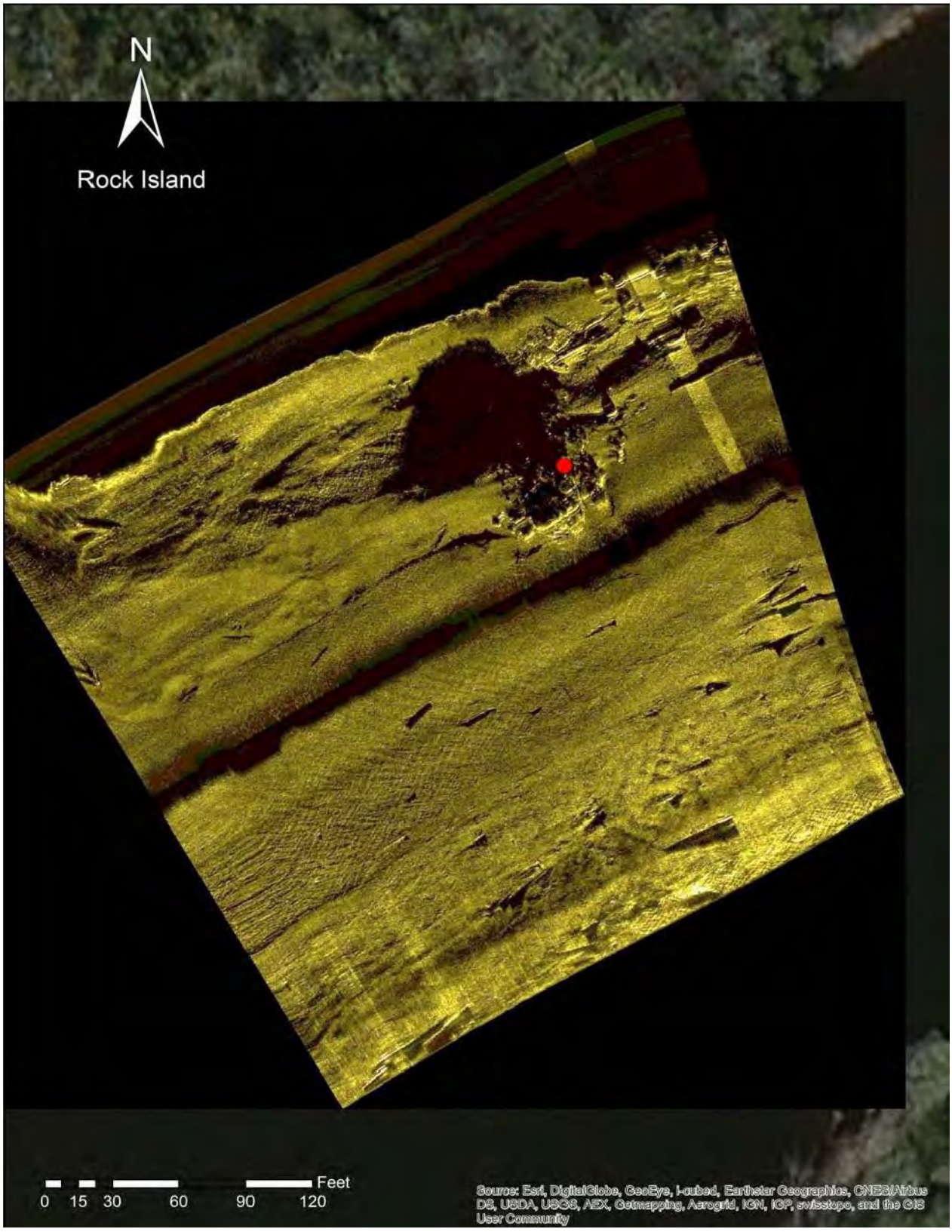


FIGURE 30. Sonar imagery below Rock Island revealing a natural rock outcropping.

Franconia Landing

Survey areas for the Franconia section of the St. Croix River were selected via historical research and the direction and experience of SACN park staff (Figures 31-32). In 1880, the USACE proposed that the construction of a 200 foot long wing dam across the slough on the Minnesota bank above Franconia might assist in maintaining depth over that stretch of the river (Annual Report of the Chief of Engineers 1880:1663). Floods in the spring of 1881 changed many features of the river, however, including the development of a large sandbar above Franconia. The USACE addressed the new obstruction with the installation of temporary brush and stone wing dams (Annual Report of the Chief of Engineers 1881:1751, Godfrey 2015:32, 34). Figures 33-36 are sketches from 1881 by assistant engineer JB Parkinson and 1883 by Darling regarding work around Franconia.

It is unknown whether or not these temporary structures were converted into permanent water control features, but the 1937 USACE map indicated a wing dam proximate to the 1880 report's proposed location. The map also indicated a recommended closing dam on the eastern side of the river, with the intent of sealing a small channel leading to Peaslee Lake.

Working from this information, and from the observations of SACN historian Jean Schaeppi-Anderson, the survey team established 10 areas to investigate. The broad search area was particularly important, as it was unclear how many dam structures might remain in the Franconia area. It was possible to acquire sonar data on four of the targets; the remaining six were investigated on foot and kayak.

The sonar imagery from GPS point 28 revealed a series of four dams: one large feature on shore near Franconia Landing, with the other three extending to the north (Figure 37). The three northern dams had logs emerging on the Minnesota shore side. The team investigated all four sites on foot, and took GPS points on the cardinal extents of each.

The sonar data showed no findings at GPS point 120, but at GPS point 45, the sonar displayed the remains of a closing dam. After investigating on foot, the feature included eight pile-driven logs, with terminal ends pointing south. The team took GPS points at the feature's cardinal extents.

Sonar imagery at GPS point 29 displayed a large wing dam just north of Eagle's Nest (Figure 38). GPS and Total Station points were acquired at the site, and the dam was deemed an ideal feature for mapping by hand.

The team placed a 235 foot long baseline running west to east, at a 100 degree compass heading (Figure 39). The team took baseline offsets of the dam every ten feet via wading and SCUBA. The intensity of the current increased as the team progressed east, so beginning at 210 feet on the baseline, they acquired measurements every five feet. After completing the offset measurements through 235 feet on the baseline, the team discovered that the dam continued further to the southeast, extending at least another 55 feet out into the river at a compass bearing of 160 degrees. A GPS point could not be collected on the southeastern tip of the underwater structure, due to its distance from shore, the depth of the water, and the speed of the river's current, but the team was able to use the sonar imagery to establish the total extent of the entire structure (approximately 310 feet long, with an overall compass bearing of 118 degrees). The measurements collected on the main dam structure along the baseline were mapped on Mylar at a 1/8 inch scale, and then inked. The final site map (Figure 40) illustrates the remains of the Franconia wing dam. This dam was composed primarily of stone, and was separated into two distinct sections.

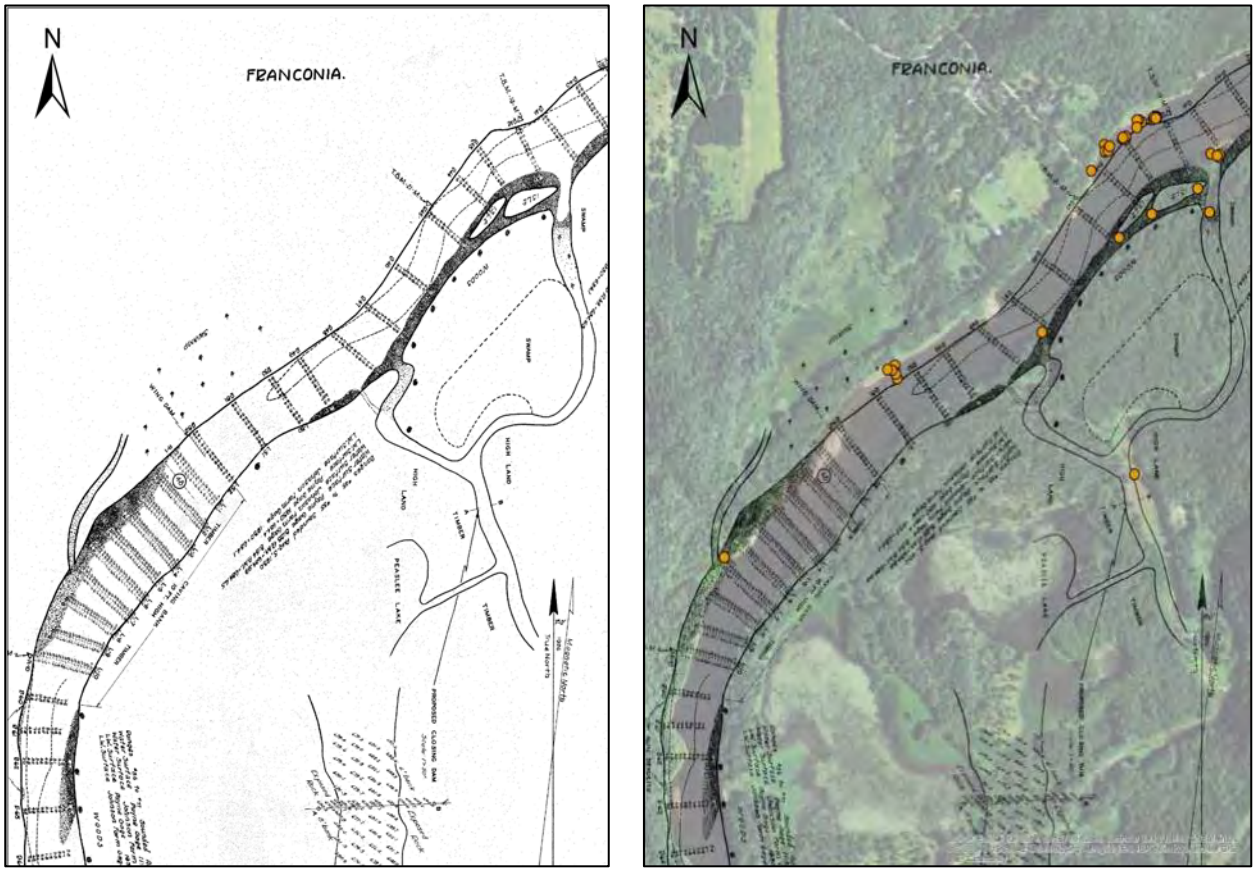
The reason behind the dam's division can only be speculated upon, but one possibility is that it naturally degraded, a deterioration perhaps prompted by a high water flood event or from the impacts of ice. Searches around the area, however, did not reveal a scatter of rocks extending downriver from the dam break to support this theory. While it is possible that the structure of the middle section of the dam was

utterly washed away, or remains present but undiscovered, other possibilities must be considered.

Another option is human interaction. The dam could have been struck by a vessel, resulting in a breach in the dam structure that widened over time. The dam might also have been purposely modified to alter the river flow. Such intentional modification would speak to the river's role as a living highway, and the ongoing importance of its control features to local constituents, long after official USACE operations ceased. Finally, given the differing angles of the dam (Figure 40), it is also possible that the dam was constructed in several stages, to adapt to changing needs, river flow patterns, or loss of dam structure.

A final option is that the missing section was never constructed at all. If the dam was indeed constructed as a patchwork of control features over many years, it is possible that the missing section was intentional or neglected, and merely another element in the effort to control the Franconia river area.

The team investigated the other six targets on foot or via kayak. Shore searches around GPS target 46 resulted in the location of two logs and a large rock, possibly the remains of a closing dam. Upon shore inspection, GPS target 48 was found to be the remains of a successful closing dam, now buried under sediment and foliage. The team also located a second similar closing dam mound nearby. GPS targets 47 and 49 resulted in negative findings, and while target 50 was associated with a single worked log in a small creek delta with large sediment deposits and foliage, it had no related stone features indicating dam structure.



FIGURES 31 and 32. USACE Map, Franconia 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI aerial map with USACE map, Franconia 1937 overlay.

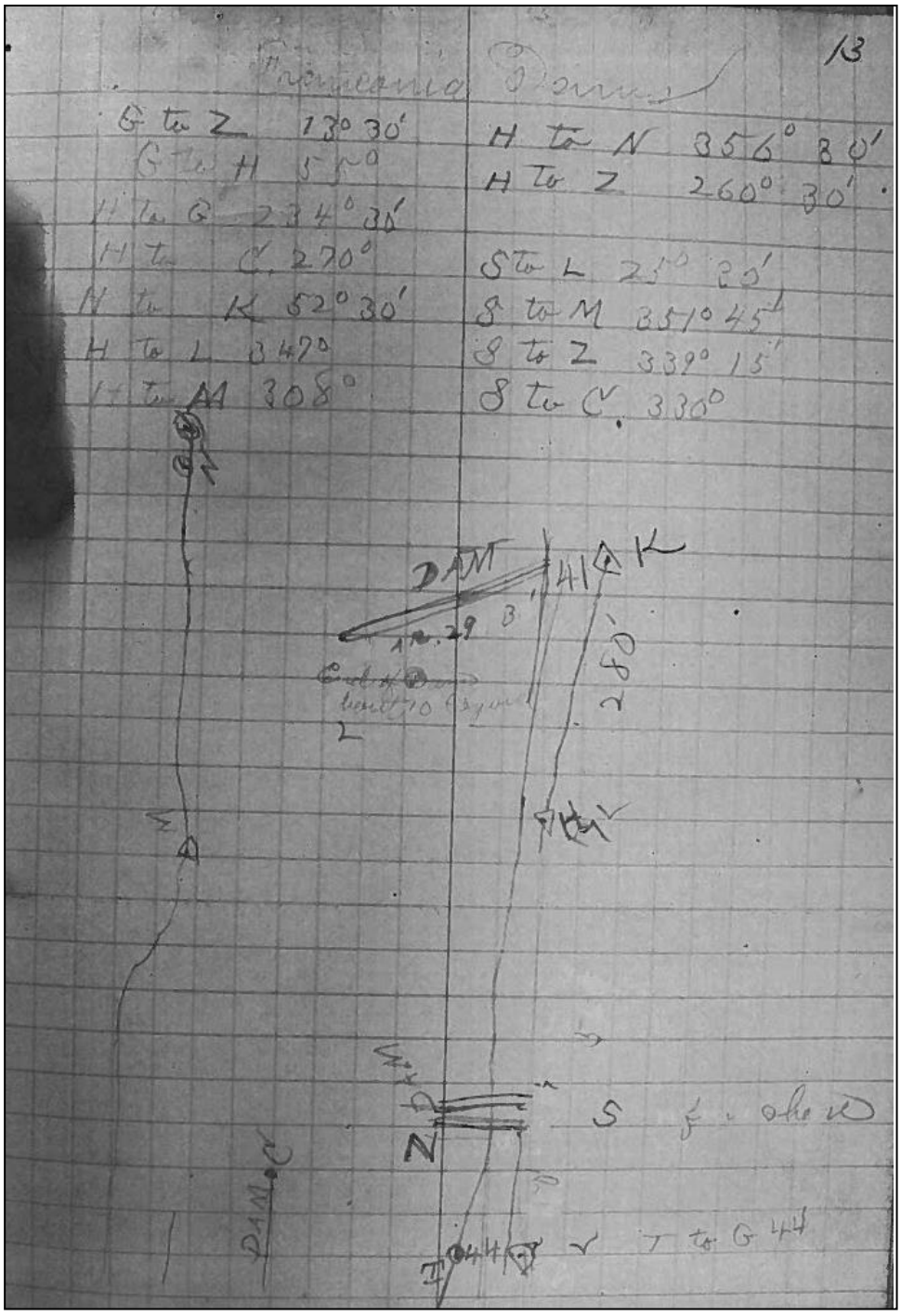
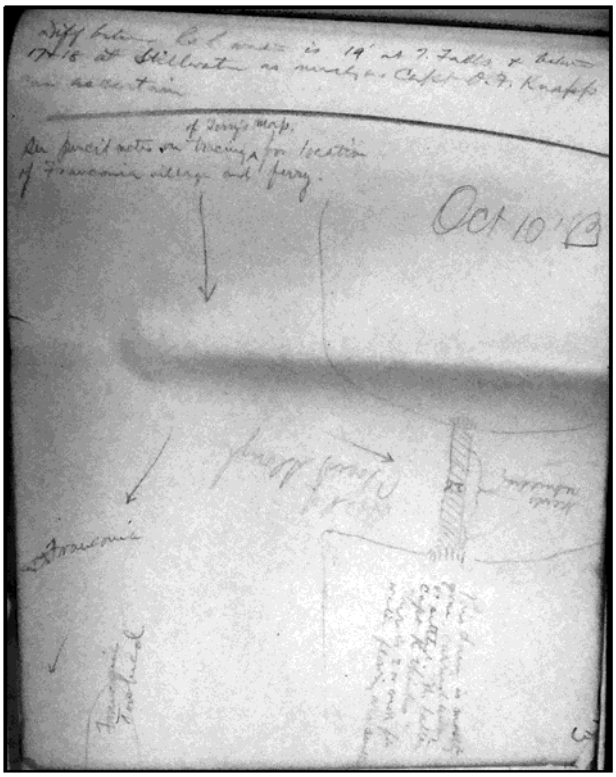
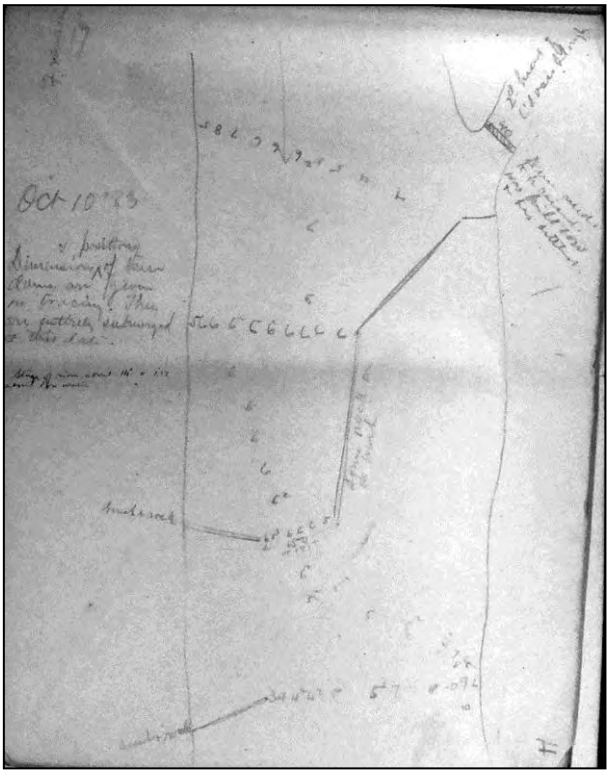
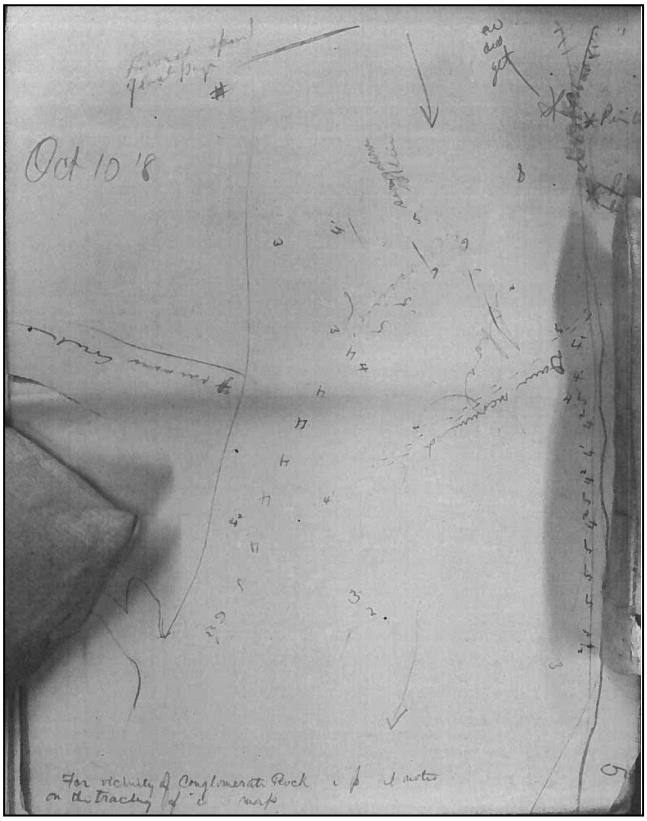


FIGURE 33. Franconia sketch in 1881 by JB Parkinson. (Courtesy of SACN 2015 and Chicago NRA).







FIGURES 34-36. Franconia sketches by Darling in 1883. (Courtesy of SACN 2015).

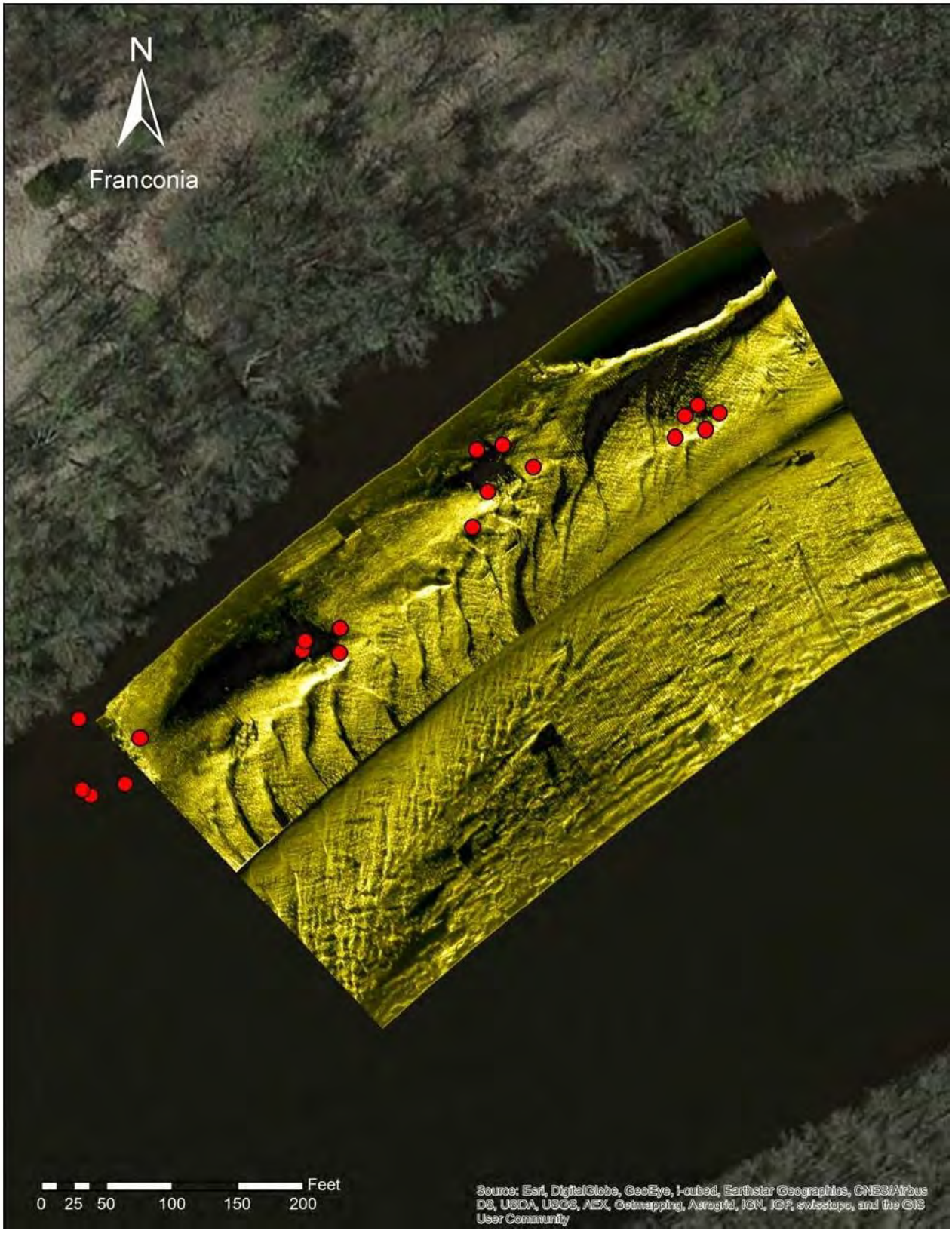


FIGURE 37. Sonar imagery above Franconia Landing at GPS 28 revealing a series of features.

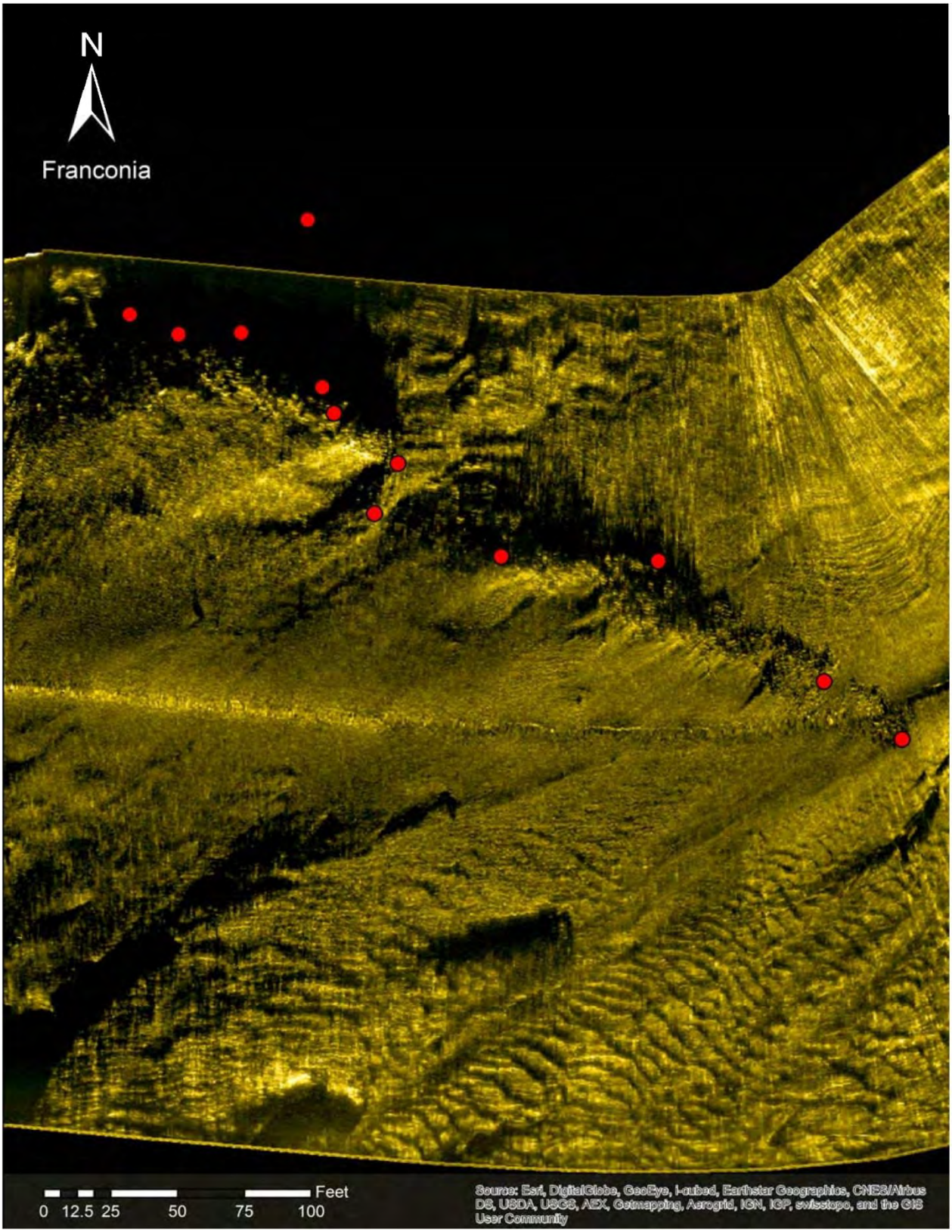


FIGURE 38. Sonar imagery below Franconia Landing at GPS 29 revealing a large wing dam.

FIGURE 39. An image from GPS 29 showing the large wing dam at Franconia.

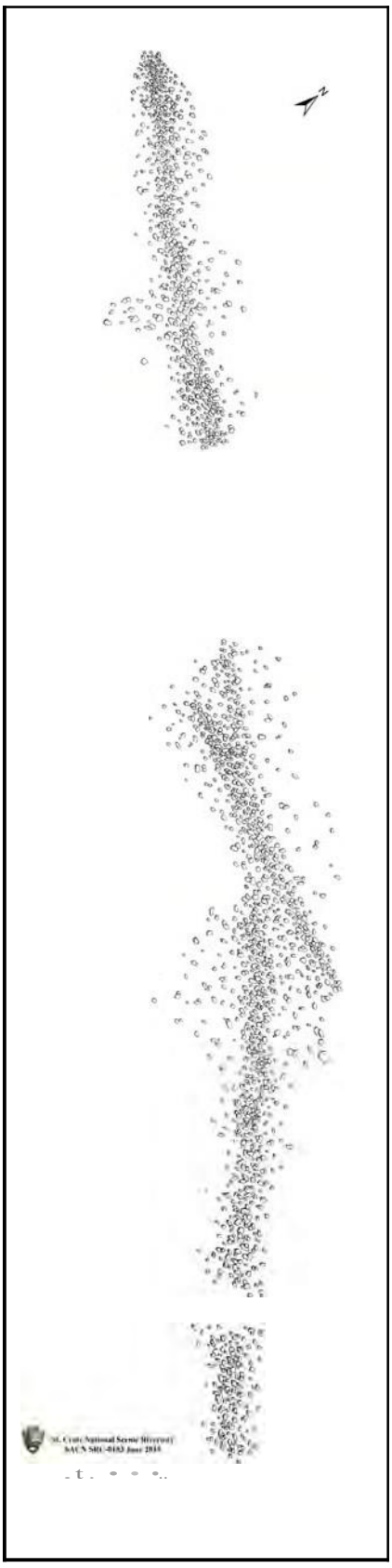
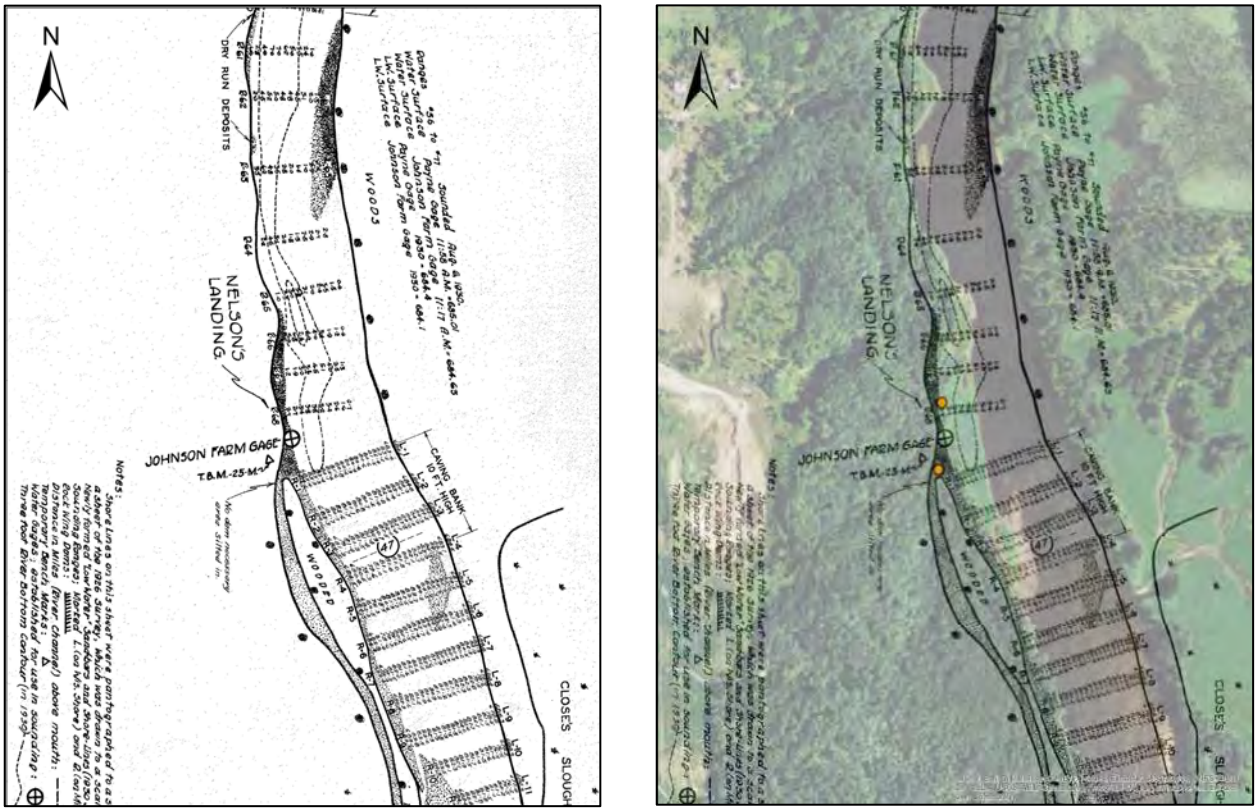


FIGURE 40. Franconia Site Map 2015.

Nelson's Landing

According to SACN staff, in 2007 the historic Nelson's Landing contained the remains of three dams constructed of logs and rocks, including one approximately 12 feet in length (Jean Schaeppi-Anderson 2015, pers. comm.). This section of the river appears to have changed significantly when compared to the 1937 USACE map (Figures 41-42). Historically, Nelson's Landing and Conglomerate Rock Slough were in the same area, near Mile 47, and may have been interchanged (Figure 43) (Godfrey 2015:118). In 1883, a dam was repaired at Conglomerate Rock, but no other references to the construction or maintenance of dam in this area were located (Godfrey 2015:38). Upon investigation, the islands have filled in with sediment and no dam remains were located. The modern day location called Nelson's Landing is above the confluence of the Snake and Kettle River, over 30 miles north of St. Croix Falls, and was not included in this investigation.



FIGURES 41 and 42. USACE Map, Nelson's Landing 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI aerial map with USACE map, Nelson's Landing 1937 overlay.

FIGURE 43. USACE Survey Map from 1926. (Minnesota Digital Library: Minnesota Reflections http://reflections.mndigital.org/cdm/singleitem/collection/ p15160coll7/id/37.; Godfrey 2015: 121).

Boom Island

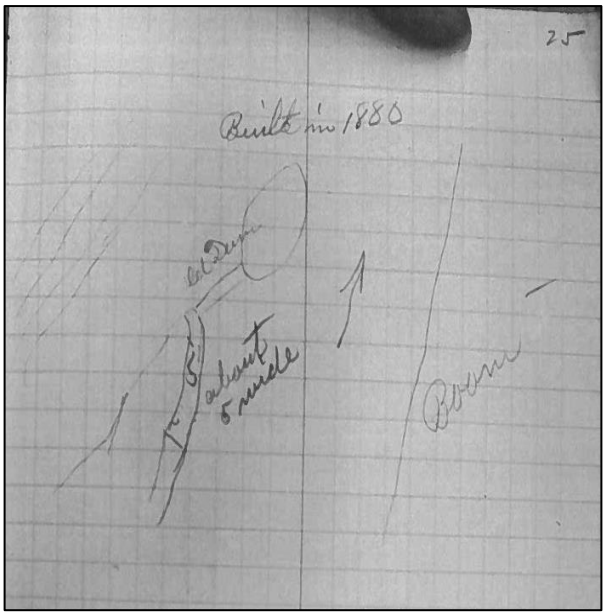
The Boom Island section of this survey began downriver from Nelson's Landing, and continued through the water surrounding the island itself. With a powerful current running along the western bank of the island, mitigation efforts to limit this channel's diversion of water from the main river were in place by 1878. An 1100 foot long revetment and a 300 foot dam complemented debris from earlier cribs that partially closed the channel, but floods in 1879 washed much of this material away. In 1880, surveyors from the USACE proposed the construction of a 620 foot long dam to limit water entering the western channel (Annual Report of the Chief of Engineers 1880:1663). Work on the closing dam began immediately with the installation of an apron, and by February 1880, the dam had 207 cubic yards of fill in place (Report of Operations 1880, Godfrey 2015:30). The sketches in Figures 44 and 45 appear to represent the dam constructed in 1880 from different angles.

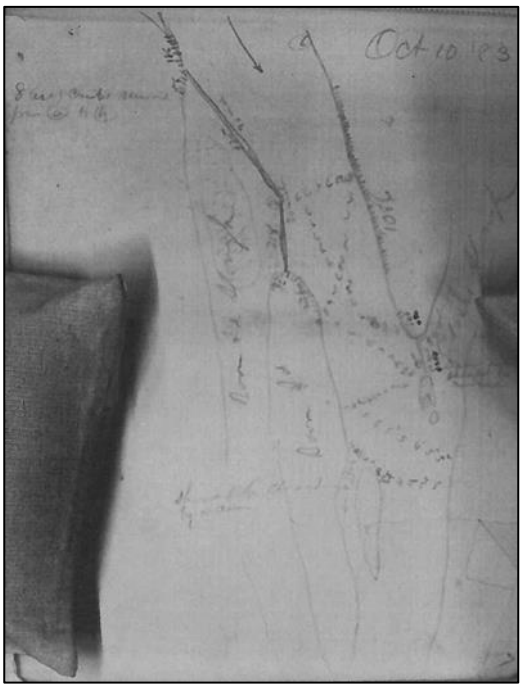
The following year, an extension of the Boom Island dam was approved, as well as maintenance in the upriver revetment on the eastern bank (Allen 1881, Godfrey 2015:31). Additional closing and wing dams were built in 1883 (Annual Report of the Chief of Engineers 1883:1444-1445, Godfrey 2015:38). The closing dam can be seen on the right side of Figure 46. Only two of these appeared on the 1937 USACE map: a closing dam and a rock wing dam, both at the head of the island at its left bank (Figures 46-47).

The survey team isolated six GPS targets based on the historical information above and discussions with park staff. The team examined most of these sites via sonar, though a few were shallow enough to require investigations on foot (Figure 48). Photographs were taken of existing features where possible (Figures 49-54). GPS targets 52 and 121 were investigated with sonar and visited in person, and are thought to be the closing and rock wing dam, respectively, marked on the 1937 USACE map (Figure 55). At 121, it was also confirmed that the corresponding revetment also remained in situ; a second GPS point was collected for this feature. SACN volunteer Bob Whaley observed that over ten years ago the revetment was connected to Boom Island, but now due to erosion, a channel runs between the island and the revetment.

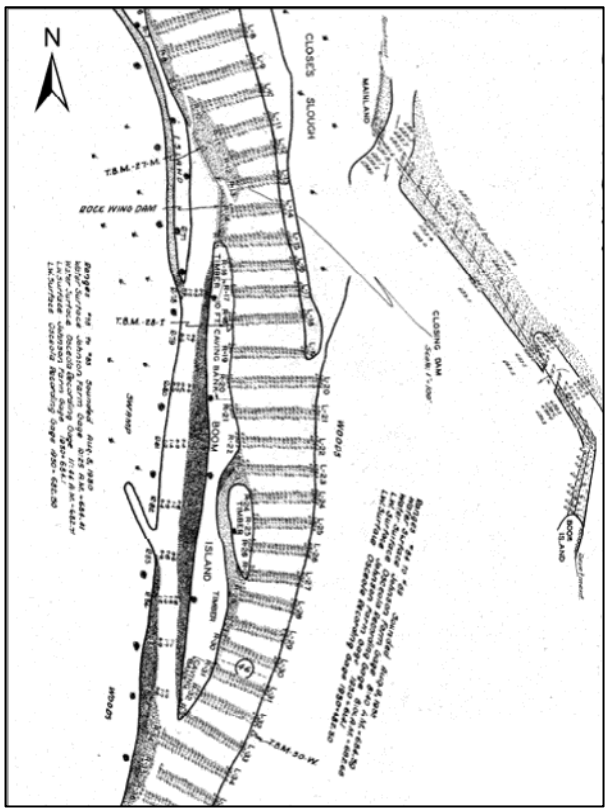
GPS target 30 was originally marked as a closing dam on the SACN park GPS, but shore investigations around the point resulted in negative findings. Similarly, target 53 also produced no findings.

Sonar imagery of target 31 prompted investigations on foot of a closing dam (Figure 56). GPS points were collected on the site's cardinal extents to delineate its boundaries. Target 32 was also a SACN park GPS point, and while sonar data collection was attempted, the target was shallow enough to require examination on foot. The team found one main pile of rocks (approximately 20x20 feet), and a few associated large rocks off the pile's western side. While the two areas did not connect to form a coherent dam structure, they establish an east-west line across the Boom Island channel.





FIGURES 44 and 45. Boom Island sketches by Parkinson in 1881 and Darling in 1883. (Courtesy of SACN 2015 and Chicago NRA).



FIGURES 46 and 47. USACE Map, Boom Island 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI aerial map with USACE map, Boom Island 1937 overlay.

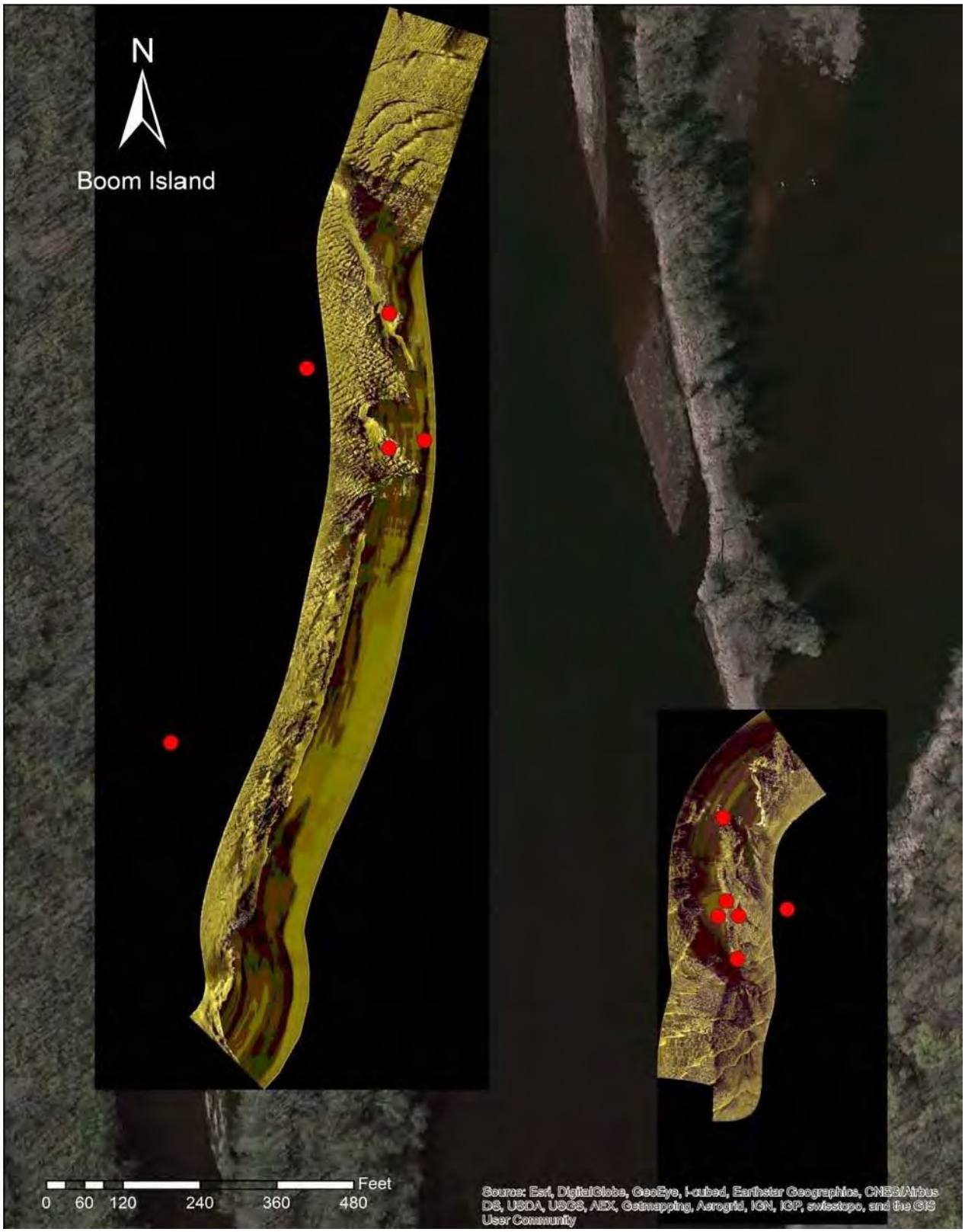
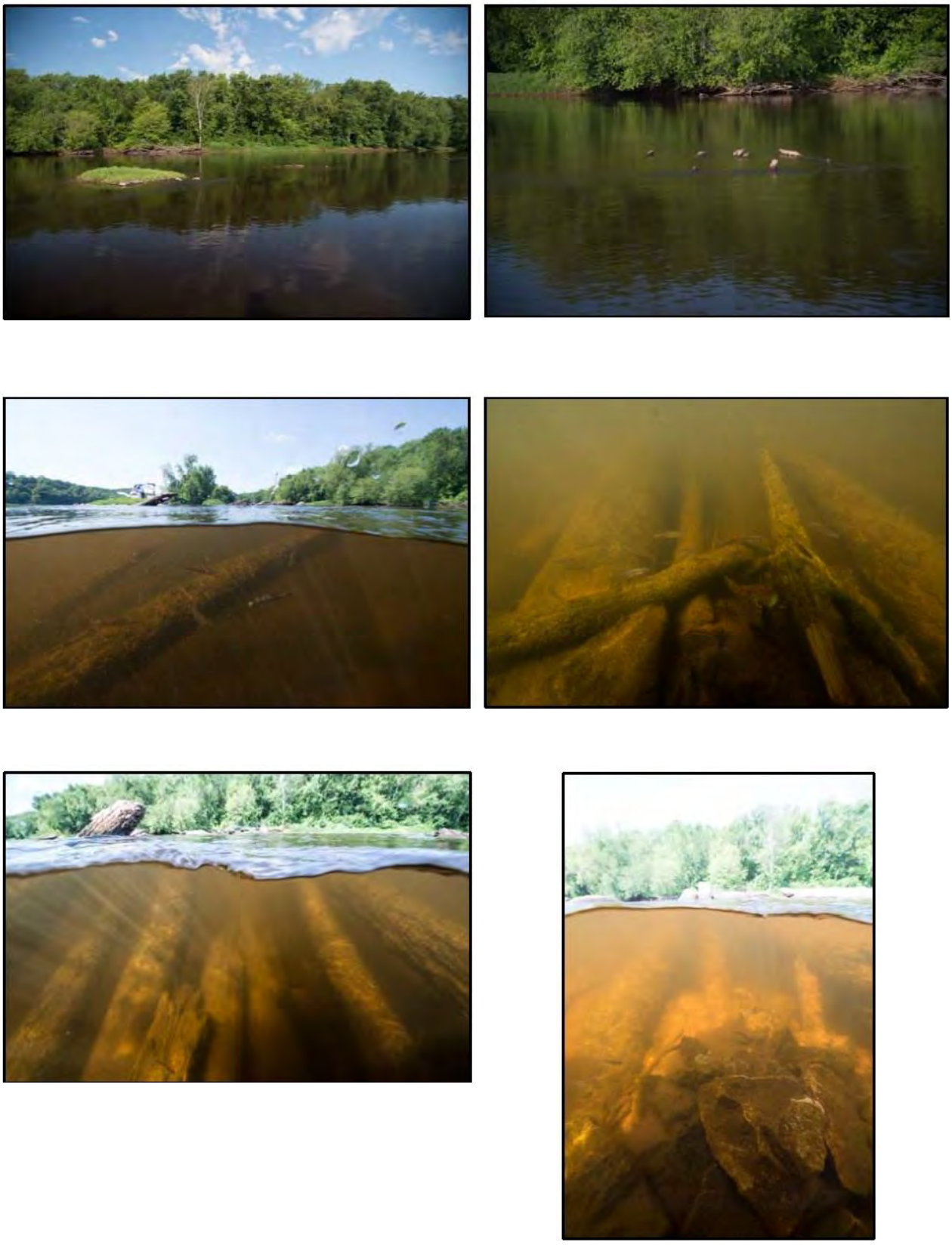


FIGURE 48. A sonar overview of Boom Island showing dams on either side of the river.



FIGURES 49-54. Images showing details of the large dam at Boom Island.

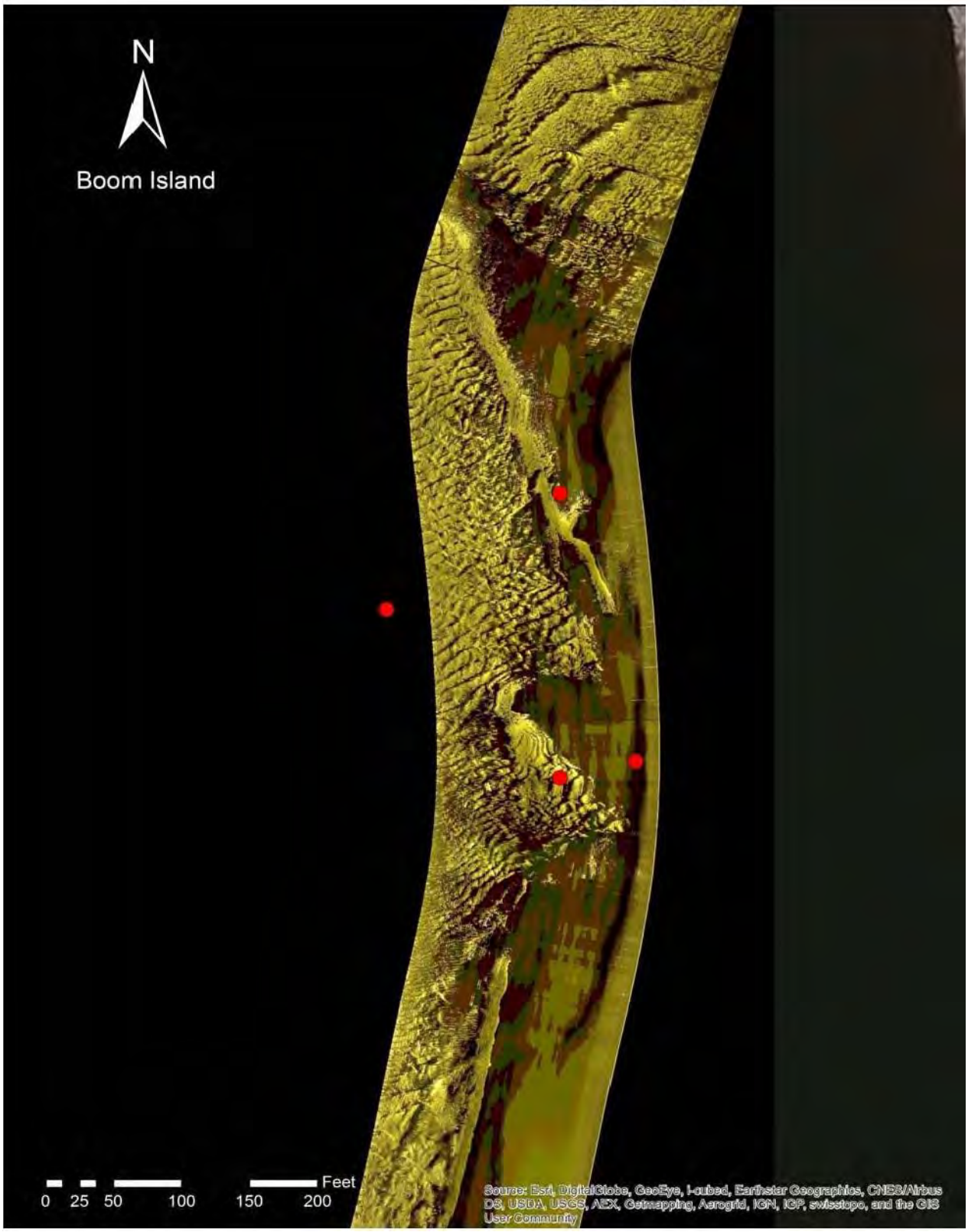


FIGURE 55. The sonar imagery from the large dam north of Boom Island.

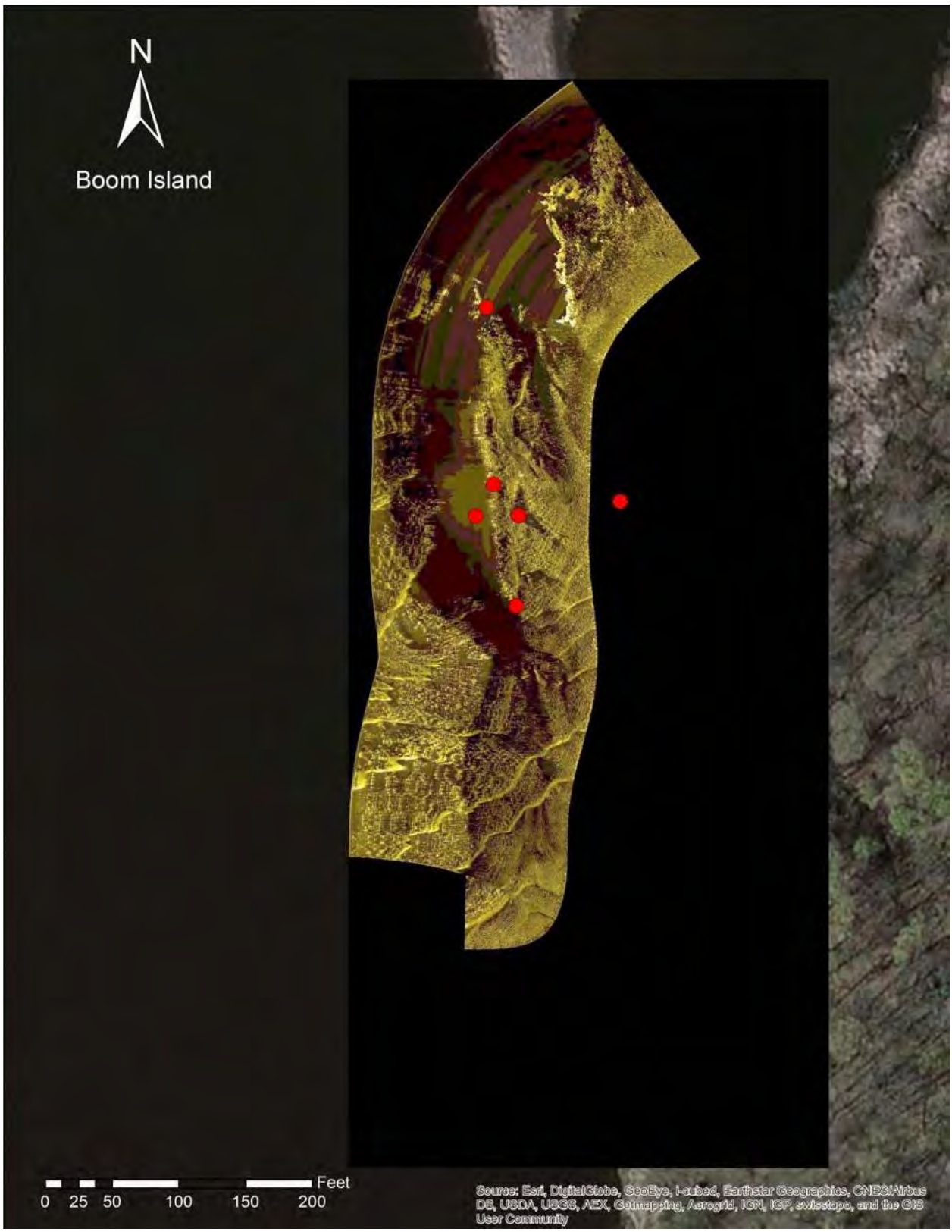


FIGURE 56. The sonar imagery from the closing dam east of Boom Island.

Osceola

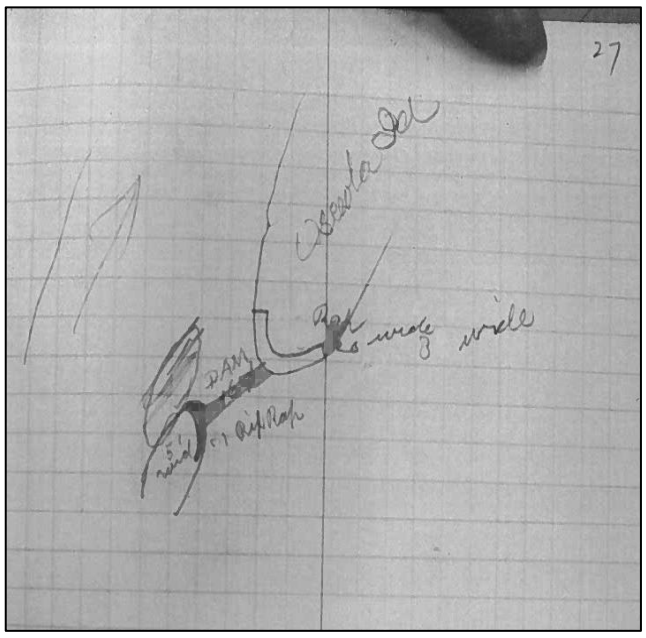
The needs of the town of Osceola, WI were a significant justification for river improvement measures in the 19th century, as it was a key location for historic log drives and river navigation. In 1880, the USACE proposed a series of dams at Osceola, totaling 1425 feet in length; some of these features were constructed in 1883 (Figures 57 and 58). Other river control measures in the area ranged from log collecting pens built at Osceola before 1850, to walls and boom piers built above the town in the 1870s (Report of Operations 1879, Annual Report of the Chief of Engineers 1883:1444-1445, Godfrey 2015:14, 21, 27).

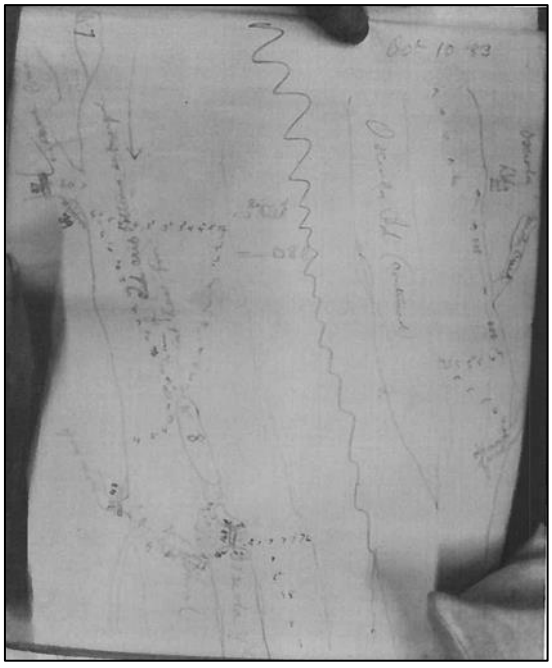
The USACE 1937 map only showed one dam remaining at Osceola, a small rock dam at the head of the island, extending upriver and connecting to a much smaller island (Figures 59-60). To locate this structure, as well as any other existing cultural remains, the survey team selected six targets for investigation. One of the challenges for the Osceola section, however, was that the banks and riverbed have undergone significant changes, particularly since 2007 (Jean Schaeppi-Anderson 2015, pers. comm.).

Sonar data could only be acquired on two of these targets due to shallow water in the area. At target 54, sonar imagery prompted diving investigations (Figure 61). The team's conclusion was that this was the site of the rock dam displayed on the 1937 map. The target had two main components: a section of worked timbers, approximately 30x15 feet, resembling a crib, and a rock pile with logs extending downstream, covering a total area of approximately 30x20 feet.

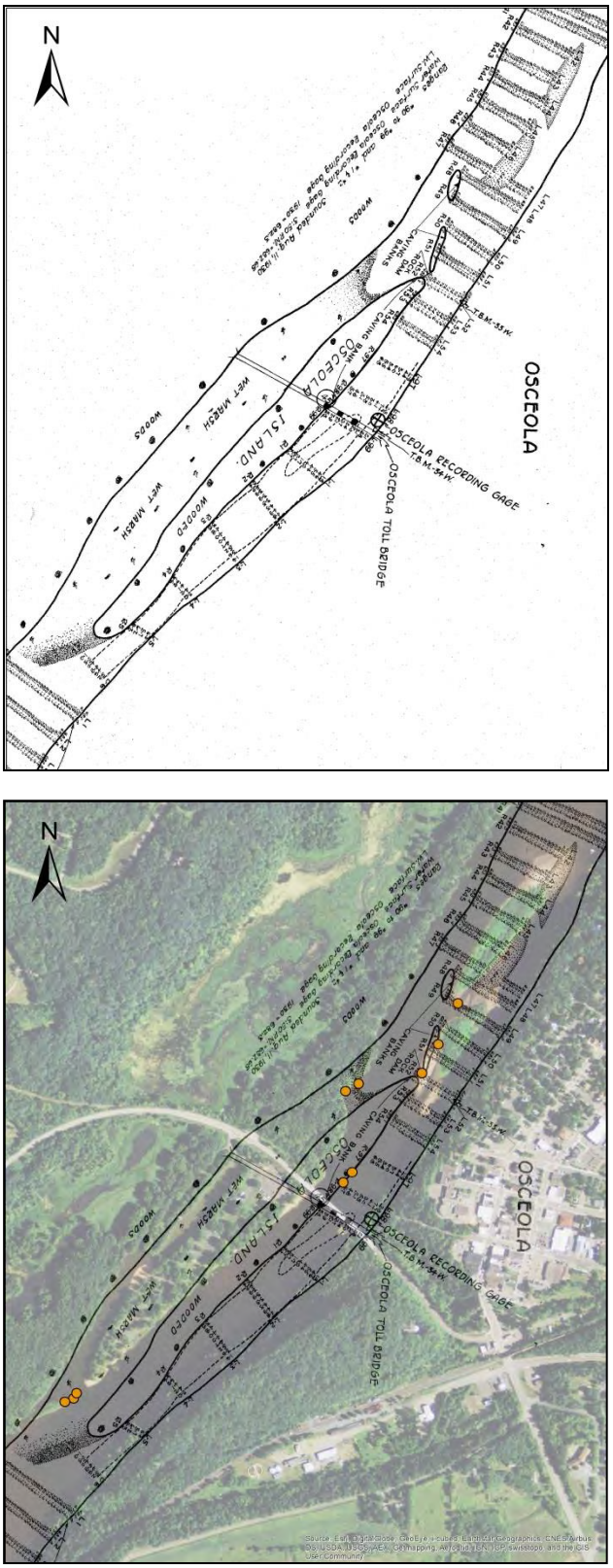
The sonar imagery from GPS target 137 was initially promising, but results from the diving investigation indicated that the imagery was displaying bottom contour, rather than the remains of a water control feature.

The other four remaining targets were investigated on foot and via kayak, but no further cultural materials were identified. It is possible that features are now buried under sediment and overgrowth, due to the considerable geographical changes in the area.





FIGURES 57 and 58. Osceola sketches by Parkinson in 1881 and by Darling in 1883. (Courtesy of SACN 2015 and Chicago NRA).



FIGURES 59 and 60. USACE Map, Osceola 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI aerial map with U SACE map, Osceola 1937 overlay.

FIGURE 61. Sonar imagery from Osceola showing two structures possibly associated with construction of the previous bridge.

Allen's Lake

The Allen's Lake section of the survey began immediately below Osceola, and covered the lake itself, the main river channel, and the islands above Lime Kiln. As early as 1880, USACE surveyors recommended the construction of two dams totaling 800 feet in length off Mile Island (also referred to as Island No. 13) to close the right-hand channel feeding into the lake (Annual Report of the Chief of Engineers 1880:1663-1664). Dam construction at Mile Island began in 1883, and continued in 1884 (Figure 62) (Annual Report of the Chief of Engineers 1883:1444-1445, Annual Report of the Chief of Engineers 1884:1606-1609, Godfrey 2015:38, 40).

The 1937 USACE map indicated one wing dam and two proposed closing dams, providing a search area for sonar survey (Figures 63 and 64). The survey team established eight GPS targets for investigation, via sonar and in-person searches on foot and kayak (Figure 65). GPS target 123 proved to be the remains of a wing dam, 40 feet long and approximately 10 feet wide. Target 57 was another wing dam, at the site indicated on the 1937 map. This dam had approximately 10 feet of remaining timber structure *in situ*, running towards the south. The other six targets were investigated, but no further remains of historical water control features were identified.

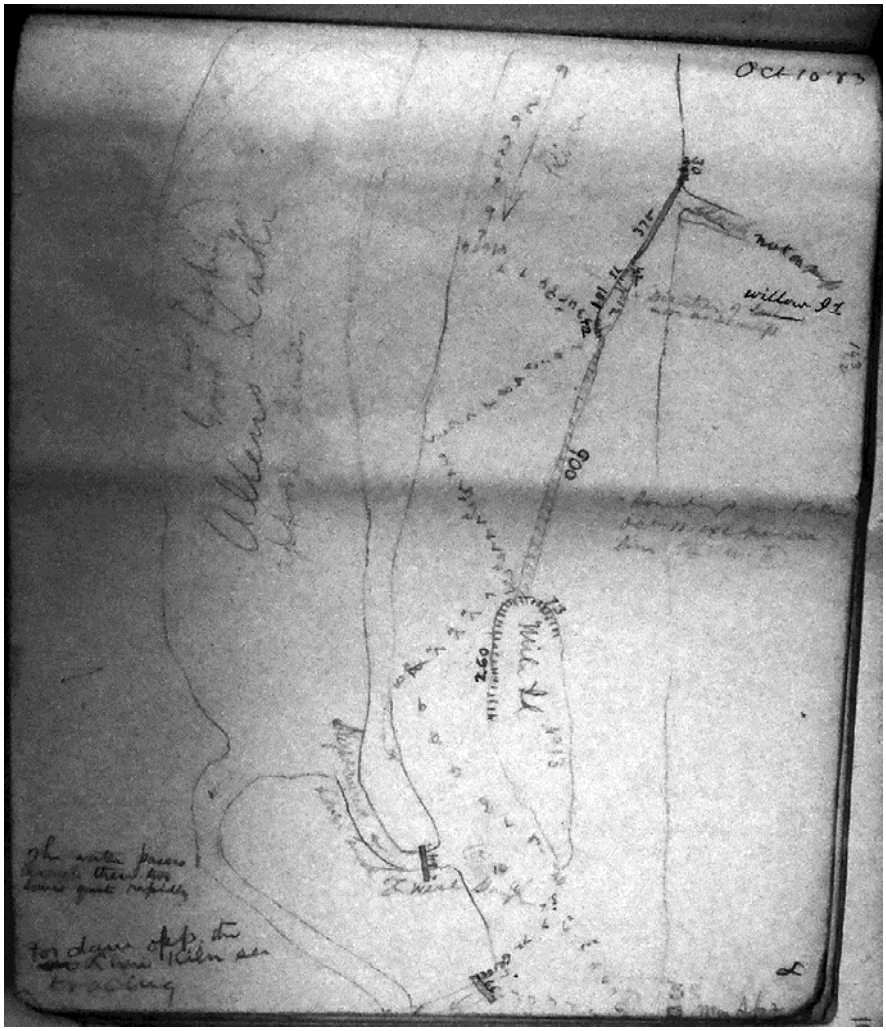
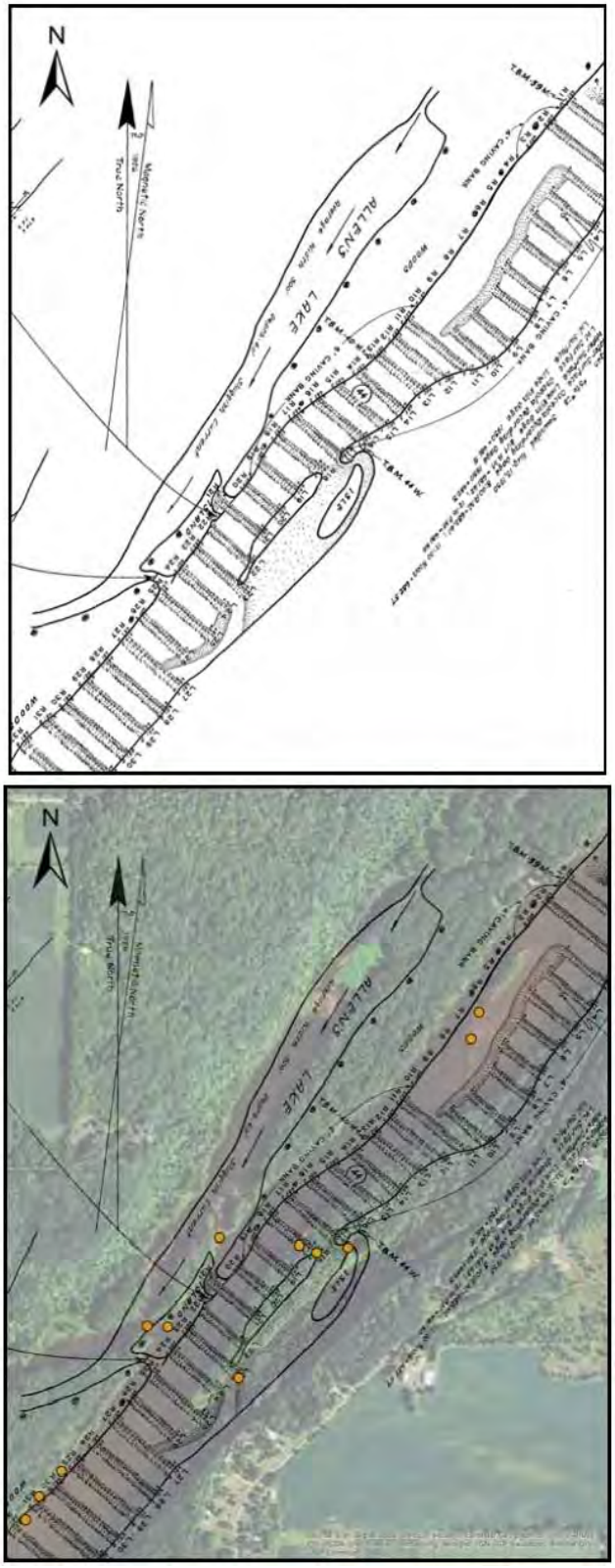


FIGURE 62. Allen's Lake sketch by Darling in 1883. (Courtesy of SACN 2015).



FIGURES 63 and 64. USACE Map, Allen's Lake 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI aerial map with USACE map, Allen's Lake 1937 overlay.

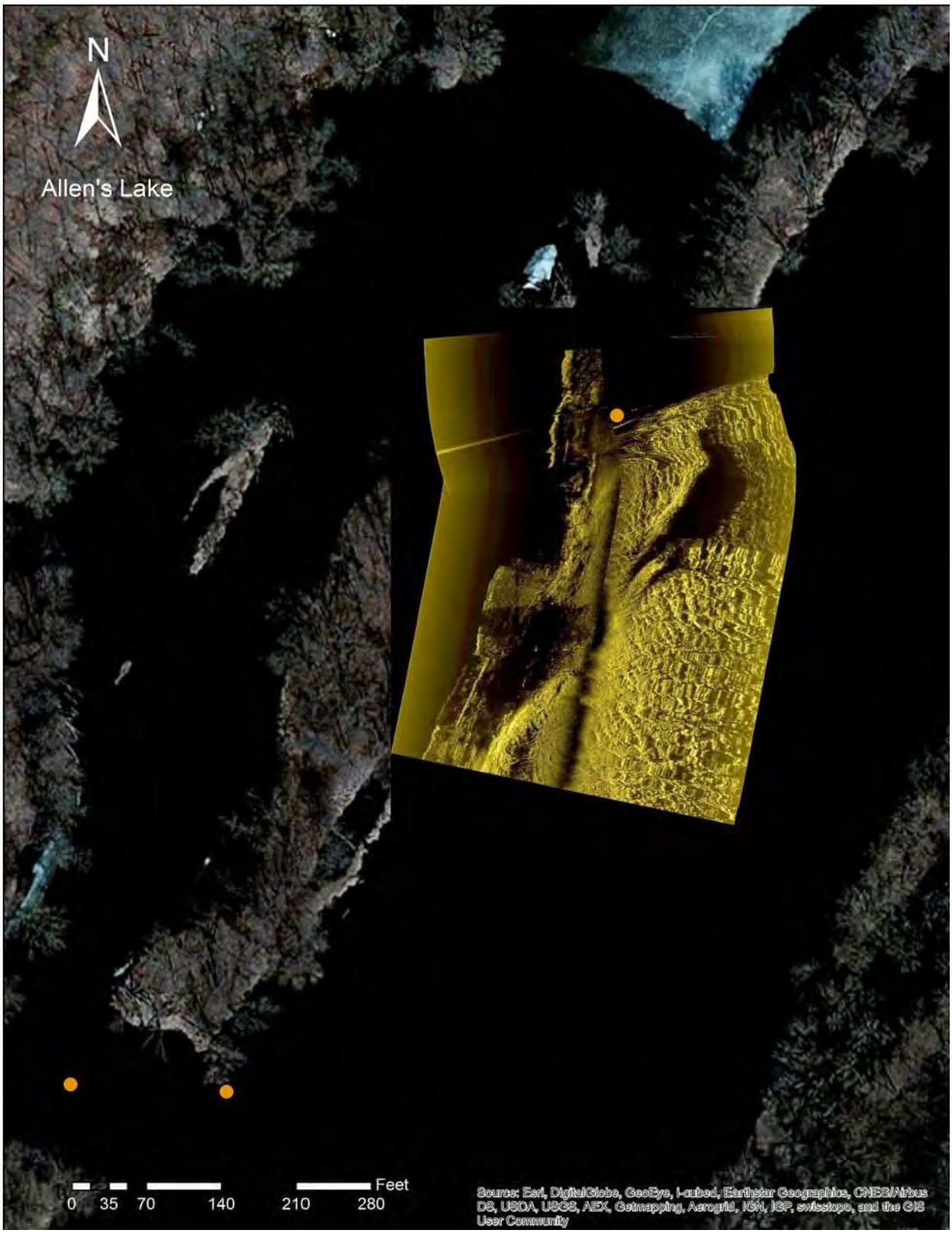
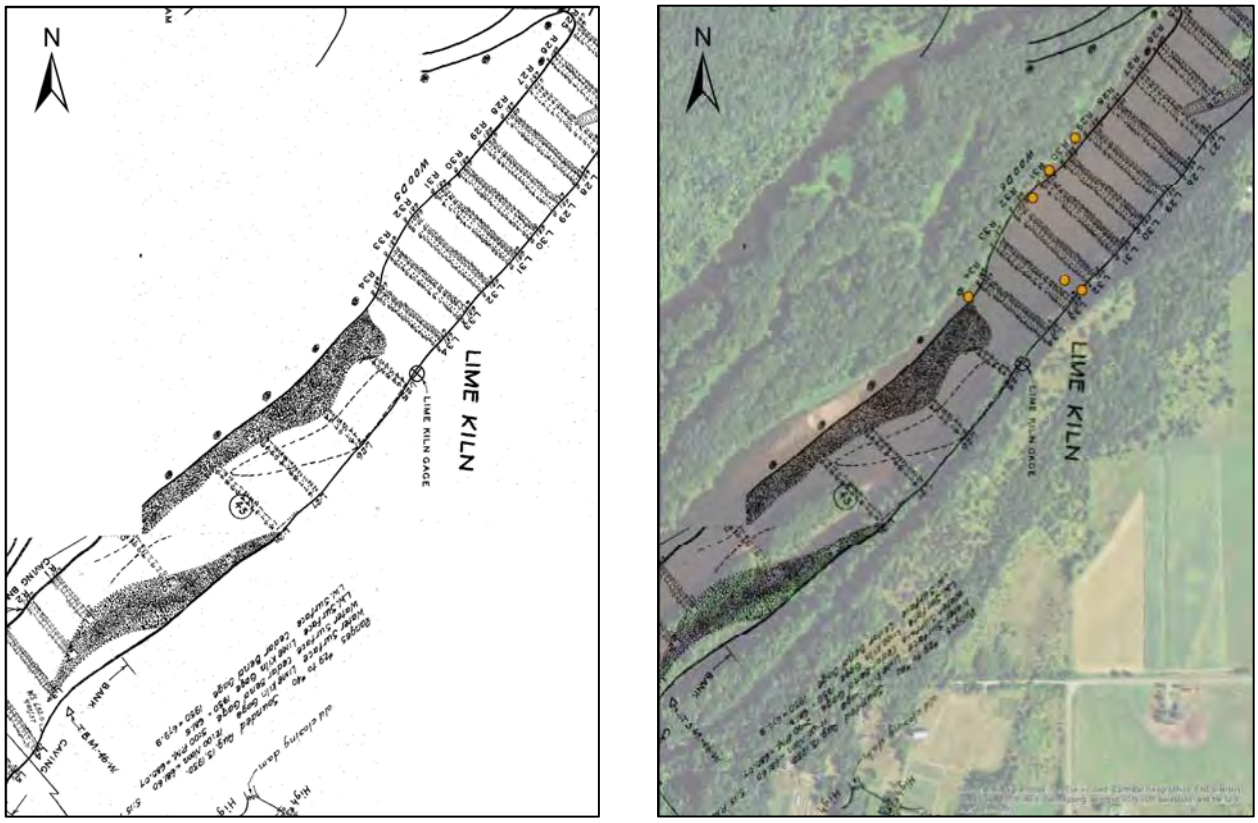


FIGURE 65. The sonar imagery from Allen's Lake.

Lime Kiln

The Lime Kiln area of the St. Croix River, also called Limekiln Crossing, was first mentioned in 1880 as a particularly problematic shallow spot for the river's steam traffic. The survey report called for 550 linear feet of brush and stonework to be placed in the area, named for the lime kilns located on the Wisconsin side of the river (Annual Report of the Chief of Engineers 1880:1664). In 1897, the USACE completed two dams at Lime Kiln, though the first had to be repaired later in the season (Annual Report of the Chief of Engineers 1898:1825-1826, Godfrey 2015:75-76). In 1917, the USACE returned to repair one of the dams again, filling a 40 foot long break (Vansant 1917, Godfrey 2015:110).

The 1926 and 1937 USACE maps, however, did not show either Lime Kiln dam present. Though perhaps they washed away entirely or were removed prior to the creation of the 1926 map, six survey targets were chosen based on the 1897 map locations, review of historic and modern topography, and discussions with park staff (Figures 66 and 67). Three possible sites emerged from the sonar survey. These were investigated on foot by walking transects and randomly probing the river floor, but all searches resulted in negative findings.



FIGURES 66 and 67. USACE Map, Lime Kiln 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI aerial map with USACE map, Lime Kiln 1937 overlay.

West Slough

The survey's West Slough section comprised the West Slough channel and islands on the St. Croix River's northern bank, but also the historic area known variously as Sweazie's (Sweezies, Sweezy's Tweezies, Tweezy's) Landing (Bar, Crossing). In 1883, the USACE began removal of snags and construction of wing and closing dams in the upper St. Croix to increase the water levels from its 1878 low-water channel depth of two feet. This included construction of a wing dam at Sweazie's Bar (Figure 68) (Annual Report of the Chief of Engineers 1883:1444-1445, Godfrey 2015:38). The dam required additional maintenance in 1884, and again in 1897, where it was reported that one- to three-foot areas had been washed away (Godfrey 2015:40).

Despite the ongoing work, West Slough remained a difficult area for river traffic, and by 1906, a logjam at Sweazie's closed all navigation after the old dam wore away (Short 1898, Knapp 1906, Godfrey 2015:80, 99). The 1937 USACE survey map indicated a closing dam at West Slough immediately downriver from Sweazie's Landing. It also highlighted a location slightly downriver, noting, "no dam necessary, area silted in." Perhaps this was the site of a past water control feature that was no longer necessary to maintain. The map also calls for a proposed closing dam directly across the river from Sweazie's (Figures 69 and 70).

This historical information provided the survey team with nine targets for sonar investigation, four of which proved to be associated with West Slough water control features (Figures 71 and 72). GPS target 65 proved to be the large closing dam recommended in the 1937 map, with a smaller rock dam (target 66) nearby, which must have closed off a small channel behind the larger dam. Investigation of target 67 revealed a successful closing dam site, an elevated mound that restricted the slough, now covered with vegetation. Finally, GPS target 69 revealed a wing dam that was investigated on foot. The team took GPS site extents and photos of the feature, and noted a fascinating assemblage of log and timber remains extending out of the island (Figures 73 and 74).

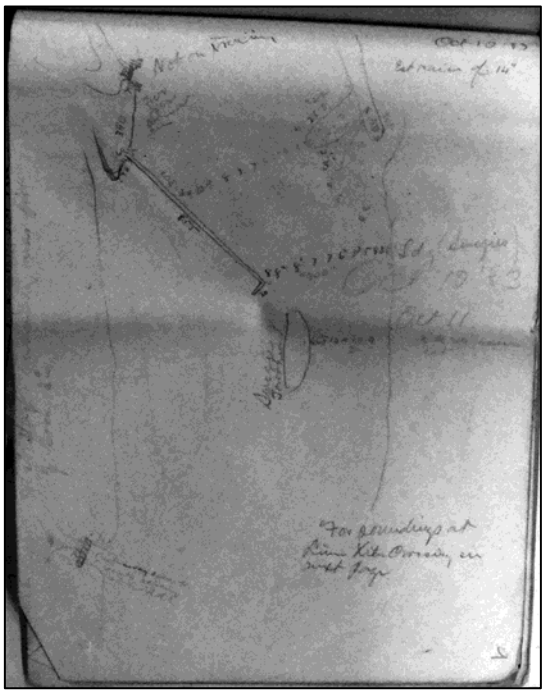
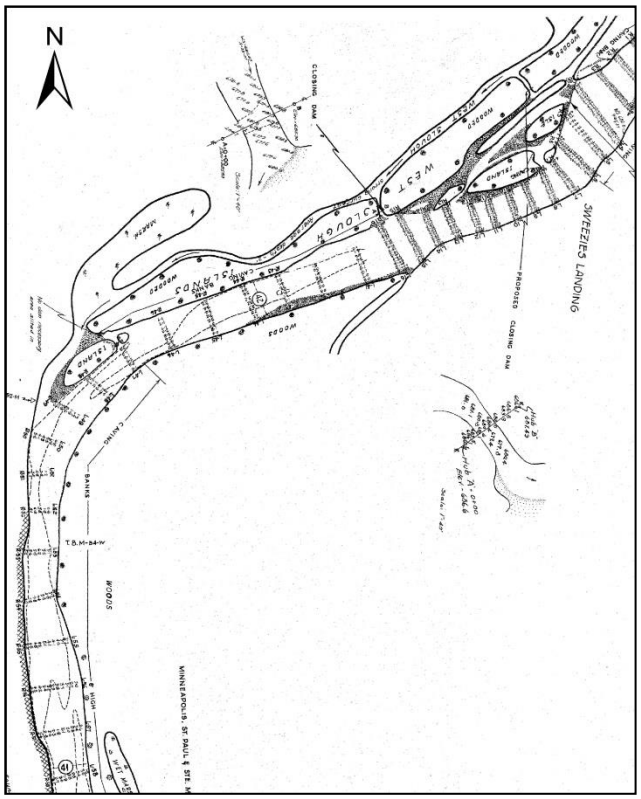
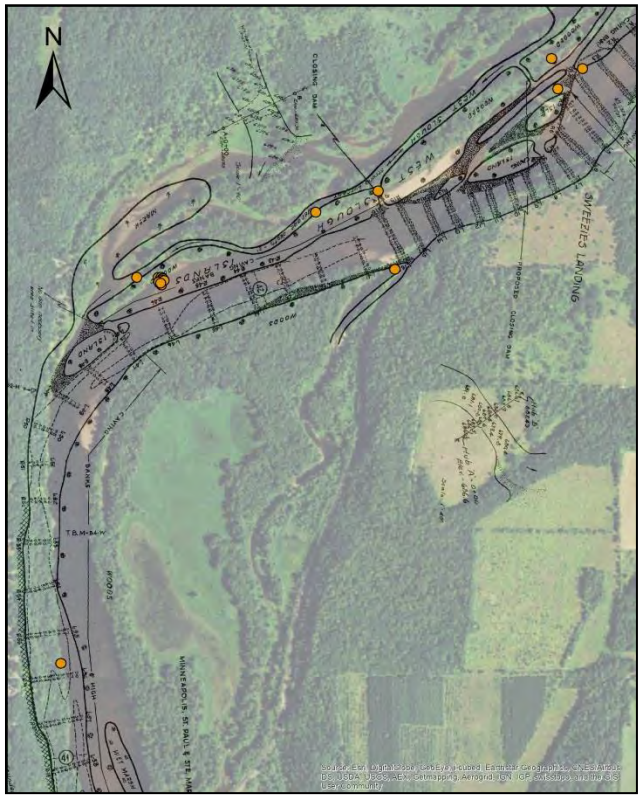


FIGURE 68. West Slough sketch by Darling in 1883. (Courtesy of SACN 2015).





FIGURES 69 and 70. USACE Map, West Slough 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI aerial map with USACE map, West Slough 1937 overlay.

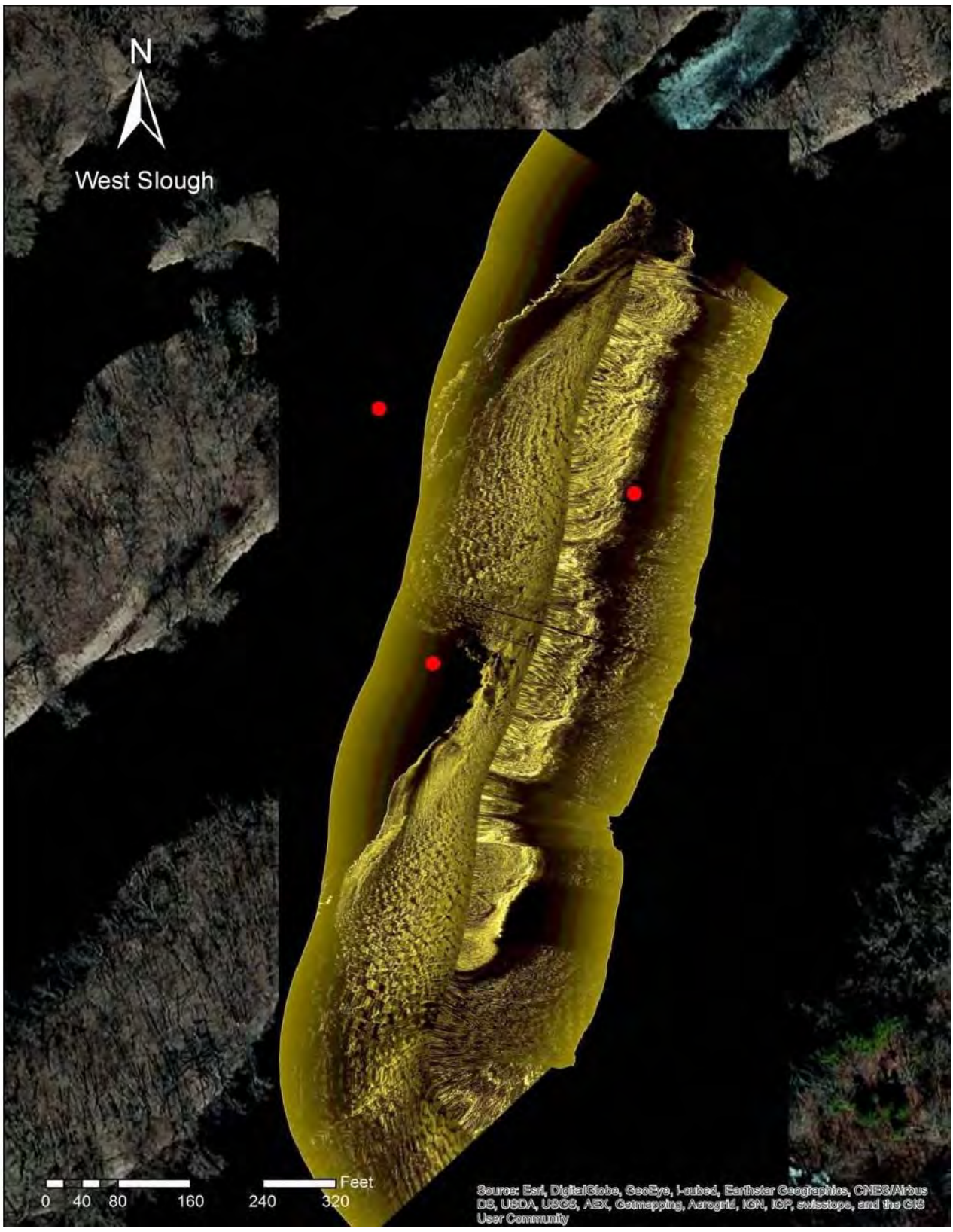


FIGURE 71. The sonar imagery from the large dam (GPS target 65) at West Slough.

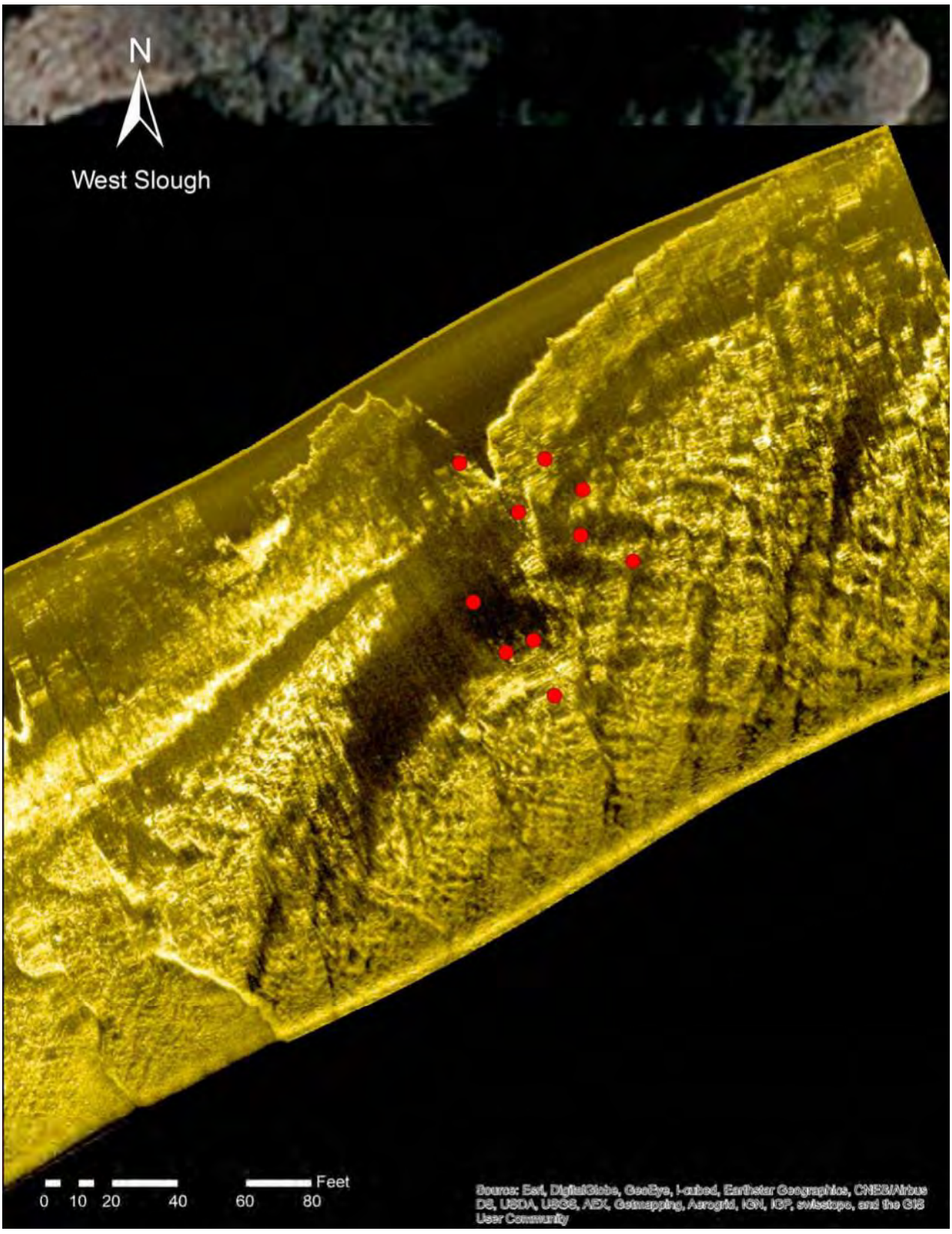


FIGURE 72. The sonar imagery from West Slough's GPS target 69 wing dam.

FIGURES 73 and 74. Images from GPS 69 showing the structure of the wing dam.

McCloud's Lake

The McCloud's Lake (also historically spelled McLeod's) section of the survey encompassed the area immediately upriver of the lake, near the Cedar Bend Gage, through the marsh that surrounds and partially composes the lake, and ended at the small island just downriver. In reports from 1880, the area upriver posed little issue for river navigation, and water control efforts were directed to the foot of the lake, where the stream widened and became perilously shallow. The USACE proposed to construct "four short spurs on the left bank, aggregating in length 675 feet" (Annual Report of the Chief of Engineers 1880:1664) (Figures 75-77).

It is unknown whether or not these spurs were constructed, but in 1897, the USACE reported making repairs on a dam at McCloud's Lake (Annual Report of the Chief of Engineers 1898:1825-1826, Godfrey 2015:75). The 1937 USACE map proposed the construction of a closing dam just upriver of the large McCloud's Lake marsh. It also indicated the presence of two other rock wing dams, one to the south of the lake, with a center section washed out and forming a channel, and another extending from the left bank of the small island immediately downriver from the lake (Figures 78 and 80).

The paucity of data on the specific number of dams constructed, as well as their locations, led to a large survey area. Twelve general GPS targets were selected for sonar data collection (Figures 79 and 81). While the sonar images were complemented by shore investigations, 11 of the targets had negative findings. GPS target 72 proved to be the site of a probable closing dam, located upriver of the marsh (Figures 82 and 83). A GPS point was taken directly over the site, but extents of the feature could not be safely determined, due to a very strong current.

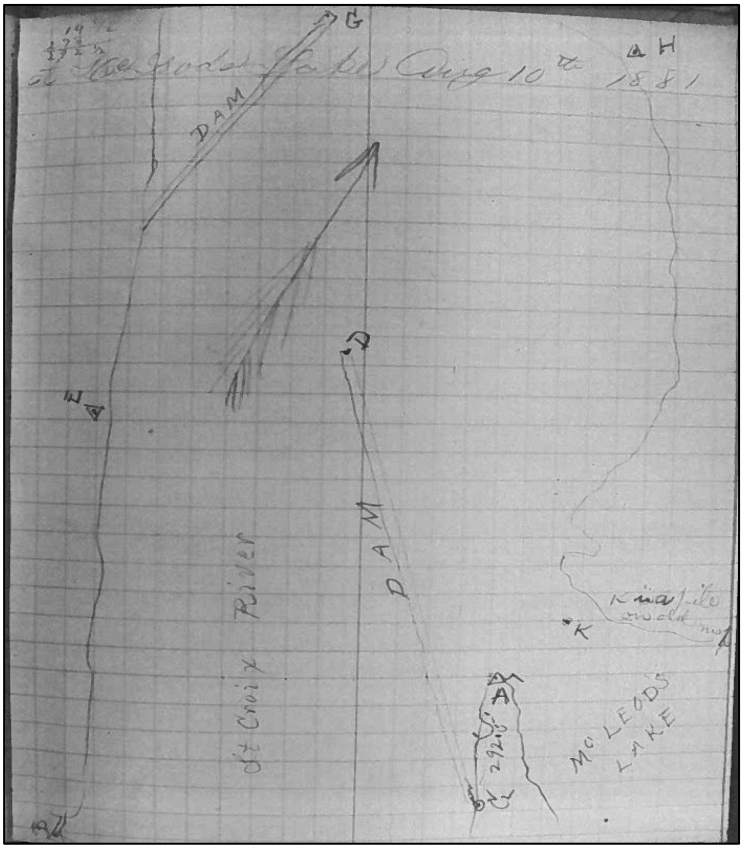
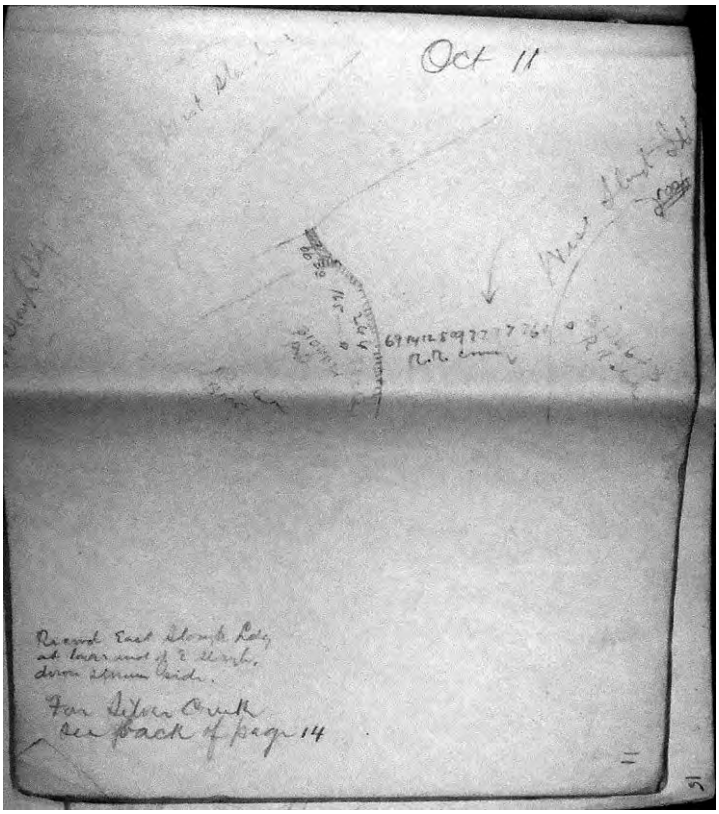
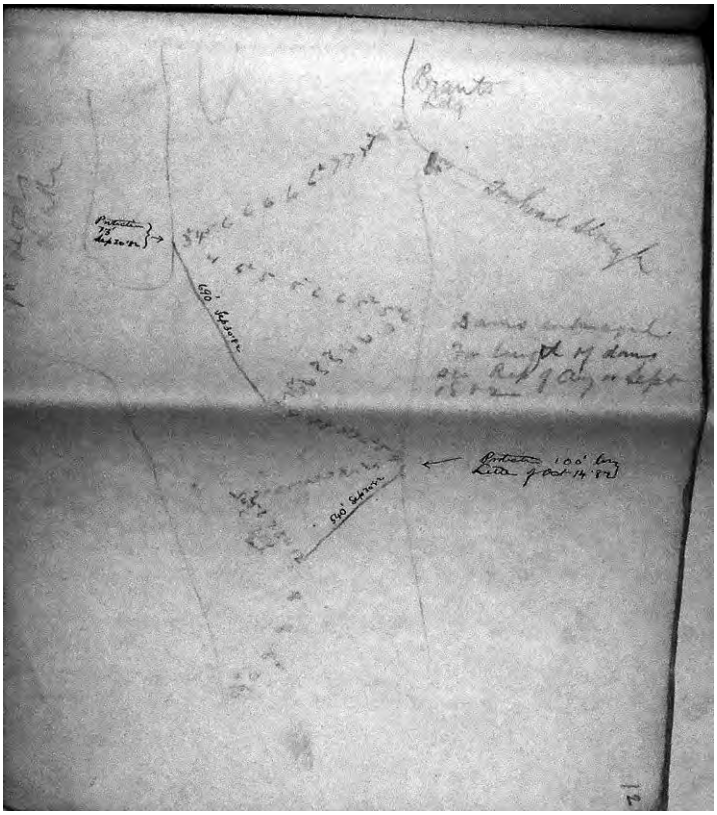
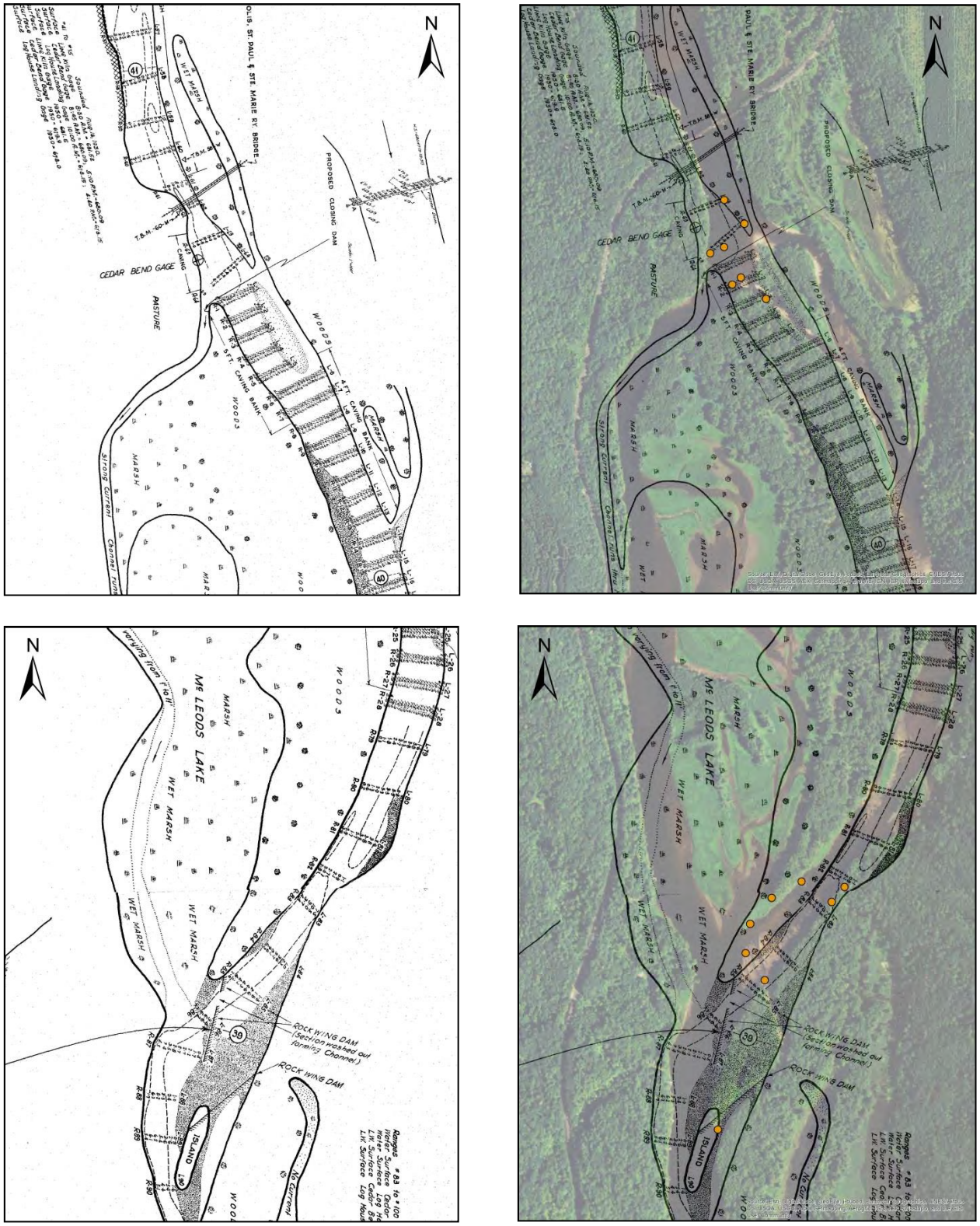


FIGURE 75. McCloud's Lake sketch by Parkinson in 1881. (Courtesy of SACN 2015).





FIGURES 76 and 77. McCloud's Lake sketches by Darling in 1883. (Courtesy of SACN 2015).



FIGURES 78-81. USACE Map, McCloud's Lake 1937. (Courtesy of USACE, St. Paul District, St. Paul, Minnesota). ESRI aerial map with USACE map, McCloud's Lake 1937 overlay.

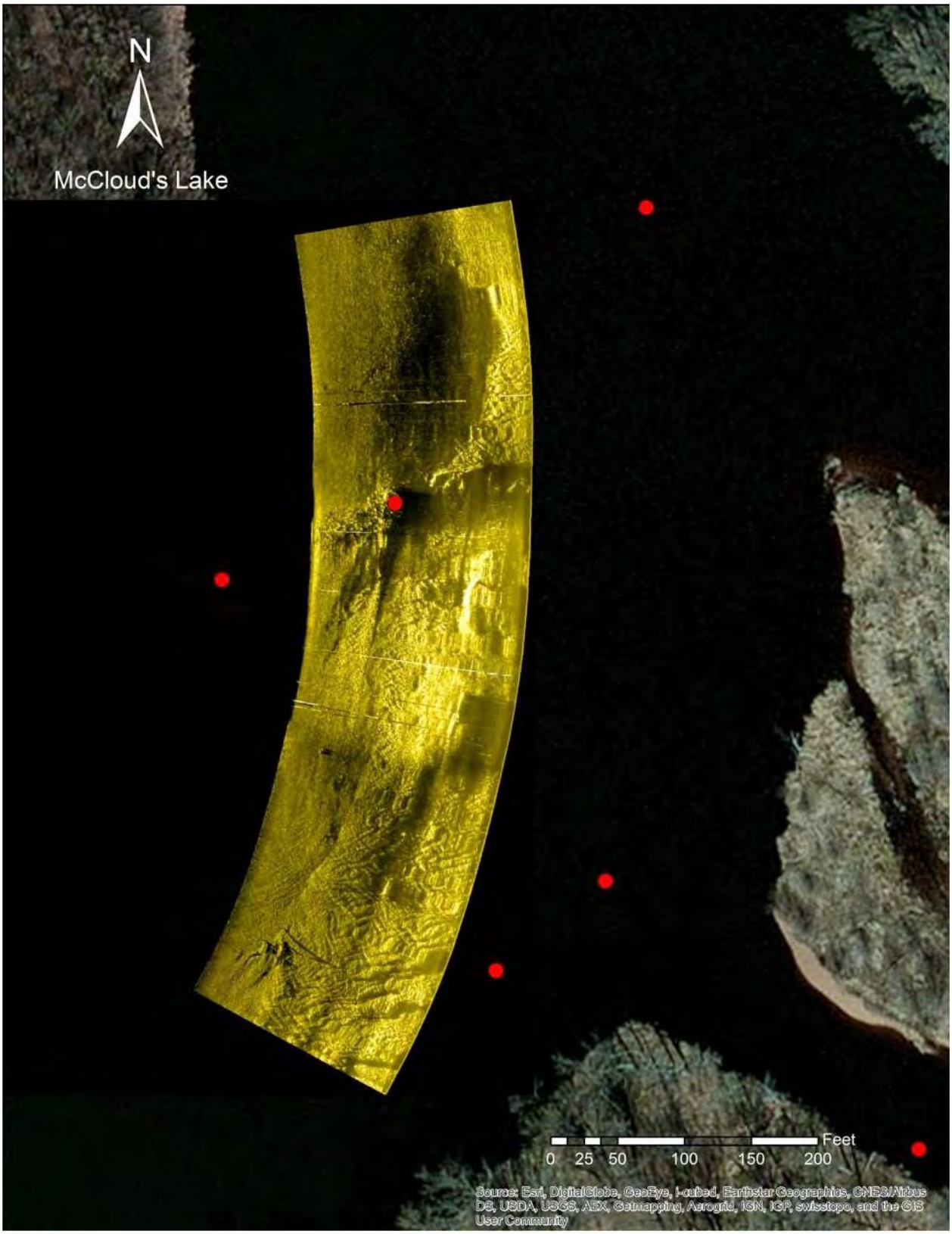


FIGURE 82. The sonar imagery from GPS target 72 at McCloud's Lake.

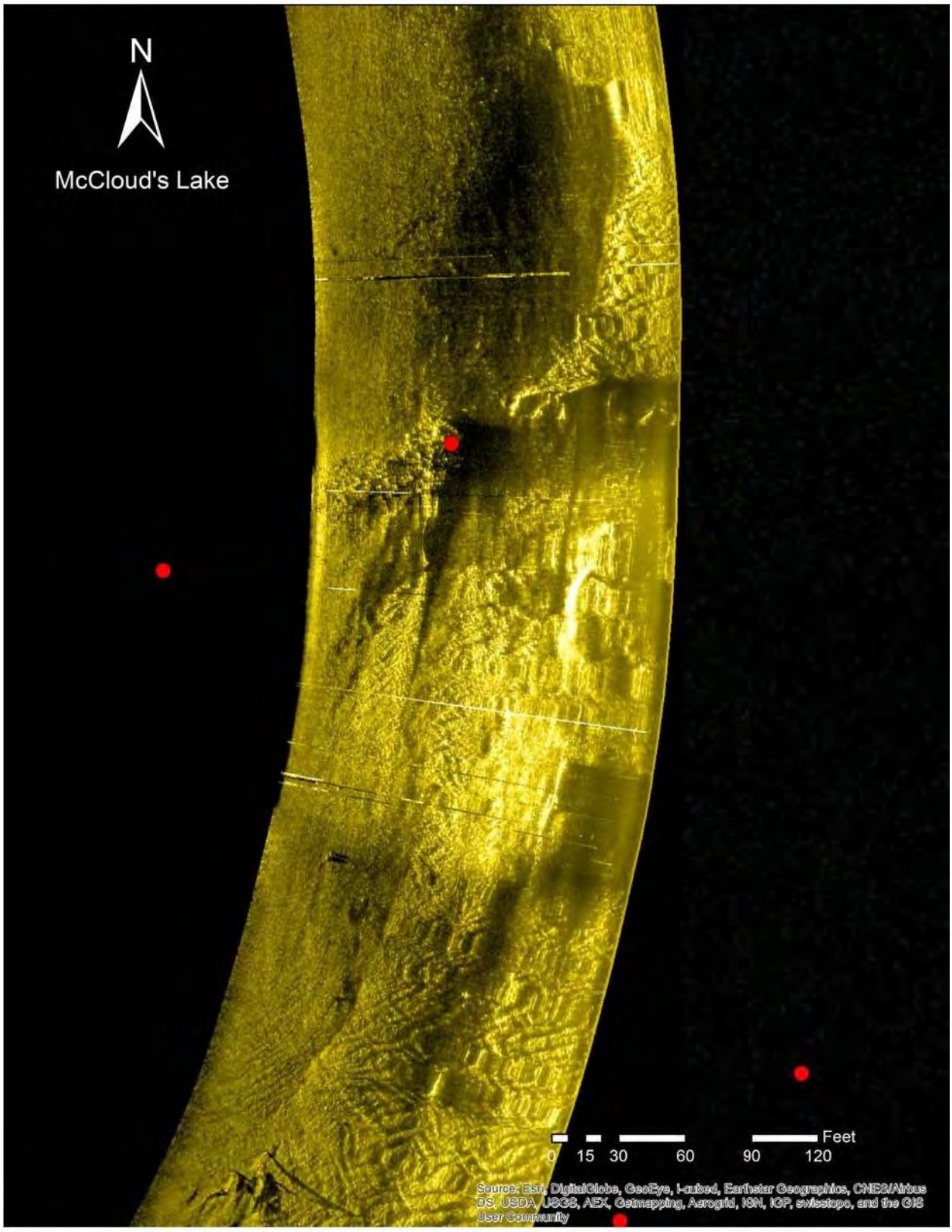


FIGURE 83. A close up of the sonar image from target 72 at McCloud's Lake.

Log House Landing

There was very little historical information on water control features constructed at Log House Landing, save for an 1883 sketch and a brief mention in 1891 that a dam there was repaired with brush and stone (Figure 84) (Report of Operations 1891, Godfrey 2015:62). The 1937 USACE map also indicated only one closing dam present (Figures 85 and 86). This information gave a focal point for survey operations in the area, and four general targets were selected for investigation.

Sonar imagery was collected for three of the targets, and one required investigation via kayak (Figures 87 and 88). Only one point proved to have a dam associated with it, but it was located very close to the point on the 1937 map, and was clearly historically constructed with brush and stone.

The Log House Landing structure seemed an ideal candidate for mapping, as it represented a specific dam construction style, had significant structure and high relief from the riverbed, and was in shallow water. GPS points were taken on the site's northern and southern extents, and a baseline was assembled down the length of the site (69 feet long, at a compass bearing of 210 degrees).

The project photographer collected images of the site (Figures 89-93). Meanwhile, team archeologists took baseline offsets to acquire the outer edges of the structure, as well as vertical measurements to define the height of the entire dam off the river bottom. Each measurement was collected every five feet on the baseline.

The dam itself comprised a large mounded structure, extending above the water's surface, and composed of layers of brush and rock. The structure's eastern side had a very steep relief of 11.5 feet over a distance of approximately 19 feet, as the dam had formed a deep channel along its bank that had collected significant debris. The slope was much more gradual on the dam's western side, steadily dropping 4.5 feet over a distance of 22 feet to the river bottom. With measurements collected, the team was able to map the plan view of the dam on Mylar, which was later inked (Figure 94).

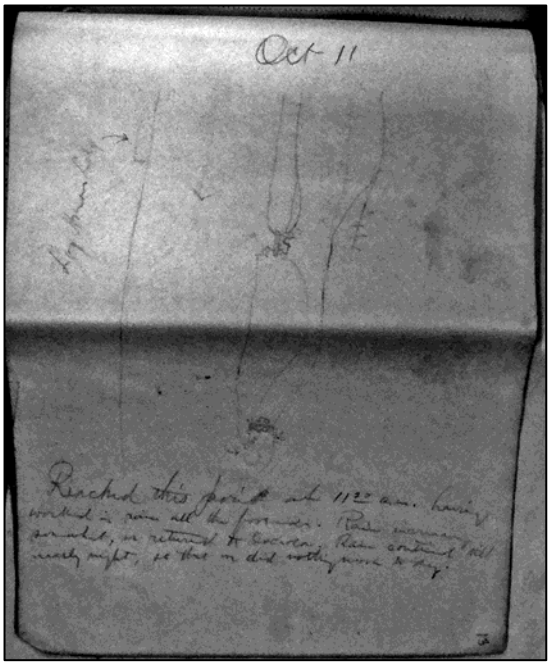
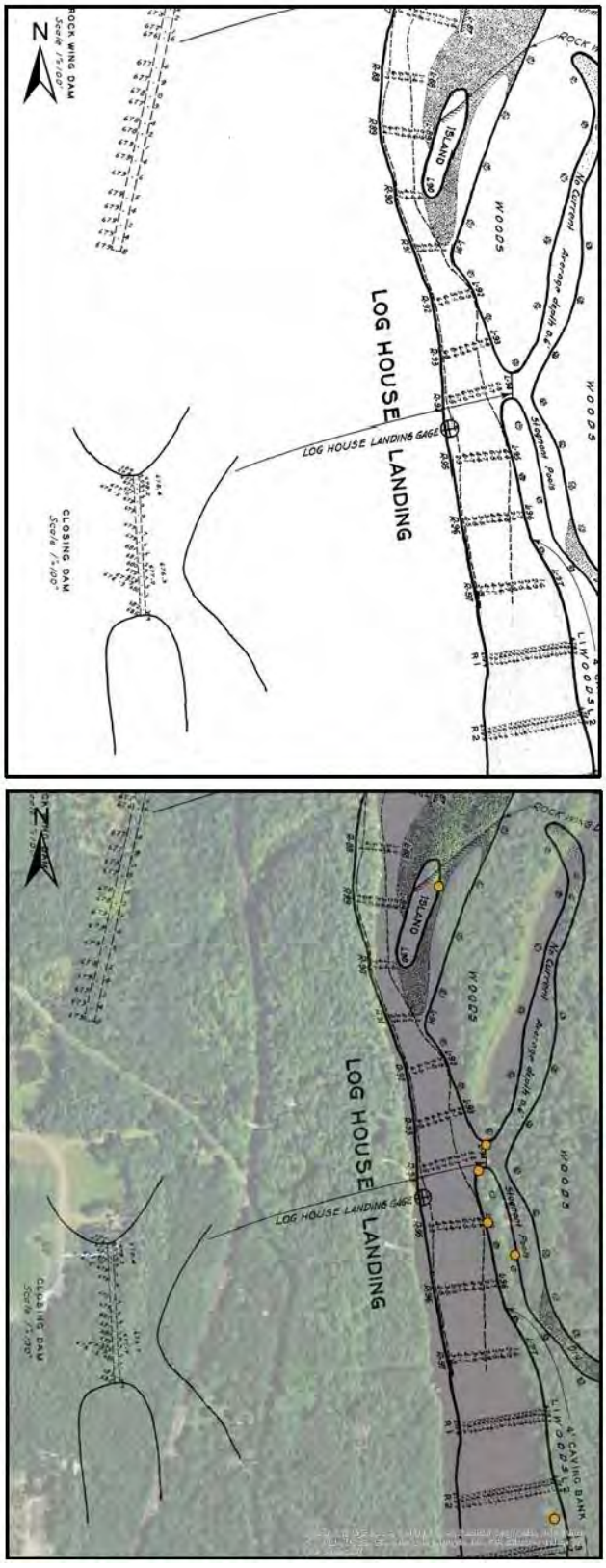


FIGURE 84. Log House Landing sketch by Darling in 1883. (Courtesy of SACN 2015).



FIGURES 85 and 86. USACE Map, Log House Landing 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI aerial map with USACE map, Log House Landing 1937 overlay.

FIGURE 87. The sonar imagery from the dam at Log House Landing.

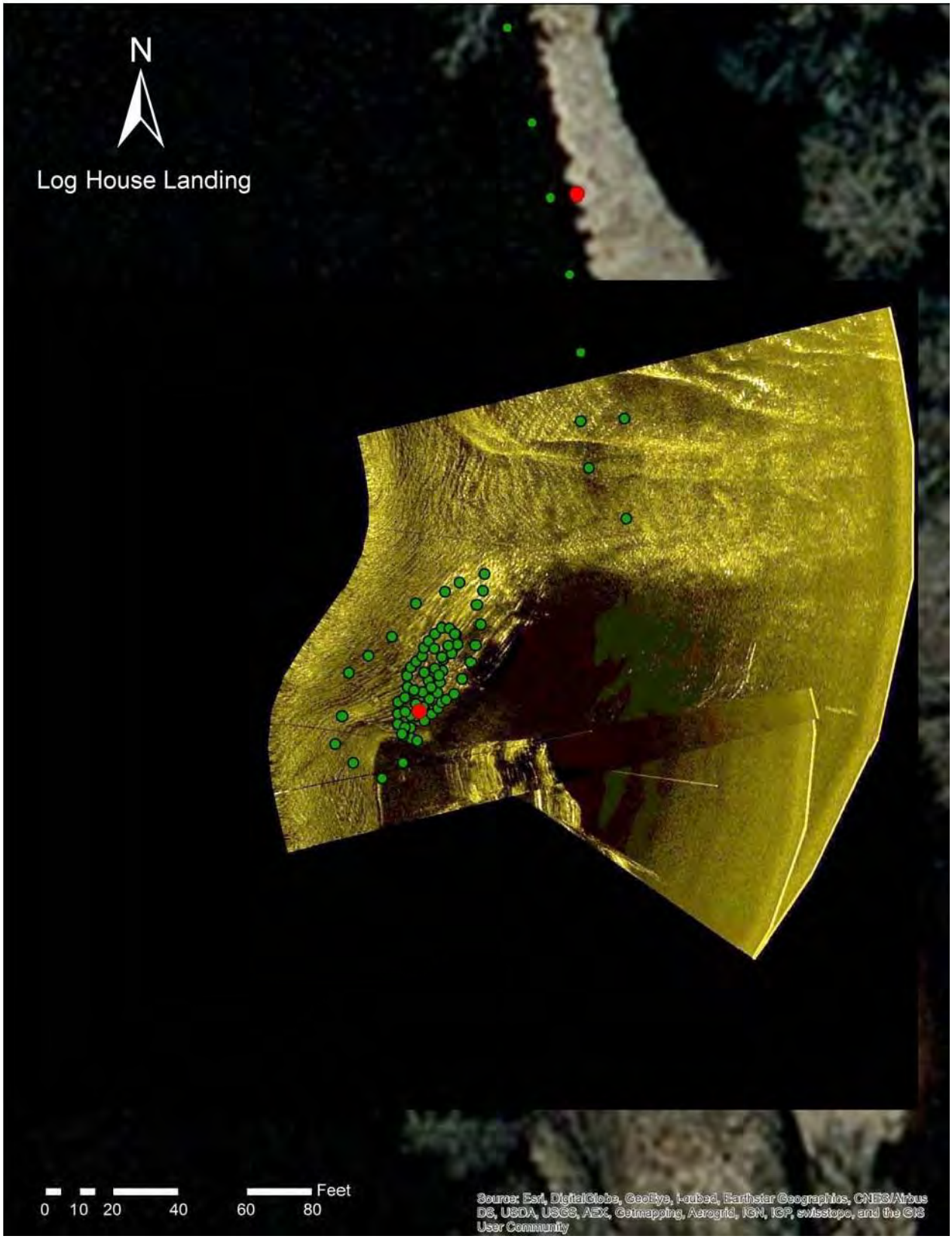


FIGURE 88. Sonar imagery of the closing dam showing transit points that have been post-processed to show their spatial locations shown in green.

FIGURES 89 and 90. Images from Log House Landing brush and rock dam.

FIGURES 91-93. Images from Log House Landing brush and rock dam.

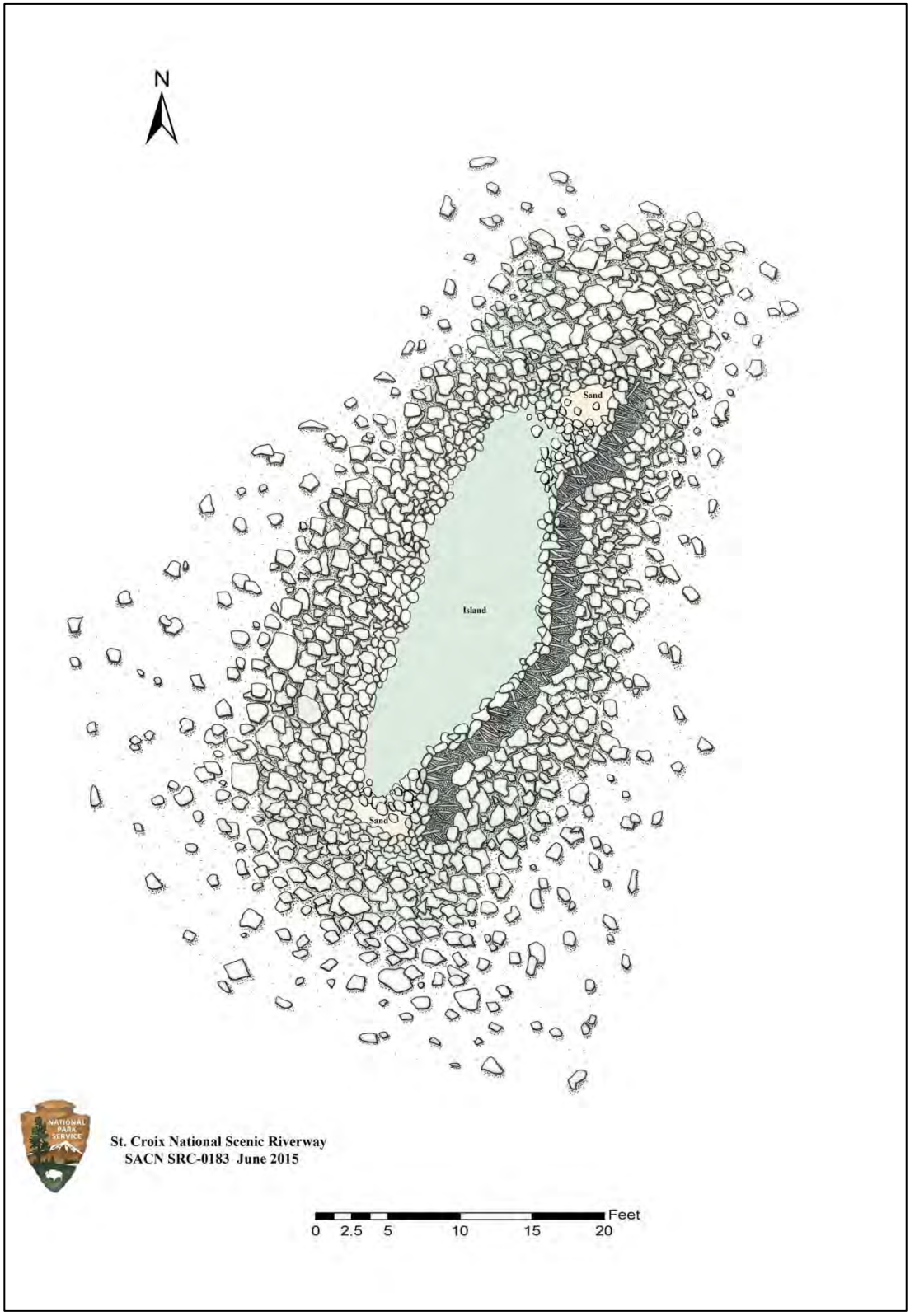


FIGURE 94. Log House Landing site map.

Pine Island

The Pine Island section of the survey focused on locating the many dams indicated in historical records. In 1880, discussion of Pine Island centered on mitigating channel shoals above the head of the island. The USACE proposal included the construction of a 600 foot long jetty, as well as maintenance of the existing revetment and a line of piling, key features in supporting the water flow around the island's right bank (Annual Report of the Chief of Engineers 1880:1664).

More dams were constructed around Pine Island, and by 1897, the USACE reported repairs on two Pine Island dams (Figures 95-97) (Godfrey 2015:75). Another was constructed in 1900, a 150 foot long and 25 foot wide brush and stone closing dam (Report of Operations 1900, Godfrey 2015:89). In 1917, two of the closing dams required emergency repairs, one at the island and one at the opposite bank. While the USACE team was on site, they also constructed a new 240 foot long wing dam there.

The prevalence of construction at Pine Island was reflected in the 1937 USACE map (Figures 98-101). This single area denotes seven separate dam structures: a closing dam on the river's eastern bank, cutting off marshy channels, two closing dams at the head of the island, two rock wing dams off the eastern bank of the island, opposite another rock wing dam extending from the eastern riverbank, and a rock wing dam off the western bank of a small island immediately downriver from Pine Island.

This map greatly assisted the placement of targets for survey and investigation. The team selected twelve areas for sonar survey, and each site with promising sonar imagery was visited in person. GPS target 85 revealed the remains of a wing dam, north of the original GPS target. The identified wing dam was labeled PineIslandLargeWingDam is seen on the 1937 map (Figures 102 and 103). GPS target 83 was confirmed to be the location of the large closing dam present on the 1937 map. The site of target 83 included rocks extending approximately 10 feet west into the water from the southern tip of the island, probably the remains of a larger dam structure that was removed or washed away. GPS target 89 was originally selected via reference to the 1937 overlay; however, during sonar investigation a rock wing dam was discovered and the new location named Pine89 (Figures 104 and 105). The team collected GPS points at Pine89 at northern, southern, and shoreline extents. Sonar imagery revealed the remains of another rock structure labeled Pine.Possible.Structure, but due to the strong current, only one GPS point was collected and it was not investigated further. This feature may be associated with the structures shown on the 1937. While sonar data was collected at each of the other targets, and shore investigations were conducted as necessary, no other cultural remains were located.

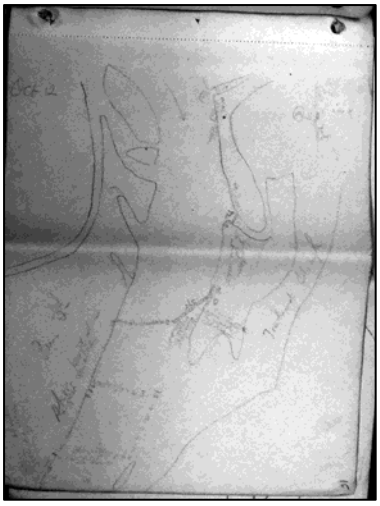


FIGURE 95. Pine Island sketches by Darling in 1883. (Courtesy of SACN 2015).

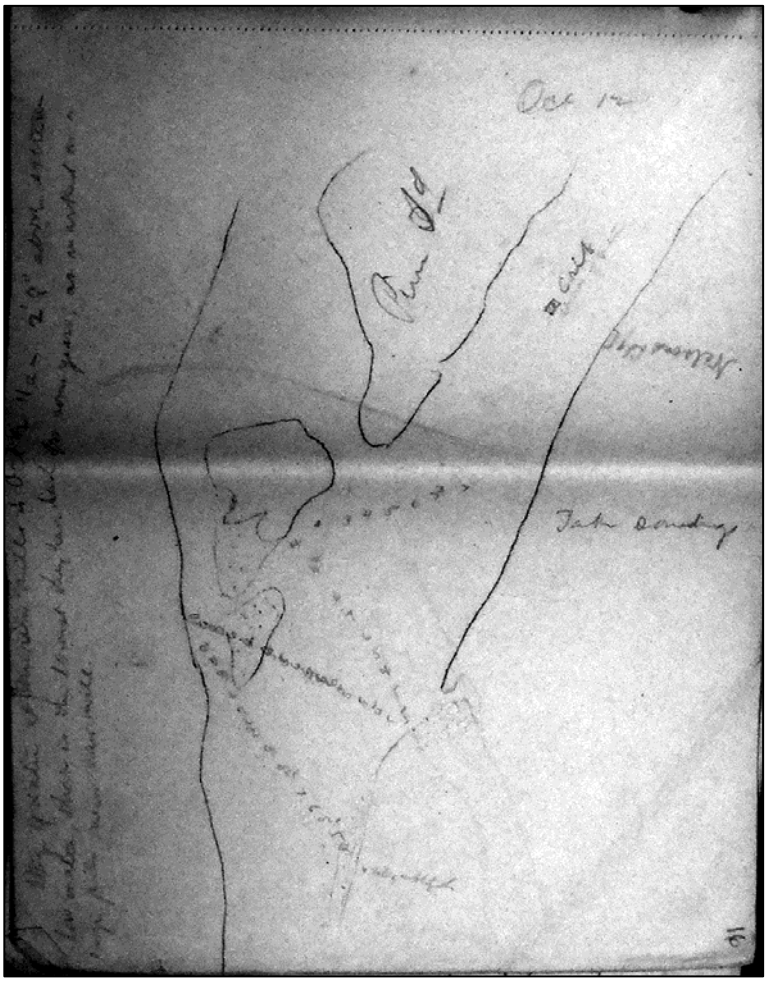


FIGURE 96. Pine Island sketches by Darling in 1883. (Courtesy of SACN 2015).

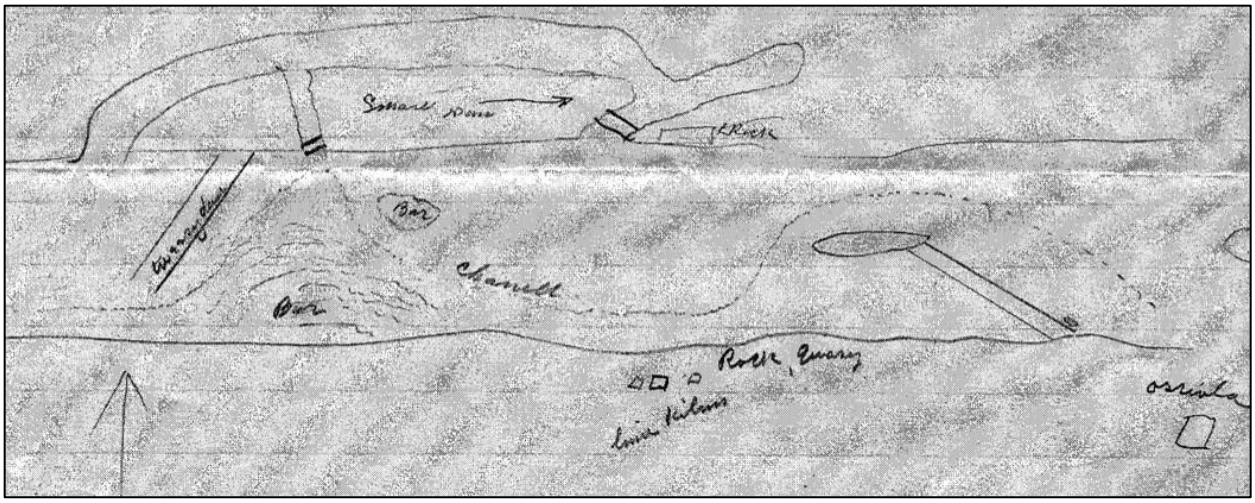
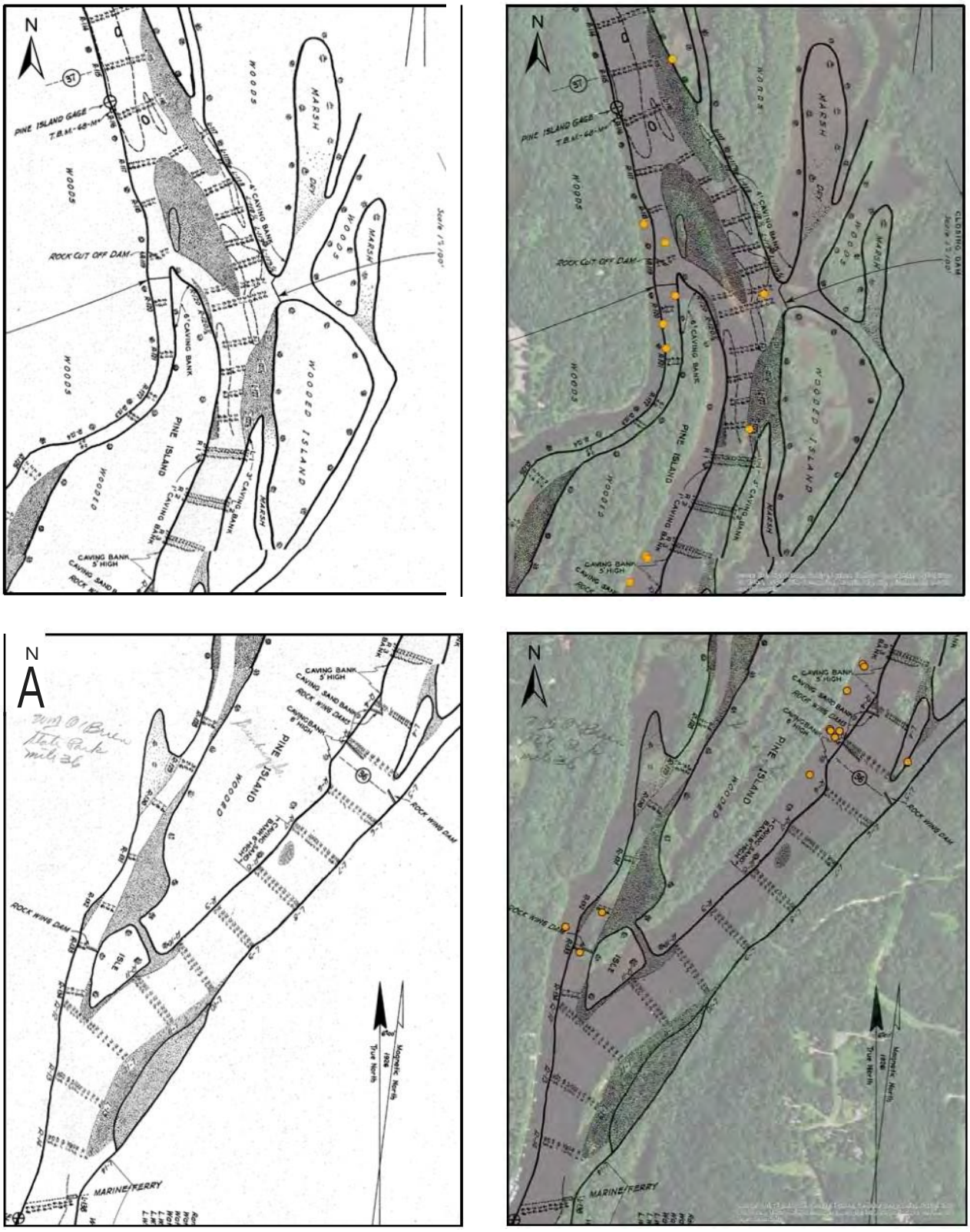


FIGURE 97. Pine Island sketch by Traux in 1897. (F.N. Truax to W.A. Jones with map, 18, 25 September 1897, Box 51, Entry 1604, Letters Received, 1889-1898, Mississippi River Above Falls of Saint Anthony–Saint Croix River, RG 77, Kansas City, Missouri; Godfrey 2015:75).



FIGURES 98-101. USACE Maps, Pine Island 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI aerial maps with USACE maps, Pine Island 1937 overlay.

FIGURE 102. The sonar imagery from upper Pine Island showing the large wing dam labeled PinelslandLargeWingDam.

FIGURE 103. A close up of the sonar imagery from PinelslandLargeWingDam.

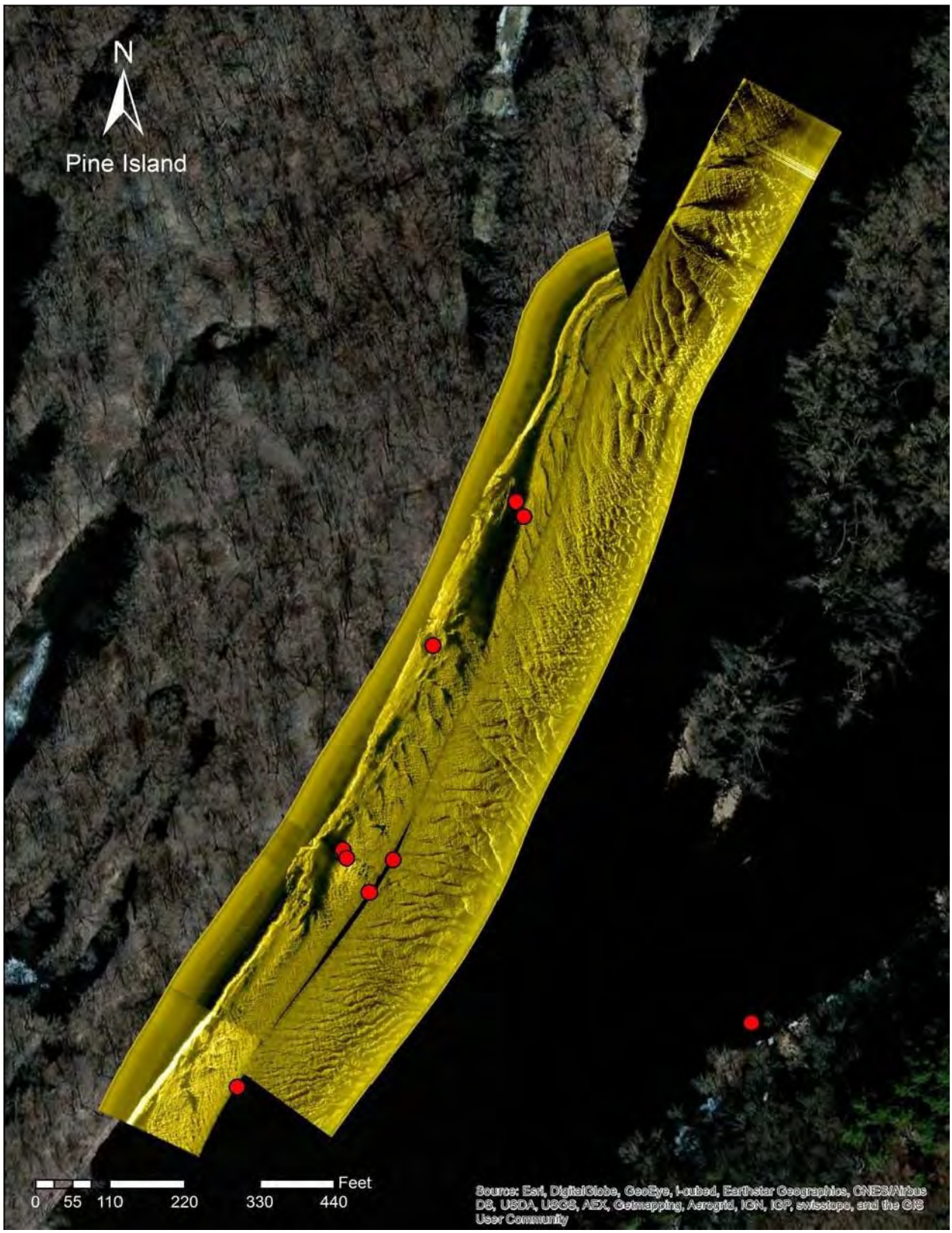


FIGURE 104. The sonar imagery from lower Pine Island.

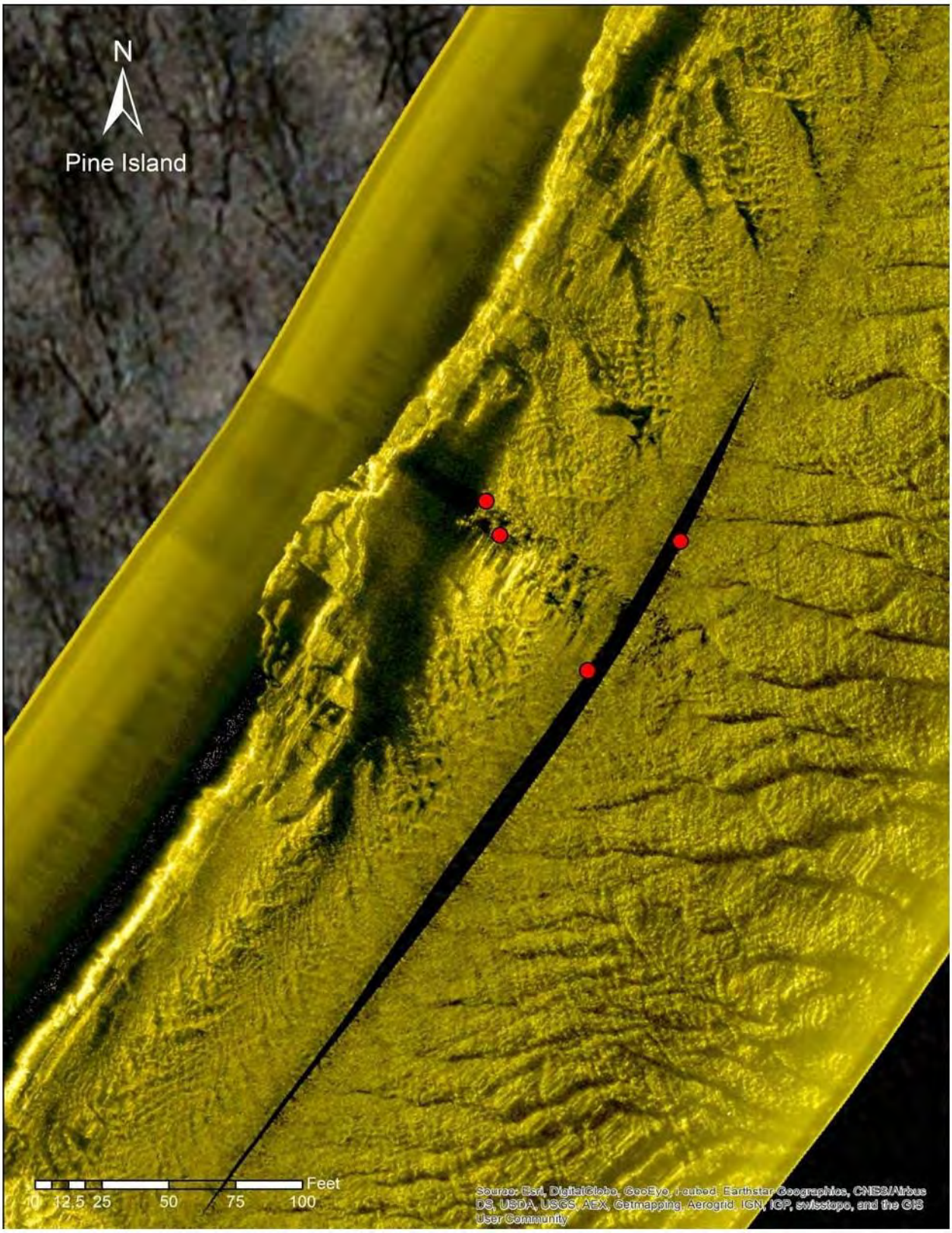


FIGURE 105. A close up of the sonar imagery of the dam atPine89.

Marine on St. Croix

The protection and stabilization of navigation around the Marine on St. Croix area was a major priority for the USACE. As early as 1879, river control features had been constructed near the town of Marine on St. Croix, including work on a dam that protected the shore at Marine Bar, and closed nearby sloughs (Report of Operations 1879, Godfrey 2015:27). By 1880, the USACE completed revetment work at Marine Bar, and placed 202 cords of brush on the Marine wing dam (Report of Operations 1880, Godfrey 2015:27).

> Apparently, by October 1882, the "Marine Dam" was completed and well revetted with stone so it could not be scoured during a moderate stage of water. It was so secure that loggers were given permission to chute a few logs through a two-foot stop gate on the dam's sluice into the nearby slough. The stop gate kept water from running through the dam when the Saint Croix Boom Company was not running logs (Figure 106) (Godfrey 2015:30-31).

In 1883, additional closing and wing dams were constructed at Marine Bar. No additional improvements were reported until 1925, when the USACE approved a permit for the construction of a rock and log wing dam half a mile above Marine (Figure 107) (Annual Report of the Chief of Engineers1883, Godfrey 2015:38). A second dam, 100 feet long and located 230 feet south of the 1925 structure, was approved in 1931 (Figure 108) (War Department Permit 1929, 1931, Godfrey 2015:113-115). These dams, at times, were associated with Pine Island, not Marine.

The 1937 USACE map indicated three dams, assisting the survey team in placing nine search targets for survey (Figures 109-111). GPS target 142 revealed two isolated rock piles, but no other remains associated with a dam structure. A second target was examined by sonar, revealing the remains of a wing dam, and a crib, a type of revetment, still remaining on the adjacent island (Figures 112 and113). A shore search near the Marine on St. Croix landing located the likely remains of a dam, with 4-6 logs on the Minnesota shore, and rocks on both sides of the landing. A third site displayed on shore cribbing with a corresponding rock wing dam. The remaining targets were surveyed with sonar, and investigated in person as needed, but no additional cultural remains were located.

The team selected the wing dam with associated cribbing at Marine on St. Croix for mapping, and collected images of the site (Figures 114-121). The location and structure visibly will benefit visitors as the river levels change throughout the year. To get the full extents of the site, two baselines were established, one across a potential revetment site, 40 feet long at a compass bearing of 320 degrees, and another departing from the first baseline's southern extent at 190 degrees, making a total baseline of 95.6 feet. To gather both plan and profile data, baseline offsets and depth measurements were acquired every five feet. The team soon realized that the dam extended almost 100 feet further into the river than first realized, and took GPS and Total Station measurements of features, baselines, and shoreline. Additional points were used from the sonar imaging to create the full site extents as swift current, increased water depth, and low visibility created possible error during physical investigations. Additionally, the team took trilateration measurements from the first baseline to map the locations of the log cribbing. The plan view of the site, and a profile view of the revetment were mapped onto Mylar, then inked (Figures 122-124).

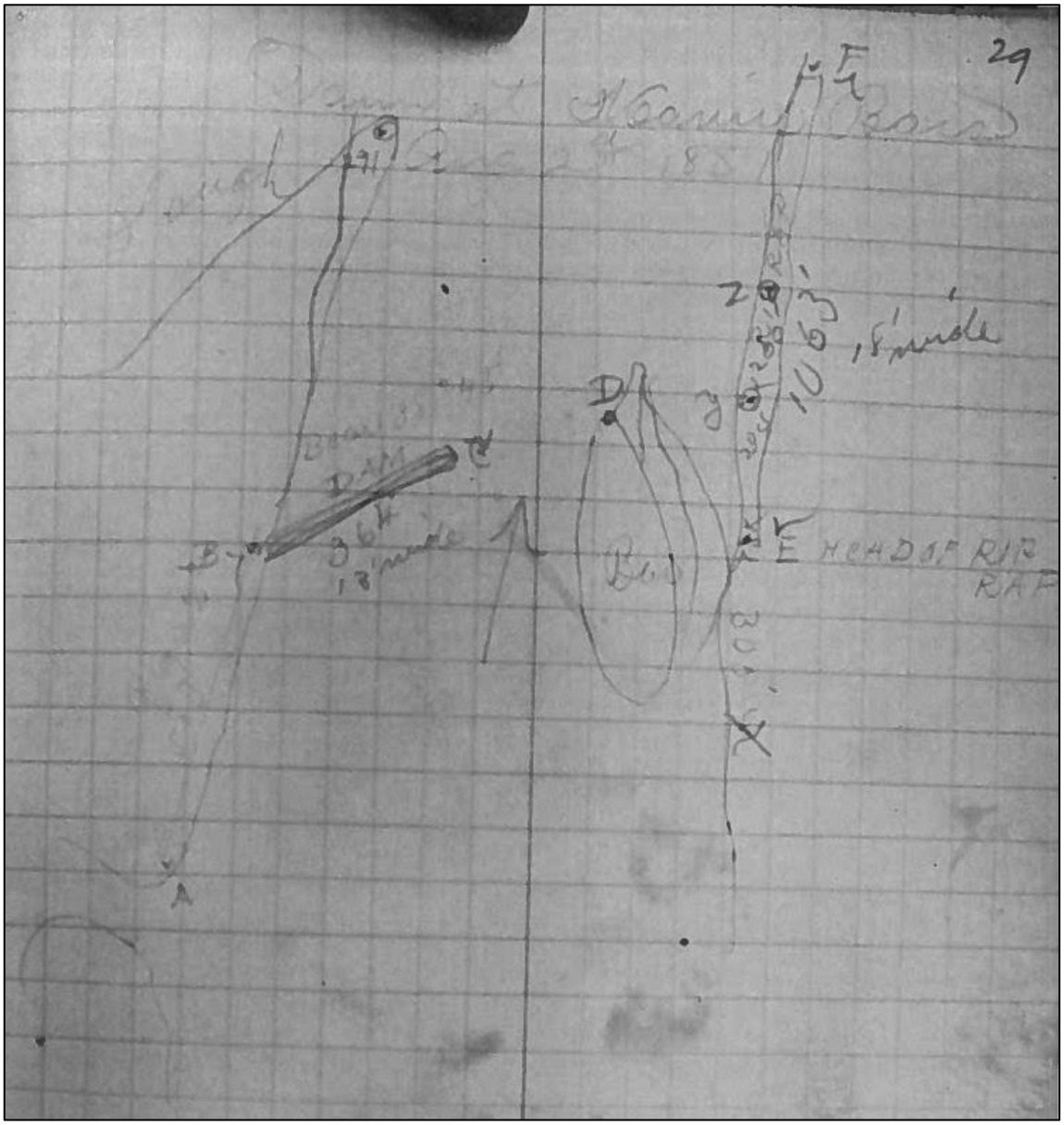


FIGURE 106. Marine on St. Croix (Marine Bar) sketch by Parkinson in 1881. (Courtesy of SACN 2015 and Chicago NRA).

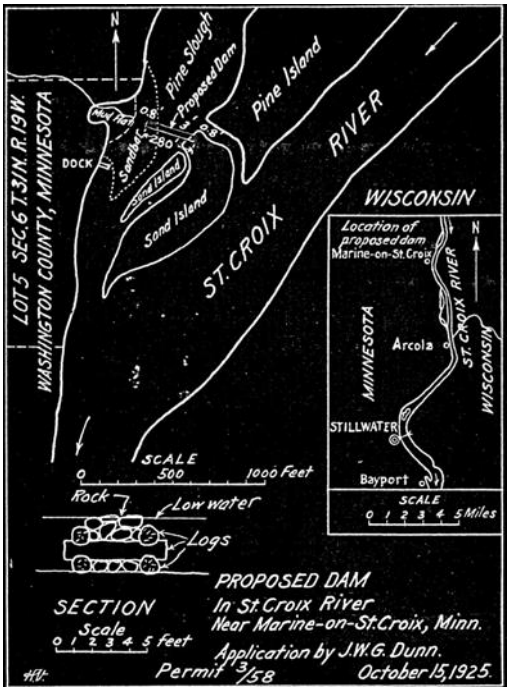


FIGURE 107. War Department Permit 3/58 1925. (War Department Permit 3/58 "Proposed Dam in Saint Croix River Near Marine-on-Saint Croix, Minnesota," 15 October 1925, MHS Manuscript 253: Saint Paul District, District Office Records, 1879-1990, Godfrey 2015:114).

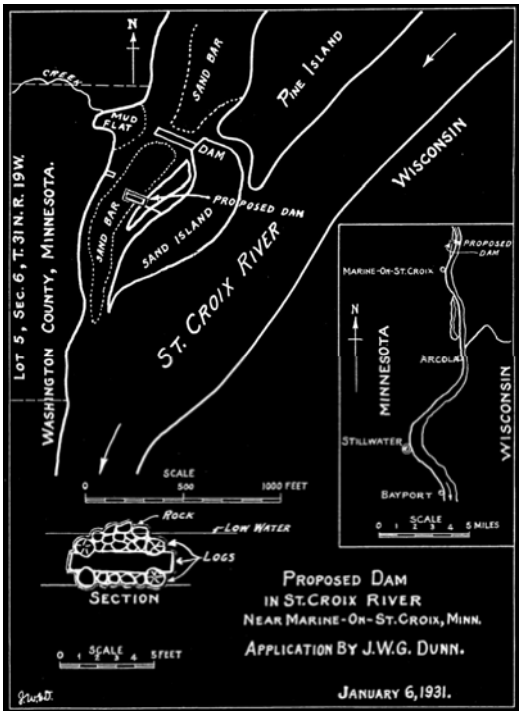
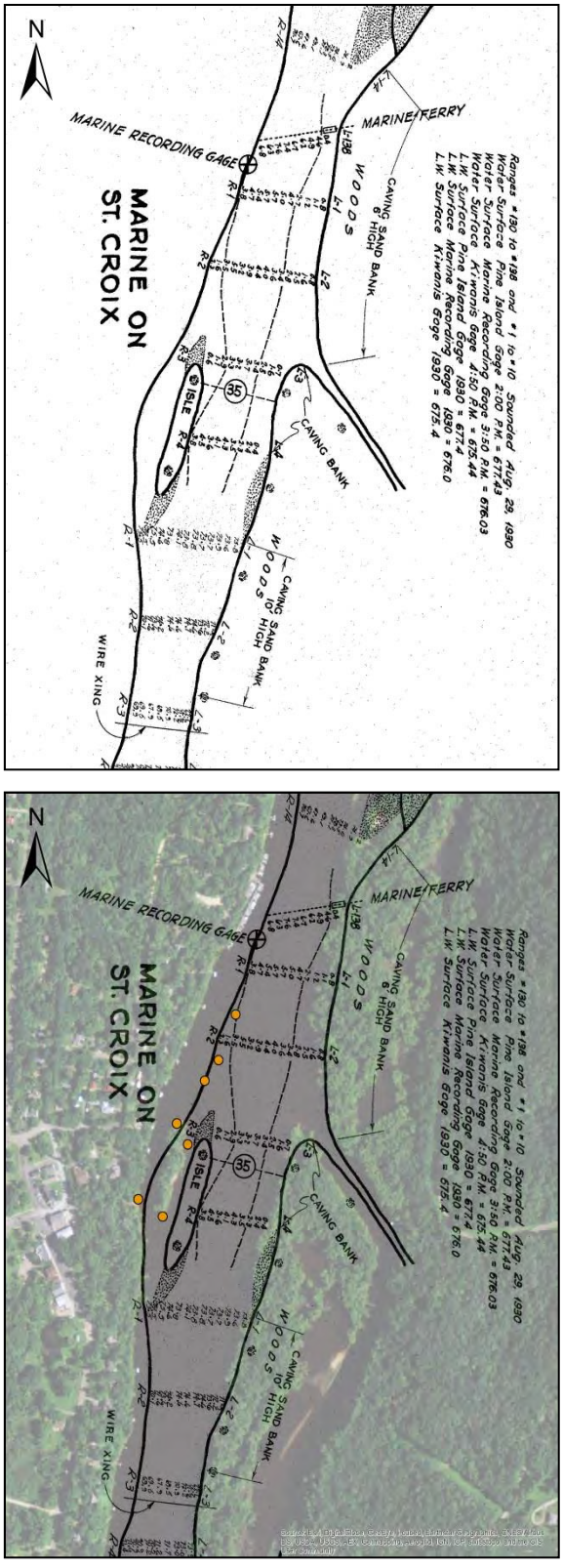


FIGURE 108. War Department Permit 2/69 1931. (War Department Permit 2/69 "Proposed Dam in Saint Croix River Near Marine-on-Saint Croix, Minnesota," 6 January 1931; J.W.G. Dunn to U.S. Engineer, 4 March 1932, MHS Manuscript 253: Saint Paul District, District Office Records, 1879-1990, Godfrey 2015:114).



FIGURES 109 and 110. USACE Map, Marine on St. Croix 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI aerial map with USACE map, Marine on St. Croix 1937 overlay.

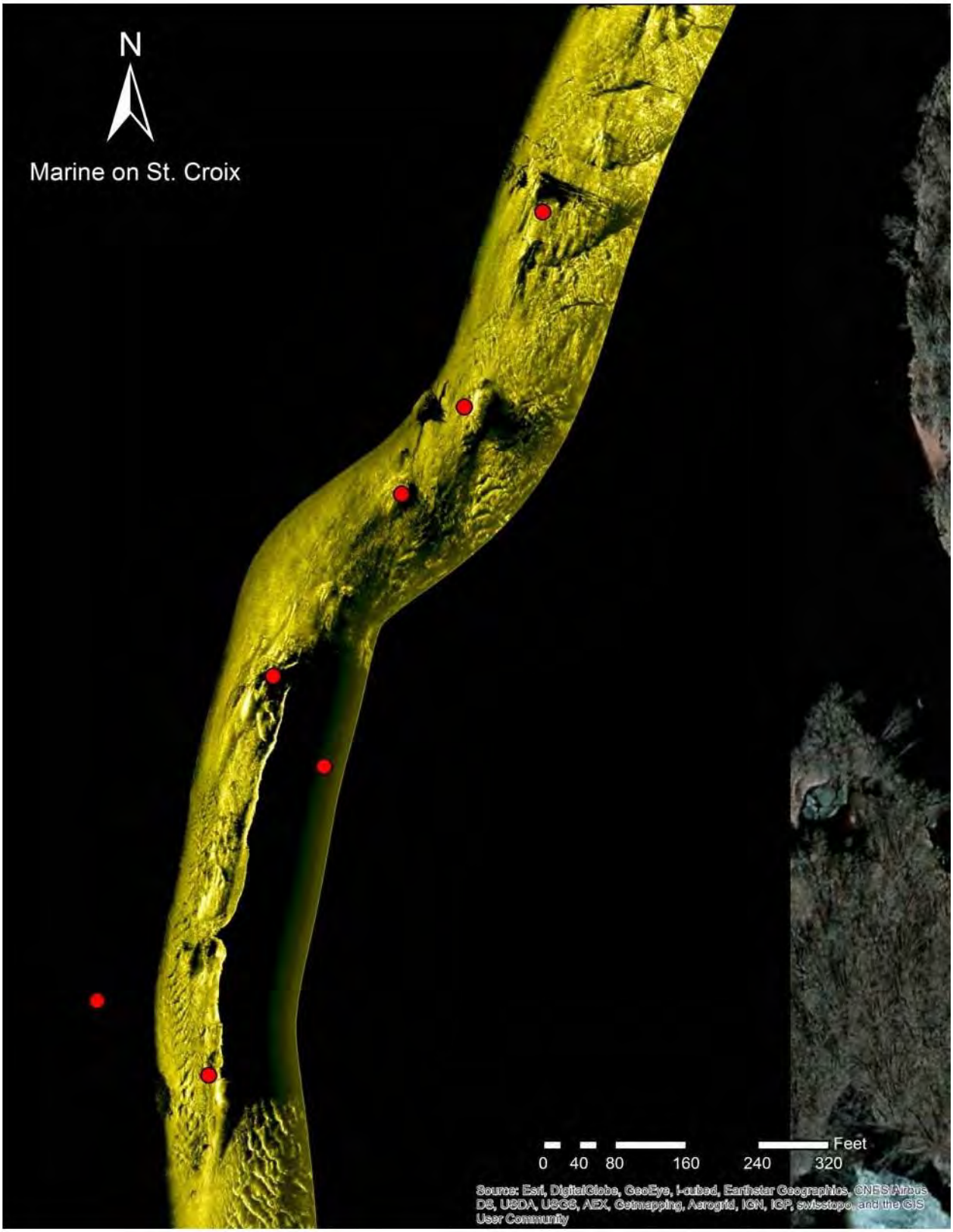


FIGURE 111. Sonar imagery from Marine on St. Croix.

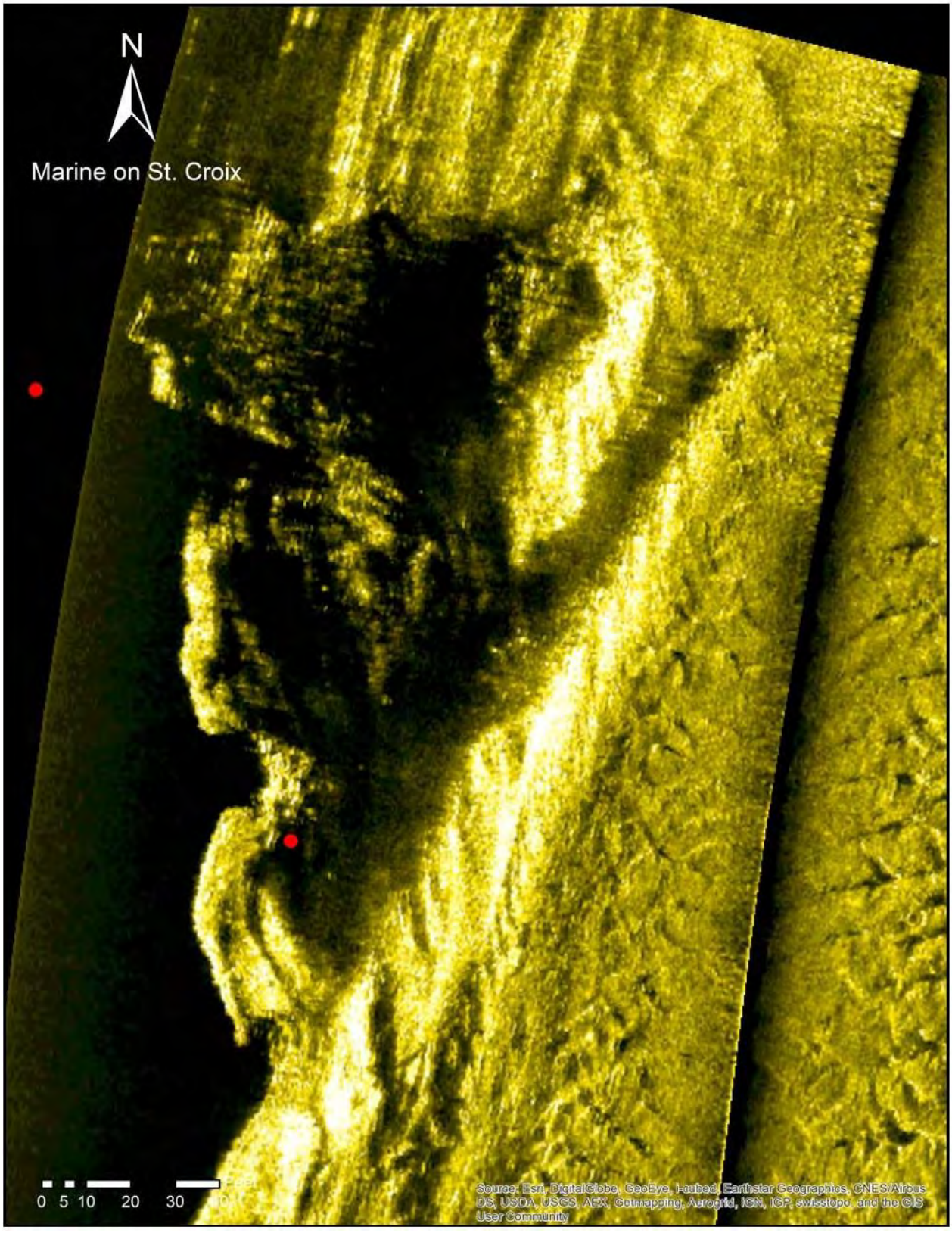


FIGURE 112. Sonar imagery from the wing dam and cribbing at Marine on St. Croix.

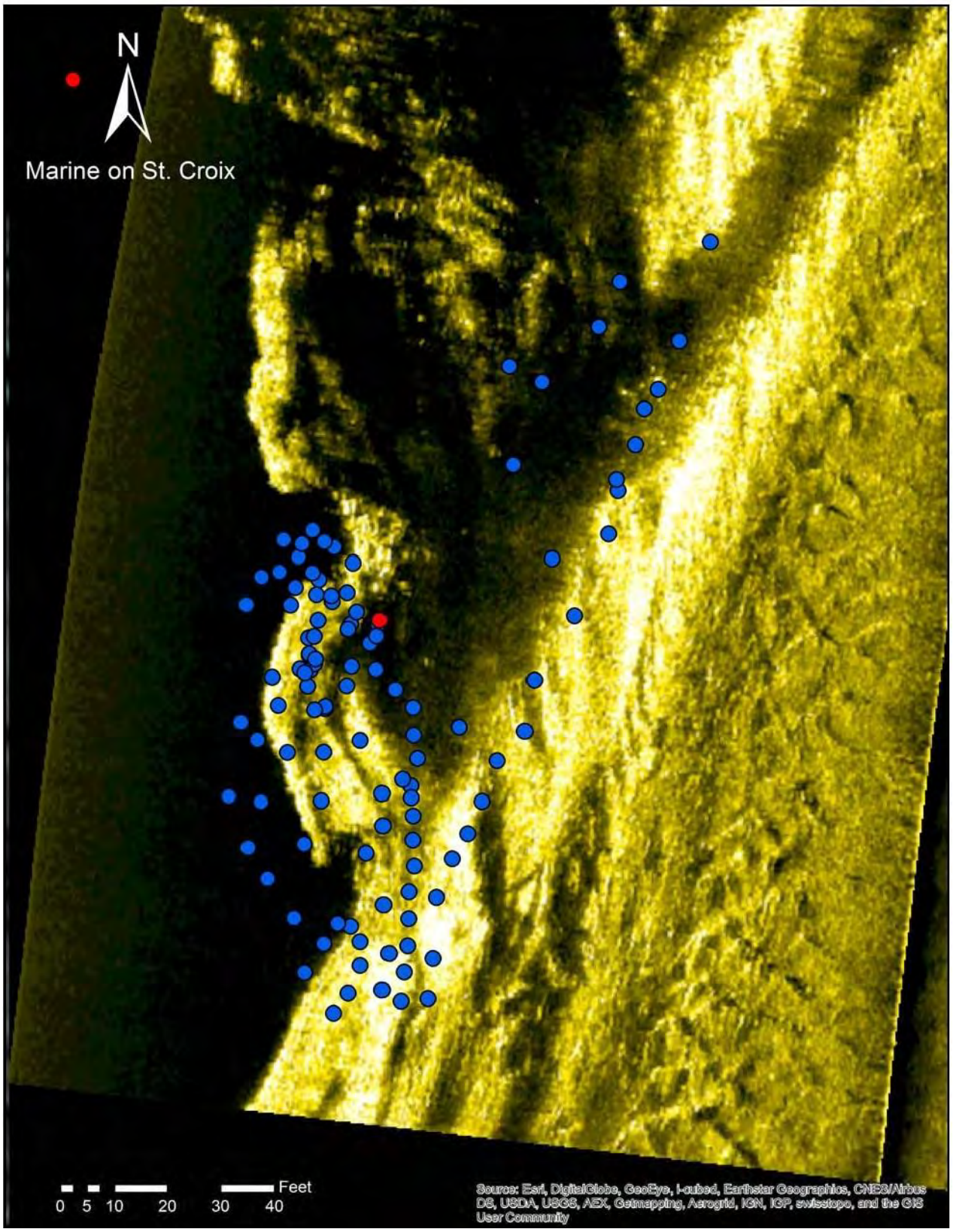


FIGURE 113. Sonar imagery of the wing dam and cribbing showing transit points that have been post-processed to show their spatial locations shown in blue.

FIGURES 114 and 115. Images from GPS 69 showing the structure of the wing dam.

FIGURES 116-121. Images from Marine on St. Croix showing the structure of the cribbing.

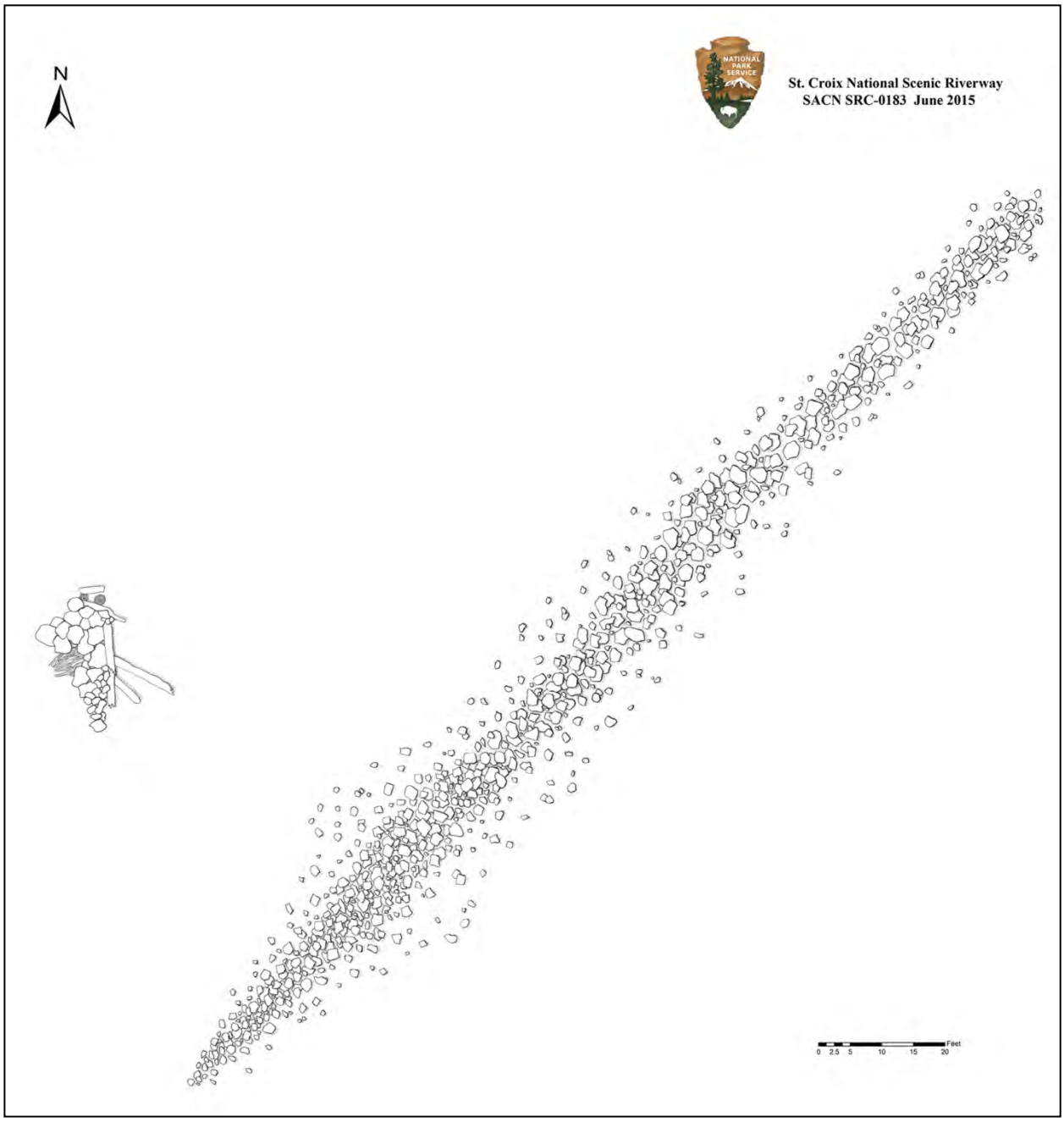


FIGURE 122. Marine on St. Croix site map.

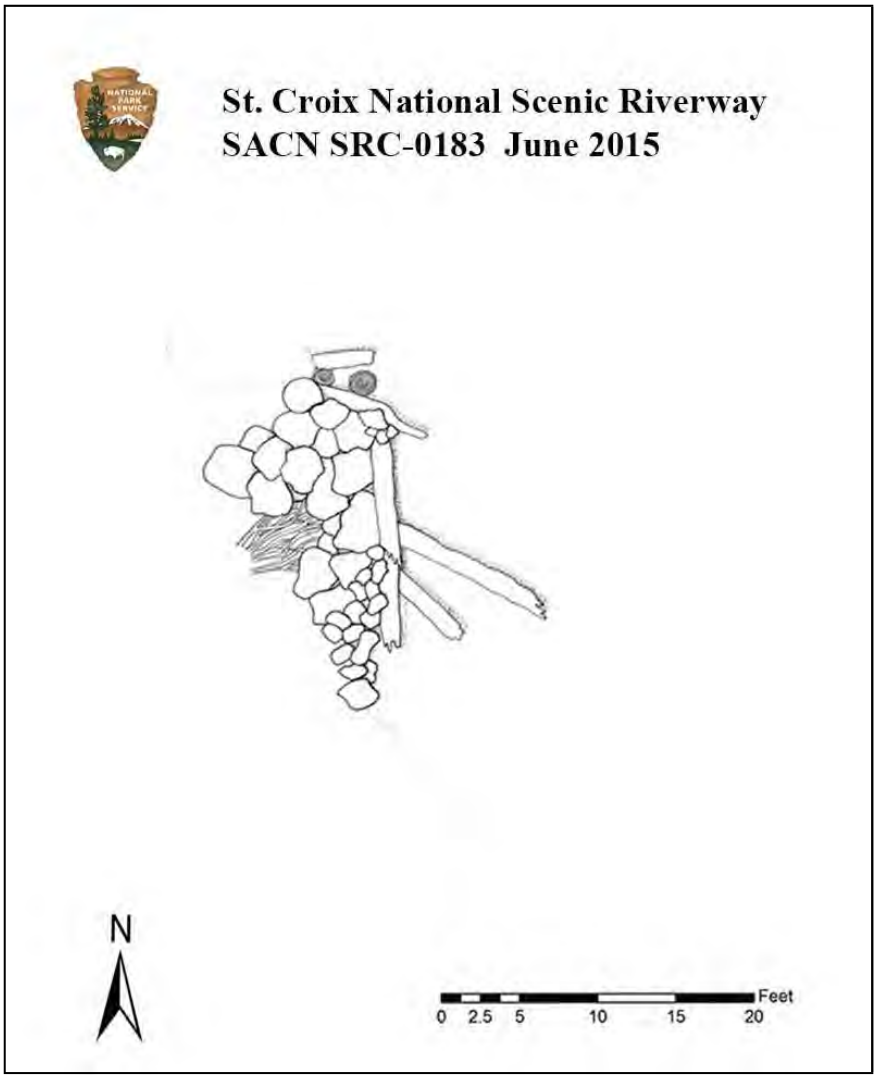


FIGURE 123. Marine on St. Croix cribbing plan view.

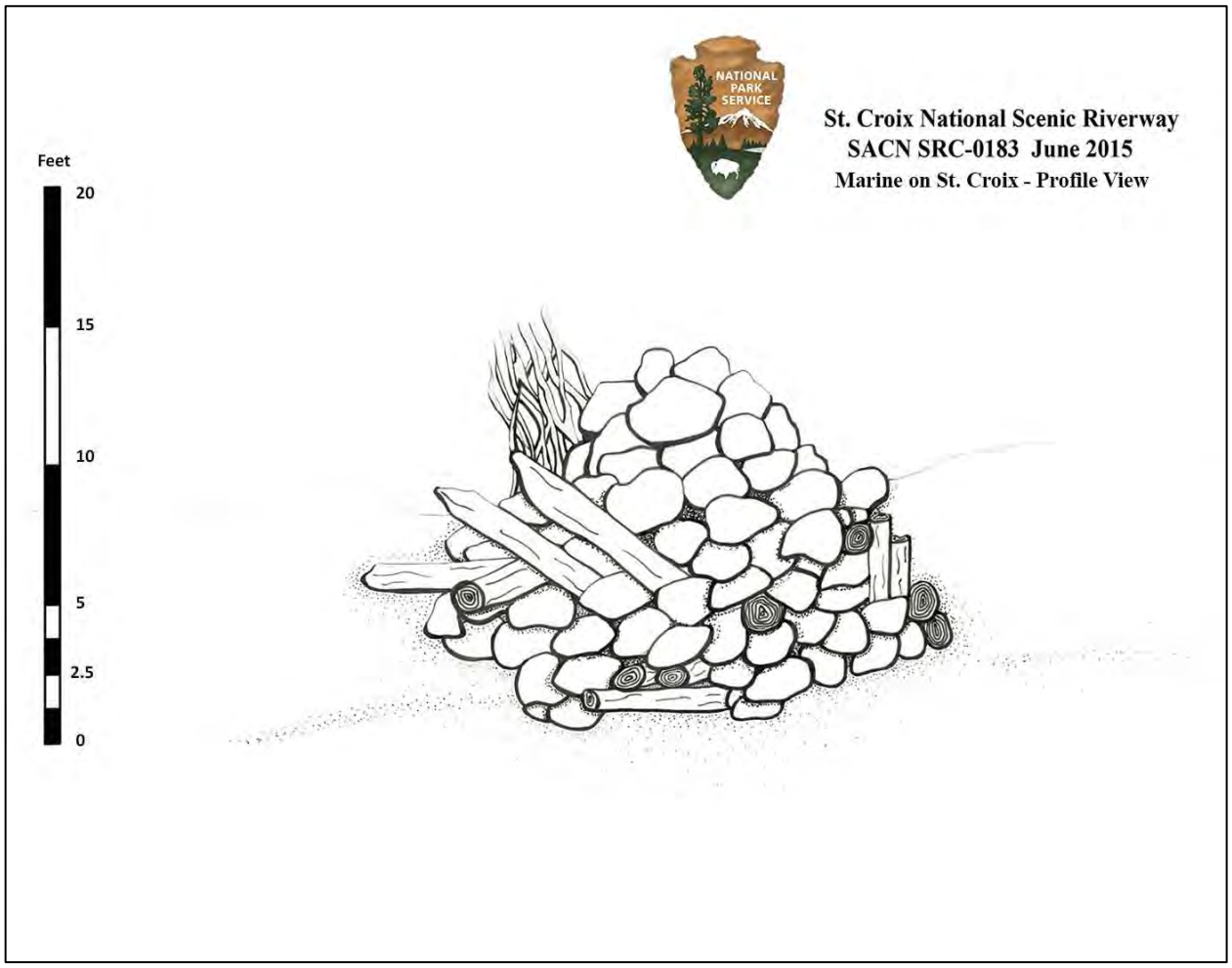


FIGURE 124. Marine on St. Croix cribbing profile view.

Page's Slough

This section encompasses both the Page Slough area of the St. Croix River, as well as Arcola immediately downriver. Early in the planning for river modifications, the USACE denoted Page's Slough as a priority spot. In 1873, a 600 linear foot brush dam was proposed to combat a troublesome sandbar (Annual Report of the Chief of Engineers 1875:372-375, Godfrey 2015:20). By 1880, Page's Slough was determined the most problematic point in the proximate river area, requiring at least 250 feet of dam, with a working goal to close many of the area's small channels using 400 feet of dam structure (Annual Report of the Chief of Engineers 1880:1664).

Much of the history surrounding the actual creation and maintenance of these dam structures is unknown, though USACE reports a brief mention of the construction of closing chutes near Arcola in 1884 (Figure 125) (Annual Report of the Chief of Engineers 1884:1606-1609, Godfrey 2015:40). The 1937 USACE map indicates four closing dams proposed in the Page's Slough area: two upriver of Arcola at caving banks on each side of the river, and two closing dams proposed further downstream to divert water into the narrow deeper center channel and through Page's Slough itself.

With only this information at hand, the survey selected 12 GPS targets to investigate via sonar, kayak, and on foot. This section of the river has undergone dramatic changes since the completion of the 1937 map, particularly with major shifting of the slough's islands (Figures 126-131). Of the 12 investigated sites, only one revealed the scant remains of a successful closing dam, now largely buried under vegetation and snags.

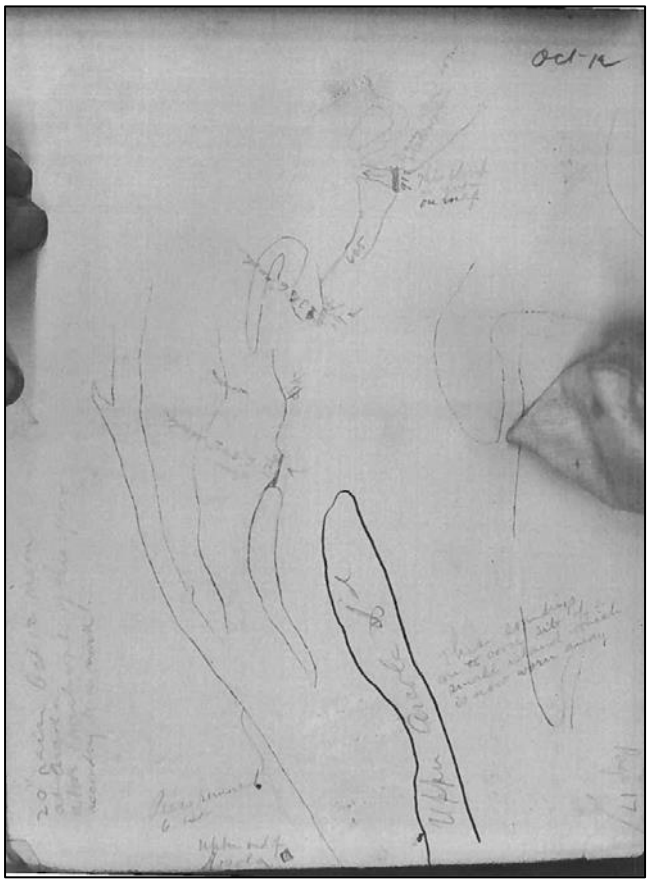
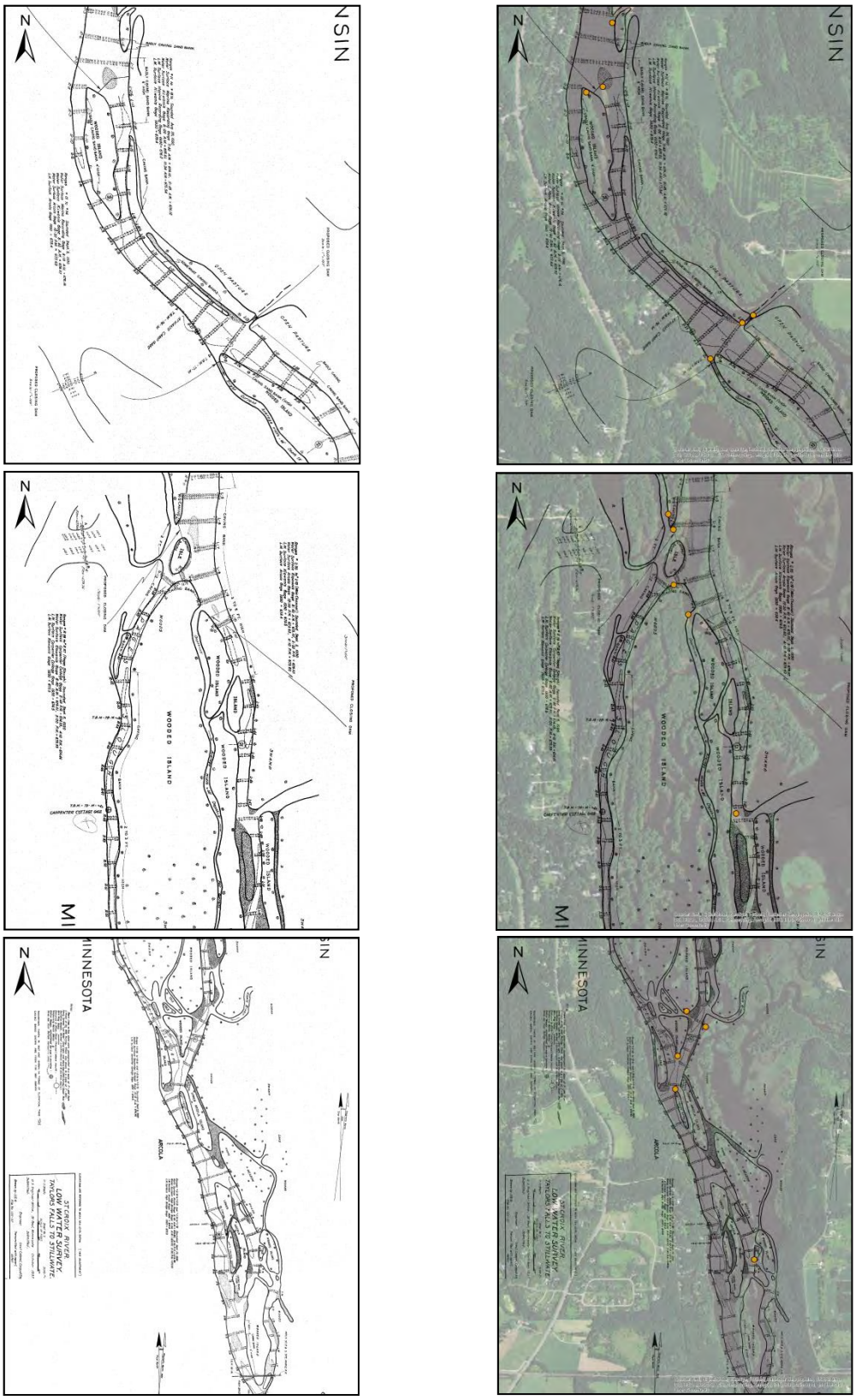


FIGURE 125. Page's Slough sketch by Darling in 1883. (Courtesy of SACN 2015).



FIGURES 126-131. USACE Map, Page's Slough 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI aerial map with USACE map, Page's Slough 1937 overlay.

Kelly's Slough

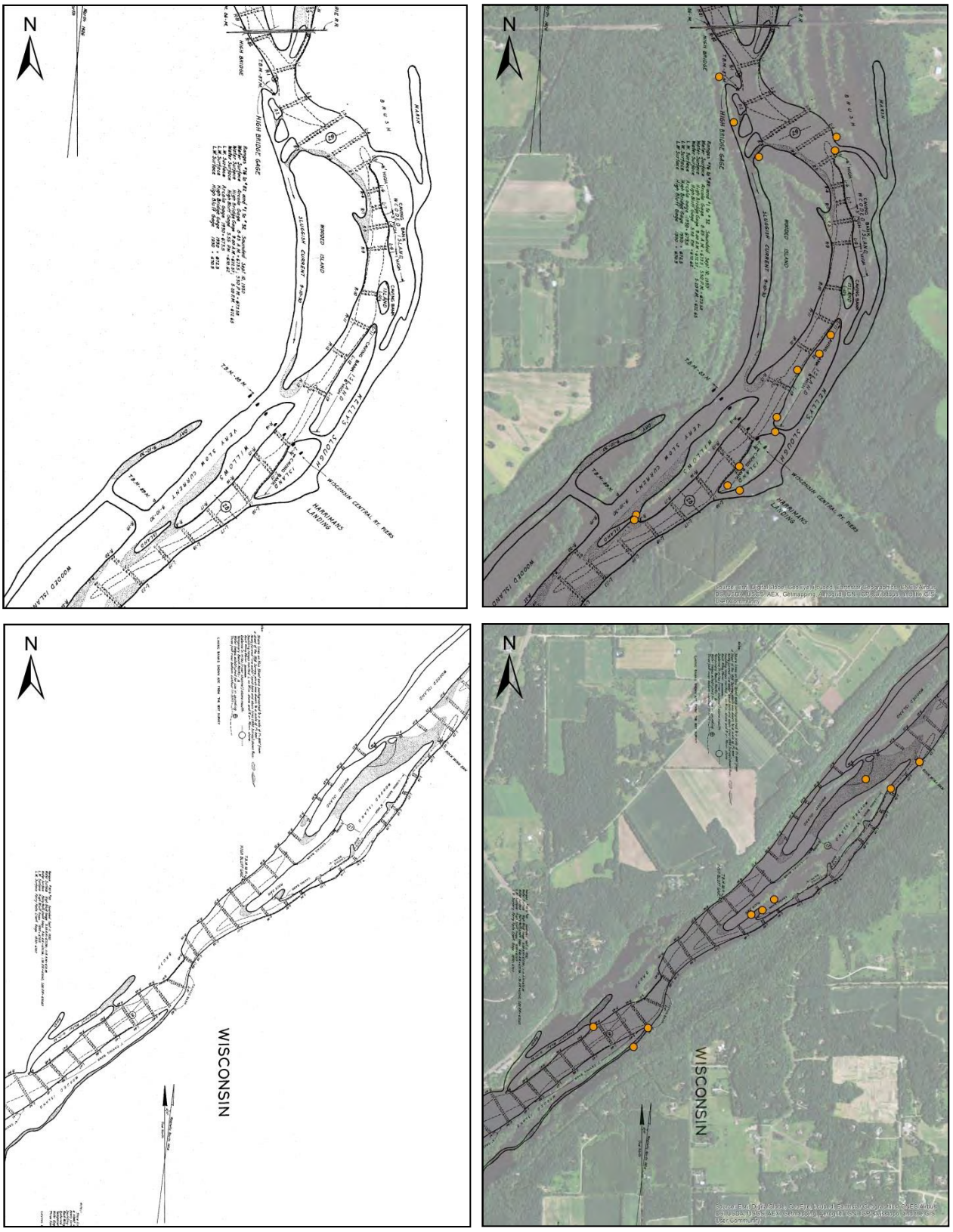
The Kelly's Slough section of the survey extended from the northern-most edge of the slough, and downriver through the several wooded islands marked on the 1937 USACE map. The USACE began constructing closing and wing dams in 1883 to manage the river flow through the main channel of the St. Croix, and limit diversion through the slough (Annual Report of the Chief of Engineers 1883:1444-1445, Godfrey 2015:38). Two years later, the riverbank collapsed half a mile above Harriman's Landing, on the western side of the river (Allen 1885, Annual Report of the Chief of Engineers 1885:1739, Godfrey 2015:43).

> This break threatened to change the course of the river down Kelly's Slough. By flanking the main channel span of the bridge, the break endangered the passage of vessels through the area. As a remedy, District Engineer Allen recommended that a high-closing dam be built there and that the banks above Harriman's Landing be well revetted at junctions with the closing dam and shore to prevent this from happening. The work of closing the breach on the left bank was completed by April 1885. Approximately 600 cubic yards of stone and 116 chords of brush were used on the project (Godfrey 2015:43).

This section of the river remained a threat, and USACE reports repeatedly worked to maintain supporting revetments at Kelly's Island (Annual Report of the Chief of Engineers 1886:1490-1492, Allen 1888, Godfrey 2015:45, 51). The 1937 USACE map indicated the presence of two existing rock dams, as well as a number of caving banks (Figures 132-135).

With limited geographic data on the location of dam structures at Kelly's Slough, but with the knowledge that the high number of caving banks and the known work in the 19th century likely left cultural remains *in situ*, the team completed sonar survey over a great deal of the area, focusing on 21 GPS targets. Targets producing promising imagery were investigated in person, either via diving or shore searches. A majority of the sites investigated revealed only bottom contours, with only two sites identified. GPS target 107 appeared to be a successful closing dam completely covered in sediment (Figures 136 and 137). Its placement between the two islands and sharp contoured edges support this assumption.

GPS target 115 proved to be the remains of a rock closing dam, which was selected for mapping and photography (Figure 138). The team established a 167 foot long baseline, at a compass bearing of 140 degrees. The dam itself was composed entirely of rocks, with very little relief. The mapping team took baseline offsets every ten feet to indicate the perimeter of the dam. They also acquired depth measurements every ten feet along the baseline, but changes in relief along the entire structure were limited to approximately one foot. Total Station and GPS points were acquired as well. Once all measurements were complete, the site was mapped on Mylar, and later inked (Figure 139). No other GPS targets at Kelly's Slough were associated with cultural remains.



FIGURES 132-135. USACE Map, Kelly's Slough 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI Aerial Map with USACE Map, Kelly's Slough 1937 overlay.

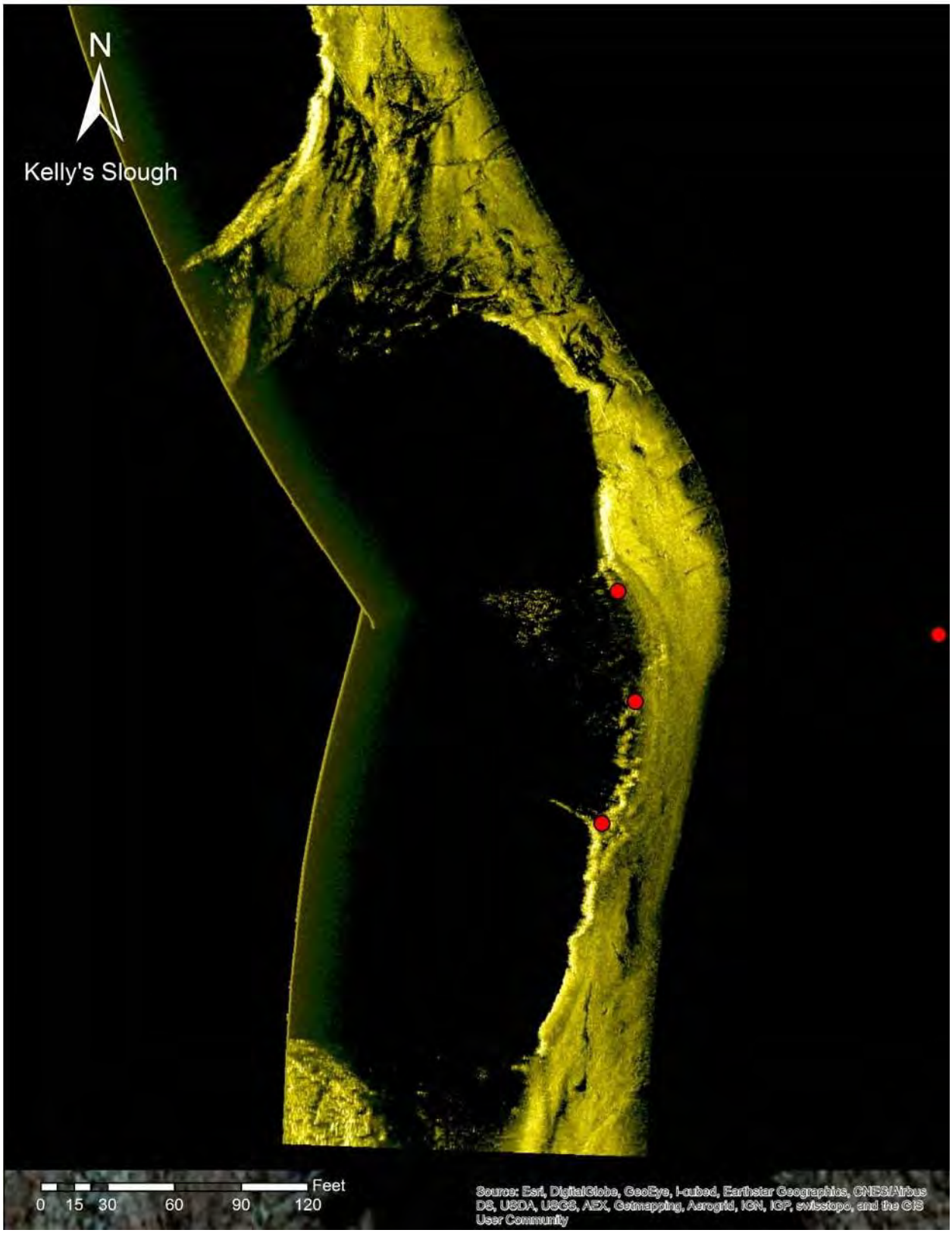


FIGURE 136. The sonar imagery from GPS target 107 at Kelly's Slough.

FIGURE 137. Image from Kelly's Slough GPS target 107 showing a submerged sediment-covered structure.

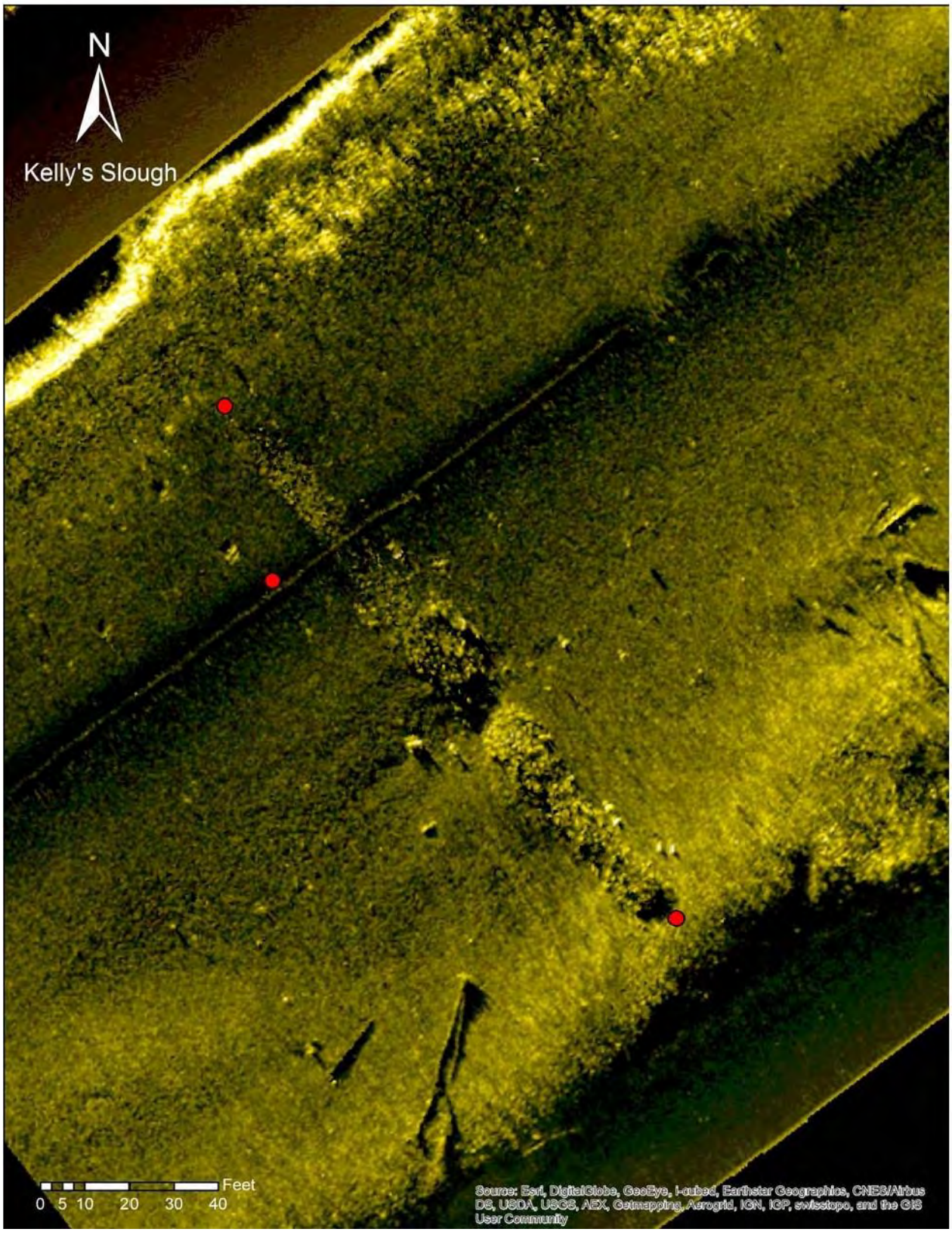


FIGURE 138. The sonar imagery from the rock dam at GPS Target 115 in Kelly's Slough.

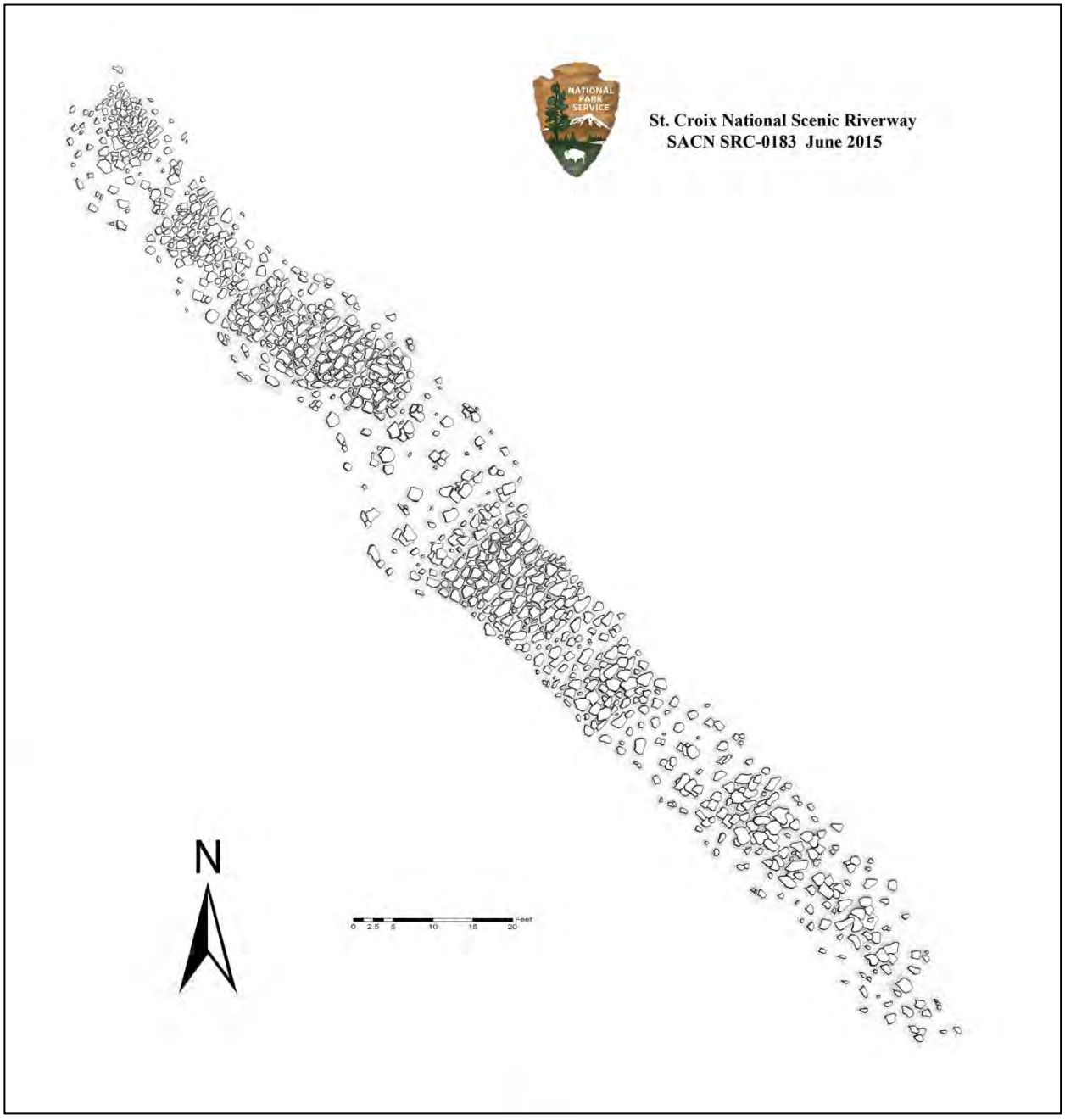
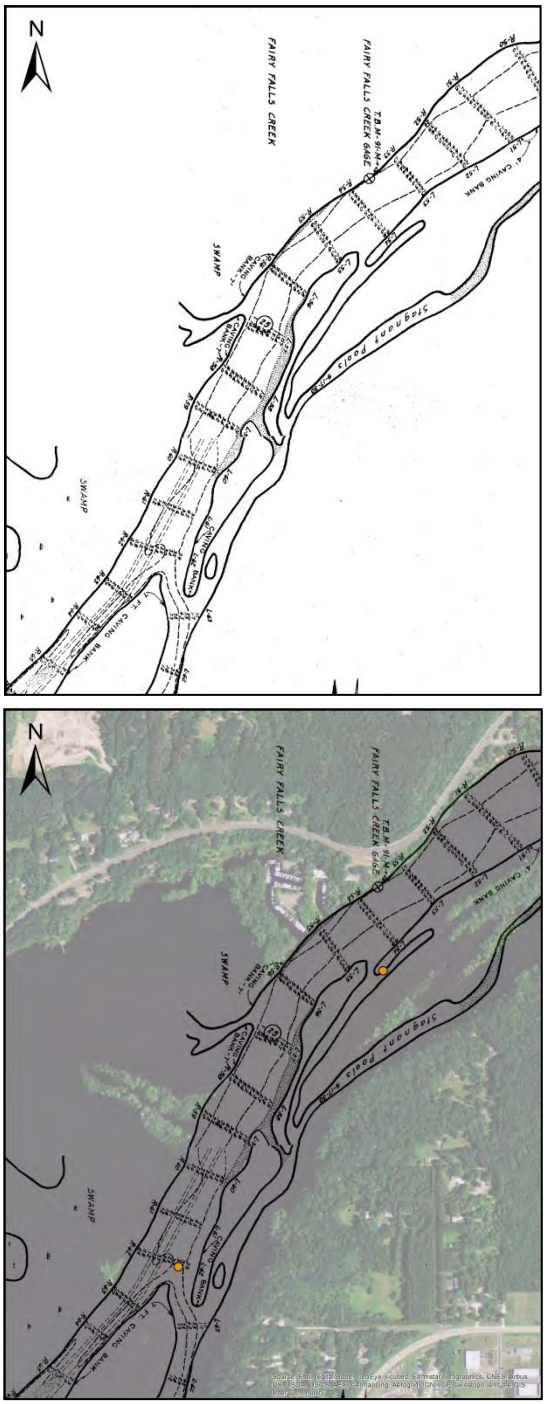


FIGURE 139. Kelly's Slough site map.

Stillwater

Two targets were placed near Stillwater based upon personal communication with SACN staff and a review of the 1926 and 1937 maps, identifying likely locations for water control features (Figures 140 and 141). As seen in Figure 142, this area has changed significantly over time. Side scan sonar of the target areas revealed no features of interest.



FIGURES 140 and 141. USACE Map, Stillwater 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI aerial map with USACE map, Stillwater 1937 overlay.

Hudson

The Hudson section of the survey project had a large amount of historical data available, as it was the focus of tremendous river improvement efforts. As early as 1873, USACE surveyors declared the Hudson sandbar one of the worst natural obstructions to navigation below Stillwater (Annual Report of the Chief of Engineers 1875:372-373, Godfrey 2015:20). Subsequent reports all declared either the dire need for dredging work at Hudson, or (with increasing weariness) described the large amounts of sediment that had been removed that season. In 1882, the continued need for dredging at the "narrow and tortuous" Hudson channel was accompanied by a proposal for the construction of a closing dam on the channel side of the Hudson bridge bar (located at a trestle drawbridge of the Western Wisconsin Railroad) (Annual Report of the Chief of Engineers 1882:1815, Godfrey 2015:35-36).

> After full consideration of the two methods of closing dam building at the time (e.g. brush and stone vs. pile driving), Allen felt that a pile-driven dam was more suitable for the situation. Very large rafts of logs frequently passed this point and during certain stages of water they were liable to strike the dam and do more damage to brush and stone dam than a pile-driven dam. He proposed a closing dam 3,500 feet long and nearly parallel with the channel for 3,000 feet, costing $1.95 per linear foot. According to his plans, piles were to be no less than ten inches at the butt end in diameter and fifteen to twenty feet in length. (Allen 1882, Godfrey 2015:38).

By the end of the 1882 construction season, the USACE had driven 350 iron spikes into the structure of the new pile and sheet closing and training dam, with the hope that the structure would both divert water into the main Hudson channel, and also keep traffic and debris away from the bar. Its design involved piles placed every three feet, and lumber sheathing placed on its channel side (Hampton 1883, Godfrey 38-39).

Construction on the dam continued in 1884, hampered by the need for more dredging—another 3500 cubic yards of sediment were removed. By the end of the season, however, the dam was over 1200 feet long, and in 1885, only 150 feet of the lower dam remained unsheathed by 3 inch pine piling (Hampton 1884, Annual Report of the Chief of Engineers 1885:1739, Godfrey 2015-42-44). The following year, the dam was extended a further 165 feet, and 758 feet of its wall was secured against scouring with the placement of brush, stone, and gravel at its base (Godfrey 2015:45).

The area's dynamic environment continued to challenge river control efforts. In the winter of 1888-1889, another 9000 cubic yards of sediment were removed from the Hudson channel. The dam was now described as, "a wing dam of round and sheet piling, seven feet high above low-water stage, and five hundred feet long, commencing at a point about eleven hundred feet above the ferry landing" (Allen 1889, Godfrey 2015:51). Apparently, despite all maintenance efforts almost 900 feet of the dam had been washed away in the previous three years. Figure 142 was taken from a letter written in 1890 by A.O Powell to W.A. Jones and included a sketch of the dam's location (Godfrey 2015:60).

Over the next 45 years, river improvements at Hudson continued to be a major funding and labor priority for the USACE at the St. Croix River (Godfrey 2015:96, 112, 131). After the turn of the 20th century, however, historic documents refer to dredging work, rather than continued maintenance or extension of the Hudson Bar dam. In 1934 alone, 70,000 cubic yards of material were removed, indicating both the challenge that the area continued to present, and perhaps also the failure or loss of the dam structure (Daley 1394, Godfrey 2015:131).

Using the detailed locational and descriptive information expressed by the historical documents above, the survey team was able to direct their efforts to a primary focal point in the Hudson area (Figure 143). Sonar imagery was collected along the bar above the still-present trestle railroad bridge. This imagery revealed the probable location of the historic dam structure, based on bottom contours (Figure 144).

The survey team established two GPS points on the sonar image contour, and divers investigated both locations using methodical search patterns. While the steep slope of the river floor indicated the likely location of the dam, any structural remains were buried entirely by sediment. Other sonar GPS points were added later to identify the sediment-covered remains as seen in Figure 144.

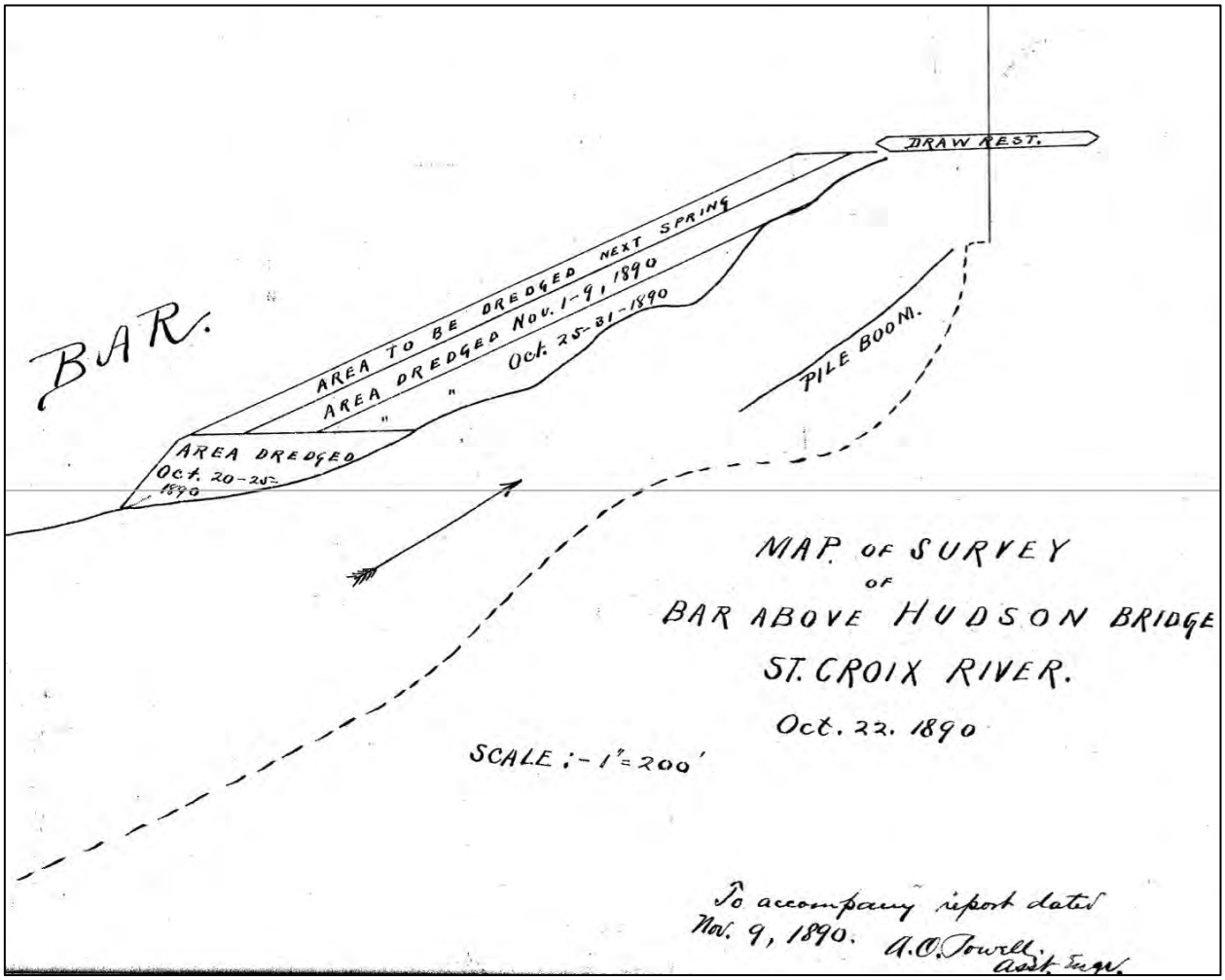


FIGURE 142. Hudson Map, Powell 1890. (A.O. Powell to W.A. Jones, 31 October 1890, 9 November 1890, Box 51, Entry 1604, Letters Received, 1889-1898, Mississippi River Above Falls of Saint Anthony–Saint Croix River, RG 77, Kansas City, Missouri; Godfrey 2015:60).

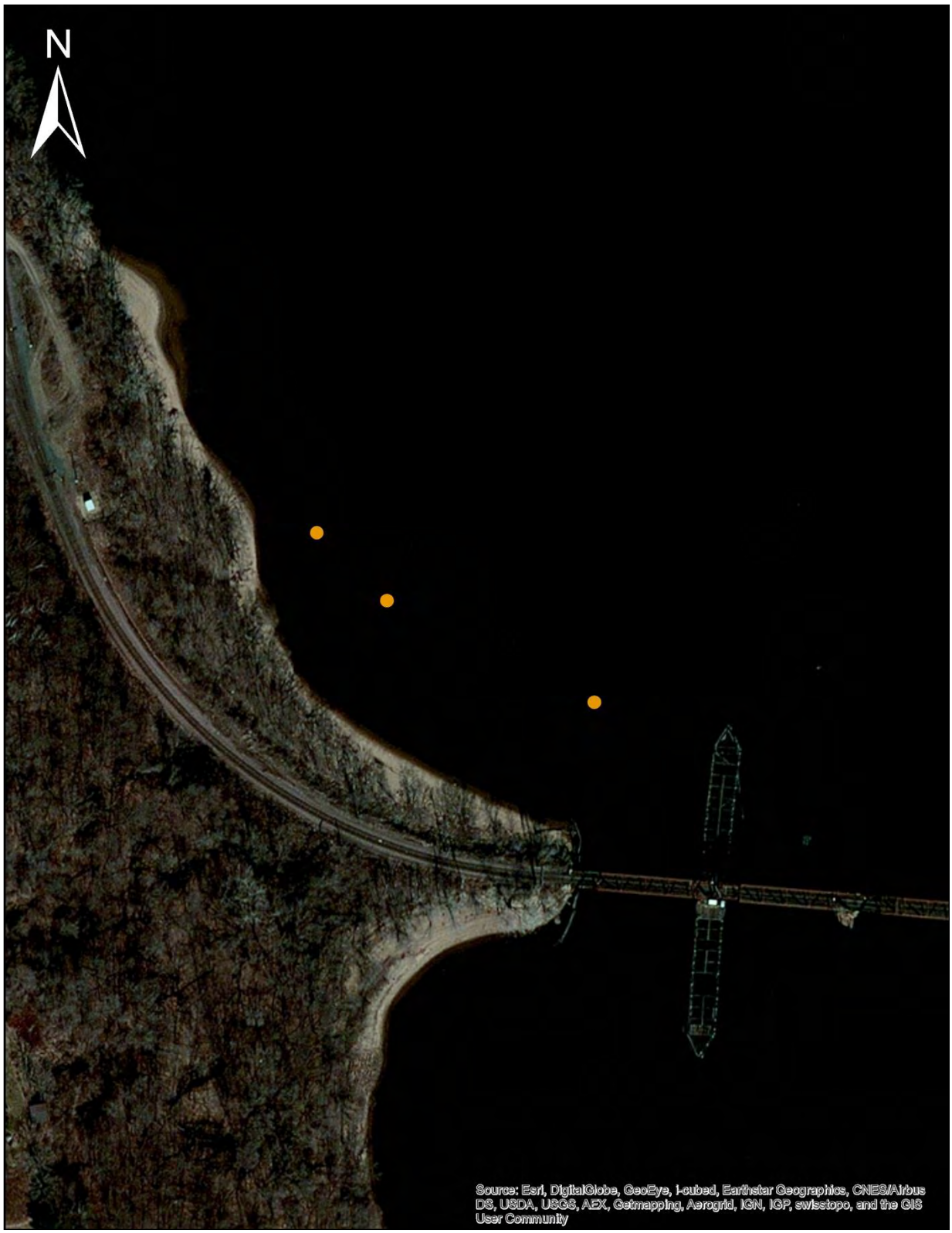


FIGURE 143. ESRI aerial map with Hudson GPS targets.

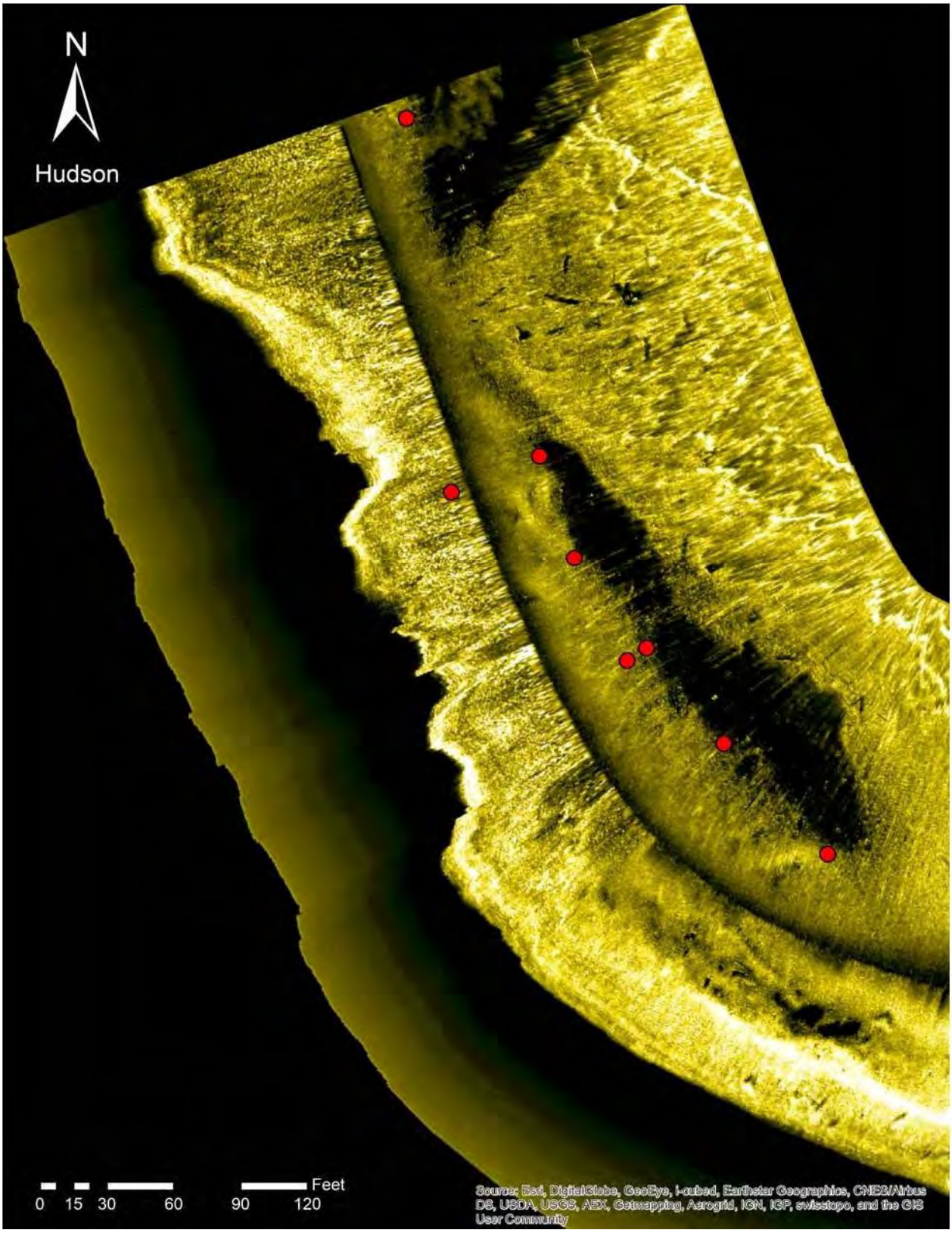


FIGURE 144. The sonar imagery from the dam at Hudson.

Catfish

Catfish Bar, six miles downriver from Hudson, was the terminus for the survey project. USACE surveyors declared the area a difficult and hazardous navigation point in 1873, describing the bar as a significant natural obstruction, and the Catfish channel too angled to allow easy traffic to Lake Saint Croix. Their report recommended the construction of a 1400 foot long wing dam (Annual Report of the Chief of Engineers 1875:372-375, Godfrey 2015:21).

Over the next 13 years, however, work at Catfish focused on dredging, rather than dam construction. With initial dredge work completed in 1880, 1500 cubic yards of material were removed in 1882 to straighten the channel (Allen 1881, Godfrey 2015:33). Using scrapers, the USACE removed 5500 cubic yards in 1884, 3900 cubic yards in 1885, and another 3000 cubic yards in 1886 (Annual Report of the Chief of Engineers 1885:1739, Godfrey 2015:42-45).

Each report discussed the need for a dam to concentrate the water flow through the main channel and assist in preserving the results of the dredge work, but no work on a Catfish dam was completed until 1888 (Godfrey 2015:45-51).

> With the last remaining funds, [District Engineer Allen] hired a minimal crew to repair, extend and level the rock and brush training or wing dam at Catfish Bar. This work took place from December 1888 to February 1889. By seasons end, 215 linear feet of wing dam had been built at Catfish Bar (Godfrey 2015:51).

The 150 foot long wing dam was constructed of brush and stone, and located at Catfish Bar on the river's Minnesota bank in front of the village of Afton (Figure 145). At time of construction, it rested three feet above the low water mark. Its eastern end was marked with an eight-foot-high pile of rocks, also reaching three feet above low water (Allen 1888, Godfrey 2015:51-52).

Following the construction of the Catfish dam, dredging operations and the mention of Catfish as a high-priority area for river improvements continued in the area through 1925 (Annual Report of the Chief of Engineers 1890: 2087-2089, Report of Operations 1892, Jones 1894, Godfrey 2015:58, 63, 64, 115). No further dam maintenance is mentioned in Godfrey's (2015) report. Additional archival research produced Figure 146 showing Catfish dam in 1929 from a USGS survey.

The 2015 survey team used the historical data above to isolate their survey patterns along the Minnesota bank at Catfish (Figure 147). The sonar imagery revealed the remains of the wing dam (Figure 148). Divers investigated and systematically searched the area designated by the sonar, but the structure was covered entirely with sediment. They identified clear extents of the structure, however, and took nine GPS coordinates defining the site for depiction in ArcGIS (Figure 149). Additional sonar GPS targets were added during post-processing to aid in the delineation of the structure, and topside photos were acquired at the site (Figures 150 and 151).

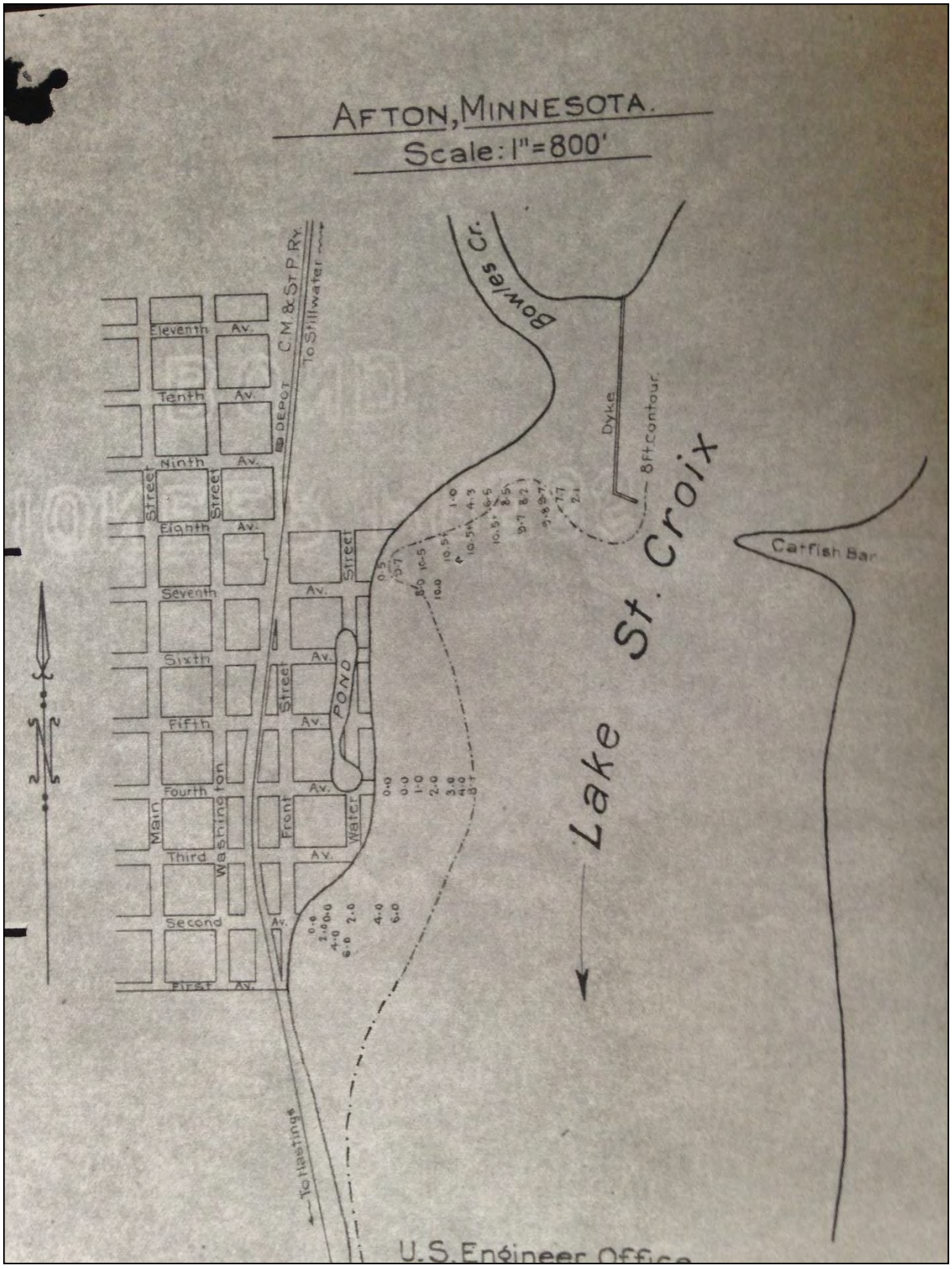


FIGURE 145. A map of Catfish dam from USACE November 7, 1910. (Courtesy of SACN 2015).

FIGURE 146. A map of Catfish brush and rock 'dike' or dam from 1929. (Plan of St. Croix River, Wisconsin and Minnesota: from mouth to a point 11 miles above Danbury, Wisconsin. Geological Survey (U.S.); United States. Army. Corps of Engineers; Byllesby Engineering and Management Corporation. Washington, D.C.: Dept. of the Interior, U.S. Geological Survey 1929, courtesy of SACN, 2015.

FIGURE 147. ERSI aerial map with Catfish dam location.

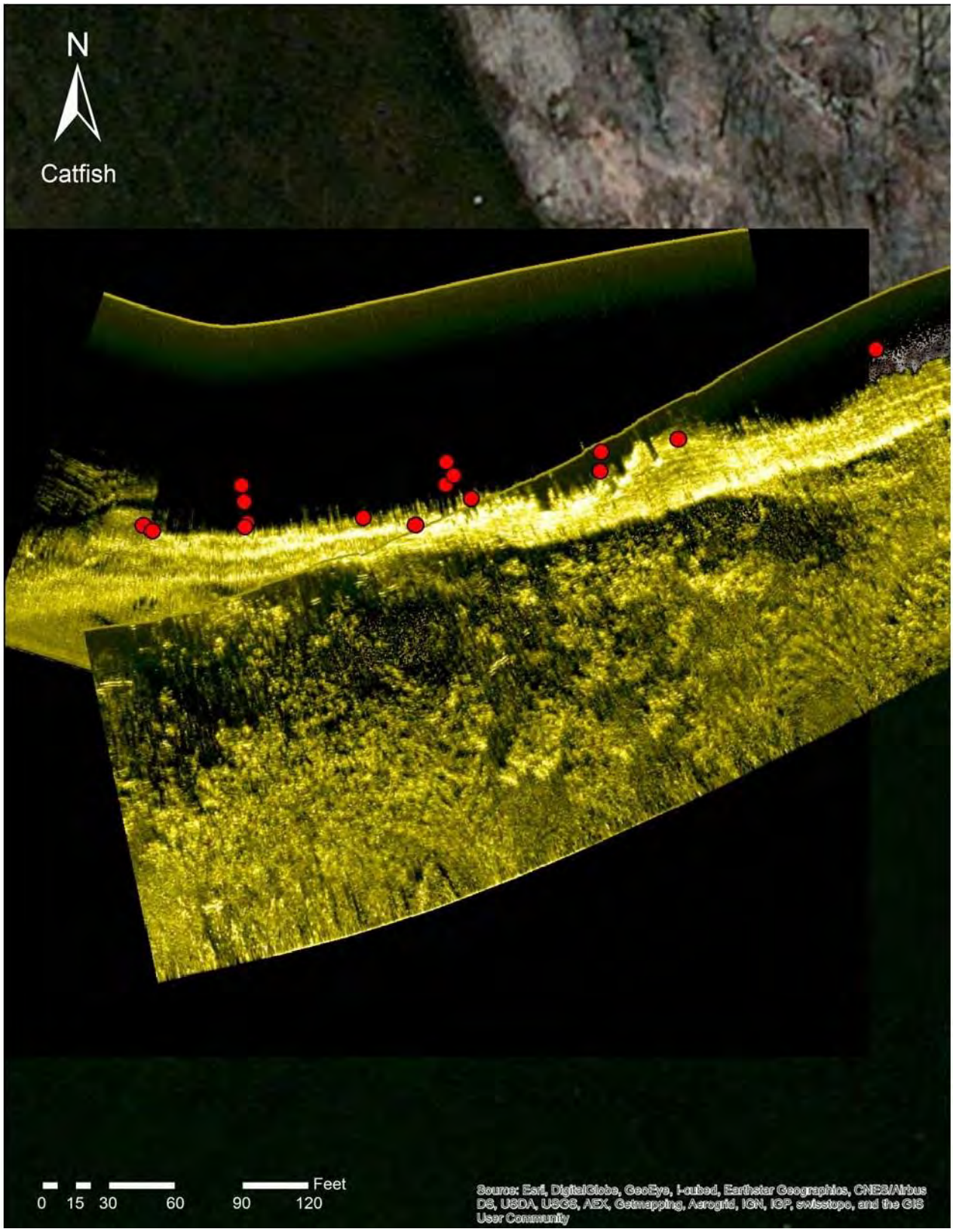


FIGURE 148. The sonar imagery from Catfish dam showing both sonar and handheld GPS points.

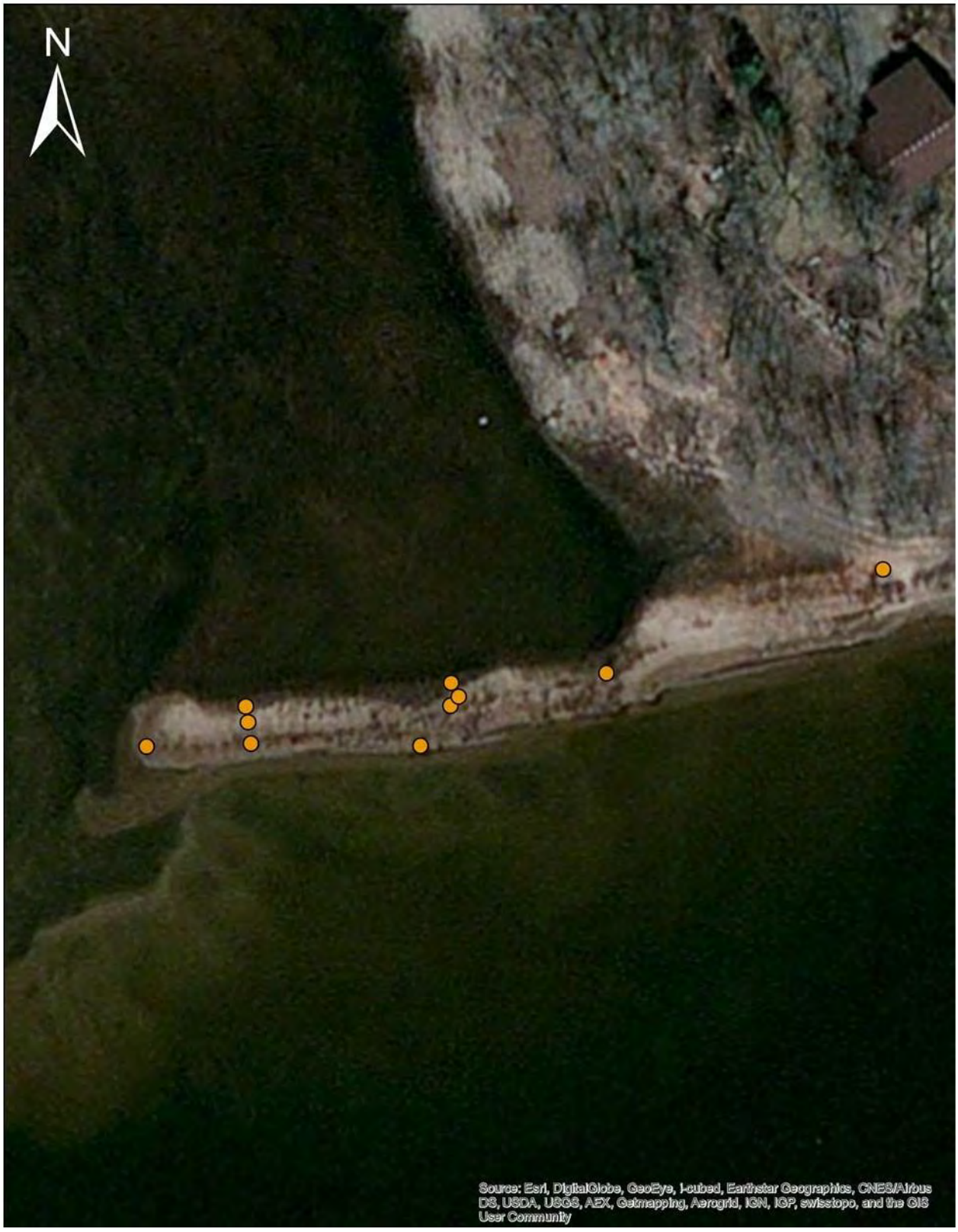


FIGURE 149. ERSI aerial map with Catfish dam1ocation with handhe1d GPS points shown in orange.

FIGURES 150 and 151. Images from Catfish showing the sediment-covered remains.

SHPO

Per the request of the Minnesota SHPO, the Stillwater Boom Grounds were surveyed with side scan sonar (Figures 152 and 153). Approximately 0.25 square miles (1.7 miles along the river) were surveyed and resulted in the identification of 23 possible targets (Figures 154 and 155). Physical investigations of these targets were not requested by SACN during this project. The locations of the targets are listed in a separate Excel spreadsheet from the rest of the project's targets and results. Reference to the Boom Grounds may provide insight to the targets once investigated (Figures 156 and 157).

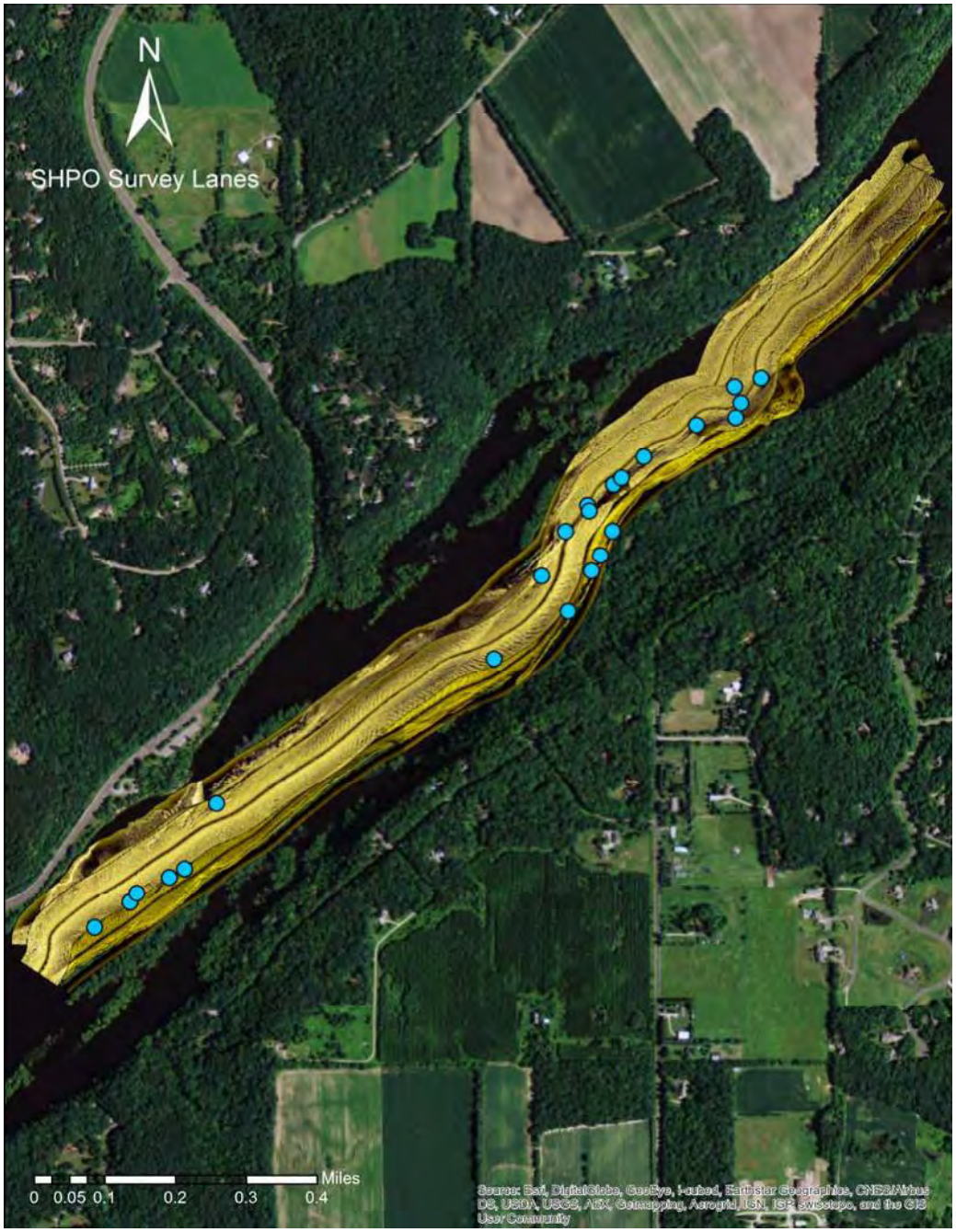


FIGURE 152. ESRI aerial map with the Stillwater Boom Ground sonar survey and identified targets.

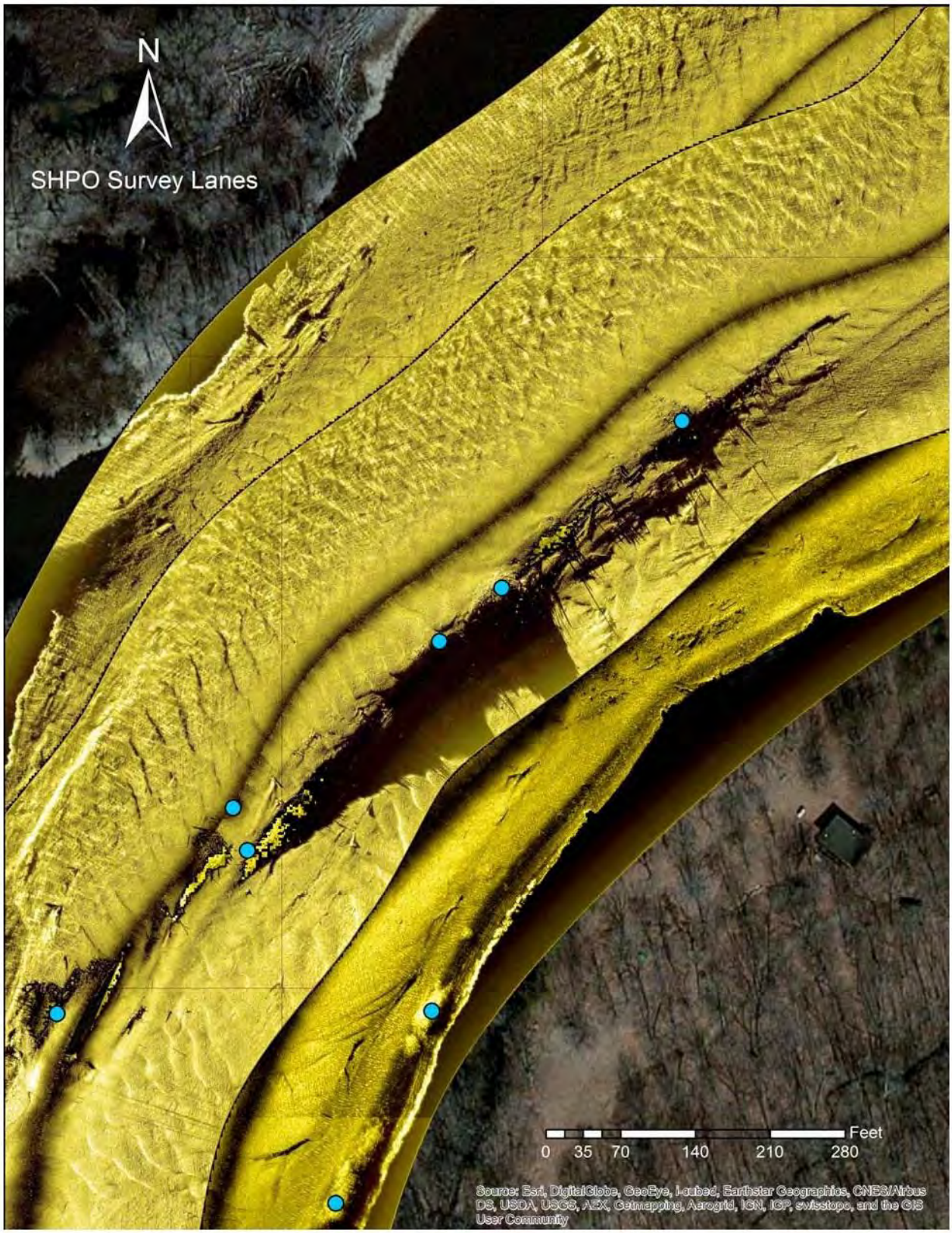
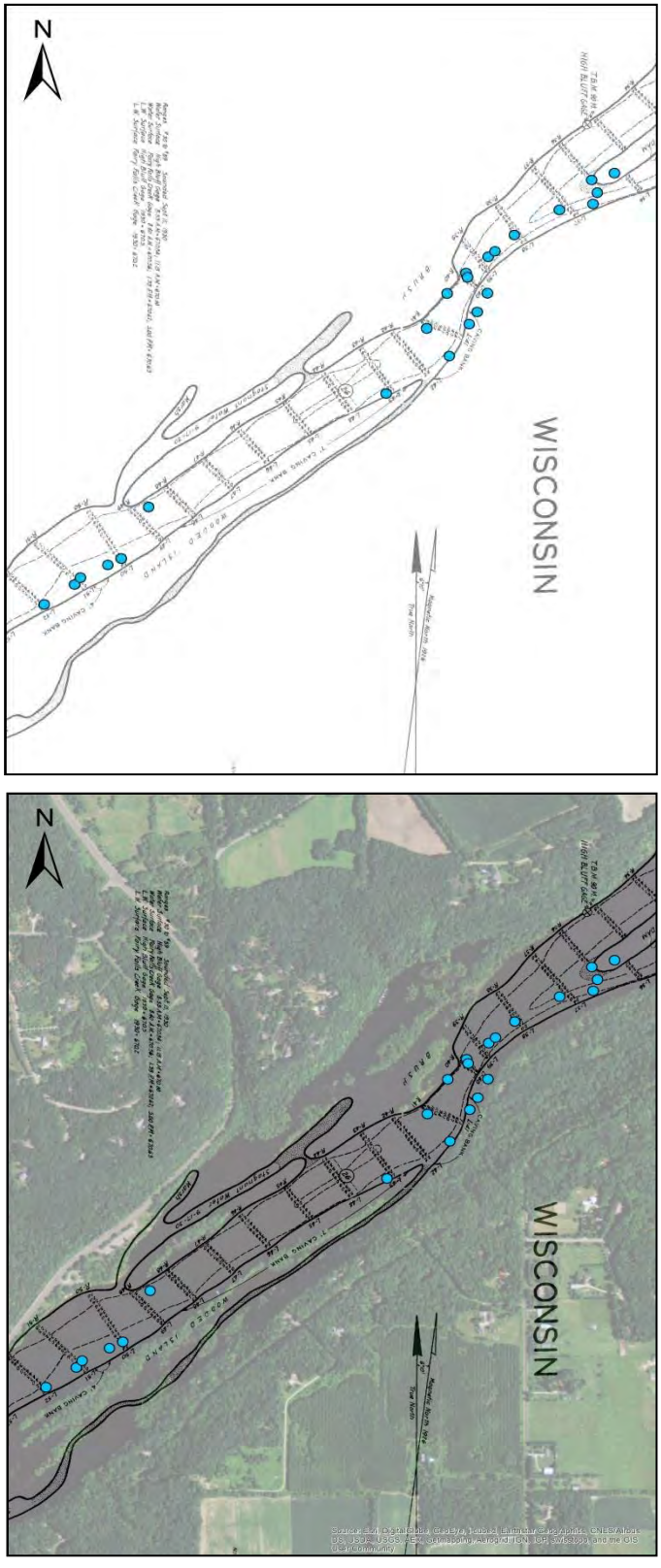


FIGURE 153. A section of the sonar imagery showing a number of targets in the Stillwater Boom Grounds.



FIGURES 154 and 155. USACE Map, Stillwater Boom Grounds 1937 (courtesy of USACE, St. Paul District, St. Paul, Minnesota), and ESRI aerial map with USACE map, Stillwater Boom Grounds 1937 overlay.

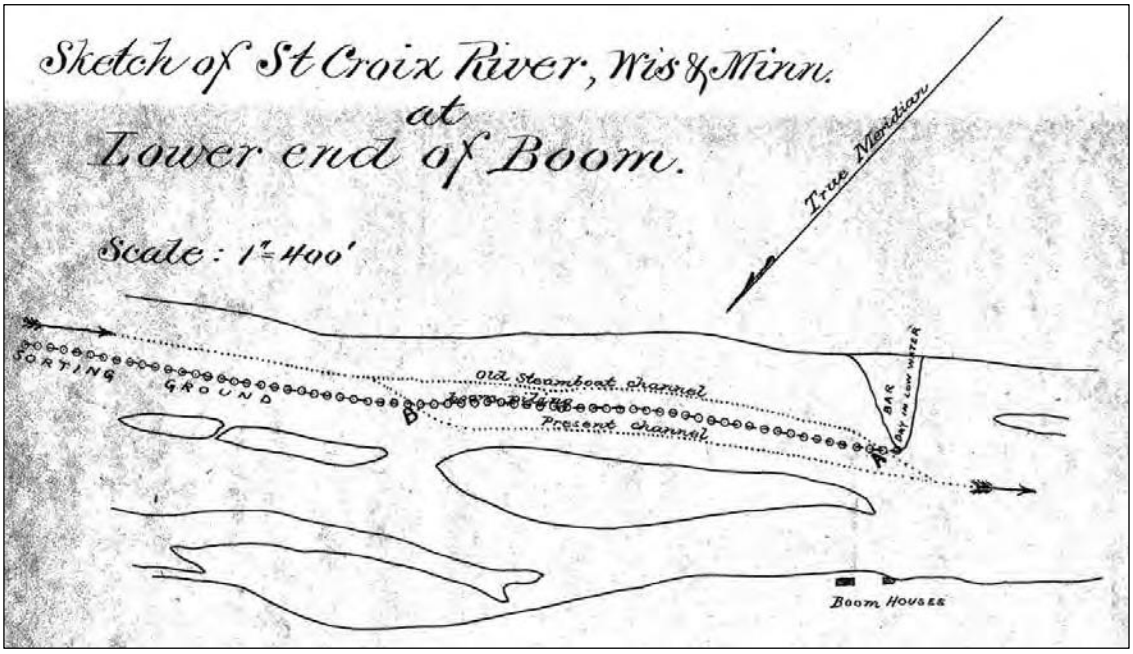


FIGURE 156. A map of the lower end of the Boom Grounds. (W.A. Jones, "Improvement of Saint Croix River, Wis. and Minn.," August 1890; W.A. Jones to Saint Croix Boom Co., 7, 16 August 1890; W.A. Jones to Chief of Engineers, 20 August 1890; Box 9, Entry 1593, Improvements of Saint Croix River, 1889-1898, RG 77, Kansas City, Missouri.; Godfrey 2015:56).

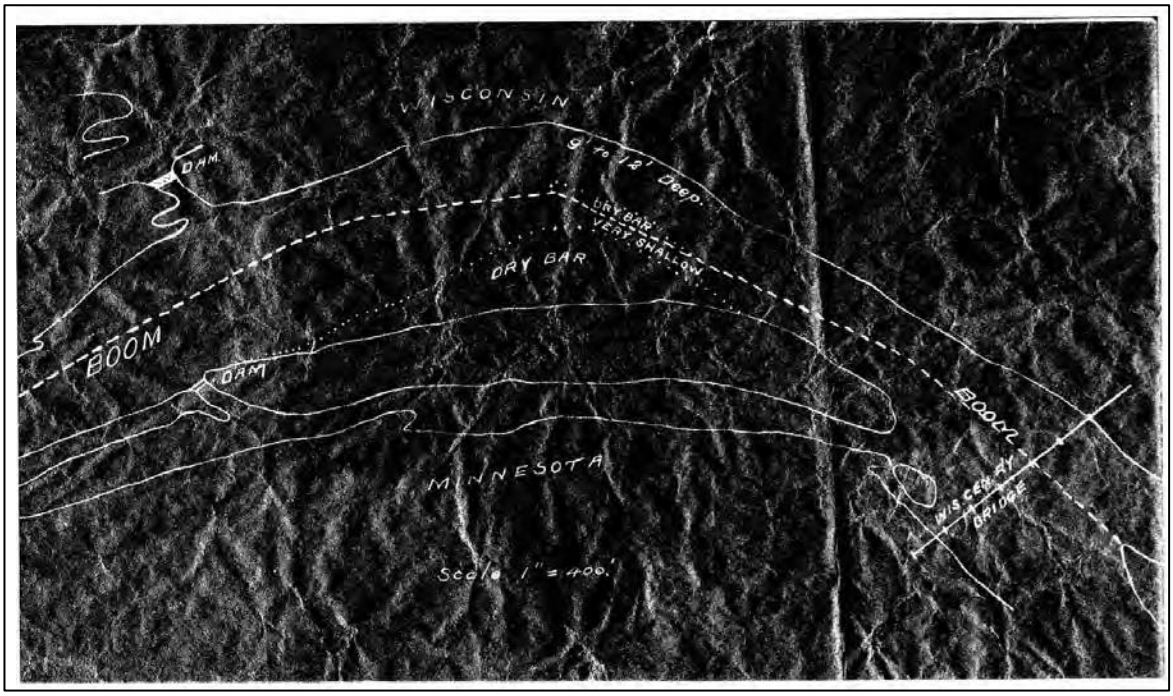


FIGURE 157. A USACE map from 1891 showing the Boom Grounds. ("Report of Operation for the Month of June 1891, Box 9, Entry 1593, Improvements of Saint Croix River, 1889-1898, RG 77, Kansas City, Missouri; Godfrey 2015:61).

Conclusion

This project presented a unique opportunity to investigate an often-overlooked area of maritime archeology, and offered insights into a vital component of SACN's history. The cultural resources identified are the extant ruins of a forgotten highway, and cohere well enough to justify the nomination of the area as an historic district in the National Register of Historic Places. The established goals of this project were accomplished, as SACN now possesses a comprehensive GIS database for identified water control features, as well as accompanying sonar data, negative targets, and search areas. Four typologically unique structures were mapped in detail, with site maps and GPS point data produced and delivered to the park. Finally, this report serves as a synthesis of the project research, and should assist in the nomination of these cultural resources to the National Register.

Taken together, the 49 individual features documented in this study hint at a larger and much more sophisticated system for hydraulic manipulation of the lower St. Croix River to facilitate riverine transportation and the movement of timber downriver. Clearly many of the features built and maintained by the USACE no longer remain and have been lost due to environmental impacts, human actions, or both, but the systemic nature of the structures should be emphasized. The complex array of individual features was a system in the sense that alterations or damage to one of the features had varying implications and effects on those that remained. The diligence shown by the USACE in the ongoing repair and maintenance of the various wing dams, closing dams, revetments, and other structures indicates a keen appreciation of the river in all its varying moods and recognition of the effects of the failure of one structure would have on others both above and below it.

The river control features of the middle Saint Croix emerged due to the economic needs of the region. Working in a remote and volatile environment, early loggers faced shifting water levels, mercurial currents, ice floes, caving banks, and snags, as well as a seemingly endless maze of islands and sandbars. As logging operations in the valley increased in scale and more settlers came to rely upon the river as their key transportation corridor, the need to control the shallow and unpredictable river became increasingly important. An already difficult annual event, the flood of spring timber into the St. Croix River compounded navigational frustrations. Log jams reached more than ten miles long and often lasted for weeks. These jams brought valley commerce to a grinding halt. Commercially dependent on the multi-million dollar logging industry, everyone from the valley's lumberjacks to merchants and doctors suffered economically until the thousands and thousands of logs were freed from their jam, milled, rafted, and sold further downriver as lumber. Steamboat traffic too was brought to a standstill, cutting-off upper-valley towns and farmers from the rest of its people, commodities, and the world.

The economic impacts of truly colossal log jams demanded a response on the St. Croix River; yet the need for a more stable supply and transport process for the logging industry was not merely a local one. St. Croix valley lumber was crucial to American settlement on the treeless prairies and plains of the frontier West. The disruptive effects of an insecure supply of milled timber (as well as the irregular and unpredictable loss of the maritime connection provided by the riverboats) on both the state and national economies were directly responsible for the funds and labor provided by an established federal agency, the USACE, to respond to these challenges.

The formalization of the USACE mandate with the passage of the Rivers and Harbors Act of 1890 (a date by which much of the Saint Croix work had been initiated) hints that the Corps had adequately met the needs of the United States for this type of work. Interestingly enough, the focus of the USACE was not necessarily driven by the hydrology of the river alone, as several of the largest features constructed served relatively small sections of the river—such as Hudson, Osceola, and Marine on Saint Croix—inhabited by a relatively large number of people in established communities. Here too we see historical processes at play where local constituencies were able to advocate

successfully for national funds that addressed relatively small regional environmental issues, but also were an important source of employment.

Following USACE intervention, what once had been a broad and shallow, meandering watercourse during most of the year, lacing through islands and smattered with sand bars, was systematically rebuilt as a commercial highway. The tamed river served as one of the thoroughfares of the frontier: by far the fastest, easiest, most profitable, and efficient way to move people, goods, and timber through the area. The river's intrinsic relationship with its communities was reflected in numerous ways, through the development of sawmilling towns on the St. Croix, the movement of people on ferry vessels and steamboats, and through their employment both as contributors and beneficiaries to USACE construction projects. The region provided natural resources that were quickly converted to economic commodities, and communities upriver and down relied on the ability of the St Croix River to transport their products. Those same communities were supported directly by the jobs created by ongoing federal hydrological construction projects that seemed limitless in funding and scope.

Finally, it would be a mistake to overlook the multiple layers of technical and scientific knowledge that went into the creation of the lower St. Croix River control system. While the principles of dam construction were well known and formally taught to the professional engineers of the US Army, many of the most prolific builders of dams, revetments, and piers were the riverboat men, farmers, and loggers who had spent a lifetime in the empirical observation of the river and its moods. Though the dams embodied sound principles of physics and engineering, the materials of their construction were seldom more than what could be procured quickly and inexpensively from the surrounding river valley. These 49 features represent an outstanding snapshot of late 19th to early 20th century frontier engineering, that later grew into the incredibly audacious water control projects in the American West, such as the Hoover Dam.

Per National Register historic property classifications, SACN's cultural resources qualify as a district. The National Register defines a district as "a unified entity" that "possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development" (National Register Bulletin 2002). There are a variety of classifications under districts, but given the nature of the water control features, we recommend nomination as a discontiguous district. "For scattered archaeological properties, a discontiguous district is appropriate when the deposits are related to each other through cultural affiliation, period of use, or site type" (National Register Bulletin 2002). As the cultural sites described here are both scattered in discrete areas along the St. Croix River, and related through their cultural affiliation (USACE manufacture, intended use, and cultural landscape), era (1879-1900), and site typologies (water control features), this characterization appears highly applicable.

We recommend using either criterion A or criterion C for the National Register district nomination. Criterion A states that the properties " …are associated with events that have made a significant contribution to the broad patterns of our history" while criterion C states that properties "…that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction" (National Register Bulletin 2002). Under criterion A, the hydraulic control system of the lower St. Croix River emerged initially as a response to the needs of logging companies to move timber downriver, but this system was later, at the urging of local communities, appropriated and refined by the federal government to facilitate riverine commerce, transportation, and to protect the properties along its banks. Under criterion C, the individual components such as wing dams, closing dams, and other features are in themselves independent and significant entities, but ones that also relate to each other per the system described briefly above. The structures on the St. Croix Riverway are unique features that were altered with the passage of time, to varying degrees, but that continue to retain significant integrity

of location, design, materials, setting, workmanship, feeling and association to easily qualify for inclusion in the National Register of Historic Places. The individual stones and piles of brush remain as important touchstones to a late 19th and early 20th century maritime cultural landscape that was engaged and manipulated by an extremely competent Federal entity, yet still deeply anchored in the wild unpredictability of the American frontier.

Area	Rock Pile	Closing	Wing	Revetment	Unknown
Folsom Island	4	2			
Clark Island	4	1	2		
Blast Island		1			
Rock Island					
Franconia Landing		3	5		1
Nelson's Landing					
Boom Island		3		1	
Osceola					
Allen's Lake			2		
Lime Kiln					
West Slough		3	1		
McCloud's Lake		1			
Log House Landing		1			
Pine Island		1	2		1
Marine On St. Croix	2		1	1	1
Page's Slough		1			
Kelly's Slough		1			1
Stillwater					
Hudson			1		
Catfish			1		
	10	**18**	**15**	**2**	**4**

Total **49**

FIGURE 158. A table of results from the SACN 2015 project.

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Appendix A:
Feature Definitions and Descriptions

Boom: Large logs chained end to end, anchored to piles driven into the riverbed to form a floating fence. A series of booms act as conduit, leading logs to holding pens. (McMahan and Karamenski 2002) Also known as boom grounds or boom piers.

Brush (Brushwood) Dam: Constructed of brush, logs, and sometimes rock through a variety of construction methods. Also called a check dam or wing dam (Arnott et al. 2013)

Check Dam: Built to prevent erosion and constructed from logs, stone, gravel-filled sandbags, bricks, or cement through a variety of construction methods. Also called gully plugs and brushwood dams (Ruffino 2009).

Closing Dam: Built between two islands, or pieces of land, which close off a channel such as Hudson Bar in 1882-1883. At least two different methods of construction were used in 1883: brush/stone and pile driving (U.S. West Research, Inc. 2015).

Crib: Timber or rock filled-timber structures, which could be anchored by timber piles. These were purposefully built to not be water-tight (Arnott et al. 2013).

Deadhead: A sunken timber log that now is a navigational hazard.

Dikes: A constructed feature that redirects river flow. Mainly built out of rock, but can include timber, concrete, and sand bags. Also called a wing dam or spur dike (USACE 2015).

Earthen Dams: Wooden piles driven deep into riverbed to anchor dirt, mud, or other types of earth.

Edgings: The outer-most boards cut off a log during the milling process with the tree's bark and rounded edges.

Fascine: A rough bundle of brushwood or other material used for strengthening a structure. Used in brush dams.

'Formal" Dam: This dam has a lift or sluicing gate that can be opened or closed when needed. Dams with gates are more costly to construct (McMahan and Karamenski 2002).

Jetty: A structure that projects out from the river bank into the water. Usually found in multiples, jetties stagger at intervals from opposite sides of the river to deepen the water. Also called a wing dam.

Rafter Type: A timber dam built to funnel water (Arnott et al. 2013) and appears similar to a St. Croix River wing dam illustration in 1875.

Revetment: A sloping structure placed along banks to absorb energy of incoming water and protect existing riverbanks or shorelines from erosion. Also called **revet** or **revetted** (USACE 2015).

Rock Dam: A dam constructed of large rocks with gravel and finer sediment placed in between. The upstream side could be layered with planks, earth, etc to increase water-resistance (Arnott et al. 2013).

Snags: Trees, branches, root masses, etc that from navigational hazards.

Splash Dam: 1) A temporary dam hastily constructed and could backup water quickly, then easily chopped open to release buildup of headwater. (McMahan and Karamenski 2002) This definition is more similar to a cutaway dam. 2) Designed to be opened and closed as needed through a gate system. This type is also referred to as gated driving dam or sluice dam (Arnott et al. 2013)

Spur (Dike): A constructed feature that diverts the flow of water. Also called a wing dam (USACE 2015).

Training Dam: A structure that modifies or 'trains' the flow and sediment disposition of a river. Examples include dikes (or wing dams), revetments, weirs, etc. (USACE 2015).

Wing dams or Pier Dams: Navigational aids built from bank stretching into river and designed to concentrate river flow in order to guide logs past potential obstructions (McMahan and Karamenski 2002). These dams can be constructed of various materials such as brush, timber, rock, and cobblestone and range in size. Also called jetty, spur, dike.

List of Acronyms

GIS – Geographic Information System
GPS – Global Positioning System
MSHS- Minnesota State Historical Society
MWAC- Midwest Archeological Center
NPS- National Park Service
SACN- St. Croix National Scenic Riverway
SRC- Submerged Resources Center
USACE- U.S. Army Corps of Engineers
USDA- U.S. Department of Agriculture
USWR- U.S. West Research, Inc.
UTM – Universal Transverse Mercator

Appendix B:
Dam Findings by River Section (detailed)

Area	GPS	Type	Rock Pile	Closing	Wing	Revetment	Unknown
Folsom Island	37	Rock Pile	1				
	25	Rock Pile	1				
	35	Closing Dam		1			
	135	Rock Pile	1				
	Folsom26.RockPile	Closing Dam		1			
	Folsom36.RockPile	Rock Pile	1				
Clark Island	Center Clark 1	Rock Pile	1				
	Center Clark 2	Rock Pile	1				
	Center Clark 3	Rock Pile	1				
	Center Clark 4	Rock Pile	1				
	39	Wing Dam			1		
	40	Wing Dam			1		
	41	Closing Dam		1			
Blast Island	42	Closing Dam		1			
Rock Island	No findings						
Franconia Landing	28A1 North Extent	Wing Dam			1		
	28A2 North Extent	Wing Dam			1		
	28B North Extent	Wing Dam			1		
	28C North Extent	Wing Dam			1		
	45	Closing Dam		1			
	Franconia46.2Logs	Possible Dam					1
	48	Closing Dam		1			
	Successful.Closing.Dam.Mound	Closing Dam		1			
	FranconiaWingDam29	Wing Dam (mapped)			1		
Nelson's Landing	No findings						
Boom Island	52	Closing Dam		1			
	Boom121	Revetment				1	
	Boom31	Closing Dam		1			
	Boom32.Closing.Dam.Rock.Pile	Closing Dam		1			
Osceola	No findings						
Allen's Lake	123	Wing Dam			1		
	56	Wing Dam			1		
Lime Kiln	No findings						
West Slough	65	Closing Dam		1			
	66	Closing Dam		1			
	67	Closing Dam		1			
	WestSlough69	Wing Dam			1		
McCloud's Lake	McCloud72	Closing Dam		1			

Log House Landing	Log-house.Landing79.Closing.Dam.N	Closing Dam (mapped)		1			
Pine Island	82	Wing Dam			1		
	83	Closing Dam		1			
	Pine89	Wing Dam			1		
	Pine.Possible.Structure.	Unknown					1
Marine On St. Croix	Marine142A-Rock Pile	Rock Pile	1				
	Marine142B-Rock Pile	Rock Pile	1				
	MarineOnSt.Croix.DamRemains.N.	Unknown					1
	MarineOnSt.Croix.Bank.Crib	Wing Dam/Cribbing (mapped)			1	1	
Page's Slough	102	Closing Dam		1			
Kelly's Slough	107	Unknown					1
	Kelly's115.Rock.Closing.Dam	Closing Dam (mapped)		1			
Stillwater	No findings						
Hudson	Hudson150.A	Wing Dam			1		
Catfish	151	Wing Dam			1		
			10	**18**	**15**	**2**	**4**

Total **49**

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