TANANA RIVER ARRC CROSSING

Preliminary Guide Bank and Embankment Spur Design Summary

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Preliminary guide bank, secondary bridge abutment protection, and embankment spur design calculations were completed for the Tanana River crossing concept plan; a main bridge with an approximate 3150-ft span, and a secondary 130-ft span bridge. A guide bank was designed for protection of the south abutment of the main proposed bridge span; flows around the north main span abutment will be guided by a proposed levee. Secondary bridge abutments will be protected by standard riprap revetment measures. Due to the Tanana River's braided condition, spurs were designed along the railroad embankment south of the main span bridge to protect against erosion caused by over bank flows or the meander of the main channel against the embankment. Given the remaining bridge and levee design unknowns numerous assumptions were made during protection design, as discussed below.

Guide Bank

- The guide bank was designed per the Federal Highway Administration's *Bridge Scour and Stream Instability Countermeasures, Second Edition* (HEC-23).
- The guide bank was located based on available CAD file alignment of the bridges, and is placed directly upstream of the bridge abutment to create a smooth contraction through the opening.
- Floodplain return flow and flow adjacent to the abutment was estimated from existing condition HEC-RAS modeling completed by HDR.
- Crest elevations were set at 603.5-ft, to allow for a minimum of 2-ft freeboard for the 100-year water surface of 601.46-ft at HEC-RAS river station 10978.6. This river station was selected as the upstream most section directly impacted by the spurs and guide banks. Water surface elevations assume a worst case scenario of debris accumulation full depth on all bridge piers.
- A crest width of 12-ft was selected to allow heavy equipment access to construct and maintain the guide bank.
- Riprap facing was previously sized for protection of the north bank levee and these sizes were used on the guide bank given the similar flow characteristics. That study recommended either AKDOT Class IV riprap or a custom gradation based on the Army Corps of Engineers

gradations; between AKDOT Class III and Class IV. For more information on the riprap sizing, reference the levee technical design memo.

  - Self launching riprap was sized to account for a maximum scour elevation of 528-530-ft or approximately 50 feet below the minimum channel invert elevation at the bridge crossing. Launching stone assumed a 2:1 (horizontal:vertical) launching slope.
  - Launching riprap assumed a 75% increase factor based on the depth of launch and the placement of launching stone in water.
  - Riprap was sized to account for ice and debris flows.
  - A riprap thickness of 4-ft was used for all guide bank protection.
  - Riprap extends to the top of the guide bank crest.
  - A portion of the embankment side slope outside of the guide bank nose protection does not have riprap revetment.
  - Riprap installation will require a filter fabric or granular filter layer between the riprap and the soil structure.

- The guide bank will be keyed back into the railroad/access embankment, but will depend on the ultimate design geometry and characteristics of the embankment fill.
- The guide bank will not extend downstream of the abutment.

Secondary Bridge Abutment Protection

- Secondary bridge abutment protection was designed per the National Cooperative Highway Research Program (NCHRP) Report 568 *Riprap Design Criteria, Recommended Specifications, and Quality Control.*
- Abutment protection measures were designed utilizing hydraulic information from the HEC-RAS model created by HDR.
- Abutment protection measures were established based on CAD and GIS files provided by internal HDR sources.
- Topographic information provided by internal HDR sources was used to obtain all existing elevations.
- Abutment riprap was also sized per the NCHRP methodology, and was found to be less conservative than the previously discussed levee revetment study. Due to the design unknowns the levee riprap sizing was used in abutment protection design.

- Abutment riprap slopes were assumed to be 2.5:1 to account for ice and debris.
- Abutment slope riprap will be installed 4-ft thick per the levee revetment recommendations.
- Riprap is assumed to extend from 603.5-ft to a minimum invert beneath the bridge of 588-ft.
- Riprap will extend two times the overall Tanana maximum channel flow depth of 16-ft around each abutment.
- A scour apron 4-ft thick and extending 32-ft from the abutment toe into the channel is included to protect against scour around the abutment toe. This apron should be designed to launch stone to the contraction scour depth and its configuration and volume will need to be verified for final design.

- Abutment protection riprap quantities assume a 24-feet wide bridge deck and rail bed at the top of the embankment.

Spurs

- Spurs were designed per the Federal Highway Administration's HEC-23.
- Spurs were assumed to be 450-ft long from the railroad embankment to tip of the spur nose. This length was used to optimize the spacing and impacts of the spurs, given the limited constraints on spur length. These constraints are typically based on reduction of channel flow area and impacts to the bank opposing the spur installation. Given the wide floodplain and limited flow area blockage resulting from spur construction, 450-ft spurs were assumed to have minimal overall impacts to the Tanana system.
- Spur spacing was checked for a 17-degree expansion of flow off the spur nose, which resulted in a maximum allowable spacing of 1470 feet. The maximum spacing for the spurs was not used, however, due to the potential for channel braids to meander into the rail embankment between spurs 1470 feet apart. This potential braid meander was based on the maximum bend radius over channel width ration of 2 identified in the Army Corps of Engineers Engineering Manual 1601. Spur spacing for this location varies from 619 feet to 1,414 feet.
- Spurs were located based on available CAD topographic information and alignment of the bridges.
- Geometry and flows used in spur design were based on the worst case of the main channel migrating toward the embankment.

- The first spur was located immediately south of the guide bank, so that expanding flow off the spur nose would align with the tip of the guide bank. Spurs were then added to the south, based on topography and bridge locations. .

- Crest elevations were set at 603.5-ft at the spur nose to allow for 2 feet of freeboard for the 100-year water surface of 601.46-ft at HEC-RAS river station 10978.6.

- An approximate 0.5% crest slope was assumed from the spur nose up to the spur heel at the railroad embankment.

- A crest width of 12-ft was selected to allow heavy equipment access to construct and maintain the spurs.

- Spurs design assumes the spurs are relatively impermeable or generally act similar to impermeable spurs.

- Riprap facing on the spur nose was sized according to the previously discussed levee revetment study. Riprap protection on the upstream and downstream side of the spur shaft was provided and sized per the Revetment discussion in HEC-23, as well as the U.S. Army Corps of Engineers EM-1601.

    - Spur nose riprap is installed on a 2.5:1 slope and is 4-ft thick of AKDOT Class IV riprap or an Army Corps of Engineers gradation between AKDOT Class III and Class IV.

    - Spur nose riprap includes a self launching apron to account for scour down to an elevation of 528-530 feet, which is approximately 50 feet of scour below the minimum cross sectional channel invert elevation.

    - Spur nose launching riprap assumed a 50% increase in volume for length of launch and dry placement below elevation 592 feet.

    - Spur nose riprap and launching stone wraps around the spur nose for 32 feet on either side of the spur (twice the flow depth) similar to recommendations for abutment protection from NCHRP.

    - Preliminary spur shaft riprap is an AKDOT Class II stone 3-ft thick to account for ice and debris.

    - Shaft riprap extends 5-ft beneath the existing surface at a 2.5:1 slope to protect against toe scour.

    - All riprap extends all the way to the top of the crest.

  - A granular filter bed or filter fabric will be included with the riprap installation.

- Spurs will be keyed back into the railroad/access embankment, but will depend on the ultimate design geometry and characteristics of the embankment fill.

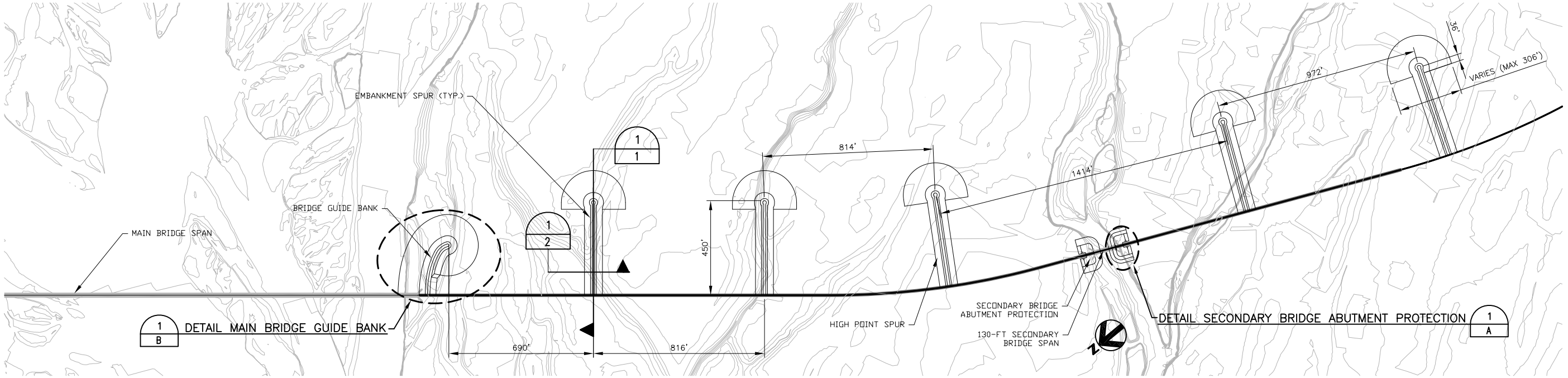
Riprap Quantity Summary

Guide Bank – 32,900 cu yds

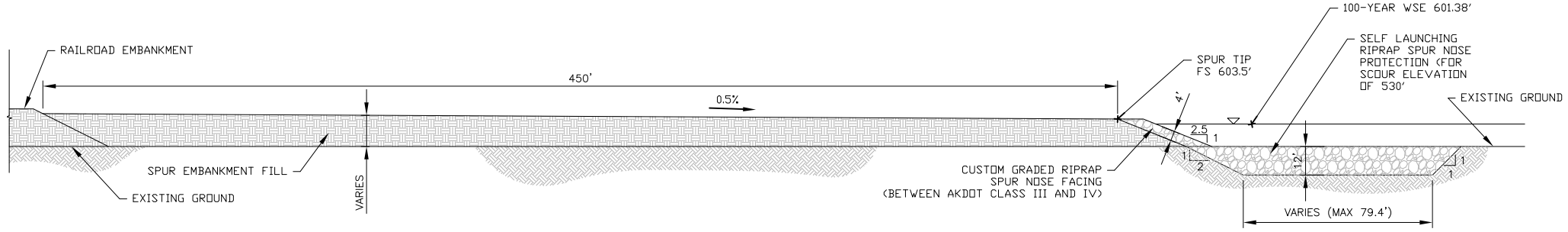
Spurs – 84,500 cu yds

Secondary bridge abutment riprap – 4,700 cu yds

As an alternative to spurs, railroad embankment revetment was considered – 141,000 cu yds



PLAN
SCALE 1"=250'



1/1 SECTION EMBANKMENT SPUR
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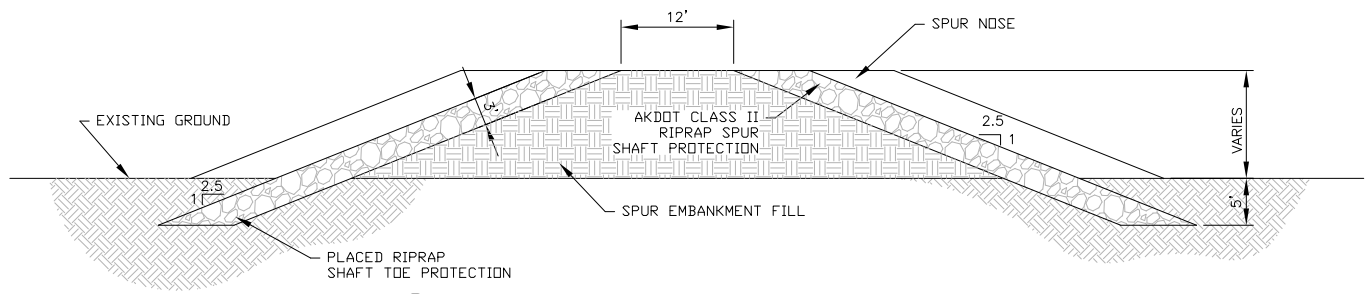
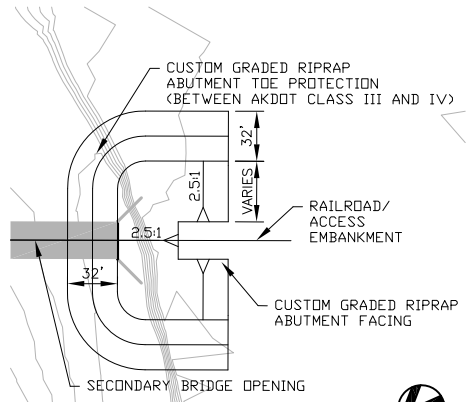


1/2 SECTION EMBANKMENT SPUR
SCALE 1"=10'



1/A DETAIL SECONDARY BRIDGE ABUTMENT PROTECTION
SCALE 1"=60'

1/B DETAIL MAIN BRIDGE GUIDE BANK
SCALE 1"=60'

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	11-20-2009	INITIAL DESIGN OVERVIEW

PROJECT MANAGER	R. BEEBEE
CHECKED	B. DOEING
DRAWN	B. SWIFT
PROJECT NUMBER	26701

Alaska Railroad Corporation
Northern Rail Extension

DRAFT
NOT FOR CONSTRUCTION

TANANA RIVER CONCEPTUAL SPUR AND GUIDE BANK DESIGN

0 1" 2"

FILENAME
SCALE

SHEET 1