Lyons Ute Highway Streambank Stabilization

HYDRAULIC STUDY REPORT

February 2024

Submitted by:

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Introduction

This report summarizes the hydraulic analysis of the proposed river improvements on the St. Vrain Creek near Lyons, Colorado. The proposed project was designed and analyzed in a hydraulic study completed by Werner Water Engineering under the guidance of a licensed professional engineer in the State of Colorado. The goal of this study is to ensure that the proposed design complies with the requirements of the National Flood Insurance Program (NFIP) for the alteration of a watercourse and to obtain a floodplain development permit that is required in order to advance to the construction phase of the project.

Project Location

The project location is at 4652 Ute Highway along the St. Vrain Creek near Lyons, Colorado. The project is the site of the old Longmont water treatment plant located east of the Highway 36 and Highway 66 intersection. The project location is shown in Figure 1.

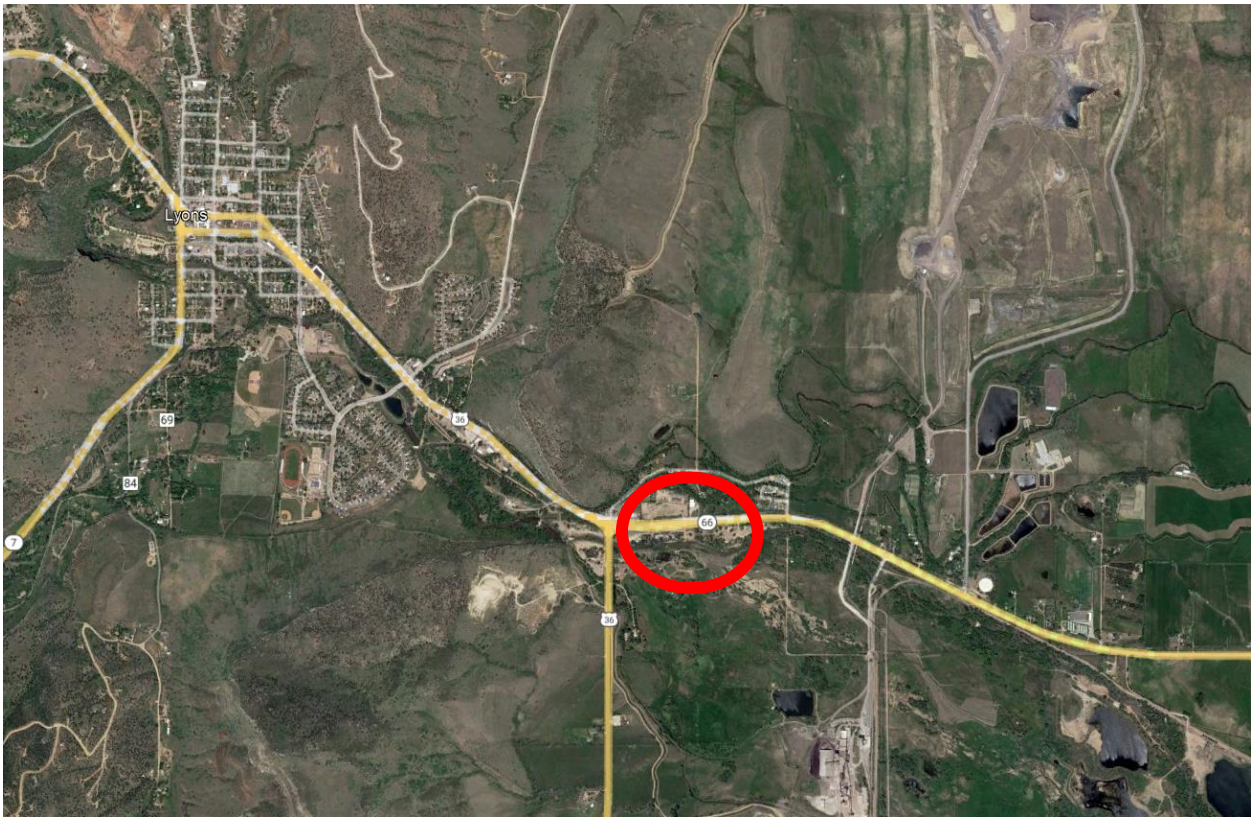


Figure 1: Project location map

Project Description

In 2013 a 500-year flood occurred on the St. Vrain River near Lyons, Colorado that caused significant damage to the watershed and nearby properties. One of the properties damaged was 4652 Ute Highway

in Lyons, Colorado, which is located on the North Bank of the St. Vrain. This address is the location of the old Longmont water treatment plant. During the event, significant flood damage occurred to the stream bank of the property and extended up to the treatment buildings. Damage included steep, eroded stream banks and build-up of concrete and metal debris from old structures and piping located within the floodplain.

Existing Conditions

The creek through this reach is one of the last reaches of the St. Vrain that has not been restored after the floods. Restoration work has been conducted downstream of the site by Boulder County and the property owner on the south side of the St. Vrain Creek has restored their banks, leaving this property as the sole property in the reach with remaining flood damage. The river in this reach is gently sloped and largely linear in nature. Several cottonwoods have survived the flood on this bank and there is an existing drop structure at the upstream end of the property that spans the river. In the time since the flood cottonwoods and willows have started to reestablish in the riparian area.

The Figures below show the existing conditions at the site:

Figure 2 Upstream design area from the middle of the site

Figure 3 Downstream design area from the middle of the site

Proposed Activities

The proposed project will clean up the debris on the site and stabilize and restore the streambanks and channel of the St. Vrain Creek.

The existing debris will be removed from this site that was left from the 2013 floods. This debris includes concrete, asphalt, pipes, and other materials that don't belong in the riparian and stream area.

The current channel is over widened through the site which is causing aggradation in the area. Immediately downstream of the property, Boulder County did a stream restoration project after the 2013 floods and the proposed channel grading will tie into the channel constructed during that project with similar channel dimensions. This will help stabilize the channel and facilitate sediment transport through the reach that is currently geomorphically unstable. The proposed channel will be a multistage channel with a low flow channel, bankfull channel, and a floodplain bench. Appropriately spaced rifles and pools will be included.

The bank stabilization in the upstream 150 feet of improvements is space limited by existing infrastructure and will include multiple single stacked boulder terraces. The downstream 275 feet of bank stabilization is not limited by existing infrastructure and the bank will be graded at a 3:1 slope and revegetated.

The total length of the improvements is 630 feet along the proposed channel centerline. The proposed bankfull width is 45-50 feet with pool riffle sequences spaced at approximately 5 times the bankfull width.

The channel and channel edge will be constructed with native cobble material. The channel has self armored over the past 10 years post flood. During construction, the existing channel cobble material will be reused as the channel material in the finished state. During many post flood projects, it was identified that an average material size of 3 inches is sufficient for the St. Vrain near Lyons. The natural armor layer material meets this specification. It is expected that with no sharp bends or local erosion points in the reach that there is not a requirement for additional hard armoring. Any local scour or erosion that occurs in the future will be maintained by the owner.

The floodplain bench area has been graded to function as floodplain, but to also allow for future plans for access to the river. Future access paths or gathering areas will be determined as the property is developed, but will be done in a way that is appropriate for a floodplain bench and will not alter the modeled roughness of the bench.

National Flood Insurance Program Compliance

The proposed project is located within a FEMA regulated and mapped floodway and floodplain and must comply with the local and federal floodplain development regulations. The project property has been annexed into the Town of Lyons. The Town of Lyons is the floodplain manager for the proposed project.

The project is located within a mapped floodway, therefore, it has been designed to meet a no-rise condition. By meeting the no-rise condition a Conditional Letter of Map Revision (CLOMR) from FEMA will not be required.

As discussed in the Hydraulic Design Process below, the comparison for compliance is being made based on a Letter of Map Revision (LOMR), that was submitted by Boulder County. This is the effective model for this area and it was based on and updated from the Colorado Hazard Mapping Program (CHAMP) study completed for the St. Vrain Creek.

Hydraulic Design Process

The hydraulic design process is described in this section that supports the projects compliance with the Town of Lyons Municipal Code, State of Colorado Rules and Regulations for Floodplain, and NFIP regulations.

The effective study for the St. Vrain Creek is an approved LOMR completed by Boulder County. The LOMR has a FEMA Case Number of 20:08:0602P and has an effective date of December 8, 2020. This is the effective and the best available data to base the hydraulic design on.

As a part of the design effort, several model plans have been created to evaluate the flood impacts of the proposed project as a part of the floodplain development permit process. The models are the effective, duplicate effective, existing and proposed. A brief description of each model follows:

Effective—The effective model is the model the December 8, 2020 LOMR was based on. The LOMR model has two plans as a part of the LOMR. Both plans have the same results in the project reach. The plan titled EWP_LORM_Multiprofile_Run was used as effective. The effective model was created in HEC-RAS version 5.0.1.

Duplicate Effective—the Duplicate Effective model was a recreation of the effective model in HEC-RAS 6.4.1. A new plan was created with all model inputs unaltered.

Existing—The existing conditions model includes additional cross sections to model the proposed project with updated geometry to match the project survey.

Proposed—the proposed geometry of the project. The existing model was used as the base model. This plan in the model is named Proposed.

Modeling Software

The hydraulic modeling for the project has been computed using HEC-RAS version 6.4.1.

Topographic Data

The topographic data is a combination of 2014 LiDAR and collected site survey. The site survey was collected in April 2017 by Flatirons, Inc.

The horizontal projection used is NAD 1983 (2011) State Plane Colorado North FIPS 0501 (US Feet). The vertical datum used is NAVD 88.

Structures

There are no structures proposed or modeled as a part of the project.

Boundary Conditions

The boundary conditions of the model were unchanged from the LOMR model and set as a known water surface elevation. The downstream boundary condition is a significant distance downstream and though FEMA prefers a normal depth is used for the boundary condition, the use of known water surfaces would have no impact on the proposed project due to the distance. The model is run with only subcritical conditions and does not require an upstream boundary condition.

Hydrology

The hydrology is based on the Hydrologic Evaluation of the St. Vrain Watershed Post September 2013 Flood Event prepared by Jacobs in August 2014. The hydrology was unchanged in the hydraulic model and matches the LOMR.

Geometry

The cross section locations from the effective model were used with additional cross sections to model the proposed improvements in greater detail. The geometry of the duplicate effective model was the same as the effective model. The existing condition model geometry was determined from an existing conditions survey combined with 2014 LiDAR and added cross sections to accurately model the project reach. One cross section was added near the upstream boundary of the project and a second was added at a natural pinch point that occurs downstream of the existing structures. The cross sections were developed using AutoCAD Civil3D and imported into HEC-RAS. Cross Section 175848.2 cuts through the existing building and in the area of the building the geometry from the CHAMP model cross section was carried over. The n values were established to be consistent with the effective model cross sections. The proposed condition adds the proposed grades of the project to the cross sections modeled in the existing conditions. Figure 4 shows the locations of the model cross sections.

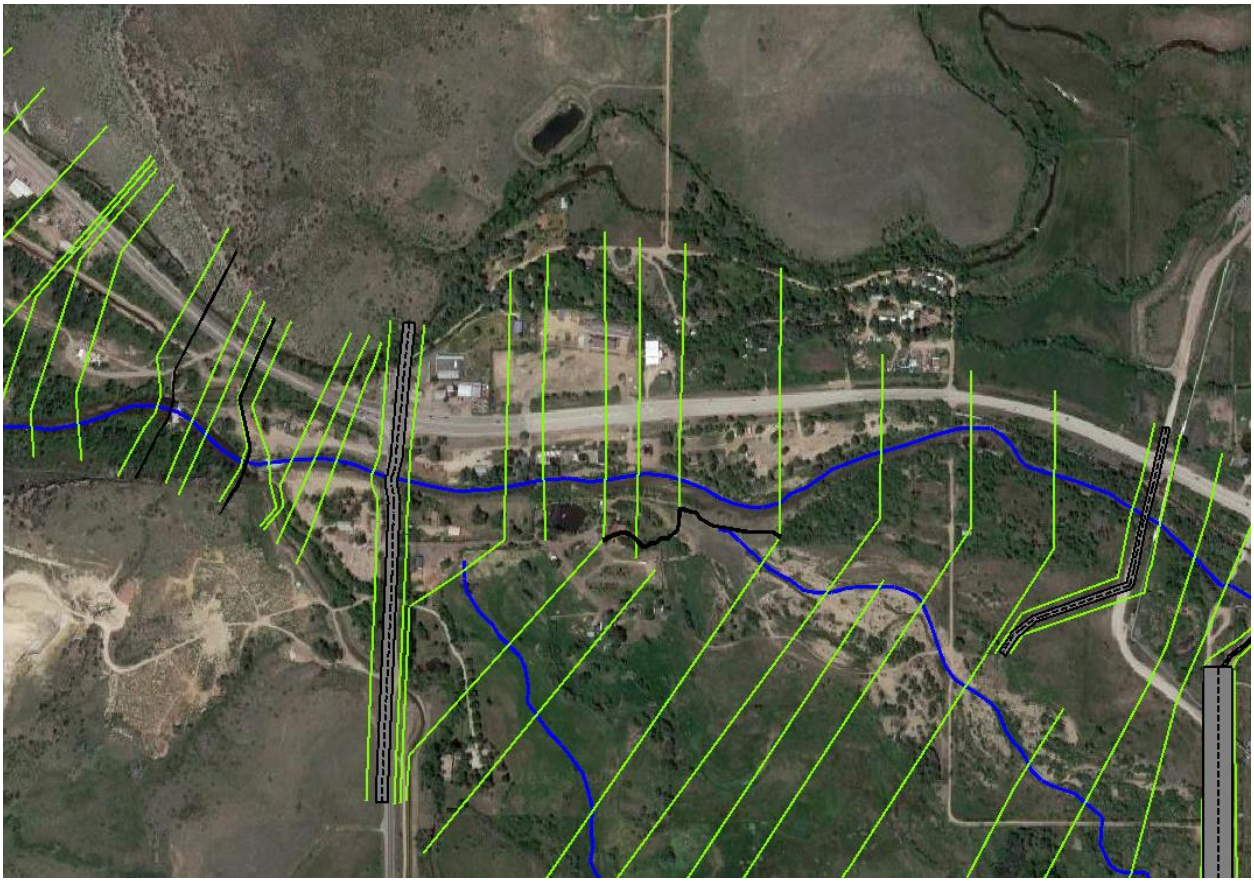


Figure 4 Model Cross Section Locations

The manning's n roughness coefficients in the model were maintained from the effective model. The added cross sections in the existing and proposed geometries were established to be consistent with the effective and appropriate for the proposed final condition.

The contraction and expansion coefficients were set to 0.1 and 0.3 respectively for all added cross sections. The coefficients at all cross sections that were existing in the effective model were not modified.

Results

CHAMP Model

The CHAMP Model results were taken from the HEC-RAS model used in the LOMR that is the effective model. The EWP_LORM_Multiprofile_Run plan was used for the basis on comparison. The model was not truncated so the model contains all the cross sections, however, for ease of comparison only the data for cross sections in the vicinity of the project are shown in Table 1.

Table 1 Effective Water Surface Elevations

Reach	River Sta	W.S. Elev
		(ft)
SVC_RM1	177461.6	5271.65
SVC_RM1	177355.2	5271.59
SVC_RM1	177244	5271.54
SVC_RM1	177141.3	5271.53
SVC_RM1	176962.2	5271.44
SVC_RM1	176888 SVC_97, US HW 36	
SVC_RM1	176782.2	5265.49
SVC_RM1	176708.6	
SVC_RM1	176324.2	5262.36
SVC_RM1	176308.6	
SVC_RM1	175848.2	5256.64
SVC_RM1	175838.7	
SVC_RM1	175486.2	5253.74
SVC_RM1	175408.2	
SVC_RM1	174985.1	5249.15

Duplicate Effective Model

The duplicate effective model was a new plan within the HEC-RAS model with the same inputs and settings as the effective model. The results of the duplicate effective reproduced the same results as the effective model plan near the proposed project. There were two cross sections upstream of the McConnell Drive Bridge that had 0.01 difference and 0.17 difference upstream of the bridge at cross section 172250.6. These cross sections had no change between the duplicate effective, existing, and proposed condition plans. The results in the project area are shown in *Table 2*.

Table 2 CHAMP and Duplicate CHAMP Results

Reach	River Sta	Effective W.S. Elev (ft)	Dup. Effective W.S. Elev (ft)	Difference Dup Eff-Eff
SVC_RM1	177461.6	5271.65	5271.65	0
SVC_RM1	177355.2	5271.59	5271.59	0
SVC_RM1	177244	5271.54	5271.54	0
SVC_RM1	177141.3	5271.53	5271.53	0
SVC_RM1	176962.2	5271.44	5271.44	0
SVC_RM1	176888 SVC_97, US HW 36			
SVC_RM1	176782.2	5265.49	5265.49	0
SVC_RM1	176708.6			
SVC_RM1	176324.2	5262.36	5262.36	0
SVC_RM1	176308.6			
SVC_RM1	175848.2	5256.64	5256.64	0
SVC_RM1	175838.7			
SVC_RM1	175486.2	5253.74	5253.74	0
SVC_RM1	175408.2			
SVC_RM1	174985.1	5249.15	5249.15	0

Existing Conditions Model

The next model computed was the existing conditions model. The existing conditions model added cross sections to model the proposed improvements. Table 3 shows the duplicate effective and existing water surface elevations. The duplicate effective results shown in red are a linear interpolation to allow for comparison of results at the added cross sections in the existing conditions plan.

In the project area there are various rises and decreases in the water surface elevations due to increased detail in the model by adding cross sections. This is expected when adding cross sections and detail to hydraulic model. There is a natural pinch in the floodplain at the added cross section at river station 175692.7 that causes a rise that propagates upstream.

Table 3 Duplicate Effective and Existing Results

Reach	River Sta	Dup. Effective W.S. Elev (ft)	Existing W.S. Elev (ft)	Difference EC-Dup Eff (ft)
SVC_RM1	177461.6	5271.65	5271.65	0
SVC_RM1	177355.2	5271.59	5271.58	-0.01
SVC_RM1	177244	5271.54	5271.54	0
SVC_RM1	177141.3	5271.53	5271.52	-0.01
SVC_RM1	176962.2	5271.44	5271.44	0
SVC_RM1	176888 SVC_97, US HW 36			
SVC_RM1	176782.2	5265.49	5265.22	-0.27
SVC_RM1	176708.6			
SVC_RM1	176324.2	5262.36	5263.26	0.9
SVC_RM1	176308.6			
SVC_RM1	176137.1	5260.11	5261.24	1.13
SVC_RM1	175848.2	5256.64	5258.67	2.03
SVC_RM1	175838.7			
SVC_RM1	175692.7	5255.39	5256.74	1.35
SVC_RM1	175486.2	5253.74	5253.74	0
SVC_RM1	175408.2			
SVC_RM1	174985.1	5249.15	5249.15	0

Proposed Conditions Model

The proposed conditions geometry was added to the existing conditions model. The resulting water surface elevations and comparisons to the existing are shown in Table 4. The project only causes changes in water surface elevations at three cross sections, and the changes are all decreases with a maximum decrease of 0.26 feet.

The proposed project does not cause an increase or decrease in water surface elevation of more than 0.3 feet, therefore, Section H of Rule 12 of the Colorado Rules and Regulations for Regulatory Floodplains will not apply, and the project will not be required, by statute, to obtain a LOMR upon project completion.

Table 4 Proposed Condition Comparisons

		Existing	Proposed	Difference
Reach	River Sta	W.S. Elev	W.S. Elev	PC-EC
		(ft)	(ft)	(ft)
SVC_RM1	177461.6	5271.65	5271.65	0
SVC_RM1	177355.2	5271.58	5271.58	0
SVC_RM1	177244	5271.54	5271.54	0
SVC_RM1	177141.3	5271.52	5271.52	0
SVC_RM1	176962.2	5271.44	5271.44	0
SVC_RM1	176888 SVC_97, US HW 36			
SVC_RM1	176782.2	5265.22	5265.22	0
SVC_RM1	176708.6			
SVC_RM1	176324.2	5263.26	5263.26	0
SVC_RM1	176308.6			
SVC_RM1	176137.1	5261.24	5260.98	-0.26
SVC_RM1	175848.2	5258.67	5258.46	-0.21
SVC_RM1	175838.7			
SVC_RM1	175692.7	5256.74	5256.65	-0.09
SVC_RM1	175486.2	5253.74	5253.74	0
SVC_RM1	175408.2			
SVC_RM1	174985.1	5249.15	5249.15	0

Floodway

The floodway at the added cross sections was interpolated graphically in Civil3d for the effective limits. A floodway run was created in the model using the interpolated limits as the encroachment stations and the resulting surcharges are equal to or less than 0.5 feet.

NFIP Compliance

For NFIP compliance the existing versus proposed water surface elevations were compared for the 100-year flow rates. As shown in Table 4, there are no rises with the proposed conditions versus the existing.

Other Permits

The project also requires a permit for compliance with Section 404 of the Clean Water Act from the Army Corps of Engineers. The project has been authorized under a Nationwide Permit (NWP 27) for compliance with Section 404.

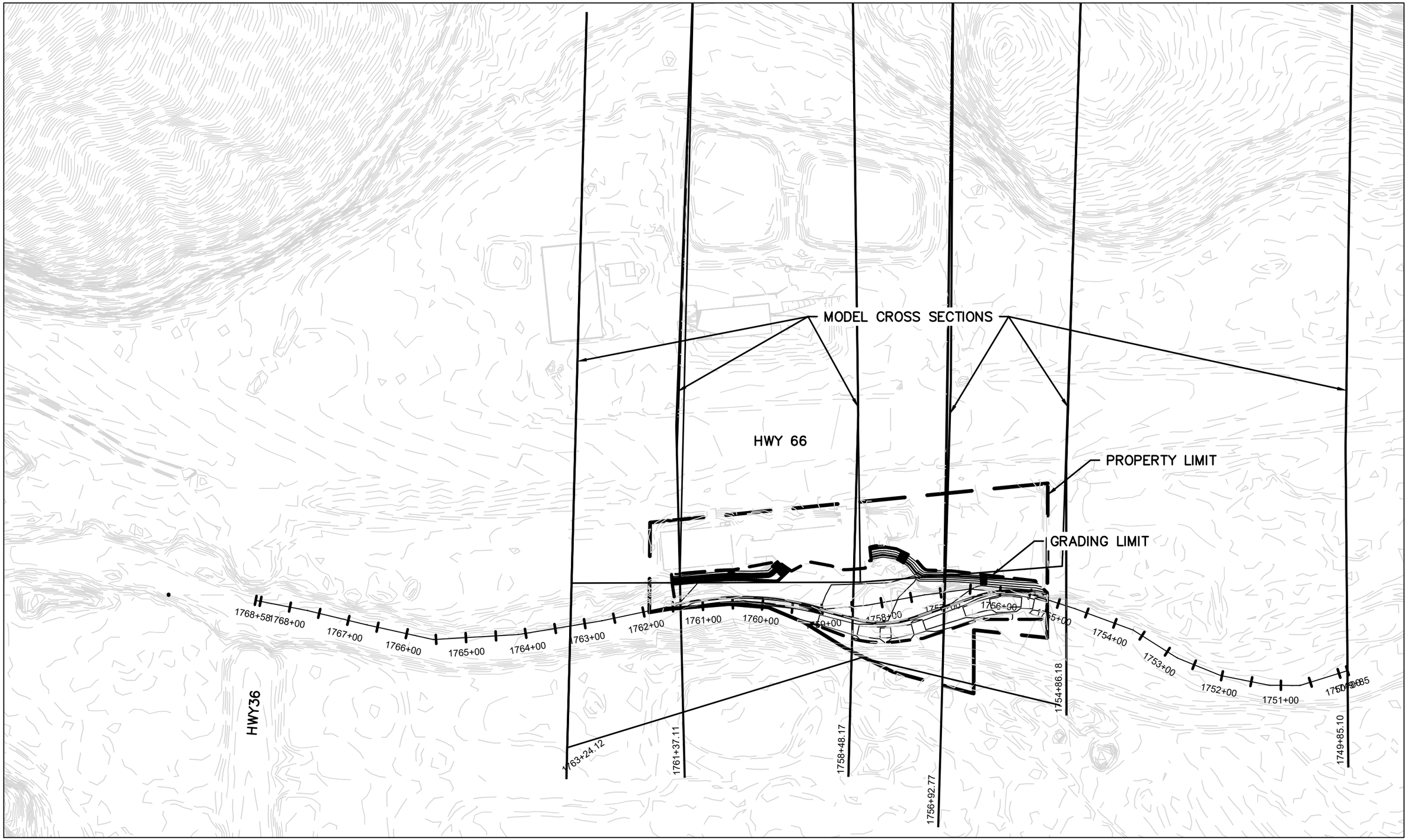
Per the Army Corps of Engineers:

> *Non-federal permittees must submit a pre-construction notification to the district engineer if any listed species (or species proposed for listing) or designated critical habitat*

(or critical habitat proposed such designation) might be affected or is in the vicinity of the activity, or if the activity is located in designated critical habitat or critical habitat proposed for such designation, and shall not begin work on the activity until notified by the district engineer that the requirements of the ESA have been satisfied and that the activity is authorized.

A habitat survey was completed as a part of the application for the Nationwide Permit 27 verification.

Appendix A – Floodplain Drawings



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DATE	REVISION DESCRIPTION

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Job Number:
Prepared For:
Designer: **NLW** | Drafter: **NLW** | Checked:

Werner WATER ENGINEERING

LYONS UTE HIGHWAY STREAMBANK STABILIZATION

PERMITTING

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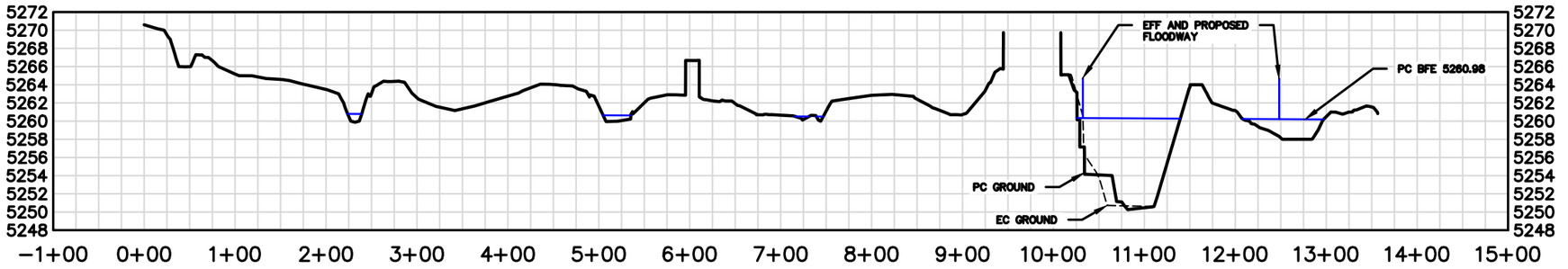
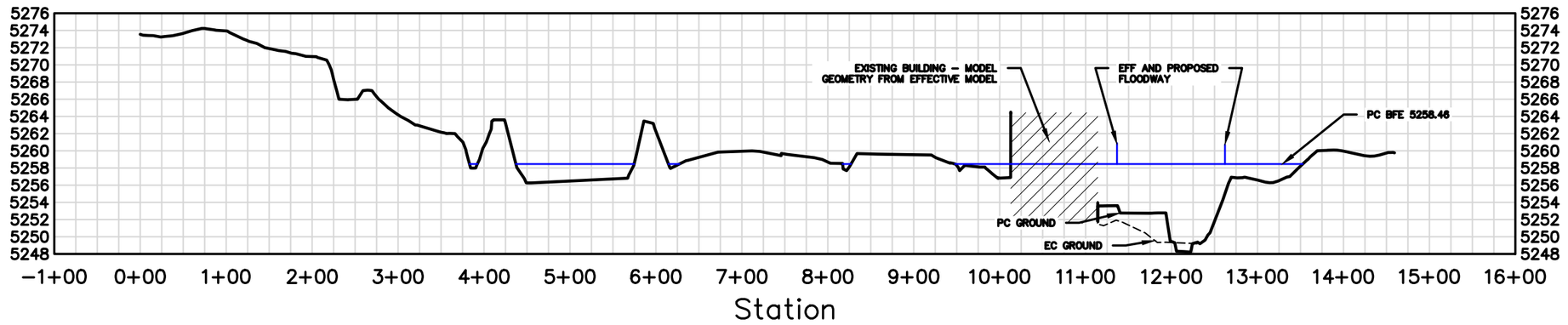
Date: **February 20, 2024**

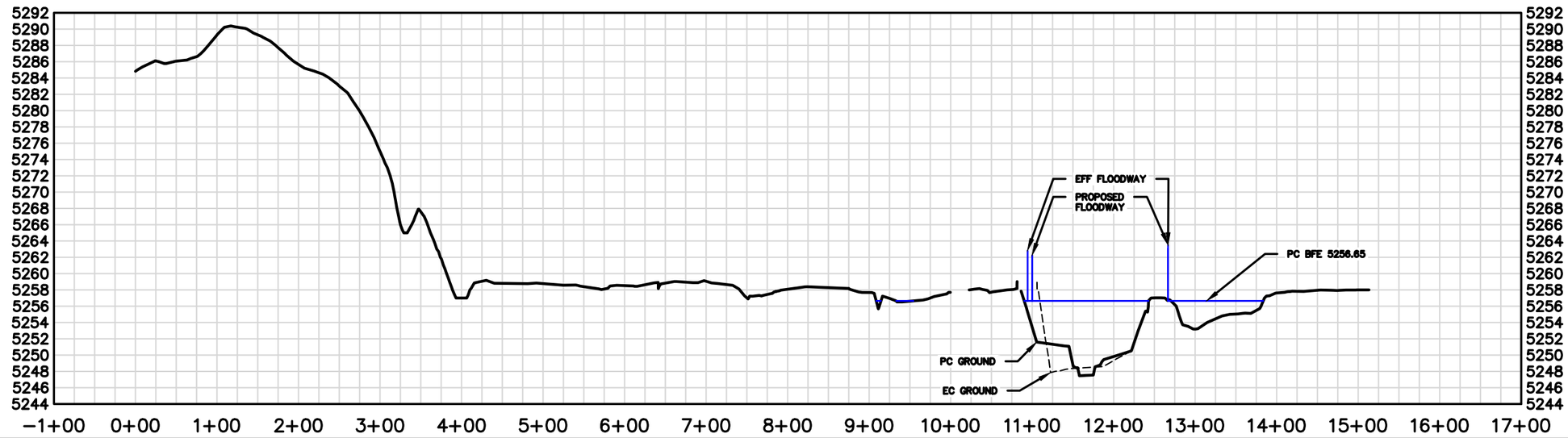
176137.11 Profile



175848.2 Profile



175692.77 Profile



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Prepared For:
Designer: **NLW**
Drafter: **NLW**
Checked:

Werner WATER ENGINEERING

LYONS UTE HIGHWAY STREAMBANK STABILIZATION

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Date: **February 20, 2024**