EXHIBIT 2.f.i: Technical Justification for Vertical Roadway Geometry Failures at Stream C Crossing (4/6/26)

April 6, 2026 Job No. 2090-004-022

Mr. Joshua M. Ranes
City of Poulsbo Engineering Department
200 NE Moe St
Poulsbo, WA 98370

RE: Technical Justification for Vertical Roadway Geometry Failures at Stream C Crossing (Pinnacle at Liberty Bay Preliminary Plat and Planned Residential Development) P-06-20-25-03

Purpose

The purpose of this letter is to provide the city staff a technical evaluation of the geometric constraints for a new roadway crossing of Stream C from Baywatch Court NE. This letter demonstrates why standard vertical roadway geometry (maximum grade and sag K-values) cannot be achieved along with State required stream crossing clearances at this location.

Explanation of Design Factors

The following criteria were used to evaluate the feasibility of a potential stream crossing road profile:

- Crossing Standard: Per the City's finding that Stream C is fish-bearing, the crossing must comply with WAC 220-110-070 and WDFW 2013 Guidelines. This requires a bottomless structure with a minimum 3.0-foot vertical freeboard above the ordinary highwater mark/top of bank to allow for debris and sediment transport.

- Maximum Grade (12%): Per City of Poulsbo Construction Standards, the maximum allowable grade for a road within the City is 12%.

- Minimum Sag Curve (K=6.0): The K-value defines the curvature of the roadway. A design target of K=6.0 was established for this crossing based on three primary safety factors:
    1. Emergency Apparatus Clearance: A K-value of 6.0 is the recognized minimum required to prevent standard fire department pumpers and ladder trucks from hitting the front or rear bumpers on the pavement. This value provides a gradual enough transition to maintain the 8-degree approach/departure angle required for emergency vehicles.
    2. Design Speed (15 mph): Given that a sag curve would be very close to the T-intersection at Baywatch Court NE, a reduced design speed of 15 mph is assumed vs a full design speed of 25 mph. At this speed, a K-value of 6.0 satisfies AASHTO passenger comfort criteria.

3. Illumination: To additionally help with reducing the K-value, it is assumed the sag curve will be fully illuminated. This removes Headlight Sight Distance as the controlling factor, allowing for shorter curve.

The Hydraulic "Floor"

The stream classification and crossing guidance provides a minimum elevation of the crossing road. Accounting for the 3.0-foot freeboard, the slab of the box culvert, the 12-inch road base estimated for HL-93 loading, and 4 inches of asphalt, the finished road surface must be at elevation 119.08' (113.75+3+1+1+.33).

Analysis of Geometric Impossibility

The horizontal distance between the existing T-intersection and the Stream C center point is approximately 95 feet. This short distance minimizes the available space to achieve necessary road geometry. The attached exhibits demonstrate the two main areas of failure.

Scenario 1: Fixed Grade and Curvature (Figure 1). In this scenario, a profile attempting to hold the City's 12.00% maximum grade and a standard K-value of 6.0 is shown.

Result: The road profile is physically unable to reach the required elevation to clear the stream. As shown in Figure 1, the road passes through the required box culvert and therefore not in compliance with WDFW freeboard requirements.

Scenario 2: Fixed Grade and Hydraulic Clearance (Figure 2). In this scenario, the road was forced to reach the required 113.75' elevation while attempting to stay near the 12% grade limit.

Result: To gain the necessary height in such a short distance, the vertical curve is reduced to 25 feet. This results in a K-value of 0.93. This curve is many times sharper than the minimum needed for emergency vehicle clearance. A standard fire pumper would hit its front bumper due to the rate of vertical rise of the road.

Note: The attached exhibits assume several non-standard geometric optimizations to attempt a viable crossing. These include eliminating the 20-foot intersection landing and superelevating the existing Baywatch Court NE to +2% to raise the curve's starting elevation. Despite these adjustments, the geometry remains out of compliance with City standards. A standard design incorporating a 20-foot landing and maintaining existing intersection cross slopes would result in even more geometric failure.

Conclusion and Mitigation

As demonstrated by the attached exhibits, there is no mathematical solution that satisfies the mandatory WDFW 3.0-foot freeboard while also meeting City standards for road grade and emergency vehicle access. It has been determined that a roadway crossing at this location is technically infeasible and will not be proposed as part of the Pinnacle at Liberty Bay development.

Respectfully,

ESM CONSULTING ENGINEERS, LLC

BRANDON LOUCKS, P.E.
Project Manager

Encl. Figure 1, Figure 2

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A PORTION OF THE SE 1/4 OF SEC 23, TWP 26 N, RGE 1 E, W.M.

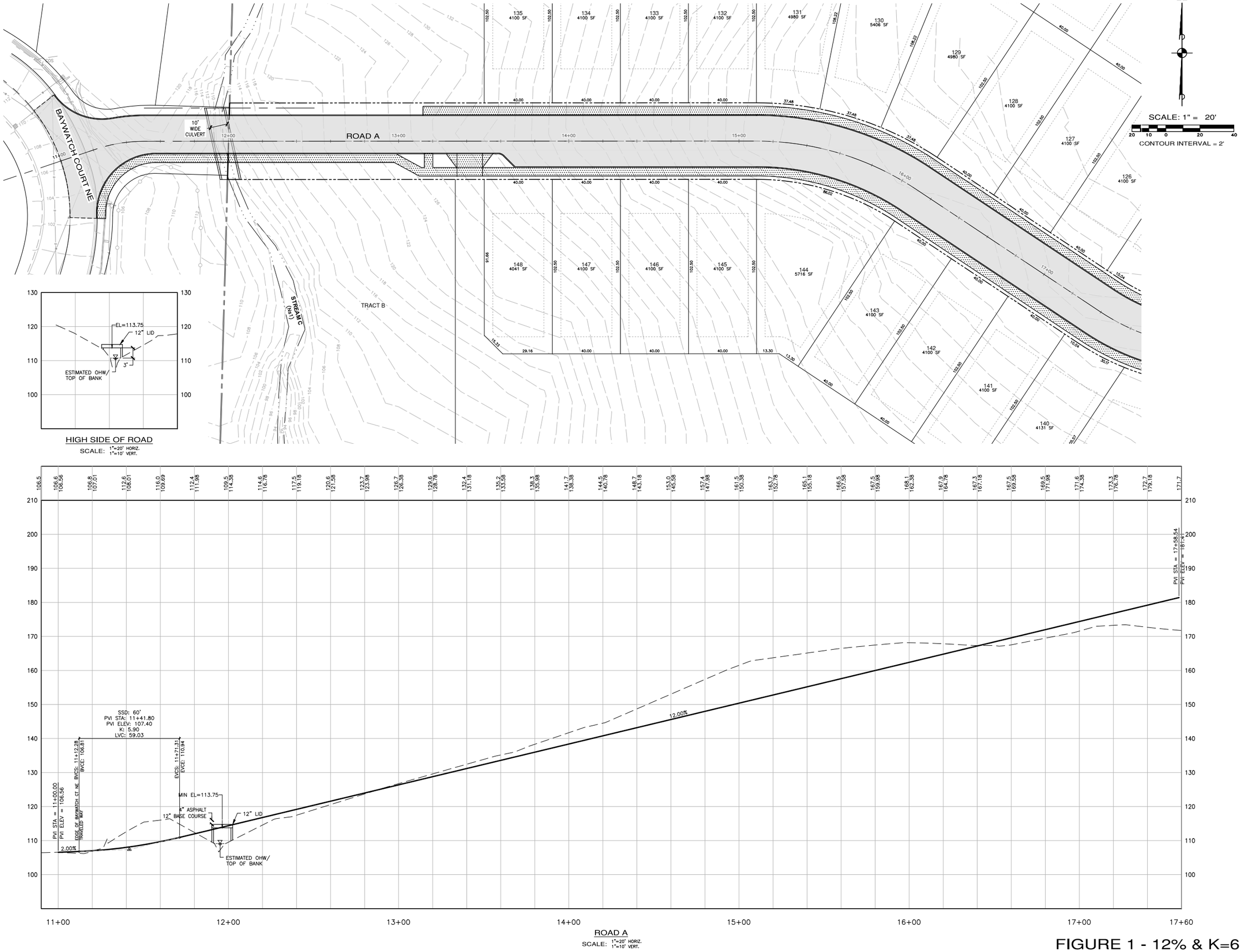

FIGURE 1 - 12% & K=6

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MONTEBANC MANAGEMENT, LLC

PINNACLE AT LIBERTY BAY SUBDIVISION

STREAM C & ROAD A CROSSING

CITY OF POULSBO WASHINGTON

JOB NO.	2090-004-022
DWG. NAME	EN-35
DESIGNED BY:	
DRAWN BY:	DCL
CHECKED BY:	
DATE:	02/25/2026

EN-35

1 OF 1 SHEETS

A PORTION OF THE SE 1/4 OF SEC 23, TWP 26 N, RGE 1 E, W.M.

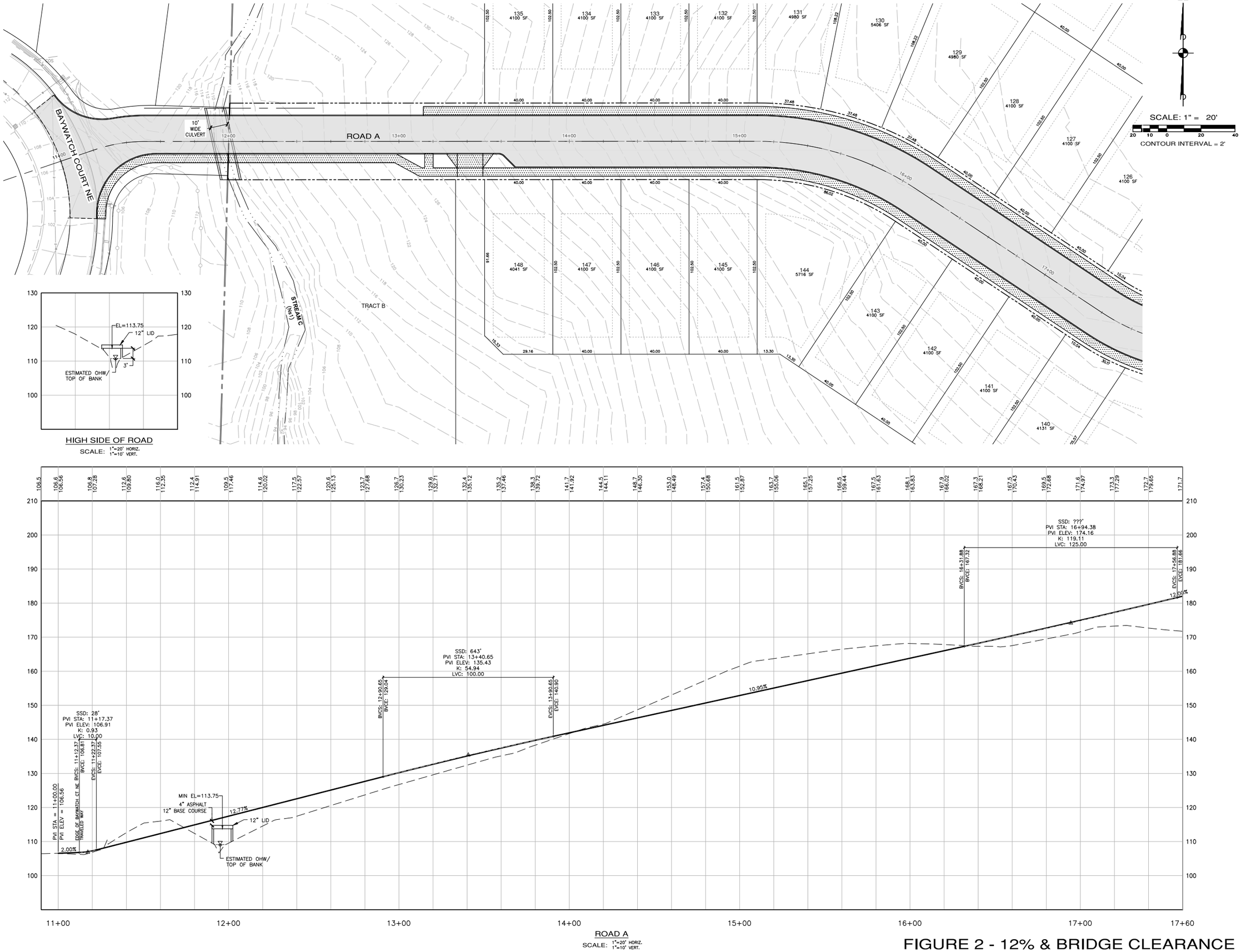

FIGURE 2 - 12% & BRIDGE CLEARANCE

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