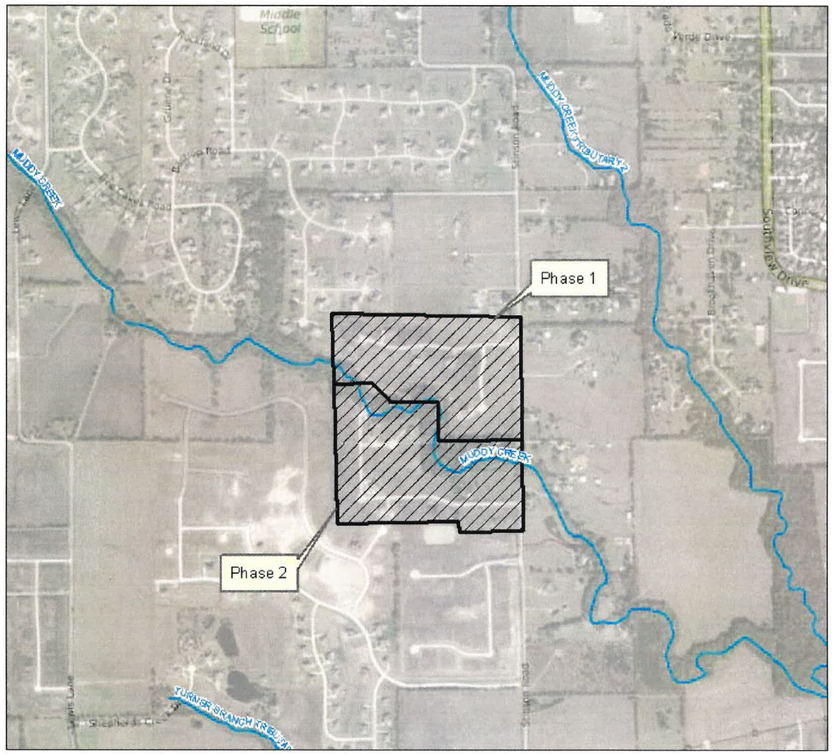
BRISTOL PARK
PHASES 1 AND 2
LETTER OF MAP REVISION



LUCAS, TX

Prepared by:

CARDINAL STRATEGIES

Prepared for:

ENGINEERING CONCEPTS & DESIGN, L.P.

January 17, 2017

CARDINAL STRATEGIES

1712 San Jacinto Drive Allen, TX 75013 Phone: 214-437-4265

January 17, 2017

Engineering Concepts & Design
Attn: Todd Wintters, P.E.
201 Windco Cir, STE 200
Wylie, Texas 75098

Re: LOMR – Muddy Creek
Project Name – Bristol Park Phases 1 and 2, Lucas, Texas

Dear Mr. Wintters:

Enclosed herewith is the LOMR for Muddy Creek in support of the Bristol Park Phases 1 and 2 Development. The report includes hydraulic modeling and results for the Pre-project and As-built conditions to support an official request to FEMA to revise the Special Flood Hazard Area and establish Base Flood Elevations along Muddy Creek through the studied reach.

Should you have any questions or concerns, please do not hesitate to contact me at (214) 437-4265 to discuss any items related to this LOMR.

Sincerely,

Michael Anderson, PE, CFM, D.WRE
Principal
Cardinal Strategies, PLLC
TBPE Firm Registration No. F-11976

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1.0 Project Description

Bristol Park Phases 1 and 2 ("Project") is a residential development located in Lucas, Texas. Muddy Creek flows through the center of the project site from west to east. The purpose of this LOMR is to show that the construction of the Bristol Park Phases 1 and 2 development meets all City of Lucas ("City") and FEMA requirements and to revise the Special Flood Hazard Area (SFHA), area inundated by the base (1-percent annual chance) flood, and to establish Base Flood Elevations (BFEs) along Muddy Creek from Stinson Drive to approximately 3,000ft upstream of Stinson Drive. The applicable MT-2 forms are provided in Attachment A.

1.1 Site Location

The Project site consists of residential homes and pad sites north and south of Muddy Creek just to the west of Stinson Road. Figure 1 shows the location of the Project in relation to Muddy Creek.

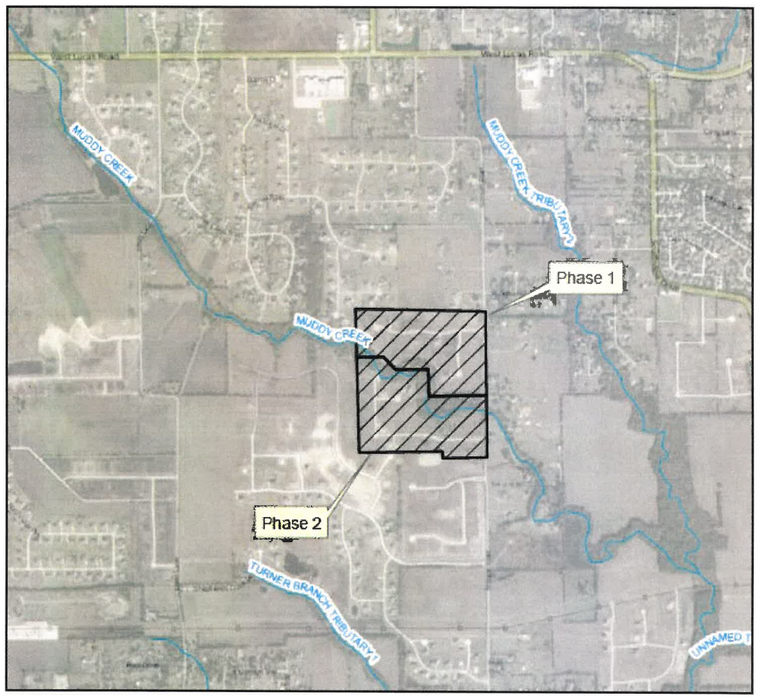

Figure 1 – Project Location

1.2 FEMA Flood Insurance Rate Map

Muddy Creek is currently shown on FEMA FIRM Panel 48085C0405J for Collin County, Texas and Incorporated areas, effective June 2, 2009. The current effective FIRM identifies the Special Flood Hazard Areas along Muddy Creek as a Zone A, an area subject to inundation by the base (1-percent annual chance) flood event with no established Base Flood Elevations (BFEs).

Figure 2 shows the areas of the effective FIRM panel that would be affected by the updated flood study along Muddy Creek.

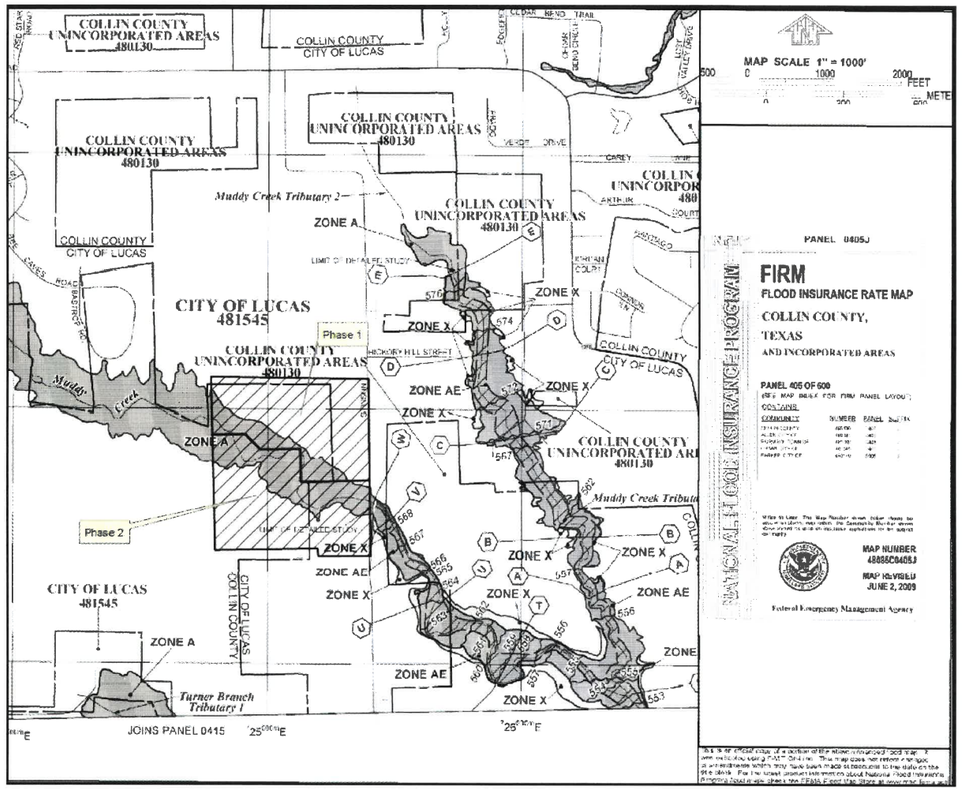

Figure 2 – FEMA FIRM

1.3 Bristol Park Phases 1 and 2 Layout

Figure 3 shows Bristol Park Phases 1 and 2 As-built conditions in relation to the Effective FEMA floodplain.

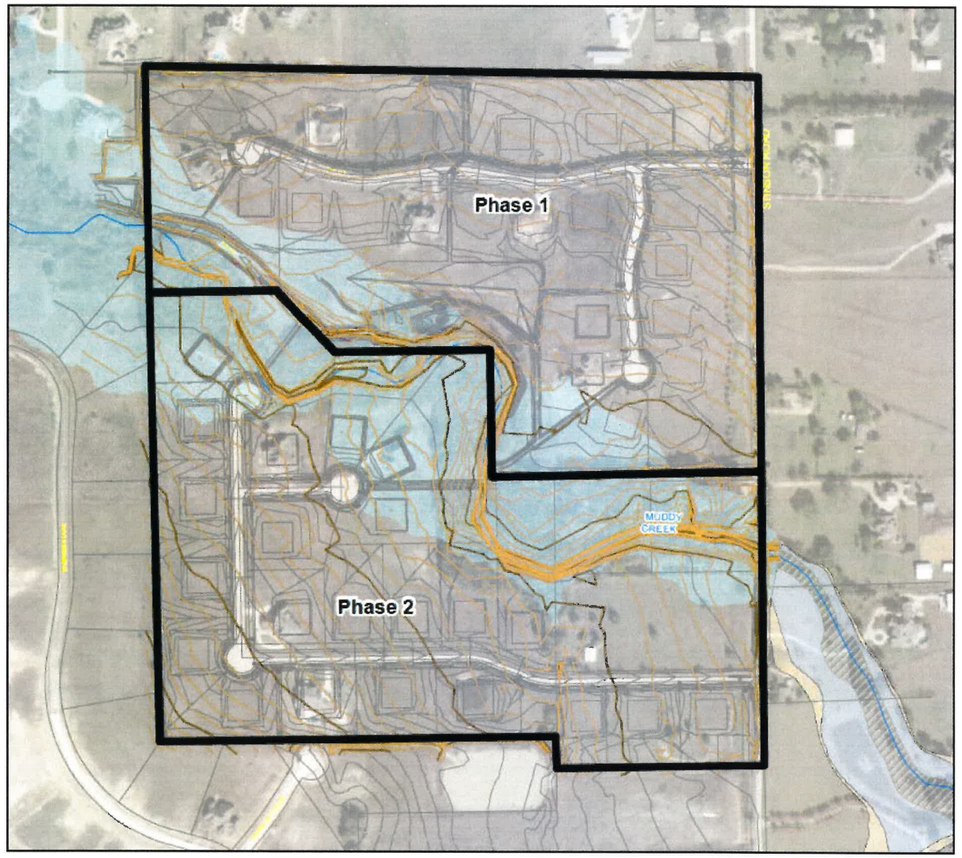

Figure 3 – Bristol Park Phase 1 and 2 Development

2.0 Effective Models

2.1 Effective Hydrology

The effective hydrology and flow rates fro Muddy Creek were prepared by CF3R JV for FEMA in September 2006 using the USACE's HEC-HMS hydrologic modeling program. The effective 100-year flow used for this study is taken at Stinson Road and is 2,925 cfs. A copy of the Summary of Discharge Table from the Collin County FIS is provided digitally in Attachment D.

2.2 Effective Hydraulic Model

The effective hydraulic model for Muddy Creek was obtained from BW2 Engineers, Inc. The model is a HEC-RAS model that includes detailed study downstream of Stinson Road, but does not include the existing culvert crossing at Stinson Road nor does it extend though the Bristol Park Phases 1 and 2 reach. A CLOMR was prepared by Kimley-Horn & Associates, Inc. ("KHA") for Stinson Highlands Phase 3 located just upstream of the Bristol Park Phases 1 and 2 development, but does not extend down through the project reach. This CLOMR is still under review by FEMA. There is no effective hydraulic model for the project reach for Bristol Park Phases 1 and 2 developments.

3.0 Hydraulic Modeling

3.1 Pre-Project Conditions

Due to the unavailability of the 2013 Aqua Terra Engineering Consultants, LLC ("ATEC") Flood Study, a Pre-project conditions HEC-RAS model was developed using pre-project contour data for the Bristol Park area. The pre-project contour data was provided by Engineering Concepts & Design ("ECD") and verified with 2009 Texas Natural Resource Information Systems ("TNRIS") topographic data. Cross-section alignments used for the As-built (existing) conditions HEC-RAS model (see Section 3.3) developed previously by ACTE were used for the Pre-project conditions model. Effective FEMA Cross-section W, RS 40418, is included as the most downstream cross-section of the model to tie into the effective HEC-RAS model downstream of Stinson Road. Figure 4 shows the cross-section layout.

Manning's n-values were selected based on pre-project arial photography. Banks stations were selected based on topographic breaks. The existing 7.5" CMP culvert at Stinson Road and an existing pedestrian bridge located approximately 220 ft upstream of Stinson Road were coded into the model. Blocked Obstructions were used to model existing homes and ineffective flow areas were coded as required.

The downstream boundary condition is set as the effective water surface elevation at FEMA cross-section W as 568.73 ft for the FEMA 100-year profile model.

HEC-RAS cross-sections, profiles and summary tables are provided in Attachment B. A digital copy of the HEC-RAS model is provided in Attachment D.

3.2 As-Built Conditions

The As-built conditions model reflects the overbank fill and channel grading that was done as part of the construction of the Bristol Park Phases 1 and 2 developments. The Pre-project conditions hydraulic modeling was used as the base for the As-Built conditions modeling. As-built survey, dated April 15, 2015, December 23, 2015 and November 29, 2016 (provided by ECD), was used to update the Pre-project conditions model to develop the Post-Conditions model. Digital copies of the As-built survey files are provided in Attachments D.

HEC-RAS cross-sections, profiles and summary tables are provided in Attachment B. A digital copy of the HEC-RAS model is provided in Attachment D.

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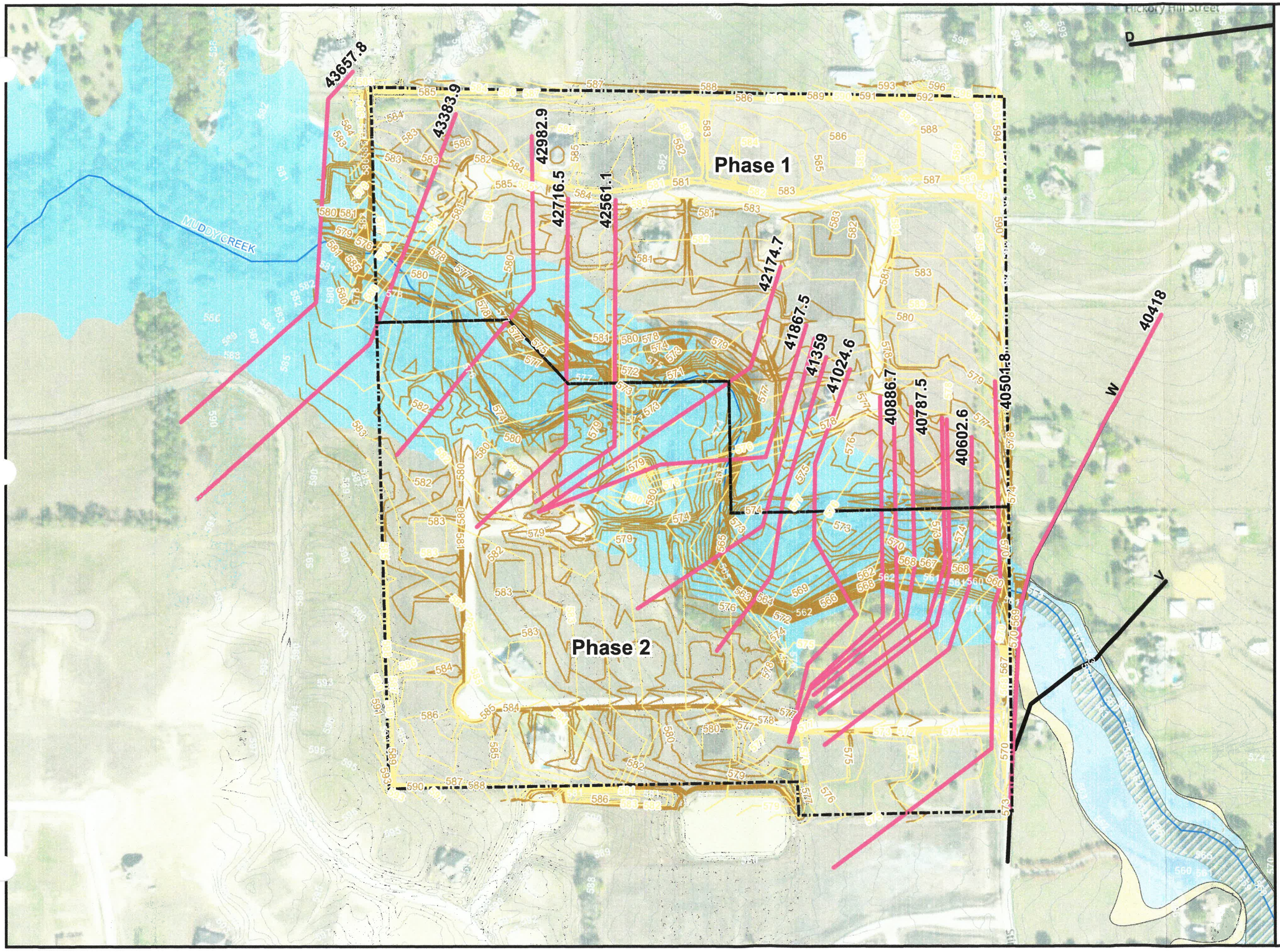
FIGURE 4: BRISTOL PARK PHASES 1 AND 2 CROSS-SECTION & TOPOGRAPHIC MAP



LEGEND

- Project Site
- Cross-sections
- As-Built Topo
- Survey Topo
- FEMA Streamline

FEMA SFHA

- A,
- AE,
- AE, FLOODWAY
- 0.2% AC Flood Hazard
- TNRIS 1ft Contours

N

0 150 300 600 Feet

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3.3 Hydraulic Modeling Results

Figure 5 shows the Pre-project and As-built conditions 100-year floodplain boundaries compared to the effective FEMA Zone A in relation to the Bristol Park Phase 1 and 2 developments. A 24″ x 36″ version of the Floodplain Workmap and an Annotated FIRM are included in Attachment C.

Table 1 summarizes the results of the Pre-project conditions and the As-built conditions hydraulic modeling for the100-year event.

Table 1: Pre-Project and As-built Conditions 100 Year Results

River Sta	Pre-Project	As-Built	*Diff*
	W.S. Elev (ft)	W.S. Elev (ft)	*W.S. Elev (cfs)*
43657.8	583.00	582.85	*-0.15*
43383.9	581.98	581.87	*-0.11*
42982.9	580.76	580.65	*-0.11*
42716.5	579.19	579.31	*0.12*
42561.1	578.35	578.49	*0.14*
42174.7	577.30	577.27	*0.23*
41867.5	575.58	575.45	*0.14*
41553.5	574.34	574.33	*-0.01*
41359	573.88	573.81	*-0.09*
41024.6	573.42	573.25	*-0.17*
40886.7	573.25	573.04	*-0.21*
40841.8	572.07	572.69	*0.62*
40787.5	572.59	572.59	*0.00*
40698.9	571.89	572.14	*0.25*
40692.6	Bridge		
40677.4	571.62	571.62	*0.00*
40602.6	571.39	571.43	*0.04*
40501.8	571.46	571.54	*0.08*
40461	Culvert		
40418 W	568.73	568.73	*0.00*

The results show some increases and decreases in water surface elevations due to the development. The increases are less than a foot. Water surface elevations for the As-built condition is less than the Pre-project conditions upstream of the development.

4.0 Summary of Results

The result of the flood study show that the Bristol Park Phase 1 and 2 development demonstrates that the project does not adversely impact the effective FEMA 100 year floodplain or water surface elevations along Muddy Creek from Stinson Road to approximately 3,000 feet upstream of Stinson Road. With this analysis, Base Flood Elevations have been established along the revised reach. As a result of the analysis, modifications to the effective SHFA and establishment of BFEs will extend upstream of the Bristol Park development to establish the required FEMA floodplain tie in. Property owner notification will be provided to FEMA following approval of the submitted hydraulic modeling analysis.

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FIGURE 5: BRISTOL PARK PHASES 1 AND 2 PRE-PROJECT & AS-BUILT FLOODPLAIN WORK MAP

River Sta	Pre-Project	As-Built	Diff
	W.S. Elev (ft)	W.S. Elev (ft)	W.S. Elev (cfs)
43657.8	583.00	582.85	-0.15
43383.9	581.98	581.87	-0.11
42982.9	580.76	580.65	-0.11
42716.5	579.19	579.31	0.12
42561.1	578.35	578.49	0.14
42174.7	577.30	577.27	0.23
41867.5	575.58	575.45	0.14
41553.5	574.34	574.33	-0.01
41359	573.88	573.81	-0.09
41024.6	573.42	573.25	-0.17
40886.7	573.25	573.04	-0.21
40841.8	572.07	572.69	0.62
40787.5	572.59	572.59	0.00
40698.9	571.89	572.14	0.25
40692.6	Bridge		
40677.4	571.62	571.62	0.00
40602.6	571.39	571.43	0.04
40501.8	571.46	571.54	0.08
40461	Culvert		
40418 W	568.73	568.73	0.00

STATE OF TEXAS
MICHAEL C. ANDERSON
89189
LICENSED
PROFESSIONAL ENGINEER
1-17-2017

Phase 1

Phase 2

MUDDY CREEK

43383.9 42982.9 42716.5 42561.1 42174.7 41867.5 41359 41024.6 40886.7 40787.5 40602.6 40501.8

Allison Road

LEGEND

- Project Site
- 100yr FEMA Floodplain - Asbuilt
- 100yr FEMA Floodplain - Pre-Project
- Cross-sections
- As-Built Topo
- Survey Topo
- FEMA Streamline

FEMA SFHA

- A,
- AE,
- AE, FLOODWAY
- 0.2% AC Flood Hazard
- TNRIS 1ft Contours

N

0 150 300 600 Feet

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ATTACHMENT A - MT-2 FORMS

U.S. DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY

OVERVIEW & CONCURRENCE FORM

O.M.B No. 1660-0016
Expires February 28, 2014

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 1 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless it displays a valid OMB control number. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 1800 South Bell Street, Arlington, VA 20958-3005, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

PRIVACY ACT STATEMENT

AUTHORITY: The National Flood Insurance Act of 1968, Public Law 90-448, as amended by the Flood Disaster Protection Act of 1973, Public Law 93-234.

PRINCIPAL PURPOSE(S): This information is being collected for the purpose of determining an applicant's eligibility to request changes to National Flood Insurance Program (NFIP) Flood Insurance Rate Maps (FIRM).

ROUTINE USE(S): The information on this form may be disclosed as generally permitted under 5 U.S.C § 552a(b) of the Privacy Act of 1974, as amended. This includes using this information as necessary and authorized by the routine uses published in DHS/FEMA/NFIP/LOMA-1 National Flood Insurance Program (NFIP); Letter of Map Amendment (LOMA) February 15, 2006, 71 FR 7990.

DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a (NFIP) Flood Insurance Rate Maps (FIRM).

A. REQUESTED RESPONSE FROM DHS-FEMA

This request is for a (check one):

☐ CLOMR: A letter from DHS-FEMA commenting on whether a proposed project, if built as proposed, would justify a map revision, or proposed hydrology changes (See 44 CFR Ch. 1, Parts 60, 65 & 72).

☒ LOMR: A letter from DHS-FEMA officially revising the current NFIP map to show the changes to floodplains, regulatory floodway or flood elevations. (See 44 CFR Ch. 1, Parts 60, 65 & 72)

B. OVERVIEW

1. The NFIP map panel(s) affected for all impacted communities is (are):

Community No.	Community Name	State	Map No.	Panel No.	Effective Date
Example: 480301 480287	City of Katy Harris County	TX TX	48473C 48201C	0005D 0220G	02/08/83 09/28/90
481545	City of Lucas (Collin County)	TX	48085C	0405J	06/02/09

2. a. Flooding Source: Muddy Creek

   b. Types of Flooding: ☒ Riverine ☐ Coastal ☐ Shallow Flooding (e.g., Zones AO and AH)
   ☐ Alluvial fan ☐ Lakes ☐ Other (Attach Description)

3. Project Name/Identifier: Bristol Park

4. FEMA zone designations affected: A (choices: A, AH, AO, A1-A30, A99, AE, AR, V, V1-V30, VE, B, C, D, X)

5. Basis for Request and Type of Revision:

   a. The basis for this revision request is (check all that apply)

   ☒ Physical Change ☒ Improved Methodology/Data ☐ Regulatory Floodway Revision ☒ Base Map Changes
   ☐ Coastal Analysis ☒ Hydraulic Analysis ☐ Hydrologic Analysis ☐ Corrections
   ☐ Weir-Dam Changes ☐ Levee Certification ☐ Alluvial Fan Analysis ☐ Natural Changes
   ☒ New Topographic Data ☐ Other (Attach Description)

   Note: A photograph and narrative description of the area of concern is not required, but is very helpful during review.

b. The area of revision encompasses the following structures (check all that apply)

Structures: ☐ Channelization ☐ Levee/Floodwall ☒ Bridge/Culvert

☐ Dam ☒ Fill ☐ Other (Attach Description)

6. ☐ Documentation of ESA compliance is submitted (required to initiate CLOMR review). Please refer to the instructions for more information.

C. REVIEW FEE

Has the review fee for the appropriate request category been included? ☒ Yes Fee amount: $_____

☐ No, Attach Explanation

Please see the DHS-FEMA Web site at http://www.fema.gov/plan/prevent/fhm/frm_fees.shtm **for Fee Amounts and Exemptions.**

D. SIGNATURE

All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Name: Todd Wintters, P.E.	Company: Engineering Concepts & Design	
Mailing Address: 201 Windco Cir, STE 200 Wylie, Texas 750	Daytime Telephone No.:	Fax No.:
	E-Mail Address:	
Signature of Requester (required):	Date:	

As the community official responsible for floodplain management, I hereby acknowledge that we have received and reviewed this Letter of Map Revision (LOMR) or conditional LOMR request. Based upon the community's review, we find the completed or proposed project meets or is designed to meet all of the community floodplain management requirements, including the requirements for when fill is placed in the regulatory floodway, and that all necessary Federal, State, and local permits have been, or in the case of a conditional LOMR, will be obtained. For Conditional LOMR requests, the applicant has documented Endangered Species Act (ESA) compliance to FEMA prior to FEMA's review of the Conditional LOMR application. For LOMR requests, I acknowledge that compliance with Sections 9 and 10 of the ESA has been achieved independently of FEMA's process. For actions authorized, funded, or being carried out by Federal or State agencies, documentation from the agency showing its compliance with Section 7(a)(2) of the ESA will be submitted. In addition, we have determined that the land and any existing or proposed structures to be removed from the SFHA are or will be reasonably safe from flooding as defined in 44CFR 65.2(c), and that we have available upon request by FEMA, all analyses and documentation used to make this determination.

Community Official's Name and Title: Stanton Foerster, Public Works Director/City Engineer	Community Name: City of Lucas	
Mailing Address: 665 Country Club Road Lucas, Texas 7500	Daytime Telephone No.: (972) 912-1208	Fax No.:
	E-Mail Address: sfoerster@lucastexas.us	
Community Official's Signature (required):	Date: 1-18-2017	

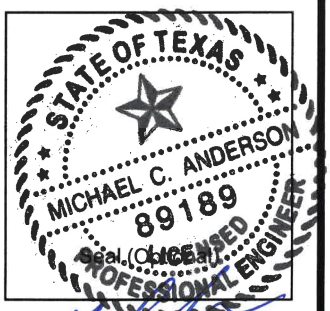
CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

This certification is to be signed and sealed by a licensed land surveyor, registered professional engineer, or architect authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting information as per NFIP regulations paragraph 65.2(b) and as described in the MT-2 Forms Instructions. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: Michael Anderson, PE, CFM, D.WRE	License No.: 89189		Expiration Date: 12/31/2017
Company Name: Cardinal-Strategies, PLLC	Telephone No.: (214) 437-4265		Fax No.:
Signature:	Date: 1-17-2017	E-Mail Address: michael.anderson@cardinal-strategies.com	

Ensure the forms that are appropriate to your revision request are included in your submittal.

Form Name and (Number)	Required if ...
☒ Riverine Hydrology and Hydraulics Form (Form 2)	New or revised discharges or water-surface elevations
☒ Riverine Structures Form (Form 3)	Channel is modified, addition/revision of bridge/culverts, addition/revision of levee/floodwall, addition/revision of dam
☐ Coastal Analysis Form (Form 4)	New or revised coastal elevations
☐ Coastal Structures Form (Form 5)	Addition/revision of coastal structure
☐ Alluvial Fan Flooding Form (Form 6)	Flood control measures on alluvial fans



1-17-2017

U.S. DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE HYDROLOGY & HYDRAULICS FORM

O.M.B No. 1660-0016
Expires February 28, 2014

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 3.5 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 1800 South Bell Street, Arlington VA 20958-3005, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

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DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a NFIP Flood Insurance Rate Maps (FIRM).

Flooding Source: Muddy Creek

Note: Fill out one form for each flooding source studied

A. HYDROLOGY

1. Reason for New Hydrologic Analysis (check all that apply)

☒ Not revised (skip to section B) ☐ No existing analysis ☐ Improved data
☐ Alternative methodology ☐ Proposed Conditions (CLOMR) ☐ Changed physical condition of watershed

2. Comparison of Representative 1%-Annual-Chance Discharges

Location	Drainage Area (Sq. Mi.)	Effective/FIS (cfs)	Revised (cfs)

3. Methodology for New Hydrologic Analysis (check all that apply)

☐ Statistical Analysis of Gage Records ☐ Precipitation/Runoff Model → Specify Model: _____
☐ Regional Regression Equations ☐ Other (please attach description)

Please enclose all relevant models in digital format, maps, computations (including computation of parameters), and documentation to support the new analysis.

4. Review/Approval of Analysis

If your community requires a regional, state, or federal agency to review the hydrologic analysis, please attach evidence of approval/review.

5. Impacts of Sediment Transport on Hydrology

Is the hydrology for the revised flooding source(s) affected by sediment transport? ☐ Yes ☐ No

If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation..

B. HYDRAULICS

1. Reach to be Revised

	Description	Cross Section	Water-Surface Elevations (ft.) Effective	Proposed/Revised
Downstream Limit*	Just d/s Stinson Rd	W	568.73	568.73
Upstream Limit*	Approx 3000 ft u/s Stinson Rd		N/A	582.8

*Proposed/Revised elevations must tie-into the Effective elevations within 0.5 foot at the downstream and upstream limits of revision.

2. Hydraulic Method/Model Used: HEC-RAS 4.1.0

3. Pre-Submittal Review of Hydraulic Models*

DHS-FEMA has developed two review programs, CHECK-2 and CHECK-RAS, to aid in the review of HEC-2 and HEC-RAS hydraulic models, respectively. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS.

4.

Models Submitted	Natural Run File Name:	Natural Run Plan Name:	Floodway Run File Name:	Floodway Run Plan Name:	Datum
Duplicate Effective Model*					
Corrected Effective Model*					
Existing or Pre-Project Conditions Model	MuddyCreek.prj	Pre-Proj	N/A	N/A	NAVD88
Revised or Post-Project Conditions Model	MuddyCreek.prj	Post-Proj AB	N/A	N/A	NAVD88
Other - (attach description)					

* For details, refer to the corresponding section of the instructions.

☒ Digital Models Submitted? (Required)

C. MAPPING REQUIREMENTS

A **certified topographic work map** must be submitted showing the following information (where applicable): the boundaries of the effective, existing, and proposed conditions 1%-annual-chance floodplain (for approximate Zone A revisions) or the boundaries of the 1%- and 0.2%-annual-chance floodplains and regulatory floodway (for detailed Zone AE, AO, and AH revisions); location and alignment of all cross sections with stationing control indicated; stream, road, and other alignments (e.g., dams, levees, etc.); current community easements and boundaries; boundaries of the requester's property; certification of a registered professional engineer registered in the subject State; location and description of reference marks; and the referenced vertical datum (NGVD, NAVD, etc.).

☒ Digital Mapping (GIS/CADD) Data Submitted (preferred)

Topographic Information: On-site survey data; TNRIS topography

Source: TNRIS; survey Date: 2009 TNRIS; site survey (Asbuilt 4/15/15 & 12/15)

Accuracy: 1-foot interval

Note that the boundaries of the existing or proposed conditions floodplains and regulatory floodway to be shown on the revised FIRM and/or FBFM must tie-in with the effective floodplain and regulatory floodway boundaries. Please attach **a copy of the effective FIRM and/or FBFM**, at the same scale as the original, annotated to show the boundaries of the revised 1%-and 0.2%-annual-chance floodplains and regulatory floodway that tie-in with the boundaries of the effective 1%-and 0.2%-annual-chance floodplain and regulatory floodway at the upstream and downstream limits of the area on revision.

☒ Annotated FIRM and/or FBFM (Required)

D. COMMON REGULATORY REQUIREMENTS*

1. For LOMR/CLOMR requests, do Base Flood Elevations (BFEs) increase? ☐ Yes ☒ No

   a. For CLOMR requests, if either of the following is true, please submit **evidence of compliance with Section 65.12 of the NFIP regulations**:

   - The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot compared to pre-project conditions.
   - The proposed project encroaches upon a SFHA with or without BFEs established and would result in increases above 1.00 foot compared to pre-project conditions.

   b. Does this LOMR request cause increase in the BFE and/or SFHA compared with the effective BFEs and/or SFHA? ☒ Yes ☐ No
   If Yes, please attach **proof of property owner notification and acceptance (if available)**. Elements of and examples of property owner notifications can be found in the MT-2 Form 2 Instructions.

2. Does the request involve the placement or proposed placement of fill? ☒ Yes ☐ No

   If Yes, the community must be able to certify that the area to be removed from the special flood hazard area, to include any structures or proposed structures, meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with the NFIP regulations set forth at 44 CFR 60.3(A)(3), 65.5(a)(4), and 65.6(a)(14). Please see the MT-2 instructions for more information.

3. For LOMR requests, is the regulatory floodway being revised? ☐ Yes ☒ No

   If Yes, attach **evidence of regulatory floodway revision notification**. As per Paragraph 65.7(b)(1) of the NFIP Regulations, notification is required for requests involving revisions to the regulatory floodway. (Not required for revisions to approximate 1%-annual-chance floodplains [studied Zone A designation] unless a regulatory floodway is being established. Elements and examples of regulatory floodway revision notification can be found in the MT-2 Form 2 Instructions.)

4. For CLOMR requests, please submit documentation to FEMA and the community to show that you have complied with Sections 9 and 10 of the Endangered Species Act (ESA).

For actions authorized, funded, or being carried out by Federal or State agencies, please submit documentation from the agency showing its compliance with Section 7(a)(2) of the ESA. Please see the MT-2 instructions for more detail.

* Not inclusive of all applicable regulatory requirements. For details, see 44 CFR parts 60 and 65.

DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE STRUCTURES FORM

O.M.B. NO. 1660-0016
Expires February 28, 2014

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 7 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 1800 South Bell Street, Arlington, VA 20598-3005, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

PRIVACY ACT STATEMENT

AUTHORITY: The National Flood Insurance Act of 1968, Public Law 90-448, as amended by the Flood Disaster Protection Act of 1973, Public Law 93-234.

PRINCIPAL PURPOSE(S): This information is being collected for the purpose of determining an applicant's eligibility to request changes to National Flood Insurance Program (NFIP) Flood Insurance Rate Maps (FIRM).

ROUTINE USE(S): The information on this form may be disclosed as generally permitted under 5 U.S.C § 552a(b) of the Privacy Act of 1974, as amended. This includes using this information as necessary and authorized by the routine uses published in DHS/FEMA/NFIP/LOMA-1 National Flood Insurance Program; Letter of Map Amendment (LOMA) February 15, 2006, 71 FR 7990.

DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a NFIP Flood Insurance Rate Maps (FIRM).

Flooding Source: Muddy Creek

Note: Fill out one form for each flooding source studied.

A. GENERAL

Complete the appropriate section(s) for each Structure listed below:
Channelization.....complete Section B
Bridge/Culvert.....complete Section C
Dam.....complete Section D
Levee/Floodwall.....complete Section E
Sediment Transport.....complete Section F (if required)

Description Of Modeled Structure

1. Name of Structure: Stinson Road

   Type (check one): ☐ Channelization ☒ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam

   Location of Structure: Just upstream of effective section W - existing structure not in effective model

   Downstream Limit/Cross Section: 40418

   Upstream Limit/Cross Section: 40501.8

2. Name of Structure: Private bridge

   Type (check one): ☐ Channelization ☒ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam

   Location of Structure: 220 feet upstream of Stinson Road

   Downstream Limit/Cross Section: 40677.4

   Upstream Limit/Cross Section: 40698.9

3. Name of Structure: _____

   Type (check one) ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam

   Location of Structure: _____

   Downstream Limit/Cross Section: _____

   Upstream Limit/Cross Section: _____

NOTE: FOR MORE STRUCTURES, ATTACH ADDITIONAL PAGES AS NEEDED.

B. CHANNELIZATION

Flooding Source: _____

Name of Structure: _____

1. Hydraulic Considerations

The channel was designed to carry _____ (cfs) and/or the _____-year flood.

The design elevation in the channel is based on (check one):

☐ Subcritical flow ☐ Critical flow ☐ Supercritical flow ☐ Energy grade line

If there is the potential for a hydraulic jump at the following locations, check all that apply and attach an explanation of how the hydraulic jump is controlled without affecting the stability of the channel.

☐ Inlet to channel ☐ Outlet of channel ☐ At Drop Structures ☐ At Transitions

☐ Other locations (specify): _____

2. Channel Design Plans

Attach the plans of the channelization certified by a registered professional engineer, as described in the instructions.

3. Accessory Structures

The channelization includes (check one):

☐ Levees [Attach Section E (Levee/Floodwall)] ☐ Drop structures ☐ Superelevated sections

☐ Transitions in cross sectional geometry ☐ Debris basin/detention basin [Attach Section D (Dam/Basin)] ☐ Energy dissipator

☐ Weir ☐ Other (Describe):

4. Sediment Transport Considerations

Are the hydraulics of the channel affected by sediment transport? ☐ Yes ☐ No

If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation for why sediment transport was not considered.

C. BRIDGE/CULVERT

Flooding Source: Muddy Creek

Name of Structure: Stinson Road & Pedestrian bridge @ 220 ft upstream

1. This revision reflects (check one):

☒ Bridge/culvert not modeled in the FIS

☐ Modified bridge/culvert previously modeled in the FIS

☐ Revised analysis of bridge/culvert previously modeled in the FIS

2. Hydraulic model used to analyze the structure (e.g., HEC-2 with special bridge routine, WSPRO, HY8): HEC-RAS
If different than hydraulic analysis for the flooding source, justify why the hydraulic analysis used for the flooding source could not analyze the structures. Attach justification.

3. Attach plans of the structures certified by a registered professional engineer. The plan detail and information should include the following (check the information that has been provided):

☒ Dimensions (height, width, span, radius, length)
☒ Shape (culverts only)
☒ Material
☐ Beveling or Rounding
☐ Wing Wall Angle
☐ Skew Angle
☐ Distances Between Cross Sections
☐ Erosion Protection
☐ Low Chord Elevations – Upstream and Downstream
☐ Top of Road Elevations – Upstream and Downstream
☐ Structure Invert Elevations – Upstream and Downstream
☐ Stream Invert Elevations – Upstream and Downstream
☐ Cross-Section Locations

4. Sediment Transport Considerations

Are the hydraulics of the structure affected by sediment transport? ☐ Yes ☒ No

If Yes, then fill out Section F (Sediment Transport) of Form 3. If no, then attach an explanation.

D. DAM/BASIN

Flooding Source: _____
Name of Structure: _____

1. This request is for (check one): ☐ Existing dam/basin ☐ New dam/basin ☐ Modification of existing dam/basin

2. The dam/basin was designed by (check one): ☐ Federal agency ☐ State agency ☐ Private organization ☐ Local government agency

   Name of the agency or organization: _____

3. The Dam was permitted as (check one): ☐ Federal Dam ☐ State Dam

   Provide the permit or identification number (ID) for the dam and the appropriate permitting agency or organization

   Permit or ID number _____ Permitting Agency or Organization _____

   a. ☐ Local Government Dam ☐ Private Dam

   Provided related drawings, specification and supporting design information.

4. Does the project involve revised hydrology? ☐ Yes ☐ No

   If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2).

   Was the dam/basin designed using critical duration storm? (must account for the maximum volume of runoff)

   ☐ Yes, provide supporting documentation with your completed Form 2.

   ☐ No, provide a written explanation and justification for not using the critical duration storm.

5. Does the submittal include debris/sediment yield analysis? ☐ Yes ☐ No

   If Yes, then fill out Section F (Sediment Transport). If No, then attach your explanation for why debris/sediment analysis was not considered?

6. Does the Base Flood Elevation behind the dam/basin or downstream of the dam/basin change? ☐ Yes ☐ No

   If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2) and complete the table below.

FREQUENCY (% annual chance)	Stillwater Elevation Behind the Dam/Basin FIS	REVISED
10-year (10%)	_____	_____
50-year (2%)	_____	_____
100-year (1%)	_____	_____
500-year (0.2%)	_____	_____
Normal Pool Elevation	_____	_____

7. Please attach a copy of the formal Operation and Maintenance Plan

E. LEVEE/FLOODWALL

1. System Elements

a. This Levee/Floodwall analysis is based on (check one): ☐ upgrading of an existing levee/floodwall system ☐ a newly constructed levee/floodwall system ☐ reanalysis of an existing levee/floodwall system

b. Levee elements and locations are (check one):

☐ earthen embankment, dike, berm, etc. Station _____ to _____
☐ structural floodwall Station _____ to _____
☐ Other (describe): Station _____ to _____

c. Structural Type (check one): ☐ monolithic cast-in place reinforced concrete ☐ reinforced concrete masonry block ☐ sheet piling ☐ Other (describe): _____

d. Has this levee/floodwall system been certified by a Federal agency to provide protection from the base flood?

☐ Yes ☐ No

If Yes, by which agency? _____

e. Attach certified drawings containing the following information (indicate drawing sheet numbers):

1. Plan of the levee embankment and floodwall structures. Sheet Numbers: _____
2. A profile of the levee/floodwall system showing the Base Flood Elevation (BFE), levee and/or wall crest and foundation, and closure locations for the total levee system. Sheet Numbers: _____
3. A profile of the BFE, closure opening outlet and inlet invert elevations, type and size of opening, and kind of closure. Sheet Numbers: _____
4. A layout detail for the embankment protection measures. Sheet Numbers: _____
5. Location, layout, and size and shape of the levee embankment features, foundation treatment, Floodwall structure, closure structures, and pump stations. Sheet Numbers: _____

2. Freeboard

a. The minimum freeboard provided above the BFE is:

Riverine

3.0 feet or more at the downstream end and throughout	☐ Yes	☐ No
3.5 feet or more at the upstream end	☐ Yes	☐ No
4.0 feet within 100 feet upstream of all structures and/or constrictions	☐ Yes	☐ No

Coastal

1.0 foot above the height of the one percent wave associated with the 1%-annual-chance stillwater surge elevation or maximum wave runup (whichever is greater).	☐ Yes	☐ No
2.0 feet above the 1%-annual-chance stillwater surge elevation	☐ Yes	☐ No

Please note, occasionally exceptions are made to the minimum freeboard requirement. If an exception is requested, attach documentation addressing Paragraph 65.10(b)(1)(ii) of the NFIP Regulations.

If No is answered to any of the above, please attach an explanation.

b. Is there an indication from historical records that ice-jamming can affect the BFE? ☐ Yes ☐ No

If Yes, provide ice-jam analysis profile and evidence that the minimum freeboard discussed above still exists.

3. Closures

a. Openings through the levee system (check one): ☐ exists ☐ does not exist

If opening exists, list all closures:

Channel Station	Left or Right Bank	Opening Type	Highest Elevation for Opening Invert	Type of Closure Device

(Extend table on an added sheet as needed and reference)

Note: Geotechnical and geologic data

In addition to the required detailed analysis reports, data obtained during field and laboratory investigations and used in the design analysis for the following system features should be submitted in a tabulated summary form. (Reference U.S. Army Corps of Engineers [USACE] EM-1110-2-1906 Form 2086.)

4. Embankment Protection

a. The maximum levee slope land side is: _____

b. The maximum levee slope flood side is: _____

c. The range of velocities along the levee during the base flood is: _____ (min.) to _____ (max.)

d. Embankment material is protected by (describe what kind): _____

e. Riprap Design Parameters (check one): ☐ Velocity ☐ Tractive stress
Attach references

Reach		Sideslope	Flow Depth	Velocity	Curve or Straight	Stone Riprap			Depth of Toedown
						D_{100}	D_{50}	Thickness	
Sta	to								
Sta	to								
Sta	to								
Sta	to								
Sta	to								
Sta	to								

(Extend table on an added sheet as needed and reference each entry)

f. Is a bedding/filter analysis and design attached? ☐ Yes ☐ No

g. Describe the analysis used for other kinds of protection used (include copies of the design analysis):

Attach engineering analysis to support construction plans.

5. Embankment And Foundation Stability

a. Identify locations and describe the basis for selection of critical location for analysis:
_____

☐ Overall height: Sta.: _____, height _____ ft.

☐ Limiting foundation soil strength:

Strength ϕ = _____ degrees, c = _____ psf

Slope: SS = _____ (h) to _____ (v)

(Repeat as needed on an added sheet for additional locations)

b. Specify the embankment stability analysis methodology used (e.g., circular arc, sliding block, infinite slope, etc.):
_____

c. Summary of stability analysis results:

E. LEVEE/FLOODWALL (CONTINUED)

5. Embankment And Foundation Stability (continued)

Case	Loading Conditions	Critical Safety Factor	Criteria (Min.)
I	End of construction		1.3
II	Sudden drawdown		1.0
III	Critical flood stage		1.4
IV	Steady seepage at flood stage		1.4
VI	Earthquake (Case I)		1.0

(Reference: USACE EM-1110-2-1913 Table 6-1)

d. Was a seepage analysis for the embankment performed? ☐ Yes ☐ No

If Yes, describe methodology used:

e. Was a seepage analysis for the foundation performed? ☐ Yes ☐ No

f. Were uplift pressures at the embankment landside toe checked? ☐ Yes ☐ No

g. Were seepage exit gradients checked for piping potential? ☐ Yes ☐ No

h. The duration of the base flood hydrograph against the embankment is _____ hours.

Attach engineering analysis to support construction plans.

6. Floodwall And Foundation Stability

a. Describe analysis submittal based on Code (check one): ☐ UBC (1988) ☐ Other (specify): _____

b. Stability analysis submitted provides for: ☐ Overturning ☐ Sliding If not, explain: _____

c. Loading included in the analyses were: ☐ Lateral earth @ P_A = _____ psf; P_p = _____ psf

☐ Surcharge-Slope @ _____, ☐ surface _____ psf

☐ Wind @ P_w = _____ psf

☐ Seepage (Uplift); _____ ☐ Earthquake @ P_{eq} = _____ %g

☐ 1%-annual-chance significant wave height: _____ ft.

☐ 1%-annual-chance significant wave period: _____ sec.

d. Summary of Stability Analysis Results: Factors of Safety.
Itemize for each range in site layout dimension and loading condition limitation for each respective reach.

Loading Condition	Criteria (Min)		Sta	To	Sta	To
	Overturn	Sliding	Overturn	Sliding	Overturn	Sliding
Dead & Wind	1.5	1.5				
Dead & Soil	1.5	1.5				
Dead, Soil, Flood, & Impact	1.5	1.5				
Dead, Soil, & Seismic	1.3	1.3				

(Ref: FEMA 114 Sept 1986; USACE EM 1110-2-2502)
Note: (Extend table on an added sheet as needed and reference)

E. LEVEE/FLOODWALL (CONTINUED)

6. Floodwall And Foundation Stability (continued)

e. Foundation bearing strength for each soil type:

Bearing Pressure	Sustained Load (psf)	Short Term Load (psf)
Computed design maximum		
Maximum allowable		

f. Foundation scour protection ☐ is, ☐ is not provided. If provided, attach explanation and supporting documentation:

Attach engineering analysis to support construction plans.

7. Settlement

a. Has anticipated potential settlement been determined and incorporated into the specified construction elevations to maintain the established freeboard margin? ☐ Yes ☐ No

b. The computed range of settlement is _____ ft. to _____ ft.

c. Settlement of the levee crest is determined to be primarily from : ☐ Foundation consolidation ☐ Embankment compression ☐ Other (Describe): _____

d. Differential settlement of floodwalls ☐ has ☐ has not been accommodated in the structural design and construction.

Attach engineering analysis to support construction plans.

8. Interior Drainage

a. Specify size of each interior watershed:

Draining to pressure conduit: _____ acres
Draining to ponding area: _____ acres

b. Relationships Established

Ponding elevation vs. storage	☐ Yes	☐ No
Ponding elevation vs. gravity flow	☐ Yes	☐ No
Differential head vs. gravity flow	☐ Yes	☐ No

c. The river flow duration curve is enclosed: ☐ Yes ☐ No

d. Specify the discharge capacity of the head pressure conduit: _____ cfs

e. Which flooding conditions were analyzed?

• Gravity flow (Interior Watershed)	☐ Yes	☐ No
• Common storm (River Watershed)	☐ Yes	☐ No
• Historical ponding probability	☐ Yes	☐ No
• Coastal wave overtopping	☐ Yes	☐ No

If No for any of the above, attach explanation.

e. Interior drainage has been analyzed based on joint probability of interior and exterior flooding and the capacities of pumping and outlet facilities to provide the established level of flood protection. ☐ Yes ☐ No If No, attach explanation.

g. The rate of seepage through the levee system for the base flood is _____ cfs

h. The length of levee system used to drive this seepage rate in item g: _____ ft.

E. LEVEE/FLOODWALL (CONTINUED)

8. Interior Drainage (continued)

i. Will pumping plants be used for interior drainage? ☐ Yes ☐ No

If Yes, include the number of pumping plants: _____ For each pumping plant, list:

	Plant #1	Plant #2
The number of pumps		
The ponding storage capacity		
The maximum pumping rate		
The maximum pumping head		
The pumping starting elevation		
The pumping stopping elevation		
Is the discharge facility protected?		
Is there a flood warning plan?		
How much time is available between warning and flooding?		

Will the operation be automatic? ☐ Yes ☐ No

If the pumps are electric, are there backup power sources? ☐ Yes ☐ No

(Reference: USACE EM-1110-2-3101, 3102, 3103, 3104, and 3105)

Include a copy of supporting documentation of data and analysis. Provide a map showing the flooded area and maximum ponding elevations for all interior watersheds that result in flooding.

9. Other Design Criteria

a. The following items have been addressed as stated:

Liquefaction ☐ is ☐ is not a problem

Hydrocompaction ☐ is ☐ is not a problem

Heave differential movement due to soils of high shrink/swell ☐ is ☐ is not a problem

b. For each of these problems, state the basic facts and corrective action taken:

Attach supporting documentation

c. If the levee/floodwall is new or enlarged, will the structure adversely impact flood levels and/or flow velocities floodside of the structure?
☐ Yes ☐ No Attach supporting documentation

d. Sediment Transport Considerations:

Was sediment transport considered? ☐ Yes ☐ No

If Yes, then fill out Section F (Sediment Transport). If No, then attach your explanation for why sediment transport was not considered.

10. Operational Plan And Criteria

a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☐ Yes ☐ No

b. Does the operation plan incorporate all the provisions for closure devices as required in Paragraph 65.10(c)(1) of the NFIP regulations?
☐ Yes ☐ No

c. Does the operation plan incorporate all the provisions for interior drainage as required in Paragraph 65.10(c)(2) of the NFIP regulations?
☐ Yes ☐ No If the answer is No to any of the above, please attach supporting documentation.

E. LEVEE/FLOODWALL (CONTINUED)

11. Maintenance Plan

Please attach a copy of the fomal maintenance plan for the levee/floodwall

12. Operations and Maintenance Plan

Please attach a copy of the formal Operations and Maintenance Plan for the levee/floodwall.

CERTIFICATION OF THE LEVEE DOCUMENTION

This certification is to be signed and sealed by a licensed registered professional engineer authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting information as per NFIP regulations paragraph 65.10(e) and as described in the MT-2 Forms Instructions. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: _____ License No.: _____ Expiration Date: _____

Company Name: _____ Telephone No.: _____ Fax No.: _____

Signature: _____ Date: _____ E-Mail Address: _____

F. SEDIMENT TRANSPORT

Flooding Source: _____

Name of Structure: _____

If there is any indication from historical records that sediment transport (including scour and deposition) can affect the Base Flood Elevation (BFE); and/or based on the stream morphology, vegetative cover, development of the watershed and bank conditions, there is a potential for debris and sediment transport (including scour and deposition) to affect the BFEs, then provide the following information along with the supporting documentation:

Sediment load associated with the base flood discharge: Volume _____ acre-feet

Debris load associated with the base flood discharge: Volume _____ acre-feet

Sediment transport rate _____ (percent concentration by volume)

Method used to estimate sediment transport: _____

Most sediment transport formulas are intended for a range of hydraulic conditions and sediment sizes; attach a detailed explanation for using the selected method.

Method used to estimate scour and/or deposition: _____

Method used to revise hydraulic or hydrologic analysis (model) to account for sediment transport: _____

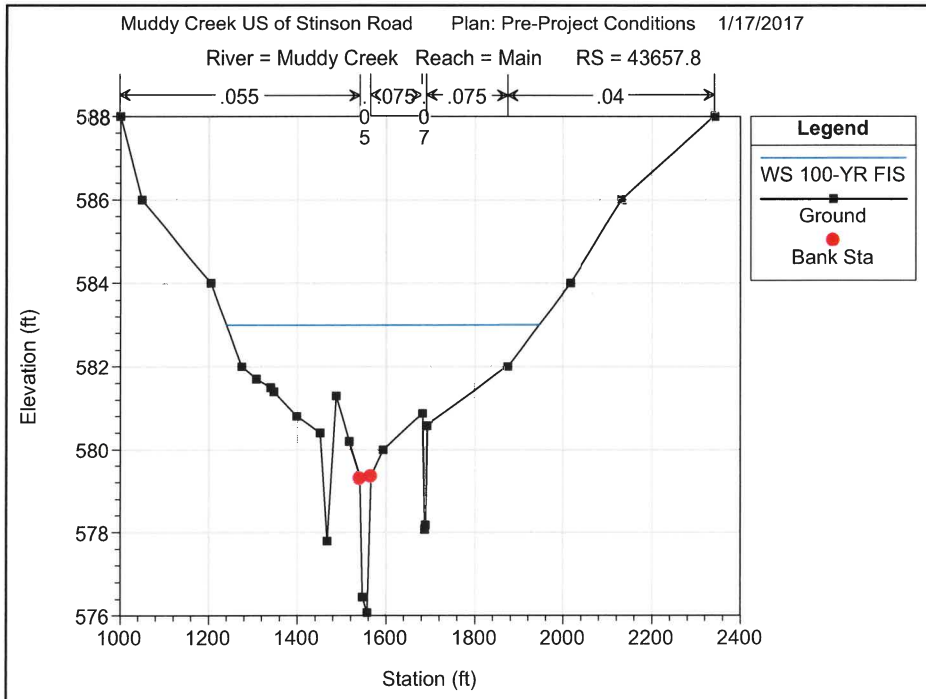
Please note that bulked flows are used to evaluate the performance of a structure during the base flood; however, FEMA does not map BFEs based on bulked flows.

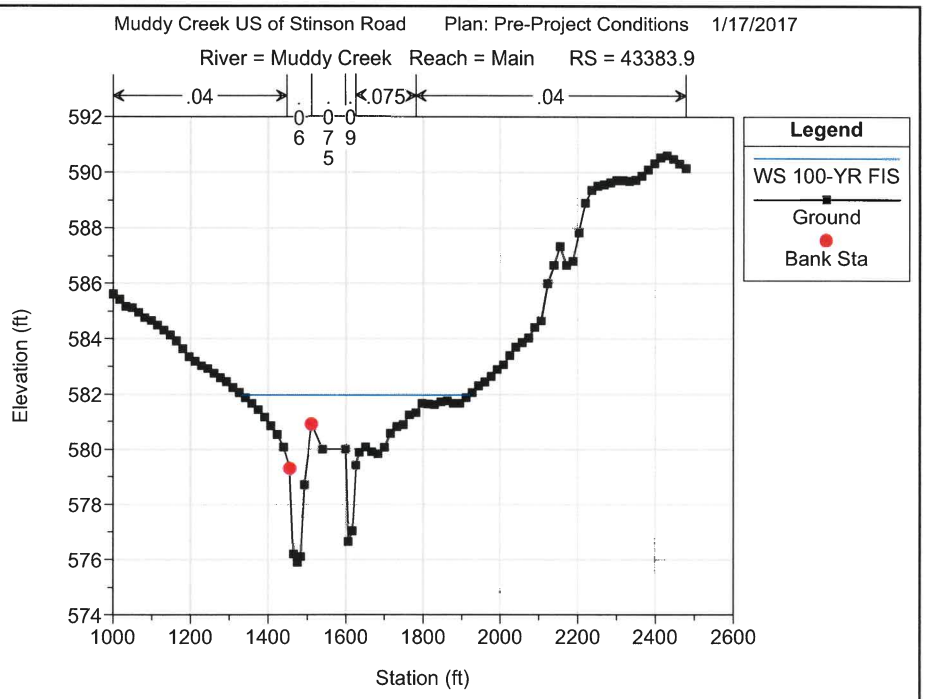
If a sediment analysis has not been performed, an explanation as to why sediment transport (including scour and deposition) will not affect the BFEs or structures must be provided.

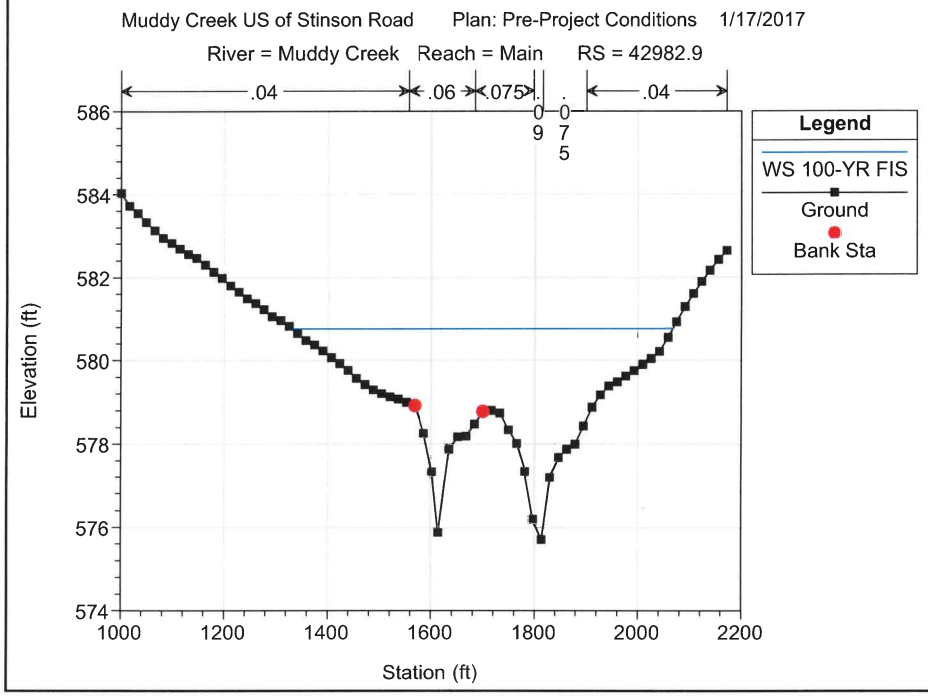
ATTACHMENT B - HYDRAULIC DATA

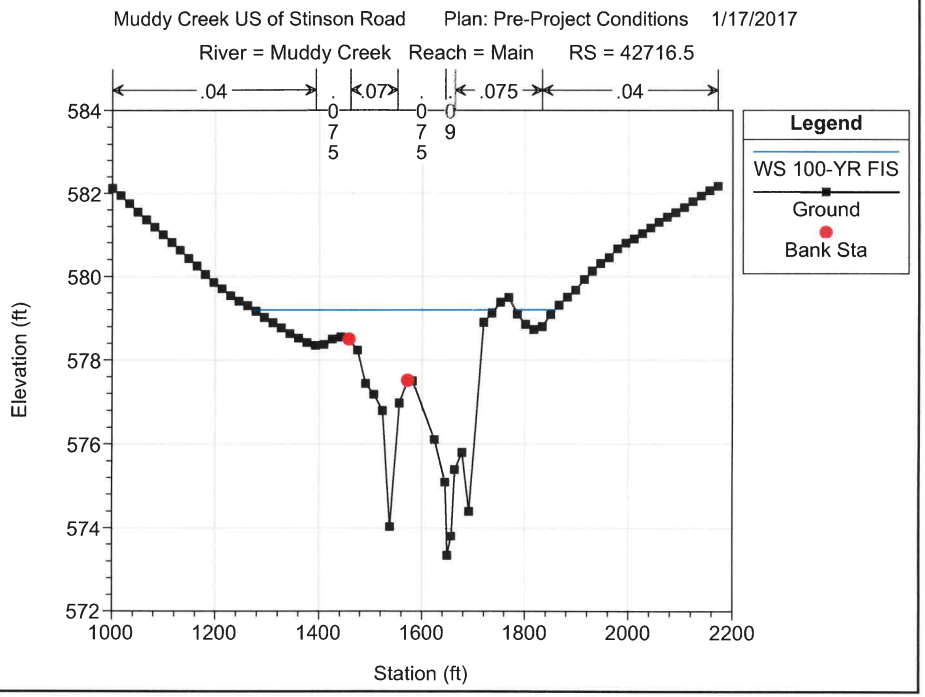
HEC-RAS Plan: Pre-Proj River: Muddy Creek Reach: Main Profile: 100-YR FIS

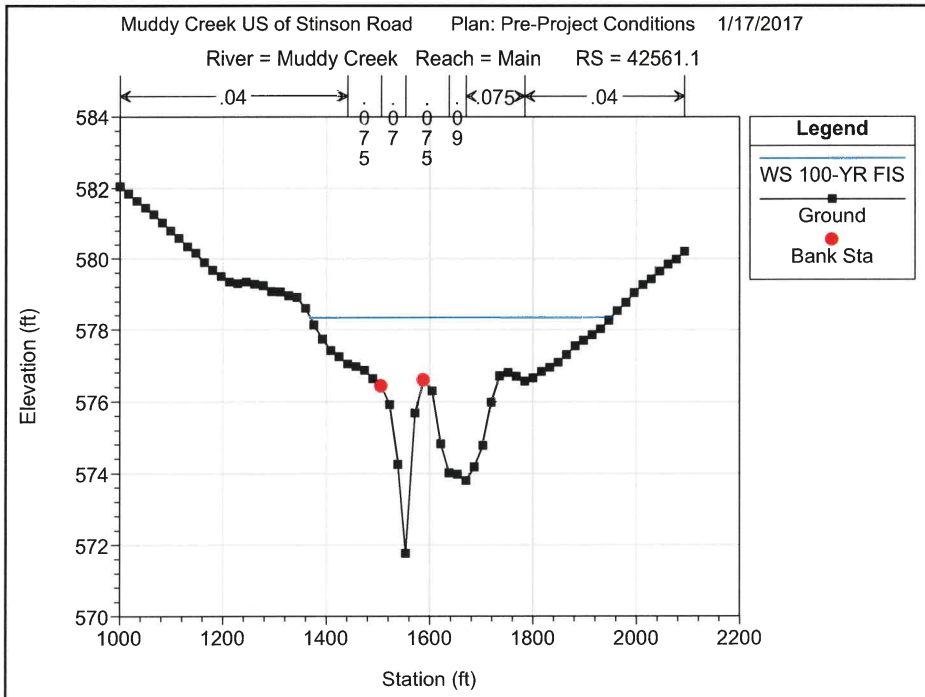
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	43657.8	100-YR FIS	2925.00	576.07	583.00		583.10	0.002080	4.28	1462.25	704.96	0.31
Main	43383.9	100-YR FIS	2925.00	575.90	581.98		582.20	0.006527	5.15	917.88	587.61	0.44
Main	42982.9	100-YR FIS	2925.00	575.88	580.76		580.83	0.002386	2.42	1412.41	735.72	0.25
Main	42716.5	100-YR FIS	2925.00	574.03	579.19		579.39	0.009819	3.58	846.18	542.18	0.42
Main	42561.1	100-YR FIS	2925.00	571.76	578.35		578.45	0.003859	2.94	1188.41	583.11	0.28
Main	42174.7	100-YR FIS	2925.00	569.80	577.04		577.28	0.005300	5.79	1021.11	536.52	0.42
Main	41867.5	100-YR FIS	2925.00	567.60	575.31		575.81	0.006734	6.20	627.93	266.97	0.47
Main	41553.5	100-YR FIS	2925.00	562.50	574.34		574.63	0.002196	4.93	1009.93	349.54	0.29
Main	41359	100-YR FIS	2925.00	561.39	573.88	570.10	574.20	0.002482	5.19	976.56	332.98	0.30
Main	41024.6	100-YR FIS	2925.00	560.24	573.42		573.62	0.001536	4.43	1045.24	300.88	0.24
Main	40886.7	100-YR FIS	2925.00	560.50	573.25		573.39	0.001189	3.90	1204.74	334.28	0.21
Main	40841.8	100-YR FIS	2925.00	559.97	572.07		573.19	0.006143	9.23	574.72	184.96	0.54
Main	40787.5	100-YR FIS	2925.00	560.20	572.59		572.74	0.001786	3.24	965.62	227.30	0.27
Main	40698.9	100-YR FIS	2925.00	559.47	571.89	569.20	572.50	0.002911	7.02	596.13	117.70	0.40
Main	40692.6		Bridge									
Main	40677.4	100-YR FIS	2925.00	559.90	571.62		572.32	0.003386	7.36	546.60	142.97	0.43
Main	40602.6	100-YR FIS	2925.00	559.79	571.39		572.05	0.003297	7.41	677.52	332.36	0.43
Main	40501.8	100-YR FIS	2925.00	559.47	571.46	568.09	571.63	0.001094	4.48	1198.45	601.73	0.26
Main	40461		Culvert									
Main	40418 W	100-YR FIS	2925.00	555.50	568.73	565.03	569.23	0.002345	7.24	846.41	269.25	0.37

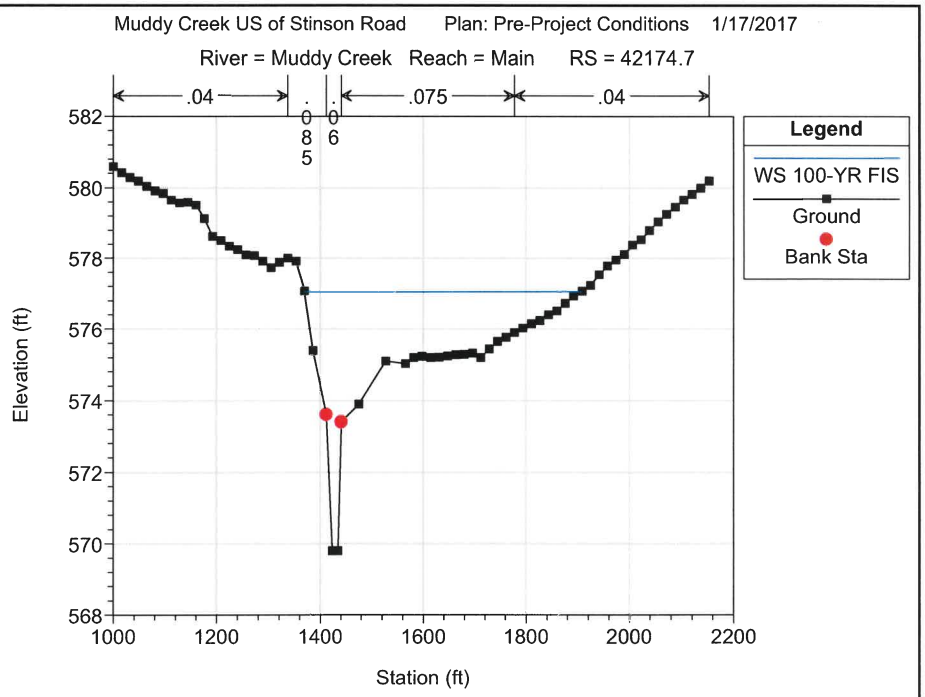

Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 43657.8
.055
.075
.075
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)

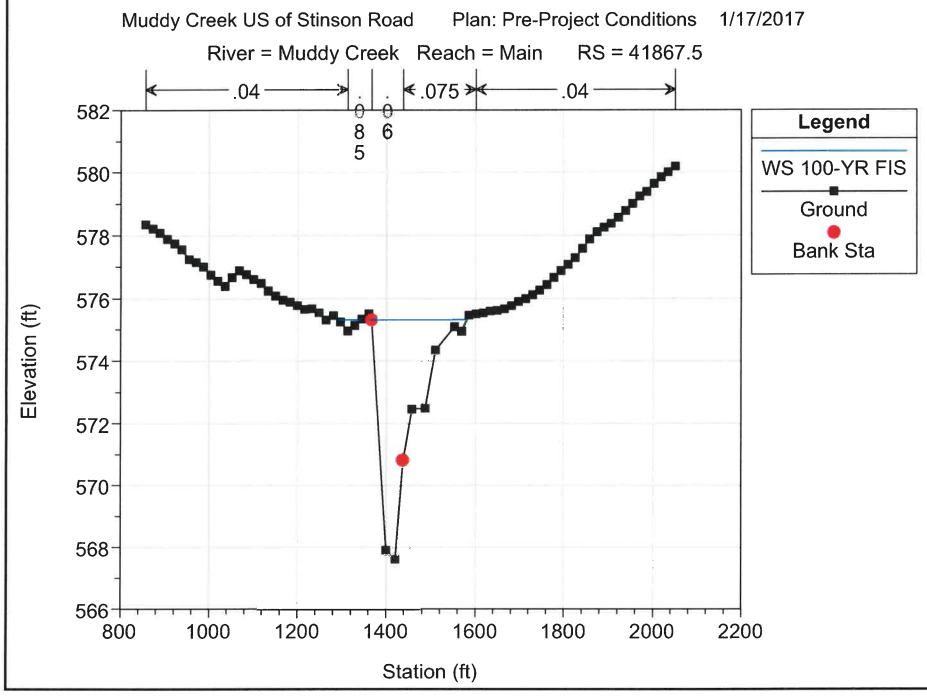

Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 43383.9
.04
.075
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)

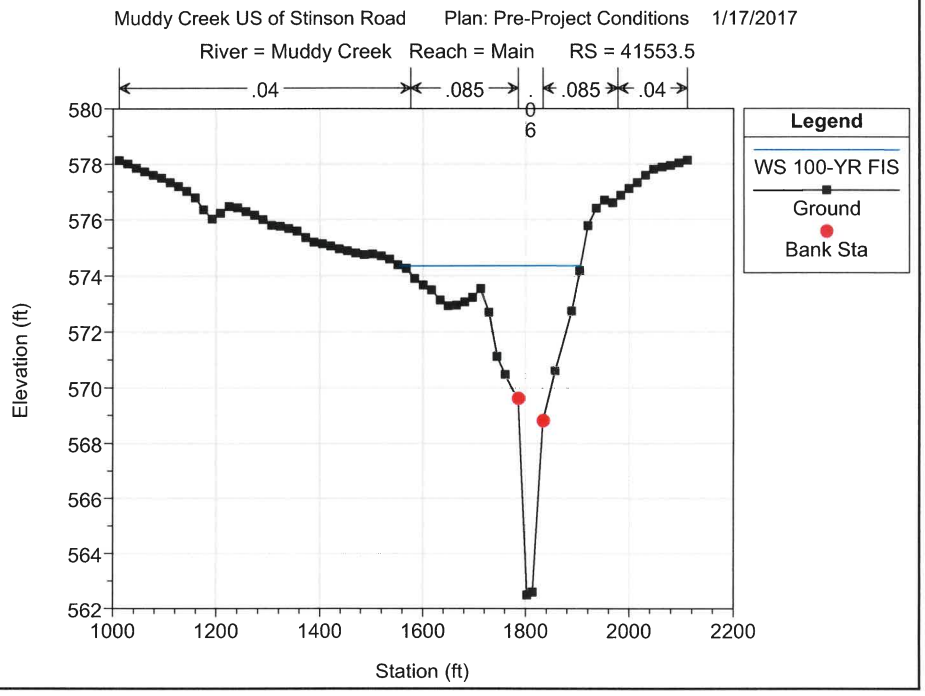

Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 42982.9
.04
.06
.075
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)

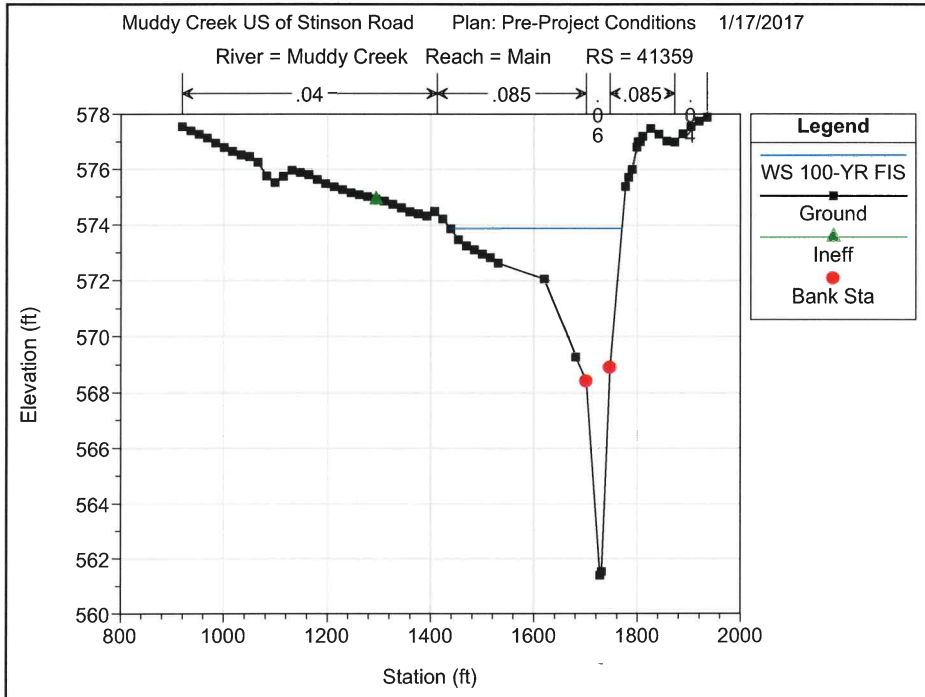

Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 42716.5
.04
.07
.075
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)

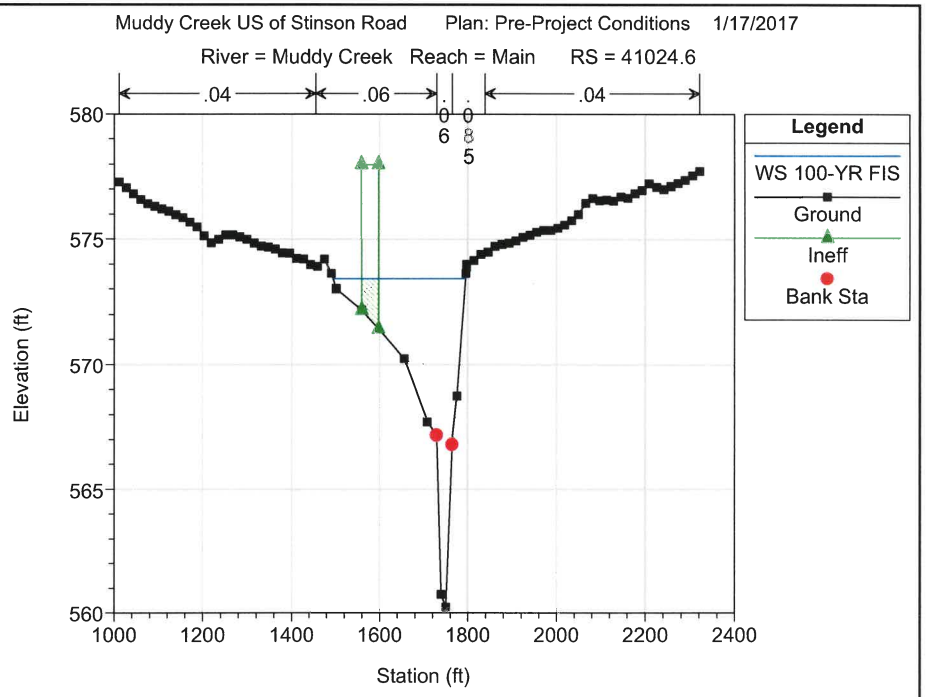

Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 42561.1
.04
.075
.04
.0755
.075
.079
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)
584
582
580
578
576
574
572
570
1000
1200
1400
1600
1800
2000
2200

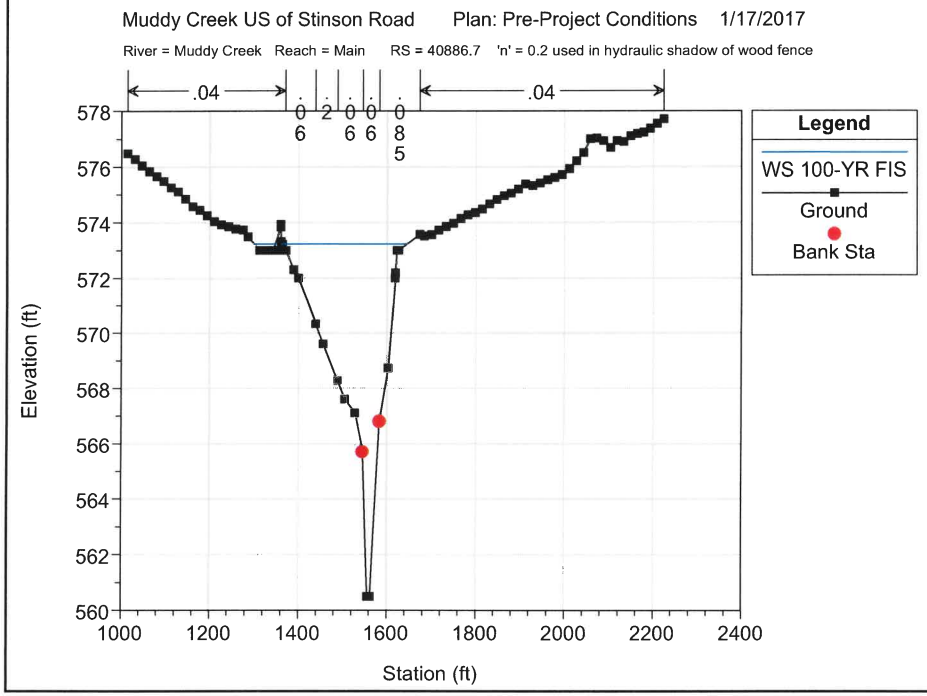

Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 42174.7
.04
.075
.04
.085
.086
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)
582
580
578
576
574
572
570
568
1000
1200
1400
1600
1800
2000
2200

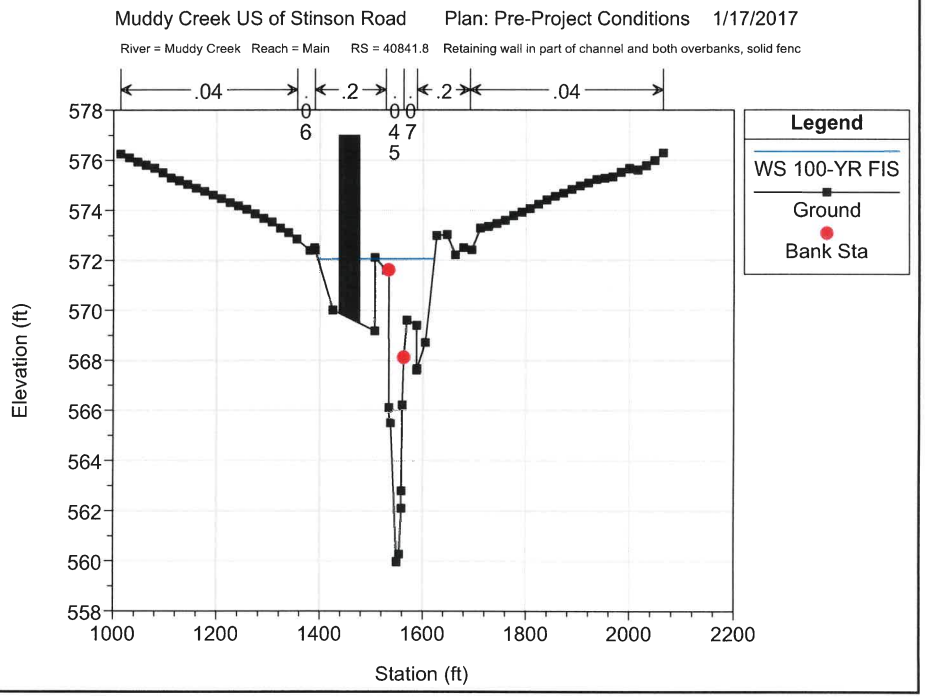

Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 41867.5
.04
.075
.04
.085
.086
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)
582
580
578
576
574
572
570
568
566
800
1000
1200
1400
1600
1800
2000
2200


Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 41553.5
.04
.085
.085
.04
.086
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)
580
578
576
574
572
570
568
566
564
562
1000
1200
1400
1600
1800
2000
2200


Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 41359
.04
.085
.085
Legend
WS 100-YR FIS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

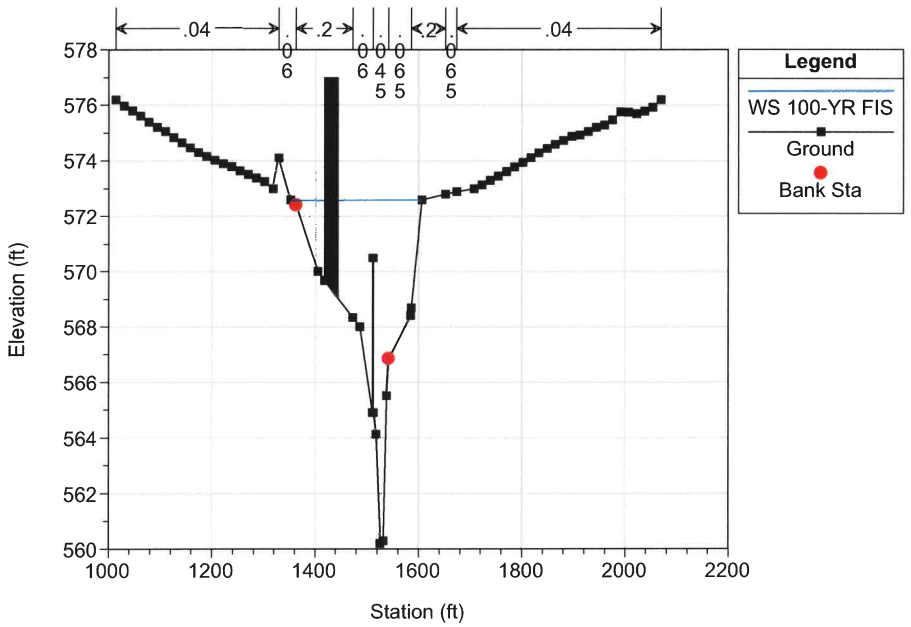

Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 41024.6
.04
.06
.04
Legend
WS 100-YR FIS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 40886.7 'n' = 0.2 used in hydraulic shadow of wood fence
.04
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)


Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 40841.8 Retaining wall in part of channel and both overbanks, solid fenc
.04
.2
.2
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)

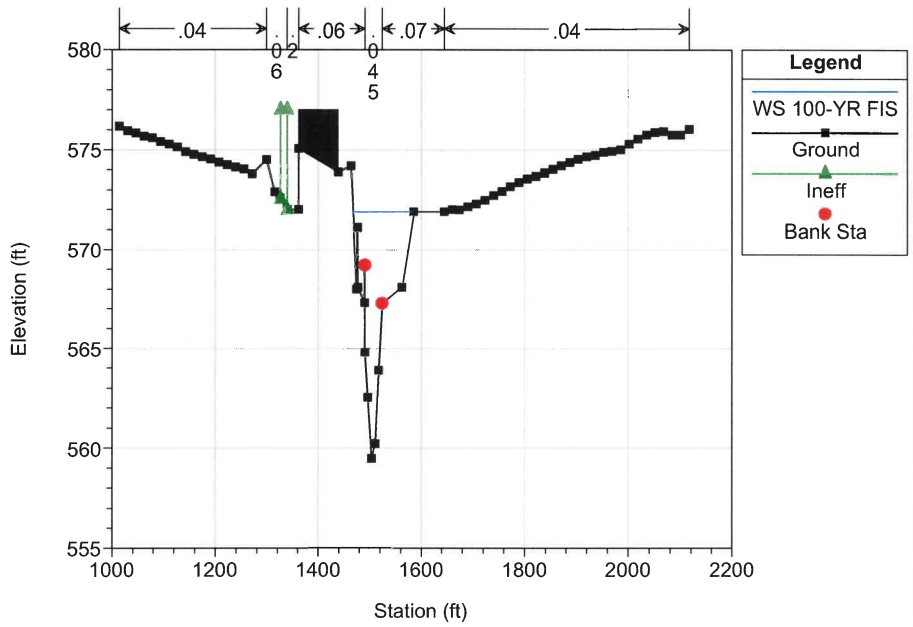
Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017

River = Muddy Creek Reach = Main RS = 40787.5 'n' = 0.2 used in hydraulic shadow of wood fence



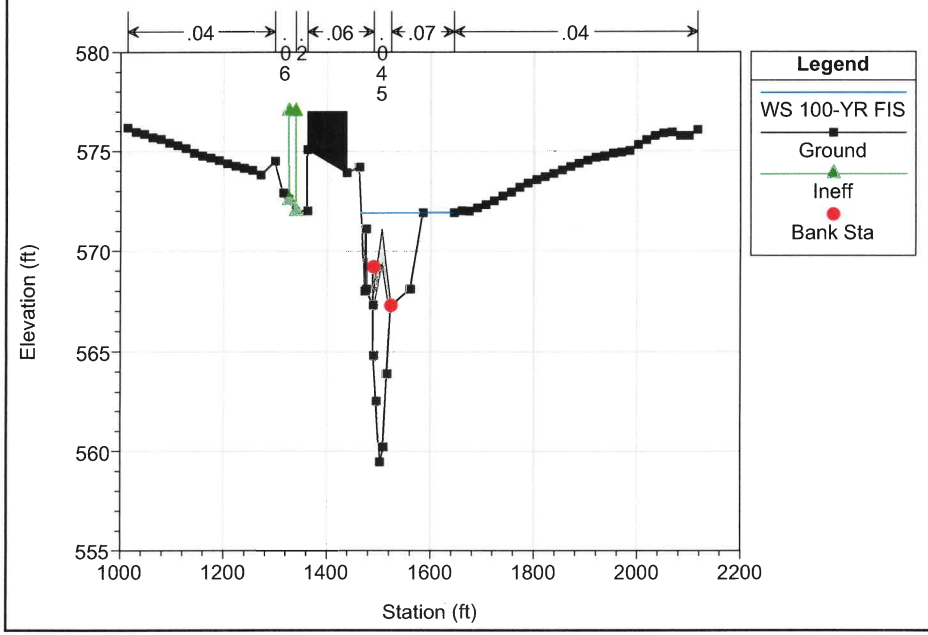
Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017

River = Muddy Creek Reach = Main RS = 40698.9 U/S of pedistrian bridge - installed by homeowner, 'n' = 0.2 use



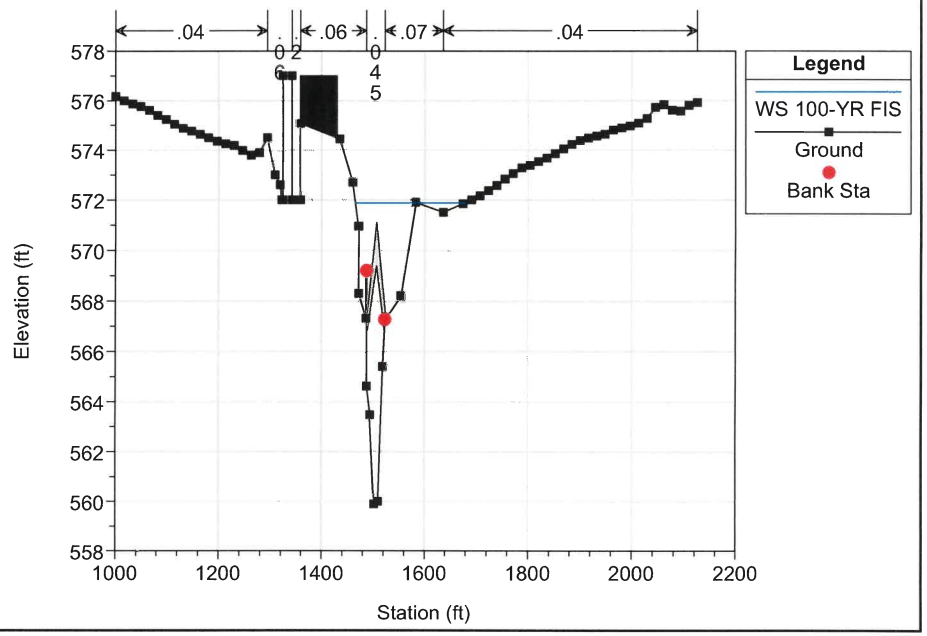
Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017

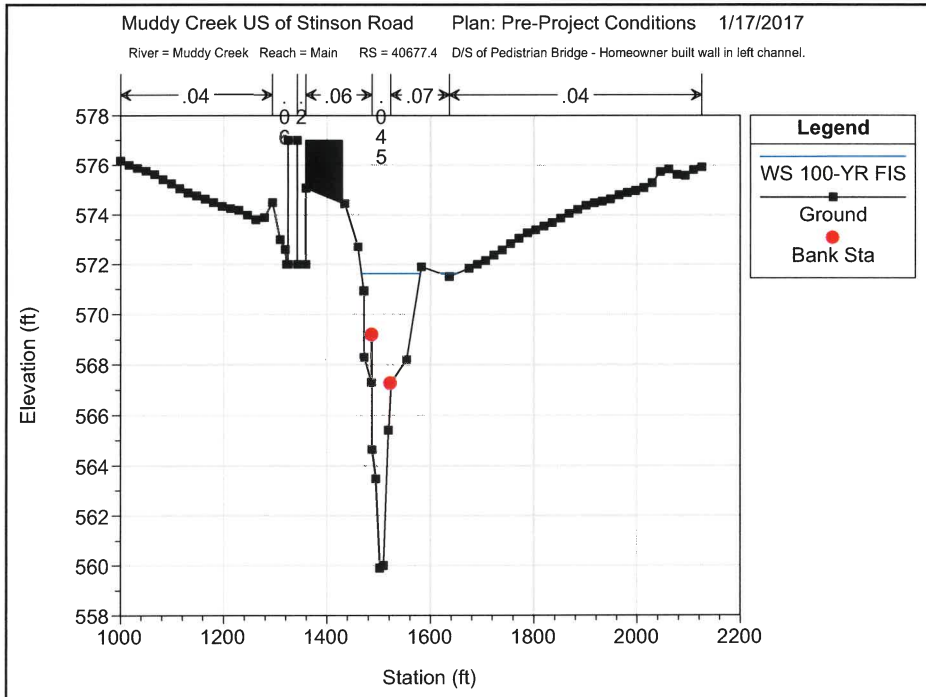
River = Muddy Creek Reach = Main RS = 40692.6 BR Existing Pedistrian Bridge - Installed by Homeowner

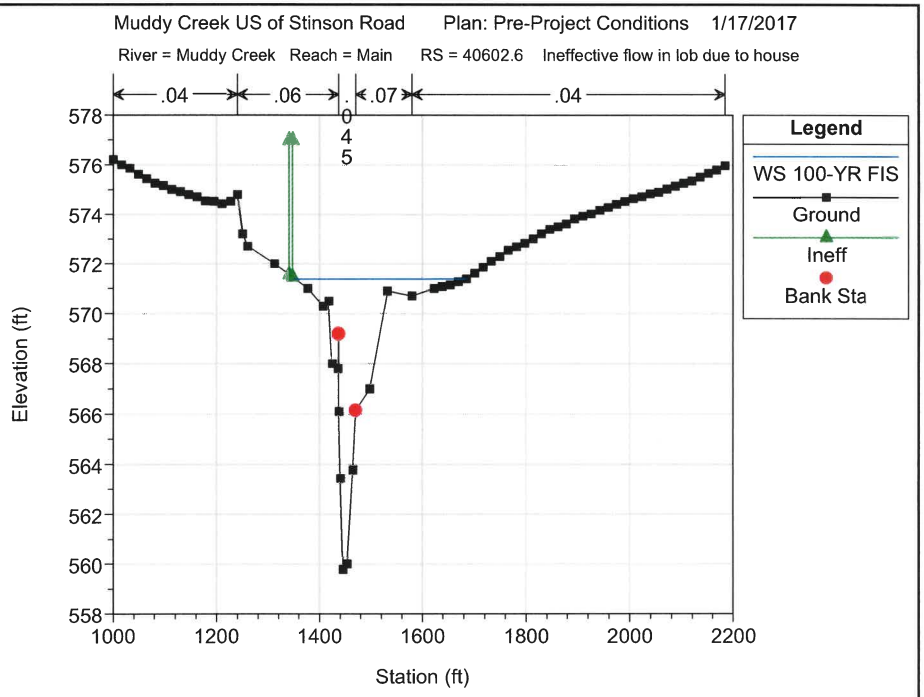


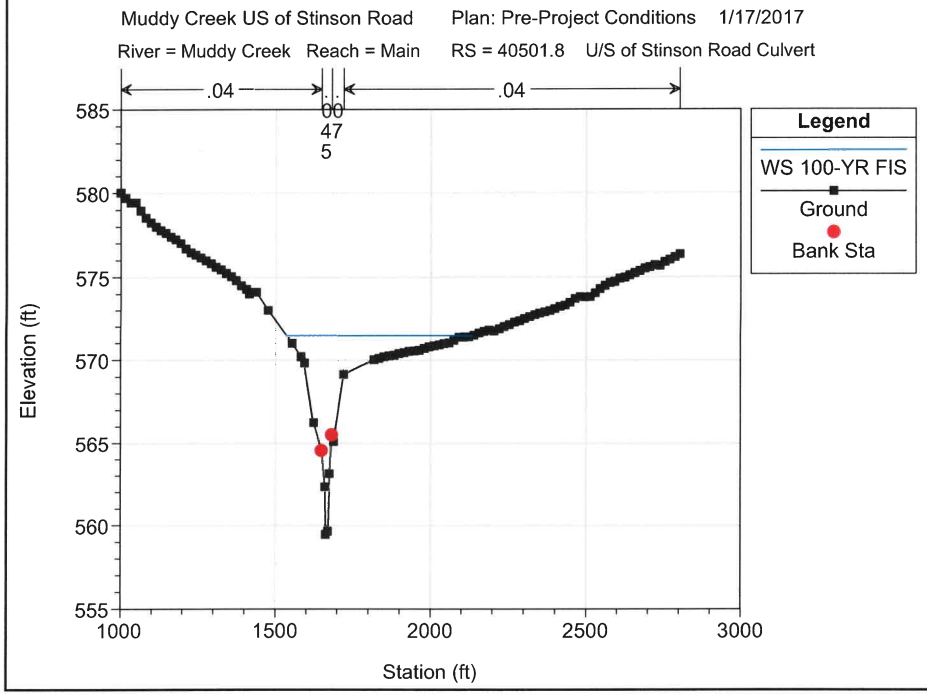
Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017

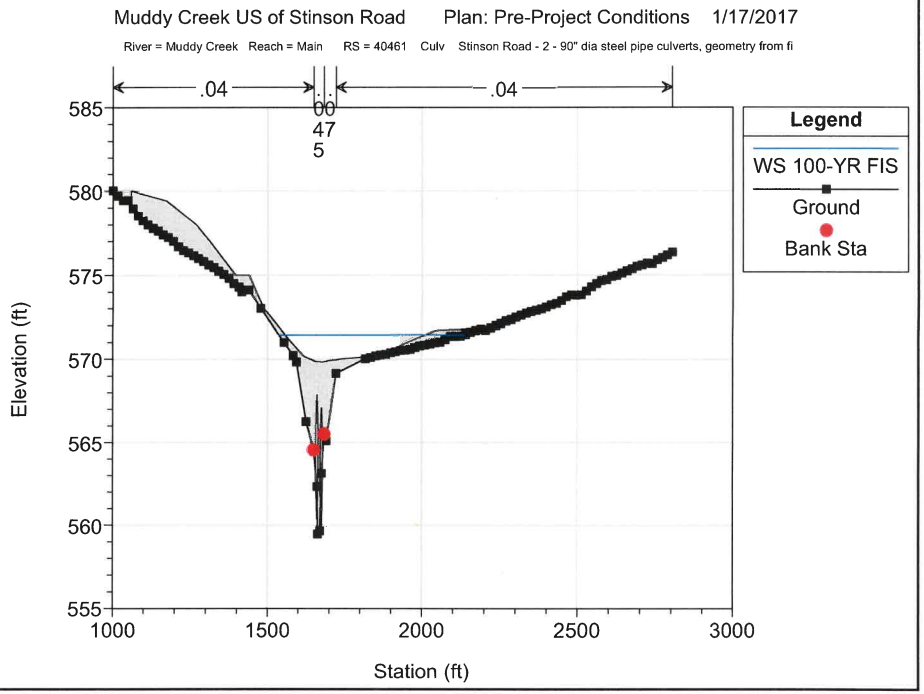
River = Muddy Creek Reach = Main RS = 40692.6 BR Existing Pedistrian Bridge - Installed by Homeowner

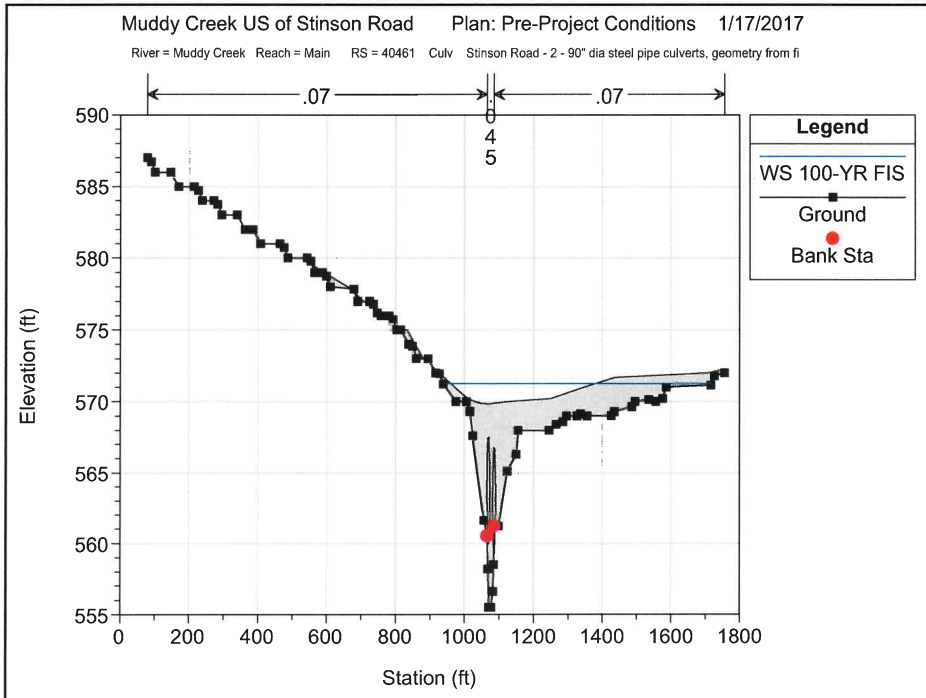


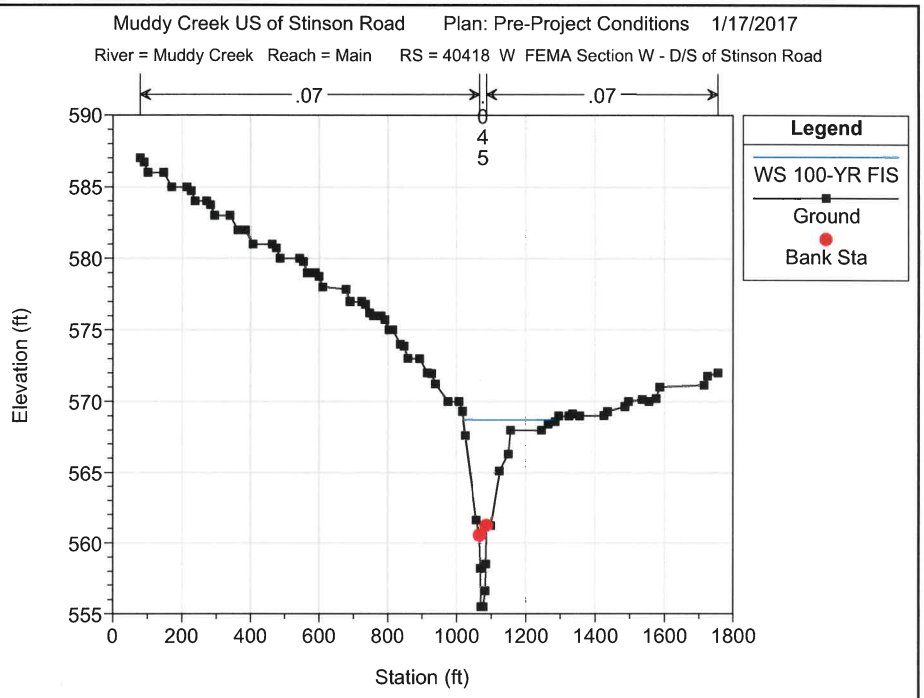

Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 40677.4 D/S of Pedistrian Bridge - Homeowner built wall in left channel.
.04
.06
.07
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)


Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 40602.6 Ineffective flow in lob due to house
.04
.06
.07
.04
Legend
WS 100-YR FIS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 40501.8 U/S of Stinson Road Culvert
.04
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)

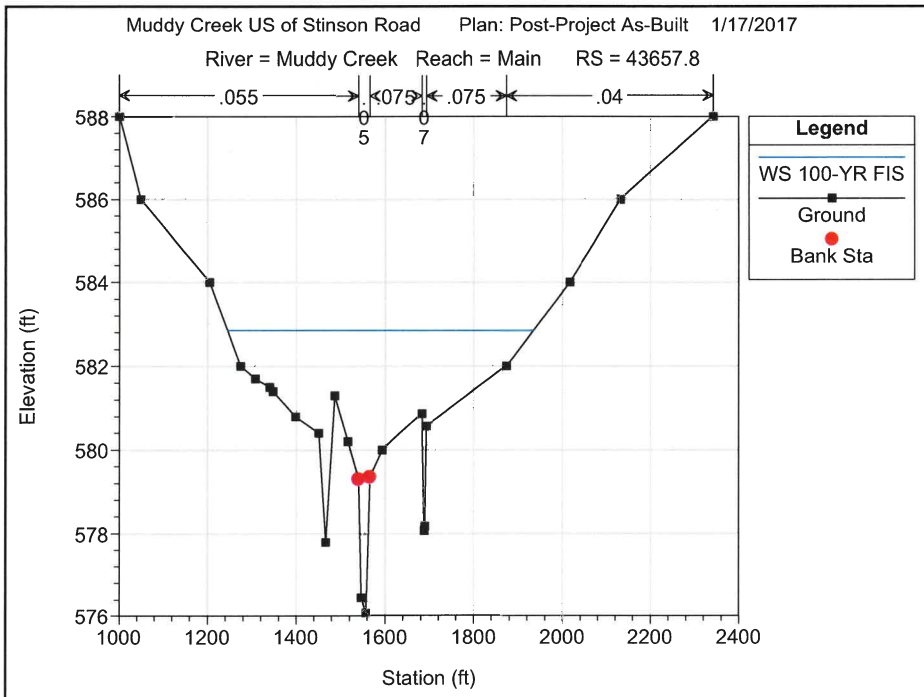

Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 40461 Culv Stinson Road - 2 - 90" dia steel pipe culverts, geometry from fi
.04
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)

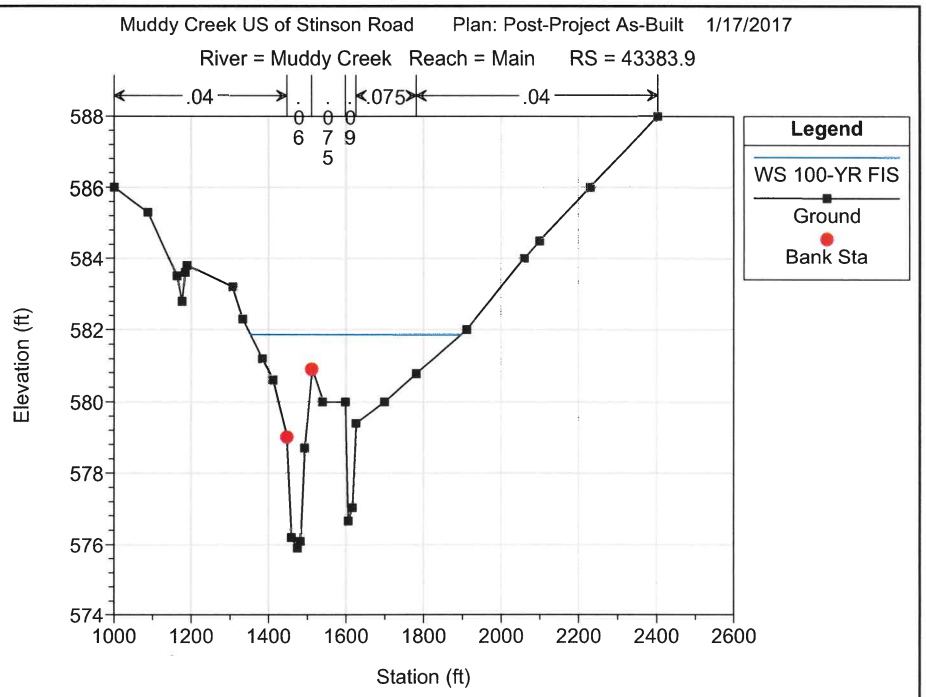

Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 40461 Culv Stinson Road - 2 - 90" dia steel pipe culverts, geometry from fi
.07
.07
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)
590
585
580
575
570
565
560
555
0
200
400
600
800
1000
1200
1400
1600
1800

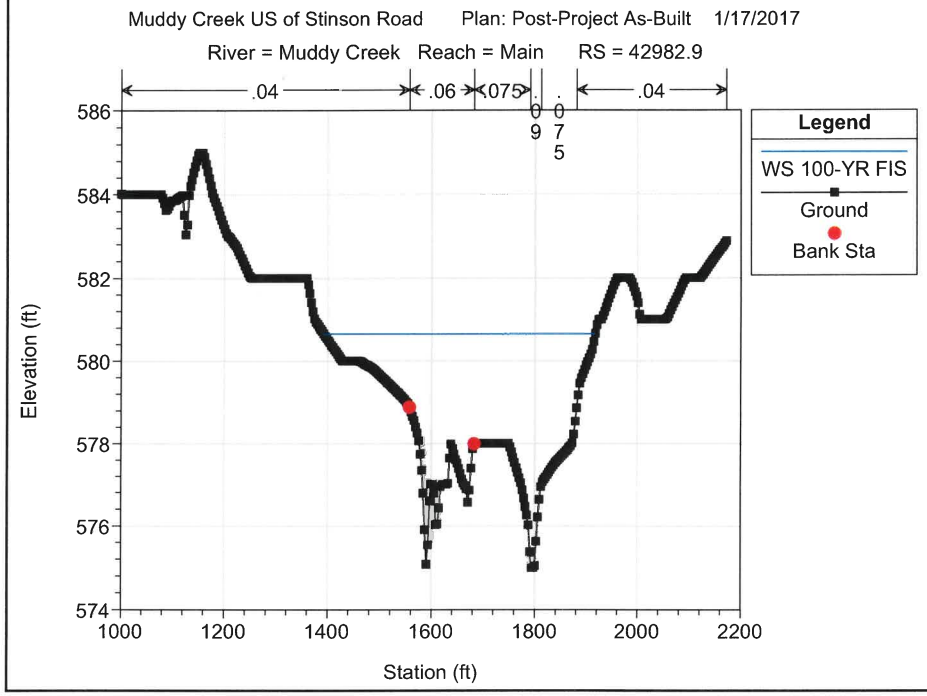

Muddy Creek US of Stinson Road Plan: Pre-Project Conditions 1/17/2017
River = Muddy Creek Reach = Main RS = 40418 W FEMA Section W - D/S of Stinson Road
.07
.07
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)
590
585
580
575
570
565
560
555
0
200
400
600
800
1000
1200
1400
1600
1800

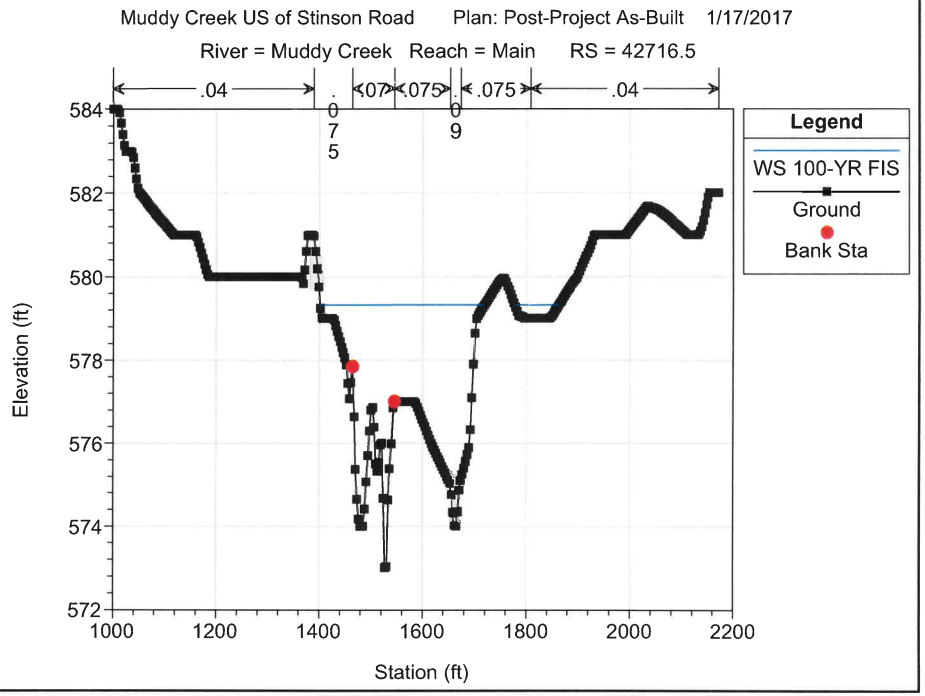
HEC-RAS Plan: PostProject-AB River: Muddy Creek Reach: Main Profile: 100-YR FIS

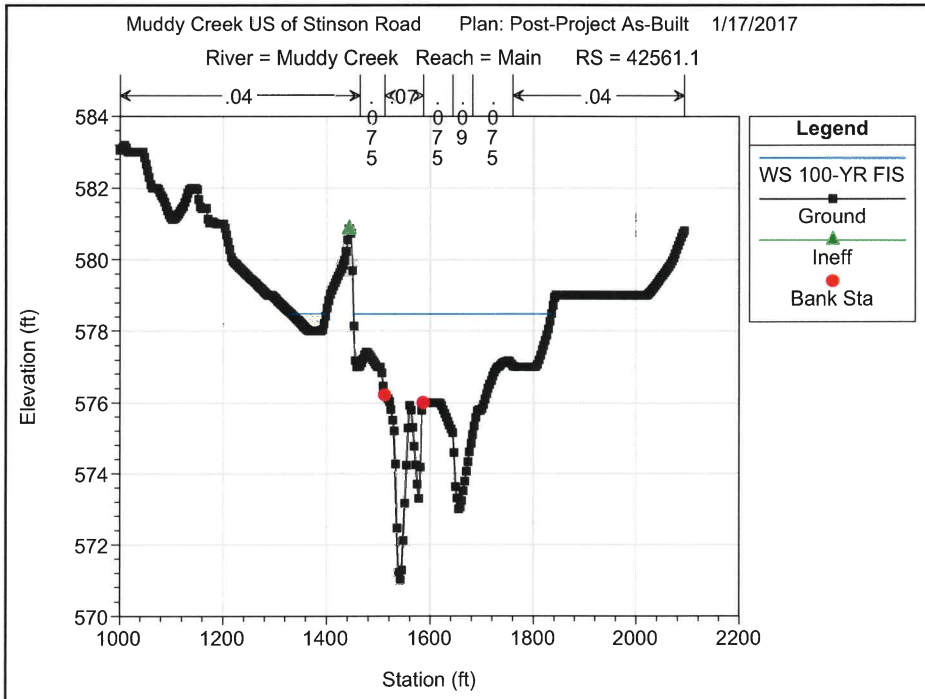
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	43657.8	100-YR FIS	2925.00	576.07	582.85		582.97	0.002536	4.64	1360.63	689.40	0.34
Main	43383.9	100-YR FIS	2925.00	575.90	581.87		582.06	0.005092	4.61	991.16	544.56	0.39
Main	42982.9	100-YR FIS	2925.00	575.08	580.65		580.75	0.002629	2.88	1241.57	524.22	0.27
Main	42716.5	100-YR FIS	2925.00	573.01	579.31		579.50	0.005811	3.99	901.69	403.42	0.35
Main	42561.1	100-YR FIS	2925.00	571.00	578.49	576.85	578.64	0.005016	3.79	965.19	449.92	0.33
Main	42174.7	100-YR FIS	2925.00	570.00	577.27	575.89	577.39	0.004643	3.64	1127.87	649.94	0.26
Main	41867.5	100-YR FIS	2925.00	568.00	575.45		575.79	0.010063	5.09	730.13	446.00	0.38
Main	41553.5	100-YR FIS	2925.00	563.00	574.33		574.58	0.001990	4.58	1127.20	515.48	0.27
Main	41359	100-YR FIS	2925.00	562.00	573.81	570.24	574.15	0.002696	5.39	945.84	336.15	0.32
Main	41024.6	100-YR FIS	2925.00	561.00	573.25		573.49	0.001844	4.76	980.34	307.63	0.26
Main	40886.7	100-YR FIS	2925.00	561.00	573.04		573.22	0.001447	4.13	1101.43	313.66	0.24
Main	40841.8	100-YR FIS	2925.00	560.82	572.69		573.12	0.001865	5.58	817.72	243.13	0.35
Main	40787.5	100-YR FIS	2925.00	561.00	572.59		573.00	0.002570	5.92	855.27	261.31	0.37
Main	40698.9	100-YR FIS	2925.00	560.71	572.14	569.41	572.74	0.002924	6.95	629.88	208.14	0.41
Main	40692.6		Bridge									
Main	40677.4	100-YR FIS	2925.00	560.06	571.62		572.41	0.003700	7.70	560.49	182.69	0.46
Main	40602.6	100-YR FIS	2925.00	560.00	571.43		572.08	0.003204	7.33	682.35	323.46	0.43
Main	40501.8	100-YR FIS	2925.00	560.00	571.54	568.10	571.68	0.000815	3.97	1332.35	565.23	0.23
Main	40461		Culvert									
Main	40418 W	100-YR FIS	2925.00	555.50	568.73	565.03	569.23	0.002345	7.24	846.41	269.25	0.37

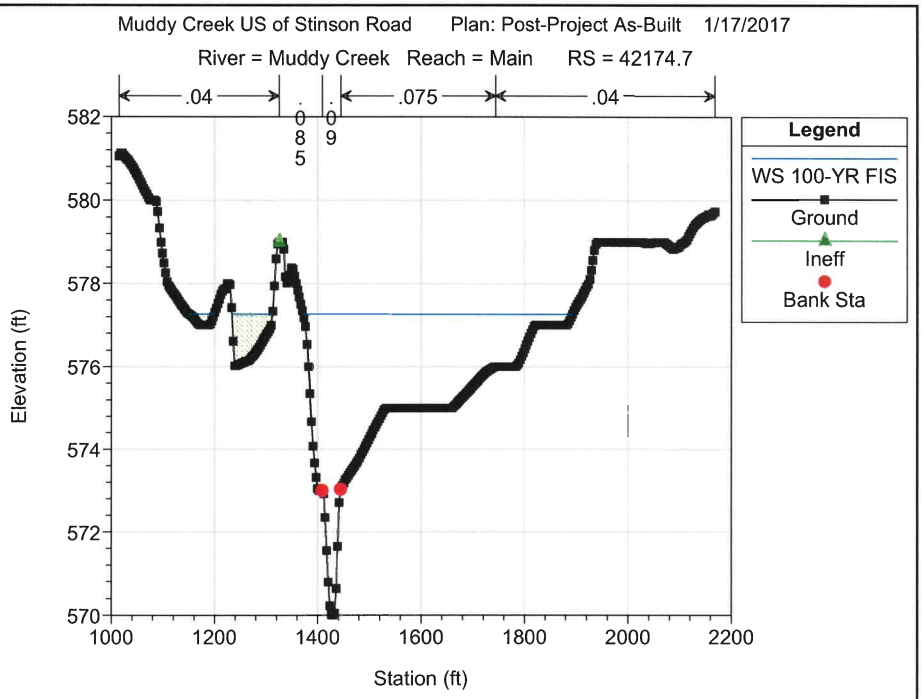

Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 43657.8
.055
.075
.075
.04
.05
.07
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)

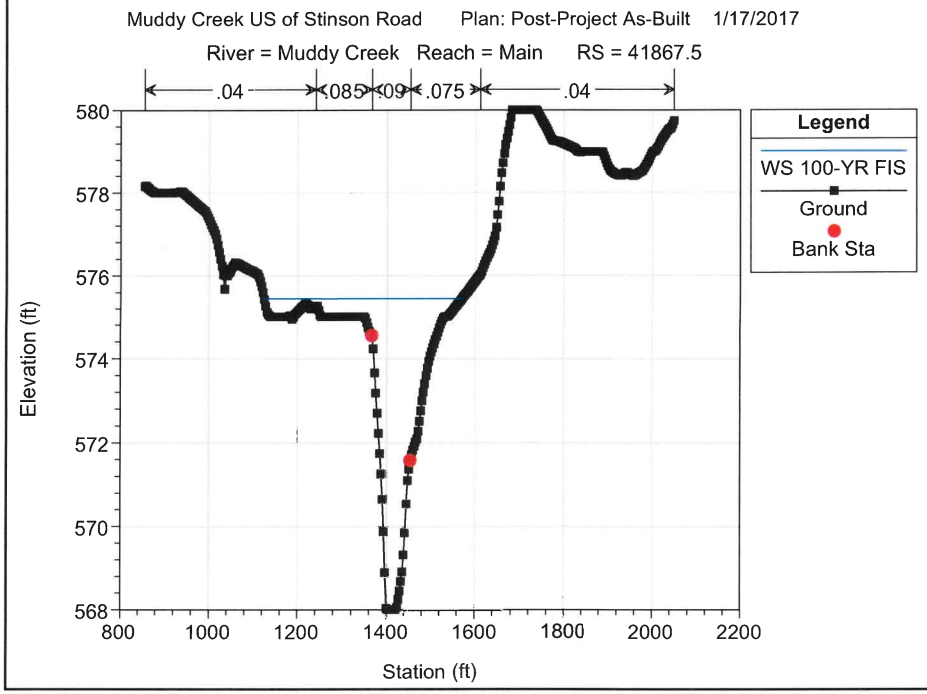

Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 43383.9
.04
.06
.075
.075
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)

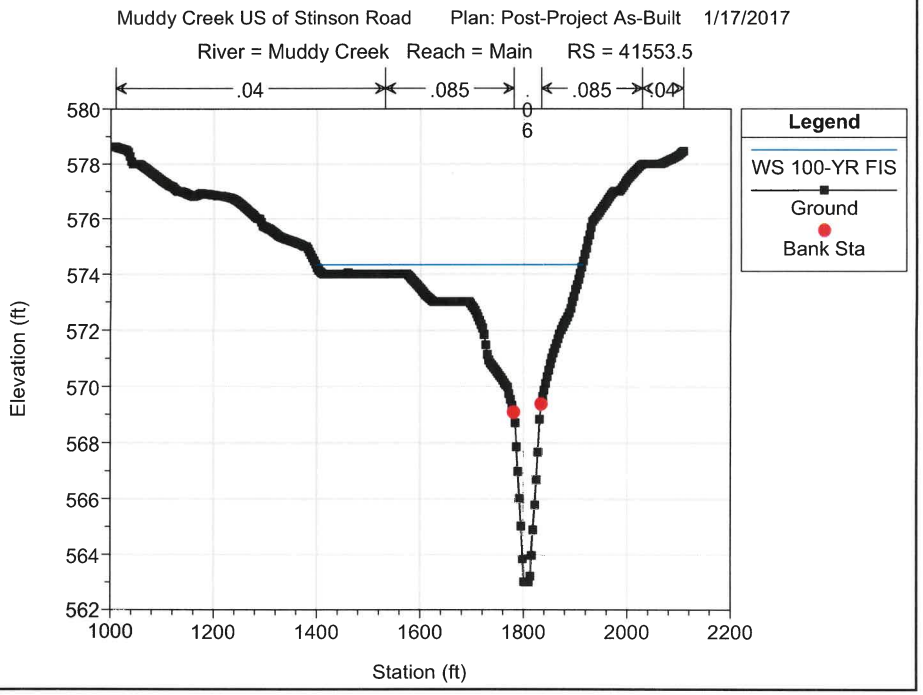

Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 42982.9
.04
.06
.075
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)

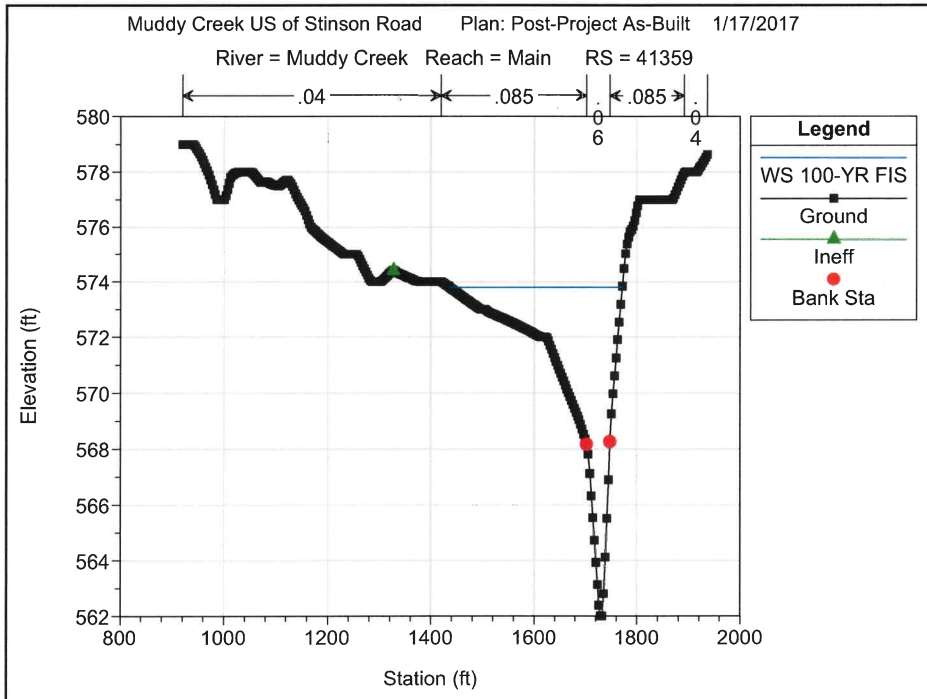

Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 42716.5
.04
.075
.075
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)

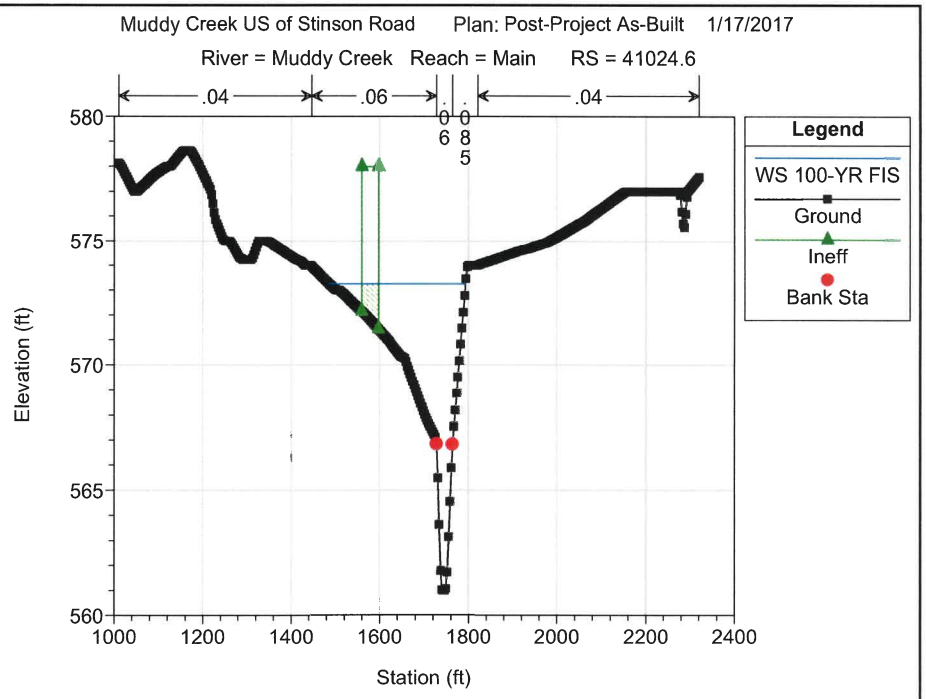

Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 42561.1
.04
.075
.075
.09
.075
.04
Legend
WS 100-YR FIS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

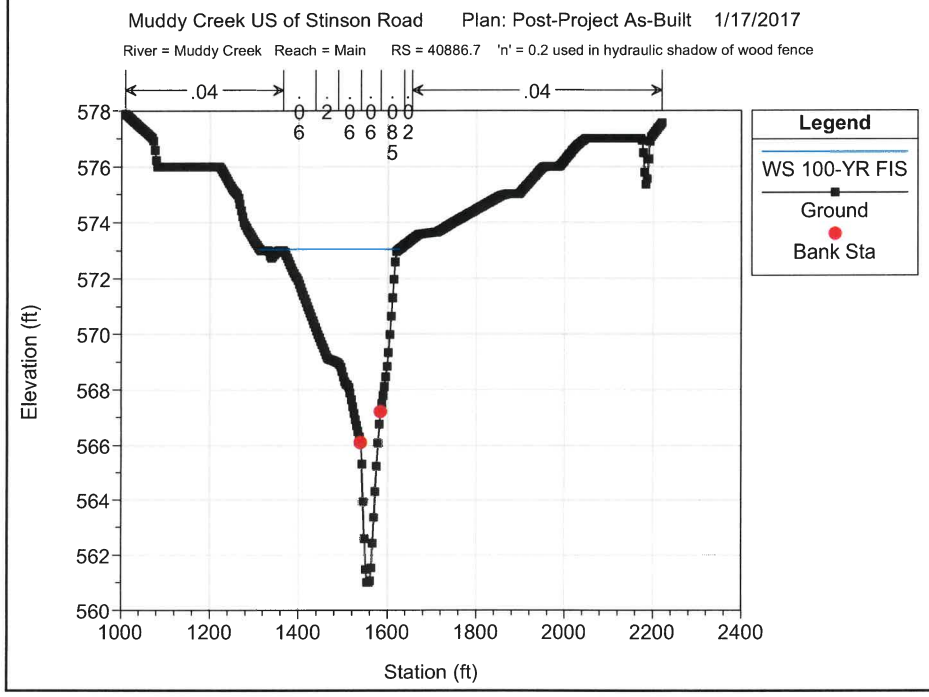

Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 42174.7
.04
.085
.09
.075
.04
Legend
WS 100-YR FIS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

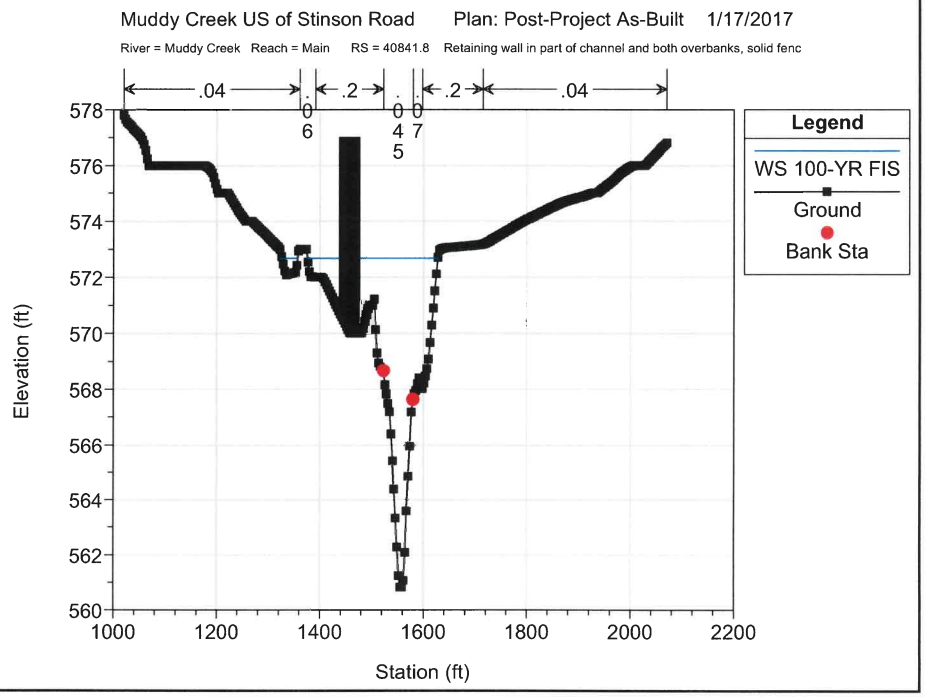

Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 41867.5
.04
.085
.09
.075
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)


Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 41553.5
.04
.085
.06
.085
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)


Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 41359
.04
.085
.085
Legend
WS 100-YR FIS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

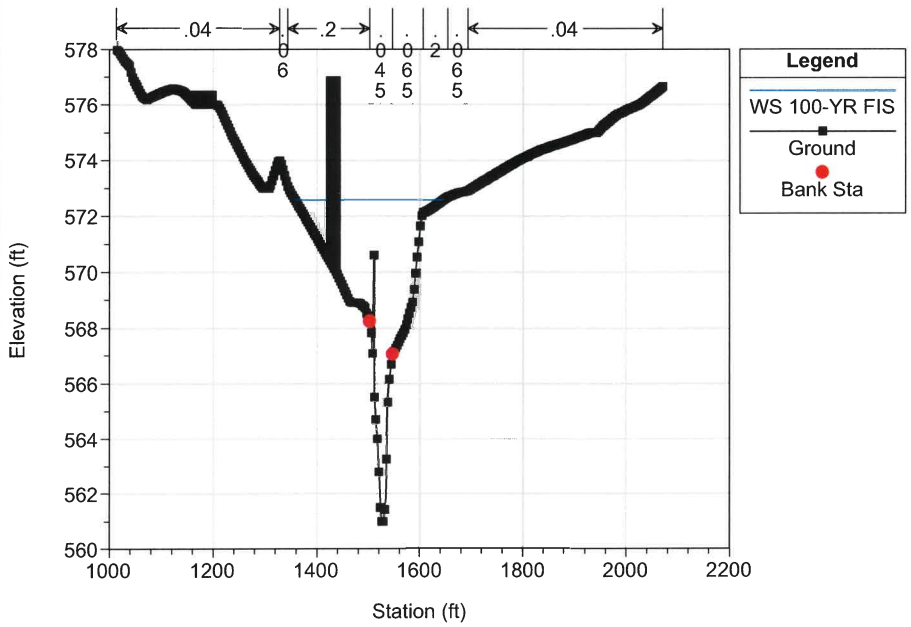

Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 41024.6
.04
.06
.04
Legend
WS 100-YR FIS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 40886.7 'n' = 0.2 used in hydraulic shadow of wood fence
.04
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)


Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 40841.8 Retaining wall in part of channel and both overbanks, solid fenc
.04
.2
.2
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)

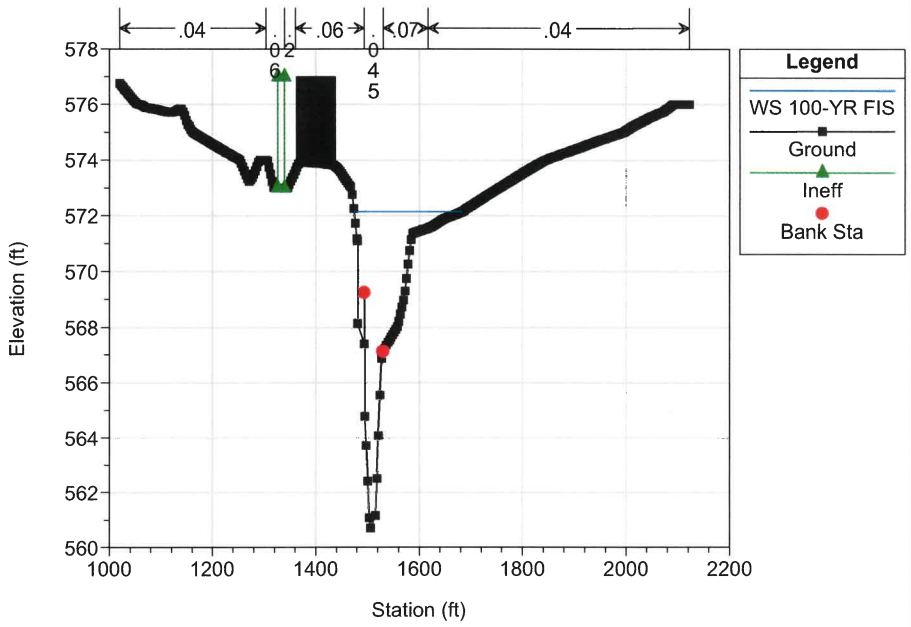
Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017

River = Muddy Creek Reach = Main RS = 40787.5 'n' = 0.2 used in hydraulic shadow of wood fence



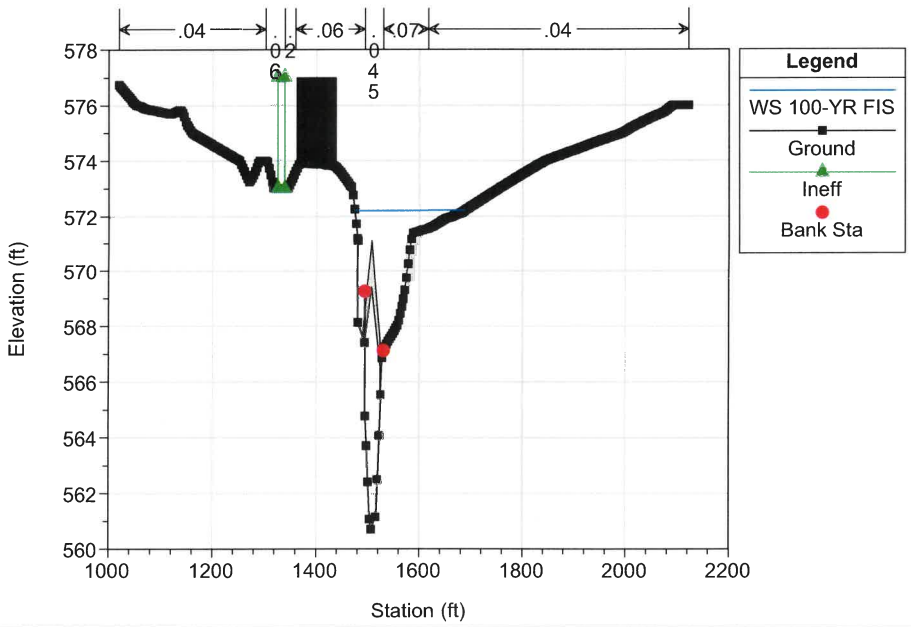
Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017

River = Muddy Creek Reach = Main RS = 40698.9 U/S of pedistrian bridge - installed by homeowner, 'n' = 0.2 use



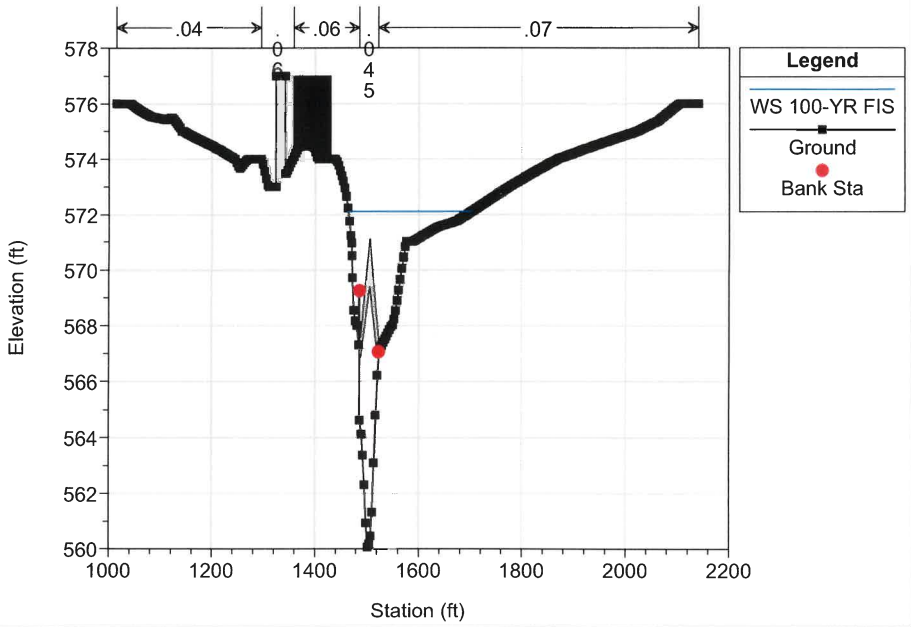
Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017

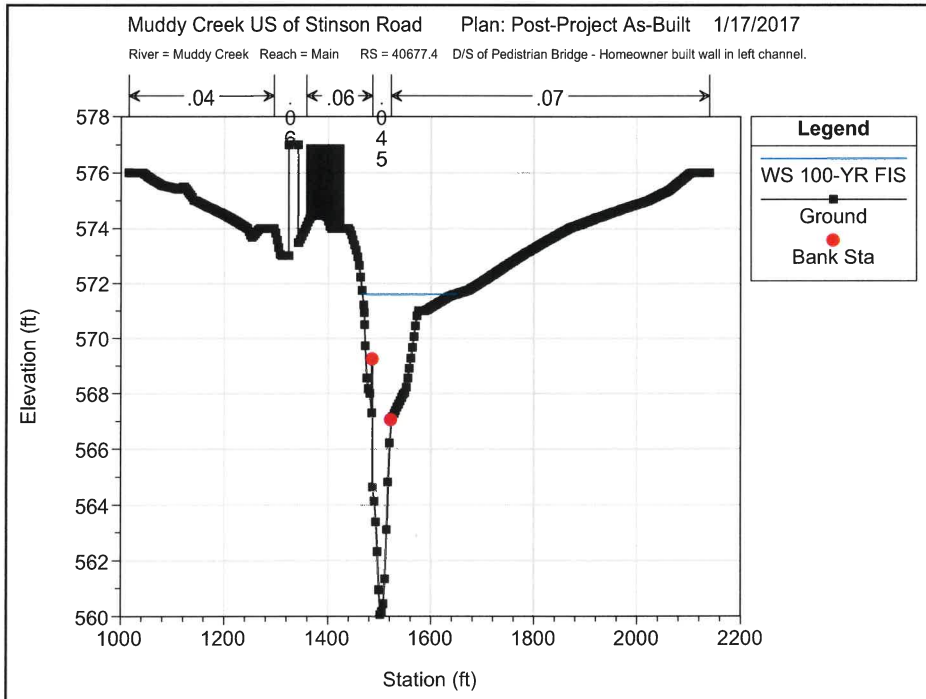
River = Muddy Creek Reach = Main RS = 40692.6 BR Existing Pedistrian Bridge - Installed by Homeowner

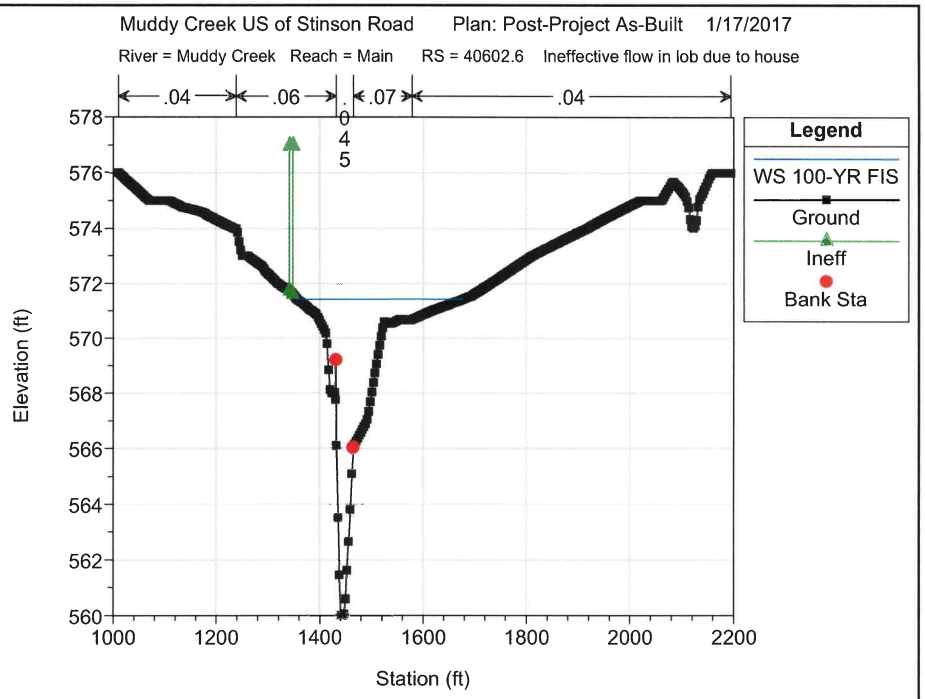


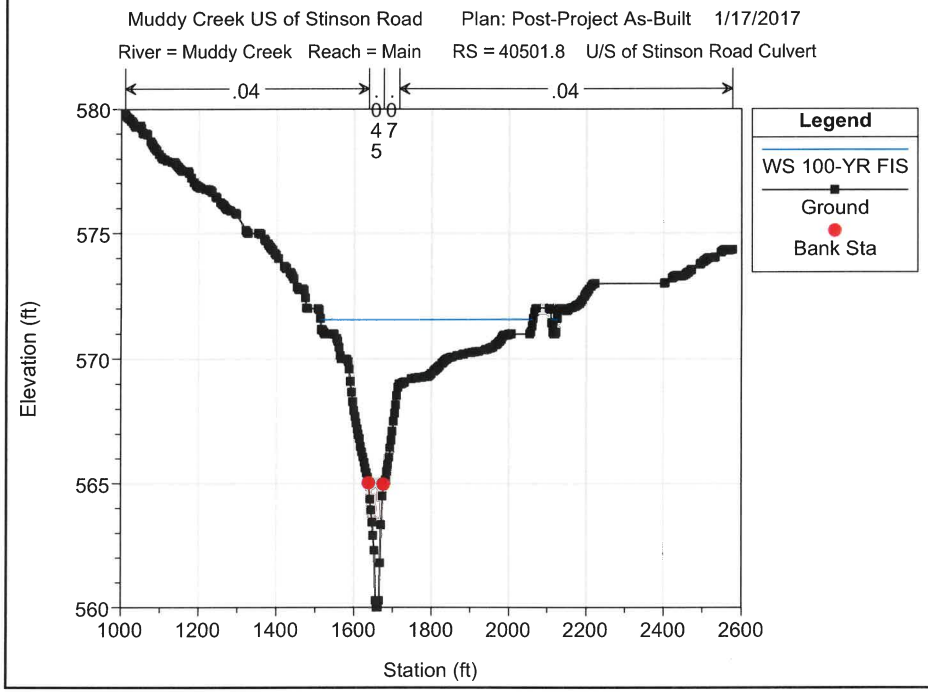
Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017

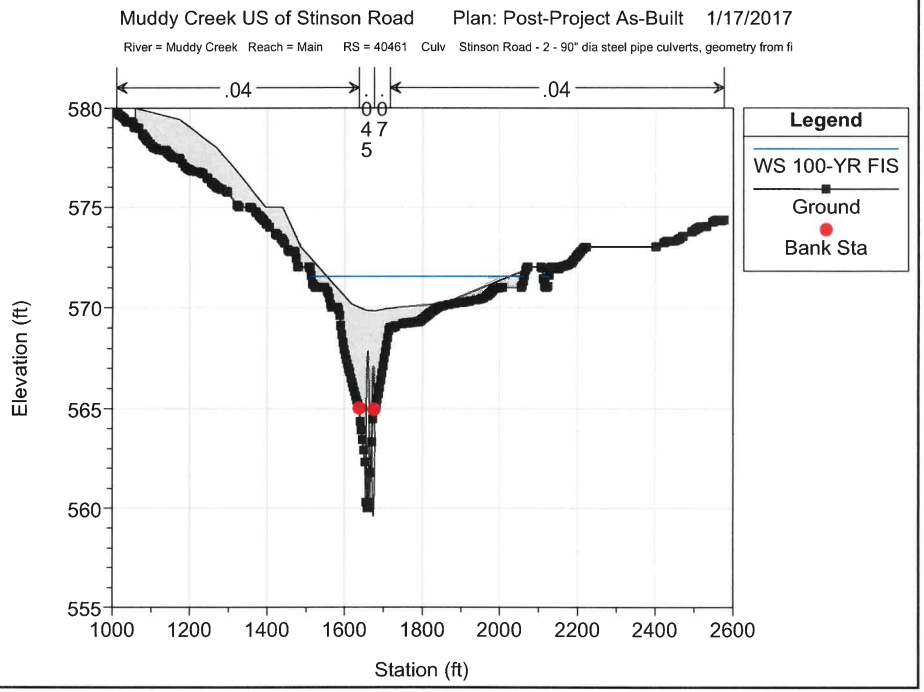
River = Muddy Creek Reach = Main RS = 40692.6 BR Existing Pedistrian Bridge - Installed by Homeowner

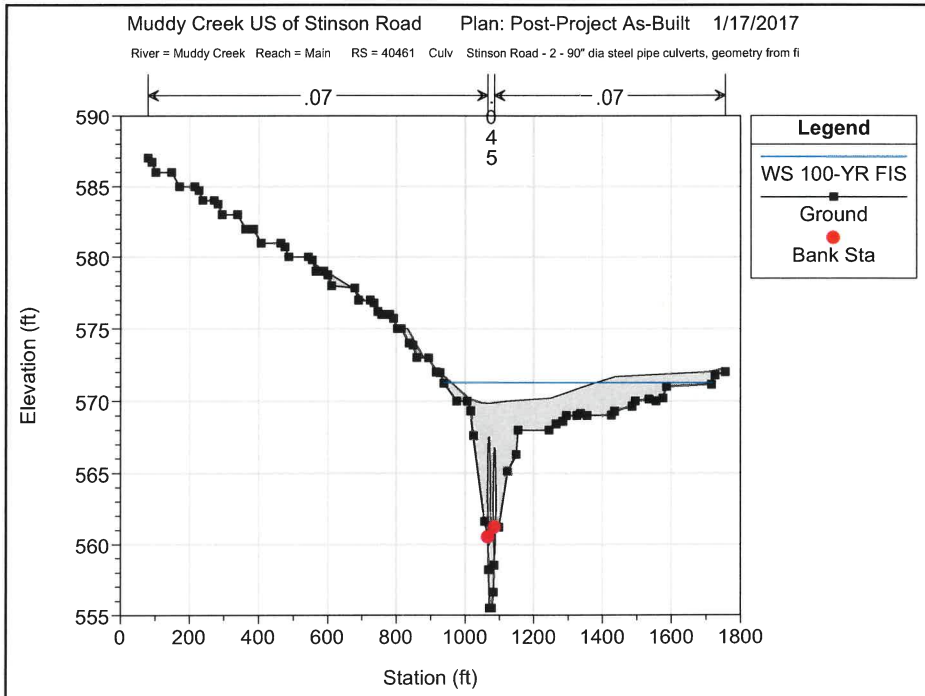


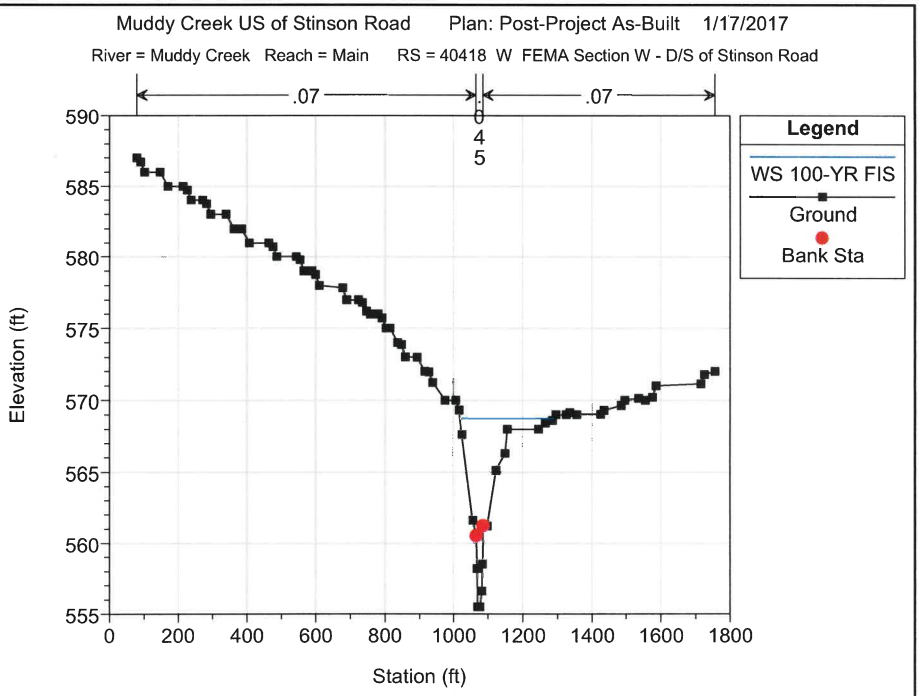

Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 40677.4 D/S of Pedistrian Bridge - Homeowner built wall in left channel.
.04
.06
.07
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)

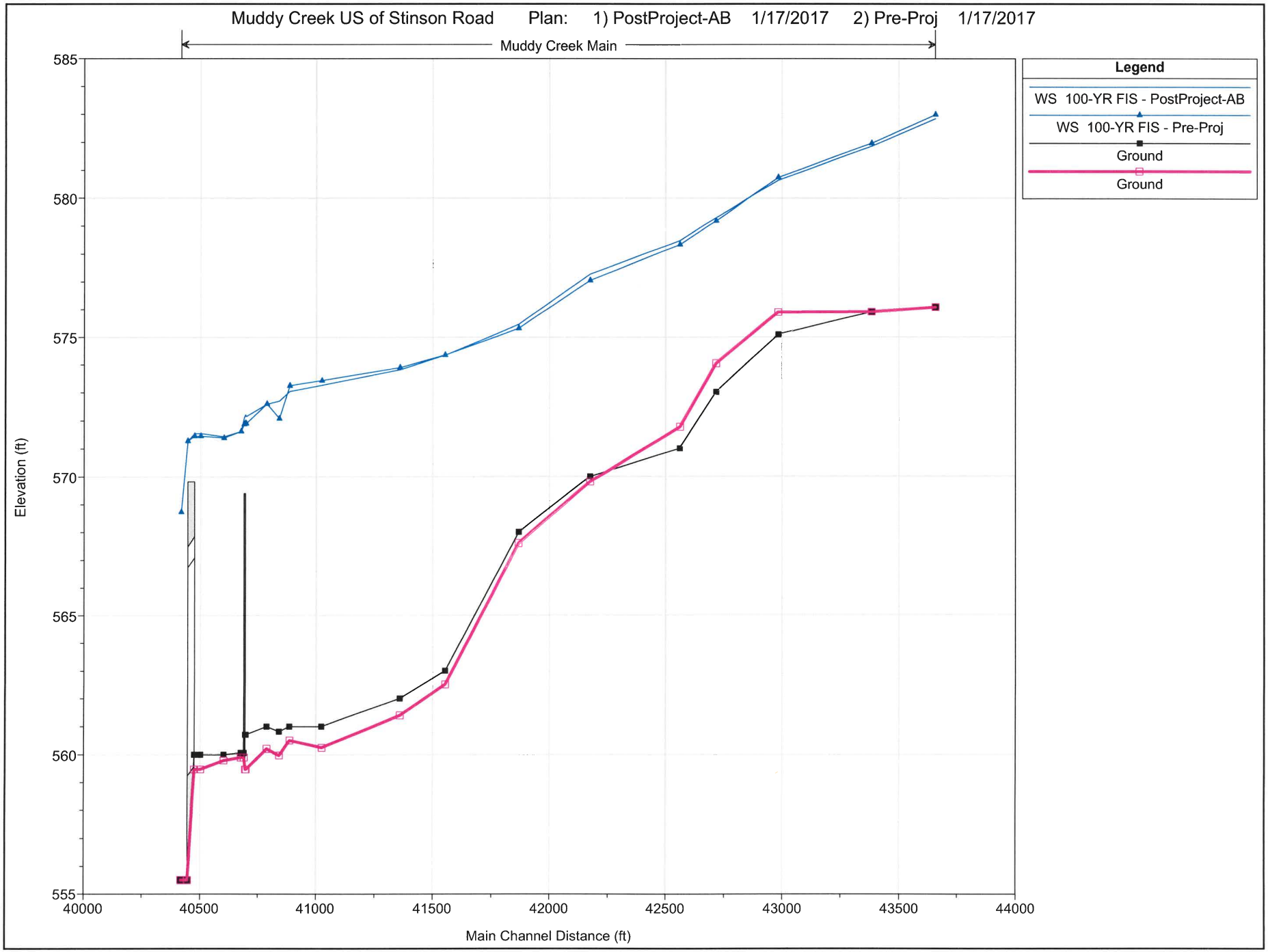

Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 40602.6 Ineffective flow in lob due to house
.04
.06
.07
.04
Legend
WS 100-YR FIS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 40501.8 U/S of Stinson Road Culvert
.04
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)


Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 40461 Culv Stinson Road - 2 - 90" dia steel pipe culverts, geometry from fi
.04
.04
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
Station (ft)


Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 40461 Culv Stinson Road - 2 - 90" dia steel pipe culverts, geometry from fi
.07
.07
0
4
5
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
590
585
580
575
570
565
560
555
0
200
400
600
800
1000
1200
1400
1600
1800
Station (ft)


Muddy Creek US of Stinson Road Plan: Post-Project As-Built 1/17/2017
River = Muddy Creek Reach = Main RS = 40418 W FEMA Section W - D/S of Stinson Road
.07
.07
0
4
5
Legend
WS 100-YR FIS
Ground
Bank Sta
Elevation (ft)
590
585
580
575
570
565
560
555
0
200
400
600
800
1000
1200
1400
1600
1800
Station (ft)


Muddy Creek US of Stinson Road Plan: 1) PostProject-AB 1/17/2017 2) Pre-Proj 1/17/2017
Muddy Creek Main
Legend
WS 100-YR FIS - PostProject-AB
WS 100-YR FIS - Pre-Proj
Ground
Ground
Elevation (ft)
585
580
575
570
565
560
555
40000
40500
41000
41500
42000
42500
43000
43500
44000
Main Channel Distance (ft)

ATTACHMENT C - EXHIBITS

ENGINEERINGCONCEPTS & DESIGN, L.P.

ANNOTATED FIRM

Legend

Project Site

N

0 1,000 2,000

Feet

CARDINAL STRATEGIES

RAVIS RANCH ROAD
ESTATES ROAD
COLLIN COUNTY CITY OF LUCAS
ZONE X
COLLIN COUNTY UNINCORPORATED AREAS 480130
COLLIN COUNTY CITY OF LUCAS
HOLLY LANE
EDGEFIELD LANE
CEDAR BEND TRAIL
CEDAR BEND CIRCLE
ZONE A
White Rock Creek East Tributary 1-1
WOODVIEW CIRCLE
LOST VALLEY DRIVE
3286
WOODMOOR DRIVE
GLENCOVE CIRCLE
HOB HILL LANE
W LUCAS ROAD
RISING SUN ROAD
RED STAR ROAD
COLLIN COUNTY CITY OF LUCAS
PRADO VERDE DRIVE
CAREY LANE
ZILKER CT.
ZONE A
Muddy Creek Tributary 2
ARTHUR COURT
EARL COURT
White Rock Creek East Tributary
SANTIAGO TRAIL
JORDAN COURT
BEE CAVES ROAD
BASTROP RD.
LIMIT OF DETAILED STUDY
ZONE X
ZONE AE
CONNOR LN.
ALAMEDA CIRCLE
E LAGO VISTA TRAIL
LAGO GRANDE
CITY OF LUCAS 481545
HICKORY HILL STREET
STINSON ROAD
COLLIN COUNTY CITY OF LUCAS
SANTA ROSA CIR.
SANTA MONICA CIR.
RIVA RIDGE ROAD
BARRANCA TRAIL
Muddy Creek
Turner Branch
254
576
574
572
571
567
568
566
565
564
563
562
561
560
559
558
557
556
555
554
553

ENGINEERINGCONCEPTS & DESIGN, L.P.

FIGURE 5: BRISTOL PARK PHASES 1 AND 2 PRE-PROJECT & AS-BUILT FLOODPLAIN WORK MAP

Phase 1

Phase 2

43857.8
43380.9
42982.9
42716.5
42561.1
42174.7
41887.5
41553.5
41359
41024.6
40886.7
40841.8
40787.5
40677.4
40602.6
40501.8
40418

LEGEND

- Project Site
- 100yr FEMA Floodplain - As-Built
- 100yr FEMA Floodplain - Pre-Project
- Cross-sections
- As-Built Topo
- Survey Topo
- FEMA Streamline

FEMA SFHA

- A,
- AE,
- AE, FLOODWAY
- 0.2% AC Flood Hazard
- TNRIS 1ft Contours

Coordinate System: NAD 1983 StatePlane Texas North Central FIPS 4202 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
False Easting: 1,968,500.0000
False Northing: 6,561,666.6667
Central Meridian: -98.5000
Standard Parallel 1: 32.1333
Standard Parallel 2: 33.9667
Latitude Of Origin: 31.6667
Units: Foot US
Vertical Datum: NAVD88

N

0 150 300 600 Feet

CARDINAL STRATEGIES

STATE OF TEXAS
MICHAEL C. ANDERSON
89189
LICENSED PROFESSIONAL ENGINEER
1-17-2017