Restoration Plan

Town of Porter Crossing #10403 - Cole Brook at Kennard Hill Road

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Narrative:

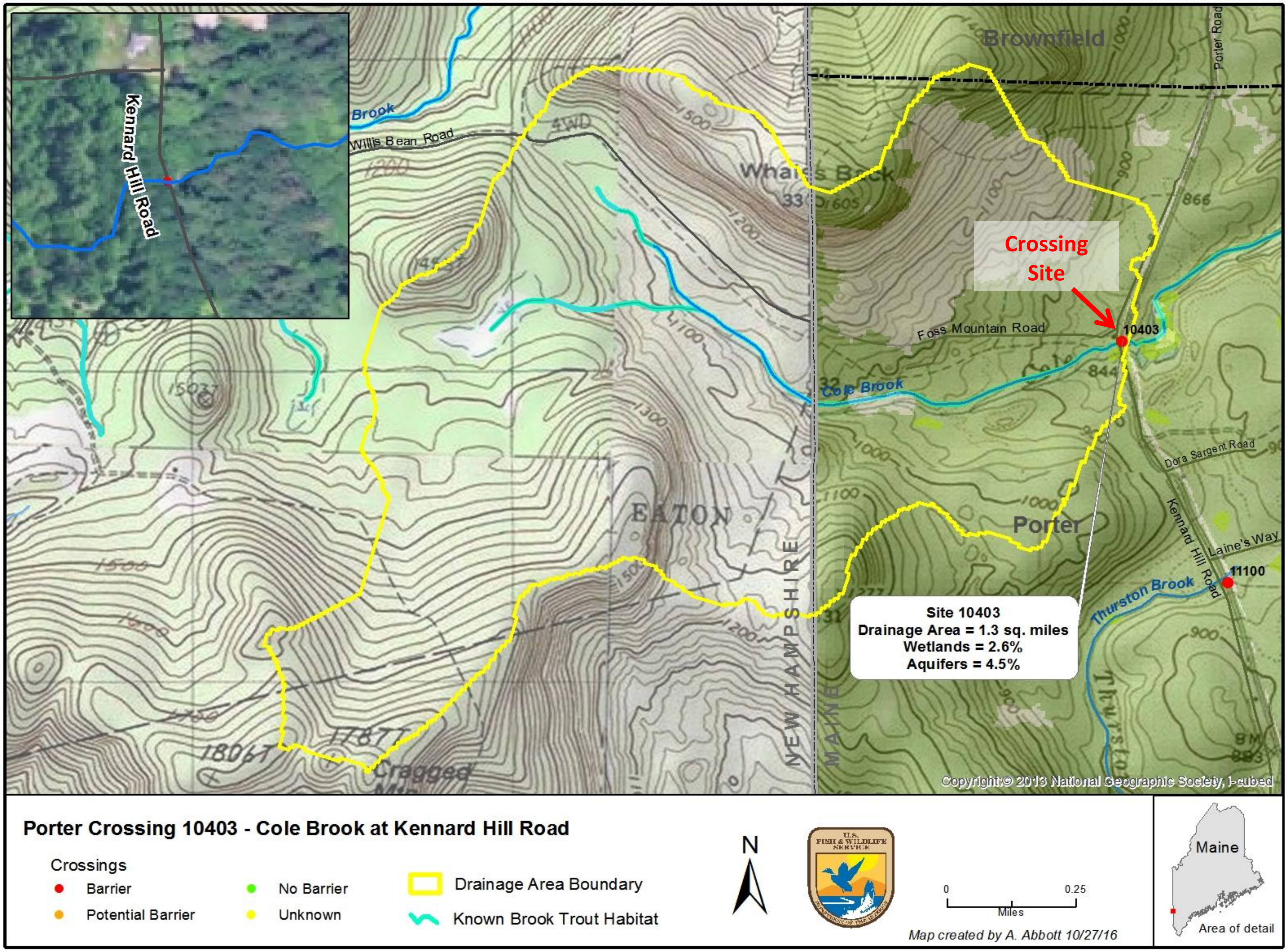
Crossing #10403 consists of one 4.3' wide elliptical corrugated metal culvert providing insufficient capacity, and presenting a barrier to aquatic organism passage on the upper reaches of Cole Brook. To restore the ability of this crossing to pass expected flood discharges while also improving aquatic organism passage, the crossing needs a substantially larger capacity structure. The new structure should have a natural bottom, be set at an appropriate lower stream bed elevation, and be sized to handle 100-year peak flows. A bottomless structure of sufficient width will allow the stream bed to adjust to accommodate movement of sediment and natural materials through the structure. An appropriate structure for the site is a concrete open-bottom box-bridge requiring little or no maintenance. Removing this barrier to aquatic organism passage will allow access to 1.7 miles of headwater brook trout habitat.

Based on its 1.3 square mile drainage area, the stream was initially estimated to have a width of approximately 9 feet, and though such regression-derived estimates are usually below field measured widths, several bankfull width measurements upstream and downstream were between 8.0' and 9.1', with an average of 8.5', matching the estimate well. The overall slope of the stream in this area is 1.3 % as measured through the entire 700 foot survey reach. In general, the substrate is composed of sand and gravel, with small amounts of cobble.

The proposed structure is an open-bottom, concrete box-bridge set on precast concrete block abutments with a clear span between abutments of 13', a rise above the stream bed of 4' 6", and a length (deck width) of 30'. The elevation of the stream bed at the inlet will be lowered from the current elevation at 920.8' to approximately 919.8', and the stream bed at the outlet will be set at approximately 919.4' feet to provide an appropriate 1.3% slope. The structure will have a cross-sectional area of approximately 50 square feet, or over five times the existing crossing capacity of about 9 square feet. Analysis of likely peak flows in this watershed using HY-8 hydraulic analysis software indicates the proposed crossing will successfully pass more than the expected 100-year peak flow of 272 cfs. The bottom of the proposed footings are to be set at approximately 918.5' in elevation(bottom of excavation at 918.0' with 6" of crushed stone for abutment bedding), below the level of potential scour, and banks built of 12-18" foundation rock will be used to armor the abutment blocks to protect them from scour during large flow events, as well as to create banks inside the crossing to focus low flows and provide terrestrial organism passage. In order to have enough capacity to pass flow flows, the road surface will need to be raised approximately 6" for a distance of 75'.

Note: This document provides both general and specific guidance in the design and installation of a replacement crossing structure, but does not address all issues related to engineering, permitting and construction. All elevations are relative and established from an approximate starting point of 925' derived from a handheld GPS receiver.

Site Map - Drainage Area



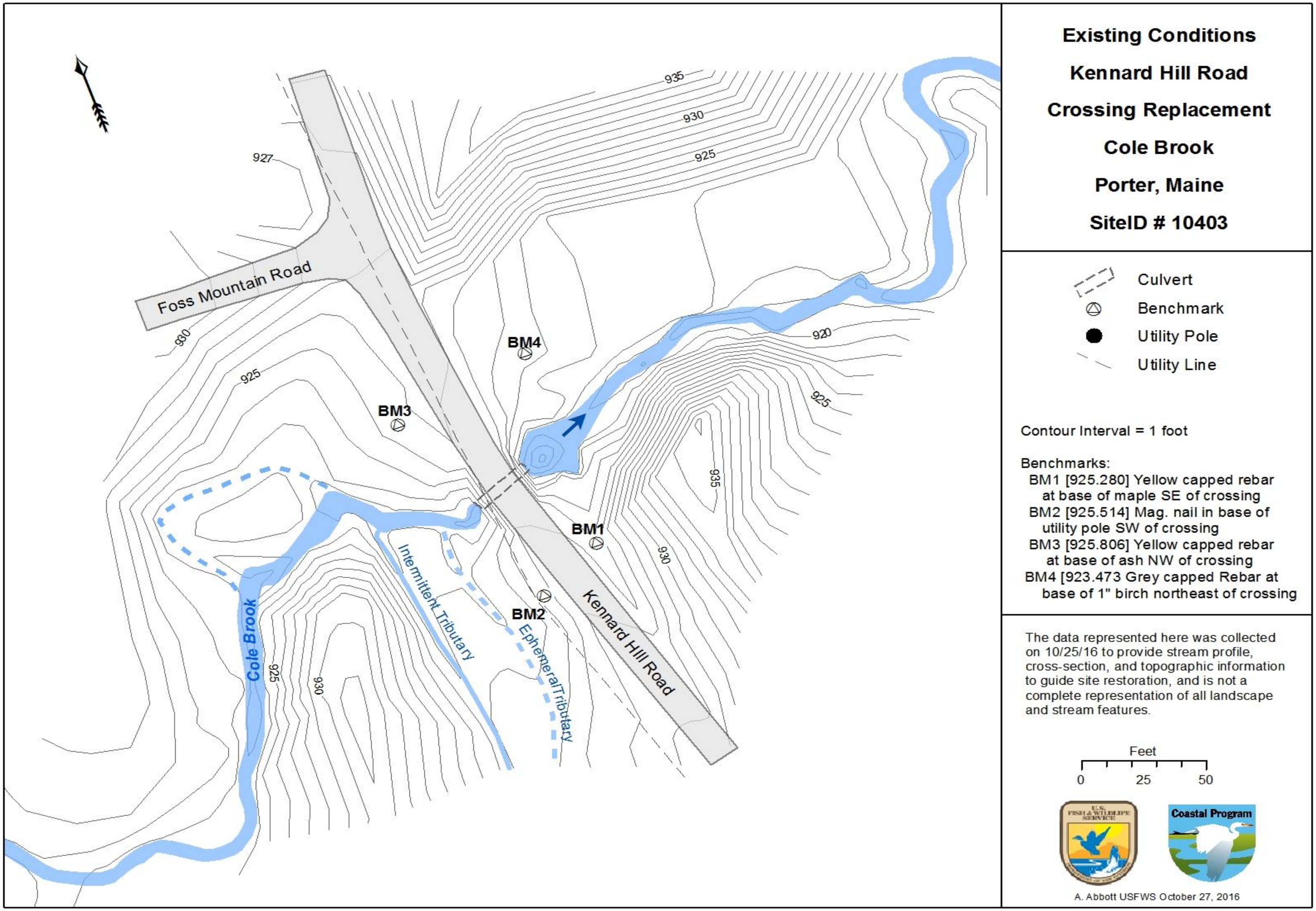
Inlet Photo

Outlet Photo

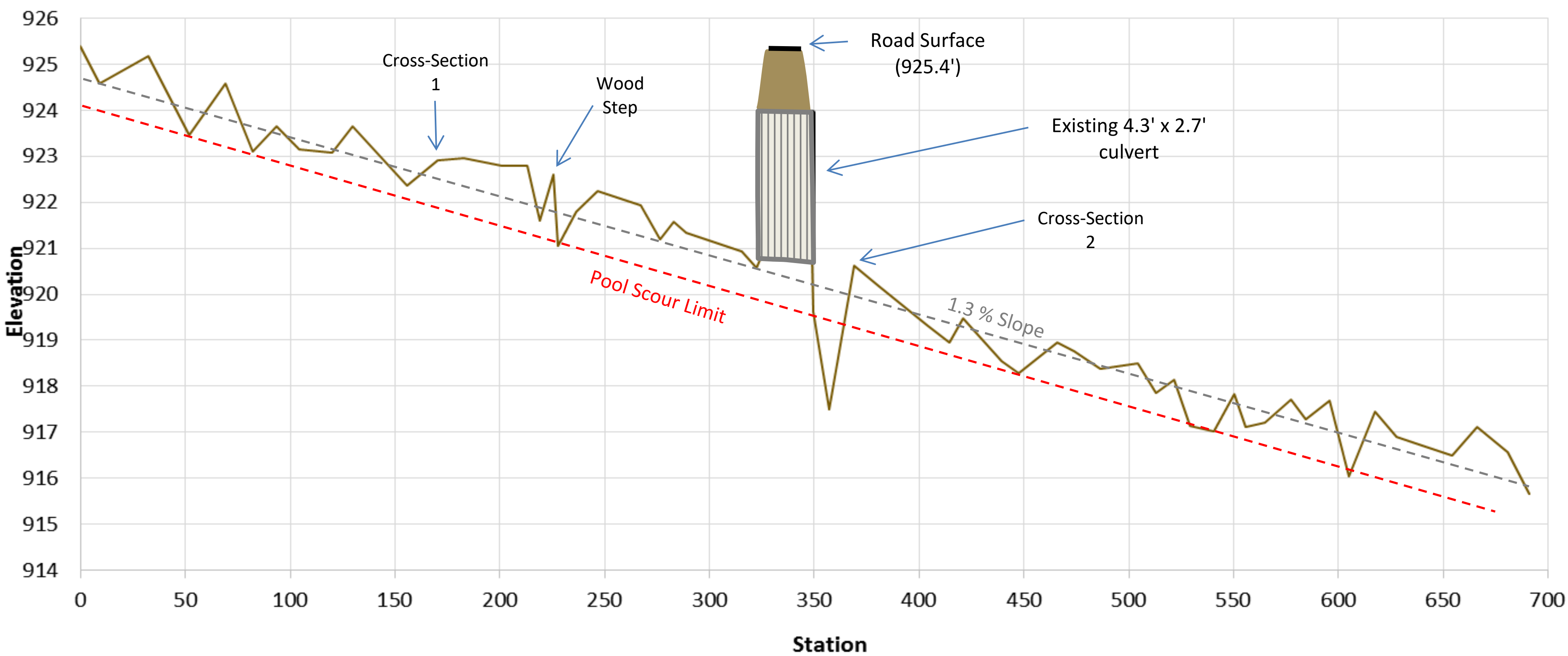
Upstream Photo

Downstream Photo

Site Topography - Existing Conditions



Longitudinal Profile - Existing Conditions



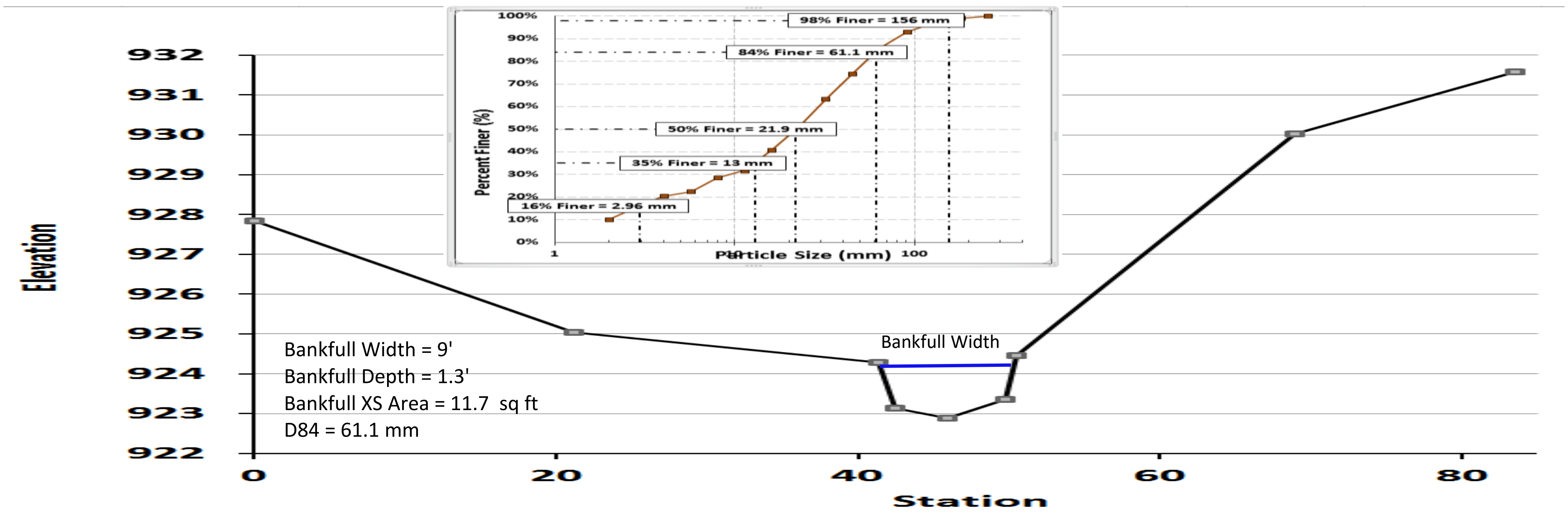
Notes:

This view is vertically exaggerated, reflecting the different scales of units for elevation and distance.

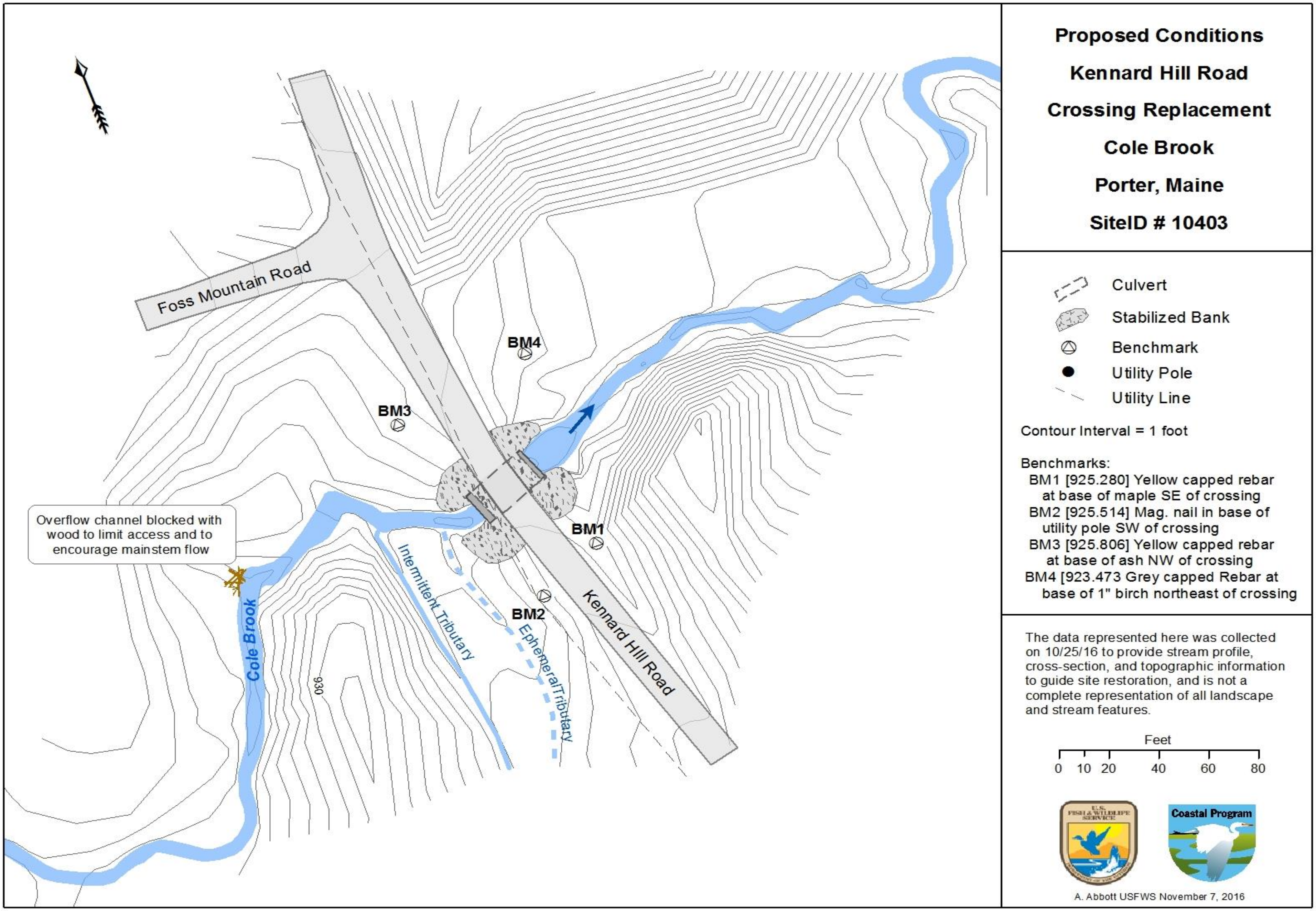
Cross-Section 1 - Reference Reach Upstream of Crossing

Upstream from Cross-Section 1

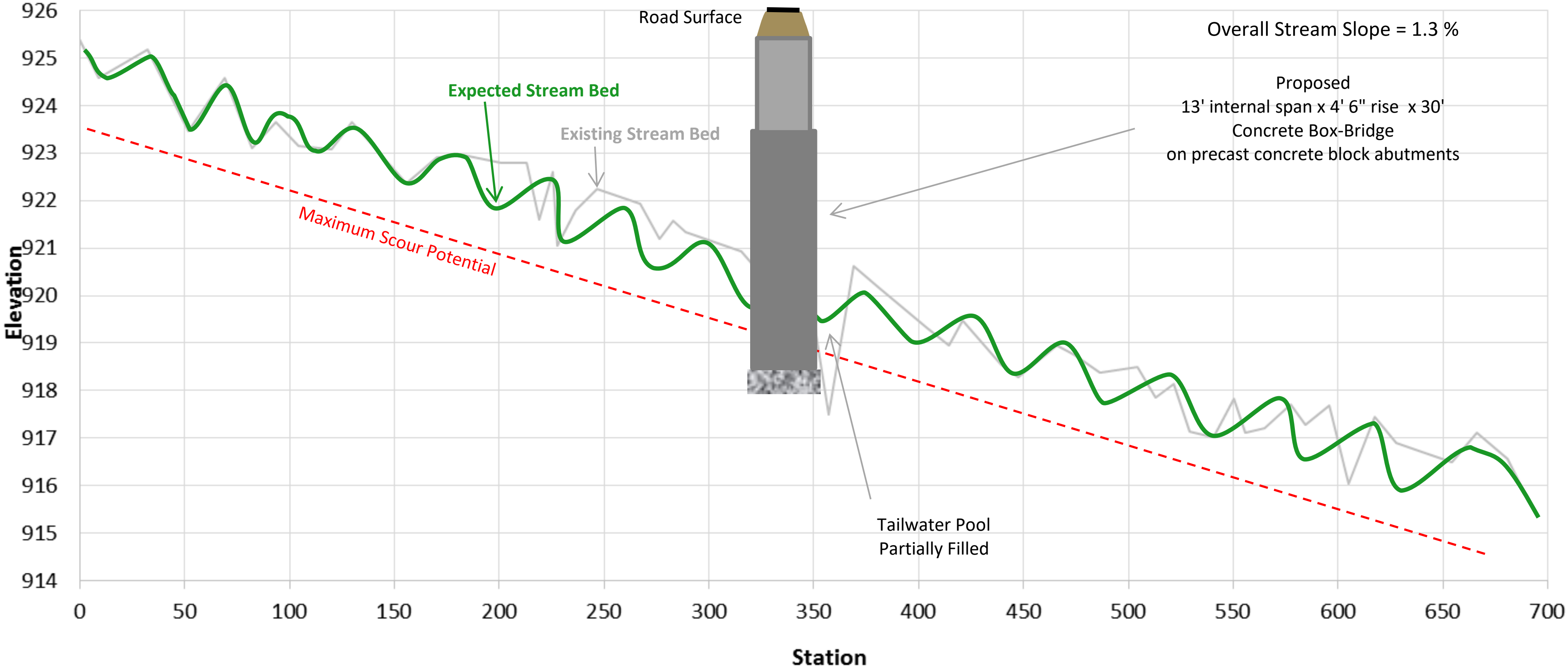
Downstream from Cross-Section 1



Site Topography - Proposed Crossing

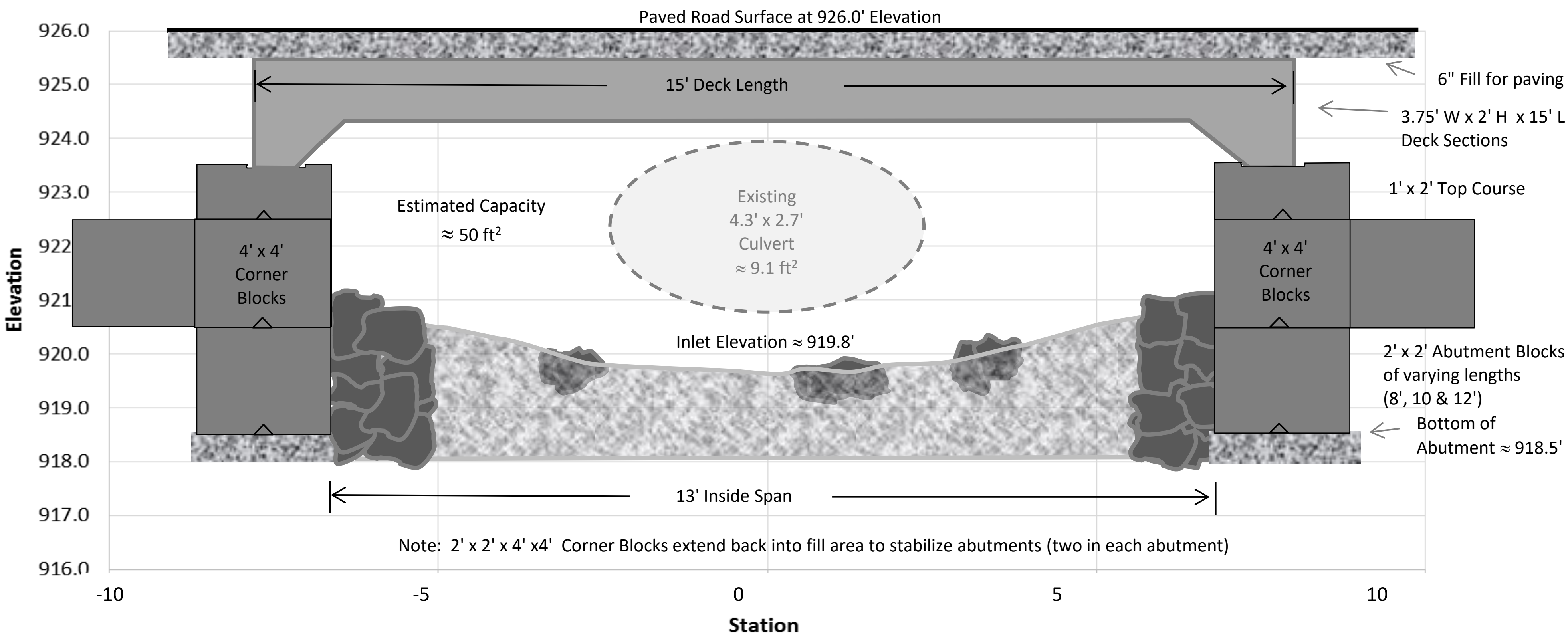


Proposed Profile View - Concrete Box-Bridge on Precast Concrete Block Abutments

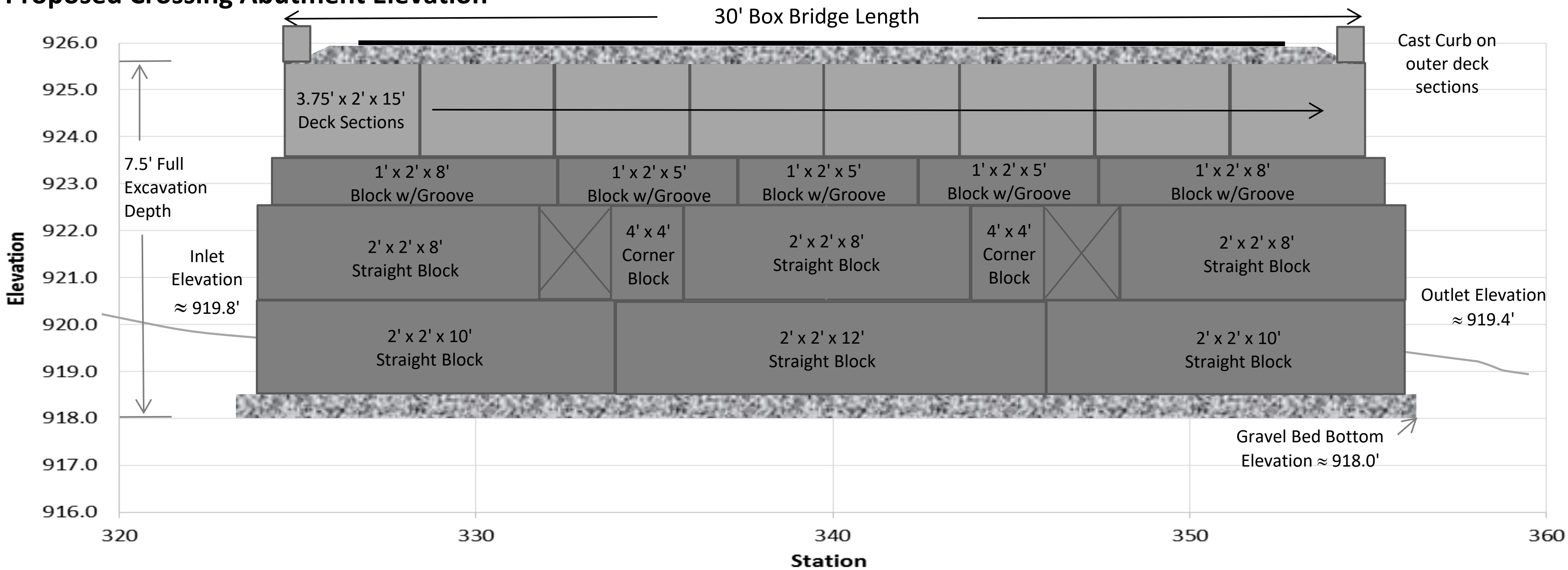


Note: This view is vertically exaggerated, reflecting the different scales of units for elevation and distance.

Proposed Crossing - Inlet Elevation

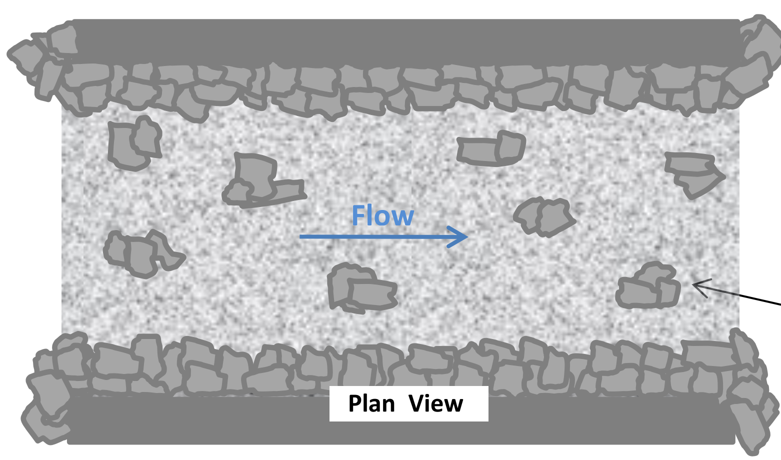


Proposed Crossing Abutment Elevation



Note: This view is slightly vertically exaggerated, reflecting the different scales of units for elevation and distance.

Bed and Bank Schematic:



Banklines and bed features are composed of 12-18 inch (average intermediate dimension – not longest or shortest measure) competent, angular to sub-angular rock.
Banklines must connect to the natural stream banks on both sides upstream and downstream to improve scour protection and terrestrial organism passage. Additional smaller rock and fine material is also necessary for filling voids in the larger material to provde more stable banklines. Fines must be watered into bed and banks to fill voids, and to avoid stream flow percolating into bed and banks.

Rock clusters help to provide alternative flow paths for aquatic organism passage, and are buried in the stream so that only their tops rise above.

Hydrology & Hydraulic Analysis

Attribute	Value	Units	Definition
Drainage Area	1.34	sq. miles	Area that drains to crossing
Wetlands	2.5	percent	Percentage of NWI storage
Elevation	912	feet	Mean basin elevation
Precipitation	43.8	inches	Mean annual precipitation
Aquifer	4.5	percent	Percentage of land underlain by sand & gravel aquifers
X-coordinate	339674	UTM	Basin centroid E/W location
Y-coordinate	4860203	UTM	Basin centroid N/S location

Return Period	Peak Flow Estimate
T (yr)	Q_T (ft³/s)
1.1	35.1
2	74.1
5	118.1
10	150.7
25	197.0
50	232.9
100	272.4
500	371.6

References:

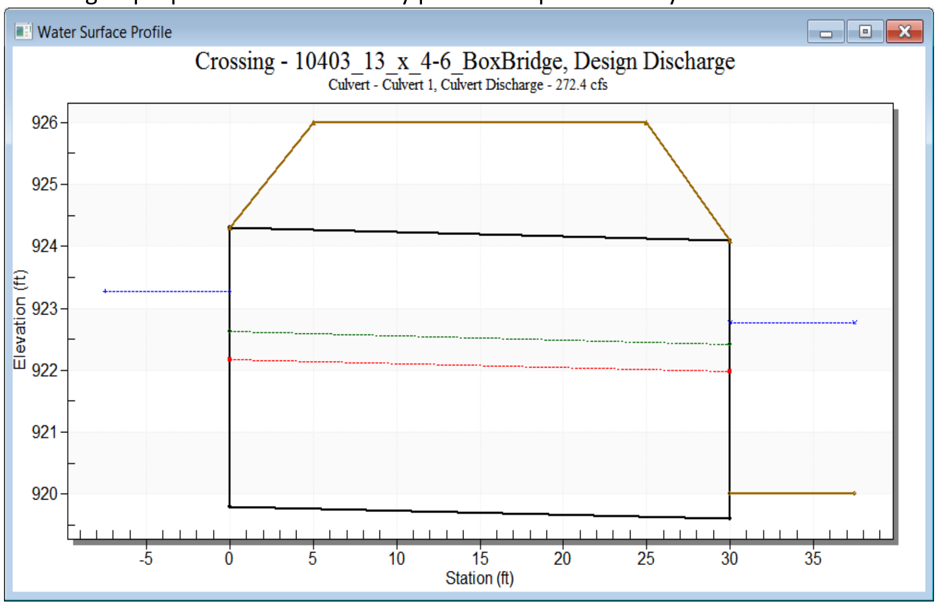
[1] Lombard, P. & Hodgkins, G., 2015. Peak Flow Regression Equations for Small, Ungaged Streams in Maine: Comparing Map-Based to Field-Based Variables. Water-Resources Investigations Report 2015-5049. US Geological Survey, Augusta, Maine.

$Q_T = b \times A^a \times 10^{-wW}$

[2] Craig, S. & Koenig, S., 2010. Regional Stream Relationship Curves from Restoration Sites - Mean Bankfull Width to Catchment Area within Northern Coastal Maine Watersheds.

$W_{bkf} = 8.7147 \times A^{0.3429}$

HY-8 Hydraulic Analysis Program of the U.S. Federal Highway Administration provides results for the above peak flow estimates for the proposed crossing design, and indicates that the crossing as proposed will successfully pass the expected 100-year storm event.



Discharge Names	Culvert Discharge	leadwate Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Outlet Velocity (ft/s)
1 year	35.10	921.07	0.88	1.27	3-M1t	2.12
2 year	74.10	921.73	1.45	1.93	3-M1t	3.27
5 year	118.10	922.33	1.97	2.53	3-M1t	4.20
10 year	150.70	922.73	2.32	2.93	3-M1t	4.74
25 year	197.00	923.24	2.77	3.44	3-M1t	5.50
50 year	232.90	923.61	3.12	3.81	3-M1t	6.06
100 year	272.40	923.27	3.47~	0.00	3-M1t	6.63
500 year	371.60	924.10	4.30~	0.00	3-M1t	7.92

Note that prediction errors are quite large when using regression equations to estimate flows and bankfull widths based on drainage area. It is best to account for potentially larger flows at these return intervals.

Water Control:

It is critical that water be controlled during construction, both allowing free flow of the stream through the site, and eliminating potential sedimentation and erosion. Any fish must thoroughly and carefully be removed and excluded from the work site before in-stream work begins (including properly screening pump intakes). All Maine Department of Environmental Protection Best Management Practices for Sediment and Erosion Control should be followed. The existing culvert can be left in place during most of the construction process, and sandbag cofferdams can be placed to control stream flow into and from the culvert to isolate the work area and maintain water quality during construction, except for the installation of rock roughness elements in the stream bed. Abutments can be excavated and installed while the existing culvert carries flow through the site, and after completed, cofferdams can be extended, the old pipe can be removed, and pumping of stream flow will be needed for a short time to allow installation of the stream bed rocks. Alternatively, pumping of stream flow can be used throughout construction. Dirty water must be removed from the work site and filtered in nearby forest to avoid contamination of the stream. Sufficient pump capacity is essential to maintain water control, with backup pumps on hand or readily available.

Existing culvert conveys water during construction

Removal of existing culvert

Dirty water pumped from work site

Dirty water filtered in nearby forest

Material Specifications:

Dirigo PreCast 15' Box-Bridge:

Deck Structure:
- 6 @ 15' x 3.75' sections
- 2 @ 15' x 3.75' sections w/curb

Abutment Blocks:
- Straight:
  - 4 @ 1' H x 2' W x 8' L w/10" x 1" groove
  - 6 @ 1' H x 2' W x 5' L w/10" x 1" groove
  - 6 @ 2' H x 2' W x 8' L
  - 4 @ 2' H x 2' W x 10' L
  - 2 @ 2' H x 2' W x 12' L
- Corner:
  - 4 @ 2' H x 2' W x 4' x 4'

Sealant for caulking seams between deck sections: SikaFlex 1A - 12 tubes
Waterproof menbrane (e.g., landfill liner) to protect deck from salt: approximately 17 yds/450 sq. feet
Gravel Bed: ≈ 4 yds 3/4" stone
Rock for bank scour protection and bed features: ≈6 yds @ 12-18" & 1 yd 6" minus
Sandbags for Cofferdams: ≈ 80 small poly (60 lb.) - recommend non-mesh/6-mil poly bags for "self-sealing" without additional poly sheeting
Polyethylene Sheeting 100' x 20' (6 mil)

Water Control: Cofferdam, Pump & Filtration Placement