ANALYSIS OF SITE CONDITIONS AND PROJECT RECOMMENDATION FOR MILJALA TRIBUTARY

October 2022
Revised November 2022

PREPARED FOR:

Rock Lake Improvement Association

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220017.1

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Contents

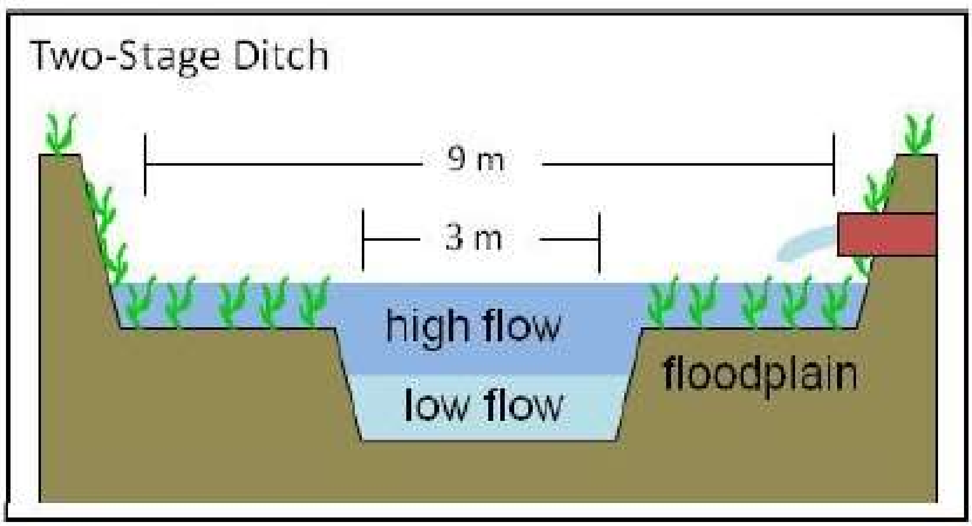
1. Background

The purpose of this report is to provide an analysis of the soil stability in the Miljala Tributary area and use the information to create a recommendation of best practice. Resource Engineering Associates, Inc. (REA) and Jefferson County Land & Water Conservation Department (LWCD) worked with landowners and the Rock Lake Improvement Association (RLIA) to review past work, collect site information, and develop the appendices of this document. This report provides a compilation of site data and literature review as a foundation for REA's bank stability recommendation. Increasing the stability of the banks of the Miljala Tributary will reduce erosion of landowner property and sediment load into the Miljala Channel. Specific attention is given to the project's ability to reduce the load of phosphorus. Our report aims to provide landowners and local stakeholders with information to understand the current condition of the Miljala Tributary banks and stability project options we recommend.

2. Definitions

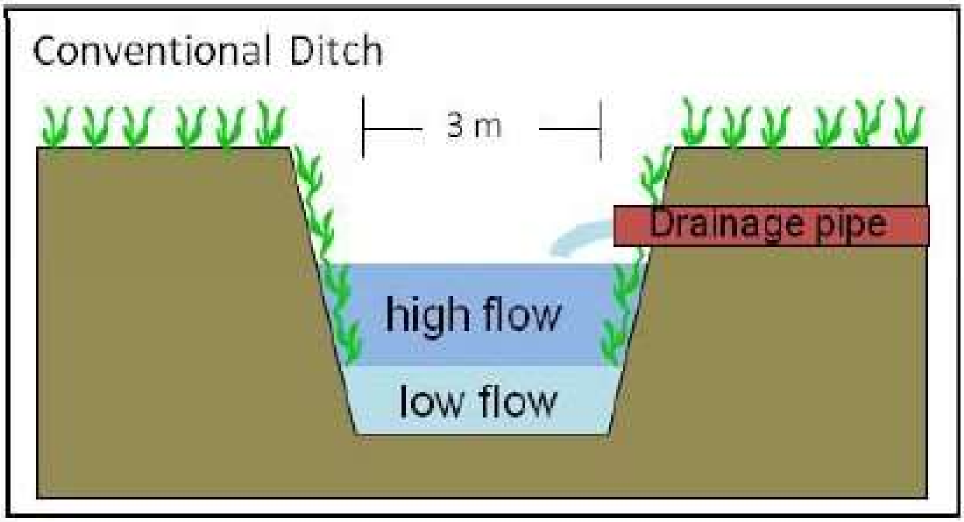
Two-Stage Ditch: "A two-stage ditch is a design conversion that modifies the geometry of a ditch to establish benches within the ditch. The ditch provides a low-flow channel and then a vegetated bench that is flooded during higher flows. The vegetation provides some slowing of water flow where sediments and other heavier material in the flow might settle." (Ohio State University Extension)

Below is a graphic from Tank et. al that shows how low flow and high flow channels function in a two-stage ditch.



Trapezoidal or Conventional Ditch: The trapezoidal ditch is a single channel ditch sized to contain between the 5-year and the 100-year, 24-hour rain event.

Below is a graphic from Tank et. al that shows how low flow and high flow channels function in a conventional ditch.



Low Flow and Low Flow Channel: Flow conditions (velocity and volume) during prolonged dry weather, e.g., after 7 days of dry weather. The **low flow channel** (sometimes referred to as the first stage of a two-stage ditch) generally contains the water during periods of low flow and normal flow. The low flow channel depth is usually sized to be overtopped (or inundated) somewhere between multiple times per year or every few years (depending on project goals).

High flow and High Flow Channel: Flow conditions during large storm events or snow melts. For example, the 5-year, 24-hour rain event in Jefferson County is 3.39" and the 25-year, 24-hour rain event in Jefferson County is 4.75". These would both lead to high flow conditions, where water inundates the low flow channel and spills into the shelf and high flow channel. The **high flow channel** (sometimes referred to as the second stage of a two-stage ditch or the flood stage) is designed to handle a certain size flood beyond low flow or normal flow conditions.

Shelf or Bench: The area that is nearly flat between the two sloped portions of a two-stage ditch. The shelf is the bottom of the second stage on either side of the low flow channel. The shelf is vegetated with tall perennial grasses that increase stability and infiltration. This portion slows the velocity of high flow events and allows for greater sediment retention.

3. Analysis

Field Work

Resource Engineering Associates Inc. (REA) and Jefferson County LWCD staff members collected seven soil samples from seven hand borings along the Miljala Tributary and nearby area on June 9th, 2022. Each of the borings were field logged using the Unified Soil Classification System, logs of the borings integrated with depth and lab results are provided in Appendix C. A map of the boring locations, the outline of the WDNR wetland delineations, and landowner lot lines is included in Appendix C. Boring locations were chosen to verify textures, depth to saturation and phosphorus content at critical areas along the project area.

1. Boring 1 was near the northeast end of the project, within 25 ft. of the tributary to collect data on bank conditions near the low flow area before the water enters the culvert and Miljala Channel.
2. Boring 2 was south of the tributary near the northeast end of the project, around 40 ft. off the bank in a lowland hardwood forest to collect data on conditions further away from the tributary, but still in the floodplain.
3. Boring 3 was where the tributary turns from east to northeast, the banks were steeper here than on the northeast portion. The boring was located 2 ft. south of the bank.
4. Boring 4 was 20’ south of boring 3 in a forested area. This boring was used to capture any change in profile and saturation from right on the bank to 20 ft. away.
5. Boring 5 was west of boring 4, around 60 ft. south of the tributary but in an open prairie area. This boring was used to capture any differences in the area corresponding to vegetation. Boring 4 was also in an area not included in the DNR’s wetland map, boring 5 is in an area marked as a wetland by the DNR.
6. Boring 6 was within 2 ft. south of the bank at the western extent of the project area where the banks are highest and steepest. This boring was taken to collect data on conditions near the beginning of the project area and where the bank erosion is most intense.
7. Boring 7 was north of the Miljala Tributary, south of Shorewood Hills Road, where gully erosion leading to the tributary was viewed. This boring was used to collect data on what soil conditions and phosphorus could be entering the tributary from this lateral erosion. We recommend including this area in future projects.

The samples were analyzed by the Wisconsin State Lab of Hygiene for particle distribution (e.g., % sand, % silt, and % clay) and total phosphorus. The particle distribution analysis provides information to help determine the angle of slopes that the soil can maintain stability at. The total phosphorus content of the soil in different portions of the tributary was collected to detail areas where phosphorus is high and how it travels through the system. Full texture and phosphorus lab results are in Appendix C.

Photos from the site are provided in Appendix A from Jefferson County LWCD. A site survey was conducted by staff members of the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) with help from Jefferson County LWCD staff on April 19, 2022. Survey data was used to create a topographic map and cross sections of parts of the tributary. Appendix B provides a topographic overview of the area, seven cross sections of the existing ground surfaces compared to two hypothetical tributary cross sections. References used for soil slope analysis and tributary designs are provided in Appendix D.

Stable Slope Ratios and Project Area

The USCS soil class most encountered in the hand borings was a low-plasticity silt (ML). This is consistent with the results for the area using the USDA’s Websoil Survey tool. Wet conditions were encountered in five of the seven hand borings with indicator colors and mottles encountered in the borings that did not reach wet conditions. Indicator colors and mottles are usually interpreted as zones of seasonal saturation, which means that the two borings that did not reach wet conditions during our soil exploration likely have wet conditions during certain wet seasons or particularly wet years. For this reason, a stable slope design should consider the soils in wet condition. In dry-moist conditions the

surface tension of low plasticity soils (e.g., the silt encountered) can be considered stable as steep as a 1:1 slope. In wet conditions, low plasticity silt slopes are often designed to be 2.5:1 – 3.5:1 because wet ML soils with a 1:1 slope encounter sloughing (NRCS 654 TS14, Pg 23). Bank destabilization and erosion from sloughing were viewed while walking the Miljala Tributary on April 19th and June 9th, 2022.
The most extreme examples of sloughing were encountered at the western portion of the project area (see photo documentation in Appendix A). Additional attention and design consideration should be given to the far western portion of the project area. Channelized erosion was viewed entering the tributary from the north and northeast on the far west end of the project area (upslope on the Muir and Anderson properties). Visual evidence indicates this area is contributing water and sediment during periods of high flow. Furthermore, the soil sample taken in this area (HB-7) had the highest level of total phosphorus (1510 mg/kg). Since this region is impacting the flow rate and phosphorus load of the Miljala Tributary, we recommend including this area in the bank stability project. Adding runoff controls and improving the grading to slow the flow of water through these areas would decrease channelized erosion and phosphorus loading while increasing the stability of the tributary during large storm events. Adding riprap to the toe of the slopes of the tributary in this western portion to increase bank stability should be considered during design of this project. Riprap is large well-graded clean (little to no soil) angular rock that protects from slope scour and armors the soil. Without intervention, the banks of the tributary on the western and central sections will continue to slough and erode until the banks widen enough to reach a stable grade.

Erosion in Stream Bed

The bottom of the portion of the tributary on the eastern section appeared to have a higher sand content than encountered in the hand borings and on the bottom edges of the western and central section of the tributary. Bed movement (e.g., saltation) of sand particles was not observed in the eastern section of the tributary. Particle transportation of settled medium-large grained sand occurs at a flow rate of approximately 10 cm/s and transportation of silt occurs between 0.1 and 1 cm/s (Physical Geology, Ch. 13.3). This suggests that flow velocity may be higher on the eastern section of the transect (but less than 10 cm/s), leading to deposition and retention of sand particles but transportation of silt during normal flow conditions. An increased flow velocity in this section is consistent with the reduced size of the low flow channel – as a similar volume of water moves through a smaller area the velocity increases. The bottom of the western portion of the tributary had more silt muck deposited, indicating a slower flow rate than the eastern section, at least in normal flow conditions. However, bed movement of silt particles was encountered and increased with disturbance (e.g., walking on the bottom) in the western part of the tributary. Since some silt was settled but was easily disturbed and transported the flow rate in this area likely fluctuates around 1 cm/s.

Particle analysis of materials collected in the Miljala Channel turbidity barrier from 2009-2011 indicate sand with some muck (silt) were collected (Montgomery Associates Resource Solutions, LLC, 2014). The word “some” in the Unified Soil Classification System indicates between 30 to 45% by mass. Current topographical data of the tributary bottom indicates that the bottom of the tributary is raising, e.g., filling in with silt from the western section (cross-section A in Appendix B) to the central section (cross-section D in Appendix B). Based on topographical data and the most recent particle analysis of materials collected in the Miljala Channel turbidity barrier, it appears as if some of the disturbed silt particles in the western portion fall out of suspension (settle) before reaching the higher velocity, eastern section of the tributary and subsequent channel.

Figure 13.16 from Physical Geology by Steven Earle provides a graphic depiction of the interplay of particle size, deposition, transportation, and erosion. Flow velocity units in ft./s were added onto the right side of the following graphic.

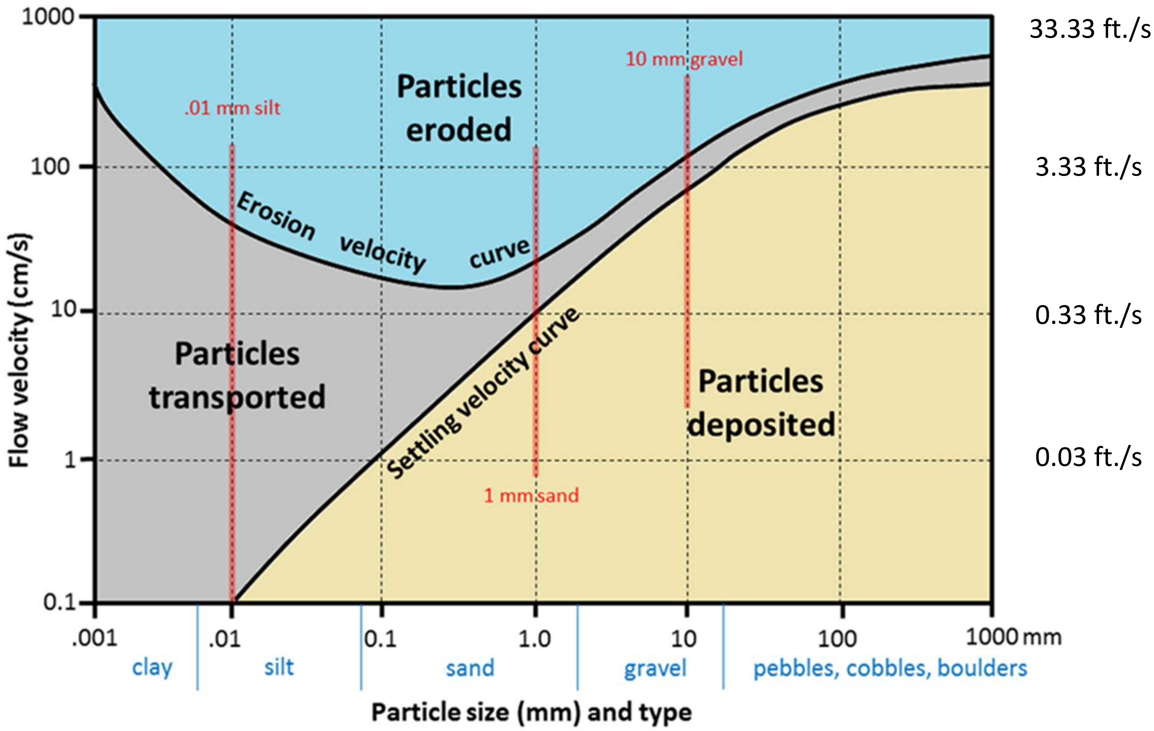


Figure 13.16 The Hjulström-Sundborg diagram showing the relationships between particle size and the tendency to be eroded, transported, or deposited at different current velocities

The eastern portion of the Miljala Tributary appears to function in a stable condition (little to no erosion) with a smaller low flow channel that runs at a higher velocity (that sand settles in, but silt flows through) surrounded by a high flow shelf and gradual, vegetated flood plain. The soil sample taken from the shelf near cross section G (HB-1), is the second highest in total phosphorus 1010 mg/kg. This suggests that phosphorus is deposited on the shelf during high flow events that inundate the low flow channel. The soil sample in this area taken from further away from the tributary and upslope (HB-2) is lower in phosphorus, at 746 mg/kg. These results could suggest that phosphorus is settling out in the naturally formed shelf (where HB-1 was sampled). The existing banks in this portion of the tributary are like a two-stage design (see cross sections F and G). Since this section of the tributary does not appear to be eroding and there is evidence of phosphorus being deposited in the shelf area near the low flow channel, it provides local documentation that a two-stage design would reduce bank erosion and phosphorus load.

Water Profile Decline Compared to Stream Bed Decline

The edge of water GPS shots (used as water surface shots) show a gradual decline in elevation as the tributary flows from the start of the project area (West) to the culvert at Cedar Lane, whereas the bottom of tributary elevations fluctuated. The elevation change in the water surface is steeper on the western section of the project. Based on survey data, the slope of the water surface from the beginning of the

project area to the Cedar Lane culvert ranges from 0.3% to 0.56% with an average decline of 0.45%, which is greater than the average slope of the bottom (~0.17%).
Slope of Water Surface Using Edge of Water GPS Shots:

West to east	Rise/Run	Percent Slope	Length	Note
Section 1	0.005607	0.56%	665.25	Corner to Shropshire
Section 2	0.003037	0.30%	434.68	Shropshire to before turn North
Section 3	0.004396	0.44%	316.17	Turn North to 50' from Road
Section 4	0.003153	0.32%	28.54	50' from Road to Culvert
AVG Total	**0.004520**	**0.45%**	**1444.64**	**Beginning to end average**

Varying bottom elevation is an indication that saturated silt soils on the steeper banks of the western portion of the Miljala Tributary are sloughing into the tributary and accumulating. As the bank material erodes away it settles during periods of low flow which leads to additional bank saturation, sloughing, and greater erosion loads during high flow events.

Evidence of silt deposition in portions of the tributary is provided by survey data and depicted in the cross sections in Appendix B. Elevation of the existing bottom in some cross sections is higher than the upstream cross section – even as the water surface elevation declines. For example, the existing bottom elevation rises even as the water flows from cross section A to C (see Appendix B).

Total Phosphorus Loading

Phosphorus reduction from two-stage ditches is generally attributed to sediment deposition and nutrient uptake by plants on the shelf (the bottom of the second stage). A case study by Krider et. Al. found that the downstream concentration of total phosphorus was reduced by 0.02 mg/L within a year of two-stage installation and plant establishment. The Mullenbach ditch involved in this project flowed from North to South. A graphic depiction of the phosphorus reduction after the two-stage installation is provided in Figure 4.24 from Krider et. Al.

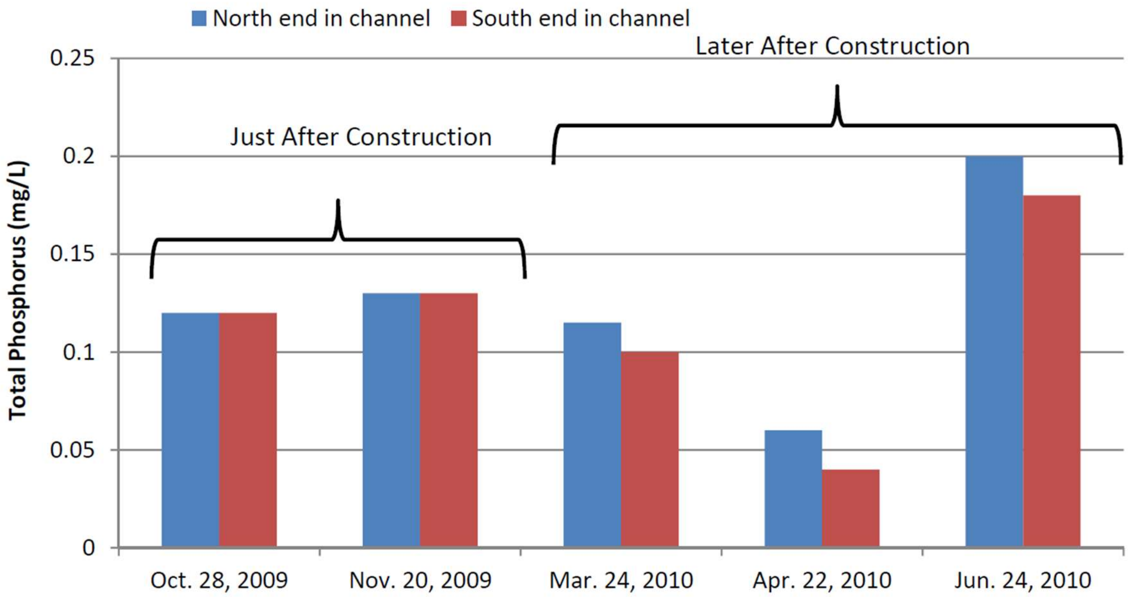


Figure 4.24. Total phosphorus (mg/L) at the north and south end of the two-stage retrofit just after construction (2009) and the year after (2010).

Similar results for reducing phosphorus by using a two-stage ditch design have been found by Professor Tank from the University of Notre Dame and Emily Kindervater at Grand Valley State University. Dr. Tank notes that greater phosphorus reduction can be achieved if the low flow channel is inundated >12 times per year and if the vegetation is well established (Tank, slide 15). Emily Kindervater found that mean total phosphorus was significantly higher in traditional trapezoid designs compared to two-stage designs via higher retention of phosphorus in soil and sediment in the Macatawa Watershed of Michigan (pg. 25). If we apply this body of research to the Miljala Tributary, we can estimate a first-year reduction of phosphorus from the tributary. The calculations below use a low annual estimate of reduction, based on Krider et. Al.'s first year data. Most work indicates that the capacity of a two-stage ditch to reduce phosphorus load increases over time.

Data from the 2009 Rock Lake Management Plan documents an average of stream flow of 0.3275 cubic feet per second (based on readings from 4 separate days), or approximately 9.27 liters per second. At this rate the tributary outlets 800,928 liters per day, or 292,338,730 liters annually. If the phosphorus loading is reduced 0.2 mg/l in the first year of a two-stage establishment (as found by Krider et. Al) that would be a reduction of 58.47 kg per year of phosphorus – or 129 lbs in the first year.

4. Conclusions and Recommendations

Visual, topographic, and academic literature all indicate that the banks on the western and central area of the Miljala Tributary will continue to erode without intervention. The Miljala Tributary banks will erode until they reach a stable slope angle to maintain a low flow channel or until the area returns to a wetland (e.g., the banks fill in the low flow channel and the area is saturated). The sediment that erodes from the banks during this process will flow into the channel or deposit along the bottom of the tributary. Evidence of sediment deposition in the tributary is provided by the rise in bottom elevation between cross section A and C.

Evidence that supports this process includes:

- The area has low-plasticity silt and sand soils. Much of the area is categorized as a wetland so the banks moisture condition will likely continue to be saturated, leading to a lower angle of stabilty.
- The banks are actively eroding, photo documentation of sloughing is available in Appendix A.
- Topographic data indicates portions of the stream bottom are accumulating silt and that the banks in the western portion of the project area are greater than a 1:1 slope.
- Known bank stability of wet silt soils occurs between 2.5:1 to 3.5:1, however the observed slopes on most of the Miljala Tributary are steeper than this ratio. The banks are stable at 3.5:1 near the northeastern section of the tributary.
- Since the soils in the area are low plasticity silt that do not maintain a 1:1 or steeper slope while saturated, the area will likely erode until the surface is flat enough to maintain a low flow channel or function as a wetland.

We recommend:

1. Installing a two-stage design that meets with the existing ground where the side slopes of the tributary reach a grade near a 3.5:1 two-stage ditch (cross section F in Appendix B).

Using a two-stage design is becoming common practice in the Midwest region, a brief quote from the engineering handbook provides an overview of this systems benefits.

> "This two-stage approach provides improved physical, as well as ecological performance. The channel-forming discharge channel provides the necessary sediment conveyance, while the flood plain channel provides for the design flood conveyance. By nesting the channel forming discharge channel within the larger channel, the entire waterway is more stable." -Part 654 Stream Restoration Design National Engineering Handbook, Pg 10-2.

The Miljala Tributary project goals provide an ideal opportunity to install a two-stage ditch design to increase stability in low and high flow conditions, while reducing phosphorus load via sedimentation during high flow events.

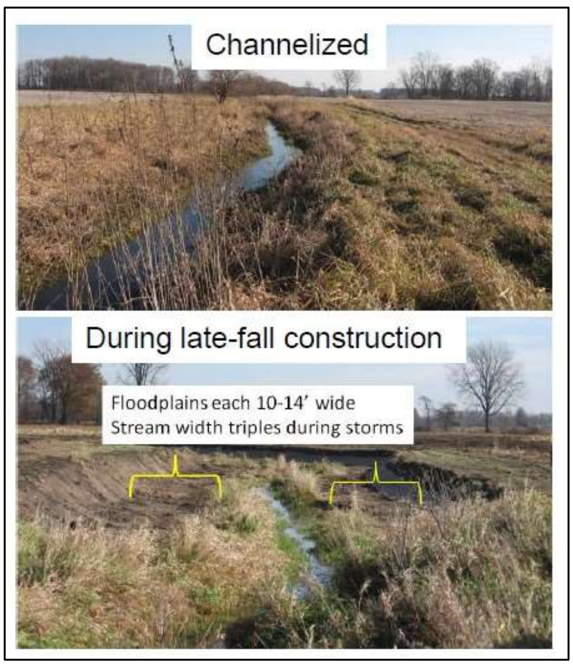
2. Reduce the northeastern reach of the project area. Topographic and site evidence indicate this area (cross section F to cross section G; Oostdik property) is already functioning with a stable low flow channel and a gradual vegetated floodplain – very similar to a designed 3.5:1 two-stage ditch.

Cross section G in Appendix B shows the stable slope viewed on the northeastern side of the Miljala Tributary (Oostdik property) lines up with a 3.5:1 slope – indicating the soils of the Miljala Tributary reach stability at 3.5:1, not 2.5:1. A shallower design (3.5:1 instead of 2.5:1) will provide a more stable slope, and be easier for machinery (e.g., mowers) to work on during vegetation establishment.

3. Extending the project area on the western section of the proposed project to include the gully erosion entering the tributary from the north and northeast. The western section of the tributary (cross section A to cross section C; Muir and Shropshire property) had the steepest banks and clear signs of erosion.

4. Installing riprap at the toe of the banks in the farthest west region (cross section A to cross section B; Muir and Shropshire property) for additional stability to areas prone to erosion. The amount and specifications of the riprap should be considered during the final design stage of the project.
5. Construct the project during the cold season (late fall/winter) to minimize downstream erosion. Partially frozen ground will reduce the likelihood of construction runoff and be easier for the equipment to move on compared to wet muck. Construction equipment and crews have higher availability in the winter. We anticipate the project would take between one week and a month.

The two-stage design would require initial seeding and erosion mats to install perennial grass species designed to meet regional requirements for critical planting zones. Maintenance until full perennial establishment would include mowing the shelf, high flow channel embankment, and a mower pass above the high flow channel to remove woody species and noxious weeds. Maintenance activities for two-stage ditches after perennial grass establishment are generally less than trapezoidal ditches. A photo of pre-construction, construction, and post-establishment from Tank et. al is provided below.



Our above recommendations are provided with the goals of increasing the stability of the Miljala Tributary banks (increasing land and tributary function) and reducing sediment phosphorus load into the Miljala Channel. It should be noted that no design or construction will eliminate *all* sediment and nutrients from entering the Miljala Channel.

5. Additional Data for Final Design

- Additional Topo Data
  - Including the proposed work area on the Anderson and Muir Property (see the map provided in Appendix B)
- Perform HydroCAD Analysis on site for final flood design dimensions

    - Decide if design should function for low flow to handle the two-year storm, or if the low flow section should be inundated for multiple times annually for greater phosphorus retention.
- Design plan to meet regulatory agencies for construction in a wetland
- Create Maintenance Plan
- Provide a stormwater erosion control plan for construction
- Construction ready Design Plan Set and Report

6. Additional Comments on Appendix B

Construction Access and Yellow Construction Zone:

Construction access to reshape the Miljala Tributary is recommended off Shorewood Hills Road, either through the Anderson property or the Muir property. The access road would be near the outside of the proposed project expansion to reshape the lateral gully erosion viewed to the northwest of the tributary. Construction road design and repair post construction would be included in the stormwater erosion control plan. If the maintenance plan for the tributary includes community support to mow and remove noxious weeds from the constructed project, the road could be repaired (e.g., stone removed and native grasses planted), but left at grade for access to the tributary. This would function as a grassed path for a mower to move from Shorewood Hills Road to the tributary. The drafted access roads outlined on page C100 of Appendix B are approximately 20' wide.

The yellow line, "Construction Area" outside of the green "Project Area" provides an additional twenty feet for equipment during project construction. This area could be reduced by strategically positioning equipment during project construction, but it would likely require additional time and cost. The construction area would be repaired at grade with similar vegetation to the tributary (see photos of finished two-stage projects provided in the "Conclusions and Recommendations" portion of this report).

Project Land and Soil Quantity Estimations:

Most of the construction and tributary reshaping would occur on the western portion of the project. The widest area of the recommended two-stage design is 85 feet at the start of the project (cross section A), where approximately 35' from the tributary would be reshaped on the southern side and approximately 50' would be reshaped on the north. These distances are for the recommended two-stage hybrid design to meet with existing ground. As the banks get less steep (moving east) there is less reshaping and width required for a two-stage ditch with a 3.5:1 slope to meet up with existing ground.

The following volume estimates of soil cut were made by calculating the area of soil removed at each cross section (A through F in Appendix B, pages C101 and C102) and multiplying by the length of the transect between cross sections. The area of soil removed at each cross section was the difference between existing ground (brown dotted line) and the recommended two-stage hybrid (pink line). To calculate the volume between A and B the average area of cut between the two cross sections was multiplied by the length of the transect. This process provides a rough estimate of how much material would be reshaped on the south and north of the tributary between cross sections.

Property lines do not completely line up with the tributary or the cross sections. For example, the calculated cut material on the south side from C to D is 75% (805 cubic yards) on Shropshire land and 25% (269 cubic yards) on Jefferson County land. Majority property owners are outlined in the table. The tributary, property lines and cross sections can all be reviewed on page C100 in Appendix B.

Cross Sections	South (Cubic Yds)	North (Cubic Yards)
From A to B	677 (Shropeshire)	792 (Muir)
From B to C	1459 (Shropeshire)	1500 (Muir)
From C to D	1074 (Shropeshire/Jefferson County)	990 (Muir)
From D to E	566 (Jefferson County)	895 (Britzke)
From E to F	41 (Oostdik)	171 (Jefferson County/Oostdik)
Total Cut Per Side	3817	4348
Project Cut	8165	

A more accurate calculation of land required to be reshaped and cut generated would be calculated and included in the final design plan set by comparing the existing ground topography to the design topography. The cut material could be used to build up the second embankment area and during project repairs. Additional cut would have to be relocated or used on site for other land shaping initiatives. Due to the wet nature of the soil in this area it would be recommended to allow any soil removed to drain before using it for other projects.

Appendix A: Site Photos

Photos taken during the topographic survey completed by WI Department of Trade and Consumer Protection (DATCP) and Jefferson County Land and Water Conservation Department (LWCD) with the exception of the final two photos taken in June of 2021 which is also noted in the photo description.

Photo 1: At the end of the Oostdik property and start of Britzke property (right) across from County property (left) the height of the banks began to increase dramatically. DATCP engineer Ryan Glassmaker is between 5' 10" and 6' 0" in height. Facing upstream.

Photo 2: looking upstream from county property (left) at significant erosion and end of Britzke property and beginning of Muir property in background (right).

Photos 3 & 4: Evidence of significant groundwater input into channel. The orange coloration in both photos is indicative of iron reduction by bacteria in the sediment and then is precipitated into the stream by the groundwater spring. The rainbow sheen in the left photo is also indicative of groundwater input and is a biofilm created by the high amount of ions in groundwater.

Photo 5: Taken facing Muir property from Shropshire property, banks still 4-6' high and vegetation thinning, lots more exposed soil. Soils were very organic, spongy to walk on.

Photo 6: example of significant disturbance from game trails that were observed numerous times over project length.

Photo 7: Facing upstream at Anderson property outside of project area. Bare banks with significant erosion 8-10 feet in height.

Photo 8: nearing end of project area, looking downstream with Muir property on left and Shropshire property on right. Banks are entirely bare now and 6+ feet in height.

Photo 9: Photo taken 6.23.21 from Cedar Ln facing the channel. This photo was taken during a severe drought and the water level on the lake was just over 10.5 inches below normal for that time of year.

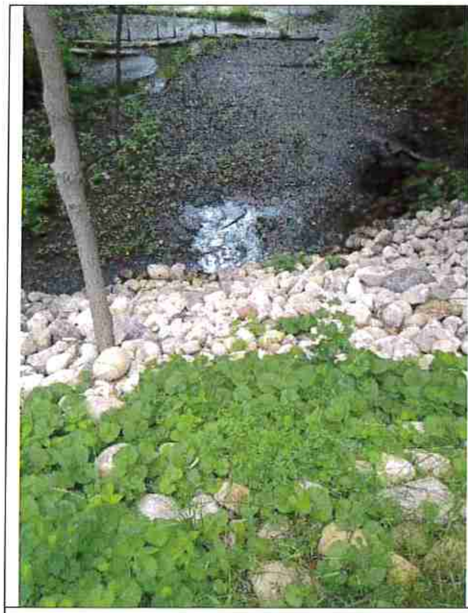
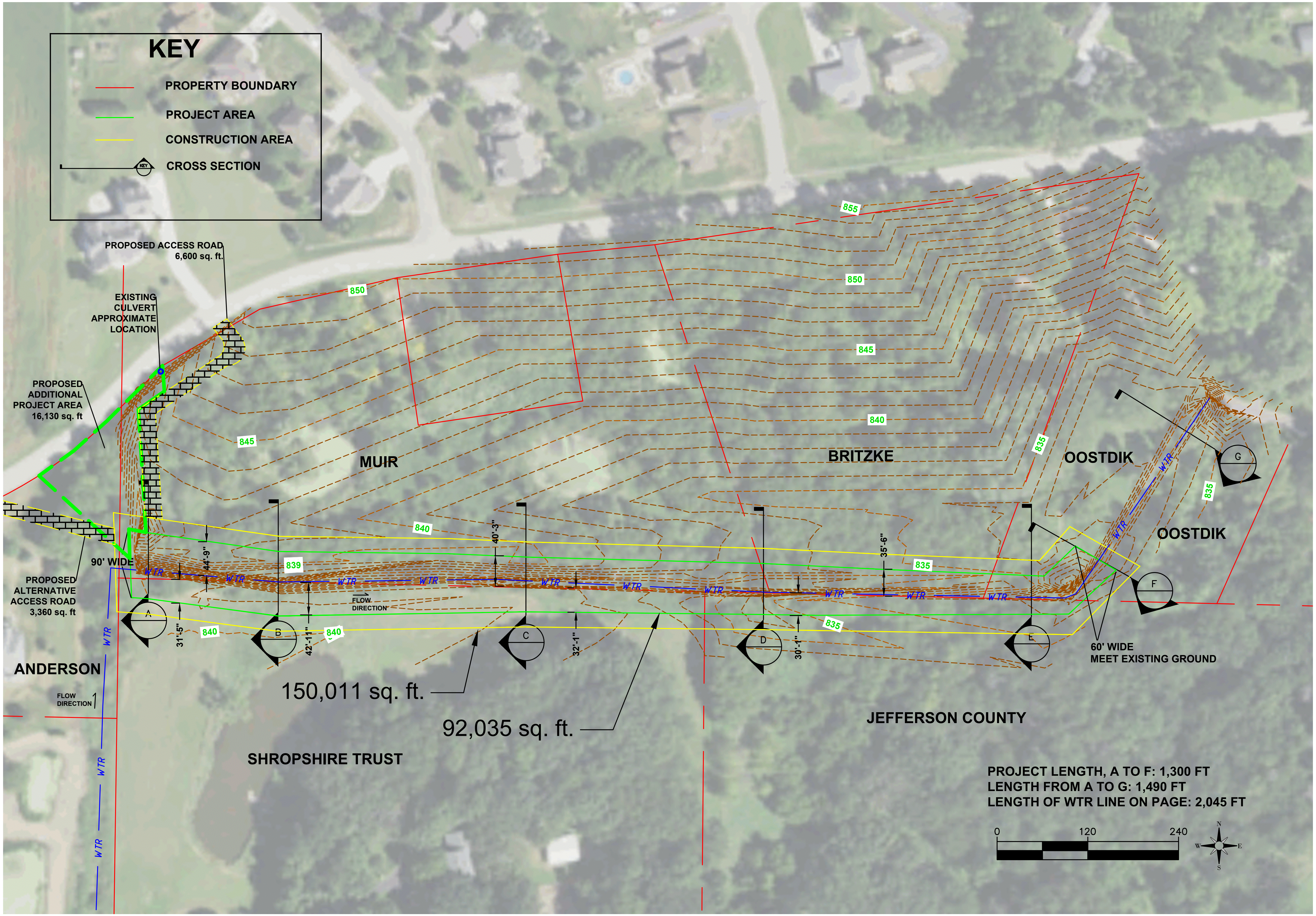


Photo 10: Photo taken 6.23.21 during extreme drought and record low water levels. Rainbow sheen at base of rock rip rap indicates significant groundwater input at this location as well.	**Photo 11:** Algae bloom in Korth bay at mouth of Miljala channel. Excessive nutrient loading from the Miljala tributary contributes to abundant algae growth in Rock Lake.

Appendix B: Site Map and Cross Sections

25 October 2022



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REVISIONS:
DATE
DATE
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DATE

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RESOURCE ENGINEERING ASSOCIATES, INC.

SITE MAP

Rock Lake Improvement Association
Lake Mills, WI, 53551

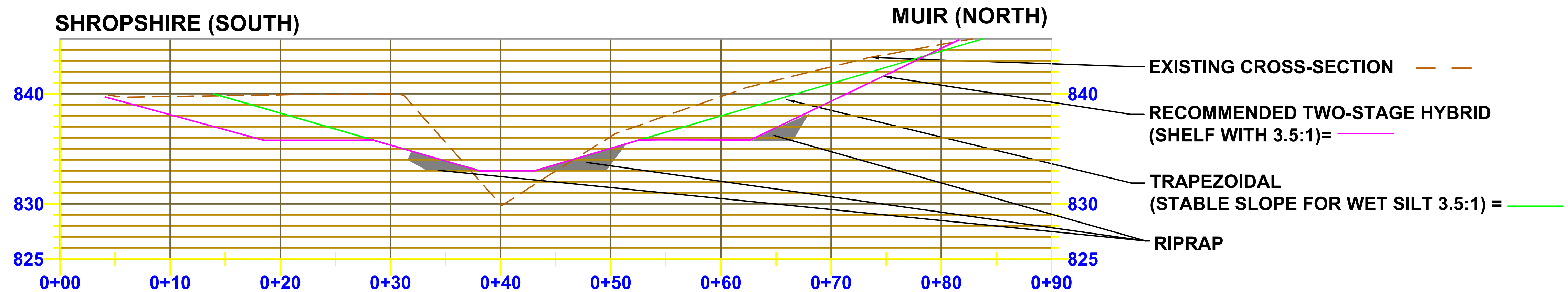
DATE: SEP 2022
DRAWN: FL
CHECKED: ---
APPROVED:
DRAWING NAME: MILJALA TOPO
PROJECT NUMBER: 220017.1

C100

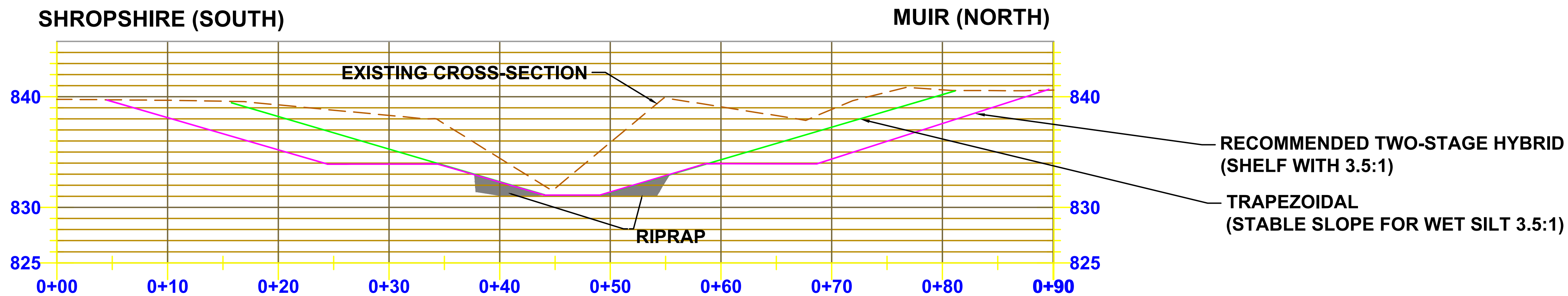
18 October 2022

WEST START OF PROJECT

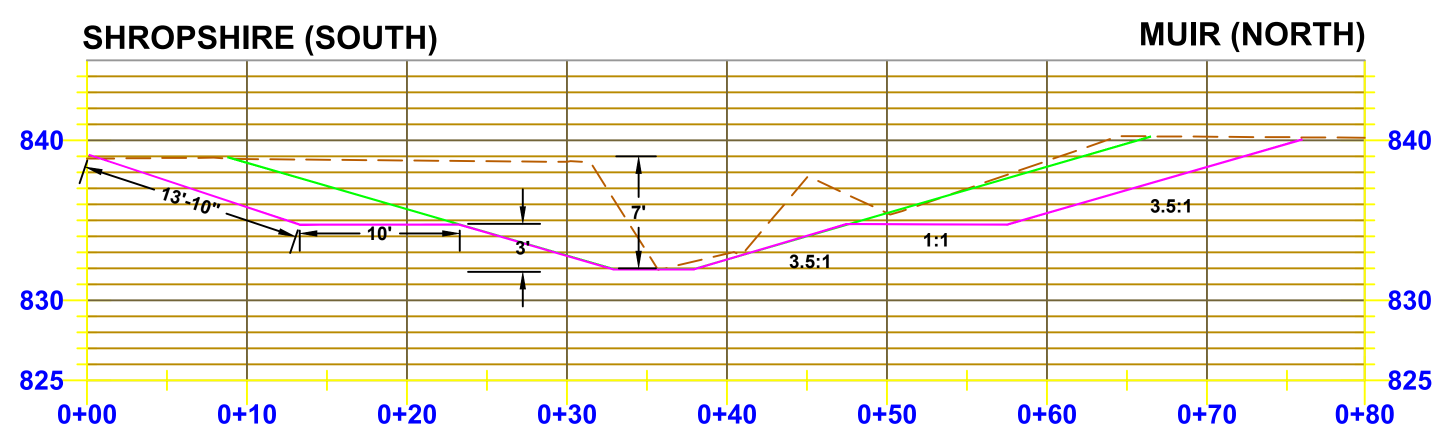
Cross Section at Alignment - A



Cross Section at Alignment - B



Cross Section at Alignment - C



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Cross Sections PG 1

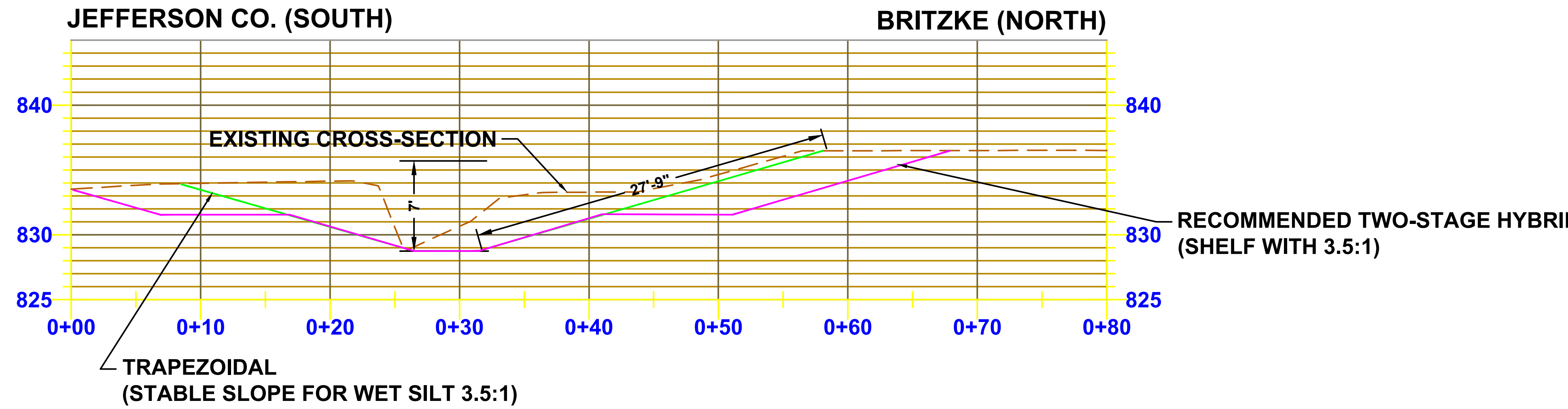
Rock Lake Improvement Association
Lake Mills, WI, 53551

DATE: SEP 2022
DRAWN: FL
CHECKED: ---
APPROVED:
DRAWING NAME: MILJALA
PROJECT NUMBER: 220017.1

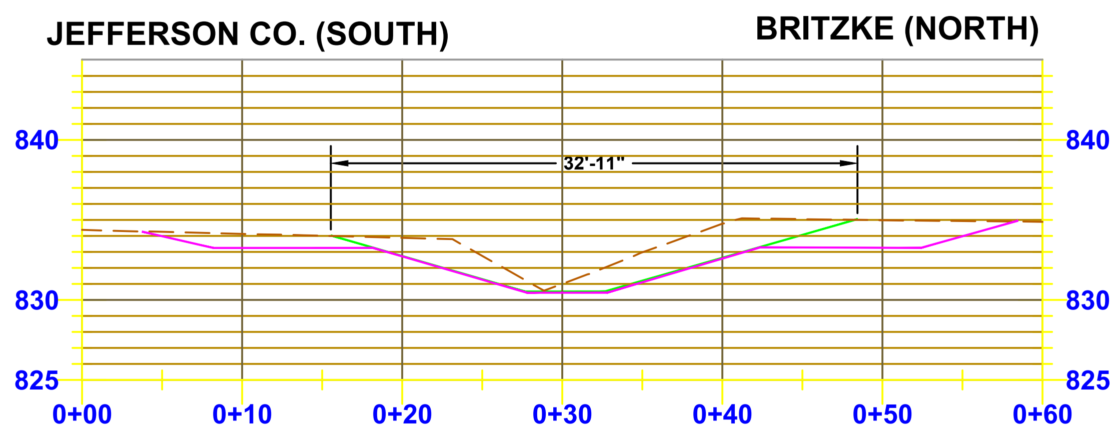
C101

18 October 2022

Cross Section at Alignment - D

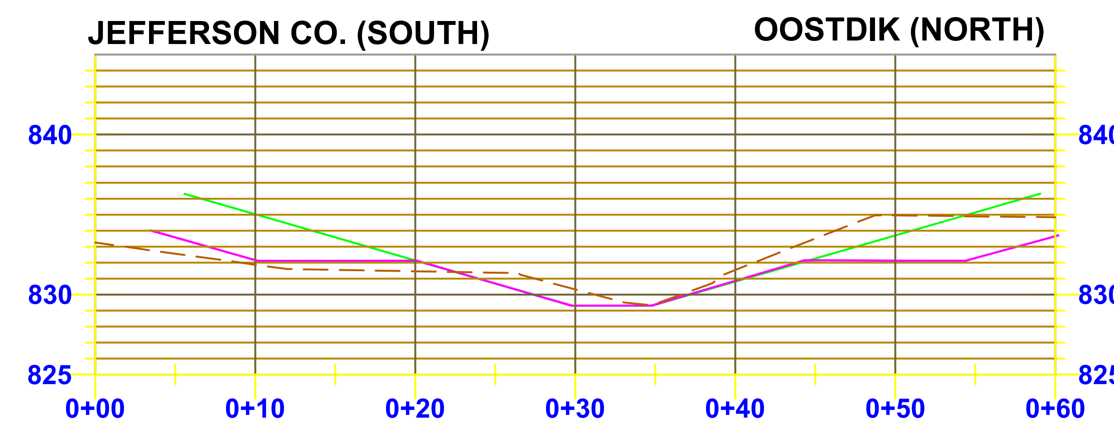


Cross Section at Alignment - E



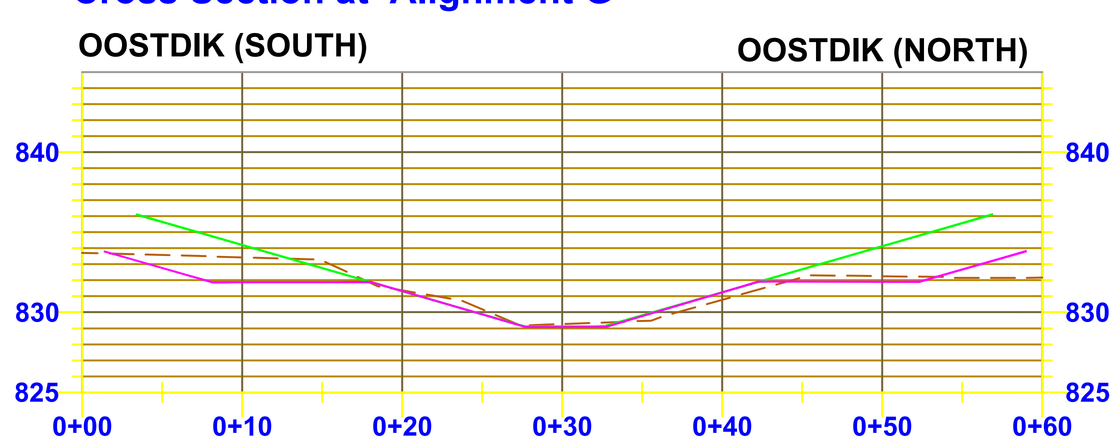
NORTHEAST END OF PROJECT WORK AREA

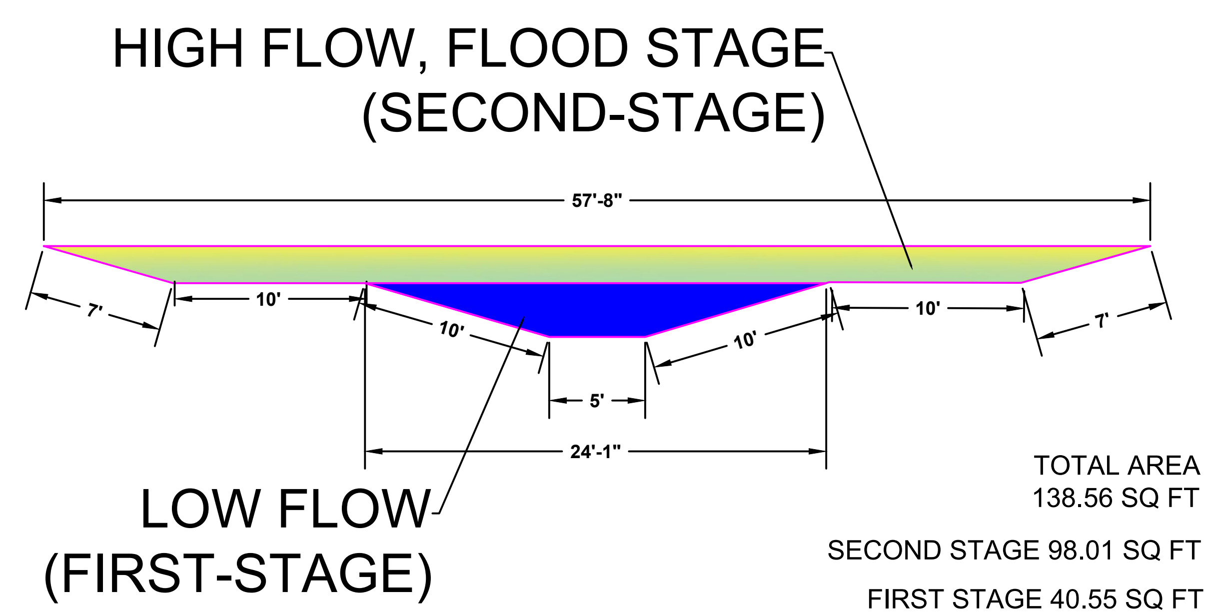
Cross Section at Alignment - F



BEYOND PROJECT WORK AREA, NEAR CEDAR LANE

Cross Section at Alignment G





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REVISIONS:
DATE
DATE
DATE
DATE

RESOURCE ENGINEERING ASSOCIATES, INC.
Resource Engineering Associates, Inc.
3510 Parmenter Street, Suite 100
Middleton, Wisconsin 53562-2507
Phone: 608-831-5522
Fax: 608-831-6564
Web: www.reaeng.com

Cross Sections PG 2

Rock Lake Improvement Association
Lake Mills, WI, 53551

DATE: Sep 2022
DRAWN: FL
CHECKED: ---
APPROVED:
DRAWING NAME:
MILJALA
PROJECT NUMBER:
220017.1

C102

Appendix C: Hand Boring Map, Logs and Lab Results

- ★ Soil Sampling Locations
- Tax Parcels
- Streams and Ditches
- Existing 2-ft Elevation Contour
- DNR Wetlands

N / W / E / S

1 inch = 150 feet

PROJECT LAYOUT:
Rock Lake Improvement Assoc.
Proposed Ditch Stabilization & Marsh Restoration

July 11, 2022

Figure C2

Main Map Projection: UTM Zone 16N | Locator Map Not to Scale

Document Path: V:\Water Resources\Lakes\Rock Lake\Channel\2021 Grant\Mijala grant\GIS\GIS_from Montgomery\Fig C2 Project Layout.mxd

Project: **Miljala Tributary Stabilization**	# Log of Boring HB-1
Project Location:	**Sheet 1 of 1**
Project Number: **220017.1**	

Date(s) Drilled **06/09/22**	Logged By **FL**	Checked By
Drilling Method **HB**	Drill Bit Size/Type	Total Depth of Borehole
Drill Rig Type **Bucket Auger**	Drilling Contractor	Approximate Surface Elevation **833.5**
Groundwater Level and Date Measured	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Oostdik, Northwest of Tributary 25', Southeast of Cedar Lane**	

Elevation (feet)	Depth (feet)	Graphic Log	Material Type	Color	MATERIAL DESCRIPTION	Sample Number	LAB RESULTS
833.5	0		ML	10YR2/1 Black	Topsoil, silt, few clay, moist-dry		
832.5	1		ML	10YR2/1	Silt, little clay, moist Gray striations with more clay, 5Y3/1		
831.5	2						
			ML	10YR2/1	Few dime size pockets of medium sand, 2.5Y5/6 Same matrix		Sand 17% Silt 58% Clay 25% Phosphorus 1010 mg/kg
830.5	3					2.5-3	
			ML	2.5Y5/6	Silt, few clay, soft, moist — Wet Silt Muck ∇		
			ML	2.5Y4/2	Silt Muck, soft, wet		
829.5	4						
	4.7		EOB		EOB at 4.7', Wet Silty Muck		
828.5	5						
827.5	6						
826.5	7						
825.5	8						
824.5	9						
823.5	10						

Project: **Miljala Tributary Stabilization**	# Log of Boring HB-2
Project Location:	**Sheet 1 of 1**
Project Number: **220017.1**	

Date(s) Drilled **06/09/22**	Logged By **FL**	Checked By
Drilling Method **HB**	Drill Bit Size/Type	Total Depth of Borehole
Drill Rig Type **Bucket Auger**	Drilling Contractor	Approximate Surface Elevation **834.5**
Groundwater Level and Date Measured	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Oostdik, Southeast of Tributary 40' in woods off of trail,**	

Elevation (feet)	Depth (feet)	Material Type	Color	MATERIAL DESCRIPTION	Sample Number	LAB RESULTS
834.5	0	ML	10YR2/1	Topsoil, silt, few clay, moist Lots of organic material		
833.5	1	ML-CL	10YR2/1	Silt, some clay, low plastic, moist-dry Gray striations 5Y3/1 Quarter size pockets of silt, 2.5Y5/3 1% red mottles		
832.5	2					
		ML	10YR2/1	Silt, little clay, very dense, med-low plastic, SAB, moist-dry 0% mottles, less gray		
831.5	3				3	Sand 23% Silt 52% Clay 25% Phosphorus 746 mg/kg
		CL	2.5Y3/2	Clay, some silt, med-low plastic, dense, moist		
830.5	4	ML	2.5Y4/2	Silt, little clay, moist		
		ML	2.5Y4/1	Color change Wet Muck at 4.8' ∇		
	4.8	EOB		EOB at 4.8', Wet Silty Muck		
829.5	5					
828.5	6					
827.5	7					
826.5	8					
825.5	9					
824.5	10					

Project: **Miljala Tributary Stabilization**	# Log of Boring HB-3
Project Location:	**Sheet 1 of 1**
Project Number: **220017.1**	

Date(s) Drilled **06/09/22**	Logged By **FL**	Checked By
Drilling Method **HB**	Drill Bit Size/Type	Total Depth of Borehole
Drill Rig Type **Bucket Auger**	Drilling Contractor	Approximate Surface Elevation **834**
Groundwater Level and Date Measured	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Oostdik/County Line South of Tributary 2' at bend**	

Elevation (feet)	Depth (feet)	Graphic Log	Material Type	Color	MATERIAL DESCRIPTION	Sample Number	LAB RESULTS
834	0		ML	10YR2/1	Topsoil, silt, few clay, few sand, moist Lots of organic material		
833	1		CL-ML	2.5YR4/3	Clay, some silt, low plastic, no structure, dense, moist-dry 5-10% red-orange mottles	1	Sand 23% Silt 44% Clay 33% Phosphorus 494 mg/kg
			ML-CL	2.5Y4-1	Silt, some clay, dense, moist		
832	2		EOB		EOB at 2', No GW encountered, but indicator soils at 2' below surface		
831	3						
830	4						
829	5						
828	6						
827	7						
826	8						
825	9						
824	10						

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Project: **Miljala Tributary Stabilization**	Log of Boring HB-4
Project Location:	**Sheet 1 of 1**
Project Number: **220017.1**	

Date(s) Drilled **06/09/22**	Logged By **FL**	Checked By
Drilling Method **HB**	Drill Bit Size/Type	Total Depth of Borehole
Drill Rig Type **Bucket Auger**	Drilling Contractor	Approximate Surface Elevation **834.25**
Groundwater Level and Date Measured	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Oostdik/City Line 20' from bank, woods, south of HB-3**	

Elevation (feet)	Depth (feet)	Graphic Log	Material Type	Color	MATERIAL DESCRIPTION	Sample Number	LAB RESULTS
834.25	0		ML-CL	10YR2/1	Topsoil, silt, some clay, trace sand, low plasticity, moist	0.6	Sand 15% Silt 50% Clay 35% Phosphorus 417 mg/kg
			ML	10YR4/2	Silt, some clay, med-high plastic, SAB, dense, moist-dry		
833.25	1		ML-CL	10YR2/2	Silt, some clay, low-medium plasticitydense, moist 10% red and gray mottles		
832.25	2		ML	10YR4/4	Silt, few clay, trace fine sand, more moist Still 10% mottles		
	2.3		EOB		EOB at 2.3', moist, mottles and gray silt		
831.25	3						
830.25	4						
829.25	5						
828.25	6						
827.25	7						
826.25	8						
825.25	9						
824.25	10						

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Project: **Miljala Tributary Stabilization**	# Log of Boring HB-5
Project Location:	**Sheet 1 of 1**
Project Number: **220017.1**	

Date(s) Drilled **06/09/22**	Logged By **FL**	Checked By
Drilling Method **HB**	Drill Bit Size/Type	Total Depth of Borehole
Drill Rig Type **Bucket Auger**	Drilling Contractor	Approximate Surface Elevation **834.5**
Groundwater Level and Date Measured	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **CTY eastern part of open field edge, prairie**	

Elevation (feet)	Depth (feet)	Graphic Log	Material Type	Color	MATERIAL DESCRIPTION	Sample Number	LAB RESULTS
834.5	0		ML	10YR2/1	Topsoil, silt, little sand, few clay, crumbly, lots of organics, moist-dry		
833.5	1		SM	10YR2/1	Fine sand, little clay, little silt, moist	1.5	Sand 54% Silt 22% Clay 25% Phosphorus 926 mg/kg
832.5	2				Silty Muck ∇		
831.5	3		ML	2.5Y3/2	Silt, few freshwater clams and snail shells, soft, wet		
			EOB		EOB 3.3' Wet Silty Muck		
830.5	4						
829.5	5						
828.5	6						
827.5	7						
826.5	8						
825.5	9						
824.5	10						

Project: **Miljala Tributary Stabilization** Project Location: Project Number: **220017.1**	# Log of Boring HB-6 **Sheet 1 of 1**

Date(s) Drilled **06/09/22**	Logged By **FL**	Checked By
Drilling Method **HB**	Drill Bit Size/Type	Total Depth of Borehole
Drill Rig Type **Bucket Auger**	Drilling Contractor	Approximate Surface Elevation **839**
Groundwater Level and Date Measured	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Shropshire, South of Tributary across from lateral**	

Elevation (feet)	Depth (feet)	Graphic Log	Material Type	Color	MATERIAL DESCRIPTION	Sample Number	LAB RESULTS
839	0		ML	10YR2/1	Topsoil, silt, little clay, SAB, lots of organics, moist-dry		
838	1						
837	2		SP	10YR4/4	Sand, few silt, moist-dry More moist at 2.3		
			ML	5YR2.5/1	Silt, few clay, few sand, moist		
836	3						
			ML	10YR3/1	Silt, little clay, low plasticity, very moist 5% gray and red mottles Silty Muck ∇	3.5	Sand 15% Silt 64% Clay 21% Phosphorus 587 mg/kg
835	4		EOB		EOB at 4', Wet Silty Muck		
834	5						
833	6						
832	7						
831	8						
830	9						
829	10						

Project: **Miljala Tributary Stabilization**	# Log of Boring HB-7
Project Location:	**Sheet 1 of 1**
Project Number: **220017.1**	

Date(s) Drilled **06/09/22**	Logged By **FL**	Checked By
Drilling Method **HB**	Drill Bit Size/Type	Total Depth of Borehole
Drill Rig Type **Bucket Auger**	Drilling Contractor	Approximate Surface Elevation **843**
Groundwater Level and Date Measured	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Muir, 50' down lateral from road culvert**	

Elevation (feet)	Depth (feet)	Graphic Log	Material Type	Color	MATERIAL DESCRIPTION	Sample Number	LAB RESULTS
843	0		SM	10YR2/1	Topsoil, fine sand, little silt, lots of organics, moist		
842	1					1.5	Sand 61% Silt 34% Clay 5% Phosphorus 1510 mg/kg
841	2				Silty Muck ∇		
			ML	10YR2/1	Wet		
			EOB	5YR2.5/1	EOB at 2.3', Wet Silty Muck		
840	3						
839	4						
838	5						
837	6						
836	7						
835	8						
834	9						
833	10						

Project: **Miljala Tributary Stabilization**	Key to Log of Boring
Project Location:	**Sheet 1 of 1**
Project Number: **220017.1**	

Elevation (feet)	Depth (feet)	Graphic Log	Material Type	Color	MATERIAL DESCRIPTION	Sample Number	LAB RESULTS
1	2	3	4	5	6	7	8

COLUMN DESCRIPTIONS

1 Elevation (feet): Elevation (MSL, feet).
2 Depth (feet): Depth in feet below the ground surface.
3 Graphic Log: Graphic depiction of the subsurface material encountered.
4 Material Type: Type of material encountered.
5 Color: Munsell Color
6 MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
7 Sample Number: Sample identification number.
8 LAB RESULTS: Information about the sample lab results

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

Lean CLAY, CLAY w/SAND, SANDY CLAY (CL)
SILTY CLAY (CL-ML)
SILT, SILT w/SAND, SANDY SILT (ML)
Silty SAND (SM)
Poorly graded SAND (SP)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
Bulk Sample
3-inch-OD California w/ brass rings
CME Sampler
Grab Sample
2.5-inch-OD Modified California w/ brass liners
Pitcher Sample
2-inch-OD unlined split spoon (SPT)
Shelby Tube (Thin-walled, fixed head)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting, AW)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

Appendix D: References

Sources Referenced In this Analysis

Two-Stage Ditch Definition: https://agbmps.osu.edu/bmp/open-channeltwo-stage-ditch-nrcs-582

Background on saltation calculations: https://opentextbc.ca/geology/chapter/13-3-stream-erosion-and-deposition/

Guidance for Stream Restoration and Rehabilitation: https://efotg.sc.egov.usda.gov/references/public/CO/TN-102.3_Yochum_106p_2017_sm.pdf

NRCS 654 TS14A Soil Properties and Special Geotechnical Problems Related to Stream Stabilization Projects: https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17810.wba

Montgomery Associates Resource Solutions, LLC (2014). “Management Plan: Miljala Channel Tributary Watershed, Town of Lake Mills, WI”. https://rocklake.org/wp-content/uploads/sites/45/2019/03/Miljala-Channel-Report_Apr14.pdf

Two-Stage Examples and Data:

Kindervater, Emily. (2017). “Phosphorus Retention in West Michigan Two-stage Agricultural Ditches”, Grand Valley State University. https://scholarworks.gvsu.edu/cgi/viewcontent.cgi?article=1865&context=theses

Krider, Lori & Kramer, Geoff & Hansen, Brad & Lahti, Linse & Asmus, Brenda & Zhang, Lu & Peterson, Joel & Wilson, Bruce & Lazarus, Bill & Nieber, John & Magner, Joe. (2014). “Minnesota Pollution Control Agency Final Report Cedar River Alternative Ditch Designs The Assessment of a Self-Sustaining Ditch Design in Mower County, Minnesota” Minnesota Department of Natural Resources. Link to Report Download

Tank, Jennifer, L. (2013). Presentation, “The Influence of the Two-Stage Ditch on Water Quality in an Agricultural Landscape”, Notre Dame University. https://environmentalchange.nd.edu/news-events/news/the-influence-of-the-two-stage-ditch-on-water-quality-in-an-agricultural-landscape/

Additional Sources for Stability and Design Information

NRCS Engineering Handbook Design Part 654, Chapter 10 Two-Stage Channel Design: https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17770.wba

Minnesota BMP Overview, Pages 163-171
http://www.swiftswcd.org/uploads/9/8/2/9/98296824/agricultural_bmp_handbook_for_minnesota_-_2nd_edition.pdf

NRCS Archive of Relevant Technical Guidance
https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=21433

NRCS 342: Critical Planting Area
www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_026475.pdf

Sources of Information Regarding the Pros and Cons of Two-Stage Ditches

Ohio State University Extension: https://agbmps.osu.edu/bmp/open-channeltwo-stage-ditch-nrcs-582

Great Lakes Regional Water Program (2011):

Overview: https://wrl.mnpals.net/islandora/object/WRLrepository%3A981/datastream/PDF/view
Economics: https://blanchard demofarms.org/wp-content/uploads/2021/06/Ditches-3.pdf

Potential Analysis Tools

STREAM: https://ascelibrary.org/doi/epdf/10.1061/41173%28414%29265

River RAT: https://www.webapps.nwfsc.noaa.gov/apex/f?p=275:1

Design Hydrology for Stream Restoration and Channel Stability:
https://nap.nationalacademies.org/read/24879/chapter/1