Technical Memorandum

To: Jason Blommel
Interim Stearns County Surveyor

Cc: Chad Martini
Stearns County Director of Land Management

From: Chris Otterness, PE
Garrett Monson, PE
Houston Engineering, Inc.

Subject: Reestablishment of Stearns County Ditch 28
Public Drainage System Records

Date: June 6, 2019
Revised June 11, 2019

Project: 6364-0010

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am dully Licensed Professional Engineer under the laws of the State of Minnesota.

6/6/19

Chris Otterness
Reg. No. 41961

Date

Introduction

The purpose of this report is to provide Stearns County with the results of the investigation and analysis of the Stearns County Ditch 28 (CD 28) public drainage system. This report contains the necessary description of alignment; cross-section; profile; hydraulic structure locations, materials, dimensions, elevations; and right-of-way of the drainage system to reestablish records as requested by the County Board.

CD 28 is an open channel ditch, which serves predominantly agricultural land, located in Holding, Krain, and Albany Townships. CD 28 is not within the jurisdiction of an existing watershed district. Minnesota Statute 103E.101 subd. 4a allows for the drainage authority to reestablish records if, after an investigation of drainage system records, it is found that the records establishing the alignment, cross-section, profile, or right-of-way of a drainage system are lost, destroyed or otherwise incomplete. The drainage authority may, by order, reestablish records defining the alignment; cross-section; profile; hydraulic structure locations, materials, dimensions, and elevations; and right-of-way of the drainage system which define the “As Constructed and Subsequently Improved Condition” or ACSIC. This report documents the investigation of drainage system records and physical investigation of the drainage system used by the engineer to recommend reestablished records to define the alignment, grade and geometry as necessary to maintain the historic function of the

drainage system. No other historical reviews or reviews of the as-constructed profile of this system are known to exist.

RELATIONSHIP TO DRAINAGE SYSTEM MAINTENANCE AND REPAIR

This memorandum establishes the ACSIC as the basis for future maintenance and repair of the public drainage system. A future repair report or similar document is expected to include the evaluation of alternatives relative to these systems serving as outlets for agricultural drainage and/or other land uses, and address issues related to the volume of runoff, water quality, and flooding. Normally, the repair report may include alternatives which adjust the elevation of the open channel and culverts, realign or abandon portions of the public system, or evaluate similar modifications as authorized by MS 103E and consistent with the ACSIC. The range of alternatives evaluated within a repair report is typically based in part on discussions with landowners served by the public drainage system and other interested parties.

DEFINITIONS

This memorandum defines the condition and therefore by inference the capacity (i.e. the existing flow rate in cubic feet per second) of the public drainage systems using three definitions:

As-Designed / Established Condition: The geometry of the public drainage systems as designed in 1906 including all subsequent designs for legal repairs and alterations. A repair or alteration is considered legal if formally authorized in some legal proceedings. The details of the As-designed / Established condition are relatively unknown due to the scarcity of the original design plan and profiles that identify the dimensions, lengths and grade elevations. The As-Designed / Established Condition may or may not reflect the As-Constructed and Subsequently Improved Condition and is generally shown on construction plans and engineering drawings.

As-Constructed and Subsequently Improved Condition: The geometry of the public drainage systems as constructed in 1908 including all subsequent legal repairs and alterations as well as other actions which maintain and are consistent with the general character and efficiency of the drainage systems. Often, survey data (and only rarely as-built drawings) show that the alignment, grade and geometry (i.e., cross sectional area) of the existing public drainage system is altered from the As-Designed / Established Condition. The definition of As-Constructed and Subsequently Improved Condition (ACSIC) is intended to establish the condition to which the system can legally be repaired consistent with the definition in MS 103E.701, which states:

> The term, "repair" means to restore all or a part of a drainage system, as nearly as practicable to the same condition as originally constructed, and subsequently improved, including re-sloping of ditches and leveling of waste banks if necessary to prevent further deterioration, realignment to original construction if necessary to restore the effectiveness of the drainage system, and routine operations that may be required to remove obstructions and maintain the efficiency of the drainage system. "Repair" also includes:

(1) incidental straightening of a tile system resulting from the tile-laying technology used to replace tiles; and

(2) replacement of tiles with the next larger size that is readily available, if the original size is not readily available.

Available records provide limited information regarding originally constructed alignment, grade (profile) and geometry (cross-section) of CD 28. Alterations to the public drainage system alignment, grade and geometry from the As-Designed / Established Condition likely resulted from the use of less accurate survey methods and construction techniques than currently exist, inaccurate culvert and crossing installation, and a need to "fit" the drainage system to the existing topography. Alterations to the public drainage system that were not performed per the requirements of MS 103E (i.e., ditch law) or its predecessors are typically not considered part of the ACSIC. However, modifications that neither obstructed or improved the system, were maintained by the public drainage authority, and relied upon by benefitted landowners, may be considered part of the ACSIC, where that alteration has been maintained for a sufficient period of time to create rights in the benefitted landowners.

Repaired Condition: The condition to which the drainage authority repairs the public drainage system. If the capacity of the Repaired Condition exceeds the ACSIC, the work is considered an improvement under MS 103E and its predecessors. The Board may decide for a variety of reasons to repair the public drainage system to some condition less than the As-Constructed and Subsequently Improved Condition.

Maintenance: There is no statutory distinction between the terms "maintenance" and "repair." However, historically, drainage authorities have drawn a distinction between the two terms as a function of the scope of work performed for each. The primary difference between maintenance and repair, is that maintenance activities are generally completed at a select (more isolated) location or locations along portions of the public drainage system, rather than a drainage system-wide assessment, analysis, recommendation, or alteration that occurs in association with a repair proceeding. Maintenance activities are those that generally occur at a specific location or some portion of the system.

Maintenance generally includes activities such as vegetation management, the removal of open channel and tile blockages (e.g., beaver dams, sediment), the replacement of tile ruptures, the installation of tile inlets and access manholes, the replacement of portions of a tile system, the stabilization and repair of slopes and spoil material, and the removal of sediment up to the repair condition. Maintenance also includes the resetting or resizing of culverts or other crossings which were inaccurately placed and result in the obstruction of the public drainage system. Maintenance activities are usually exempt from wetland permitting requirements under the Wetland Conservation Act and Section 404 of the Clean Water Act.

Location, General Description and History of the Public Drainage System

LOCATION

The Stearns County 28 public drainage system is located in Sections 1, 12, and 13 (of T125 R31) within the township of Albany, and Section 36 (of T126 R31) within the township of Krain, and Sections 17, 19, 20, 30, and 31 (of T126 R30) within the township of Holding (see **Figure 1**). CD 28 flows from south to north. The drainage system starts near the intersection of Rushmeyer Lake Road and Quaker Road and terminates on the south side of County RD 17 in the City of Holdingford. The ditch is approximately 7.8 miles in length and contains roughly 3,089 benefitted acres. The drainage area is predominantly developed for agricultural land use.

HISTORY OF THE PUBLIC DRAINAGE SYSTEM

The Stearns County 28 public drainage system was established in 1906 at which time only three specific areas were excavated (Sta. 84+46 to 89+99, 103+08 to 120+37, 235+15 to 264+00, and 296+72 to 450+48). The County preformed spot repairs at three locations downstream of Two Rivers Lake in July of 2014. The repairs are described in a report by Pinnacle Engineering.

CURRENT ALIGNMENT

This portion of the memorandum describes the current condition of the public drainage system as observed “on-the-ground” (i.e., existing) as determined by a review of the available records, field survey, aerial imagery, and other available historical evidence. CD 28 consists entirely of an open channel ditch with several culvert crossings. The stationing used to describe the alignment proceeds from upstream to downstream. **Appendix A** shows the existing and ACSIC grades and alignment.

The upstream end of the CD 28 alignment begins at Sta 0+00 approximately 100ft southeast of Quaker Road. The alignment then continues north under County Road 154 at Station 150+00, and St Anna Drive at Station 206+00, until it reaches Two Rivers Lake at Station 264+00, where the upper portion of the alignment ends. The lower portion of the public drainage then resumes at the outlet of Two Rivers Lake at Station 296+72. CD 28 then continues north and flows under a bridge at Lake Wobegon Trail near Station 440+00. The public drainage system terminates at Station 450+48 in the City of Holdingford at the downstream end of County Road 17 (Rivers Street). The channel continues as a natural, meandering stream. All crossings of CD 28 were constructed independent of the establishment of CD 28 and therefore are not a component of the public drainage system.

SOURCE OF SURVEY DATA USED IN THIS ASSESSMENT

Survey data was collected by Stearns County staff in the spring of 2018 to determine the existing condition of the public drainage system. All survey data collected utilizes the Stearns County Coordinate System and North American Vertical Datum 1988 (NAVD'88). (Note: Unless otherwise noted, all elevations provided herein are based on NAVD'88 vertical datum).

Analysis of Current Function in Historical Context

SYSTEM MODIFICATIONS AFFECTING FUNCTION

No significant modifications on the CD 28 public drainage system have been documented in the available records since its establishment in 1906. The survey indicated no substantial modifications from the ACSIC.

RIGHT-OF-WAY

Proceedings for the original establishment of the drainage system awarded damages for the areas physically occupied by the drainage system along with an easement for the area required for construction activities such as land clearing and spoil disposal. This combination of areas constitutes the right-of-way for the drainage system and is often described as the area reasonably necessary for the drainage authority to perform its repair, maintenance, inspection obligations, along with an area of reasonable set-back to protect the drainage system. The right of way required was estimated by computing the approximate geometry of the spoil piles and the width needed for continued maintenance which is measured from the top of bank. The right of way calculations were based on the ditch cross sectional area and top width provided by the 1906 Engineering Report. The ditch cross sectional area was used to determine the spoil pile width. The spoil pile width was based off of 3:1 slopes on the ditch side, 5:1 slopes on the non-ditch side and a top width of 8 feet. The ROW width includes both the spoil pile width on both sides of the ditch and the width of the top of ditch. Along portions of the public drainage system where excavation did not occur, the ROW is 55 feet centered on the ditch centerline. This is the average top width of the channel plus one rod (16.5-feet) on either side of the channel for access. See **Table 1** and **Figure 2** for right of way widths and locations.

Table 1

Beginning Station	Ending Station	ROW Width (Centered on ditch CL)
90+72	95+38	80
108+92	124+80	90
238+78	254+66	100
296+72	383+00	100
383+00	432+00	120
432+00	450+48	110

AS-CONSTRUCTED AND SUBSEQUENTLY IMPROVED GRADE AND GEOMETRY

Ideally, the grade of the ACSIC would be determined through the use of as-built drawings that identify the constructed alignment, grade and geometry. However, since as-built plans were rarely recorded for public drainage systems in the late 19th century, engineers have frequently utilized the profile drawings from the original design of the public drainage system in conjunction with probes to the hard ditch bottom (which typically indicated the bottom of accumulated sediment and the historic ditch bottom) to determine and/or corroborate the ACSIC. The 1906 Engineers Report shows that the ditch was designed with 1:1 side slopes and a constant 10-foot bottom width. The average top width and cross-sectional area were 18 feet and 53 square feet respectively.

The CD 28 original 1906 design profiles were based on an assumed vertical datum referring to a benchmark no longer in existence. As-built plans are not available. To determine the ACSIC in a modern vertical datum, soil probes of the channel hard-bottom collected during field survey were used to determine “as-built” excavation depths where the material transitions from accumulated sediment to native mineral soil. A statistical comparison of the hard-bottom elevations and original design profile elevations was then performed for each section of ditch previously excavated. Through the comparison process, datum adjustment factors were calculated to convert the design profile from the local datum to NAVD88 (See **Appendix B**). Hard-bottom elevations that were not within the standard deviation from the datum adjustments calculated from each set of hard-bottom elevations were deemed to be outliers and were removed from the final datum adjustment calculation.

Multiple outliers are located throughout each of the statistical analyses as noted in **Appendix B**. The hard-bottom interface identified at these locations provided a difference from the historic elevation of more than one standard deviation and thus were not used in the calculation of the datum adjustments. There are many likely causes of the outliers. “Low” outliers may be a result of scouring, soft soils, or previous attempts at maintenance. “High” outliers may be due to bank sloughing, deposition of mineral sediments, or location of soil probes outside of the center of the historic channel.

Two excavated portions of CD 28 that had a good statistical fit (STA 103+08 – 120+37 and downstream of Two Rivers Lake), when analyzed separately, both result in a vertical datum adjustment of 1036.6. The furthest upstream portion of CD 28 that was excavated (STA 84+46 - 89+99), did not have an acceptable fit of the 1906 design profile to the observed hard bottom shots. Similarly, the ACSIC grade directly upstream of Two Rivers Lake (Sta. 238+78 – 264+00) did not have an acceptable fit to 1906 design profile.

Additionally, much of CD 28 upstream of Two Rivers Lake was not identified as requiring excavation in the original design profile but was still established as part of the CD 28 condition upon which lands were determined to be damaged or benefited. The ACSIC for this portion of CD 28 is identical to its 1906 condition. To determine the ACSIC in the portions of CD 28 upstream of Two Rivers Lake that were originally unexcavated or did not provide an acceptable fit when analyzed, a datum adjustment of 1036.6 was applied to key highpoints and breaks in grade to determine an approximate profile. This was compared to the surveyed hard-bottom survey gathered in 2018 and revealed that connecting the highpoint of the channel to the high confidence portion of the ACSIC near STA 103+08 provided a good fit to both the historical high points and the hard-bottom survey.

There is an inconsistency in the 1906 profile near historic STA 110+00 that results in a poor fit of the profile from current STA 120+37 to 264+00. In this reach the ACSIC was determined by drawing a “best fit” line to match the hard-bottom survey. When this was compared to the historic 1906 profile, it was found that the best fit line reflected the general rising and falling characteristics of the original profile. See **Appendix A** for the ACSIC profile, as compared to existing open channel bottom survey elevations.

WETLAND IMPACTS AND REGULATORY CONSIDERATIONS

The CD 28 public drainage system runs through a series of wetland complexes, as shown by the National Wetland Inventory (NWI) in **Figure 3** and the Public Waters Inventory (PWI) of **Figure 3.** Under most regulatory programs (i.e. Minnesota Wetland Conservation Act (WCA), Federal Clean Water Act (CWA); and Minnesota Public Waters Law) activities related to maintenance of a public drainage system, though potentially taking place within wetlands, are generally exempt from regulation, including mitigation requirements. These activities related to public drainage system maintenance include:

- Excavation in the drainage system channel when limited to removal of sediment or debris such as trees, logs, stumps, beaver dams, blockage of culverts, and trash, provided the removal does not result in alteration of the original cross-section of the drainage system
- Removing those materials placed by beaver;
- Removing or moving materials blocking installed roadway culverts and related drainage structures; and

- Temporary or seasonal water level management activities done for the purpose of performing maintenance.

As seen in **Figure 3,** the CD 28 public drainage system flows through one MnDNR listed Public Water Basin (Two River Lake, #73-138W). Additionally, the entirety of the CD 28 drainage system is also listed as Public Ditch / Altered Natural Watercourse (South Two River, # M-084) within the Public Waters Inventory. The MnDNR regulates many activities within listed Public Waters. Drainage system repair activities within Public Waters (below the OHW elevation of the PW) require notification to the MnDNR. Repairs to a Public Ditch / Altered Natural Watercourse are exempt from permitting requirements.

Under the federal CWA, all drainage system repair is exempt from regulation, as outlined in Regulatory Guidance Letter 07-02: “Exemptions for Construction or Maintenance of Irrigation Ditches and Maintenance of Drainage Ditches under Section 404 of the Clean Water Act”. Repairs to CD 28 consistent with the ACSIC meet the criteria of maintenance of drainage ditches and are exempt from regulation under the federal CWA.

Under the WCA, activities related to maintenance or repair of a public drainage system may result in wetland impacts but are exempt from replacement, which include:

- Maintenance or repair of a public drainage system which drains Type 1, 2, 6, 7, or 8 wetlands; and
- Maintenance or repair of a public drainage system which drains Type 3, 4, or 5 wetlands that have existed for 25 years or less.

Activities considered to be exempt or would result in “no-loss”, do not require the preparation of wetland replacement plans under the WCA. Though not required, in these cases it may be prudent for the drainage authority to apply to the Local Government Unit (LGU) for a no-loss or exemption decision prior to proceeding with the repair activity. The LGU for this location is Stearns County.

Several public drainage system repair activities may result in wetland impacts that are not exempt under the WCA and would likely require wetland replacement. These activities include, but are not limited to:

- Maintenance or repair of a public drainage system which drains Type 3, 4, or 5 wetlands that have existed for more than 25 years; and
- Maintenance or repair of a public drainage system not authorized by the drainage authority.

Because the CD 28 public drainage system intersects several Type 3, 4 and 5 wetlands, modifications to the current public drainage system grade may require a permit application to the Local Government Unit (LGU) with a replacement plan or an application for a No Loss determination.

Further investigation, including field delineation or review, is recommended before drainage system repairs are completed.

RECOMMENDATIONS

We recommend that this report be submitted to the Minnesota Department of Natural Resources. The Engineer then recommends that the Drainage Authority schedule, notice and hold a public hearing, and consider adopting corrected records consistent with this report. The corrected drainage system records should be based on the alignment, grade, and geometry described within this historical review. The alignment, grade, and geometry is, in the Opinion of the Engineer, necessary to reestablish the historic function of the legal drainage system to be the basis for maintenance and repair of the public drainage systems, future redeterminations of benefits, and other drainage proceedings.

AVAILABLE INFORMATION/HISTORIC RECORDS

Historic records for the CD 28 public drainage system are available from the County digital records. The following documents have been specifically utilized or referenced for this report:

- 1906 CD 28 Map and Profile
- CD 28 Ditch Map
- Stearns County CD 28 Original Construction Documents
- CD 28 Pinnacle Engineering Study
- County Ditch 28 Hydraulic Report (Bolton & Menk)

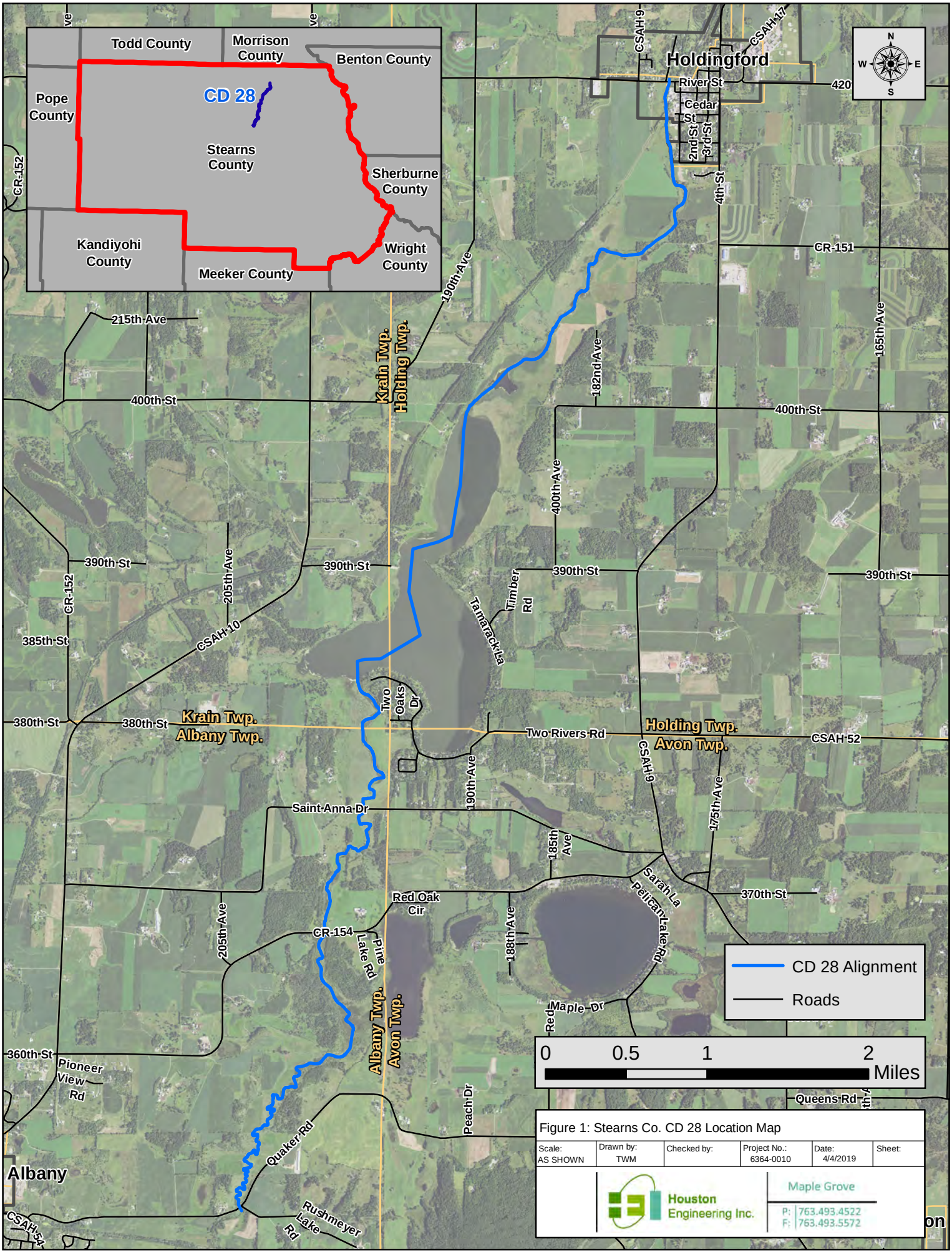

Figure 1: Stearns Co. CD 28 Location Map

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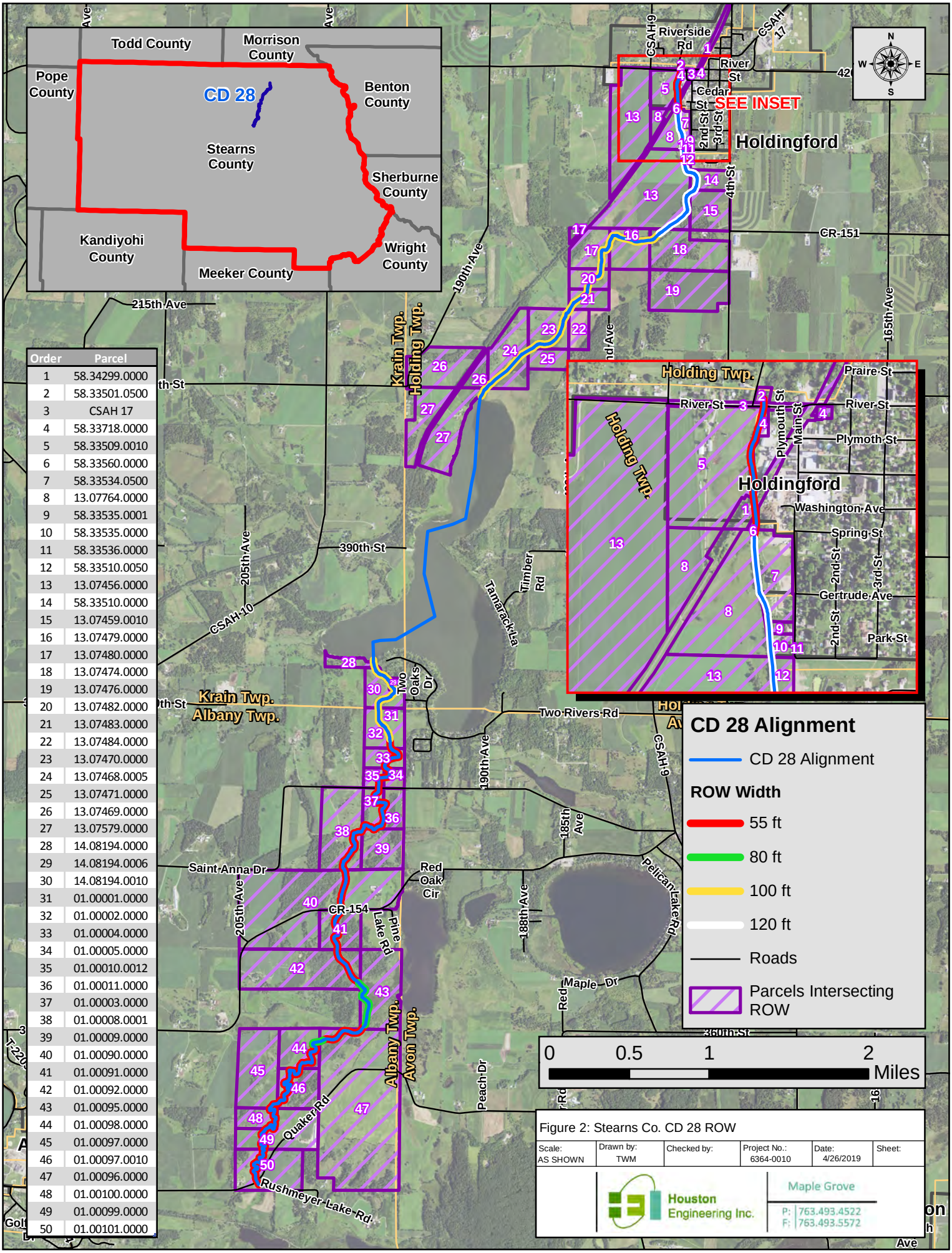

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Figure 2: Stearns Co. CD 28 ROW

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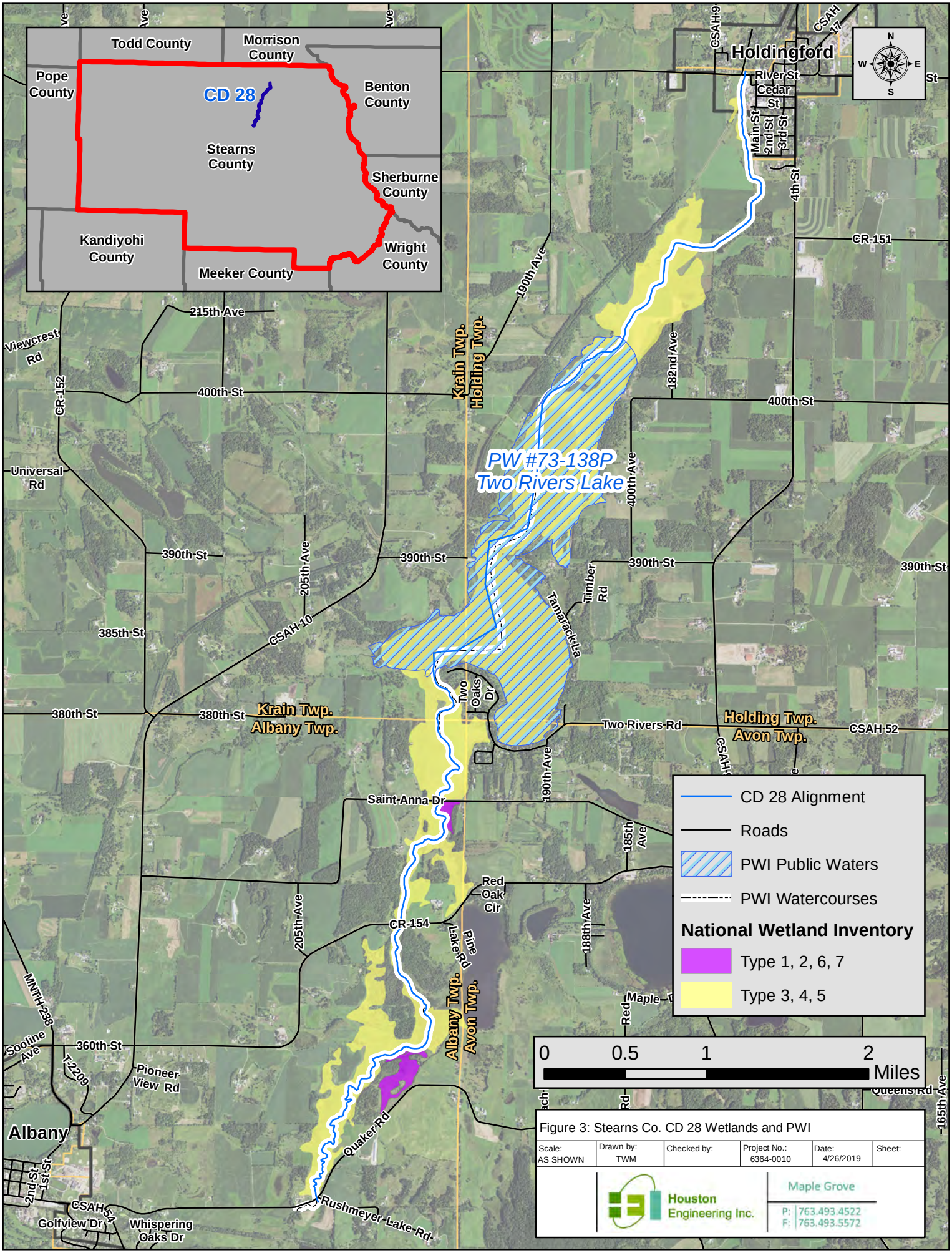

Figure 3: Stearns Co. CD 28 Wetlands and PWI

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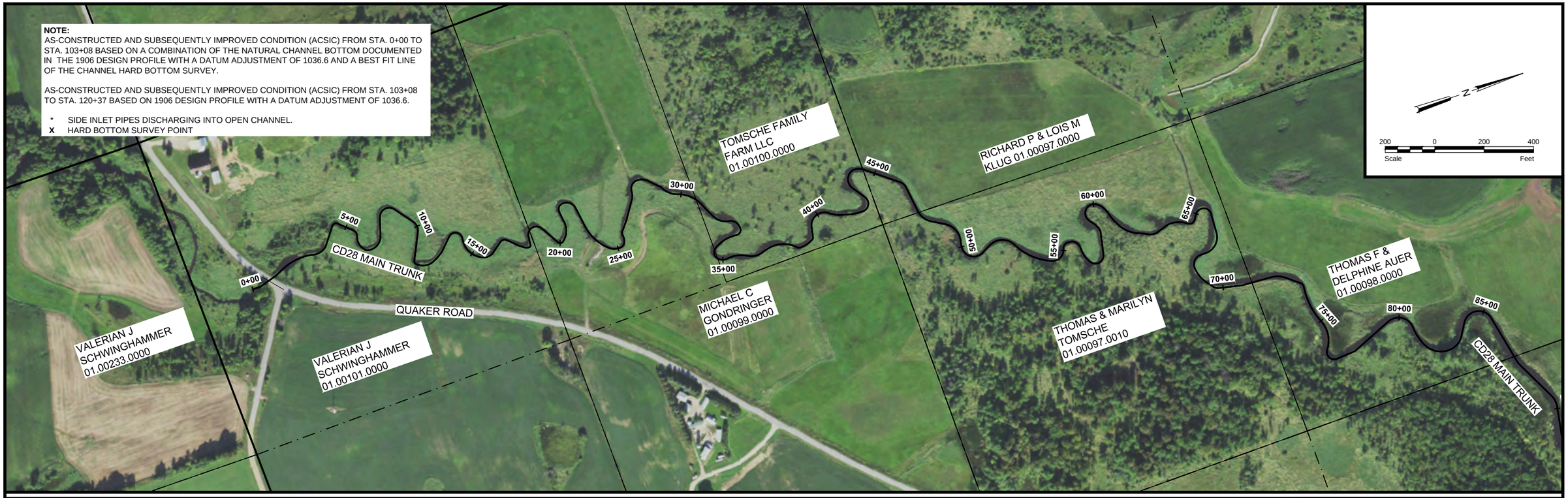
Appendix A

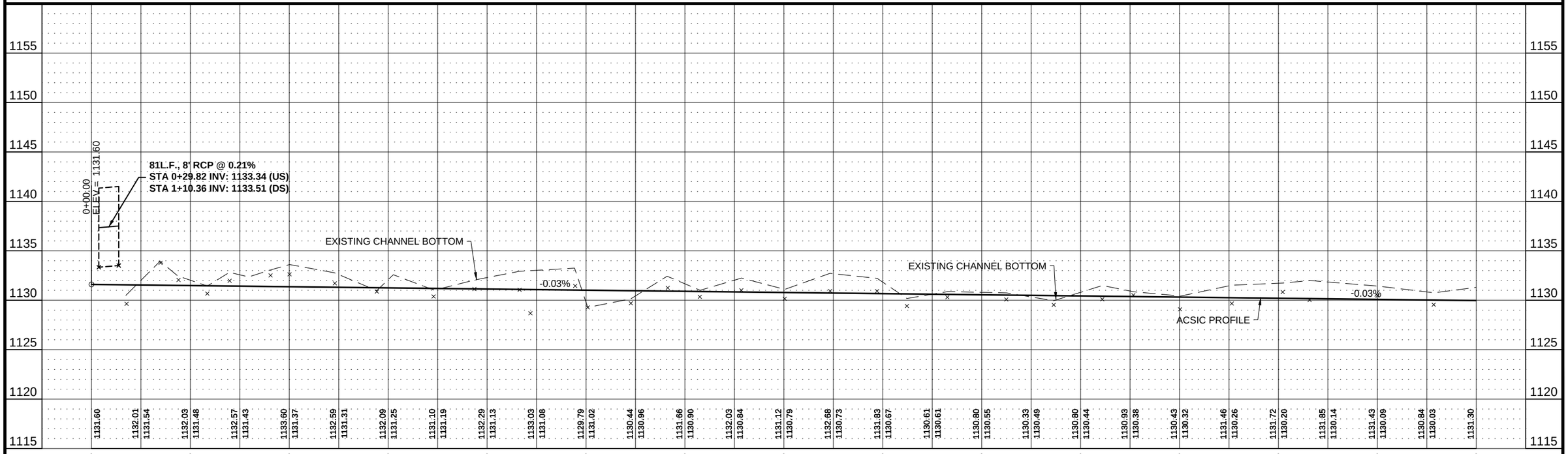
Plans and Profiles

NOTE:
AS-CONSTRUCTED AND SUBSEQUENTLY IMPROVED CONDITION (ACSIC) FROM STA. 0+00 TO STA. 103+08 BASED ON A COMBINATION OF THE NATURAL CHANNEL BOTTOM DOCUMENTED IN THE 1906 DESIGN PROFILE WITH A DATUM ADJUSTMENT OF 1036.6 AND A BEST FIT LINE OF THE CHANNEL HARD BOTTOM SURVEY.

AS-CONSTRUCTED AND SUBSEQUENTLY IMPROVED CONDITION (ACSIC) FROM STA. 103+08 TO STA. 120+37 BASED ON 1906 DESIGN PROFILE WITH A DATUM ADJUSTMENT OF 1036.6.

* SIDE INLET PIPES DISCHARGING INTO OPEN CHANNEL.
X HARD BOTTOM SURVEY POINT





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REESTABLISHMENT OF STEARNS COUNTY DITCH 28
STEARNS COUNTY
HOLDINGFORD, MN

STEARNS COUNTY DITCH 28
STA. 0+00 - 56+00
PROJECT NO. 6364-010

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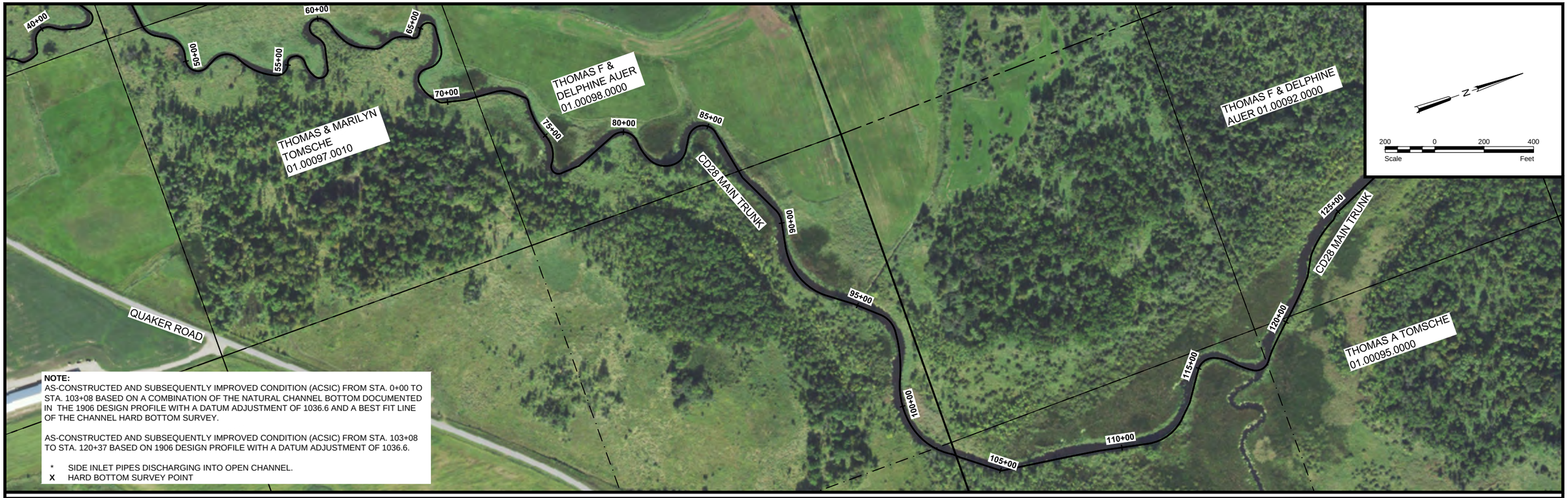

NOTE:
AS-CONSTRUCTED AND SUBSEQUENTLY IMPROVED CONDITION (ACSIC) FROM STA. 0+00 TO STA. 103+08 BASED ON A COMBINATION OF THE NATURAL CHANNEL BOTTOM DOCUMENTED IN THE 1906 DESIGN PROFILE WITH A DATUM ADJUSTMENT OF 1036.6 AND A BEST FIT LINE OF THE CHANNEL HARD BOTTOM SURVEY.

AS-CONSTRUCTED AND SUBSEQUENTLY IMPROVED CONDITION (ACSIC) FROM STA. 103+08 TO STA. 120+37 BASED ON 1906 DESIGN PROFILE WITH A DATUM ADJUSTMENT OF 1036.6.

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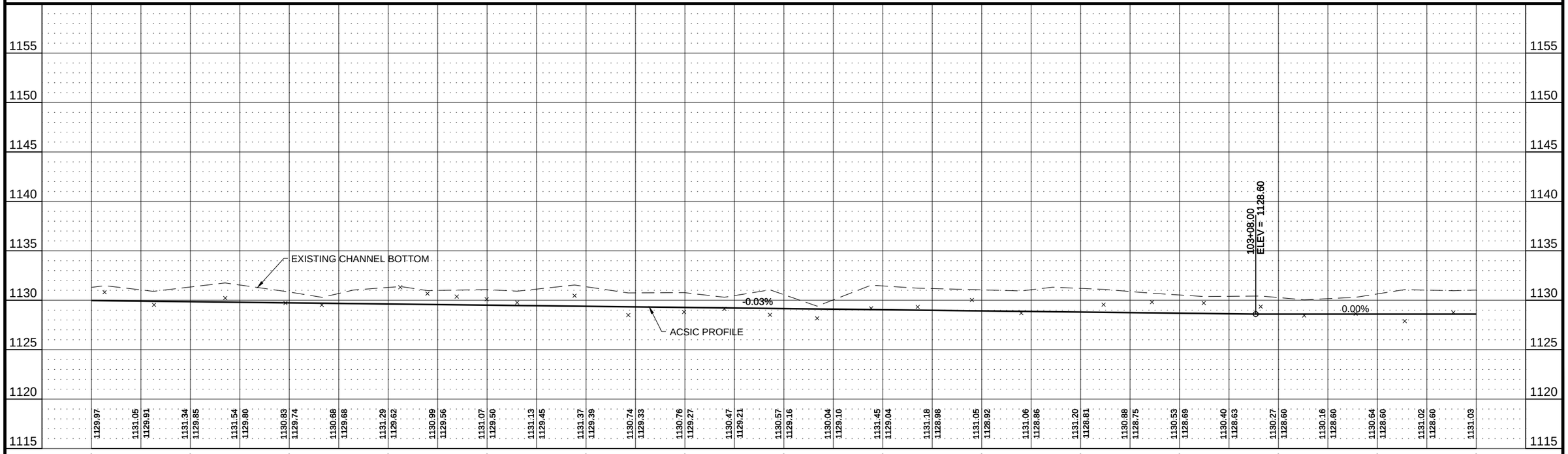

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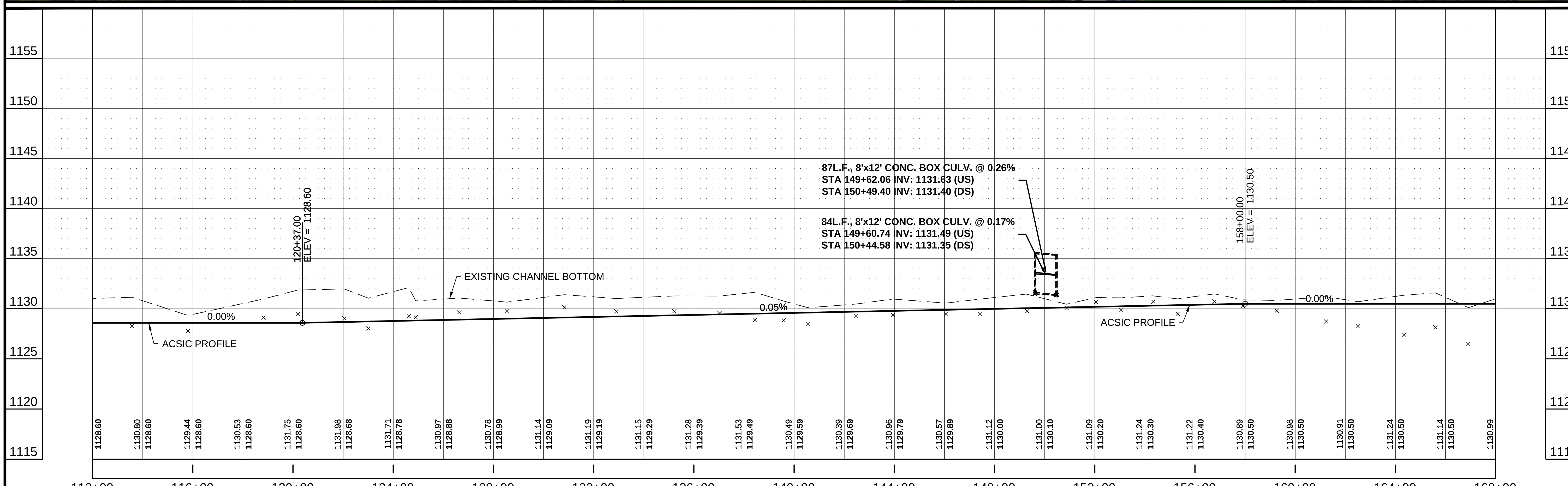
REESTABLISHMENT OF STEARNS COUNTY DITCH 28
STEARNS COUNTY
HOLDINGFORD, MN

STEARNS COUNTY DITCH 28
STA. 56+00 - 112+00
PROJECT NO. 6364-010

NOTE:
AS-CONSTRUCTED AND SUBSEQUENTLY APPROVED CONDITION (ACSIC) FROM STA. 120+37 TO STA. 264+00 BASED ON A BEST FIT LINE OF THE CHANNEL HARD BOTTOM SURVEY AND CONSISTENT WITH THE RISING AND FALLING CHARACTERISTICS OF THE NATURAL CHANNEL BOTTOM DOCUMENTED IN 1906 DESIGN PROFILE.

* SIDE INLET PIPES DISCHARGING INTO OPEN CHANNEL.
X HARD BOTTOM SURVEY POINT



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STEARNS COUNTY DITCH 28
STA. 112+00 - 168+00
PROJECT NO. 6364-010

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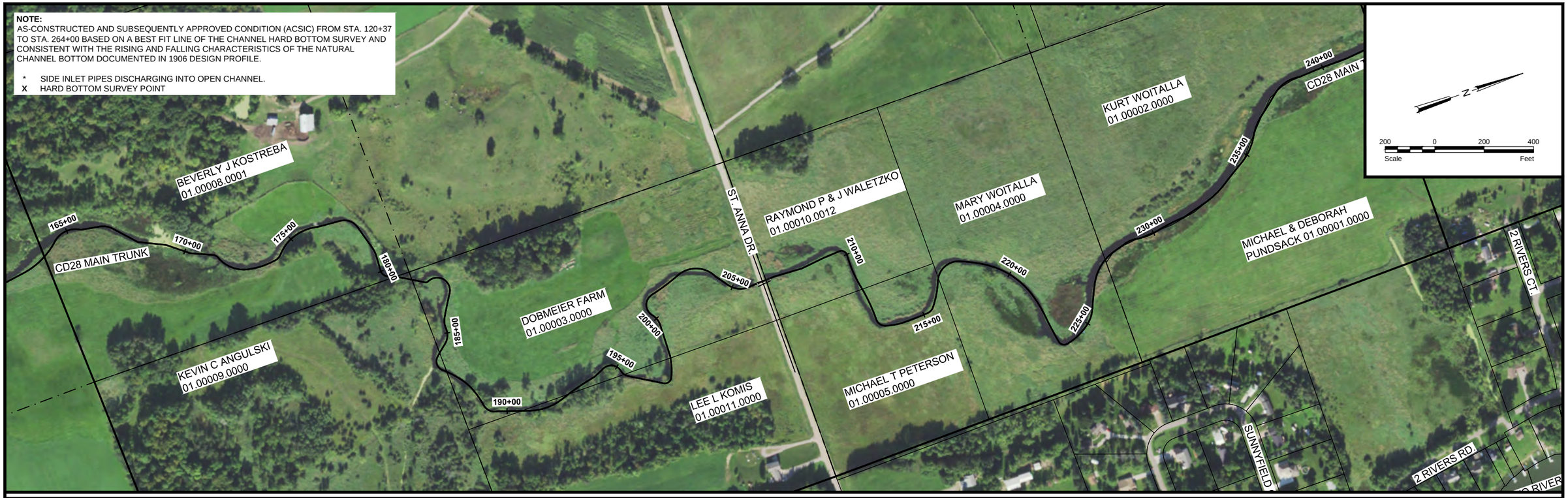
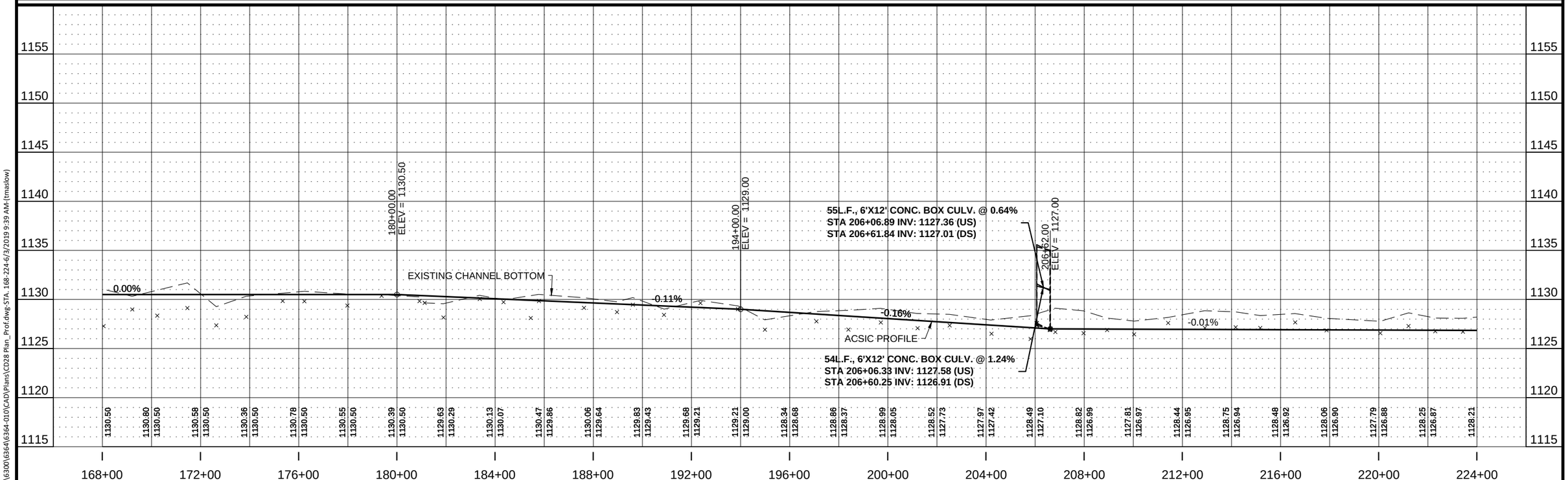
NOTE:
AS-CONSTRUCTED AND SUBSEQUENTLY APPROVED CONDITION (ACSIC) FROM STA. 120+37 TO STA. 264+00 BASED ON A BEST FIT LINE OF THE CHANNEL HARD BOTTOM SURVEY AND CONSISTENT WITH THE RISING AND FALLING CHARACTERISTICS OF THE NATURAL CHANNEL BOTTOM DOCUMENTED IN 1906 DESIGN PROFILE.

* SIDE INLET PIPES DISCHARGING INTO OPEN CHANNEL.
X HARD BOTTOM SURVEY POINT





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REESTABLISHMENT OF STEARNS COUNTY DITCH 28
STEARNS COUNTY
HOLDINGFORD, MN

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STA. 168+00 - 224+00
PROJECT NO. 6364-010

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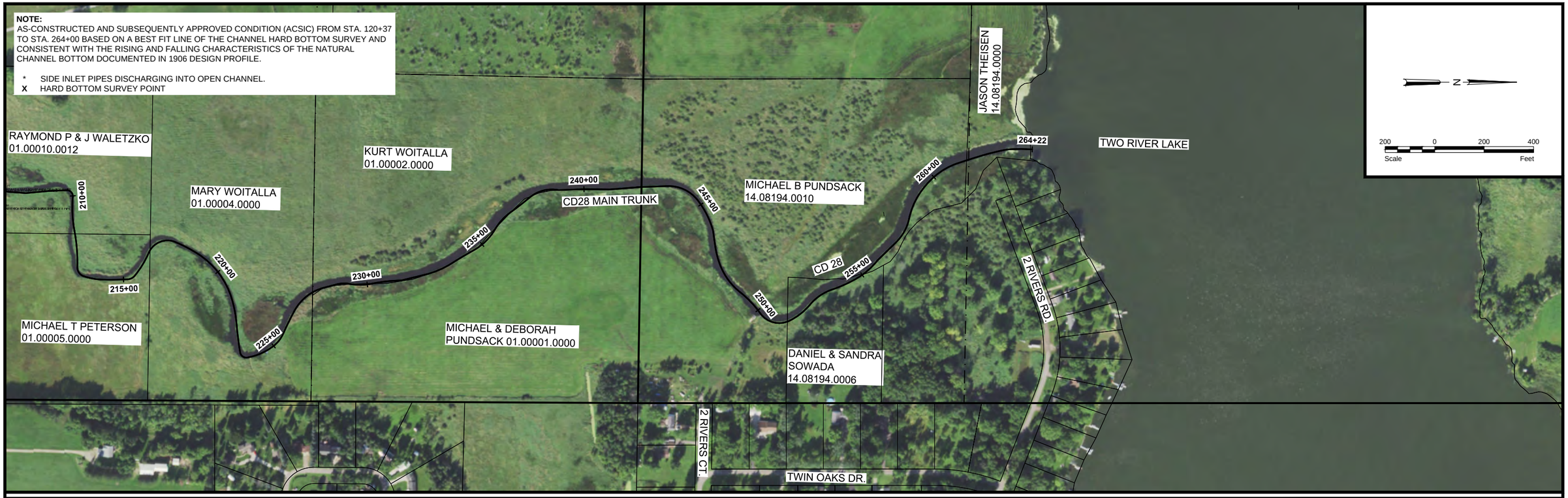
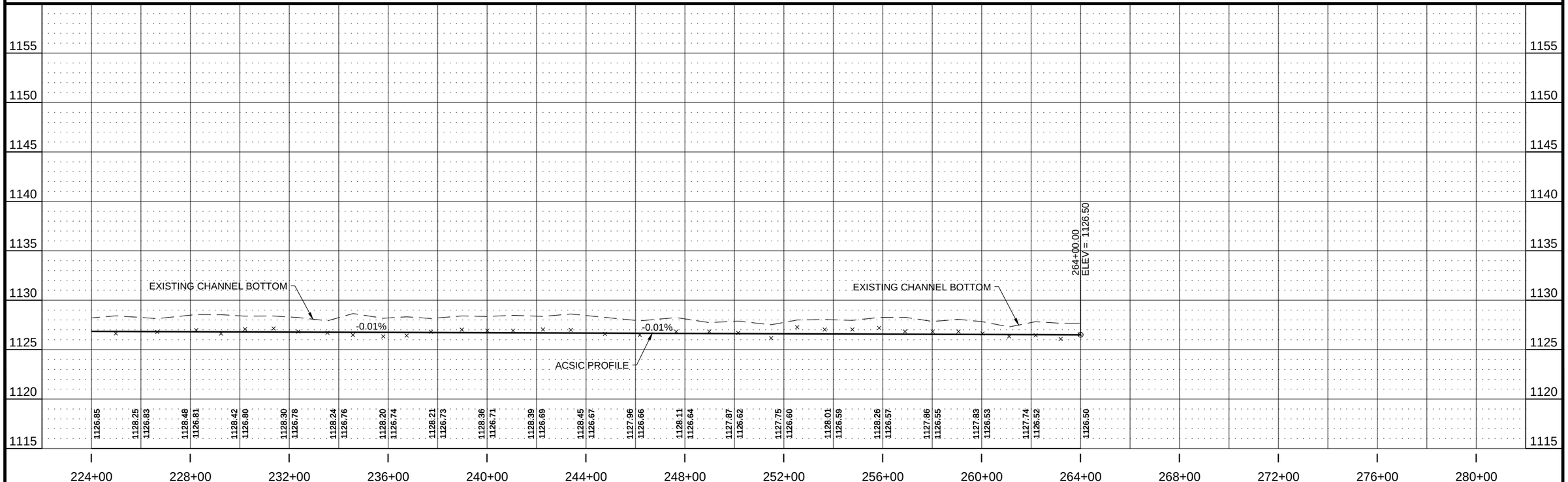
NOTE:
AS-CONSTRUCTED AND SUBSEQUENTLY APPROVED CONDITION (ACSIC) FROM STA. 120+37 TO STA. 264+00 BASED ON A BEST FIT LINE OF THE CHANNEL HARD BOTTOM SURVEY AND CONSISTENT WITH THE RISING AND FALLING CHARACTERISTICS OF THE NATURAL CHANNEL BOTTOM DOCUMENTED IN 1906 DESIGN PROFILE.

* SIDE INLET PIPES DISCHARGING INTO OPEN CHANNEL.
X HARD BOTTOM SURVEY POINT





No.	Revision	Date	By

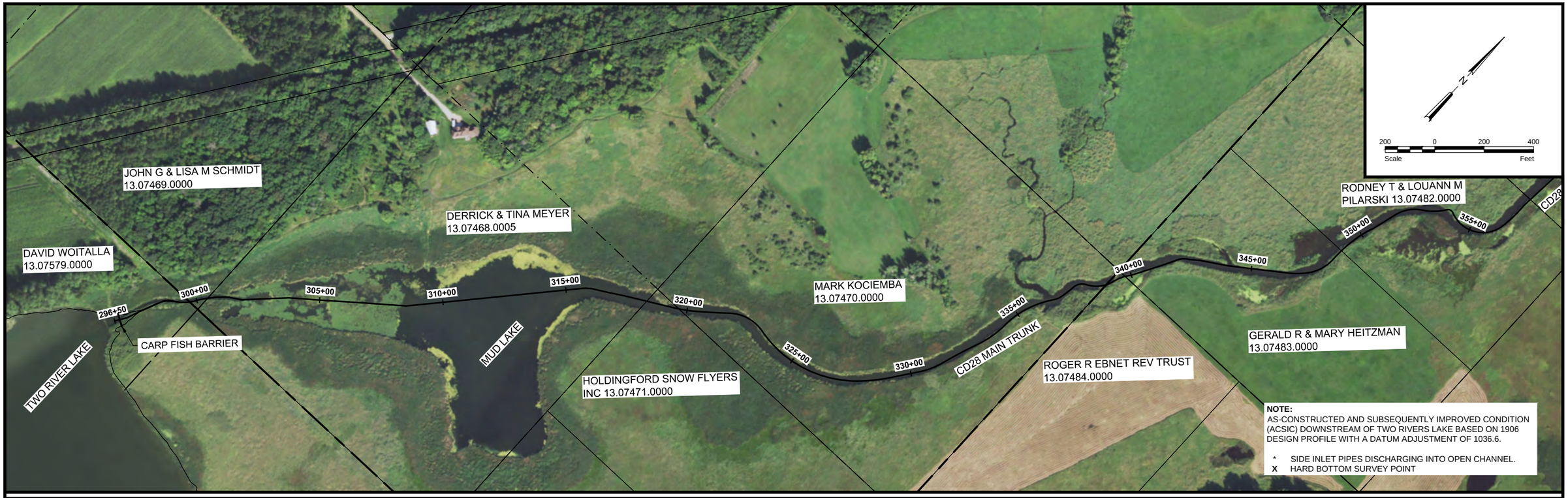
PRELIMINARY
Not for Construction

Houston Engineering Inc.
Maple Grove
P: 763.493.4522
F: 763.493.5572

Drawn by	Date
TAM	5-09-2019
Checked by	Scale
GM	AS SHOWN

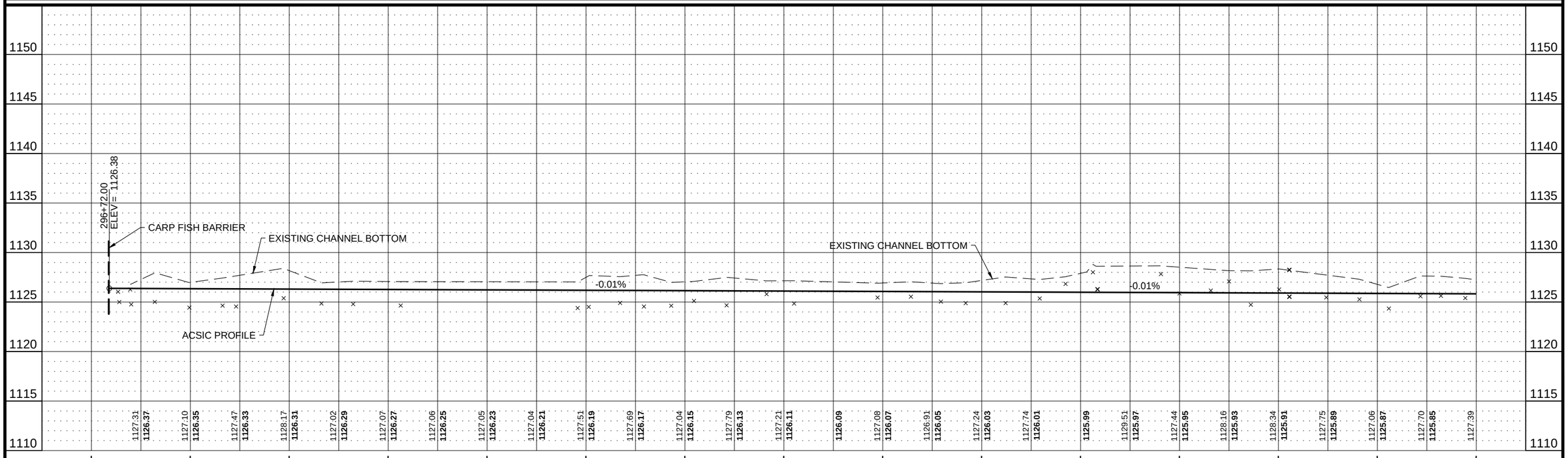
REESTABLISHMENT OF STEARNS COUNTY DITCH 28
STEARNS COUNTY
HOLDINGFORD, MN

STEARNS COUNTY DITCH 28
STA. 224+00 - 264+00
PROJECT NO. 6364-010



NOTE:
AS-CONSTRUCTED AND SUBSEQUENTLY IMPROVED CONDITION (ACSIC) DOWNSTREAM OF TWO RIVERS LAKE BASED ON 1906 DESIGN PROFILE WITH A DATUM ADJUSTMENT OF 1036.6.

* SIDE INLET PIPES DISCHARGING INTO OPEN CHANNEL.
X HARD BOTTOM SURVEY POINT



No.	Revision	Date	By

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Maple Grove
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Drawn by	Date
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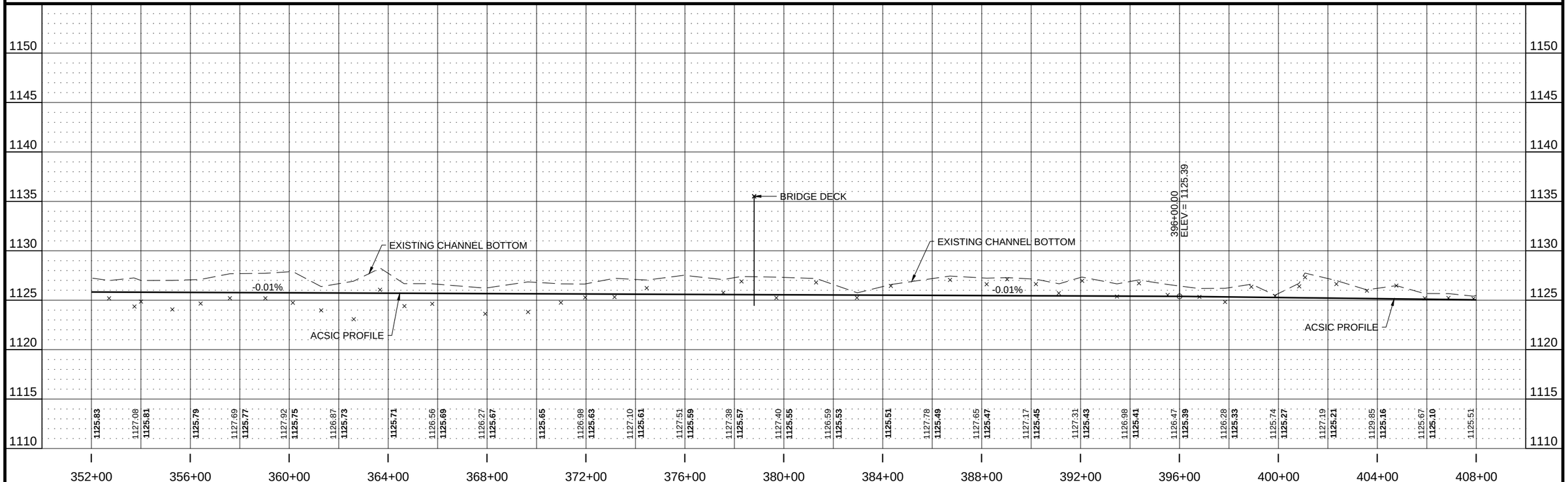
GM	AS SHOWN

REESTABLISHMENT OF STEARNS COUNTY DITCH 28
STEARNS COUNTY
HOLDINGFORD, MN

STEARNS COUNTY DITCH 28
STA. 296+00 - 352+00
PROJECT NO. 6364-010

NOTE:
AS-CONSTRUCTED AND SUBSEQUENTLY IMPROVED CONDITION (ACSIC) DOWNSTREAM OF TWO RIVERS LAKE BASED ON 1906 DESIGN PROFILE WITH A DATUM ADJUSTMENT OF 1036.6.

* SIDE INLET PIPES DISCHARGING INTO OPEN CHANNEL.
X HARD BOTTOM SURVEY POINT



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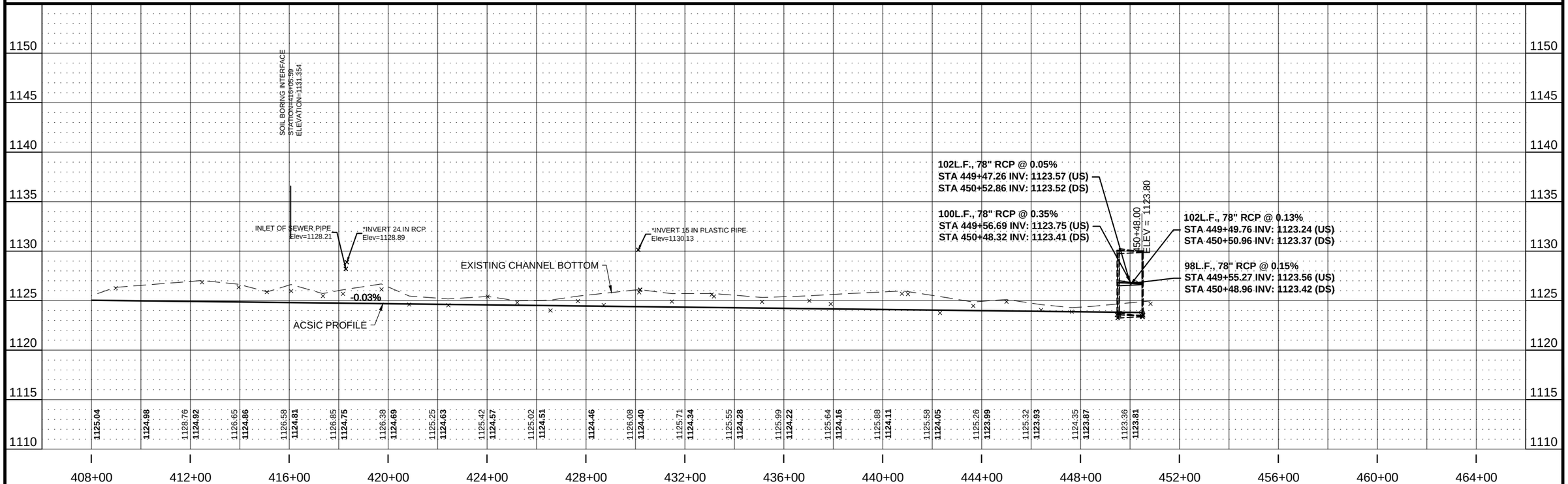
GM	AS SHOWN

REESTABLISHMENT OF STEARNS COUNTY DITCH 28
STEARNS COUNTY
HOLDINGFORD, MN

STEARNS COUNTY DITCH 28
STA. 356+00 - 408+00
PROJECT NO. 6364-010

NOTE:
AS-CONSTRUCTED AND SUBSEQUENTLY IMPROVED CONDITION (ACSIC) DOWNSTREAM OF TWO RIVERS LAKE BASED ON 1906 DESIGN PROFILE WITH A DATUM ADJUSTMENT OF 1036.6.

* SIDE INLET PIPES DISCHARGING INTO OPEN CHANNEL.
X HARD BOTTOM SURVEY POINT



No.	Revision	Date	By

PRELIMINARY
Not for Construction

Houston Engineering Inc.
Maple Grove
P: 763.493.4522
F: 763.493.5572

Drawn by	Date
TAM	5-09-2019
Checked by	Scale
GM	AS SHOWN

REESTABLISHMENT OF STEARNS COUNTY DITCH 28
STEARNS COUNTY
HOLDINGFORD, MN

STEARNS COUNTY DITCH 28
STA. 408+00 - 464+00
PROJECT NO. 6364-010

SHEET
8 of 8

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Appendix B

ACSIC Determination

STA 84+46 - 89+99

Survey (Current) Station	Hard Bottom (Survey) Elevation	Historic Elevation	Difference	Deviation from Datum Adjustment of 1038.6
85+35	1128.17	91.46	1,036.71	1.89
87+53	1129.18	90.59	1,038.59	0.01
89+41	1129.33	89.66	1,039.67	-1.07

This analysis inconclusive. Used best fit line as shown in plan and profiles

STA 103+08 - 120+37

Survey (Current) Station	Hard Bottom (Survey) Elevation	Historic Elevation	Difference	Deviation from Datum Adjustment of 1036.6
103+28	1,129.35	92.00	1,037.35	-0.75*
105+04	1,128.45	92.00	1,036.45	0.15
107+12	1,128.65	92.00	1,036.65	-0.05
109+11	1,127.89	92.00	1,035.89	0.71*
111+07	1,128.76	92.00	1,036.76	-0.16
113+57	1,128.26	92.00	1,036.26	0.34
115+81	1,127.80	92.00	1,035.80	0.80*
118+82	1,129.11	92.00	1,037.11	-0.51
120+19	1,129.48	92.00	1,037.48	-0.88*

* Indicates outliers that was not used in determining the Datum Adjustment (standard deviation value of 0.57

**Root-Mean-Square Error = 0.29

STA 235+15 - 264+00

Survey (Current) Station	Hard Bottom (Survey) Elevation	Historic Elevation	Difference	Deviation from Datum Adjustment of 1033.4
236+75	1,126.34	96.21	1,030.13	3.27
237+73	1,126.92	95.88	1,031.04	2.36
238+98	1,126.92	95.52	1,031.40	2.00
240+01	1,127.04	95.21	1,031.83	1.57
241+05	1,126.99	94.90	1,032.09	1.31
242+26	1,126.59	94.54	1,032.05	1.35
243+38	1,126.48	94.25	1,032.23	1.17
244+77	1,126.82	93.91	1,032.91	0.49
247+65	1,126.83	93.75	1,033.08	0.32
248+98	1,126.69	93.56	1,033.13	0.27
250+16	1,126.17	93.36	1,032.81	0.59
251+49	1,127.27	93.02	1,034.25	-0.85
252+54	1,127.03	92.75	1,034.28	-0.88
253+65	1,127.04	92.45	1,034.59	-1.19
254+77	1,127.19	92.13	1,035.06	-1.66
255+85	1,126.84	91.86	1,034.98	-1.58
256+90	1,126.83	91.61	1,035.22	-1.82
258+02	1,126.84	91.40	1,035.44	-2.04
259+06	1,126.63	91.25	1,035.38	-1.98
260+03	1,126.33	91.03	1,035.30	-1.90
261+11	1,126.45	90.73	1,035.72	-2.32
262+18	1,126.08	90.41	1,035.67	-2.27

This analysis inconclusive. Used best fit line as shown in plan and profiles

STA 296+72 - 450+48

Survey (Current) Station	Hard Bottom (Survey) Elevation	Historic Elevation	Difference	Deviation from Datum Adjustment of 1036.6
297+13	1,125.00	89.62	1,035.38	1.22*
297+61	1,124.76	89.61	1,035.15	1.45*
298+56	1,125.01	89.60	1,035.41	1.19*
299+96	1,124.44	89.59	1,034.85	1.75*
301+30	1,124.64	89.58	1,035.06	1.54*
301+85	1,124.55	89.57	1,034.98	1.62*
303+77	1,125.39	89.55	1,035.84	0.76
305+30	1,124.85	89.54	1,035.31	1.29*
306+58	1,124.79	89.52	1,035.27	1.33*
308+51	1,124.65	89.51	1,035.14	1.46*
315+66	1,124.39	89.43	1,034.96	1.64*
316+11	1,124.51	89.43	1,035.08	1.52*
317+38	1,124.91	89.42	1,035.49	1.11*
318+34	1,124.54	89.41	1,035.13	1.47*
319+44	1,124.63	89.40	1,035.23	1.37*
320+37	1,125.11	89.39	1,035.72	0.88
321+68	1,124.67	89.37	1,035.30	1.30*
323+30	1,125.80	89.36	1,036.44	0.16
324+41	1,124.85	89.35	1,035.50	1.10*
327+79	1,125.45	89.31	1,036.14	0.46
329+14	1,125.54	89.30	1,036.24	0.36
331+35	1,124.89	89.28	1,035.61	0.99
332+97	1,124.89	89.26	1,035.63	0.97
334+35	1,125.36	89.25	1,036.11	0.49
335+39	1,126.83	89.24	1,037.59	-0.99
336+50	1,128.01	89.23	1,038.78	-2.18*
339+25	1,127.82	89.20	1,038.62	-2.02*
340+00	1,125.87	89.19	1,036.68	-0.08
341+27	1,126.16	89.18	1,036.98	-0.38
342+00	1,127.08	89.17	1,037.91	-1.31*
342+88	1,124.73	89.17	1,035.56	1.04
344+03	1,126.27	89.15	1,037.12	-0.52
345+93	1,125.47	89.14	1,036.33	0.27
347+27	1,125.27	89.12	1,036.15	0.45
348+47	1,124.34	89.11	1,035.23	1.37*
349+74	1,125.58	89.10	1,036.48	0.12
350+57	1,125.62	89.09	1,036.53	0.07
351+55	1,125.40	89.08	1,036.32	0.28
352+71	1,125.19	89.07	1,036.12	0.48
353+74	1,124.36	89.06	1,035.30	1.30*
354+00	1,124.86	89.06	1,035.80	0.80
355+27	1,124.07	89.05	1,035.02	1.58*
356+42	1,124.66	89.04	1,035.62	0.98
357+60	1,125.21	89.02	1,036.19	0.41
359+03	1,125.20	89.01	1,036.19	0.41
360+14	1,124.74	89.00	1,035.74	0.86
361+29	1,123.97	88.99	1,034.98	1.62*
362+61	1,123.08	88.97	1,034.11	2.49*
363+67	1,126.06	88.96	1,037.10	-0.50
364+66	1,124.40	88.96	1,035.44	1.16*
365+78	1,124.63	88.95	1,035.68	0.92
367+93	1,123.62	88.93	1,034.69	1.91*
369+66	1,123.81	88.91	1,034.90	1.70*
370+98	1,124.76	88.90	1,035.86	0.74
371+97	1,125.28	88.89	1,036.39	0.21
373+15	1,125.32	88.87	1,036.45	0.15

STA 296+72 - 450+48

Survey (Current) Station	Hard Bottom (Survey) Elevation	Historic Elevation	Difference	Deviation from Datum Adjustment of 1036.6
374+45	1,126.23	88.86	1,037.37	-0.77
377+55	1,125.76	88.83	1,036.93	-0.33
379+70	1,125.24	88.81	1,036.43	0.17
381+30	1,126.79	88.79	1,038.00	-1.40*
382+95	1,125.25	88.78	1,036.47	0.13
384+33	1,126.45	88.76	1,037.69	-1.09
386+72	1,127.05	88.74	1,038.31	-1.71*
388+20	1,126.49	88.73	1,037.76	-1.16*
389+03	1,127.12	88.72	1,038.40	-1.80*
390+19	1,126.63	88.71	1,037.92	-1.32*
391+12	1,125.71	88.70	1,037.01	-0.41
392+06	1,126.96	88.69	1,038.27	-1.67*
393+47	1,125.37	88.67	1,036.70	-0.10
394+36	1,126.71	88.66	1,038.05	-1.45*
395+52	1,125.53	88.65	1,036.88	-0.28
396+80	1,125.34	88.64	1,036.70	-0.10
397+84	1,124.82	88.63	1,036.19	0.41
398+90	1,126.36	88.62	1,037.74	-1.14*
399+86	1,125.42	88.61	1,036.81	-0.21
400+84	1,126.40	88.60	1,037.80	-1.20*
401+08	1,127.32	88.60	1,038.72	-2.12*
402+34	1,126.64	88.58	1,038.06	-1.46*
403+58	1,125.96	88.54	1,037.42	-0.82
404+77	1,126.47	88.51	1,037.96	-1.36*
405+92	1,125.20	88.47	1,036.73	-0.13
406+87	1,125.22	88.44	1,036.78	-0.18
407+89	1,125.16	88.41	1,036.75	-0.15
408+98	1,126.26	88.38	1,037.88	-1.28*
412+47	1,126.85	88.27	1,038.58	-1.98*
413+95	1,126.36	88.23	1,038.13	-1.53*
415+09	1,125.87	88.20	1,037.67	-1.07
416+08	1,125.96	88.17	1,037.79	-1.19*
417+36	1,125.46	88.13	1,037.33	-0.73
418+17	1,125.68	88.10	1,037.58	-0.98
419+73	1,126.13	88.06	1,038.07	-1.47*
420+85	1,124.61	88.02	1,036.59	0.01
422+43	1,124.53	87.98	1,036.55	0.05
424+02	1,125.41	87.93	1,037.48	-0.88
425+22	1,124.81	87.89	1,036.92	-0.32
426+56	1,124.00	87.85	1,036.15	0.45
427+67	1,124.96	87.82	1,037.14	-0.54
428+72	1,124.55	87.79	1,036.76	-0.16
430+15	1,125.84	87.75	1,038.09	-1.49*
431+47	1,124.91	87.71	1,037.20	-0.60
433+08	1,125.62	87.66	1,037.96	-1.36*
433+17	1,125.42	87.65	1,037.77	-1.17*
435+12	1,124.88	87.60	1,037.28	-0.68
437+03	1,124.98	87.54	1,037.44	-0.84
437+90	1,124.66	87.51	1,037.15	-0.55
440+78	1,125.70	87.43	1,038.27	-1.67*
441+02	1,125.66	87.42	1,038.24	-1.64*
442+31	1,123.76	87.38	1,036.38	0.22
443+66	1,124.47	87.34	1,037.13	-0.53
445+00	1,124.89	87.30	1,037.59	-0.99
446+40	1,124.06	87.26	1,036.80	-0.20
447+65	1,123.88	87.22	1,036.66	-0.06

* Indicates outliers that was not used in determining the Datum Adjustment (standard deviation value of 1.1

**Root-Mean-Square Error = 0.58