Memorandum

To: Bob Klinefelter, P.E.
VTrans Structures Project Manager

Date: October 26, 2021

Project #: 58643.00

From: Aaron Guyette, P.E. Project Manager
Ryan Barnes, P.E. Senior Structural Engineer

Re: Royalton BF 0147(29) NECR over VT 14
Alternatives Analysis

Background

The Royalton BF 0147(29) Project consists of providing a safe alternative to address the existing deficiencies with the New England Central Railroad (NECR) Crossing over VT Route 14 in Royalton, Vermont. The bridge is Bridge No. 35.01 at Milepost 35.01 on NECR Roxbury Subdivision and is located at Milemarker 5.131 on VT Route 14. The project was initiated by VTrans as an emergency project following a vehicle impact to the existing bridge in July 2021. The bridge crossing has low vertical clearance (12'-1"), substandard roadway width (single lane) with a severe "S" curve, and the bridge is in poor condition with frequent vehicle impacts. No guardrail is present to protect vehicles from the bridge abutments. The intent of this memo is to establish the purpose and need statement and design criteria and analyze alternatives to make a recommendation that will provide a safe crossing to address the current deficiencies.

Purpose and Need Statement

The purpose of the project is to construct a safe highway-railroad crossing that meets current design standards with a long, low-maintenance service life. The project is needed because the existing bridge crossing has limited vertical and horizontal roadway clearance, sight distance, and horizontal alignment that do not meet current design standards. The bridge is in poor condition and has had many impacts resulting in damage to the steel superstructure and abutments.

Design Criteria

The design standards for this project that are pertinent to the alternative analysis are summarized in the table that follows. The minimum standards referenced in the following table are for Major Collector State Highway based on an ADT of 3600vpd and a design speed of 40 mph. Design standards for a reduced design speed of 30mph are also provided where different from 40 mph.

Vermont Route 14 alternatives are based on the Vermont State Design Standards and AASHTO's A Policy on Geometric Design of Highways and Streets. It is important to note that this portion of VT 14 is a high use / high priority bicycle corridor in the VTrans Bicycle Corridor Priority Map. The project team will investigate appropriate bicycle accommodations to incorporate into the project during the Preliminary Design Phase.

- Vermont State Standards, dated October 22, 1997 (VSS)
- AASHTO's A Policy on Geometric Design of Highways and Streets, 7th Edition (AASHTO Green Book), 2018
- AASHTO's Roadside Design Guide, 4th Edition, 2011
- VTrans Structures Design Manual, Fifth Edition, 2010 (VTrans SDM)
- AREMA Manual for Railway Engineering, 2021 (AREMA)

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Design Criteria	Source	Existing Condition	Standard	Comment on Existing Condition
Roadway Lane and Shoulder Widths	VSS Table 5.3 VSS Section 5.6	19'-3" between abutment faces, one-lane	3'/11'/11'/3', two-lanes	Substandard
Clear Zone Distance	VSS Table 5.5 VSS Section 5.9	Existing Abutments within Clear Zone	12-feet (Cut) 14-feet (Fill)	Substandard
Speed	VSS Section 5.3	45mph / 40mph (Northbound / Southbound) 20mph Advisory at Bridge	40mph (Northbound & Southbound) 30mph Advisory at Bridge	Greater than 10mph decrease from legal speed to advisory speed
Horizontal Alignment	AASHTO Green Book 7th Edition	Southbound Curve 1: R = 155 ft (*e=6%)* Southbound Curve 2: R = 122' (*e=6%)*	30 mph: R_{min} = 231 ft 40 mph: R_{min} = 485 ft (e_{max} = *6%)*	Substandard
Vertical Curve K-Value	VSS Table 5.1 VSS Section 5.4	13 (Sag curve under existing bridge)	30 mph: (30 Crest / 40 Sag) 40 mph: (60 Crest / 60 Sag)	Substandard
Vertical Clearance	VSS Section 5.8	12'-1"	14'-3"	Substandard
Stopping Sight Distance	VSS Table 5.1 VSS Section 5.4	140 ft / 184 ft (Northbound / Southbound)	30 mph - 200-feet 40 mph – 275-feet	Substandard
Intersection Sight Distance (Vesper Road)	AASHTO Table 9-9 AASHTO Table 9-7 AASHTO Table 9-11	524 ft Southbound 105 ft Northbound	30 mph: SB = 335-feet NB = 290-feet 40 mph: SB = 445-ft NB = 385-feet	Substandard (Northbound)

Design Criteria	Source	Existing Condition	Standard	Comment on Existing Condition
Structural Capacity	AREMA 8-1.3.3	Unknown	Cooper E-80	-
Railroad Maximum Grade	Genesee & Wyoming	0.75%	0.75%	-
Railroad Design Speed	Genesee & Wyoming	40mph Freight 60mph Amtrak	40mph Freight 60mph Amtrak	-

Alternatives Discussion

1. Alternative 1 – Do Nothing

This alternative consists of leaving the bridge and roadway in its current state and carries with it no initial construction cost. The substandard roadway vertical and horizontal clearances, sight distances, and horizontal alignment all remain unchanged. The poor bridge condition and susceptibility to future vehicle impacts all remain as concerns for maintenance and serviceability of the bridge. The bridge abutments remain as fixed obstructions within the clear zone. This alternative does not meet the purpose and need of the project.

2. Alternative 2 – Bridge Replacement

This alternative consists of removal and replacement of the existing bridge with a new bridge, designed to provide roadway clearances and geometry that meet geometric and structural design standards. The most prudent location for a new bridge replacement is to the south of the existing bridge. This location will allow the necessary modifications to the roadway curvature to occur within the existing right-of-way as well as allow the majority of the bridge construction to occur prior to removal of the existing structure. There is also an area to the south of the existing bridge, west of the track, that could be used as a staging area. This area is in the existing right-of-way and could be used to facilitate a lateral bridge slide as part of accelerated bridge construction. A new bridge will provide a minimum of 14'-6" vertical clearance to meet the minimum design standard.

Bridge Replacement Structure Type

The anticipated replacement superstructure type is an open-deck steel through girder structure. This superstructure type is capable of the required span length with the least depth (measured from top of rail to bottom of girder) compared to other viable superstructure types and will provide the required vertical clearance, without excessive impacts to the roadway and railroad limits. Weathering steel could be used for the superstructure in this location which will eliminate the initial cost and future maintenance associated with painting

or otherwise coating. An open-deck through girder bridge will also be a cost-effective superstructure type that will be constructable by a wide range of contractors and have relatively low future maintenance costs.

Two different structure layout alternatives were considered; one skewed layout (skewed approx. 52-degrees), and one with no skew. The skewed layout would have the abutments and bridge end skewed to the rail alignment and span approximately 70'-0" between centerlines of bearing (with a 30mph roadway layout). The alternative with no skew would span approximately 105'-0" (with a 30mph roadway layout) to provide the necessary clearances. The skewed alternative will have lesser material costs over the alternative with no skew, although there are several disadvantages summarized below:

- The fabrication of the girders and floor system components at the end of the bridge are much more complicated and customized. A heavily skewed end floor beam, variable length stringers, and bent connection plates are needed. Additionally, the crossties at the skewed end would bear partially on a stringer and partially on a backwall or ballast.
- Due to the heavy skew, each girder will deflect differently at a perpendicular section, creating out-of-plane bending stresses. Out-of-plane bending stresses increase the probability of fatigue cracking over the design life of the bridge.
- The abutments and foundation elements are longer and more costly than an alternative without a skew.
- A skewed structure is more difficult and costly to install by means of a lateral slide than an alternative without a skew.

Because of the preceding disadvantages without significant advantages, a non-skewed bridge structure layout is recommended.

It is anticipated that the substructures will consist of deep foundation elements (drilled shafts, micropiles, or driven H-Piles) with a precast concrete cap. These substructures would be installed during short-term track closures in advance of the superstructure installation. The particular deep foundation element will be determined following the subsurface investigations. It is also anticipated that soldier pile retaining walls would be constructed to allow initial installation of the piles and a top-down installation of the lagging to occur during new roadway construction.

Roadway Horizontal and Vertical Alignment

Roadway and bridge layouts, and roadway profiles were developed both with 30mph and 40mph VT-14 roadway design speeds. Maximum superelevation of 6% is used for both 30mph and 40mph design speeds due to the presence of intersecting roads (Vesper Road). Drawings for both alternatives are provided in Appendix A and the following summarizes the advantages and disadvantages.

a. Alternative 2A – 30mph Roadway Design Speed

Advantages:

- A shorter bridge with less superstructure cost is required as compared to a 40mph alternative.
- Stopping sight distance will meet standards of a 30-mph collector for vehicles traveling northbound and southbound.
- Vertical alignment will minimize impacts and work to Vesper Road.
- Existing drainage patterns are maintained.

Disadvantages:

- A slower design speed is required than areas directly to the north and south of the project area and appropriate advancing warning signs will have to be installed. The design speed may be 10mph lower than legal speed without a design exception (VSS Section 5.3)
- Intersection sight distance for Vesper Road is substandard when looking to the south (viewing northbound traffic). The AASHTO standard (Table 9-9, Case B2 Right Turn from Stop) calls for a minimum of 290-feet, where the configuration of the roadway geometry and the bridge provides for 203-feet, or 70% of the desired sight distance. The intersection sight distance is less than desirable; however, the stopping sight distance is adequate. Cars exiting Vesper Road may cause an inconvenience for mainline motorists, but the proposed configuration will not cause a safety concern.

b. Alternative 2B – 40mph Roadway Design Speed

Advantages:

- This alternative proposes a design speed equal to the posted speed limit directly to the north and south of the project area, eliminating the need for a lower advisory speed while traveling under the bridge.

Disadvantages:

- A longer bridge is required with greater superstructure cost as compared to a 30mph alternative.
- Impacts to Vesper Road will be greater than 30-mph alternative requiring additional roadway reconstruction and the need for permanent retaining wall support structures. The additional work adds both time and expense to the project and results in increased impacts from an environmental and utility perspective.
- Limits of road work will extend further along VT Route 14 to maintain standard approach grades and the vertical clearance under the new bridge.

- Intersection sight distance for Vesper Road is substandard when looking to the south (viewing northbound traffic). The AASHTO standard (Table 9-9, Case B2 Right Turn from Stop) calls for a minimum of 385-feet, where the configuration of the roadway geometry and the bridge provides for 155-feet, or 40% of the desired sight distance. The intersection sight distance is less than desirable and does not allow for adequate stopping sight distance for mainline vehicles approaching Vesper Road from the south, meaning that vehicles exiting Vesper Road and entering VT 14 may be at risk for collision with vehicles traveling northbound along VT 14. This condition will present a safety hazard that is worse than the current condition for vehicles exiting Vesper Road.

Railroad Horizontal and Vertical Alignment

Altering the railroad horizontal alignment was considered as a means to improve track geometry and/or aid in construction phasing. Raising the track grade to obtain the required vertical clearance is necessary with a bridge replacement alternative. An off-alignment railroad alternative would allow the new (higher grade) track to be constructed with minimal interruption to train service. However, an off-alignment alternative would also have significant right-of-way and environmental impacts and resulting in undesirable track geometry on the west side and undesirable impacts to Vesper Road on the east side.

A bridge replacement alternative will require raising the track grade approximately 2-feet to obtain the necessary 14'-6" vertical clearance along VT-14. It is anticipated that track re-construction or re-profiling will extend approximately 800-feet north and south of the bridge to tie the new, higher grade to the existing track grade.

Construction Phasing

To facilitate raising the track grade associated with a bridge replacement alternative, it's anticipated that raising the track grade at the north and south ends of the approaches would occur under short-term track closures with a temporary abrupt transition down to the grade of the existing bridge. Also, under short-term track closures the new bridge substructures would be constructed with track being removed and reset as necessary. A new bridge superstructure would likely be constructed offline on temporary abutments and then set into place during an extended short-term track closure with associated approach track grade adjustments immediately north and south of the bridge. Prior to the extended short-term track closure, VT Route 14 would be closed to allow the existing bridge to be removed and the area to be filled to construct a new rail embankment. Following the extended short-term track closure, the area under the new bridge would be excavated, new retaining wall lagging installed, and the new VT Route 14 roadway to be constructed underneath the new bridge.

Interstate 89, between Exits 2 and 3, roughly parallels the section of VT-14 with Bridge No. 35.01 and provides a convenient detour with adequate capacity and functionality. There are also detour routes for local traffic on Town Highways.

3. Alternative 3 – Bridge Replacement with NECR Owned Bridge

NECR owns a ballasted deck steel through girder bridge that could be used as a replacement structure for Bridge No. 35.01. The bridge is 63'-0" long between centerlines of bearing, with no skew, and has a superstructure depth (from top of rail to bottom of girder) of approximately 4'-2". As discussed under Alternative 2, a significantly longer non-skewed bridge is required to obtain the necessary horizontal clearances and roadway alignment. Additionally, the depth of this ballasted deck structure is greater than the open deck structure discussed under Alternative 2, which would necessitate a significant amount more rail and roadway approach work.

If it were desired to adapt this bridge to fit the skewed structure layout, the modifications would be significant and require new end floor beams, cutting and shortening several floor beams, and many new connections. Additional superstructure depth may be required to obtain the track superelevation, and some of the skewed bridge disadvantages described under Alternative 2 would apply as well. The condition and structural capacity of the structure would need to be evaluated to ensure that it would meet the need of the project.

The non-skewed bridge of Alternative 3 does not meet the purpose of this project with regards to horizontal alignment and clearance. The challenges involved with adapting this existing bridge to fit a skewed structure layout are substantial without corresponding benefits. The design life of the superstructure under this alternative is uncertain and therefore also does not meet the purpose of this project.

4. Alternative 4 – Bridge Removal and Construction of At-Grade Crossing

This alternative consists of removing the existing bridge structure and raising the grade of VT-14 to allow for an at-grade rail crossing. This alternative eliminates the initial and future maintenance costs associated with a new bridge. There are construction and maintenance costs with an at-grade crossing pertaining to the track and crossing surface, signals, gate arms, and detection equipment, although it's anticipated that these costs will be less than that of a new bridge. There are several disadvantages associated with initiating a new rail crossing, summarized as follows:

- An additional crossing creates a potential conflict point between vehicles and rail cars creating a significant safety hazard for users of VT-14.
- An additional crossing impacts the operations of NECR and interrupts traffic flow along VT-14. There are currently three highway-rail crossings within approximately one mile north of the bridge and one crossing within approximately one mile south of the bridge along NECR.
- This particular crossing would be highly skewed to meet the roadway geometry, which may restrict motorist's ability to detect oncoming trains and be a safety hazard for motorcycles and bicycles with wheels getting caught in the space between rail and crossing surface.
- An at-grade crossing creates an unfavorable profile along VT Route 14 in that it will occur along a superelevated curve within the tracks. Constructing this would likely result in a substandard superelevation transition within the roadway.

- This crossing would, for both alignment alternatives, be placed within 100 ft of an intersecting roadway which increases potential for conflicting vehicular movements.
- Both alignment alternatives for an at-grade crossing require significant amounts of fill material to raise the roadway to the existing track elevation. This will extend the limits of work farther along the mainline, alter existing drainage patterns and cause greater environmental impacts.

Roadway Horizontal and Vertical Alignment

Roadway layouts and profiles for the at-grade crossing alternative were developed both with 30mph and 40mph roadway design speeds which maintain the same horizontal alignments as proposed in Alternatives 2A and 2B. Drawings for both alternatives are provided in Appendix A. The preceding section summarized several disadvantages with an at-grade crossing, and below are advantages and disadvantages particular to the 30mph and 40mph design speeds that were analyzed.

a. Alternative 4A – 30mph Roadway Design Speed

Advantages:

- Preferrable roadway profile for an at-grade crossing as there is a smaller (51°) skew from the tracks.
- Exceeds standard for intersection sight distance and stopping sight distance for a 30-mph design speed.

Disadvantages:

- Slower speed through crossing with advanced warning signs needed.
- An at grade crossing presents a significant safety concern.

b. Alternative 4B – 40mph Roadway Design Speed

Advantages:

- Alternative will maintain a design speed closer to the existing posted speed limit.
- Exceeds standard for stopping sight distance for a 40-mph design speed.

Disadvantages:

- Less preferrable roadway alignment as it creates a greater skew (62°) from the tracks. This skew between the tracks and the roadway creates a safety hazard for bicyclist crossing the tracks as the gap between rail and pavement will be greater than the 30-mph alternative.
- An at grade crossing presents a significant safety concern.

Railroad Horizontal and Vertical Alignment

The railroad horizontal and vertical alignment would remain essentially unchanged from the existing alignment because there are not currently any deficiencies and lowering the track to make the highway-rail at-grade crossing is not necessary.

Construction Phasing

A roadway alignment to the south of the existing bridge would be used to allow the at-grade crossing to be constructed largely without conflicting with VT-14. It is anticipated that a short-term closure, or at a minimum lane closures of VT-14 would be necessary to tie the at-grade crossing into the existing roadway. It is also anticipated that short term closures of the railroad would be necessary to construct the at-grade crossing.

Opinion of Probable Construction Cost (Concept-Level)

Opinions of Probable Construction Costs were developed for the alternatives considered. The costs include only the initial construction cost and exclude items such as right-of-way and engineering costs, and future maintenance costs. The costs are based on recent bid history or supplier quotes where applicable (increased to cover installed cost). The opinions of probable construction cost for each alternative are provided in the Alternatives Comparison Matrix and included in Appendix B.

Alternatives Comparison Matrix

Evaluation Criteria	Alternative 1 – Do Nothing	Alternative 2 – Bridge Replacement		Alternative 3 – Bridge Replacement with NECR Owned Bridge	Alternative 4 – Bridge Removal and Construction of At-Grade Crossing	
		2A – 30mph Design Speed	2B – 40mph Design Speed		4A – 30mph Design Speed	4B – 40mph Design Speed
Vertical and Horizontal Roadway Clearance	🔴	🟢	🟢	🟢	🟢	🟢
Stopping and Intersection Sight Distance	🟡	🟡	🔴	🟡	🟢	🟢
Safe Crossing, Not Impeding Train and Vehicle Flow	🟡	🟢	🟢	🟢	🔴	🔴
Roadway Horizontal and Vertical Alignment	🔴	🟢	🟢	🟢	🟡	🟡
Constructability	🟢	🟡	🟡	🔴	🟢	🟢
Expected Future Maintenance	🔴	🟢	🟢	🟡	🟡	🟡
Opinion of Probable Construction Cost	$0	$5,100,000	$6,300,000	N/A*	$1,525,000	$1,650,000

🟢 = Good / Significant Improvement over Existing Conditions

🟡 = Fair / Minor Improvement over Existing Conditions

🔴 = Poor / Regression from Existing Conditions

*Alternative does not meet the purpose of this project; therefore an opinion of probable construction cost is not provided.

Recommendation

VHB Recommends Alternative 2A – Bridge Replacement with a 30mph Roadway Design Speed. The reasons for this recommendation are discussed in this memo and summarized below.

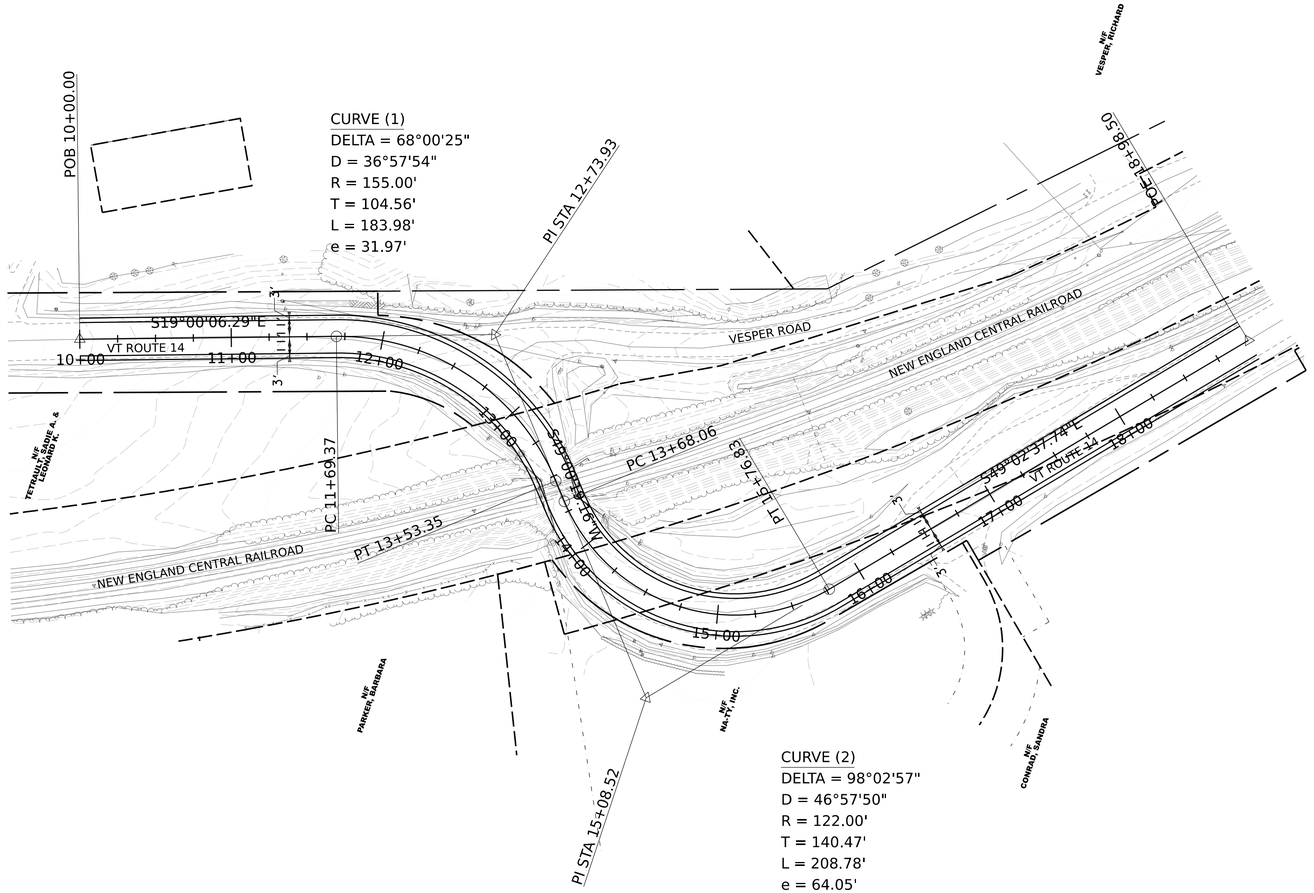
- A bridge replacement as described in this memo will provide the necessary vertical and horizontal roadway clearances along VT-14. A new structure will have a long service life with low maintenance and a decreased probability of future vehicle impacts. A grade separated crossing will eliminate safety concerns associated with an at-grade crossing and will not impede vehicle flow along NECR or VT-14.
- The 30mph bridge replacement alternative provides a balance between roadway speed and functionality, roadway safety with bridge length and cost, and overall project impacts.
- Alternatives 4A and 4B – Bridge Removal and Construction of At-Grade Crossing (30mph and 40mph) will create an additional potential conflict point between vehicles and rail cars, which along with the skew of the crossing and placement near a roadway intersection (Vesper Road) is a significant safety concern. An additional at-grade crossing also impedes traffic flow and operations for both NECR and VT Route 14. For these reasons, Alternatives 4A and 4B are not recommended.
- Alternative 1 – Do Nothing and Alternative 3 – Bridge Replacement with NECR Owned Bridge do not meet the purpose and need of the project and therefore are not recommended.

Appendices

Appendix A – Alternative Plan and Profiles

Appendix B – Alternative Opinions of Probable Construction Cost

Appendix A - Alternative Plan and Profiles



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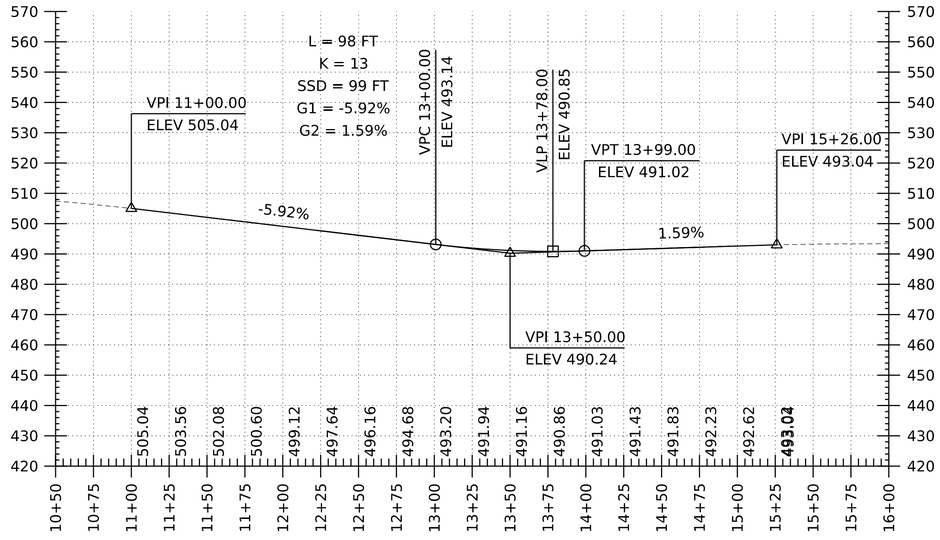
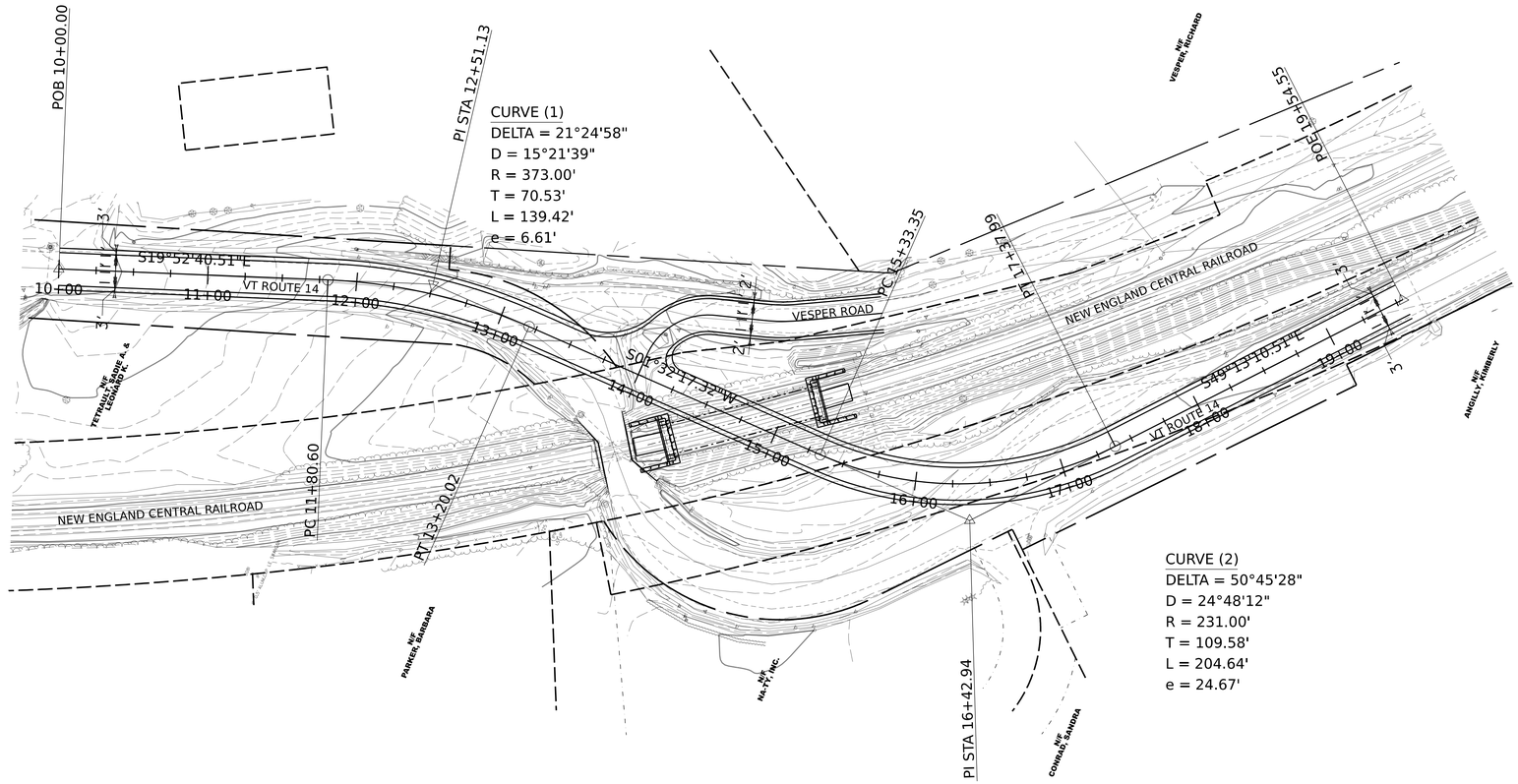


PROJECT NAME:	ROYALTON
PROJECT NUMBER:	BF 0147(29)
FILE NAME: z21j240_ali_ALT 1.dgn	PLOT DATE: 10/1/2021
PROJECT LEADER: A.P. GUYETTE	DRAWN BY: T.D. BURT
DESIGNED BY: T.D. BURT	CHECKED BY: J.D. BACHIOCHI
ALT 1- DO NOTHING	SHEET 1 OF 5



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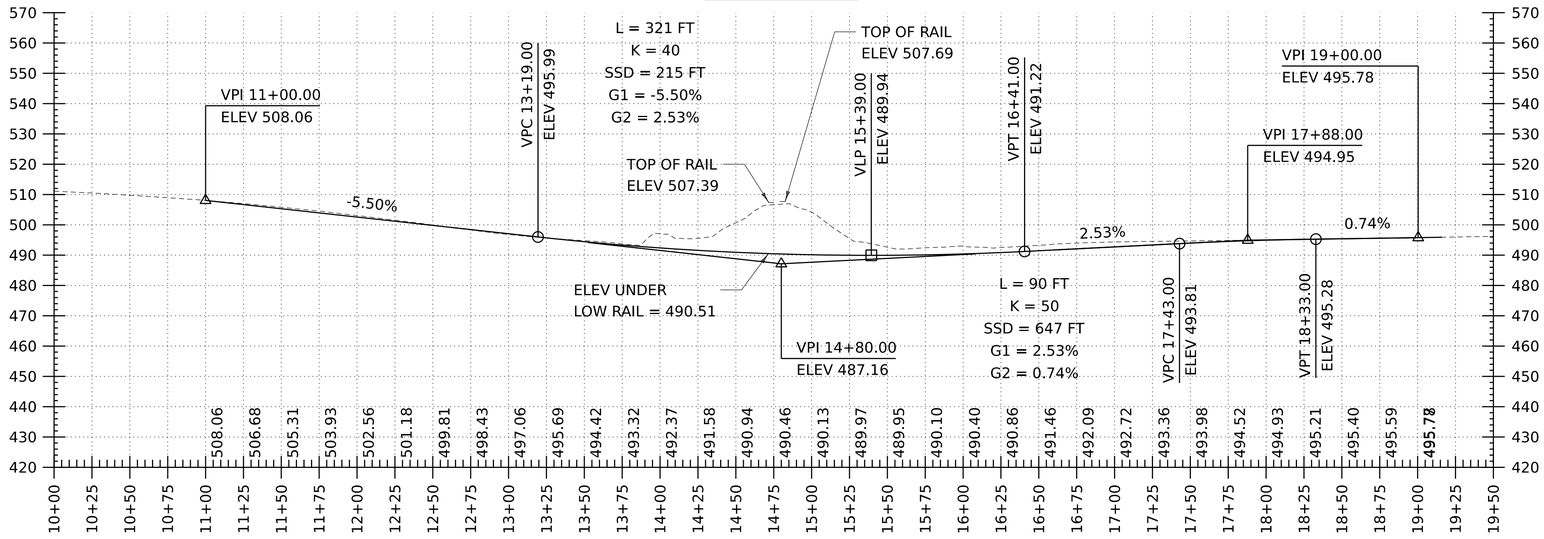
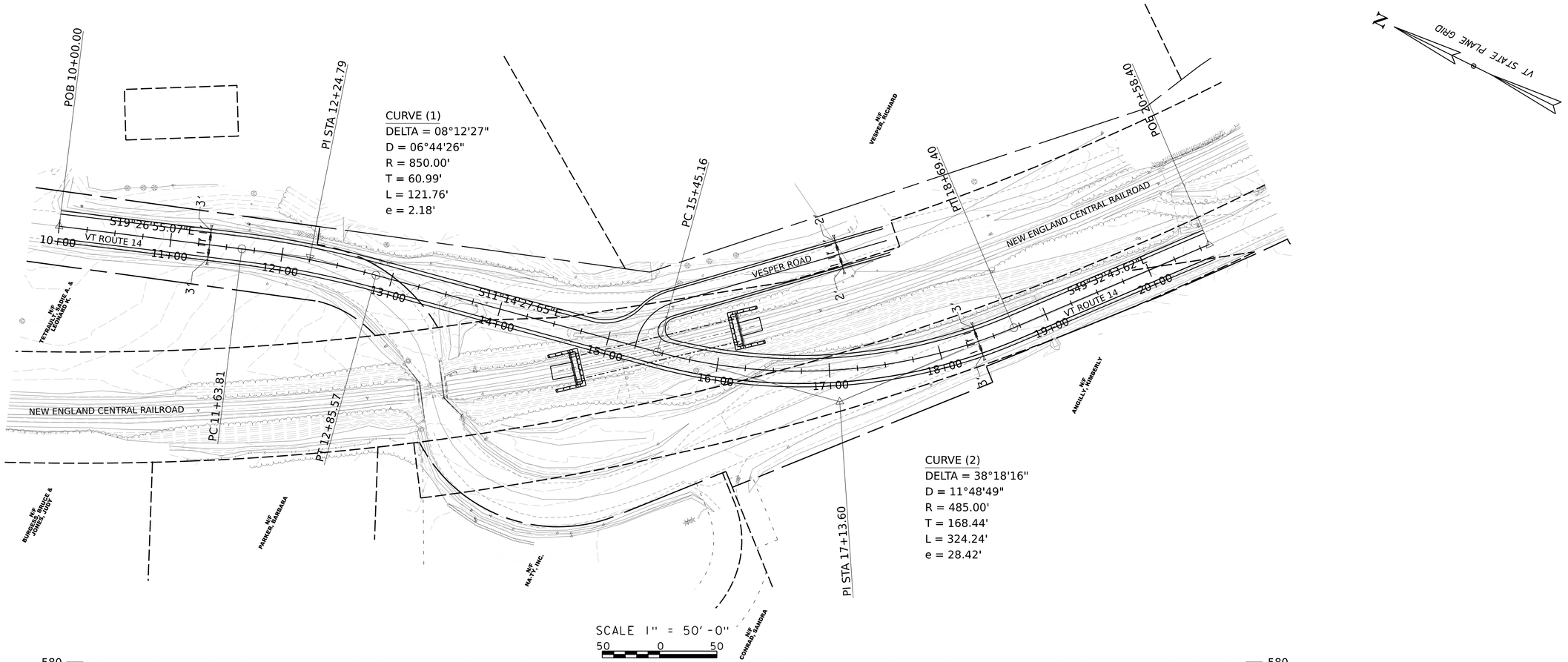
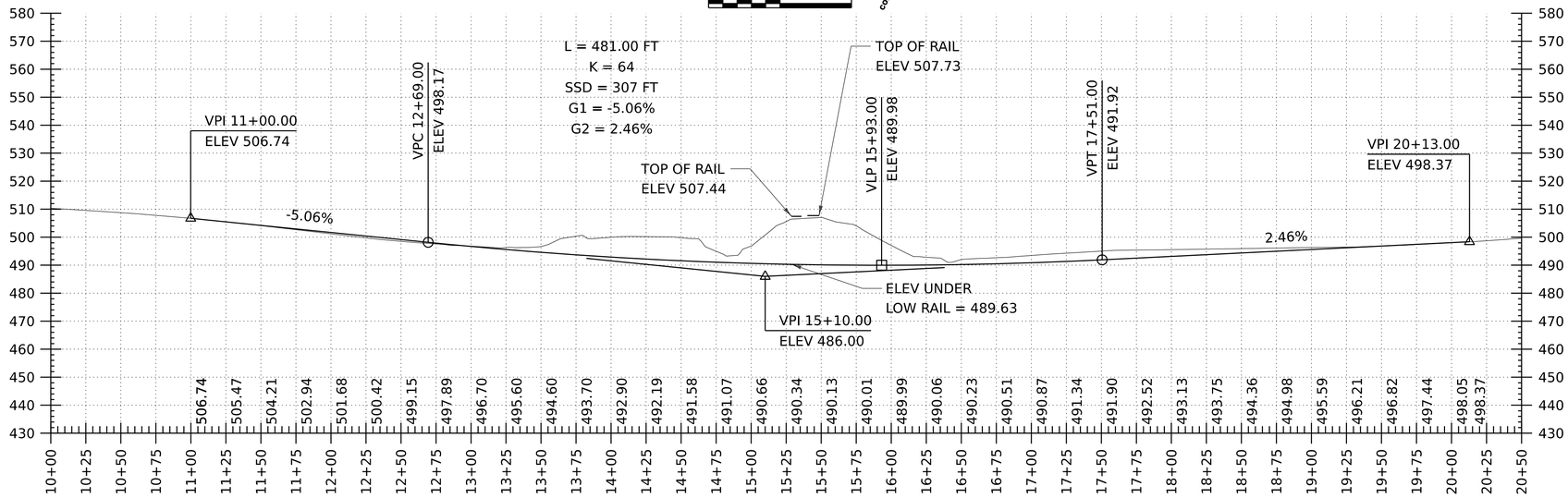
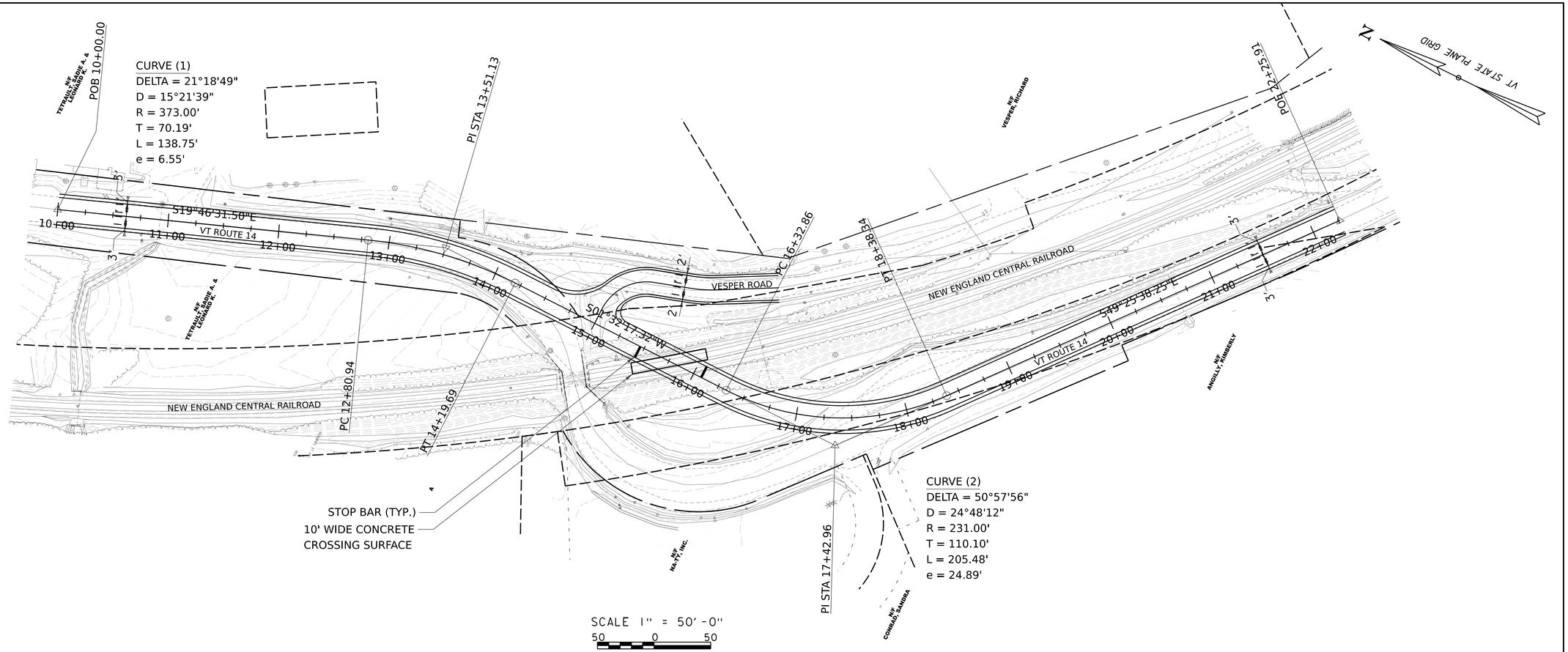


PROJECT NAME:	ROYALTON
PROJECT NUMBER:	BF 0147(29)
FILE NAME: z21j240_ali_ALT 2A.dgn	PLOT DATE: 10/1/2021
PROJECT LEADER: A.P. GUYETTE	DRAWN BY: T.D. BURT
DESIGNED BY: T.D. BURT	CHECKED BY: J.D. BACHIOCHI
ALT 2A - 30 MPH BRIDGE	SHEET 2 OF 5





PROJECT NAME:	ROYALTON
PROJECT NUMBER:	BF 0147(29)
FILE NAME: z21j240_ali_ALT 2B.dgn	PLOT DATE: 10/1/2021
PROJECT LEADER: A.P. GUYETTE	DRAWN BY: T.D. BURT
DESIGNED BY: T.D. BURT	CHECKED BY: J.D. BACHIOCHI
ALT 2B - 40 MPH BRIDGE	SHEET 3 OF 5



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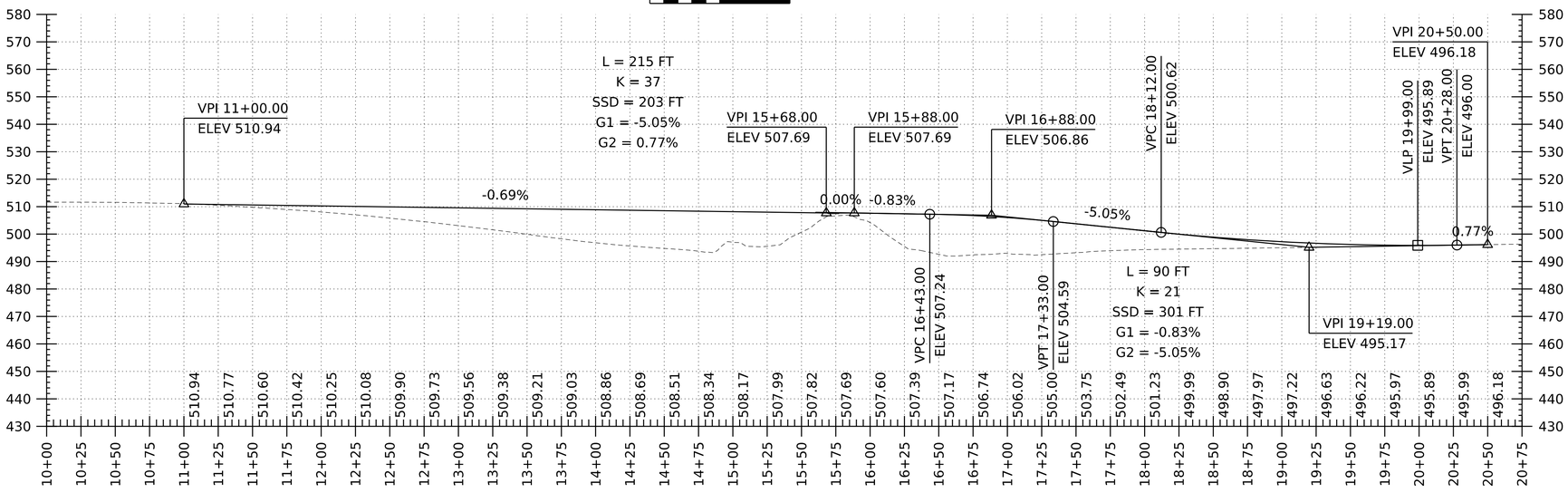


PROJECT NAME:	ROYALTON
PROJECT NUMBER:	BF 0147(29)
FILE NAME: z21j240_ali_ALT 4A.dgn	PLOT DATE: 10/1/2021
PROJECT LEADER: A.P. GUYETTE	DRAWN BY: T.D. BURT
DESIGNED BY: T.D. BURT	CHECKED BY: J.D. BACHIOCHI
ALT 4A - 30 MPH AT-GRADE CROSSING	SHEET 4 OF 5

POB 10+00.00

PI STA 13+21.88

CURVE (1)
DELTA = 08°20'57"
D = 06°44'26"
R = 850.00'
T = 62.04'
L = 123.86'
e = 2.26'

PC 16+45.18

PT 19+69.04

PC 12+59.84

PT 13+83.70

PI STA 18+13.62

CURVE (2)
DELTA = 38°18'16"
D = 11°48'49"
R = 485.00'
T = 168.44'
L = 324.24'
e = 28.42'

S19°35'25.08"E

S11°14'27.65"E

S49°32'43.62"E

VT ROUTE 14

VESPER ROAD

NEW ENGLAND CENTRAL RAILROAD

TETRAULT, NF & LEONARD, K.

VESPER FAMILY TRUST

VESPER, RICHARD

VESPER, ROBIN L. & CHERYL

ANGILLY, KIMBERLY

NA-TY, INC.

10' WIDE CONCRETE CROSSING SURFACE

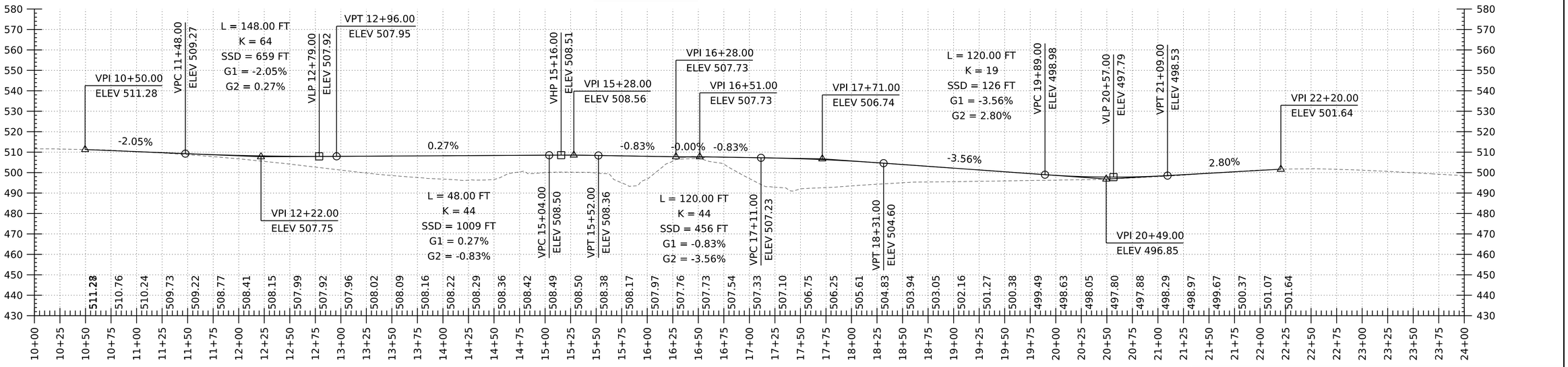
STOP BAR (TYP.)

N

VT STATE PLANE GRID

SCALE 1" = 50'-0"

50 0 50



PROJECT NAME:	ROYALTON
PROJECT NUMBER:	BF 0147(29)
FILE NAME: z2ij240_alt_ALT 4B.dgn	PLOT DATE: 10/1/2021
PROJECT LEADER: A.P. GUYETTE	DRAWN BY: T.D. BURT
DESIGNED BY: T.D. BURT	CHECKED BY: J.D. BACHIOCHI
ALT 4B - 40 MPH AT-GRADE CROSSING	SHEET 5 OF 5

Conceptual Cost Estimate

Project **Royalton BF 0147(29)** Project # **58643.00**
Location **Royalton, VT** Sheet
Calculated by **RHB** Date **9/3/2021**
Reviewed by **APG** Date **9/21/2021**
Title **Conceptual Cost Estimate**

Conceptual Cost Estimate
(Alternative 2A)
Bridge Replacement (30mph Roadway Design Speed)

Item No.	Item Description	Unit	Quantity	Unit Cost	Total Cost
203.15	COMMON EXCAVATION	CY	11,500	$ 15.00	$ 172,500
203.31	SAND BORROW	CY	900	$ 27.00	$ 24,300
301.26	SUBBASE OF CRUSHED GRAVEL, FINE GRADED	CY	400	$ 40.00	$ 16,000
301.35	SUBBASE OF DENSE GRADED CRUSHED STONE	CY	2,000	$ 45.00	$ 90,000
406.35	SUPERPAVE BITUMINOUS CONCRETE PAVEMENT	TON	1,000	$ 150.00	$ 150,000
501.38	HIGH PERFORMANCE CONCRETE, CLASS PCS	CY	105	$ 1,200.00	$ 126,000
504.10	FURNISHING EQUIPMENT FOR DRIVING PILING	LS	1	$ 50,000.00	$ 50,000
505.18	STEEL PILING, HP 14 X 89	LF	1,300	$ 90.00	$ 117,000
505.45	DYNAMIC PILE LOADING TEST	EA	2	$ 5,000.00	$ 10,000
506.50	STRUCTURAL STEEL, ROLLED BEAM	LB	280,000	$ 3.50	$ 980,000
506.55	STRUCTURAL STEEL, PLATE GIRDER	LB	120,000	$ 3.50	$ 420,000
507.12	REINFORCING STEEL, LEVEL II	LB	13,000	$ 2.50	$ 32,500
522.20	STRUCTURAL LUMBER AND TIMBER, UNTREATED	MFBM	11	$ 8,000.00	$ 88,000
529.15	REMOVAL OF STRUCTURE	EA	1	$ 30,000.00	$ 30,000
531.15	BEARING DEVICE ASSEMBLY, HIGH LOAD MULTI-ROTATIONAL	EA	4	$ 5,000.00	$ 20,000
540.10	PRECAST CONCRETE STRUCTURE (ABUTMENT NO. 1)	LS	1	$ 42,000.00	$ 42,000
540.10	PRECAST CONCRETE STRUCTURE (ABUTMENT NO. 2)	LS	1	$ 42,000.00	$ 42,000
540.10	PRECAST CONCRETE STRUCTURE (APPROACH SLAB NO. 1)	LS	1	$ 47,000.00	$ 47,000
540.10	PRECAST CONCRETE STRUCTURE (APPROACH SLAB NO. 2)	LS	1	$ 47,000.00	$ 47,000
601.2615	18" CPEP(SL)	LF	530	$ 58.00	$ 30,740
604.20	PRECAST REINFORCED CONCRETE CATCH BASIN WITH CAST IRON GRATE	EA	4	$ 4,020.00	$ 16,080
621.20	STEEL BEAM GUARDRAIL, GALVANIZED	LF	200	$ 19.00	$ 3,800
632.10	RAILROAD FLAGGERS (N.A.B.I.)	DL	26,000	$ 1.00	$ 26,000
641.11	TRAFFIC CONTROL, ALL-INCLUSIVE	LS	1	$ 30,000.00	$ 30,000
900.620	SPECIAL PROVISION (FURNISH AND INSTALL CROSS TIES)	EA	700	$ 250.00	$ 175,000
900.640	SPECIAL PROVISION (RAISE, ALIGN AND SURFACE TRACK)	LF	800	$ 30.00	$ 24,000
900.640	SPECIAL PROVISION (CONTINUOUS WELDED RAIL)	LF	1,600	$ 150.00	$ 240,000
900.645	SPECIAL PROVISION (TEMPORARY SUPPORTS AND LATERAL BRIDGE SLIDE)	LS	1	$ 300,000.00	$ 300,000
900.680	SPECIAL PROVISION (RAILROAD BALLAST)	TON	1,400	$ 35.00	$ 49,000

Items Sub Total	$	*3,398,920*
10% Mobilization	$	339,892
25% Standard Contingency	$	849,730
5% Construction Engineering	$	169,946
10% Accelerated Construction Premium	$	339,892
Sub Total	$	*5,098,380*
Construction Cost	**$**	**5,100,000**

Conceptual Cost Estimate

Project	**Royalton BF 0147(29)**	Project #	**58643.00**
Location	**Royalton, VT**	Sheet	
Calculated by	**RHB**	Date	**9/3/2021**
Reviewed by	**APG**	Date	**9/21/2021**
Title	**Conceptual Cost Estimate**		

Conceptual Cost Estimate
(Alternative 2B)
Bridge Replacement (40mph Roadway Design Speed)

Item No.	Item Description	Unit	Quantity	Unit Cost	Total Cost
203.15	COMMON EXCAVATION	CY	20,500	$ 15.00	$ 307,500
203.31	SAND BORROW	CY	1,000	$ 27.00	$ 27,000
301.26	SUBBASE OF CRUSHED GRAVEL, FINE GRADED	CY	400	$ 40.00	$ 16,000
301.35	SUBBASE OF DENSE GRADED CRUSHED STONE	CY	2,500	$ 45.00	$ 112,500
401.10	AGGREGATE SURFACE COURSE	CY	150	$ 50.00	$ 7,500
406.35	SUPERPAVE BITUMINOUS CONCRETE PAVEMENT	TON	1,200	$ 150.00	$ 180,000
501.38	HIGH PERFORMANCE CONCRETE, CLASS PCS	CY	105	$ 1,200.00	$ 126,000
504.10	FURNISHING EQUIPMENT FOR DRIVING PILING	LS	1	$ 50,000.00	$ 50,000
505.18	STEEL PILING, HP 14 X 89	LF	1,300	$ 90.00	$ 117,000
505.45	DYNAMIC PILE LOADING TEST	EA	2	$ 5,000.00	$ 10,000
506.50	STRUCTURAL STEEL, ROLLED BEAM	LB	300,000	$ 3.50	$ 1,050,000
506.55	STRUCTURAL STEEL, PLATE GIRDER	LB	180,000	$ 3.50	$ 630,000
507.12	REINFORCING STEEL, LEVEL II	LB	13,000	$ 2.50	$ 32,500
522.20	STRUCTURAL LUMBER AND TIMBER, UNTREATED	MFBM	11	$ 8,000.00	$ 88,000
529.15	REMOVAL OF STRUCTURE	EA	1	$ 30,000.00	$ 30,000
531.15	BEARING DEVICE ASSEMBLY, HIGH LOAD MULTI-ROTATIONAL	EA	4	$ 5,000.00	$ 20,000
540.10	PRECAST CONCRETE STRUCTURE (ABUTMENT NO. 1)	LS	1	$ 42,000.00	$ 42,000
540.10	PRECAST CONCRETE STRUCTURE (ABUTMENT NO. 2)	LS	1	$ 42,000.00	$ 42,000
540.10	PRECAST CONCRETE STRUCTURE (APPROACH SLAB NO. 1)	LS	1	$ 47,000.00	$ 47,000
540.10	PRECAST CONCRETE STRUCTURE (APPROACH SLAB NO. 2)	LS	1	$ 47,000.00	$ 47,000
601.2615	18" CPEP(SL)	LF	530	$ 58.00	$ 30,740
604.20	PRECAST REINFORCED CONCRETE CATCH BASIN WITH CAST IRON GRATE	EA	4	$ 4,020.00	$ 16,080
621.20	STEEL BEAM GUARDRAIL, GALVANIZED	LF	200	$ 19.00	$ 3,800
632.10	RAILROAD FLAGGERS (N.A.B.I.)	DL	26,000	$ 1.00	$ 26,000
641.11	TRAFFIC CONTROL, ALL-INCLUSIVE	LS	1	$ 30,000.00	$ 30,000
900.620	SPECIAL PROVISION (FURNISH AND INSTALL CROSS TIES)	EA	700	$ 250.00	$ 175,000
900.640	SPECIAL PROVISION (RAISE, ALIGN AND SURFACE TRACK)	LF	800	$ 30.00	$ 24,000
900.640	SPECIAL PROVISION (CONTINUOUS WELDED RAIL)	LF	1,600	$ 150.00	$ 240,000
900.645	SPECIAL PROVISION (TEMPORARY SUPPORTS AND LATERAL BRIDGE SLIDE)	LS	1	$ 350,000.00	$ 350,000
900.670	SPECIAL PROVISION (PRECAST CONCRETE RETAINING WALL)	SF	900	$ 300.00	$ 270,000
900.680	SPECIAL PROVISION (RAILROAD BALLAST)	TON	1,400	$ 35.00	$ 49,000

Items Sub Total	$	*4,196,620*
10% Mobilization	$	419,662
25% Standard Contingency	$	1,049,155
5% Construction Engineering	$	209,831
10% Accelerated Construction Premium	$	419,662
Sub Total	$	*6,294,930*
Construction Cost	**$**	**6,300,000**

Conceptual Cost Estimate

Project	**Royalton BF 0147(29)**	Project #	**58643.00**
Location	**Royalton, VT**	Sheet	
Calculated by	**RHB**	Date	**9/3/2021**
Reviewed by	**APG**	Date	**9/21/2021**
Title	**Conceptual Cost Estimate**		

Conceptual Cost Estimate
(Alternative 4A)
Bridge Removal and Construction of At-Grade Crossing (30mph Roadway Design Speed)

Item No.	Item Description	Unit	Quantity	Unit Cost	Total Cost
203.10	EARTH BORROW	CY	11,000	$ 13.00	$ 143,000
203.15	COMMON EXCAVATION	CY	1,500	$ 15.00	$ 22,500
203.31	SAND BORROW	CY	1,000	$ 27.00	$ 27,000
301.35	SUBBASE OF DENSE GRADED CRUSHED STONE	CY	2,400	$ 45.00	$ 108,000
406.35	SUPERPAVE BITUMINOUS CONCRETE PAVEMENT	TON	1,200	$ 150.00	$ 180,000
601.2615	18" CPEP(SL)	LF	160	$ 58.00	$ 9,280
621.20	STEEL BEAM GUARDRAIL, GALVANIZED	LF	700	$ 19.00	$ 13,300
632.10	RAILROAD FLAGGERS (N.A.B.I.)	DL	26,000	$ 1.00	$ 26,000
641.11	TRAFFIC CONTROL, ALL-INCLUSIVE	LS	1	$ 30,000.00	$ 30,000
900.620	SPECIAL PROVISION (FURNISH AND INSTALL CROSS TIES)	EA	45	$ 250.00	$ 11,250
900.645	SPECIAL PROVISION (CONSTRUCT RAIL-HIGHWAY CROSSING)	LS	1	$ 200,000	$ 200,000
900.645	SPECIAL PROVISION (RAIL-HIGHWAY CROSSING ACTIVE WARNING SYSTEM)	LS	1	$ 300,000	$ 300,000
900.680	SPECIAL PROVISION (RAILROAD BALLAST)	TON	200	$ 35.00	$ 7,000

Items Sub Total	*$*	*1,077,330*
10% Mobilization	$	107,733
25% Standard Contingency	$	269,333
5% Construction Engineering	$	53,867
Sub Total	*$*	*1,508,262*
Construction Cost	**$**	**1,525,000**

Conceptual Cost Estimate

Project	**Royalton BF 0147(29)**	Project #	**58643.00**
Location	**Royalton, VT**	Sheet	
Calculated by	**RHB**	Date	**9/3/2021**
Reviewed by	**APG**	Date	**9/21/2021**
Title	**Conceptual Cost Estimate**		

Conceptual Cost Estimate
(Alternative 4B)
Bridge Removal and Construction of At-Grade Crossing (40mph Roadway Design Speed)

Item No.	Item Description	Unit	Quantity	Unit Cost	Total Cost
203.10	EARTH BORROW	CY	9000	$ 13.00	$ 117,000
203.15	COMMON EXCAVATION	CY	2,500	$ 15.00	$ 37,500
203.31	SAND BORROW	CY	1,300	$ 27.00	$ 35,100
301.35	SUBBASE OF DENSE GRADED CRUSHED STONE	CY	2,900	$ 45.00	$ 130,500
406.35	SUPERPAVE BITUMINOUS CONCRETE PAVEMENT	TON	1,500	$ 150.00	$ 225,000
601.2615	18" CPEP(SL)	LF	240	$ 58.00	$ 13,920
621.20	STEEL BEAM GUARDRAIL, GALVANIZED	LF	700	$ 19.00	$ 13,300
632.10	RAILROAD FLAGGERS (N.A.B.I.)	DL	26,000	$ 1.00	$ 26,000
641.11	TRAFFIC CONTROL, ALL-INCLUSIVE	LS	1	$ 30,000.00	$ 30,000
900.620	SPECIAL PROVISION (FURNISH AND INSTALL CROSS TIES)	EA	45	$ 250.00	$ 11,250
900.645	SPECIAL PROVISION (CONSTRUCT RAIL-HIGHWAY CROSSING)	LS	1	$ 230,000	$ 230,000
900.645	SPECIAL PROVISION (RAIL-HIGHWAY CROSSING ACTIVE WARNING SYSTEM)	LS	1	$ 300,000	$ 300,000
900.680	SPECIAL PROVISION (RAILROAD BALLAST)	TON	200	$ 35.00	$ 7,000

Items Sub Total	*$*	*1,169,570*
10% Mobilization	$	116,957
25% Standard Contingency	$	292,393
5% Construction Engineering	$	58,479
Sub Total	*$*	*1,637,398*
Construction Cost	**$**	**1,650,000**