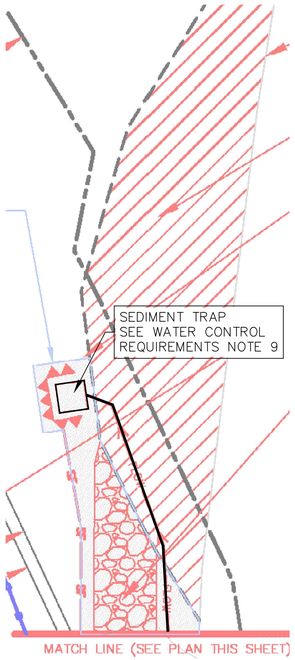
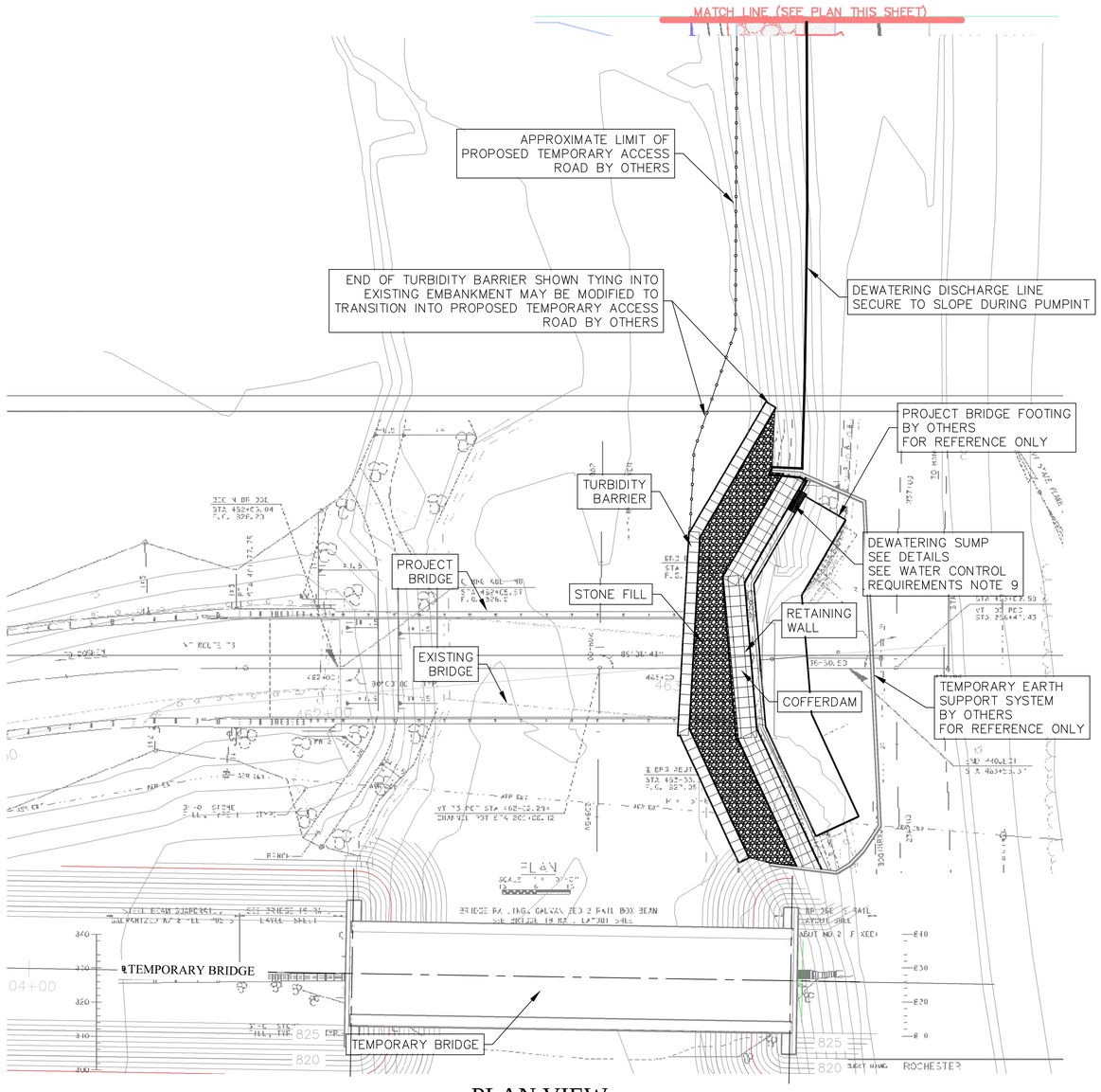
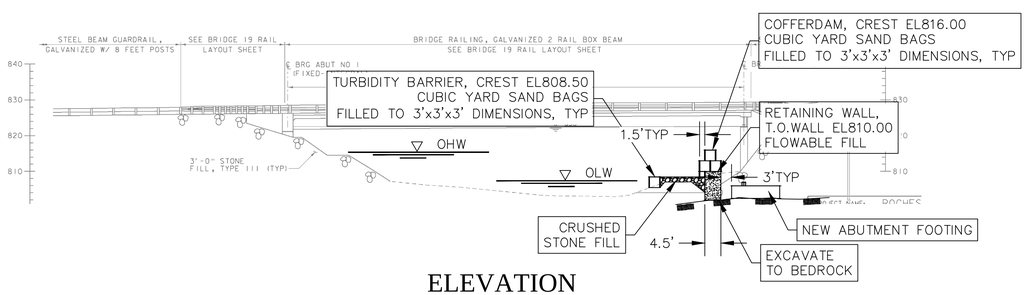




PLAN VIEW

1" = 20'



ELEVATION

1" = 20'

Construction Sequence:

1. Applicable EPSC and erosion control measures are to be put into place.
2. Perform local excavation behind the turbidity barrier down to base elevation for individual sandbag installation and progressively install base rows of sandbags.
3. Backfill behind the lower rows of sandbags with crushed stone fill up to current water level where granular fill can be compacted
4. Once above water level, continue installation of sandbag rows backfilling with granular fill compacted to 95% to T.O. Sandbag elevation.
5. Install stone fill top surface to Cofferdam Crest elevation.

Water Control Requirements:

1. The water control system is to be coordinated with the EPSC work.
2. This work shall consist of the construction, material excavation within, dewatering, maintenance and removal of water control system in accordance with the specifications at locations designated in the Plans or in the Contract.
3. This work shall consist of providing a method for the purpose of constructing, in the dry, a specific foundation or other component of a structure in accordance with Contract requirements.
4. This involves construction, maintenance, and removal of a watertight structure or may involve alternate methods of de-watering and stabilizing the specific site.
5. The Contractor shall obtain any and all necessary permits or clearances for alternate methods.
6. The locations and elevations for excavation shall be as indicated on the Plans.
7. The Engineer may order removal of poor foundation material below the normal designated elevation and replacement with an approved material.
8. Dewatering system elements shown on the plan are approximate
9. Actual location and sizing of dewatering system elements are to be based on current field conditions
10. During the performance of all work under this contract, the Contractor shall adopt such precautions in the conduct of his operation as may be necessary to avoid contaminating ground or surface water.
11. All earthwork, grading, moving of equipment, water control and other operation likely to create silting, shall be so planned and conducted as to minimize pollution in any wetland resource area.
12. Water used for any purpose whatsoever by the Contractor, which has become contaminated with soil, bitumen, salt, concrete or other pollutants shall not be discharged into any wetland resource area.
13. Under no circumstances shall the Contractor discharge pollutants into a wetland resource area.
14. The Contractor shall not store fuel or permit any refueling of construction equipment while such equipment is within 100 feet of any resource area.
15. The contractor shall make all efforts to control the run-off of water and sediment from the project site during path construction.
16. All work to be done in the dry.
17. The Contractor shall use such equipment and shall perform his operations in such a manner that boiling or other disturbances of the soil in the construction area will be prevented.
18. He shall keep the area being excavated dry by such means that water will be prevented from entering from the adjacent soils.
19. All dewatering and related earthworks shall be conducted in such a manner as to prevent siltation or contamination of the brook.
20. The pumping discharge shall not be allowed to enter directly into the brook.
21. The water from the work areas shall be pumped to a sediment system in accordance with the EPSC Plan.
22. The Contractor shall provide and maintain ample pumps, pipes and other devices to promptly and continually remove and dispose of water from the excavation areas.
23. The size and configuration of pumps and pipes shall be selected by the contractor.
24. After having served its purpose, the water control system shall become the property of the Contractor and shall be removed by the Contractor from the site subject to the Engineer's approval.

Water Control Procedure:

1. The Water Control System is to control water intrusion into the work areas such that the work can be performed "in-the-dry"
2. Water control includes all dewatering necessary to accomplish existing bridge removal, new bridge base material placement, new bridge construction, and new stream bed construction "in-the-dry"
3. The need and extent of sedimentation systems and dewatering techniques and sedimentation controls needed to control water and sediment at the site are to be determined in the field based on current conditions and the EPSC Plan.
4. Provide the means of removing all sediment from water pumped from the excavation areas
5. Apply pumping operations, installation of sandbags, geotextile fabrics, and all other means to collect, settle, and discharge water back in to the waterway as required during construction
6. Stream diversions shall be conducted in such a manner as to minimize siltation and prevent contamination of the waterway
7. Ensure that water control operations neither cause the accumulation of siltation nor any adverse effect to the water or the environment
8. The effectiveness of the water control method used will vary based on the field conditions at the time at which the work is being performed
9. Weather monitoring will be required.
10. If a storm is forecast additional adequate measures are to be at the ready to handle anticipated flow increases.
11. Flow increases can be handled by addition of by-pass pumps in size and number to be determined in the field based on current conditions and anticipated flow increases.
12. If flows are beyond the capacity of all available measures, the water control system is to be remove, the excavation flooded and all obstacle preventing free flow of the stream removed.
13. The Water Control System is non-permanent and is to not harm the ecology of the waterway, land under water, and surrounding land

General Notes

General:

1. Existing conditions are taken from Contract Drawings.
2. All dimensions relative to existing elements are to be field checked prior to fabrication and installation of proposed elements.
3. Control datums are those from the Contract Documents.
4. Design is based on conditions shown in the Contract Documents. Should conditions encountered in the field vary from those indicated conditions, the design may be invalid and revisions should be investigated.

Water Control System

1. Place 1 cy sand bags as the Turbidity Barrier at outermost streamside EPSC limits, upper limit 1' above OLW (EL806±streambed + 1.5'±OLW depth + 1' = EL808.5±)
2. Fill behind Turbidity Barrier with rock fill or existing streamside fill to 1' above OLW (EL808.5±)
3. Remove existing abutment and excavate to soil nail wall, to just above normal water elev. (EL810.0)
4. Layout Retaining Wall line at 3' off the face of the new abutment footing
5. Excavate in a 24' x 4.5' trench box, dewater, form ends w/ plywood
6. Fill with digable flowable fill, CLSM, pour 2-3 higher than OLW (EL810.00)
7. Remove trench box once CLSM hardens
8. Move up station and repeat process until entire Retaining Wall limits have CLSM in bottom
9. Backfill w/ stone fill top of Turbidity Barrier (EL808.50)
10. Place cubic yard sandbag Cofferdam over Retaining Wall to just above restricted OHW (EL816.0)
11. Excavate for new abutment footing
12. Dewater as required, discharge into approved upland treatment area

STATE OF VERMONT
TERRY WAITE
LICENSED PROFESSIONAL ENGINEER

-140529-

No.	Revision/Issue	Date

Firm Name and Address

TAW Associates
Waterville Valley, NH
603-236-4247 www.TAWAssociates.net

Proposed Improvement Bridge Project Bridge No. 13, 15, 16 & 19 - Rochester, VT Vtrans ER BRF 0162(19), (16), (17) & (18)

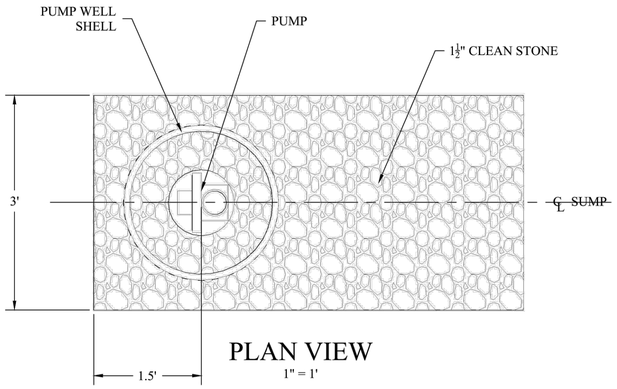
Project Name and Address

Water Control
Bridge 19

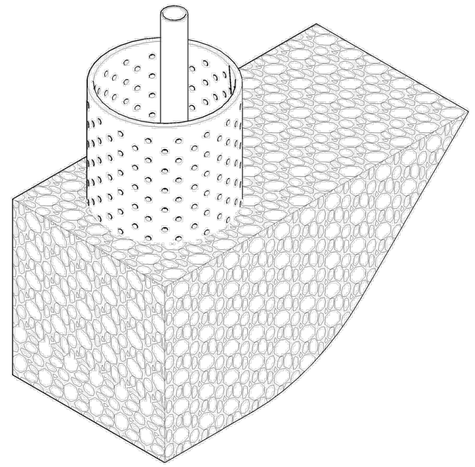
GENERAL PLAN

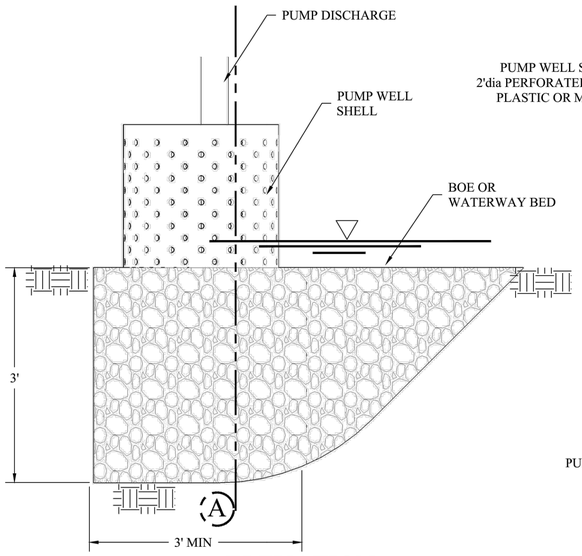
Project 140403D	Sheet WC01
Date May 29, 2014	
Scale noted	

SCHULTZ CONSTRUCTION, INC.

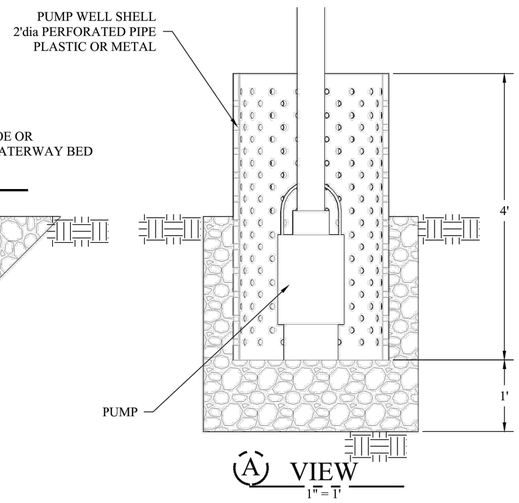


PLAN VIEW
1" = 1'





ELEVATION



VIEW
1" = 1'

SUMP DETAIL
NTS

General Notes

-140529-

No.	Revision/Issue	Date

Firm Name and Address
TAW Associates
Waterville Valley, NH
603-236-4247 www.TAWAssociates.net

Proposed Improvement Bridge Project Bridge No. 13, 15, 16 & 19 - Rochester, VT Vtrans ER BRF 0162(19), (16), (17) & (18)

Project Name and Address
Water Control
Bridge 19

DETAILS

Project	Sheet
1404030	WC02
Date May 29, 2014	
Scale noted	

SCHULTZ CONSTRUCTION, INC.

DOCUMENT: 140403D

Engineering Computations

Water Control Plan
Bridge 19

-

For The Project:
Proposed Improvement Bridge Project Bridge No. 13, 15, 16 & 19 – Rochester, VT
Vtrans ER BRF 0162(19), (16), (17) & (18)

-

for

SCHULTZ CONSTRUCTION, INC.

by

TAW ASSOCIATES

May 29, 2014

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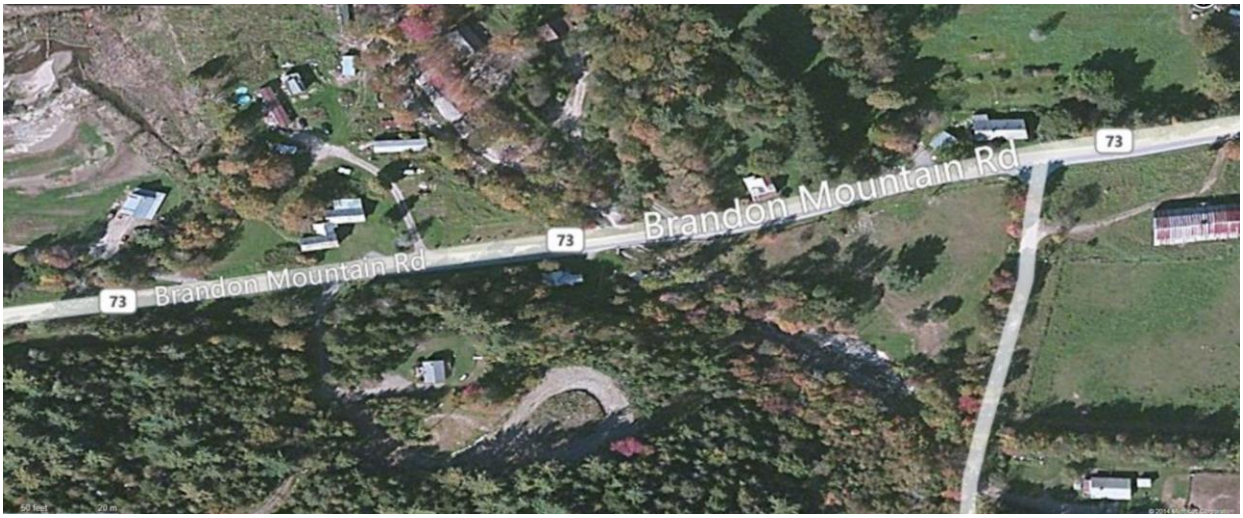
Turbidity Barrier: **15**
Retaining Wall: **21**
Sandbag Cofferdam: **30**

PHOTOS:

73
Brandon Mountain Rd
73
Bra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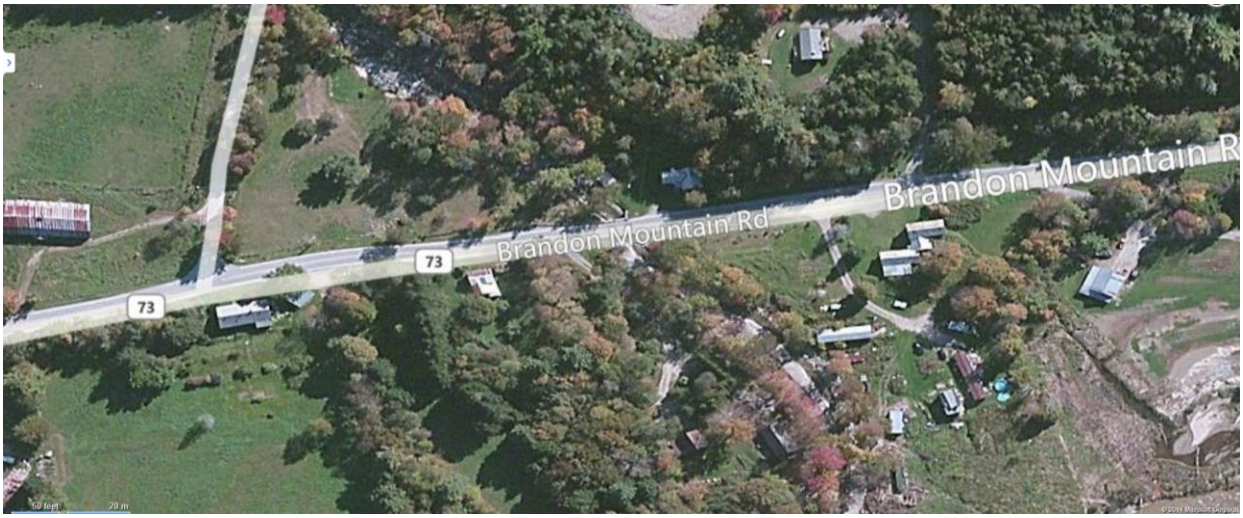
Brandon Mountain Rd
73
Brandon Mountain Rd
73

don Mountain Rd
73
Corporation Rd


Brandon Mountain R
Brandon Mountain Rd
73
73

73
Brandon M

HYDROLOGIC DATA

Date: 4/16/13

DRAINAGE AREA : 79.5 sq. mi.
CHARACTER OF TERRAIN : Mountainous Valley
STREAM CHARACTERISTICS : Sinuous, not braided
NATURE OF STREAMBED : Sand and gravel

PEAK FLOW DATA

Q 2.33 =	4560 cfs	Q 50 =	13175 cfs
Q 10 =	8100 cfs	Q 100 =	16220 cfs
Q 25 =	10840 cfs	Q 500 =	23000 cfs

DATE OF FLOOD OF RECORD : Unknown
ESTIMATED DISCHARGE: Unknown
WATER SURFACE ELEV.: Unknown
NATURAL STREAM VELOCITY : @ Q50 = 5.1 ft/s
ICE CONDITIONS : Moderate
DEBRIS: Moderate
DOES THE STREAM REACH MAXIMUM HIGHWATER ELEV. RAPIDLY? No
IS ORDINARY RISE RAPID? No
IS STAGE AFFECTED BY UPSTREAM OR DOWNSTREAM CONDITIONS? No
IF YES, DESCRIBE:

WATERSHED STORAGE: <1%

HEADWATERS:
UNIFORM: X
IMMEDIATELY ABOVE SITE:

EXISTING STRUCTURE INFORMATION

STRUCTURE TYPE:	Concrete Deck with Steel Beams
YEAR BUILT:	1974
CLEAR SPAN(NORMAL TO STREAM):	70'-0"
VERTICAL CLEARANCE ABOVE STREAMBED:	17'-0"
WATERWAY OF FULL OPENING:	1,098 sf
DISPOSITION OF STRUCTURE:	Damaged during Irene, Replaced with Temp. Br.
TYPE OF MATERIAL UNDER SUBSTRUCTURE:	See Borings

WATER SURFACE ELEVATIONS AT:

Q2.33 =	816.6 ft	VELOCITY =	4.4 ft/s
Q10 =	820.3 ft	"	5.5 ft/s
Q25 =	822.4 ft	"	6.6 ft/s
Q50 =	827.0 ft	"	7.3 ft/s
Q100 =	828.5 ft	"	8.0 ft/s

LONG TERM STREAMBED CHANGES: Lateral Movement

IS THE ROADWAY OVERTOPPED BELOW Q100:	Yes
FREQUENCY:	Q50
RELIEF ELEVATION:	824.80'
DISCHARGE OVER ROAD @Q100:	1269 cfs

PROPOSED STRUCTURE

STRUCTURE TYPE: Single Span Steel Plate Girder with Concrete Deck

CLEAR SPAN(NORMAL TO STREAM):	124'-6"
VERTICAL CLEARANCE ABOVE STREAMBED:	15'-6"
WATERWAY OF FULL OPENING:	1,837 sf

WATER SURFACE ELEVATIONS AT:

Q2.33 =	816.1 ft	VELOCITY=	4.7 ft/s
Q10 =	819.3 ft	"	5.5 ft/s
Q25 =	820.9 ft	"	6.6 ft/s
Q50 =	823.6 ft	"	7.4 ft/s
Q100 =	824.6 ft	"	8.2 ft/s

IS THE ROADWAY OVERTOPPED BELOW Q100: No
FREQUENCY: N/A
RELIEF ELEVATION: 825.06
DISCHARGE OVER ROAD @Q100: N/A

AVERAGE LOW ELEVATION OF SUPERSTRUCTURE: 821.7 ft
VERTICAL CLEARANCE: @ Q50 = -1.9 ft

SCOUR: Contraction Scour up to Q100 = 6.7 ft and up to Q500 = 9.4 ft

REQUIRED CHANNEL PROTECTION: Stone Fill, Type III

PERMIT INFORMATION

		DEPTH OR ELEVATION:
AVERAGE DAILY FLOW:	140 cfs	
ORDINARY LOW WATER:	40 cfs	1.5 ft
ORDINARY HIGH WATER:	2850 cfs	11.0 ft

GENERAL PROCEDURE:

The GC has proposed this general procedure regarding this Project:

Construct a sandbag cofferdam using IVI Cubic Yard Bags amb Indian Valley Industries, Inc. which will allow construction of the Project East Abutment of the new bridge in the dry and will be incorporated into a temporary access road over which equipment will travel for access to the work. The cofferdam is to be capable of withstanding Ordinary High Water conditions.

Weather monitoring will be required. If a storm is forecast additional adequate measures are to be at the ready to handle anticipated flow increases. Flow increases can be handled by addition of by-pass pumps in size and number to be determined in the field based on current conditions and anticipated flow increases.

Should a storm occur of flow rate greater than the capacity of the design by-pass system, the by-pass system will be allowed to overtop and the area below the existing bridge allowed to temporarily flood.

WATER CONTROL SYSTEM:

Construction Sequence:

1. Applicable EPSC and erosion control measures are to be put into place.
2. Perform local excavation behind the turbidity barrier down to base elevation for individual sandbag installation and progressively install base rows of sandbags.
3. Backfill behind the lower rows of sandbags with crushed stone fill up to current water level where granular fill can be compacted
4. Once above water level, continue installation of sandbag rows backfilling with granular fill compacted to 95% to T.O. Sandbag elevation.
5. Install stone fill top surface to Cofferdam Crest elevation.

Water Control Requirements:

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20. The pumping discharge shall not be allowed to enter directly into the brook.
21. The water from the work areas shall be pumped to a sediment system in accordance with the EPSC Plan.
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24. After having served its purpose, the water control system shall become the property of the Contractor and shall be removed by the Contractor from the site subject to the Engineer's approval.

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1. The Water Control System is to control water intrusion into the work areas such that the work can be performed "in-the-dry"
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7. Ensure that water control operations neither cause the accumulation of siltation nor any adverse effect to the water or the environment
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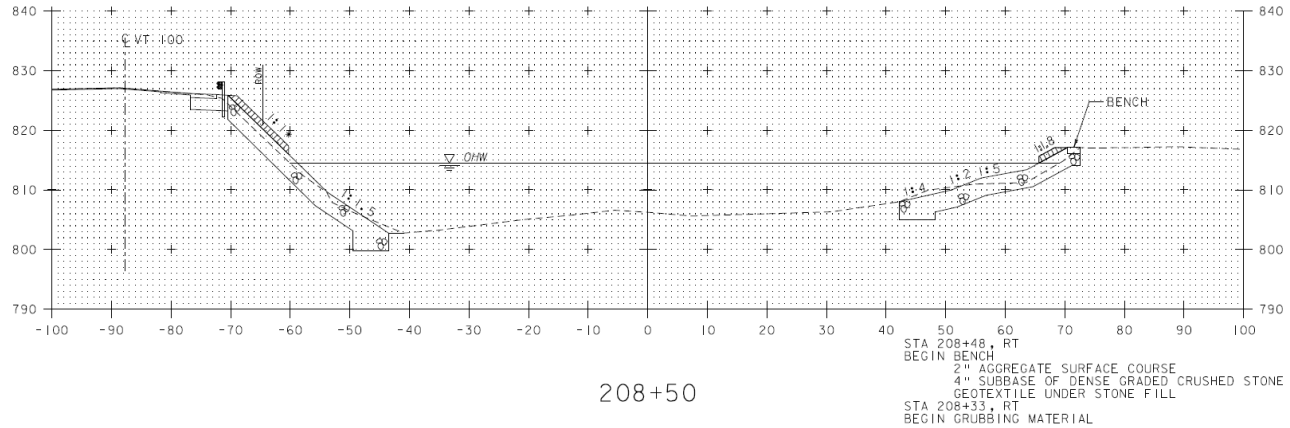
Water Control System

1. Place 1 cy sand bags as the Turbidity Barrier at outermost streamside EPSC limits, upper limit 1' above OLW (EL806±streambed + 1.5'±OLW depth + 1' = EL808.5±)
2. Fill behind Turbidity Barrier with rock fill or existing streamside fill to 1' above OLW (EL808.5±)
3. Remove existing abutment and excavate to soil nail wall, to just above normal water elev. (EL810.0)
4. Layout Retaining Wall line at 3' off the face of the new abutment footing
5. Excavate in a 24' x 4.5' trench box, dewater, form ends w/ plywood
6. Fill with digable flowable fill, CLSM, pour 2-3 higher than OLW (EL810.00)
7. Remove trench box once CLSM hardens
8. Move up station and repeat process until entire Retaining Wall limits have CLSM in bottom
9. Backfill w/ stone fill top of Turbidity Barrier (EL808.50)
10. Place cubic yard sandbag Cofferdam over Retaining Wall to just above restricted OHW (EL816.0)
11. Excavate for new abutment footing
12. Dewater as required, discharge into approved upland treatment area

SUPPORTING ANALYSIS:

Channel Flows:



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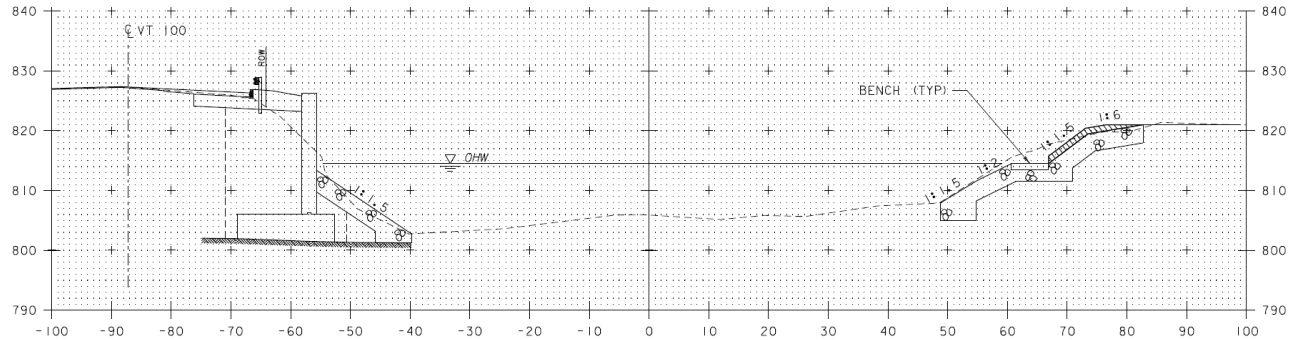

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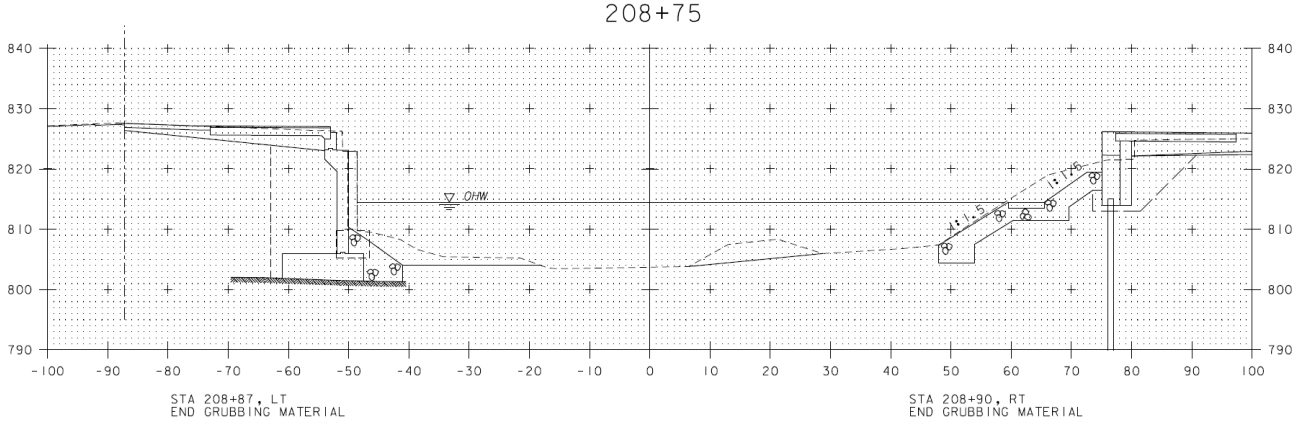

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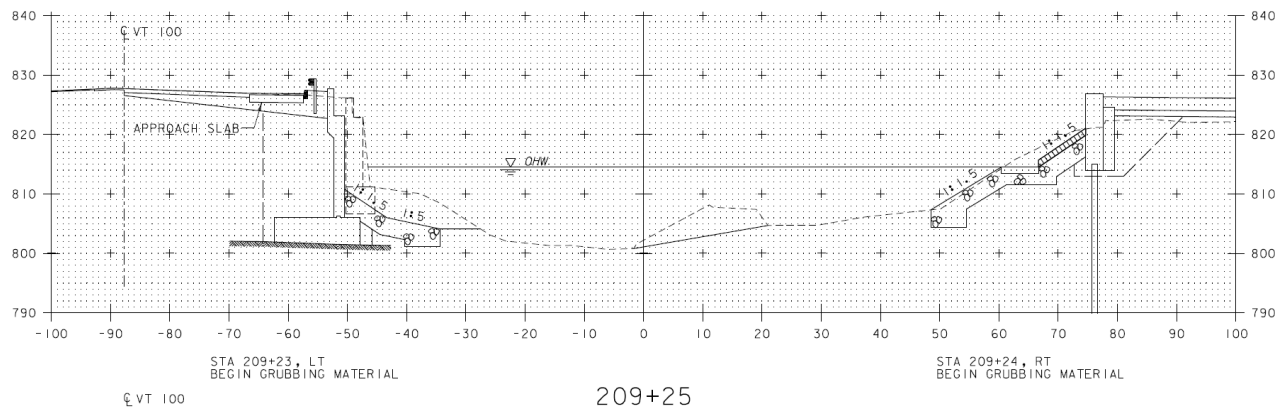
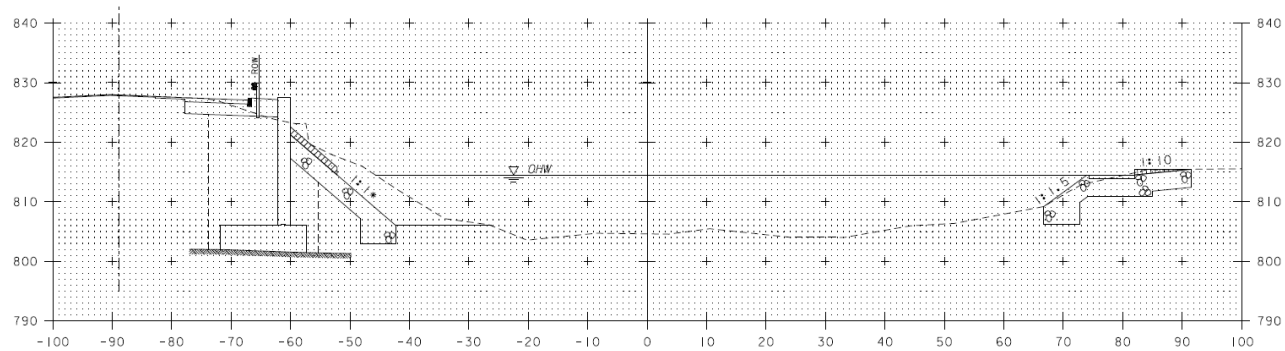
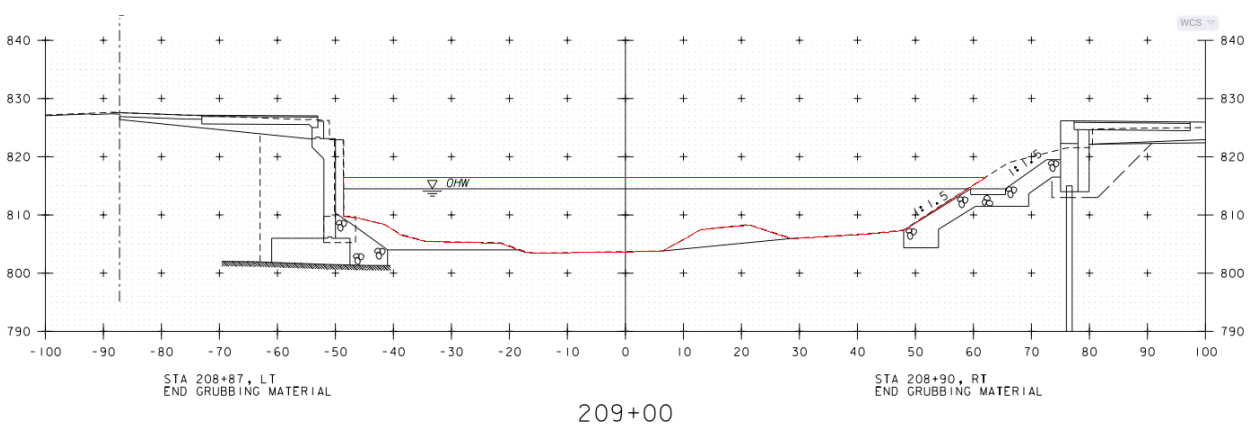




Determine characteristics of the existing channel through the existing bridge. From the Contract Documents for,

$EL_{Q2.33}$ = 816.6 ft
$V_{Q2.33}$ = 4.4 fps
$Q_{2.33}$ = 4560 cfs

Based on,



P = 122.7’

A = 1092.4sf

Natural Channels (minor streams, top width at flood state < 100 feet)	
Fairly regular section	0.030 to 0.070
Irregular section with pools	0.040 to 0.100

Source: Design and Construction of Sanitary and Storm Sewers, American Society of Civil Engineers and the Water Pollution Control Federation, 1969.

n = 0.095

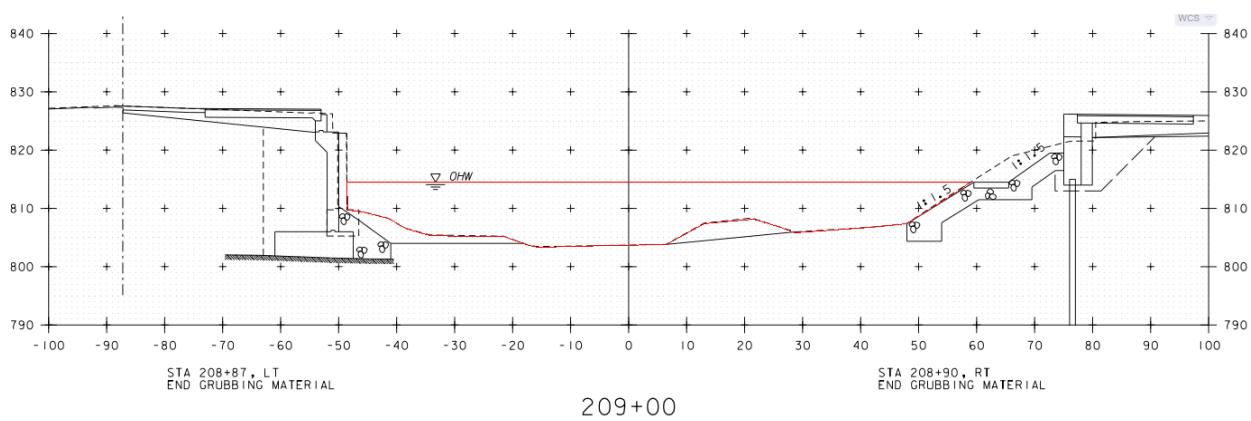
Then,

S	ft/ft	0.00390
n		0.095
P	ft	122.700
A	ft^2	1092.400
R=A/P	ft	8.903
$Q = A\ (1.486/n)\ R^{2/3}\ S^{1/2}$	cfs	4584
V=Q/A	fps	4.20

The Q and V values correspond closely with the Contract Plan hydraulic data for $Q_{2.33}$.

Using these assumptions which conform will with the specified $Q_{2.33}$, determine the characteristics for Ordinary High Water (Q_{OHW}).

S = 0.00390
EL_{OHW} = 814.5 ft (from Contract Plan channel section)
Q_{OHW} = 2850 cfs



P = 116.9'
A = 877.7sf

S	ft/ft	0.00390

n		0.095
		116.90
P	ft	0
		877.70
A	ft^2	0
R=A/P	ft	7.508
Q = A (1.486/n) $R^{2/3}$ $S^{1/2}$	cfs	3287
V=Q/A	fps	3.75

Q = 3287 cfs

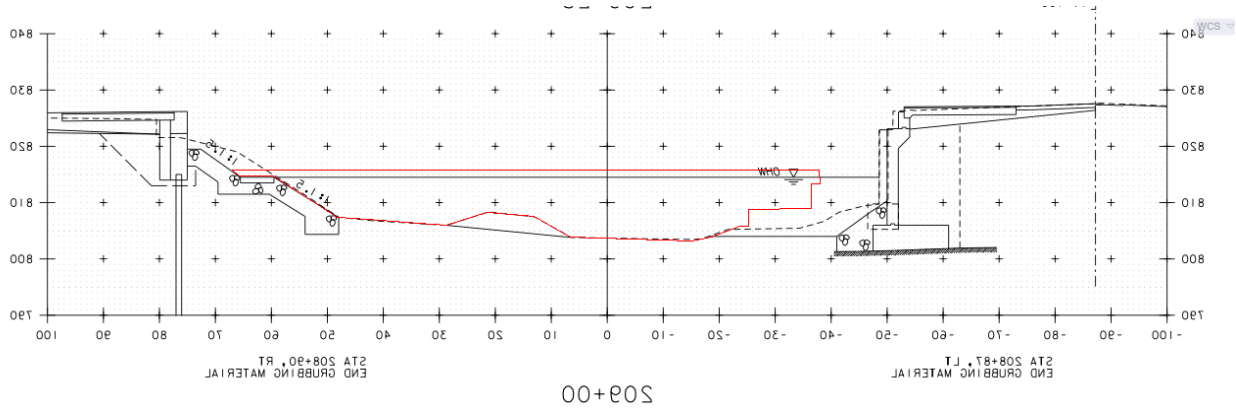
Therefore,

Q_{OHW} = 3287 cfs

The GC desires to design the cofferdam for Q_{OHW}, therefore

Q_{design} = Q_{OHW} = 3287 cfs

Determine the water surface elevation for Q_{design} for the channel restricted by the proposed cofferdam (channel section view reversed to be consistent with bridge elevation view).



EL_{OHW} = 815.4 ft
P = 119.2'
A = 888.5 sf

S	ft/ft	0.00390
n		0.095
P	ft	119.200
A	ft^2	888.500
R=A/P	ft	7.454
Q = A (1.486/n) $R^{2/3}$ $S^{1/2}$	cfs	3312
V=Q/A	fps	3.73

$Q_{OHW\ Restricted}$ = 3312cfs > 3287cfs OK

Turbidity Barrier:

The Turbidity Barrier, located along the EPSC approved limit of disturbed area, will be constructed of sandbags to divert stream flow around the work area. The crest of the Turbidity Barrier will be at EL808.5. The land side of the Turbidity Barrier will be backfilled with available existing material and stone fill to the top of the barrier.

The Turbidity Barrier will be constructed of Cubic Yard sand bags 3'x3'x3' in nominal dimension. Large and Small sandbags may be used in construction of the barrier to accommodate varying bed elevations and to facilitate sealing.

The Turbidity Barrier will be subjected to loads and will be investigated for two load conditions,

1. Condition 1: water on one side to top
2. Condition 2: granular backfill on one side to top, equipment surcharge

Unless otherwise noted the assumptions used as a basis for the design as applicable are as follows:

- weight of water, γ_w = 62.4pcf
- weight of sand, γ_s' = 125pcf

AASHTO 5.2.2.3 calls for design of overall stability of retaining walls to have a minimum Factor of Safety of 1.3 for static loads and 1.5 for installations with a low tolerance for failure.

Condition 1: water on one side to top

Wall Section	Location STA± from	to	Depth from T.O.Wall ft	Wall/Ftg Width ft
1	0+00	0+01	0.00	3.00
			1.00	3.00
			2.00	3.00
			3.00	3.00

W_{stem} = width of stem =	3.00	ft	average
H_{stem} = height of stem =	3.00	ft	
γ_{stem} = density of stem material =	0.135	kcf	
HRE = height toe of ftg to top of retained earth =	3.00	ft	
HBF = height of backfill on front face from BOF =	0.00	ft	
γ'_{soil} = density of soil, wet =	0.135	kcf	
ϕ = friction angle of soil =	30	°	

c = coefficient of friction sandbag/soil = tanϕ = 0.58

DRIVING FORCES:

ACTIVE EARTH Horizontal Load:		0.000	k			0.000	ft-k
WATER Horizontal Load:		0.125	k			0.094	ft-k

Depth from T.O. Wall:

				F_D		MA		M_D	
0		0.000	k	0.000	k	0.00	ft	0.000	ft-k
1	water	0.000	k	0.000	k	0.00	ft	0.000	ft-k
2	water	0.062	k	0.031	k	1.50	ft	0.047	ft-k
3	water	0.125	k	0.094	k	0.50	ft	0.047	ft-k

SURCHARGE Horizontal Load:	0.000	k		0.000	ft-k
STREAM FLOW PRESSURE:	0.076	k		0.089	ft-k

P_{max} = maximum stream pressure = $2P_{avg}$ / 1000 = 0.04 ksf [AASHTO 3.18.1.1.1]

where:

$P_{avg} = KV_{avg}^2$ = 22.4 psf

K = constant for barrier shape = 1.4 for flat face

V_{avg} = average velocity of water = Q/A = 4 fps

q = angle of attack = 45 °

$P = P_{max}\sin\theta$ = 0.03 ksf

Depth from T.O. Wall:

	ID			F_D		MA		M_D	
0			k	0.000	k	0.00	ft	0.000	ft-k
1	stream pressure	0.03	k	0.032	k	2.00	ft	0.063	ft-k
2	stream pressure	0.03	k	0.025	k	1.00	ft	0.025	ft-k
3	stream pressure	0.02	k	0.019	k	0.00	ft	0.000	ft-k

$F_{sliding} = \Sigma F_D$ = **0.201 k**

$M_{overturning} = \Sigma M_D$ = **0.182 ft-k**

RESISTING FORCES:

SELF-WEIGHT & VERTICAL LOADS:	1.215	k		1.823	ft-k

Depth from B.O. Excavation:

	ID			F_V		MA		M_R	
0	Wall	0.000	k	0.000	k	1.50	ft	0.000	ft-k
1	Wall	0.405	k	0.405	k	1.50	ft	0.608	ft-k
2	Wall	0.405	k	0.405	k	1.50	ft	0.608	ft-k
3	Wall	0.405	k	0.405	k	1.50	ft	0.608	ft-k

$F_{resisting} = c\Sigma F_V + \Sigma F_R =$	**0.701**	**k**	**>=**	**0.201**	**k**	**FS =**	**3.49**	**OK**
$M_{resisting} = \Sigma M_R =$	**1.823**	**ft-k**	**>=**	**0.182**	**ft-k**	**FS =**	**10.00**	**OK**

Condition 2: granular backfill on one side to top, equipment surcharge

Surcharge Loading:

Surcharge
Equipment

Height of Wall = 3
Depth of Wall = 0
Load Factor of Surcharge Loading = 1

Wall Condition:
Flexible Wall Condition -- Small Movement or deflection are allowed.

**********Loading**********

STRIP LOADING:

Xarea	Width	Length	Qarea
0.0	10.0	30.0	0.4

**********Total Pressure Distribution**********

Max. Pressure =0.195 at depth =0.15

Depth	Pressure
0.00	0.000
0.15	0.195
0.30	0.191
0.45	0.187
0.60	0.183
0.75	0.180
0.90	0.176
1.05	0.172
1.20	0.168
1.35	0.165
1.50	0.161
1.65	0.158
1.80	0.154
1.95	0.150
2.10	0.147
2.25	0.143
2.40	0.140
2.55	0.137
2.70	0.133
2.85	0.130

3.00	0.127
3.30	0.121
3.60	0.115
3.90	0.109
4.20	0.103
4.50	0.098
4.80	0.093
5.10	0.088
5.40	0.083
5.70	0.079
6.00	0.074
6.60	0.067
7.20	0.060
7.80	0.054
8.40	0.048
9.00	0.043
9.60	0.039
10.20	0.035
10.80	0.031
11.40	0.028
12.00	0.000

Depth Is Measured From Top of the Wall
LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf

Wall Section	Location from	STA± to	ft	Depth from T.O.Wall ft	Wall/Ftg Width
1	0+00	0+01	0.00	3.00	
			1.00	3.00	
			2.00	3.00	
			3.00	3.00	
				0.00	
				0.00	
				0.00	
				0.00	

Wftg = width of footing =	0.00	ft	
tftg = thickness of footing =	0.00	ft	
gftg = density of ftg material =		0.135	kcf
Wstem = width of stem =	3.00	ft	average
Hstem = height of stem =	3.00	ft	
gstem = density of stem material =		0.135	kcf

HRE = height toe of ftg to top of retained earth = 3.00 ft

HBF = height of backfill on front face from BOF = 0.00 ft

Xtoe = distance face of wall to toe of ftg = 0.00 ft

g'soil = density of soil, wet = 0.135 kcf
f = friction angle of soil = 34 °
d = friction angle of soil on wall = 14 °
b = slope angle from horizontal of retained earth = 0 °

Ka = active soil coefficient = 0.26 where Ka = cos2f / {cosd[1+(sin(f+d)sin(f-b)/(cosdcosb))1/2]2}
Kp = passive soil coefficient = 5.93 where Kp = cos2f / {cosd[1-(sin(f+d)sin(f+b)/(cosdcosb))1/2]2}

c = coefficient of friction sandbag/soil = tanf = 0.67

DRIVING FORCES:

ACTIVE EARTH Horizontal Load: 0.157 k 0.166 ft-k
Depth from T.O. Wall:

	ID		FD		MA		MD		
0	cofferdam	0.000	k	0.000	k	3.00	ft	0.000	ft-k
1	cofferdam	0.035	k	0.017	k	2.50	ft	0.044	ft-k
2	cofferdam	0.070	k	0.052	k	1.50	ft	0.079	ft-k
3	cofferdam	0.105	k	0.087	k	0.50	ft	0.044	ft-k

SURCHARGE Horizontal Load: 0.470 k 0.738 ft-k
Depth from T.O. Wall:

Depth	Pressure		FD		MA		MD	
0.00	0.000	ksf	0.000	k	3.00	ft	0.000	ft-k
0.15	0.195	ksf	0.015	k	2.93	ft	0.043	ft-k
0.30	0.191	ksf	0.029	k	2.78	ft	0.080	ft-k
0.45	0.187	ksf	0.028	k	2.63	ft	0.074	ft-k
0.60	0.183	ksf	0.028	k	2.48	ft	0.069	ft-k
0.75	0.180	ksf	0.027	k	2.33	ft	0.063	ft-k
0.90	0.176	ksf	0.027	k	2.18	ft	0.058	ft-k
1.05	0.172	ksf	0.026	k	2.03	ft	0.053	ft-k
1.20	0.168	ksf	0.026	k	1.88	ft	0.048	ft-k
1.35	0.165	ksf	0.025	k	1.73	ft	0.043	ft-k
1.50	0.161	ksf	0.024	k	1.58	ft	0.039	ft-k
1.65	0.158	ksf	0.024	k	1.43	ft	0.034	ft-k

1.80	0.154	ksf	0.023	k	1.28	ft	0.030	ft-k
1.95	0.150	ksf	0.023	k	1.13	ft	0.026	ft-k
2.10	0.147	ksf	0.022	k	0.98	ft	0.022	ft-k
2.25	0.143	ksf	0.022	k	0.83	ft	0.018	ft-k
2.40	0.140	ksf	0.021	k	0.68	ft	0.014	ft-k
2.55	0.137	ksf	0.021	k	0.53	ft	0.011	ft-k
2.70	0.133	ksf	0.020	k	0.38	ft	0.008	ft-k
2.85	0.130	ksf	0.020	k	0.23	ft	0.004	ft-k
3.00	0.127	ksf	0.019	k	0.08	ft	0.001	ft-k

Fsliding = SFD = 0.627 k
Moverturning = SMD = 0.904 ft-k

RESISTING FORCES:

SELF-WEIGHT & VERTICAL LOADS: 1.215 k
1.823 ft-k
Depth from B.O. Excavation:

	ID			FV		MA		MR	
0	Wall	0.000	k	0.000	k	1.50	ft	0.000	ft-k
1	Wall	0.405	k	0.405	k	1.50	ft	0.608	ft-k
2	Wall	0.405	k	0.405	k	1.50	ft	0.608	ft-k
3	Wall	0.405	k	0.405	k	1.50	ft	0.608	ft-k

Fresisting = cSFV + SFR = 0.820 k >= 0.627 k FS = 1.31
Mresisting = SMR = 1.823 ft-k >= 0.904 ft-k FS = 2.02 OK

Retaining Wall:

The Retaining Wall will be constructed on the opposite side of the access road from the Turbidity Barrier, at about 3' off the face of the new Abutment 2 footing. It will be founded on bedrock and extend up to EL810.00. It will be 4' thick.

The Retaining Wall will be investigated for two load conditions,

1. Condition 1: granular backfill on one side to top, equipment surcharge
2. Condition 2: granular backfill on one side to top, horizontal force at top of wall resulting from water pressure against Cofferdam sitting atop the wall, horizontal and vertical forces from Cofferdam

Unless otherwise noted the assumptions used as a basis for the design as applicable are as follows:

- weight of water, γ_w = 62.4pcf
- weight of sand, γ_s' = 125pcf

AASHTO 5.2.2.3 calls for design of overall stability of retaining walls to have a minimum Factor of Safety of 1.3 for static loads and 1.5 for installations with a low tolerance for failure.

Condition 1: granular backfill on one side to top, equipment surcharge

Equipment Travelling Surcharge:

East Side Equipment.lp8

Surcharge
Equipment

Height of Wall = 8
Depth of Wall = 0
Load Factor of Surcharge Loading = 1

Wall Condition:
Flexible Wall Condition -- Small Movement or deflection are allowed.

**********Loading**********

STRIP LOADING:

Xarea	Width	Length	Qarea
0.0	10.0	30.0	0.4

**********Total Pressure Distribution**********

Max. Pressure =0.188 at depth =0.40

Depth	Pressure
0.00	0.000
0.40	0.188
0.80	0.178
1.20	0.168
1.60	0.159
2.00	0.149
2.40	0.140
2.80	0.131
3.20	0.123
3.60	0.115
4.00	0.107
4.40	0.100
4.80	0.093
5.20	0.086
5.60	0.080
6.00	0.074
6.40	0.069
6.80	0.064
7.20	0.060
7.60	0.056
8.00	0.052
8.80	0.045
9.60	0.039
10.40	0.034
11.20	0.029
12.00	0.026
12.80	0.023
13.60	0.020
14.40	0.018
15.20	0.016
16.00	0.014
17.60	0.011
19.20	0.009
20.80	0.007
22.40	0.006
24.00	0.005
25.60	0.004
27.20	0.004
28.80	0.003
30.40	0.003
32.00	0.000

Depth Is Measured From Top of the Wall
LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf

Wall Section	Location			Depth from T.O.Wall	Wall/Ftg Width
		STA±			
	from	to	ft	ft	
1	0+00	0+01	0.00	4.50	
			1.00	4.50	

2.00	4.50
3.00	4.50
4.00	4.50
5.00	4.50
6.00	4.50
7.00	4.50
8.00	4.50

Wftg = width of footing =	4.50	ft	
tftg = thickness of footing =	0.00	ft	
gftg = density of ftg material =		0.145	kcf
Wstem = width of stem =	4.50	ft	average
Hstem = height of stem =	8.00	ft	
gstem = density of stem material =		0.145	kcf

HRE = height toe of ftg to top of retained earth = 8.00 ft

HBF = height of backfill on front face from BOF = 0.00 ft

Xtoe = distance face of wall to toe of ftg = 0.00 ft

g'soil = density of soil, wet =	0.135	kcf	
f = friction angle of soil =	34	°	
d = friction angle of soil on wall =		14	°
b = slope angle from horizontal of retained earth =			0 °

Ka = active soil coefficient = 0.26 where Ka = cos2f / {cosd[1+(sin(f+d)sin(f-b)/(cosdcosb))1/2]2}

Kp = passive soil coefficient = 5.93 where Kp = cos2f / {cosd[1-(sin(f+d)sin(f+b)/(cosdcosb))1/2]2}

c = coefficient of friction conc/rock = tanf = 0.75

DRIVING FORCES:

ACTIVE EARTH Horizontal Load: 1.118 k 3.005 ft-k

Depth from T.O. Wall:

	ID			FD		MA		MD	
0	wall 1	0.000	k	0.000	k	8.00	ft	0.000	ft-k
1	wall 1	0.035	k	0.017	k	7.50	ft	0.131	ft-k
2	wall 1	0.070	k	0.052	k	6.50	ft	0.341	ft-k
3	wall 1	0.105	k	0.087	k	5.50	ft	0.480	ft-k
4	wall 1	0.140	k	0.122	k	4.50	ft	0.550	ft-k

5	wall 1	0.175	k	0.157	k	3.50	ft	0.550	ft-k
6	wall 1	0.210	k	0.192	k	2.50	ft	0.480	ft-k
7	wall 1	0.245	k	0.227	k	1.50	ft	0.341	ft-k
8	wall 1	0.279	k	0.262	k	0.50	ft	0.131	ft-k

SURCHARGE Horizontal Load: 0.866 k 4.102 ft-k
Depth from T.O. Wall:

Depth	Pressure		FD		MA		MD	
0.00	0.000	ksf	0.000	k	8.00	ft	0.000	ft-k
0.40	0.188	ksf	0.038	k	7.80	ft	0.293	ft-k
0.80	0.178	ksf	0.073	k	7.40	ft	0.542	ft-k
1.20	0.168	ksf	0.069	k	7.00	ft	0.484	ft-k
1.60	0.159	ksf	0.065	k	6.60	ft	0.432	ft-k
2.00	0.149	ksf	0.062	k	6.20	ft	0.382	ft-k
2.40	0.140	ksf	0.058	k	5.80	ft	0.335	ft-k
2.80	0.131	ksf	0.054	k	5.40	ft	0.293	ft-k
3.20	0.123	ksf	0.051	k	5.00	ft	0.254	ft-k
3.60	0.115	ksf	0.048	k	4.60	ft	0.219	ft-k
4.00	0.107	ksf	0.044	k	4.20	ft	0.186	ft-k
4.40	0.100	ksf	0.041	k	3.80	ft	0.157	ft-k
4.80	0.093	ksf	0.039	k	3.40	ft	0.131	ft-k
5.20	0.086	ksf	0.036	k	3.00	ft	0.107	ft-k
5.60	0.080	ksf	0.033	k	2.60	ft	0.086	ft-k
6.00	0.074	ksf	0.031	k	2.20	ft	0.068	ft-k
6.40	0.069	ksf	0.029	k	1.80	ft	0.051	ft-k
6.80	0.064	ksf	0.027	k	1.40	ft	0.037	ft-k
7.20	0.060	ksf	0.025	k	1.00	ft	0.025	ft-k
7.60	0.056	ksf	0.023	k	0.60	ft	0.014	ft-k
8.00	0.052	ksf	0.022	k	0.20	ft	0.004	ft-k

STREAM FLOW PRESSURE: 0.000 k 0.000 ft-k

Pmax = maximum stream pressure = 2Pavg / 1000 =
0.00 ksf [AASHTO 3.18.1.1.1]
where:
Pavg = KVavg2 = 0.0 psf
K = constant for barrier shape = 1.4 for flat face

Vavg = average velocity of water = Q/A = 0 fps

q = angle of attack = 45 °
P = Pmaxsinq = 0.00 ksf
Depth from T.O. Wall:

ID	FD	MA	MD

0			k	0.000	k	0.00	ft	0.000	ft-k	
1	stream pressure			0.00	k	0.000	k	0.00	ft	0.000 ft-k
2	stream pressure			0.00	k	0.000	k	0.00	ft	0.000 ft-k
3	stream pressure			0.00	k	0.000	k	0.00	ft	0.000 ft-k
4	stream pressure			0.00	k	0.000	k	0.00	ft	0.000 ft-k
5	stream pressure			0.00	k	0.000	k	0.00	ft	0.000 ft-k
6	stream pressure			0.00	k	0.000	k	0.00	ft	0.000 ft-k
7			k	0.000	k	0.00	ft	0.000	ft-k	
8			k	0.000	k	0.00	ft	0.000	ft-k	
9			k	0.000	k	0.00	ft	0.000	ft-k	
10			k	0.000	k	0.00	ft	0.000	ft-k	

OTHER Horizontal Concentrated Load: 0.000 k
0.000 ft-k
Depth from T.O. Wall:

ID			FD		MA		MD	
0		k	0.000	k	0.00	ft	0.000	ft-k
1		k	0.000	k	0.00	ft	0.000	ft-k
2		k	0.000	k	0.00	ft	0.000	ft-k
3		k	0.000	k	0.00	ft	0.000	ft-k
4		k	0.000	k	0.00	ft	0.000	ft-k
5		k	0.000	k	0.00	ft	0.000	ft-k
6		k	0.000	k	0.00	ft	0.000	ft-k
7		k	0.000	k	0.00	ft	0.000	ft-k
8		k	0.000	k	0.00	ft	0.000	ft-k
9		k	0.000	k	0.00	ft	0.000	ft-k
10		k	0.000	k	0.00	ft	0.000	ft-k

Fsliding = SFD = 1.984 k
Moverturning = SMD = 7.107 ft-k

RESISTING FORCES:

SELF-WEIGHT & VERTICAL LOADS: 5.220 k
11.745 ft-k
Depth from B.O. Excavation:

ID				FV		MA		MR	
0	Wall	0.000	k	0.000	k	2.25	ft	0.000	ft-k
1	Wall	0.653	k	0.653	k	2.25	ft	1.468	ft-k
2	Wall	0.653	k	0.653	k	2.25	ft	1.468	ft-k
3	Wall	0.653	k	0.653	k	2.25	ft	1.468	ft-k
4	Wall	0.653	k	0.653	k	2.25	ft	1.468	ft-k
5	Wall	0.653	k	0.653	k	2.25	ft	1.468	ft-k
6	Wall	0.653	k	0.653	k	2.25	ft	1.468	ft-k
7	Wall	0.653	k	0.653	k	2.25	ft	1.468	ft-k

8	Wall	0.653	k	0.653	k	2.25	ft	1.468	ft-k

Fresisting = cSFV + SFR =	**3.915**	**k**	**>=**	**1.984**	**k**	**FS =**	**2.0**	**OK**
Mresisting = SMR =	**11.745**	**ft-k**	**>=**	**7.107**	**ft-k**	**FS =**	**1.7**	**OK**

Condition 2: granular backfill on one side to top, horizontal force at top of wall resulting from water pressure against Cofferdam sitting atop the wall, horizontal and vertical forces from Cofferdam

Surcharge
Cofferdam

Height of Wall = 8
Depth of Wall = 0
Load Factor of Surcharge Loading = 1

Wall Condition:
Flexible Wall Condition -- Small Movement or deflection are allowed.

**********Loading**********

STRIP LOADING:

Xstrip	Width	Qstrip
0.0	1.5	0.2

**********Total Pressure Distribution**********

Max. Pressure =0.063 at depth =0.40

Depth	Pressure
0.00	0.000
0.40	0.063
0.80	0.040
1.20	0.024
1.60	0.015
2.00	0.010
2.40	0.007
2.80	0.005
3.20	0.003
3.60	0.002
4.00	0.002
4.40	0.001
4.80	0.001
5.20	0.001
5.60	0.001
6.00	0.001
6.40	0.000
6.80	0.000
7.20	0.000

7.60	0.000
8.00	0.000
8.80	0.000
9.60	0.000
10.40	0.000
11.20	0.000
12.00	0.000
12.80	0.000
13.60	0.000
14.40	0.000
15.20	0.000
16.00	0.000
17.60	0.000
19.20	0.000
20.80	0.000
22.40	0.000
24.00	0.000
25.60	0.000
27.20	0.000
28.80	0.000
30.40	0.000
32.00	0.000

Depth Is Measured From Top of the Wall
LENGTH/DEPTH: ft, Qpoint: kip, Qline: kip/ft, Qstrip/Qarea/PRESSURE: ksf

Wall Section	Location from	STA± to	ft	Depth from T.O.Wall ft	Wall/Ftg Width
1	0+00	0+01	0.00	4.50	
			1.00	4.50	
			2.00	4.50	
			3.00	4.50	
			4.00	4.50	
			5.00	4.50	
			6.00	4.50	
			7.00	4.50	
			8.00	4.50	

Wftg = width of footing =	4.50	ft	
tftg = thickness of footing =	0.00	ft	
gftg = density of ftg material =		0.145	kcf
Wstem = width of stem =	4.50	ft	average
Hstem = height of stem =	8.00	ft	
gstem = density of stem material =		0.145	kcf

HRE = height toe of ftg to top of retained earth = 8.00 ft

HBF = height of backfill on front face from BOF = 0.00 ft

Xtoe = distance face of wall to toe of ftg = 0.00 ft

g'soil = density of soil, wet = 0.135 kcf
f = friction angle of soil = 34 °
d = friction angle of soil on wall = 14 °
b = slope angle from horizontal of retained earth = 0 °

Ka = active soil coefficient = 0.26 where Ka = cos2f / {cosd[1+(sin(f+d)sin(f-b)/(cosdcosb))1/2]2}
Kp = passive soil coefficient = 5.93 where Kp = cos2f / {cosd[1-(sin(f+d)sin(f+b)/(cosdcosb))1/2]2}

c = coefficient of friction conc/rock = tanf = 0.75

DRIVING FORCES:

ACTIVE EARTH Horizontal Load: 1.118 k 3.005 ft-k
Depth from T.O. Wall:

	ID			FD		MA		MD	
0	wall 1	0.000	k	0.000	k	8.00	ft	0.000	ft-k
1	wall 1	0.035	k	0.017	k	7.50	ft	0.131	ft-k
2	wall 1	0.070	k	0.052	k	6.50	ft	0.341	ft-k
3	wall 1	0.105	k	0.087	k	5.50	ft	0.480	ft-k
4	wall 1	0.140	k	0.122	k	4.50	ft	0.550	ft-k
5	wall 1	0.175	k	0.157	k	3.50	ft	0.550	ft-k
6	wall 1	0.210	k	0.192	k	2.50	ft	0.480	ft-k
7	wall 1	0.245	k	0.227	k	1.50	ft	0.341	ft-k
8	wall 1	0.279	k	0.262	k	0.50	ft	0.131	ft-k

SURCHARGE Horizontal Load: 0.070 k 0.479 ft-k
Depth from T.O. Wall:

Depth	Pressure		FD		MA		MD	
0.00	0.000	ksf	0.000	k	8.00	ft	0.000	ft-k
0.40	0.063	ksf	0.013	k	7.80	ft	0.098	ft-k
0.80	0.040	ksf	0.021	k	7.40	ft	0.152	ft-k
1.20	0.024	ksf	0.013	k	7.00	ft	0.090	ft-k
1.60	0.015	ksf	0.008	k	6.60	ft	0.051	ft-k
2.00	0.010	ksf	0.005	k	6.20	ft	0.031	ft-k
2.40	0.007	ksf	0.003	k	5.80	ft	0.020	ft-k

2.80	0.005	ksf	0.002	k	5.40	ft	0.013	ft-k
3.20	0.003	ksf	0.002	k	5.00	ft	0.008	ft-k
3.60	0.002	ksf	0.001	k	4.60	ft	0.005	ft-k
4.00	0.002	ksf	0.001	k	4.20	ft	0.003	ft-k
4.40	0.001	ksf	0.001	k	3.80	ft	0.002	ft-k
4.80	0.001	ksf	0.000	k	3.40	ft	0.001	ft-k
5.20	0.001	ksf	0.000	k	3.00	ft	0.001	ft-k
5.60	0.001	ksf	0.000	k	2.60	ft	0.001	ft-k
6.00	0.001	ksf	0.000	k	2.20	ft	0.001	ft-k
6.40	0.000	ksf	0.000	k	1.80	ft	0.000	ft-k
6.80	0.000	ksf	0.000	k	1.40	ft	0.000	ft-k
7.20	0.000	ksf	0.000	k	1.00	ft	0.000	ft-k
7.60	0.000	ksf	0.000	k	0.60	ft	0.000	ft-k
8.00	0.000	ksf	0.000	k	0.20	ft	0.000	ft-k
8.80	0.000	ksf	0.000	k	0.00	ft	0.000	ft-k

OTHER Horizontal Concentrated Load: 1.123 k
8.986 ft-k
Depth from T.O. Wall:

	ID	FD		MA		MD			
0	water against CD B	1.123	k	1.123	k	8.00	ft	8.986	ft-k

Fsliding = SFD = 2.312 k
Moverturning = SMD = 12.469 ft-k

RESISTING FORCES:

SELF-WEIGHT & VERTICAL LOADS: 8.033 k
18.917 ft-k
Depth from B.O. Excavation:

	ID			FV		MA		MR		
0	Cofferdam B	2.813	k	2.813	k	2.55	ft	7.172	ft-k	
1	Wall	0.653	k	0.653	k	2.25	ft	1.468	ft-k	
2	Wall	0.653	k	0.653	k	2.25	ft	1.468	ft-k	
3	Wall	0.653	k	0.653	k	2.25	ft	1.468	ft-k	
4	Wall	0.653	k	0.653	k	2.25	ft	1.468	ft-k	
5	Wall	0.653	k	0.653	k	2.25	ft	1.468	ft-k	
6	Wall	0.653	k	0.653	k	2.25	ft	1.468	ft-k	
7	Wall	0.653	k	0.653	k	2.25	ft	1.468	ft-k	
8	Wall	0.653	k	0.653	k	2.25	ft	1.468	ft-k	

Fresisting = cSFV + SFR = 6.024 k >= 2.312 k FS = 2.6 OK
Mresisting = SMR = 18.917 ft-k >= 12.469 ft-k FS = 1.5 OK

Sandbag Cofferdam:

Cofferdam, located along top of the Retaining Wall, will be constructed of sandbags allow dewatering of the work area. The crest of Cofferdam will be at EL816.00. The land side of

Cofferdam A will be constructed of Cubic Yard Sandbags, approximately 3'x3'x3' in nominal dimension. Large and Small sandbags may be used in construction of the Cofferdam to accommodate varying bed elevations and to facilitate sealing.

Cofferdam will be investigated for one load condition,

1. Condition 1: water on one side to top of cofferdam

Unless otherwise noted the assumptions used as a basis for the design as applicable are as follows:

- weight of water, γ_w = 62.4pcf
- weight of sand, γ_s' = 125pcf

AASHTO 5.2.2.3 calls for design of overall stability of retaining walls to have a minimum Factor of Safety of 1.3 for static loads and 1.5 for installations with a low tolerance for failure.

Condition 1: water on one side to top of cofferdam

Wall Section	Location STA± from	to	Depth from T.O.Wall ft	Wall/Ftg Width ft
1	0+00	0+01	0.00	3.00
			1.00	3.00
			2.00	3.00
			3.00	3.00
			4.00	6.00
			5.00	6.00
			6.00	6.00

W_{ftg} = width of footing =	6.00	ft	
t_{ftg} = thickness of footing =	0.00	ft	
γ_{ftg} = density of ftg material =	0.135	kcf	
W_{stem} = width of stem =	4.29	ft	average
H_{stem} = height of stem =	6.00	ft	
γ_{stem} = density of stem material =	0.135	kcf	
c = coefficient of friction sandbag/soil = tanϕ =	0.58		

DRIVING FORCES:

WATER Horizontal Load: 1.123 k 2.278 ft-k
Depth from T.O. Wall:

				F_D		MA		M_D	
0	water	0.000	k	0.000	k	0.00	ft	0.000	ft-k
1	water	0.062	k	0.031	k	5.50	ft	0.172	ft-k
2	water	0.125	k	0.094	k	4.50	ft	0.421	ft-k
3	water	0.187	k	0.156	k	3.50	ft	0.546	ft-k
4	water	0.250	k	0.218	k	2.50	ft	0.546	ft-k
5	water	0.312	k	0.281	k	1.50	ft	0.421	ft-k
6	water	0.374	k	0.343	k	0.50	ft	0.172	ft-k

STREAM FLOW PRESSURE: 0.076 k 0.348 ft-k

P_{max} = maximum stream pressure = $2P_{avg}$ / 1000 = 0.04 ksf [AASHTO 3.18.1.1.1]

where:

$P_{avg} = KV_{avg}^2$ = 22.4 psf

K = constant for barrier shape = 1.4 for flat face

V_{avg} = average velocity of water = Q/A = 4 fps

q = angle of attack = 45 °

$P = P_{max}\sin\theta$ = 0.03 ksf

Depth from T.O. Wall:

	ID			F_D		MA		M_D	
0			k	0.000	k	0.00	ft	0.000	ft-k
1	stream pressure	0.03	k	0.032	k	5.00	ft	0.158	ft-k
2	stream pressure	0.03	k	0.025	k	4.00	ft	0.101	ft-k
3	stream pressure	0.02	k	0.019	k	3.00	ft	0.057	ft-k
4	stream pressure	0.01	k	0.013	k	2.00	ft	0.025	ft-k
5	stream pressure	0.01	k	0.006	k	1.00	ft	0.006	ft-k
6	stream pressure	0.00	k	0.000	k	0.00	ft	0.000	ft-k

$F_{sliding} = \Sigma F_D$ = **1.199** **k**

$M_{overturning} = \Sigma M_D$ = **2.626** **ft-k**

RESISTING FORCES:

SELF-WEIGHT & VERTICAL LOADS: 3.645 k 10.935 ft-k
Depth from B.O. Excavation:

	ID			F_V		MA		M_R	
0	Wall	0.000	k	0.000	k	3.00	ft	0.000	ft-k
1	Wall	0.405	k	0.405	k	3.00	ft	1.215	ft-k
2	Wall	0.405	k	0.405	k	3.00	ft	1.215	ft-k
3	Wall	0.405	k	0.405	k	3.00	ft	1.215	ft-k
4	Wall	0.810	k	0.810	k	3.00	ft	2.430	ft-k
5	Wall	0.810	k	0.810	k	3.00	ft	2.430	ft-k

6	Wall	0.810	k	0.810	k	3.00	ft	2.430	ft-k

$F_{resisting} = c\Sigma F_V + \Sigma F_R =$	**2.104**	**k**	**>=**	**1.199**	**k**	**FS =**	**1.75**	**OK**
$M_{resisting} = \Sigma M_R =$	**10.935**	**ft-k**	**>=**	**2.626**	**ft-k**	**FS =**	**4.16**	**OK**