Geosyntec consultants

TID	SC_0799	**ACP Segment**	AP-1
Stream Name	Pond Hollow	**MP**	158.91
Survey Date	13-May-2016	**Start Time**	1100 hrs

- Stream possesses a cascade step-pool morphology in a colluvial valley.
- Very steep channel slope with lateral valley confinement from roadway embankment on right bank and debris flow terraces on the left bank.
- Vertical confinement provided by boulder channel materials
- Channel bed is predominantly comprised of large boulders.
    - Boulder sizes typically ranged from 3 to 8 feet.
    - Gravel and cobble occur within the channel between boulders and in depositional areas.
    - Protrusion height of smaller, embedded cobbles ranged from 0.7 to 1-foot.
- Banks composed of mostly rounded to sub-rounded gravel, cobble, and boulders in a fine grained matrix.
- Bankfull channel width is 13.5 feet and bankfull depth is 0.7 feet.
- Culvert upstream of crossing introduces flow from roadway.
- Additional information on stream crossing is available on stream reconnaissance form.

Recommendation:

Evaluate scour depth for pipeline burial depth at stream crossing and maintain same burial elevation between sag bends. Given potential for debris flow, sag bends should be located on the west side Beech Grove Road and at the valley wall approximately 150 feet beyond the left bank. To provide further protection of buried pipeline and stability to stream, replacement of excavated trench materials including large boulders is recommended. To reestablish stability to the stream, replace excavated channel materials to rebuild channel slope to approximately match the pre-construction condition.

Stream Reconnaissance (Based on Thorne, 1998)

Section 1 - Site Description

Date:	13-May-16	Stream Name:	Pond Hollow
Crossing ID:	SC_0799		

Section 2 - Region and Valley Description

Part 1: Watershed

Land Use

- [x] Natural
- [ ] Agricultural
- [ ] Urban
- [ ] Suburban
- [ ] Rural
- [ ] Industrial
- [ ] Cattle grazing

Part 2: River Valley Conditions

Vegetation

- [ ] None
- [ ] Grass
- [ ] Pasture
- [ ] Crops
- [x] Shrubs
- [x] Deciduous Forest/trees
- [ ] Coniferous Forest/trees

Valley Side Features

- [x] None
- [ ] Occasional
- [ ] Frequent

Failure Locations

- [x] None
- [ ] Away from river
- [ ] Along river

Part 3: Floodplain

Floodplain Width

- [ ] None
- [ ] 1 < river widths
- [ ] 1-5 river widths
- [ ] 5-10 river widths
- [x] > 10 river widths

Land Use

- [x] Natural
- [ ] Agricultural
- [ ] Urban
- [ ] Suburban
- [ ] Rural
- [ ] Industrial
- [ ] Mining
- [ ] Cattle grazing

Vegetation

- [ ] None
- [ ] Grass
- [ ] Pasture
- [ ] Orchards
- [ ] Crops
- [x] Shrubs
- [x] Deciduous Forest/trees
- [ ] Coniferous Forest/trees

Riparian Buffer Strip

- [ ] None
- [ ] < 1 river width
- [ ] 1-5 river widths
- [x] > 5 river widths

Part 4: Vertical Confinement

Terraces

- [x] None
- [ ] Left bank
- [ ] Right bank

Levees

- [x] None
- [ ] Natural
- [ ] Constructed

Levee Location

- [ ] Along channel bank
- [ ] Set back < 1 river width
- [ ] Set back > 1 river width

Part 5: Lateral Relation of Channel to Valley

Planform

- [ ] Straight
- [x] Meandering
- [ ] Braided
- [ ] Anastomosed
- [ ] Engineered

Meander Characteristics

- [x] Mild bends
- [ ] Moderate bends
- [ ] Tight bends

Section 3 - Channel Description (select all that apply)

Part 6: Channel Description (select all that apply)

Bed Controls

- [ ] None
- [ ] Occasional
- [ ] Frequent
- [x] Confined

Control Types

- [ ] None
- [ ] Bedrock
- [x] Boulders

Width Controls

- [ ] None
- [ ] Occasional
- [ ] Frequent
- [x] Confined

Control Types

- [ ] None
- [ ] Bedrock
- [x] Boulders

Other

- [ ] Debris
- [ ] Mining
- [ ] Reservoir
- [ ] Knickpoint

Flow Habit

- [x] Perennial
- [ ] Flashy perennial
- [ ] Intermittent
- [ ] Ephemeral

Channel Width: 13.5'

M-B Classification

- [X] Cascade or step-pool
- [ ] Plane, pool-riffle, dune-ripple
- [ ] Braided

Part 7: Bed Sediment Description (select all that apply)

Bed Material

- [ ] Clay
- [ ] Silt
- [ ] Sand
- [ ] Gravel
- [x] Cobbles
- [x] Boulders
- [ ] Bedrock

Bar Types

- [x] None
- [ ] Alternate bars
- [ ] Point bars
- [ ] Mid-channel bars
- [ ] Diagonal bars
- [ ] Irregular/combination
- [ ] Braided

Bar Material

- [ ] Silt
- [ ] Sand
- [ ] Gravel
- [ ] Cobbles

Bar Vegetation

- [ ] None
- [ ] Grasses
- [ ] Reeds/shrubs
- [ ] Trees

Bar Width

- [ ] None
- [ ] Narrow
- [ ] Moderate
- [ ] Wide

Percent sand in bed = _____ %

Section 4 - Bank Survey (select all that apply)

Bank Characteristic	***Left Bank***	***Right Bank***
Bank Material	[ ] Clay [ ] Silt [ ] Gravel [x] Cobbles [x] Boulders [ ] Bedrock	[ ] Clay [ ] Silt [ ] Gravel [x] Cobbles [x] Boulders [ ] Bedrock
Layer Material	[x] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders	[x] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders
Bank Height	~5'	~20'
Bank Slope	[ ] Steep [ ] Moderate [x] Shallow	[x] Steep [ ] Moderate [ ] Shallow
Bank Vegetation	[ ] None [ ] Grasses/annuals [x] Reeds/shrubs [ ] Trees: Falling trees? [ ] Y [x] N Tree density [ ] sparse [x] dense Tree health [x] good [ ] poor tree ages [x] young [x] mature [ ] old tree diversity [x] Y [ ] N	[ ] None [ ] Grasses/annuals [X] Reeds/shrubs [ ] Trees: Falling trees? [ ] Y [x] N Tree density [ ] sparse [x] dense Tree health [x] good [ ] poor tree ages [x] young [x] mature [ ] old tree diversity [x] Y [ ] N
Bank Erosion and Failure Location	location of erosion [ ] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [x] general type of erosion [x] fluvial [ ] geotechnical	location of erosion [ ] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [x] general type of erosion [x] fluvial [ ] geotechnical

PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0799, Pond Hollow at MP 158.91 (AP-1)

Photograph 1	
Date: 13 May 2016	
Direction: looking upstream	
Description: Step pools with large boulders and well established riparian buffer.	

PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0799, Pond Hollow at MP 158.91 (AP-1)

Photograph 2	
Date: 13 May 2016	
Direction: looking downstream	
Description: large boulder and cobble bed with little signs of clear under scour at channel spanning log indicating relatively stable bed.	

PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0799, Pond Hollow at MP 158.91 (AP-1)

Photograph 3	
Date: 13 May 2016	
Direction: looking downstream	
Description: well established riparian buffer and valley walls providing lateral confinement. Vertical confinement provided by channel bed materials. Some sands and gravels in depositional pools.	

PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0799, Pond Hollow at MP 158.91 (AP-1)

Photograph 4	
Date: 13 May 2016	
Direction: looking upstream	
Description: bed characteristics and very large boulders should be maintained.	

PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0799, Pond Hollow at MP 158.91 (AP-1)

Photograph 5 (IMG_0757)	
Date: 13-May-2016	
Direction: Upstream	
Description: Large boulders (2 to 5 feet at smallest dimension) on cascade stream bed. Right bank is embankment slope to Beech Grove Rd. – State Highway 664.	

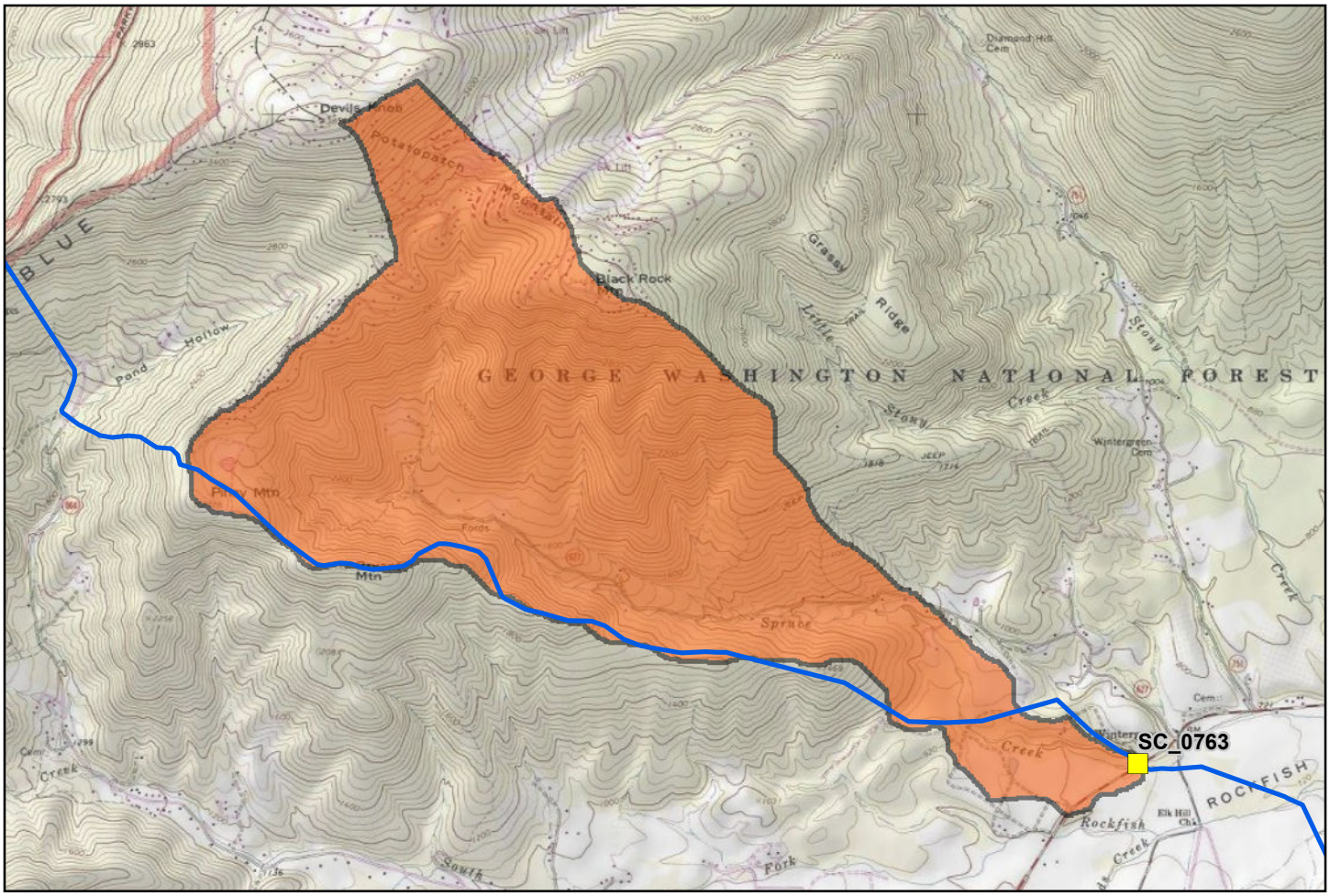
PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0799, Pond Hollow at MP 158.91 (AP-1)

Photograph 6 (IMG_0758)	
Date: 13-May-2016	
Direction: Downstream	
Description: Notice dense deciduous forest.	



TID	Unique ID	ACP Branch	Mile Post	State	County
SC_0763	nhd_va_a_004	AP-1	163.13	Virginia	Nelson

Attribute	Value
Stream Name	Spruce Creek
Physiographic Province[1]	Blue Ridge
Drainage Area (square miles)[2]	2.834
Flow Regime	Perennial
Measured Bank Full Width (ft)[3]	26.4
Slope At Crossing Over 200ft Long Reach (%)[4]	1.764
Proposed Construction Method[5]	1) Dam and Pump 2) Flume

Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636
- Watershed Boundary

Drainage Area Map

1:50,000

0 1,125 2,250 4,500 Feet

0 1 Miles

N

Document Information:

Document No:
DOM_EC_HYD_MA_SER001_SC_0763

Revision	Date	Created By	Approved by
0	08-01-2016	BP	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

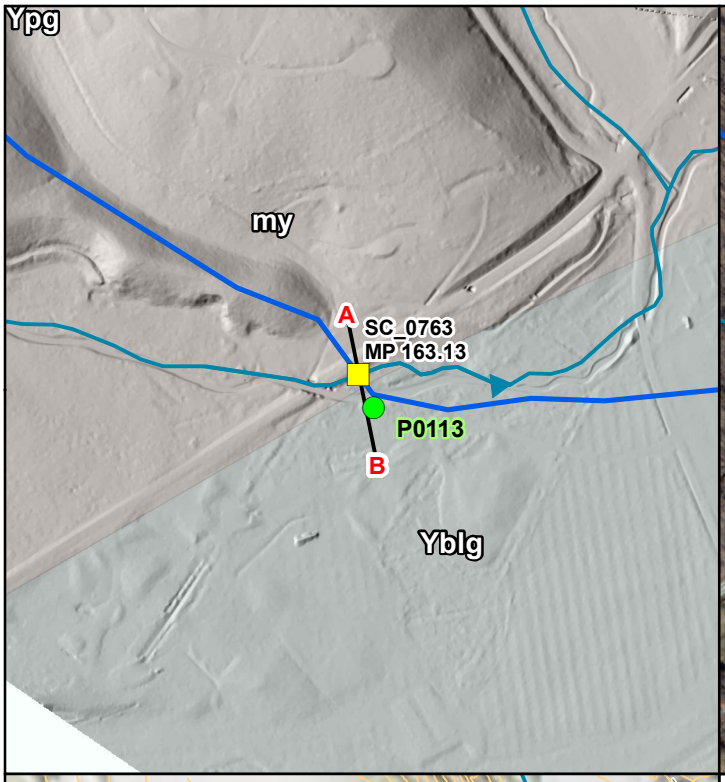
Notes:

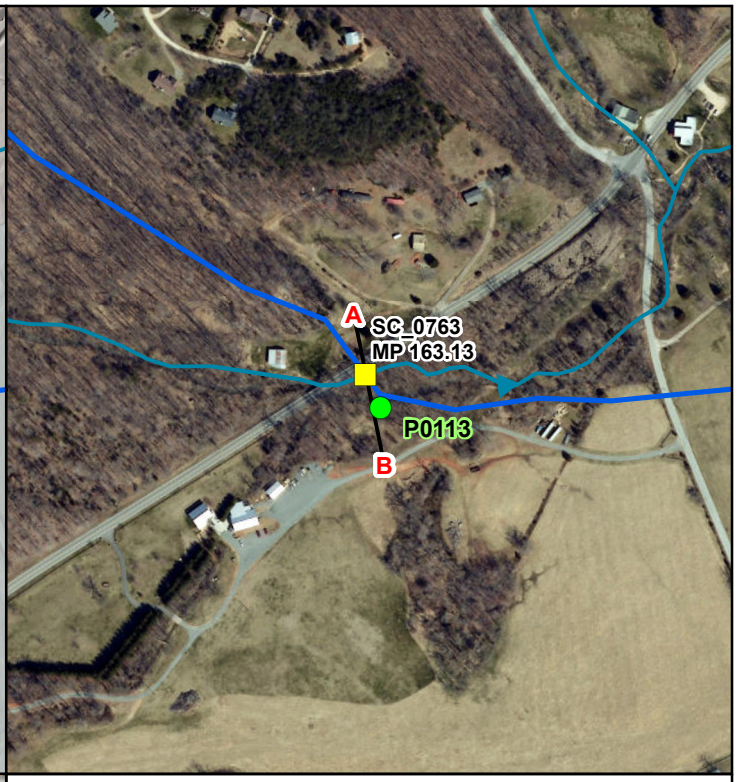
1) After Fenneman (1946)
2) Calculated using USGS 1:24,000 topographic maps and ArcGIS interface.
3) Measured during stream reconnaissance.
4) Calculated using one of four methods described in Section 3.2.3.1.
5) The current alignment centerline and mileposts provided by Dominion/GAI.

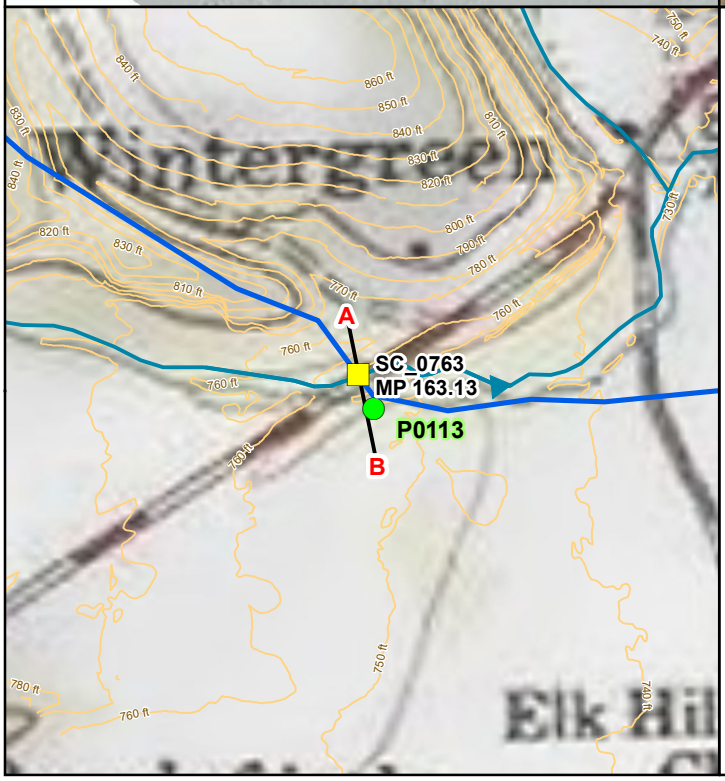
Dominion

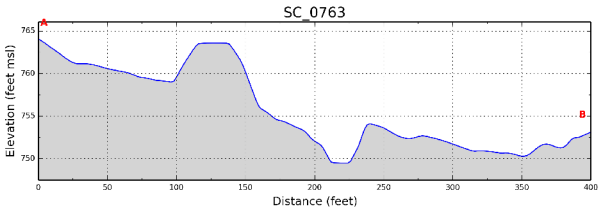
Geosyntec consultants

TESSELLATIONS









Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- Field Observation Locations
- Profile Line (400ft)
- Stream with Flow Direction
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636

Stream Crossing Plan View and Profile

Location ID: nhd_va_a_004

TID_SC: SC_0763

Stream Name: Spruce Creek

1:6,000

0 125 250 500 Feet

0 0.025 0.05 0.1 Miles

N

Document Information:

Document No:
DOM_EC_CRO_MA_001_SC_0763

Revision	Date	Created By	Approved by
0	07-28-2016	CR	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

Notes:

1) The current alignment centerline provided by Dominion/GAI
2) Projection: UTM 17N feet, NAD 83
3) The vertical exaggeration on the profile graph is 4:1
4) Hillshade (azimuth: 280) created from 2 foot lidar data provided by Dominion/GAI
5) In areas that did not have lidar data, hillshade was created from 1/3 arc-second (10m) NED

Dominion

Geosyntec consultants

TESSELLATIONS

Geosyntec consultants

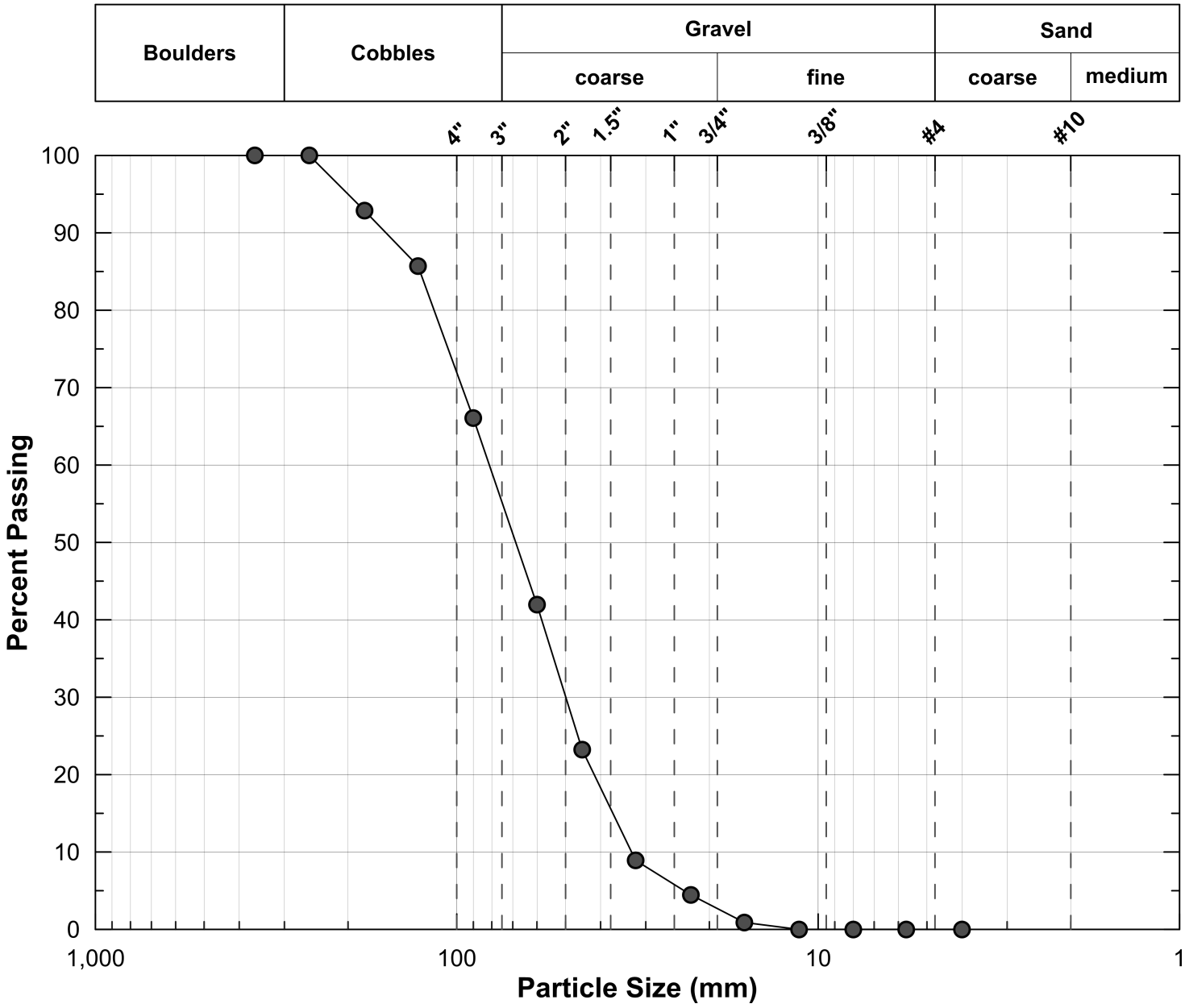
TID	SC_0763	**ACP Segment**	AP-1
Stream Name	Spruce Creek	**MP**	163.13
Survey Date	27-Sep-2016	**Start Time**	1240 hrs

- Stream surveyed approximately 200-ft downstream of bridge crossing at State Rd. 151.
- Riffle-pool morphology.
- BFW = 26.4 feet, BFD = 1.5 ft, BFD (maximum) = 1.8 ft (left bank).
- Stream observed at a straight reach.
- Stream bed comprised of cobbles and some boulders.
- Wolman pebble count was conducted.
- Right and left bank high terraces are approximately 4.5 and 5 ft, respectively, with an intermediate terrace on the left bank at 3.2 ft.
- 1-ft high headcut about 100-ft upstream of pipeline crossing.

Recommendation:

Given that crossing is located downstream of bridge crossing that provides lateral and vertical control is provided by the large particle sized. Conduct scour assessment to assess pipeline burial depth and place sag bends one stream width on each side from top of terrace.

Wolman Pebble Count at SC_0763



Geosyntec consultants

engineers | scientists | innovators

Wolman Pebble Count

Phase 2 Hydrotechnical Characterization Program
Virginia and West Virginia
Atlantic Coast Pipeline
February 2017 Dominion Transmission Inc.

Stream Reconnaissance (Based on Thorne, 1998)

Section 1 - Site Description

Date:	27-Sep-16	Stream Name:	Spruce Creek
Crossing ID:	SC_0763		

Section 2 - Region and Valley Description

Part 1: Watershed

Land Use

- [X] Natural
- [ ] Agricultural
- [ ] Urban
- [ ] Suburban
- [ ] Rural
- [ ] Industrial
- [ ] Cattle grazing

Part 2: River Valley Conditions

Vegetation

- [ ] None
- [ ] Grass
- [ ] Pasture
- [ ] Crops
- [X] Shrubs
- [X] Deciduous Forest/trees
- [ ] Coniferous Forest/trees

Valley Side Features

- [X] None
- [ ] Occasional
- [ ] Frequent

Failure Locations

- [ ] None
- [ ] Away from river
- [ ] Along river

Part 3: Floodplain

Floodplain Width

- [ ] None
- [ ] 1 < river widths
- [X] 1-5 river widths
- [ ] 5-10 river widths
- [ ] > 10 river widths

Land Use

- [X] Natural
- [ ] Agricultural
- [ ] Urban
- [ ] Suburban
- [ ] Rural
- [ ] Industrial
- [ ] Mining
- [ ] Cattle grazing

Vegetation

- [ ] None
- [ ] Grass
- [ ] Pasture
- [ ] Orchards
- [ ] Crops
- [X] Shrubs
- [X] Deciduous Forest/trees
- [ ] Coniferous Forest/trees

Riparian Buffer Strip

- [ ] None
- [ ] < 1 river width
- [X] 1-5 river widths
- [ ] > 5 river widths

Part 4: Vertical Confinement

Terraces

- [ ] None
- [X] Left bank
- [ ] Right bank

Levees

- [X] None
- [ ] Natural
- [ ] Constructed

Levee Location

- [ ] Along channel bank
- [ ] Set back < 1 river width
- [ ] Set back > 1 river width

Part 5: Lateral Relation of Channel to Valley

Planform

- [X] Straight
- [ ] Meandering
- [ ] Braided
- [ ] Anastomosed
- [ ] Engineered

Meander Characteristics

- [ ] Mild bends
- [ ] Moderate bends
- [ ] Tight bends

Section 3 - Channel Description (select all that apply)

Part 6: Channel Description (select all that apply)

Bed Controls

- [ ] None
- [ ] Occasional
- [X] Frequent
- [ ] Confined

Control Types

- [ ] None
- [ ] Bedrock
- [X] Boulders
- [X] Gravel Armor

Width Controls

- [ ] None
- [ ] Occasional
- [ ] Frequent
- [X] Confined

Control Types

- [ ] None
- [ ] Bedrock
- [ ] Boulders
- [X] Bridge abutments

Other

- [ ] Debris
- [ ] Mining
- [ ] Reservoir
- [ ] Knickpoint

Flow Habit

- [X] Perennial
- [ ] Flashy perennial
- [ ] Intermittent
- [ ] Ephemeral

Channel Width: 26.4'

M-B Classification

- [ ] Cascade or step-pool
- [ ] Plane, pool-riffle, dune-ripple
- [ ] Braided

Part 7: Bed Sediment Description (select all that apply)

Bed Material	***Bar Types***	***Bar Material***	***Bar Vegetation***	***Bar Width***
[ ] Clay	[X] None	[ ] Silt	[ ] None	[ ] None
[ ] Silt	[ ] Alternate bars	[ ] Sand	[ ] Grasses	[ ] Narrow
[ ] Sand	[ ] Point bars	[ ] Gravel	[ ] Reeds/shrubs	[ ] Moderate
[X] Gravel	[ ] Mid-channel bars	[ ] Cobbles	[ ] Trees	[ ] Wide
[X] Cobbles	[ ] Diagonal bars			
[ ] Boulders	[ ] Irregular/combination			
[ ] Bedrock	[ ] Braided			

Percent sand in bed = <5 %

Section 4 - Bank Survey (select all that apply)

Bank Characteristic	***Left Bank***	***Right Bank***
Bank Material	[ ] Clay [X] Silt SAND [ ] Gravel [ ] Cobbles [ ] Boulders [ ] Bedrock	[ ] Clay [ ] Silt SAND [ ] Gravel [ ] Cobbles [ ] Boulders [ ] Bedrock
Layer Material	[X] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders	[X] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders
Bank Height		
Bank Slope	[ ] Steep [ ] Moderate [X] Shallow	[X] Steep [ ] Moderate [ ] Shallow
Bank Vegetation	[ ] None [ ] Grasses/annuals [X] Reeds/shrubs [X] Trees: Falling trees? [X] Y [ ] N Tree density [ ] sparse [X] dense Tree health [X] good [ ] poor tree ages [X] young [X] mature [ ] old tree diversity [X] Y [ ] N	[ ] None [ ] Grasses/annuals [X] Reeds/shrubs [X] Trees: Falling trees? [X] Y [ ] N Tree density [ ] sparse [X] dense Tree health [X] good [ ] poor tree ages [X] young [X] mature [ ] old tree diversity [X] Y [ ] N
Bank Erosion and Failure Location	location of erosion [ ] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [X] general type of erosion [X] fluvial [ ] geotechnical	location of erosion [ ] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [X] general type of erosion [X] fluvial [ ] geotechnical

GEOSYNTEC CONSULTANTS

Photographic Record

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0763, Spruce Creek at MP 163.13 (AP-1)

Photograph 1 (IMG_1136.jpg) Date: 27 September 2016 Direction: Downstream Description: View of cobble-lined stream channel with dense vegetation mostly comprising shrubs and young deciduous trees.	
Photograph 2 (IMG_3959.jpg) Date: 27 September 2016 Direction: Upstream Description: Stream bankfull depth (maximum) is approximately 1.8 ft (left bank). Right and left bank high terraces are approximately 4.5 and 5 ft, respectively, with an intermediate terrace on the left bank at 3.2 ft.	

GEOSYNTEC CONSULTANTS

Photographic Record

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0763, Spruce Creek at MP 163.13 (AP-1)

Photograph 3
(IMG_1140.jpg)

Date: 27 September 2016

Direction: Towards right bank

Description: View of right bank terrace showing cobble-sized particles in a fine-grained matrix at toe of bank with fine-grained bank material above.

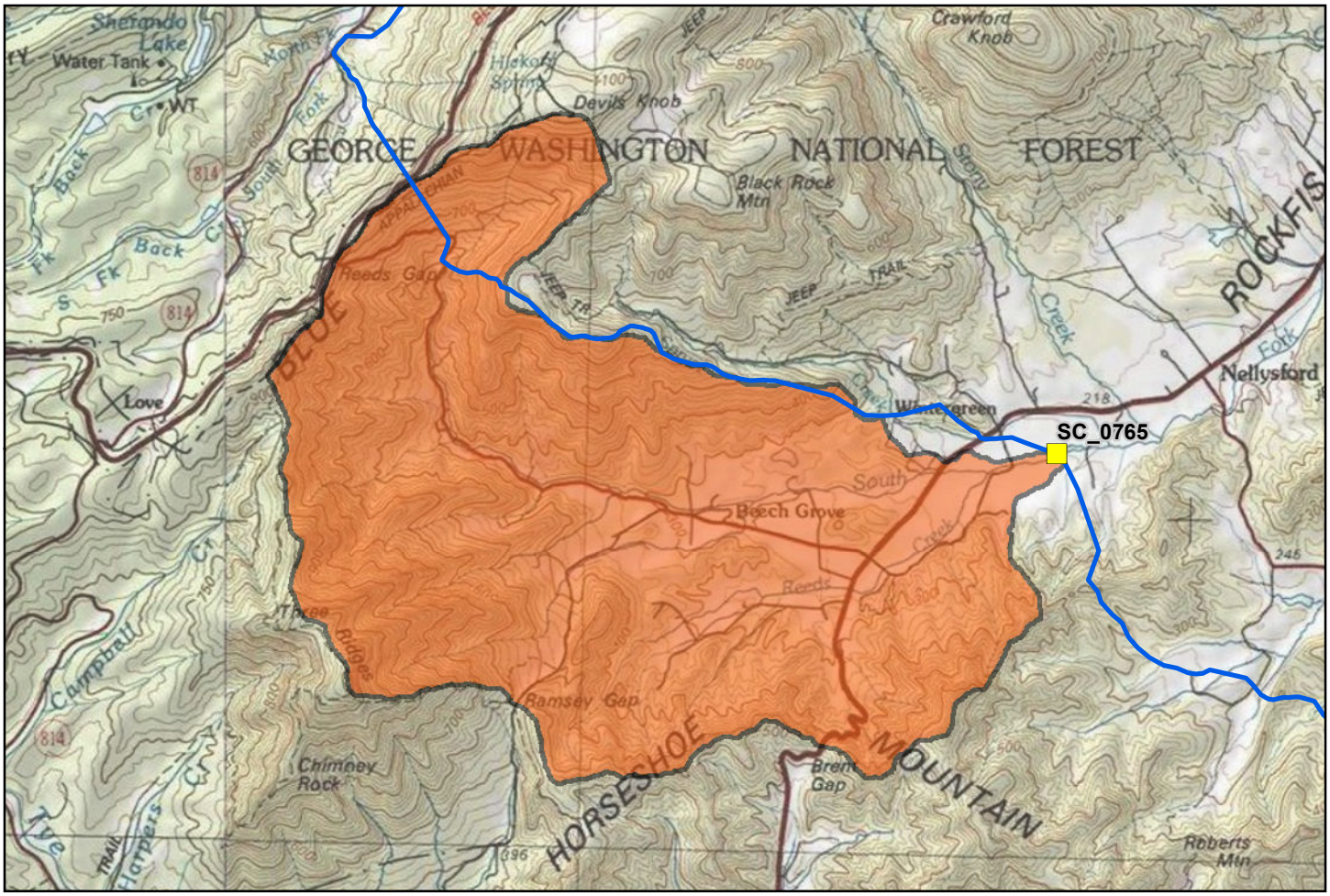
GEOSYNTEC CONSULTANTS

Photographic Record

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0763, Spruce Creek at MP 163.13 (AP-1)

Photograph 4 (IMG_3965.jpg)	
Date: 27 September 2016	
Direction: Upstream	
Description: State Rd. 151 bridge located about 200 ft upstream of crossing that provides lateral confinement. Clearance is about 7 ft.	



TID	Unique ID	ACP Branch	Mile Post	State	County
SC_0765	nhd_va_379	AP-1	163.71	Virginia	Nelson

Attribute	Value
Stream Name	South Fork Rockfish River
Physiographic Province[1]	Blue Ridge
Drainage Area (square miles)[2]	14.836
Flow Regime	Perennial
Measured Bank Full Width (ft)[3]	25.7
Slope At Crossing Over 200ft Long Reach (%)[4]	0.828
Proposed Construction Method[5]	1) Flume 2) Dam and Pump

Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636
- Watershed Boundary

Drainage Area Map

1:100,000

0 2,250 4,500 9,000 Feet

0 2 Miles

N

Document Information:

Document No:
DOM_EC_HYD_MA_SER001_SC_0765

Revision	Date	Created By	Approved by
0	08-01-2016	BP	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

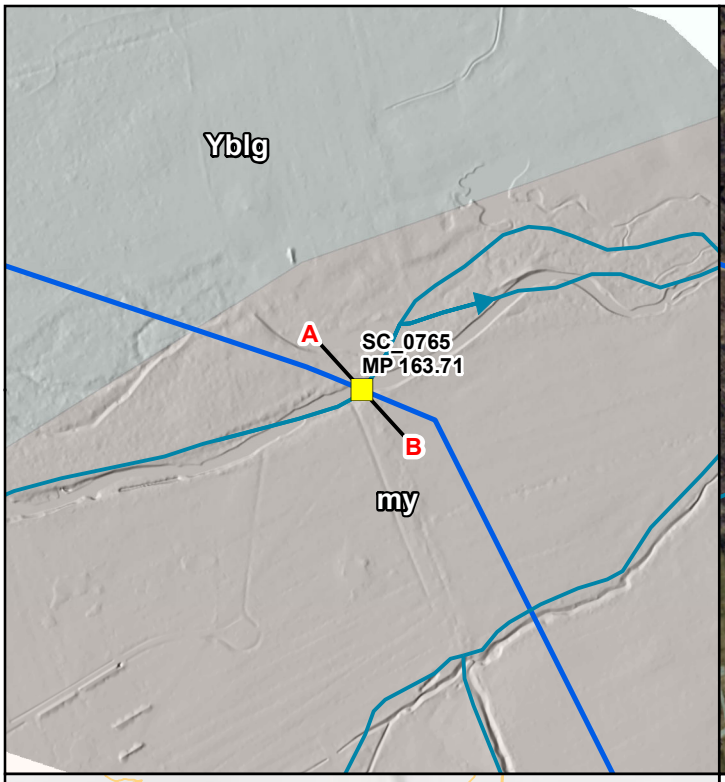
Notes:

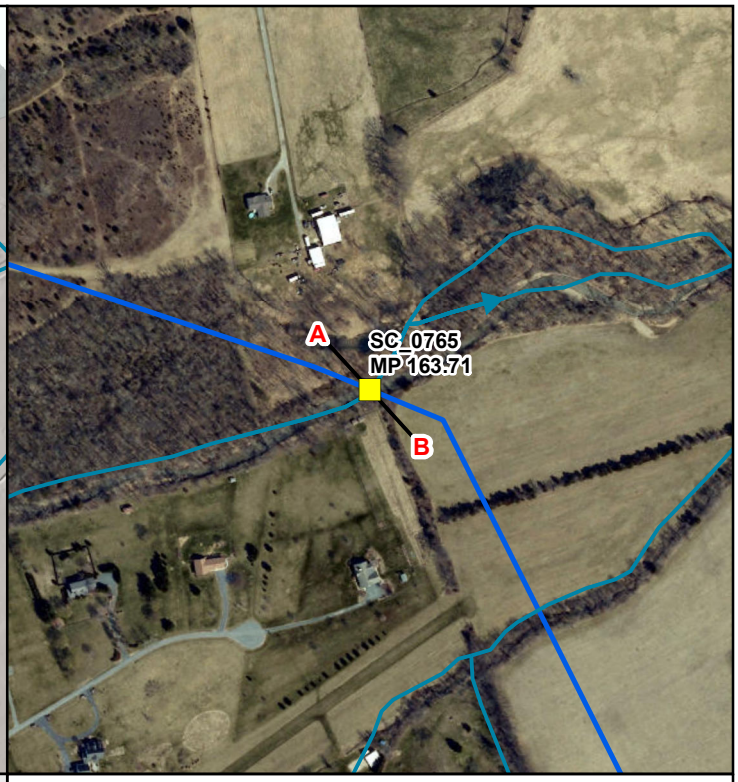
1) After Fenneman (1946)
2) Calculated using USGS 1:24,000 topographic maps and ArcGIS interface.
3) Measured during stream reconnaissance.
4) Calculated using one of four methods described in Section 3.2.3.1.
5) The current alignment centerline and mileposts provided by Dominion/GAI.

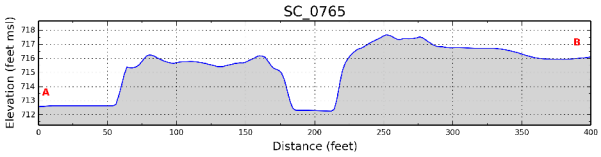
Dominion

Geosyntec consultants

TESSELLATIONS







Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- Field Observation Locations
- Profile Line (400ft)
- Stream with Flow Direction
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636

Stream Crossing Plan View and Profile

Location ID: nhd_va_379

TID_SC: SC_0765

Stream Name: South Fork Rockfish River

1:6,000

0 125 250 500 Feet

0 0.025 0.05 0.1 Miles

N

Document Information:

Document No:
DOM_EC_CRO_MA_001_SC_0765

Revision	Date	Created By	Approved by
0	07-28-2016	CR	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

Notes:

1) The current alignment centerline provided by Dominion/GAI
2) Projection: UTM 17N feet, NAD 83
3) The vertical exaggeration on the profile graph is 4:1
4) Hillshade (azimuth: 280) created from 2 foot lidar data provided by Dominion/GAI
5) In areas that did not have lidar data, hillshade was created from 1/3 arc-second (10m) NED

Dominion

Geosyntec consultants

TESSELLATIONS

Geosyntec consultants

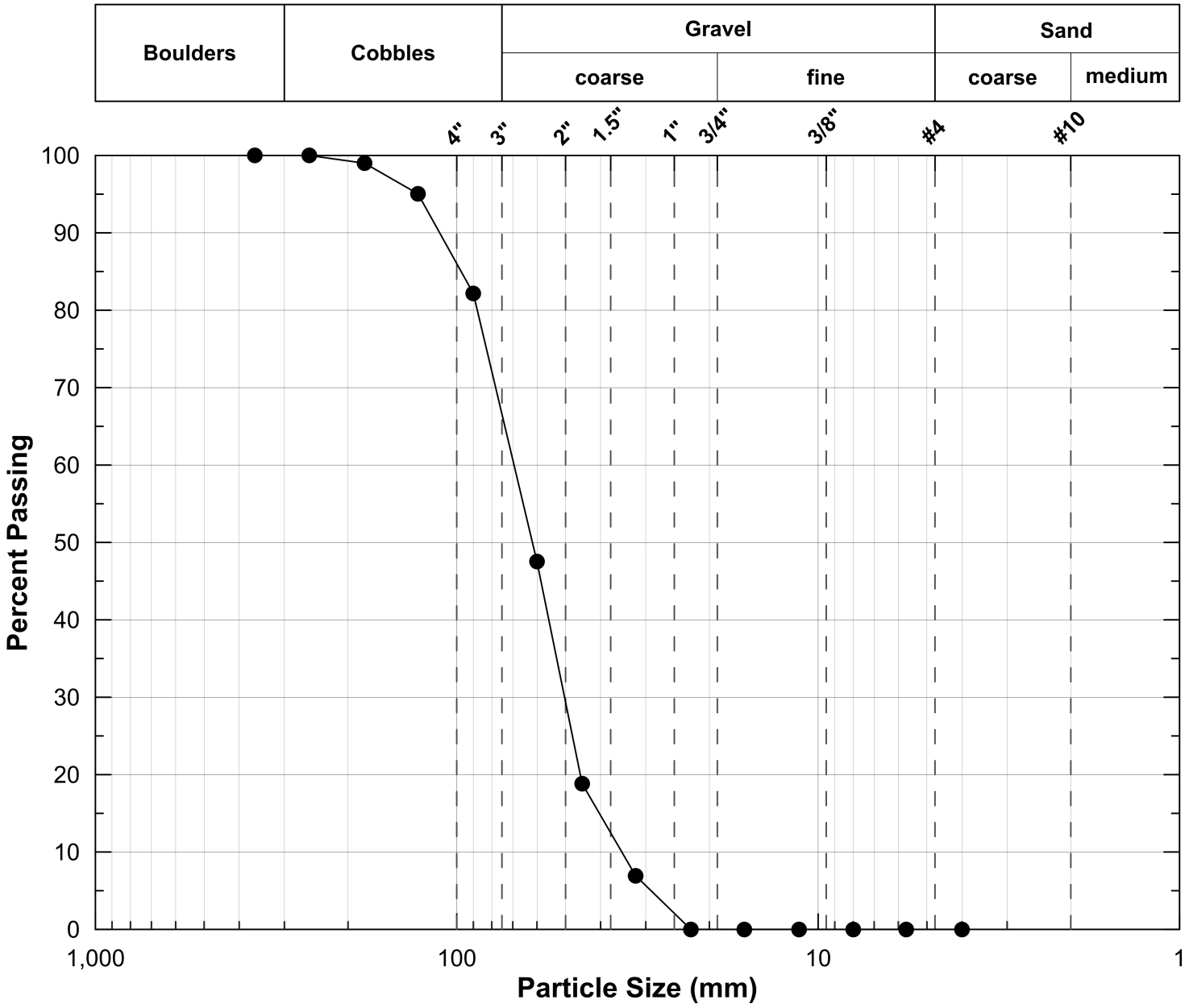
TID	SC_0765	**ACP Segment**	AP-1
Stream Name	South Fork Rockfish River	**MP**	163.71
Survey Date	13-May-2016	**Start Time**	1155 hrs

- River possesses a riffle-pool morphology with mild bends, though reach evaluated is largely straight in a terraced alluvial valley.
- River crossing occurs at a riffle and contains lateral bars in the vicinity of the crossing.
- Typical fluvial erosion along banks observed. Bank height of 2.5 feet observed at crossing. Upstream of crossing top of bank (terrace) heights on outside of bend approximately 8 feet.
- Channel bed comprised predominantly of cobble and gravel.
    - Wolman pebble count conducted; D_{50} is 62 mm (coarse gravel).
- Riverbanks composed of silty sand and gravel.
- Well connected floodplain on both left and right banks that is largely agricultural with some homes near river.
- Deciduous riparian buffer at the crossing location 12 channel widths wide on left bank and one channel width wide on the right bank.
- Bankfull channel width is 25.7 feet and bankfull depth is 1.2 feet.
- Additional information on stream crossing is available on stream reconnaissance form.

Recommendation:

Evaluate scour depth for pipeline burial depth. Lateral migration hazard is moderate given fluvial erosion patterns, especially downstream of crossing. Recommend placing sag bends a least five river widths from left and right top of banks and maintain pipeline crown elevation between sag bends.

Wolman Pebble Count at SC_0765



Geosyntec consultants

engineers | scientists | innovators

Wolman Pebble Count

Phase 2 Hydrotechnical Characterization Program
Virginia and West Virginia
Atlantic Coast Pipeline
February 2017 Dominion Transmission Inc.

Stream Reconnaissance (Based on Thorne, 1998)

Section 1 - Site Description

Date:	13-May-16	Stream Name:	South Fork Rockfish River
Crossing ID:	SC_0765		

Section 2 - Region and Valley Description

Part 1: Watershed

Land Use

- [x] Natural
- [x] Agricultural
- [ ] Urban
- [ ] Suburban
- [ ] Rural
- [ ] Industrial
- [ ] Cattle grazing

Part 2: River Valley Conditions

Vegetation

- [ ] None
- [ ] Grass
- [x] Pasture
- [x] Crops
- [ ] Shrubs
- [x] Deciduous Forest/trees
- [ ] Coniferous Forest/trees

Valley Side Features

- [x] None
- [ ] Occasional
- [ ] Frequent

Failure Locations

- [ ] None
- [ ] Away from river
- [ ] Along river

Part 3: Floodplain

Floodplain Width

- [ ] None
- [ ] 1 < river widths
- [ ] 1-5 river widths
- [ ] 5-10 river widths
- [x] > 10 river widths

Land Use

- [ ] Natural
- [x] Agricultural
- [ ] Urban
- [ ] Suburban
- [ ] Rural
- [ ] Industrial
- [ ] Mining
- [x] Cattle grazing

Vegetation

- [ ] None
- [x] Grass
- [x] Pasture
- [ ] Orchards
- [ ] Crops
- [ ] Shrubs
- [x] Deciduous Forest/trees
- [ ] Coniferous Forest/trees

Riparian Buffer Strip

- [ ] None
- [x] < 1 river width RB
- [ ] 1-5 river widths
- [x] > 5 river widths LB

Part 4: Vertical Confinement

Terraces

- [x] None
- [ ] Left bank
- [ ] Right bank

Levees

- [x] None
- [ ] Natural
- [ ] Constructed

Levee Location

- [ ] Along channel bank
- [ ] Set back < 1 river width
- [ ] Set back > 1 river width

Part 5: Lateral Relation of Channel to Valley

Planform

- [x] Straight
- [ ] Meandering
- [ ] Braided
- [ ] Anastomosed
- [ ] Engineered

Meander Characteristics

- [x] Mild bends
- [ ] Moderate bends
- [ ] Tight bends

Section 3 - Channel Description (select all that apply)

Part 6: Channel Description (select all that apply)

Bed Controls

- [x] None
- [ ] Occasional
- [ ] Frequent
- [ ] Confined

Control Types

- [x] None
- [ ] Bedrock
- [ ] Boulders

Width Controls

- [x] None
- [ ] Occasional
- [ ] Frequent
- [ ] Confined

Control Types

- [x] None
- [ ] Bedrock
- [ ] Boulders

Other

- [ ] Debris
- [ ] Mining
- [ ] Reservoir
- [ ] Knickpoint

Flow Habit

- [x] Perennial
- [ ] Flashy perennial
- [ ] Intermittent
- [ ] Ephemeral

Channel Width: 25.7'

M-B Classification

- [ ] Cascade or step-pool
- [x] Plane, pool-riffle, dune-ripple
- [ ] Braided

Part 7: Bed Sediment Description (select all that apply)

Bed Material	*Bar Types*	*Bar Material*	*Bar Vegetation*	*Bar Width*
[ ] Clay	[x] None	[ ] Silt	[ ] None	[ ] None
[ ] Silt	[ ] Alternate bars	[ ] Sand	[ ] Grasses	[ ] Narrow
[x] Sand	[ ] Point bars	[ ] Gravel	[ ] Reeds/shrubs	[ ] Moderate
[ ] Gravel	[ ] Mid-channel bars	[ ] Cobbles	[ ] Trees	[ ] Wide
[x] Cobbles	[ ] Diagonal bars			
[ ] Boulders	[ ] Irregular/combination			
[ ] Bedrock	[ ] Braided			

Percent sand in bed = <10 %

Section 4 - Bank Survey (select all that apply)

Bank Characteristic	*Left Bank*	*Right Bank*
Bank Material	[ ] Clay [x] Silt [x] Gravel [ ] Cobbles [ ] Boulders [ ] Bedrock	[ ] Clay [x] Silt [x] Gravel [ ] Cobbles [ ] Boulders [ ] Bedrock
Layer Material	[x] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders	[x] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders
Bank Height	2.4'	
Bank Slope	[x] Steep [ ] Moderate [ ] Shallow	[ ] Steep [ ] Moderate [x] Shallow
Bank Vegetation	[ ] None [ ] Grasses/annuals [x] Reeds/shrubs [ ] Trees: Falling trees? [ ] Y [x] N Tree density [ ] sparse [x] dense Tree health [x] good [ ] poor tree ages [x] young [x] mature [ ] old tree diversity [x] Y [ ] N	[ ] None [x] Grasses/annuals [ ] Reeds/shrubs [ ] Trees: Falling trees? [ ] Y [x] N Tree density [x] sparse [ ] dense Tree health [x] good [ ] poor tree ages [x] young [x] mature [ ] old tree diversity [x] Y [ ] N
Bank Erosion and Failure Location	location of erosion [ ] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [x] general type of erosion [x] fluvial [ ] geotechnical	location of erosion [ ] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [x] general type of erosion [x] fluvial [ ] geotechnical

PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0765, South Fork Rockfish River at MP 163.71 (AP-1)

Photograph 1	
Date: 13 May 2016	
Direction: looking downstream	
Description: Riffle section with relatively narrow riparian buffer and shallow right bank, well connected floodplain.	

PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0765, South Fork Rockfish River at MP 163.71 (AP-1)

Photograph 2	
Date: 13 May 2016	
Direction: looking upstream	
Description: thicker riparian buffer and higher banks off left bank with upstream eroded banks visible in the distance.	

PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0765, South Fork Rockfish River at MP 163.71 (AP-1)

Photograph 3 (IMG_0763)	
Date: 13-May-2016	
Direction: Downstream	
Description: Left bank exhibits wider riparian buffer than is between 5 and 10 river widths, whereas right bank riparian buffer is only about 1 river width. Rounded to subrounded cobbles on stream bed.	

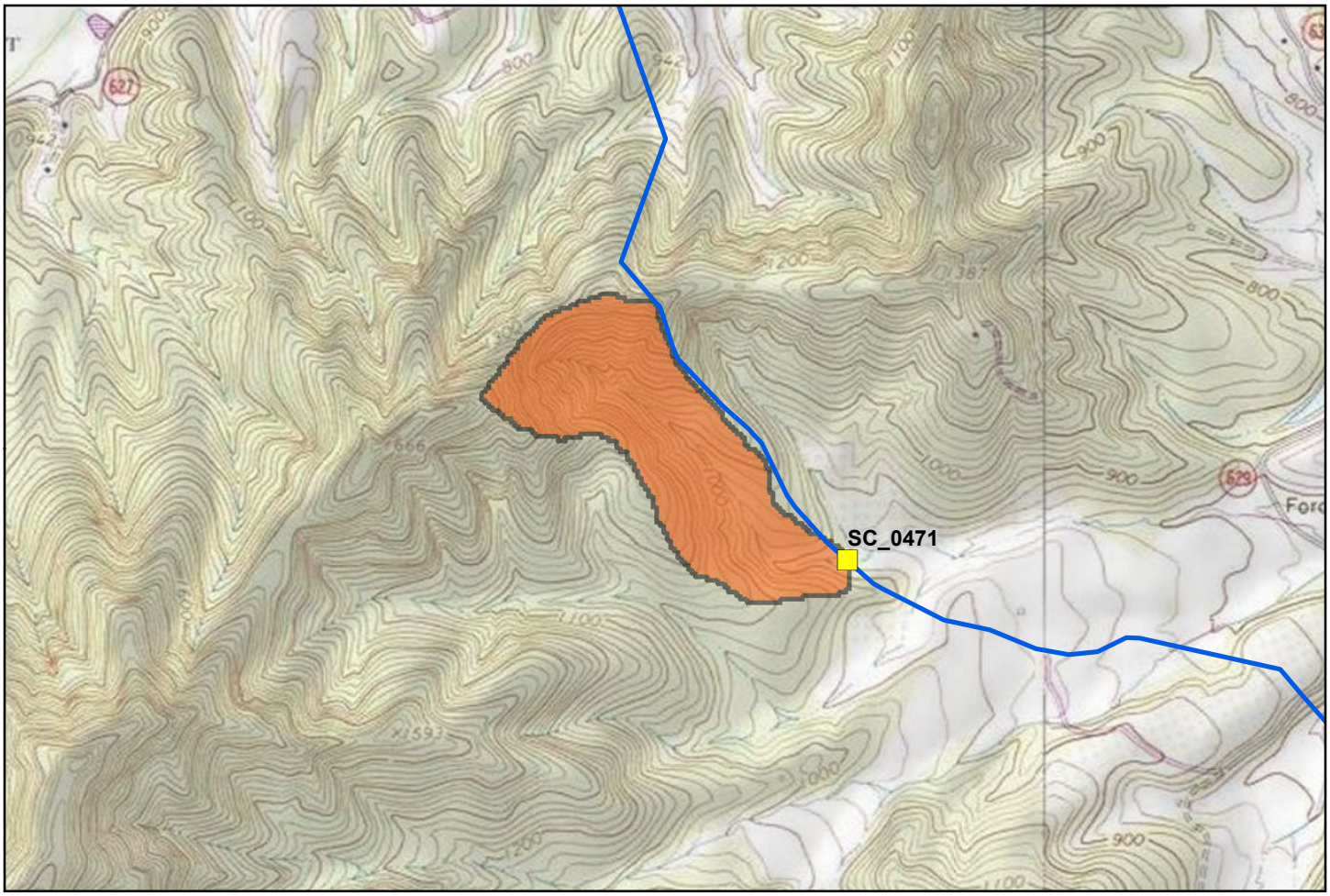
PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0765, South Fork Rockfish River at MP 163.71 (AP-1)

Photograph 4 (IMG_0764)	
Date: 13-May-2016	
Direction: Upstream	
Description: Stream well connected to flood plain with relatively low bank height (2 ft or less at full bank)	



TID	Unique ID	ACP Branch	Mile Post	State	County
SC_0471	snec052	AP-1	165.35	Virginia	Nelson

Attribute	Value
Stream Name	UNT to Rockfish River
Physiographic Province[1]	Blue Ridge
Drainage Area (square miles)[2]	0.132
Flow Regime	Perennial
Measured Bank Full Width (ft)[3]	4.3
Slope At Crossing Over 200ft Long Reach (%)[4]	3.842
Proposed Construction Method[5]	1) Dam and Pump 2) Flume

Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636
- Watershed Boundary

Drainage Area Map

1:24,000

0 500 1,000 2,000 Feet

0 0.5 Miles

N

Document Information:

Document No:
DOM_EC_HYD_MA_SER001_SC_0471

Revision	Date	Created By	Approved by
0	08-01-2016	BP	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

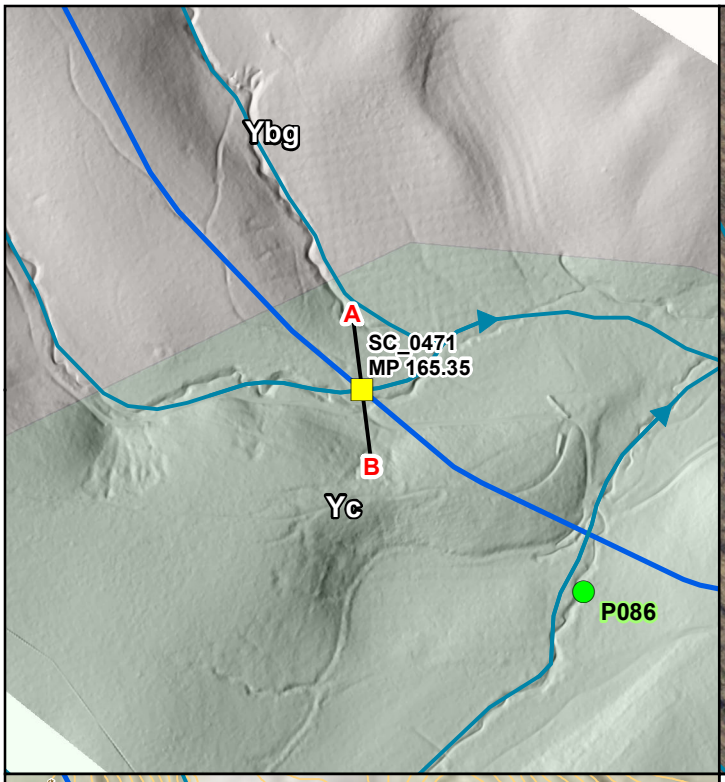
Notes:

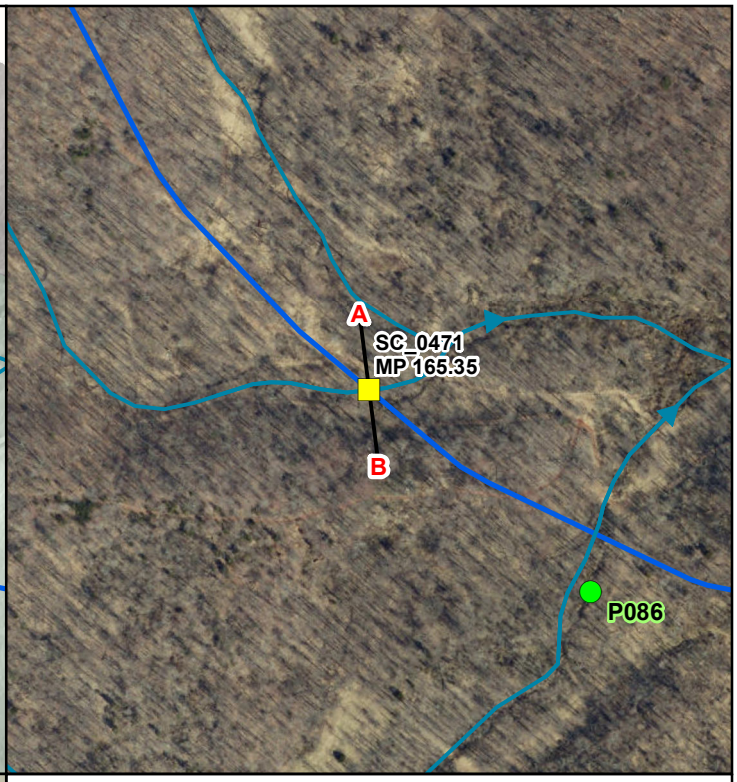
1) After Fenneman (1946)
2) Calculated using USGS 1:24,000 topographic maps and ArcGIS interface.
3) Measured during stream reconnaissance.
4) Calculated using one of four methods described in Section 3.2.3.1.
5) The current alignment centerline and mileposts provided by Dominion/GAI.

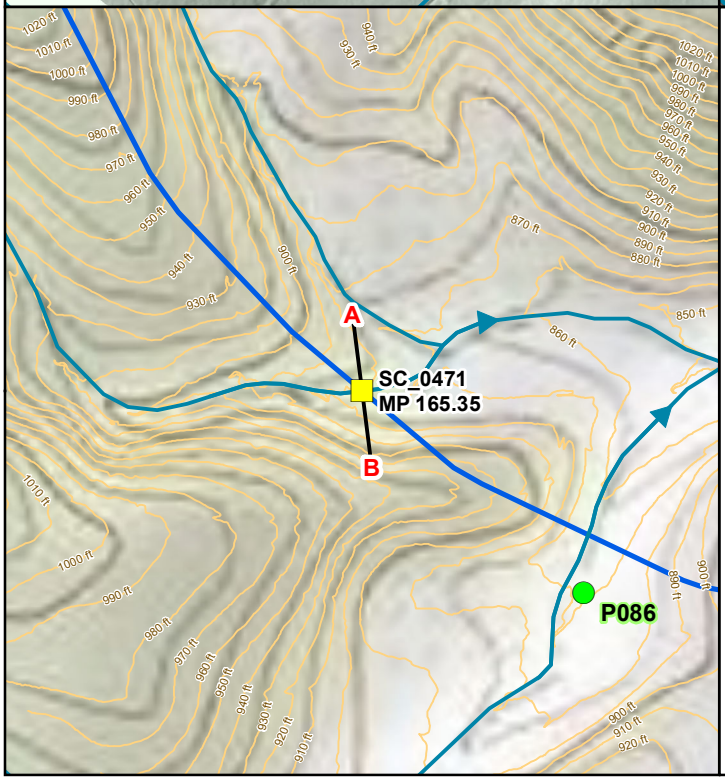
Dominion

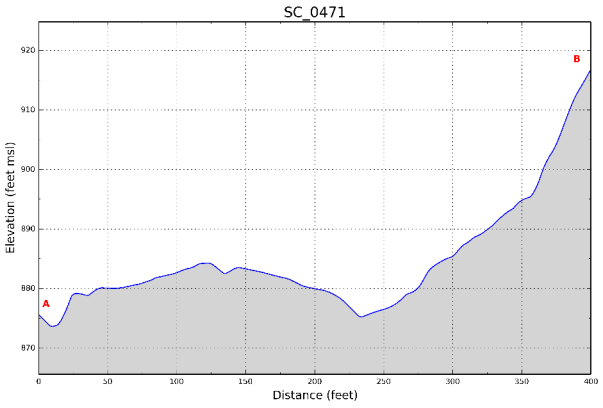
Geosyntec consultants

TESSELLATIONS









Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- Field Observation Locations
- Profile Line (400ft)
- Stream with Flow Direction
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636

Stream Crossing Plan View and Profile

Location ID: snec052

TID_SC: SC_0471

Stream Name: UNT to Rockfish River

1:6,000

0 125 250 500 Feet

0 0.025 0.05 0.1 Miles

N

Document Information:

Document No:
DOM_EC_CRO_MA_001_SC_0471

Revision	Date	Created By	Approved by
0	07-28-2016	CR	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

Notes:

1) The current alignment centerline provided by Dominion/GAI
2) Projection: UTM 17N feet, NAD 83
3) The vertical exaggeration on the profile graph is 4:1
4) Hillshade (azimuth: 280) created from 2 foot lidar data provided by Dominion/GAI
5) In areas that did not have lidar data, hillshade was created from 1/3 arc-second (10m) NED

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TESSELLATIONS

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TID	SC_0471	**ACP Segment**	AP-1
Stream Name	UNT to Rockfish River	**MP**	165.35
Survey Date	13-May-2016	**Start Time**	1410 hrs

- Stream possesses a riffle-pool morphology with mild meandering.
- Banks composed of fine-grained silt/clay with some sand and gravel.
- Eroded bank heights of approximately 5 feet observed.
- Channel bed composed of sand with some silt and cobbles 6 to 8 inches in size.
- Well established deciduous riparian buffer across valley bottom.
- Stream channel laterally confined and well established riparian buffer.
- Bankfull channel width is 4.3 feet and bankfull depth is 0.3 feet.
- Additional information on stream crossing is available on stream reconnaissance form.

Recommendation:

Given potential for debris flows, sag bends should be located at valley edges. If bedrock is encountered shallower than proposed burial depth, burial in bedrock is recommended.

Stream Reconnaissance (Based on Thorne, 1998)

Section 1 - Site Description

Date:	13-May-16	Stream Name:	UNT to Rockfish River
Crossing ID:	SC_0471		

Section 2 - Region and Valley Description

Part 1: Watershed

Land Use

- [X] Natural
- [ ] Agricultural
- [ ] Urban
- [ ] Suburban
- [ ] Rural
- [ ] Industrial
- [ ] Cattle grazing

Part 2: River Valley Conditions

Vegetation

- [ ] None
- [ ] Grass
- [ ] Pasture
- [ ] Crops
- [X] Shrubs
- [X] Deciduous Forest/trees
- [ ] Coniferous Forest/trees

Valley Side Features

- [ ] None
- [ ] Occasional
- [X] Frequent

Failure Locations

- [ ] None
- [ ] Away from river
- [ ] Along river

Part 3: Floodplain

Floodplain Width

- [ ] None
- [X] 1 < river widths
- [ ] 1-5 river widths
- [ ] 5-10 river widths
- [ ] > 10 river widths

Land Use

- [X] Natural
- [ ] Agricultural
- [ ] Urban
- [ ] Suburban
- [ ] Rural
- [ ] Industrial
- [ ] Mining
- [ ] Cattle grazing

Vegetation

- [ ] None
- [ ] Grass
- [ ] Pasture
- [ ] Orchards
- [ ] Crops
- [X] Shrubs
- [X] Deciduous Forest/trees
- [ ] Coniferous Forest/trees

Riparian Buffer Strip

- [ ] None
- [ ] < 1 river width
- [ ] 1-5 river widths
- [X] > 5 river widths

Part 4: Vertical Confinement

Terraces

- [X] None
- [ ] Left bank
- [ ] Right bank

Levees

- [X] None
- [ ] Natural
- [ ] Constructed

Levee Location

- [ ] Along channel bank
- [ ] Set back < 1 river width
- [ ] Set back > 1 river width

Part 5: Lateral Relation of Channel to Valley

Planform

- [ ] Straight
- [X] Meandering
- [ ] Braided
- [ ] Anastomosed
- [ ] Engineered

Meander Characteristics

- [ ] Mild bends
- [ ] Moderate bends
- [X] Tight bends

Section 3 - Channel Description (select all that apply)

Part 6: Channel Description (select all that apply)

Bed Controls

- [ ] None
- [X] Occasional
- [ ] Frequent
- [ ] Confined

Control Types

- [ ] None
- [ ] Bedrock
- [ ] Boulders

Width Controls

- [ ] None
- [ ] Occasional
- [ ] Frequent
- [ ] Confined

Control Types

- [ ] None
- [ ] Bedrock
- [ ] Boulders

Other

- [ ] Debris
- [ ] Mining
- [ ] Reservoir
- [ ] Knickpoint

Flow Habit

- [X] Perennial
- [ ] Flashy perennial
- [ ] Intermittent
- [ ] Ephemeral

Channel Width: 4.3'

M-B Classification

- [ ] Cascade or step-pool
- [X] Plane, pool-riffle, dune-ripple
- [ ] Braided

Part 7: Bed Sediment Description (select all that apply)

Bed Material	*Bar Types*	*Bar Material*	*Bar Vegetation*	*Bar Width*
[ ] Clay	[ ] None	[ ] Silt	[X] None	[ ] None
[X] Silt	[ ] Alternate bars	[X] Sand	[ ] Grasses	[ ] Narrow
[X] Sand	[X] Point bars	[ ] Gravel	[ ] Reeds/shrubs	[ ] Moderate
[ ] Gravel	[ ] Mid-channel bars	[ ] Cobbles	[ ] Trees	[ ] Wide
[X] Cobbles	[ ] Diagonal bars			
[ ] Boulders	[ ] Irregular/combination			
[ ] Bedrock	[ ] Braided			

Percent sand in bed = > 80 %

Section 4 - Bank Survey (select all that apply)

Bank Characteristic	*Left Bank*	*Right Bank*
Bank Material	[ ] Clay [X] Silt [X] sand [ ] Gravel [ ] Cobbles [ ] Boulders [ ] Bedrock	[ ] Clay [X] Silt [X] sand [ ] Gravel [ ] Cobbles [ ] Boulders [ ] Bedrock
Layer Material	[X] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders	[X] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders
Bank Height	~5'	~5'
Bank Slope	[ ] Steep [X] Moderate [ ] Shallow	[ ] Steep [X] Moderate [ ] Shallow
Bank Vegetation	[ ] None [ ] Grasses/annuals [X] Reeds/shrubs [X] Trees: Falling trees? [X] Y [ ] N Tree density [ ] sparse [X] dense Tree health [X] good [ ] poor tree ages [X] young [X] mature [ ] old tree diversity [X] Y [ ] N	[ ] None [ ] Grasses/annuals [X] Reeds/shrubs [X] Trees: Falling trees? [X] Y [ ] N Tree density [ ] sparse [X] dense Tree health [X] good [ ] poor tree ages [X] young [X] mature [ ] old tree diversity [X] Y [ ] N
Bank Erosion and Failure Location	location of erosion [ ] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [X] general type of erosion [X] fluvial [ ] geotechnical	location of erosion [ ] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [X] general type of erosion [X] fluvial [ ] geotechnical

PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0471, UNT to Rockfish River at MP 165.35 (AP-1)

Photograph 1	
Date: 13 May 2016	
Direction: looking downstream	
Description: thick, well established riparian buffer. Photo taken from small road crossing approximately 20 yards upstream of pipeline crossing.	

PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0471, UNT to Rockfish River at MP 165.35 (AP-1)

Photograph 2	
Date: 13 May 2016	
Direction: looking at across stream, flow to the left	
Description: minor debris embedded into predominantly sand channel.	

PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0471, UNT to Rockfish River at MP 165.35 (AP-1)

Photograph 3	
Date: 13 May 2016	
Direction: looking upstream	
Description: minor debris in channel with lateral confinement provided by local topology and riparian buffer, trekking pole shown for scale.	

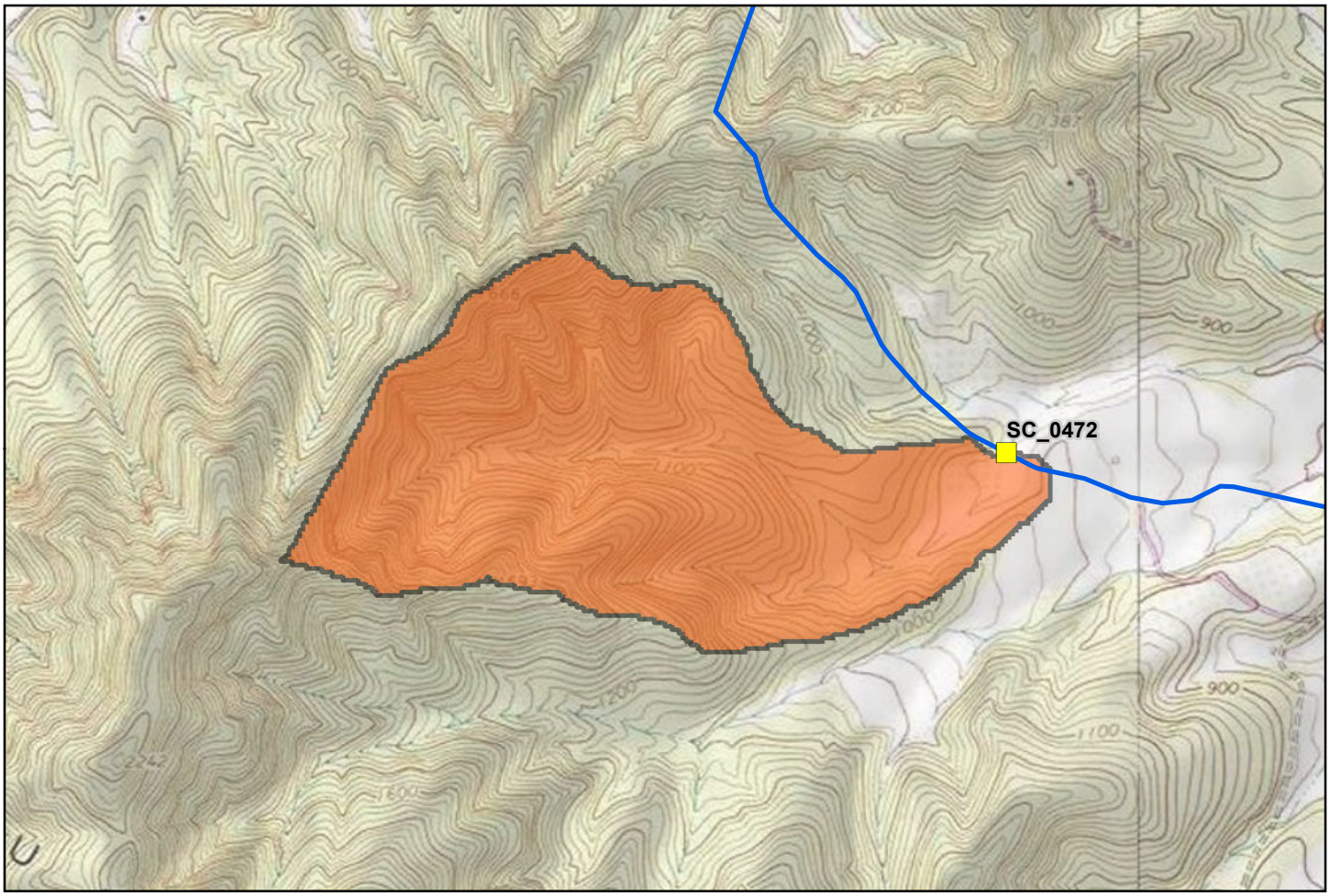
PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0471, UNT to Rockfish River at MP 165.35 (AP-1)

Photograph 4	
Date: 13 May 2016	
Direction: looking downstream	
Description: thick riparian buffer and local topology providing lateral confinement. Eroded banks on outside of bends, trekking pole shown for scale.	



TID	Unique ID	ACP Branch	Mile Post	State	County
SC_0472	snec050	AP-1	165.48	Virginia	Nelson

Attribute	Value
Stream Name	UNT to Rockfish River
Physiographic Province[1]	Blue Ridge
Drainage Area (square miles)[2]	0.500
Flow Regime	Perennial
Measured Bank Full Width (ft)[3]	5.1
Slope At Crossing Over 200ft Long Reach (%)[4]	2.924
Proposed Construction Method[5]	Dam and Pump

Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636
- Watershed Boundary

Drainage Area Map

1:24,000

0 500 1,000 2,000 Feet

0 0.5 Miles

N

Document Information:

Document No:
DOM_EC_HYD_MA_SER001_SC_0472

Revision	Date	Created By	Approved by
0	08-01-2016	BP	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

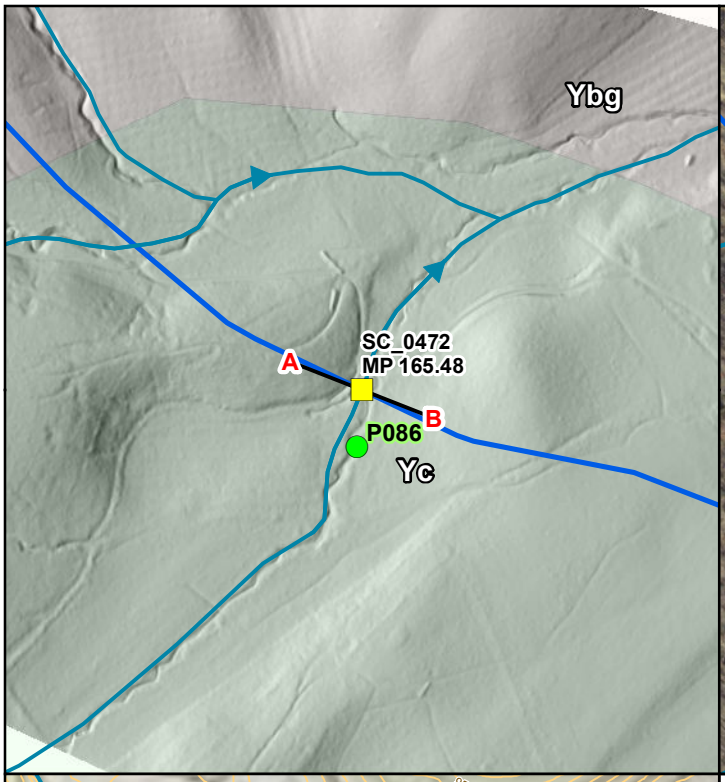
Notes:

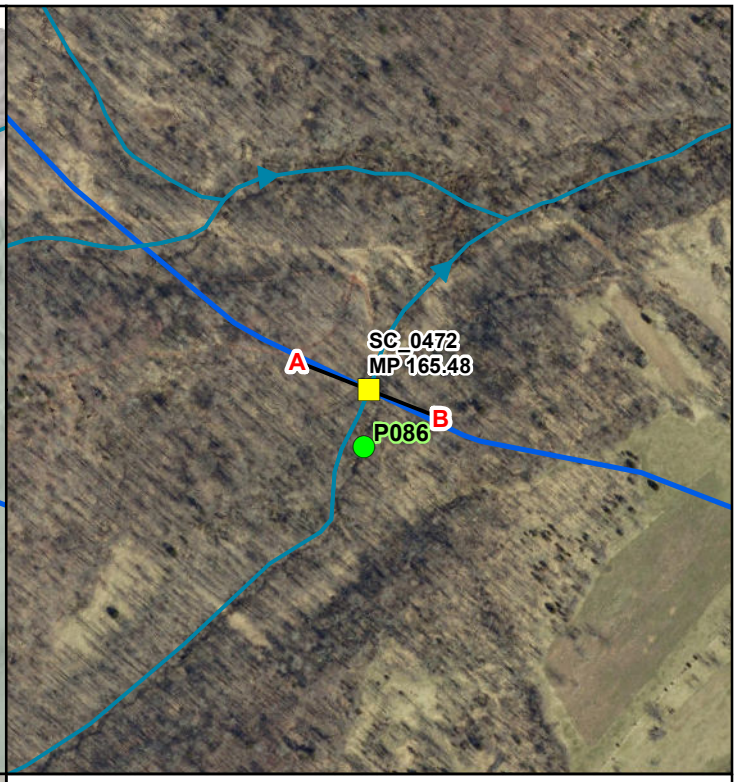
1) After Fenneman (1946)
2) Calculated using USGS 1:24,000 topographic maps and ArcGIS interface.
3) Measured during stream reconnaissance.
4) Calculated using one of four methods described in Section 3.2.3.1.
5) The current alignment centerline and mileposts provided by Dominion/GAI.

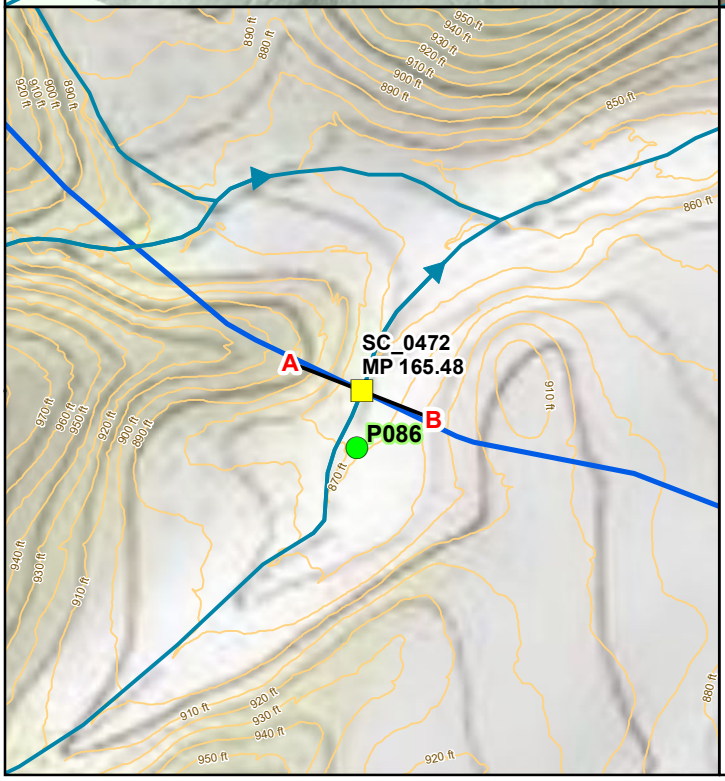
Dominion

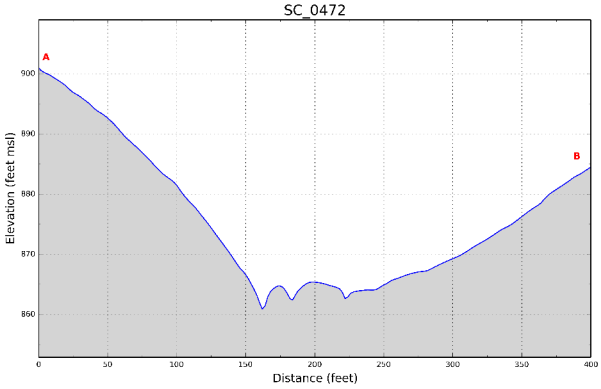
Geosyntec consultants

TESSELLATIONS









Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- Field Observation Locations
- Profile Line (400ft)
- Stream with Flow Direction
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636

Stream Crossing Plan View and Profile

Location ID: snec050

TID_SC: SC_0472

Stream Name: UNT to Rockfish River

1:6,000

0 125 250 500 Feet

0 0.025 0.05 0.1 Miles

N

Document Information:

Document No:
DOM_EC_CRO_MA_001_SC_0472

Revision	Date	Created By	Approved by
0	07-28-2016	CR	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

Notes:

1) The current alignment centerline provided by Dominion/GAI
2) Projection: UTM 17N feet, NAD 83
3) The vertical exaggeration on the profile graph is 4:1
4) Hillshade (azimuth: 280) created from 2 foot lidar data provided by Dominion/GAI
5) In areas that did not have lidar data, hillshade was created from 1/3 arc-second (10m) NED

Dominion

Geosyntec consultants

TESSELLATIONS

Geosyntec consultants

TID	SC_0472	**ACP Segment**	AP-1
Stream Name	UNT to Rockfish River	**MP**	165.48
Survey Date	13-May-2016	**Start Time**	1440 hrs

- Stream possesses a riffle-pool morphology in a terraced alluvial valley with historical debris flow activity.
- Confluence of channels occurs downstream of crossing prior to small culvert at dirt road.
- Main channel bankfull width is 5.1 feet and bankfull depth is 0.4 feet. Secondary channel has a bankfull width of 4.2 feet and a bankfull depth of 0.3 feet.
- Channel bed comprised of medium to fine gravels.
- Banks composed of fine-grained silt/clay with some sand and gravel.
- Typical fluvial erosion along incised channel. Top of bank (terrace) heights in vicinity of crossing are 2 feet above the channel bed.
- Well established deciduous riparian buffer.
- Additional information on stream crossing is available on stream reconnaissance form.

Recommendation:

Given potential for debris flows, sag bends should be located at valley edges. If bedrock is encountered shallower than proposed burial depth, burial in bedrock is recommended.

Stream Reconnaissance (Based on Thorne, 1998)

Section 1 - Site Description

Date:	13-May-16	Stream Name:	UNT to Rockfish River
Crossing ID:	SC_0472		

Section 2 - Region and Valley Description

Part 1: Watershed

Land Use

- [X] Natural
- [ ] Agricultural
- [ ] Urban
- [ ] Suburban
- [ ] Rural
- [ ] Industrial
- [ ] Cattle grazing

Part 2: River Valley Conditions

Vegetation

- [ ] None
- [ ] Grass
- [ ] Pasture
- [ ] Crops
- [X] Shrubs
- [X] Deciduous Forest/trees
- [ ] Coniferous Forest/trees

Valley Side Features

- [ ] None
- [ ] Occasional
- [X] Frequent

Failure Locations

- [ ] None
- [ ] Away from river
- [ ] Along river

Part 3: Floodplain

Floodplain Width

- [ ] None
- [ ] 1 < river widths
- [ ] 1-5 river widths
- [X] 5-10 river widths
- [ ] > 10 river widths

Land Use

- [X] Natural
- [ ] Agricultural
- [ ] Urban
- [ ] Suburban
- [ ] Rural
- [ ] Industrial
- [ ] Mining
- [ ] Cattle grazing

Vegetation

- [ ] None
- [ ] Grass
- [ ] Pasture
- [ ] Orchards
- [ ] Crops
- [ ] Shrubs
- [X] Deciduous Forest/trees
- [ ] Coniferous Forest/trees

Riparian Buffer Strip

- [ ] None
- [ ] < 1 river width
- [ ] 1-5 river widths
- [X] > 5 river widths

Part 4: Vertical Confinement

Terraces

- [X] None
- [ ] Left bank
- [ ] Right bank

Levees

- [X] None
- [ ] Natural
- [ ] Constructed

Levee Location

- [ ] Along channel bank
- [ ] Set back < 1 river width
- [ ] Set back > 1 river width

Part 5: Lateral Relation of Channel to Valley

Planform

- [ ] Straight
- [X] Meandering
- [ ] Braided
- [ ] Anastomosed
- [ ] Engineered

Meander Characteristics

- [ ] Mild bends
- [X] Moderate bends
- [ ] Tight bends

Section 3 - Channel Description (select all that apply)

Part 6: Channel Description (select all that apply)

Bed Controls

- [X] None
- [ ] Occasional
- [ ] Frequent
- [ ] Confined

Control Types

- [ ] None
- [ ] Bedrock
- [ ] Boulders

Width Controls

- [X] None
- [ ] Occasional
- [ ] Frequent
- [ ] Confined

Control Types

- [ ] None
- [ ] Bedrock
- [ ] Boulders

Other

- [ ] Debris
- [ ] Mining
- [ ] Reservoir
- [ ] Knickpoint

Flow Habit

- [X] Perennial
- [ ] Flashy perennial
- [ ] Intermittent
- [ ] Ephemeral

Channel Width: 5.1'

M-B Classification

- [ ] Cascade or step-pool
- [X] Plane, pool-riffle, dune-ripple
- [ ] Braided

Part 7: Bed Sediment Description (select all that apply)

Bed Material	*Bar Types*	*Bar Material*	*Bar Vegetation*	*Bar Width*
[ ] Clay	[ ] None	[ ] Silt	[X] None	[ ] None
[ ] Silt	[ ] Alternate bars	[X] Sand	[ ] Grasses	[ ] Narrow
[X] Sand	[X] Point bars	[ ] Gravel	[ ] Reeds/shrubs	[ ] Moderate
[X] Gravel	[ ] Mid-channel bars	[ ] Cobbles	[ ] Trees	[ ] Wide
[ ] Cobbles	[ ] Diagonal bars			
[ ] Boulders	[ ] Irregular/combination			
[ ] Bedrock	[ ] Braided			

Percent sand in bed = > 80 %

Section 4 - Bank Survey (select all that apply)

Bank Characteristic	*Left Bank*	*Right Bank*
Bank Material	[X] Clay [X] Silt [X] Sand [X] Gravel [ ] Cobbles [ ] Boulders [ ] Bedrock	[X] Clay [X] Silt [X] Sand [X] Gravel [ ] Cobbles [ ] Boulders [ ] Bedrock
Layer Material	[X] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders	[X] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders
Bank Height	2'	2'
Bank Slope	[ ] Steep [X] Moderate [ ] Shallow	[ ] Steep [X] Moderate [ ] Shallow
Bank Vegetation	[ ] None [ ] Grasses/annuals [X] Reeds/shrubs [X] Trees: Falling trees? [X] Y [ ] N Tree density [ ] sparse [X] dense Tree health [X] good [ ] poor tree ages [X] young [X] mature [ ] old tree diversity [X] Y [ ] N	[ ] None [ ] Grasses/annuals [X] Reeds/shrubs [X] Trees: Falling trees? [X] Y [ ] N Tree density [ ] sparse [X] dense Tree health [X] good [ ] poor tree ages [X] young [X] mature [ ] old tree diversity [X] Y [ ] N
Bank Erosion and Failure Location	location of erosion [ ] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [X] general type of erosion [X] fluvial [ ] geotechnical	location of erosion [ ] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [X] general type of erosion [X] fluvial [ ] geotechnical

PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0472, UNT to Rockfish River at MP 165.48 (AP-1)

Photograph 1	
Date: 13 May 2016	
Direction: looking downstream	
Description: large fraction of sand characteristic of channel bed along with some cobbles and well established riparian buffer off both banks. Main channel of two shown. Similar channel approximately 55’ off left bank. Confluence point prior to downstream culvert.	

PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0472, UNT to Rockfish River at MP 165.48 (AP-1)

Photograph 2	
Date: 13 May 2016	
Direction: looking at across stream, flow to the right	
Description: minor debris and change in bed slope indicated by change in bed materials. Upstream of crossing.	

PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0472, UNT to Rockfish River at MP 165.48 (AP-1)

Photograph 3	
Date: 13 May 2016	
Direction: looking down at channel bed, flow to the right	
Description: scale showing relative size of the larger cobbles, embedded in sand.	

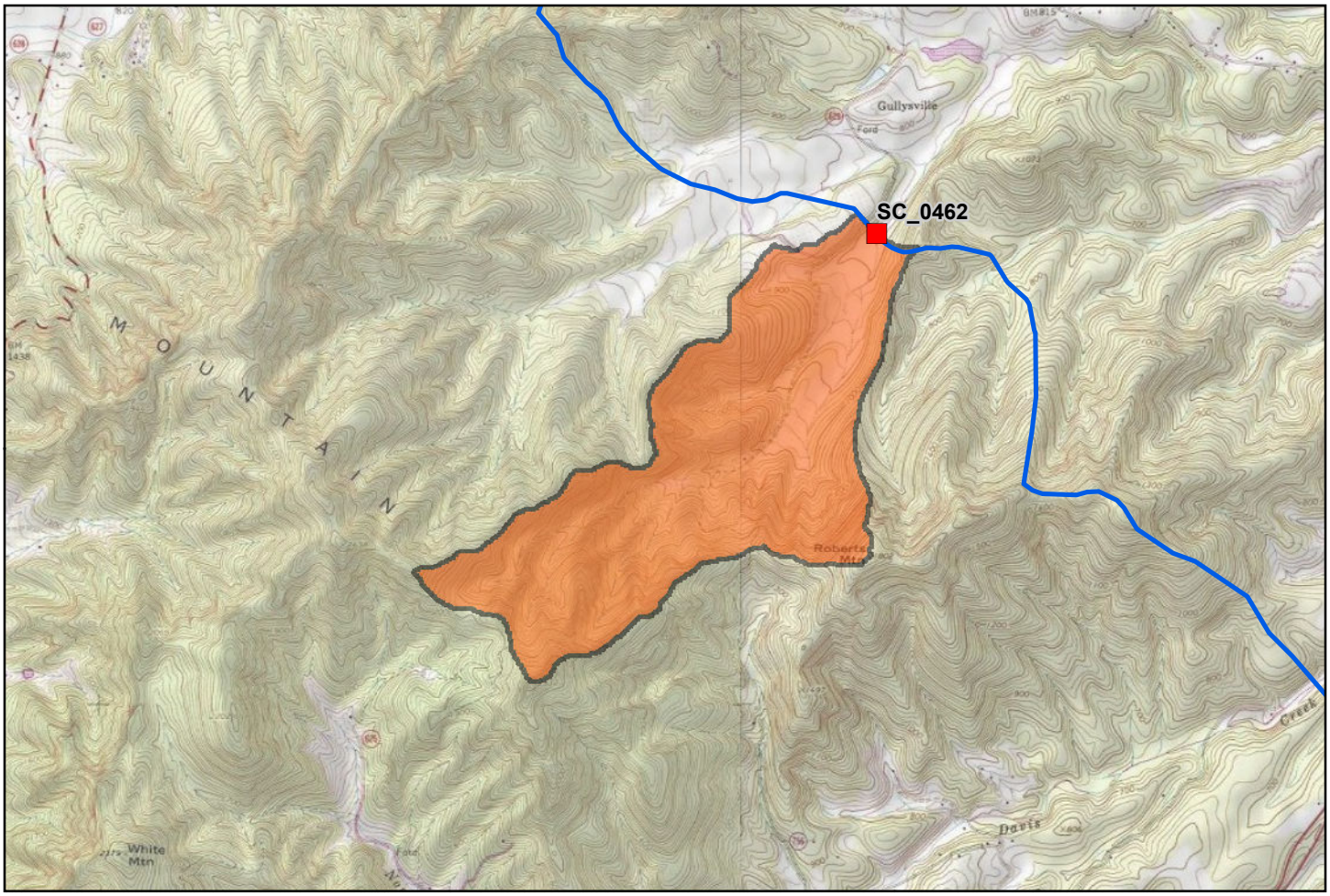
PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0472, UNT to Rockfish River at MP 165.48 (AP-1)

Photograph 4	
Date: 13 May 2016	
Direction: looking downstream	
Description: thick riparian buffer and local topology providing lateral confinement. Multiple threads of channel present along with minor debris and fallen tree limbs.	



TID	Unique ID	ACP Branch	Mile Post	State	County
SC_0462	snea050	AP-1	166.25	Virginia	Nelson

Attribute	Value
Stream Name	UNT to Rockfish River
Physiographic Province[1]	Blue Ridge
Drainage Area (square miles)[2]	1.156
Flow Regime	Perennial
Measured Bank Full Width (ft)[3]	9
Slope At Crossing Over 200ft Long Reach (%)[4]	1.801
Proposed Construction Method[5]	1) Flume 2) Dam and Pump

Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636
- Watershed Boundary

Drainage Area Map

1:50,000

0 1,125 2,250 4,500 Feet

0 1 Miles

N

Document Information:

Document No:
DOM_EC_HYD_MA_SER001_SC_0462

Revision	Date	Created By	Approved by
0	08-01-2016	BP	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

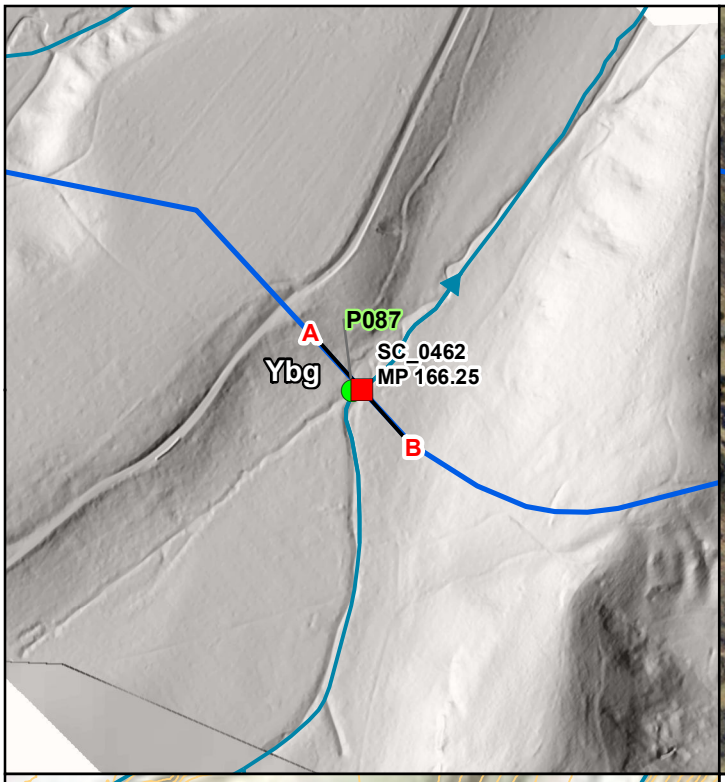
Notes:

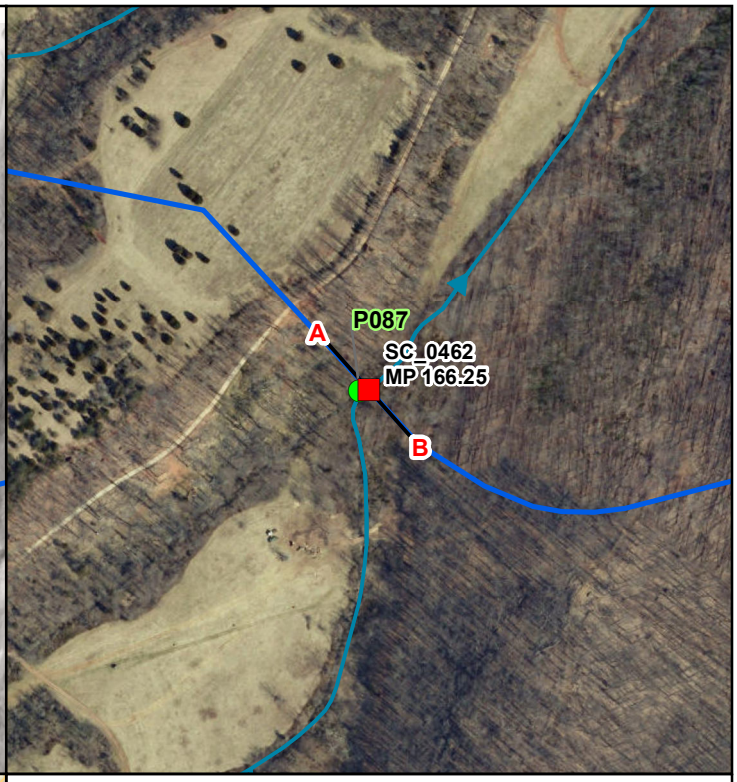
1) After Fenneman (1946)
2) Calculated using USGS 1:24,000 topographic maps and ArcGIS interface.
3) Measured during stream reconnaissance.
4) Calculated using one of four methods described in Section 3.2.3.1.
5) The current alignment centerline and mileposts provided by Dominion/GAI.

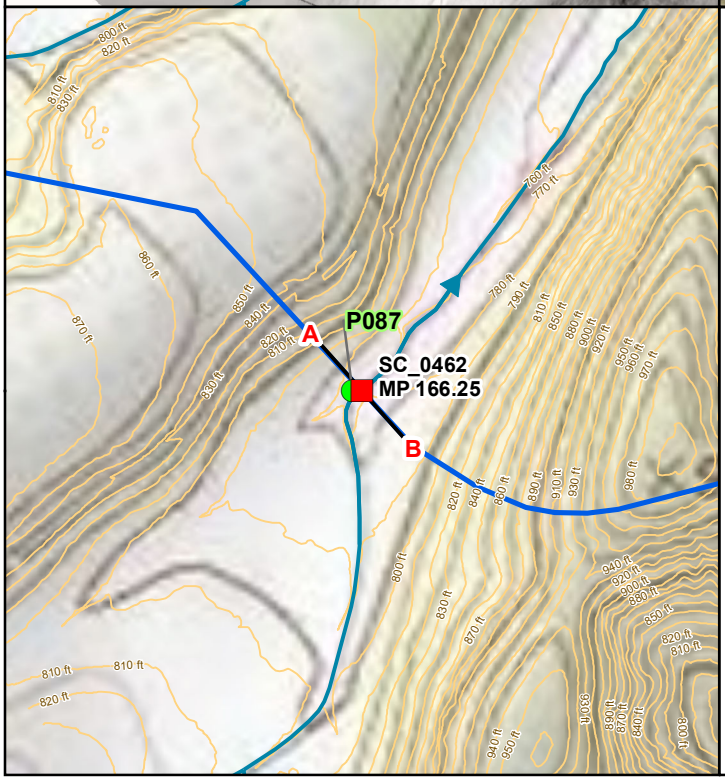
Dominion

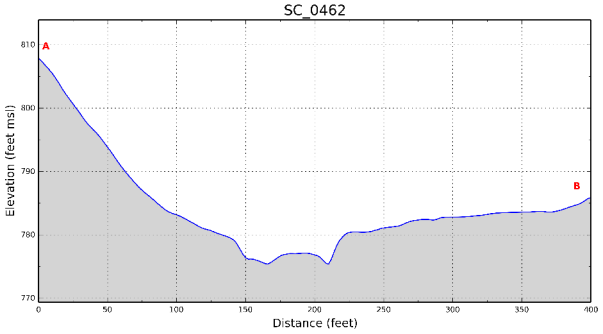
Geosyntec consultants

TESSELLATIONS









Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- Field Observation Locations
- Profile Line (400ft)
- Stream with Flow Direction
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636

Stream Crossing Plan View and Profile

Location ID: snea050

TID_SC: SC_0462

Stream Name: UNT to Rockfish River

1:6,000

0 125 250 500 Feet

0 0.025 0.05 0.1 Miles

N

Document Information:

Document No:
DOM_EC_CRO_MA_001_SC_0462

Revision	Date	Created By	Approved by
0	07-28-2016	CR	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

Notes:

1) The current alignment centerline provided by Dominion/GAI
2) Projection: UTM 17N feet, NAD 83
3) The vertical exaggeration on the profile graph is 4:1
4) Hillshade (azimuth: 280) created from 2 foot lidar data provided by Dominion/GAI
5) In areas that did not have lidar data, hillshade was created from 1/3 arc-second (10m) NED

Dominion

Geosyntec consultants

TESSELATIONS

Geosyntec consultants

TID	SC_0462	**ACP Segment**	AP-1
Stream Name	UNT to Rockfish River	**MP**	166.25
Survey Date	13-May-2016	**Start Time**	1544 hrs

- Stream possesses a riffle-pool morphology in a terraced alluvial valley with historical debris flow activity.
- Riffles present in meanders which indicates lateral instability.
- Pool depths observed were 1.25 feet below water surface.
- Stream channel approximately 55 feet from adjacent stream (SC_1138) with confluence downstream of pipeline crossings.
- Some small terraces and mid-channel bars.
- Upstream eroded bank height on outside of bend is approximately 4 feet high.
    - Top of bank height at crossing is 1.5 feet
- Headcut (approximately 1.5 feet bed elevation change) observed downstream of crossing, being held from migration by tree root across channel.
- Channel bed comprised of cobbles and medium to fine gravels with sand in depositional areas.
- Embedded cobble protrusion height is 0.3 feet.
- Stream bank composed of fine-grained silt/clay with some sand and gravel.
- Dense deciduous riparian buffer on both banks across valley width.
- Bankfull channel width is 9 feet and bankfull depth is 0.5 feet.
- Additional information on stream crossing is available on stream reconnaissance form.

Recommendation:

Evaluate scour depth for pipeline burial depth. Given potential for debris flows, sag bends should be located at valley edges. If bedrock is encountered shallower than proposed burial depth, burial in bedrock is recommended.

Stream Reconnaissance (Based on Thorne, 1998)

Section 1 - Site Description

Date:	13-May-16	Stream Name:	UNT to Rockfish River
Crossing ID:	SC_0462		

Section 2 - Region and Valley Description

Part 1: Watershed

Land Use

- [x] Natural
- [x] Agricultural
- [ ] Urban
- [ ] Suburban
- [ ] Rural
- [ ] Industrial
- [ ] Cattle grazing

Part 2: River Valley Conditions

Vegetation

- [ ] None
- [ ] Grass
- [x] Pasture
- [ ] Crops
- [x] Shrubs
- [x] Deciduous Forest/trees
- [ ] Coniferous Forest/trees

Valley Side Features

- [x] None
- [ ] Occasional
- [ ] Frequent

Failure Locations

- [ ] None
- [ ] Away from river
- [ ] Along river

Part 3: Floodplain

Floodplain Width

- [ ] None
- [ ] 1 < river widths
- [ ] 1-5 river widths
- [ ] 5-10 river widths
- [x] > 10 river widths

Land Use

- [x] Natural
- [ ] Agricultural
- [ ] Urban
- [ ] Suburban
- [ ] Rural
- [ ] Industrial
- [ ] Mining
- [ ] Cattle grazing

Vegetation

- [ ] None
- [ ] Grass
- [ ] Pasture
- [ ] Orchards
- [ ] Crops
- [x] Shrubs
- [x] Deciduous Forest/trees
- [ ] Coniferous Forest/trees

Riparian Buffer Strip

- [ ] None
- [ ] < 1 river width
- [ ] 1-5 river widths
- [x] > 5 river widths

Part 4: Vertical Confinement

Terraces

- [x] None
- [ ] Left bank
- [ ] Right bank

Levees

- [x] None
- [ ] Natural
- [ ] Constructed

Levee Location

- [ ] Along channel bank
- [ ] Set back < 1 river width
- [ ] Set back > 1 river width

Part 5: Lateral Relation of Channel to Valley

Planform

- [ ] Straight
- [x] Meandering
- [ ] Braided
- [ ] Anastomosed
- [ ] Engineered

Meander Characteristics

- [ ] Mild bends
- [x] Moderate bends
- [ ] Tight bends

Section 3 - Channel Description (select all that apply)

Part 6: Channel Description (select all that apply)

Bed Controls

- [x] None
- [ ] Occasional
- [ ] Frequent
- [ ] Confined

Control Types

- [x] None
- [ ] Bedrock
- [ ] Boulders

Width Controls

- [ ] None
- [x] Occasional
- [ ] Frequent
- [ ] Confined

Control Types

- [ ] None
- [ ] Bedrock
- [ ] Boulders

Other

- [ ] Debris
- [ ] Mining
- [ ] Reservoir
- [ ] Knickpoint

Flow Habit

- [x] Perennial
- [ ] Flashy perennial
- [ ] Intermittent
- [ ] Ephemeral

Channel Width: 9.0'

M-B Classification

- [ ] Cascade or step-pool
- [x] Plane, pool-riffle, dune-ripple
- [ ] Braided

Part 7: Bed Sediment Description (select all that apply)

Bed Material	***Bar Types***	***Bar Material***	***Bar Vegetation***	***Bar Width***
[ ] Clay	[ ] None	[ ] Silt	[ ] None	[ ] None
[ ] Silt	[ ] Alternate bars	[x] Sand	[x] Grasses	[ ] Narrow
[x] Sand	[ ] Point bars	[ ] Gravel	[ ] Reeds/shrubs	[ ] Moderate
[ ] Gravel	[x] Mid-channel bars	[x] Cobbles	[ ] Trees	[ ] Wide
[x] Cobbles	[ ] Diagonal bars			
[ ] Boulders	[ ] Irregular/combination			
[ ] Bedrock	[ ] Braided			

Percent sand in bed = _____ %

Section 4 - Bank Survey (select all that apply)

Bank Characteristic	***Left Bank***	***Right Bank***
Bank Material	[ ] Clay [ ] Silt [x] sand (sm/ml) [ ] Gravel [ ] Cobbles [ ] Boulders [ ] Bedrock	[ ] Clay [ ] Silt [x] sand (sm/ml) [ ] Gravel [ ] Cobbles [ ] Boulders [ ] Bedrock
Layer Material	[x] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders	[x] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders
Bank Height	1.5'	4'
Bank Slope	[ ] Steep [ ] Moderate [x] Shallow	[x] Steep [ ] Moderate [ ] Shallow
Bank Vegetation	[ ] None [ ] Grasses/annuals [x] Reeds/shrubs [ ] Trees: Falling trees? [x] Y [ ] N Tree density [ ] sparse [x] dense Tree health [x] good [ ] poor tree ages [x] young [x] mature [ ] old tree diversity [x] Y [ ] N	[ ] None [ ] Grasses/annuals [x] Reeds/shrubs [x] Trees: Falling trees? [x] Y [ ] N Tree density [ ] sparse [x] dense Tree health [x] good [ ] poor tree ages [x] young [x] mature [ ] old tree diversity [x] Y [ ] N
Bank Erosion and Failure Location	location of erosion [ ] outside meander bend [x] inside meander bend [ ] opposite bar or obstruction [ ] general type of erosion [x] fluvial [ ] geotechnical	location of erosion [x] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [ ] general type of erosion [x] fluvial [ ] geotechnical

PHASE 2 – RAPID SITE RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0462 (UNT to Rockfish River at MP AP-1, 166.25)

Photograph 1	
Date: 13 May 2016	
Direction: looking upstream on SC_0462	
Description: thick, well established riparian buffer. Steep eroded banks on outside of bend near steeper stream section. Crossing upstream of riffle.	

PHASE 2 – RAPID SITE RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0462 (UNT to Rockfish River at MP AP-1, 166.25)

Photograph 2	
Date: 13 May 2016	
Direction: looking downstream on SC_0462	
Description: head cut being held from migrating by riparian root growth in channel. Tree on right of photo with main trunk growing horizontal and roots into channel.	

GEOSYNTEC CONSULTANTS

Photographic Record

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

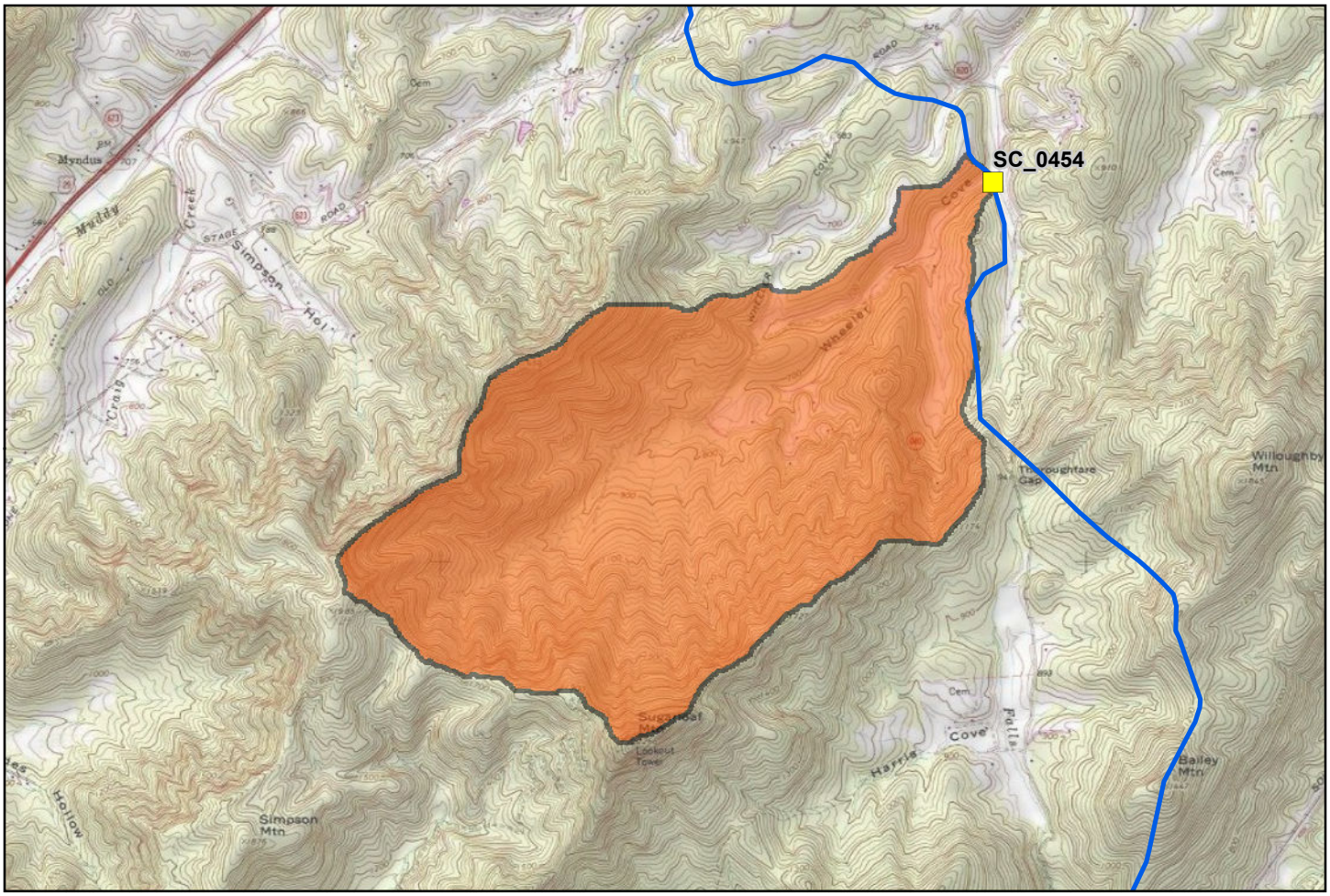
Subject Site: SC_0462 (UNT to Rockfish River at MP AP-1, 166.25)

Photograph 3

Date: 13 May 2016

Direction: looking across riparian buffer, stream flow to the right

Description: thick riparian buffer throughout valley.



TID	Unique ID	ACP Branch	Mile Post	State	County
SC_0454	snea400	AP-1	171.62	Virginia	Nelson

Attribute	Value
Stream Name	Wheeler Cove
Physiographic Province[1]	Piedmont
Drainage Area (square miles)[2]	2.463
Flow Regime	Perennial
Measured Bank Full Width (ft)[3]	16.5
Slope At Crossing Over 200ft Long Reach (%)[4]	0.857
Proposed Construction Method[5]	1) Dam and Pump 2) Flume

Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636
- Watershed Boundary

Drainage Area Map

1:50,000

0 1,125 2,250 4,500 Feet

0 1 Miles

N

Document Information:

Document No:
DOM_EC_HYD_MA_SER001_SC_0454

Revision	Date	Created By	Approved by
0	08-01-2016	BP	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

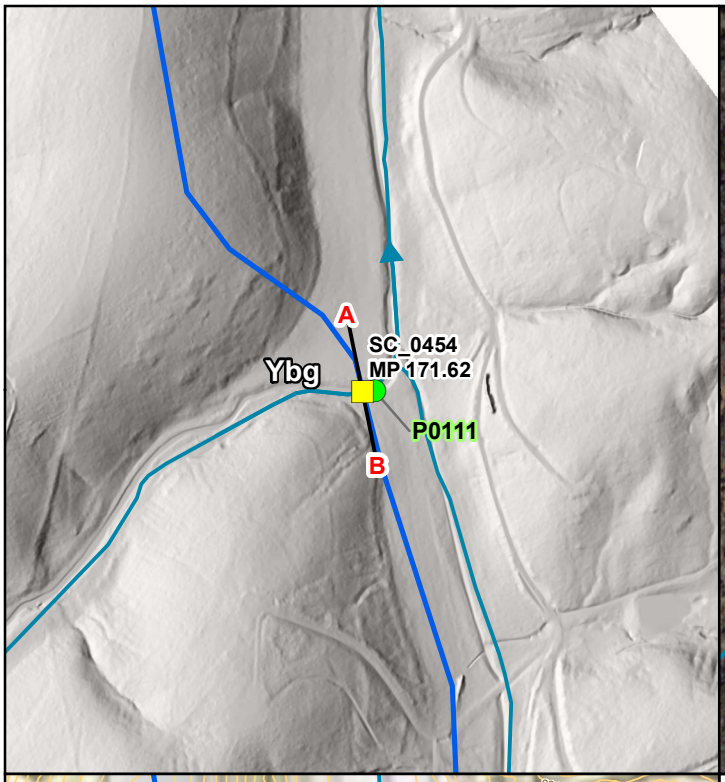
Notes:

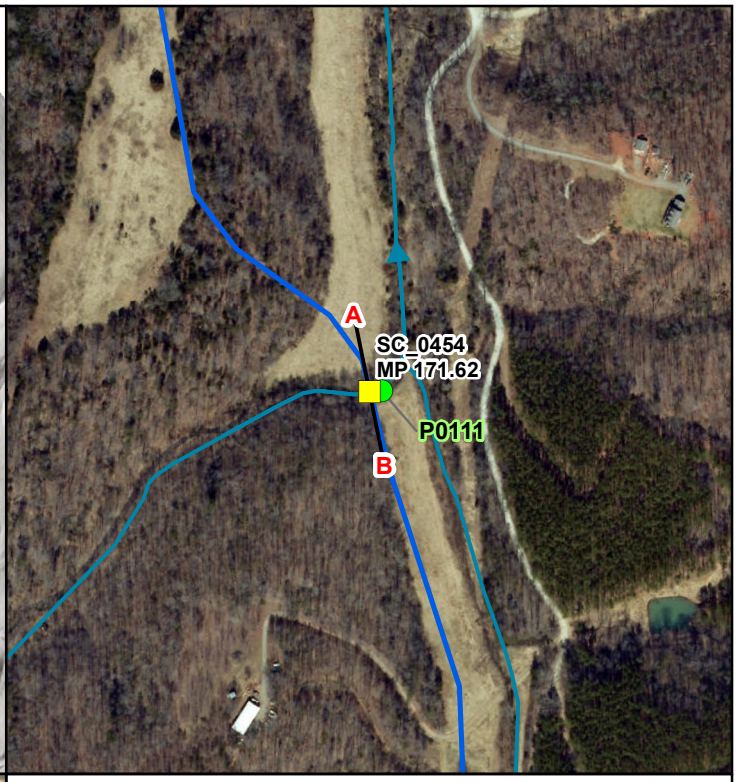
1) After Fenneman (1946)
2) Calculated using USGS 1:24,000 topographic maps and ArcGIS interface.
3) Measured during stream reconnaissance.
4) Calculated using one of four methods described in Section 3.2.3.1.
5) The current alignment centerline and mileposts provided by Dominion/GAI.

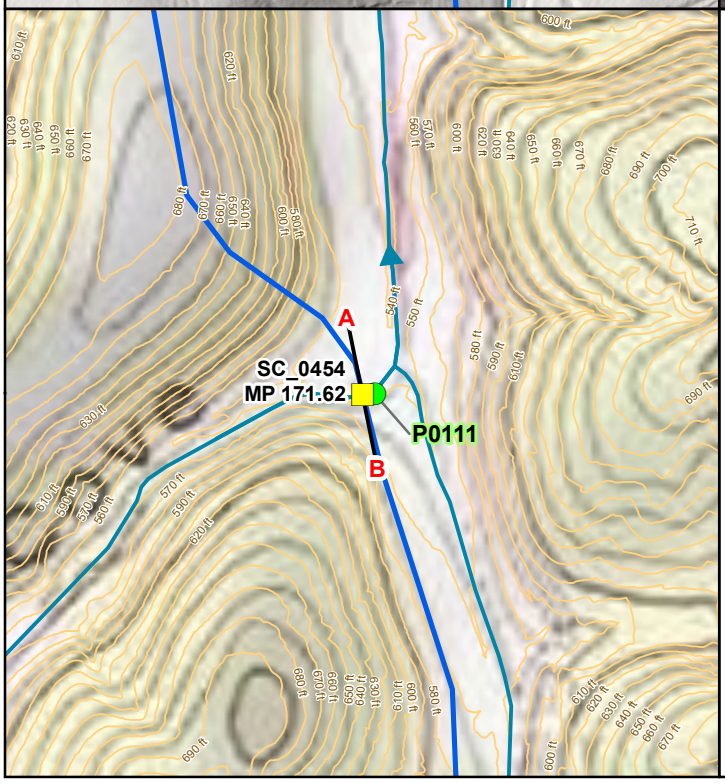
Dominion

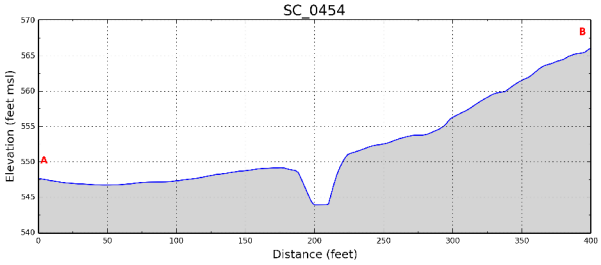
Geosyntec consultants

TESSELLATIONS









Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- Field Observation Locations
- Profile Line (400ft)
- Stream with Flow Direction
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636

Stream Crossing Plan View and Profile

Location ID: snea400

TID_SC: SC_0454

Stream Name: Wheeler Cove

1:6,000

0 125 250 500 Feet

0 0.025 0.05 0.1 Miles

N

Document Information:

Document No:
DOM_EC_CRO_MA_001_SC_0454

Revision	Date	Created By	Approved by
0	07-28-2016	CR	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

Notes:

1) The current alignment centerline provided by Dominion/GAI
2) Projection: UTM 17N feet, NAD 83
3) The vertical exaggeration on the profile graph is 4:1
4) Hillshade (azimuth: 280) created from 2 foot lidar data provided by Dominion/GAI
5) In areas that did not have lidar data, hillshade was created from 1/3 arc-second (10m) NED

Dominion

Geosyntec consultants

TESSELLATIONS

Geosyntec consultants

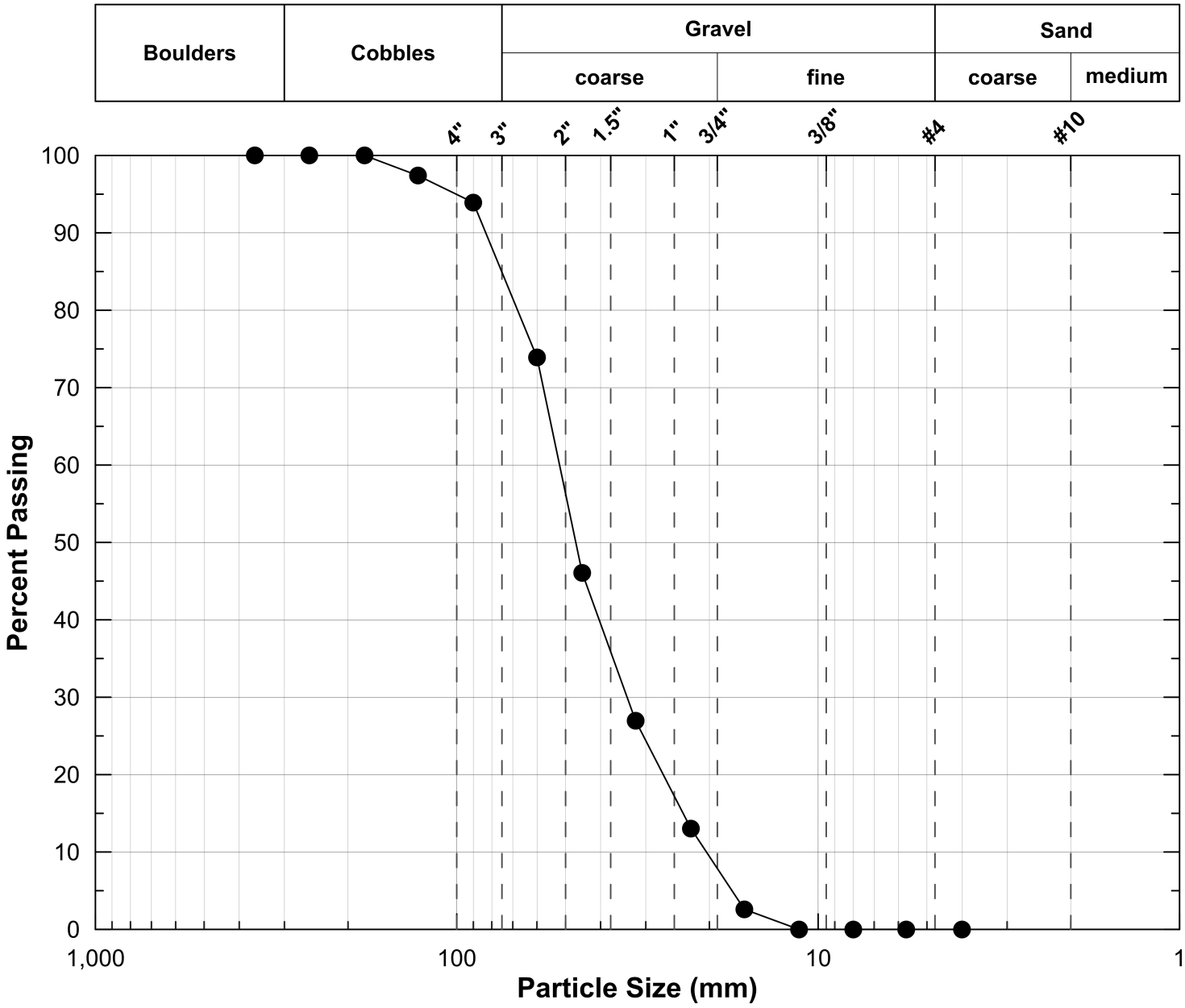
TID	SC_0454	**ACP Segment**	AP-1
Stream Name	Wheeler Cove	**MP**	171.62
Survey Date	27-Sep-2016	**Start Time**	1040 hrs

- Stream bed comprises gravel armor with some cobble-sized particles.
- Riffle-pool morphology.
- BFW = 16.5 feet, BFD = 1.3 feet, BFD (maximum) = 1.8 feet.
- Stream observed at a straight reach.
- Right bank terrace is about 7-ft high and left bank about 5-ft high.
- Observed layering on right bank comprising fine and medium gravel-sized particles overlain by sand and silt.
- Potential observation of bedrock in channel bed along toe of right bank.
- Narrow riparian buffer of about 1 to 2 stream widths.
- Conducted Wolman Pebble Count.

Recommendation:

Evaluate scour depth for pipeline burial depth. Conduct lateral migration evaluation to set location of sag bends. Our field observations suggest one stream width from each top of terrace.

Wolman Pebble Count at SC_0454



Geosyntec consultants

engineers | scientists | innovators

Wolman Pebble Count

Phase 2 Hydrotechnical Characterization Program
Virginia and West Virginia
Atlantic Coast Pipeline
February 2017 Dominion Transmission Inc.

Stream Reconnaissance (Based on Thorne, 1998)

Section 1 - Site Description

Date:	27-Sep-16	Stream Name:	Wheeler Cove
Crossing ID:	SC_0454		

Section 2 - Region and Valley Description

Part 1: Watershed

Land Use

- [X] Natural
- [X] Agricultural
- [ ] Urban
- [ ] Suburban
- [ ] Rural
- [ ] Industrial
- [ ] Cattle grazing

Part 2: River Valley Conditions

Vegetation

- [ ] None
- [ ] Grass
- [ ] Pasture
- [ ] Crops
- [ ] Shrubs
- [X] Deciduous Forest/trees
- [ ] Coniferous Forest/trees

Valley Side Features

- [X] None
- [ ] Occasional
- [ ] Frequent

Failure Locations

- [X] None
- [ ] Away from river
- [ ] Along river

Part 3: Floodplain

Floodplain Width

- [ ] None
- [ ] 1 < river widths
- [ ] 1-5 river widths
- [X] 5-10 river widths
- [ ] > 10 river widths

Land Use

- [X] Natural
- [ ] Agricultural
- [ ] Urban
- [ ] Suburban
- [ ] Rural
- [ ] Industrial
- [ ] Mining
- [ ] Cattle grazing

Vegetation

- [ ] None
- [X] Grass
- [ ] Pasture
- [ ] Orchards
- [ ] Crops
- [X] Shrubs
- [ ] Deciduous Forest/trees
- [ ] Coniferous Forest/trees

Riparian Buffer Strip

- [ ] None
- [ ] < 1 river width
- [X] 1-5 river widths
- [ ] > 5 river widths

Part 4: Vertical Confinement

Terraces

- [X] None
- [ ] Left bank
- [ ] Right bank

Levees

- [X] None
- [ ] Natural
- [ ] Constructed

Levee Location

- [ ] Along channel bank
- [ ] Set back < 1 river width
- [ ] Set back > 1 river width

Part 5: Lateral Relation of Channel to Valley

Planform

- [X] Straight
- [ ] Meandering
- [ ] Braided
- [ ] Anastomosed
- [ ] Engineered

Meander Characteristics

- [X] Mild bends
- [ ] Moderate bends
- [ ] Tight bends

Section 3 - Channel Description (select all that apply)

Part 6: Channel Description (select all that apply)

Bed Controls

- [X] None
- [ ] Occasional
- [ ] Frequent
- [ ] Confined

Control Types

- [X] None
- [ ] Bedrock
- [ ] Boulders

Width Controls

- [X] None
- [ ] Occasional
- [ ] Frequent
- [ ] Confined

Control Types

- [X] None
- [ ] Bedrock
- [ ] Boulders

Other

- [ ] Debris
- [ ] Mining
- [ ] Reservoir
- [ ] Knickpoint

Flow Habit

- [X] Perennial
- [ ] Flashy perennial
- [ ] Intermittent
- [ ] Ephemeral

Channel Width: 16.5'

M-B Classification

- [ ] Cascade or step-pool
- [X] Plane, pool-riffle, dune-ripple
- [ ] Braided

Part 7: Bed Sediment Description (select all that apply)

Bed Material	***Bar Types***	***Bar Material***	***Bar Vegetation***	***Bar Width***
[ ] Clay	[X] None	[ ] Silt	[ ] None	[ ] None
[ ] Silt	[ ] Alternate bars	[ ] Sand	[ ] Grasses	[ ] Narrow
[ ] Sand	[ ] Point bars	[ ] Gravel	[ ] Reeds/shrubs	[ ] Moderate
[X] Gravel	[ ] Mid-channel bars	[ ] Cobbles	[ ] Trees	[ ] Wide
[ ] Cobbles	[ ] Diagonal bars			
[ ] Boulders	[ ] Irregular/combination			
[ ] Bedrock	[ ] Braided			

Percent sand in bed = <5 %

Section 4 - Bank Survey (select all that apply)

Bank Characteristic	***Left Bank***	***Right Bank***
Bank Material	[ ] Clay [X] Silt [X] Sand [ ] Gravel [ ] Cobbles [ ] Boulders [ ] Bedrock	[ ] Clay [X] Silt [X] Sand [X] Gravel [ ] Cobbles [ ] Boulders [ ] Bedrock
Layer Material	[ ] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders	[ ] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders
Bank Height	5'	7'
Bank Slope	[ ] Steep [X] Moderate [ ] Shallow	[ ] Steep [X] Moderate [ ] Shallow
Bank Vegetation	[ ] None [X] Grasses/annuals [ ] Reeds/shrubs [ ] Trees: Falling trees? [X] Y [ ] N Tree density [X] sparse [ ] dense Tree health [X] good [ ] poor tree ages [X] young [ ] mature [ ] old tree diversity [X] Y [ ] N	[ ] None [X] Grasses/annuals [ ] Reeds/shrubs [ ] Trees: Falling trees? [X] Y [ ] N Tree density [X] sparse [ ] dense Tree health [X] good [ ] poor tree ages [X] young [ ] mature [ ] old tree diversity [X] Y [ ] N
Bank Erosion and Failure Location	location of erosion [X] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [ ] general type of erosion [X] fluvial [ ] geotechnical	location of erosion [X] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [ ] general type of erosion [X] fluvial [ ] geotechnical

GEOSYNTEC CONSULTANTS
Photographic Record

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0454, Wheeler Cove at MP 171.62 (AP-1)

Photograph 1 (IMG_1124.jpg) Date: 27 September 2016 Direction: Downstream Description: View of densely vegetated narrow riparian buffer (1 channel width on both banks) and entrenched stream at pipeline crossing. Bankfull width is 16.5 ft and depth (maximum) is 1.8 ft. Right bank terrace is 7-ft high and left bank terrace is 5-ft high.	
Photograph 2 (IMG_1125.JPG) Date: 27 September 2016 Direction: Upstream Description: Stream bed is comprised of gravel armor and some cobble-sized particles. The water is turbid due to precipitation prior to survey.	

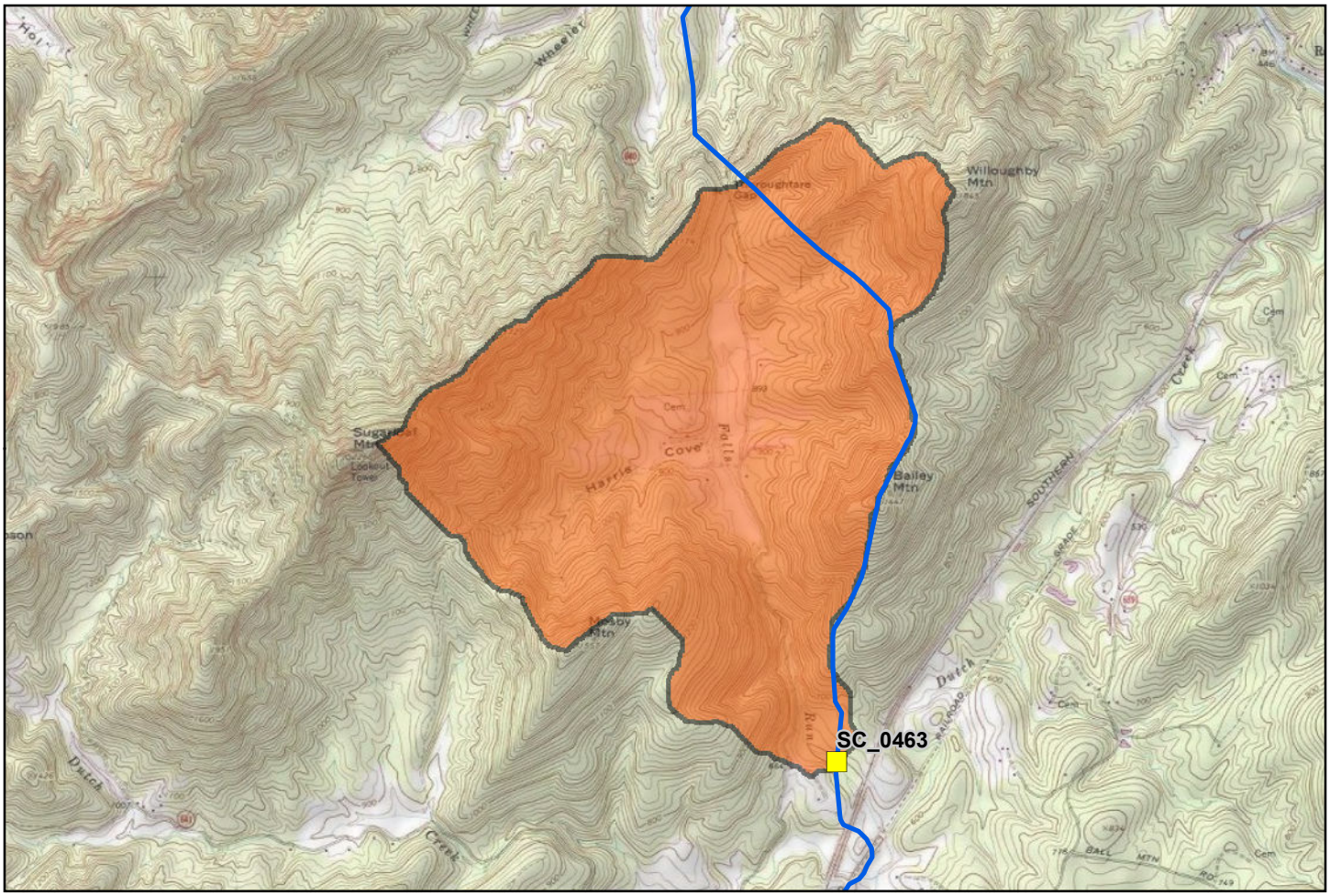
GEOSYNTEC CONSULTANTS

Photographic Record

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0454, Wheeler Cove at MP 171.62 (AP-1)

Photograph 3 IMG_1128.JPG	
Date: 27 September 2016	
Direction: Towards right bank	
Description: Layering of coarse gravel-sized particles on right bank overlain by fine grained soils with possible outcrop of weathered bedrock (or boulder) at toe of bank below water surface.	



TID	Unique ID	ACP Branch	Mile Post	State	County
SC_0463	snec057	AP-1	175.14	Virginia	Nelson

Attribute	Value
Stream Name	Falls Run
Physiographic Province[1]	Piedmont
Drainage Area (square miles)[2]	2.537
Flow Regime	Perennial
Measured Bank Full Width (ft)[3]	19
Slope At Crossing Over 200ft Long Reach (%)[4]	1.601
Proposed Construction Method[5]	Dam and Pump

Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636
- Watershed Boundary

Drainage Area Map

1:50,000

0 1,125 2,250 4,500 Feet

0 1 Miles

N

Document Information:

Document No:
DOM_EC_HYD_MA_SER001_SC_0463

Revision	Date	Created By	Approved by
0	08-01-2016	BP	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

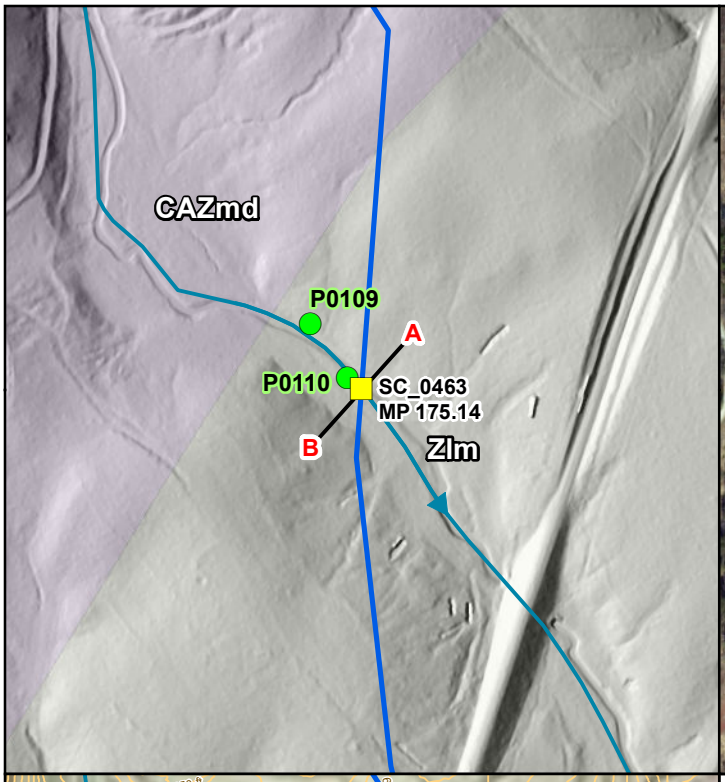
Notes:

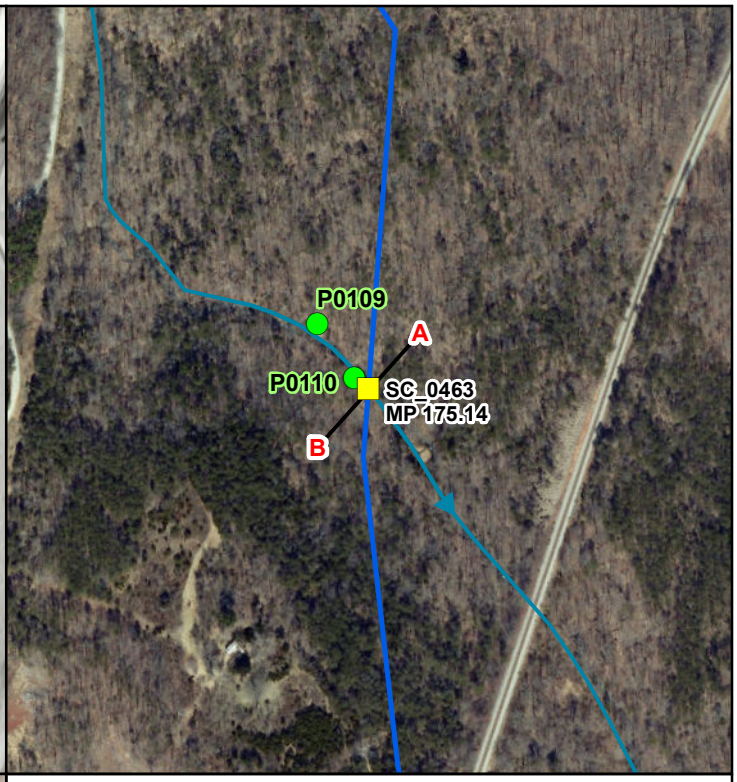
1) After Fenneman (1946)
2) Calculated using USGS 1:24,000 topographic maps and ArcGIS interface.
3) Measured during stream reconnaissance.
4) Calculated using one of four methods described in Section 3.2.3.1.
5) The current alignment centerline and mileposts provided by Dominion/GAI.

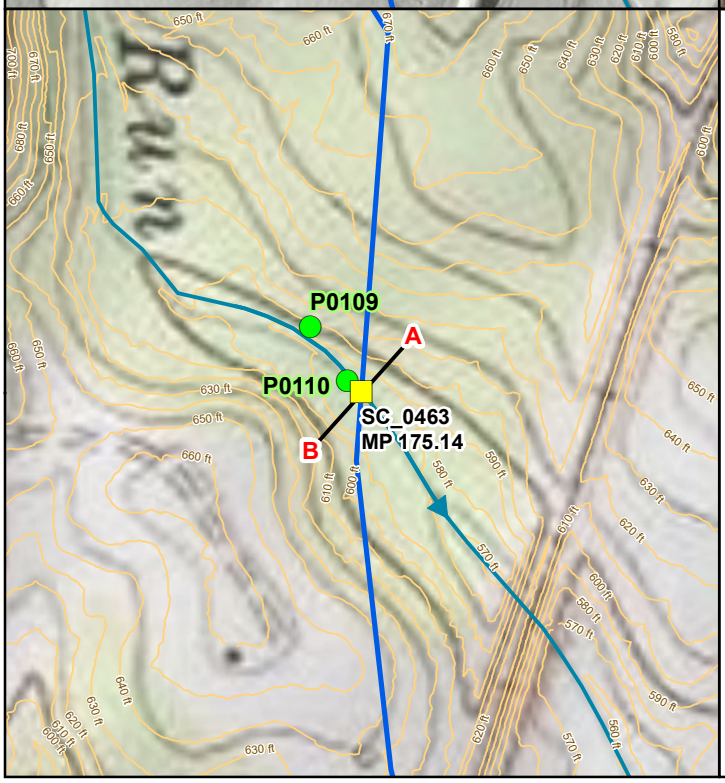
Dominion

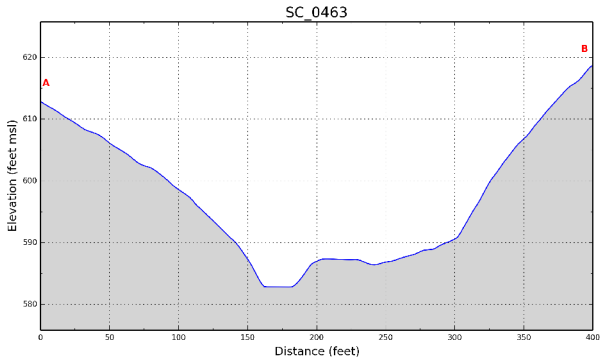
Geosyntec consultants

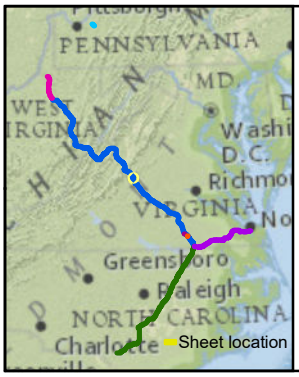
TESSELLATIONS











Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- Field Observation Locations
- Profile Line (400ft)
- Stream with Flow Direction
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636

Stream Crossing Plan View and Profile

Location ID: snec057

TID_SC: SC_0463

Stream Name: Falls Run

1:6,000

0 125 250 500 Feet

0 0.025 0.05 0.1 Miles

N

Document Information:

Document No:
DOM_EC_CRO_MA_001_SC_0463

Revision	Date	Created By	Approved by
0	07-28-2016	CR	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

Notes:

1) The current alignment centerline provided by Dominion/GAI
2) Projection: UTM 17N feet, NAD 83
3) The vertical exaggeration on the profile graph is 4:1
4) Hillshade (azimuth: 280) created from 2 foot lidar data provided by Dominion/GAI
5) In areas that did not have lidar data, hillshade was created from 1/3 arc-second (10m) NED

Dominion

Geosyntec consultants

TESSELLATIONS

TID	SC_0463	**ACP Segment**	AP-1
Stream Name	Falls Run	**MP**	175.14
Survey Date	27-Sep-2016	**Start Time**	0918 hrs

- Stream bed comprises primarily large cobbles and some boulders, but bedrock outcrops were also identified during the survey.
- BFW = 19 feet, BFD = 1.5 feet, BFD (maximum) = 2.1 feet.
- Riffle-pool morphology.
- Stream observed at a straight reach.
- Left and right bank terraces are 3 feet above bankfull.
- Floodplain off right bank is approximately 5 stream widths wide and left bank is constrained by valley wall.
- Densely vegetated floodplain with young and mature trees.

Recommendation:

Bury pipe into bedrock and from valley wall to valley wall.

Stream Reconnaissance (Based on Thorne, 1998)

Section 1 - Site Description

Date:	27-Sep-16	Stream Name:	Falls Run
Crossing ID:	SC_0463		

Section 2 - Region and Valley Description

Part 1: Watershed

Land Use

- [X] Natural
- [ ] Agricultural
- [ ] Urban
- [ ] Suburban
- [ ] Rural
- [ ] Industrial
- [ ] Cattle grazing

Part 2: River Valley Conditions

Vegetation

- [ ] None
- [ ] Grass
- [ ] Pasture
- [ ] Crops
- [X] Shrubs
- [X] Deciduous Forest/trees
- [ ] Coniferous Forest/trees

Valley Side Features

- [ ] None
- [X] Occasional
- [ ] Frequent

Failure Locations

- [ ] None
- [ ] Away from river
- [ ] Along river

Part 3: Floodplain

Floodplain Width

- [ ] None
- [ ] 1 < river widths
- [X] 1-5 river widths
- [ ] 5-10 river widths
- [ ] > 10 river widths

Land Use

- [X] Natural
- [ ] Agricultural
- [ ] Urban
- [ ] Suburban
- [ ] Rural
- [ ] Industrial
- [ ] Mining
- [ ] Cattle grazing

Vegetation

- [ ] None
- [ ] Grass
- [ ] Pasture
- [ ] Orchards
- [ ] Crops
- [X] Shrubs
- [X] Deciduous Forest/trees
- [ ] Coniferous Forest/trees

Riparian Buffer Strip

- [ ] None
- [ ] < 1 river width
- [X] 1-5 river widths
- [ ] > 5 river widths

Part 4: Vertical Confinement

Terraces

- [ ] None
- [ ] Left bank
- [X] Right bank

Levees

- [X] None
- [ ] Natural
- [ ] Constructed

Levee Location

- [ ] Along channel bank
- [ ] Set back < 1 river width
- [ ] Set back > 1 river width

Part 5: Lateral Relation of Channel to Valley

Planform

- [X] Straight
- [ ] Meandering
- [ ] Braided
- [ ] Anastomosed
- [ ] Engineered

Meander Characteristics

- [ ] Mild bends
- [ ] Moderate bends
- [ ] Tight bends

Section 3 - Channel Description (select all that apply)

Part 6: Channel Description (select all that apply)

Bed Controls

- [ ] None
- [ ] Occasional
- [X] Frequent
- [ ] Confined

Control Types

- [ ] None
- [X] Bedrock
- [X] Boulders

Width Controls

- [ ] None
- [ ] Occasional
- [ ] Frequent
- [X] Confined

Control Types

- [ ] None
- [X] Bedrock
- [X] Boulders

Other

- [ ] Debris
- [ ] Mining
- [ ] Reservoir
- [ ] Knickpoint

Flow Habit

- [X] Perennial
- [ ] Flashy perennial
- [ ] Intermittent
- [ ] Ephemeral

Channel Width: 19'

M-B Classification

- [ ] Cascade or step-pool
- [X] Plane, pool-riffle, dune-ripple
- [ ] Braided

Part 7: Bed Sediment Description (select all that apply)

Bed Material	***Bar Types***	***Bar Material***	***Bar Vegetation***	***Bar Width***
[ ] Clay	[X] None	[ ] Silt	[ ] None	[ ] None
[ ] Silt	[ ] Alternate bars	[ ] Sand	[ ] Grasses	[ ] Narrow
[ ] Sand	[ ] Point bars	[ ] Gravel	[ ] Reeds/shrubs	[ ] Moderate
[ ] Gravel	[ ] Mid-channel bars	[ ] Cobbles	[ ] Trees	[ ] Wide
[X] Cobbles	[ ] Diagonal bars			
[X] Boulders	[ ] Irregular/combination			
[ ] Bedrock	[ ] Braided			

Percent sand in bed = <5 %

Section 4 - Bank Survey (select all that apply)

Bank Characteristic	***Left Bank***	***Right Bank***
Bank Material	[ ] Clay [ ] Silt SAND [X] Gravel [X] Cobbles [ ] Boulders [ ] Bedrock	[ ] Clay [ ] Silt SAND [X] Gravel [X] Cobbles [ ] Boulders [ ] Bedrock
Layer Material	[X] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders	[X] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders
Bank Height	1.5'	4'
Bank Slope	[ ] Steep [X] Moderate [ ] Shallow	[ ] Steep [ ] Moderate [ ] Shallow
Bank Vegetation	[ ] None [ ] Grasses/annuals [X] Reeds/shrubs [X] Trees: Falling trees? [X] Y [ ] N Tree density [ ] sparse [X] dense Tree health [X] good [ ] poor tree ages [X] young [ ] mature [ ] old tree diversity [X] Y [ ] N	[ ] None [ ] Grasses/annuals [ ] Reeds/shrubs [ ] Trees: Falling trees? [X] Y [ ] N Tree density [ ] sparse [X] dense Tree health [X] good [ ] poor tree ages [X] young [X] mature [ ] old tree diversity [X] Y [ ] N
Bank Erosion and Failure Location	location of erosion [ ] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [X] general type of erosion [X] fluvial [ ] geotechnical	location of erosion [ ] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [X] general type of erosion [X] fluvial [ ] geotechnical

GEOSYNTEC CONSULTANTS

Photographic Record

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0463, Falls Run at MP 175.14 (AP-1)

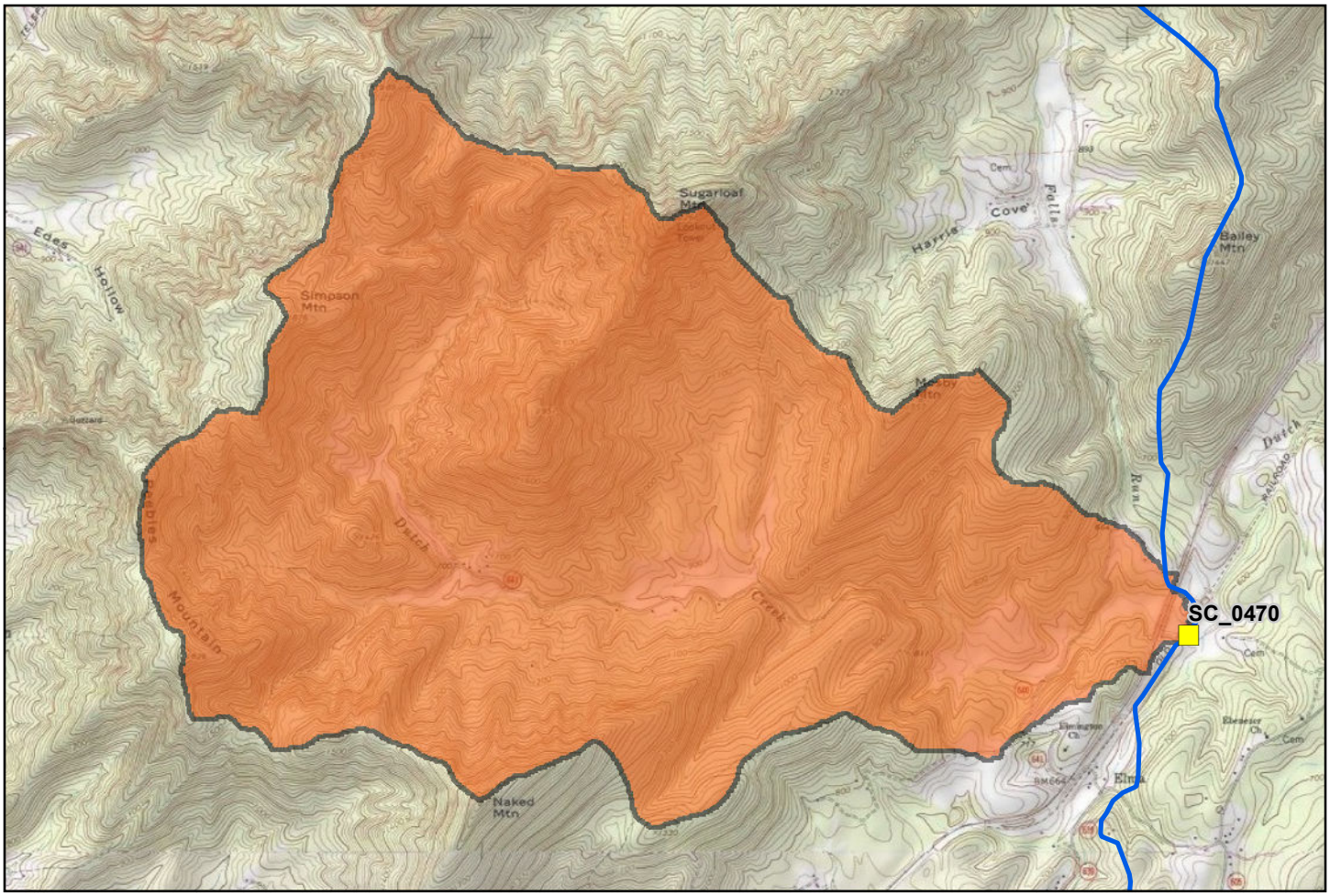
Photograph 1 (IMG_1111.JPG) Date: 27 September 2016 Direction: Upstream Description: View of densely vegetated riparian buffer along a straight reach at pipeline crossing. Stream comprises large cobbles and some boulders and underlain by bedrock. The water is turbid because survey was conducted in the morning following precipitation.	
Photograph 2 (IMG_1113.JPG) Date: 27 September 2016 Direction: Downstream Description: Similar observations as above in this downstream view. Stream bankfull width is 19 ft and depth (maximum) is 2.1 ft. Right and left bank terraces are 3 ft above bankfull.	

GEOSYNTEC CONSULTANTS
Photographic Record

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0463, Falls Run at MP 175.14 (AP-1)

Photograph 3 (IMG_3934.JPG) Date: 27 September 2016 Direction: Upstream Description: Bedrock identified in stream bed (red arrow). Bedrock was observed upstream and downstream of the crossing.	
Photograph 4 (IMG_1121.JPG) Date: 27 September 2016 Direction: Upstream Description: View of step pool morphology with stream bed dominated by boulders at a road crossing about 0.8 miles upstream of pipeline crossing.	



TID	Unique ID	ACP Branch	Mile Post	State	County
SC_0470	snec056	AP-1	175.56	Virginia	Nelson

Attribute	Value
Stream Name	Dutch Creek
Physiographic Province[1]	Piedmont
Drainage Area (square miles)[2]	5.589
Flow Regime	Perennial
Measured Bank Full Width (ft)[3]	26
Slope At Crossing Over 200ft Long Reach (%)[4]	0.702
Proposed Construction Method[5]	Dam and Pump

Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636
- Watershed Boundary

Drainage Area Map

1:50,000

0 1,125 2,250 4,500 Feet

0 1 Miles

N

Document Information:

Document No:
DOM_EC_HYD_MA_SER001_SC_0470

Revision	Date	Created By	Approved by
0	08-01-2016	BP	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

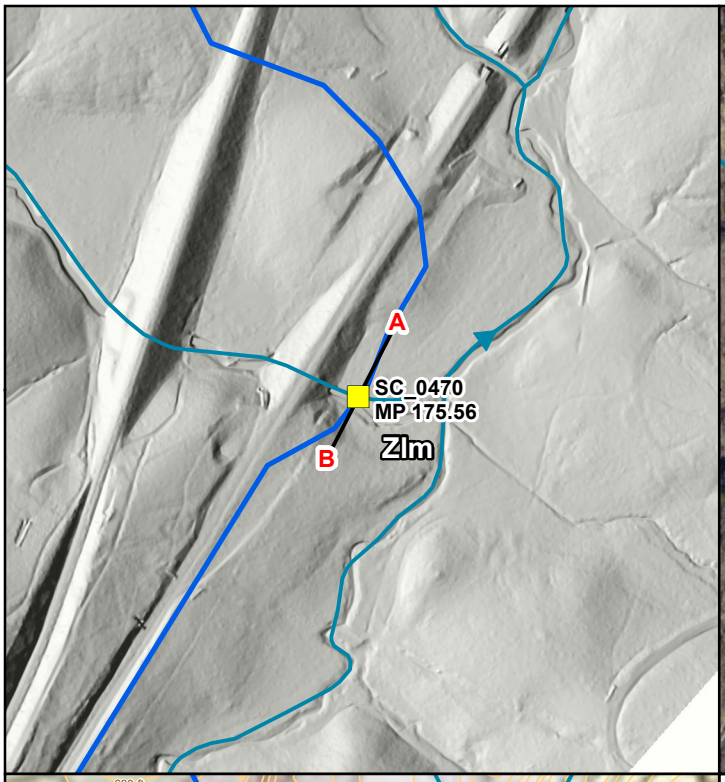
Notes:

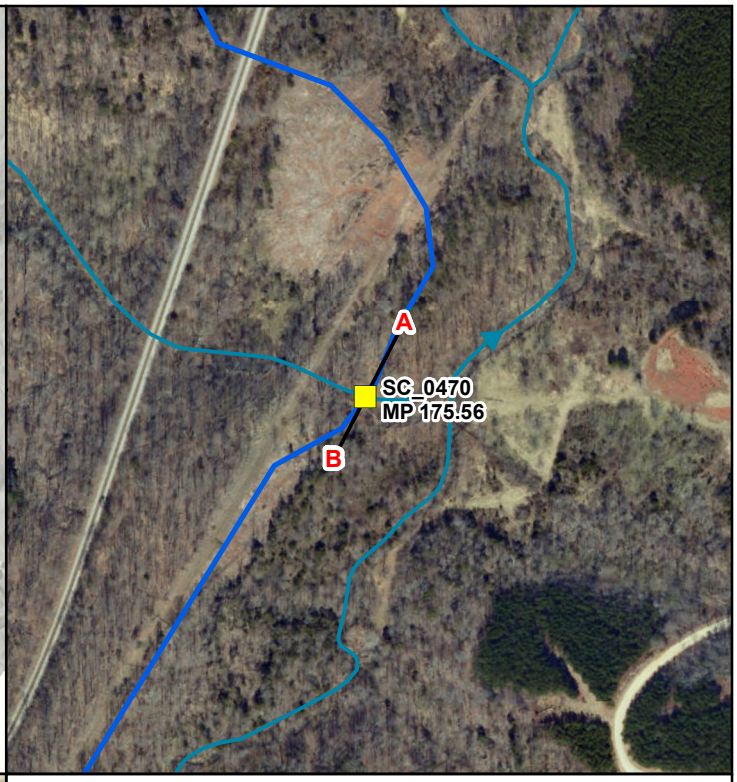
1) After Fenneman (1946)
2) Calculated using USGS 1:24,000 topographic maps and ArcGIS interface.
3) Measured during stream reconnaissance.
4) Calculated using one of four methods described in Section 3.2.3.1.
5) The current alignment centerline and mileposts provided by Dominion/GAI.

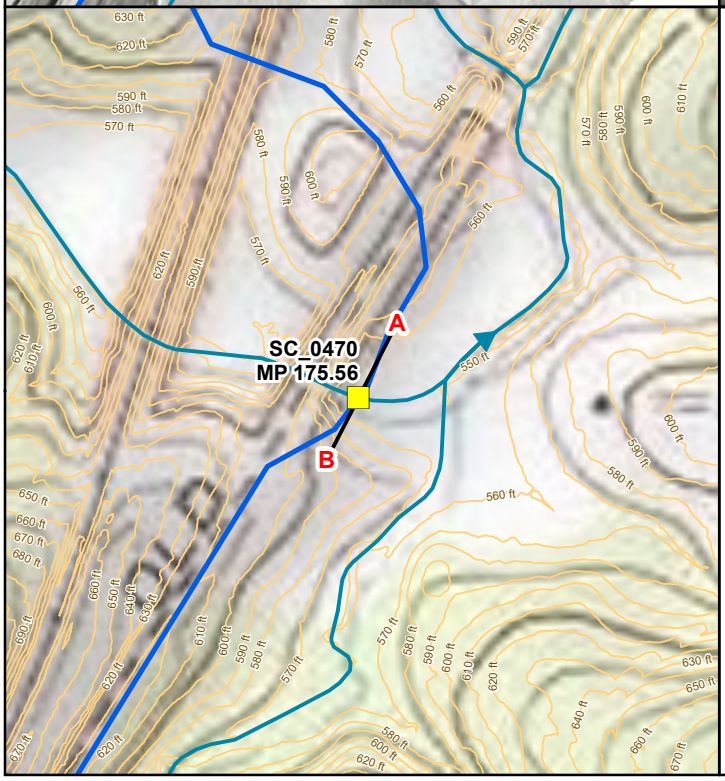
Dominion

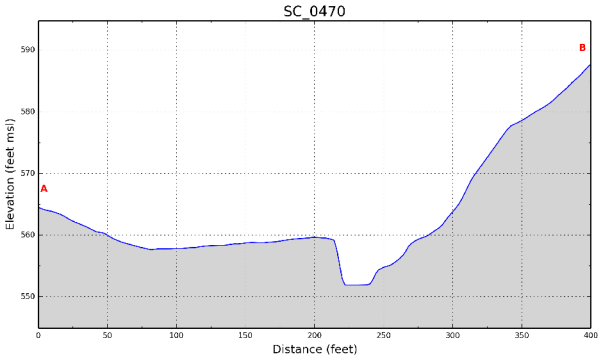
Geosyntec consultants

TESSELLATIONS









Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- Field Observation Locations
- Profile Line (400ft)
- Stream with Flow Direction
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636

Stream Crossing Plan View and Profile

Location ID: snec056

TID_SC: SC_0470

Stream Name: Dutch Creek

1:6,000

0 125 250 500 Feet

0 0.025 0.05 0.1 Miles

N

Document Information:

Document No:
DOM_EC_CRO_MA_001_SC_0470

Revision	Date	Created By	Approved by
0	07-28-2016	CR	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

Notes:

1) The current alignment centerline provided by Dominion/GAI
2) Projection: UTM 17N feet, NAD 83
3) The vertical exaggeration on the profile graph is 4:1
4) Hillshade (azimuth: 280) created from 2 foot lidar data provided by Dominion/GAI
5) In areas that did not have lidar data, hillshade was created from 1/3 arc-second (10m) NED

Dominion

Geosyntec consultants

TESSELLATIONS

TID	SC_0470	**ACP Segment**	AP-1
Stream Name	Dutch Creek	**MP**	175.56
Survey Date	26-Sep-2016	**Start Time**	1815 hrs

- Pipeline crossing is located approximately 100-ft downstream of a 14-ft wide arch tunnel underneath an abandoned railroad embankment that is about 40-ft high. The embankment and tunnel provide lateral control.
- Riffle-pool morphology.
- Stream measurements taken at a pool where stream is beginning to meander
- BFW = 26 feet, BFD = 2.1, BFD (maximum) = 3.2 feet
- Left bank terrace is near vertical and about 7-ft high and is comprised of silty fine and medium sand.
- Stream bed comprised of coarse sand and fine gravel and some small cobble.
- Densely vegetated riparian buffer comprising young and mature trees and shrubs.

Recommendation:

Evaluate scour depth for pipeline burial depth. Conduct lateral migration evaluation to set location of sag bends.

Stream Reconnaissance (Based on Thorne, 1998)

Section 1 - Site Description

Date:	26-Sep-16	Stream Name:	Dutch Creek
Crossing ID:	SC_0470		

Section 2 - Region and Valley Description

Part 1: Watershed

Land Use

X	Natural
	Agricultural
	Urban
	Suburban
	Rural
	Industrial
	Cattle grazing

Part 2: River Valley Conditions

Vegetation

	None
	Grass
	Pasture
	Crops
X	Shrubs
X	Deciduous Forest/trees
	Coniferous Forest/trees

Valley Side Features

X	None
	Occasional
	Frequent

Failure Locations

	None
	Away from river
	Along river

Part 3: Floodplain

Floodplain Width

	None
X	1 < river widths
	1-5 river widths
	5-10 river widths
	> 10 river widths

Land Use

X	Natural
	Agricultural
	Urban
	Suburban
	Rural
	Industrial
	Mining
	Cattle grazing

Vegetation

	None
	Grass
	Pasture
	Orchards
	Crops
X	Shrubs
X	Deciduous Forest/trees
	Coniferous Forest/trees

Riparian Buffer Strip

	None
	< 1 river width
X	1-5 river widths
	> 5 river widths

Part 4: Vertical Confinement

Terraces

	None
	Left bank
X	Right bank

Levees

X	None
	Natural
	Constructed

Levee Location

	Along channel bank
	Set back < 1 river width
	Set back > 1 river width

Part 5: Lateral Relation of Channel to Valley

Planform

X	Straight
	Meandering
	Braided
	Anastomosed
	Engineered

Meander Characteristics

	Mild bends
	Moderate bends
	Tight bends

Section 3 - Channel Description (select all that apply)

Part 6: Channel Description (select all that apply)

Bed Controls

X	None
	Occasional
	Frequent
	Confined

Control Types

X	None
	Bedrock
	Boulders

Width Controls

	None
	Occasional
	Frequent
X	Confined

Control Types

	None
	Bedrock
	Boulders
X	Confined

Other

	Debris
	Mining
	Reservoir
	Knickpoint

Flow Habit

- [X] Perennial
- [ ] Flashy perennial
- [ ] Intermittent
- [ ] Ephemeral

Channel Width: 26'

M-B Classification

- [ ] Cascade or step-pool
- [X] Plane, pool-riffle, dune-ripple
- [ ] Braided

Part 7: Bed Sediment Description (select all that apply)

Bed Material	***Bar Types***	***Bar Material***	***Bar Vegetation***	***Bar Width***
[ ] Clay	[ ] None	[ ] Silt	[ ] None	[ ] None
[ ] Silt	[ ] Alternate bars	[X] Sand	[X] Grasses	[X] Narrow
[X] Sand	[X] Point bars	[X] Gravel	[ ] Reeds/shrubs	[ ] Moderate
[X] Gravel	[ ] Mid-channel bars	[ ] Cobbles	[ ] Trees	[ ] Wide
[ ] Cobbles	[ ] Diagonal bars			
[ ] Boulders	[ ] Irregular/combination			
[ ] Bedrock	[ ] Braided			

Percent sand in bed = _____ %

Section 4 - Bank Survey (select all that apply)

Bank Characteristic	***Left Bank***	***Right Bank***
Bank Material	[ ] Clay [X] Silt SAND [ ] Gravel [ ] Cobbles [ ] Boulders [ ] Bedrock	[ ] Clay [X] Silt SAND [ ] Gravel [ ] Cobbles [ ] Boulders [ ] Bedrock
Layer Material	[X] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders	[X] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders
Bank Height	7'	
Bank Slope	[X] Steep [ ] Moderate [ ] Shallow	[ ] Steep [ ] Moderate [ ] Shallow
Bank Vegetation	[ ] None [ ] Grasses/annuals [X] Reeds/shrubs [X] Trees: Falling trees? [X] Y [ ] N Tree density [ ] sparse [X] dense Tree health [X] good [ ] poor tree ages [X] young [X] mature [ ] old tree diversity [X] Y [ ] N	[ ] None [ ] Grasses/annuals [X] Reeds/shrubs [X] Trees: Falling trees? [X] Y [ ] N Tree density [ ] sparse [X] dense Tree health [X] good [ ] poor tree ages [X] young [X] mature [ ] old tree diversity [X] Y [ ] N
Bank Erosion and Failure Location	location of erosion [ ] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [X] general type of erosion [X] fluvial [ ] geotechnical	location of erosion [ ] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [X] general type of erosion [X] fluvial [ ] geotechnical

GEOSYNTEC CONSULTANTS

Photographic Record

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0470, Dutch Creek at MP 175.56 (AP-1)

Photograph 1 (IMG_1104.JPG) Date: 26 September 2016 Direction: Downstream Description: View of point bar and meander at pipeline stream crossing, where stream bed comprises coarse sand and fine and coarse gravel. Stream bankfull width is 26 ft and depth (maximum) is 3.2 ft (cross-section was at a pool).	
Photograph 2 (IMG_3923.JPG) Date: 26 September 2016 Direction: Upstream Description: 14-ft wide tunnel underneath embankment of abandoned railroad. This upstream structure provides lateral confinement.	

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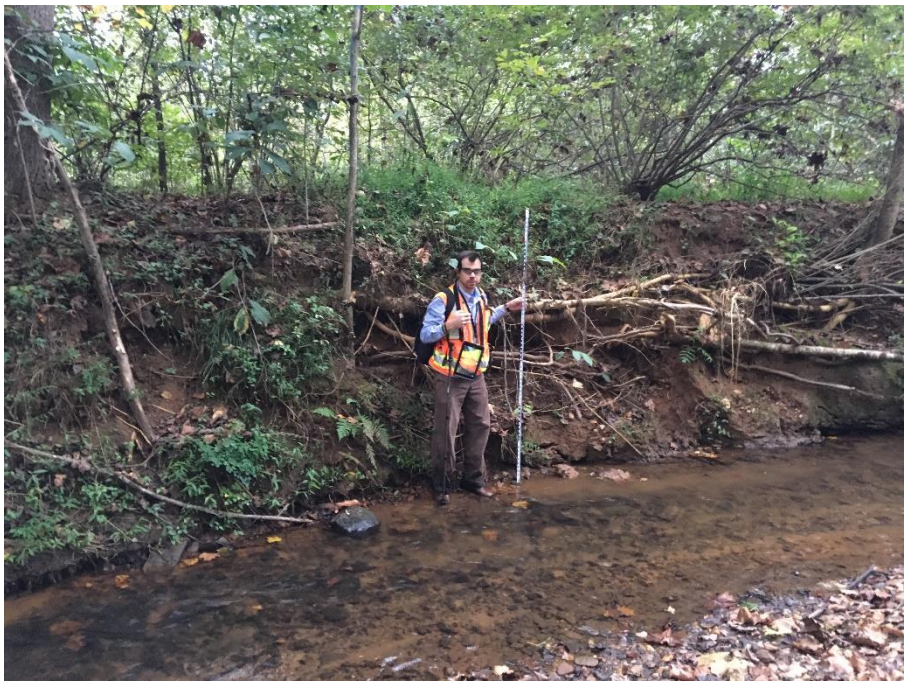
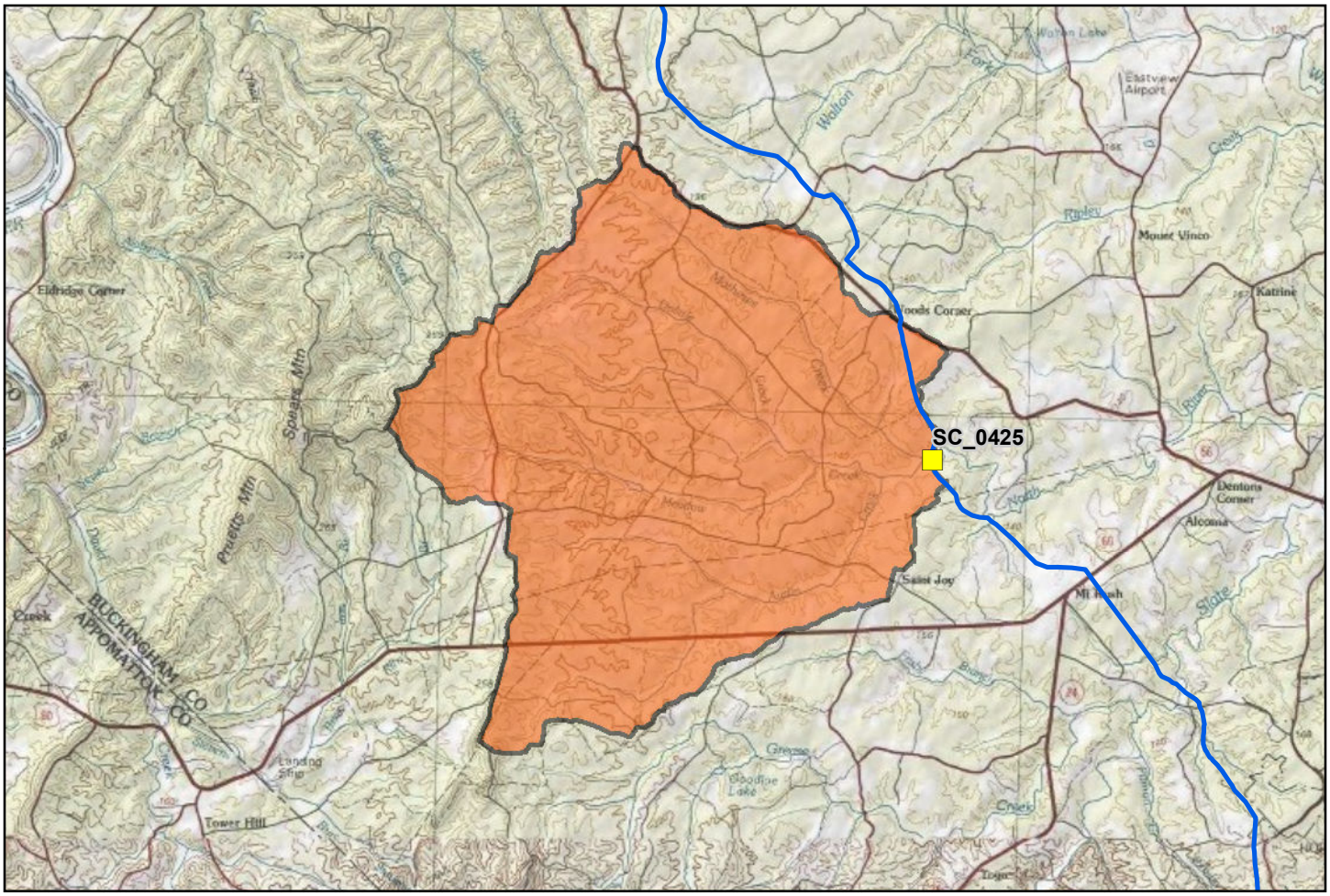
Photographic Record

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0470, Dutch Creek at MP 175.56 (AP-1)

Photograph 3 (IMG_3924.JPG) Date: 26 September 2016 Direction: Towards left bank Description: View of steep 7-ft high left bank terrace at meander comprising silt and fine sand and densely vegetated riparian buffer of young and mature trees and shrubs.	
Photograph 4 (IMG_3928.JPG) Date: 26 September 2016 Direction: at point bar Description: View of coarse sand to coarse gravel particle sizes at point bar.	



TID	Unique ID	ACP Branch	Mile Post	State	County
SC_0425	sbuc005	AP-1	194.11	Virginia	Buckingham

Attribute	Value
Stream Name	North River
Physiographic Province[1]	Piedmont
Drainage Area (square miles)[2]	22.500
Flow Regime	Perennial
Measured Bank Full Width (ft)[3]	34
Slope At Crossing Over 200ft Long Reach (%)[4]	0.264
Proposed Construction Method[5]	1) Dam and Pump 2) Flume

Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636
- Watershed Boundary

Drainage Area Map

1:150,000

0 3,350 6,700 13,400 Feet

0 3.5 Miles

N

Document Information:

Document No:
DOM_EC_HYD_MA_SER001_SC_0425

Revision	Date	Created By	Approved by
0	08-01-2016	BP	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

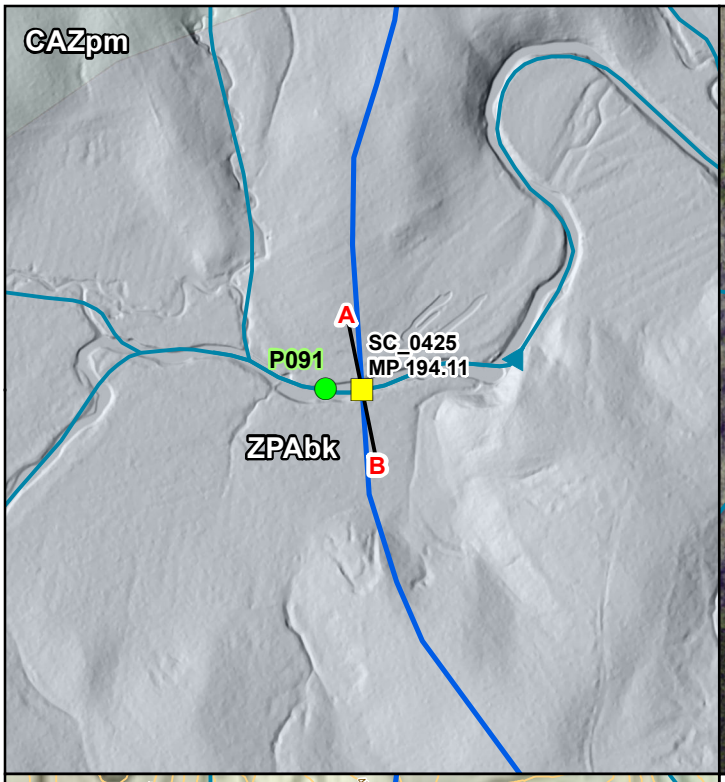
Notes:

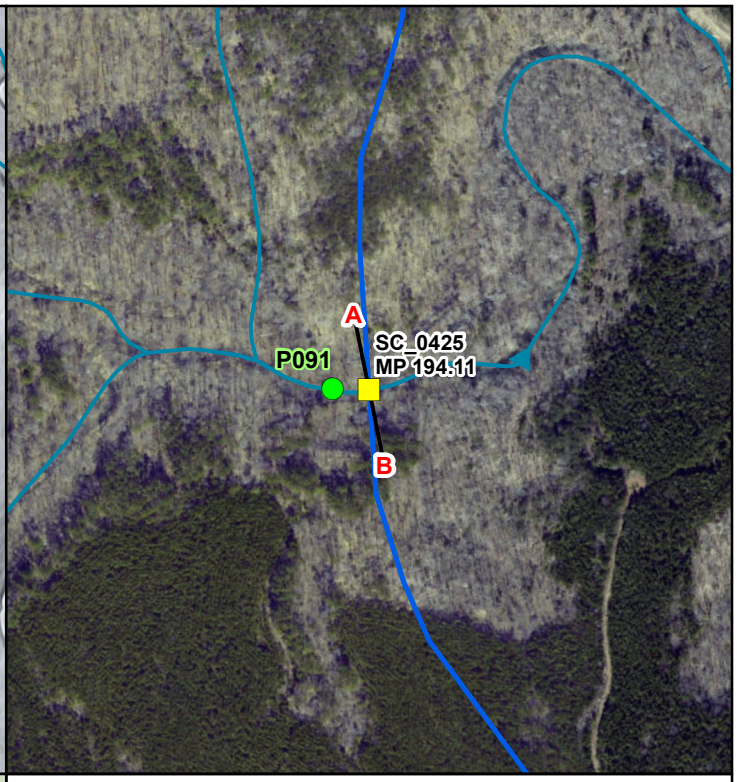
1) After Fenneman (1946)
2) Calculated using USGS 1:24,000 topographic maps and ArcGIS interface.
3) Measured during stream reconnaissance.
4) Calculated using one of four methods described in Section 3.2.3.1.
5) The current alignment centerline and mileposts provided by Dominion/GAI.

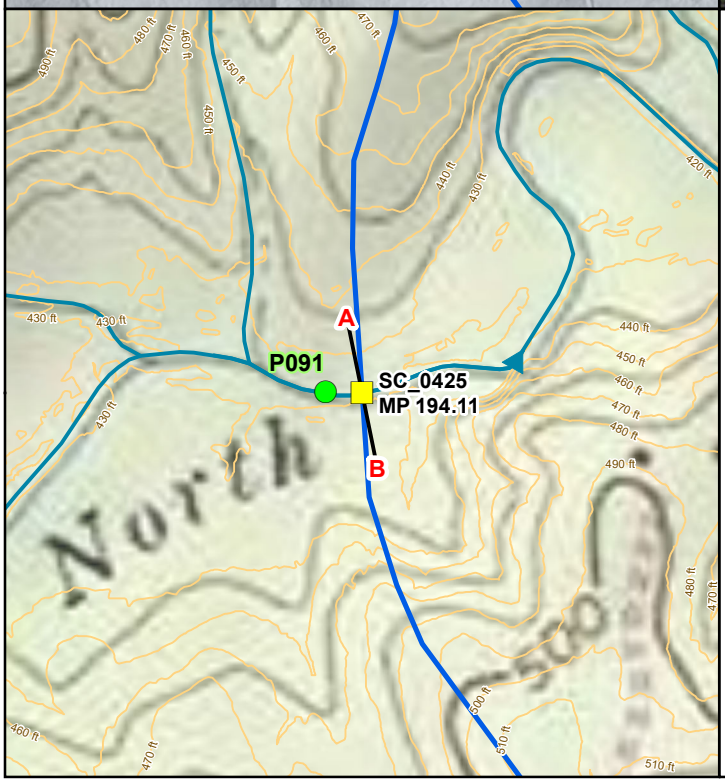
Dominion

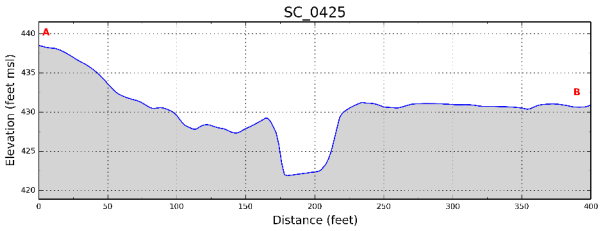
Geosyntec consultants

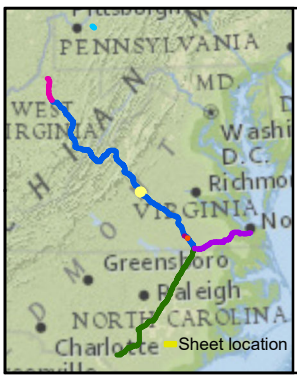
TESSELLATIONS











Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- Field Observation Locations
- Profile Line (400ft)
- Stream with Flow Direction
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636

Stream Crossing Plan View and Profile

Location ID: sbuc005

TID_SC: SC_0425

Stream Name: North River

1:6,000

0 125 250 500 Feet

0 0.025 0.05 0.1 Miles

N

Document Information:

Document No:
DOM_EC_CRO_MA_001_SC_0425

Revision	Date	Created By	Approved by
0	07-28-2016	CR	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

Notes:

1) The current alignment centerline provided by Dominion/GAI
2) Projection: UTM 17N feet, NAD 83
3) The vertical exaggeration on the profile graph is 4:1
4) Hillshade (azimuth: 280) created from 2 foot lidar data provided by Dominion/GAI
5) In areas that did not have lidar data, hillshade was created from 1/3 arc-second (10m) NED

Dominion

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TID	SC_0425	**ACP Segment**	AP-1
Stream Name	North River	**MP**	194.11
Survey Date	14-May-2016	**Start Time**	0925 hrs

- Stream possesses a riffle-pool morphology in a terraced alluvial valley of the Piedmont.
- Mid-channel bars observed and scour around roots and at banks.
- Stream is relatively straight in the vicinity of the crossing.
- Pool depths of approximately 1.7 feet below water surface.
- Channel bed comprised primarily of sand covering medium to fine gravel and some boulders of varying sizes (2 to 6 feet).
- Bedrock outcroppings observed upstream of crossing.
    - Generally, a loosely consolidated bed outside of bedrock sections
- Stream banks composed of fine-grained silt/clay with some sand and gravel.
- Well established deciduous riparian buffer through floodplain.
- Bankfull channel width is 34 feet and bankfull depth is approximately 2 feet.

Additional information on stream crossing is available on stream reconnaissance form.

Recommendation:

Evaluate scour depth for pipeline burial depth. Given lateral migration hazard is moderate due to incised nature of stream, sag bends should be located at least two channel widths outside of left and right banks. If bedrock is encountered shallower than proposed burial depth, burial in bedrock is recommended.

Stream Reconnaissance (Based on Thorne, 1998)

Section 1 - Site Description

Date:	14-May-16	Stream Name:	North River
Crossing ID:	SC_0425		

Section 2 - Region and Valley Description

Part 1: Watershed

Land Use

x	Natural
	Agricultural
	Urban
	Suburban
	Rural
	Industrial
	Cattle grazing

Part 2: River Valley Conditions

Vegetation

	None
	Grass
	Pasture
	Crops
x	Shrubs
x	Deciduous Forest/trees
	Coniferous Forest/trees

Valley Side Features

X	None
	Occasional
	Frequent

Failure Locations

	None
	Away from river
	Along river

Part 3: Floodplain

Floodplain Width

	None
	1 < river widths
	1-5 river widths
	5-10 river widths
x	> 10 river widths

Land Use

x	Natural
	Agricultural
	Urban
	Suburban
	Rural
	Industrial
	Mining
	Cattle grazing

Vegetation

	None
	Grass
	Pasture
	Orchards
	Crops
x	Shrubs
x	Deciduous Forest/trees
	Coniferous Forest/trees

Riparian Buffer Strip

	None
	< 1 river width
	1-5 river widths
x	> 5 river widths

Part 4: Vertical Confinement

Terraces

x	None
	Left bank
	Right bank

Levees

	None
x	Natural
	Constructed

Levee Location

x	Along channel bank
	Set back < 1 river width
	Set back > 1 river width

Part 5: Lateral Relation of Channel to Valley

Planform

x	Straight
	Meandering
	Braided
	Anastomosed
	Engineered

Meander Characteristics

x	Mild bends
	Moderate bends
	Tight bends

Section 3 - Channel Description (select all that apply)

Part 6: Channel Description (select all that apply)

Bed Controls

x	None
	Occasional
	Frequent
	Confined

Control Types

x	None
	Bedrock
	Boulders

Width Controls

	None
	Occasional
	Frequent
x	Confined

Control Types

	None
	Bedrock
	Boulders

Other

	Debris
	Mining
	Reservoir
	Knickpoint

Possible Bedrock Upstream (30' & 100') but unverified at crossing

Incised Channel disconnected from flood plain

Flow Habit

- [x] Perennial
- [ ] Flashy perennial
- [ ] Intermittent
- [ ] Ephemeral

Channel Width: 34.0'

M-B Classification

- [ ] Cascade or step-pool
- [x] Plane, pool-riffle, dune-ripple
- [ ] Braided

Part 7: Bed Sediment Description (select all that apply)

Bed Material	*Bar Types*	*Bar Material*	*Bar Vegetation*	*Bar Width*
[ ] Clay	[ ] None	[ ] Silt	[x] None	[ ] None
[ ] Silt	[ ] Alternate bars	[ ] Sand	[ ] Grasses	[x] Narrow
[x] Sand	[ ] Point bars	[x] Gravel	[ ] Reeds/shrubs	[ ] Moderate
[x] Gravel	[x] Mid-channel bars	[ ] Cobbles	[ ] Trees	[ ] Wide
[ ] Cobbles	[ ] Diagonal bars			
[ ] Boulders	[ ] Irregular/combination			
[ ] Bedrock	[ ] Braided			

Percent sand in bed = _____ %

Section 4 - Bank Survey (select all that apply)

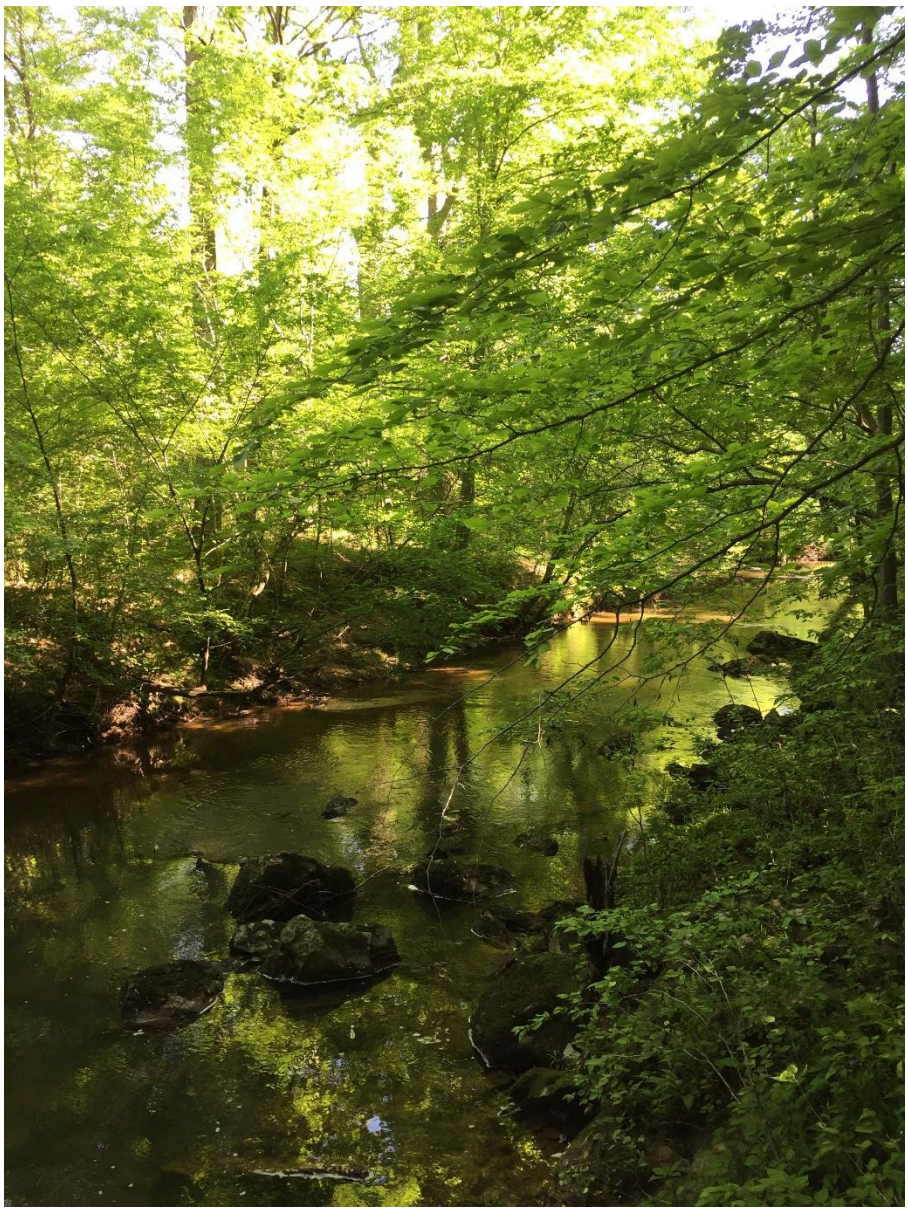
Bank Characteristic	*Left Bank*	*Right Bank*
Bank Material	[ ] Clay [ ] Silt [x] Sand [ ] Gravel [ ] Cobbles [ ] Boulders	[ ] Clay [ ] Silt [x] Sand [ ] Gravel [ ] Cobbles [ ] Boulders
Layer Material	[x] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders	[x] No layers [ ] Cohesive [ ] Sand [ ] Gravel [ ] Cobbles [ ] Boulders
Bank Height	6-8'	6-8'
Bank Slope	[x] Steep [ ] Moderate [ ] Shallow	[x] Steep [ ] Moderate [ ] Shallow
Bank Vegetation	[ ] None [ ] Grasses/annuals [x] Reeds/shrubs [x] Trees: Falling trees? [x] Y [ ] N Tree density [ ] sparse [x] dense Tree health [x] good [ ] poor tree ages [x] young [x] mature [x] old tree diversity [x] Y [ ] N	[ ] None [ ] Grasses/annuals [x] Reeds/shrubs [x] Trees: Falling trees? [x] Y [ ] N Tree density [ ] sparse [x] dense Tree health [x] good [ ] poor tree ages [x] young [x] mature [x] old tree diversity [x] Y [ ] N
Bank Erosion and Failure Location	location of erosion [ ] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [x] general type of erosion [x] fluvial [ ] geotechnical	location of erosion [ ] outside meander bend [ ] inside meander bend [ ] opposite bar or obstruction [x] general type of erosion [x] fluvial [ ] geotechnical

PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0425, North River at MP 194.11 (AP-1)

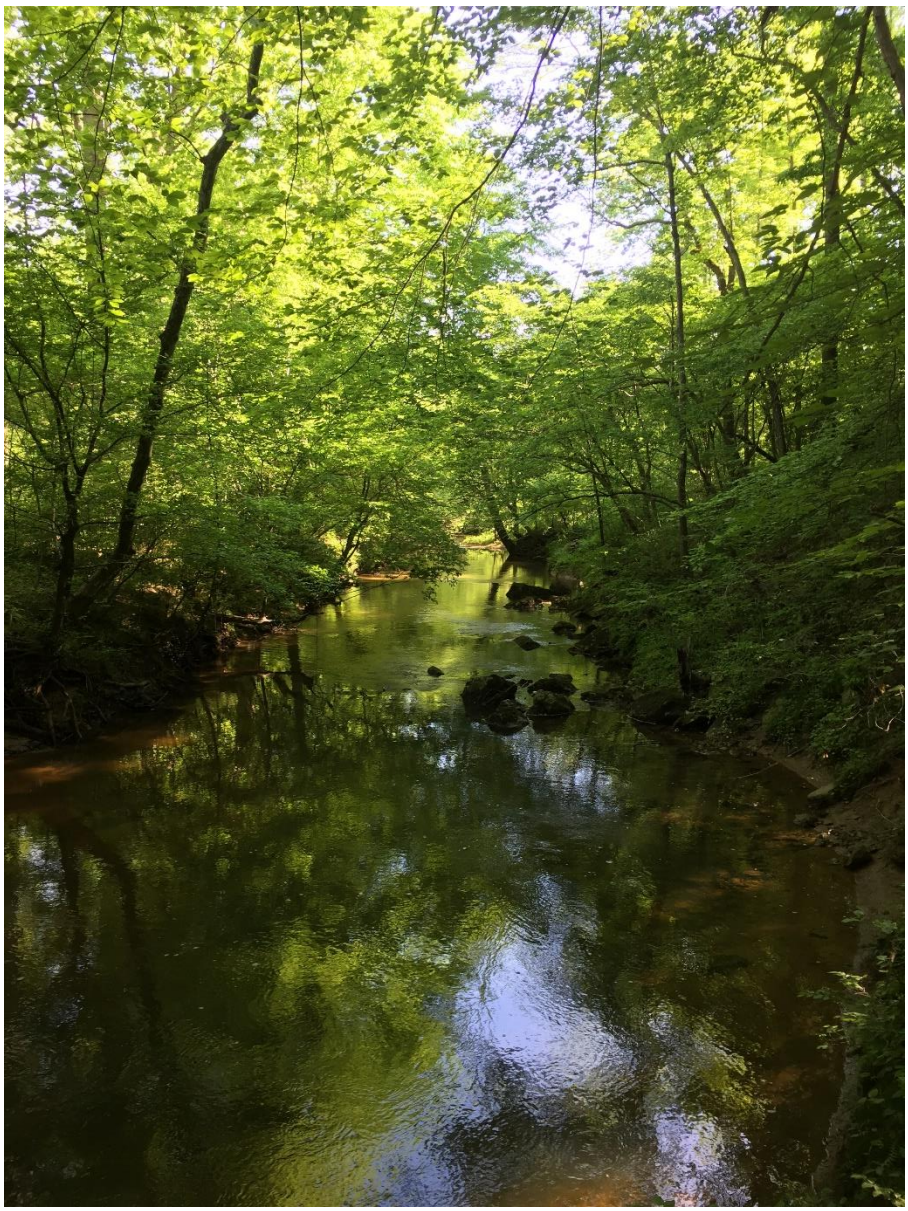
Photograph 1	
Date: 14 May 2016	
Direction: looking downstream	
Description: thick, well established riparian buffer. Lateral confinement provided by valley walls and riparian buffer.	

PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0425, North River at MP 194.11 (AP-1)

Photograph 2	
Date: 14 May 2016	
Direction: looking downstream	
Description: relatively steep banks in vicinity of crossing and historical channel incision. Maturity of some trees near bank indicating slow rates of fluvial erosion.	

PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0425, North River at MP 194.11 (AP-1)

Photograph 3	
Date: 14 May 2016	
Direction: looking downstream	
Description: bedrock outcropping upstream of crossing. Outside of bedrock and gravel bars, bed is loosely consolidated sand.	

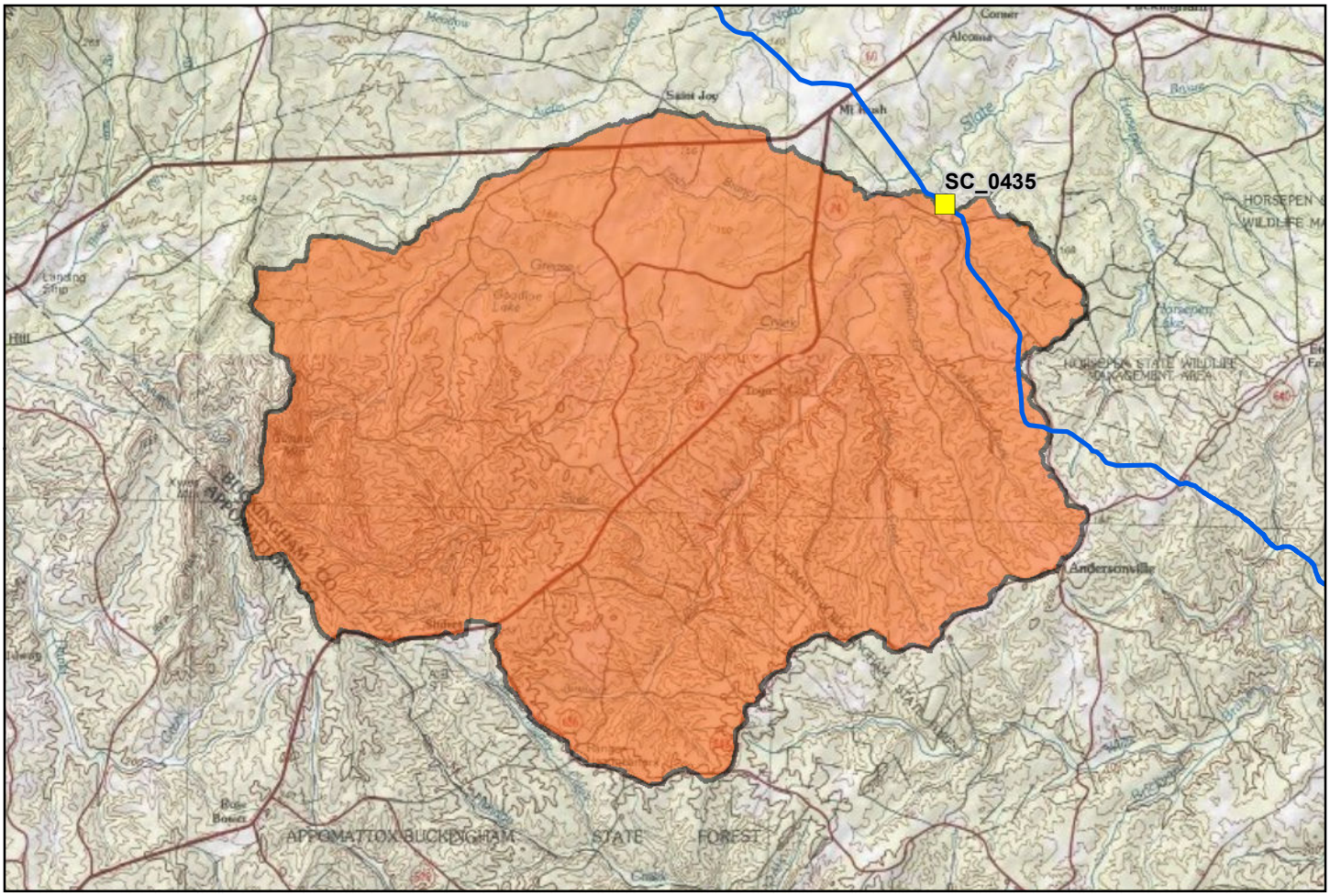
PHASE 2 - RAPID STREAM RECONNAISSANCE
Photographic Record

Geosyntec consultants

Client: Atlantic Coast Pipeline **Project Number:** TXG0007

Subject Site: SC_0425, North River at MP 194.11 (AP-1)

Photograph 4	
Date: 14 May 2016	
Direction: looking upstream	
Description: fallen trees and in channel debris upstream of crossing and bedrock outcropping. Scour present around structures/debris.	



TID	Unique ID	ACP Branch	Mile Post	State	County
SC_0435	sbuk012	AP-1	197.91	Virginia	Buckingham

Attribute	Value
Stream Name	Slate River
Physiographic Province[1]	Piedmont
Drainage Area (square miles)[2]	43.364
Flow Regime	Perennial
Measured Bank Full Width (ft)[3]	33.7
Slope At Crossing Over 200ft Long Reach (%)[4]	0.120
Proposed Construction Method[5]	1) Dam and Pump 2) Flume

Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636
- Watershed Boundary

Drainage Area Map

1:150,000

0 3,350 6,700 13,400 Feet

0 3.5 Miles

N

Document Information:

Document No:
DOM_EC_HYD_MA_SER001_SC_0435

Revision	Date	Created By	Approved by
0	08-01-2016	BP	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

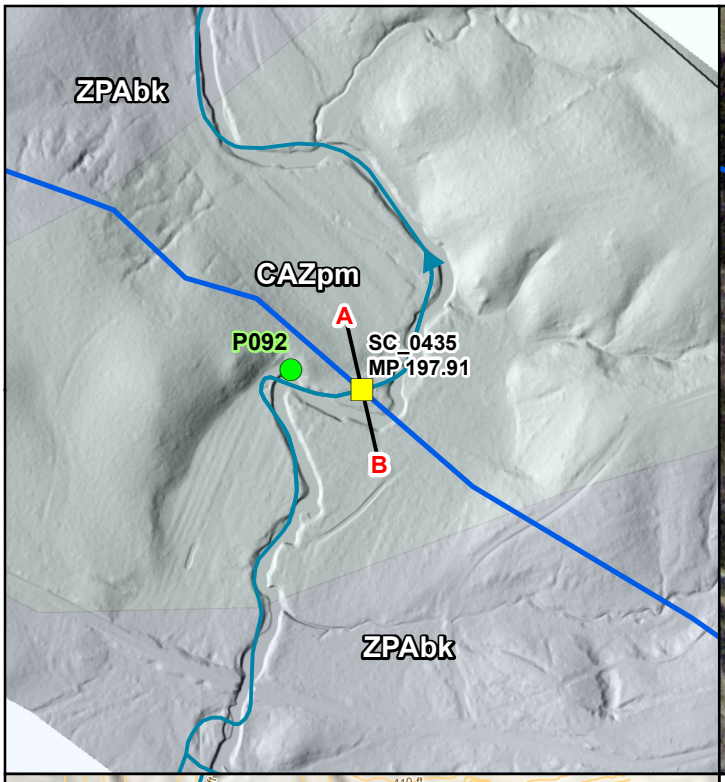
Notes:

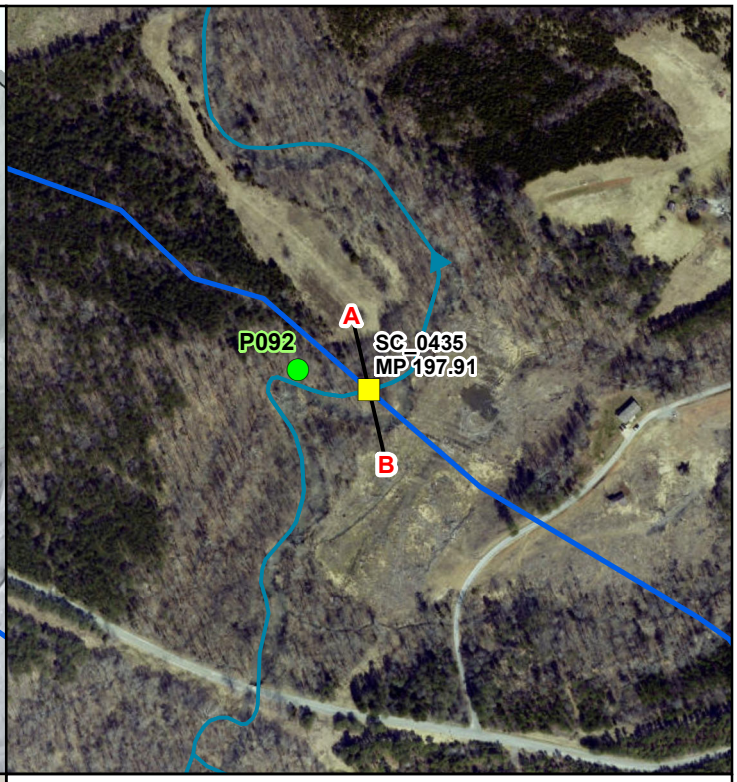
1) After Fenneman (1946)
2) Calculated using USGS 1:24,000 topographic maps and ArcGIS interface.
3) Measured during stream reconnaissance.
4) Calculated using one of four methods described in Section 3.2.3.1.
5) The current alignment centerline and mileposts provided by Dominion/GAI.

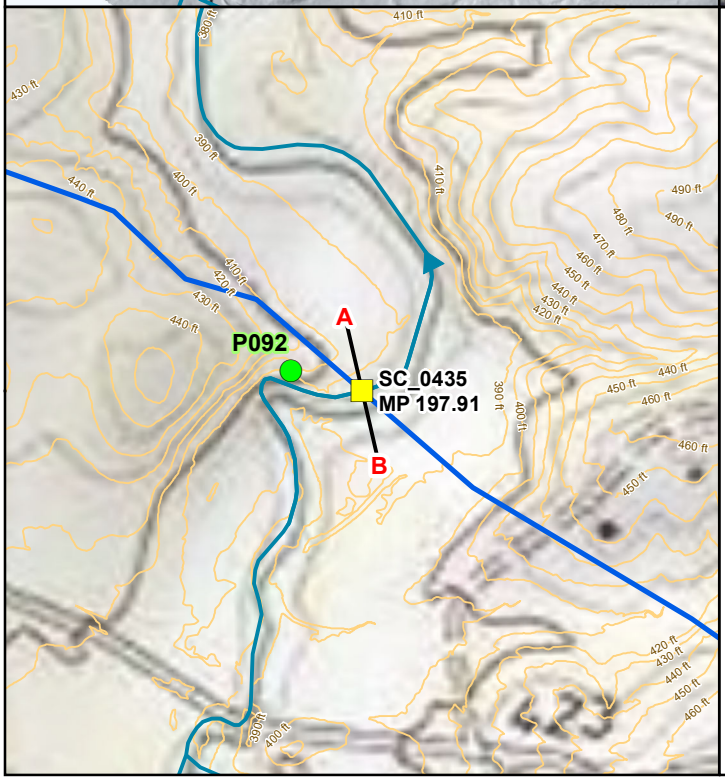
Dominion

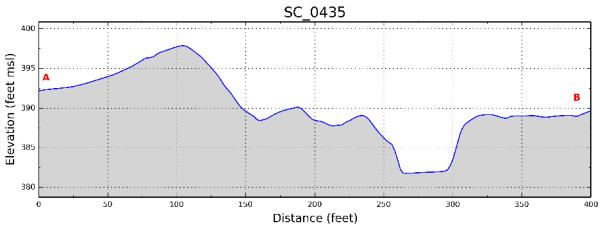
Geosyntec consultants

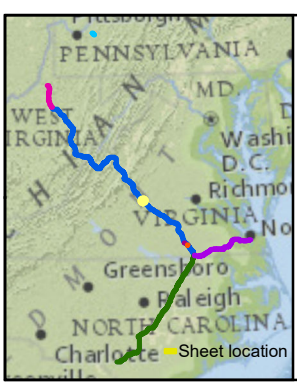
TESSELLATIONS











Legend

Hydrotechnical Hazards

- High
- Moderate
- Low
- Field Observation Locations
- Profile Line (400ft)
- Stream with Flow Direction
- ACP AP-1
- ACP AP-2
- ACP AP-3
- ACP AP-4
- ACP AP-5
- TL-635
- TL-636

Stream Crossing Plan View and Profile

Location ID: sbuk012

TID_SC: SC_0435

Stream Name: Slate River

1:6,000

0 125 250 500 Feet

0 0.025 0.05 0.1 Miles

N

Document Information:

Document No:
DOM_EC_CRO_MA_001_SC_0435

Revision	Date	Created By	Approved by
0	07-28-2016	CR	RS
1	03-01-2017	BP	RS
2	04-21-2017	BP	RS

Notes:

1) The current alignment centerline provided by Dominion/GAI
2) Projection: UTM 17N feet, NAD 83
3) The vertical exaggeration on the profile graph is 4:1
4) Hillshade (azimuth: 280) created from 2 foot lidar data provided by Dominion/GAI
5) In areas that did not have lidar data, hillshade was created from 1/3 arc-second (10m) NED

Dominion

Geosyntec consultants

TESSELLATIONS

Geosyntec consultants

TID	SC_0435	**ACP Segment**	AP-1
Stream Name	Slate River	**MP**	197.91
Survey Date	14-May-2016	**Start Time**	1135 hrs

- River possesses a dune-ripple morphology in a terraced alluvial valley of the Piedmont.
- River crossing located in a meander.
- Pool depths are 6+ feet upstream of crossing (below water surface).
    - Bedrock outcropping on outside upstream meander bend affecting hydraulics of river which contributes to the deep pool scour.
- Channel bed composed primarily of sand with some fine gravel.
- River banks composed of fine-grained silt/clay with some sand and gravel.
- Top of bank (terrace) heights on outside of bends are 6 to 8+ feet high.
- River has wide floodplain with a well-established deciduous riparian buffer on left bank and very thin (less than one channel width) on the right bank.
- River crossing and morphology affected by local scour related to amount of woody debris, fallen trees, and large boulders in channel and high banks which prohibit floodplain connectivity for lower return period storms event flows.
- Lateral migration potential is moderate due to incised nature of river, cohesive stream banks, and very thin riparian buffer on right bank.
- Bankfull channel width is 33.7 feet and bankfull depth is approximately 2.5 feet.
- Additional information on stream crossing is available on stream reconnaissance form.

Recommendation:

Evaluate scour depth for pipeline burial depth especially considering local scour potential resulting from woody debris and boulders within channel. Additionally, consider realignment of crossing approximately 120 feet downstream in a straight reach. If crossing is maintained at present location, the right bank would require significant armoring to maintain stability of the crossing. Sag bends should be located at least two channel widths outside of respective banks. If bedrock is encountered shallower than proposed burial depth, burial in bedrock is recommended.