# Twenty Mile Bridge No. 634

Project No.: Z581050000

# DESIGN STUDY REPORT DRAFT

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

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STATE OF ALASKA

DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
DESIGN AND ENGINEERING SERVICES – CENTRAL REGION

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For

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## NOTICE TO READERS

This report is a product of CE A438, Design of Civil Engineering Systems, a senior-level course at the University of Alaska Anchorage (UAA), and was prepared by students. It is not intended to be used in actual design or construction and is an academic exercise.

## NOTICE TO USERS

This report reflects the thinking and design decisions at the time of publication. Changes frequently occur during the evolution of the design process, so persons who may rely on information contained in this document should check with the Alaska Department of Transportation and Public Facilities for the most current design.

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## LIST OF ACRONYMS

| | |
|---|---|
| AADT | Annual Average Daily Traffic |
| AASHTO | American Association of State Highway and Transportation Officials |
| ACGP | Alaska Construction General Permit |
| ADEC | Alaska Department of Environmental Conservation |
| APDES | Alaska Pollutant Discharge Elimination System |
| ARRC | Alaska Railroad Corporation |
| ATM | Alaska Traffic Manual |
| BMP | Best Management Practice |
| CFR | Code of Federal Regulations |
| DOT&PF | Alaska Department of Transportation and Public Facilities |
| ESCP | Erosion and Sediment Control Plan |
| EPA | Environmental Protection Agency |
| FHWA | Federal Highway Administration |
| HPCM | Alaska Highway Preconstruction Manual |
| HMCP | Hazardous Material Control Plan |
| HSIP | Highway Safety Improvement Program |
| LOS | Level of Service |
| MADT | Monthly Average Daily Traffic |
| MOA | Municipality of Anchorage |
| MP | Milepost |
| MPH | Miles Per Hour |
| MUTCD | Manual on Uniform Traffic Control Devices |
| NPDES | National Pollutant Discharge Elimination System |
| PGDHS | A Policy on Geometric Design of Highways and Streets |
| PIP | Public Information Plan |
| ROW | Right-of-Way |
| SWMM | Storm Water Management Model |
| SWPPP | Storm Water Pollution Prevention Plan |
| TCP | Traffic Control Plan |
| TMP | Traffic Management Plan |
| UAA | University of Alaska Anchorage |
| USGS | United States Geological Survey |

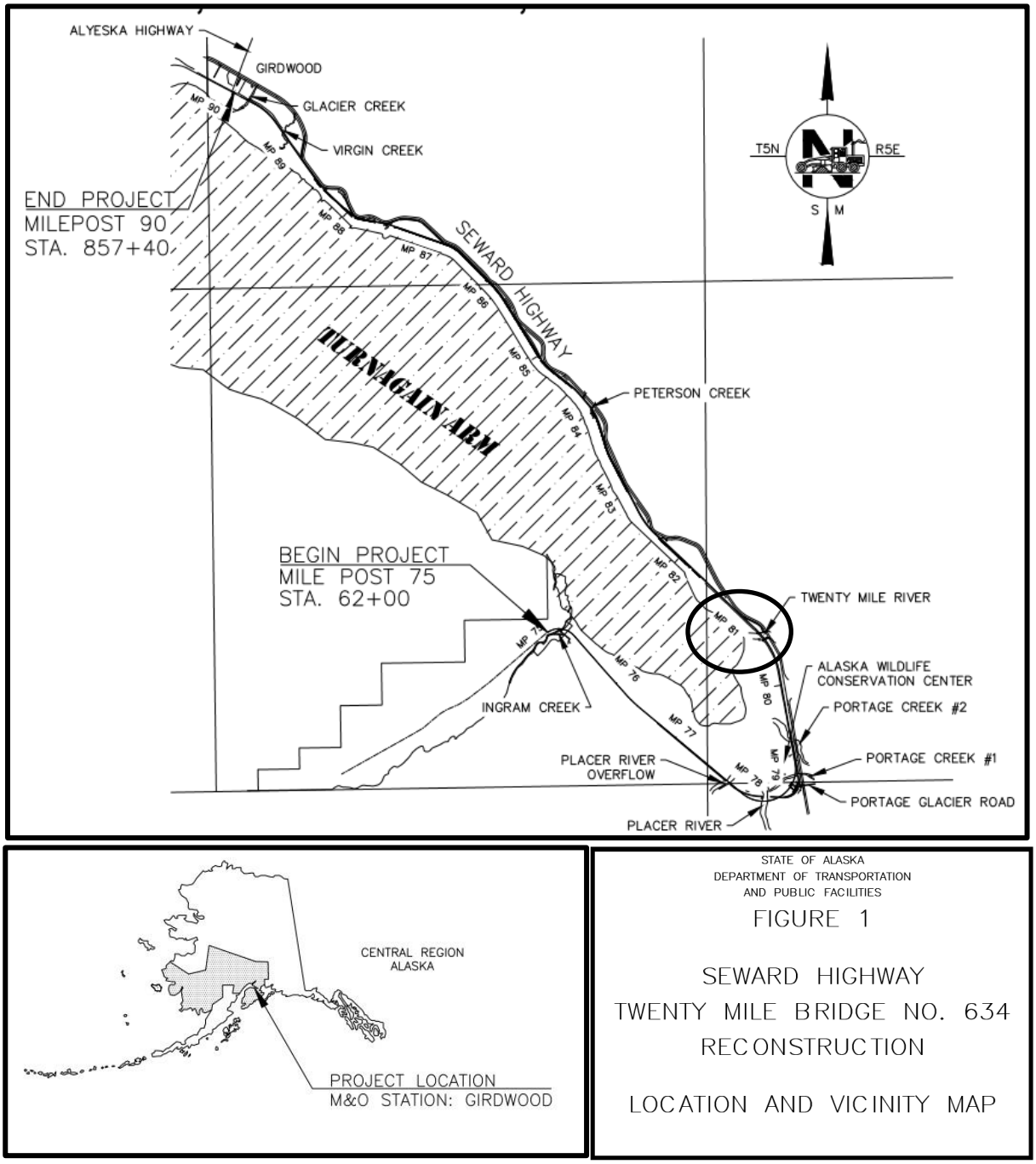


**Figure 1 Location and Vicinity Map**

# 1.0 PROJECT DESCRIPTION

## 1.1 Project Location and Description

The Alaska Department of Transportation and Public Facilities (DOT&PF) in cooperation with the Federal Highway Administration (FHWA) proposes to replace Twenty Mile Bridge No. 634 and realign the Seward Highway from approximately Milepost 80 to 81. The project is located in Section 21 of Township 5 North, Range 5 East, Seward Meridian, USGS Topographical Map Seward D-6 SE; Latitude 60.5069˚N, Longitude 148.59295˚W, within the Municipality of Anchorage (MOA) near the community of Portage, Alaska. See Figure 1 for Location & Vicinity Map.

The proposed project includes realigning the roadway to the new bridge location, approximately 30 feet east of the existing bridge; expanding the bridge width to include a 10-foot shared use path; adding accommodations for a future shared use undercrossing below the bridge on the north side of Twenty Mile River; and expanding the parking lot on the northwest side of the bridge. Work also includes resurfacing the existing roadway, striping, replacing signage, and drainage.

## 1.2 Existing Facilities and Land Use

The current bridge was built in 1967 and replaced a bridge that was destroyed in the 1964 Good Friday Earthquake. It is a 568-ft., seven-span steel girder bridge with a concrete deck, 12-foot lanes, and 2-foot shoulders. The substructure is made of concrete pier walls with pile foundations driven to a depth of 24-26 feet. The bridge underwent a Phase 1 seismic retrofit in 1999; however, it does not meet standards for a design seismic event. The existing roadway alignment contains horizontal curves on approaches to the bridge from the north and south (a "broken-back" curve). The ADT is currently 5,760 through this portion of the Seward Highway, which increases during the summer months.

The project location lies near the end of the Turnagain Arm of Cook Inlet. The arm itself lies within a narrow, glacially-carved valley, bordered by steep mountains which rise from sea level to nearly 4000 feet. The local tides are dynamic, and have a major influence on alluvial processes such as those in the Twenty Mile River. The land itself is composed primarily by glacial and alluvial deposits, as well as by marine sediments carried by tides and by wave action. The region is seismically active, and most of the existing bridges in the area are replacements for those destroyed in 1964.

The Twenty Mile River is also a popular summer recreational area. Residents and visitors dipnet for hooligan near the bridge, and many use the adjacent boat launch to travel upstream for salmon fishing. Sightseers also frequent this location. In 1989 the Seward Highway was designated a National Forest Scenic Byway. In 1993 it was designated a State Scenic Byway. Finally, in 2000, the Seward Highway was declared and All-American Road, and was added to the National Scenic Byway program.

## 1.3 Purpose and Need

The primary purpose of this project is to replace the Twenty Mile River Bridge and improve safety.

Twenty Mile Bridge No. 634 is classified as structurally deficient (SD). Its most recent inspection was conducted in June 2015. The bridge deck is in poor condition (condition factor of 4) and the load rating is less than the original design load of HS20-44. Pier walls are cracked and vertical rebar is exposed.

Competing uses of the corridor cause safety concerns resulting in major injury and fatality crashes. Competition is highest in the summertime, when traffic volume is at its peak and the area is used by hooligan fishermen and women. Parking is limited in the area, and safety improvements are needed.

## 2.0 DESIGN STANDARDS AND GUIDELINES

Design standards and guidelines that apply to the Twenty Mile Bridge No. 634 are contained in the following publications:

Standards:

- A Policy on Geometric Design of Highways and Streets (PGDHS or "Green Book"), American Association of State Highway and Transportation Officials (AASHTO), 2004.
- Alaska Bridges and Structures Manual (Draft) (ABSM), State of Alaska, Department of Transportation and Public Facilities, 2016.
- Alaska Geotechnical Procedures Manual, State of Alaska, Department of Transportation and Public Facilities, 2007.
- Alaska Highway Preconstruction Manual (HPCM), State of Alaska, Department of Transportation and Public Facilities, 2005 (including all revisions thru November 15, 2013).
- Design & Construction of Driven Pile Foundations, Federal Highway Administration, U.S. Department of Transportation, 2006.
- Standard Specifications for Highway Construction, State of Alaska, Department of Transportation and Public Facilities, 2015.

Guidelines:

- Guide for the Development of Bicycle Facilities, 4th Edition, AASHTO, 2012.

Appendix A contains the project Design Criteria and Design Designation.

## 3.0 DISCUSSION OF ALTERNATIVES

Several alternatives were considered for Twenty Mile Bridge, and they are described below.

### 3.1 First Alternative

The first alternative is the No-Build alternative. Due to the SD classification, this alternative was rejected.

### 3.2 Second Alternative

The second alternative is to remove the existing bridge and construct the new bridge in the same location. This would require both a temporary two-lane detour bridge, and a temporary realignment of the highway. It would also require that demolition and removal of the existing bridge be completed prior to construction of the new bridge. Due to the impact of these factors on costs and construction time, this alternative was rejected.

### 3.3 Third Alternative

The third alternative is to design and build the proposed bridge to the west of the existing bridge. The river is wider here, thus a longer bridge would be needed. This would result in higher costs. The larger

footprint created by a longer bridge would also result in more significant environmental impacts. Based on these considerations, this alternative was rejected.

### 3.4 Fourth Alternative

The fourth alternative consists of a five-span bridge built to the east of the existing bridge. The superstructure includes nine 115-foot girders per span, bringing the bridge length to 575 feet. For the substructure, there are nine 24-inch-diameter piles per abutment, and four 48-inch-diameter piles at each of the four piers. This alternative was determined to be the most expensive of the bridge configuration options and was therefore rejected.

### 3.5 Fifth Alternative

The fifth alternative consists of a six-span bridge built to the east of the existing bridge. The superstructure includes eight 96-foot girders per span, bringing the bridge length to 576 feet. For the substructure, there are eight 24-inch-diameter piles per abutment, and four 48-inch-diameter piles at each of the five piers. This alternative was not the most cost effective bridge configuration considered and was therefore rejected.

### 3.6 Sixth Alternative

The sixth alternative consists of a straight bridge built to the east of the existing bridge, with an alignment comprised of two horizontal curves to the north and one horizontal curve to the south. Each of the three curves has a radius of 3000 feet and a superelevation of 4.4 percent. The two curves on the north side, opposite in curvature direction, are each separated by a short tangent of 163 feet. This design would result in a broken-back curve similar to the existing highway alignment. This alternative was rejected based on the opportunity to replace the broken-back curve with a single horizontal curve.

## 4.0 PREFERRED ALTERNATIVE

The preferred alternative places the proposed bridge to the east of the current location, between the existing bridge and the Alaska Railroad. The highway alignment consists of a single 4900-foot horizontal curve, 3,849 feet in length beginning 1,578’ north of the bridge and extending 1,695’ south of the bridge. A vertical crest curve is located north of the bridge, which provides a 0.5 percent grade for deck drainage. The bridge is fully superelevated at 3.2 percent, with superelevation transition zones located both to the north and to the south of the approach slabs. See Appendix B for plans.

This alternative employs a four-span bridge. The superstructure includes nine 144-foot girders per span, bringing the bridge length to 576 feet. For the substructure, there are nine 24-inch-diameter piles per abutment, and four 48-inch-diameter piles at each of the three piers. This design minimizes the number of piers in the water and was found to be the most cost effective of the various bridge configurations considered on this alignment.

Connections to the old alignment will be provided to the north and the south of the bridge. Access will be maintained to the parking lot south of the bridge and to the parking lot just north of the bridge, which also serves as a boat launch.

This preferred alternative meets the purpose and need of the project.

The existing bridge will be removed as part of this project.

## 5.0 TYPICAL SECTIONS

The typical road section for the preferred alternative will consist of two paved 12-foot travel lanes and two paved 8-foot shoulders. The fill sections consist of 4:1 foreslopes for 22 feet from edge of pavement and 2:1 foreslopes beyond that distance. The cut sections feature 4:1 foreslopes for 22 feet from edge of pavement, a six-foot flat bottom ditch, and 2:1 back slopes.

The typical roadway section on the bridge will consist of two 12-foot travel lanes, two 8-foot shoulders, and one 10-foot shared use pathway on the eastern side of the bridge. One Alaska Multistate 2-Tube Bridge Rail will serve as the barrier on the western edge of the bridge, and an Oregon 3-Tube Pedestrian Rail will separate the travel lanes from the shared use walkway. A pedestrian railing will serve as the barrier on the eastern edge of the bridge.

The typical sections are provided in Appendix B.

## 6.0 HORIZONTAL AND VERTICAL ALIGNMENT

### 6.1 Horizontal Alignment

The preferred alignment contains one horizontal curve with a 4900-foot radius that meets the minimum 65 mph design speed. The new bridge will be located approximately 30 feet east of the existing bridge, and the horizontal curve will extend throughout the length of the new bridge at the same 4900-foot radius.

### 6.2 Vertical Alignment

The alignment closely follows the inlet coastline and has only slight variation in elevation. The proposed alignment will provide a 0.5 percent longitudinal grade across the bridge. Vertical curves meeting minimum design criteria will be provided.

## 7.0 EROSION AND SEDIMENT CONTROL

Appropriate erosion and sediment control measures will be utilized and are not yet designed at this stage.

## 8.0 DRAINAGE

Drainage accommodations will be adequately sized and designed.

## 9.0 SOIL CONDITIONS

Soil conditions in the project area were determined primarily by a 2015 subsurface exploration performed by Shannon and Wilson, Inc, which is documented in detail in the Foundation Geology Report for 20 Mile River Bridge No. 634 (document available upon request). This exploration included the advancement of seven geotechnical test holes in the vicinity of the bridge. Selected samples were sent to the laboratory for analysis, with the primary goal of determining gradation, moisture content, and the plasticity of the silts and clays.

The native soils were found to consist mainly of silty sand, sandy silt, and silt. At two of the seven test holes, layers of clay and clayey silt were also encountered. A thick layer of fill material was found near the river banks, which was significantly different than the native soil. This fill consisted of sand with silt and gravel, and gravel with sand. Both fill and native material varied widely in density, from loose to very dense by layer. The silts and clays encountered are expected to behave more like granular material rather than cohesive material. The average moisture content was approximately 27 percent. Bedrock was encountered at an average depth of 130 feet.

In addition to the laboratory tests, soil strength parameters were determined. These parameters were used to calculate the bearing capacities for the proposed bridge foundations. In many of the layers, the data indicated the potential for liquefaction during a seismic event. Liquefaction is a known hazard in this location, and contributed to the failure of the original Twenty Mile Bridge during the 9.2-magnitude 1964 Good Friday Earthquake.

## 10.0 ACCESS CONTROL FEATURES

Access control will continue to be maintained through Right-of-Way permitting functions by the Department.

## 11.0 TRAFFIC ANALYSIS

Traffic analysis will be performed as necessary as the design progresses beyond the 35 percent design stage.

## 12.0 SAFETY IMPROVEMENTS

The new alignment replaces the existing "broken-back" curve with a single curve using a larger radius of curvature, reducing the number of horizontal curves from two to one.

The addition of accommodations for a future shared use pathway beneath the northern edge of the bridge will allow bicyclists and pedestrians to cross under the roadway without directly crossing traffic; this will be of particular significance during periods of high recreational use. The proposed pathway accommodations along the eastern edge of the new bridge will allow for bicyclists and pedestrians to cross the bridge while separated from vehicles by a 3-tube pedestrian rail.

The roadway will continue to have a 30-foot clear zone, and existing utility poles will remain outside this zone.

## 13.0 RIGHT-OF-WAY REQUIREMENTS

The preferred alignment stays within the existing Right-of-Way (ROW). No additional ROW acquisition or temporary easements will be required.

## 14.0 PEDESTRIAN AND BICYCLE FACILITIES

As a part of this project, the bridge was designed to accommodate a future shared use pathway that will cross under the Seward Highway by passing beneath the bridge on the north side of the river. The purpose of this path is to minimize foot traffic across the roadway, thus improving safety for both

motorists and recreational users. The project will also include a pathway accommodation on the bridge, in accordance with an agreement with the U.S. Forest Service (USFS). The USFS has plans to develop a shared use pathway, which will utilize this accommodation.

## 15.0 UTILITY RELOCATION AND COORDINATION

Utility companies with facilities in the project limits include:

- Chugach Electric Association (CEA)
- General Communications, Inc. (GCI)

The status of each of these utilities as they relate to the preferred alignment are summarized in the following sections.

The proposed bridge will be designed to accommodate current or future utilities, as needed.

### 15.1 CEA

CEA operates aboveground power transmission lines that roughly parallel the Seward Highway through the project region. There are no known conflicts for the preferred alternative, thus no relocation of this utility will be required.

### 15.2 GCI

GCI owns and operates an underground fiber optic cable that crosses the Twenty Mile River on the underside of the existing bridge deck. This utility will need to be relocated to match the new alignment and to cross the river on the new bridge.

## 16.0 PRELIMINARY WORK ZONE TRAFFIC CONTROL

The Alaska Highway Preconstruction Manual (HPCM), Section 1400.2 establishes the criteria for determining if a project is "significant" for purposes of determining the level of effort required in developing a Traffic Management Plan (TMP). As the determination of whether this project can be classified as "significant" is outside the scope of the Senior Design Class, no designation was made.

## 17.0 STRUCTURAL SECTION AND PAVEMENT DESIGN

Based on the available geotechnical information and on similar projects in this area, the preliminary recommended section is:

<u>Pavement Structural Section</u>
2 inches Hot Mix Asphalt Concrete, Type II; Class A
4 inches Asphalt Treated Base Course
2 inches Aggregate Base Course, Grading D-1
36 inches Selected Material, Type A

The preliminary recommended section is provided in Appendix B. Material sources for this project will be contractor-supplied.

## 18.0 COST ESTIMATE

The engineer's estimate is as follows:

- Bridge: $9,100,000
- Roadway: $1,900,000
- Non-Material: $7,400,000

Total: $18,400,000

A detailed cost estimate is provided in Appendix D.

## 19.0 ENVIRONMENTAL COMMITMENTS AND CONSIDERATIONS

Environmental commitments and considerations will be developed as the project progresses beyond the 35 percent development stage. See Appendix F.

## 20.0 BRIDGES

The proposed Twenty Mile River bridge is four spans of 144 feet per span, for a total bridge length of 576 feet. The width will be 54 feet, with two 12-foot travel lanes, two 8-foot shoulders, and a 10-foot wide shared use pathway. The bridge will contain a horizontal curve with a radius of 4900 feet and will be superelevated at 3.2 percent. The longitudinal grade will be a 0.5 percent upgrade traveling north, which will provide adequate drainage for the bridge deck.

The bridge superstructure includes nine decked bulb-tee girders per span, each 66 inches deep. The substructure consists of two abutments and three piers. There are nine 24-inch-diameter piles per abutment, and four 48-inch-diameter piles at each of the three piers.

The low chord of the bridge will be 33 feet on the southern end, and 35 feet on the northern end, due to the longitudinal grade. This allows adequate vertical clearance for the shared use pathway underneath the north end of the bridge.

The wearing surfacing will consist of a four-inch asphalt overlay above an impermeable waterproofing membrane.

The AKDOT&PF designs highway bridges in accordance with state and federal standards. Specifically, new bridges are designed in accordance with the most current edition of the AASHTO LRFD Bridge Design Specifications and the AASHTO Guide Specifications for LRFD Seismic Bridge Design. These documents are the national standards, and help the AKDOT&PF to provide safe, durable and economical highway bridges. They address both the demands (Loads) acting on bridges and the capacities (Resistance) of supporting members. The current design highway loading is designated HL-93 and encompasses a wide range of commercial truck configurations used throughout the country. The national AASHTO standards are supplemented by the AKDOT&PF Bridge Design Manual that addresses design issues specific to Alaska. These include region construction practices, cold climate considerations, and project development. The 35% design of Twenty Mile Bridge was achieved using the April 2016 edition of the Bridge Design Manual.

## 21.0 EXCEPTIONS TO DESIGN STANDARDS

There are no exceptions to design standards for this project.

## 22.0 MAINTENANCE CONSIDERATIONS

Bridge and roadway maintenance are expected to initially decrease after improvements are complete, and will remain the responsibility of the State of Alaska and the local DOT&PF Maintenance and Operations Station located in Girdwood, Alaska. Parking lot maintenance and pathway maintenance are the responsibility of the U.S. Forest Service.

## 23.0 ITS FEATURES

No intelligent Transportation System features are included in the project.