MUDDY RUN STREAM RESTORATION PROJECT
BASELINE MONITORING REPORT

DUPLIN COUNTY, NORTH CAROLINA, PROJECT # 95018

Prepared for:

North Carolina Ecosystem Enhancement Program

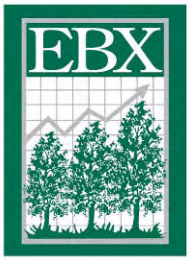
North Carolina Department of Environment and Natural Resources
1652 Mail Service Center
Raleigh, NC 27699-1652

September 2014

Muddy Run
Duplin County, North Carolina
EEP Project ID 95018

Cape Fear River Basin
HUC 0030007060010

Prepared by:



Environmental Banc & Exchange
909 Capability Drive, Suite 3100
Raleigh, NC 27606
919-829-9909

WK Dickson & Co., Inc.
720 Corporate Center Drive
Raleigh, NC 27607
919-782-0495

EXECUTIVE SUMMARY

The Muddy Run Stream Restoration Project is located within an agricultural watershed in Duplin County, North Carolina, approximately six miles south of Beulaville. The stream channels were heavily impacted by channelization and agricultural practices. The project involved the restoration and protection of streams in the Muddy Creek watershed. The purpose of this restoration project was to restore and enhance a stream/wetland complex located within the Cape Fear River Basin.

The project lies within USGS Hydrologic Unit Code 03030007060010 (USGS, 1998) and within the North Carolina Division of Water Quality (NCDWQ) Cape Fear River Subbasin 03-06-22 (NCDENR, 2002). The project consists of three unnamed tributaries to Muddy Creek, but the project has been divided into five distinct reaches for design purposes. Reach 1A is the upstream-most portion of Reach 1; it begins approximately 50 feet below an agricultural road crossing, and extends to STA17+25. Reach 1B is the middle reach of the main stem; it begins at STA17+25, and runs through a clear-cut area to STA33+67. Reach 1C is the downstream section of Reach 1; it begins at a culvert crossing (STA33+67) and flows westward to STA47+08. Reach 2 starts on the south side of eight hog houses and flows northwest around two hog lagoons before entering Reach 1C. Reach 3 runs north to south, and flows directly into Reach 1C.

The Muddy Run II Mitigation Project is located on upstream of Reach 3 and downstream of Reach 1C. Muddy Run II will also include riparian wetland restoration areas directly adjacent to the Muddy Run Easement on Reach 1B, Reach 1C, Reach 2, and Reach 3. Muddy Run II was constructed immediately following Muddy Run.

The site consists of farmland, concentrated animal feeding operations (CAFO), and wooded areas. The total easement area is 19.1 acres, 1.6 acres of which are wooded. The remaining area is agricultural or clear-cut. The wooded areas along the corridor designated for restoration are classified as disturbed deciduous forest, and invasive species are prevalent throughout. Several ditches exist throughout the project and flow into the main channel. Each ditch contributes to the overall design discharge of the channel. All existing channels were degraded to a point where they no longer accessed their floodplain, water quality was poor, and aquatic life was not supported. Little habitat was available to support aquatic life, and the channels were not maximizing their potential to filter nutrients because they were entrenched.

The goal for the Muddy Run project is to restore the channelized streams based on reference reach conditions, enrich the aquatic ecosystem through stream restoration and riparian buffer habitat improvements, and provide ecological uplift within the Cape Fear River Basin. The design will be based on reference conditions, USACE guidance (USACE, 2005), and criteria that are developed during this project to achieve success.

The objective for this restoration project is to restore a natural waterway through a stream/wetland complex with appropriate cross-sectional dimension and slope that will provide function and meet the appropriate success criteria for the existing streams. Accomplishing this objective entails the restoration of natural stream characteristics, such as stable cross sections, planform, and in-stream habitat. The floodplain areas will be hydrologically reconnected to the channel to provide natural exchange and storage during flooding events. Additional project objectives, such as restoring the riparian buffer with native vegetation, ensuring hydraulic stability, and eradicating invasive species, are listed in Section 6 along with several other project objectives.

The headwater valley restoration approach was performed along Reach 1A and continues down to Reach 1B. The existing channel adjacent to the hog houses was backfilled to the extent possible such that cut and fill was balanced along the reach. Priority Level I restoration was completed on Reach 1B. For the majority of the reach, the channel was rerouted to the south of its original location. The elevated road bed along the north side of the existing channel was removed to maintain a continuous connection between the proposed channel and its floodplain. The downstream section of Reach 1B was relocated to avoid impacts to two existing wetland areas adjacent to the channel. Priority Level I restoration was constructed on Reach 1C. The restoration approach on this reach included relocating the channel to the north of its current location within the adjacent agricultural field. Priority Level I restoration was performed on Reach 2. The channel now flows northwest to the confluence with Reach 1C. The majority of Reach 2 has been moved north and east of its original location into an area of fill material adjacent to two hog waste lagoons. The restoration now allows the channel to access its floodplain regularly. Priority Level I restoration was completed on Reach 3. Restoration involved relocating the channel east of the existing ditch into the adjacent spray field. The reach has been reconnected with the primary channel (Reach 1) approximately 150 feet downstream of the confluence with Reach 1C. A temporary log ramp was originally installed at the downstream end to tie the proposed channel into the existing ditch but has since been removed for construction of the Muddy Run II project.

All construction and planting activities have been completed, therefore the site will be monitored on a regular basis, and a physical inspection of the site will be conducted a minimum of twice per year throughout the five year post-construction monitoring period, or until performance standards are met. These site inspections will identify site components and features that require routine maintenance. Annual monitoring data will be reported using the EEP monitoring template.

Upon approval for closeout by the Interagency Review Team (IRT), the site will be transferred to the State of North Carolina (State). The State shall be responsible for periodic inspection of the site to ensure that restrictions required in the conservation easement or the deed restriction document(s) are upheld. Endowment funds required to uphold easement and deed restrictions shall be negotiated prior to site transfer to the responsible party.

The original EEP full delivery contact was for 6,797 SMUs. Due to design constraints and landowner negotiations the final design and construction plans included 6,770 SMUs. This reduction was primarily due to a change in approach at the upstream end of Reach 2 that retained the current alignment of the farm road. Following construction, the as-built survey indicated 6,734 linear feet of channel within the easement and 6,702 SMUs when the agricultural access areas are deducted. This reduction was primarily due to the contractor failing to follow the design planform along Reach 1B and Reach 2. All channels were constructed within acceptable design parameters.

Reach	Mitigation Type	Stationing	Existing Length	As-Built Length	Mitigation Ratio	SMUs
Reach 1A	Headwater Valley	0+66 to 17+87	1,659	1,691	1:1	1,691
Reach 1B	P1 Restoration	17+87 to 33+98	1,597	1,581	1:1	1,581
Reach 1C	P1 Restoration	33+98 to 47+73	1,317	1,345	1:1	1,330
Reach 2	P1 Restoration	2+00 to 17+10	1,448	1,510	1:1	1,493
Reach 3	P1 Restoration	0+94 to 7+01	464	607	1:1	607
		Total	**6,485**	**6,734**		**6,702**

*As-Built length does not include channel in easement breaks.
** SMUs does not include channel in irrigation access areas inside easement.

TABLE OF CONTENTS

Appendices

1 PROJECT GOALS, BACKGROUND AND ATTRIBUTES

1.1 Location and Setting

The Muddy Run Stream Site is located in Duplin County approximately 1.4 miles east of Chinquapin, NC (**Figure 1**). The project is in the Cape Fear River Basin (8-digit USGS HUC 03030007, 14-digit USGS HUC 0303007060010) (USGS, 1998) and the NCDWQ Cape Fear 03-06-22 sub-basin (NCDWQ, 2002). To access the Site from the town of Chinquapin, travel east on Highway 50, take the first left onto Pickett Bay Road (SR 1819), go 1.1 miles, then turn left onto Kenney Crawley Road. This private road is gravel and will split just past the residential house on the right. Keeping to the left will take you to the downstream portion of Reach 1 and Reaches 2 and 3. Going to the right at the split will take you to the upstream limits of Reach 1 at the Headwater Valley restoration portion.

1.2 Project Goals and Objectives

The Muddy Run stream mitigation project will provide numerous ecological and water quality benefits within the Cape Fear River Basin. While many of these benefits are limited to the project area, others, such as pollutant removal and improved aquatic and terrestrial habitat, have more far-reaching effects. Expected improvements to water quality, hydrology, and habitat are outlined below.

Design Goals and Objectives

Benefits Related to Water Quality	
Nutrient removal	Benefit will be achieved through filtering of runoff from adjacent CAFOs through buffer areas, the conversion of active farm fields to forested buffers, improved denitrification and nutrient uptake through buffer zones, and installation of BMPs at the headwaters of selected reaches and ditch outlets.
Sediment removal	Benefit will be achieved through the stabilization of eroding stream banks and reduction of sediment loss from field areas due to lack of vegetative cover. Channel velocities will also be decreased through a reduction in slope, therefore decreasing erosive forces.
Increase dissolved oxygen concentration	Benefit will be achieved through the construction of instream structures to increase turbulence and dissolved oxygen concentrations and lower water temperature to increase dissolved oxygen capacity.
Runoff filtration	Benefit will be achieved through the restoration of buffer areas that will receive and filter runoff, thereby reducing nutrients and sediment concentrations reaching water bodies downstream.
Benefits to Flood Attenuation	
Water storage	Benefit will be achieved through the restoration of buffer areas which will infiltrate more water during precipitation events than under current site conditions.
Improved groundwater recharge	Benefit will be achieved through the increased storage of precipitation in buffer areas, ephemeral depressions, and reconnection of existing floodplain. Greater storage of water will lead to improved infiltration and groundwater recharge.
Improved/restored hydrologic connections	Benefit will be achieved by restoring the stream to a natural meandering pattern with an appropriately sized channel, such that the channel's floodplain will be flooded more frequently at flows greater than the bankfull stage.
Benefits Related to Ecological Processes	
Restoration of habitats	Benefit will be achieved by restoring riparian buffer habitat to appropriate bottomland hardwood ecosystem.
Improved substrate and instream cover	Benefit will be achieved through the construction of instream structures designed to improve bedform diversity and to trap detritus. Substrate will become more coarse as a result of the stabilization of stream banks and an overall decrease in the amount of fine materials deposited in the stream.

Addition of large woody debris	Benefit will be achieved through the addition of wood structures as part of the restoration design. Such structures may include log vanes, root wads, and log weirs.
Reduced temperature of water due to shading	Benefit will be achieved through the restoration of canopy tree species to the stream buffer areas.
Restoration of terrestrial habitat	Benefit will be achieved through the restoration of riparian buffer bottomland hardwood habitats.

1.3 Project Structure

Table 1. Muddy Run Project Components

Reach	Mitigation Type	Stationing	Existing Length	As-Built Length	Mitigation Ratio	SMUs
Reach 1A	Headwater Valley	0+66 to 17+87	1,659	1,691	1:1	1,691
Reach 1B	P1 Restoration	17+87 to 33+98	1,597	1,581	1:1	1,581
Reach 1C	P1 Restoration	33+98 to 47+73	1,317	1,345	1:1	1,330
Reach 2	P1 Restoration	2+00 to 17+10	1,448	1,510	1:1	1,493
Reach 3	P1 Restoration	0+94 to 7+01	464	607	1:1	607
		Total	**6,485**	**6,734**		**6,702**

*As-Built length does not include channel in easement breaks.
** SMUs does not include channel in irrigation access areas inside easement.

1.3.1 Restoration Type and Approach

Reach 1A

The principal drainage feature (Reach 1) generally flows northwest to west across the site. It was divided into three reaches (Reach 1A, Reach 1B, and Reach 1C) based on slope, drainage area, and surrounding landscape. Reach 1A flows in a northerly direction adjacent to several hog houses and two large lagoons. The planform of this G-type channel is generally straight and is deeply incised throughout. No large woody debris was observed in the channel. A maintained access path built upon spoil material runs along the channel bank. The channel scored 24 points on the NCDWQ Stream Identification Form (Version 4.11). The natural drainage of this channel was bypassed through a deep, excavated ditch through uplands that connects to Reach 2.

Headwater valley restoration was performed along Reach 1A and continued down to Reach 1B. The existing channel adjacent to the hog houses was backfilled to the extent possible such that cut and fill was balanced along the reach. The existing 18-inch corrugated plastic pipe located under the gravel road was removed and replaced with three 12-inch CMPs at a slightly higher elevation. A sediment trapping pool and level spreader BMP immediately downstream of the road crossing was constructed to provide diffuse flow into the valley and collect sediment from the farm access road. The BMP is located outside the conservation easement to allow for maintenance. The reach was not completely filled so as to prevent hydrologic trespass upstream of the road. Grade control structures were placed along portions of the reach that was filled to provide additional vertical stability. During construction, a drain tile was encountered near STA 7+10. The portion of the tile located within the easement was removed, and a subsurface flow structure was installed per Bulletin Drawing #1 (Appendix D).

A forested buffer approximately 115 feet wide was planted throughout this reach. Where the channel was redirected towards Reach 2 near STA 11+31, a channel plug was constructed, and flow has been redirected back in a northerly direction. A channel plug and grade control structure has also been installed where an existing ditch enters the buffer from the east. Flow was directed along the reach such that it follows along the natural valley from STA 11+31 down to Reach 1B. An existing 30-inch CMP culvert located at STA 11+12 has been removed and replaced with three 12-inch CMPs to allow the landowner access to all areas of his property, as the restoration will bisect his land. The terminus of the headwater valley at STA 17+25 includes a grade control structure at the transition to a stable channel for Reach 1B.

Reach 1B

The middle section (Reach 1B) of this reach was mostly excavated through a forested area. The surrounding riparian forest contains jurisdictional wetlands that are adjacent to Reach 1B. This channel had been dredged to nearly four feet in depth. A farm road that is elevated 0.85 feet above the flood plain was located along the right bank. The planform of this F-type channel was generally straight with occasional bends. The channel was entrenched throughout. The banks were nearly vertical in many locations and had almost no vegetation. No large woody debris was observed in the channel. The channel scored 29 points on the NCDWQ Stream Identification Form (Version 4.11).

Priority Level I restoration was constructed on Reach 1B. For the majority of the reach, the channel has been rerouted to the south of its current location. Relocating the channel did not impact any forested areas because most of the buffer was clear cut in the fall of 2011. However, there is a small, wooded area along the upstream portion of the reach. The restored channel from STA 17+25 to 20+78 meanders along the existing channel footprint in order to minimize impacts to the established buffer to the south. The elevated road bed along the north side of the existing channel has been removed in order to maintain a continuous connection between the proposed channel and its floodplain. A channel plug and grade control structure was installed where an existing ditch entered the buffer from the north near STA 18+08. An existing 42-inch CMP culvert crossing was removed and replaced with two 36-inch CMPs at STA 20+93 to maintain access to all portions of the landowner's property. The downstream section of Reach 1B has been relocated to avoid impacts to two existing wetland areas adjacent to the channel. There are two existing ditches within the proposed easement that cross the wetland to the south. These ditches have been plugged to provide diffuse flow through the wetland and into the restored channel. Structures installed along Reach 1B included log grade controls, root wads, and various woody debris structures to enrich habitat and ensure bank stability and channel integrity.

Reach 1C

The downstream section of Reach 1 (Reach 1C) is located within a cleared hay field. This reach appeared to have been straightened and had been dredged. A farm road that is elevated 0.5 to 1.1 feet above bankfull is located along the right bank. Reach 1C was an F-type channel with a planform that was generally straight with a few minor bends throughout. The entire reach was moderately to severely incised with steep banks due to repeated dredging by the landowner. The dominant bed materials were fine sand and silt. The banks were nearly vertical with sparse vegetation. The channel scored 33 points on the NCDWQ Stream Identification Form (Version 4.11).

Priority Level I restoration was performed on Reach 1C. The restoration approach on this reach included relocating the channel to the north of its current location within the adjacent agricultural field. The relocation also included moving the confluence with Reach 2 to STA 45+27. The existing channel was plugged and filled to prevent continued flow within the ditch. An existing 36-inch CMP culvert crossing located at the upstream end of the reach has been removed and relocated to STA

33+67. Twin 42-inch culverts were placed in-line with the restored stream to maintain access to all portions of the landowner's property.

By rerouting and raising the channel, the restoration will allow the channel frequent access to its floodplain and the opportunity for creating small depressional areas within the buffer to enhance habitat for wildlife and aquatic organisms. Structures along this reach will included log grade controls, root wads, leaf packs, and various woody debris structures that will improve in-stream habitat and bank stability.

The downstream end of Reach 1C terminates at a temporary grade drop structure. The restoration will be continued in a subsequent phase of the project, Muddy Run II.

Reach 2
Flowing into Reach 1C are two smaller tributary reaches (Reach 2 and Reach 3). Reach 2 begins south of Reach 1C at a wetland, and follows a shallow drainage feature to the confluence with Reach 1C. It receives flow through a ditch from Reach 1A. This F-type channel was actively maintained and had been dredged to nearly four feet in depth. The banks were nearly vertical in many locations and had almost no vegetation. No large woody debris was observed in the channel. The channel scored 26.5 points on the NCDWQ Stream Identification Form (Version 4.11).

Priority Level I restoration was performed on Reach 2. The bed elevation at the top of the reach is controlled by a 42-inch CMP culvert. This culvert and the associated farm road were moved approximately 100 feet upstream of its current location. The culvert has been replaced with a 36-inch CMP to maintain access to the adjacent hog houses and lagoons located just north of the upstream end of the reach. The channel now flows in a northwesterly direction to the confluence with Reach 1C.

The majority of the channel has been relocated north and east of the existing ditch towards the lagoons. The lower end meanders through a large spoil area constructed during installation of the lagoons. This area was graded down to match pre-disturbance elevations, and the cut material was used to fill abandoned ditches throughout the project. The restored stream channel can now access its floodplain regularly. Typical in-stream structures along this reach included log grade controls, root wads, leaf packs, and various woody debris structures that will improve habitat and bank stability. All areas within the easement have been planted with native shrub and tree species.

Reach 3
Reach 3, an F-type stream channel, began north of Reach 1C at a wetland ditch and followed a shallow drainage feature to Reach 1C. A hay field is located on the east side, and a scrub community lies to the west. This channel had been dredged and the dominant bed material is fine sand. The banks were nearly vertical in many locations and had almost no vegetation. No large woody debris was observed in the channel. The channel scored 24.5 points on the NCDWQ Stream Identification Form (Version 4.11).

Priority Level I restoration was performed on Reach 3. Its bed elevation was controlled at the top of the reach by a 24-inch CMP culvert. This culvert was removed and replaced with two 42-inch CMPs at a higher elevation to maintain access across the property. The culvert was raised a minimal amount to prevent hydrologic trespass upstream of the project. Restoration began just south of the culvert crossing, and involved relocating the channel to the east of the existing ditch into the adjacent spray field. The reach has been reconnected with the primary channel (Reach 1) approximately 146 feet downstream of the confluence with Reach 1C at STA 5+72. A temporary log ramp has been installed at the downstream end to tie the restored channel into the existing ditch. This structure will be removed when the Muddy Run II Mitigation Project is constructed.

By relocating the channel, the restoration will allow the channel regular access to its floodplain and the opportunity for enhanced wetland habitat throughout the buffer. In-stream structures along this reach included log grade controls, root wads, leaf packs, and various woody debris structures that will provide bed diversity and subsequently improve habitat and bank stability. All areas within the easement were planted with native shrub and tree species.

Reach 3 was designed to reflect a proposed drainage area of 391 acres as opposed to the existing area of 85 acres. This significant increase in watershed size incorporates a drainage area that borders Reach 3 to the north and east, which currently directs flows away from the project site. It appears that the drainage features within this additional area were historically diverted north across a natural divide to promote drainage for agricultural production. The proposed Muddy Run II Stream and Wetland Mitigation Project reconnects this drainage to the Muddy Run project site.

1.4 Project History, Contacts and Attribute Data

1.4.1 Project History

The Muddy Run Restoration Site was restored by Environmental Banc & Exchange, LLC (EBX) through a full-delivery contract awarded by NCEEP in 2011. Tables 2, 3, and 4 provide a time sequence and information pertaining to the project activities, history, contacts, and baseline information.

1.4.2 Project Watersheds

The easement totals 19.1 acres and is broken into five reaches. Reach 1A has a drainage area of 0.23 square miles (145 acres); it begins at the start of the restoration project (sta. 0+62) and extends north and west to STA17+25. Reach 1B has a drainage area of 0.28 square miles (177 acres); it begins at STA17+25 and extends to STA33+67. Reach 1C is the downstream section (Sta. 33+67 to 47+08) of Reach 1 and has a drainage area of 0.37 square miles (238 acres). Reach 2 has a drainage area of 0.1 square miles (60 acres) and flows northwest directly into Reach 1. Reach 3 has a drainage area of 0.13 square miles (85 acres) extending north to south (**Figure 2**). The land use in the project watershed is approximately 49 percent cultivated, 33 percent southern yellow pine, 9 percent bottomland forest/hardwood swamp, 7 percent wooded and shrubland, and 2 percent managed herbaceous cover.

2 SUCCESS CRITERIA

The success criteria for the Muddy Run Site stream restoration will follow accepted and approved success criteria presented in the USACE Stream Mitigation Guidelines and subsequent NCEEP and agency guidance. Specific success criteria components are presented below.

2.1 Stream Restoration

2.1.1 Bankfull Events

Two bankfull flow events must be documented within the five-year monitoring period. The two bankfull events must occur in separate years. Otherwise, the stream monitoring will continue until two bankfull events have been documented in separate years. Bankfull events will be documented using crest gauges, auto-logging crest gauges, photographs, and visual assessments for evidence of debris rack lines.

2.1.2 Cross Sections

There should be little change in as-built cross-sections. If changes do take place, they should be evaluated to determine if they represent a movement toward a less stable condition (for example down-cutting or erosion), or are minor changes that represent an increase in stability (for example settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). Cross-sections shall be classified using the Rosgen stream classification method, and all monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type.

2.1.3 Digital Image Stations

Digital images will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures. Longitudinal images should not indicate the absence of developing bars within the channel or an excessive increase in channel depth. Lateral images should not indicate excessive erosion or continuing degradation of the banks over time. A series of images over time should indicate successional maturation of riparian vegetation.

2.2 Vegetation

Specific and measurable success criteria for plant density within the riparian buffers on the site will follow NCEEP Guidance. Vegetation monitoring plots are 0.02 acres in size, and cover greater than two percent of the planted area. Vegetation monitoring will occur annually in the fall of each year. The interim measures of vegetative success for the site will be the survival of at least 320 three-year-old trees per acre at the end of Year 3, and the final vegetative success criteria will be 260 trees per acre at the end of Year 5. Invasive species on the site will be monitored and controlled if necessary throughout the required vegetation monitoring period.

2.3 Scheduling/Reporting

The monitoring program will be implemented to document system development and progress toward achieving the success criteria. The restored stream morphology will be assessed to determine the success of the mitigation. The monitoring program will be undertaken for five years or until the final success criteria are achieved, whichever is longer.

Monitoring reports will be prepared in the fall of each year of monitoring and submitted to NCEEP. The monitoring reports will include all information, and will be in the format required by NCEEP in Version 2.0 of the NCEEP Monitoring Report Template.

3 MONITORING PLAN

Annual monitoring shall be conducted for stream and vegetation monitoring parameters as noted below for five years prior to completion of construction or until success criteria have been met.

3.1 Stream Restoration

3.1.1 As-Built Survey

An as-built survey was conducted following construction to document channel size, condition, and location. The survey includes a complete profile of thalweg, top of bank, and in stream channel structures to compare with future geomorphic data. Longitudinal profiles will not be required in annual monitoring reports unless requested by NCEEP or USACE.

3.1.2 Bankfull Events

Four sets of manual and auto-logging crest gauges were installed on the site, one along Reach 1A, one along Reach 1C, one along Reach 2, and one along Reach 3. The auto logging crest gauges were installed within the channel and will continuously record flow conditions at an hourly interval. Manual crest gauges were installed on the bank at bankfull elevation. Crest gauges will be checked during each site visit to determine if a bankfull event has occurred since the last site visit. Crest gauge readings and debris rack lines will be photographed to document evidence of bankfull events.

3.1.3 Cross Sections

A total of 39 permanent cross sections were installed to monitor channel dimensions and stability. Five cross sections were installed along Reach 1A of the headwater valley restoration section. Ten cross sections (five pools and five shallows) were installed along Reach 1B and four pool and four shallow cross sections were installed along Reach 1C. Reach 2 has a total of 14 cross sections installed throughout its length. Two permanent cross sections were installed along Reach 3. Cross sections were typically located at representative shallow and pool sections along each stream reach. Each cross section was permanently marked with 3/8 rebar pin to establish a monument location at each end. A marker pole was also installed at both ends of each cross section to allow ease locating during monitoring activities. Cross section surveys will be performed once a year during annual monitoring and will include all breaks in slope including top of bank, bottom of bank, streambed, edge of water, and thalweg.

3.1.4 Digital Image Stations

Digital photographs will be taken at least once a year to visually document stream and vegetation conditions. This monitoring practice will continue for five years following construction and planting. Permanent photo point locations at cross sections and vegetation plots have been established so that the same directional view and location may be repeated each monitoring year. Monitoring photographs will also be used to document any stream and vegetation problematic areas such as erosion, stream and bank instability, easement encroachment and vegetation damage.

3.1.5 Bank Pin Arrays

Ten bank pin arrays have been installed at cross sections located on meander pools. These bank pin arrays were installed along the upstream and downstream third of the meander. Bank pins are a minimum of three feet long, and have been installed just above the water surface and every two feet above the lowest pin. Bank pin exposure will be recorded at each monitoring event, and the exposed pin will be driven flush with the bank.

3.1.6 Visual Assessment Monitoring

Visual monitoring of all mitigation areas will be conducted a minimum of twice per monitoring year by qualified individuals. The visual assessments will include vegetation density, vigor, invasive species, and easement encroachments. Visual assessments of stream stability will include a complete stream walk and structure inspection. Digital images will be taken at fixed representative locations to record each monitoring event as well as any noted problem areas or areas of concern. Results of visual monitoring will be presented in a plan view exhibit with a brief description of problem areas and digital images. Photographs will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures. Longitudinal photos should indicate the absence of developing bars within the channel or an excessive increase in channel depth. Lateral photos should not indicate excessive erosion or continuing degradation of the banks over time. A series of photos over time should indicate successional maturation of riparian vegetation.

3.1.7 Surface Flow

Headwater valley restoration areas will be monitored to document intermittent or seasonal surface flow. This will be accomplished through direct observation, photo documentation of dye tests, and surface flow gauges. An auto logging crest gauge has been installed within the headwater valley channel and will continuously record flow conditions at an hourly interval. This gauge will be downloaded during each site visit to determine if intermittent or seasonal flows conditions are present.

3.2 Vegetation

A total of 20 vegetation plots were randomly established within the planted stream riparian buffer easement. Each vegetation plot measures 22 feet by 40 feet (0.02 acres) and has all four corners marked with PVC posts. Planted woody vegetation was assessed within each plot to establish a baseline dataset. Within each vegetation plot, each planted stem was identified for species, "X" and "Y" origin located, and measured for height. Reference digital photographs were also captured to document baseline conditions. Species composition, density, growth patterns, damaged stems, and survival ratios will be measured and reported on an annual basis. Vegetation plot data will be reported for each plot as well as an overall site average.

4 MAINTENANCE AND CONTINGENCY PLAN

All identified problematic areas or areas of concern such as stream bank erosion/instability, aggradation/degradation, lack of targeted vegetation, and invasive/exotic species which prevent the site from meeting performance success criteria will be evaluated on a case by case basis. These areas will be documented and remedial actions will be discussed amongst NCEEP staff to determine a plan of action. If it is determined remedial action is required, a plan will be provided.

4.1 Stream

Any stream problem areas which are identified during post construction monitoring activities will be documented and mapped on the Current Conditions Plan View (CCPV) as part of the annual stream monitoring report. Stream problem areas or areas of concern may include bank erosion, aggradation/degradation, structure failure or not performing as designed, beaver dams, cattle encroachment due to fence damage, etc. If it is determined through NCEEP correspondence that remedial action is required to repair an area, a proposed work plan will submitted for remediation.

4.2 Vegetation

Any vegetation problem areas which are identified during post construction monitoring activities will be documented and mapped on the Current Conditions Plan View (CCPV) as part of the annual stream monitoring report. Vegetation problem areas or areas of concern may include vegetation plot not meeting success criteria, invasive species abundance, sparse vegetation areas, etc. If it is determined through NCEEP correspondence that remedial action is required to repair an area, a proposed work plan will submitted for remediation.

5 AS-BUILT CONDITIONS (BASELINE)

The Muddy Run Stream Restoration as-built survey was completed between April and May 2014. A topographic survey on the constructed stream channel and adjacent floodplain areas was performed to document post construction conditions. The survey involved locating the stream channel thalweg, top of bank, stream structures, culvert crossings, woody debris bundles, monitoring cross sections, vegetation plots, crest gauges, and a rain gauge.

5.1 As-Built Drawings

The Muddy Run Stream Restoration As-Built Drawing is located in Appendix D which document post construction conditions for the project.

The original EEP full delivery contact was for 6,797 SMUs. Due to design constraints and landowner negotiations the final design and construction plans included 6,770 SMUs. This reduction was primarily due to a change in approach at the upstream end of Reach 2 that retained the current alignment of the farm road. Following construction, the as-built survey indicated 6,734 SMUs. This reduction was primarily due to the contractor failing to follow the design planform along Reach 1B and Reach 2. All channels were constructed within acceptable design parameters.

5.2 Baseline Data Collection

5.2.1 Morphological State of the Channel

All morphological stream data for the as-built profile and dimensions were collected during the as-built survey performed during April and May 2014. Appendix B includes summary data tables, morphological parameters, and stream photographs.

Profile
The baseline (MY-0) profiles closely matches the proposed design profiles. The plotted longitudinal profiles can be found on the As-Built Drawings in Appendix 4 and morphological summary data tables can be found in Appendix B.

Dimension
The baseline (MY-0) cross sectional dimensions closely matches the proposed design cross section parameters. All cross section plots and data tables can be found in Appendix B.

Sediment Transport
The as-built conditions show that shear stress and velocities have been reduced for all three restoration reaches. Pre-construction conditions documented all three reaches as sand bed channels and remain classified as sand bed channels post-construction. Visual assessment shows the channel is transporting sediment as designed and will continue to be monitored for aggradation and degradation.

5.2.2 Vegetation

The baseline monitoring (MY-0) vegetation survey was completed in early May 2014. The baseline vegetation monitoring on the Muddy Run Stream Restoration Site resulted in an average of 785 planted stems per acre, which is greater than the required 680 stems per acre density. The average stems per vegetation plot was 15.7 planted stems. The minimum planted stems per plots was 13 stems and the maximum was 18 stems per plot. Vegetation summary data tables and vegetation plot photos can be found in Appendix C.

5.2.3 Photo Documentation

Permanent photo point locations have been established at cross sections, vegetation plots, stream crossings, and stream structures by WK Dickson staff. Any additional problem areas or areas of concern will also be document with a digital photograph during monitoring activities. Stream digital photographs can be found in Appendix B and Appendix C for vegetation photos.

5.2.4 Hydrology

Multiple bankfull events have been observed during construction and post construction activities on stream reaches 1 and 2. Four sets of manual and auto-logging crest gauges were installed on the site, one along Reach 1A, one along Reach 1C, one along Reach 2, and one along Reach 3. Crest gauge data will be reported in the Year 1 monitoring report.

6 REFERENCES

Chow, Ven Te. 1959. Open-Channel Hydraulics, McGraw-Hill, New York.

Cowardin, L.M., V. Carter, F.C. Golet and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service, Office of Biological Services, FWS/OBS-79/31. U.S. Department of the Interior, Washington, DC.

Environmental Banc & Exchange (2012). Muddy Run Stream Restoration Project Final Mitigation Plan. North Carolina Ecosystems Enhancement Program, Raleigh, NC.

Horton, J. Wright Jr. and Victor A. Zullo. 1991. The Geology of the Carolinas, Carolina Geological Society Fiftieth Anniversary Volume. The University of Tennessee Press. Knoxville, TN.

Johnson PA. 2006. Assessing stream channel stability at bridges in physiographic regions. U.S. Department of Transportation. Federal Highway Administration. Report Number FHWA-HRT-05-072.

Krstolic, J.L., and Chaplin, J.J. 2007. Bankfull regional curves for streams in the non-urban, non-tidal Coastal Plain Physiographic Province, Virginia and Maryland: U.S. Geological Survey Scientific Investigations Report 2007-5162, 48 p.

LeGrand, H.E., Jr. and S.P. Hall, eds. 1999. Natural Heritage Program List of the Rare Animal Species of North Carolina. North Carolina Natural Heritage Program, Division of Parks and Recreation, North Carolina Department of Environment and Natural Resources. Raleigh, North Carolina.

Natural Resources Conservation Service (NRCS). 2007. Stream Restoration Design Handbook (NEH 654), USDA

NCDENR. "Water Quality Stream Classifications for Streams in North Carolina." Water Quality Section. http://h2o.enr.state.nc.us/wqhome/html (June 2005).

Radford, A.E., H.E. Ahles and F.R. Bell. 1968. Manual of the Vascular Flora of the Carolinas. The University of North Carolina Press, Chapel Hill, North Carolina.

Schafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina, Third Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, NCDENR, Raleigh, NC.

Sweet, William V. and Jens W. Geratz. 2003. Bankfull Hydraulic Geometry Relationships and Recurrence Intervals for North Carolina's Coastal Plain. J. of the American Water Resources Association (JAWRA) 39(4):861-871.

Tweedy, K. A Methodology for Predicting Channel Form in Coastal Plain Headwater Systems. Stream Restoration in the Southeast: Advancing the Science and Practice, November 2008, Asheville, NC. Unpublished Conference Paper, 2008.
http://www.bae.ncsu.edu/programs/extension/wqg/srp/2008conference/tweedy_paper.pdf

Appendix A

General Tables and Figures

Tables 1 - 4

Appendix A. General Tables and Figures
Table 1 Project Components and Mitigation Credits
Baseline Monitoring Report Year 0

Table 1. Project Components and Mitigation Credits
Muddy Run Stream Restoration/NCEEP Project # 95018

Mitigation Credits

	Stream		Riparian Wetland		Non-riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	6,702		N/A	N/A	N/A	N/A	N/A	N/A	N/A

Project Components

Project Component -or- Reach ID	As-Built Stationing/Location (LF)	Existing Footage/Acreage	Approach (PI, PII etc.)	Restoration -or- Restoration Equivalent	Restoration Footage or Acreage	Mitigation Ratio
Reach 1A	0+66 to 17+87	1,659	HWV	Restoration	1,691	1 : 1
Reach 1B	17+87 to 33+98	1,597	P1	Restoration	1,581	1 : 1
Reach 1C	33+98 to 47+73	1,317	P1	Restoration	1,330	1 : 1
Reach 2	2+00 to 17+10	1,448	P1	Restoration	1,493	1 : 1
Reach 3	0+94 to 7+01	464	P1	Restoration	607	1 : 1

Component Summation

Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-riparian Wetland (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	5,011					
Headwater Valley	1,691					
Enhancement						
Enhancement I						
Enhancement II						
Creation						
Preservation						
High Quality Preservation						

BMP Elements

Element	Location	Purpose/Function	Notes
---	---	---	---
---	---	---	---
---	---	---	---

BMP Elements
BR = Bioretention Cell; SF = Sand Filter; SW = Stormwater Wetland; WDP = Wet Detention Pond; DDP = Dry Detention Pond; FS = Filter Strip; S = Grassed Swale; LS = Level Spreader; NI = Natural Infiltration Area; FB = Forested Buffer

Table 2. Project Activity and Reporting History

Project Activity and Reporting History Muddy Run Stream Restoration / EEP Project #95018		
Activity or Report	**Data Collection Complete**	**Completion or Delivery**
Mitigation Plan	NA	November 2012
Final Design – Construction Plans	NA	August 2013
Construction Completed	NA	April 2014
Site Planting Completed	NA	April 2014
Baseline Monitoring Document (Year 0 Monitoring – baseline)	April 2014	May 2014
Year 1 Monitoring		
Year 2 Monitoring		
Year 3 Monitoring		
Year 4 Monitoring		
Year 5 Monitoring		

Table 3. Project Contacts

Project Contacts Table Muddy Run Stream Restoration /EEP Project # 95018	
Designer	WK Dickson and Co., Inc. 720 Corporate Center Drive Raleigh, NC 27607 (919) 782-0495 Frasier Mullen, PE
Construction Contractor	GP Jenkins 6566 HWY 55 W Kinston, NC 28504 (252) 569-1222 Gary Jenkins
Planting Contractor	H&J Forestry Matt Hitch
Seeding Contractor	Rain Services, Inc. Lupe Cruz
Seed Mix Sources	Green Resource
Nursery Stock Suppliers	Arbogen
Full Delivery Provider Project Manager:	Environmental Banc & Exchange, LLC 909 Capability Drive, Suite 3100 Raleigh, NC 27606 (919) 829-9909 David Godley
Monitoring Performers Project Manager:	WK Dickson and Co., Inc. 720 Corporate Center Drive Raleigh, NC 27607 (919) 782-0495 Daniel Ingram

Table 4. Project Information

Project Information			
Project Name	Muddy Run Stream Restoration		
County	Duplin		
Project Area (acres)	19.1		
Project Coordinates (latitude and longitude)	34.830843^0 N , -77.792838 ^{0} W		
Project Watershed Summary Information			
Physiographic Province	Coastal Plain		
River Basin	Cape Fear		
USGS Hydrologic Unit 8-digit	03030007	USGS Hydrologic Unit 14-digit	0303007060010
DWQ Sub-basin	03-06-22		
Project Drainage Area (acres)	391		
Project Drainage Area Percentage of Impervious Area	>1%		
CGIA Land Use Classification			

Reach Summary Information

Parameters	Reach 1A	Reach 1B	Reach 1C	Reach 2	Reach 3
Length of Reach (linear feet)	1,691	1,581	1,330	1,510	607
Valley Classification					
Drainage Area (acres)	145	177	238	60	391
NCDWQ Stream Identification Score	24	29	33	26.5	24.5
NCDWQ Water Quality Classification	NA	NA	NA	NA	NA
Morphological Description (stream type)					
Evolutionary Trend					
Underlying Mapped Soils	Foreston / Rains	Goldsboro / Rains	Goldsboro / Rains	Rains	Rains
Drainage Class	---	---	---	---	---
Soil Hydric Status	Hydric	Hydric	Hydric	Hydric	Hydric
Slope	0.0016	0.0022	0.0019	0.0023	0.0010
FEMA Classification	Zone X	Zone X	Zone X	Zone X	Zone X
Native Vegetation Community	Coastal Plain Small Stream Swamp				
Percent Composition of Exotic Invasive Vegetation	0%	0%	0%	0%	0%

Wetland Summary Information

Parameters	Wetland 1	Wetland 2	Wetland 3
Size of Wetland (acres)			
Wetland Type (non-riparian, riparian riverine or riparian non-riverine)			
Mapped Soil Series			
Drainage class			
Soil Hydric Status			
Source of Hydrology			
Hydrologic Impairment			
Native vegetation community			
Percent composition of exotic invasive vegetation			

Regulatory Considerations

Regulation	Applicable?	Resolved?	Supporting Documentation
Waters of the United States – Section 404	X	X	USACE NWP 27
Waters of the United States – Section 401	X	X	401 Water Quality Cert.
Endangered Species Act	X	X	USFWS (Corr. Letter)
Historic Preservation Act	X	X	SHPO (Corr. Letter)
Coastal Zone Management Act (CZMA)/ Coastal Area Management Act (CAMA)	N/A	N/A	N/A
FEMA Floodplain Compliance			
Essential Fisheries Habitat	N/A	N/A	N/A

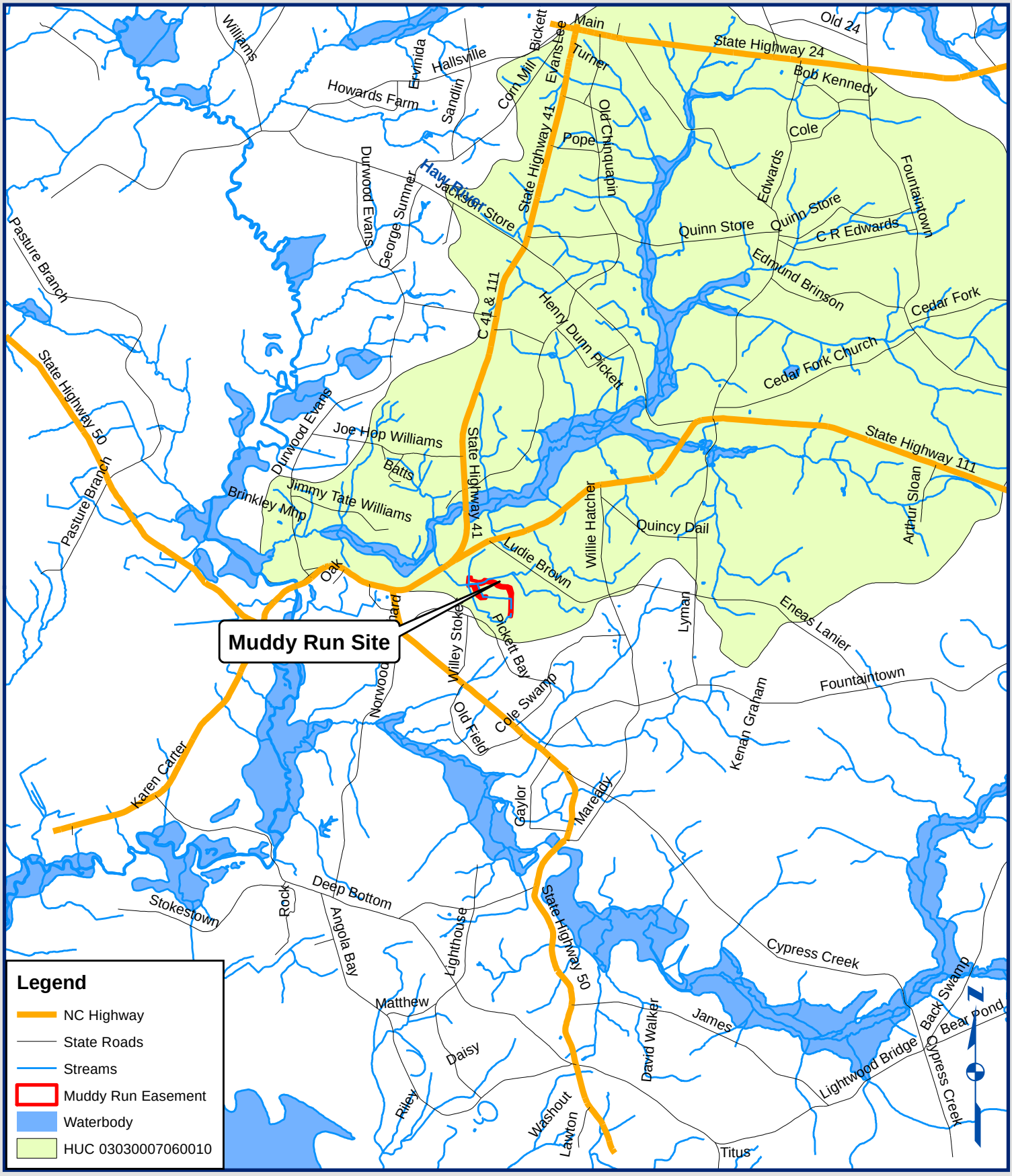
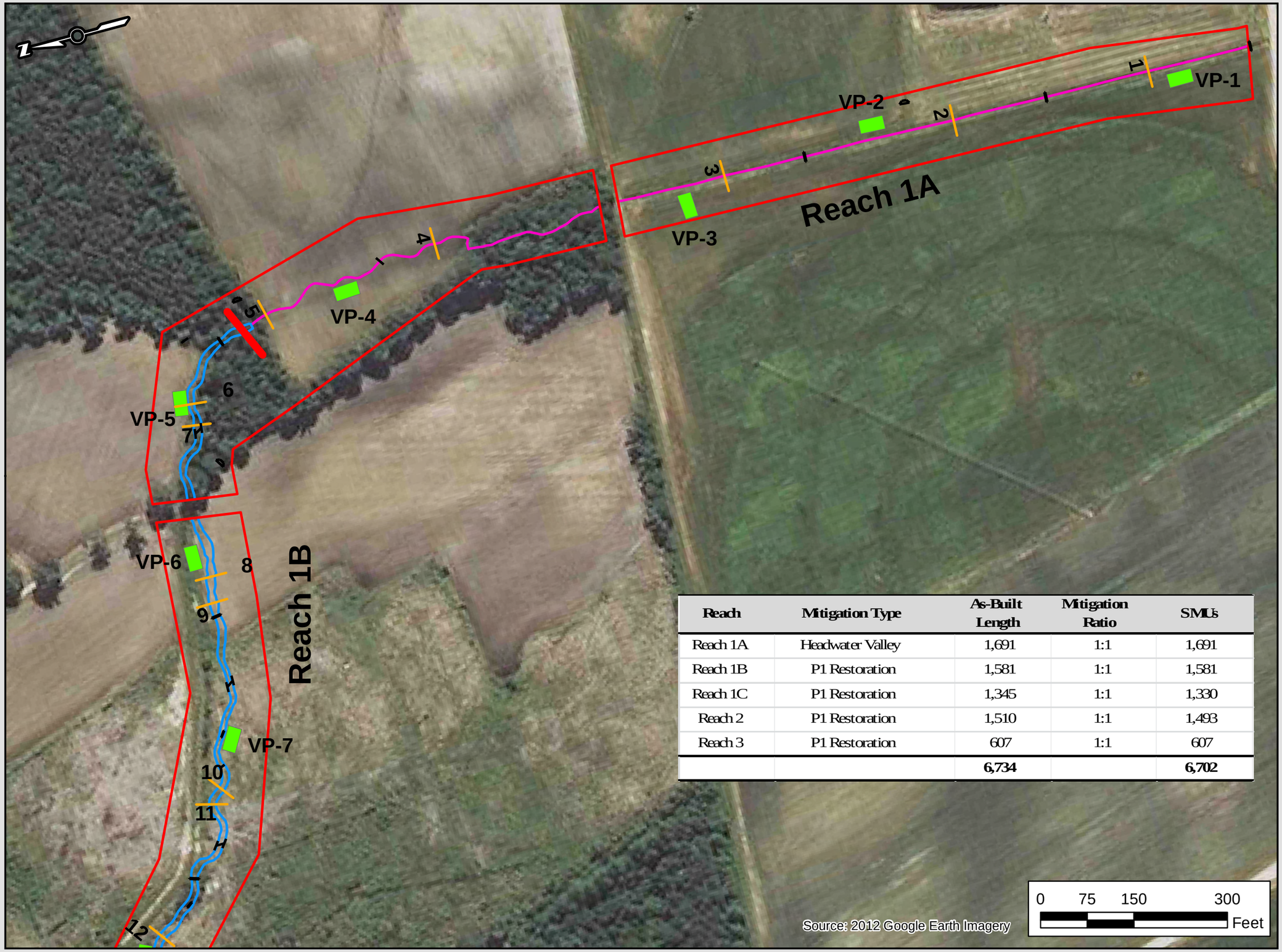


Figure 1.
Project Vicinity Map
Muddy Run Site



Reach	Mitigation Type	As-Built Length	Mitigation Ratio	SMUs
Reach 1A	Headwater Valley	1,691	1:1	1,691
Reach 1B	P1 Restoration	1,581	1:1	1,581
Reach 1C	P1 Restoration	1,345	1:1	1,330
Reach 2	P1 Restoration	1,510	1:1	1,493
Reach 3	P1 Restoration	607	1:1	607
		6,734		**6,702**

Source: 2012 Google Earth Imagery

0 75 150 300 Feet

Figure 2a.
Muddy Run Mitigation Site
Current Conditions Map
Duplin County, NC

EBX

Legend

- Restoration
- HWV Restoration
- Vegetation Plots
- Cross Sections
- Easement Boundary
- Stream Structures
- Reach Breaks

Riparian Buffer Conditions

Invasive Species	Target Community: Present	Marginal	Absent
Absent	No Fill		
Present			
Common			

Reach	Mitigation Type	As-Built Length	Mitigation Ratio	SMUs
Reach 1A	Headwater Valley	1,691	1:1	1,691
Reach 1B	P1 Restoration	1,581	1:1	1,581
Reach 1C	P1 Restoration	1,345	1:1	1,330
Reach 2	P1 Restoration	1,510	1:1	1,493
Reach 3	P1 Restoration	607	1:1	607
		6,734		**6,702**

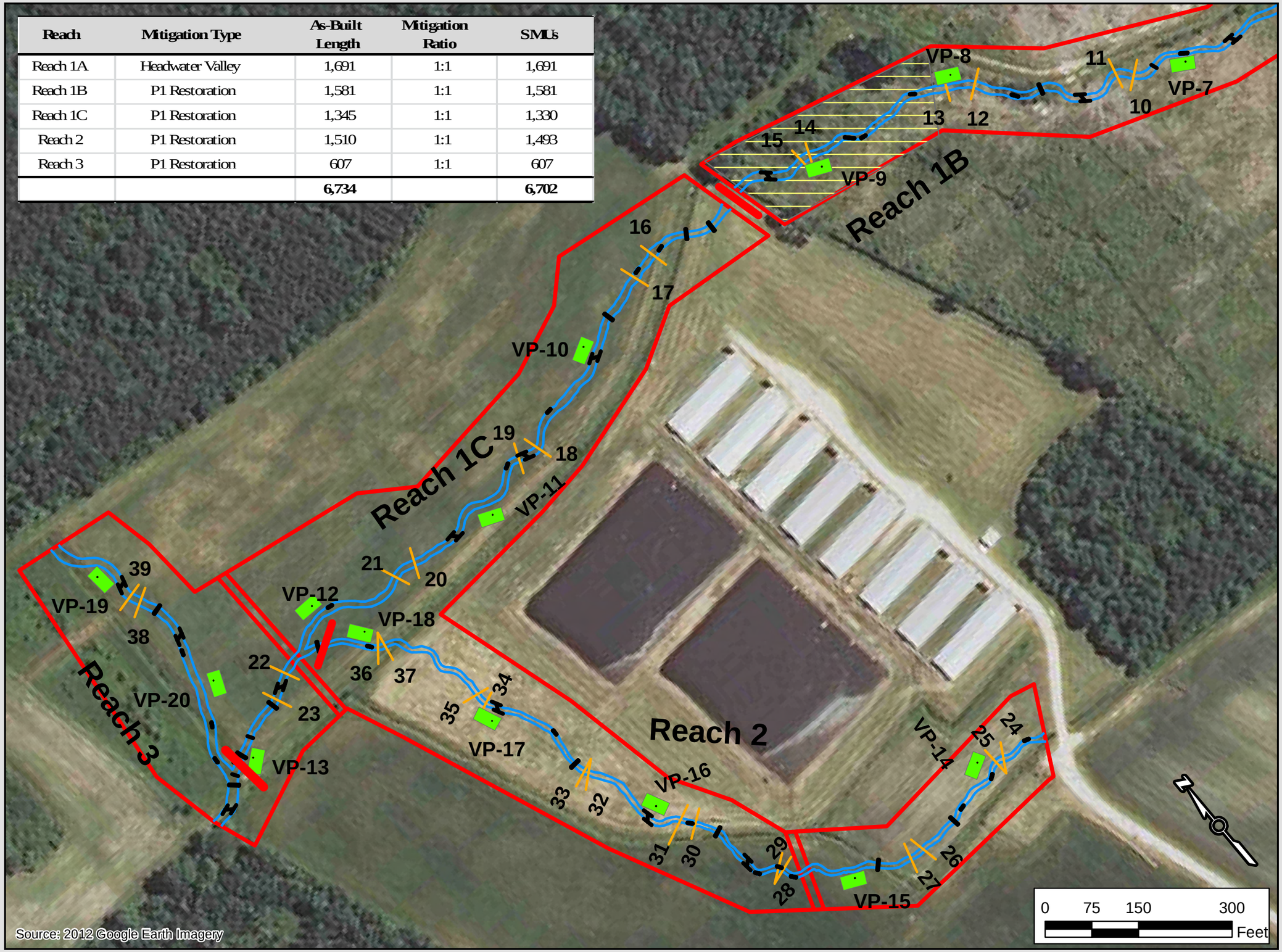


Figure 2b.
Muddy Run Mitigation Site
Current Conditions Map
Duplin County, NC

Legend

- Restoration
- Vegetation Plots
- Cross Sections
- Easement Boundary
- Stream Structures
- Reach Breaks

Riparian Buffer Conditions

Invasive Species	Target Community: Present	Target Community: Marginal	Target Community: Absent
Absent	No Fill		
Present			
Common			

Figure 3a.
Muddy Run Mitigation Site
Conditions Overlay Map
Duplin County, NC

Reach 1A

Reach 1B

Legend

- Reach Breaks
- Easement Boundary
- As-Built Streams
- Designed Streams
- Pre-Construction Streams

0 75 150 300
Feet

Source: 2012 Google Earth Imagery

Figure 3b.
Muddy Run Mitigation Site
Conditions Overlay Map
Duplin County, NC

Reach 1B

Reach 1C

Reach 3

Reach 2

N

0 75 150 300
Feet

Source: 2012 Google Earth Imagery

Legend

- Reach Breaks
- Easement Boundary
- As-Built Streams
- Designed Streams
- Pre-Construction Streams

Appendix B

Morphological Summary Data and Plots

Tables 5 -6

Cross Section Plots

Stream Photos

Appendix B. Table 5 - Morphological Parameters Summary Data
Project Name/Number: Muddy Run Mitigation Project/95018

	Reference Reach			Existing[1]					Design								As-Built/Baseline							
				MR1A	MR1B	MR1C	MR2	MR3	MR1B		MR1C		MR2		MR3		MR1B		MR1C		MR2		MR3	
Feature	Pool	Run	Shallow	Run	Run	Run	Run	Run	Shallow		Shallow		Shallow		Shallow		Shallow		Shallow		Shallow		Shallow	
Drainage Area (ac)	286	286	286	145	177	238	60	85	177		238		60		391		177		238		60		391	
NC Regional Curve Discharge (cfs)			9.3	6	7	8	3	4	7		8		3		12		7		8		3		12	
Design/Calculated Discharge (cfs)	---	---	13	---	---	---	---	---	9		13		4		19		12.1		13.8		5.4		13.5	
Dimension																								
BF Width (ft)	10.9	8.9	7.0	6.6	7.3	9.7	6.9	7.2	8.2		9.5		5.6		11.4		11.6		11.5		9.9		11.9	
Floodprone Width (ft)	100	100	100	9.9	10.3	15.3	10.3	10.7	> 50		> 50		> 50		> 50		> 50		> 50		> 50		> 50	
BF Cross Sectional Area (ft^2)	11.4	8.4	5	5	4.4	5.6	3.6	3.3	6.6		8.9		3.1		13.1		7.4		8.3		4.8		9.3	
BF Mean Depth (ft)	1.0	0.9	0.8	0.8	0.6	0.6	0.5	0.5	0.8		0.9		0.6		1.1		0.6		0.7		0.5		0.8	
BF Max Depth (ft)	2.1	1.7	1.3	1.1	0.9	1.3	1.0	0.8	1.3		1.5		0.9		1.7		1.4		1.5		1		1.6	
Width/Depth Ratio	10.4	9.5	8.8	8.7	12.2	17.1	13.2	15.8	10		10		10		10		18.6		15.7		21.2		15.1	
Entrenchment Ratio	9.2	11.2	15.1	1.5	1.4	1.5	1.5	10.5	> 2.2		> 2.2		> 2.2		> 2.2		> 2.2		> 2.2		> 2.2		> 2.2	
Wetted Perimeter (ft)	12.8	9.7	7.4	6.9	7.7	10.3	7.2	7.4	8.7		10.1		5.9		12.1		12.2		11.9		10.3		12.4	
Hydraulic Radius (ft)	0.9	0.9	0.7	0.7	0.6	0.5	0.5	0.4	0.8		0.9		0.5		1.1		0.6		0.7		0.5		0.8	
Substrate																								
	Fine Sand			Fine Sand					Fine Sand		Fine Sand		Fine Sand		Fine Sand		Fine Sand		Fine Sand		Fine Sand		Fine Sand	
Pattern																								
	Min	**Max**	**Med**	---	---	---	---	---	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Channel Beltwidth (ft)	13.6	31.8	23.1	---	---	---	---	---	13.3	40.0	18.0	37.2	10.2	26.8	20.6	40.3	17.9	45.3	14.9	40.3	12.1	27.5	17.3	45.8
Radius of Curvature (ft)	11.0	27.6	17.6	---	---	---	---	---	11.4	40.4	14.8	40.8	8.9	21.7	22.8	46.5	14.5	48.7	16.8	54.9	11.1	29.4	33.8	74.9
Radius of Curvature Ratio	1.5	3.7	2.3						1.4	4.9	1.6	3.5	1.6	3.4	2.0	4.1	1.3	4.2	1.5	4.8	1.1	3.0	2.8	6.3
Meander Wavelength (ft)	34.9	68.3	54.5	---	---	---	---	---	23.2	89.9	33.2	71.2	16.2	48.6	56.5	144	44.9	99.2	37.3	94.9	20.6	44.0	41.88	88.7
Meander Width Ratio	1.8	4.2	3.1	---	---	---	---	---	1.6	4.9	1.9	3.9	1.8	4.8	1.8	3.5	1.5	3.9	1.3	3.5	1.2	2.8	1.5	3.8
Profile																								
Shallow Length (ft)	3.1	30.7	12.6	---	---	---	---	---	5	72	10	72	4	62	25.9	39.9	8	27	18	35	7.1	24.3	6.0	27.0
Run Length (ft)	2.2	33.2	11.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pool Length (ft)	4.2	9.5	5.8	---	---	---	---	---	17	36	20	34	9	20	18.2	49.0	12	28	14	30	11.6	20.2	9.0	28.0
Pool -to-Pool Spacing (ft)	17.5	59.8	36.3	---	---	---	---	---	23	95	25	97	16	78	37.0	90.0	20	82	25	69	22	75	16.0	90.0
Additional Reach Parameters																								
Valley Length (ft)	274			---	---	---	---	---	1485		1194		1560		554		1485		1194		1560		554	
Channel Length (ft)	309			1638	1590	1324	1448	464	1652		1386		1533		613		1584		1344		1510		607	
Sinuosity	1.1			1.0	1.0	1.0	1.0	1.0	1.1		1.2		1.0		1.1		1.1		1.1		1.0		1.1	
Water Surface Slope (ft/ft)	0.004			---	---	---	---	---	---		---		---		---		---		---		---		---	
Channel Slope (ft/ft)	0.003			0.0016	0.0033	0.0035	0.0032	0.0055	0.0022		0.0019		0.0023		0.0008		0.0036		0.0031		0.0024		0.0022	
Rosgen Classification	E5			G5c	F5	F5	F5	F5	E5		E5		E5		E5		E5		E5		E5		E5	
*Habitat Index																								

[1] Bankfull stage was estimated using NC Regional Curve equations and existing conditions data

Appendix B. Table 6 - Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters – Cross Sections)

Project Name/Number: Muddy Run Mitigation Project/95018

	Cross Section 1 (HWV)							Cross Section 2 (HWV)							Cross Section 3 (HWV)							Cross Section 4 (HWV)							Cross Section 5 (HWV)						
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Record elevation (datum) used	(Headwater Valley Restoration) No Morphological Parameters were determined for HWV Reaches.							(Headwater Valley Restoration) No Morphological Parameters were determined for HWV Reaches.							(Headwater Valley Restoration) No Morphological Parameters were determined for HWV Reaches.							(Headwater Valley Restoration) No Morphological Parameters were determined for HWV Reaches.							(Headwater Valley Restoration) No Morphological Parameters were determined for HWV Reaches.						
Bankfull Width (ft)																																			
Floodprone Width (ft)																																			
Bankfull Mean Depth (ft)																																			
Bankfull Max Depth (ft)																																			
Bankfull Cross Sectional Area (ft^2)																																			
Bankfull Width/Depth Ratio																																			
Bankfull Entrenchment Ratio																																			
Bankfull Bank Height Ratio																																			

	Cross Section 6 (Pool)							Cross Section 7 (Shallow)							Cross Section 8 (Shallow)							Cross Section 9 (Pool)							Cross Section 10 (Shallow)						
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Record elevation (datum) used	49.5							49.5							48.5							48.3							46.5						
Bankfull Width (ft)	9.0							10.7							9.6							8.8							14.3						
Floodprone Width (ft)	50.0							50.0							50.0							50.0							50.0						
Bankfull Mean Depth (ft)	1.1							0.7							0.7							0.9							0.5						
Bankfull Max Depth (ft)	2.2							1.7							1.4							1.7							1.3						
Bankfull Cross Sectional Area (ft^2)	9.4							8.0							6.4							7.5							6.8						
Bankfull Width/Depth Ratio	8.5							14.4							14.4							10.3							29.9						
Bankfull Entrenchment Ratio	>2.2							>2.2							>2.2							>2.2							>2.2						
Bankfull Bank Height Ratio	1.0							1.0							1.0							1.0							1.0						

	Cross Section 11 (Pool)							Cross Section 12 (Shallow)							Cross Section 13 (Pool)							Cross Section 14 (Shallow)							Cross Section 15 (Pool)						
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Record elevation (datum) used	46.4							45.6							45.5							45.0							44.4						
Bankfull Width (ft)	14.7							11.4							13.2							12.0							10.0						
Floodprone Width (ft)	50.0							50.0							50.0							50.0							50.0						
Bankfull Mean Depth (ft)	0.6							0.6							0.6							0.7							0.9						
Bankfull Max Depth (ft)	1.8							1.2							1.4							1.4							1.9						
Bankfull Cross Sectional Area (ft^2)	9.1							7.1							8.4							8.7							9.1						
Bankfull Width/Depth Ratio	23.9							18.2							20.7							16.4							11.1						
Bankfull Entrenchment Ratio	>2.2							>2.2							>2.2							>2.2							>2.2						
Bankfull Bank Height Ratio	1.0							1.0							1.0							1.0							1.0						

	Cross Section 16 (Shallow)							Cross Section 17 (Pool)							Cross Section 18 (Pool)							Cross Section 19 (Shallow)							Cross Section 20 (Shallow)						
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Record elevation (datum) used	44.0							43.7							42.8							43.0							42.6						
Bankfull Width (ft)	13.3							13.0							8.9							11.9							10.8						
Floodprone Width (ft)	50.0							50.0							50.0							50.0							50.0						
Bankfull Mean Depth (ft)	0.8							0.9							1.1							0.7							0.7						
Bankfull Max Depth (ft)	1.4							1.5							2.0							1.5							1.6						
Bankfull Cross Sectional Area (ft^2)	10.0							11.3							10.2							8.1							8.0						
Bankfull Width/Depth Ratio	17.6							15.0							7.7							17.4							14.5						
Bankfull Entrenchment Ratio	>2.2							>2.2							>2.2							>2.2							>2.2						
Bankfull Bank Height Ratio	1.0							1.0							1.0							1.0							1.0						

1 = Widths and depths for annual measurements will be based on the baseline bankfull datum regardless of dimensional/depositional development. Input the elevation used as the datum, which should be consistent and based on the baseline datum established. If the performer has inherited the project and cannot acquire the datum used for prior years this must be discussed with EEP. If this cannot be resolved in time for a given years report submission a footnote in this should be included that states: "It is uncertain if the monitoring datum has been consistent over the monitoring history, which may influence calculated values. Additional data from a prior performer is being acquired to provide confirmation. Values will be recalculated in a future submission based on a consistent datum if determined to be necessary."

Appendix B. Table 6 - Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters – Cross Sections)

Project Name/Number: Muddy Run Mitigation Project/95018

	Cross Section 21 (Pool)							Cross Section 22 (Shallow)							Cross Section 23 (Pool)							Cross Section 24 (Shallow)							Cross Section 25 (Pool)						
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Record elevation (datum) used	42.3							41.8							41.5							45.2							45.2						
Bankfull Width (ft)	10.6							9.8							10.6							9.1							8.6						
Floodprone Width (ft)	50.0							50.0							50.0							50.0							50.0						
Bankfull Mean Depth (ft)	1.1							0.7							0.7							0.5							0.6						
Bankfull Max Depth (ft)	2.2							1.4							1.2							1.0							1.3						
Bankfull Cross Sectional Area (ft^2)	11.5							7.2							7.0							4.6							5.3						
Bankfull Width/Depth Ratio	9.8							13.3							16.3							18.2							13.9						
Bankfull Entrenchment Ratio	>2.2							>2.2							>2.2							>2.2							>2.2						
Bankfull Bank Height Ratio	1.0							1.0							1.0							1.0							1.0						

	Cross Section 26 (Shallow)							Cross Section 27 (Pool)							Cross Section 28 (Shallow)							Cross Section 29 (Pool)							Cross Section 30 (Pool)						
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Record elevation (datum) used	44.6							44.5							44.0							43.6							42.7						
Bankfull Width (ft)	7.3							7.0							19.6							9.7							7.4						
Floodprone Width (ft)	50.0							50.0							50.0							50.0							50.0						
Bankfull Mean Depth (ft)	0.6							0.7							0.4							0.7							0.5						
Bankfull Max Depth (ft)	1.1							1.4							1.2							1.5							1.1						
Bankfull Cross Sectional Area (ft^2)	4.3							5.1							8.2							6.4							4.0						
Bankfull Width/Depth Ratio	12.2							9.5							47.1							14.7							13.6						
Bankfull Entrenchment Ratio	>2.2							>2.2							>2.2							>2.2							>2.2						
Bankfull Bank Height Ratio	1.0							1.0							1.0							1.0							1.0						

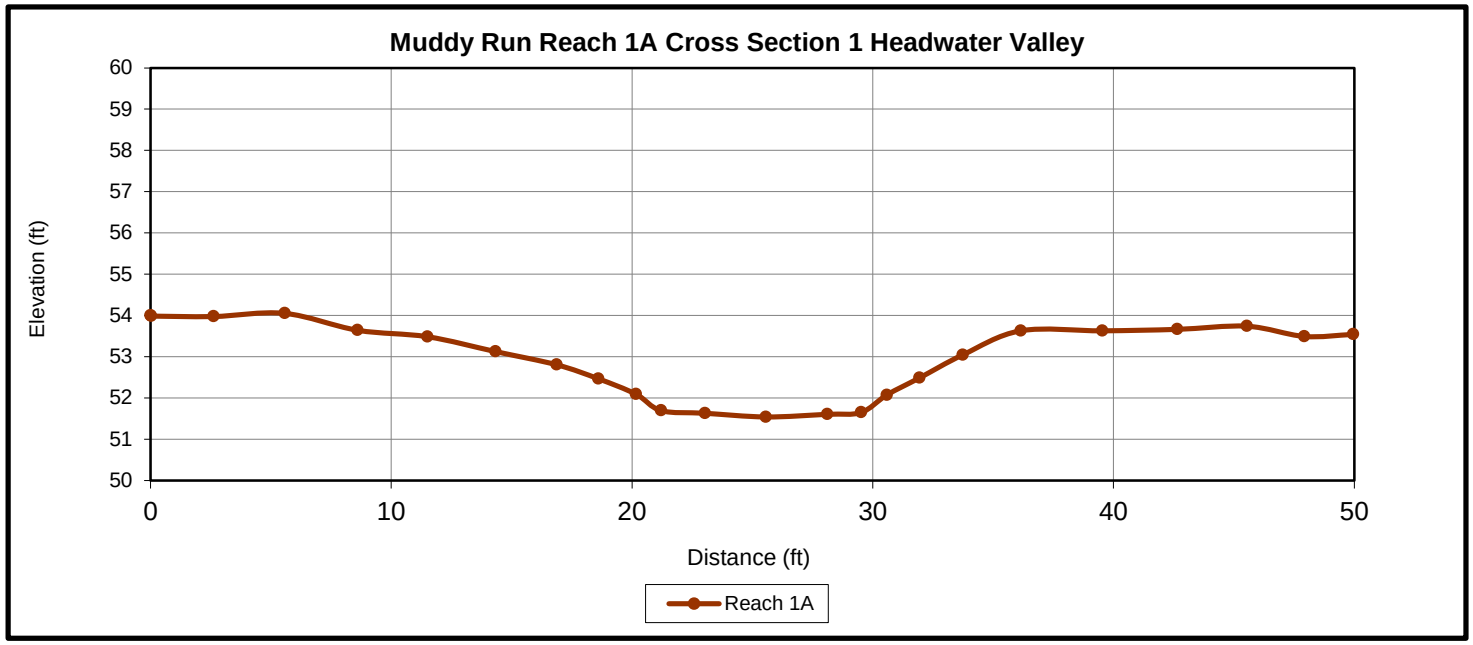
	Cross Section 31 (Shallow)							Cross Section 32 (Shallow)							Cross Section 33 (Pool)							Cross Section 34 (Shallow)							Cross Section 35 (Pool)						
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Record elevation (datum) used	42.9							42.6							42.4							42.2							42.1						
Bankfull Width (ft)	11.3							6.8							7.1							8.4							7.7						
Floodprone Width (ft)	70.0							50.0							50.0							50.0							50.0						
Bankfull Mean Depth (ft)	0.4							0.5							0.6							0.5							0.7						
Bankfull Max Depth (ft)	0.9							1.0							1.1							0.9							1.4						
Bankfull Cross Sectional Area (ft^2)	4.6							3.7							4.3							3.9							5.6						
Bankfull Width/Depth Ratio	28.3							12.4							11.5							18.1							10.5						
Bankfull Entrenchment Ratio	>2.2							>2.2							>2.2							>2.2							>2.2						
Bankfull Bank Height Ratio	1.0							1.0							1.0							1.0							1.0						

	Cross Section 36 (Shallow)							Cross Section 37 (Pool)							Cross Section 38 (Pool)							Cross Section 39 (Shallow)													
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Record elevation (datum) used	41.8							41.8							41.1							41.1													
Bankfull Width (ft)	7.4							9.6							15.6							11.9													
Floodprone Width (ft)	50.0							50.0							50.0							50.0													
Bankfull Mean Depth (ft)	0.6							0.5							1.2							0.8													
Bankfull Max Depth (ft)	1.0							1.3							2.5							1.6													
Bankfull Cross Sectional Area (ft^2)	4.4							5.1							18.6							9.3													
Bankfull Width/Depth Ratio	12.2							18.2							13.0							15.1													
Bankfull Entrenchment Ratio	>2.2							>2.2							>2.2							>2.2													
Bankfull Bank Height Ratio	1.0							1.0							1.0							1.0													

1 = Widths and depths for annual measurements will be based on the baseline bankfull datum regardless of dimensional/depositional development. Input the elevation used as the datum, which should be consistent and based on the baseline datum established. If the performer has inherited the project and cannot acquire the datum used for prior years this must be discussed with EEP. If this cannot be resolved in time for a given years report submission a footnote in this should be included that states: "It is uncertain if the monitoring datum has been consistent over the monitoring history, which may influence calculated values. Additional data from a prior performer is being acquired to provide confirmation. Values will be recalculated in a future submission based on a consistent datum if determined to be necessary."

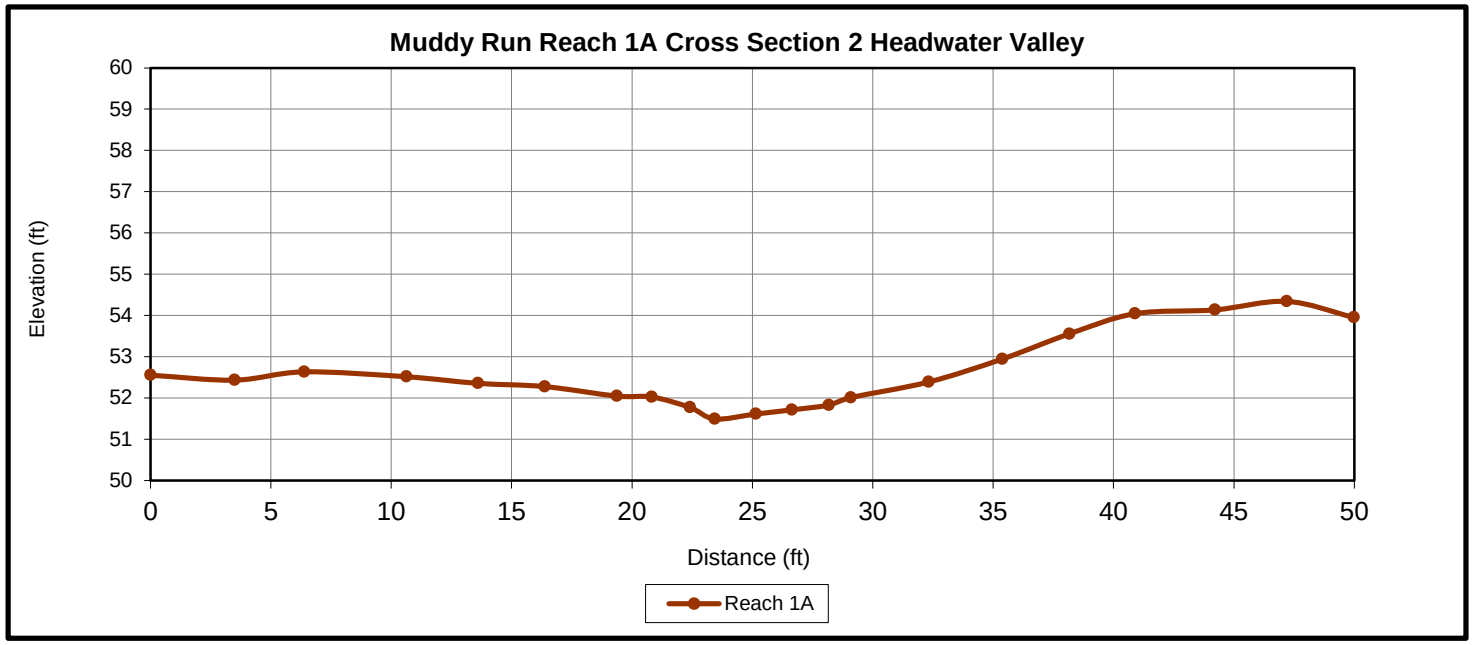
Upstream

Downstream



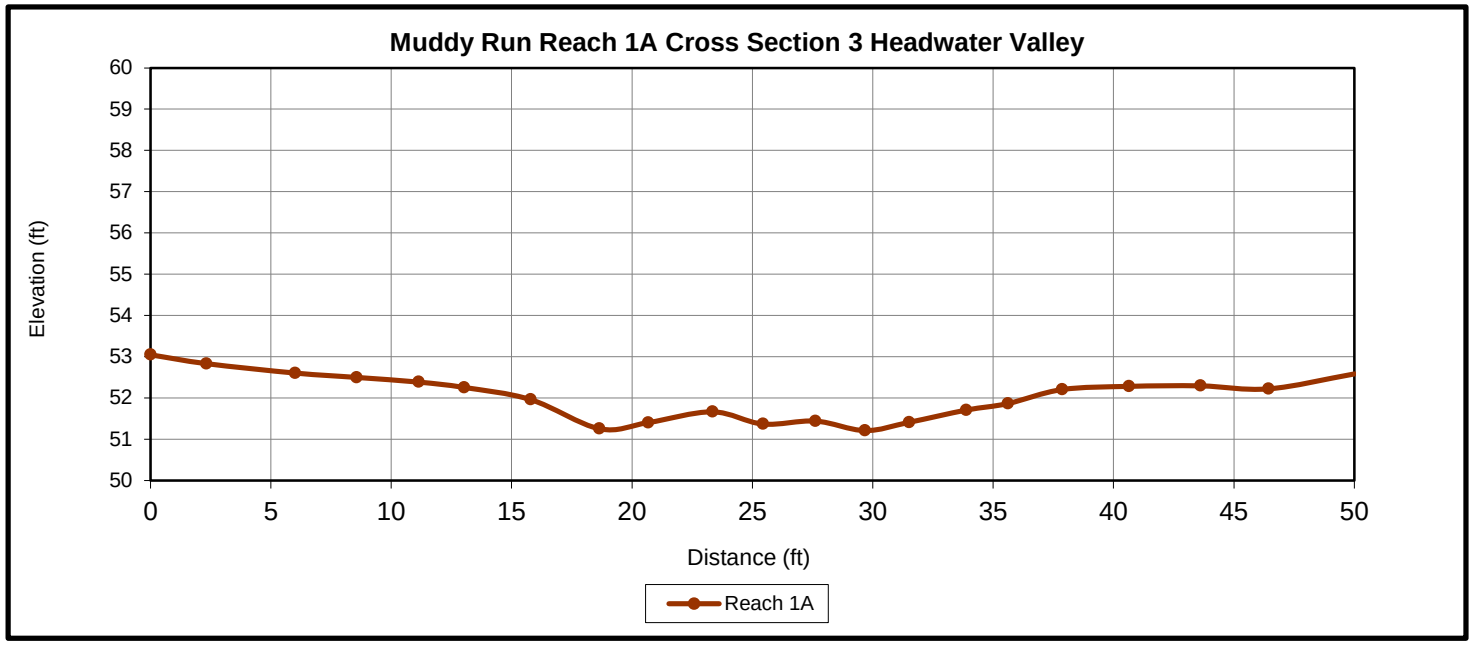
Upstream

Downstream



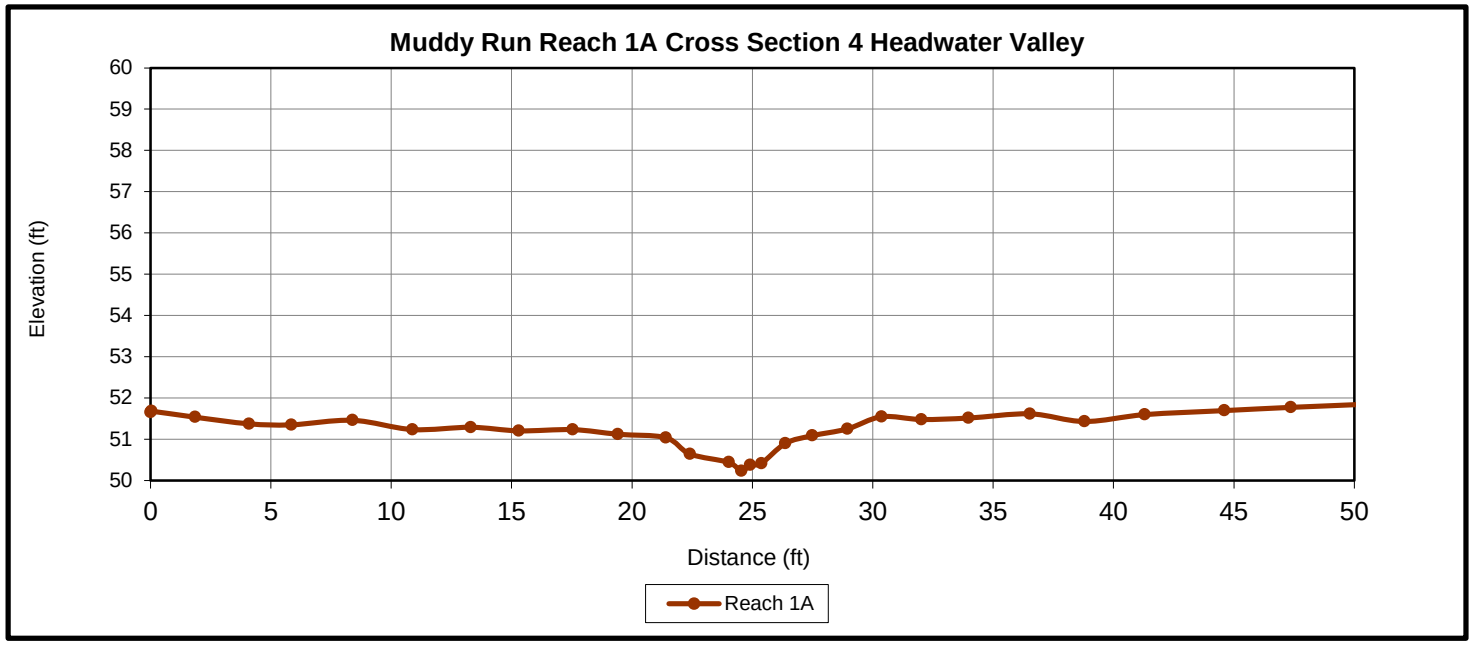
Upstream

Downstream



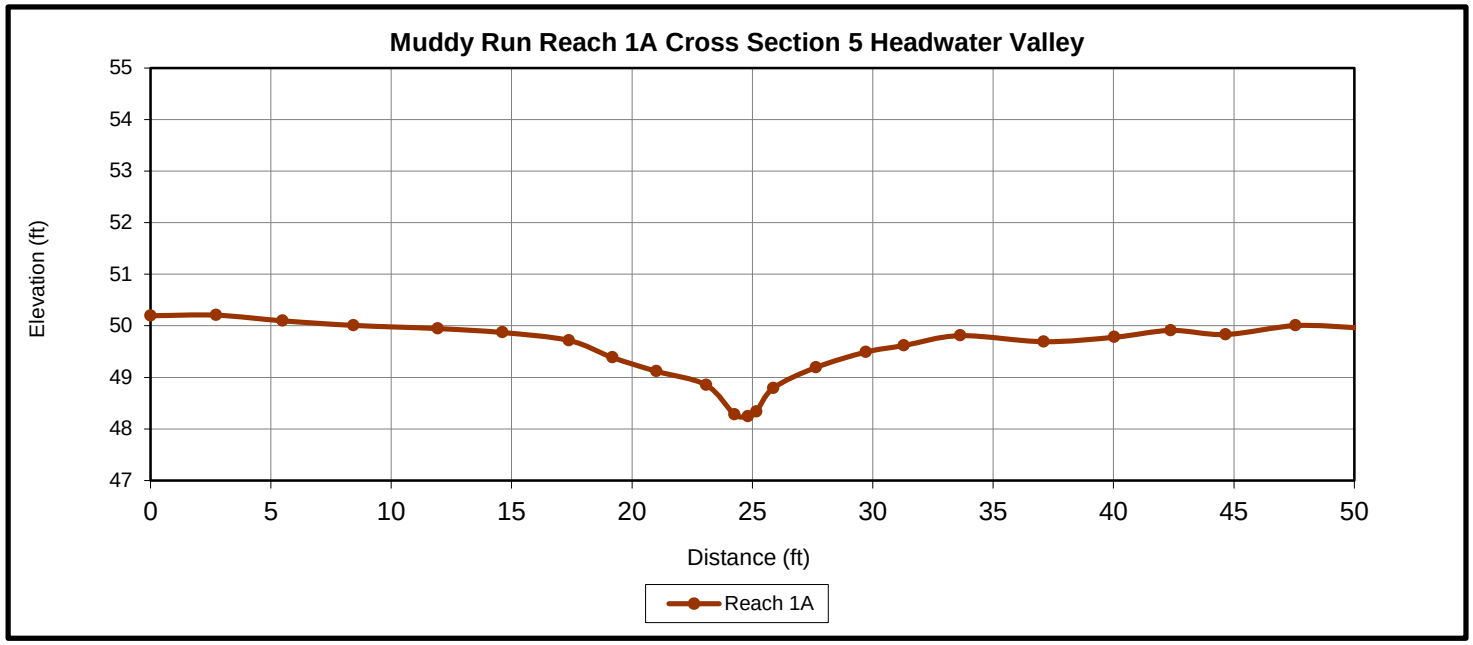
Upstream

Downstream



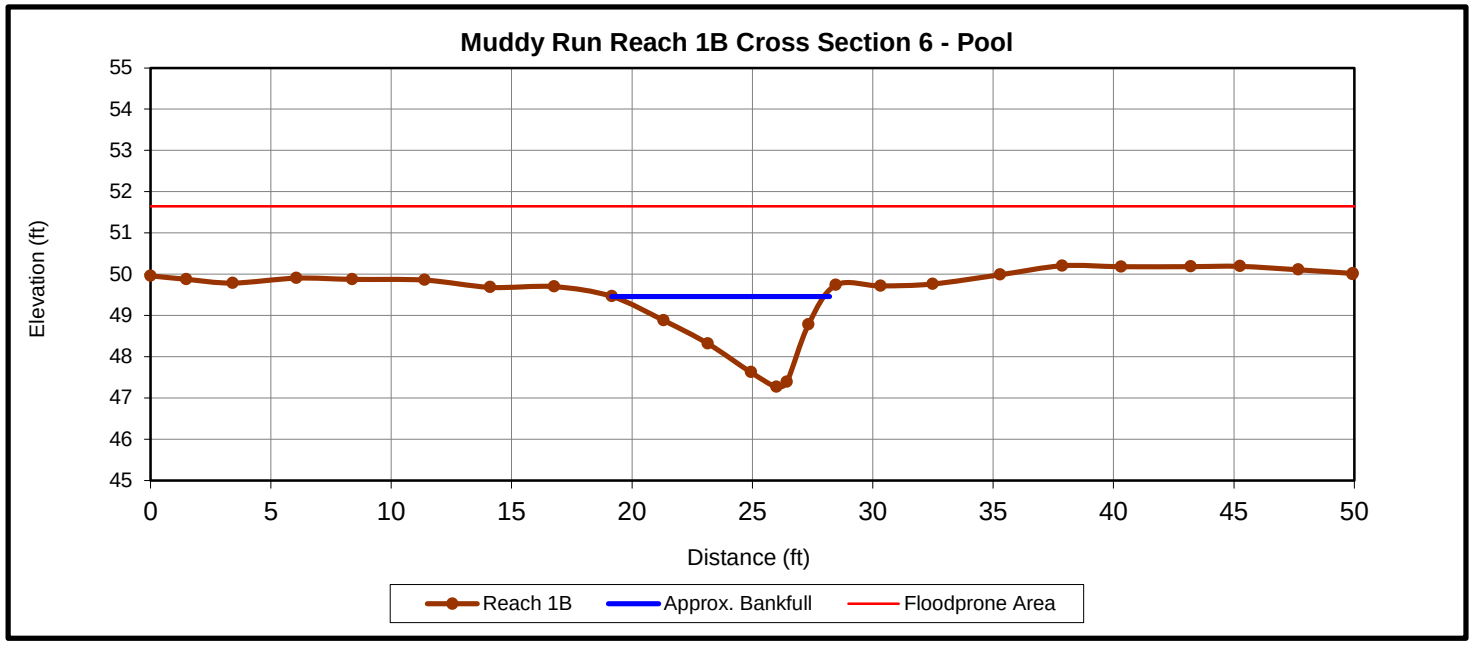
Upstream

Downstream



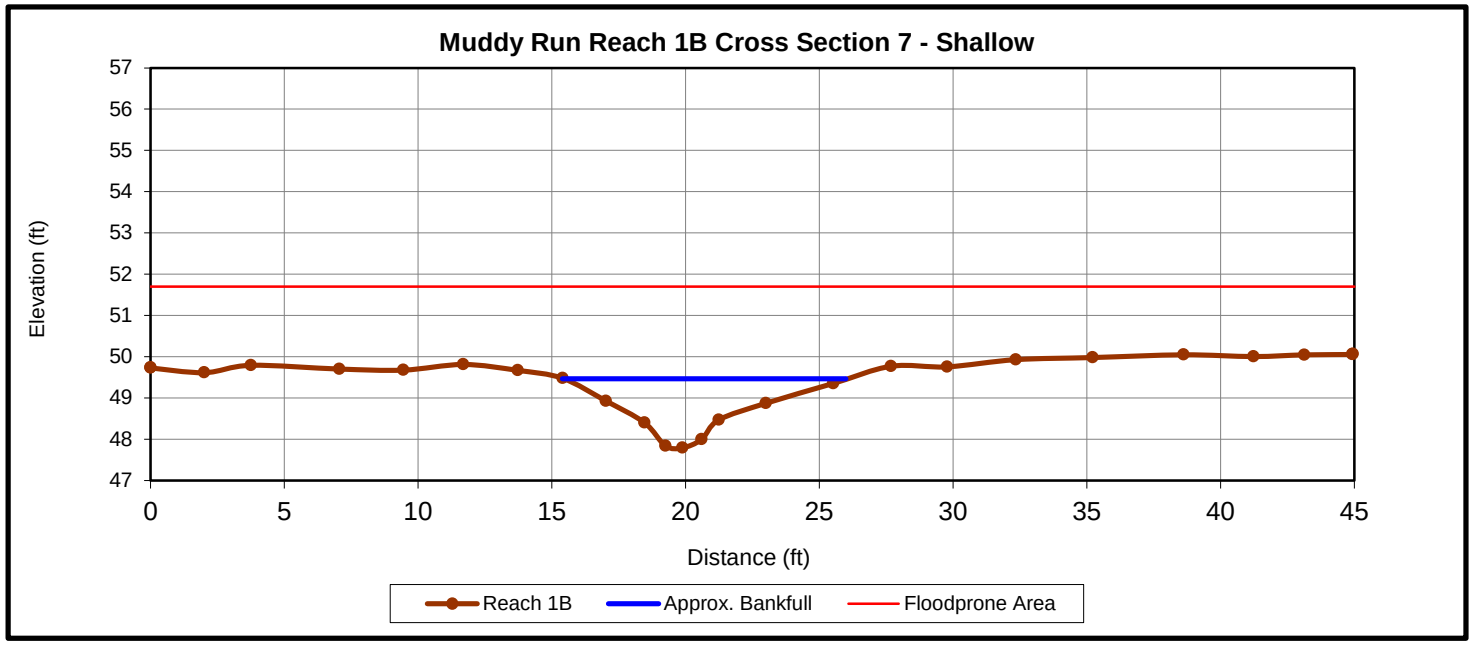
Upstream

Downstream



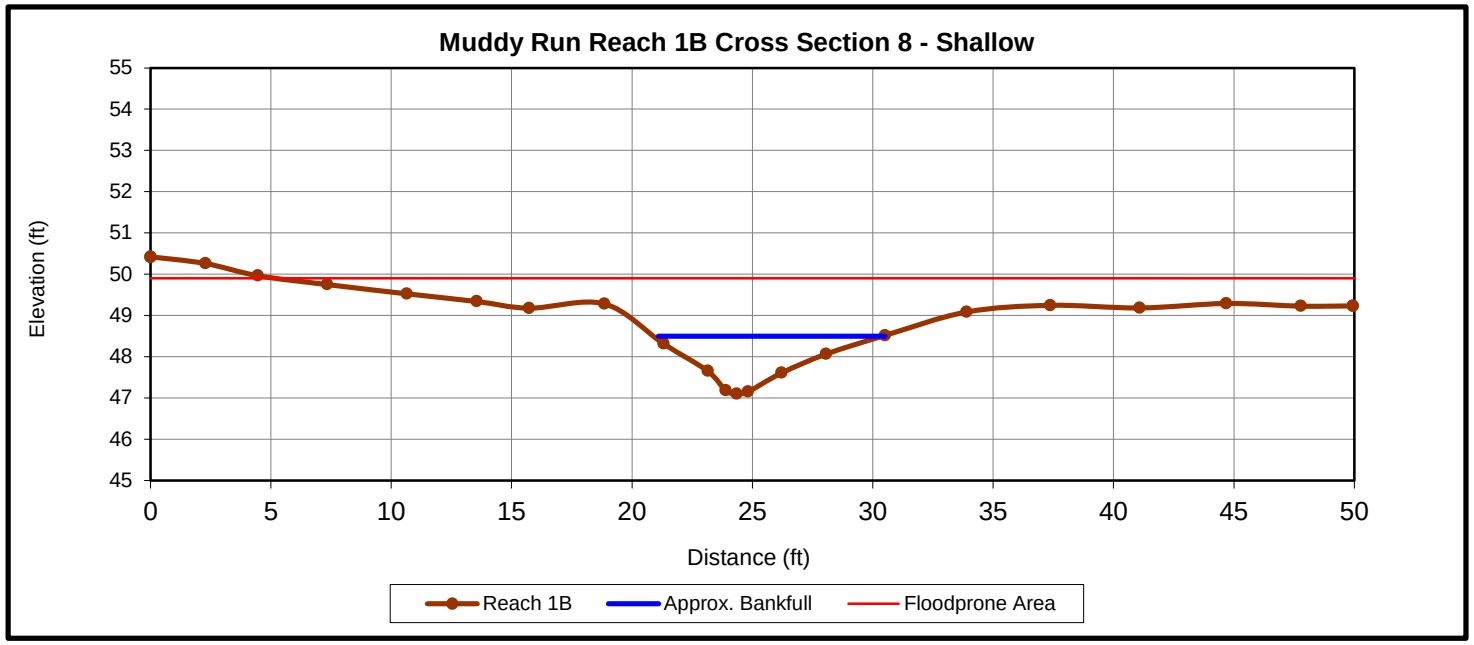
Upstream

Downstream



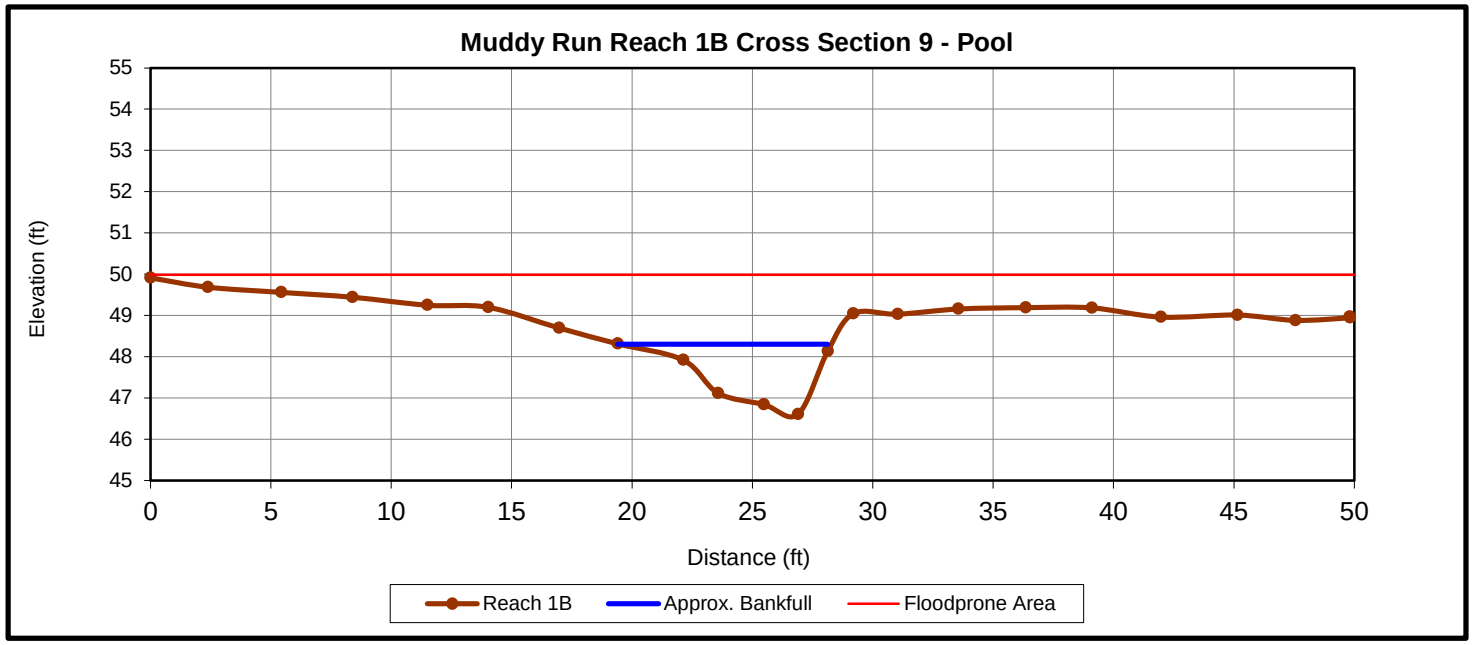
Upstream

Downstream



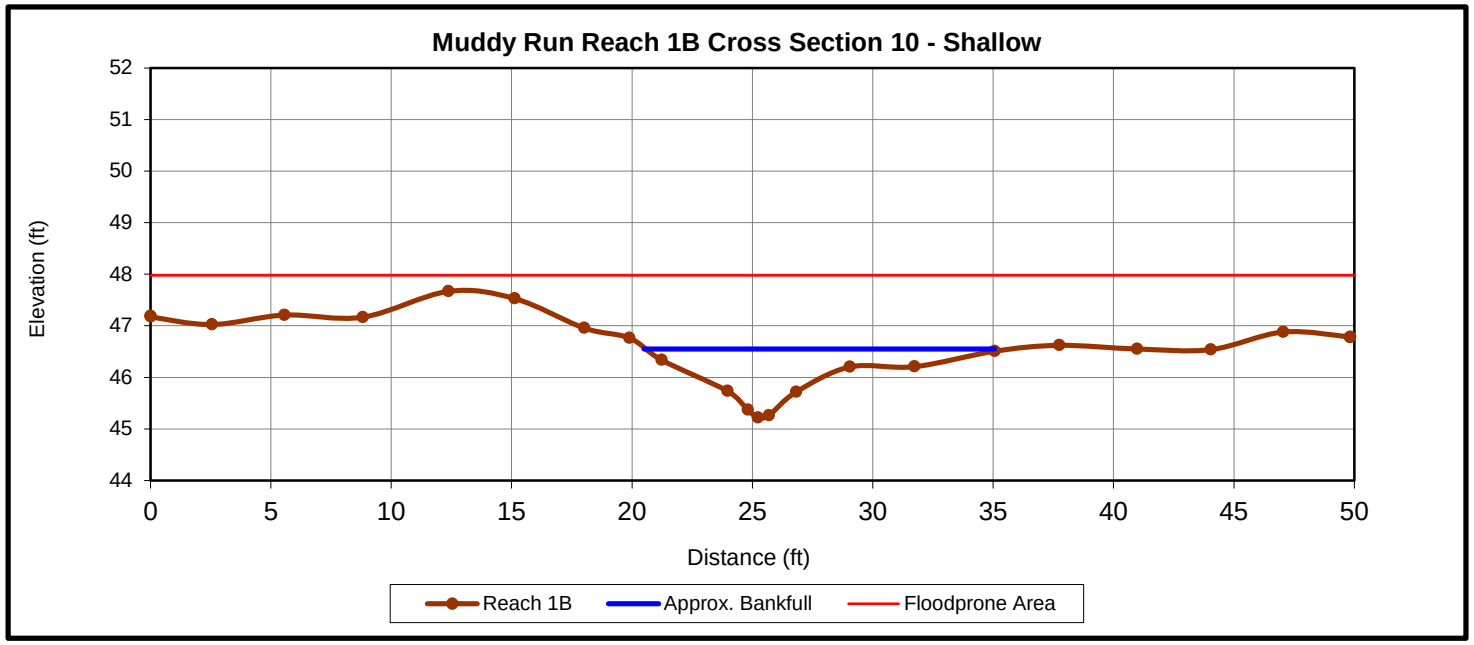
Upstream

Downstream



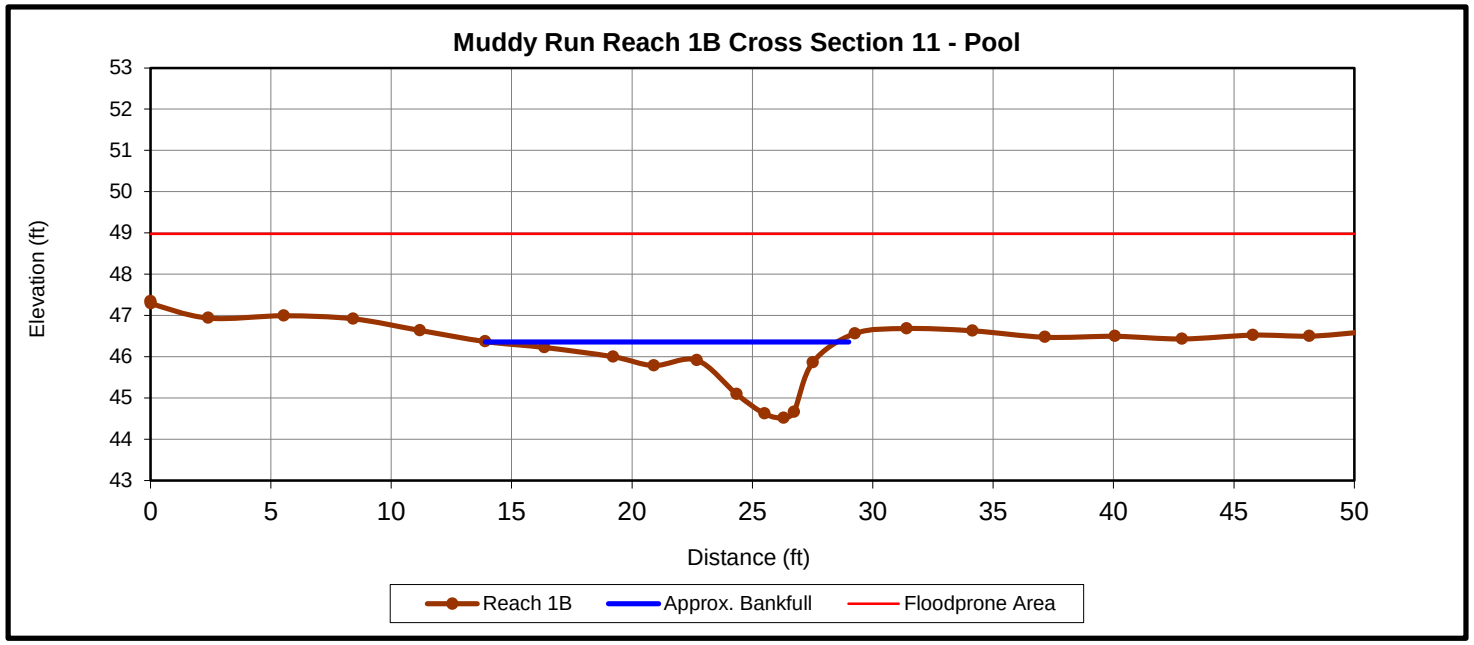
Upstream

Downstream



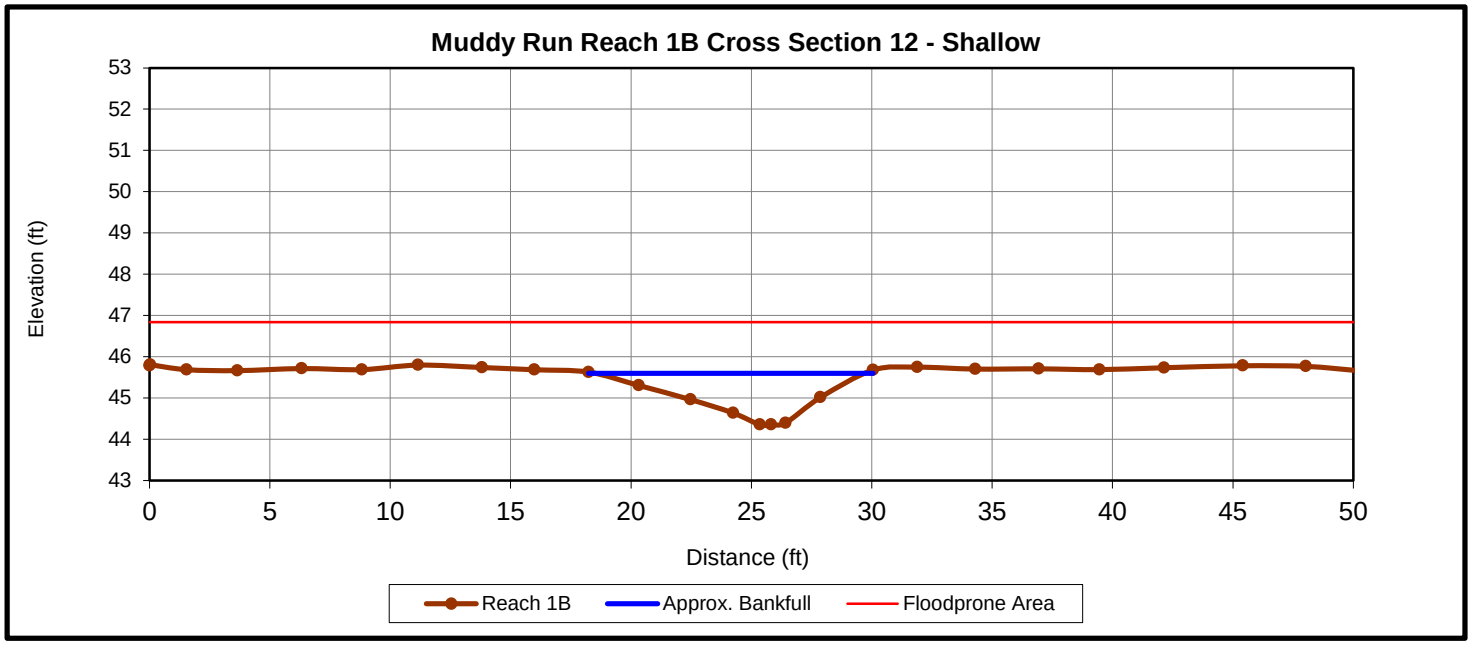
Upstream

Downstream



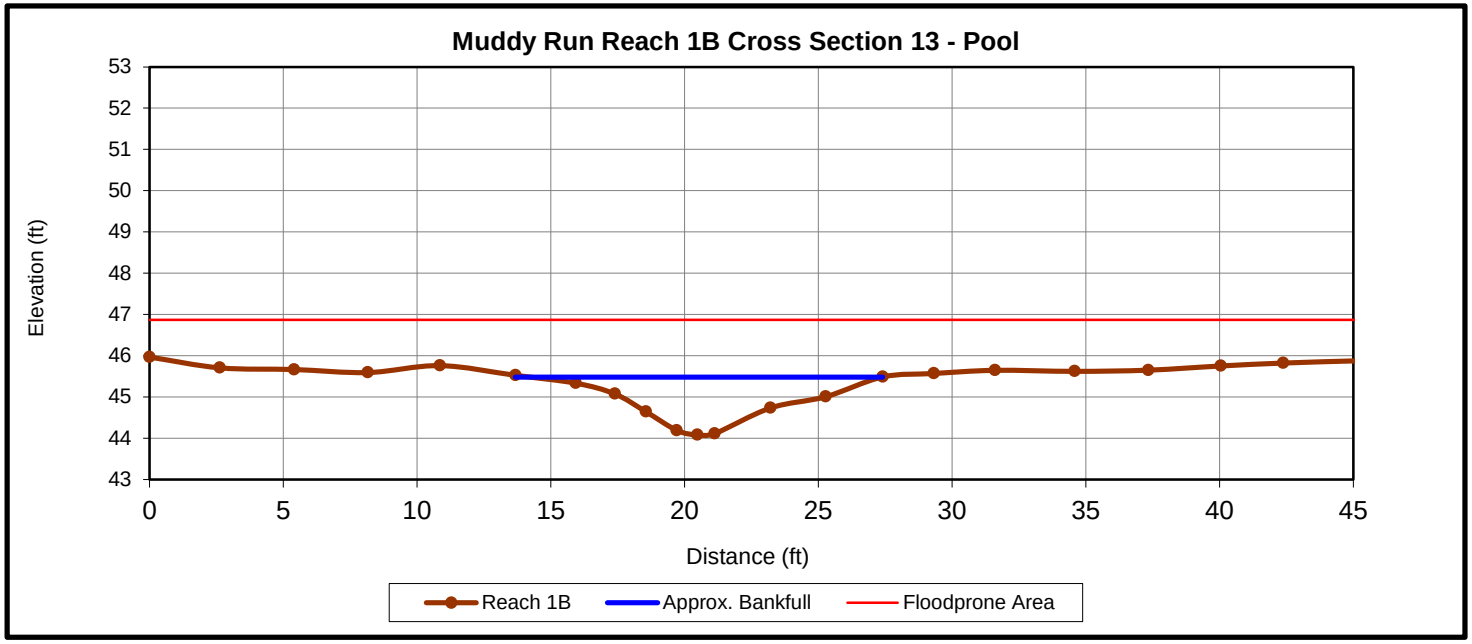
Upstream

Downstream



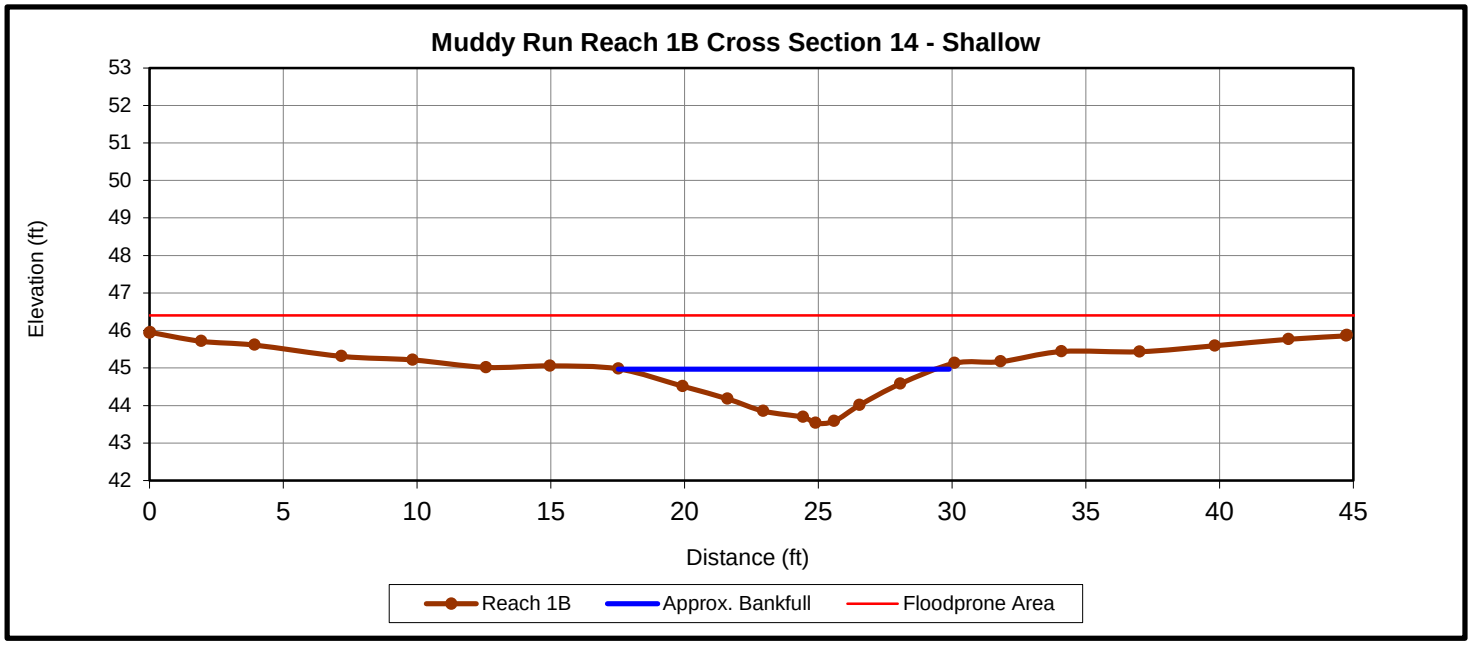
Upstream

Downstream



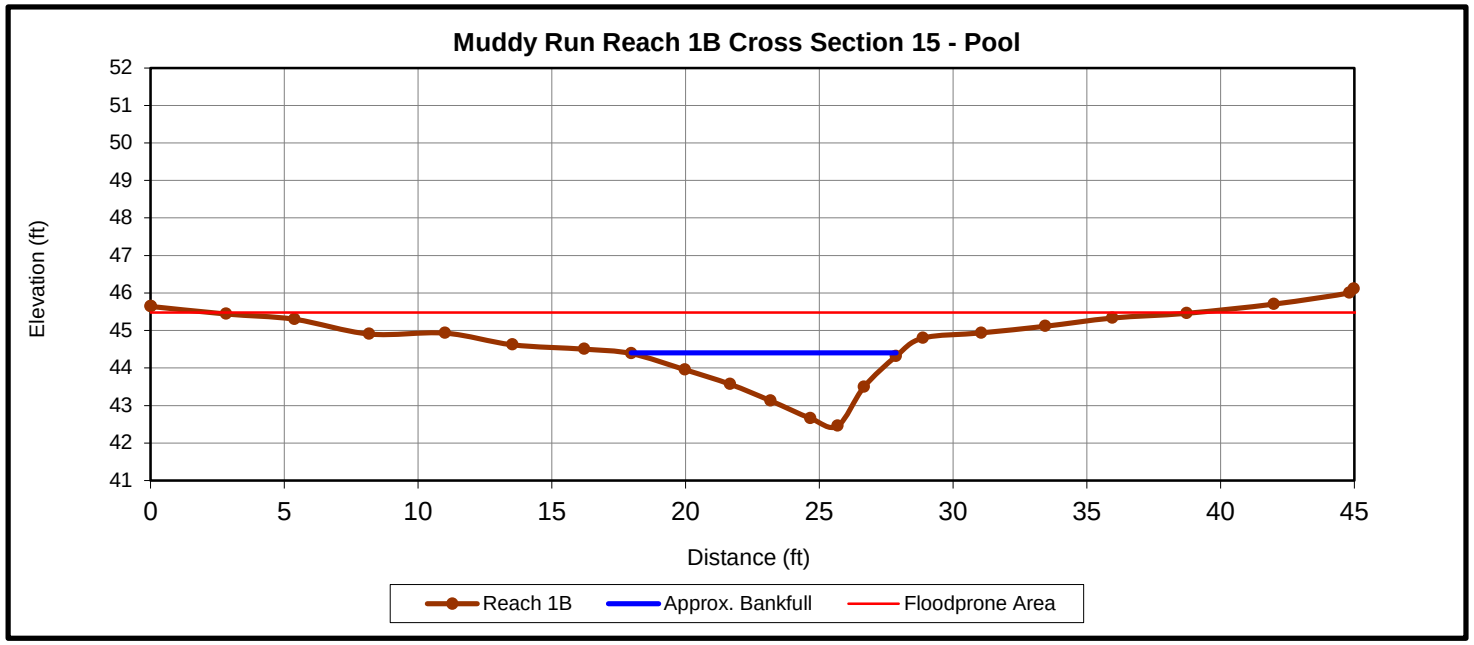
Upstream

Downstream



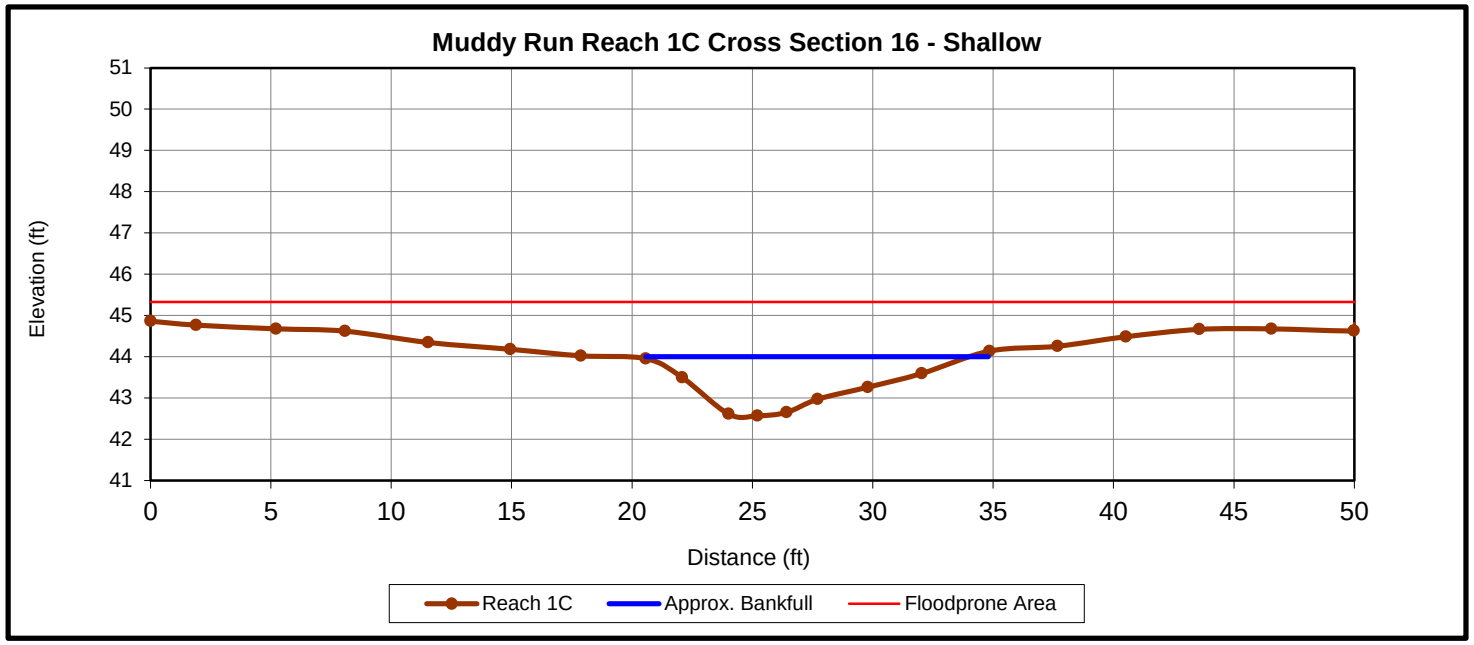
Upstream

Downstream



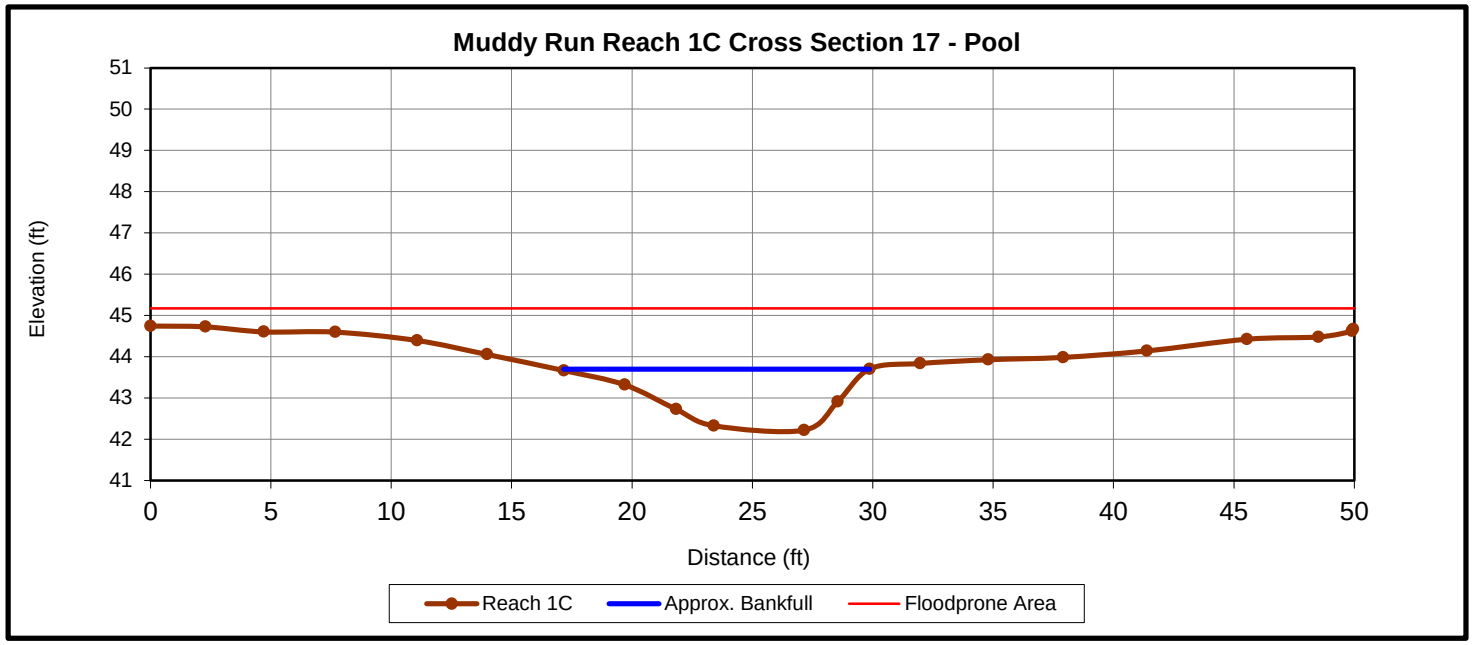
Upstream

Downstream



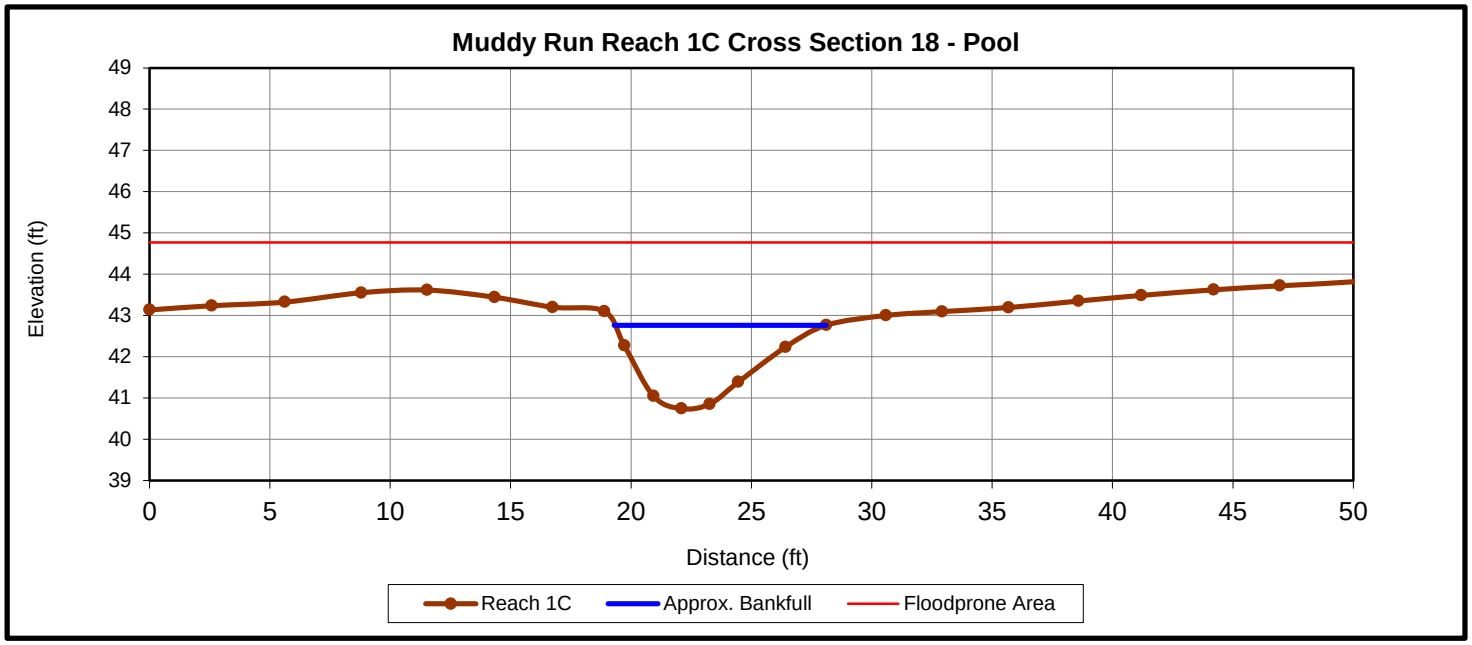
Upstream

Downstream



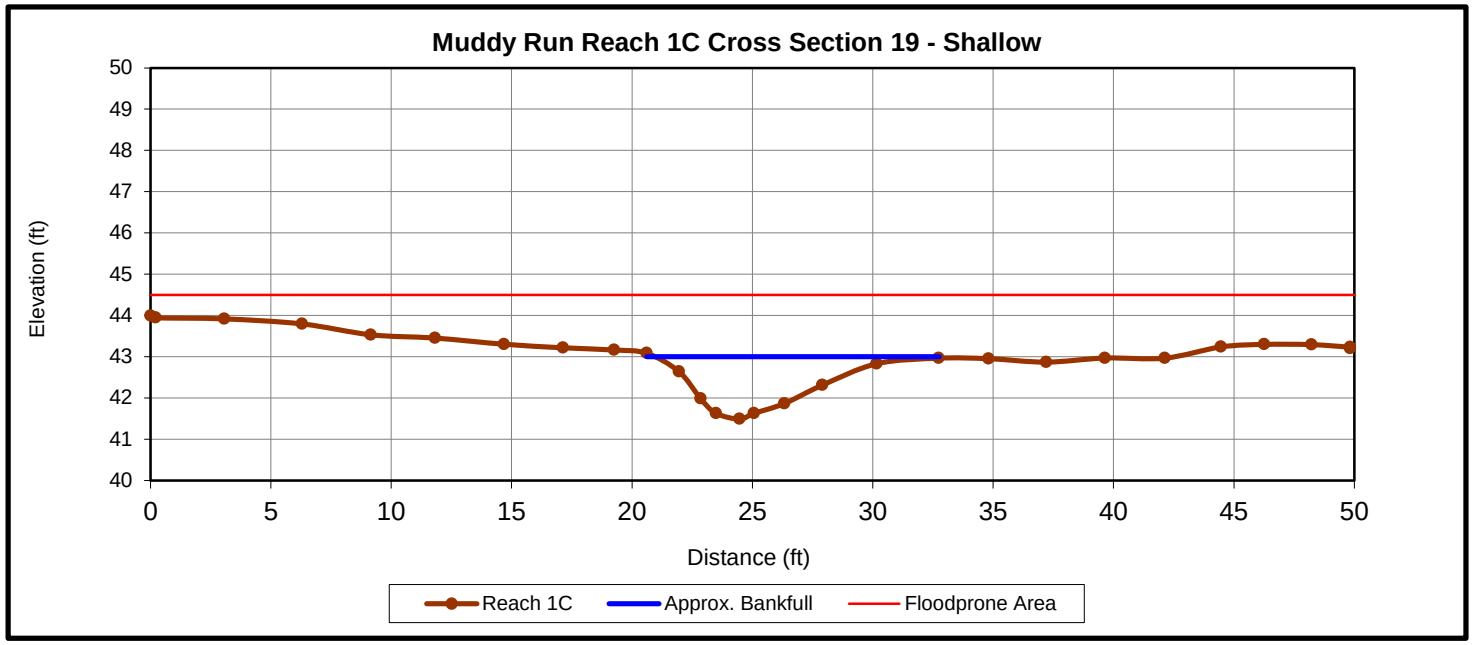
Upstream

Downstream



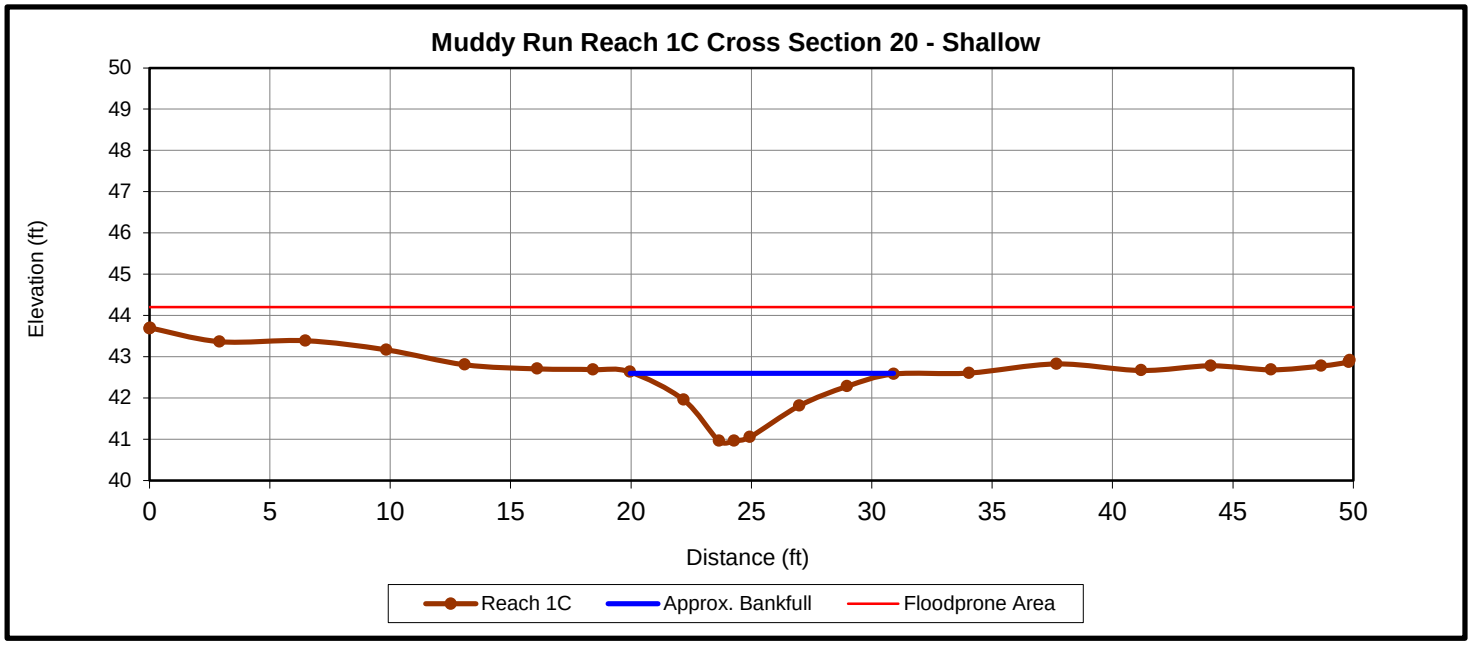
Upstream

Downstream



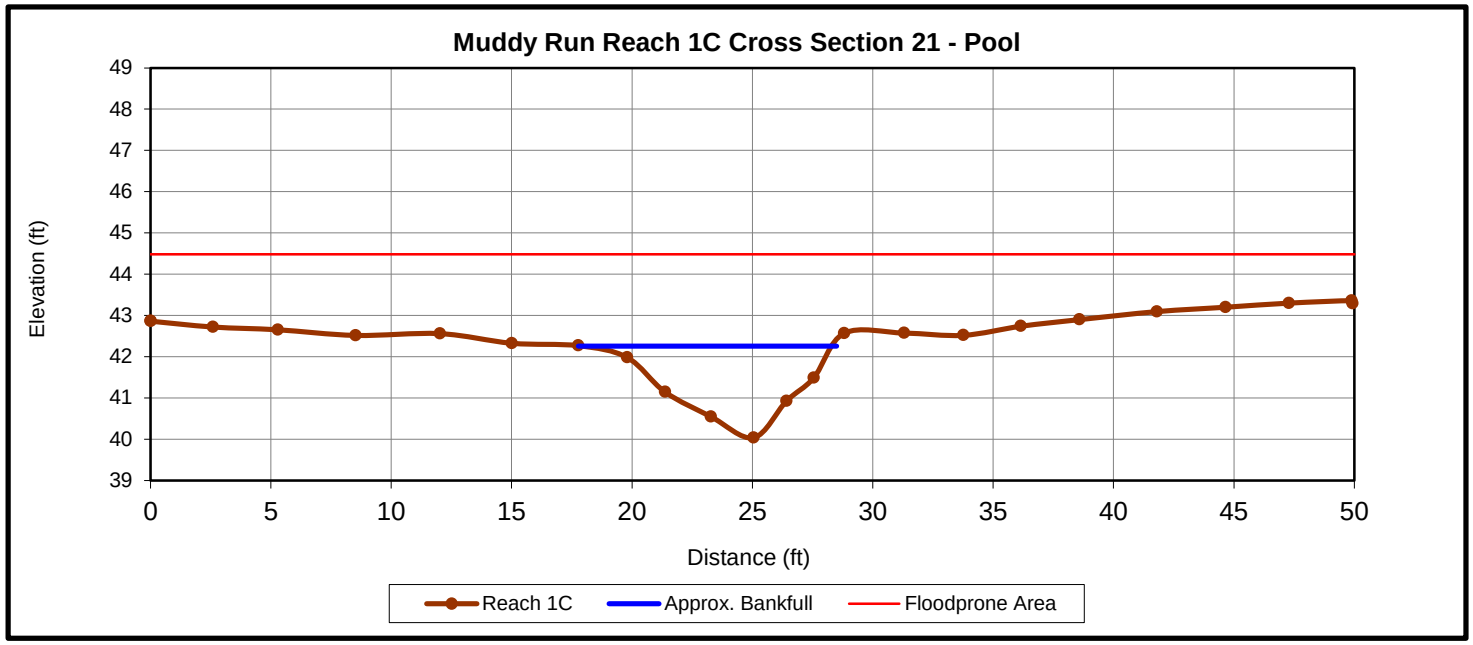
Upstream

Downstream



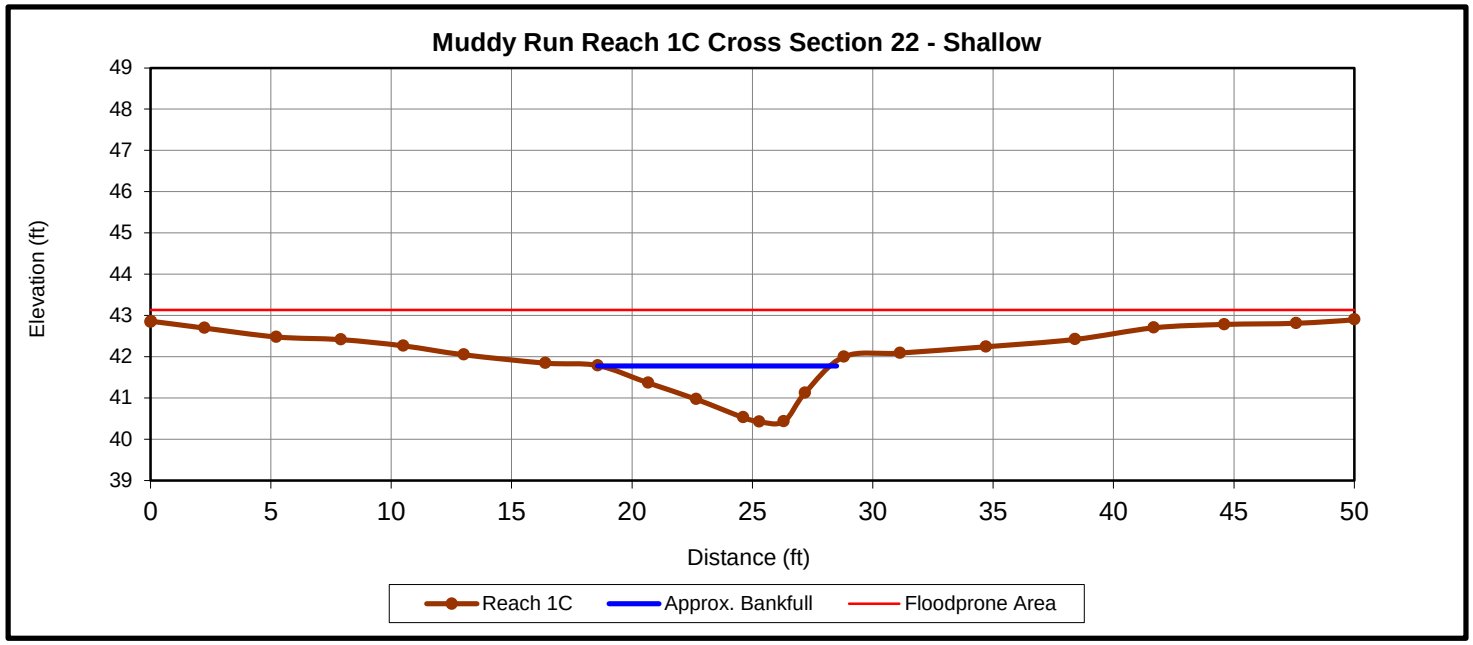
Upstream

Downstream



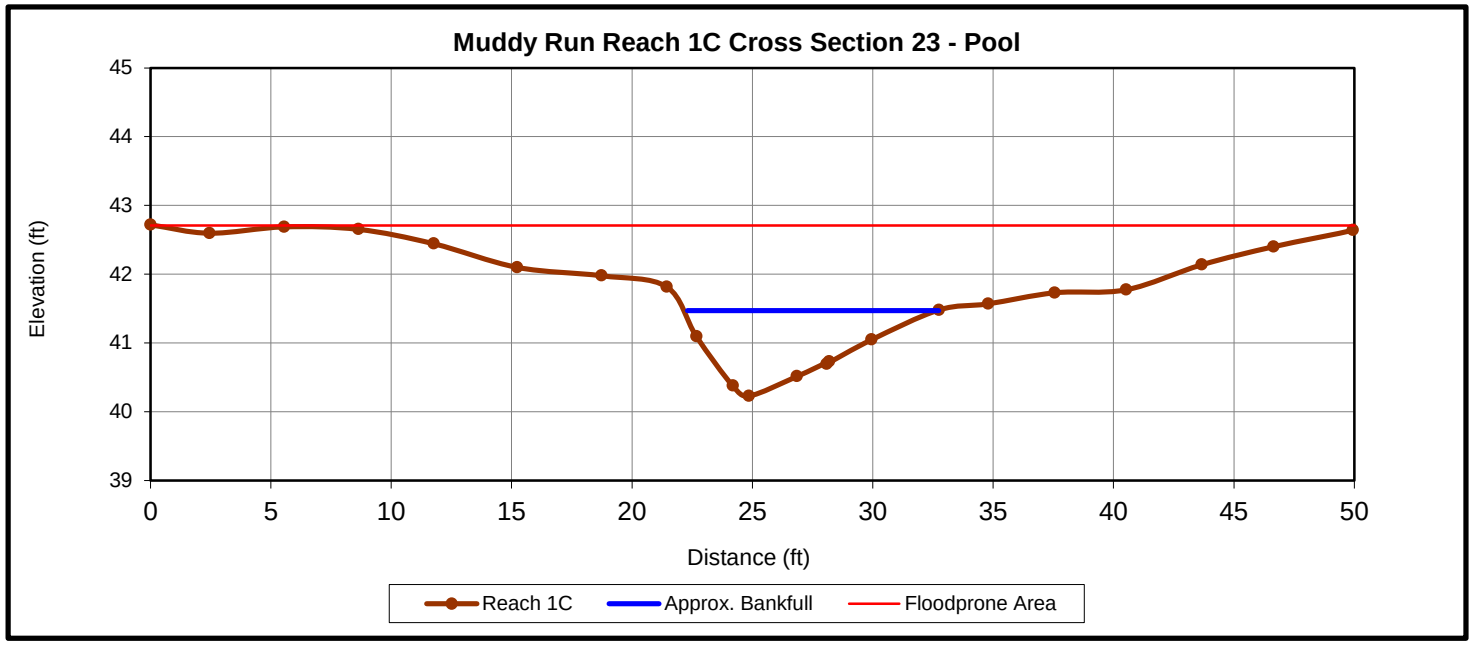
Upstream

Downstream



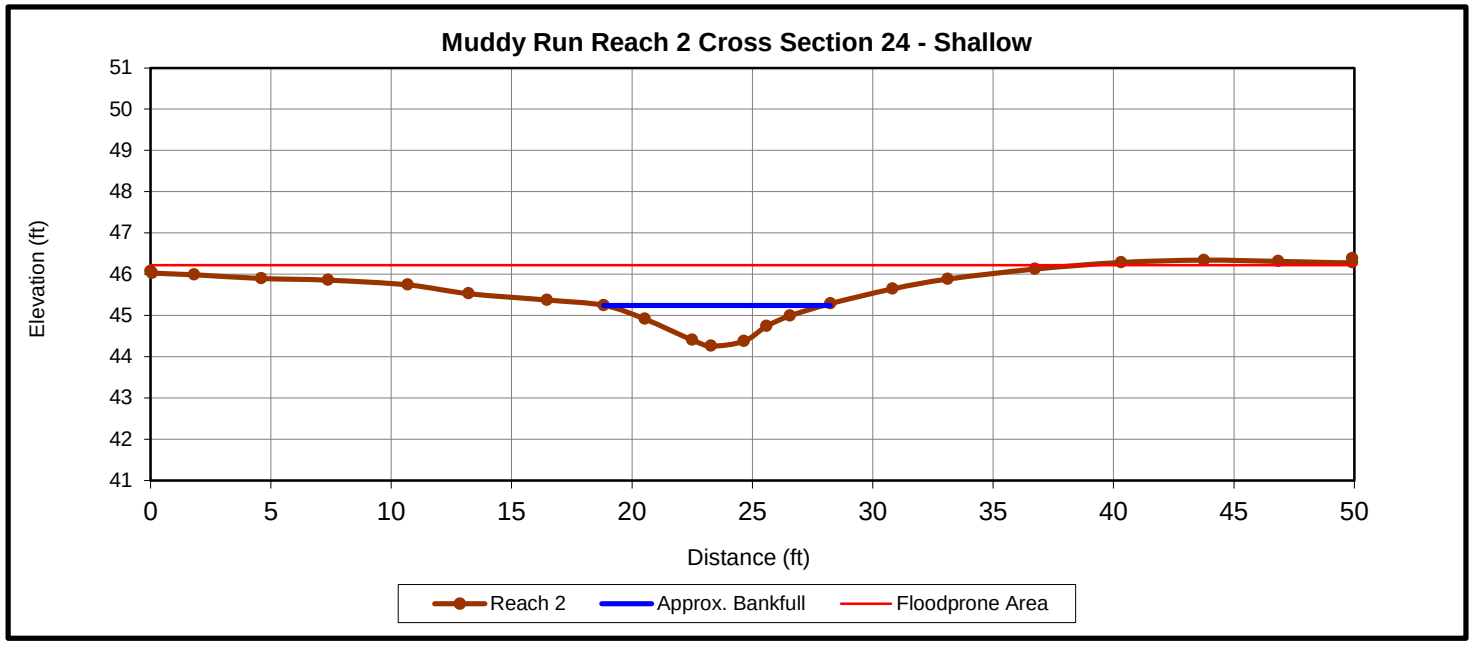
Upstream

Downstream



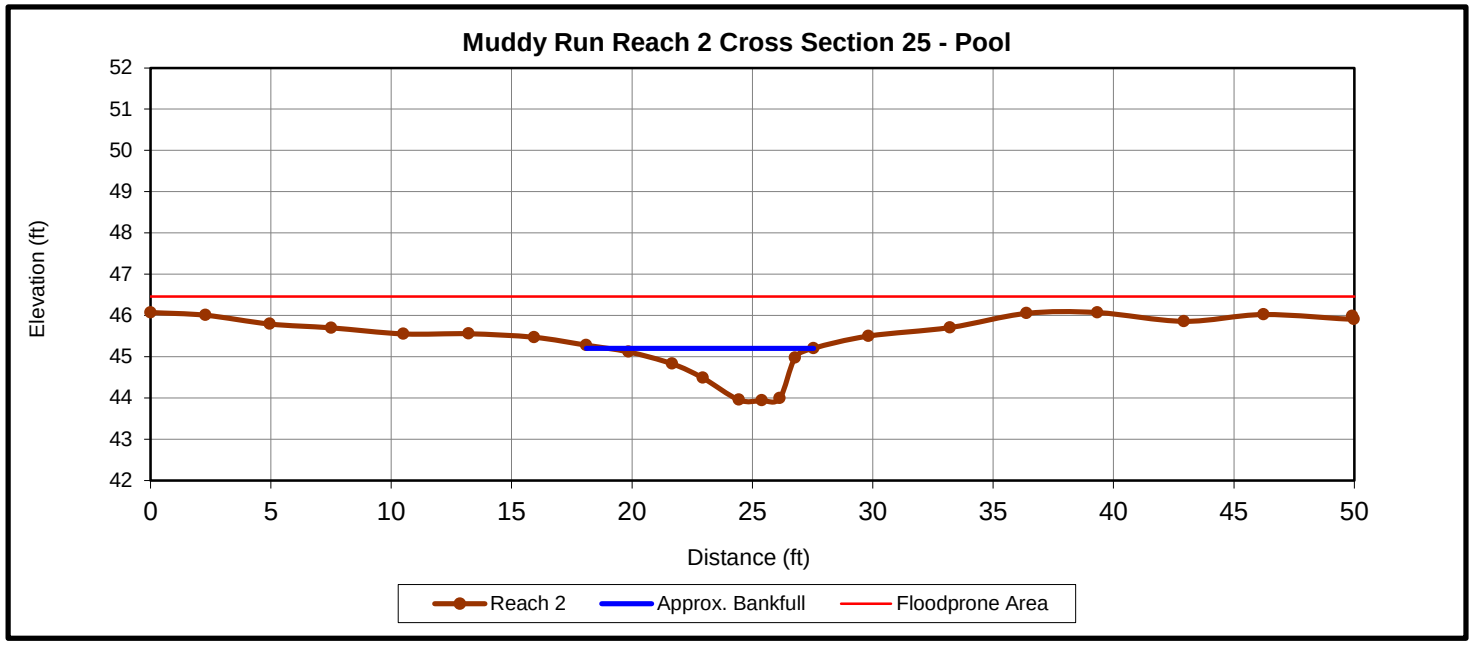
Upstream

Downstream



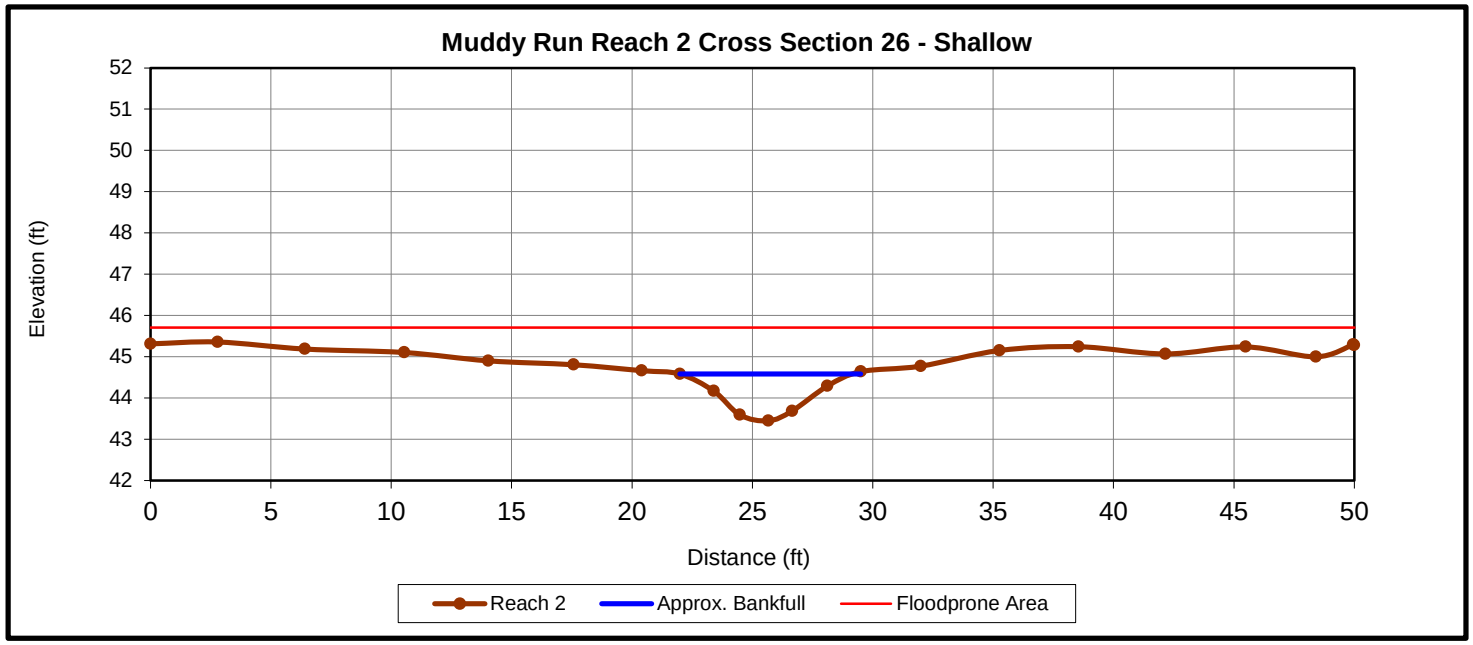
Upstream

Downstream



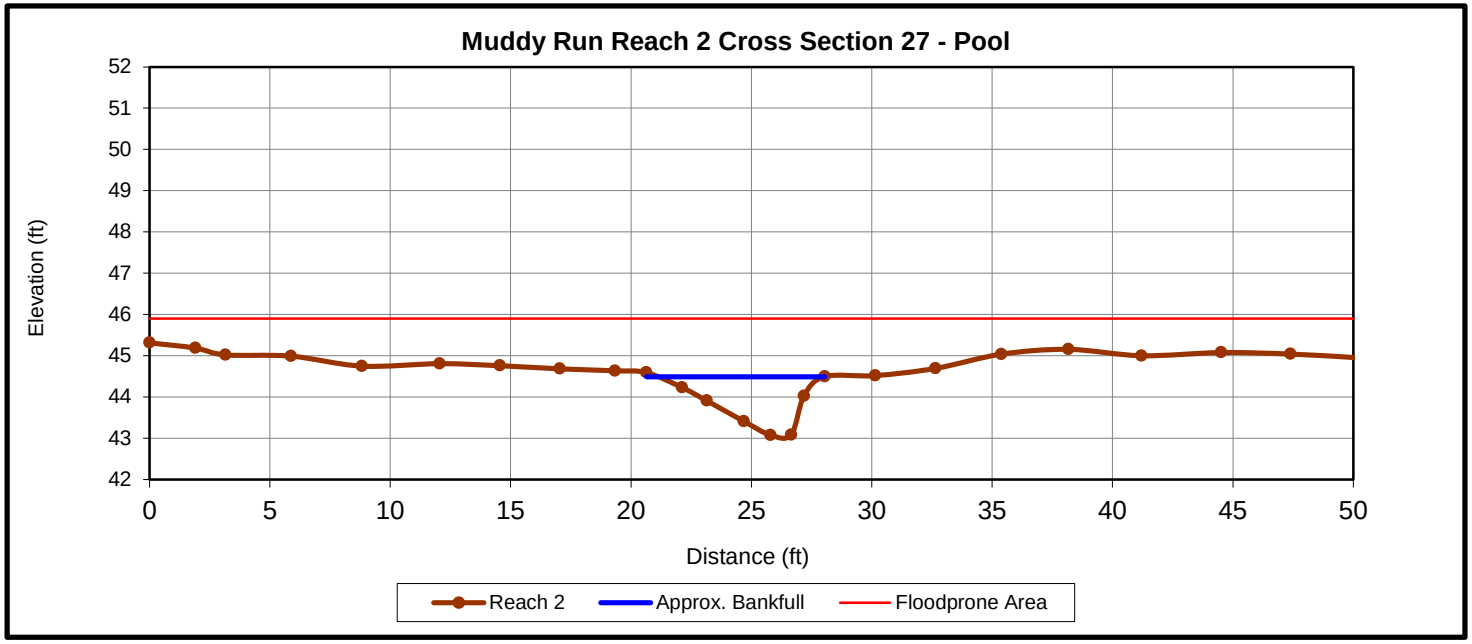
Upstream

Downstream



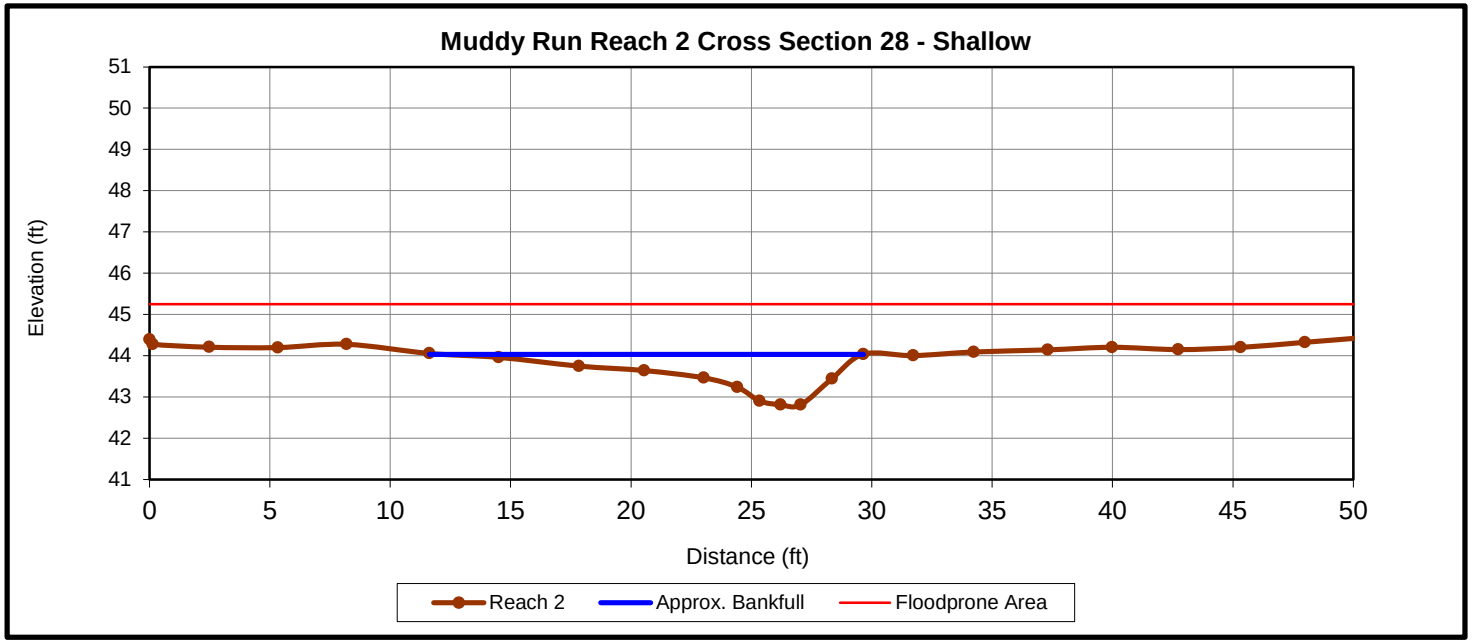
Upstream

Downstream



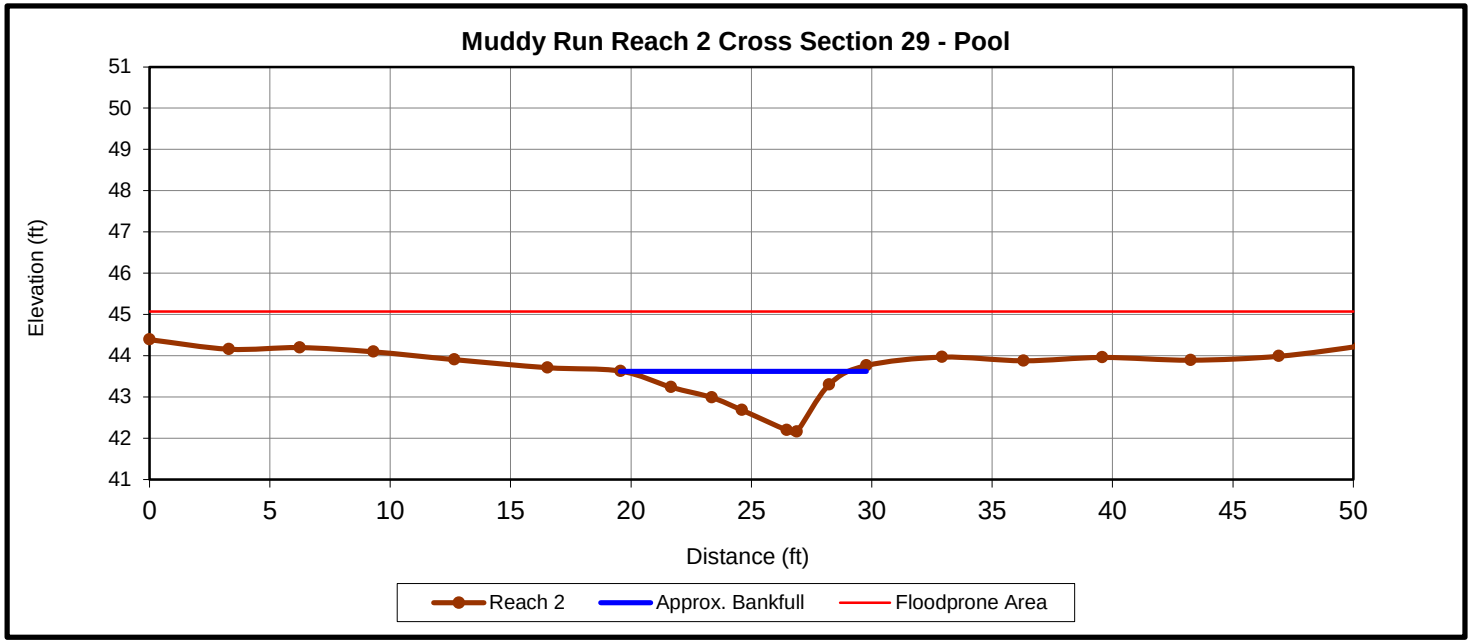
Upstream

Downstream



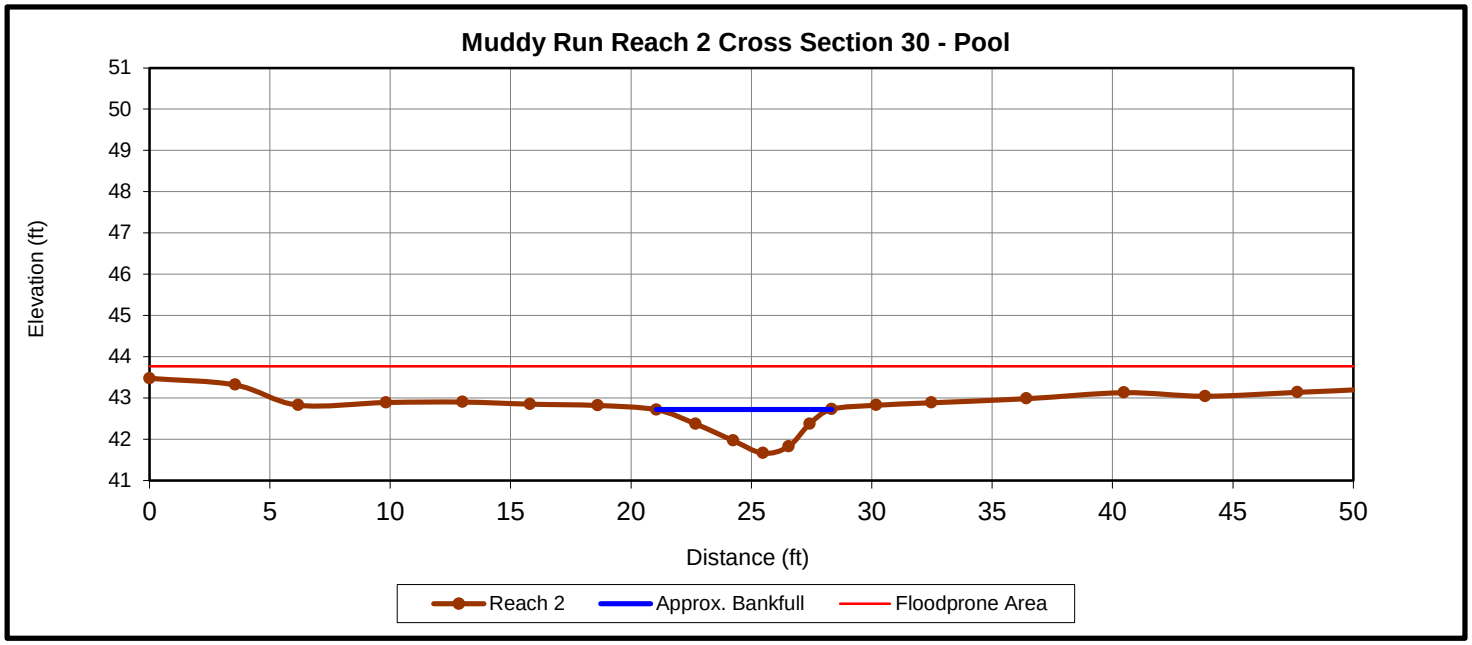
Upstream

Downstream

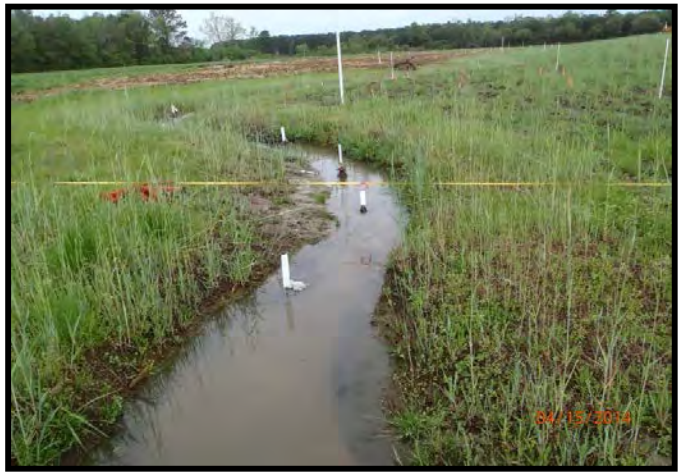


Upstream

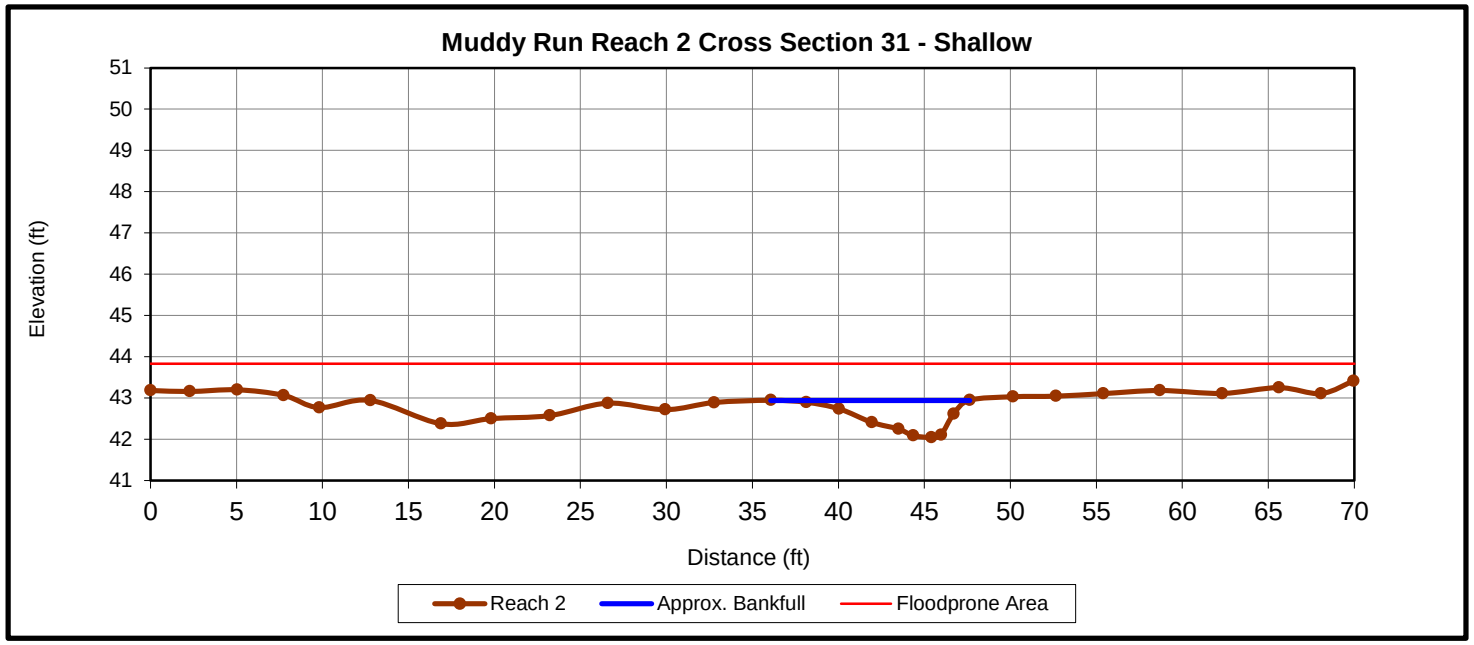
Downstream



Upstream

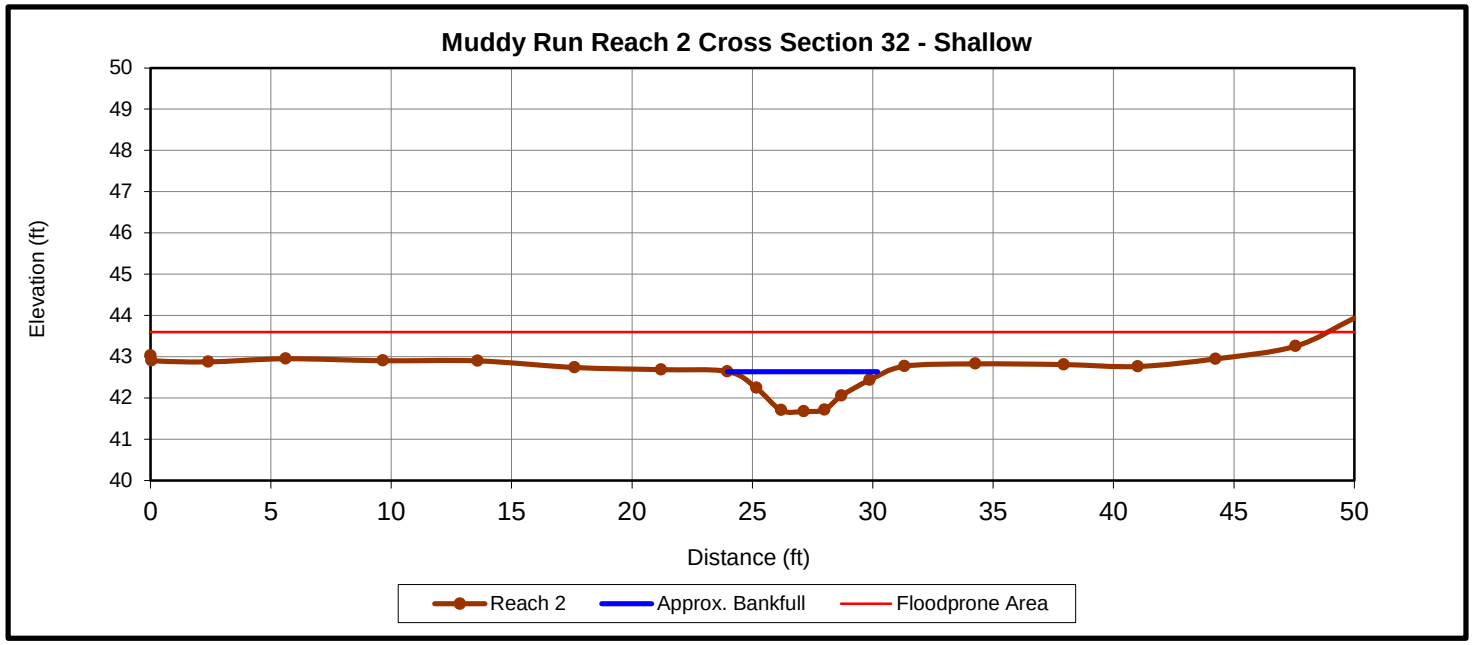


Downstream



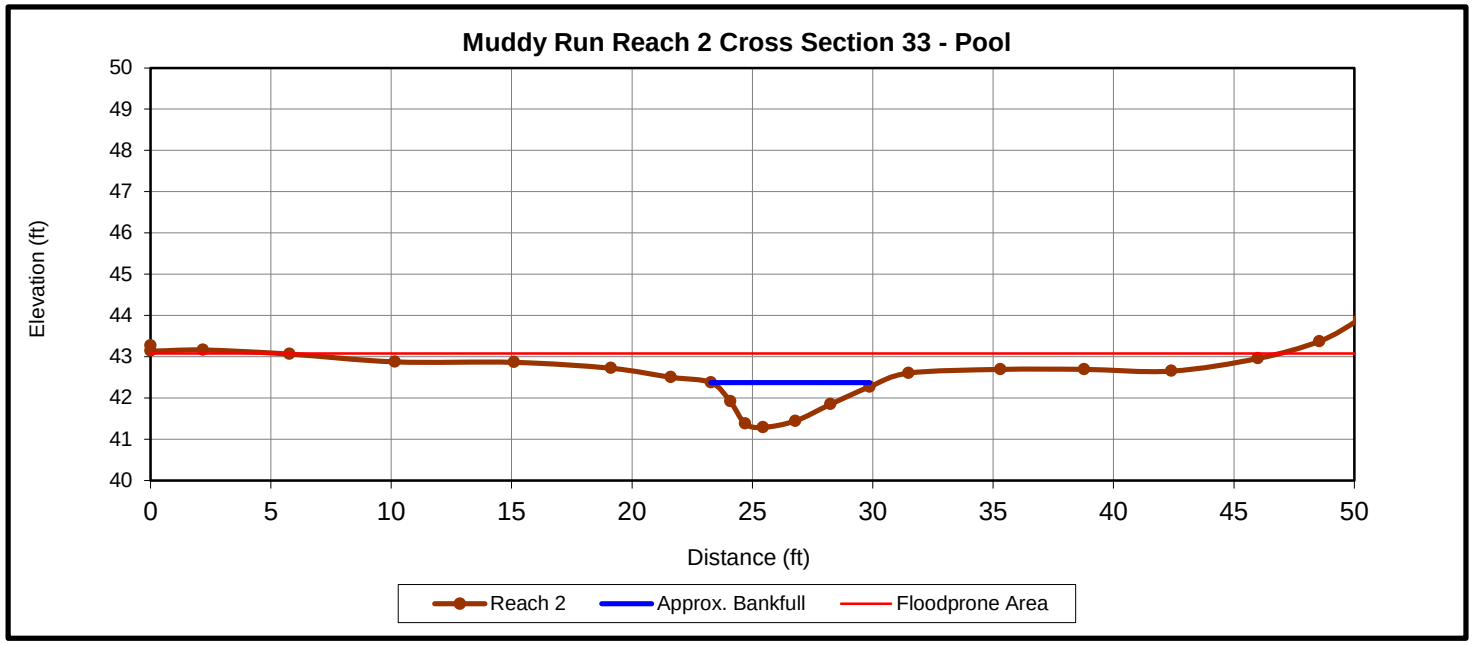
Upstream

Downstream



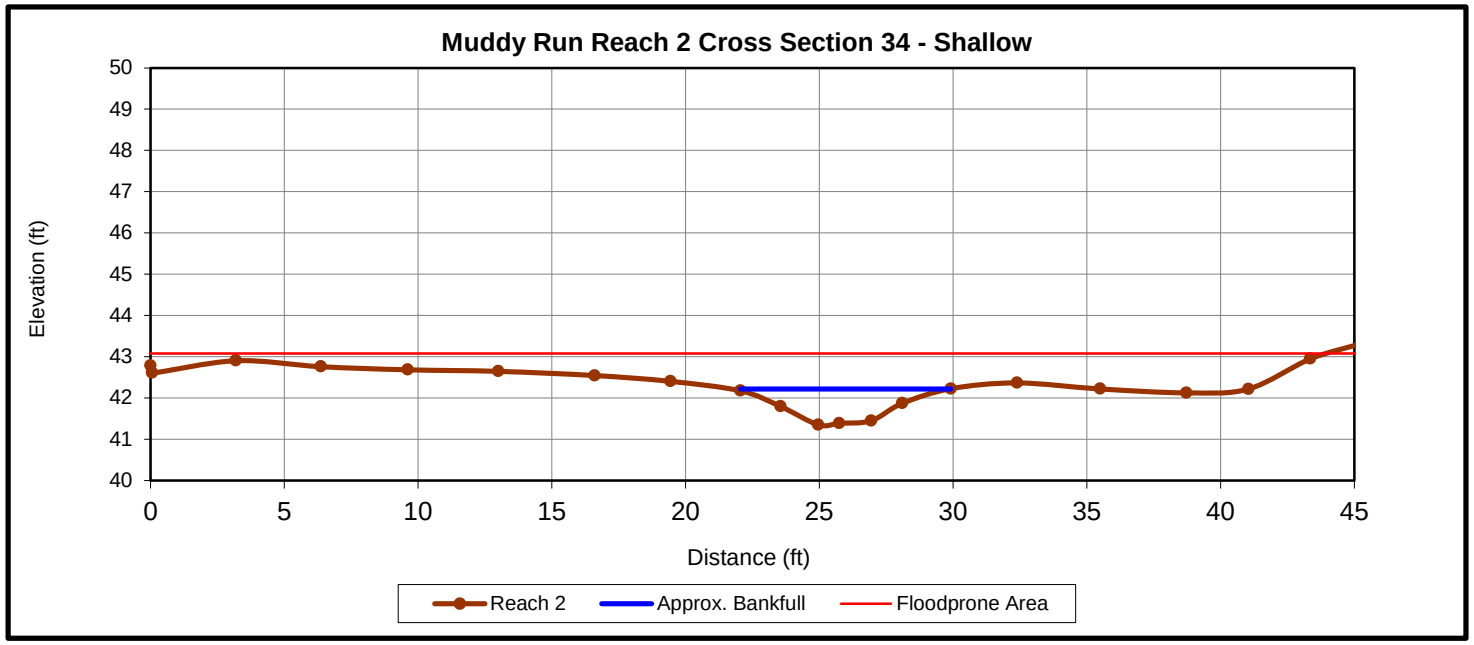
Upstream

Downstream



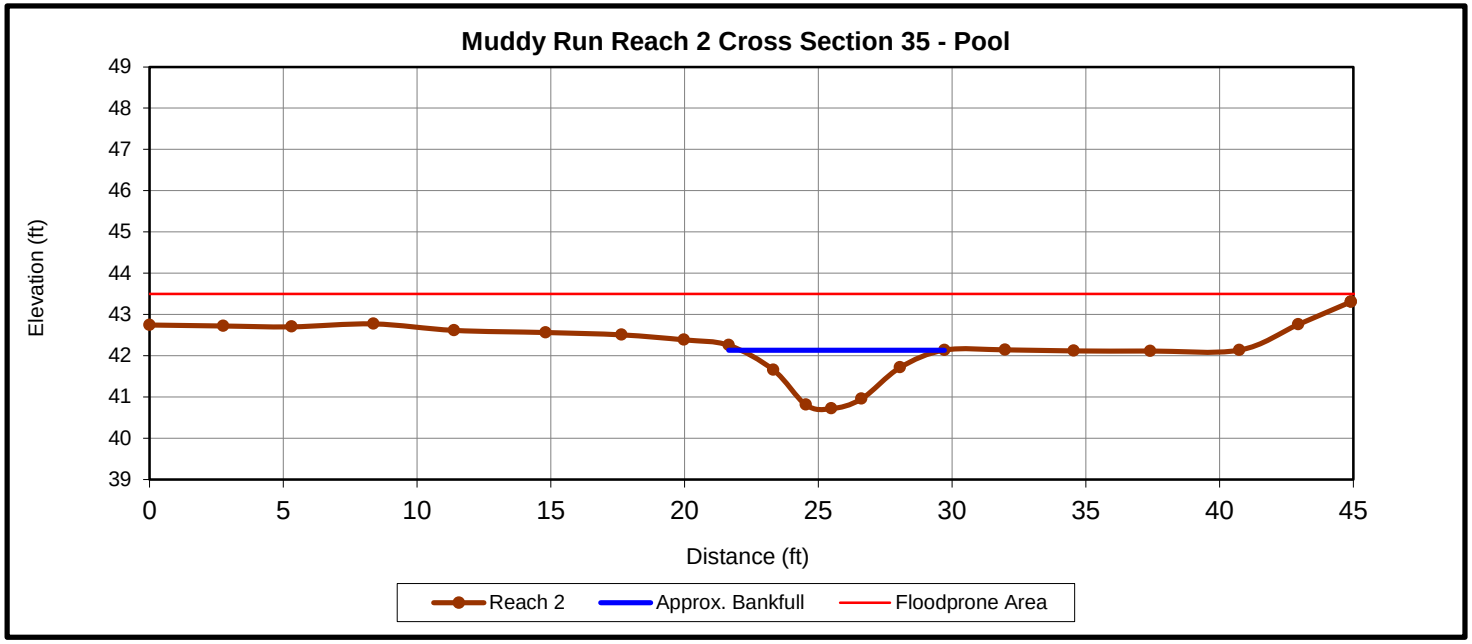
Upstream

Downstream



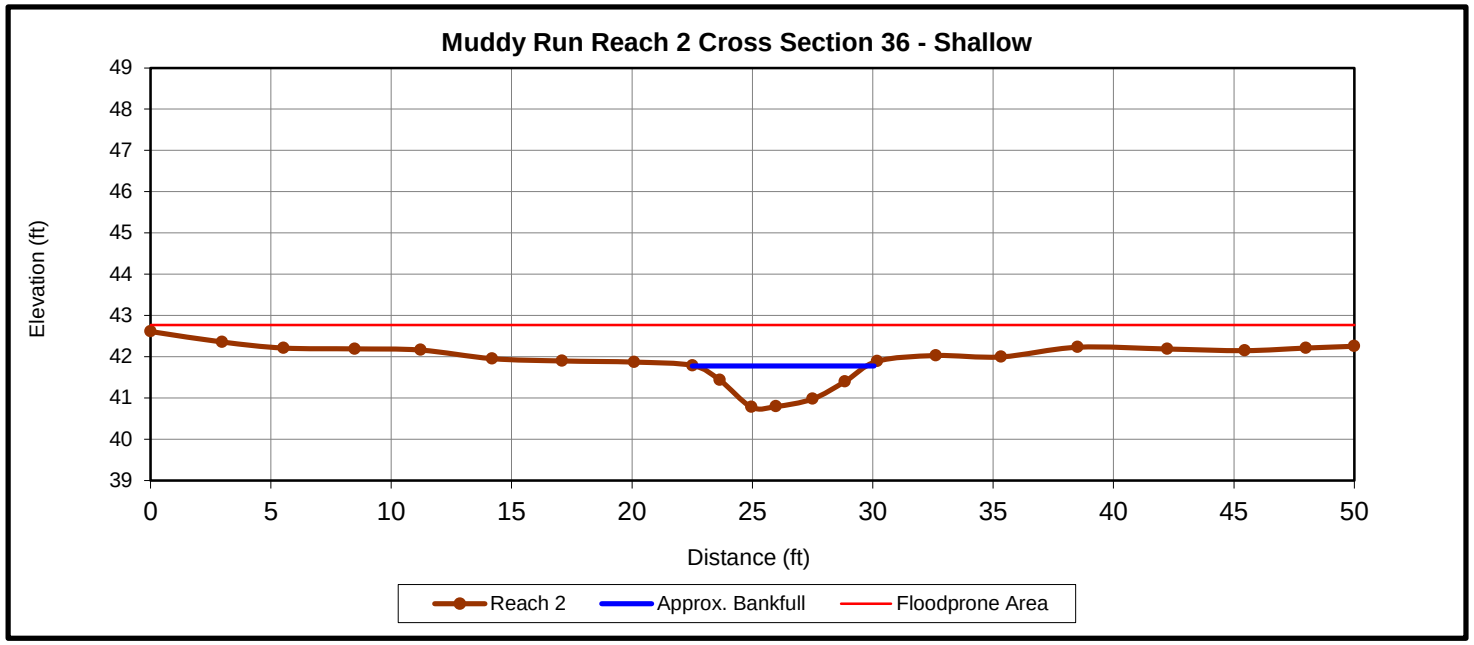
Upstream

Downstream



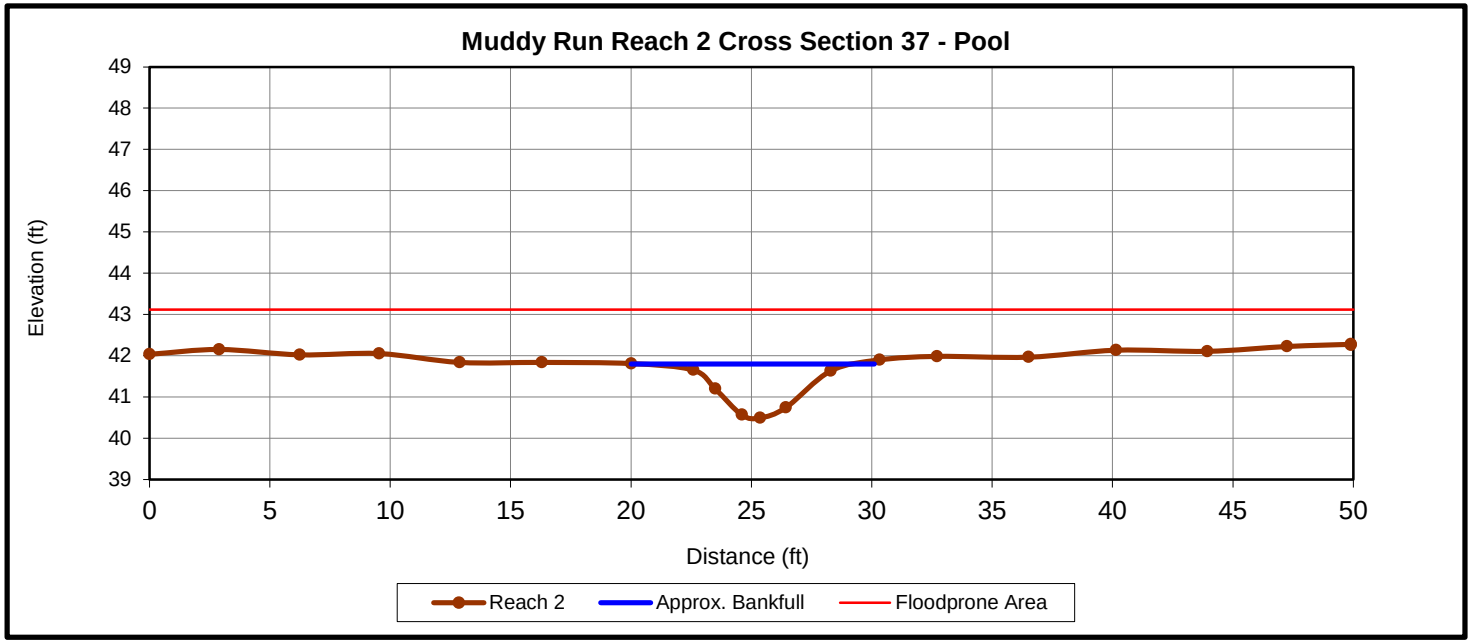
Upstream

Downstream



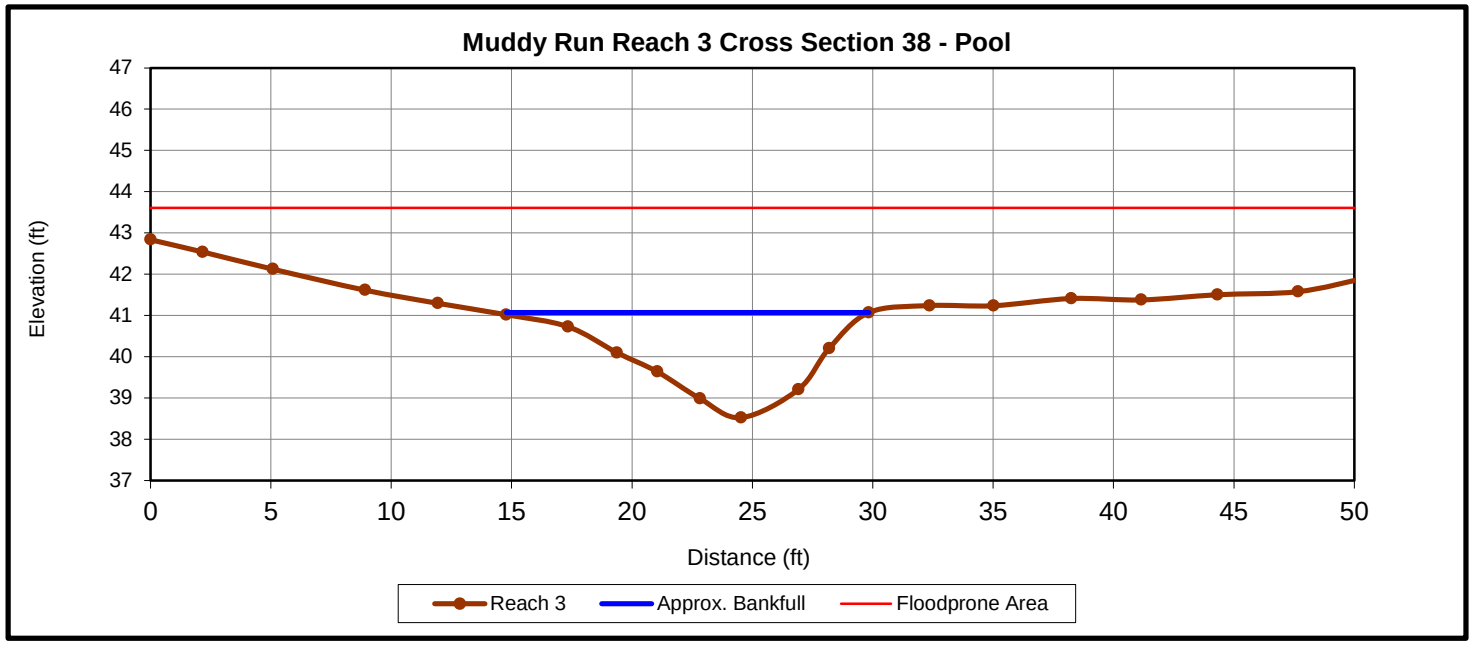
Upstream

Downstream



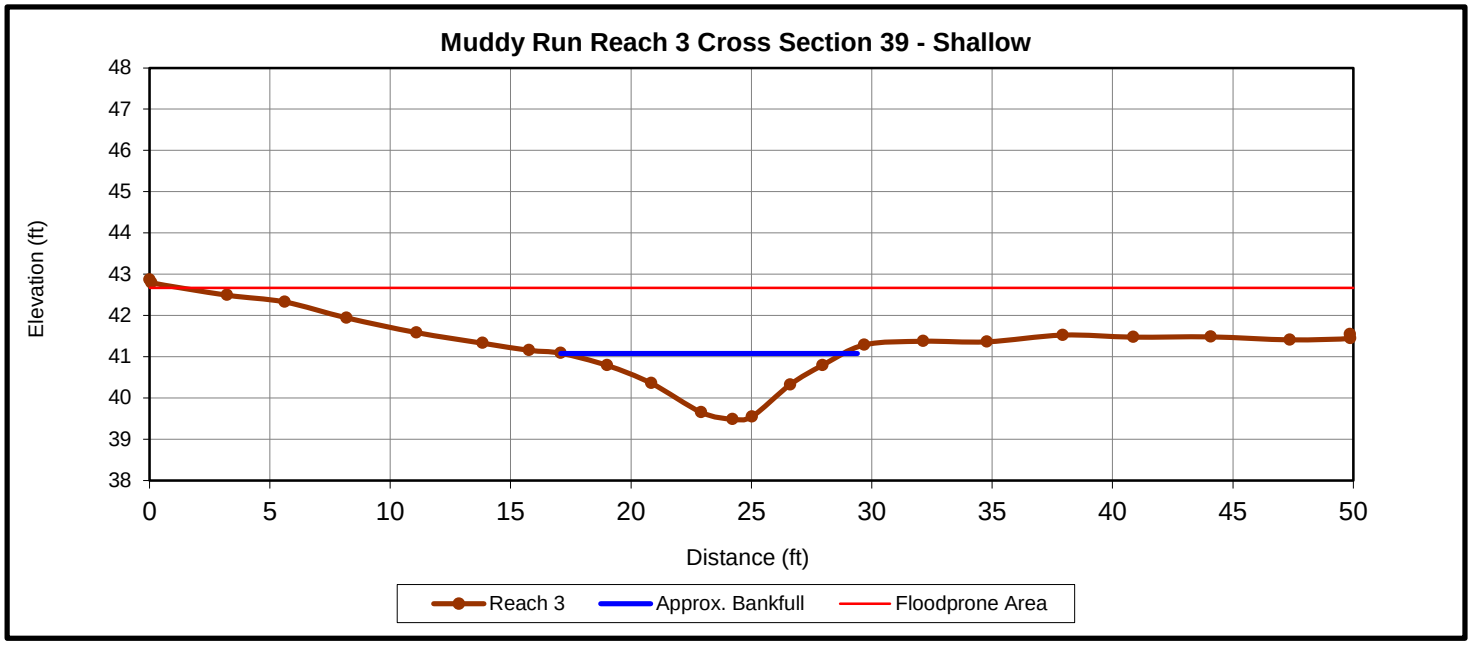
Upstream

Downstream



Upstream

Downstream



Appendix B - Stream Photos

Reach 1A HWV – Looking Downstream - Sta. 2+80 Construction (09/26/2013)

Reach 1A HWV – Looking Downstream - Sta. 2+80 Post-Construction (04/14/2014)

Reach 1A Looking Downstream Sta. 14+80 - Construction (09/26/2013)

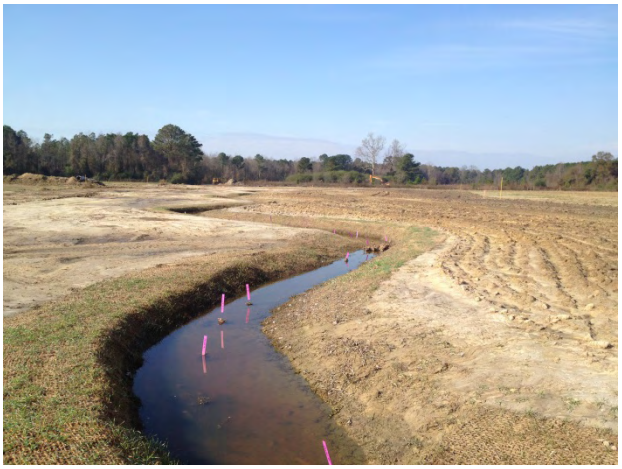
Reach 1A Looking Downstream Sta. 14+80 – Post-Construction (04/14/2014)

Reach 1A Looking Downstream Sta. 20+55 - Construction (10/03/2013)

Reach 1A Looking Downstream Sta. 20+55 – Post -Construction (04/14/2014)

Reach 1A/1B Looking Downstream Sta. 22+00 - Crossing (12/03/2013)

Reach 1B Looking Downstream Sta. 34+00 - Crossing (12/03/2013)



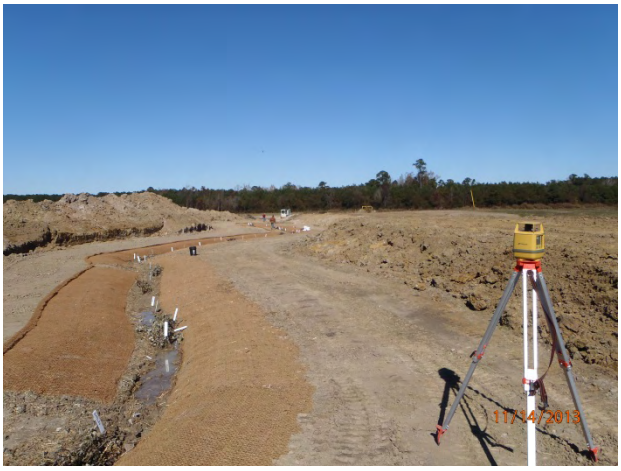
Reach 1C Looking Downstream Sta. 39+50 – Post -Construction (12/03/2013)

Reach 1C/2 Looking Downstream Sta. 45+50 – Confluence (12/03/2013)

Reach 1C/3 Looking Upstream Sta. 47+80 – Confluence (12/03/2013)

Reach 2 Looking Downstream Sta. 2+00 – Post - Construction (12/03/2013)

Reach 2 Looking Downstream Sta. 8+15 – Post - Construction (12/03/2013)



Reach 2 Looking Downstream Sta. 11+10 - Construction (11/14/2013)

Reach 2 Looking Upstream Sta. 16+10 - Construction (11/21/2013)

Reach 3 Looking Upstream Sta. 1+50 - Crossing (12/03/2013)

Reach 3 Looking Downstream Sta. 2+60 -Post-Construction (11/14/2013)

Reach 3 Looking Downstream Sta. 3+20 -Post-Construction (04/14/2014)

Crest Gauge 1 Reach 1A (04/15/2014)

Crest Gauge 1C Reach 1C (04/15/2014)

Crest Gauge 2 Reach 1C (04/15/2014)

Crest Gauge 3 Reach 1C (04/15/2014)

Appendix C

Vegetation Plot Data

Tables 7a – 7c.

Vegetation Plot Photos

Appendix C. Vegetation Plot Data

Muddy Run Stream Restoration Project - (NCEEP Project # 95018)

Table 7a. Baseline Planted Stem Count Summary

Vegetation Plot	Stems Planted	Stems/Acre Baseline
1	16	800
2	15	750
3	17	850
4	14	700
5	14	700
6	15	750
7	17	850
8	16	800
9	13	650
10	16	800
11	17	850
12	14	700
13	16	800
14	17	850
15	18	900
16	16	800
17	18	900
18	16	800
19	14	700
20	15	750
Average	**15.7**	**785**
Min	**13**	**650**
Max	**18**	**900**

Table 7b. Planted Species Totals

Species	Common Name	Total Planted
Trees - Bare Root		
Taxodium distichum	Bald Cypress	2,000
Fraxinus pennsylvanica	Green Ash	1,900
Quercus lyrata	Overcup Oak	1,600
Betula nigra	River birch	1,600
Quercus michauxii	Swamp Chestnut Oak	2,000
Nyssa biflora	Swamp Tupelo	1,800
Plantanus occidentalis	American Sycamore	2,000
Quercus laurifolia	Laurel Oak	1,600
	Total	**14,500**
Live Stakes		
Salix nigra	Black Willow	3,000
	Total	**3,000**

Table 7c. Planted and Total Stem Counts (Species by Plot)

		Vegetation Plot 1						Vegetation Plot 2						Vegetation Plot 3						Vegetation Plot 4						Vegetation Plot 5					
Species	**Common Name**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
Taxodium distichum	Bald Cypress	5												6												2					
Fraxinus pennsylvanica	Green Ash	3						1						3						1											
Quercus sp.	Unknown Oak sp.	1																								2					
Quercus lyrata	Overcup Oak																			1											
Betula nigra	River birch	5						2						1						1											
Quercus michauxii	Swamp Chestnut Oak	1												3						6						1					
Nyssa biflora	Swamp Tupelo							4						1						2						5					
Plantanus occidentalis	American Sycamore	1						8						2						3						2					
Quercus laurifolia	Laurel Oak													1												2					
	Species Count	**6**						**4**						**7**						**6**						**6**					
	Stem Count	**16**						**15**						**17**						**14**						**14**					
	Stems per Acre	**800**						**750**						**850**						**700**						**700**					

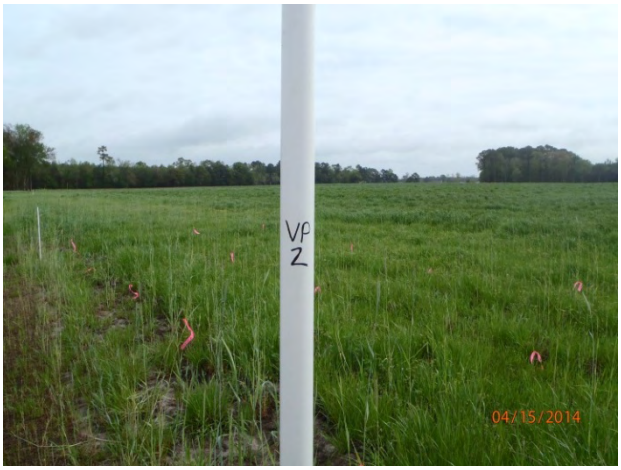
		Vegetation Plot 6						Vegetation Plot 7						Vegetation Plot 8						Vegetation Plot 9						Vegetation Plot 10					
Species	**Common Name**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
Taxodium distichum	Bald Cypress	1						1						1						1						5					
Fraxinus pennsylvanica	Green Ash	1												5						2											
Quercus sp.	Unknown Oak sp.	2												1												1					
Quercus lyrata	Overcup Oak							3						1																	
Betula nigra	River birch																									1					
Quercus michauxii	Swamp Chestnut Oak	2						7						1						1						1					
Nyssa biflora	Swamp Tupelo	1						4																		1					
Plantanus occidentalis	American Sycamore	1												2						6						3					
Quercus laurifolia	Laurel Oak	7						2						5						3						4					
	Species Count	**7**						**5**						**7**						**5**						**7**					
	Stem Count	**15**						**17**						**16**						**13**						**16**					
	Stems per Acre	**750**						**850**						**800**						**650**						**800**					

		Vegetation Plot 11						Vegetation Plot 12						Vegetation Plot 13						Vegetation Plot 14						Vegetation Plot 15					
Species	**Common Name**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
Taxodium distichum	Bald Cypress	4						5						5						5											
Fraxinus pennsylvanica	Green Ash	2																		1						3					
Quercus sp.	Unknown Oak sp.	1						3												1						3					
Quercus lyrata	Overcup Oak	1																		1						1					
Betula nigra	River birch							2																		1					
Quercus michauxii	Swamp Chestnut Oak	1						3						1												4					
Nyssa biflora	Swamp Tupelo	1						1						7						3						5					
Plantanus occidentalis	American Sycamore	5												3						3											
Quercus laurifolia	Laurel Oak	2																		3						1					
	Species Count	**8**						**5**						**4**						**7**						**7**					
	Stem Count	**17**						**14**						**16**						**17**						**18**					
	Stems per Acre	**850**						**700**						**800**						**850**						**900**					

		Vegetation Plot 16						Vegetation Plot 17						Vegetation Plot 18						Vegetation Plot 19						Vegetation Plot 20					
Species	**Common Name**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
Taxodium distichum	Bald Cypress	5						3												6											
Fraxinus pennsylvanica	Green Ash																									7					
Quercus sp.	Unknown Oak sp.	1						2																		2					
Quercus lyrata	Overcup Oak	1						1						1												1					
Betula nigra	River birch	3						1												1						1					
Quercus michauxii	Swamp Chestnut Oak													5																	
Nyssa biflora	Swamp Tupelo	1						9						3						6						3					
Plantanus occidentalis	American Sycamore	2						1						2												1					
Quercus laurifolia	Laurel Oak	3						1						5						1											
	Species Count	**7**						**7**						**5**						**4**						**6**					
	Stem Count	**16**						**18**						**16**						**14**						**15**					
	Stems per Acre	**800**						**900**						**800**						**700**						**750**					

Vegetation Plot Photos

Vegetation Plot 1 (04/15/2014)



Vegetation Plot 2 (04/15/2014)

Vegetation Plot 3 (04/15/2014)

Vegetation Plot 4 (04/15/2014)

Vegetation Plot 5 (04/15/2014)

Vegetation Plot 6 (04/15/2014)

Vegetation Plot 7 (04/15/2014)

Vegetation Plot 8 (04/15/2014)

Vegetation Plot 9 (04/15/2014)

Vegetation Plot 10 (04/15/2014)

Vegetation Plot 11 (04/15/2014)

Vegetation Plot 12 (04/15/2014)

Vegetation Plot 13 (04/15/2014)

Vegetation Plot 14 (04/15/2014)

Vegetation Plot 15 (04/15/2014)

Vegetation Plot 16 (04/15/2014)

Vegetation Plot 17 (04/15/2014)

Vegetation Plot 18 (04/15/2014)

Vegetation Plot 19 (04/15/2014)

Vegetation Plot 20 (04/15/2014)

Appendix D

As-Built Survey

Construction Bulletin Drawing

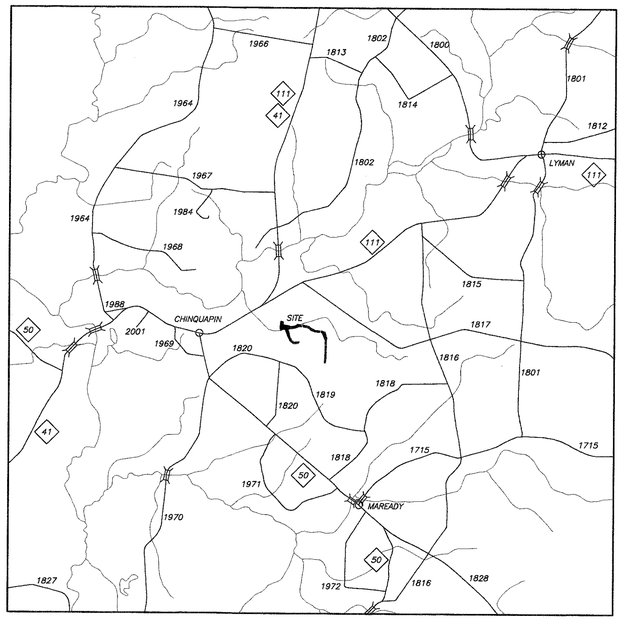
NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, PLLC.

MUDDY RUN STREAM RESTORATION PROJECT
DUPLIN COUNTY, NORTH CAROLINA

CAPE FEAR RIVER BASIN
HUC 003000706001O

NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM
PROJECT ID 95018 Contract #003981

AS-BUILT SURVEY



VICINITY MAP
NOT TO SCALE

PROJECT COORDINATES:
LATITUDE: 34.830843° N
LONGITUDE: -77.792838° W

PROJECT DIRECTORY

DESIGNER:
WK DICKSON AND CO., INC.
720 CORPROATE CENTER DRIVE
RALEIGH, NC 27607
(919)782-0495
CONTACT: DANIEL INGRAM

CONSTRUCTION CONTRACTOR:
GP JENKINS
6566 HWY 55 W
KINSTON, NC 28504
(252)569-1222

FULL DELIVERY PROVIDER:
ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE, SUITE 3100
RALEIGH, NC 27606
(919)829-9909
CONTACT: DAVID GODLEY

MONITORING PERFORMERS:
WK DICKSON AND CO., INC.
720 CORPROATE CENTER DRIVE
RALEIGH, NC 27607
(919)782-0495

SURVEYING:
MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
(252)522-2500

SHEET INDEX

SEAL
NORTH CAROLINA PROFESSIONAL L-4189 LAND SURVEYOR CHRISTOPHER K. PADERICK
7/22/14

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 031435 ENGINEER ANNE C. COUCH
7/23/14

COVER SHEET

MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

SCALE		DEPARTMENT
DRAWN BY	DATE STARTED	SHEET No.
CKP	4-28-14	1 OF 20
APPROVED		DRAWING NO.
CKP		S-1
DRAWING NAME		
MR1-Asbuilt-Revised.dwg		
PROJECT NO.		
20110047		

NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, PLLC.

LEGEND

C/L =CENTERLINE
R/W =RIGHT OF WAY
CMP =CORRUGATED METAL PIPE
HDPE =HIGH DENSITY POLYETHYLENE PIPE
XS =CROSS SECTION
VP =VEGETATION PLOT
◯ =RAIN GAUGE
RG =RAIN GAUGE
◎ =CREST GAUGE
CG =CREST GAUGE
● =AUTO-CREST GAUGE
ACG =AUTO-CREST GAUGE
⊗ =WOODY DEBRIS BUNDLE
=LOG GRADE CONTROL
=LOG STRUCTURE
=LOG TOE PROTECTION
=BEDDED LOG STRUCTURE
=DIFFUSE FLOW STRUCTURE
=CONSERVATION EASEMENT LINE
=BOUNDARY LINE
=BOUNDARY/CONSERVATION EASEMENT LINE
=WOODLINE

SEAL
NORTH CAROLINA PROFESSIONAL LAND SURVEYOR L-4189 CHRISTOPHER K. PADRICK
7/22/14

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 031445 ENGINEER ANN P. MULLEN
7/23/14

Legend

MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

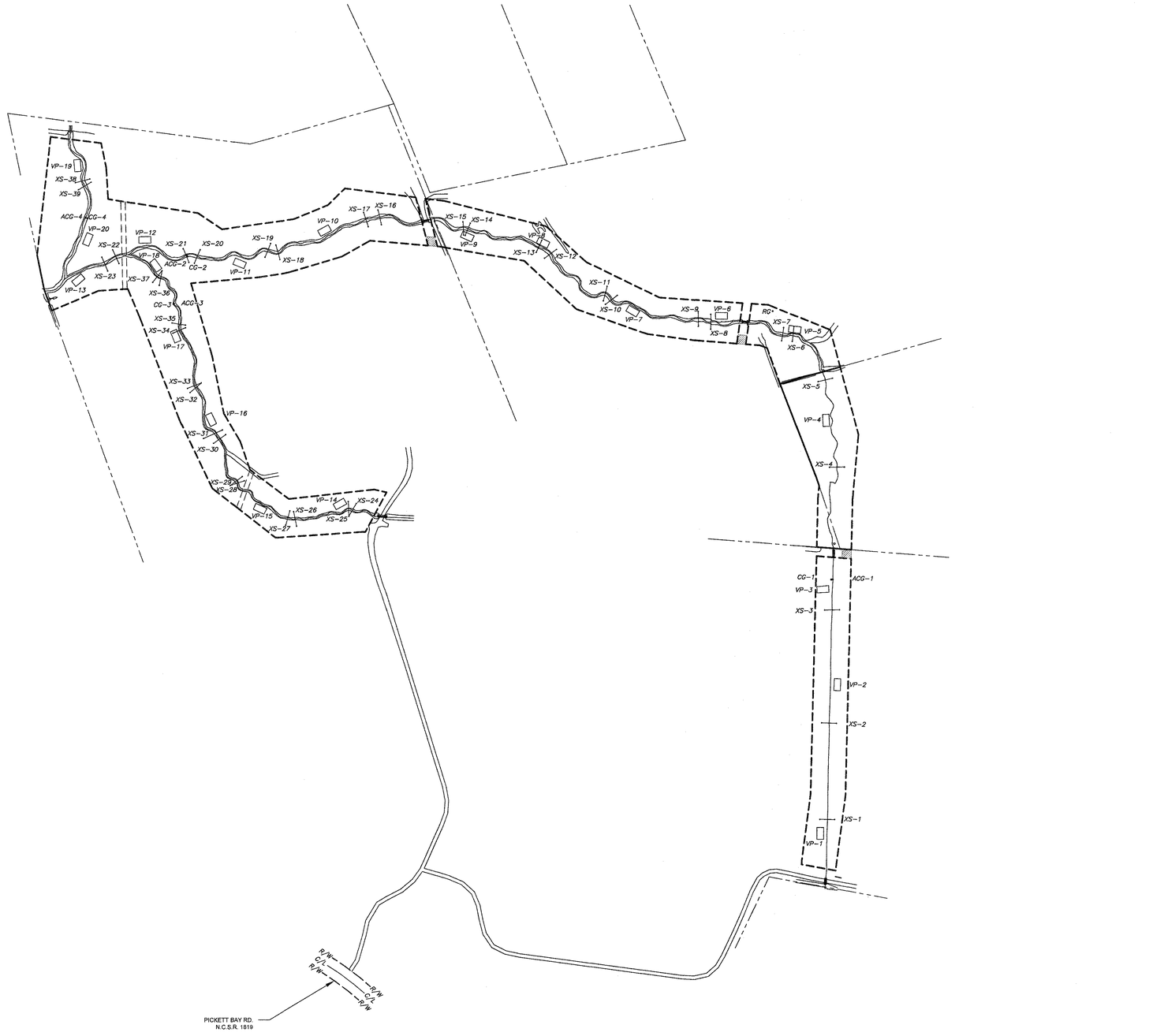
MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

SCALE	DEPARTMENT
DRAWN BY: CKP / DATE STARTED: 4-28-14	SHEET No.: 2 OF 20
APPROVED: CKP	DRAWING NO.: S-2
DRAWING NAME: MR1-Asbuilt-Revised.dwg	
PROJECT NO.: 20110047	

NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, P.L.L.C.

NAD 83(2007)



SEAL

NORTH CAROLINA PROFESSIONAL SEAL L-4189 LAND SURVEYOR CHRISTOPHER K. PADERICK
7/22/14

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 034235 ENGINEER ANITA A. MULLEN
7/23/14

STREAM MONITORING OVERVIEW

MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

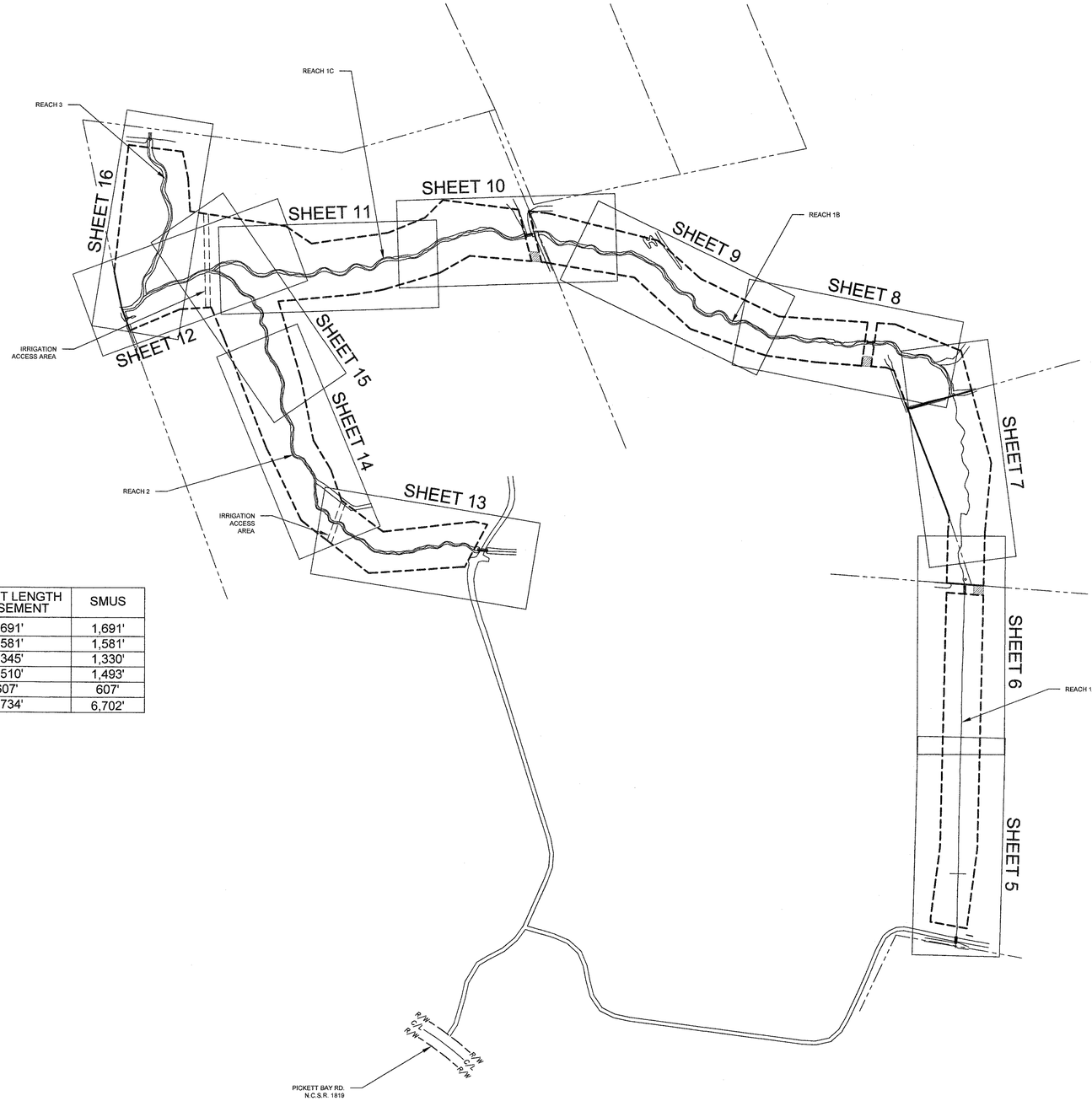
MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

SCALE 1" = 200'		DEPARTMENT
DRAWN BY CKP	DATE STARTED 4-28-14	SHEET No. 3 OF 20
APPROVED CKP		DRAWING NO. S-3
DRAWING NAME MR1-Asbuilt-Revised.dwg		
PROJECT NO. 20110047		

NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, P.L.L.C.

NAD 83(2007)



REACH	MITIGATION TYPE	AS-BUILT LENGTH IN EASEMENT	SMUS
1A	HWV RESTORATION	1,691'	1,691'
1B	P1 RESTORATION	1,581'	1,581'
1C	P1 RESTORATION	1,345'	1,330'
2	P1 RESTORATION	1,510'	1,493'
3	P1 RESTORATION	607'	607'
	TOTAL	6,734'	6,702'

SEAL
NORTH CAROLINA PROFESSIONAL SEAL LAND SURVEYOR CHRISTOPHER K. PADEN
7/22/14

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 031435 ENGINEER ANN E. MULLEN
7/23/14

STREAM BASELINE OVERVIEW

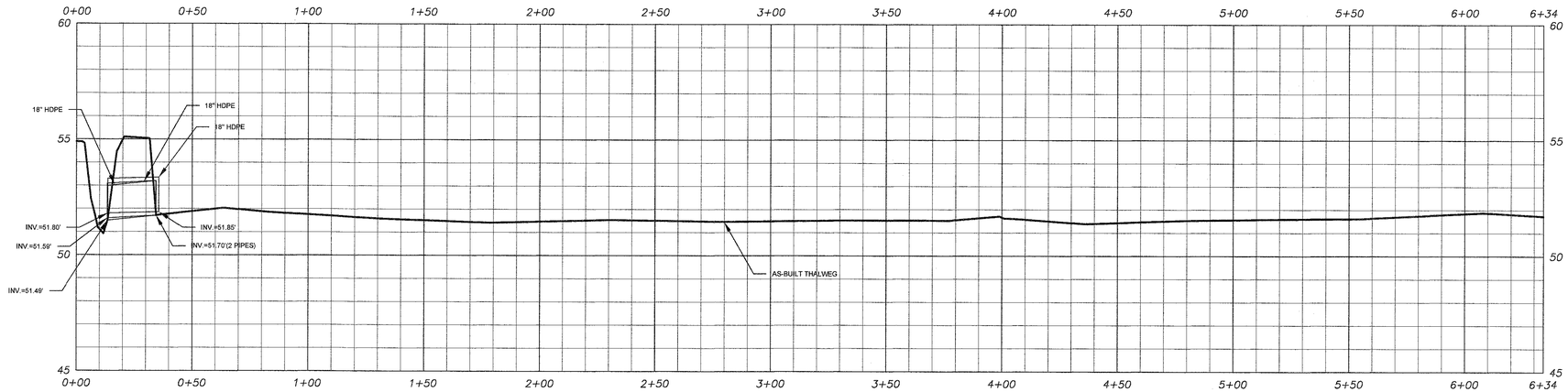
MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

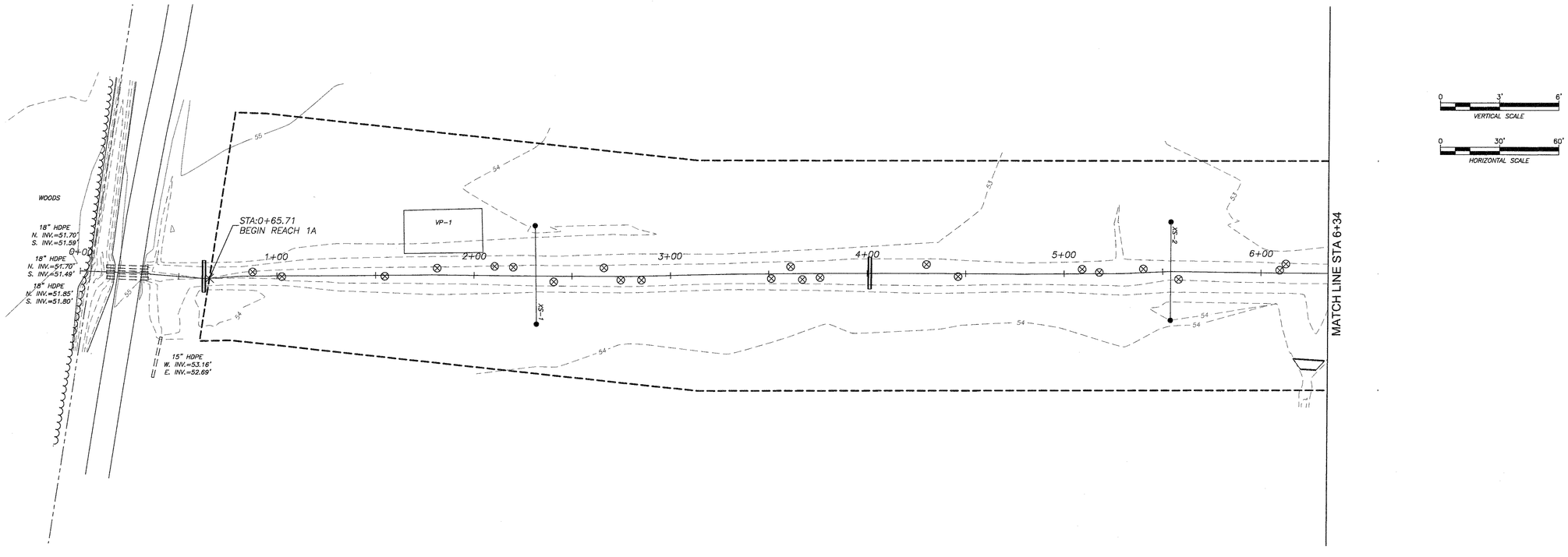
ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

SCALE 1" = 200'		DEPARTMENT
DRAWN BY CKP	DATE STARTED 4-28-14	SHEET No. 4 OF 20
APPROVED CKP		DRAWING NO. S-4
DRAWING NAME MR1-Asbuilt-Revised.dwg		
PROJECT NO. 20110047		

NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, PLLC.



NAD 83(2007)



0 3' 6'
VERTICAL SCALE

0 30' 60'
HORIZONTAL SCALE

SEAL
NORTH CAROLINA PROFESSIONAL SEAL L-4682 LAND SURVEYOR CHRISTOPHER K. PADERA
1/22/14

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 031435 ENGINEER ANN E. MULLEN
7/23/14

STREAM BASELINE AS-BUILT
REACH 1 PLAN & PROFILE (STA 0+00 - 6+34)

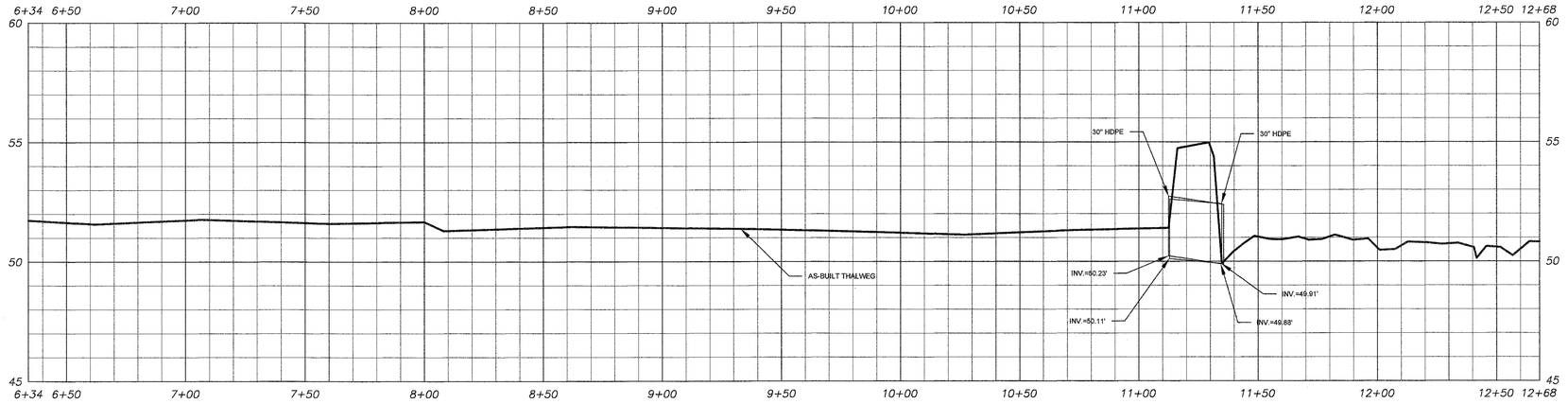
MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

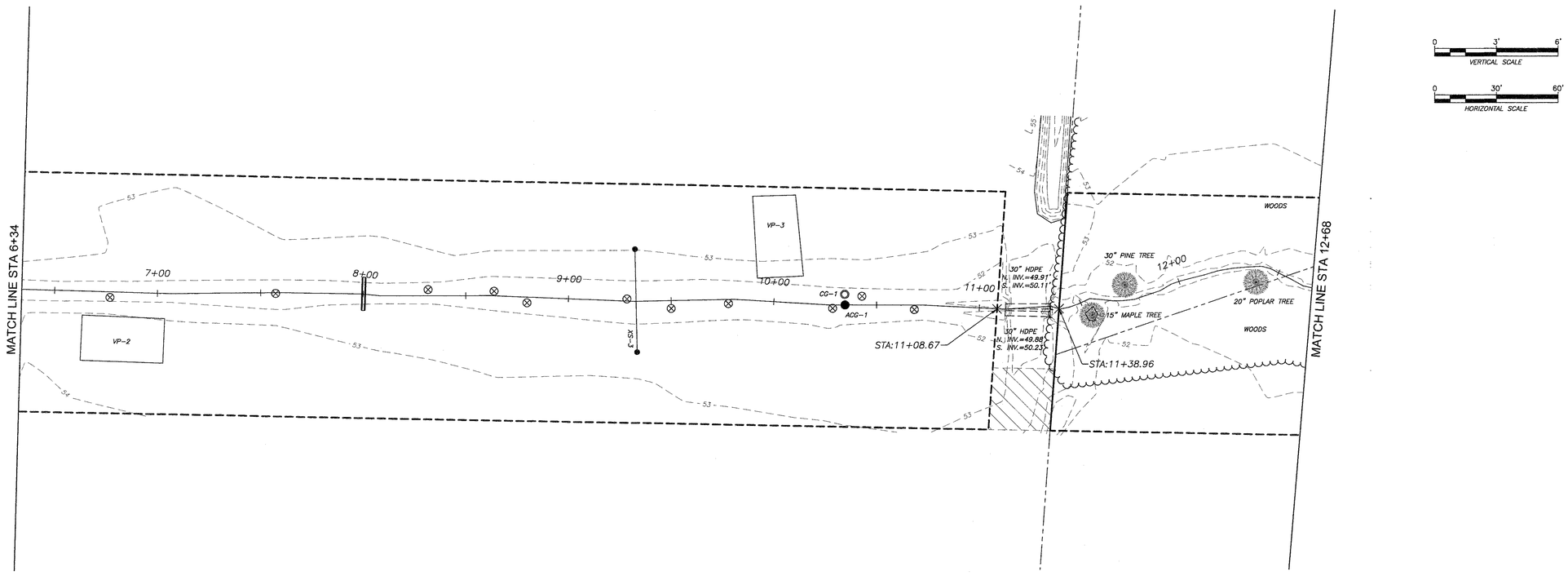
ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

SCALE: 1" = 30'		DEPARTMENT:	
DRAWN BY: CKP	DATE STARTED: 4-28-14	SHEET No.: 5 OF 20	
APPROVED: CKP		DRAWING NO.: S-5	
DRAWING NAME: MR1-Asbuilt-Revised.dwg			
PROJECT NO.: 20110047			

NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, PLLC.



NAD 83(2007)



SEAL
NORTH CAROLINA PROFESSIONAL LAND SURVEYOR L-4165 CHRISTOPHER K. PADERICK
1/22/14

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 035458 ENGINEER ANN F. MULLEN
7/30/14

STREAM BASELINE AS-BUILT
REACH 1 PLAN & PROFILE (STA 6+34 - 12+68)

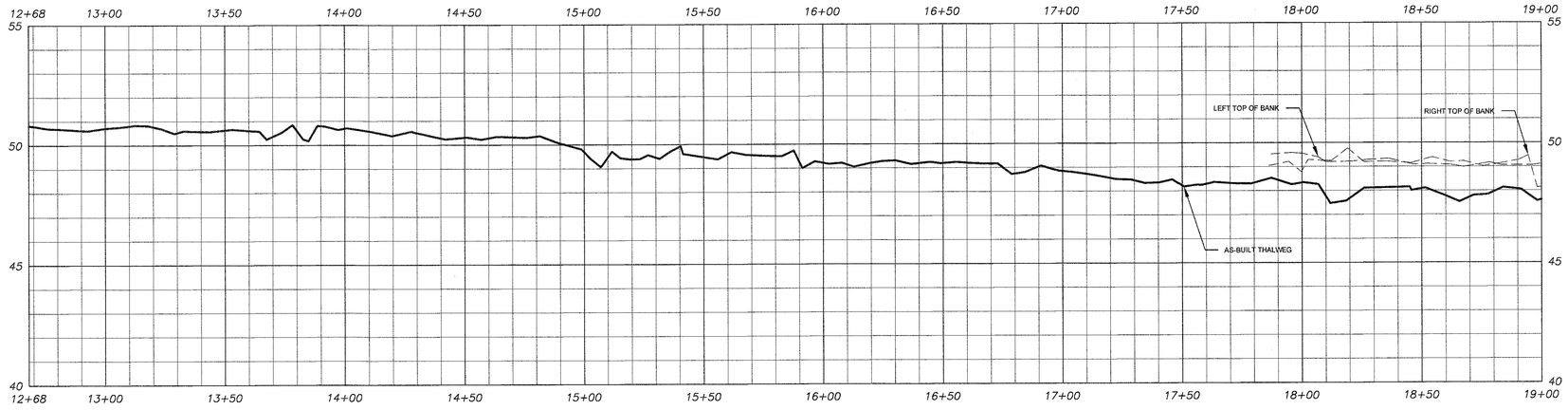
MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

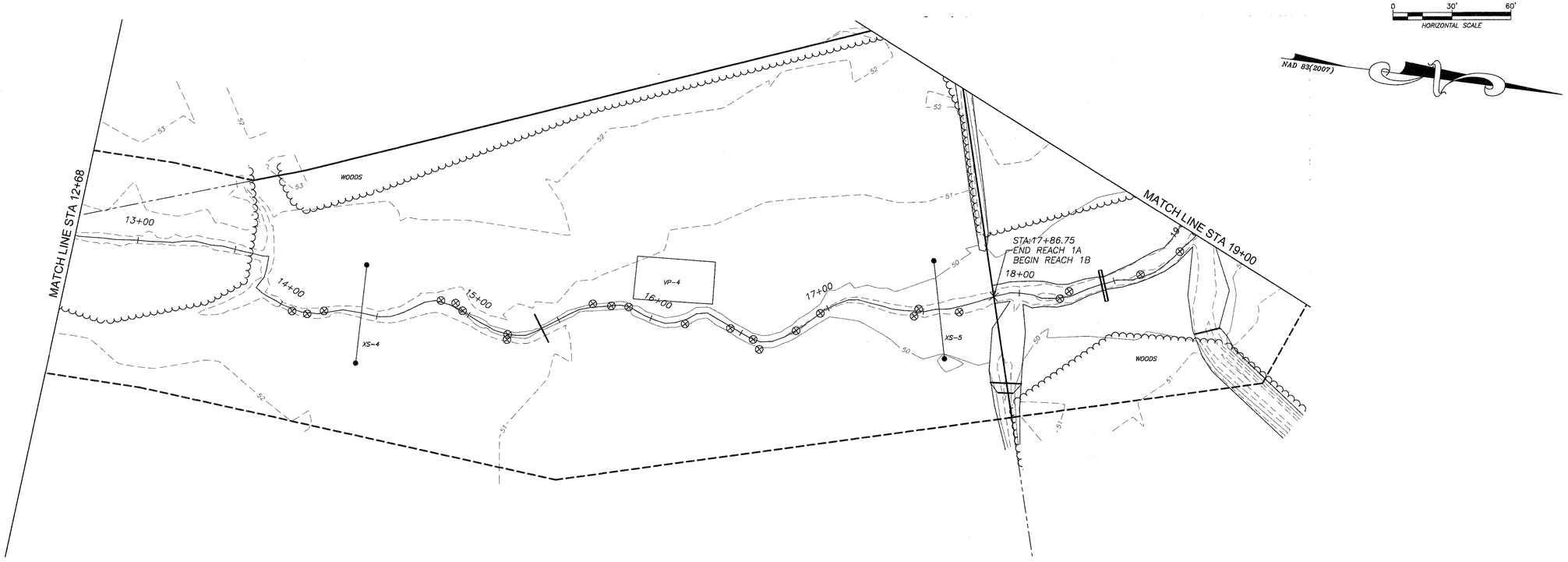
MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL.: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

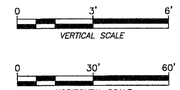
ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

SCALE 1" = 30'		DEPARTMENT
DRAWN BY CKP	DATE STARTED 4-28-14	SHEET No. 6 OF 20
APPROVED CKP		DRAWING NO. S-6
DRAWING NAME MR1-Asbuilt-Revised.dwg		
PROJECT NO. 20110047		

NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, PLLC.







SEAL
NORTH CAROLINA PROFESSIONAL SEAL L-4682 LAND SURVEYOR CHRISTOPHER K. PADEN
7/22/14

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 031435 ENGINEER ANN F. MULLEN
12-23-14

STREAM BASELINE AS-BUILT
REACH 1 PLAN & PROFILE (STA 12+68 - 19+00)

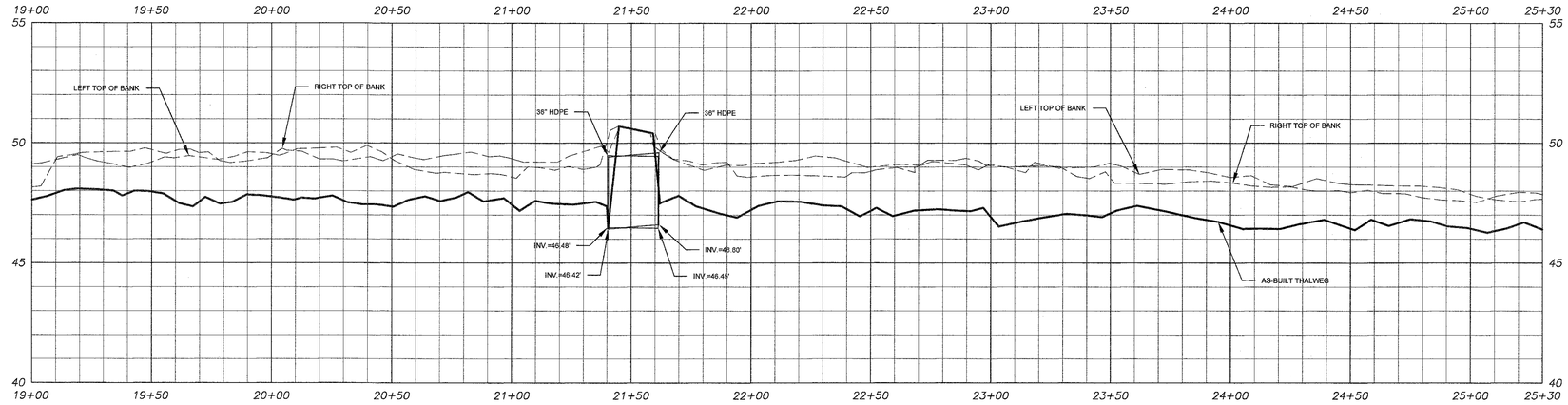
MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

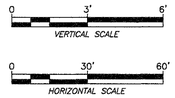
MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

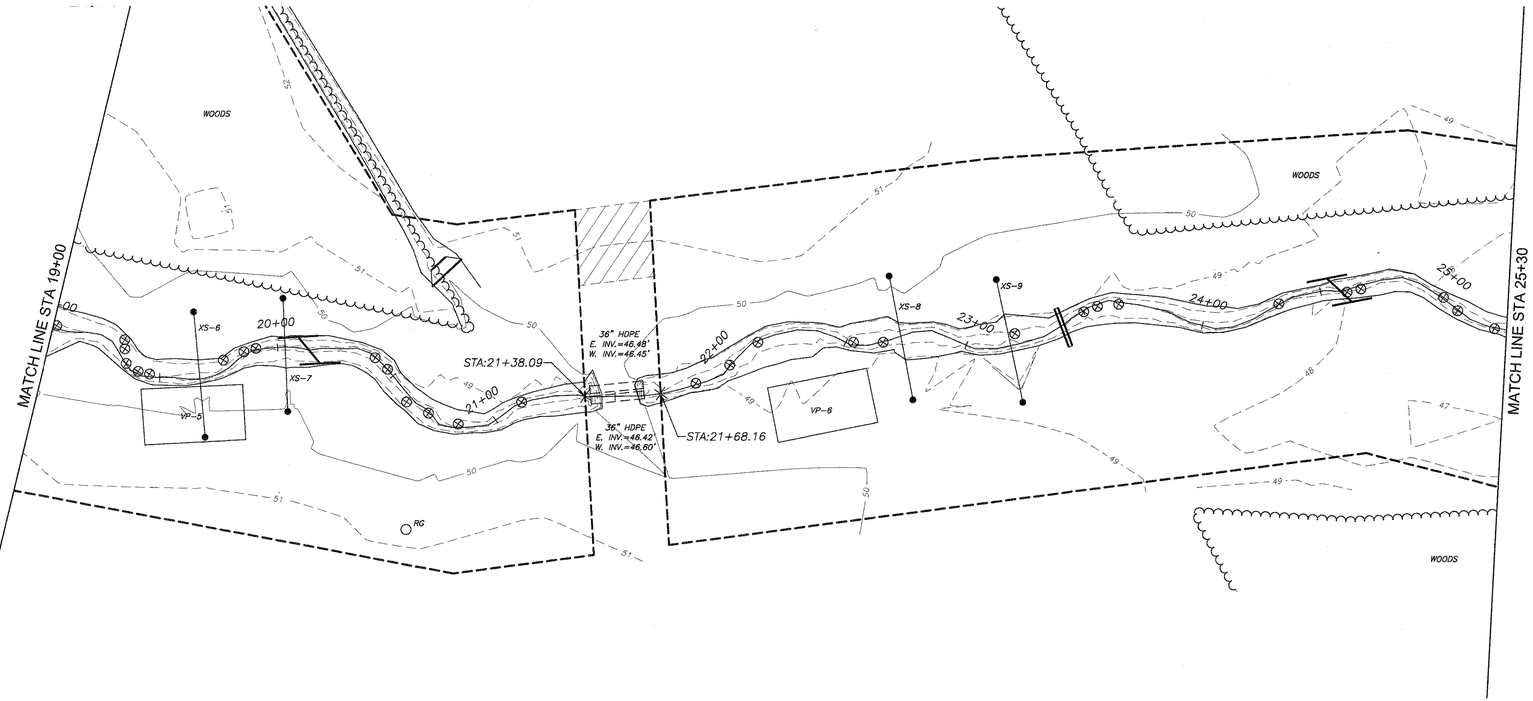
ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

SCALE 1" = 30'		DEPARTMENT
DRAWN BY CKP	DATE STARTED 4-28-14	SHEET No. 7 OF 20
APPROVED CKP		DRAWING NO. S-7
DRAWING NAME MR1-Asbuilt-Revised.dwg		
PROJECT NO. 20110047		

NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, PLLC.







SEAL
NORTH CAROLINA PROFESSIONAL L-4180 LAND SURVEYOR CHRISTOPHER K. PAGER
7/22/14

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 031439 ENGINEER ANNE MULLEN
7/25/14

STREAM BASELINE AS-BUILT
REACH 1 PLAN & PROFILE (STA 19+00 - 25+30)

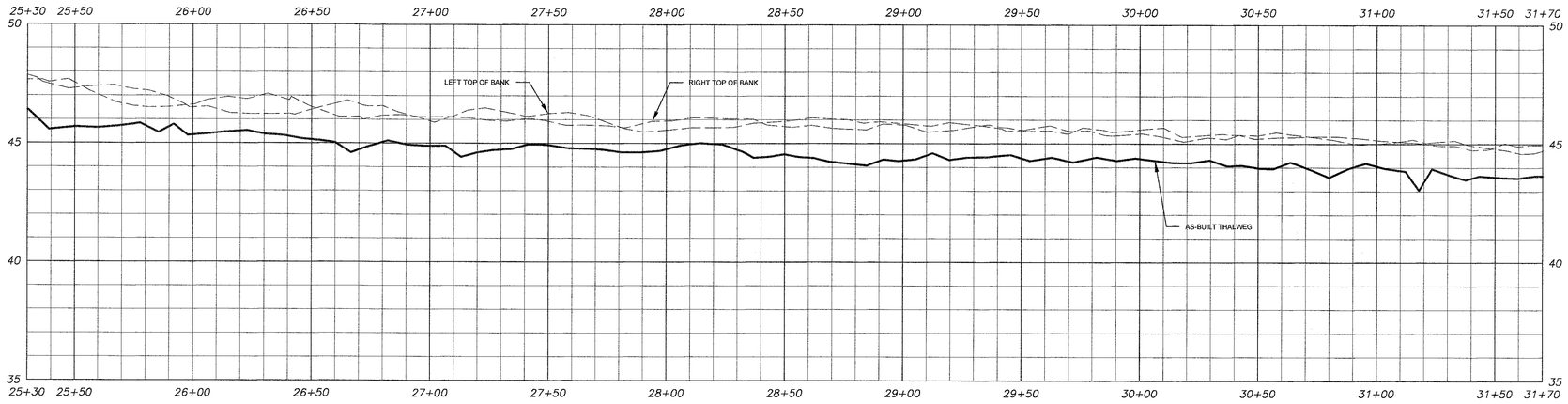
MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

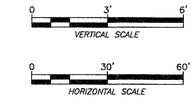
MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

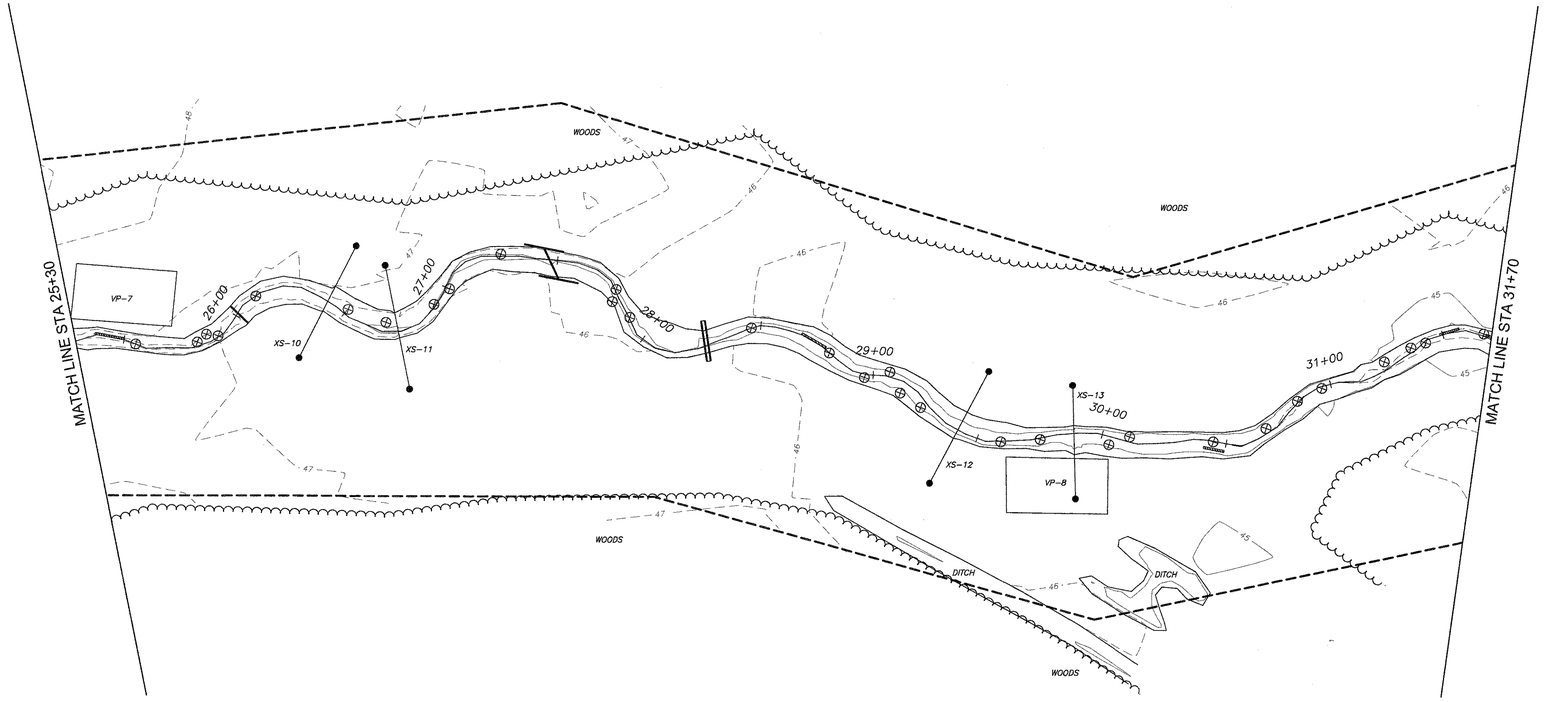
ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

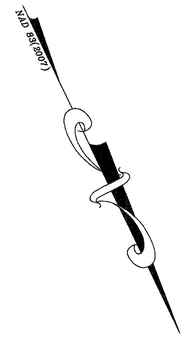
SCALE: 1" = 30'	DEPARTMENT:
DRAWN BY: CKP	DATE STARTED: 4-28-14
SHEET No.: 8 OF 20	
APPROVED: CKP	DRAWING NO.: S-8
DRAWING NAME: MR1-Asbuilt-Revised.dwg	
PROJECT NO.: 20110047	

NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, P.L.L.C.









SEAL

NORTH CAROLINA PROFESSIONAL SEAL 24189 LAND SURVEYOR CHRISTOPHER K. PADGETT
7/22/14

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 031435 ENGINEER ANN C. MULLEN
7/23/14

STREAM BASELINE AS-BUILT
REACH 1 PLAN & PROFILE (STA 25+30 - 31+70)

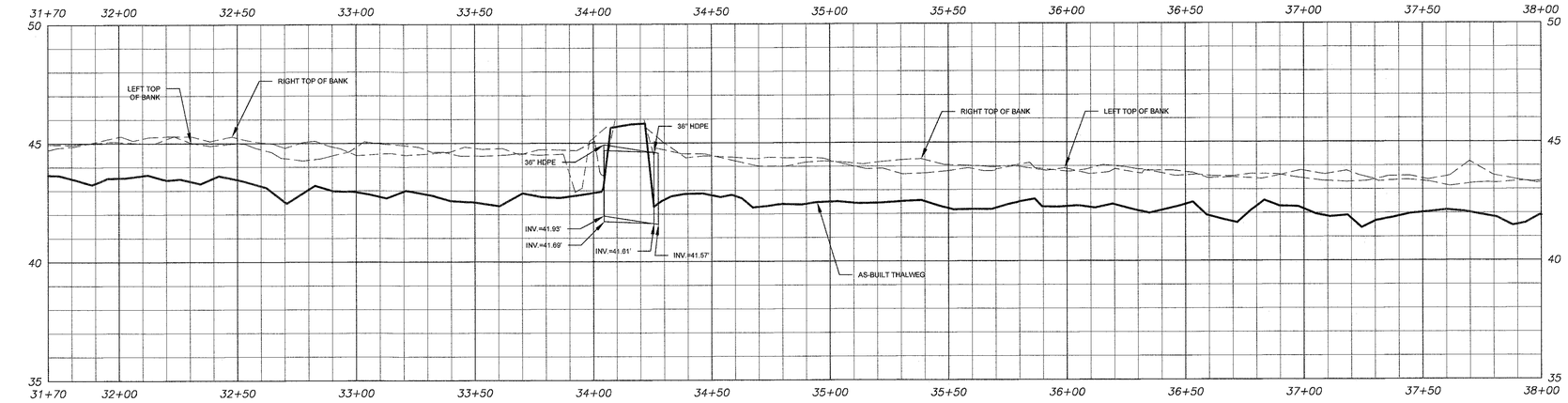
MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

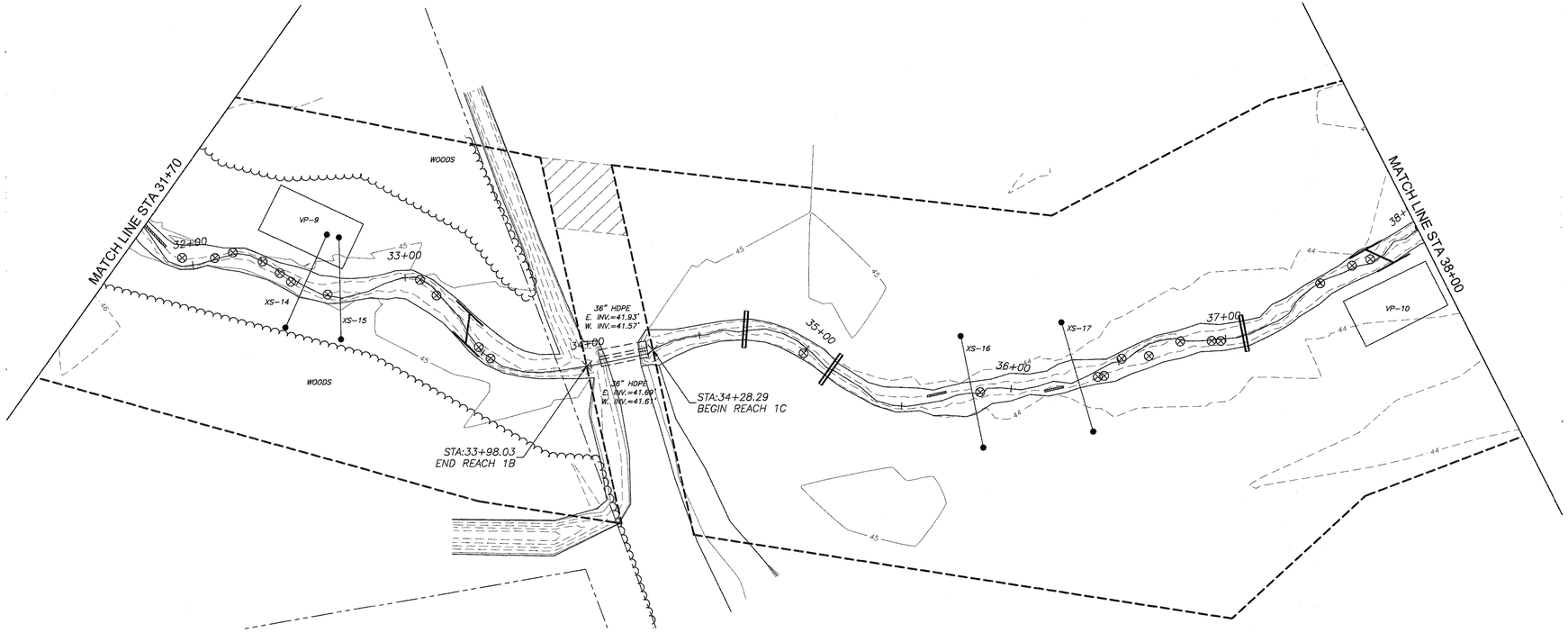
SCALE 1" = 30'		DEPARTMENT
DRAWN BY CKP	DATE STARTED 4-28-14	SHEET No. 9 OF 20
APPROVED CKP		DRAWING NO. S-9
DRAWING NAME MR1-Asbuilt-Revised.dwg		
PROJECT NO. 20110047		

NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, PLLC.



0 3' 6'
VERTICAL SCALE

0 30' 60'
HORIZONTAL SCALE



NAD 83(2007)

SEAL
NORTH CAROLINA PROFESSIONAL SEAL L-4544 LAND SURVEYOR CHRISTOPHER K. MADER
7/22/14

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 031435 ENGINEER ANN F. MULLEN
7/23/14

STREAM BASELINE AS-BUILT
REACH 1 PLAN & PROFILE (STA 31+70 - 38+00)

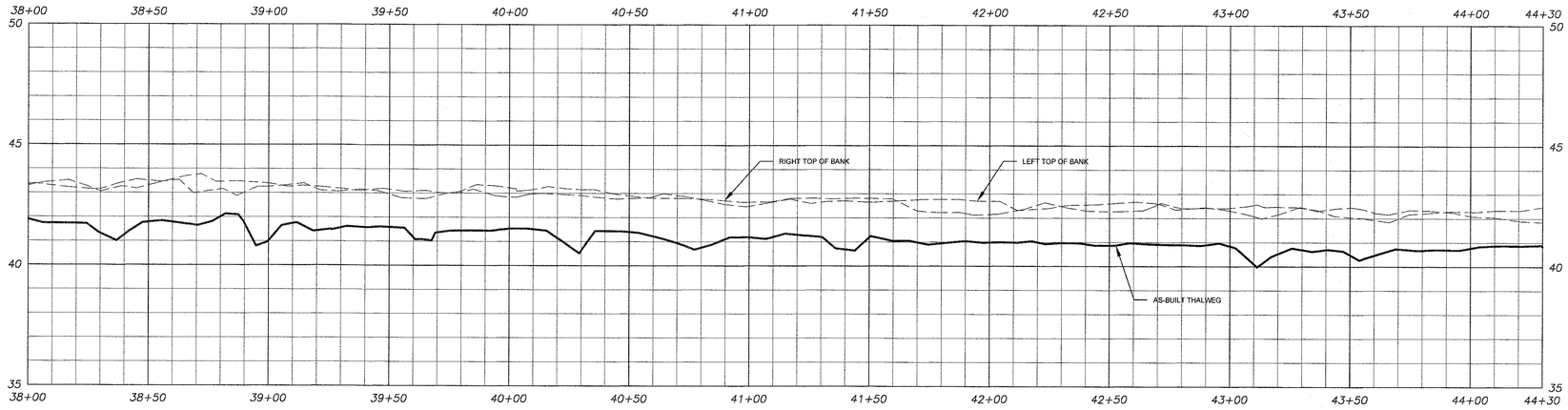
MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

SCALE 1" = 30'	DEPARTMENT
DRAWN BY CKP / DATE STARTED 4-28-14	SHEET No. 10 OF 20
APPROVED CKP	DRAWING NO. S-10
DRAWING NAME MR1-Asbuilt-Revised.dwg	
PROJECT NO. 20110047	

NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, P.L.L.C.



0 3' 6'
VERTICAL SCALE

0 30' 80'
HORIZONTAL SCALE

NAD 83(2007)

SEAL
NORTH CAROLINA PROFESSIONAL LAND SURVEYOR L-4189 CHRISTOPHER K. PADRICK
7/22/14

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 031435 ENGINEER ANN F. MULLEN
9/23/14

STREAM BASELINE AS-BUILT
REACH 1 PLAN & PROFILE (STA 38+00 - 44+30)

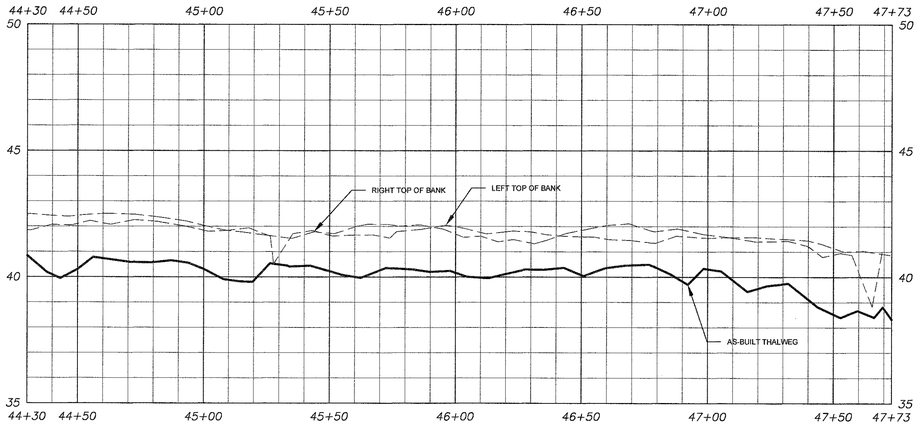
MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

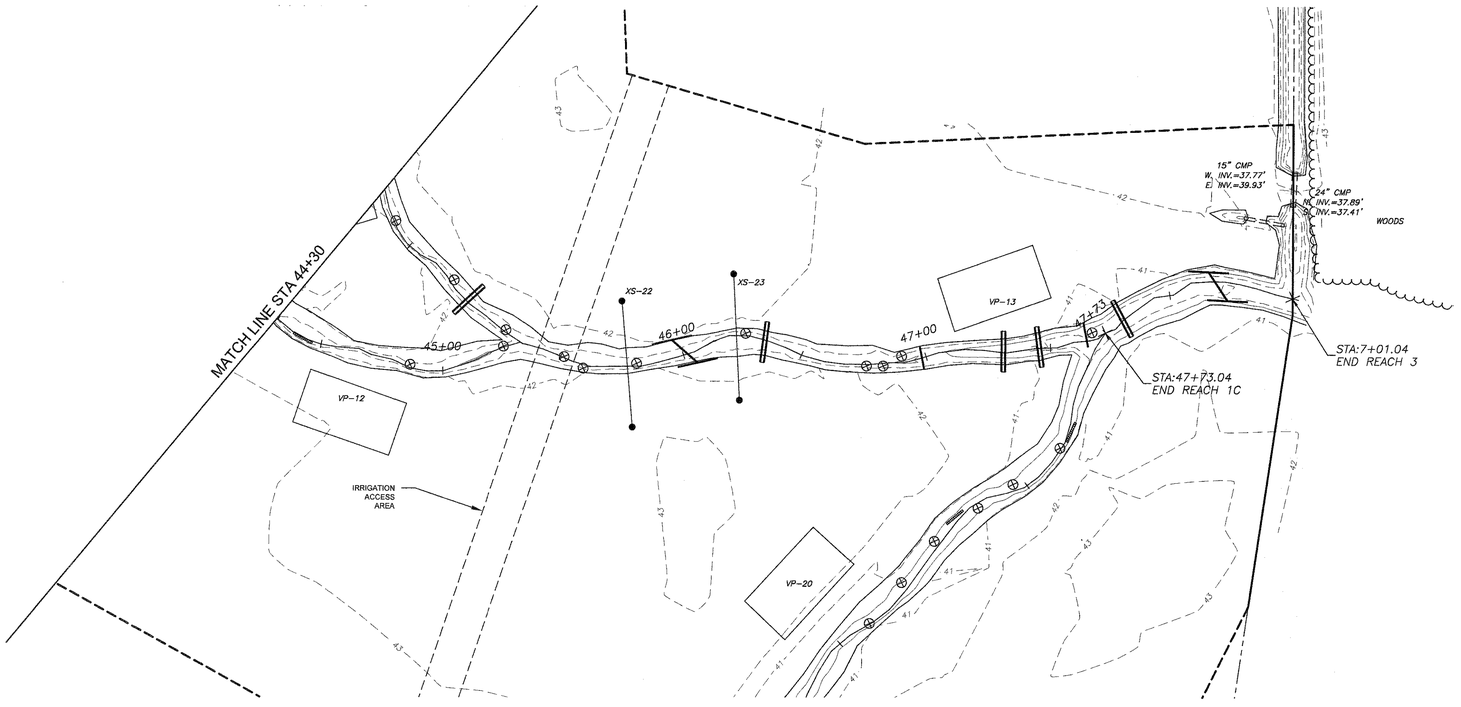
SCALE 1" = 30'		DEPARTMENT
DRAWN BY CKP	DATE STARTED 4-28-14	SHEET No. 11 OF 20
APPROVED CKP		DRAWING NO. S-11
DRAWING NAME MR1-Asbuilt-Revised.dwg		
PROJECT NO. 20110047		

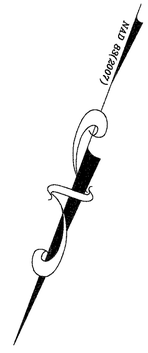
NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, PLLC.



0 3' 6'
VERTICAL SCALE

0 30' 60'
HORIZONTAL SCALE





SEAL

NORTH CAROLINA PROFESSIONAL SEAL L-4189 LAND SURVEYOR CHRISTOPHER K. PADRICK
1/22/14

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 031935 ENGINEER ANN F. MULLEN
1/23/14

STREAM BASELINE AS-BUILT
REACH 1 PLAN & PROFILE (STA 44+30 - 47+73)

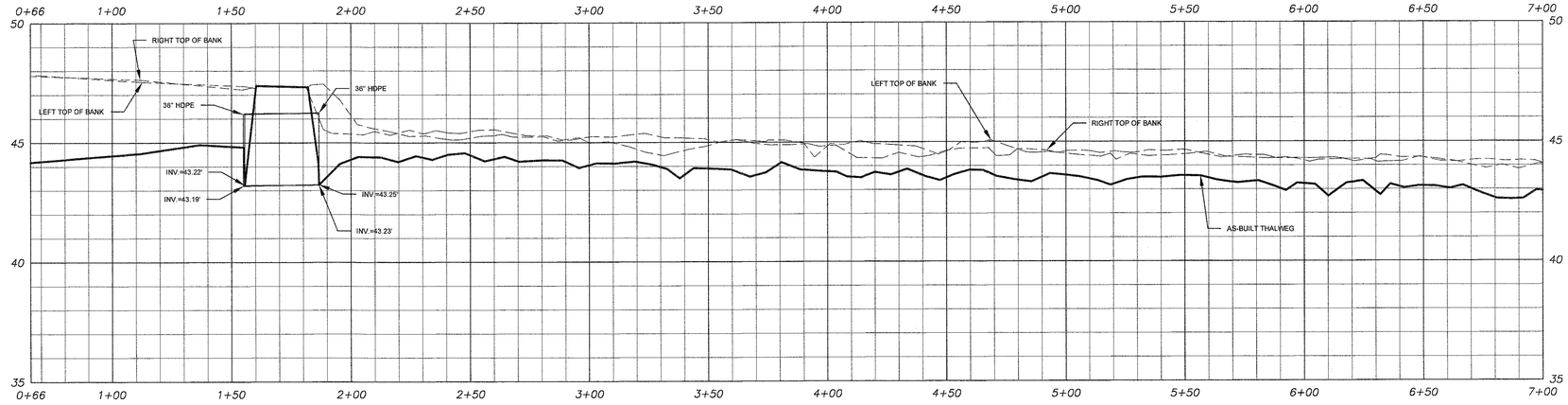
MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

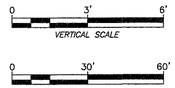
MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

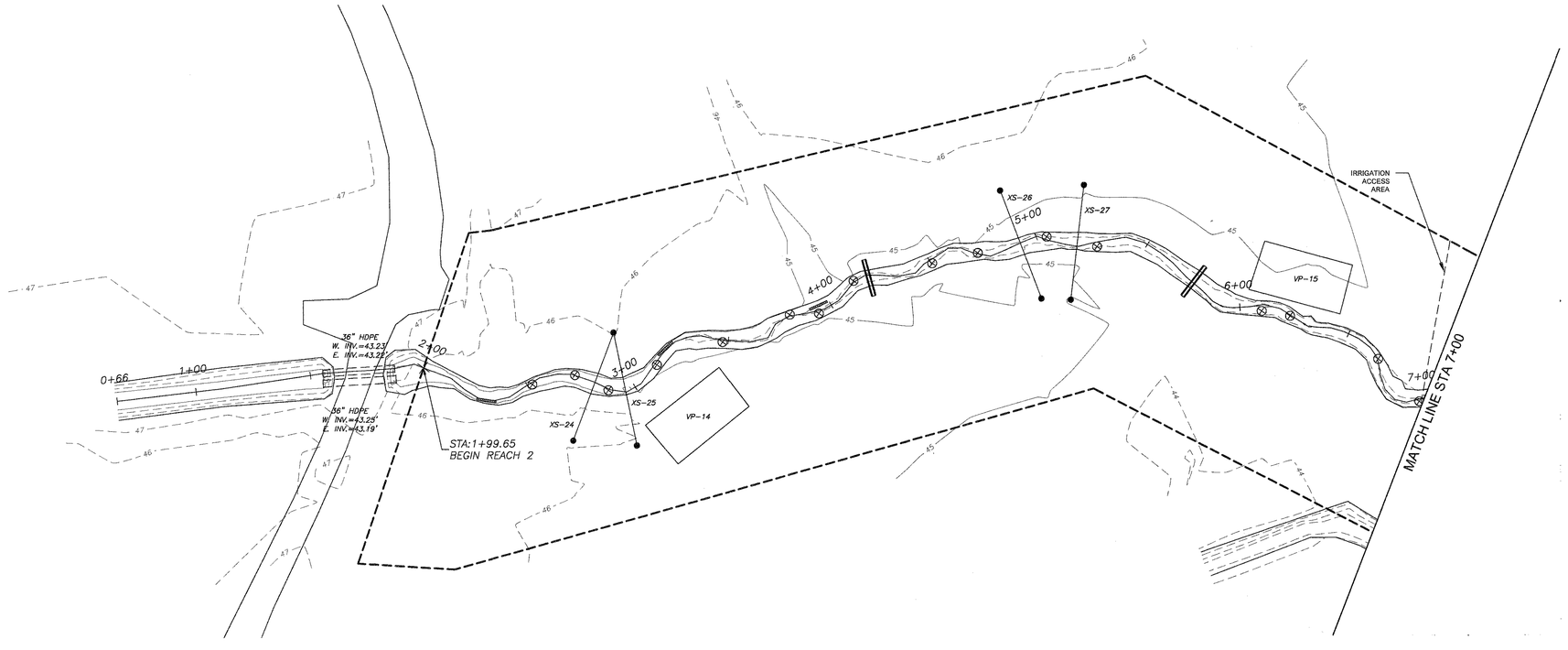
ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

SCALE 1" = 30'		DEPARTMENT
DRAWN BY CKP	DATE STARTED 4-28-14	SHEET No. 12 OF 20
APPROVED CKP		DRAWING NO. S-12
DRAWING NAME MR1-Asbuilt-Revised.dwg		
PROJECT NO. 20110047		

NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, PLLC.







SEAL
NORTH CAROLINA PROFESSIONAL SEAL L-4747 LAND SURVEYOR CHRISTOPHER K. PADERICK
7/22/14

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 031436 ENGINEER ANN F. MILLER
7/23/14

STREAM BASELINE AS-BUILT
REACH 2 PLAN & PROFILE (STA 0+66 - 7+00)

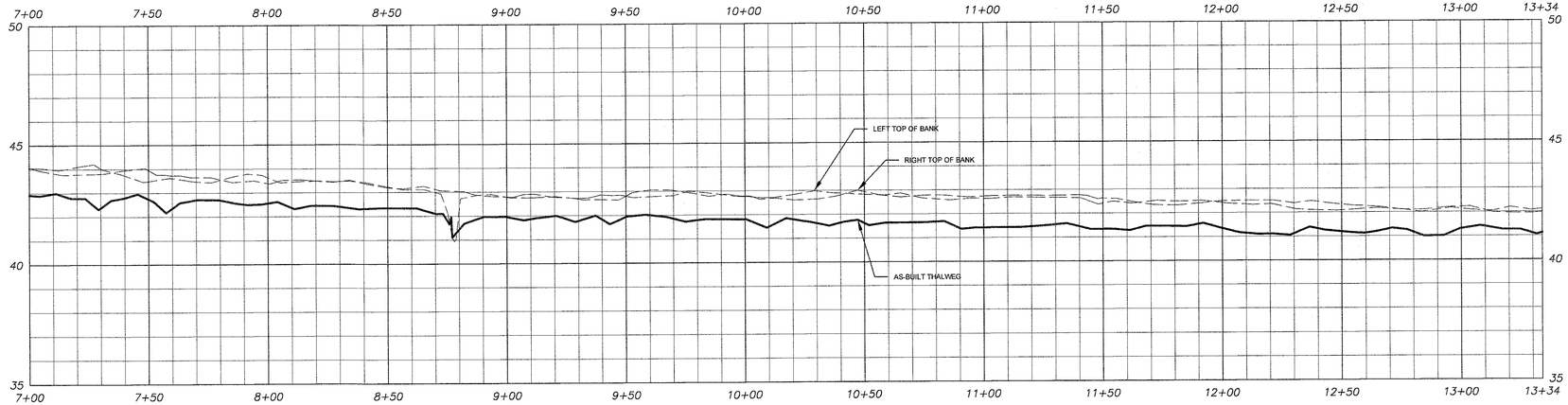
MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

MATRIX East
MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

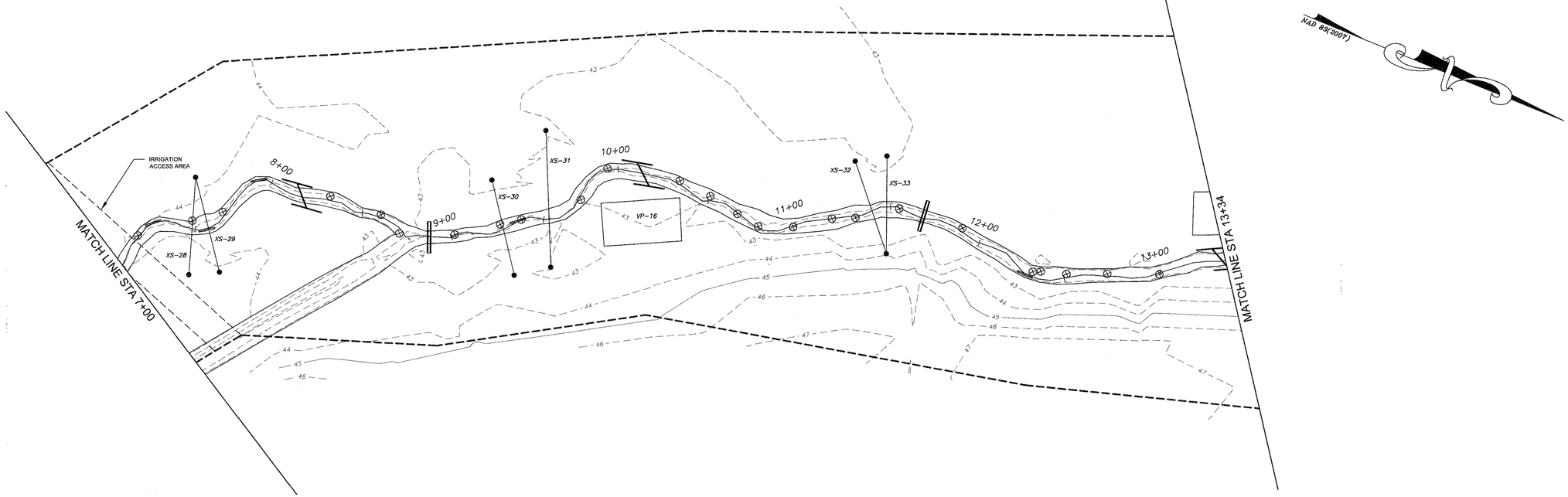
SCALE 1" = 30'		DEPARTMENT
DRAWN BY CKP	DATE STARTED 4-28-14	SHEET No. 13 OF 20
APPROVED CKP		DRAWING NO. **S-13**
DRAWING NAME MR1-Asbuilt-Revised.dwg		
PROJECT NO. 20110047		

NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, PLLC.



0 3' 6'
VERTICAL SCALE

0 30' 60'
HORIZONTAL SCALE



SEAL
NORTH CAROLINA PROFESSIONAL SEAL L-4822 SURVEYOR CHRISTOPHER K. PADEN
7/22/14

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 031435 ENGINEER ANN F. MULLEY
7/23/14

STREAM BASELINE AS-BUILT
REACH 2 PLAN & PROFILE (STA 7+00 - 13+34)

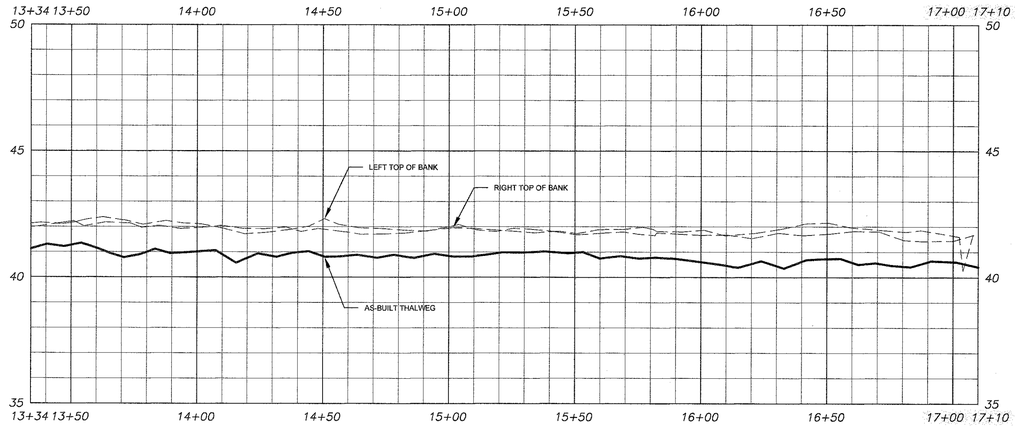
MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

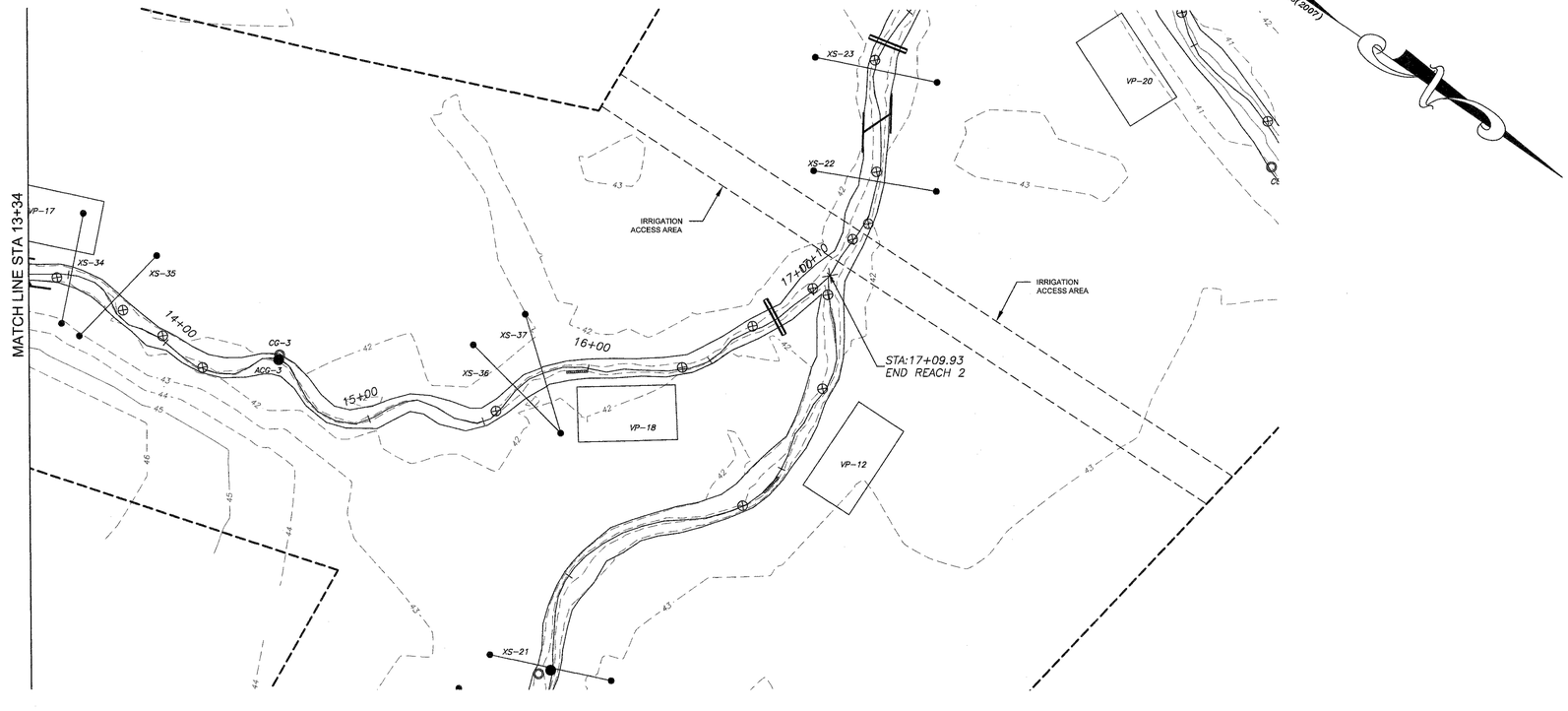
SCALE: 1" = 30'		DEPARTMENT:
DRAWN BY: CKP	DATE STARTED: 4-28-14	SHEET No.: 14 OF 20
APPROVED: CKP		DRAWING NO.: S-14
DRAWING NAME: MR1-Asbuilt-Revised.dwg		
PROJECT NO.: 20110047		

NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, P.L.L.C.



0 3' 6'
VERTICAL SCALE

0 30' 60'
HORIZONTAL SCALE



SEAL

NORTH CAROLINA PROFESSIONAL L-4189 LAND SURVEYOR CHRISTOPHER K. CADER
1/22/14

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 031435 ENGINEER ANN F. MULLEN
7/23/14

MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

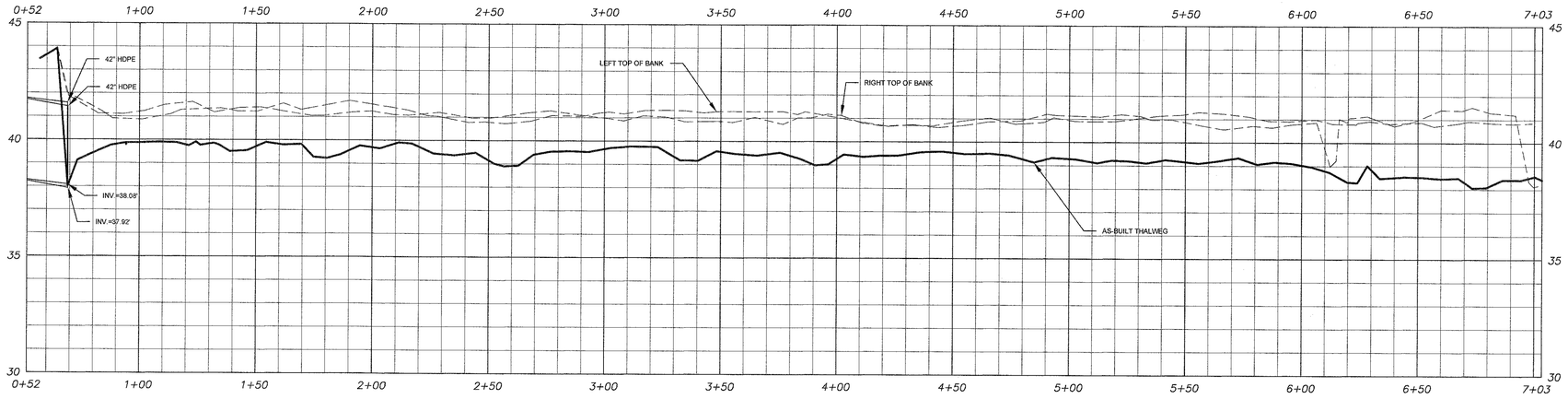
STREAM BASELINE AS-BUILT
REACH 2 PLAN & PROFILE (STA 13+34 - 17+10)

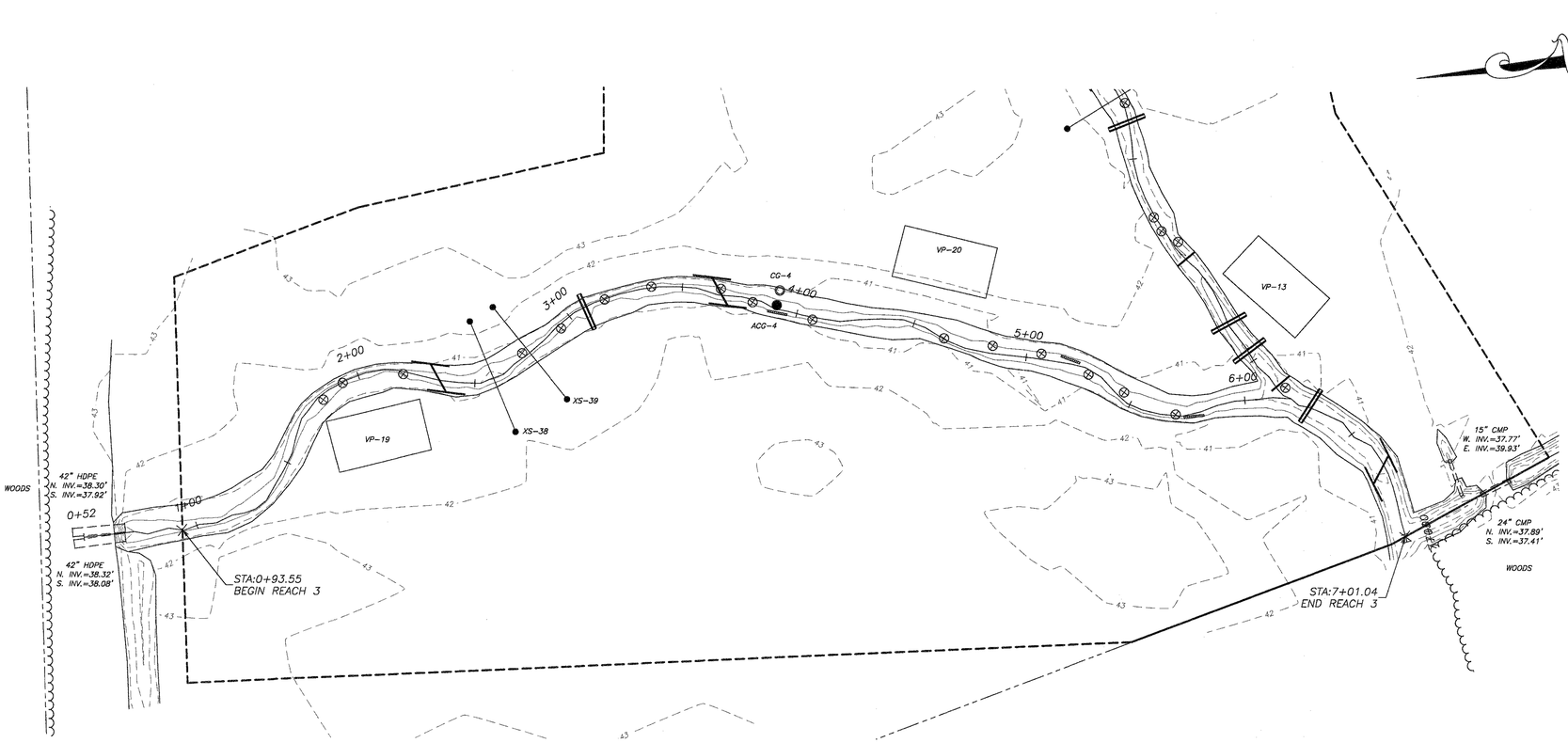
MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

SCALE 1" = 30'		DEPARTMENT
DRAWN BY CKP	DATE STARTED 4-28-14	SHEET No. 15 OF 20
APPROVED CKP		DRAWING NO. S-15
DRAWING NAME MR1-Asbuilt-Revised.dwg		
PROJECT NO. 20110047		

NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, PLLC.





SEAL

NORTH CAROLINA PROFESSIONAL LAND SURVEYOR L-4189 CHRISTOPHER K. PADRICK
7/22/14

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 031436 ENGINEER ANN F. MULLEN
9/23/14

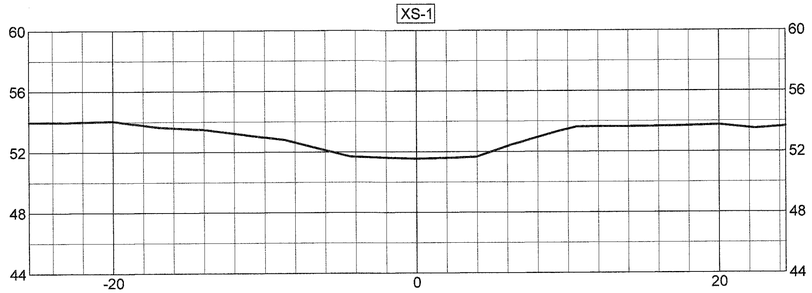
STREAM BASELINE AS-BUILT
REACH 3 PLAN & PROFILE (STA 0+52 - 7+03)

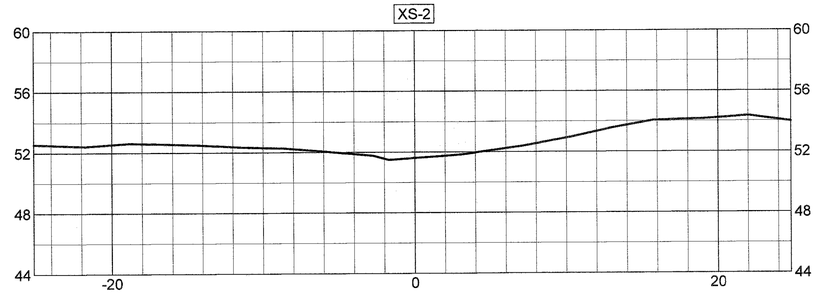
MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

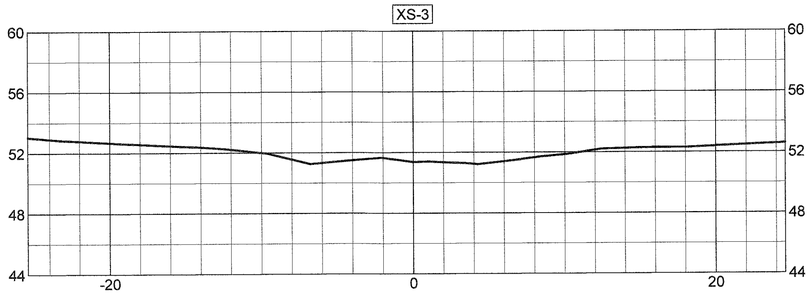
MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

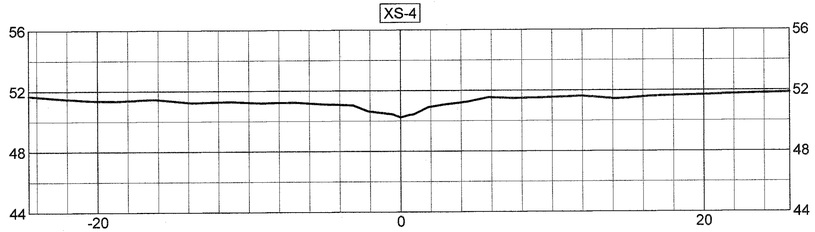
ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

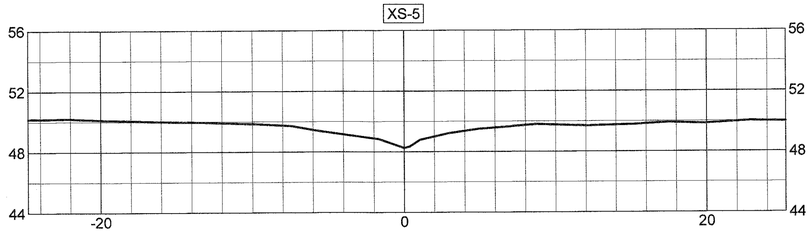
SCALE: 1" = 30'		DEPARTMENT:
DRAWN BY: CKP	DATE STARTED: 4-28-14	SHEET No.: 16 OF 20
APPROVED: CKP		DRAWING NO.: S-16
DRAWING NAME: MR1-Asbuilt-Revised.dwg		
PROJECT NO.: 20110047		

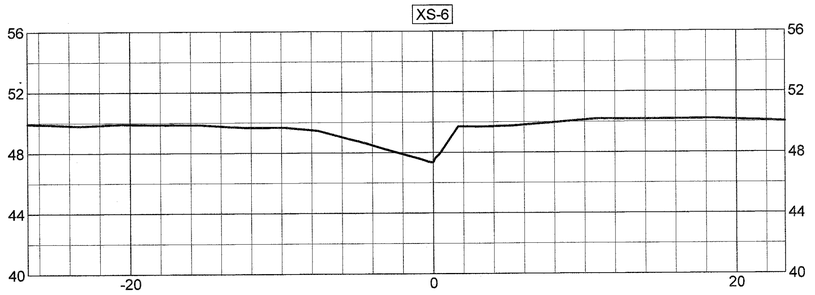


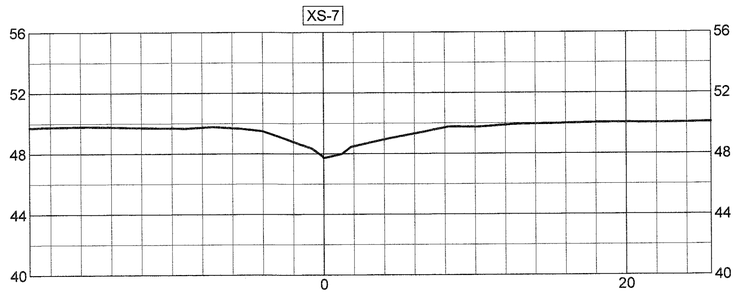


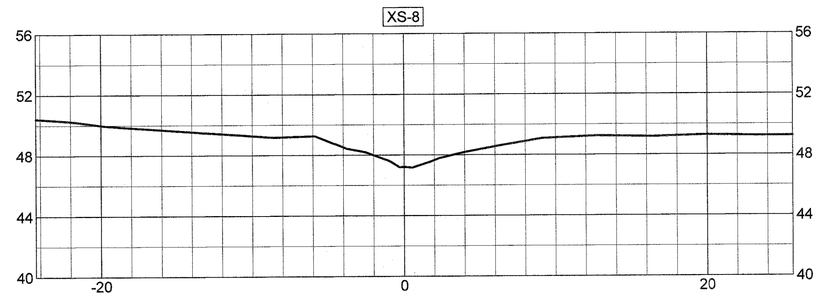


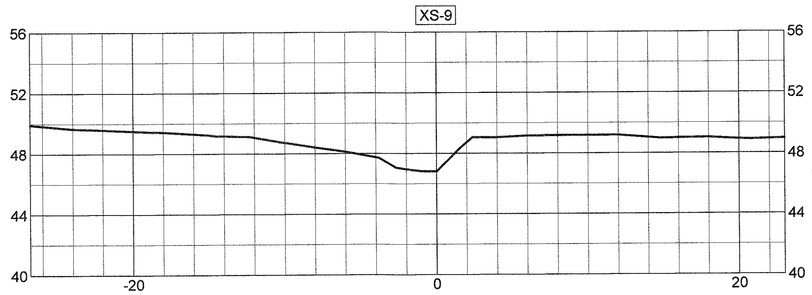


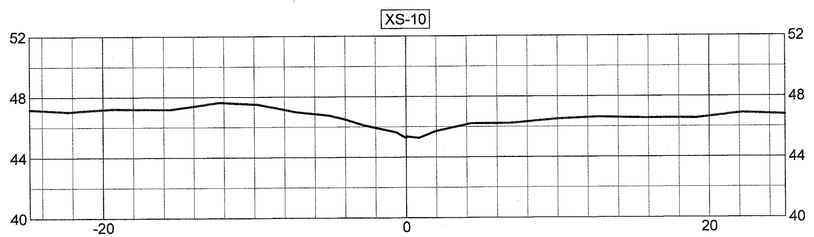




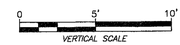








NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, PLLC.



SEAL
NORTH CAROLINA PROFESSIONAL SEAL 031435 LAND SURVEYOR CHRISTOPHER K. PARTRICK
1/22/14

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 031435 ENGINEER ANN F. MULLEN
7/23/14

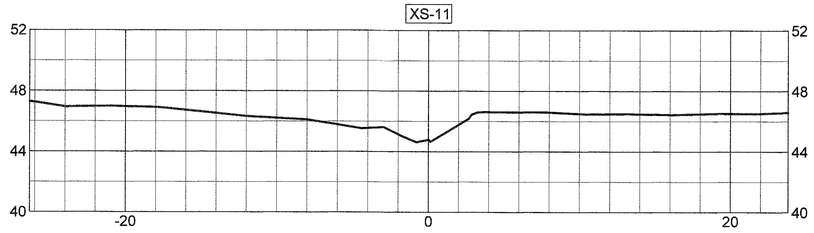
STREAM CROSS-SECTIONS (XS-1 - XS-10)

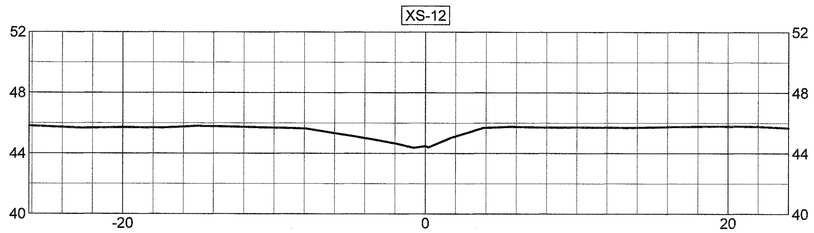
MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

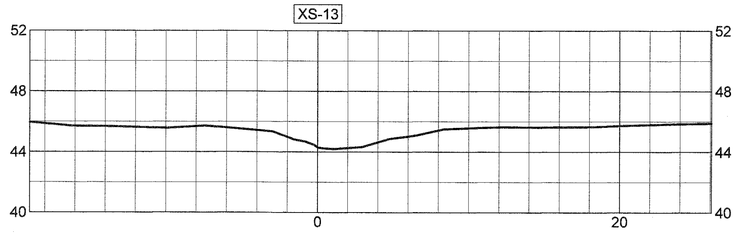
MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

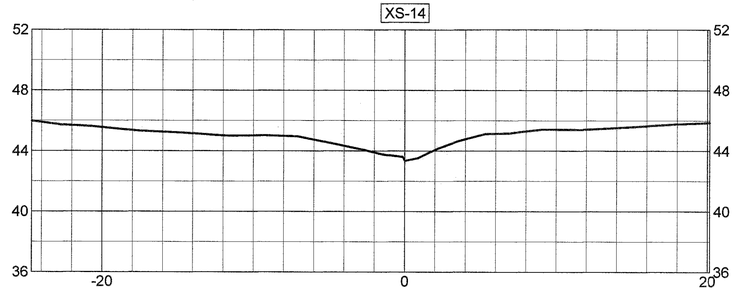
ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

SCALE: 1" = 5'	DEPARTMENT
DRAWN BY: CKP	DATE STARTED: 4-28-14
SHEET No.: 17 OF 20	
APPROVED: CKP	DRAWING NO.: S-17
DRAWING NAME: MR1-Asbuilt.dwg	
PROJECT NO.: 20110047	

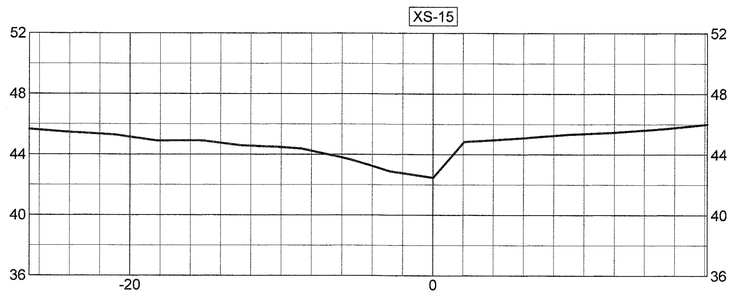


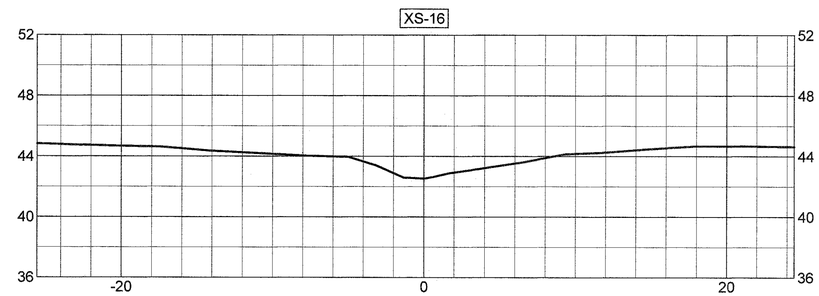


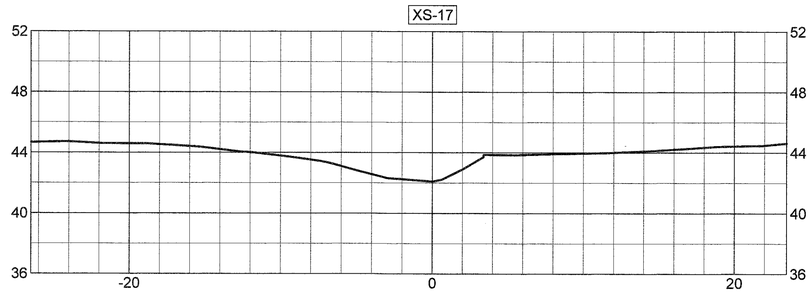


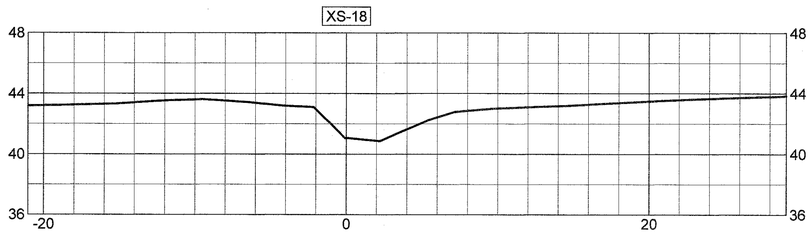


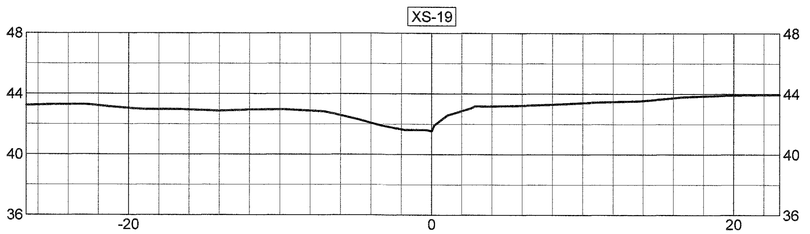
NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, PLLC.

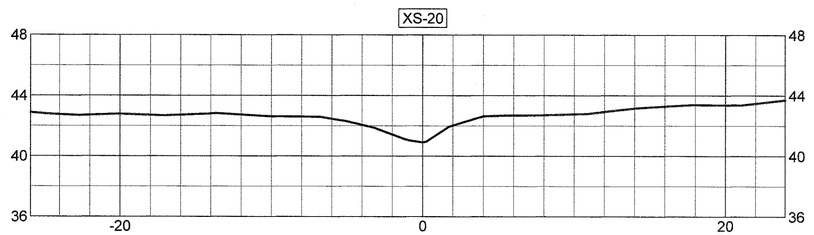


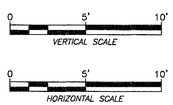












SEAL

NORTH CAROLINA PROFESSIONAL SEAL L-4193 LAND SURVEYOR CHRISTOPHER K. FADER
7/22/14

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 031435 ENGINEER ANN F. MULLEN
7/23/14

STREAM CROSS-SECTIONS (XS-11 - XS-20)

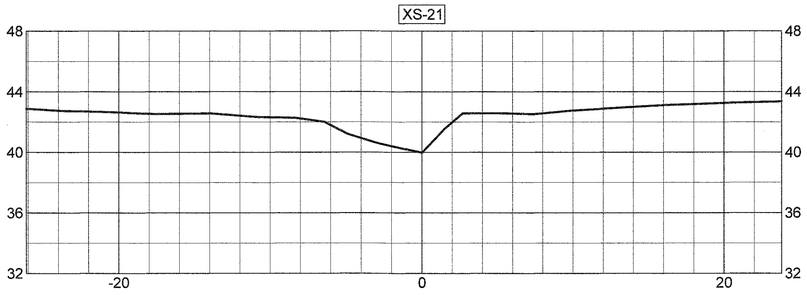
MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

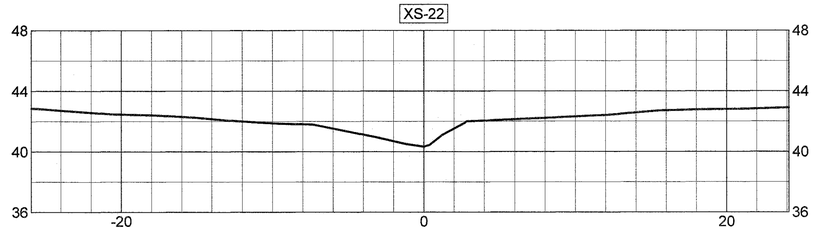
MATRIX EAST, PLLC

906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

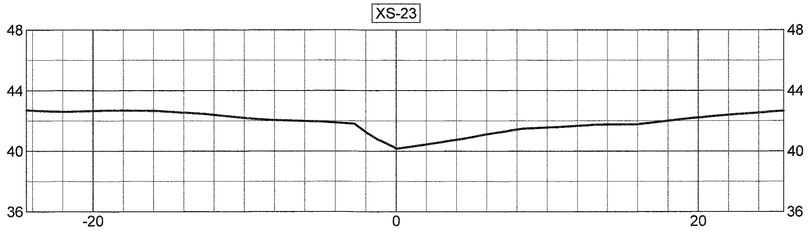
ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

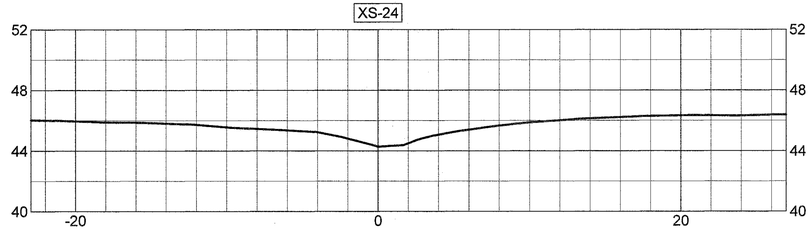
SCALE: 1" = 5'		DEPARTMENT:	
DRAWN BY: CKP	DATE STARTED: 4-28-14	SHEET No.: 18 OF 20	
APPROVED: CKP		DRAWING NO.: S-18	
DRAWING NAME: MR1-Asbuilt.dwg			
PROJECT NO.: 20110047			

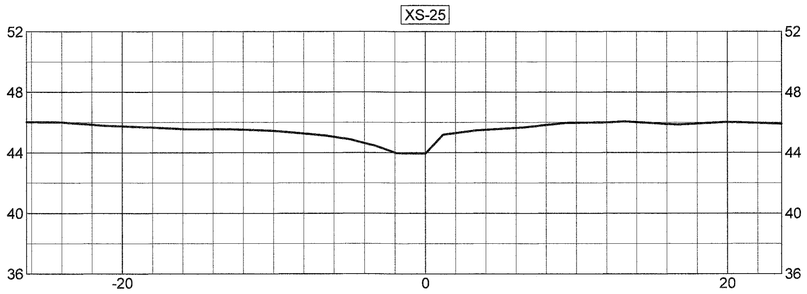


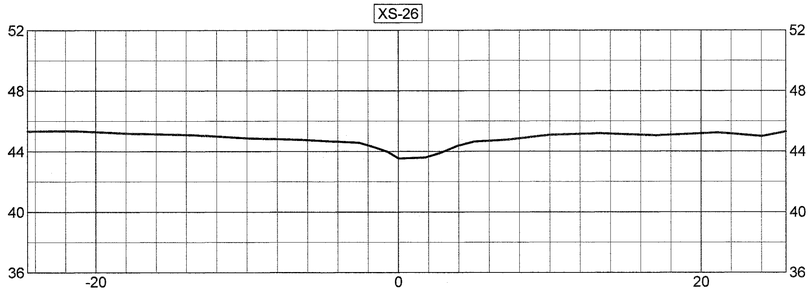


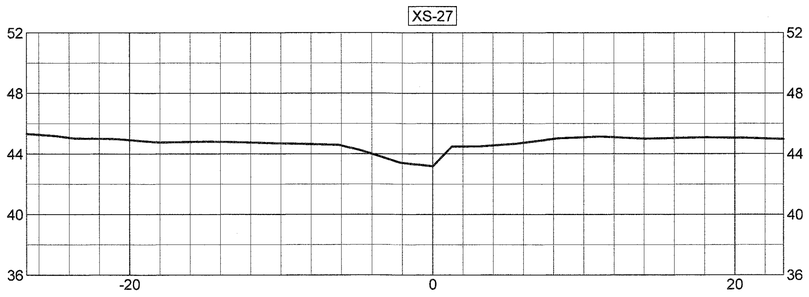
NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, PLLC.

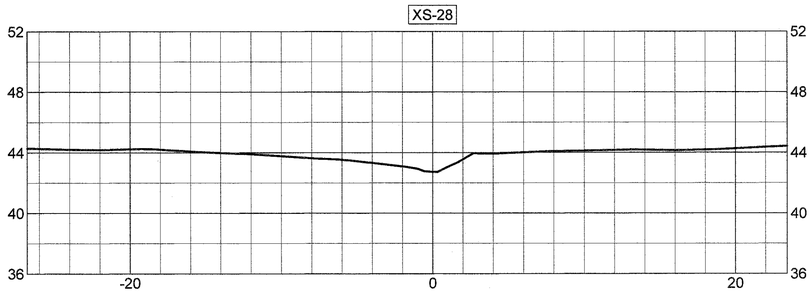


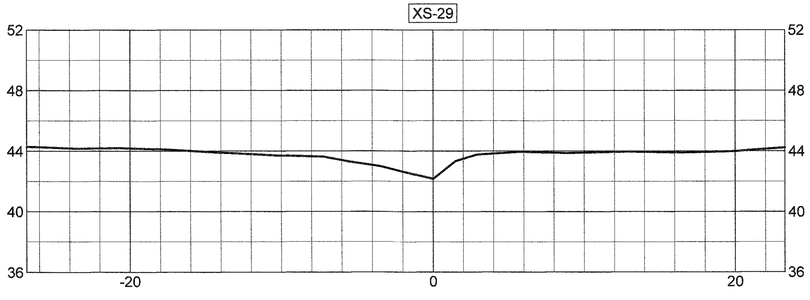


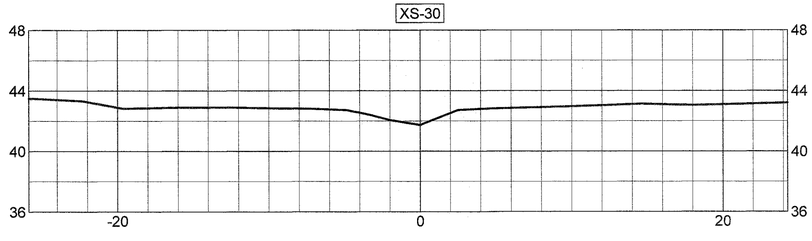


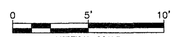


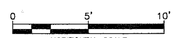












SEAL
NORTH CAROLINA PROFESSIONAL SEAL L-4682 LAND SURVEYOR CHRISTOPHER K. PADGETT
1/22/14

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 031435 ENGINEER ANN F. MULLEN
7/23/14

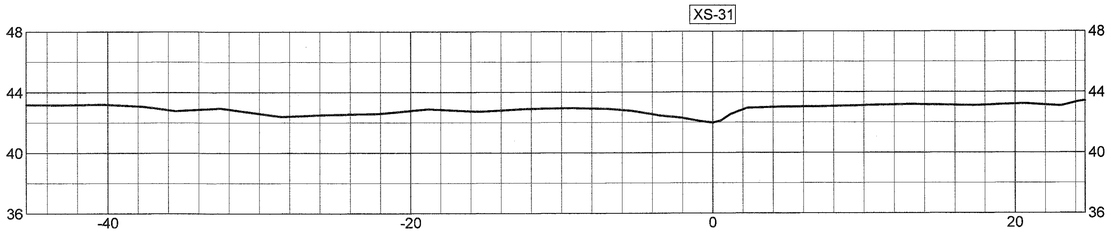
STREAM CROSS-SECTIONS (XS-21 - XS-30)

MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

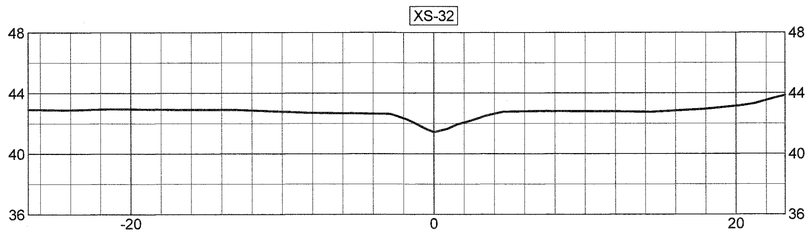
MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

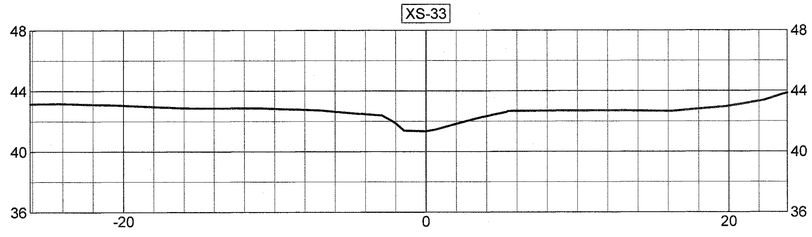
ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

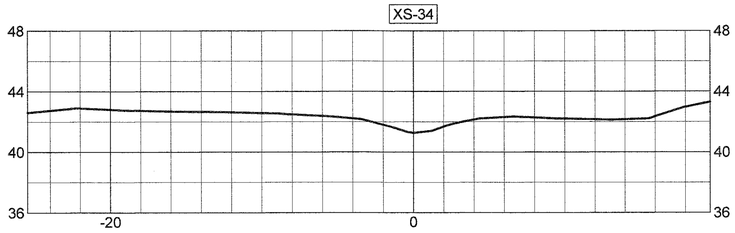
SCALE 1" = 5'	DEPARTMENT
DRAWN BY CKP	DATE STARTED 4-28-14
SHEET No. 19 OF 20	
APPROVED CKP	DRAWING NO. S-19
DRAWING NAME MR1-Asbuilt.dwg	
PROJECT NO. 20110047	

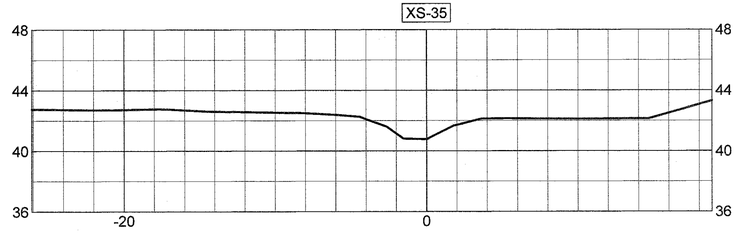


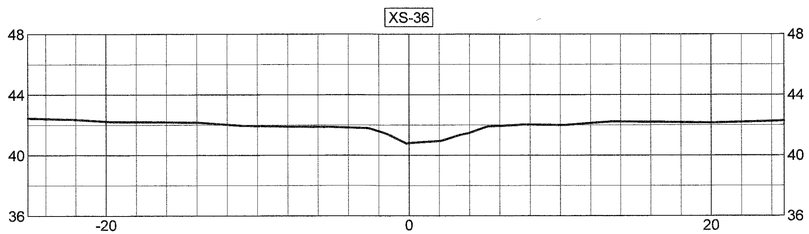
NOTE:
THALWEG SURVEY FOR REACHES 1B, 1C, 2, & 3 WAS PERFORMED BY W.K. DICKSON AND CO., INC. ALL OTHER SURVEYING WAS PERFORMED BY MATRIX EAST, PLLC.

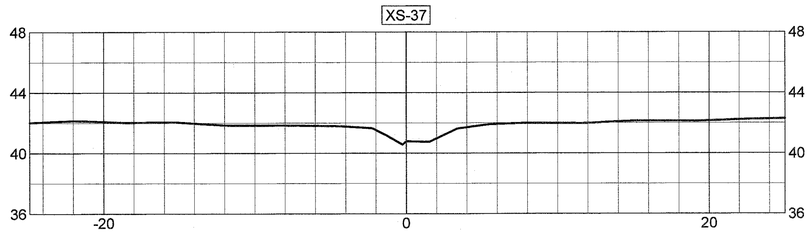


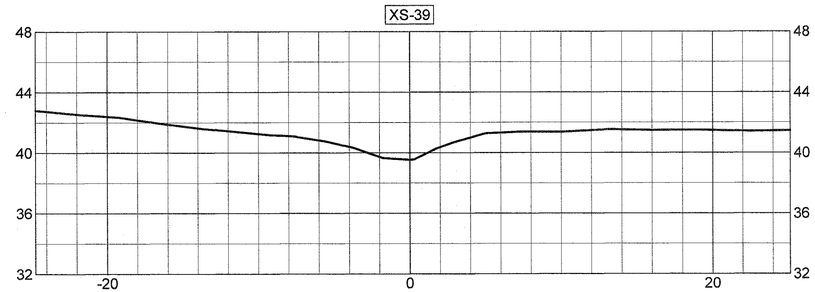


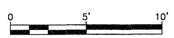












SEAL
NORTH CAROLINA PROFESSIONAL LAND SURVEYOR
CHRISTOPHER K. PAIER
L-4168
7/22/14

SEAL
NORTH CAROLINA PROFESSIONAL ENGINEER
SEAL
031435
ANN F. MULLEN
7/23/14

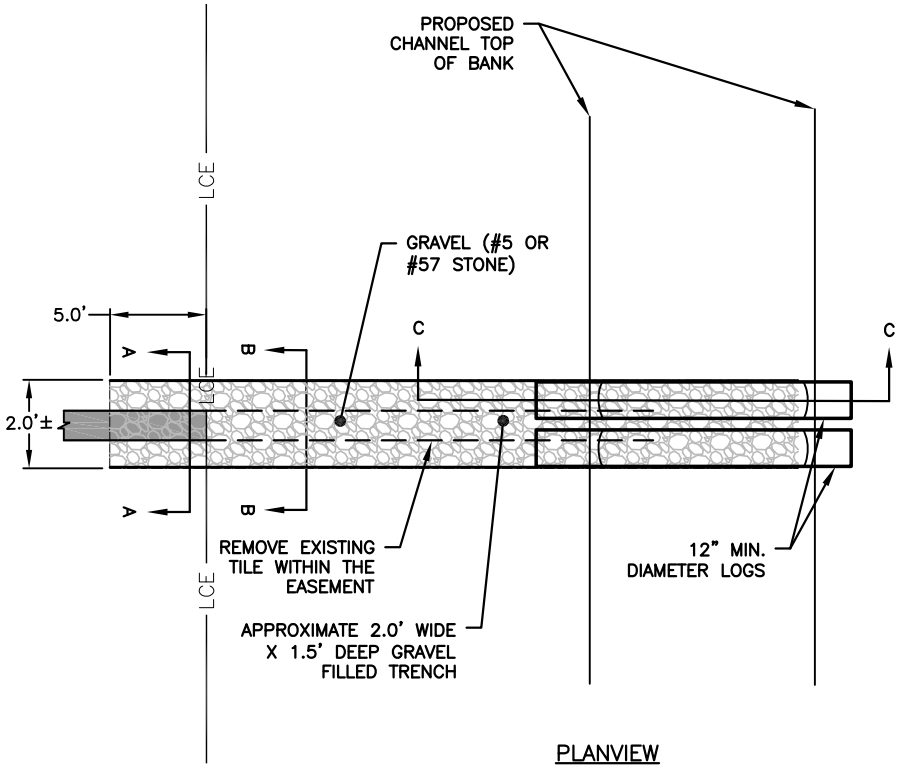
STREAM CROSS-SECTIONS (XS-31 - XS-39)

MUDDY RUN MITIGATION PROJECT DUPLIN COUNTY, N.C.

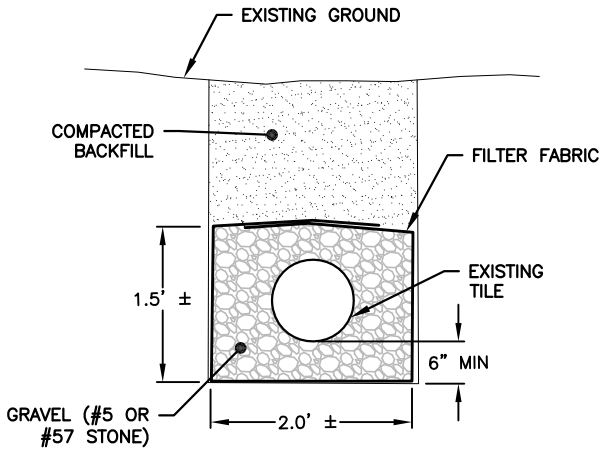
MATRIX EAST, PLLC
906 N. QUEEN ST., SUITE A
KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747
FIRM LIC. # P-0221
EMAIL: surveyor@matrixeast.net

ENVIRONMENTAL BANC & EXCHANGE, LLC
909 CAPABILITY DRIVE
SUITE 3100
RALEIGH, N.C. 27606

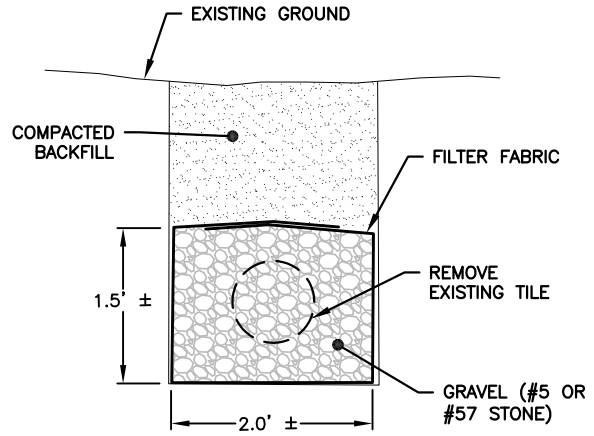
SCALE: 1" = 5'	DEPARTMENT:
DRAWN BY: CKP	DATE STARTED: 4-28-14
SHEET No.: 20 OF 20	
APPROVED: CKP	DRAWING NO.: S-20
DRAWING NAME: MR1-Asbuilt.dwg	
PROJECT NO.: 20110047	



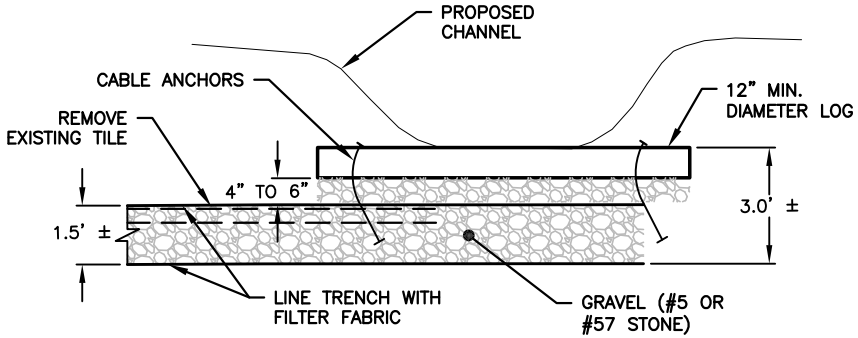
PLANVIEW



SECTION A–A



SECTION B–B



SECTION B–B

NOTES:
1. LOGS SHOULD BE AT LEAST 12 INCHES IN DIAMETER, HARDWOOD SPECIES, A MINIMUM OF 10 TO 20 FEET IN LENGTH (UNLESS OTHERWISE NOTED), AND RELATIVELY STRAIGHT.
2. START TRENCH APPROXIMATELY 5.0' OUTSIDE OF EASEMENT AND LINE TRENCH WITH FILTER FABRIC.
3. FILTER FABRIC USED SHALL BE NCDOT TYPE 2 ENGINEERING FABRIC OR EQUIVALENT.

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

PROJ. DATE:	DEC 2011
PRINCIPAL:	
PROJ. MGR.:	DPI
CAD TECH:	FM
Q.C.:	DPI
Q.C. DATE:	9/26/2013

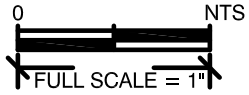
PLOT DATE: 9/26/2013

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT

OWNER OR CLIENT:
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
SUBSURFACE FLOW STRUCTURE

FULL SCALE: NTS



DRAWING NUMBER:
BULLETIN DRAWING #1

WKD PROJ. NO.:
2011017600RA