

Date: **2/20/2024**

Project No.: **21641 – Bunganuc Road Bridge No. 5219 – Bunganuc Road over Bunganuc Stream**

To: **Mr. Trey Crews, Town Engineer (Town of Brunswick)**

From: **Owen Chaplin, PE**

Subject: **Bunganuc Road Bridge No. 5219 – Conceptual Design Summary**

The purpose of this memorandum is to review existing documentation for the Bunganuc Road Bridge and provide recommendations for repair or replacement of the bridge.

Existing Conditions

Wright-Pierce performed a site visit on November 15, 2023, to verify existing conditions and observations documented from the April 18, 2022, MaineDOT Routine Highway Bridge Inspection Report of the Bunganuc Road Bridge performed by Stantec. The inspection report can be found in **Appendix B**. Below is a summary of the existing conditions.

Bunganuc Road Bridge No. 5219

Bridge No. 5219 was constructed in 1948 according to existing plans and was a structural steel plate arch with a span of 16'-0" and rise of 7'-11" supported on reinforced concrete footings approximately 5'-0" in height. The arch was placed along a skew of ~20° with a length between miters of 37'-2" and a total length of 54'-0". The arch was mitered on a 1 to 1 slope that matched the embankment slope. Embankments were armored with riprap and a w-beam guardrail utilized for an improvised headwall at the east end (outlet) of the arch. No headwall was present at the west end (inlet) at the time of the site visit. According to the most recent bridge inspection report, the bridge was rated as "STRUCTURALLY DEFICIENT" (3) according to National Bridge Inventory Standards (NBIS). A condition rating of 4 or less for a structure of this type (Item 62 – Culvert) is considered to be structurally deficient. Moderate to severe corrosion and section loss was observed and reported along the spring line of the arch on both sides. Some areas along the spring line have 100% section loss with backfill leaking through. Other deficiencies include concrete spalling along the south footing, scattered hairline cracking with efflorescent on both footings, and a 6 inch wide by 3-foot-long section of corroded bolts at the top middle of the outlet.

Bunganuc Road

MaineDOT identified Bunganuc Road as a functional class 7R – Local (Rural) roadway with a posted speed limit of 45 miles per hour and an Average Annual Daily Traffic (AADT) of 690 vehicles per day (VPD) as reported in 2022 by the MaineDOT traffic count database. The roadway generally runs south to north connecting Freeport's Flying Point Road to Woodside Road and is part of Brunswick's Highland Road Bike Loop network. The roadway was approximately 24' wide and included two, 12-foot travel lanes and 1-foot informal gravel shoulders on either side of the roadway to meet the face of the existing guardrail. Bunganuc Road runs along a horizontal tangent as it crosses over the bridge with a sag vertical curve. A horizontal curve is located along the northern end of the project. The apparent low point in the roadway is just north of the existing bridge. The roadway appeared to provide minimal crown/cross slope at the bridge crossing, causing insufficient surface drainage and subsequent potholes and pavement deterioration. Additionally, berms likely caused by winter sand and sediment buildup were evident along the edge of pavement.

Standard highway guardrail was provided on both sides of Bunganuc Road along the bridge approaches and at the bridge to protect errant vehicles from leaving the road. Guardrail posts were placed at the top of the slope with insufficient supporting “guardrail berm” soils and embankments of 1 to 1 or steeper directly behind the posts. The existing guardrail exhibited signs of moderate impact damage in spot locations from plows and vehicles along both sides of the roadway. Additionally, the guardrail and terminals did not appear to meet current MASH requirements for guardrails and should be replaced.

Utilities

Overhead utility lines ran along the west side of Bunganuc Road on the north before crossing over to the east side of the road in proximity to the bridge. There was a drainage ditch and pipe along the northwest side of Bunganuc Road with cross-piping under the driveway at 310 Bunganuc Road with an observed outlet near Bunganuc Stream. No other signs of underground utilities were found in the roadway or identified on available plan information.

Bunganuc Stream

The average bankfull width of Bunganuc Stream was measured upstream of the bridge estimated to be 25 feet. Downstream bankfull width measurements were not obtained in the field but are estimated at greater than 75 feet for 1,500 feet until discharging into Maquoit Bay. The stream bottom near the bridge consisted of native bedrock, which was irregular in nature. No apparent signs of scour were observed. The stream banks appeared stable with heavy vegetation.

An informal discussion with abutters during the site visit indicated a storm event occurred in the mid 1950’s that washed out the embankments but left the bridge in place. A large tree fell near the inlet that caused damming of the inlet and subsequent washout. No record of this event was found within existing available documents.

Proposed Work

Wright-Pierce evaluated three alternatives to repair or replace the current bridge in accordance with our contract with the Town. These alternatives were developed using readily available existing plan information, aerial photographs, and existing LiDAR data. These alternates are described and discussed below:

Roadway

Wright-Pierce proposes matching the existing vertical geometry, horizontal geometry, and typical roadway section by providing two, 11-foot lanes with a 2-foot shoulder on either side to minimize impacts to project abutters. However, alternative 2 provides 5-foot shoulders to accommodate future bike lanes on both sides of the roadway. Impacts outside of existing right-of-way are anticipated due to the proposed shoulder widening. Full depth reconstruction of the roadway is proposed with areas of milling and paving at the project limits to match existing pavement grade. The roadway will be reconstructed to generally match the intended existing cross slopes which appear to be superelevated on the southern approach and transitioned to crowned at the northern approach. Cross slope modifications are proposed to improve uniformity and surface drainage while limiting roadway reconstruction limits. Other drainage improvements include installation of a drainage swale at the low point, reconstruction of the drainage ditch at the northwest side of the project, and replacement of the driveway culvert at 310 Bunganuc Road. Additional improvements for each alternative will be addressed as described below:

In addition to roadway improvements described above, Alternatives 1 and 3 will add an impervious membrane over the existing plate arch to shed water away from the arch that is infiltrating through the roadway base. The intent is to reduce chloride exposure to the arch structure and limit subsequent corrosion activity.

Bridge

Alternative 1 – Concrete Liner

Wright-Pierce proposes lining the existing structural steel arch by installing a reinforced concrete liner for Alternative 1. The existing stream bed is proposed to be dewatered to facilitate the repair, performing repairs, and dewatering to one side of the arch at a time in the dry. The repair will consist of filling any voids behind the arch with a pumped grout and then applying a reinforcing concrete liner to the lower portion of the pipe. This repair alternative is anticipated to have a 25-year design life based on the nature of the repair and the age of the existing structure.

This alternative features additional improvements, including the addition of concrete headwalls to retain the roadway embankment and to provide a structure for bridge railing construction.

A concept layout of this alternative can be found on sheet C-2 of **Appendix C**.

Alternative 2 – Precast Concrete Rigid Frame

A precast, concrete rigid frame is proposed to replace the existing structural steel arch to meet the hydraulic needs of the crossing and to provide the recommended 1.2 times the bankfull width of Bunganuc Stream at the upstream end. Providing a span of 1.2 times the bankfull width is one of the primary principles of Stream Smart designs, and strongly encouraged by environmental agencies including Army Corps of Engineers and US Fish & Wildlife Service. The proposed structure has a 30'-0" clear span with a 9'-4" rise. The rigid frame is proposed to be supported on a cast-in-place footing on bedrock. Wingwalls are proposed at all corners to retain the roadway embankment and accommodate shoulder widening.

This replacement alternative is anticipated to have a 75-year design life. Based on Maine Bridge Law (23 MRSA, Chapter 9, Subchapter 4-A), when replacing a "Minor Span" bridge of span length of at least 10 feet but less than 20 feet and replacing it with a "Bridge" as defined as having a span of at least 20 feet, future capital improvements and maintenance will be the responsibility of MaineDOT. For acceptance by the Department, the bridge must be built to the standards of its Bridge Design Guide. Coordination with MaineDOT is recommended early in the design process.

A concept layout of this alternative can be found on sheet C-3 of **Appendix C**.

Alternative 3 – Slip Liner

A galvanized steel plate arch structure supported on a cast-in-place footing extension is proposed to rehabilitate the existing structure. The proposed structure has a 14'-0" clear span and 5'-7" rise. The structure is anticipated to be constructed with the existing arch remaining in place and the annular space between the existing and proposed arch pumped with grout. This alternative provides sufficient hydraulic capacity, and the type/material selection is consistent with **Table 1-1** of the MaineDOT Bridge Design Guide. The slip liner structure is designed to carry all legal loads without relying on any strength from the existing arch and is anticipated to have a 75-year design life.

A concept layout of this alternative can be found on sheet C-4 of **Appendix C**.

The rehabilitation and replacement alternatives described herein (Alternative 2 & 3) are consistent with the recommendations provided in **Table 1-1** of the MaineDOT Bridge Design Guide for "Type/Material Selection Guide for Small Bridge Projects".

Hydrologic and Hydraulic Analysis

Wright-Pierce performed a preliminary Hydrologic and Hydraulic analysis to determine the capacity of the existing culvert and the required hydraulic opening for the proposed alternatives to meet MaineDOT freeboard standards. The hydraulic analysis was performed using the FHWA HY-8 Culvert Analysis Program (HY-8). Supplemental information was sourced from a site visit conducted by Wright-Pierce, existing 1948 Plans developed by MaineDOT (formerly the State Highway Commission), and reported peak flows from StreamStats, an online mapping tool developed by United States Geological Survey (USGS) that uses regression techniques.

Hydrologic Analysis

Hydrologic characteristics of Bunganuc Stream were determined using StreamStats. Bunganuc Stream at the project site has an approximate 5.3 square mile watershed, extending north to Route 1 near Durham Road. The output report from StreamStats can be found in **Appendix E. Table 1-1** below provides the peak flows of Bunganuc Stream at the project site for the 50- and 100-year, 24 hour storm events.

Table 1-1. 50-Year and 100-Year Peak Flows at the Bunganuc Road Bridge

Storm Event	StreamStats Peak Flow
50-Year	945 cfs
100-Year	1110 cfs

The watershed boundary provided by StreamStats was backchecked using 2-ft contours. During the review, Wright-Pierce found no major errors in the watershed. Therefore, the flows from StreamStats were deemed adequate to be used in the hydraulic model.

HY-8 Modeling

The FHWA HY-8 Culvert Analysis Program was used to determine if the existing size of and the proposed design alternatives for the Bunganuc Road Bridge are adequate for the 50- and 100-year storm events. The geometry and invert inputs for the Bunganuc Road Bridge were based on in-field measurements, the 1948 Plans, and the proposed design plans.

Existing Bunganuc Road Bridge Culvert

The existing culvert was modeled as corrugated steel with 16' span and 12'-7" rise. Due to the limited options for pipe arch's in HY-8, the geometry was manually input using x-y coordinates to match the existing cross section and accurately depict the area of the hydraulic opening. The Manning's "n" value for the sides and top of the culvert was calculated as 0.021 to account for the corrugated steel culvert and 4'-10" tall concrete footings. Since the culvert is open bottom, the Manning's "n" value for the stream bed, 0.025, was used for the bottom of the culvert.

Alternative 1: Concrete Liner

For the concrete liner alternative, the cross section developed for the existing culvert was adjusted to account for the proposed concrete liner on the sides of the culvert. Although the rise of the culvert was maintained at 12'-7" the span decreased to 15'. The Manning's "n" value for the sides and top of culvert was calculated as 0.017 to account for the existing corrugated steel and proposed concrete liner on the sides of the culvert. Similar to existing

conditions, since the culvert is open bottom, the Manning’s “n” value for the stream bed, 0.025, was used for the bottom of the culvert.

Alternative 2: Precast Concrete Rigid Frame

The precast concrete rigid frame was modeled as a concrete box with a 30’ clear span and approximately 11’-3” rise. The cross section used in modeling accounts for the proposed riprap on the inside of the rigid frame. The Manning’s “n” value for concrete, 0.012, was used for the tops and sides of the structure. Since the rigid frame is open bottom, the Manning’s “n” value for the stream bed, 0.025, was used for the bottom of the structure.

Alternative 3: Slip Liner

Similar to the concrete liner, the cross section of the existing culvert was adjusted for the slip liner alternative to account for the proposed steel plate arch. Adding the steel plate arch to the existing culvert reduces the rise and span to 13’-9” and 11’-5”, respectively. Since the culvert is open bottom, the Manning’s “n” value for the stream bed, 0.025, was used for the bottom of the culvert. The Manning’s “n” value for the sides and top of culvert was calculated as 0.019 to account for the steel plate and 6’-2” tall concrete footings.

Findings

Alternatives 1 & 3

According to the MaineDOT Bridge Design Guide (Updated 2018), the “headwater depth versus structure depth ratio (HW/D) should be approximately equal to or less than 0.9” (pg 2-30) for culverts conveying a 50-year storm event. For 100-year storms, “a minimum of one foot of freeboard at the edge of the pavement” (pg 2-30) is preferred. The resulting headwater elevations for the existing culvert and proposed alternatives to add a concrete liner (Alternative 1) and steel plate arch (Alternative 3), were assessed under these MaineDOT requirements. **Table 1-3** and **1-4** below shows the modeling results for the 50- and 100-year storm, respectively. For each culvert option, MaineDOT requirements are met for the 50-year and 100-year storm. It should be noted that the top of the roadway is assumed to be at elevation 22’.

Table 1-3. 50-Year Storm Culvert Results

Alternative	Headwater Elevation (ft)	Headwater Depth (ft) (HW)	Structure Depth (ft) (S)	HW:S	MaineDOT Requirement
Existing	16.03	8.45	12.63	0.67	Met
Concrete Liner	16.51	8.93	12.63	0.71	Met
Steel Plate Arch	16.02	8.56	11.48	0.75	Met

Table 1-4. 100-Year Storm Culvert Results

Alternative	Headwater Elevation (ft)	Top of Roadway Elevation (ft)	Freeboard (ft)	MaineDOT Requirement
Existing	17.00	22.00	5.00	Met
Concrete Liner	17.56	22.00	4.44	Met
Steel Plate Arch	17.01	22.00	4.99	Met

Alternative 2

For bridge type structures, according to the MaineDOT Bridge Design Guide, “a depth of 2 feet minimum is recommended on smaller streams where there has been no history of ice jams” (pg 2-30) for the 50-year storm. To our knowledge, there has not been a history of ice jams at the Bunganuc Road Bridge. For the 100-year storm “there should be 1 foot of freeboard” (pg 2-31) underneath the top of the structure. It was determined the precast concrete rigid frame design alternative meets the MaineDOT requirements for both storm events. **Table 1-5** below shows the modeling results for the 50- and 100-year storm for the bridge design alternative. HY-8 Reports for the existing culvert and three alternatives can be found in **Appendix F**.

Table 1-5. 50-Year and 100-Year Storm Bridge Results

Alternative	Storm Event	Headwater Elevation (ft)	Top of Opening Elevation (ft)	Freeboard (ft)	MaineDOT Requirement
Precast Rigid Frame (30' Span)	50-Year	12.47	18.60	6.13	Met
	100-Year	12.88		5.72	Met

Modeling Assumptions

This analysis is preliminary and intended to determine if the existing Bunganuc Road Bridge has adequate hydraulic capacity and determine rehabilitation and replacement options that will effectively convey flows during the 50- and 100-year, 24-hour storms. Reported flows at the crossing, record drawings dating back to 1948, field measurements, and assumptions listed below were used to develop the model. Therefore, if improvements to the bridge or roadway are made, more detailed data collection, such as on the ground topographic surveying and bathymetry within Bunganuc Stream should be conducted to better define the geometry of the bridge and adjacent channels. An open channel hydraulic modeling program such as HEC-RAS is recommended to further refine hydraulic conveyance.

The following assumptions made throughout modeling and analysis should be considered:

Geometry of the bridge and surrounding area are based on field measurements, record drawings, and assumptions. For instance, the stream slope was assumed to be 0.5%. A detailed survey is recommended for further investigation.

It is assumed the existing crossing is not tidally influenced. However, once a detailed survey is completed, elevations can be compared to peak tide and surcharge elevations to verify the hydraulic influence. It is also recommended that a tide gauge be installed at the crossing to better understand the tidal activity.

50- and 100-year, 24-hour storm flows were assumed based on available StreamStats data. It is recommended to further analyze the peak flows and consider confirming the flows using HydroCAD.

It is recommended future hydraulic modeling include refining the analysis with HEC-RAS. HEC-RAS can model the stream's geometry using stream centerlines and cross sections which will help refine water surface profiles.

Permit Requirements

Permitting would be required for each design alternative. Culvert lining (Alternatives 1 & 3) may have different permitting requirements than replacing the culvert with a bridge (Alternative 2). The culvert lining alternatives will likely have more stringent permitting requirements for Army Corps and Maine DEP. All three alternatives will have the same permitting requirements for the Town of Brunswick.

Alternatives 1 & 3

To line the existing culvert with concrete, permitting will likely be required from the Army Corps of Engineers and the Town of Brunswick. General Condition 29 for Stream Work and Crossings, and Wetland Crossings, states that “work resulting in a decreased width, height, or diameter of an existing crossing (e.g. slip lining and culvert lining) is discouraged and requires PCN.” Therefore, a Pre-construction Notification will be required by Army Corps to line the existing culvert with concrete or a steel plate arch. If the application is approved, Army Corps will provide written verification of the notification within 60 days of receiving it. Work may not begin until written verification from Army Corps has been received. The Town of Brunswick's Permit Types and Definitions states that a Shoreland Protection Zone Permit will be required for work that occurs “within 75 feet, horizontal distance of the normal high water line of a stream.” It has been confirmed with the Town of Brunswick that a Shoreland Protection Zone Permit will be required for work done on the Bunganuc Road culvert. It shall be confirmed with Maine DEP if lining the culvert requires a permit. Statute 38 MRS § 480-Q(2-D) may apply, which exempts repairs and maintenance of a crossing from needing a permit. However, the crossing cannot block fish passage. These repair alternatives shall be reviewed with Maine DEP to verify concurrence that fish passage isn't impeded by the addition of a concrete or steel plate liner.

Alternative 2

To replace the existing culvert with a bridge, permitting will likely be required from the Army Corps of Engineers and the Town of Brunswick. A Self-Verification Notification Permit will be required by Army Corps of Engineers under Section 22 Stream and Wetland Work Crossings. This permit is for “Stream work and crossings with <15,000 SF of permanent and/or temporary inland water and or/wetland fill and associated secondary impacts.” There are numerous design requirements from Army Corps that will need to be met to qualify for the permit. Self-Verification must be provided to Army Corps 2 weeks prior to the start of work, and they will provide acknowledgement of the permit in writing. As previously mentioned, the project site falls within 75 feet of a stream which will require a Shoreland Protection Zone Permit from the Town of Brunswick. For Maine DEP, the work will likely qualify for an exemption through Statute 38 MRS § 480-Q(2-D) which states, “A permit is not required for the repair and maintenance of an existing crossing or for the replacement of an existing crossing.” Therefore, a permit will likely not be required by Maine DEP.

Construction Sequencing

The construction sequencing for the three alternatives were evaluated and are discussed below.

Temporary River Diversion and Control

Alternative 1 & 3: Concrete Liner & Slip Liner

Alternative 1 & 3 require temporarily diverting water through one-half of the existing opening while the other half is being repaired or a separate pipe can be used to divert water through the entire opening while the concrete liner or slip liner is installed.

Alternative 2: Precast Concrete Rigid Frame

Water will be temporarily diverted through the existing opening while the proposed structure is built behind the limits of the existing pipe arch footings. Localized dewatering and support of excavation are anticipated to construct the proposed return walls. Temporary water diversion through one-half of the existing opening or a separate pipe used to divert water through the entire opening is anticipated to demolish the existing footings and restore the streambed.

Road Closure and Detour

As discussed with the Town during project kick-off, full road closure and detour is anticipated for each of the three alternatives described herein. An approximate 5.5-mile, 10-minute route is available to detour traffic during construction. The detour route is from Highland Road to Pleasant Hill Road, to Casco Road, and back to Bunganuc Road. A full road closure would provide the contractor full access to the site to perform the work in one phase, reducing overall project cost and construction duration.

Alternate Lane Closure – Phased Construction

If phased construction is desired during final design, consideration should be given based on each alternative described below. Phased construction when compared to a full closure of the roadway can add measurable cost to the project to the order of an additional 25% for each phase compared to completing the work during a full closure of the roadway. Phased construction will also add to the overall construction duration of the project.

Alternative 1 & 3: Concrete Liner & Slip Liner

Alternatives 1 & 3 are best suited for construction phasing, as most of the bridge work can be completed while the roadway is in service. Headwall construction and roadway reconstruction can take place with a single lane closure with one lane of alternating traffic.

Alternative 2: Precast Concrete Rigid Frame

This alternative is not as well suited for phased construction when compared to the other alternatives and would need further investigation to determine its feasibility. The rigid frame joints need to be designed to line up with the phase line and a temporary phasing wall is needed to separate the work. The rigid frame is likely to be overbuilt to accommodate phasing and could be outside existing Town Right-of-Way. Two mobilizations to complete concrete work, water diversion, and setting of the rigid frame would add to the construction cost.

Utility Coordination

Utility coordination letters were sent to confirm the location of utilities within the project area. A summary of impacted utilities is described below.

Consolidated Communications is the pole owner within the project area with multiple utility attachees. Attachees include Lincolnville Comm., Revolution Networks, Mid-Maine Comm., Comcast, and Central Maine Power (CMP). The utility pole at the southwest corner of the bridge is anticipated to be relocated to facilitate wingwall construction for all alternatives. Further coordination with the affected utilities will be required during final design.

Engineer's Cost Opinion

The Engineer's Opinion of Construction Cost developed for the proposed work includes mobilization, proposed repair/replacement alternatives, associated roadway work, design, and construction engineering costs. The cost opinions were developed assuming a full roadway closure and detour during construction. The cost opinion was developed using unit prices from applicable recently awarded MaineDOT projects supplemented by Wright-Pierce's bid experience with similar projects. Please refer to **Appendix D** for cost opinions for each alternative.

Alternative 1: Concrete Liner

The concrete liner alternative's cost is influenced by the concrete work associated with the liner and headwall/wingwall construction required to support the roadway embankments. Our cost opinion projects the anticipated cost of the work to be \$1.25M to \$1.68M for this alternative.

Alternative 2: Precast Concrete Rigid Frame

Alternative 2 requires the most extensive amount of cofferdam and water diversion effort associated with installing the proposed rigid frame footings at an elevation under the existing streambed. The amount of concrete work associated with this structure is also a large driver of its cost. Our cost opinion projects the anticipated cost of the work to be \$1.90M to \$2.57M for this alternative.

Alternative 3: Slip Liner

The slip liner alternative's cost is influenced by the headwall and wingwall construction required to support the roadway embankments. Our cost opinion projects the anticipated cost of the work to be \$1.45M to \$1.96M for this alternative.

Recommendation

Wright-Pierce recommends replacement of the existing bridge with a precast rigid frame as described in Alternative 2. This alternative has the largest hydraulic opening, provides the longest design life, improves bicycle facilities, is comparable in cost to the other alternatives, and would be the maintenance responsibility of MaineDOT following construction. If the Town's budget does not permit this alternative, Alternative 1 is a viable way to minimize initial investment. This alternative will bring the structure into a good state of repair, but the Town will have to consider the drawbacks associated with reduced design life of approximately a third compared to replacement alternatives and will be the ongoing maintenance responsibility of the Town following rehabilitation. The replacement of the structure will be required following the design life of alternative 1 (25-years) which will cost approximately \$6M based on the cost of replacement in today's dollars adjusted for 4% inflation year over year.

Appendices:

Appendix A: Existing Bridge Plans (1948)

Appendix B: Highway Bridge Inspection Report Bridge No. 5219 – April 2022

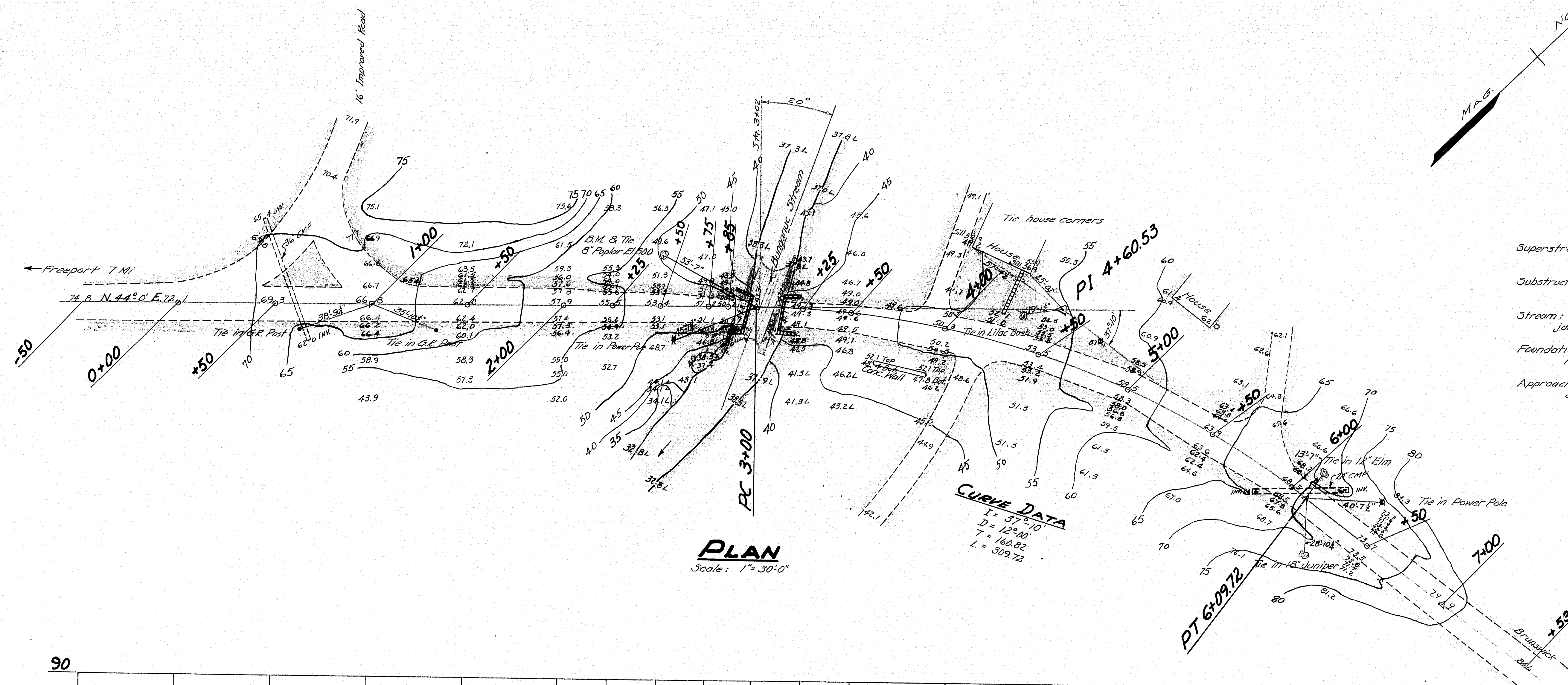
Appendix C: Conceptual Review Plans

Appendix D: Engineer's Cost Opinion

Appendix E: StreamStats

Appendix F: HY-8 Output

Appendix A
Existing Bridge Plans (1948)



GENERAL NOTES

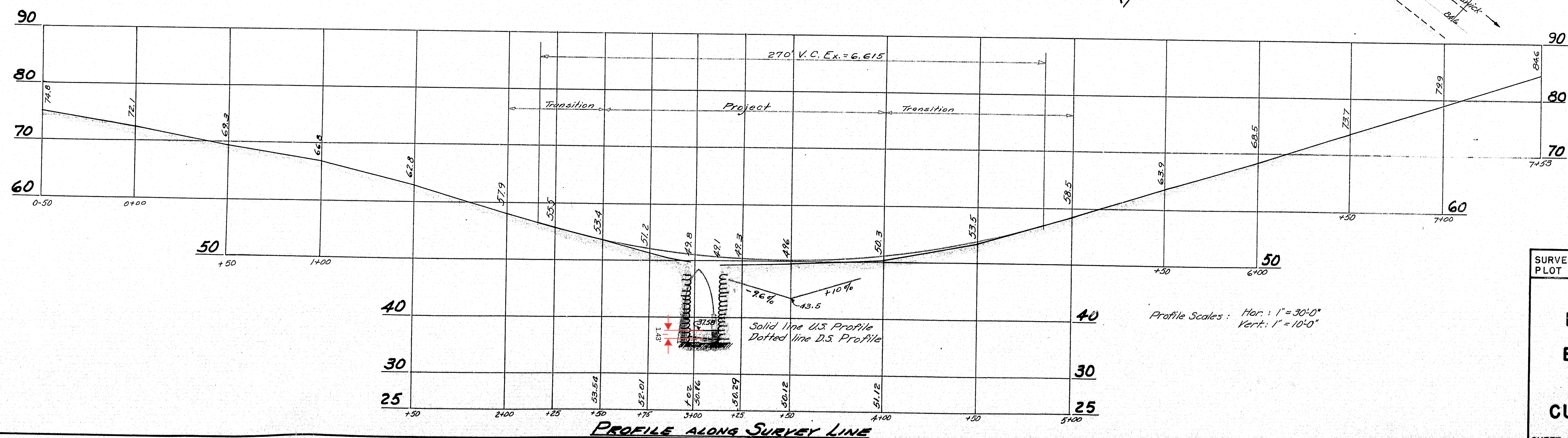
Superstructure: 3" longitudinal planking, 8"x13" needle beams.
 2" Steel I-beams. All in poor condition.

Substructure: Large split granite laid up dry both abutments
 badly bulged. Poor condition.

Stream: High water El. 47.0. 1' over road due to ice
 jam El. 50.0

Foundation: Stream bed all ledge. Both abutments
 resting on ledge.

Approaches: Narrow surface treated gravel in poor
 condition.

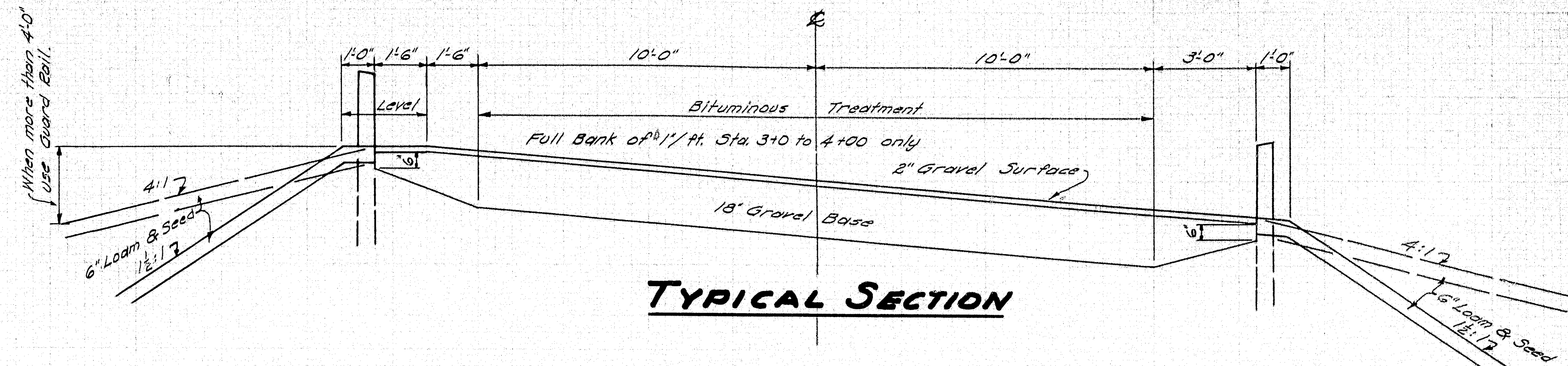
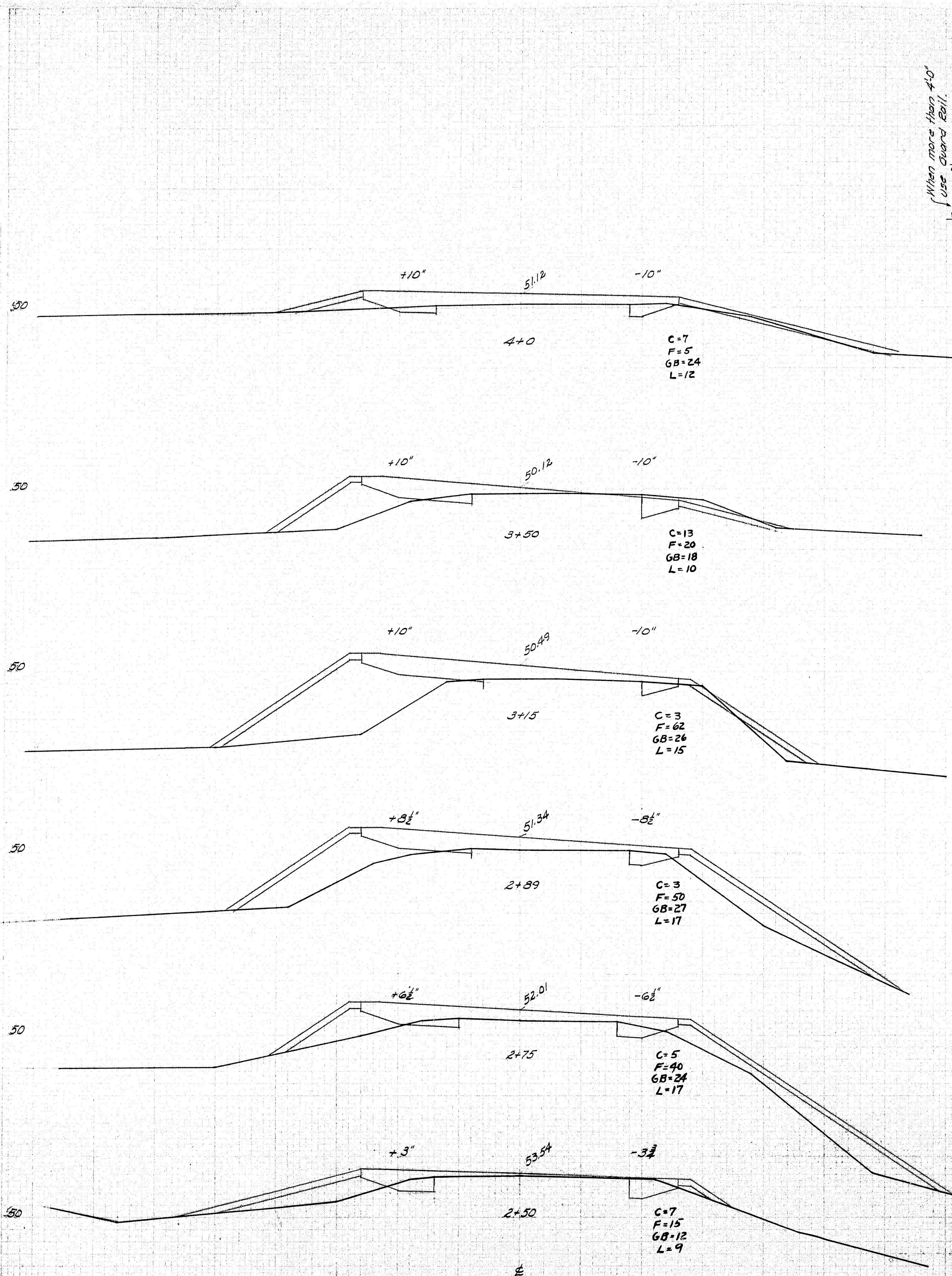


SURVEY - BLAKE
 PLOT & TRACE - SAVAGE & GUN
 BRIDGE - 5219

STATE HIGHWAY COMMISSION
 BRIDGE DIVISION

BUNGANUC BRIDGE
 OVER
BUNGANUC STREAM
 IN THE TOWN OF
BRUNSWICK
CUMBERLAND COUNTY

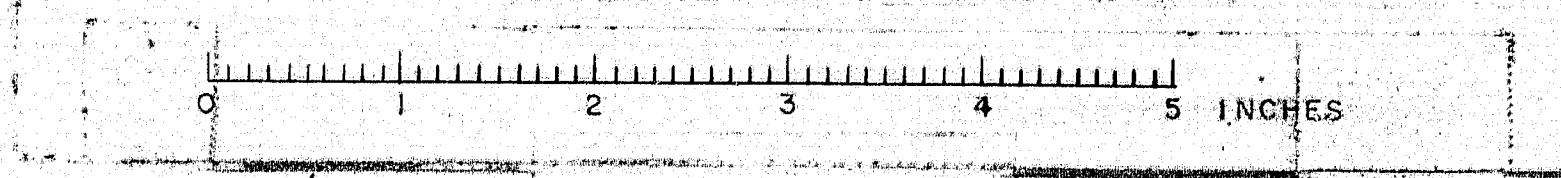
SURVEY
 SHEET 1 OF 3 AUGUSTA, MAINE APRIL 1948



NOTE: The existing roadway need not be excavated for base if the material is suitable.

PLAN - ALLEN	BRIDGE - 5219
CHECK - Hamilton	
STATE HIGHWAY COMMISSION BRIDGE DIVISION	
BUNGANUC BRIDGE	
OVER	
BUNGANUC STREAM	
IN THE TOWN OF	
BRUNSWICK	
CUMBERLAND COUNTY	
CROSS SECTIONS	
SHEET 2 OF 3 AUGUSTA, MAINE JULY 1948	

46-189



Appendix B
Highway Bridge Inspection Report
Bridge No. 5219 – April 2022

Inspector: Stantec, Stantec

Structure Number: 5219

Inspection Date: 04/18/2022

Facility Carried: BUNGANUC RD

Highway Bridge Inspection Report

Inspection Type(s): Routine

Bridge Name: BUNGANAC

Town: Brunswick



Inspector: Stantec, Stantec Structure Number: 5219
 Inspection Date: 04/18/2022 Facility Carried: BUNGANUC RD

Highway Bridge Inspection Report

National Bridge Inventory

Status: 1 - SD Bridge Name: BUNGANAC Sufficiency Rating: 44.7

Inspections

(90) INSPECTION DATE	& (91) DESIGNATED INSPECTION FREQUENCY	12	04/18/2022
(92) CRITICAL FEATURE INSPECTION	& (93) CFI DATE		
(92A) FRACTURE CRITICAL DETAIL		N	
(92B) UNDERWATER INSPECTION		N	
(92C) OTHER SPECIAL INSPECTION		N	

Identification

(1) STATE CODE	231 - Maine
(8) STRUCTURE NUMBER	5219
(5) INVENTORY ROUTE	
(5A) RECORD TYPE	1: Route carried "on" the structure
(5B) ROUTE SIGNING PREFIX	5 - CITY STREET
(5C) DESIGNATED LEVEL OF SERVICE	0 - None
(5) INVENTORY ROUTE	0
(5) INVENTORY ROUTE	0 - NOT APPLICABLE
(2) HIGHWAY AGENCY DISTRICT	01 - Southern
(3) COUNTY CODE	005 Cumberland
(4) PLACE CODE	08430
(6) FEATURES INTERSECTED	BUNGANUC BRK
(7) FACILITY CARRIED	BUNGANUC RD
(9) LOCATION	1 MI N TOWNLIN
(11) MILEPOINT	6.040
(12) BASE HIGHWAY NETWORK	Inventory Route is not on the Base Network
(13) LRS INVENTORY ROUTE, SUBROUTE	
(13A) LRS INVENTORY ROUTE	0000500350
(13B) SUBROUTE NUMBER	00
(16) LATITUDE	43.86465
(17) LONGITUDE	-70.02073
(98A) BORDER BRIDGE CODE	
(98B) PERCENT RESPONSIBILITY	0
(99) BORDER BRIDGE STRUCT NO.	n/a

Structure Type and Material

(43) STRUCTURE TYPE, MAIN	
(43A) KIND OF MATERIAL/DESIGN	3 - Steel
(43B) TYPE OF DESIGN/CONSTR	19 - Culvert (includes frame culverts)
(44) STRUCTURE TYPE, APPROACH SPANS	
(44A) KIND OF MATERIAL/DESIGN	0 - Other
(44B) TYPE OF DESIGN/CONSTRUCTION	00 - Other
(45) NUMBER OF SPANS IN MAIN UNIT	1
(46) NUMBER OF APPROACH SPANS	0
(107) DECK STRUCTURE TYPE	N - Not Applicable
(108) WEARING SURFACE/PROTECTIVE SYSTEMS	
(108A) WEARING SURFACE	N - NA
(108B) DECK MEMBRANE	N - NA
(108C) DECK PROTECTION	N - NA

Age of Service

(27) YEAR BUILT	1949
(106) YEAR RECONSTRUCTED	0
(42) TYPE OF SERVICE	
(42A) TYPE OF SERVICE ON BRIDGE	1 - Highway
(42B) TYPE OF SERVICE UNDER BRIDGE	5 - Waterway
(28) LANES	
(28A) LANES ON THE STRUCTURE	02
(28B) LANES UNDER THE STRUCTURE	00

Inspector:	Stantec, Stantec	Structure Number:	5219
Inspection Date:	04/18/2022	Facility Carried:	BUNGANUC RD

Highway Bridge Inspection Report

(29) AVERAGE DAILY TRAFFIC	656
(30) YEAR OF AVERAGE DAILY TRAFFIC	2016
(109) AVERAGE DAILY TRUCK TRAFFIC	5
(19) BYPASS DETOUR LENGTH	5

Geometric Data

(48) LENGTH OF MAXIMUM SPAN (ft.)	17.0
(49) STRUCTURE LENGTH (ft.)	17.0
(50) CURB/SIDEWALK WIDTHS	
(50A) LEFT CURB SIDEWALK (ft.)	0
(50B) RIGHT CURB SIDEWALK (ft.)	0
(51) BRDG RDWY WIDTH CURB-TO-CURB (ft.)	0
(52) DECK WIDTH, OUT-TO-OUT (ft.)	0
(32) APPROACH ROADWAY WIDTH (ft.)	26.0
(33) BRIDGE MEDIAN	0 - No median
(34) SKEW (deg.)	20
(35) STRUCTURE FLARED	0 - No flare
(10) INV RTE, MIN VERT CLEARANCE (ft.)	328.05
(47) TOTAL HORIZONTAL CLEARANCE (ft.)	25.5
(53) VERTICAL CLEARANCE OVER BRIDGE ROADWAY (ft.)	327.76
(54) MIN VERTICAL UNDERCLEARANCE	
(54A) REFERENCE FEATURE	N - Feature not a highway or railroad
(54B) MIN VERTICAL UNDERCARENCE (ft.)	0
(55) MIN LATERAL UNDER CLEARANCE RIGHT	
(55A) REFERENCE FEATURE	N - Feature not a highway or railroad
(55B) MIN LATERAL UNDER CLEARANCE RIGHT (ft.)	327.76
(56) MIN LATERAL UNDER CLEARANCE (ft.)	99.9

Classification

(112) NBIS BRIDGE LENGTH	No
(104) HIGHWAY SYSTEM OF THE INVENTORY ROUTE	0 - Structure/Route is NOT on NHS
(26) FUNCTIONAL CLASSIFICATION OF INVENTORY ROUTE	09 - Rural - Local
(100) STRAHNET HIGHWAY DESIGNATION	Not a STRAHNET route
(101) PARALLEL STRUCTURE DESIGNATION	N - No parallel structure
(102) DIRECTION OF TRAFFIC	2-way traffic
(103) TEMP STRUCTURE	
(105) FEDERAL LANDS HIGHWAYS	Not Applicable
(110) DESIGNATED NATIONAL NETWORK	Inventory route not on network
(20) TOLL	3 - On Free Road
(21) MAINTENANCE RESPONSIBILITY	03 - Town or Township Highway Agency
(22) OWNER	03 - Town or Township Highway Agency
(37) HISTORICAL SIGNIFICANCE	5 - Not eligible

Condition

(58) DECK	N - Not Applicable
(59) SUPERSTRUCTURE	N - Not Applicable
(60) SUBSTRUCTURE	N - Not Applicable
(61) CHANNEL & CHANNEL PROTECTION	7 - Bank protection needs minor repairs
(62) CULVERT	3 - As in 4 but excessive

Load Rating and Posting

(31) DESIGN LOAD	2 - H 15
(63) METHOD USED TO DETERMINE OPERATING RATING	2 - Allowable Stress (AS)
(64) OPERATING RATING	34.3
(65) METHOD USED TO DETERMINE INVENTORY RATING	2 - Allowable Stress (AS)
(66) INVENTORY RATING	24.5
(70) BRIDGE POSTING	5 - Equal to or above legal loads
(41) STRUCTURE OPEN/POSTED/CLOSED	A - Open

Appraisal

(67) STRUCTURAL EVALUATION	3
----------------------------	---

Inspector: Stantec, Stantec
Inspection Date: 04/18/2022

Structure Number: 5219
Facility Carried: BUNGANUC RD

Highway Bridge Inspection Report

(68) DECK GEOMETRY	N
(69) UNDERCLEARANCES, VERTICAL & HORIZONTAL	N
(71) WATERWAY ADEQUACY	8 - Bridge Above Approaches
(72) APPROACH ROADWAY ALIGNMENT	6 - Equal to present minimum criteria
(36) TRAFFIC SAFETY FEATURE	
36A) BRIDGE RAILINGS:	N - NA/Safety feature not required
36B) TRANSITIONS:	N - NA/Safety feature not required
36C) APPROACH GUARDRAIL	0 - Does not meet acceptable standards/safety feature is required
36D) APPROACH GUARDRAIL ENDS	0 - Does not meet acceptable standards/safety feature is required
(113) SCOUR CRITICAL BRIDGES	8 - Stable for scour conditions

Proposed Improvements

(75) TYPE OF WORK	
(75A) TYPE OF WORK PROPOSED	
(75B) WORK DONE BY	
(76) LENGTH OF STRUCTURE IMPROVEMENT (ft.)	
(94) BRIDGE IMPROVEMENT COST (\$K)	
(95) ROADWAY IMPROVEMENT COST (\$K)	
(96) TOTAL PROJECT COST	
(97) YEAR OF IMPROVEMENT COST ESTIMATE	
(114) FUTURE ADT	1050
(115) YEAR OF FUTURE ADT	2036

Navigation Data

(38) NAVIGATION CONTROL	0 - No navigation control on waterway (bridge permit not required)
(111) PIER OR ABUTMENT PROTECTION	
(39) NAV VERT CLEARANCE	0
(116) MIN NAVIGATION VERT CLEARANCE, VERT LIFT BRIDGE	0
(40) NAV HORIZONTAL CLEARANCE	0

Inspector: Stantec, Stantec
Inspection Date: 04/18/2022

Structure Number: 5219
Facility Carried: BUNGANUC RD

Highway Bridge Inspection Report

Inspection Notes

Structure Number: 5219

Town: Brunswick

Structure Name: BUNGANAC

Structure Notes

1949 ~ 16-foot span corrugated steel, structural plate pipe arch on concrete footings.

Wearing Surface

There is cracking in the bituminous roadway over the culvert, typical throughout this road.

Deck

NBI Item 58: N

Superstructure

NBI Item 59: N

Substructure

NBI Item 60: N

Culvert

NBI Item 62: 3

There is section loss at the spring line with backfill falling through 4"-5" holes for 6' on the north abutment in the middle of the culvert. There is heavy rust that continues for 3' on each side of this area.
The south spring line has heavy rusting with scattered holes for about 60' starting at the downstream end. The rusting is just above the

Inspector: Stantec, Stantec

Structure Number: 5219

Inspection Date: 04/18/2022

Facility Carried: BUNGANUC RD

Highway Bridge Inspection Report

spring line with a height of about 6 inches.

The top of the south concrete footing has spalled and is exposing the spring line for approximately 16' at the downstream end.

One spall in the middle of the south footing allows backfill to leak out from under the spring line.

There are scattered hairline cracks with efflorescence on both footings.

There is a 6 in wide x 3 ft long section of corroded bolts at the top middle of the outlet.

The "headwall" at the south side of the culvert is a section of w-beam guardrail.

Channel

NBI Item 61: 7

There is a large tree that has fallen and is lying in and on the inlet end of the culvert.

There is a large void in the riprap at the southeast corner, 4 ft long x 2 ft high x 2 ft deep.

Other

There is a tear in the southbound lane guardrail. The northbound guardrail has been flattened by collision damage.

Special Inspection

Monitoring

Pontis Notes

Inspector: Stantec Stantec
Inspection Date: 04/18/2022

Structure Number: 5219
Facility Carried: BUNGANUC RD

Highway Bridge Inspection Report

Pictures

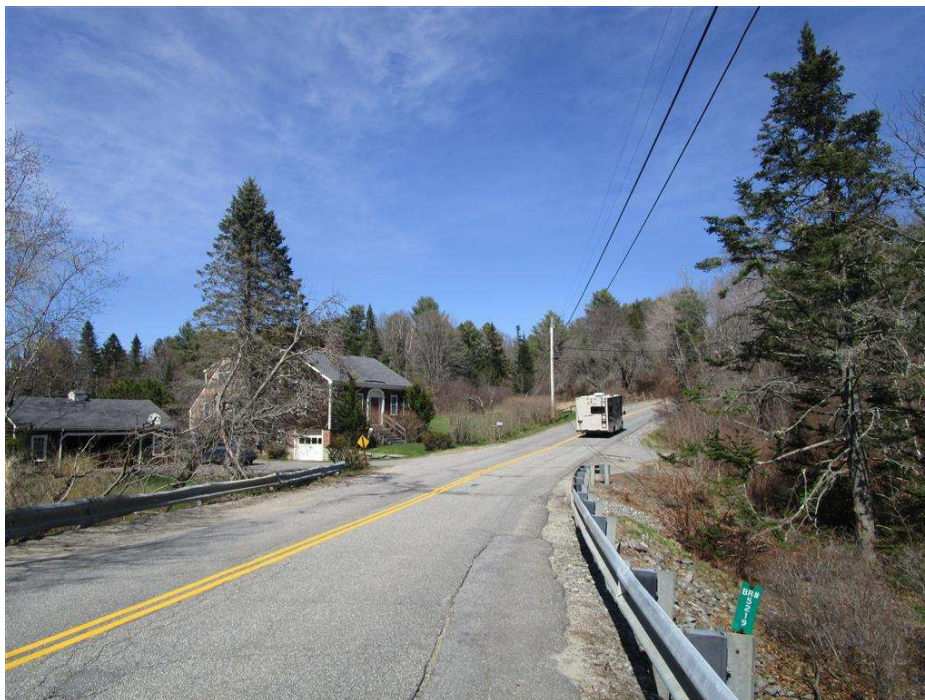


PHOTO 1

Description Roadway looking north



PHOTO 2

Description Roadway looking south

Inspector: Stantec Stantec
Inspection Date: 04/18/2022

Structure Number: 5219
Facility Carried: BUNGANUC RD

Highway Bridge Inspection Report

Pictures



PHOTO 3

Description Looking upstream (west)



PHOTO 4

Description Looking downstream (east)

Inspector: Stantec Stantec
Inspection Date: 04/18/2022

Structure Number: 5219
Facility Carried: BUNGANUC RD

Highway Bridge Inspection Report

Pictures



PHOTO 5

Description West (upstream) elevation



PHOTO 6

Description East (downstream) elevation

Inspector: Stantec Stantec
Inspection Date: 04/18/2022

Structure Number: 5219
Facility Carried: BUNGANUC RD

Highway Bridge Inspection Report

Pictures

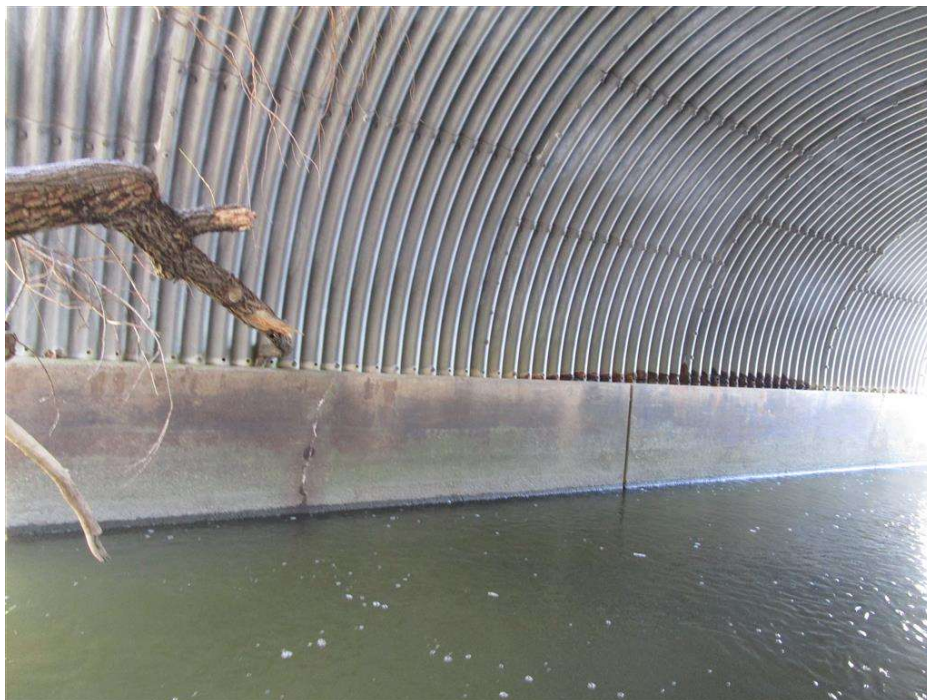


PHOTO 7

Description North culvert wall



PHOTO 8

Description South culvert wall

Inspector: Stantec Stantec
Inspection Date: 04/18/2022

Structure Number: 5219
Facility Carried: BUNGANUC RD

Highway Bridge Inspection Report

Pictures



PHOTO 9

Description Corrosion at spring line on north culvert wall



PHOTO 10

Description Spalls and leaking spring line at south culvert wall

Inspector: Stantec Stantec
Inspection Date: 04/18/2022

Structure Number: 5219
Facility Carried: BUNGANUC RD

Highway Bridge Inspection Report

Pictures



PHOTO 11

Description Spall with exposed spring line and backfill leakage



PHOTO 12

Description W-beam headwall and bolt corrosion at top of culvert (east side)

Inspector: Stantec Stantec
Inspection Date: 04/18/2022

Structure Number: 5219
Facility Carried: BUNGANUC RD

Highway Bridge Inspection Report

Pictures



PHOTO 13

Description Large void under riprap at the southeast corner



PHOTO 14

Description Slumped stone protection and fallen tree at the northwest corner

Inspector: Stantec Stantec
Inspection Date: 04/18/2022

Structure Number: 5219
Facility Carried: BUNGANUC RD

Highway Bridge Inspection Report

Pictures



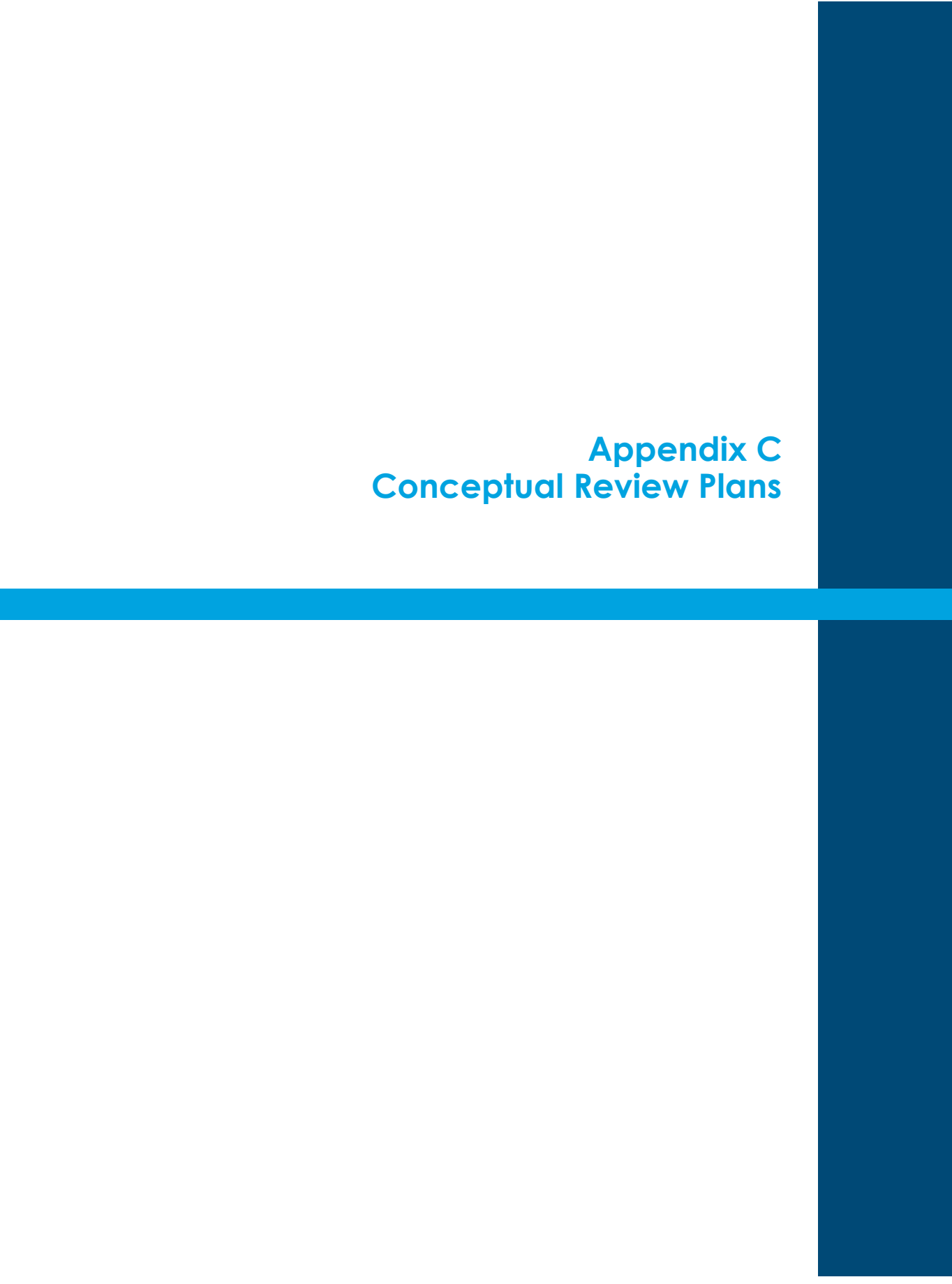
PHOTO 15

Description Stacked stone protection at the southwest corner



PHOTO 16

Description Guardrail overfill on west side of road



Appendix C

Conceptual Review Plans

TOWN OF BRUNSWICK, MAINE

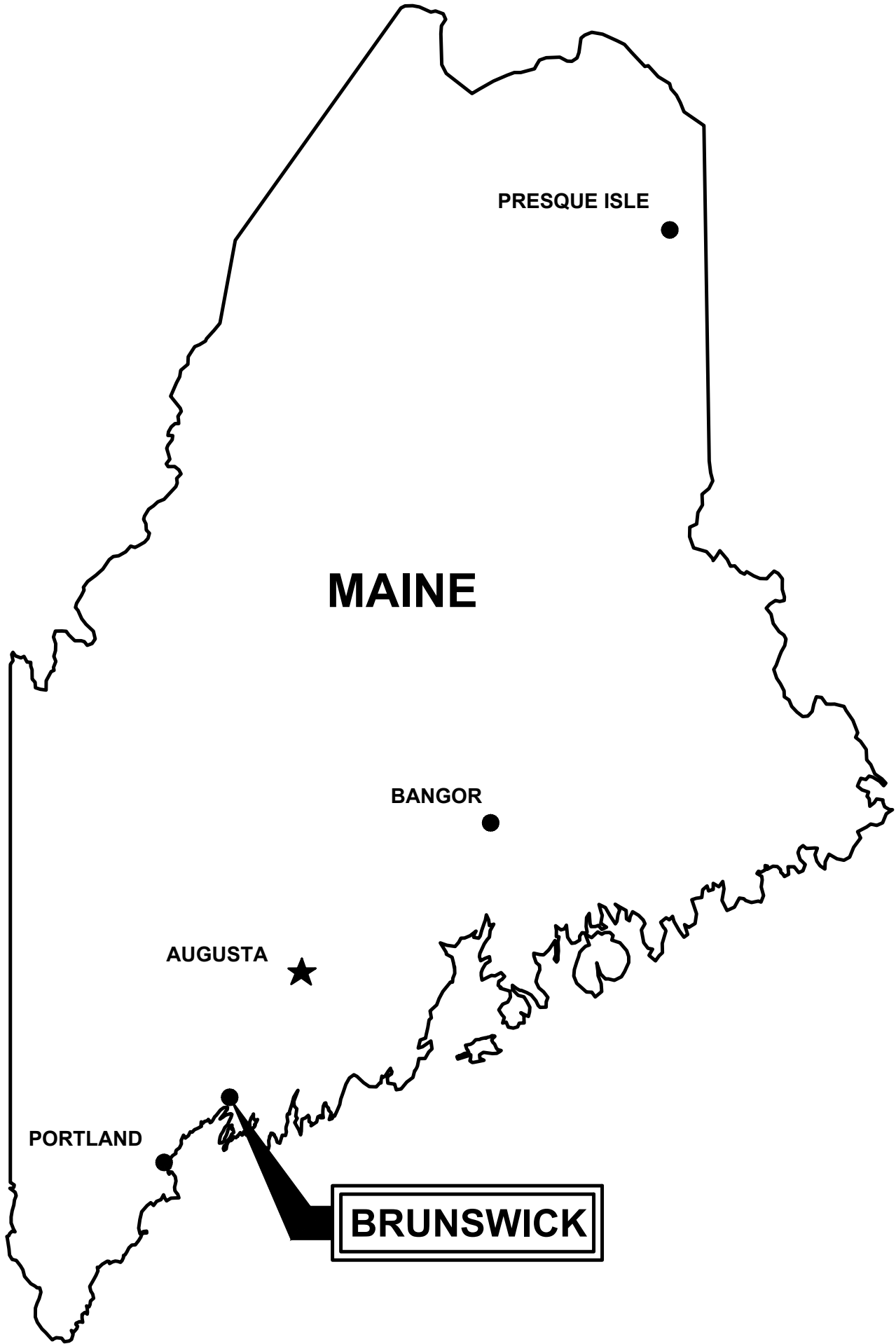
CONCEPTUAL DESIGN DRAWINGS FOR

BUNGANUC ROAD BRIDGE No. 5219

BUNGANUC ROAD OVER BUNGANUC STREAM

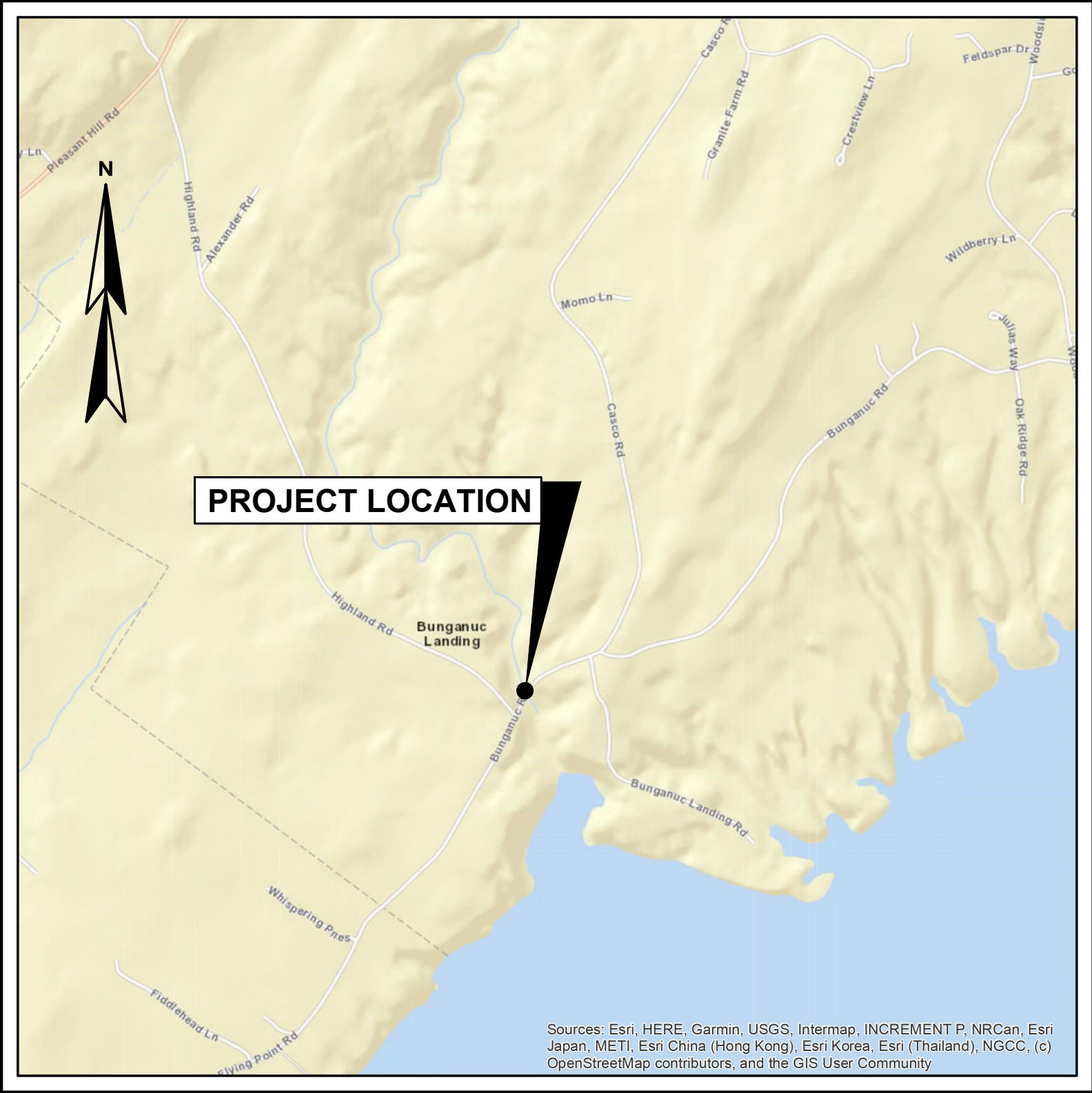
FEBRUARY 2024

CONCEPTUAL REVIEW



DRAWING INDEX

<u>GENERAL</u>	
---	COVER SHEET
<u>CIVIL</u>	
C-1	GENERAL NOTES, LEGEND AND ABBREVIATIONS
C-2	PROPOSED ALTERNATIVE 1
C-3	PROPOSED ALTERNATIVE 2
C-4	PROPOSED ALTERNATIVE 3

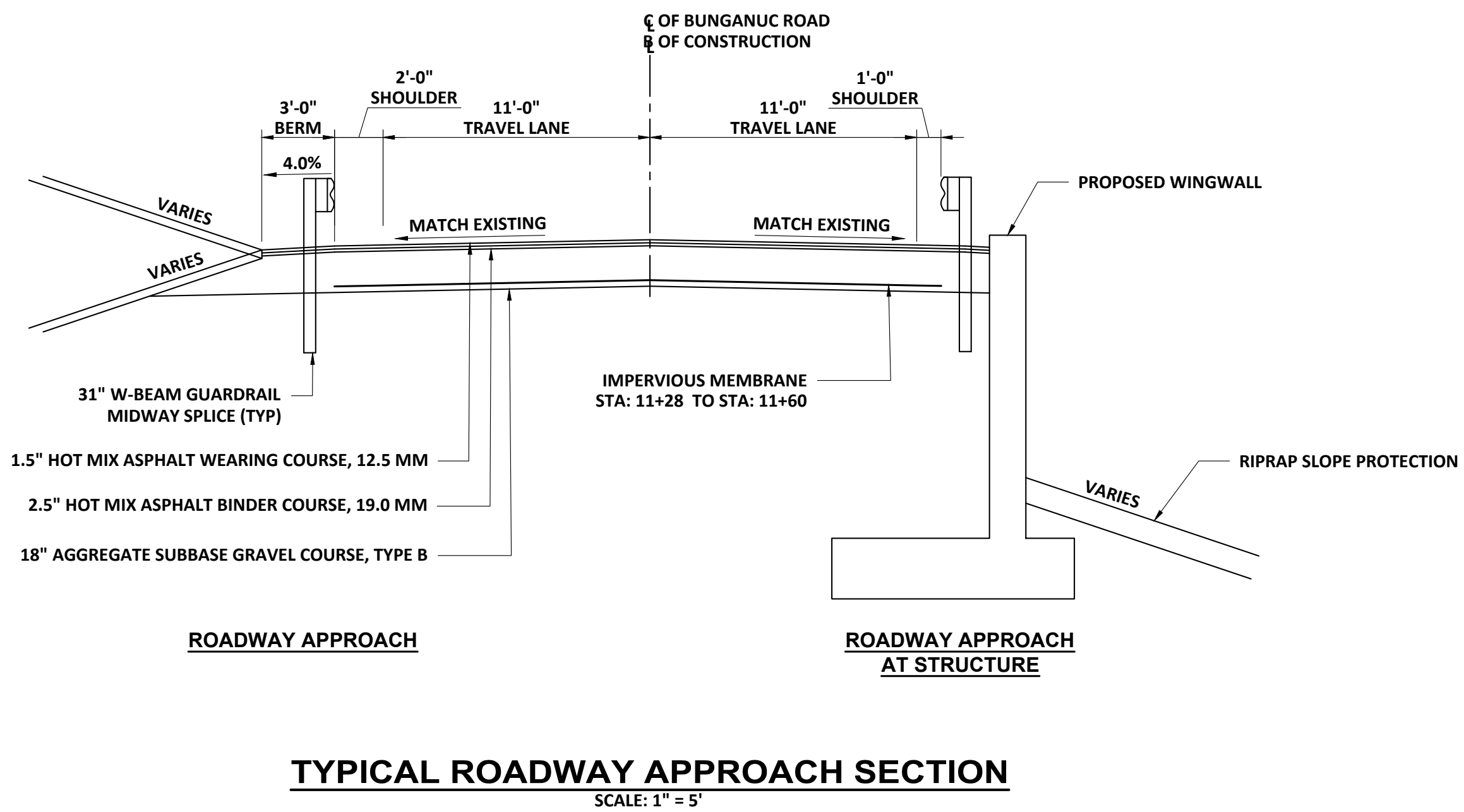
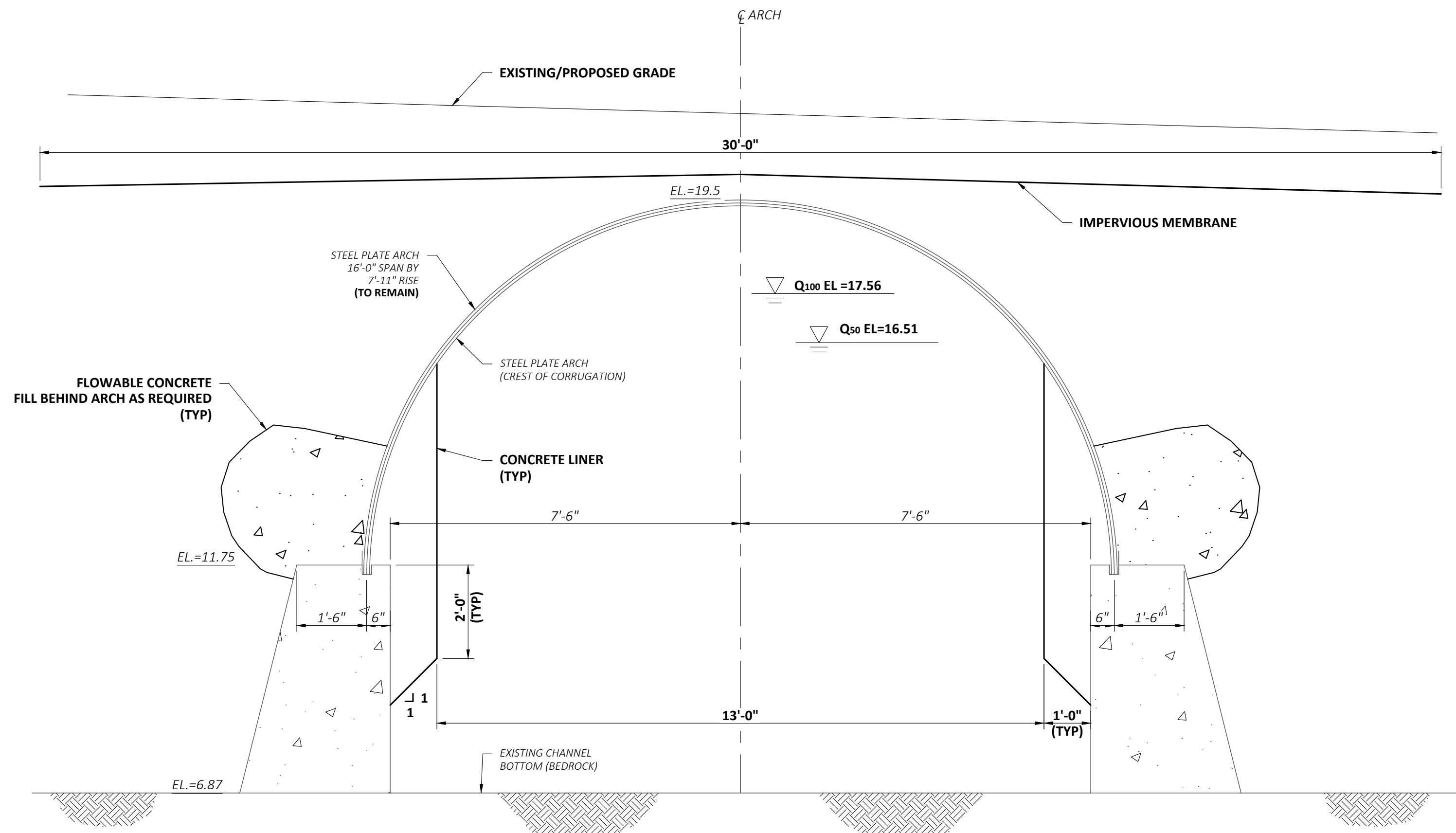
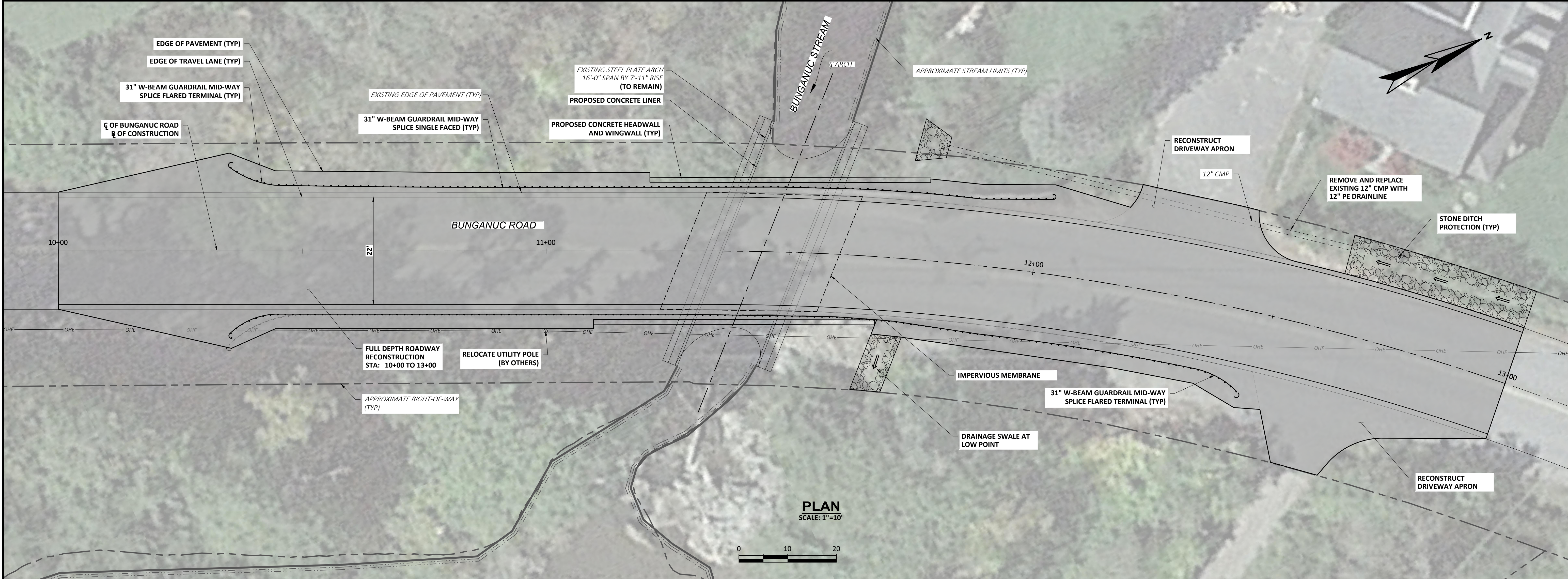


LOCATION PLAN

SCALE: 1"=2,000'

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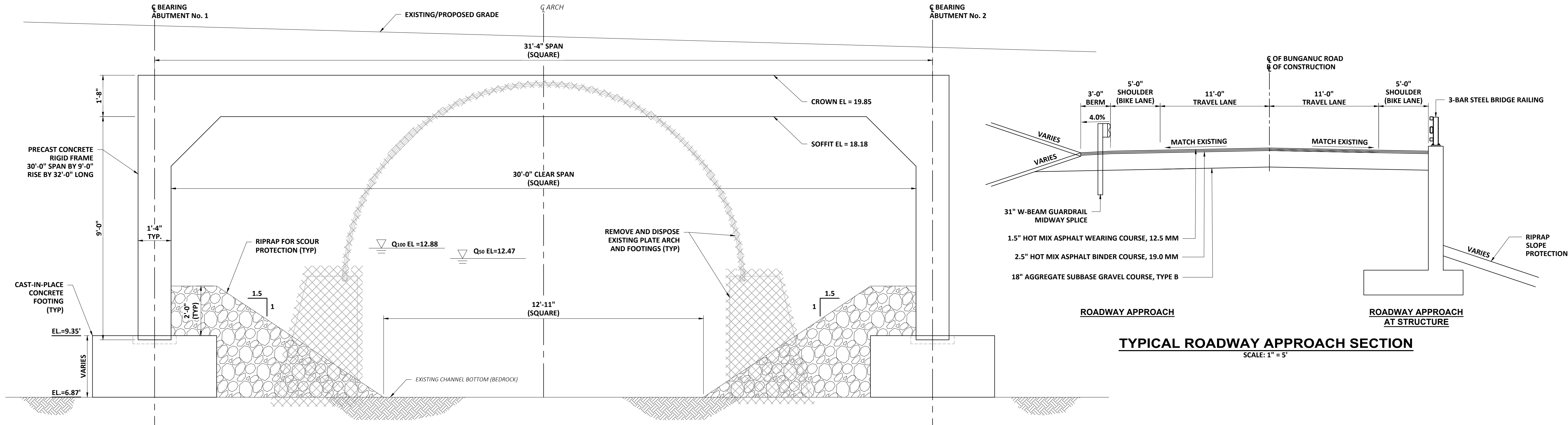
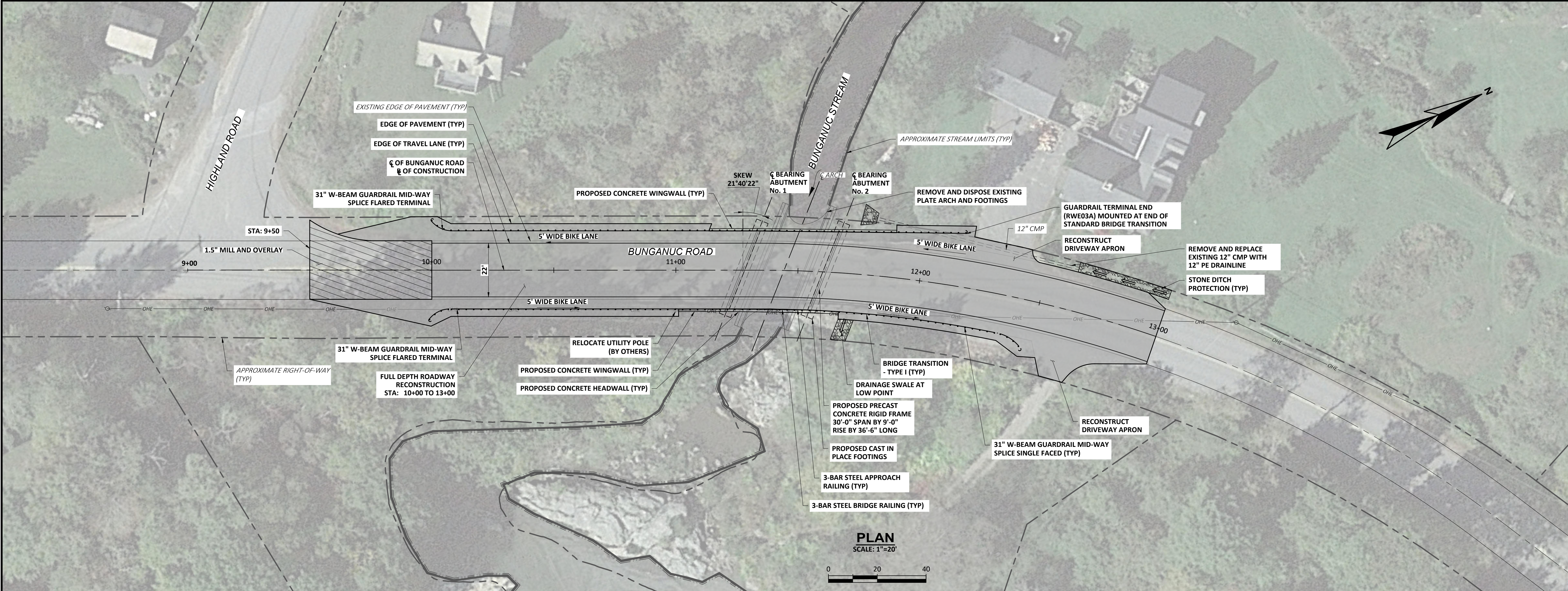
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REVISIONS		APPD	DATE
NO	Δ		
PROJECT NO: 21641		DESIGNED: B. SPRINGER	
CAD COORD: MLAPIERRE		CAD: MLAPIERRE	
CHECKED: W. NUJN		DATE: FEBRUARY 2024	
APPROVED: O. CHAPIN		DATE: FEBRUARY 2024	
SUBMISSION: CONCEPTUAL REVIEW			
TOWN OF BRUNSWICK, MAINE BUNGANUC ROAD BRIDGE NO. 5219 BUNGANUC ROAD OVER BUNGANUC STREAM			
PROPOSED ALTERNATIVE 1			
DRAWING		C-2	

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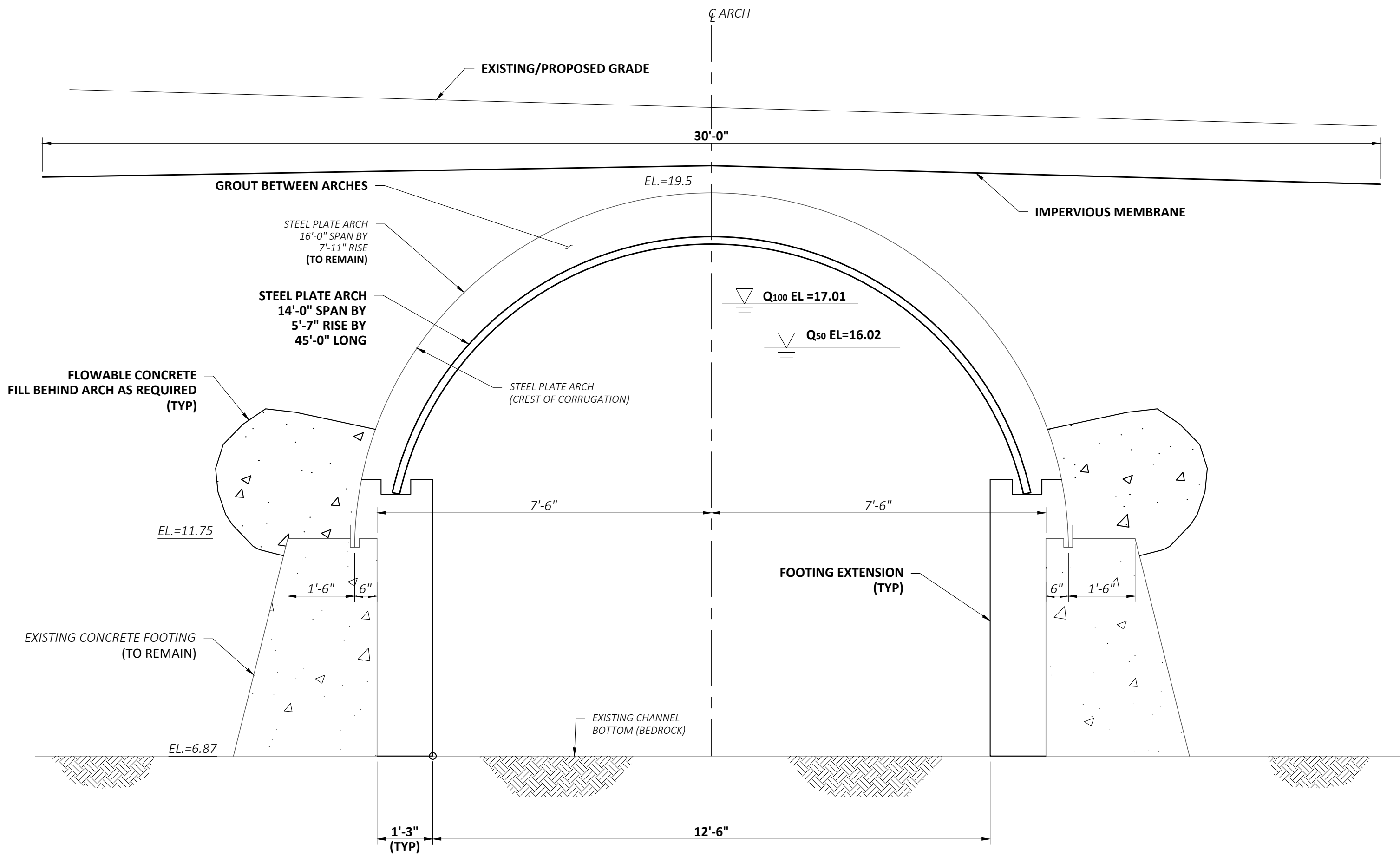
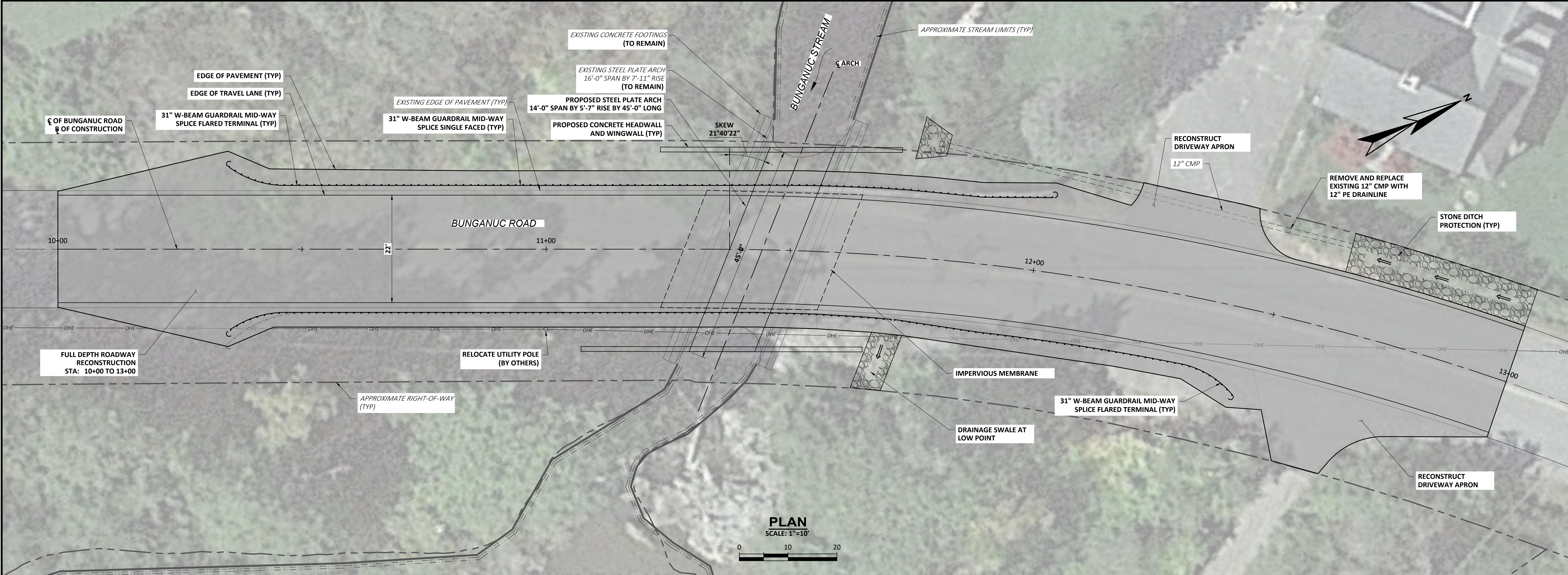
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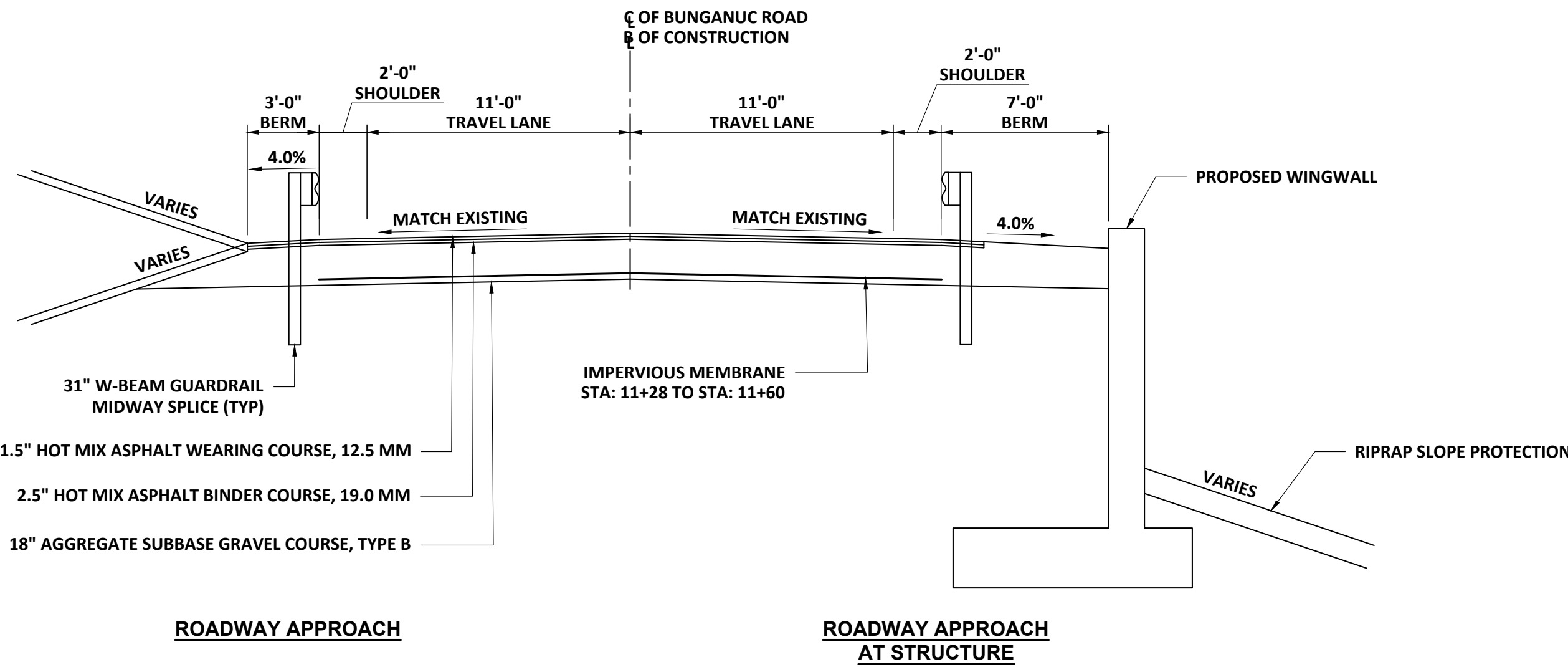
TOWN OF BRUNSWICK, MAINE BUNGANUC ROAD BRIDGE NO. 5219 BUNGANUC ROAD OVER BUNGANUC STREAM		 WRIGHT-PIERCE 207.725.8721 www.wright-pierce.com 11 BOWDOIN MILL ISLAND, SUITE 140, TOPSHAM, ME 04086								PROJECT NO.: 21641 DESIGNED: B. SPRINGER CAD COORD: M. LAPIERRE CAD: M. LAPIERRE CHECKED: W. NUHN DATE: FEBRUARY 2024 APPROVED: O. CHAPLIN DATE: FEBRUARY 2024 SUBMISSION: CONCEPTUAL REVIEW		NO	REVISIONS	APPD	DATE
												△			
PROPOSED ALTERNATIVE 2										△		△			
												△			
DRAWING															
C-3															

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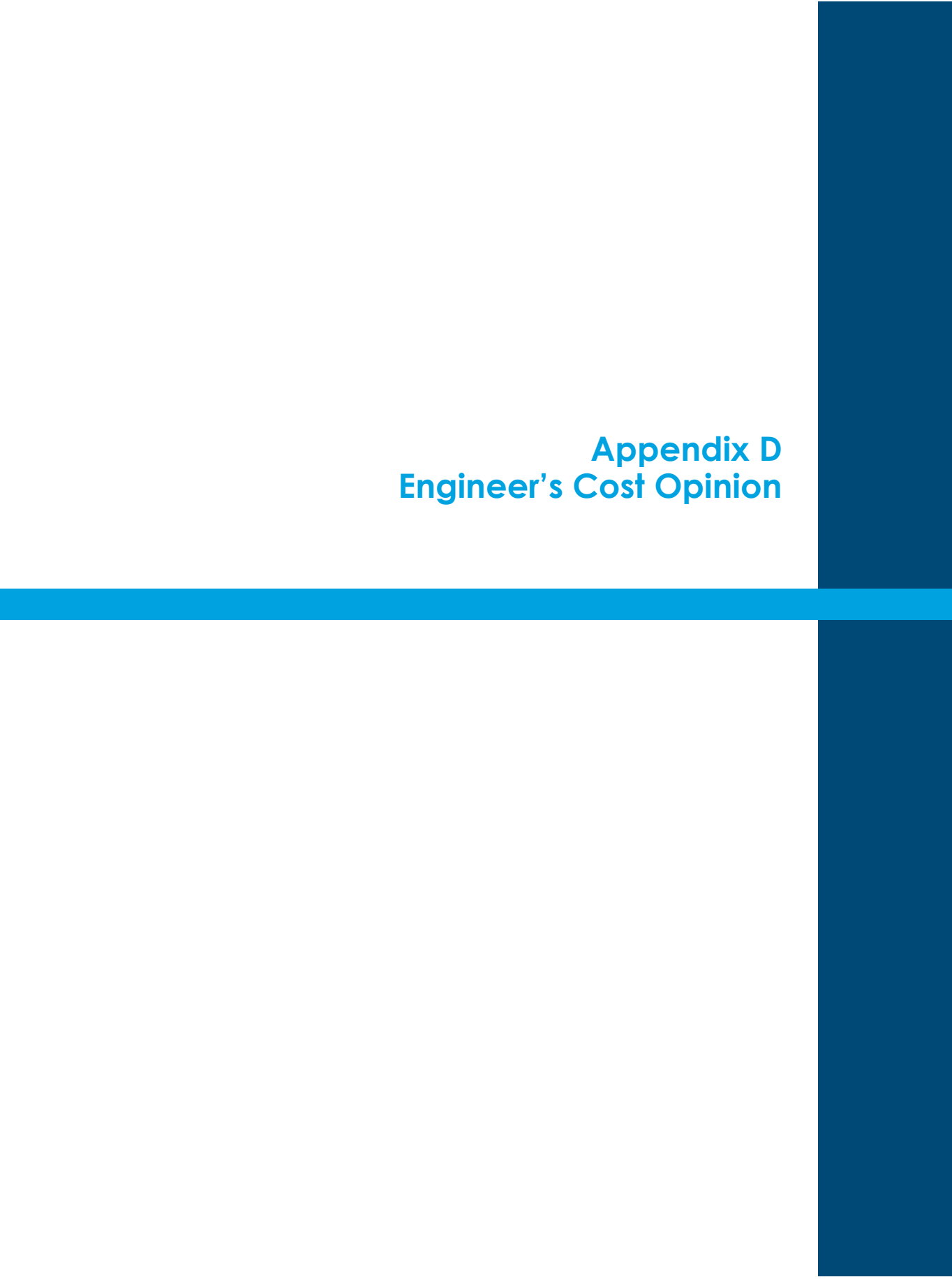


LONGITUDINAL SECTION
ALTERNATIVE 3: SLIP LINER
SCALE: 1/2"=1'-0"



TYPICAL ROADWAY APPROACH SECTION
SCALE: 1"=5'

REVISIONS		APPD	DATE
NO	Δ		
PROJECT NO: 21641		DESIGNED: B. SPRINGER	
CAD COORD: MLAPIERRE		CAD: MLAPIERRE	
CHECKED: W. NUHN		DATE: FEBRUARY 2024	
APPROVED: O. CHAPIN		DATE: FEBRUARY 2024	
SUBMISSION: CONCEPTUAL REVIEW			
TOWN OF BRUNSWICK, MAINE BUNGANUC ROAD BRIDGE NO. 5219 BUNGANUC ROAD OVER BUNGANUC STREAM			
PROPOSED ALTERNATIVE 3			
DRAWING C-4			



Appendix D

Engineer's Cost Opinion



PROJECT NAME: Bunganuc Rd
PROJECT NUMBER: 21641
CITY/TOWN: Brunswick, ME
CLIENT: Town of Brunswick, ME

MADE BY: RJQ
CHECKED BY: WTN
SHEET: 1
DATE: 2/14/2024
DATE: 2/16/2024
OF 1

ENGINEER'S OPINION OF COST - ALTERNATE 1 - CONCRETE LINER

ITEM NUMBER	ITEM DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTAL PRICE
202.202	REMOVING PAVEMENT SURFACE	SY	\$ 25.00	840	\$ 21,000.00
203.20	COMMON EXCAVATION	CY	\$ 30.00	570	\$ 17,100.00
203.21	ROCK EXCAVATION	CY	\$ 300.00	10	\$ 3,000.00
203.25	GRANULAR BORROW	CY	\$ 80.00	280	\$ 22,400.00
206.082	STRUCTURAL EARTH EXCAVATION - MAJOR STRUCTURES, PLAN QUANTITY	CY	\$ 50.00	280	\$ 14,000.00
304.10	AGGREGATE SUBBASE COURSE - GRAVEL	CY	\$ 60.00	541	\$ 32,460.00
403.207	HOT MIX ASPHALT, 19.0 MM NOMINAL MAXIMUM SIZE	T	\$ 300.00	152	\$ 45,600.00
403.208	HOT MIX ASPHALT, 12.5 MM NOMINAL MAXIMUM SIZE	T	\$ 300.00	91	\$ 27,300.00
409.15	BITUMINOUS TACK COAT, APPLIED	G	\$ 30.00	44	\$ 1,320.00
502.111	STRUCTURAL CONCRETE FOOTINGS	CY	\$ 2,000.00	66	\$ 132,000.00
502.32	STRUCTURAL CONCRETE CULVERT END WALL	CY	\$ 2,000.00	62	\$ 124,000.00
502.325	STR CONC CULVERT INVERT LINING	CY	\$ 2,000.00	26	\$ 52,000.00
503.12	REINFORCING STEEL, FABRICATED AND DELIVERED	LB	\$ 1.75	20000	\$ 35,000.00
503.13	REINFORCING STEEL, PLACING	LB	\$ 2.00	20000	\$ 40,000.00
503.16	WELDED STEEL WIRE FABRIC, COMPLETE IN PLACE	LB	\$ 8.00	523	\$ 4,184.00
511.07	COFFERDAM: UPSTREAM	LS	\$ 80,000.00	1	\$ 80,000.00
511.07	COFFERDAM: DOWNSTREAM	LS	\$ 40,000.00	1	\$ 40,000.00
602.3	FLOWABLE CONCRETE FILL	CY	\$ 750.00	10	\$ 7,500.00
603.15	12 INCH CULVERT PIPE OPTION I	LF	\$ 100.00	85	\$ 8,500.00
606.1301	31" W-BM GR, MID-WAY SPLICE-SGL FACED	LF	\$ 50.00	238	\$ 11,900.00
606.1305	31" W-BM GR, MD-WY SPLC FLARED TERM	EA	\$ 4,500.00	4	\$ 18,000.00
606.363	GUARDRAIL REMOVE AND DISPOSE	LF	\$ 15.00	152	\$ 2,280.00
610.08	PLAIN RIPRAP	CY	\$ 125.00	60	\$ 7,500.00
610.18	STONE DITCH PROTECTION	CY	\$ 150.00	17	\$ 2,550.00
636.35	IMPERVIOUS MEMBRANE	SY	\$ 100.00	100	\$ 10,000.00
652.36	MAINTENANCE OF TRAFFIC CONTROL DEVICES	LS	\$ 25,000.00	1	\$ 25,000.00
656.75	TEMPORARY SOIL EROSION AND WATER POLLUTION CONTROL	LS	\$ 10,000.00	1	\$ 10,000.00
659.10	MOBILIZATION	LS	\$ 86,000.00	1	\$ 86,000.00
801.03	TEST PITS	EA	\$ 3,000.00	2	\$ 6,000.00

Subtotal \$ 886,594.00
Contingency and Incidentals @ 30% \$ 265,978.20
Engineering Services, Design & Construction @ 30% \$ 265,978.20
Price escalation for 2025 construction year @ 4% \$ 35,463.76

Engineer's Opinion of Cost \$ 1,460,000.00

Range of Costs for Budgeting Purposes	\$ 1,250,000.00	to	\$ 1,680,000.00
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PROJECT NAME: Bunganuc Rd
PROJECT NUMBER: 21641
CITY/TOWN: Brunswick, ME
CLIENT: Town of Brunswick, ME

MADE BY: RJQ DATE: 2/14/2024
CHECKED BY: WTN DATE: 2/16/2024
SHEET: 1 OF 1

ENGINEER'S OPINION OF COST - ALTERNATE 2: RIGID FRAME

ITEM NUMBER	ITEM DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTAL PRICE
201.12	SELECTIVE CLEARING AND THINNING	LS	\$ 30,000.00	0.25	\$ 7,500.00
202.19	REMOVING EXISTING BRIDGE	LS	\$ 60,000.00	1	\$ 60,000.00
202.202	REMOVING PAVEMENT SURFACE	SY	\$ 25.00	982	\$ 24,550.00
203.20	COMMON EXCAVATION	CY	\$ 30.00	642	\$ 19,260.00
203.21	ROCK EXCAVATION	CY	\$ 300.00	15	\$ 4,500.00
203.25	GRANULAR BORROW	CY	\$ 80.00	44	\$ 3,520.00
206.082	HOT MIX ASPHALT, 19.0 MM NOMINAL MAXIMUM SIZE	CY	\$ 50.00	564	\$ 28,200.00
304.10	AGGREGATE SUBBASE COURSE - GRAVEL	CY	\$ 60.00	659	\$ 39,540.00
403.207	HOT MIX ASPHALT, 19.0 MM NOMINAL MAXIMUM SIZE	T	\$ 300.00	185	\$ 55,500.00
403.208	HOT MIX ASPHALT, 12.5 MM NOMINAL MAXIMUM SIZE	T	\$ 300.00	123	\$ 36,900.00
409.15	BITUMINOUS TACK COAT, APPLIED	G	\$ 30.00	59	\$ 1,770.00
502.111	STRUCTURAL CONCRETE FOOTINGS	CY	\$ 2,000.00	114	\$ 228,000.00
502.289	STRUCTURAL CONCRETE RIGID FRAME STRUCTURES	LS	\$ 215,000.00	1	\$ 215,000.00
502.32	STRUCTURAL CONCRETE CULVERT END WALL	CY	\$ 2,000.00	69	\$ 138,000.00
503.12	REINFORCING STEEL, FABRICATED AND DELIVERED	LB	\$ 1.75	22000	\$ 38,500.00
503.13	REINFORCING STEEL, PLACING	LB	\$ 2.00	22000	\$ 44,000.00
507.0815	STEEL APPROACH RAIL, 3 BAR	LS	\$ 13,000.00	1	\$ 13,000.00
507.082	STEEL BRIDGE RAILING, 3-BAR	LF	\$ 350.00	93	\$ 32,550.00
511.07	COFFERDAM: UPSTREAM	LS	\$ 100,000.00	1	\$ 100,000.00
511.07	COFFERDAM: DOWNSTREAM	LS	\$ 50,000.00	1	\$ 50,000.00
603.15	12 INCH CULVERT PIPE OPTION I	LF	\$ 100.00	85	\$ 8,500.00
606.1301	31" W-BM GR, MID-WAY SPLICE-SGL FACED	LF	\$ 50.00	156	\$ 7,800.00
606.1305	31" W-BM GR, MD-WY SPLC FLARED TERM	EA	\$ 4,500.00	3	\$ 13,500.00
606.1721	BRIDGE TRANSITION - TYPE I	EA	\$ 4,500.00	4	\$ 18,000.00
606.363	GUARDRAIL REMOVE AND DISPOSE	LF	\$ 15.00	152	\$ 2,280.00
610.08	PLAIN RIPRAP	CY	\$ 125.00	120	\$ 15,000.00
610.18	STONE DITCH PROTECTION	CY	\$ 150.00	17	\$ 2,550.00
652.36	MAINTENANCE OF TRAFFIC CONTROL DEVICES	CD	\$ 25,000.00	1	\$ 25,000.00
656.75	TEMPORARY SOIL EROSION AND WATER POLLUTION CONTROL	LS	\$ 10,000.00	1	\$ 10,000.00
659.10	MOBILIZATION	LS	\$ 124,000.00	1	\$ 124,000.00

Subtotal \$ 1,359,420.00
Contingency and Incidentals @ 30% \$ 407,826.00
Engineering Services, Design & Construction @ 30% \$ 407,826.00
Price escalation for 2025 construction year @ 4% \$ 54,376.80

Engineer's Opinion of Cost **\$ 2,230,000.00**

Range of Costs for Budgeting Purposes	\$ 1,900,000.00	to	\$ 2,570,000.00
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PROJECT NAME: Bunganuc Rd
PROJECT NUMBER: 21641
CITY/TOWN: Brunswick, ME
CLIENT: Town of Brunswick, ME

MADE BY: RJQ DATE: 2/14/2024
CHECKED BY: WTN DATE: 2/16/2024
SHEET: 1 OF 1

ENGINEER'S OPINION OF COST - ALTERNATE 3: STEEL PLATE ARCH

ITEM NUMBER	ITEM DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTAL PRICE
202.202	REMOVING PAVEMENT SURFACE	SY	\$ 25.00	840	\$ 21,000.00
203.20	COMMON EXCAVATION	CY	\$ 30.00	581	\$ 17,430.00
203.21	ROCK EXCAVATION	CY	\$ 300.00	10	\$ 3,000.00
203.25	GRANULAR BORROW	CY	\$ 80.00	280	\$ 22,400.00
206.082	STRUCTURAL EARTH EXCAVATION - MAJOR STRUCTURES, PLAN QUANTITY	CY	\$ 50.00	280	\$ 14,000.00
304.10	AGGREGATE SUBBASE COURSE - GRAVEL	CY	\$ 60.00	553	\$ 33,180.00
403.207	HOT MIX ASPHALT, 19.0 MM NOMINAL MAXIMUM SIZE	T	\$ 300.00	155	\$ 46,500.00
403.208	HOT MIX ASPHALT, 12.5 MM NOMINAL MAXIMUM SIZE	T	\$ 300.00	93	\$ 27,900.00
409.15	BITUMINOUS TACK COAT, APPLIED	G	\$ 30.00	45	\$ 1,350.00
502.111	STRUCTURAL CONCRETE FOOTINGS	CY	\$ 2,000.00	58	\$ 116,000.00
502.32	STRUCTURAL CONCRETE CULVERT END WALL	CY	\$ 2,000.00	57	\$ 114,000.00
502.325	STR CONC CULVERT INVERT LINING	CY	\$ 2,000.00	60	\$ 120,000.00
502.57	ANNULAR SPACE GROUTING	CY	\$ 1,000.00	34	\$ 34,000.00
503.12	REINFORCING STEEL, FABRICATED AND DELIVERED	LB	\$ 1.75	22000	\$ 38,500.00
503.13	REINFORCING STEEL, PLACING	LB	\$ 2.00	22000	\$ 44,000.00
509.13	STEEL STRUCTURAL PLATE ARCH	LS	\$ 60,000.00	1	\$ 60,000.00
511.07	COFFERDAM: UPSTREAM	LS	\$ 80,000.00	1	\$ 80,000.00
511.07	COFFERDAM: DOWNSTREAM	CY	\$ 40,000.00	1	\$ 40,000.00
602.3	FLOWABLE CONCRETE FILL	CY	\$ 500.00	10	\$ 5,000.00
603.15	12 INCH CULVERT PIPE OPTION I	LF	\$ 100.00	85	\$ 8,500.00
606.1301	31" W-BM GR, MID-WAY SPLICE-SGL FACED	LF	\$ 50.00	238	\$ 11,900.00
606.1305	31" W-BM GR, MD-WY SPLC FLARED TERM	LF	\$ 4,500.00	4	\$ 18,000.00
606.363	GUARDRAIL REMOVE AND DISPOSE	LF	\$ 15.00	152	\$ 2,280.00
610.08	PLAIN RIPRAP	CY	\$ 125.00	15	\$ 1,875.00
610.18	STONE DITCH PROTECTION	CY	\$ 150.00	17	\$ 2,550.00
636.35	IMPERVIOUS MEMBRANE	SY	\$ 100.00	100	\$ 10,000.00
652.36	MAINTENANCE OF TRAFFIC CONTROL DEVICES	CD	\$ 25,000.00	1	\$ 25,000.00
656.75	TEMPORARY SOIL EROSION AND WATER POLLUTION CONTROL	LS	\$ 10,000.00	1	\$ 10,000.00
659.10	MOBILIZATION	LS	\$ 99,000.00	1	\$ 99,000.00
801.03	TEST PITS	EA	\$ 3,000.00	2	\$ 6,000.00

Subtotal \$ 1,033,365.00

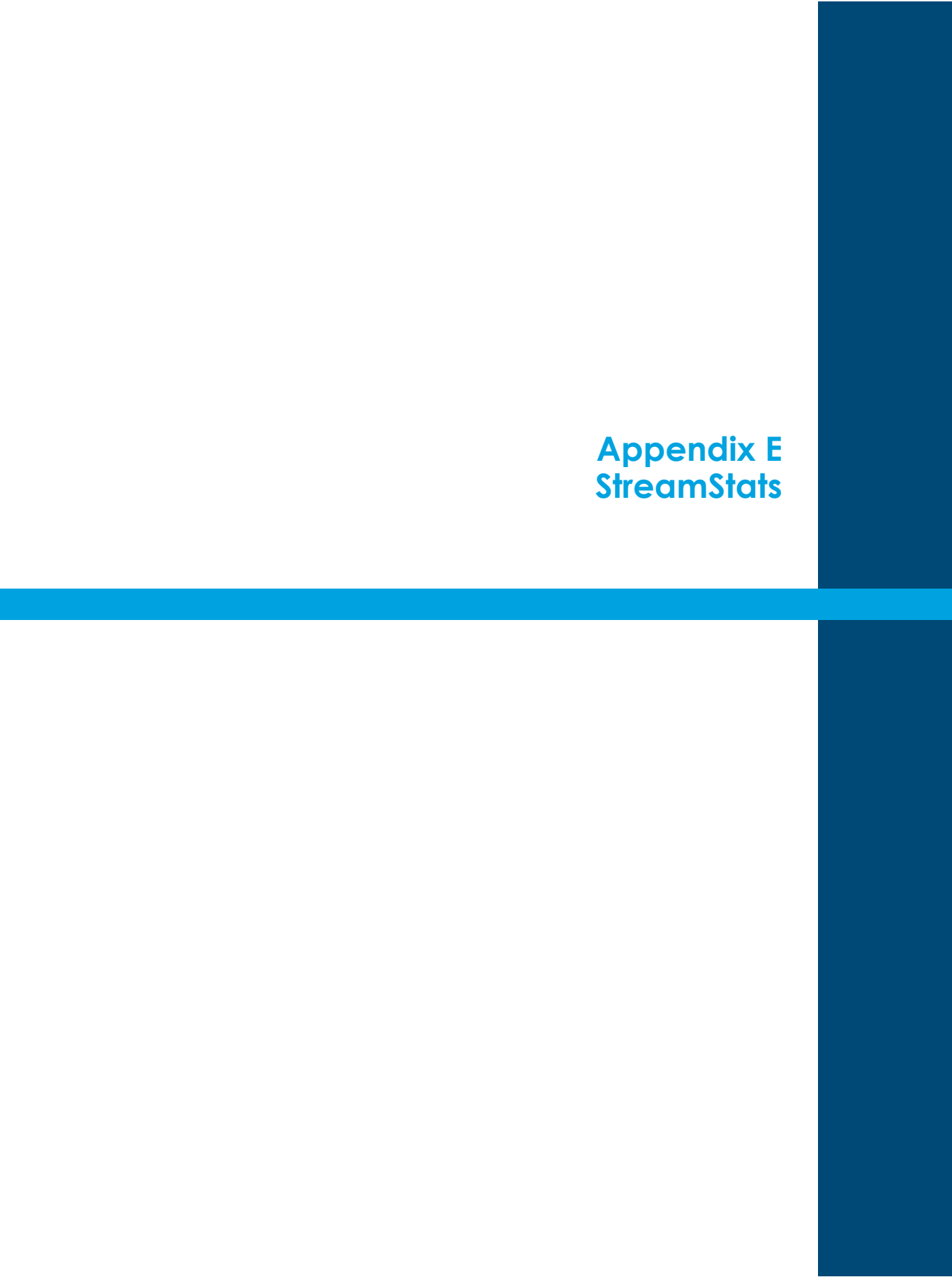
Contingency and Incidentals @ 30% \$ 310,009.50

Engineering Services, Design & Construction @ 30% \$ 310,009.50

Price escalation for 2025 construction year @ 4% \$ 41,334.60

Engineer's Opinion of Cost \$ 1,700,000.00

Range of Costs for Budgeting Purposes		\$ 1,450,000.00	to \$ 1,960,000.00
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Appendix E StreamStats

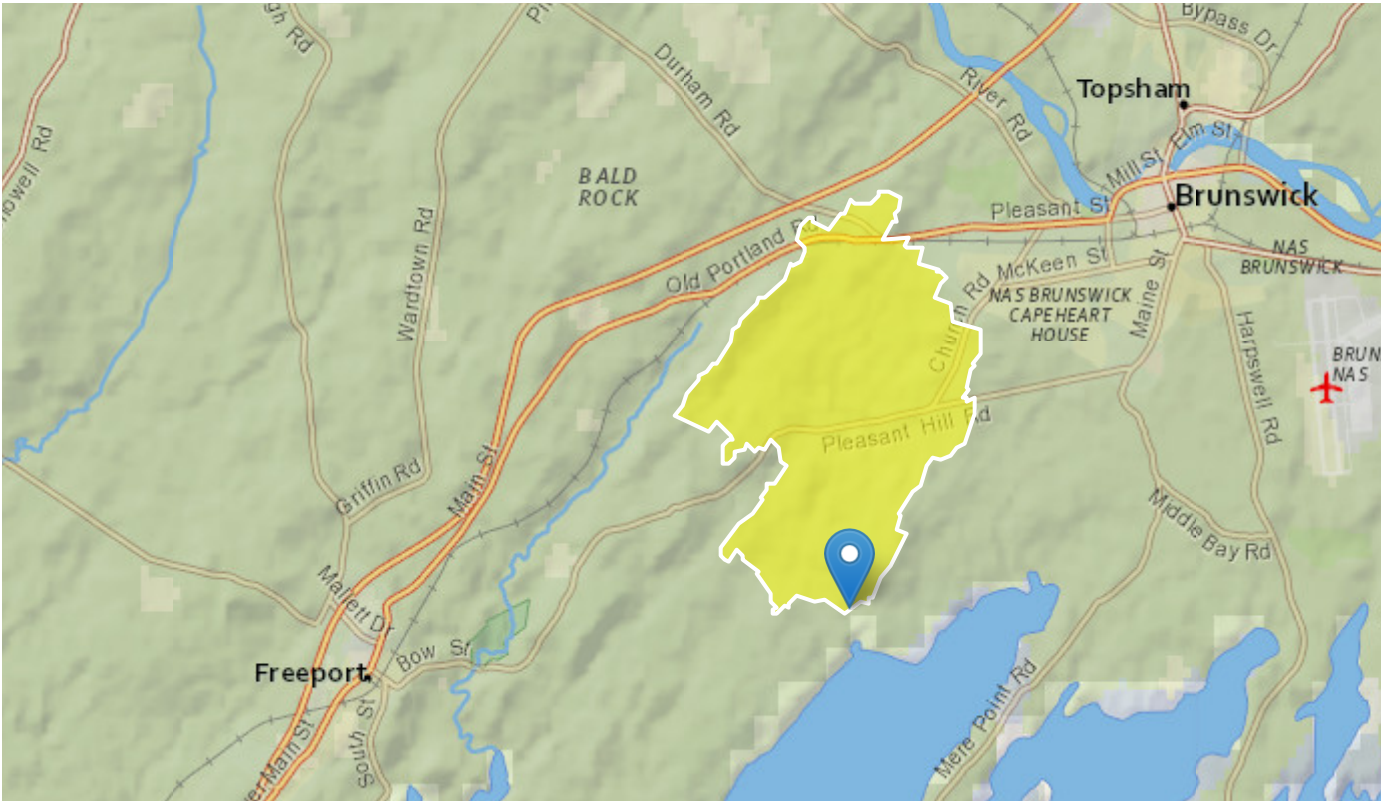
StreamStats Report

Region ID: ME

Workspace ID: ME20231031203854281000

Clicked Point (Latitude, Longitude): 43.86461, -70.02068

Time: 2023-10-31 16:39:22 -0400



[+ Collapse All](#)

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BSLDDEM10M	Mean basin slope computed from 10 m DEM	7.66	percent
COASTDIST	Shortest distance from the coastline to the basin centroid	42.5	miles
DRNAREA	Area that drains to a point on a stream	5.26	square miles
ELEV	Mean Basin Elevation	109.8	feet
ELEVMAX	Maximum basin elevation	279.6	feet

Parameter Code	Parameter Description	Value	Unit
I24H100Y	Maximum 24-hour precipitation that occurs on average once in 100 years	7.49	inches
I24H10Y	Maximum 24-hour precipitation that occurs on average once in 10 years	4.85	inches
I24H200Y	Maximum 24-hour precipitation that occurs on average once in 200 years	8.48	inches
I24H25Y	Maximum 24-hour precipitation that occurs on average once in 25 years	5.89	inches
I24H2Y	Maximum 24-hour precipitation that occurs on average once in 2 years - Equivalent to precipitation intensity index	3.18	inches
I24H500Y	Maximum 24-hour precipitation that occurs on average once in 500 years	10.08	inches
I24H50Y	Maximum 24-hour precipitation that occurs on average once in 50 years	6.66	inches
I24H5Y	Maximum 24-hour precipitation that occurs on average once in 5 years	4.09	inches
JULAVPRE	Mean July Precipitation	3.45	inches
LC06WATER	Percent of open water, class 11, from NLCD 2006	0	percent
PCTSNDGRV	Percentage of land surface underlain by sand and gravel deposits	0.404	percent
SANDGRAVAF	Fraction of land surface underlain by sand and gravel aquifers	0.004	dimensionless
SANDGRAVAP	Percentage of land surface underlain by sand and gravel aquifers	0.41	percent
STATSGOA	Percentage of area of Hydrologic Soil Type A from STATSGO	17.8	percent
STORAGE	Percentage of area of storage (lakes ponds reservoirs wetlands)	5.305	percent

➤ Peak-Flow Statistics

Peak-Flow Statistics Parameters [Statewide multiparameter peakflows SIR 2020 5092]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	0.26	5680
I24H2Y	24 Hour 2 Year Precipitation	3.18	inches	1.92	4.17
STORAGE	Percent Storage	5.305	percent	0	29.4
I24H5Y	24 Hour 5 Year Precipitation	4.09	inches	2.48	5.38
I24H10Y	24 Hour 10 Year Precipitation	4.85	inches	2.84	6.38
I24H25Y	24 Hour 25 Year Precipitation	5.89	inches	3.3	7.75
I24H50Y	24 Hour 50 Year Precipitation	6.66	inches	3.65	8.79
I24H100Y	24 Hour 100 Year Precipitation	7.49	inches	3.99	9.88
I24H200Y	24 Hour 200 Year Precipitation	8.48	inches	5.26	11.1
I24H500Y	24 Hour 500 Year Precipitation	10.08	inches	5.95	13.1

Peak-Flow Statistics Flow Report [Statewide multiparameter peakflows SIR 2020 5092]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIL	PIU	ASEp
50-percent AEP flood	283	ft ³ /s	152	528	39.1
20-percent AEP flood	464	ft ³ /s	252	853	38.1
10-percent AEP flood	602	ft ³ /s	323	1120	38.9
4-percent AEP flood	792	ft ³ /s	419	1500	39.9
2-percent AEP flood	945	ft ³ /s	492	1820	39.7

Statistic	Value	Unit	PIL	PIU	ASEp
1-percent AEP flood	1110	ft ³ /s	580	2120	40.7
0.5-percent AEP flood	1270	ft ³ /s	642	2510	42.8
0.2-percent AEP flood	1520	ft ³ /s	756	3060	43.8

Peak-Flow Statistics Citations

Lombard, P.J., and Hodgkins, G.A.,2020, Estimating flood magnitude and frequency on gaged and ungaged streams in Maine: U.S. Geological Survey Scientific Investigations Report 2020–5092, 56 p. (<https://doi.org/10.3133/sir20205092>)

➤ Annual Flow Statistics

Annual Flow Statistics Parameters [Statewide Annual SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	14.9	1419
SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0.004	dimensionless	0	0.212
ELEV	Mean Basin Elevation	109.8	feet	239	2120

Annual Flow Statistics Disclaimers [Statewide Annual SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Annual Flow Statistics Flow Report [Statewide Annual SIR 2015 5151]

Statistic	Value	Unit
Mean Annual Flow	11	ft ³ /s

Annual Flow Statistics Citations

Dudley, R.W.,2015, Regression equations for monthly and annual mean and selected percentile streamflows for ungaged rivers in Maine: U.S. Geological Survey Scientific Investigations Report 2015–5151, 35 p. (<http://dx.doi.org/10.3133/sir20155151>)

➤ Low-Flow Statistics

Low-Flow Statistics Parameters [Statewide LowFlow SIR 2004 5026]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	9.79	1418
SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0.004	dimensionless	0	0.455

Low-Flow Statistics Disclaimers [Statewide LowFlow SIR 2004 5026]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Low-Flow Statistics Flow Report [Statewide LowFlow SIR 2004 5026]

Statistic	Value	Unit
7 Day 10 Year Low Flow	0.165	ft ³ /s

Low-Flow Statistics Citations

Dudley, R.W., 2004, Estimating Monthly, Annual, and Low 7-Day, 10-Year Streamflows for Ungaged Rivers in Maine: U.S. Geological Survey Scientific Investigations Report 2004-5026, 22 p. (<http://water.usgs.gov/pubs/sir/2004/5026/pdf/sir2004-5026.pdf>)

➤ Base Flow Statistics

Base Flow Statistics Parameters [Maine August Unit Baseflow RivResAppl 2021]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
PCTSNDGRV	Percent Underlain By Sand And Gravel	0.404	percent	0	73
JULAVPRE	Mean July Precipitation	3.45	inches	3.3	4.9

Base Flow Statistics Flow Report [Maine August Unit Baseflow RivResAppl 2021]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE
Mean August unit baseflow	0.212	ft^3/s/mi^2	20.8

Base Flow Statistics Citations

2021, Pamela J. Lombard, Robert W. Dudley, Mathias J. Collins, Rory Saunders, Earnie AtkinsonModel estimated baseflow for streams with endangered Atlantic Salmon in Maine, USA; John Wiley & Sons Ltd., River Research and Applications, Volume 37, Issue 9, pp 1254-1264. (<https://doi.org/10.1002/rra.3835>)

➤ Bankfull Statistics

Bankfull Statistics Parameters [Central and Coastal Bankfull 2004 5042]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	2.92	298

Bankfull Statistics Parameters [Appalachian Highlands D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	0.07722	940.1535

Bankfull Statistics Parameters [New England P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	3.799224	138.999861

Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	0.07722	59927.7393

Bankfull Statistics Flow Report [Central and Coastal Bankfull 2004 5042]

Statistic	Value	Unit
Bankfull Streamflow	29.7	ft^3/s

Statistic	Value	Unit
Bankfull Width	18.2	ft
Bankfull Depth	1.04	ft
Bankfull Area	19	ft^2

Bankfull Statistics Flow Report [Appalachian Highlands D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	30.3	ft
Bieger_D_channel_depth	1.81	ft
Bieger_D_channel_cross_sectional_area	55.5	ft^2

Bankfull Statistics Flow Report [New England P Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	40.2	ft
Bieger_P_channel_depth	1.98	ft
Bieger_P_channel_cross_sectional_area	80.7	ft^2

Bankfull Statistics Flow Report [USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	22.2	ft
Bieger_USA_channel_depth	1.72	ft
Bieger_USA_channel_cross_sectional_area	41.9	ft^2

Bankfull Statistics Flow Report [Area-Averaged]

Statistic	Value	Unit
Bankfull Streamflow	29.7	ft^3/s
Bankfull Width	18.2	ft
Bankfull Depth	1.04	ft
Bankfull Area	19	ft^2
Bieger_D_channel_width	30.3	ft
Bieger_D_channel_depth	1.81	ft
Bieger_D_channel_cross_sectional_area	55.5	ft^2

Statistic	Value	Unit
Bieger_P_channel_width	40.2	ft
Bieger_P_channel_depth	1.98	ft
Bieger_P_channel_cross_sectional_area	80.7	ft^2
Bieger_USA_channel_width	22.2	ft
Bieger_USA_channel_depth	1.72	ft
Bieger_USA_channel_cross_sectional_area	41.9	ft^2

Bankfull Statistics Citations

Dudley, R.W.,2004, Hydraulic-Geometry Relations for Rivers in Coastal and Central Maine: U.S. Geological Survey Scientific Investigations Report 2004-5042, 30 p (<http://pubs.usgs.gov/sir/2004/5042/pdf/sir2004-5042.pdf>)

Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p. (https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_

➤ Maximum Probable Flood Statistics

Maximum Probable Flood Statistics Parameters [Crippen Bue Region 1]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	0.1	10000

Maximum Probable Flood Statistics Flow Report [Crippen Bue Region 1]

Statistic	Value	Unit
Maximum Flood Crippen Bue Regional	11900	ft^3/s

Maximum Probable Flood Statistics Citations

Crippen, J.R. and Bue, Conrad D.1977, Maximum Floodflows in the Conterminous United States, Geological Survey Water-Supply Paper 1887, 52p. (<https://pubs.usgs.gov/wsp/1887/report.pdf>)

➤ Monthly Flow Statistics

Monthly Flow Statistics Parameters [Statewide January SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	14.9	1419
STATSGOA	STATSGO Percent Hydrologic Soil Type A	17.8	percent	0	31.5

Monthly Flow Statistics Parameters [Statewide February SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	14.9	1419
COASTDIST	Distance From Coast To Basin Centroid	42.5	miles	46.6	193
BSLDEM10M	Mean Basin Slope from 10m DEM	7.66	percent	1.5	26.6

Monthly Flow Statistics Parameters [Statewide March SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	14.9	1419
COASTDIST	Distance From Coast To Basin Centroid	42.5	miles	46.6	193
LC06WATER	Percent_Water_from_NLCD2006	0	percent	0	6.2

Monthly Flow Statistics Parameters [Statewide April SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	14.9	1419

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
COASTDIST	Distance From Coast To Basin Centroid	42.5	miles	46.6	193

LC06WATER	Percent_Water_from_NLCD2006	0	percent	0	6.2
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Monthly Flow Statistics Parameters [Statewide May SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	14.9	1419

BSLDEM10M	Mean Basin Slope from 10m DEM	7.66	percent	1.5	26.6
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LC06WATER	Percent_Water_from_NLCD2006	0	percent	0	6.2
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Monthly Flow Statistics Parameters [Statewide June SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	14.9	1419

BSLDEM10M	Mean Basin Slope from 10m DEM	7.66	percent	1.5	26.6
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LC06WATER	Percent_Water_from_NLCD2006	0	percent	0	6.2
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Monthly Flow Statistics Parameters [Statewide July SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	14.9	1419

SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0.004	dimensionless	0	0.212
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ELEV	Mean Basin Elevation	109.8	feet	239	2120
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Monthly Flow Statistics Parameters [Statewide August SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	14.9	1419

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0.004	dimensionless	0	0.212
ELEV	Mean Basin Elevation	109.8	feet	239	2120

Monthly Flow Statistics Parameters [Statewide September SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	14.9	1419
SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0.004	dimensionless	0	0.212
ELEV	Mean Basin Elevation	109.8	feet	239	2120

Monthly Flow Statistics Parameters [Statewide October SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	14.9	1419
SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0.004	dimensionless	0	0.212
ELEV	Mean Basin Elevation	109.8	feet	239	2120

Monthly Flow Statistics Parameters [Statewide November SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	14.9	1419
ELEVMAX	Maximum Basin Elevation	279.6	feet	633	6290

Monthly Flow Statistics Parameters [Statewide December SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	14.9	1419
STATSGOA	STATSGO Percent Hydrologic Soil Type A	17.8	percent	0	31.5

Monthly Flow Statistics Disclaimers [Statewide January SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Monthly Flow Statistics Flow Report [Statewide January SIR 2015 5151]

Statistic	Value	Unit
January 1st percentile flow	1.8	ft ³ /s
January_5th_percentile_flow	2.52	ft ³ /s
January_10th_percentile_flow	3.27	ft ³ /s
January 25th percentile flow	4.74	ft ³ /s
January_50th_percentile_flow	6.31	ft ³ /s
January 75th percentile flow	10.6	ft ³ /s
January_90th_percentile_flow	22.2	ft ³ /s
January 95th percentile flow	44.2	ft ³ /s
January 99th percentile flow	112	ft ³ /s
January Mean Flow	12.6	ft ³ /s

Monthly Flow Statistics Disclaimers [Statewide February SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Monthly Flow Statistics Flow Report [Statewide February SIR 2015 5151]

Statistic	Value	Unit
February 1st percentile flow	1.74	ft ³ /s
February_5th_percentile_flow	1.97	ft ³ /s
February_10th_percentile_flow	2.49	ft ³ /s
February 25th percentile flow	3.4	ft ³ /s
February_50th_percentile_flow	4.97	ft ³ /s
February 75th percentile flow	9.61	ft ³ /s
February_90th_percentile_flow	18.2	ft ³ /s
February 95th percentile flow	38.1	ft ³ /s

Statistic	Value	Unit
February 99th percentile flow	105	ft ³ /s
February Mean Flow	9.92	ft ³ /s

Monthly Flow Statistics Disclaimers [Statewide March SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Monthly Flow Statistics Flow Report [Statewide March SIR 2015 5151]

Statistic	Value	Unit
March 1st percentile flow	2.51	ft ³ /s
March_5th_percentile_flow	3.4	ft ³ /s
March_10th_percentile_flow	4.74	ft ³ /s
March 25th percentile flow	8.37	ft ³ /s
March_50th_percentile_flow	18.6	ft ³ /s
March 75th percentile flow	39.2	ft ³ /s
March_90th_percentile_flow	81.2	ft ³ /s
March 95th percentile flow	115	ft ³ /s
March 99th percentile flow	259	ft ³ /s
March Mean Flow	34.7	ft ³ /s

Monthly Flow Statistics Disclaimers [Statewide April SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Monthly Flow Statistics Flow Report [Statewide April SIR 2015 5151]

Statistic	Value	Unit
April 1st percentile flow	4.98	ft ³ /s
April_5th_percentile_flow	6.81	ft ³ /s
April_10th_percentile_flow	8.63	ft ³ /s
April 25th percentile flow	12.9	ft ³ /s
April_50th_percentile_flow	18.5	ft ³ /s

Statistic	Value	Unit
April 75th percentile flow	36.3	ft ³ /s
April_90th_percentile_flow	73.7	ft ³ /s
April 95th percentile flow	115	ft ³ /s
April 99th percentile flow	292	ft ³ /s
April Mean Flow	33.7	ft ³ /s

Monthly Flow Statistics Disclaimers [Statewide May SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Monthly Flow Statistics Flow Report [Statewide May SIR 2015 5151]

Statistic	Value	Unit
May 1st percentile flow	1.01	ft ³ /s
May_5th_percentile_flow	1.64	ft ³ /s
May_10th_percentile_flow	2.14	ft ³ /s
May 25th percentile flow	3.41	ft ³ /s
May_50th_percentile_flow	5.61	ft ³ /s
May 75th percentile flow	9.61	ft ³ /s
May_90th_percentile_flow	17.7	ft ³ /s
May 95th percentile flow	28.3	ft ³ /s
May 99th percentile flow	65.2	ft ³ /s
May Mean Flow	9.03	ft ³ /s

Monthly Flow Statistics Disclaimers [Statewide June SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Monthly Flow Statistics Flow Report [Statewide June SIR 2015 5151]

Statistic	Value	Unit
June 1st percentile flow	0.631	ft ³ /s
June 5th percentile flow	0.852	ft ³ /s

Statistic	Value	Unit
June_10th_percentile_flow	1.02	ft ³ /s
June 25th percentile flow	1.68	ft ³ /s
June_50th_percentile_flow	3.09	ft ³ /s
June 75th percentile flow	7.62	ft ³ /s
June_90th_percentile_flow	20.8	ft ³ /s
June 95th percentile flow	43.4	ft ³ /s
June 99th percentile flow	150	ft ³ /s
June Mean Flow	8.91	ft ³ /s

Monthly Flow Statistics Disclaimers [Statewide July SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Monthly Flow Statistics Flow Report [Statewide July SIR 2015 5151]

Statistic	Value	Unit
July 1st percentile flow	0.0664	ft ³ /s
July_5th_percentile_flow	0.142	ft ³ /s
July_10th_percentile_flow	0.193	ft ³ /s
July 25th percentile flow	0.336	ft ³ /s
July_50th_percentile_flow	0.811	ft ³ /s
July 75th percentile flow	2.38	ft ³ /s
July_90th_percentile_flow	6.4	ft ³ /s
July 95th percentile flow	11.7	ft ³ /s
July 99th percentile flow	30.9	ft ³ /s
July Mean Flow	2.7	ft ³ /s

Monthly Flow Statistics Disclaimers [Statewide August SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Monthly Flow Statistics Flow Report [Statewide August SIR 2015 5151]

Statistic	Value	Unit
August 1st percentile flow	0.0031	ft ³ /s
August_5th_percentile_flow	0.0128	ft ³ /s
August_10th_percentile_flow	0.0208	ft ³ /s
August 25th percentile flow	0.114	ft ³ /s
August_50th_percentile_flow	0.303	ft ³ /s
August 75th percentile flow	1.16	ft ³ /s
August_90th_percentile_flow	3.37	ft ³ /s
August 95th percentile flow	5.87	ft ³ /s
August 99th percentile flow	20.8	ft ³ /s
August Mean Flow	1.4	ft ³ /s

Monthly Flow Statistics Disclaimers [Statewide September SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Monthly Flow Statistics Flow Report [Statewide September SIR 2015 5151]

Statistic	Value	Unit
September 1st percentile flow	0.00274	ft ³ /s
September_5th_percentile_flow	0.00425	ft ³ /s
September_10th_percentile_flow	0.0277	ft ³ /s
September 25th percentile flow	0.0887	ft ³ /s
September_50th_percentile_flow	0.312	ft ³ /s
September 75th percentile flow	1.3	ft ³ /s
September_90th_percentile_flow	3.42	ft ³ /s
September 95th percentile flow	7.22	ft ³ /s
September 99th percentile flow	31.4	ft ³ /s
September Mean Flow	1.67	ft ³ /s

Monthly Flow Statistics Disclaimers [Statewide October SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Monthly Flow Statistics Flow Report [Statewide October SIR 2015 5151]

Statistic	Value	Unit
October 1st percentile flow	0.0324	ft ³ /s
October_5th_percentile_flow	0.0525	ft ³ /s
October_10th_percentile_flow	0.131	ft ³ /s
October 25th percentile flow	0.538	ft ³ /s
October_50th_percentile_flow	2.1	ft ³ /s
October 75th percentile flow	7.68	ft ³ /s
October_90th_percentile_flow	21	ft ³ /s
October 95th percentile flow	39.6	ft ³ /s
October 99th percentile flow	118	ft ³ /s
October Mean Flow	8.8	ft ³ /s

Monthly Flow Statistics Disclaimers [Statewide November SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Monthly Flow Statistics Flow Report [Statewide November SIR 2015 5151]

Statistic	Value	Unit
November 1st percentile flow	0.361	ft ³ /s
November_5th_percentile_flow	0.664	ft ³ /s
November_10th_percentile_flow	1.65	ft ³ /s
November 25th percentile flow	4.76	ft ³ /s
November_50th_percentile_flow	9.27	ft ³ /s
November 75th percentile flow	17.8	ft ³ /s
November_90th_percentile_flow	35	ft ³ /s
November 95th percentile flow	52.8	ft ³ /s

Statistic	Value	Unit
November 99th percentile flow	121	ft ³ /s
November Mean Flow	15.9	ft ³ /s

Monthly Flow Statistics Disclaimers [Statewide December SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Monthly Flow Statistics Flow Report [Statewide December SIR 2015 5151]

Statistic	Value	Unit
December 1st percentile flow	0.742	ft ³ /s
December_5th_percentile_flow	1.97	ft ³ /s
December_10th_percentile_flow	3.57	ft ³ /s
December 25th percentile flow	6.13	ft ³ /s
December_50th_percentile_flow	9.9	ft ³ /s
December 75th percentile flow	16.1	ft ³ /s
December_90th_percentile_flow	30.5	ft ³ /s
December 95th percentile flow	54.9	ft ³ /s
December 99th percentile flow	145	ft ³ /s
December Mean Flow	16.8	ft ³ /s

Monthly Flow Statistics Flow Report [Area-Averaged]

Statistic	Value	Unit
January 1st percentile flow	1.8	ft ³ /s
January_5th_percentile_flow	2.52	ft ³ /s
January_10th_percentile_flow	3.27	ft ³ /s
January 25th percentile flow	4.74	ft ³ /s
January_50th_percentile_flow	6.31	ft ³ /s
January 75th percentile flow	10.6	ft ³ /s
January_90th_percentile_flow	22.2	ft ³ /s
January 95th percentile flow	44.2	ft ³ /s
January 99th percentile flow	112	ft ³ /s

Statistic	Value	Unit
January Mean Flow	12.6	ft ³ /s
February 1st percentile flow	1.74	ft ³ /s
February_5th_percentile_flow	1.97	ft ³ /s
February_10th_percentile_flow	2.49	ft ³ /s
February 25th percentile flow	3.4	ft ³ /s
February_50th_percentile_flow	4.97	ft ³ /s
February 75th percentile flow	9.61	ft ³ /s
February_90th_percentile_flow	18.2	ft ³ /s
February 95th percentile flow	38.1	ft ³ /s
February 99th percentile flow	105	ft ³ /s
February Mean Flow	9.92	ft ³ /s
March 1st percentile flow	2.51	ft ³ /s
March_5th_percentile_flow	3.4	ft ³ /s
March_10th_percentile_flow	4.74	ft ³ /s
March 25th percentile flow	8.37	ft ³ /s
March_50th_percentile_flow	18.6	ft ³ /s
March 75th percentile flow	39.2	ft ³ /s
March_90th_percentile_flow	81.2	ft ³ /s
March 95th percentile flow	115	ft ³ /s
March 99th percentile flow	259	ft ³ /s
March Mean Flow	34.7	ft ³ /s
April 1st percentile flow	4.98	ft ³ /s
April_5th_percentile_flow	6.81	ft ³ /s
April_10th_percentile_flow	8.63	ft ³ /s
April 25th percentile flow	12.9	ft ³ /s
April_50th_percentile_flow	18.5	ft ³ /s
April 75th percentile flow	36.3	ft ³ /s
April_90th_percentile_flow	73.7	ft ³ /s
April 95th percentile flow	115	ft ³ /s
April 99th percentile flow	292	ft ³ /s

Statistic	Value	Unit
April Mean Flow	33.7	ft ³ /s
May 1st percentile flow	1.01	ft ³ /s
May_5th_percentile_flow	1.64	ft ³ /s
May_10th_percentile_flow	2.14	ft ³ /s
May 25th percentile flow	3.41	ft ³ /s
May_50th_percentile_flow	5.61	ft ³ /s
May 75th percentile flow	9.61	ft ³ /s
May_90th_percentile_flow	17.7	ft ³ /s
May 95th percentile flow	28.3	ft ³ /s
May 99th percentile flow	65.2	ft ³ /s
May Mean Flow	9.03	ft ³ /s
June 1st percentile flow	0.631	ft ³ /s
June 5th percentile flow	0.852	ft ³ /s
June_10th_percentile_flow	1.02	ft ³ /s
June 25th percentile flow	1.68	ft ³ /s
June_50th_percentile_flow	3.09	ft ³ /s
June 75th percentile flow	7.62	ft ³ /s
June_90th_percentile_flow	20.8	ft ³ /s
June 95th percentile flow	43.4	ft ³ /s
June 99th percentile flow	150	ft ³ /s
June Mean Flow	8.91	ft ³ /s
July 1st percentile flow	0.0664	ft ³ /s
July_5th_percentile_flow	0.142	ft ³ /s
July_10th_percentile_flow	0.193	ft ³ /s
July 25th percentile flow	0.336	ft ³ /s
July_50th_percentile_flow	0.811	ft ³ /s
July 75th percentile flow	2.38	ft ³ /s
July_90th_percentile_flow	6.4	ft ³ /s
July 95th percentile flow	11.7	ft ³ /s
July 99th percentile flow	30.9	ft ³ /s

Statistic	Value	Unit
July Mean Flow	2.7	ft ³ /s
August 1st percentile flow	0.0031	ft ³ /s
August_5th_percentile_flow	0.0128	ft ³ /s
August_10th_percentile_flow	0.0208	ft ³ /s
August 25th percentile flow	0.114	ft ³ /s
August_50th_percentile_flow	0.303	ft ³ /s
August 75th percentile flow	1.16	ft ³ /s
August_90th_percentile_flow	3.37	ft ³ /s
August 95th percentile flow	5.87	ft ³ /s
August 99th percentile flow	20.8	ft ³ /s
August Mean Flow	1.4	ft ³ /s
September 1st percentile flow	0.00274	ft ³ /s
September_5th_percentile_flow	0.00425	ft ³ /s
September_10th_percentile_flow	0.0277	ft ³ /s
September 25th percentile flow	0.0887	ft ³ /s
September_50th_percentile_flow	0.312	ft ³ /s
September 75th percentile flow	1.3	ft ³ /s
September_90th_percentile_flow	3.42	ft ³ /s
September 95th percentile flow	7.22	ft ³ /s
September 99th percentile flow	31.4	ft ³ /s
September Mean Flow	1.67	ft ³ /s
October 1st percentile flow	0.0324	ft ³ /s
October_5th_percentile_flow	0.0525	ft ³ /s
October_10th_percentile_flow	0.131	ft ³ /s
October 25th percentile flow	0.538	ft ³ /s
October_50th_percentile_flow	2.1	ft ³ /s
October 75th percentile flow	7.68	ft ³ /s
October_90th_percentile_flow	21	ft ³ /s
October 95th percentile flow	39.6	ft ³ /s
October 99th percentile flow	118	ft ³ /s

Statistic	Value	Unit
October Mean Flow	8.8	ft ³ /s
November 1st percentile flow	0.361	ft ³ /s
November_5th_percentile_flow	0.664	ft ³ /s
November_10th_percentile_flow	1.65	ft ³ /s
November 25th percentile flow	4.76	ft ³ /s
November_50th_percentile_flow	9.27	ft ³ /s
November 75th percentile flow	17.8	ft ³ /s
November_90th_percentile_flow	35	ft ³ /s
November 95th percentile flow	52.8	ft ³ /s
November 99th percentile flow	121	ft ³ /s
November Mean Flow	15.9	ft ³ /s
December 1st percentile flow	0.742	ft ³ /s
December_5th_percentile_flow	1.97	ft ³ /s
December_10th_percentile_flow	3.57	ft ³ /s
December 25th percentile flow	6.13	ft ³ /s
December_50th_percentile_flow	9.9	ft ³ /s
December 75th percentile flow	16.1	ft ³ /s
December_90th_percentile_flow	30.5	ft ³ /s
December 95th percentile flow	54.9	ft ³ /s
December 99th percentile flow	145	ft ³ /s
December Mean Flow	16.8	ft ³ /s

Monthly Flow Statistics Citations

Dudley, R.W.,2015, Regression equations for monthly and annual mean and selected percentile streamflows for ungaged rivers in Maine: U.S. Geological Survey Scientific Investigations Report 2015–5151, 35 p. (<http://dx.doi.org/10.3133/sir20155151>)

➤ June Flow-Duration Statistics

June Flow-Duration Statistics Parameters [Southern Median Monthly SIR 2010

5179]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	0.04	74.1
SANDGRAVAP	Percentage of Sand and Gravel Aquifers	0.41	percent	0	84.1
COASTDIST	Distance From Coast To Basin Centroid	42.5	miles	14.3	94

June Flow-Duration Statistics Flow Report [Southern Median Monthly SIR 2010 5179]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	ASEp
June 50 Percent Duration	2.83	ft ³ /s	45.3

June Flow-Duration Statistics Citations

Lombard, P.J.,2010, June and August median streamflows estimated for ungaged streams in southern Maine: U.S. Geological Survey Scientific Investigations Report 2010–5179, 16 p. (<http://pubs.usgs.gov/sir/2010/5179/pdf/sir2010-5179.pdf>)

➤ August Flow-Duration Statistics

August Flow-Duration Statistics Parameters [Southern Median Monthly SIR 2010 5179]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	0.04	74.1
SANDGRAVAP	Percentage of Sand and Gravel Aquifers	0.41	percent	0	84.1
COASTDIST	Distance From Coast To Basin Centroid	42.5	miles	14.3	94

August Flow-Duration Statistics Flow Report [Southern Median Monthly SIR 2010 5179]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	ASEp
August 50 Percent Duration	0.646	ft ³ /s	66.4

August Flow-Duration Statistics Citations

Lombard, P.J.,2010, June and August median streamflows estimated for ungaged streams in southern Maine: U.S. Geological Survey Scientific Investigations Report 2010–5179, 16 p. (<http://pubs.usgs.gov/sir/2010/5179/pdf/sir2010-5179.pdf>)

➤ Flow Percentile Statistics

Flow Percentile Statistics Parameters [Statewide Annual SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5.26	square miles	14.9	1419
SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0.004	dimensionless	0	0.212
ELEV	Mean Basin Elevation	109.8	feet	239	2120

Flow Percentile Statistics Disclaimers [Statewide Annual SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Flow Percentile Statistics Flow Report [Statewide Annual SIR 2015 5151]

Statistic	Value	Unit
1st Percentile Flow	0.0138	ft ³ /s
5th Percentile Flow	0.0871	ft ³ /s
10th Percentile Flow	0.246	ft ³ /s
25th Percentile Flow	1.3	ft ³ /s
50th Percentile Flow Median	4.6	ft ³ /s

Statistic	Value	Unit
75th Percentile Flow	12.1	ft ³ /s
90th Percentile Flow	27.3	ft ³ /s
95th Percentile Flow	42.7	ft ³ /s
99th Percentile Flow	103	ft ³ /s

Flow Percentile Statistics Citations

Dudley, R.W.,2015, Regression equations for monthly and annual mean and selected percentile streamflows for ungaged rivers in Maine: U.S. Geological Survey Scientific Investigations Report 2015–5151, 35 p. (<http://dx.doi.org/10.3133/sir20155151>)

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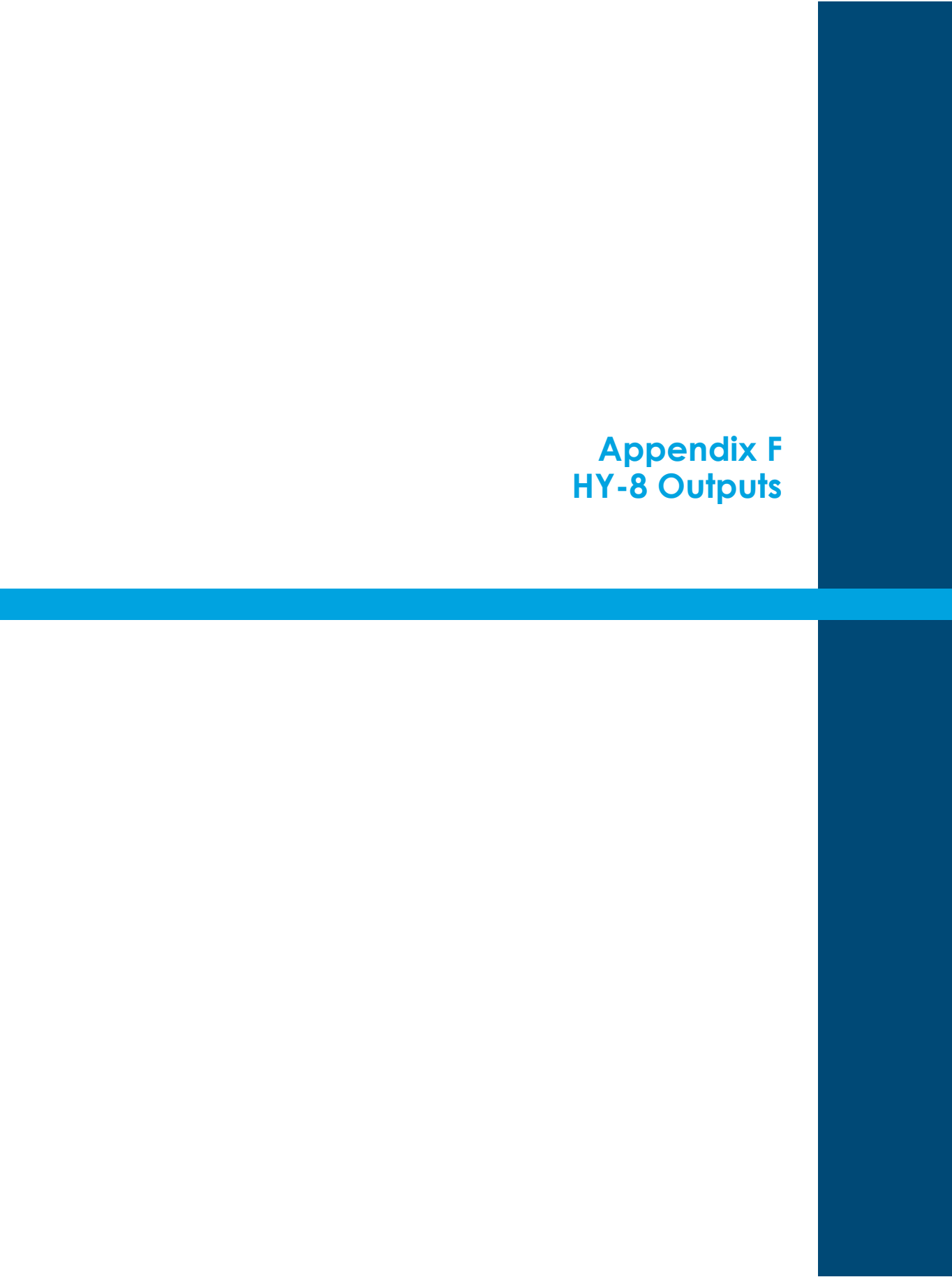
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Application Version: 4.18.1

StreamStats Services Version: 1.2.22

NSS Services Version: 2.2.1



Appendix F HY-8 Outputs

HY-8 Culvert Analysis Report

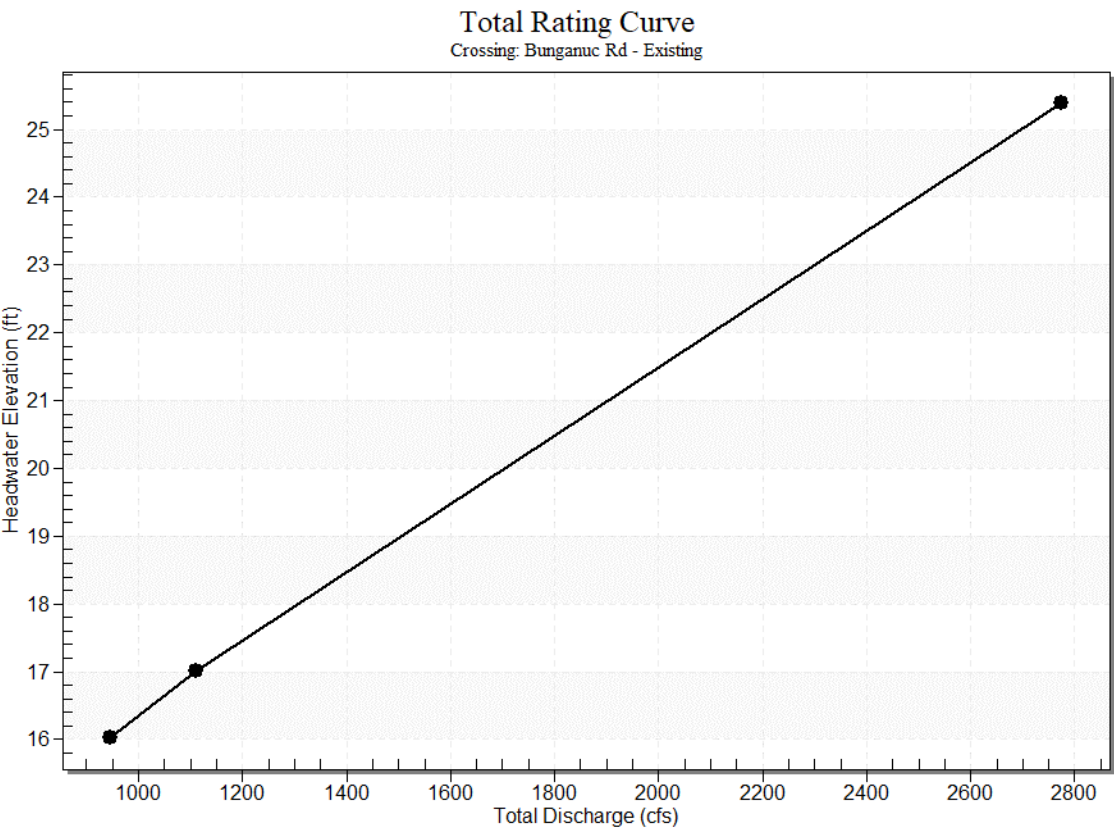
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: Bunganuc Rd - Existing

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Existing Conditions Discharge (cfs)	Roadway Discharge (cfs)	Iterations
16.03	Q50	945.00	945.00	0.00	1
17.00	Q100	1110.00	1110.00	0.00	1
22.00	Overtopping	1923.33	1923.33	0.00	Overtopping

Rating Curve Plot for Crossing: Bunganuc Rd - Existing



Culvert Data: Existing Conditions

Table 1 - Culvert Summary Table: Existing Conditions

Disc harg e Nam es	Tota l Disc harg e (cfs)	Culv ert Disc harg e (cfs)	Head wate r Eleva tion (ft)	Inle t Con trol De pth (ft)	Out let Con trol De pth (ft)	Fl o w Ty pe	Nor mal De pth (ft)	Crit ical De pth (ft)	Ou tle t De pt h (ft)	Tail wate r Dept h (ft)	Out let Vel ocit y (ft/ s)	Tail wate r Velo city (ft/s)
Q50	945. 00 cfs	945. 00 cfs	16.03	8.4 5	4.5 56	1- S2 n	3.6 0	5.0 7	3.9 1	4.30	16.1 1	9.07
Q10 0	1110 .00 cfs	1110 .00 cfs	17.00	9.4 2	5.4 27	1- S2 n	4.0 2	5.5 9	4.4 2	4.79	16.7 5	9.56

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

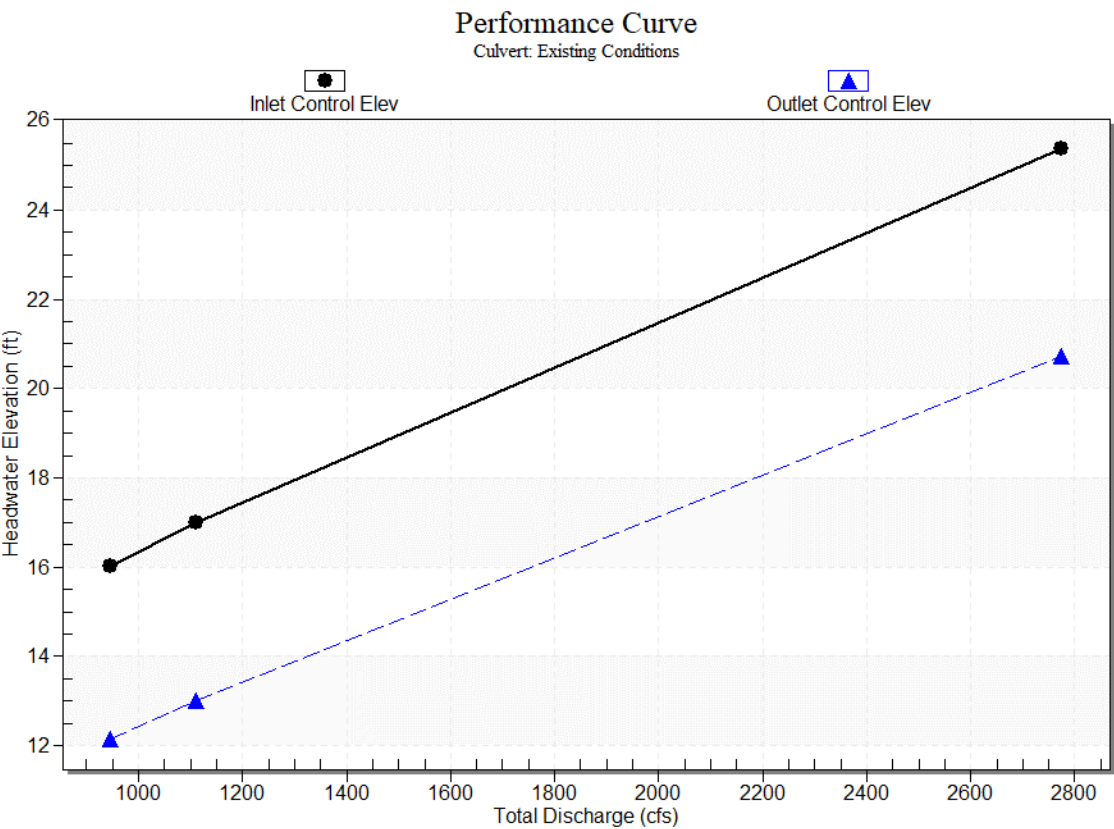
Inlet Elevation (invert): 7.58 ft,

Outlet Elevation (invert): 6.15 ft

Culvert Length: 54.02 ft,

Culvert Slope: 0.0265

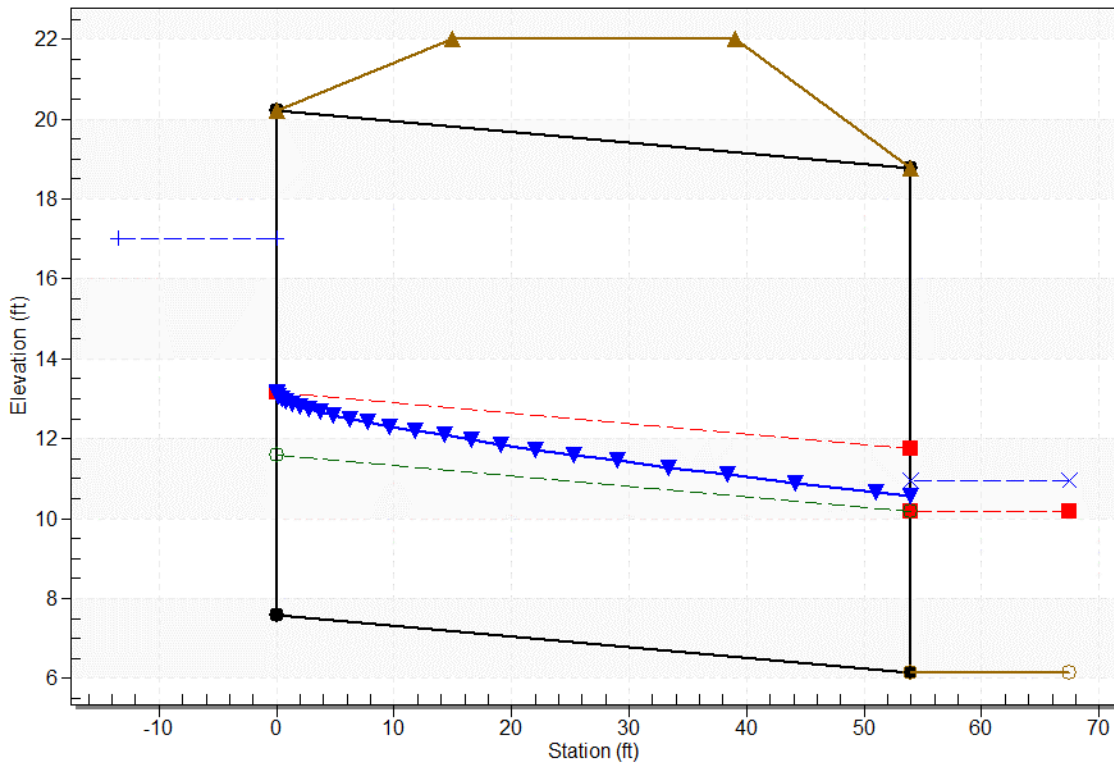
Culvert Performance Curve Plot: Existing Conditions



Water Surface Profile Plot for Culvert: Existing Conditions

Crossing - Bunganuc Rd - Existing, Design Discharge - 1110.0 cfs

Culvert - Existing Conditions, Culvert Discharge - 1110.0 cfs



Site Data - Existing Conditions

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7.58 ft

Outlet Station: 54.00 ft

Outlet Elevation: 6.15 ft

Number of Barrels: 1

Culvert Data Summary - Existing Conditions

Barrel Shape: User Defined

Barrel Span: 16.00 ft

Barrel Rise: 12.63 ft

Barrel Material: Corrugated Metal Riveted or Welded

Embedment: 0.00 in

Barrel Manning's n: 0.0210 (top and sides)

Manning's n: 0.0250 (bottom)

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope (Ke=0.7)

Inlet Depression: None

Tailwater Data for Crossing: Bunganuc Rd - Existing

Table 2 - Downstream Channel Rating Curve (Crossing: Bunganuc Rd - Existing)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
945.00	10.45	4.30	9.07	1.34	0.77
1110.00	10.94	4.79	9.56	1.49	0.77

Tailwater Channel Data - Bunganuc Rd - Existing

Tailwater Channel Option: Rectangular Channel

Bottom Width: 24.25 ft

Channel Slope: 0.0050

Channel Manning's n: 0.0250

Channel Invert Elevation: 6.15 ft

Roadway Data for Crossing: Bunganuc Rd - Existing

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 24.25 ft

Crest Elevation: 22.00 ft

Roadway Surface: Paved

Roadway Top Width: 24.00 ft

HY-8 Culvert Analysis Report

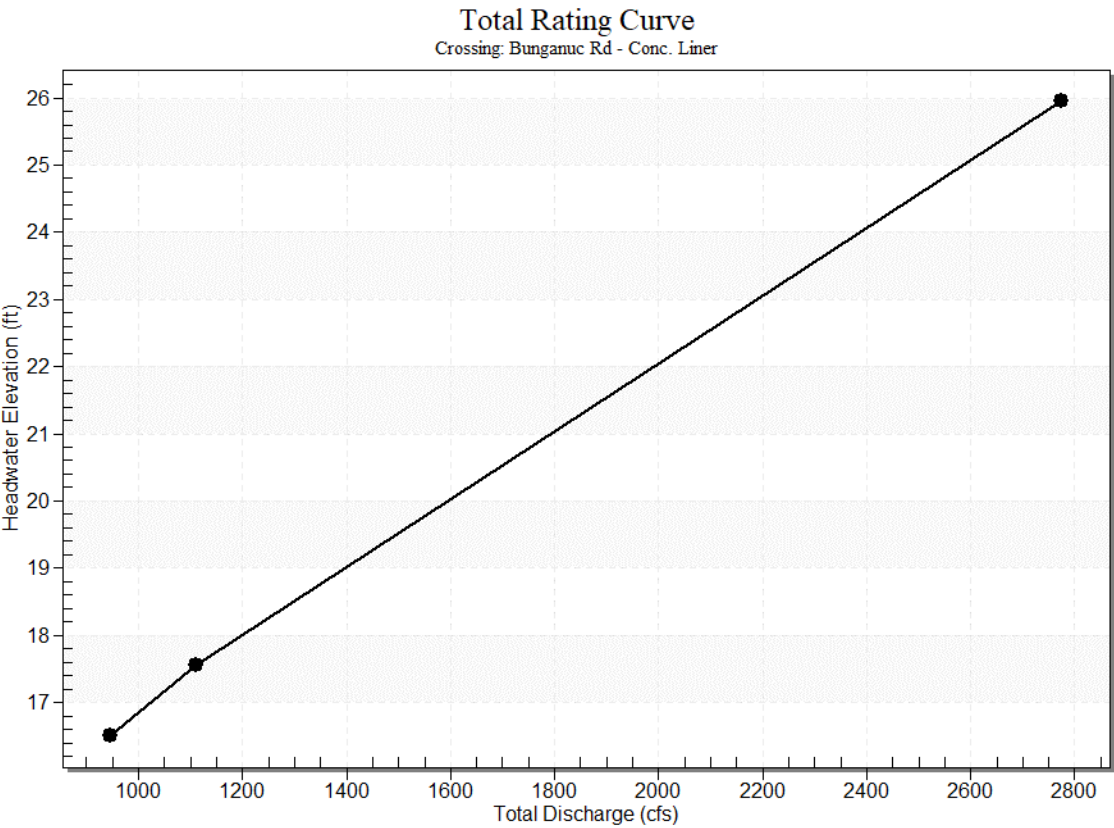
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: Bunganuc Rd - Conc. Liner

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Concrete Liner Discharge (cfs)	Roadway Discharge (cfs)	Iterations
16.51	Q50	945.00	945.00	0.00	1
17.56	Q100	1110.00	1110.00	0.00	1
22.00	Overtopping	1771.36	1771.36	0.00	Overtopping

Rating Curve Plot for Crossing: Bunganuc Rd - Conc. Liner



Culvert Data: Concrete Liner

Table 1 - Culvert Summary Table: Concrete Liner

Disc harg e Nam es	Tota l Disc harg e (cfs)	Culv ert Disc harg e (cfs)	Head wate r Eleva tion (ft)	Inle t Con trol De pth (ft)	Out let Con trol De pth (ft)	Fl o w Ty pe	Nor mal De pth (ft)	Crit ical De pth (ft)	Ou tle t De pt h (ft)	Tail wate r Dept h (ft)	Out let Vel ocit y (ft/ s)	Tail wate r Velo city (ft/s)
Q50	945. 00 cfs	945. 00 cfs	16.51	8.9 3	4.7 50	1- S2 n	3.5 7	5.1 1	3.9 4	4.30	16.8 7	9.07
Q10 0	1110 .00 cfs	1110 .00 cfs	17.56	9.9 8	5.7 75	1- S2 n	4.0 1	5.7 3	4.4 7	4.79	17.6 5	9.56

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

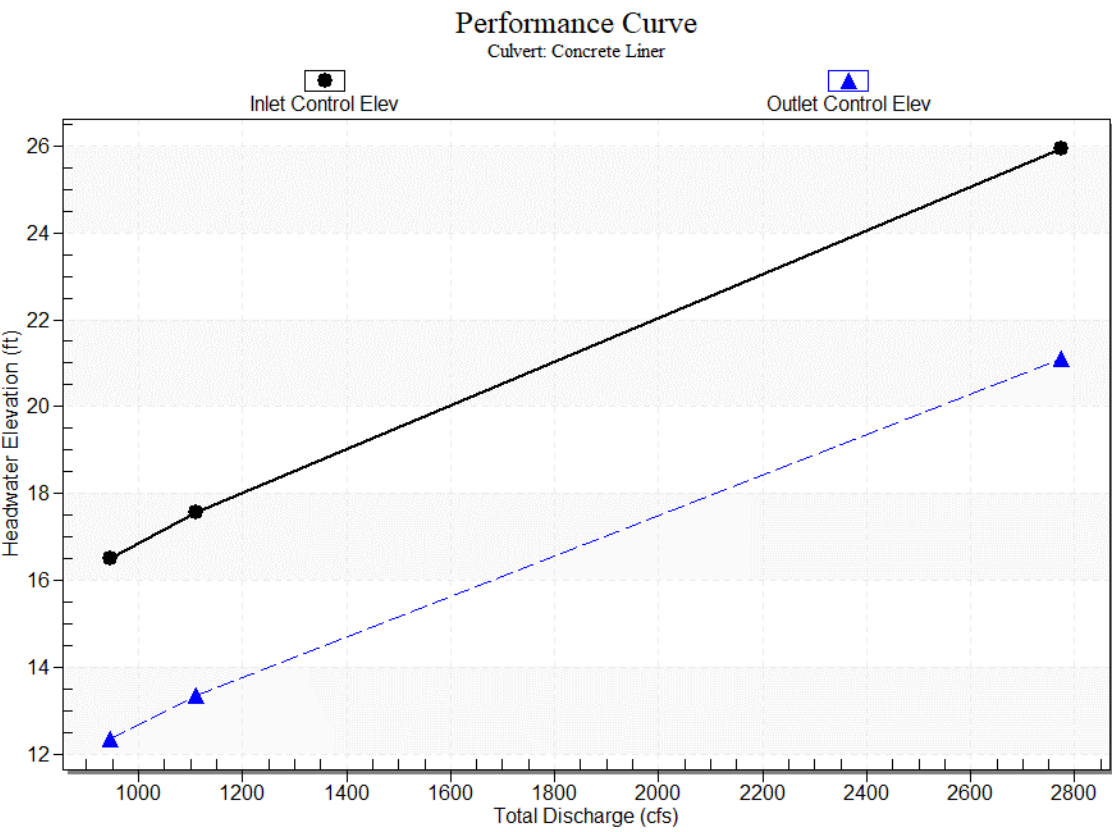
Inlet Elevation (invert): 7.58 ft,

Outlet Elevation (invert): 6.15 ft

Culvert Length: 54.02 ft,

Culvert Slope: 0.0265

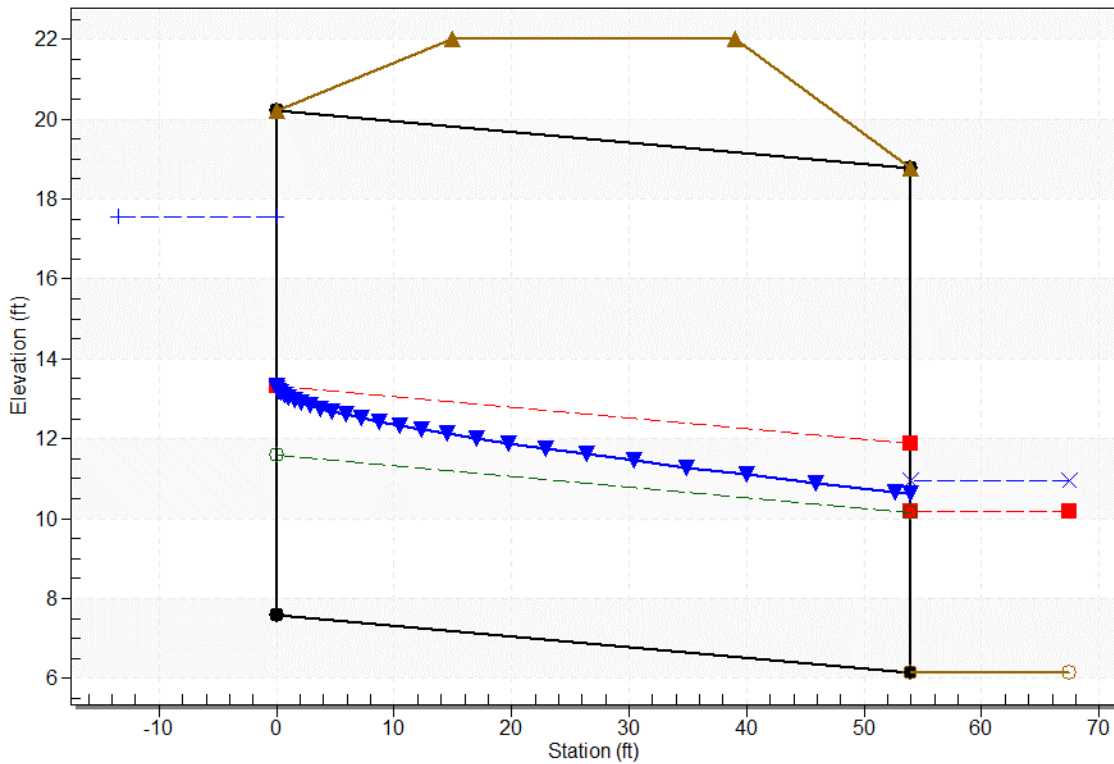
Culvert Performance Curve Plot: Concrete Liner



Water Surface Profile Plot for Culvert: Concrete Liner

Crossing - Bunganuc Rd - Conc. Liner, Design Discharge - 1110.0 cfs

Culvert - Concrete Liner, Culvert Discharge - 1110.0 cfs



Site Data - Concrete Liner

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7.58 ft

Outlet Station: 54.00 ft

Outlet Elevation: 6.15 ft

Number of Barrels: 1

Culvert Data Summary - Concrete Liner

Barrel Shape: User Defined

Barrel Span: 15.00 ft

Barrel Rise: 12.63 ft

Barrel Material: Corrugated Metal Riveted or Welded

Embedment: 0.00 in

Barrel Manning's n: 0.0170 (top and sides)

Manning's n: 0.0250 (bottom)

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope (Ke=0.7)

Inlet Depression: None

Tailwater Data for Crossing: Bunganuc Rd - Conc. Liner

Table 2 - Downstream Channel Rating Curve (Crossing: Bunganuc Rd - Conc. Liner)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
945.00	10.45	4.30	9.07	1.34	0.77
1110.00	10.94	4.79	9.56	1.49	0.77

Tailwater Channel Data - Bunganuc Rd - Conc. Liner

Tailwater Channel Option: Rectangular Channel

Bottom Width: 24.25 ft

Channel Slope: 0.0050

Channel Manning's n: 0.0250

Channel Invert Elevation: 6.15 ft

Roadway Data for Crossing: Bunganuc Rd - Conc. Liner

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 24.25 ft

Crest Elevation: 22.00 ft

Roadway Surface: Paved

Roadway Top Width: 24.00 ft

HY-8 Culvert Analysis Report

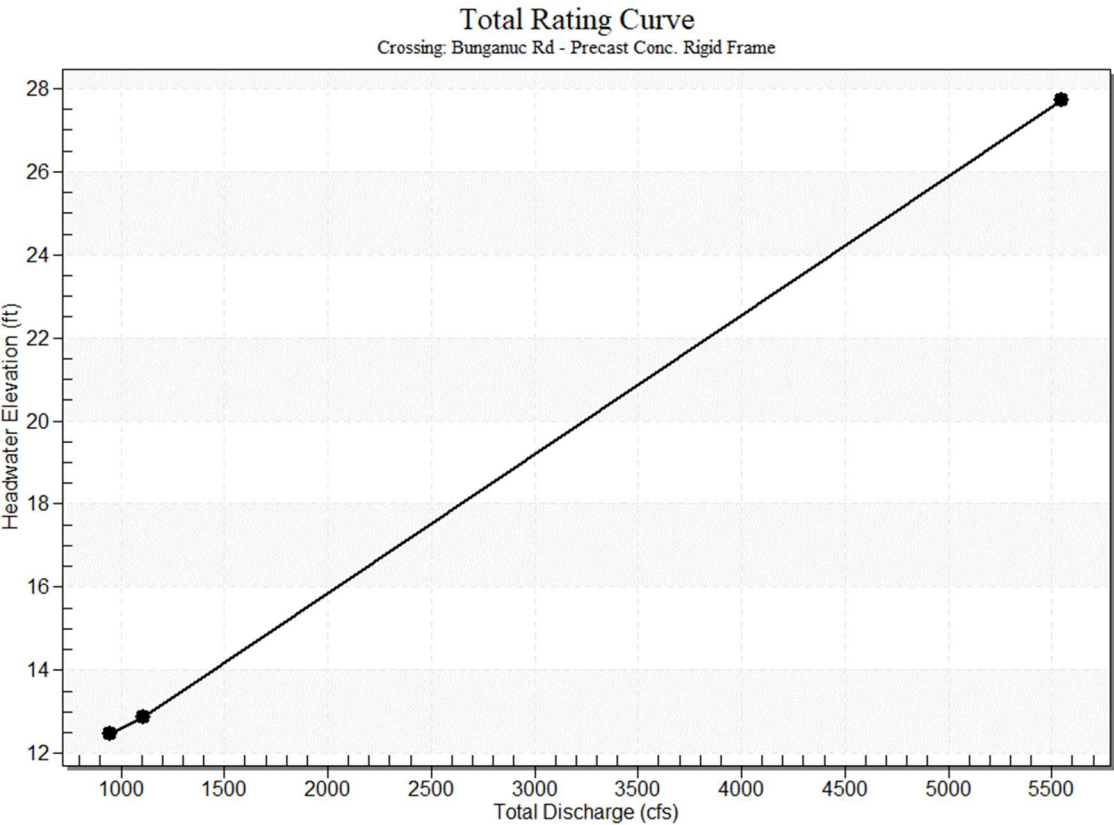
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: Bunganuc Rd - Precast Conc. Rigid Frame

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Precast Concrete Rigid Frame Discharge (cfs)	Roadway Discharge (cfs)	Iterations
12.47	Q50	945.00	945.00	0.00	1
12.88	Q100	1110.00	1110.00	0.00	1
22.00	Overtopping	3845.66	3571.74	0.00	Overtopping

Rating Curve Plot for Crossing: Bunganuc Rd - Precast Conc. Rigid Frame



Culvert Data: Precast Concrete Rigid Frame

Table 1 - Culvert Summary Table: Precast Concrete Rigid Frame

Disc harg e Nam es	Tota l Disc harg e (cfs)	Culv ert Disc harg e (cfs)	Head wate r Eleva tion (ft)	Inle t Con trol De pth (ft)	Out let Con trol De pth (ft)	Fl o w Ty pe	Nor mal De pth (ft)	Crit ical De pth (ft)	Ou tle t De pt h (ft)	Tail wate r Dept h (ft)	Out let Vel ocit y (ft/ s)	Tail wate r Velo city (ft/s)
Q50	945. 00 cfs	945. 00 cfs	12.47	5.1 2	3.9 83	1- S2 n	3.1 7	4.6 9	3.6 3	4.30	14.1 7	9.07
Q10 0	1110 .00 cfs	1110 .00 cfs	12.88	5.5 3	4.4 40	1- S2 n	3.4 6	5.0 4	4.0 4	4.79	14.5 1	9.56

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

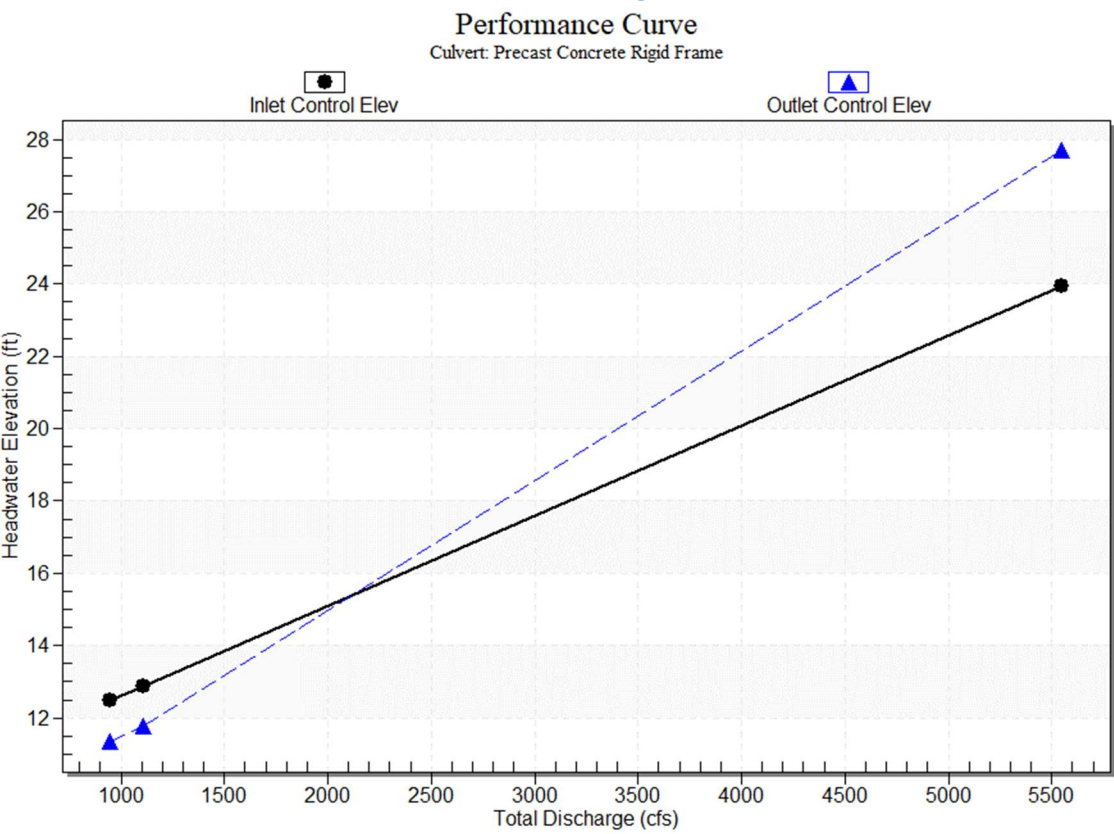
Inlet Elevation (invert): 7.35 ft,

Outlet Elevation (invert): 6.38 ft

Culvert Length: 36.51 ft,

Culvert Slope: 0.0266

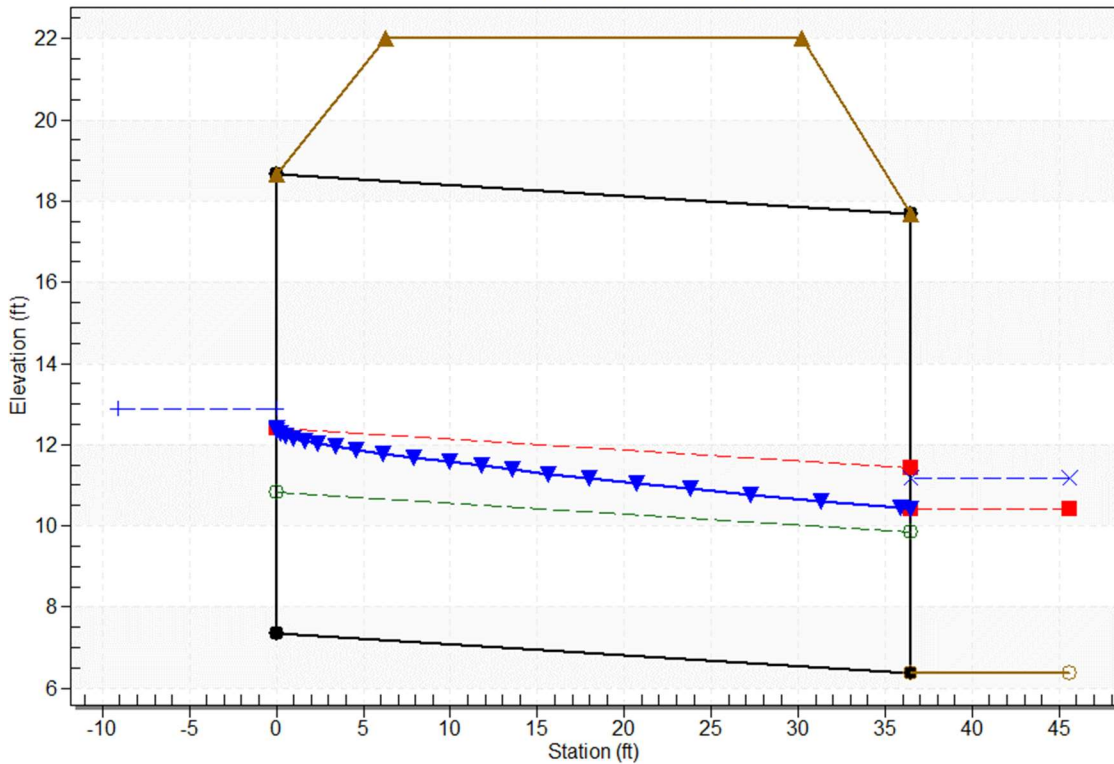
Culvert Performance Curve Plot: Precast Concrete Rigid Frame



Water Surface Profile Plot for Culvert: Precast Concrete Rigid Frame

Crossing - Bunganuc Rd - Precast Conc. Rigid Frame, Design Discharge - 1110.0 cfs

Culvert - Precast Concrete Rigid Frame, Culvert Discharge - 1110.0 cfs



Site Data - Precast Concrete Rigid Frame

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7.35 ft

Outlet Station: 36.50 ft

Outlet Elevation: 6.38 ft

Number of Barrels: 1

Culvert Data Summary - Precast Concrete Rigid Frame

Barrel Shape: User Defined

Barrel Span: 30.00 ft

Barrel Rise: 11.31 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120 (top and sides)

Manning's n: 0.0250 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall ($K_e=0.5$)

Inlet Depression: None

Tailwater Data for Crossing: Bunganuc Rd - Precast Conc. Rigid Frame

Table 2 - Downstream Channel Rating Curve (Crossing: Bunganuc Rd - Precast Conc. Rigid Frame)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
945.00	10.68	4.30	9.07	1.34	0.77
1110.00	11.17	4.79	9.56	1.49	0.77

Tailwater Channel Data - Bunganuc Rd - Precast Conc. Rigid Frame

Tailwater Channel Option: Rectangular Channel

Bottom Width: 24.25 ft

Channel Slope: 0.0050

Channel Manning's n: 0.0250

Channel Invert Elevation: 6.38 ft

Roadway Data for Crossing: Bunganuc Rd - Precast Conc. Rigid Frame

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 24.25 ft

Crest Elevation: 22.00 ft

Roadway Surface: Paved

Roadway Top Width: 24.00 ft

HY-8 Culvert Analysis Report

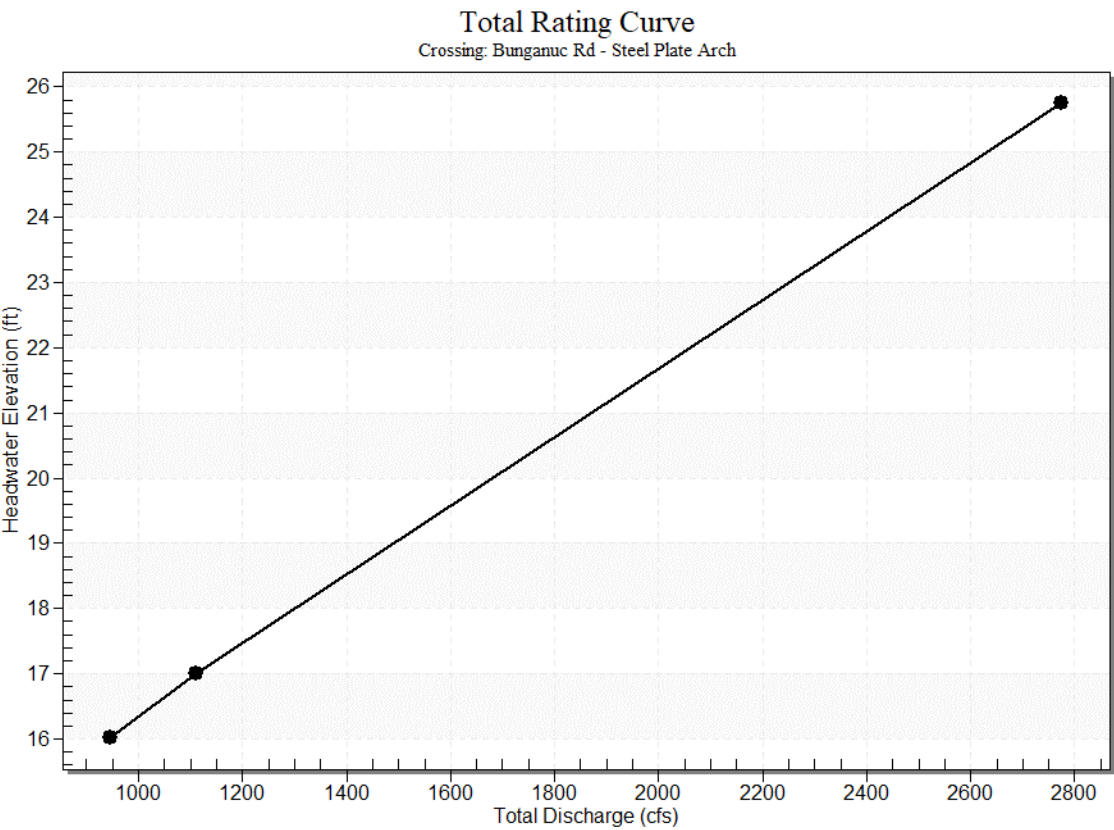
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: Bunganuc Rd - Slip Liner Steel Plate Arch

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Steel Plate Arch Discharge (cfs)	Roadway Discharge (cfs)	Iterations
16.02	Q50	945.00	945.00	0.00	1
17.01	Q100	1110.00	1110.00	0.00	1
22.00	Overtopping	1803.58	1803.58	0.00	Overtopping

Rating Curve Plot for Crossing: Bunganuc Rd - Steel Plate Arch



Culvert Data: Steel Plate Arch

Table 1 - Culvert Summary Table: Slip Liner Steel Plate Arch

Disc harg e Nam es	Tota l Disc harg e (cfs)	Culv ert Disc harg e (cfs)	Head wate r Eleva tion (ft)	Inle t Con trol De pth (ft)	Out let Con trol De pth (ft)	Fl ow Ty pe	Nor mal De pth (ft)	Crit ical De pth (ft)	Ou tle t De pt h (ft)	Tail wate r Dept h (ft)	Out let Vel ocit y (ft/ s)	Tail wate r Velo city (ft/s)
Q50	945. 00 cfs	945. 00 cfs	16.02	8.5 6	5.7 98	1- S2 n	4.2 2	5.6 2	4.5 9	4.30	16.4 7	9.07
Q10 0	1110 .00 cfs	1110 .00 cfs	17.01	9.5 5	7.1 22	1- S2 n	4.7 4	6.4 3	5.1 7	4.79	17.1 6	9.56

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

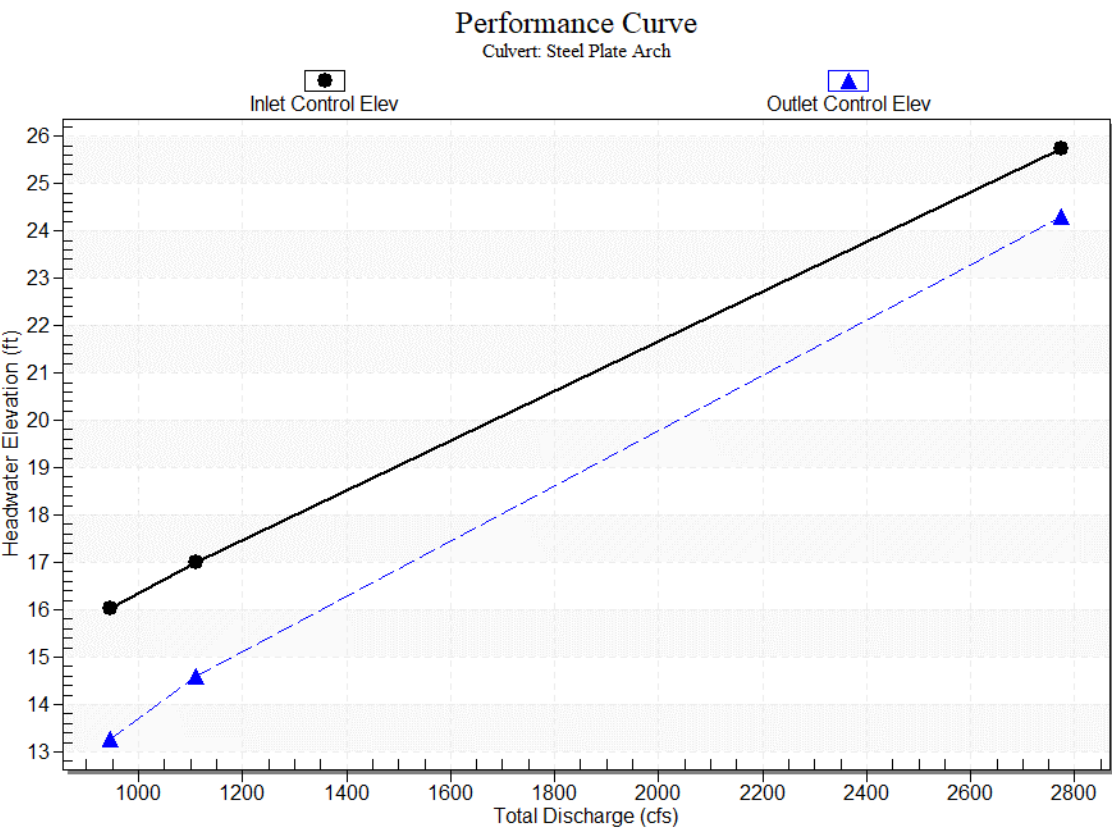
Inlet Elevation (invert): 7.46 ft,

Outlet Elevation (invert): 6.27 ft

Culvert Length: 45.02 ft,

Culvert Slope: 0.0264

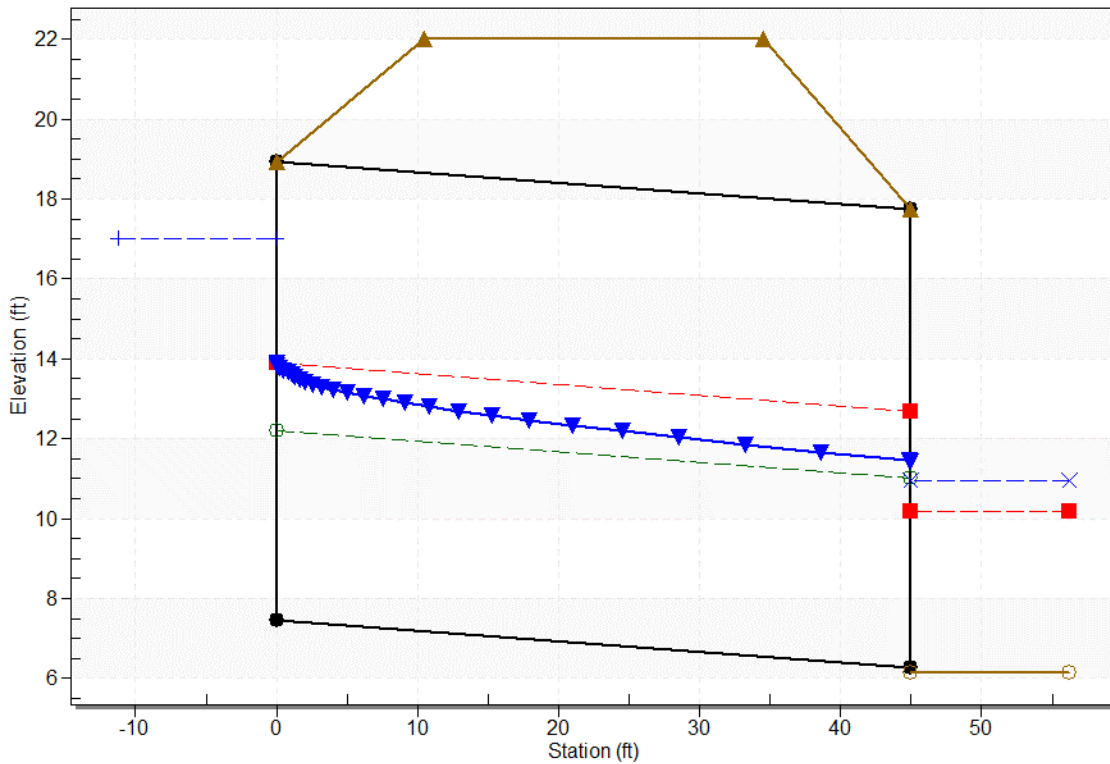
Culvert Performance Curve Plot: Slip Liner Steel Plate Arch



Water Surface Profile Plot for Culvert: Slip Liner Steel Plate Arch

Crossing - Bunganuc Rd - Steel Plate Arch, Design Discharge - 1110.0 cfs

Culvert - Steel Plate Arch, Culvert Discharge - 1110.0 cfs



Site Data - Slip Liner Steel Plate Arch

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7.46 ft

Outlet Station: 45.00 ft

Outlet Elevation: 6.27 ft

Number of Barrels: 1

Culvert Data Summary - Slip Liner Steel Plate Arch

Barrel Shape: User Defined

Barrel Span: 13.82 ft

Barrel Rise: 11.48 ft

Barrel Material: Corrugated Metal Riveted or Welded

Embedment: 0.00 in

Barrel Manning's n: 0.0190 (top and sides)

Manning's n: 0.0250 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: Bunganuc Rd - Slip Liner Steel Plate Arch

Table 2 - Downstream Channel Rating Curve (Crossing: Bunganuc Rd - Steel Plate Arch)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
945.00	10.45	4.30	9.07	1.34	0.77
1110.00	10.94	4.79	9.56	1.49	0.77

Tailwater Channel Data - Bunganuc Rd - Slip Liner Steel Plate Arch

Tailwater Channel Option: Rectangular Channel

Bottom Width: 24.25 ft

Channel Slope: 0.0050

Channel Manning's n: 0.0250

Channel Invert Elevation: 6.15 ft

Roadway Data for Crossing: Bunganuc Rd - Slip Liner Steel Plate Arch

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 24.25 ft

Crest Elevation: 22.00 ft

Roadway Surface: Paved

Roadway Top Width: 24.00 ft