Nomad Engineering

Cooper Creek Bridge

Design Study Report

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EXECUTIVE SUMMARY

The Cooper Landing Walkable Community Project organization is working to provide safe and accessible routes for individuals within Cooper Landing. The existing path system within Cooper Landing stops just west of Alaska Wildland Adventures, which is located just west of Sterling Highway Milepost 50. This results in travelers using the space between the existing guardrail and shoulder of the road slope to travel further west. Upon reaching the Cooper Creek Bridge, which currently does not meet modern highway geometric standards and therefore provides no shoulders or non-motorized paths, travelers have to compete with vehicular traffic to cross Cooper Creek.

Nomad Engineering, who represents a design firm composed of University of Alaska Anchorage (UAA) civil engineering students, was selected to design a connection across Cooper Creek for non-motorized travelers. This pathway would expand upon the existing trail system within Cooper Landing providing access between Alaska Wildland Adventures and Kenai Sacketts Grill or the Cooper Creek North and South campgrounds.

Nomad Engineering explored three alternatives and presented these to the client so that a preferred alternative design could be selected and further refined. Alternative One proposed constructing a path located north of the existing Sterling Highway alignment, and south of the Kenai River. Alternative Two would follow the existing Sterling Highway alignment but be located just south of the roadway. Alternative Three proposed constructing a path that wrapped up the steep hillside just south of the Sterling Highway. Details of these alternatives are described in the submitted Alternatives Analysis Report.

Alternative One was selected as the preferred alternative due to it’s direct route, safe passage, and scenic view of the Kenai River. This pathway consists of four distinct components: upgrades or maintenance of the existing pathway, an elevated light penetrating structure (boardwalk), a prefabricated bridge, and a raised trail development. Details of these components, and how they would function together to create a seamless path for active travelers are provided in the body of this report. In addition, a 35% design plan set was also submitted to the client for review.

INTRODUCTION

The existing geometry of Alaska's Sterling Highway, within the Cooper Landing area, does not meet modern highway geometric and safety standards. Lanes for vehicles are too narrow and adequate shoulders are not provided to buffer vehicles and active travelers from competing traffic. The Cooper Creek Bridge, which is approximately located at Sterling Highway Milepost 50.9, is a particularly unsafe location for active travelers along this corridor. Non-existent shoulders and narrow lanes mean that people have to virtually run across the bridge in order to cross Cooper Creek, hoping to make it to the other side before a vehicle approaches at a dangerously close proximity.

Figure 1. *The project is located within Cooper Landing, Alaska. The project analysis and design area extends along the Sterling Highway, between Alaska Wildland Adventures and Sackett's Kenai Grill.*

The goal of the Cooper Creek Bridge Project is to connect the existing pedestrian pathway near Alaska Wildland Adventures on the north side of the Sterling Highway to the Cooper Creek

Forest Service campgrounds, and to Sackett's Kenai Grill. Nomad Engineering, which is a design team composed of four UAA civil engineering students, was selected to complete this design. Three alternatives were analyzed as possible connections between these locations that would additionally provide safe travel across Cooper Creek. The client selected their preferred alternative design which was further refined to a 35% level of completion. Details of significant design components are described in this report.

EXISTING CONDITIONS

Currently, conditions in this area of the Sterling Highway are unfit for active transportation across Cooper Creek. The only path provided between land on either side of Cooper Creek is the Cooper Creek Bridge. This bridge was constructed over 50 years ago and considerations for adequate shoulder width and pedestrian passage were not included. Therefore, pedestrians have no choice but to use this bridge to cross the creek through active traffic lanes. Limited adjacent land in the area does not permit the roadway to be rehabilitated to meet current Alaska Department of Transportation (DOT) specifications. However, providing a safe east-west connection across Cooper Creek for pedestrian traffic is necessary to increase the level of safety for visitors and residents within the Cooper Landing area.

Cooper Creek is a small body of water, but the span distance to achieve connections between both banks of the creek is roughly 70 feet. The existing Sterling Highway is a narrow traffic path, nestled between the Kenai River and a steeply inclined slope on the southern, inland side of the highway. This slope consists of silty, non-cohesive soils which are prone to erosion and at higher risk for slope failure. There are other pedestrian trails in the area, but they stop before reaching this stretch of highway, near milepost 50. Without a continuation of safe trail, those traveling by foot face dangerous decisions to cross into a line of traffic in an area with sharp turns and limited sight distance.

Figure 2. *Example of limited access for active travelers on north edge of Sterling Highway.*

EXPLORED ALTERNATIVES

Three alternatives were considered and presented to the client. These alternatives was designed to provide a safe non-motorized connection while addressing the following concerns:

- The path designed to connect pedestrians across Cooper Creek must do so without impacting the two adjacent anadromous waterways, Cooper Creek and the Kenai River. This means that alternative designs cannot impact the water by running through it, placing posts in the water, or obstructing wildlife flow and growth for any reason.
- The designed pathway should expand upon the existing trail system within Cooper Landing. Once complete, the Cooper Creek Bridge Project should also provide feasible expansion options for future trail additions throughout Cooper Landing. This aligns with the goals of the Cooper Landing Walkable Community Project.
- The trail structure must be able to safely hold the weight of a maximum load of pedestrians at any one time. Methods of snow removal access, ice formation and snow/wind loads that might occur on the structure must also be considered.

Details of the three alternatives, as presented to the client, are outlined below. These details come directly from the previously submitted Alternatives Analysis Report.

Alternative 1

Overview

Alternative 1 proposes constructing a walkway along the north side of the Sterling Highway. This provides a direct connection between the existing trail east of Alaska Wildland Adventures (AWA) and the Cooper Creek North Campground. This walkway will follow the existing alignment of the highway and will function as a separate structure that serves as a path for non-motorized travelers. The walkway will overlook the Kenai River and be constructed as a boardwalk-style pathway which will make use of pillars due to the lack of soil on this side of the highway. A hard packed bare earth pathway will be provided east and west of this boardwalk so travelers can access AWA and a proposed crosswalk west of the existing Cooper Creek Bridge. This crosswalk would provide safe passage between Sackett's Kenai Grill and the Cooper Creek North Campground.

Design Criteria Overview

- 5 foot wide clear tread width on trail
- 6 foot clear tread width on structures

- 7-8 wide boardwalk structure
- Steel and wood
- Piles/boardwalk style
- 2% max cross slope
- Approximate path length: 1,850 ft (~ ⅓ mile)
- Time to traverse path (@ 3 mph): 10 min

Plan View (Horizontal Alignment)

This path runs adjacent to the existing Sterling Highway alignment. The conjoined path and boardwalk structure will be built three feet offset from the road. This alternative begins with a hard packed pathway connecting to the existing pathway on the east side of Alaska Wildland adventures. This section will run about 465 ft where it will transition into boardwalk. The boardwalk will run the majority of the pathway. Upon approaching Cooper Creek bridge, pillars that are used to stabilize the walkway until this point will cease in order to have a clear span across the connecting waterways of Kenai River and Cooper Creek. 100 ft past the footbridge adjacent to Cooper Creek Bridge, the alternative will meet once more with a hard packed pathway off of the boardwalk structure. This will carry travelers to the North Cooper Creek Campground where the trail will end.

Appendix A.1 displays the proposed horizontal alignment of this alternative.

Appendix A.2 displays potential Right of Way (ROW) impacts for the proposed path. For Alternative 1, no ROW impacts are evident.

Typical Section

This alternative does not require a significant need for large soil excavation or fill quantities due to the fact it will be primarily a structure based path. Based on elevation data within the area, the roadway has a varying cross slope that changes as the roadway transitions between curved and straight segments. Due to the varying gradient of the roadway, and the limited horizontal distance north of the Sterling Highway, developing a pathway on the existing ground is not safe or practical. With the boardwalk style of pathway, pillars will be able to go deep into the embankment soil in order to stabilize the structure. Because the pathway is right along a large river prone to flooding, the embankment soils are at a higher risk for erosion and potential failure. Therefore, the piles must be driven deep enough into the ground, to meet the point of refusal, in order to avoid the risk of being washed out.

A representation of a typical section for Alternative 1 is shown in **Appendix A.3**. Further refinement of Alternative 1 sections and details are described further in this report and are also provided in the accompanying planset.

Considerations / Potential Impacts

With this alternative, it is important to consider potential environmental impacts. Having a boardwalk just above the Kenai River poses potential for debris or pollution entering into the water below. Going forward, environmental permitting will need to be addressed, due to construction of this alternative being so close to an anadromous waterway.

It is important to also consider the location of this alternative being so close to the highway. Although improbable, car accidents, flying rocks, and loud noise could cause discomfort for walking travelers.

Alternative 2

Overview

Alternative 2 proposes developing a walkable path along the inside shoulder of the existing Sterling Highway alignment. The road will be widened along this inside shoulder to provide a five-foot-wide, paved trail for travelers. In addition, the existing inside shoulder will be extended five feet and guardrail will be placed between this shoulder and the provided path to increase the safety of non-motorized travelers. In order to maintain the existing drainage pattern and prevent water from directly spilling onto the trail from the adjacent hillside, a ditch will be constructed between the path and the face of the slope. This ditch will channel into the existing ditch at the path extents. Due to the steep slope of the hillside, at least one row of 3-foot x 3-foot (cross-section dimensions) gabion baskets will be placed between the ditch and the hillside. This will provide stability to the slope and also will provide a means to connect the proposed cut back into the existing topography. Travelers will cross Cooper Creek via a footbridge located just south of the existing Cooper Creek Bridge and head west toward Sacketts via a hard packed trail separated from the existing roadway by a ten-foot vegetative buffer.

Design Criteria Overview

- Five-foot-wide path
- Asphalt surface
- 5% max running slope
- 2% max cross slope
- Shoulder along the path will be extended to reach width of five feet
- Guardrail will act as barrier between motorized and non-motorized traffic
- Backslope not to exceed (be steeper than) 2H:1V slope
- Footbridge to be constructed across Cooper Creek, south of existing Cooper Creek Bridge
- Approximate path length: 2,818 ft (~ ½ mile)
- Time to traverse path (@ 3 mph): 10 min

Plan View (Horizontal Alignment)

This path would follow the existing alignment of the Sterling Highway, south of the highway and north of the steep hillside along the road. A pedestrian crosswalk would be established east of AWA, near Milepost 50, in order to connect the existing trail with this proposed pathway. Heading west, the trail would lead to a footbridge that would provide non-motorized access across Cooper Creek, just south of the existing Cooper Creek Bridge. In order to reduce cost and increase construction efficiency, a prefabricated steel bridge will be used at this location. The running slope of the path is not to exceed a grade of 5% in order to adhere to ADA standards.

Appendix B.1 displays the proposed horizontal alignment of this alternative.

Appendix B.2 displays potential Right of Way (ROW) impacts for the proposed path. For Alternative 2, minimal ROW impacts are evident.

Typical Section

This path design requires that a cut be made into the existing hillside face in order to accomodate space for an extended shoulder and five-foot-wide path. In order to meet ADA standards, a maximum 2% cross slope will be provided to ensure that water does not collect on the path. This path will slope down toward the hillside. The elevation data for the area represents the roadway as superelevated with a unidirectional cross slope across the entire width of the traveled way. In order to avoid a sudden difference in slopes between the traveled width and the inside shoulder that could alarm drivers and create unsafe driving conditions, the shoulder will be sloped upward so that water falling on the shoulder would sheet across the roadway. The cross slope of the shoulder will be 4% in order to ensure adequate drainage.

Existing drainage patterns will be maintained by constructing a ditch along the toe of the hillside. The typical section for this alternative proposed a shallow one-foot deep ditch with 2H:1V foreslopes and backslopes. If this alternative is selected as the preferred alternative, a hydrologic analysis will have to be performed in order to determine the required ditch dimensions.

The surface of the pathway would preferably be paved with asphalt in order to increase its durability and longevity. However, the extended width of the shoulder will be surfaced with non-bituminous materials, such as gravel and crushed rock in order to reduce the cost of paving this additional surface area.

A representation of a typical section for Alternative 2 is shown in **Appendix B.3**.

Considerations / Potential Impacts

The proximity of the path to motorized traffic presents a safety hazard if a vehicle were to lose control and approach the path. The guardrail and extended shoulder were included in the design in order to provide as much barrier as possible given the limited horizontal space. Additionally, it is anticipated that the construction of this path would not occur until after the Sterling Highway Bypass Project is at or near completion. It is anticipated that 70% of the existing highway traveling the existing Sterling Highway will be diverted to the new Bypass. This means that traffic along the existing stretch of the Sterling Highway will be drastically reduced, thereby increasing the level of safety for all travelers. If the adjacency to the roadway is still a concern however, an elevated pathway design can be developed.

Another thing to consider is the stability of the slope given the cuts that would be made into the hillside. Geotechnical reports within the area indicate that due to the silty composition of this hillside, large cuts into the slope could pose a high chance for slope instability and possible failure. Therefore, slope stability measures, in addition to the gabion baskets, may have to be included in the final design of this alternative.

Alternative 3

Overview

Alternative 3 proposes using the hillside that rises from the inside shoulder of the existing highway, as a means to provide a scenic route for active travelers. Heading west from AWA, travelers would cross the street near Milepost 50 of the Sterling Highway and then travel up the hillside along several ground-packed switchbacks for an elevation gain between 250-300 feet from the roadway. Travelers would then head west along the perimeter of the hillside, adjacent to the existing powerline easement and then descend toward Cooper Creek with a series of elevated boardwalk-style ramps that eventually connect back to a traditional hard packed trail system. A foot bridge would be provided south of the existing Cooper Creek Bridge to provide access across Cooper Creek. Benefits of this design include travelers being separated from traffic, limited environmental impacts, and scenic views of the surrounding habitat. This route would be designed to meet American Disabilities Act (ADA) accessibility requirements.

Design Criteria Overview

- 5 foot width
- Trail surface will consist of hard-packed bare earth
- A boardwalk-style ramp structure will provide access along rapidly eroding areas; (approximate length: 1,860 ft)
- Average 5% running grade
- 8.33% max grade at running lengths of 200 ft; landing areas provided
- 5% max cross slope
- Footbridge to be constructed south of existing Cooper Creek Bridge

- Approximate Path Length: 7,800 ft (~1.5 miles)
- Time to traverse path (@ 3 mph): 30 min

Plan View (Horizontal Alignment)

This trail is designed to meet ADA accessibility requirements in order to provide access to as many people as possible. The USDA Forest Service Trail Accessibility Guidelines (FSTAG) were used as reference in order to meet ADA guidelines that consider the extreme topography of the area. These requirements permit a maximum running slope of 5% for any distance. A running slope of 8.33% may be provided for distances up to 200 ft. Where the trail grade exceeds 5%, resting intervals shall be provided that are at least 60 inches in length and shall at minimum match the width of the widest section of the trail.

In order to gain the required elevation difference, the trail will follow the contours of the hillside across from AWA, in a series of switchbacks, at a 5% grade, each about 1,000 feet in length. Upon reaching an elevation approximately 250 feet above the roadway, the trail will wrap around the ridge of the mountain and then run closely parallel to the existing powerline easement on the hillside. Due to the instability of the slope on the far west side of this hillside, developing a trail into the face of the slope is not feasible. Therefore, a series of ramps will be constructed that will be stabilized and supported by driven pile columns. Once the ramps reach stable ground, the trail will be constructed into the existing topography and then provide access across the Cooper Creek Bridge via a prefabricated steel footbridge. The trail will then cut north through the Cooper Creek South Campground and follow west toward Sackett's Kenai Grill along a path set back from the existing highway alignment by a ten-foot vegetative buffer.

Appendix C.1 represents the proposed horizontal alignment of Alternative 3.

Typical Section

ADA requirements dictate that passing spaces must be provided at regular intervals on trails less than 60 inches in width. Therefore, the clear tread width of the trail will maintain a width of 60 inches along the entire traveled length in order to provide adequate room for travelers heading in different directions and those using strollers or wheelchairs. A maximum 5% outslope will provide drainage and maintain the integrity of the trail, while still allowing comfortable conditions for travelers.

This trail will be constructed using a bench cut, which is a section of tread cut across the side of a hill. A full bench cut is constructed by cutting the full width of the trail into the hillside. Given the silty and sandy materials that compose this hillside, a full bench trail construction will provide a stable platform for travelers that is resistant to erosion, provides longevity, and requires lower maintenance compared to a partial bench trail construction.

The inner edge of the trail will blend into the natural topography of the hillside by a diagonal backslope that will vary in degree of slope, depending on the trail location and adjacent terrain. However, these cuts (backslopes) are not to exceed a slope greater than 1H:1V in order to maintain the structural integrity of the hillside. The backslopes will be revegetated in order to slow water runoff as it approaches the trail surface and reduce sloughing of the hillside.

Aside from the pier ramps that traverse the west side of the hillside, the surface of the trail will be hard packed earth. A hard-packed earth surface is easier to construct and reduces costs to construct and maintain the trail. Native soil will have to be tested in order to ensure it offers a reasonable level of slip resistance and compactibility; otherwise, additional material will have to be transported and incorporated into the design.

A representation of the switchback trail section is displayed in **Appendix C.2**.

Considerations / Potential Impacts

In order to move people away from the edge of the road, this trail would travel into land outside of the existing publc Right of Way. The path crosses land owned by the Kenai Peninsula Borough and the USDA Forest Service. Easements across this land would have to be granted in order to continue development of this trail. Therefore, if this trail is selected as the preferred alternative, landowners would have to be contacted in order to determine feasibility of the trail.

Parcels impacted by the Alternative 3 design are displayed in **Appendix C.3**.

PREFERRED ALTERNATIVE DESIGN

Alternative 1 was selected after much site analysis and continuing discussions with our client, in an effort to match their vision with a feasible design. After the selection of Alternative 1, further site analysis and calculations were made to advance the project and bring it closer to a 35% design.

Existing Trail Component

Currently, active travelers heading west from Alaska Wildland Adventures (AWA) commute using the space between the existing guardrail and the shoulder of the road foreslope. The portion of trail that is closest to AWA is well compacted and free of vegetation. Therefore, as long as a 5 ft minimum clear tread width is available, this section of the trail does not need to be redeveloped. In areas just shy of this 5 foot minimum width, the roadway embankment can be extended north, so long as the Kenai River would not be impacted with materials.

Where the existing pathway is directly sandwiched between the Kenai River and the Sterling Highway, and a minimum 5 ft clear tread width is not available, an elevated light penetrating

structure (ELPS) would be developed. Based on topography data acquired from the Kenai Peninsula Borough (KPB) and imagery taken during the site visit, the ELPS would intercept the existing trail near Station 22+50, as shown in the accompanying planset. Details of the ELPS are described below.

Elevated Light-Penetrating Structure

Alternative 1 includes four main design aspects, one being an elevated light-penetrating structure, also known as a boardwalk. The terms ELPS and boardwalk will be used interchangeably throughout this report. The ELPS will make up roughly ¾ of the total path distance.

An ELPS is an independent structure sitting on a driven pile foundation, this style of pathway was chosen for several reasons that are desirable in the overall project. Most importantly the ELPS provides a feasible and safe design to align with our clients vision. Our client wanted a pathway to go between the Sterling Highway and the Kenai River, where ground space and the presence of stable soils is a premium. The roadway sits about 10’ above the river, where armour rock shoulder slope down to the Kenai River. Adding a traditional rock/dirt/paved pathway would be challenging from an environmental and erosion aspect, the ELPS pathway proved to be a suitable answer to this complication. The low profile nature of an ELPS allows the pathway to have only minor effects on the adjacent roadway, the river’s water, and to follow the natural contours of the area. The structure will have standard run of 30’ per section (30’ between pile sets) allowing for each section to adjust directions with the road and river, nestling between the two and providing a visually appealing profile. The piling foundation lowers environmental concerns in regards to effecting the Kenai River’s natural flow, especially since the piling will be above the mean high water line. The low impact on the river using the piling would not be achievable with simply extending the road’s shoulder width to accommodate a pathway. By having a detached path from the roadway, pedestrians will be kept separate and have blockades between the dangers of the Sterling Highway as well as the Kenai River.

An elevated light-penetrating structure is intended to provide pedestrian transport without having a large environmental impact. Structures should allow 60 percent of light to pass through to the vegetation underneath so that vegetation may continue to grow in the area. These structures may not be closer than four inches to the ground below the pathway, and should be no wider than eight feet according to the Kenai Peninsula Borough Code of Ordinances. The design of our structure puts the width at 6 feet of clear travel space, and 7 feet in total. By having fiberglass decking, the suggested percentage of light will be allowed to pass through the structure and continue growth beneath and around the pathway. The fiberglass grating will sit on top of 4”X4” wood floor beams, which are secured to the W12X53 steel girders, supported by the pile caps (comprised of a W12X53 with shear stiffeners). Each pile cap will be attached to two 6” piling driven to a specified resistance to accommodate the calculated loads. The ELPS maintains a 3.5’ railing on both sides, keeping travelers safe.

Prefabricated Pedestrian Bridge

A prefabricated pedestrian bridge section will be implemented to allow travelers to safely cross Cooper Creek. Currently, the vehicular bridge does not have enough space for both pedestrians and cars to cross at the same time. An independent pedestrian footbridge (separate from the roadway structure) will effectively cross Cooper Creek, connecting the ELPS to the developed trail section on the west side of Cooper Creek. Piling foundations on either side of the creek will support the 70' bridge allowing safe travel of pedestrians from one side to another while also maintaining overall project aesthetics during the transition between two parts of the trail. Each foundation on either side of the bridge will consist of two 12" piling driven to a specified resistance, with a pile cap (W12X53 with stiffeners) atop the two 12" piling.

Developed Trail Component

The developed trail section of the project extends from Station 1+00 to Station 6+25. Heading west past Cooper Creek, the trail addition would be constructed where the existing ground is both stable and wide enough to support the full development of the raised trail. Additional boardwalk would be provided between the prefabricated bridge and the starting point of the raised trail to maintain functionality during the transition.

The finished grade of the trail was designed to closely match the elevation of the existing roadway surface. Doing so would result in increased comfort and safety for active travelers who would be able to observe their surroundings, including oncoming traffic. Furthermore, since the topography of the ground in this area is at a lower elevation than the surface of the roadside and adjacent hillside to the south, providing a raised trail section prevents the surface of the trail from getting overly saturated and creating muddy or wet conditions for travelers to tread through.

In order to maintain the structural integrity of the trail the existing drainage pattern of the area needs to be improved. Ditches currently line the south side of the existing Sterling Highway alignment. The volume of water that drains north of the Sterling Highway is only what falls on the surface of the roadway, therefore a 1.5 ft to 2 ft depth ditch would be adequate to effectively manage rainfall. Water would then be diverted to a minimum of two 18" diameter culverts placed under the developed trail. Each culvert would be placed at low elevation points within the ditch, which would be graded so that water is able to drain at a minimum 1.5 % slope.

The existing foreslope of the road would be regraded to a 4H:1V vertical relationship in order to provide a recoverable slope for vehicle traffic in this area. A recoverable slope provides drivers a higher chance of regaining control of their vehicle if they were to accidentally veer off the shoulder of the road. This offers a mutual safety benefit to drivers and active travelers since drivers would be able to avoid colliding with the trail and/or individuals traveling across it.

Slopes composing the raised trail section would have a 3H:1V relationship. All slopes, including the regraded road foreslope, would be seeded during the final stages of construction for added stability and also to help prevent particles and potential contaminants from entering the Kenai River. Per Americans with Disabilities Act (ADA) Standards, the clear width of the trail would be 5 ft and the cross slope would be 1.5%. These values ensure that travelers can comfortably pass one another on the trail, and also prevent water from pooling and degrading the finished grade of the trail.

The subgrade of the trail would be constructed with 2 ft minimum (height) of suitable material that is able to create a solid foundation for the finished grade. 6 inches (height) of crushed aggregate surface course would be used for the finished grade of the trail. This material is fine enough to create a strong bond between particles once they are compacted, while still allowing water to drain if it reaches the surface of the trail.

Crosswalk

The proposed path design leads travelers, heading west, directly to the Cooper Creek North Campground. However, travelers most likely want to access Kenai Sackett's Grill and the Cooper Creek South Campground. Therefore, a crosswalk would be designated in order to localize crossing traffic to one location that is visible to both active and motorized travelers.

This design was provided under the assumption that it would not be constructed until after the Sterling Highway Bypass Project is mostly completed. As a result of the Bypass Project, about 70% of the traffic traveling across the existing Sterling Highway will be redirected away from Cooper Landing which reduces the average daily traffic amount in the area to about 1,400 vehicles per day. Therefore, the classification of the road can be changed from a major arterial to either a minor arterial or major collector, and the speed limit of the road can be further reduced from 35 miles per hour (mph) to 25 mph.

These reduced speed limit signs would be placed along the highway where the driver would be expected to reduce their speed. In addition, signs marking the location of the crosswalk would be placed at either approach. Warning signs used to alert drivers of an upcoming (and unanticipated) crosswalk would be placed approximately 150 ft-200 ft ahead of the crosswalk. If desired, additional signs with a designated distance from the crosswalk (such as 1000 ft) can be placed alongside the road as an additional cautionary measure.

Adequate sight distance needs to be provided on either side of the crosswalk in order to provide drivers enough perception-reaction time to slow or stop their vehicle before entering the crosswalk. Since the road curves east of crosswalk location, the tangent stretch of road needs to meet required sight distance requirements for the posted speed limit. At 25 mph, the minimum required sight distance is 155 ft. In order to provide a factor of safety, required sight distances for

travelers at 35 mph and 45 mph, are 250 ft and 360 ft respectively. The placement of the crosswalk, as depicted in the included planset, provides a 500 ft sight distance, east of the crosswalk and a much greater distance west of the crosswalk, since this section of roadway continues as a straight stretch beyond the extents of our project.

Additional measures of safety for travelers at the crosswalk include use of flashing beacons, transverse rumble strips and additional striping in advance of the crosswalk. However, approximated hourly volumes indicate that these additional measures would not provide a higher level of safety compared to the extra costs. Once the Sterling Bypass Project is completed however, pedestrian and vehicle counts within the area can be measured to determine if additional safety measures would be beneficial.

PREFERRED ALTERNATIVE COST ESTIMATE

Each alternative presented included a cost estimation. Below is the total cost estimation for alternative 1. Costs for line items of similar projects in the area were referenced to get a relative unit price per each item. In addition, experienced engineers and contractors provided Nomad Engineering approximate quotes for item costs. Total costs were then calculated for each item based on the quantity and unit prices. The estimates for each alternative are outlined below. Please note that these are approximate estimates that would be refined with the progression of the design.

Cost Estimate #1

Item #	Description	Pay Unit	Unit Price	Quantity	Total
201(1A)	Clearing/Grubbing	Acre	$8,000	0.250	$2,000
203(3)	Unclassified Excavation	CY	$7.00		$0
203(5)	Borrow	CY	$10.00	740.74	$7,407
301(1)	Aggredgate Base Course (D-1)	TON	$35	216.00	$7,560
306(1)	ATB	TON	$85.00	0.00	$0
306(2)	Asphalt Binder	TON	$750.00		$0
504(1)	Structural Steel	Lump Sum	$70,000	1	$70,000
505(5)	Furnish Structural Steel Piles	Lump Sum	$25,000	1	$25,000
507(2)	Pedestrian Railing	Lump Sum	$35,000	1	$35,000
603(22)	18" Culvert	Linear Foot	$180	25	$4,500
606(1)	W-beam Guardrail	Linear Foot	$40		$0
608(2)	Asphalt Sidewalk	SY	$33		$0
636(1)	Gabion	CY	$350		$0
640(1)	Mobilization and Demobilization	Lump Sum	$50,000	1	$50,000
641(2)	Temporary Erosion, Sediment and Pollution Cc	Cont. Sum	$25,000	1	$25,000
642(1)	Construction Surveying	Lump Sum	$15,000	1	$15,000
643(2)	Traffic Maitenance	Lump Sum	$20,000	1	$20,000
643(15)	Flagging	Cont. Sum	$15,000	1	$15,000
643(25)	Traffic Control	Cont. Sum	$45,000	1	$45,000
644(1)	Field Office	Lump Sum	$12,000	1	$12,000
670(12)	MMA pavement markings	Lump Sum	$1,000	1	$4,000
	Elevated Light Penetrating Structure	Linear Foot	$376	2000	$751,500
				TOTAL	$1,088,967

CONCLUSIONS AND RECOMMENDATIONS

With the current level of analysis on the Cooper Creek Bridge Project, we have determined that Alternative 1 mentioned above is the best course of action in order to solve the current issue of limited foot traffic accessibility in the Cooper Creek area. Alternative 1 will provide Cooper Landing residents and visitors safe access from Alaska Wildland Adventures to the Southern Cooper Creek Campground.

Installing an elevated pathway and independant pedestrian bridge allows travelers safe non-motorized transportation that is currently not available in the area. In addition, designing this to be a separate structure from the Sterling Highway will mitigate future maintenance conflicts, so any improvements or renovations on either structure will only have a minor affect the their everyday use. This also means that the scope of this project does not need to look at the vehicle bridge crossing Cooper Creek, as this will have no bearing on the pedestrian traffic and can be examined at a later date by a separate party.

We suggest that the construction of this pedestrian pathway should not be done until after completion of the Sterling Highway bypass project. Upon completion of this roadway project, the traffic in the Cooper Creek area is expected to decrease greatly providing shorter delays for vehicular travelers during construction, and safer environment for construction crews during installation.

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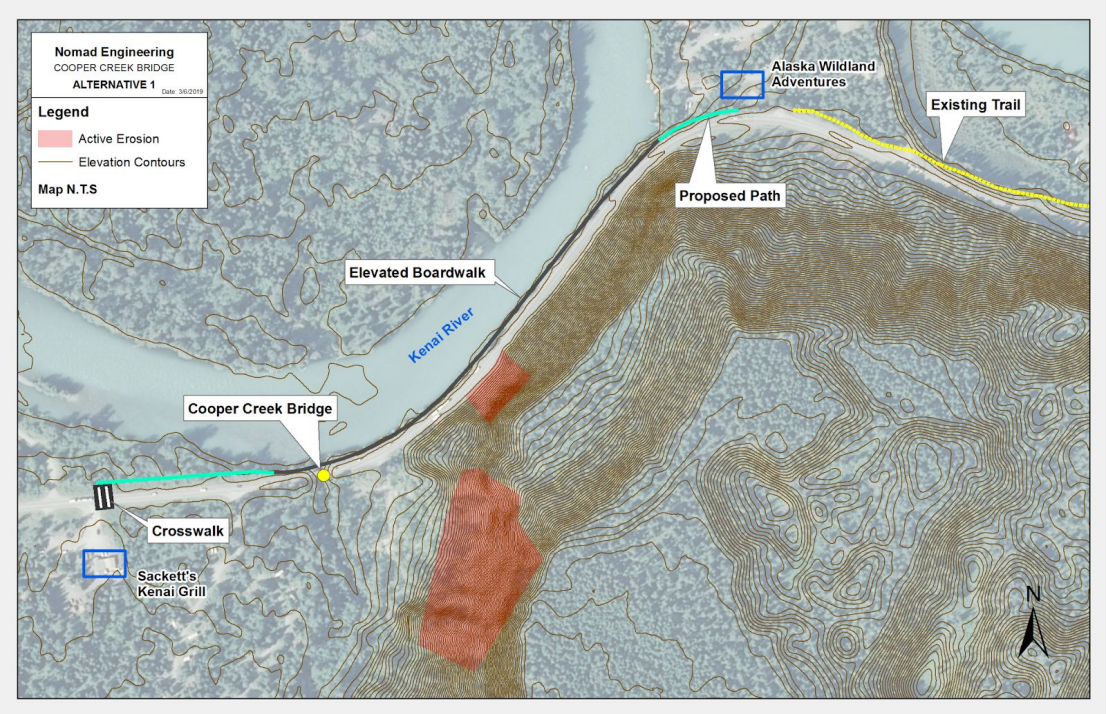
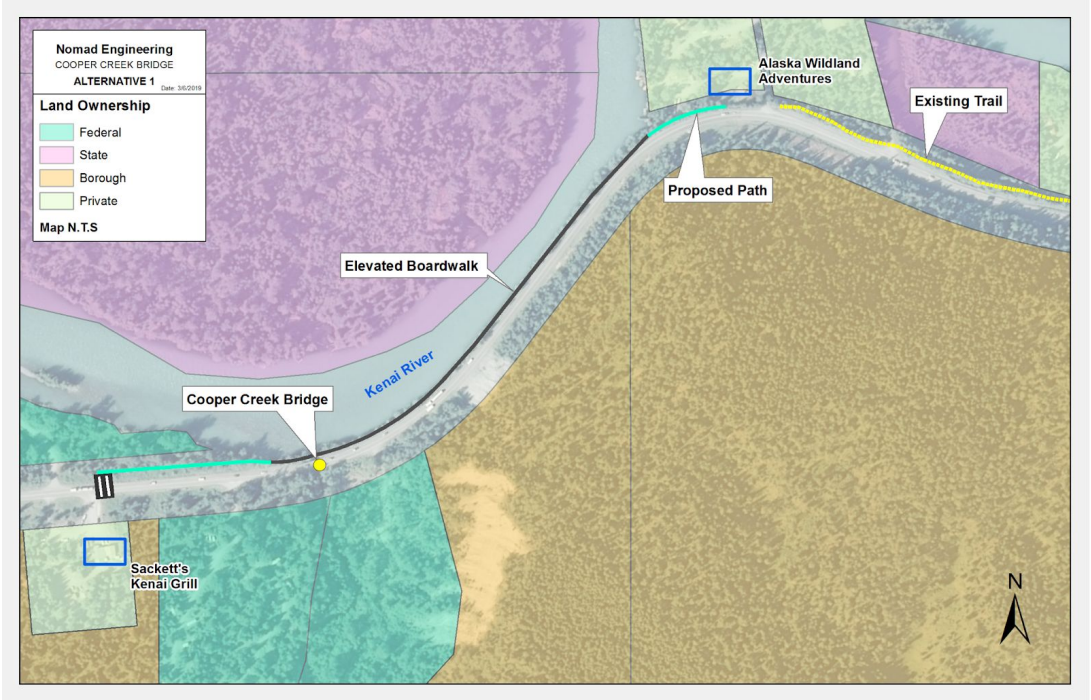
APPENDIXES

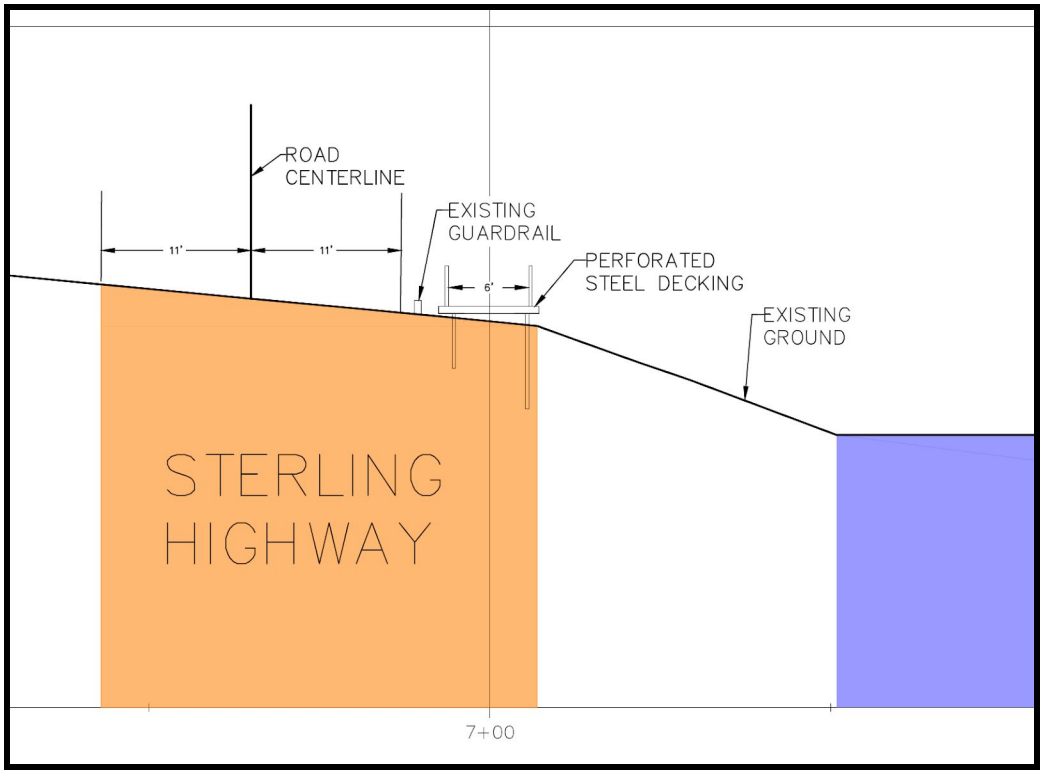
Appendix A: Alternative 1



Appendix A.1. Alternative 1 Horizontal Alignment



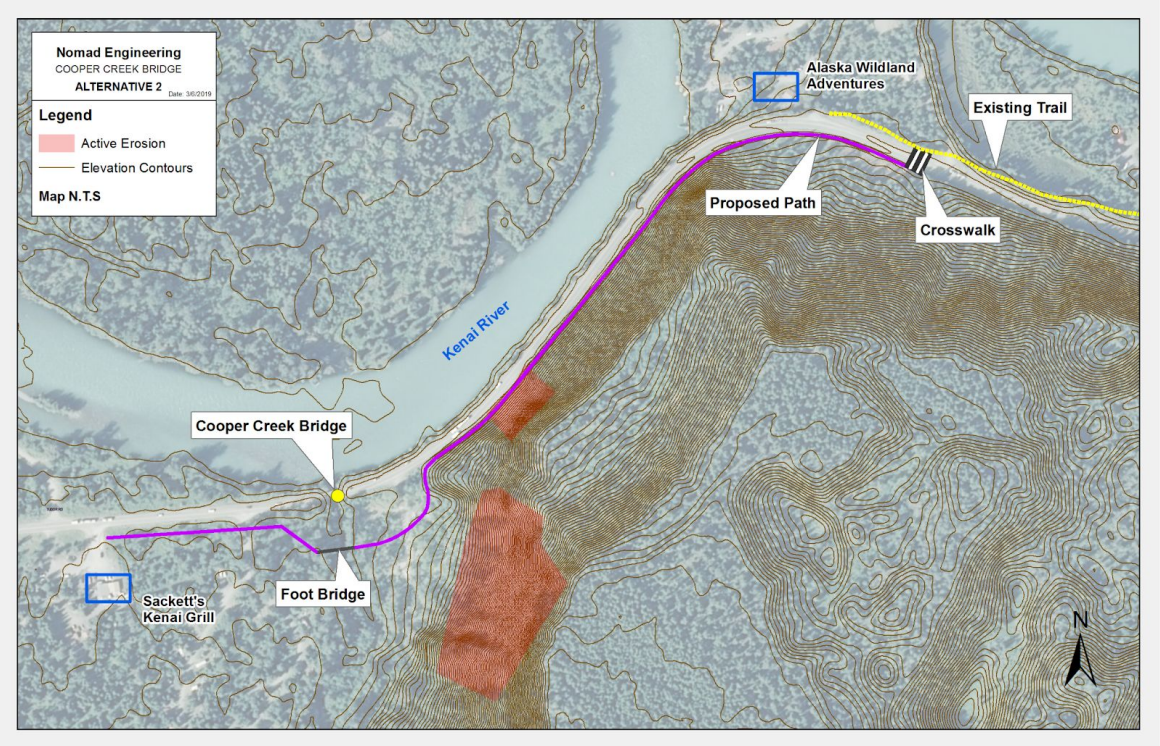
Appendix A.2. Alternative 1 Parcel and ROW Impacts



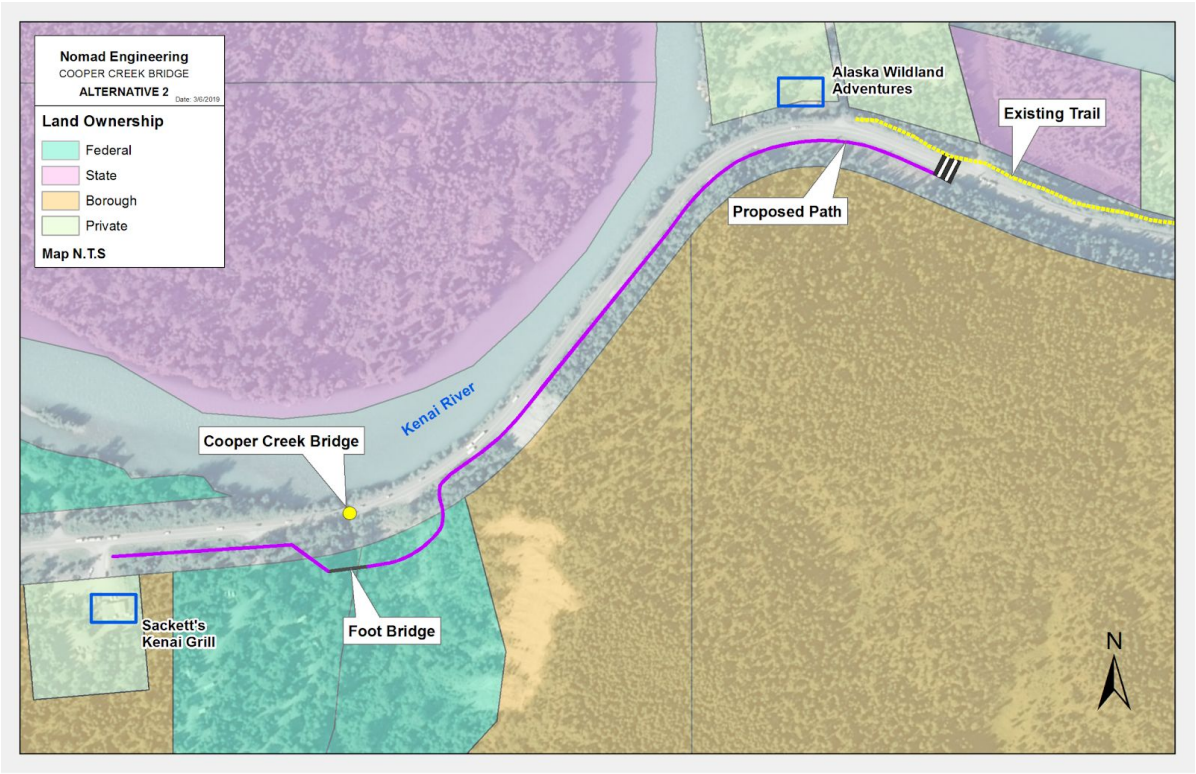
Appendix A.3. Alternative 1 Typical Section

**The position of the pathway will most likely be shifted farther north toward the Kenai River*

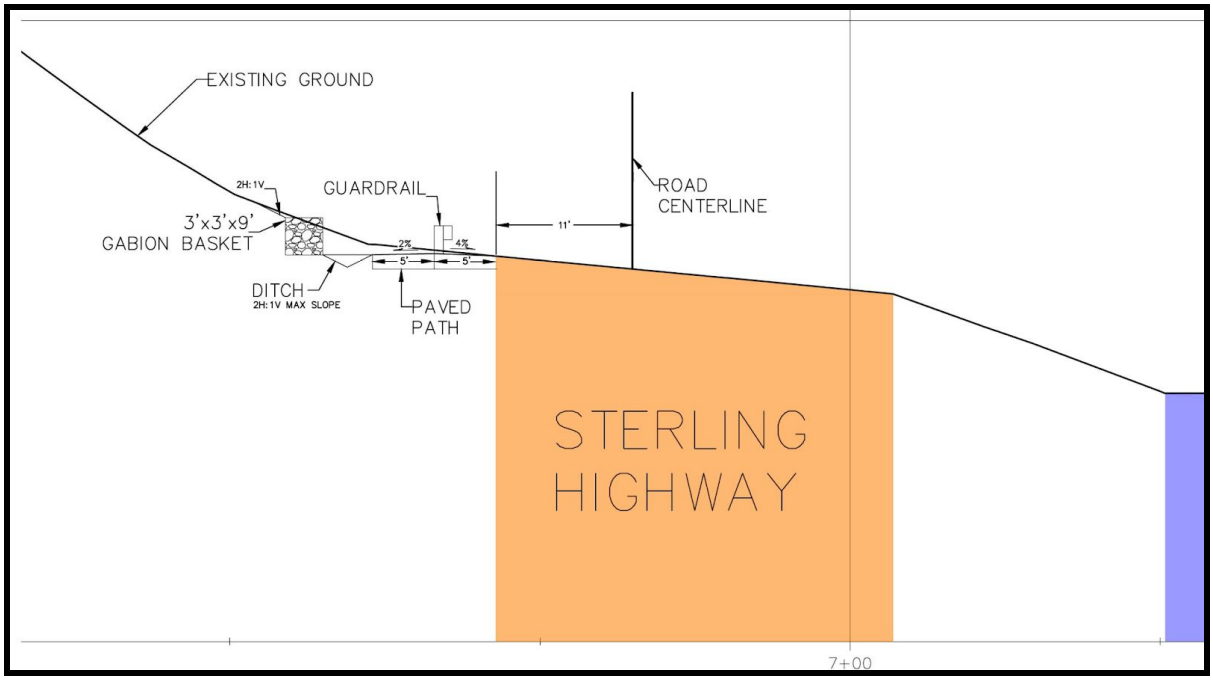
Appendix B: Alternative 2



Appendix B.1. Alternative 2 Horizontal Alignment

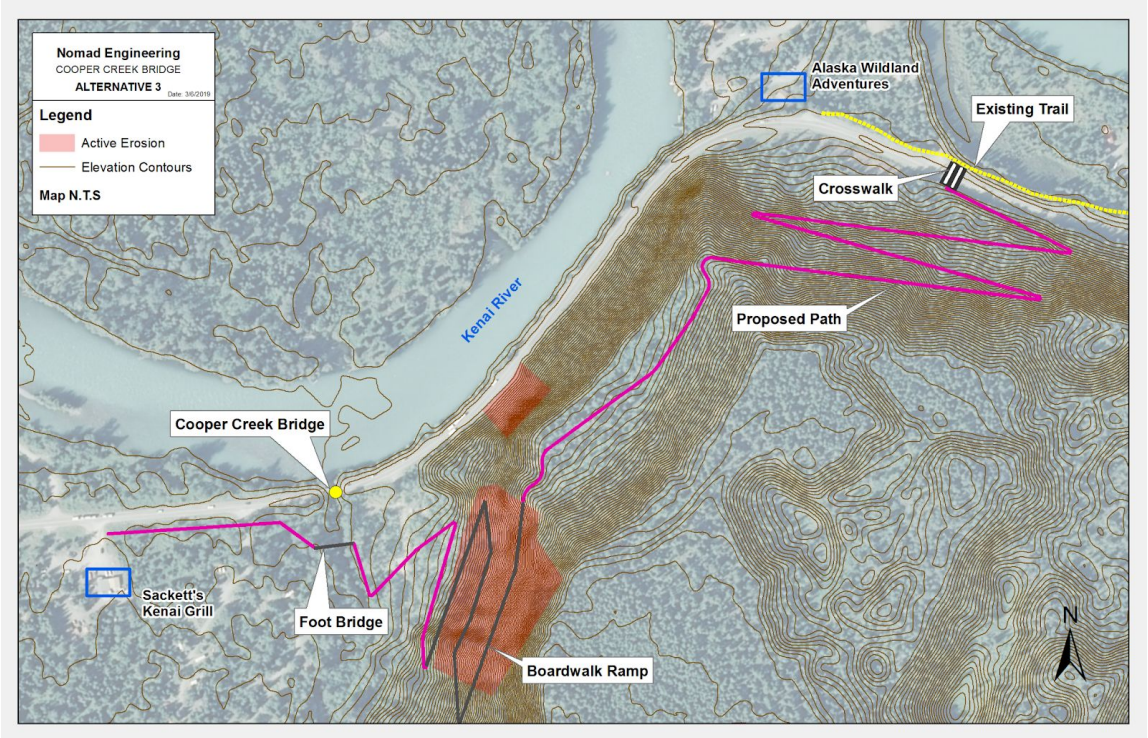


Appendix B.2. Alternative 2 Parcel Impacts

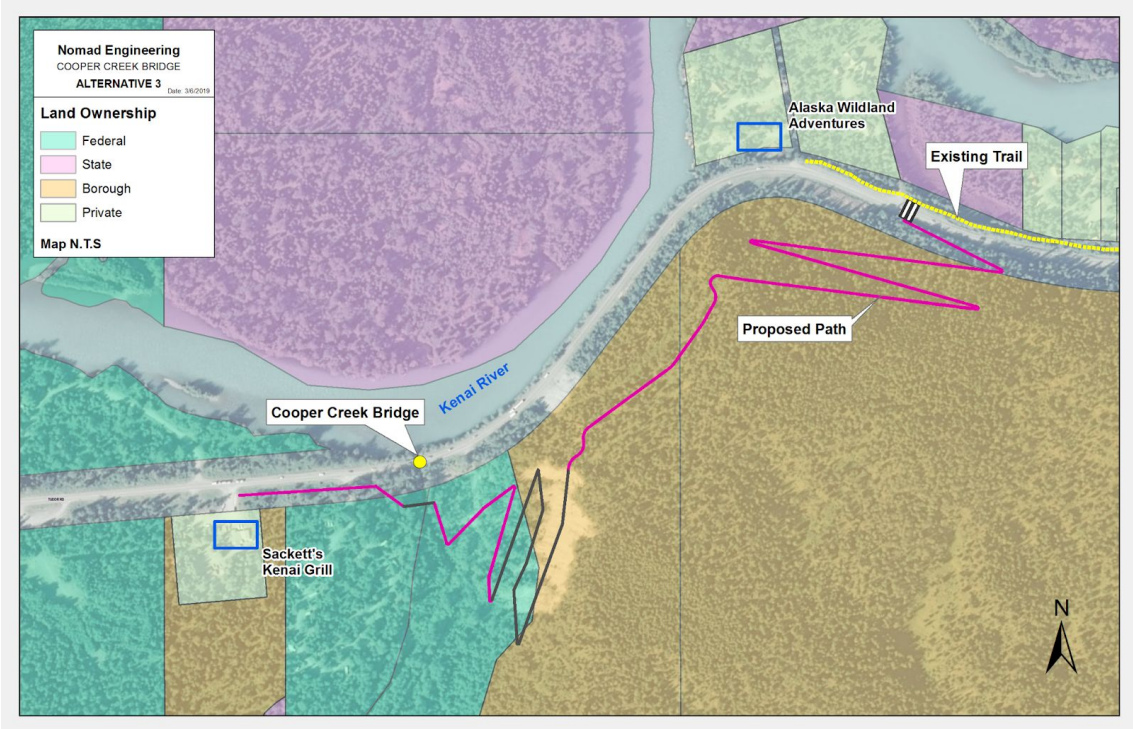


Appendix B.3. Alternative 2 Typical Section

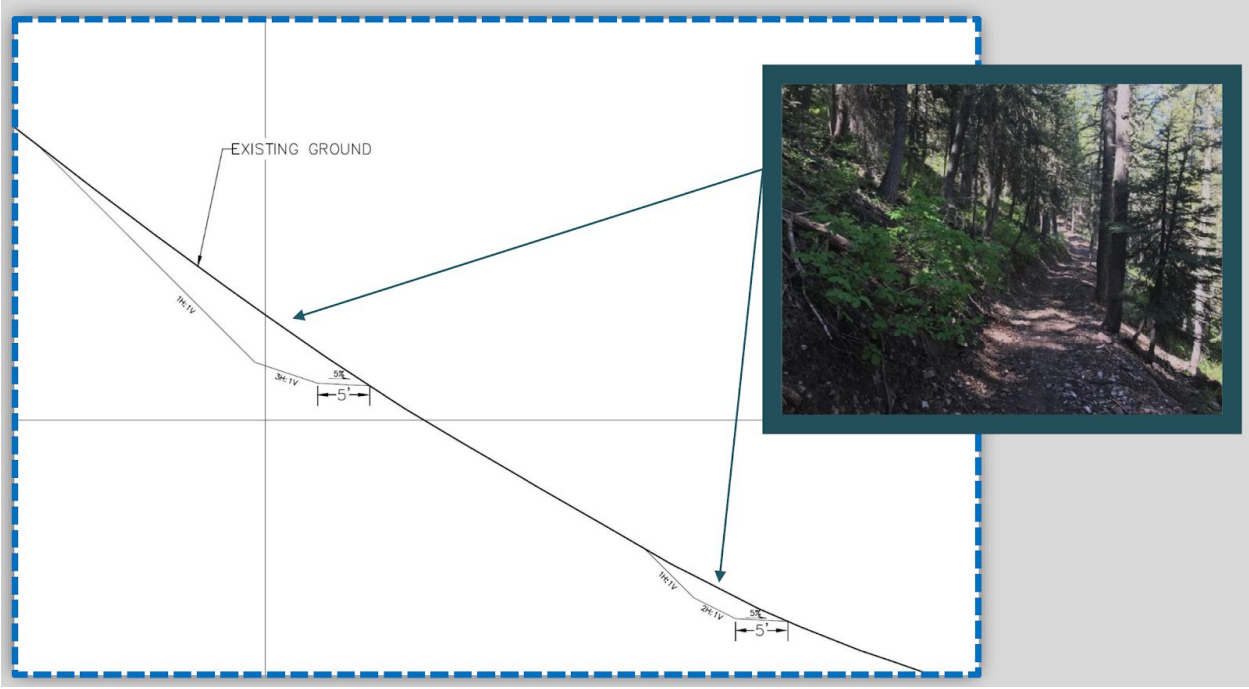
Appendix C: Alternative 3



Appendix C.1. Alternative 3 Horizontal Alignment



Appendix C.2. Alternative 3 Parcel Impacts



Appendix C.3. Alternative 3 Typical Section

Appendix D: Structural Calculations

$S_L := 70\ psf$ $I := 425\ in^4$

$D_L := 16\ psf$

$Load := 1.2 \cdot (D_L) + 1.6 \cdot L_L + 0.5 \cdot S_L = 198.2\ psf$

$l := 30\ ft$

$W := 6\ ft$

$A := l \cdot W = 180\ ft^2$

$w := Load \cdot W$ $AL := A \cdot Load = 35.676\ kip$

$F := \frac{AL}{30}$ $AL_{Bridge} := w \cdot 75\ ft = 89.19\ kip$

$M_n := w \cdot \frac{l^2}{8} = 133.785\ kip \cdot ft$

$F_{cross} := \frac{F}{3} = 0.396\ kip$

$M_u := \frac{M_n}{0.9} = 148.65\ kip \cdot ft$

$M_{beam} := \frac{M_u}{2} = 74.325\ kip \cdot ft$

Choose W12X53

$d := 5 \cdot w \cdot \frac{l^4}{384 \cdot E \cdot I} = 0.147\ ft$

$M_{beam} := 77.9\ kip \cdot ft$ $Max_d := \frac{l}{200} = 0.15\ ft$ Deflection is Okay

Pile Caps

$V_u := w \cdot \frac{l}{2} = 17.838\ kip$

$V_n := \frac{V_u}{0.75} = 23.784\ kip$

$V_{u12X53} := 125\ kip$ Good to go

Suggest using same beam for Pile cap, plenty of capacity and plenty of landing room for beams being place/set.

Also suggest adding stiffeners to the landing areas of the pile cap (under where each beam lands) to stiffen where the beam contacts the pile cap. Stiffiner size should be same as the web, 3/8" thick

Appendix D.1 . Beam Calculations for Primary Structure

Pile Resistance Per Pile - Safety factor of 6 is reccomended - ENR Formula

$$Q_u := V_n$$

W*h is the hammer power, or energy
Call is a 5000lb hammer
pilebuckhammerratingchart

$E := 5000\ ft \cdot lb$
$C := 0.1\ in$ $Q_u := 24000\ lb$

$S := \frac{E}{Q_u} - C = 2.4\ in$ $S_{safety} := \frac{S}{6} = 0.4\ in$

0.4" required per blow of a 5000ft*lb hammer
Contractor will be required to provide hammer minimum 5000ft*lb and proof pile resistance to 24000lb with a safety factor of 6

$E := 5000\ ft \cdot lb$
$C := 0.1\ in$ $Q_u := 50000\ lb$

$S := \frac{E}{Q_u} - C = 1.1\ in$ $S_{safety} := \frac{S}{6} = 0.183\ in$

0.183" required per blow of a 5000ft*lb hammer
Contractor will be required to provide minimum 5000ft*lb hammer, and a resistance of 50000lb per 12" pile with a safety factor of 6

$d := 20$

$B := 2.27 \cdot d^{-0.67} = 0.305$

Appendix D.1 . Piling Calculations for Both ELPS and Bridge