

Polychrome Pass Project Delivery Plan



SEPTEMBER
2020
(FINAL)



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EXECUTIVE SUMMARY

Background and Objective

Federal Highway Administration - Western Federal Lands Highway Division (WFLHD) is providing the National Park Service (NPS), our project management and technical staff to produce this Project Delivery Plan.

The Project Delivery Plan is in response to the road maintenance issues caused by the Pretty Rocks Landslide in the Polychrome Pass area of the Denali Park Road. Pretty Rocks Landslide is located at the midpoint of the 92-mile long road and impacts approximately 350 feet of the Denali Park Road. Accelerated landslide movement at this site is causing access to be cut off near MP 45.3; having been displaced 15 ft. from last September 2019 to January 2020 and currently moves at an approximate rate of 2 inches per day. The rate of movement in the area is accelerating and is approaching the limit of the park's ability to maintain access without significant additional resources. If the park staff is unable to maintain the road through Polychrome Pass, at least five major attractions within Denali National Park and the town of Kantishna would become inaccessible by motor vehicle.

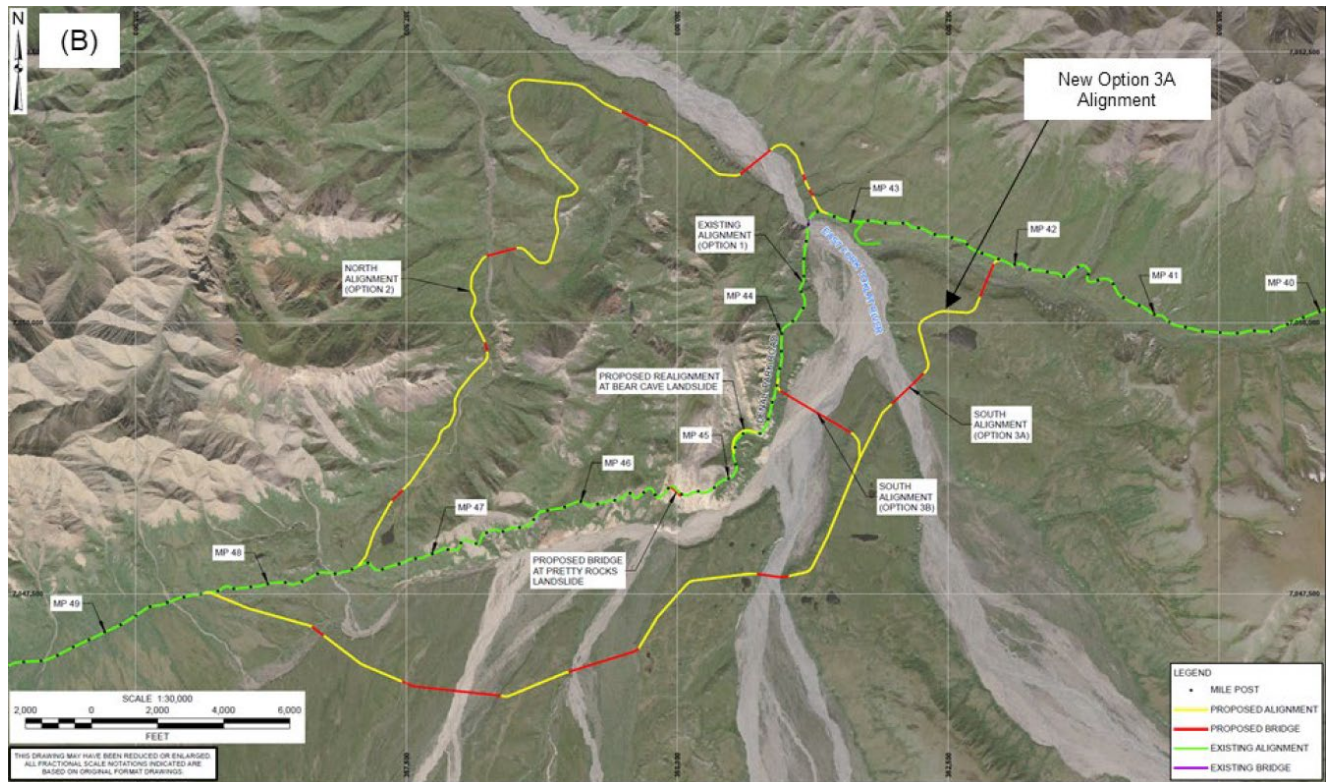
Options

Three alignment options are proposed in this report. Option 1 (Mainline Option) is the proposed work on the existing Polychrome Pass alignment and calls for a bridge constructed over the active Pretty Rocks Landslide and a quarter mile long roadway shift with drainage improvements, upslope and away from the retrogressing Bear Cave Landslide. The realignment was considered for the Bear Cave Landslide but during the expert-based risk assessment, the findings pointed out that the Bear Cave Landslide would still be one of the riskier road way sections along this option and the proposed realignment would not necessarily preserve access without a moderate to high risk over a 50-year design life. With this in mind, a more robust option was proposed, with a higher initial cost, WFLHD proposed to construct a buried cylinder pile wall to reinforce the existing roadway and upslope area above the active Bear Cave Landslide for approximately 900 feet in length. For the perlite landslide, adjacent to the proposed east bridge approach to the Pretty Rocks Landslide, a cut side retaining wall and horizontal drains are proposed to reduce the risk of future failure. The other work identified in Option 1 is improving the condition and reducing the risk of five other highly rated (poor condition) unstable rock slopes along the existing Polychrome Pass road corridor that require slope scaling and reinforcement of loose rock and unsupported rock mass features. This option will need 3 years for preliminary and final engineering (geotechnical analysis, survey design), permitting, procurement and 2 to 4 years to construct.

Option 2 reroutes Denali Park Road to the north, near the existing East Fork Toklat River Bridge site at MP 43, then westerly through approximately 6-miles of mountainous terrain, and includes up to 8 bridges with spans ranging from 225 to 1,175 feet, with the largest bridge crossing the East Fork Toklat River. This potential roadway traverses large areas of discontinuous permafrost and landslide features with differing levels of observed activity and rejoins the road near MP 48. This option will need 4 to 6 years for preliminary and final engineering and 12 to 14 years to construct.

Option 3 reroutes Denali Park Road to the south and has two potential start points, which are

identified as Options 3A and 3B. Option 3A begins just west of the Ghiglione Bridge near MP 42.1 and Option 3B begins west of the existing East Fork Toklat River Bridge at MP 44.3 (6 miles and 5.3 miles, respectively). Both alignments meet up after crossing the East Fork Toklat river. The road alignment then traverses a broad valley, known as the Plains of Murie, with wide floodplains, discontinuous permafrost, and muskeg. Bridges or causeways will be required to bridge several active, braided river and stream channels. This option crosses large open drainage areas, which may require 5 to 8 bridges with over 9,000 feet of total bridge length with individual bridge spans ranging from 450 to 3,000 feet. Both of these options will need 4 to 6 years for preliminary and final engineering and 11 to 13 years to construct.



Considerations

Construction logistics associated with the mainline option will be similar to previous road and bridge projects completed in Denali N.P. Northern and Southern Route Options are much larger in scope and scale than the mainline option and for this reason will require more space for staging equipment, material and personnel than is currently available at existing Denali N.P. facilities and staging areas.

There is a considerable difference in the amount of geotechnical information available for each of the alignments. The performance of the existing alignment has been observed for nearly 100 years and there have been several investigations targeted at understanding the geological and geotechnical issues along the road. In contrast, there is very little known about the geological and geotechnical conditions along the north and south alignments. BGC Engineering is in the process of investigating the impacts of the geomorphic and geotechnical issues on these options.

Sources of aggregate from within the park have been identified and are recommended for

construction of the project and for the next 50-years of road maintenance. Areas near the East Fork River bridge and the tributaries of the East Fork River have been identified as potential sources of aggregate for construction, but quality of the aggregate is yet to be verified. . The currently permitted area at the Toklat River (north of the causeway) and at the East Fork River scrape area are available to supply quality aggregate for maintenance of the existing Park Road and Option 1 (if chosen), but likely contain insufficient volumes to balance scraping and environmental compliance techniques required to support the aggregate needs for the next 50 years of maintenance for Options 2, 3A, and 3B in the Polychrome Pass area therefore, an area south of the Toklat River Causeway is proposed for aggregate scrape to potentially augment the quality aggregate required for maintenance of Polychrome Pass Options 2, 3A, and 3B over the course of the next 50 years.

The acreage within Denali National Park to be impacted by each alignment option and associated aggregate source is defined in the table below. Due to potential significant impacts of the proposed reroute alternatives, including impacts to federally designated Wilderness, an Environmental Impact Study (EIS) will likely be required. Completion of the EIS under One Federal Decision timelines and pre-NEPA field work will take approximately 3 to 4 years.

The table below provides estimated impact acres for the roadway corridor and for the aggregate source areas with the approximate aggregate needs assumed. Figures 14 and 15 illustrate the proposed roadway corridors and aggregate source areas and are contained in the aggregate material source section of this report.

| Options & Aggregate Source | Agg Source (CUYD) | Estimated Impacts (ACRES) |
|---|--------------------------|----------------------------------|
| Mainline (1) Road Corridor | | 45 |
| North Alignment (2) Road Corridor | | 362 |
| North Alignment (2) Agg Source | 1,863,000 | 385 |
| South Alignment (3A) Road Corridor | | 365 |
| South Alignment (3B) Road Corridor | | 318 |
| Southern Agg Source 1 | 651,000 | 135 |
| Southern Agg Source 2 | 443,000 | 92 |
| Southern Agg Source 3 | 399,000 | 82 |
| Southern Agg Source 4 | 756,000 | 156 |
| Future Maintenance Agg (1) ¹ | 90,000 | 0 |
| Future Maintenance Agg (2, 3A, 3B) ^{2,3} | 150,000 | 31 |

Costs

| | Preliminary Engineering | Construction Engineering | Total Project Costs* |
|-------------------|--------------------------------|---------------------------------|-----------------------------|
| Option #1 | \$ 7,570,100.00 | \$ 7,570,100.00 | \$ 90,842,000.00 |
| Option #2 | \$ 15,494,000.00 | \$ 15,494,000.00 | \$ 186,000,000.00 |
| Option #3A | \$ 22,944,100.00 | \$ 22,844,100.00 | \$ 275,300,000.00 |
| Option #3B | \$ 21,727,200.00 | \$ 21,272,200.00 | \$ 255,300,000.00 |

*Total project costs is the total to construct the options and includes 4 years of inflation at 1.9% per year

Recommendation

Based on all the factors outlined in this report, WFLHD recommends proceeding with design and NEPA for Option 1. This option provides the most benefit with the least amount of risks and will allow the park road to operate for many years to come.

PROJECT DELIVERY PLAN

INTRODUCTION

This Project Delivery Plan (PDP) documents alignment options considered to reroute Denali Park Road to the north, south, or improve resiliency of the existing alignment, which includes constructing safe and reliable access across the Pretty Rocks Landslide. The need to keep the road open and safe, and the increasing landslide movement at Pretty Rocks Landslide over Polychrome Pass has led to the consideration of these optional routes.

PURPOSE AND NEED

The Denali Park Road over Polychrome pass is vital and serves as the sole road access to the western regions of the park, including Kantishna. Pretty Rocks Landslide (Figure 1) impacts approximately 350 feet of the Denali Park Road near Mile Post (MP) 45.3. While private vehicles of Park visitors are only allowed access up to MP 15, and on a limited basis during road lottery in September each year from MP 15 to MP 92, professionally trained drivers provide bus access for the vast majority of visitors to the park between MP 15 to MP 92. The exception to general road access rules, between MP 15 and MP 92, is the private vehicles and commercial deliveries for Kantishna land owners and residents that use the Park Road to the Park Boundary (MP 87.5); where the road continues to MP 92, but is under the jurisdiction of the State of Alaska Department of Transportation and Public Facilities to the town of Kantishna.

The Pretty Rocks Landslide (Figures 3, 4, and 5) at MP 45.3 is one of several known (soil and rock) unstable slopes along the route. If access at Pretty Rocks is cutoff by landslide movement, the following major attractions will no longer be accessible by road:

- Toklat Rest Stop (MP 53)
- Stony Hill Overlook (MP 62)
- Eielson Visitor Center (MP 66)
- Wonder Lake Campground (MP 85)
- Kantishna (MP 89 to 92)

Iconic, scenic views beyond Milepost 43 of the park would be inaccessible by road to park visitors should these sites become unreachable. Furthermore, a primary aggregate source and west end Park housing facilities would not be accessible by road at the Toklat Rest Area and Camp (MP 53).

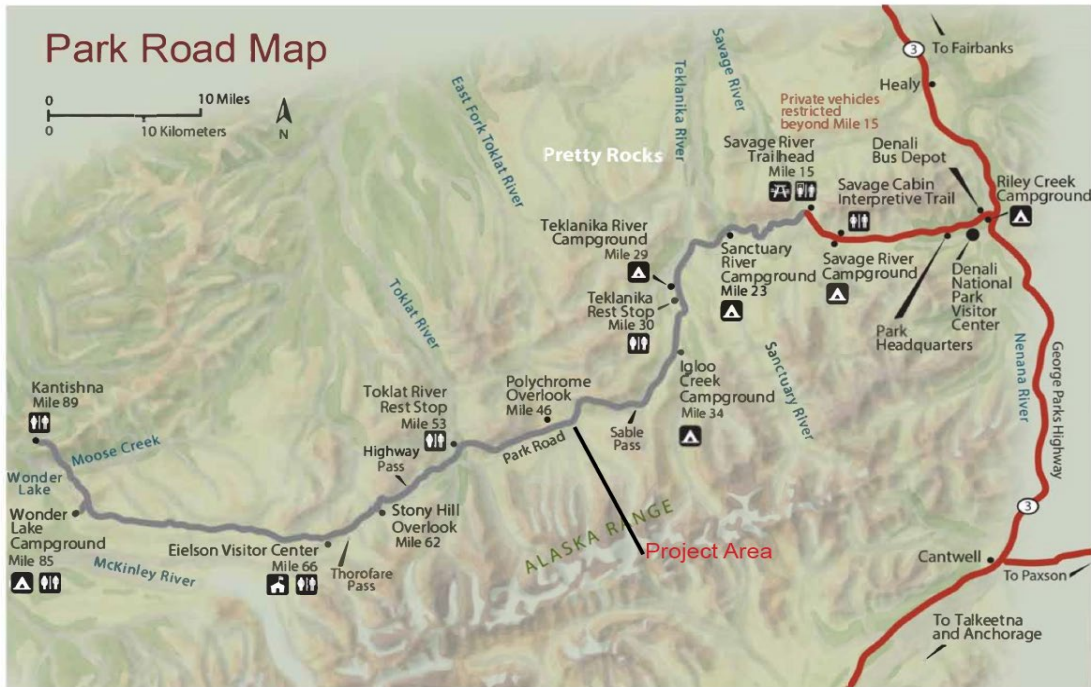


Figure 1. Park Map

Along the Denali Park Road are over 140 unstable slopes with varying degrees of operational impact potential. There are two significant landslides within the Polychrome Pass area: Bear Cave Landslide (Mile Post (MP) 44.8), Pretty Rocks Landslide (MP 45.3). The Pretty Rocks Landslide’s rate of movement has increased in recent years. In Spring 2018, the road movement was measured at approximately 0.2 to 0.3 inches per day and it was difficult to maintain through the summer season by Park maintenance crews. From September 2018 to March 2019, road surface movement measurements had increased to 0.4 inches per day. Following record warm average temperatures in the summer of 2019 and record breaking rain events in August 2019, the rate of road subsidence has increased significantly at the Pretty Rocks Landslide. From August 2019 to January 2020, landslide surface change measurements have been, on average, 2 inches per day.

Denali National Park has also experienced warming temperatures over the last 14 years. A temperature analysis was conducted by the National Park Service (2020a) to best characterize the changing conditions at the Pretty Rocks Landslide from 2006 to 2019. Figure 2 illustrates the increase in 12-month running mean temperatures at the Eielson Visitor Centre (EVC), Denali HQ and at the Toklat River. This warming has changed the climatic regime to one where temperatures are now greater than 0 °C. Climate and soil conditions control permafrost stability and it tends to degrade at air temperatures greater than 0 °C (NPS, 2020a). The trend from past data and climate models indicate that most years will experience average mean annual temperatures over 0°C.

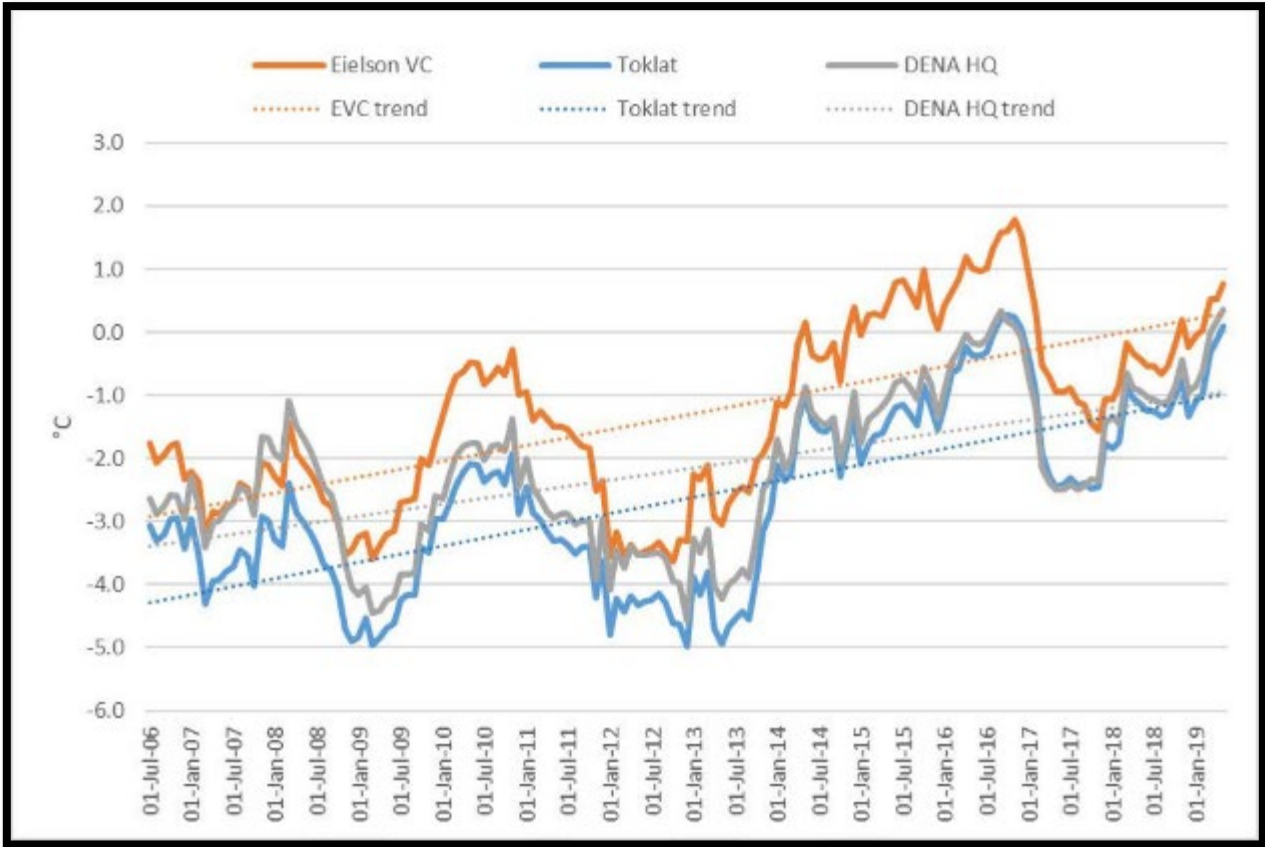


Figure 2. Twelve month running mean temperatures at EVC (orange), Toklat (blue), and Denali Park HQ (grey) with 14-year linear trend (dashed lines) (National Park Service 2020a)



Figure 3. Denali Park Road at the Pretty Rocks Landslide. NPS photo (Date unknown)



Figure 4. Pretty Rocks Landslide scarp at the Denali Park Road in November 2019 (National Park Service 2020). The road had been displaced approximately 10 ft. since September 2019 (from red arrow to yellow arrow).



Figure 5. The same location as Figure 3 at the Pretty Rocks Landslide in January 2020 (National Park Service, 2020). The road had been displaced approximately 15 ft. since September 2019.

To ensure that the accessibility is both safer and more sustainable for the long term, NPS with technical support from the Western Federal Lands Highway Division (WFLHD) have evaluated three options for a more resilient roadway corridor in the Polychrome Pass area between MP 43 and 48.3. These options, explained in this report, focus on roadway improvement in the Polychrome Pass area along this critical transportation corridor. Figure 6 shows a plan view of the options.

- Option 1: Mainline (Existing Alignment)
- Option 2: Northern route
- Options 3A and 3B: Southern route –
 - 3A begins to the west of the existing Ghiglione Bridge and,
 - 3B begins to the west of the existing East Fork Toklat River Bridge.

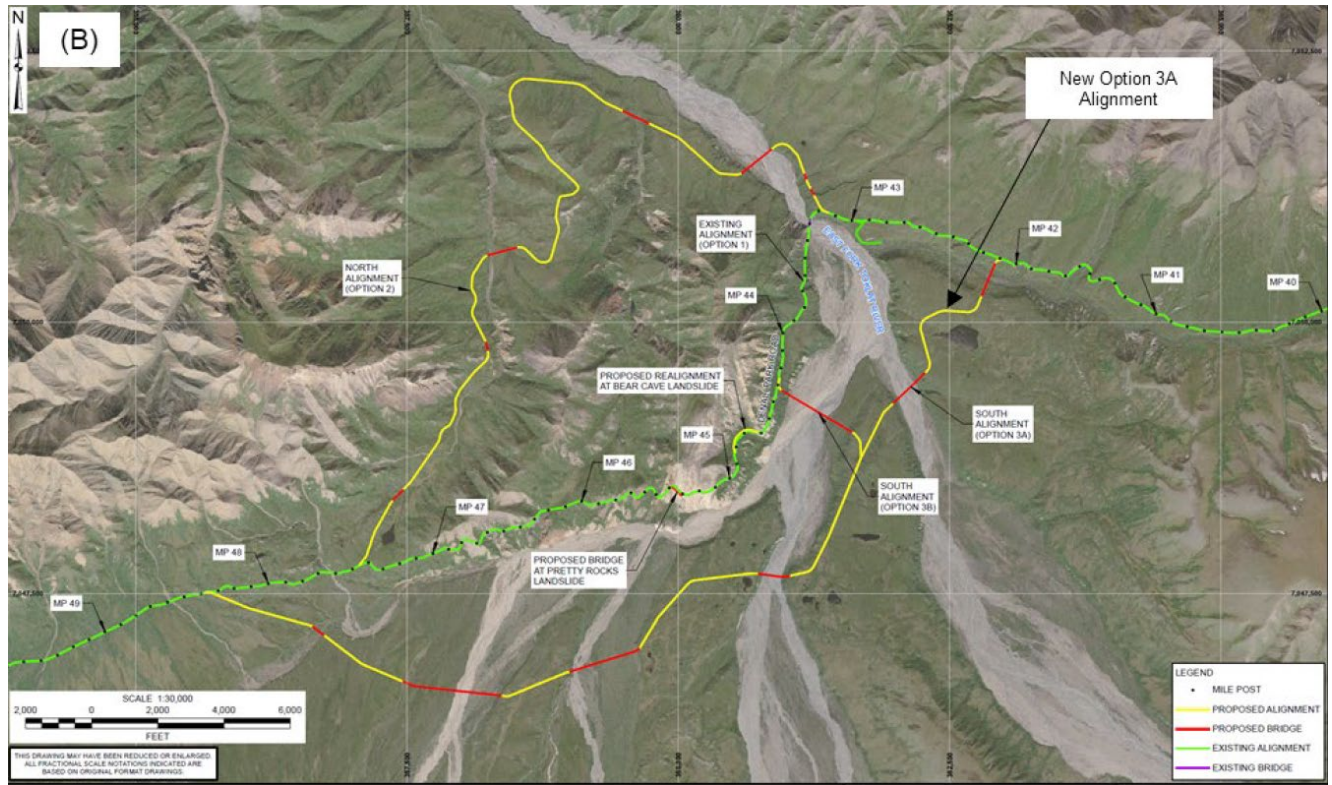


Figure 6. Options Locations Map

BACKGROUND

Denali National Park is home to the tallest peak in North America, measuring 20,310 feet in elevation, and is the home to an abundance of wildlife. Tourism is the critical driver of the regional economy. In 2017, 400,000 people visited Denali National Park and Preserve and spent \$632 million in the local region. That spending supported over 8,100 jobs in the local area and had a cumulative benefit to the local economy of nearly \$924 million, according to a National Park Service Report.

The existing alignment traverses a precipitous section of road known as Polychrome Pass. Built in the 1920s and 1930s as a scenic high-line route that overlooks the Plains of Murie, this section of road between about MP 43 and MP 48 is approximately mid-way on the 92-mile long road. The roadway through Polychrome Pass is critical to the park as it is the only access to major viewing sites, campgrounds, and in holder owned private land.

SUMMARY OF OPTIONS

An interdisciplinary team of employees at WFLHD and Denali National Park developed the alignment options described in this section.

Option 1: Mainline (Existing Alignment)

For this evaluation, the proposed work on the existing Polychrome Pass alignment calls for a bridge constructed over the active Pretty Rocks Landslide and a quarter mile long roadway shift with drainage improvements, upslope and away from the retrogressing Bear Cave Landslide. The realignment was considered for the Bear Cave Landslide but during the expert-based risk assessment, the findings pointed out that the Bear Cave Landslide would still be one of the riskier road way sections along this option and the proposed realignment would not necessarily preserve access without a moderate to high risk over a 50-year design life. With this in mind, we proposed a more robust, higher initial cost, buried cylinder pile wall in the existing roadway to reinforce the existing roadway and upslope area above the active Bear Cave Landslide for approximately 900 feet in length. For the perlite landslide, adjacent to the proposed east bridge approach to the Pretty Rocks Landslide, a cut side retaining wall and horizontal drains are proposed to reduce the risk of future failure at this location. The other work identified in Option 1 is improving the condition and reducing the risk of five other highly rated (poor condition) unstable rock slopes along the existing Polychrome Pass road corridor that require slope scaling and reinforcement of loose rock and unsupported rock mass features (see Appendix B).

Several highly rated (poor condition) unstable slopes are identified along this corridor and are shown in red in Figure 7. Site specific hazard and risk ratings are detailed in the Denali National Park Unstable Slope Management Program (USMP), adopted from the USMP for Federal Land Management Agencies (FLMA) publication and website tools (FLH, January 2019) (Appendix B).

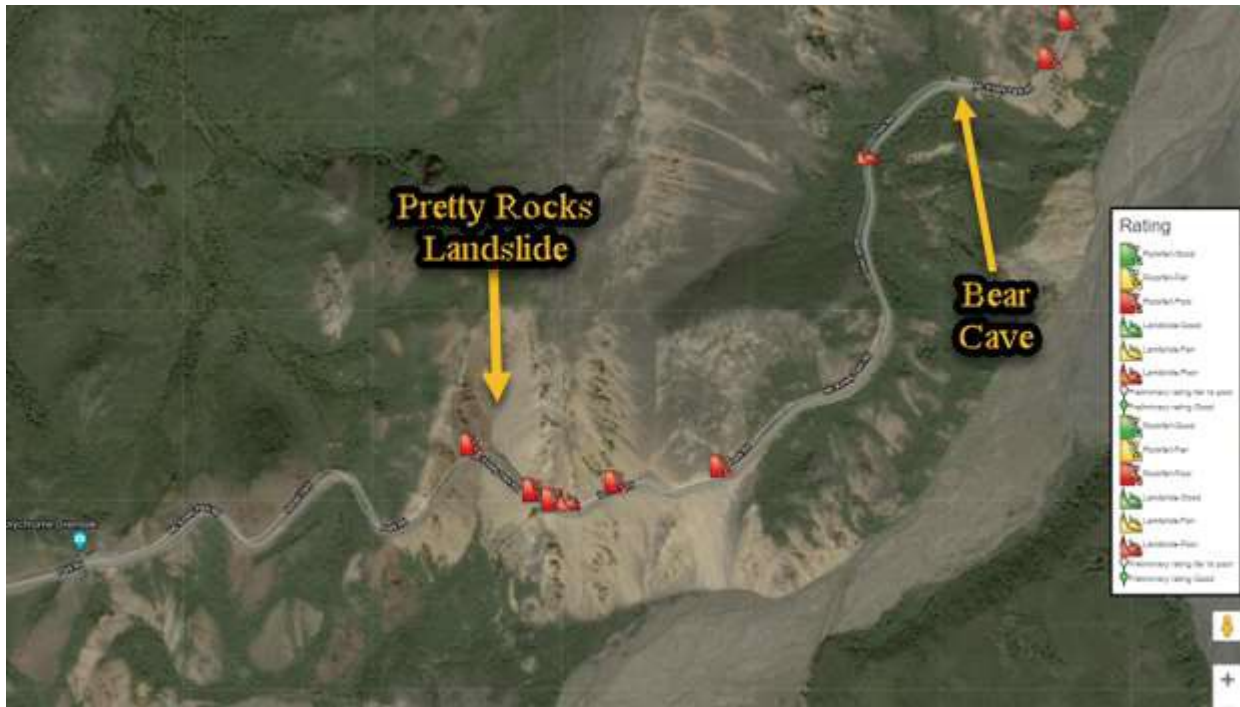


Figure 7. Option 1

Figure 7 shows a portion of the existing mainline road (Option 1) over Polychrome Pass where soil and rock unstable slopes rated higher than 400 points are located. These are the locations where roadway risk reduction improvements and reconstruction efforts are being focused for the comparison to the northern (Option 2) and southern (Option 3A and 3B) alignments being considered. The USMP ratings of nearly 2500 unstable slopes across the United States over time have provided a consistent site condition range of points that correspond to the road/slope condition being generally in a good, fair, and poor condition. The range for good conditioned slopes is typically between 0 and 200 points; fair condition ranges from 200 to 400 points; and a poor condition is generally higher than 400 points, respectively. Although the proposed north and south alignments would be new and assumed to be initially in good condition, the presence of landslides and permafrost will likely result in a good to fair condition road section; therefore, the mainline option comparison has only been brought up to a fair condition for comparison. *(<https://usmp.info/client/login.php>, accessed on 4/2/2020 at 3:16 pm PST.)

The Pretty Rocks Landslide site within Option 1 has been the location of most geologic and geotechnical studies since 2016, where several options were considered for risk reduction and mitigation of the accelerating landslide movement. The current practice, which requires filling in the subsiding roadway to bring it back to grade required an emergency contract to place approximately 5,000 cubic yards of fill and aggregate in 2020 as the movement of the landslide has significantly increased since 2014. This was removed from further consideration as a long-term solution since the movement of the landslide continues to increase and Denali maintenance forces are beginning to struggle to keep up with the releveling of the roadway.

We also conceptualized and considered several risk reduction efforts for the Pretty Rocks Landslide since the 2018 geotechnical drilling investigation, instrumentation, and laboratory testing provided adequate information to characterize the landslide and begin analyzing its stability. Four broader categories with conceptual considerations were brainstormed by FHWA

and NPS in February 2019:

Avoidance:

- Realignment away from the landslide (Options 2, 3A, 3B)
- Remove the landslide – earthwork option
- Bridge the landslide
- Short and long tunnel

Reduce Driving Forces of the Landslide:

- Minor shift in roadway alignment upslope with terracing
- Reduce weight in upper portion of the landslide (redistribute loads, lightweight fill options) – combine with earthwork option where appropriate
- Improve drainage (surface and subsurface) – combine with all alternatives, if feasible

Increase Resisting Forces (external loads):

- Shear key buttress and/or counter berm at landslide toe, or rock-filled shafts to increase shear resistance
- Structural wall with tie-back anchor systems – combine with minor roadway shift and upslope terracing large, pre-cast or cast-in-place anchor pads on the surface of the landslide

Increase Resisting Forces (internally):

- Large area of rock-filled shafts with drainage improvements in the lower landslide – combine with earthwork option
- Ground freezing technology (keep permafrost frozen)

Out of these conceptual alternatives, the avoidance alternatives were moved forward for proof in concept and constructability considerations along with the light weight fill replacement of the roadway embankment with minor earthwork and large pre-cast or cast-in-place anchor pads on the surface of the landslide. The short list of conceptual alternatives moved forward are detailed in the 2018 Geotechnical Investigation and Conceptual Design Considerations Report contained in Appendix J. After presenting this short list of conceptual alternatives with a list of pro's and con's under the proof of concept stage, the NPS selected moving forward with the realignment options (2, 3A, 3B), remove the landslide earthwork option (Appendix I), and bridging the landslide option (Appendix A) in June 2019.

Additional test boring, instrumentation, and laboratory testing was initiated in September 2019 to conduct viability and constructability for the earthwork and bridging options. The Earthwork Option is feasible and constructible and would impair access on the road and would require more than one field season to complete. However, based on our findings, it would likely only be an intermediate risk reduction measure because it would require ongoing and possibly significant work to arrest erosion and failures from newly exposed, very weak rock over the next 50 years initiating from the high, new cut slope above the road. In this option, over one million cubic yards of material (including permafrost rich soils) will need to be removed from the upper hillside to reach the very weak bedrock material to build the road upon. The excavated material will be partially placed on the landslide toe at the base of the slope and to the east on the edge of the valley floor flood plain. The impacts, design, and construction considerations for this option are contained in the Pretty Rocks Landslide Earthwork Feasibility and

Constructability Geotechnical Memorandum 14-20 in Appendix I.

The bridging option is feasible and constructible but will have impacts to existing road access in order to be completed in two construction seasons. Constructing the bridge will take longer if only shoulder season road closures and work are allowed. The Pretty Rocks bridging option discussion and details is further discussed in the REVISED Geotechnical Memorandum 03-20 in Appendix A. Preliminary discussions with NPS in early 2020 resulted in moving forward with the bridging option for this Polychrome Pass Alternatives analyses and cost estimating for Option 1 (Mainline).

Option 2: Northern Alignment

This alignment reroutes Denali Park Road, near the existing East Fork Toklat River Bridge site at MP 43, then westerly through approximately 5.7 miles of mountainous terrain, crossing rivers and several drainages, and includes up to 8 bridges with spans ranging from 225 to 1,175 feet, with the largest bridge crossing the East Fork Toklat River (Figure 8). Option 2 roadway traverses large areas of discontinuous permafrost and landslide features with differing levels of observed activity and rejoins the road near MP 48.



Figure 8. Option 2

Options 3A and 3B: Southern Alignment

Option 3A begins just west of the Ghiglione Bridge near MP 42.1 and Option 3B begins west of the existing East Fork Toklat River Bridge at MP 44.3 (6.3 miles and 5.3 miles long, respectively), per Figure 9. Both alignments meet up after crossing the East Fork Toklat river. The road alignment then traverses a broad valley, known as the Plains of Murie, with wide floodplains, discontinuous permafrost, and muskeg (wetlands). The road reconnects to the existing mainline road at MP 48.5.

Bridges will be required to bridge several active, braided river and stream channels. This option crosses large open drainage areas, which may require bridges between 450 and 3000 feet long, with one of the most substantial ones crossing the East Fork Toklat River at the beginning of Option 3B at 2,500 feet-long and 200 ft. tall.



Figure 9: Options 3A and 3B

DESIGN CONSIDERATIONS

The project development process, no matter which option is chosen, will be quite challenging. While significant efforts have been made to inventory construction needs, development of project plans will require additional field evaluations and geological reconnaissance. This is a critical factor to ensure the success of the project.

Estimated time required for project development for Option 1 (Mainline) is 3 years. Depending on the complexity of the project, estimated project development for Options 2 (North) and 3 (South) routes will need 4 to 6 years. This time factors in preliminary and final engineering (geological analysis, survey design), permitting and procurement.

ROADWAY STRUCTURE

Typical roadway structure for these options will require eight inches of roadway aggregate to be applied to areas that do not cross over permafrost and muskeg, per Figure 9.

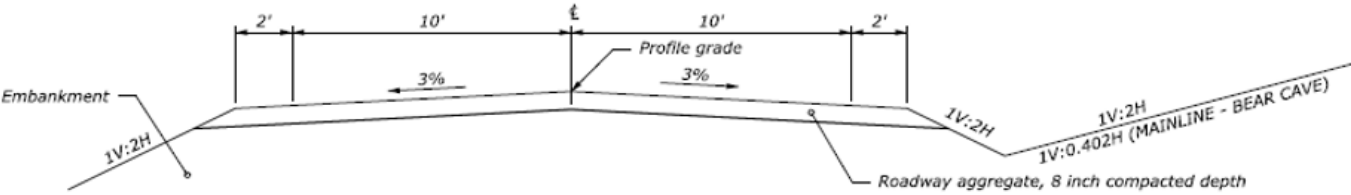


Figure 10. Typical Roadway Section

A considerable amount of material will be needed for Options 2, 3A, and 3B, since these alignments cross through permafrost and muskeg. Due to the anticipated prevalence of permafrost in the northern and southern alignments, excavation was minimized in the profile grades and road locations where possible and embankment sections were kept 3-feet high to maintain drainage. Initial excavation estimates, per typical sections shown in Figures 10 and 11, were calculated and every effort was made to avoid permafrost and muskeg areas during the preliminary design of the alignments. A more in-depth analysis will determine the soil types in the areas and the plan for the analysis is further discussed in the Interim Geotechnical Summary Report of Existing Conditions, Appendix C. Alignments can be further refined as more information is collected.

Initial approximations for Option 2 will require over 4 miles of typical thermal section and under a quarter mile of typical muskeg section, while Option 3 will require approximately 3 to 4 miles of a typical thermal section and 0.5 mile of a typical muskeg section.

When crossing permafrost ground the park has determined that they would like to go with a standard aggregate section rather than a typical thermal section that would contain Styrofoam. The standard section will accelerate permafrost degradation approximately in the first 10 years of life. Aggregate needs will therefore be increased in the first 10 years to maintain the roadway elevation and drainage.

CONSTRUCTION CONSIDERATIONS

Option 1: Mainline

The logistics associated with the mainline option will be similar to previous road and bridge projects completed in the Denali N.P. backcountry and will require 2 to 4 years to construct. Toklat Road Camp is of sufficient size to be used for aggregate material production and most of the space required for construction equipment, materials and project office trailers. Toklat Road Camp also has enough RV trailer spaces to house the contractor's core work force. Additional housing or material storage needs can be met in existing park staging areas and campgrounds.

Although the Mainline Option is smaller in scope and scale than the other Options, it has a greater likelihood of impacting public traffic with construction work occurring immediately adjacent to and within the existing Park Road alignment. Some of these impacts can be mitigated by scheduling work that cannot be completed under public traffic during the shoulder seasons, or at night, when public traffic volumes are lower. However, limiting the work window will extend the overall duration and cost to complete the project.

Options 2 and 3: Northern and Southern Alignment

The Northern and Southern Route Options are much larger in scope and scale than the mainline option and for this reason will require more space for staging equipment, material and personnel than is currently available at existing Denali N.P. facilities and staging areas. Option 2 will require 12 to 14 years and Options 3A and 3B will require 11 to 13 years. These estimates are based on the limited information currently available.

Space for staging should be provided along the proposed routes, or as close as possible, to limit public traffic conflicts and to reduce the travel time between the staging location and active construction. Staging for the Northern and Southern Alignments includes space necessary to perform the following; production and stockpiling of processed roadway material, construction equipment, construction materials, field offices, and lodging for the contractor's work force.

At a minimum, 7 to 10 acres will be required to produce and store aggregate material for roadway construction. For comparison, the portion of Toklat currently used for processing and storing aggregate is approximately 7 acres.

Another 7 to 10 acres of space is needed to stage equipment and miscellaneous construction materials (culverts, geotextile, insulating board, containers for small tool storage, etc.) and field offices for the contractor and subcontractors.

In addition to the staging areas outlined above, each bridge will require a lay down area outside of the proposed alignment to store bridge materials and equipment. Additional space is also required immediately adjacent to the bridge abutments for construction of the bridge foundations and to provide adequate space for crane support. The amount of space will vary depending on the size and complexity of the bridge.

The number of workers supporting the field project work will vary significantly depending on the type and number of construction activities. The anticipated crew size for large bridge and road construction operations is typically 15 to 30 individuals for each operation.

Although it's not necessary to house all the workers on-site, as many are transient and only involved with the work for days or weeks at a time; there is an advantage to housing those

workers that will remain with the project for longer durations. The commute from potential housing locations in Healy, AK to the project site requires 1.5 to 2 hours each direction. If housing options are not provided near the project, it would lead to a shorter work shift (longer construction duration) and higher costs. Housing accommodations for the construction staff only requires providing sufficient space for the contractor to organize a work camp. This camp would likely consist of recreational vehicles with the contractor providing essential services such as water, electricity and waste water disposal.

Although both the Northern and Southern alignment work will be performed outside of the existing alignment, the work will require a significant amount of construction traffic on the first 43 miles of the existing Park Road. To the extent possible, roadway materials (waste, fill and processed material) will be sourced, produced, stored and wasted along the proposed alignments. However, there is still a large volume of material and equipment that will be transported across the existing Park Road including all bridge materials and miscellaneous road construction items. Most of these shipments can be scheduled outside of peak visitation hours. Additional maintenance will be required along the gravel section of the Park Road as a result of the additional construction traffic.

The arctic weather conditions in Denali National Park presents one of the biggest challenges to construction. The months of December and January are too cold to efficiently complete any item of work with low temperatures routinely dropping below -20°F. Temperatures during the months of November and February are generally warmer but can still drop to levels that would prevent construction from occurring. Snow is also prevalent during this time of year and can block access to the work sites. Practically, construction for most operations would begin in March and conclude in October, providing an 8-month construction season. Although the weather in March and October is still marginal for construction with the potential for temperatures to drop below 0°F and snow fall events that block access to and from the work sites.

The topography of the Northern and Southern alignments and distance from the existing Park Road requires a linear sequential approach to road construction. There is not an opportunity to access the proposed alignments at any point other than the beginning and end of the routes where they tie in with the existing Park Road. Temporary bridges may be used to span depressions or drainages that cannot otherwise be traversed until the permanent structures are completed. This will allow construction to proceed at multiple sites concurrently and reduce the overall duration of construction.

GEOTECHNICAL CONSIDERATIONS

There is a considerable difference in the amount of geotechnical information available for each of the alignments. The performance of the existing alignment has been observed for nearly 100 years and there have been several investigations targeted at understanding the geological and geotechnical issues along the road. In contrast, there is very little known about the geological and geotechnical conditions along the north and south alignments; so far, knowledge is limited to what can be synthesized from the following:

- Review of air photos and satellite imagery.
- Observations collected by WFLHD in September of 2019 while walking along the proposed alignment corridors. This includes photos, geological hazard observation (e.g. landslides and permafrost) which is presented as geomorphic mapped units produced by WFLHD (Figure 13), and scattered ground temperature measurements along the south alignment.
- Review of existing geological maps.
- Satellite Interferometric synthetic aperture radar (InSAR) collected and processed by TRE ALTAMiRA in March of 2020.

Note: All mapping and data tables discussed in these bullets are contained in Appendix C in the interim geotechnical summary report of existing conditions

For comparison between the alignments, the slopes have been classified into three categories: less than 20 degrees inclination (less likely to have unstable slopes), 20 to 34 degrees (moderate likelihood of having unstable slopes), and greater than 34 degrees (higher probability of having unstable slopes and initiating snow avalanches). When the preliminary roadway intersection are analyzed with natural slope inclinations, most of the terrain that the alignments intersect is less than 20 degrees in slope (measured in any direction) (Table 2), ranging from approximately 51 percent of the total alignment length for the north alignment to greater than 80 percent of slope intersections greater than 34 degrees. The north alignment has the largest percentage of slope intersections greater than 20 degrees. The south alignments do not have as much intersection with steep slopes, but they do intersect a higher percentage of 20 to 34-degree slopes when compared to the existing alignment

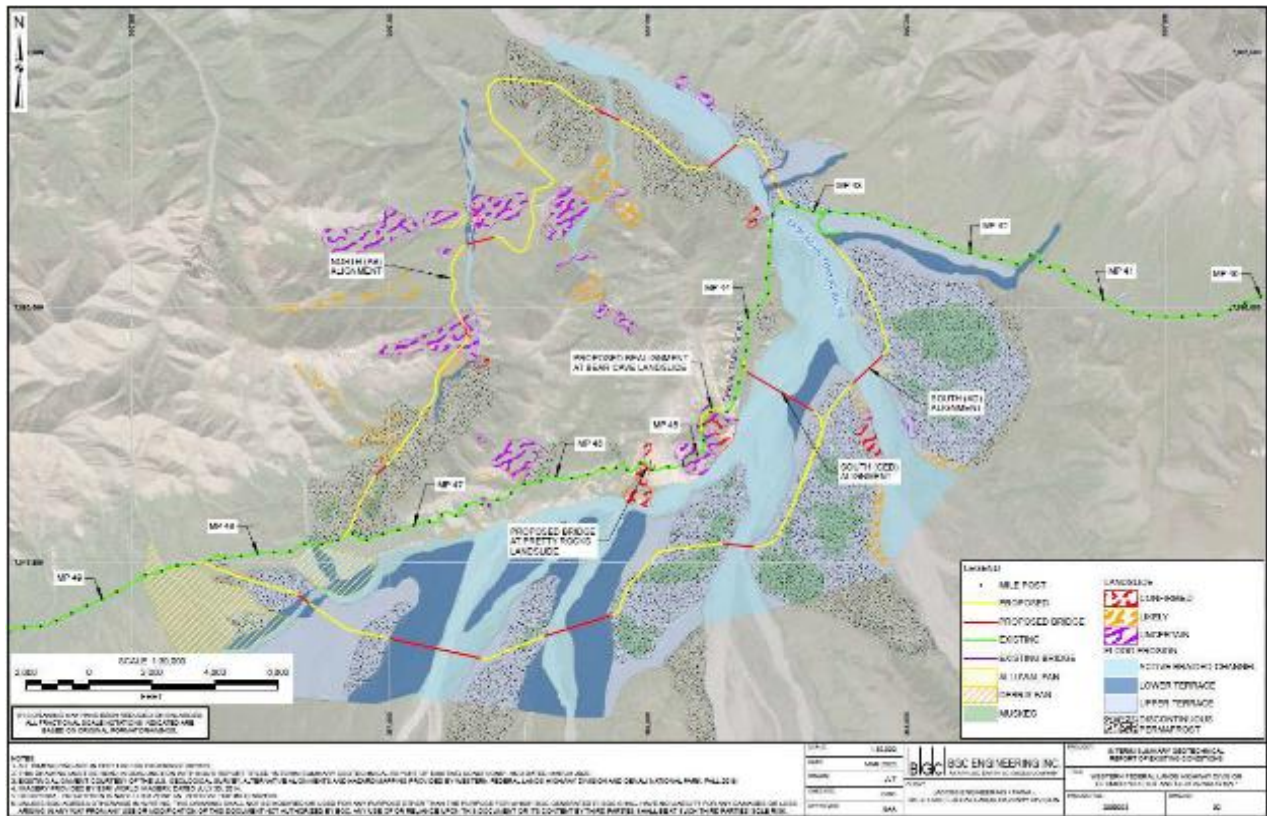


Figure 11. November 2019 Geomorphic Features Mapping by WFLHD

Table 1. Summary of slope class along the existing alignment and the north and south alignments. For reference, please note the Northern Alignment *AB* is Option 2, South Alignment *AD* is Option 3B, South Alignment *CED* is Option 3A, and Existing Alignment is Option 1.

| Slope Class (degrees) | Percentage and Length (ft) of Alignment | | | | | | | |
|-----------------------|---|--------|---------------------------------|--------|----------------------------------|--------|--------------------|--------|
| | North Alignment_AB ^{1,2} | | South Alignment_AD ¹ | | South Alignment_CED ¹ | | Existing Alignment | |
| | Percentage | Length | Percentage | Length | Percentage | Length | Percentage | Length |
| 0 - 20 | 51% | 16,093 | 81% | 25,665 | 83% | 23,264 | 84% | 24,019 |
| 20 - 34 | 25% | 7,774 | 14% | 4,472 | 14% | 3,865 | 8% | 2,229 |
| > 34 | 5% | 1,433 | 5% | 1,529 | 3% | 844 | 9% | 2,518 |
| Total | 80% | 25,300 | 100% | 31,665 | 100% | 27,973 | 100% | 28,765 |

Notes:

1. Letter designations per FHWA GIS alignment files.
2. DEM missing for part of North Alignment. Only 80% of the North Alignment is accounted for.

The distribution in slope inclination intersections and the hazard mapping intersections shown in Figure 13 provide an objective measure for developing comparisons and describing the general character of the alignments and associated geologic hazards. For instance, the existing alignment has more length intersecting steep slopes than other alignments (Table 2) and has more length intersecting landslides (Table 3); the south alignments cross a larger percentage of flatter terrain with permafrost, muskeg, and flood/erosion hazards, and the north alignment is

more of a mixture of geomorphic characteristics with permafrost, flood/erosion hazards, and mapped landslides (Table 3).

Table 2. Summary of hazards along the existing alignment and the north and south alignments. For reference, please note the Northern Alignment AB is Option 2, South Alignment AD is Option 3B, South Alignment_CED is Option 3A, and Existing Alignment is Option 1.

| Hazard Type | | Percentage and Length (ft) of Alignment | | | | | | | |
|-------------------|------------------------|---|-----------------------|---------------------------------|-----------------------|----------------------------------|-----------------------|--------------------|-----------------------|
| | | North Alignment_AB ¹ | | South Alignment_AD ¹ | | South Alignment_CED ¹ | | Existing Alignment | |
| | | Percentage | Length (ft) | Percentage | Length (ft) | Percentage | Length (ft) | Percentage | Length (ft) |
| Permafrost | Discontinuous | 43% | 13,595 | 57% | 17,934 | 50% | 13,886 | - | - |
| Flood/ Erosion | Active Braided Channel | 4% | 1,157 | 12% | 3,695 | 15% | 4,168 | 1% | 155 |
| | Lower Terrace | 1% | 364 | 12% | 3,786 | 14% | 4,035 | 1% | 273 |
| | Upper Terrace | 9% | 2,847 | 71% | 22,394 | 61% | 17,100 | 7% | 1,892 |
| Fans | Debris Fan | 4% | 1,193 | - | - | - | - | - | - |
| | Alluvial Fan | - | - | - | - | - | - | 1% | 340 |
| Muskeg | Muskeg | - | - | 3% | 1,086 | 4% | 1,003 | - | - |
| Landslides | Confirmed | - | - | - | - | - | - | 1% | 302 |
| | Likely | - | - | - | - | - | - | - | - |
| | Uncertain | 5% | 1,495 | - | - | - | - | 6% | 1,641 |
| Alignment Length | | | 31,569 (6.0 miles) | | 31,665 (6.0 miles) | | 27,973 (5.3 miles) | | 28,765 (5.4 miles) |

Note:

1. Letter designations per FHWA GIS alignment files.

Knowledge of the existing conditions on the proposed north and south alignments is based on mapping, a traverse performed on foot in 2019, and InSAR collected in 2020. These data sources and mapping efforts have informed the proposed preliminary investigation plan for the potential new alignments. The InSAR data mapping provides satellite image comparisons that identify areas of ground surface movement to focus efforts for further investigation when looking at long alignment section in potentially unstable geologic settings.

BGC Engineering has prepared a conceptual scope of the preliminary geotechnical investigation, along with a conceptual cost estimate for the contracted exploration services. The preliminary plan along the alternative alignments will include subsurface explorations at the abutments of proposed bridges, three identified landslides, 5.2 miles of earthwork on the north alignment and 4.5 miles on the south alignment. The proposed investigation scope also includes:

- geotechnical drilling,
- sampling and testing,
- temperature subsurface profiles
- geophysical surveys, and
- instrumentation and monitoring.

The locations and quantities of these are shown in Appendix D.

Preliminary drilling for the structures will identify the conditions for foundation design, including material type and frost depth. Given the need to establish site variability and subsurface conditions for type, size, and location (TSL) plans, it is proposed to drill each abutment of each bridge to a depth that would be required for final design. Until bridge TSL plans are complete, no intermediate pier foundations are recommended for drilling under this

preliminary phase of investigation.

Preliminary drilling for the landslides will characterize the subsurface materials and temperatures, denote the presence of groundwater and/or ice, depth of potential landslide movement, and current level of activity. The field exploration program will help develop an understanding of how climate or proposed construction could affect landslide activity. The drilling will also provide insight into whether the landslides could be mitigated, would need to be avoided, or will likely be an ongoing maintenance or safety issue throughout the 50-year design life of the alignment.

Preliminary drilling for the earthwork will provide a better understanding of the spatial variation of permafrost, the depth of seasonal ice, and distribution of subsurface materials and presence of seasonal groundwater conditions. Note that there are means and methods for this work that would cause a relatively high degree of disturbance, such as pioneering roads to provide access to locations for rubber tire or track rigs. To limit disturbance, these methods are not recommended given the long-lasting impacts, and helicopter access is specified for the boring location plan in Drawing 01 of the Conceptual Geotechnical Investigation and Instrumentation Plan in Appendix D.

An alternative approach for accessing sensitive drilling locations, or a combination of the two approaches, would be to use lightweight equipment that can be carried by a team of people, such as the Talon drill by Kryotek. This type of lightweight equipment will not likely be as successful at drilling to depths greater than about 20 feet, may more often hit refusal on cobbles and boulders, and would not provide SPT results, but it would allow for more holes to be drilled, and better characterization of depth of seasonal ice, presence of permafrost, and frost susceptibility variability along the alignments. An alternate plan of test hole locations using this lightweight equipment is proposed in Drawing 02 of the Conceptual Geotechnical Investigation and Instrumentation Plan in Appendix D.

Electrical resistivity tomography (ERT) geophysical surveys will be coupled with boreholes and downhole instrumentation to provide additional insight into the spatial variability of ground ice conditions at bridge, landslide, and earthwork locations along each alignment. Other geophysical methods may be used in conjunction with ERT.

Although the existing alignment has had more study, there are some areas where additional investigation is desired to understand current ground movement or the potential for future ground movement. These six holes will be located between MP 43 and MP 48. Five holes will be drilled from the existing road and one will be drilled below the road and will require helicopter access. Prior investigations at the Polychrome Overlook have focused on landsliding impacting the road. However, the lidar, orthophotos, and InSAR presented in Appendix C along with recent changes in landslide movement at the edge of the parking area since 2018-2019 suggest we should pay close attention to this area as it shows sign of deterioration and has the attributes of the other big landslides on the existing Polychrome Pass. The imagery suggests that there may be two existing landslides lower on the slope. These landslides have a toe at the river elevation or below and while they have not apparently impacted the road yet, if they are active landslides or were to reactivate, they could impact the road in the future. We acknowledge that this unstable slope does not currently rate higher than 400 points in the unstable slope management program, but it would be wise and proactive to characterize the lower landslide features and the risk of potential impact to the Polychrome parking area since this is high value view point and parking area for the visitor experience before additional landslide activity is observed.

Possible aggregate source locations have also been identified in channels and low terraces for preliminary sampling and testing. New aggregate sources will be needed if the north or south alignments are selected, and possible even for work and growing maintenance needs on the existing alignment. These locations are shown on Drawings 01 and 02 of the Conceptual Geotechnical Investigation and Instrumentation Plan in Appendix D. Test pits will be approximately 10 feet deep and will include mapping and bulk samples for grain size analysis and testing for aggregate suitability.

As presented above, the review of aerial and satellite imagery, existing geologic maps, and WFLHD generated geomorphic mapping and data combined with the acquisition of satellite InSAR data has provided the basis for the preliminary geotechnical investigation and instrumentation plan document in Appendix D. The proposed investigation scope includes geotechnical drilling, sampling and testing, geophysical surveys, and instrumentation and monitoring. The approximate conceptual level costs for this preliminary geotechnical investigation for each alignment option is as follows:

| | | |
|-----------|---------------------|-------------|
| Option 1: | Mainline Alignment | \$405,000 |
| Option 2: | Northern Alignment | \$1,190,000 |
| Option 3: | Southern Alignments | \$1,310,000 |

EXPERT BASED RISK ASSESSMENT

An Expert Based Risk Assessment (EBRA) was convened in May 2020 to estimate the long-term geotechnical risks to long-term performance of the three proposed alignment options. Risks such as cost, duration and other non-geotechnical sources of risk were not a part of this assessment except in evaluating how they might affect long-term performance objectives for the roadway.

The long-term performance objectives included:

1. Achieve resilient, low life cycle cost solution
2. Ensure opportunities through continuity of access
3. Hold cultural, aesthetic, and wilderness values intact

Results of the EBRA showed a significant expectation of “exceptional maintenance” activities throughout all of the alignments and that the expectation of a transition to a state of “unpredictable reliability” is a key differentiator between the three alternatives. The EBRA determined that Options 3A and 3B (South Alignments) would most likely meet long-term performance objectives with the lowest long-term geotechnical risks, Option 1 (mainline) had slightly higher risks followed by Option 2 (North Alignment). It is also noted in the EBRA that its findings would need to be considered along with the high cost, long construction period, and potential visual, cultural, and environmental impacts of these alternatives. The Value Analysis was envisioned as the next step in the process to further discussions related to these elements of each design alternative. The complete draft EBRA report is attached in appendix K.

The EBRA highlighted the geotechnical risk that Bear Cave presents to the Park Road. Similar to the bridge solution at the Pretty Rocks landslide, with a more substantial engineering solution at Bear Cave, the risk would significantly be reduced to make Option 1 a more viable alternative. With a more substantive solution at Bear Cave, we feel the geotechnical risks can be

reduced to be more in line with the Option 3 alternatives.

VALUE ANALYSIS

A Value Analysis was conducted in July 2020 to evaluate additional criteria that were not considered during the EBRA. These criteria included providing safe visits and working conditions for vehicles and pedestrians, protecting natural and cultural resources, improving the efficiency, reliability and sustainability of park operations, and providing cost-effective, environmentally responsible and otherwise beneficial development to the national park system. The VA team gave each of these criteria a score based on the advantages and disadvantages of each alignment, these scores are summarized in Figure 12-choosing by advantages. Option 1 (mainline alignment) scored the highest and provided the best value based on importance and initial costs as well as total lifecycle costs. The full draft value analysis report is located in appendix L.

| <i>FACTOR</i> | <i>OPTION 1 (Mainline)</i> | <i>Option 2</i> | <i>Option 3A</i> | <i>Option 3B</i> |
|--|---------------------------------------|------------------------|-------------------------|-------------------------|
| <i>Provide safe visits and working conditions for vehicles and pedestrians</i> | 82 | 30 | 119 | 116 |
| <i>Protect natural and cultural resources</i> | 342 | 29 | 28 | 47 |
| <i>Improve visitor enjoyment through better service and educational and recreational opportunities</i> | 238 | 84 | 97 | 100 |
| <i>Improve the efficiency, reliability and sustainability of park operations</i> | 188 | 0 | 29 | 53 |
| <i>Provide cost-effective, environmentally responsible and otherwise beneficial development to the national park system</i> | 72 | 66 | 0 | 6 |
| | | | | |
| <i>Total Importance of advantages (benefits)</i> | 922 | 209 | 273 | 322 |

Figure 12: Choosing by advantages summary table
note: for full table with sub-factors for each category refer to appendix L.

AGGREGATE MATERIAL SOURCE CONSIDERATIONS

Proposed Construction and Maintenance Aggregate Areas

To avoid importing considerable embankment and quality aggregate materials into the Park, we recommend considering aggregate needs for the initial construction and for up to 50 years of maintenance. For the south alignment option, the preliminary embankment and aggregate surfacing needed to build the roadway sections between drainages from the East Fork Bridge to the west are shown in the white polygons with the estimated volume of aggregate noted for each. The northern alignment option preliminary aggregate needs is illustrated in yellow polygons, and the absence of drainages for aggregate production along the northern alignment requires the use of two large areas identified in the East Fork River drainage to build the northern alignment option, per Figure 13.



Figure 13. Aggregate Sources. North alignment (yellow polygon) preliminary road aggregate construction needs is approximately 1.86 million cubic yards (CY), and the south alignments preliminary road construction aggregate needs is about 2.25 million CY

For all the alignments, the assumptions for the aggregate scraping process is the average depth of scraping, 3 feet deep, in one mining entry for constructing the initial alignments. The assumed loss of material during aggregate production is 10%, based on Toklat River Scrap Aggregate Processing measurements over the years. Due to the unknown mix of embankment

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materials and bridge spans for stream crossing designs at this time, we have assumed that embankments will be used for the width of the drainage rather than bridges to estimate the aggregate needs. This allows for additional aggregate area and capacity in the preliminary planning because the quality of the aggregate in each of these drainages, originating from differing geologic formations, is unknown until a material investigation confirms quality aggregate products in each drainage. We are hopeful these areas will be reduced as the material investigation confirms quality aggregate materials for road building and it becomes clearer what combination of bridge lengths and embankments may be used for the drainage crossings.

Maintenance for 50 years on the new alignments (Option 2, 3A, 3B) would require more aggregate than the currently permitted Toklat (north of the causeway) and East Fork River scrape areas can provide. In an effort to minimize the impact on the landscape following initial road building needs, an area of the Toklat River (south of the causeway) could be considered as a new source of aggregate for the realignment options. See Figure 14 for the location of the proposed maintenance aggregate source for the new alignments and an estimated area for the gravel portion of the Denali Park Road for the next 100 years. Maintenance provided the assumption that 20,000 cubic yards per year of aggregate would be needed.”

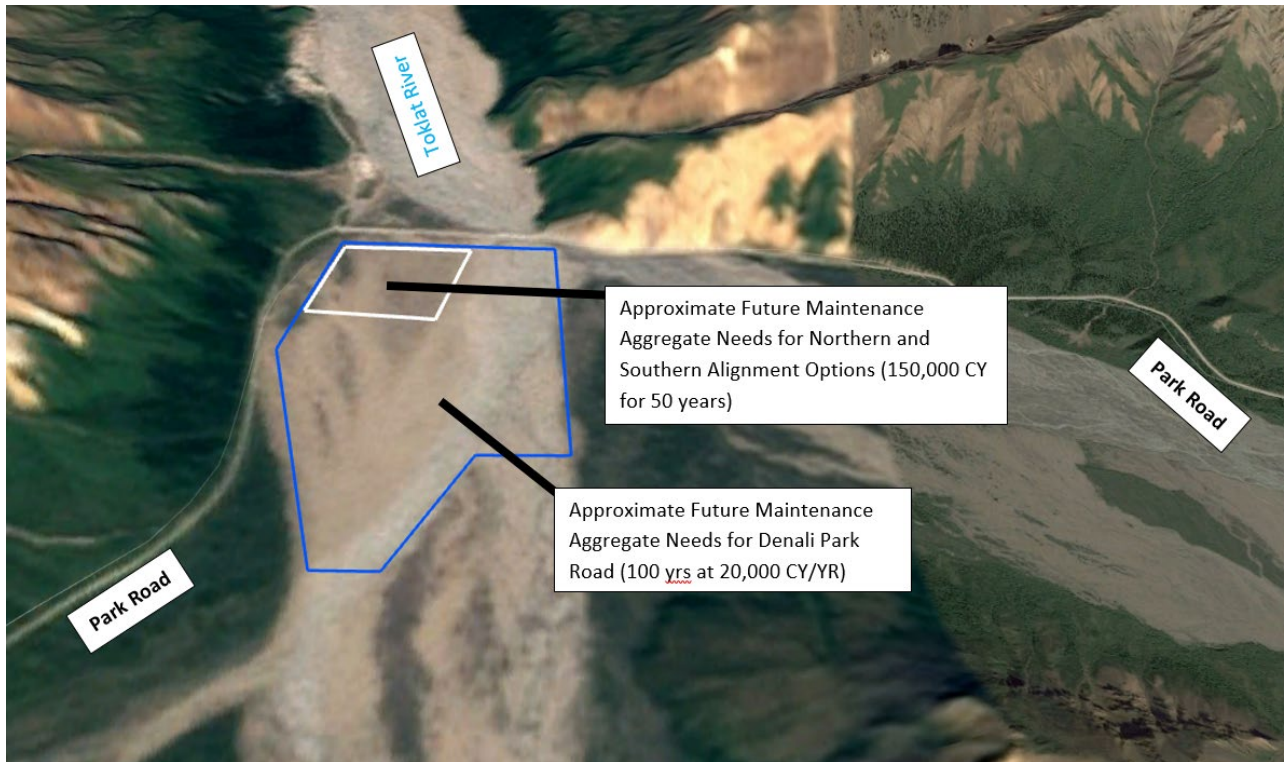


Figure 14. Proposed Maintenance Aggregate Source

Greater aggregate quantities than currently estimated (at 500 cubic yards (CY) per year) for the existing alignment over Polychrome Pass will be required to maintain a new northern or southern alignment. At this time, with limited information, we estimate that we will need to replace several culverts in the 50-year design life as a result of permafrost melting related subsidence, to continually add aggregate to the new alignment to maintain the vertical grade for

drainage as the roadway subsides, and for the problematic roadway sections in need of spot repairs, similar to other road building projects over intermittent to sporadic permafrost and mapped landslides such as, the Dalton Highway.

Currently, the preliminary design suggests construction aggregate needs for the northern alignment is about 1.9 million CY while the southern (longer) alignment will require approximately 2.3 million CY of aggregate. Based on these preliminary assumptions, it is assumed there will be a need for about 50% of the initial aggregate needs, at approximately 1 million CY of quality aggregate for maintenance over the 50-year design life of a new alignment. It is our opinion that the existing Toklat (North) and East Fork River scrape areas can be augmented to maintain the northern, and southern alignments as shown in the Toklat (South – of the causeway) area. Another advantage of designating the maintenance aggregate needs area to the south of the Toklat Causeway, is scrapes could be designed to improve upstream hydraulic interaction with the causeway embankment and bridge sections, which are frequently in need of repair and fortification to protect the Park Road.

STRUCTURE CONSIDERATIONS

Option 1, Mainline alignment would require only one bridge, a new structure at the Pretty Rocks Landslide. The most feasible (although still very challenging) option would be a launchable modular steel truss. A launchable steel truss is one that is assembled at one end and pushed out or cantilevered out over the ground or river that is intended to be crossed. For shorter spans, this can be accomplished without cranes. For the span length at this site a large crane will likely still be needed near the western abutment. Another option would be to construct the truss along a parallel alignment to the permanent location and then lift the bridge onto its foundation with two large cranes. This method would still utilize constructing this bridge at the eastern abutment and pushing it out along the temporary road alignment. The maximum span length for commercially available bridges of this type is in the order of 400 feet. Site constraints, crane locations, and limited work space are still major constructability challenges for the launchable modular steel truss option.

Other advantages of this structure type include light weight small structural pieces (easier transportation to the remote site), high friction metal plate decks (eliminating casting concrete deck in remote location), and relatively quick construction/launch of the superstructure (minimal impacts to traffic from road closures). Figure 15 shows the typical section for a single lane launchable bridge.

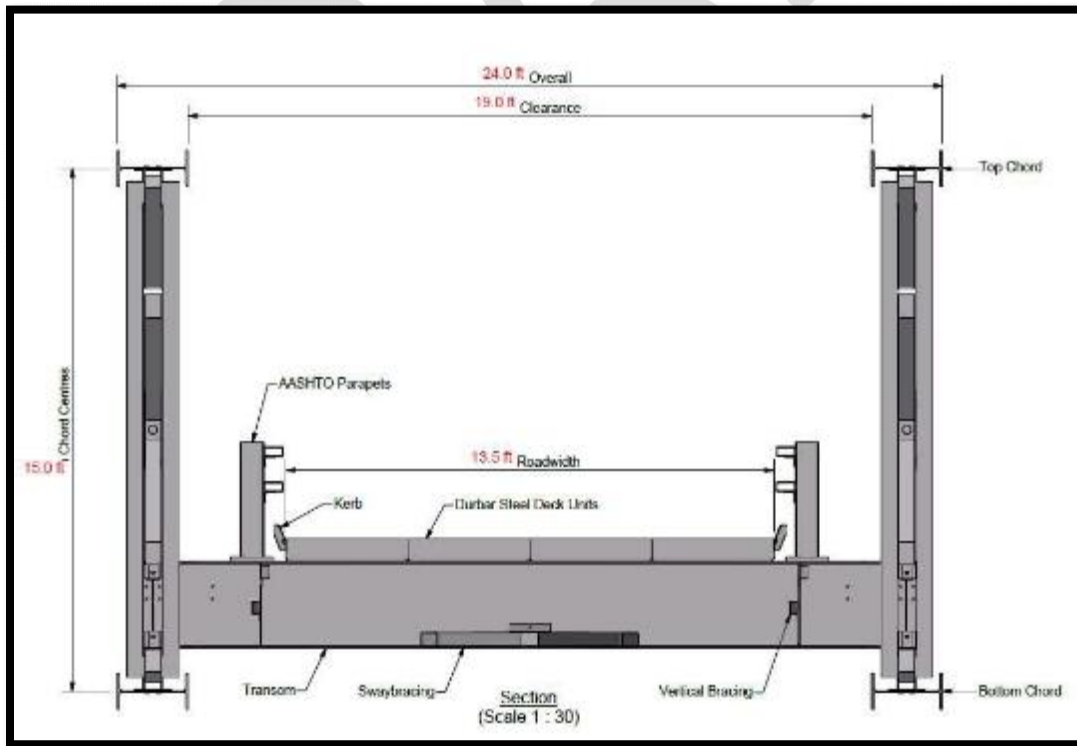


Figure 15. Typical Section Single Lane Launchable Truss

Option 2 (Northern - mountainous realignment) – would require approximately eight bridge structures. These bridges range in size and complexity from medium to large, with bridge lengths ranging from 225 to 1,175 feet for a total of over 4000 feet. Maximum bridge heights for structures on this crossing are approximately 75 feet, with the majority of structures less than 50 feet tall. The taller and longer structures will most efficiently be spanned with steel plate girder bridges. See Appendix F for a typical layout of this bridge type. For the smaller and lower structures, bridge superstructures constructed with precast concrete decked bulb-tee will be most efficient. See Appendix F for a typical layout of this bridge type. For the taller and longer spans, cost of tall piers starts to offset the higher cost of steel girders.

Option 3 (Southern - valley floor realignment) – would require the greatest amount of new bridges to be constructed, ranging from 5 to 8 with over 9,000 feet of bridge total span required. The overall project parameters limit excavation into the permafrost and tundra along the new alignments. As such the bridge structures along this route will follow vertical profiles that span from the tops of the land forms and will create very tall bridges (some of the crossings would be approximately 150 to 200 feet above the existing ground). Similar to Option 2, the taller and longer structures will most efficiently be spanned with steel plate girder bridges. See Appendix F for a typical layout of this bridge type. For the smaller and lower structures, bridge superstructures constructed with precast concrete decked bulb-tee will be most efficient.

General considerations, every effort should be made to prefabricate structural bridge elements, including precast concrete piers, abutments, concrete decks and girder or truss elements. Transporting or mixing fresh concrete at the bridge sites will be challenging (especially for the quantities of concrete needed for Option 2 and Option 3). Long span steel plate girders will have transportation challenges and will need to be fabricated in the lower 48 states, barged to Anchorage then trucked to the bridge locations. For precast concrete decked bulb-tee bridge superstructures, if span lengths are limited to 140 feet to 145 feet the girders could be fabricated in Alaska.

The existing East Fork Toklat River Bridge pier foundations appear to be founded on rock. This is based off evaluation of the as-built change orders where steel casing and the concrete footings were advanced to a stable rock layer). This impacts discussion on risk to the existing bridge being susceptible to outburst flooding associated with the Pretty Rocks Landslide failure. Based on the as-built plans the risk is low, as the bridge is not a shallow foundation on erodible material.

ENVIRONMENTAL CONSIDERATIONS

Environmental Feasibility Study, Appendix D, outlines the environmental considerations at the Mainline alignment, the Northern alignment, and the Southern alignment. All options will require work within federally designated wilderness and will take approximately 3 to 4 years to complete an Environmental Impact Study. Impacts to this landscape will range from removing the upper portion of the pretty rocks landslide, bridging the Pretty Rocks landslide at Polychrome Pass or full construction of optional routes to the north or south.

| Options & Aggregate Source | Agg Source (CUYD) | Estimated Impacts (ACRES) |
|---|--------------------------|----------------------------------|
| Mainline (1) Road Corridor | | 45 |
| North Alignment (2) Road Corridor | | 362 |
| North Alignment (2) Agg Source | 1,863,000 | 385 |
| South Alignment (3A) Road Corridor | | 365 |
| South Alignment (3B) Road Corridor | | 318 |
| Southern Agg Source 1 | 651,000 | 135 |
| Southern Agg Source 2 | 443,000 | 92 |
| Southern Agg Source 3 | 399,000 | 82 |
| Southern Agg Source 4 | 756,000 | 156 |
| Future Maintenance Agg (1) ¹ | 90,000 | 0 |
| Future Maintenance Agg (2, 3A, 3B) ^{2,3} | 150,000 | 31 |

Table 3. Estimated Impact Areas

HYDRAULIC CONSIDERATIONS

WFLHD hydraulics group reviewed each option for fluvial geomorphic, hydrologic, and hydraulic considerations. The results are explained in detail in the Polychrome Pass Alternatives Analysis Hydraulics Memo in Appendix F.

The drainage infrastructure in place for the existing roadway, Option 1 (Mainline), will largely be maintained with minor drainage improvements with the Bear Cave cylinder pile wall proposed. Option 2 (North), reroutes the Denali Park Road through one crossing of the East Fork Toklat River and several additional crossings of moderately sized drainageways. There are more drainage crossings in Option 2 (North) compared to Options 3A & 3B (South); however, the additional drainage crossings are generally smaller, the channels are more confined, and the systems appear to be less dynamic. Option 3, reroute south of the existing Polychrome Pass crossing, must cross four large glacier fed tributaries of the East Fork Toklat River, per Figure 16.



Figure 16. Drainageways

Since the tributaries to the East Fork Toklat River are fed by glacier meltwater, the high flows are likely to occur during the construction season. Braided systems generally have low discharges comparable to their width so flow rates will likely be manageable during construction using diversion and dewatering techniques. However, due to the dynamic nature of the braided

systems diversions required within the braided glacier fed streams may require more frequent monitoring and maintenance.

GEOMATICS CONSIDERATIONS

Survey efforts for the three primary options near Polychrome Pass will vary greatly. All three options will include ground control and pre-design topography using ground-based methods. Current topography from remote sensing applications will continue to be used for planning level studies, but preparation of contract documents will require additional monuments and ground-based topography to capture updated changes in slides, water courses, and existing roadway profiles. Also to be considered is the staking of multiple alignment options for field reviews.

Option 1 (Mainline) represents the lowest level of expected survey effort. While the width of required topography is relatively large in some areas, the easy access and the shorter length make these options much quicker and easier to survey. Some rock slopes along the existing roadway can be mapped using laser scanners to minimize safety concerns.

Options 3A and 3B (South) represent the second lowest level of effort for survey. Alignments in this area are generally in flat uniform glacial moraine. While there is some vertical relief, the uniformity of the surface allows topography to be generated using a lower point density. Also, the expected cuts and fills should be relatively narrow which reduces the amount of area that needs to be mapped. The length of the southerly routes (6 miles \pm) are significantly greater than options along the existing roadway. Mapping a corridor of this length without vehicular access does involve increased time to walk in, effectively reducing the daily production rate and increasing the number of days needed to complete the work, therefore increasing costs.

Option 2 (North) is the most challenging route from the standpoint of survey effort. The potential route is approximately the same length as the southern route but involves much more vertical relief and much less uniform terrain. Cuts and fills along this route will be much bigger, which leads to the need for a wider swath of topographic data. The steep side slopes in this area also mean that it generally takes longer to move from one topo data point to the next and the lack of uniformity in the terrain means that more data points need to be collected. Combined with a more difficult walk in from the existing roadway, the northern option will require a significantly greater effort than either of the other options.

As a level of effort comparison, it is expected that Option 3A and 3B (South) would take 3 to 4 times the amount of effort as Option 1 (Mainline) along the existing roadway and Option 2 (North) would take 5 to 7 times the same effort. Because of the type of terrain and vegetative cover, the northern options also represent a much higher risk of animal interactions and a much more difficult challenge to remedy any personal injuries that occur while so far off the existing road corridor.

SAFETY CONSIDERATIONS

The WFLHD Highway Safety Team completed a safety assessment with the use of the Interactive Highway Safety Design Model (IHSDM) for the four proposed Polychrome Pass options. The overall goal for this study is to provide a high-level comparison among the project options to approximate the safety performance over the design life. For this study, the results from this high-level analysis are essentially a measure of the exposure to the traveling public for each alignment. An increase in exposure, such as increased alignment length, additional horizontal curves, steep grades, roadside hazards, etc., is correlated with an increase in crashes.

While most motorists in this section of the Park will be familiar with the road and its conditions, differences in exposure will still correlate with expected crashes over time. From a safety perspective and based on the geometry data available at this time, the following is the preferred order of alignment options: Southern Options 3A and 3B, Option 2 North alignment, and Option 1 Mainline alignment. Please see the Polychrome Pass Alternatives Analysis Safety and Traffic Assessment Memorandum in Appendix G for further discussion.

SUMMARY OF COSTS

A breakdown of costs for each of the design options is shown below in Tables 5 to 8. Inflation is calculated using the average inflation rate over the past 10 years. It is important to keep in mind total project costs shown can vary by +/- 5% as more information is gathered for each of the options. The construction duration for each option is taken into consideration when determining the percentages used in the estimates.

| Option 1 - Mainline Construction Cost Estimate | | |
|---|---|-----------------------|
| Description | Unit | Total Cost |
| Clearing & Grubbing | ACRE | \$ 12,600 |
| Roadway Excavation | CUYD | \$ 4,380,000 |
| Unclassified Borrow | CUYD | \$ 980,000 |
| Select Borrow | TON | \$ 238,500 |
| Separation-Stabilization Geotextile, Class 1, Type C | SQYD | \$ 30,200 |
| Polystyrene Foam, Type V | SQYD | \$ 307,500 |
| Roadway Aggregate, Method 2 | TON | \$ 1,220,300 |
| Structures | LPSM | \$ 12,000,000 |
| Geotechnical | LPSM | \$ 1,665,500 |
| Bear cave Improvements | LPSM | \$ 17,260,000 |
| Perlite improvements | LPSM | \$ 1,085,000 |
| | <u>Subtotal 1 =</u> | \$ 39,179,600 |
| <u>Temporary Traffic Control</u> | | \$ 4,701,600 |
| <u>Permanent Traffic Control</u> | | \$ 1,175,400 |
| <u>Soil Erosion Control</u> | | \$ 1,959,000 |
| <u>Drainage</u> | | \$ 3,918,000 |
| <u>Re-vegetation</u> | | \$ 587,700 |
| <u>Construction Scheduling</u> | | \$ 587,700 |
| <u>Contractor QC/QA and Testing</u> | | \$ 1,959,000 |
| <u>Survey and Staking</u> | | \$ 783,600 |
| <u>Contingency</u> | | \$ 7,836,000 |
| | <u>Subtotal 2 =</u> | \$ 62,687,600 |
| <u>Mobilization</u> | | \$ 7,523,000 |
| | <u>Subtotal 3 =</u> | \$ 70,210,600 |
| | <u>Inflation (1.9%/year for 4 years) =</u> | \$ 5,490,000 |
| | Total Estimated Construction Cost, 2024 = | \$ 75,701,000 |
| <hr/> | | |
| Additional Components | | Estimated Cost |
| Preliminary Engineering | | \$7,570,100 |
| Construction Engineering | | \$7,570,100 |
| | Total Estimated Project Development Cost = | \$15,140,200 |
| | Total Project Cost = | \$ 90,841,200 |

Table 4. Option 1 Estimate

| Option 2: Northern Alignment Construction Estimate | | |
|---|---|-----------------------|
| Description | | Total Cost |
| Clearing & Grubbing | | \$ 628,900 |
| Roadway Excavation | | \$ 109,000 |
| Unclassified Borrow | | \$ 29,084,000 |
| Select Borrow | | \$ 2,620,700 |
| Separation-Stabilization Geotextile, Class 1, Type C | | \$ 321,600 |
| Polystyrene Foam, Type V | | \$ 3,265,900 |
| Roadway Aggregate, Method 2 | | \$ 1,266,300 |
| Structures | | \$ 53,700,000 |
| | Subtotal 1 = | \$ 90,996,400 |
| <u>Temporary Traffic Control</u> | 1.5% | \$ 1,365,000 |
| <u>Permanent Traffic Control</u> | 1.5% | \$ 1,365,000 |
| <u>Soil Erosion Control</u> | 5% | \$ 4,549,900 |
| <u>Drainage</u> | 4% | \$ 3,639,900 |
| <u>Re-vegetation</u> | 1.5% | \$ 1,365,000 |
| <u>Construction Scheduling</u> | 1.5% | \$ 1,365,000 |
| <u>Contractor QC/QA and Testing</u> | 5% | \$ 4,549,900 |
| <u>Survey and Staking</u> | 1% | \$ 910,000 |
| <u>Contingency</u> | 20% | \$ 18,199,300 |
| | Subtotal 2 = | \$ 128,305,400 |
| <u>Mobilization</u> | 12% | \$ 15,397,000 |
| | Subtotal 3 = | \$ 143,702,400 |
| | <u>Inflation (1.9%/year for 4 years) =</u> | <u>\$ 11,237,000</u> |
| | Total Estimated Construction Cost, 2024 = | \$ 154,940,000 |
| Additional Components | | Estimated Cost |
| Preliminary Engineering | 10% | \$15,494,000 |
| Construction Engineering | 10% | \$15,494,000 |
| | Total Estimated Project Development Cost = | \$30,988,000 |
| | Total Project Cost = | \$ 185,928,000 |

Table 5. Option 2 Estimate

| Option 3A - Southern Alignment Construction Cost Estimate | | |
|--|---|-----------------------|
| Description | | Total Cost |
| Clearing & Grubbing | | \$ 547,000 |
| Roadway Excavation | | \$ 2,440,000 |
| Unclassified Borrow | | \$ 11,948,000 |
| Select Borrow | | \$ 2,946,800 |
| Separation-Stabilization Geotextile, Class 1, Type C | | \$ 325,900 |
| Polystyrene Foam, Type V | | \$ 3,242,900 |
| Roadway Aggregate, Method 2 | | \$ 1,101,300 |
| Structures | | \$ 112,200,000 |
| | Subtotal 1 = | \$ 134,751,900 |
| <u>Temporary Traffic Control</u> | 1.5% | \$ 2,021,300 |
| <u>Permanent Traffic Control</u> | 1.5% | \$ 2,021,300 |
| <u>Soil Erosion Control</u> | 5% | \$ 6,737,600 |
| <u>Drainage</u> | 4% | \$ 5,390,100 |
| <u>Re-vegetation</u> | 1.5% | \$ 2,021,300 |
| <u>Construction Scheduling</u> | 1.5% | \$ 2,021,300 |
| <u>Contractor QC/QA and Testing</u> | 5% | \$ 6,737,600 |
| <u>Survey and Staking</u> | 1% | \$ 1,347,600 |
| <u>Contingency</u> | 20% | \$ 26,950,400 |
| | Subtotal 2 = | \$ 190,000,400 |
| <u>Mobilization</u> | 12% | \$ 22,800,000 |
| | Subtotal 3 = | \$ 212,800,400 |
| | <u>Inflation (1.9%/year for 4 years) =</u> | <u>\$ 16,640,000</u> |
| | Total Estimated Construction Cost, 2024 = | \$ 229,441,000 |
| <hr/> | | |
| Additional Components | | Estimated Cost |
| Preliminary Engineering | 10% | \$22,944,100 |
| Construction Engineering | 10% | \$22,944,100 |
| | Total Estimated Project Development Cost = | \$45,888,200 |
| | Total Project Cost = | \$ 275,329,200 |

Table 6. Option 3A Estimate

| Option 3B - Southern Alignment Construction Cost Estimate | | |
|--|---|-----------------------|
| Description | | Total Cost |
| Clearing & Grubbing | | \$ 426,000 |
| Roadway Excavation | | \$ 13,200 |
| Unclassified Borrow | | \$ 8,364,000 |
| Select Borrow | | \$ 2,390,600 |
| Separation-Stabilization Geotextile, Class 1, Type C | | \$ 255,600 |
| Polystyrene Foam, Type V | | \$ 2,525,700 |
| Roadway Aggregate, Method 2 | | \$ 857,700 |
| Structures | | \$ 110,100,000 |
| | Subtotal 1 = | \$ 124,932,800 |
| <u>Temporary Traffic Control</u> | 1.5% | \$ 1,874,000 |
| <u>Permanent Traffic Control</u> | 1.5% | \$ 1,874,000 |
| <u>Soil Erosion Control</u> | 5% | \$ 6,246,700 |
| <u>Drainage</u> | 4% | \$ 4,997,400 |
| <u>Re-vegetation</u> | 2% | \$ 1,874,000 |
| <u>Construction Scheduling</u> | 2% | \$ 1,874,000 |
| <u>Contractor QC/QA and Testing</u> | 5% | \$ 6,246,700 |
| <u>Survey and Staking</u> | 1% | \$ 1,249,400 |
| <u>Contingency</u> | 20% | \$ 24,986,600 |
| | Subtotal 2 = | \$ 176,155,600 |
| <u>Mobilization</u> | 12% | \$ 21,139,000 |
| | Subtotal 3 = | \$ 197,294,600 |
| | <u>Inflation (1.9%/year for 4 years) =</u> | <u>\$ 15,427,000</u> |
| | Total Estimated Construction Cost, 2024 = | \$ 212,722,000 |
| <hr/> | | |
| Additional Components | | Estimated Cost |
| Preliminary Engineering | 10% | \$21,272,200 |
| Construction Engineering | 10% | \$21,272,200 |
| | Total Estimated Project Development Cost = | \$42,544,400 |
| | Total Project Cost = | \$ 255,266,400 |

Table 7. Option 3B Estimate

See Table 8 below for the estimated bridge lengths, construction costs, PE labor costs, and PE labor hours associated with each design option.

| Option 1 - Mainline Alignment - Bridge at Pretty Rocks | | | | | |
|---|--------------------|----------------|---------------------------------|------------------|--------------|
| | Bridge Data | | Bridge Costs Only | | |
| | Length LNFT | Deck Area SQFT | Construction Cost (Bridge ONLY) | PE Labor (cost) | PE Labor Hrs |
| Bridge #1 | 400 | 7,200 | \$12,000,000 | \$437,500 | 2,500 |
| TOTALS = | 0 | 7,200 | \$12,000,000 | \$437,500 | 2,500 |

| Option 2 - Northern Alignment | | | | | |
|--------------------------------------|--------------------|----------------|---------------------------------|--------------------|---------------|
| | Bridge Data | | Bridge Costs Only | | |
| | Length LNFT | Deck Area SQFT | Construction Cost (Bridge ONLY) | PE Labor (cost) | PE Labor Hrs |
| Bridge #1 | 225 | 5,400 | \$2,700,000 | \$202,500 | 1,200 |
| Bridge #2 | 225 | 5,400 | \$2,700,000 | \$202,500 | 1,200 |
| Bridge #3 | 1,175 | 28,200 | \$14,100,000 | \$1,057,500 | 6,000 |
| Bridge #4 | 900 | 21,600 | \$10,800,000 | \$810,000 | 4,600 |
| Bridge #5 | 950 | 22,800 | \$11,400,000 | \$855,000 | 4,900 |
| Bridge #6 | 250 | 6,000 | \$3,000,000 | \$225,000 | 1,300 |
| Bridge #7 | 300 | 7,200 | \$3,600,000 | \$270,000 | 1,500 |
| Bridge #8 | 450 | 10,800 | \$5,400,000 | \$405,000 | 2,300 |
| TOTALS = | 4,475 | 107,400 | \$53,700,000 | \$4,027,500 | 23,000 |

| Option 3A - Southern Alignment - Not Over existing East Fork Toklat River Bridge | | | | | |
|---|--------------------|----------------|---------------------------------|--------------------|---------------|
| | Bridge Data | | Bridge Costs Only | | |
| | Length LNFT | Deck Area SQFT | Construction Cost (Bridge ONLY) | PE Labor (cost) | PE Labor Hrs |
| Bridge #1 | 750 | 18,000 | \$9,000,000 | \$675,000 | 3,900 |
| Bridge #2 | 150 | 3,600 | \$1,800,000 | \$135,000 | 800 |
| Bridge #3 | 425 | 10,200 | \$5,100,000 | \$382,500 | 2,200 |
| Bridge #4 | 1,350 | 32,400 | \$16,200,000 | \$1,215,000 | 6,900 |
| Bridge #5 | 950 | 22,800 | \$11,400,000 | \$855,000 | 4,900 |
| Bridge #6 | 2,275 | 54,600 | \$27,300,000 | \$2,047,500 | 11,700 |
| Bridge #7 | 3,000 | 72,000 | \$36,000,000 | \$2,700,000 | 15,400 |
| Bridge #8 | 450 | 10,800 | \$5,400,000 | \$405,000 | 2,300 |
| TOTALS = | 9,350 | 224,400 | \$112,200,000 | \$8,415,000 | 48,100 |

| Option 3B - Southern Alignment - Over existing East Fork Toklat River Bridge | | | | | |
|---|--------------------|----------------|---------------------------------|--------------------|---------------|
| | Bridge Data | | Bridge Costs Only | | |
| | Length LNFT | Deck Area SQFT | Construction Cost (Bridge ONLY) | PE Labor (cost) | PE Labor Hrs |
| Bridge #1 | 2,500 | 60,000 | \$30,000,000 | \$2,250,000 | 12,900 |
| Bridge #2 | 950 | 22,800 | \$11,400,000 | \$855,000 | 4,900 |
| Bridge #3 | 2,275 | 54,600 | \$27,300,000 | \$2,047,500 | 11,700 |
| Bridge #4 | 3,000 | 72,000 | \$36,000,000 | \$2,700,000 | 15,400 |
| Bridge #5 | 450 | 10,800 | \$5,400,000 | \$405,000 | 2,300 |
| TOTALS = | 9,175 | 220,200 | \$110,100,000 | \$8,257,500 | 47,200 |

Assumptions -
 *Labor rate - for typical bridge project Structural PE = 10% cost of bridge construction, assume some efficiency with repeating structure type for all spans, use 7.5%
 *Cost per SQFT of bridges - Option 1: \$1,250 (unique long single span bridge) Options 2 & 3: \$500 per SQFT (height of bridges and remoteness of locations increase costs over typical Alaska bridge construction)
 *Deck width - Option 1: 18 ft curb to curb, Options 2 & 3: 24 ft curb to curb

Table 8. Bridge Estimates

ALTERNATIVE CONTRACTING METHODS

Contracting methods create an environment for successful project delivery. There are three primary contracting methods for federally funded highways: design-bid-build (D-B-B), design-build (D-B), and construction manager/general contractor (CM/GC). The vast majority of the highway system was built with the D-B-B delivery method. Potential benefits of the two alternative contracting methods, D-B and CM/GC, include saving project costs, lowering operational costs and/or project lifecycle costs, improving constructability, enhancing innovation, reducing risk, expediting project delivery, and shortening construction schedules..

Definitions of Project Delivery Methods

- D-B-B. This is the traditional delivery method where the agency contracts separately for design and construction services, the bid is based on complete (100 percent) plans and specifications, and design and construction occur sequentially. D-B-B is typically a unit priced contract, but it can also include lump-sum items.
- CM/GC. The agency procures professional services on a qualifications or best-value basis from a construction manager during the design phase to offer suggestions on innovations, cost and schedule savings, and constructability issues. Upon completion of the design or individual design packages, the contractor and agency negotiate a price for the construction contract, and then the construction manager acts as a general contractor to complete construction. The contract can employ a guaranteed maximum price administered on a cost-reimbursable basis, unit price, or lump-sum contract.
- D-B. The agency contracts with one entity to complete the design and construction of a project under a single contract, typically a lump sum with allowances or unit cost items to address risk. D-B has been implemented using various procurement approaches, including qualified low bid (LB) and best value (BV).

In summary, it has been shown that alternative contracting methods are shorter in duration, have an earlier cost certainty, and have a higher project intensity. In essence, agencies are getting more work in place with less disruption to the traveling public. WFLHD has utilized CM/CG contracting methods with great success on recent projects. Moving forward with the chosen alternative, it is likely that this method of contracting would be selected as a way to improve constructability and lower costs.

POTENTIAL FUNDING SOURCES

With the estimated Polychrome construction costs ranging from \$91M to \$275M, the funding sources currently available both through the Federal Highway Administration and the National Park Service are likely not enough to viably fund the project in full. Funds would likely need to be appropriated from federal legislation to fund construction. Below are a range of funding sources available for NPS transportation projects. Although most of them will not have enough funding available as a single source, they may be able to fund a portion of the project.

Federal Lands Transportation Program

The National Park Service receives transportation infrastructure funding from the Federal Highway Trust Fund through a program called the Federal Lands Transportation Program (FLTP). The NPS FLTP is jointly administered by the secretaries of the Department of the Interior (DOI) and the Department of Transportation under federal statute (23 U.S.C. 203(a) (3) and 315). The NPS FLTP is the main source of funding for transportation infrastructure improvements in NPS units, including the resurfacing, rehabilitation, and reconstruction of public roads, bridges, parking areas, and development and maintenance of NPS-owned alternative transportation systems. The multi-year authorization of funding enables long-term planning of capital improvements. The FLTP funds are available the year of authorization and three additional years, providing a reliable source of funding for improvements that often cannot be completed in a single fiscal year. In 2020, the NPS FLTP has an authority of \$300M to be allocated out to the Interior Regions by formula. Of that annual \$300M authority, Interior Region 11 (NPS Alaska Region) historically receives approximately \$6.5M per year. With the funding estimates for the Polychrome alternatives ranging from \$91M to \$275M, the NPS FLTP allocation for Interior Region 11 is not a realistic funding source to fully fund this project. However, this is the funding source currently being utilized to fund planning and preliminary engineering efforts.

Nationally Significant Federal Lands and Tribal Projects (NSFLTP) Program

The Nationally Significant Federal Lands and Tribal Projects Program (NSFLTP) of The Fixing America's Surface Transportation Act (FAST Act) (Pub. L. 114-94, section 1123), provides funding for the construction, reconstruction, and rehabilitation of nationally-significant projects within, adjacent to, or accessing Federal and tribal lands. This Program provides an opportunity to address significant challenges across the nation for transportation facilities that serve Federal and tribal lands. The NSFLTP Program provides discretionary funding for projects that have an estimated construction cost of at least \$25 million. Construction projects with an estimated cost equal to and exceeding \$50 million receive priority consideration in the selection process. There is a requirement of at least 10% of costs matched by funds not provided under any USDOT programs authorized under titles 23 or 49 of the U.S. Code. If this funding source is re-authorized in the next transportation funding bill, NSFLTP would potentially be a good candidate for funding the preferred Polychrome alternative. However, funds are not available on an ongoing basis through the Highway Trust Fund, they are subject to appropriation from the General Fund. Up to \$100M/year was authorized in the FAST Act for a maximum of \$500M, but only \$370M has been appropriated in total. These funds are distributed on a competitive basis as funds are available, and can only fund Construction, not preliminary engineering. With the uncertainty of the reauthorization of this funding source, along with the fact that this project would need to compete with other projects across the Nation, NSFLTP is likely not a reliable source for funding construction.

Theme 2

Some NPS transportation facilities that have become functionally obsolete or have exceeded their design life will require large investments. The National Park Service has some regionally critical transportation projects so large as to exceed the funds available

annually to the regions in which these projects are located; the projected cost in some cases would exceed the funds currently available to the entire NPS transportation program on an annual basis.

The Theme 2 funding class was created to help address the challenge of funding these large projects (i.e., costing a minimum of \$20 million). Theme 2 projects are ambitious undertakings that often require structured partnerships with other public and private partners to meet funding requirements. The idea behind Theme 2 is to reserve some NPS funds to help leverage additional funding from other federal, state, municipal, or private partners to accomplish these projects (e.g., Arlington Memorial Bridge Reconstruction in Washington, DC).

NPS Funding Sources

The NPS has several funding sources, most of which are not appropriate to fund such a large project. The Repair / Rehabilitation Program funds minor repairs to roads and bridges, so would not be appropriate. The Cyclic Maintenance Program aims to reduce the deferred maintenance backlog by funding preventative maintenance, so is not a good match. The Federal Lands Recreation Enhancement Act (FLREA) Program allows park units to charge fees for access to specific areas/attractions. The park units are allowed to use a portion of these funds for certain purposes within the park unit, including transportation projects. However the funds available would not be nearly enough to fund Polychrome. The NPS Line-Item Construction Program provides funds to develop new parks and areas within parks are budgeted through the Line-Item Construction program. Funds from this program are appropriated by line item in the annual Department of the Interior appropriation act. Line-item funds normally do not expire. If Congress decides to fund this project through federal legislation, funds would likely come through this program.

Great American Outdoors Act

On August 4, 2020, President Trump signed the “Great American Outdoors Act” that established a National Parks and Public Land Legacy Restoration Fund to address the maintenance backlog of Federal Land Management Agencies. Between 2021 and 2025, Federal energy receipts will be diverted to the fund up to \$1.9B a year. 70% of these funds will go to the National Park Service, and 35% of the NPS funding will be set aside for transportation projects, providing \$465.5M per year for NPS Transportation Projects. At this time, it is unclear how funds will be distributed and how well Polychrome will compete for this funding. However, even if Polychrome doesn’t compete well for these funds directly, this new funding source would likely free up funds from the other programs outlined above and make funding the project more viable.