3.12 Geology and Topography

3.12.1 Affected Environment

3.12.1.1 Earthquakes

The Kenai Peninsula is predisposed to earthquakes in the range of 6.0 to 8.8 on the Richter scale, with a predicted 75-year recurrence interval for magnitude 7.3 earthquakes. There are many small inactive faults in the project area, including the Border Ranges fault west of Cooper Landing.

3.12.1.2 Rock and Soil Stability

The project area is located in a deep glacial valley that trends east-west through the Kenai Mountains. The existing Sterling Highway is located between mountains ranging from 2,000 to 4,000 feet in elevation, with the valley located at elevations around 400 feet. Tributary valleys enter from the north (Juneau Creek) and south (Russian River and Cooper Creek). The terrain varies from steep and mountainous, to level benches bordered by steep side slopes above the floodplain of the Kenai River, to flat river bottom floodplain areas. The Kenai Mountains are underlain primarily by slate and greywacke. The depth to bedrock is highly variable and unknown in much of the area. Much of the surface material is unconsolidated glacial deposit consisting of gravelly sand, sand, and silt. Alluvial and till benches, as well as the original glacial valley floor, have been deeply eroded by the Kenai River and its tributaries. The unconsolidated soils of gravel, silt, and sand and talus slopes are highly susceptible to erosion. Along the Kenai River, erosion threatens the existing highway at several locations (e.g., Milepost [MP] 50.3 and MP 55.5), and the Alaska Department of Transportation and Public Facilities (DOT&PF) has armored the road embankment with large boulders (riprap) to help prevent further erosion.

Sand, gravelly sand, and silt sediment soils in the project area vary from thin layers on steep topography to deep layers on the alluvial benches that may be either well-drained or overlie deposits of relatively impermeable glacial till (Davis et al. 1980). The well-drained soils of all depths are generally sandy loams. In addition, there are some poorly drained wetland areas with sphagnum peat deposits.

Geotechnical studies done for the Sterling Highway in the project area, particularly multiple test holes DOT&PF drilled along the existing alignment (Narusch 1983) and farther south on the same topographic bench (DOT&PF 2014, 2015), have noted some locations that have fine-grained soils that are subject to failure (landslide) and where large steep cuts in the soil are not recommended. Actively eroding, steep slopes with undercutting of the overlying material are common in these soils. These soils are located particularly in the area around Cooper Creek and eastward along the Sterling Highway in the MP 49.5 to MP 50.5 area. Along Juneau Creek Canyon, the bedrock is part of the Valdex Formation, consisting of interbedded layers of sandstone and siltstone that have been altered by fracturing. Weathering of the underlying soft, graphic (greasy), layers of rock along frequent fractures produces highly unstable slopes. The geotechnical studies are summarized in a report (HDR 2014b). High precipitation and runoff in the area, along with frequent freeze-thaw cycles, contribute to erosive factors on both fine-grained material and fractured rock.

3.12.1.3 Avalanches

The project area is characterized by steep mountains and heavy snowfall, which can combine to create avalanche hazards. Several avalanche path areas exist within the project area where avalanches commonly occur (Map 3.12-1). Two avalanche paths in the project area impinge directly on the existing highway (Fesler 2001). The first avalanche path is located at MP 46.3, where the Sterling Highway has been blocked with debris twice in the last 30 years and has been hit by powder blast (strong winds preceding the mass of moving snow) twice more. The highway was blocked by avalanche debris in January 1980 and again in February 2000, when an avalanche swept a vehicle off the road. The second avalanche path is at MP 47. Many trees upslope of the highway have been destroyed by avalanches at this location, and the highway itself has been affected at least once in the last 40 years. Most of the avalanches in this path, however, stop above 700 feet elevation.

There are approximately 26 avalanche paths between MP 48 and 51, east of Juneau Creek and upslope of Bean Creek. Of these paths, the six that fall between MP 50 and MP 51 have the greatest potential avalanche frequency. On the south side of the valley, west of Cooper Creek, avalanche paths between MP 51 and MP 53 cross the old power line right-of way and terminate at the new power line right-of-way lower on the slope. Approximately 12 bowls and gullies found above this section frequently produce sizable avalanches.

3.12.2 Environmental Consequences

This section describes the potential effects of the project alternatives on geology and topography. It also provides an assessment of avalanche risk. Wind data suggest that effects on the project alternatives from wind would be similar for all build alternatives and would be negligible and have no negative effect. A detailed geotechnical investigation would be required under any build alternative to support the design of engineered slopes, bridge foundations, and other project features.

3.12.2.1 No Build Alternative

Direct and Indirect Impacts

Geology and Topography

The No Build Alternative would have no effects on the topography of the project area. Earth-moving activities associated with routine erosion maintenance or periodic bridge repair or replacement occurring under the No Build Alternative would have the potential to impact water quality. See Section 3.27, Cumulative Impacts (particularly 3.27.4 and 3.27.7.9), for a discussion of those impacts.

Effects of Avalanche

The existing highway passes through avalanche paths at MP 46.3 and 47 (see Map 3.12-1). The path at MP 46.3 can produce infrequent large slides, and the path at MP 47 can produce very infrequent major slides (Fesler 2001). Avalanches would continue posing potential hazards on the existing highway under the No Build Alternative.

3.12.2.2 Issues Applicable to the Build Alternatives

Construction Impacts

The build alternatives would alter the topography along the roadway corridor through roadway construction, grading, and extraction of sand and gravel for road foundation materials. Areas within 10 feet of the cut and fill limits would be temporarily disturbed by construction equipment operation (e.g., soil compaction, minor re-grading, and erosion). Construction staging areas adjacent to new bridge locations would be used for material stockpiling and equipment operation. These temporary impacts at staging areas and within 10 feet of the cut and fill limits would be unavoidable. The majority of the roadway construction would occur during non-winter months, so potential avalanche hazards associated with construction workers would be minimized.

Bridge construction would require excavations and/or blasting, which would change the topographic contours and remove rock and soils. Temporary construction roads would need to be built to provide access to construct the bridges. These temporary construction roads would be restored and re-vegetated following construction.

Earth-moving activities related to highway construction have the potential to impact water quality. To limit soil-related, water quality impacts within the project area, best management practices will be followed (see Section 3.13.2.2 in Water Bodies and Water Quality).

The roadway would be designed to optimize the use of excavated materials within the project footprint. Additional materials would be provided by the contractor from permitted material sites. Materials needed to construct any of the build alternatives would range between 600,000 and 1 million cubic yards, depending on the alternative (see Table 3.26-1 in Section 3.26). If the construction material were extracted to an average depth of 20 feet (as an example), it would mean a material site would extend over 18 to 31 acres. It is anticipated that the numerous cultural, historic, and recreation resources within and adjacent to the project would complicate or prohibit permitting of material sources within the project area on adjacent public lands, and therefore any additional materials would be hauled in by truck from outside the project area. See Section 3.26 for additional detail. If the contractor wished to obtain materials from public lands, the contractor would need to obtain permits/clearance from managing agencies for those lands.

For material needed from outside the project area for any alternative, DOT&PF would first make available developed State-owned material sources relatively nearby, such as those at MP 40 and MP 48 of the Seward Highway (about 11 miles and 19 miles, respectively, from the eastern edge of the project area). Second, the contractor could pursue Forest Service material sources that have been previously developed, such as those at MP 33 or MP 35 (10 and 12 miles, respectively, from the eastern edge of the project area). At this time, it is not clear that all material of the proper type would be available in the quantity needed from these four sites, but it is likely that a substantial portion of the needed material could come from these sites.

In addition, DOT&PF recently negotiated with KNWR to extract material for the adjacent MP 58–79 project from a previously used KNWR site near MP 63.3 of the Sterling Highway (about 5 miles west of the western end of this project). It is possible that material for this project could come from that location as well. The contractor may pursue acquisition of material from new sites on Kenai Peninsula Borough lands inside or outside the project area, on State lands inside or outside the project area, or at new sites on CNF or KNWR lands. The contractor's motivation, based on trucking costs, would generally be to seek sites closest to the project.

Based on the example given above (18–31 acres), a new material source for half of the needed material could encompass 9 to 15 acres and result in the loss of this acreage of forest, vegetation, and habitat in a new location. Typically, such sites are screened from visible areas (e.g., the highway and nearby structures). But viewed from mountainsides, such an area would be visible as a new and non-natural opening in a typically forested landscape.

3.12.2.3 Cooper Creek Alternative

Direct and Indirect Impacts

Geology and Topography

The Cooper Creek Alternative would follow benches along the south side of the Kenai River Valley at a maximum elevation of about 716 feet and would cross Cooper Creek approximately one-half mile upstream of the existing bridge. Retaining walls would be required both upslope and downslope of the new bridge. A cut approximately 2,500 feet long and up to 120 feet high through the Cooper Creek bluff would be required on the east side of the creek. Geotechnical field reconnaissance completed by DOT&PF (2014, 2015) found highly erodible layers of silt, gravel, and sand in all of the test holes. No groundwater was encountered, and the depth to bedrock is unknown.

Mud or soil slides, including fine-grained soils that turn gel-like and can flow (having thixotropic properties), are known to occur within the Cooper Creek canyon. Although the Cooper Creek Alternative has been designed to minimize cuts in suspected soils of this type, additional investigation to prevent damage to the alternative from potential slides would be required for final design. It is possible that side slopes would have to be constructed at lower angles than normal, employ occasional benches, use "anchored reinforced vegetation system" erosion control products, and/or be buttressed with local rock in areas where these soils are identified, to keep erosion and slides in check. Disruption of the project area by large cuts and retaining walls would irreversibly alter surficial geology in those areas. The impacts associated with this alternative would primarily be aesthetic (see Section 3.16, Visual Environment). The alternative presents some geotechnical risk, particularly at the Cooper Creek Bridge approach, but standard engineering investigations during project design would ensure a good understanding of geology at the bridge and would allow engineers to mitigate risks through their design. Otherwise, average geotechnical risk would be associated with retaining walls, large earth cuts, and other bridges. Further geotechnical investigation would be required before final slopes or retaining wall types would be selected and designed.

Topography of the Kenai River valley would affect use and maintenance of the Cooper Creek Alternative. The climb to elevation 716 feet would be about 270 feet lower than Turnagain Pass on the Seward Highway. It is likely that more snow removal would be necessary at the higher elevations than on the existing highway, and the grades occasionally would be transition zones from wet pavement to snow and ice. This portion of the highway is located on the north-facing slopes of nearby mountains and so would be shaded throughout the day in mid-winter, which would tend to retain cooler conditions. This would sometimes reduce mid-winter freeze-thaw cycles and maintain road surface consistency, but at other times would prevent thawing and drying of the surface. Such conditions are common on Alaska's highways, both for drivers and for maintenance crews, but based on topography, both driving and maintenance would be challenges at certain times.

Effects of Avalanche

The Cooper Creek Alternative would pass through or near several known avalanche paths. On the eastern end of the project area, north of Kenai Lake, this alternative would cross avalanche paths at MP 46.3 and MP 47 (see Map 3.12-1). On the south side of the Kenai River, between MP 51 and 53, the Cooper Creek Alternative would pass near several avalanche paths. Analysis of potential avalanche hazard was conducted in a study that recommended alignments in this vicinity not extend above the 1,000-foot elevation contour (Fesler 2001). The Cooper Creek Alternative would stay well below this advisory elevation, with a maximum elevation of 733 feet.

Construction Impacts

Construction impacts of the Cooper Creek Alternative would be similar to those for other build alternatives and are described above in Section 3.12.2.2.

Mitigation

No specific mitigation for impacts to the project area geology is proposed for the Cooper Creek Alternative.

3.12.2.4 G South Alternative

Direct and Indirect Impacts

Geology and Topography

The G South Alternative would depart from the existing highway alignment at MP 46.3 and climb the hillside toward Bean Creek for 1.25 miles to a maximum elevation of 776 feet. The alternative then would descend to cross Juneau Creek on a new bridge 1,320 feet long located downstream of the canyon, at a location where the valley widens.[1] The alternative would continue down the western side of the Juneau Creek valley and cross the Kenai River, also on a new bridge, before rejoining the existing highway corridor at MP 51.9. The G South Alternative would require a cut slope approximately 1,000 feet long and up to 220 feet high on the west side of the Juneau Creek crossing, and a cut 2,000 feet long and up to 70 feet high on the east side of the Juneau Creek crossing. The material within the proposed cuts is assumed to be primarily glacial and alluvial soils, based on geotechnical review of the area, and at this level of design, it is assumed that bedrock will not be encountered.

The impacts associated with this alternative would be aesthetic (see Section 3.16, Visual Environment). Average geotechnical risk would be associated with retaining walls, large earth cuts, and bridges. Further geotechnical investigation would be required before final slopes or retaining wall types would be selected and designed.

Topography of the Kenai River valley would affect use and maintenance of the G South Alternative. The climb to elevation 776 feet would be about 200 feet lower than Turnagain Pass

[1] Note that a 2005 geotechnical report for the Juneau Creek alternatives examined the bedrock canyon rims upstream and found areas of instability that forced relocation of the bridge over the canyon for that alternative. The G South Alternative is located downstream and outside the area of concern.

on the Seward Highway. It is likely more snow removal would be necessary at the higher elevation than on the existing highway, and the grade occasionally would be a transition zone from wet pavement to snow and ice. Such conditions are common on Alaska's highways, both for drivers and for maintenance crews, but based on topography, both driving and maintenance would be challenges at certain times. This alignment faces south, so it should thaw and dry sooner than the north-facing Cooper Creek Alternative.

Effects of Avalanche

The G South Alternative would pass through avalanche paths at MP 46.3 and MP 47 at the east end of the project area (see Map 3.12-1). These paths are common to the existing highway, the No Build Alternative, and all build alternatives. Avalanches would continue posing potential hazards on the G South Alternative at these locations. The G South Alternative would also be subject to a low level of avalanche danger between approximately MP 48 and MP 50 where the alignment would cross below 20 avalanche chutes, but outside the anticipated hazard areas. Culverts or other drainage features may require specific measures to accommodate the interaction between the highway and avalanche or debris flow deposits. The resulting maintenance liabilities at MP 46.3 and 47 would be similar to those for the No Build Alternative. Winter maintenance between MP 48 and 50 could be slightly greater than that for other stretches of road to remove avalanche debris or mitigate the risk.

Construction Impacts

Construction impacts of the G South Alternative would be similar to those for other build alternatives and are described above in Section 3.12.2.2.

Mitigation

No specific mitigation for impacts to the project area geology is proposed for the G South Alternative.

3.12.2.5 Juneau Creek and Juneau Creek Variant Alternatives

Direct and Indirect Impacts

Geology and Topography

The alignment of the Juneau Creek (preferred alternative) and Juneau Creek Variant alternatives would depart from the existing highway alignment at MP 46.3 and would be benched into the hillside east of Juneau Creek. The alternatives would cross the Juneau Creek canyon via a new bridge and, immediately west of the bridge, reach a maximum elevation of 1,150 feet before descending the hillside for approximately 4 miles and rejoining the existing highway corridor near MP 55.8. The location of the bridge crossing Juneau Creek canyon was chosen based on results from fieldwork for a rock stability investigation that revealed few areas of relatively stable rock. Substantial rockfalls, landslides, and fractured rock within the canyon walls characterize most of the canyon (R&M 2005). Rock fractures deposit large blocks that slide downslope over time to form steep talus slopes. Material at the base of the slopes is eroded by Juneau Creek, perpetuating continued rock fall from the steep slopes. The rock is platy in structure and is therefore more susceptible to fracturing and sliding downslope. Fractured rock was observed more than 200 feet back from the canyon rims. Geotechnical engineers recommended the bridge site because it demonstrated stable canyon walls compared to areas farther downstream. Geotechnical field work was performed at a level sufficient to move forward with preliminary design and environmental work. Further field investigations would determine more precisely how far back the bridge abutments would be located from the canyon rim and where any piers would be located, to ensure placement in competent rock. While refinement of the bridge design may be necessary, engineers are confident a bridge can be built in this location. In the unlikely event that later field work would determine that the site was not appropriate, a new bridge site would be examined and a reevaluation of this Final EIS would be necessary. No construction access road into the canyon would be required.

Retaining walls would be used on these alternatives in the area west of Juneau Creek and between Juneau Creek at the intersection with the existing highway. The impacts associated with this alternative would primarily be aesthetic. Geotechnical risk would exist particularly at the bridge crossing, but standard engineering investigations during the design process would ensure a good understanding of the bridge site geology and allow engineers to design for it. Otherwise, average geotechnical risk would be associated with retaining walls and large earth cuts.

Topography of the Kenai River valley would affect use and maintenance of these alternatives. Both alternatives include climbs 4.5 to 5.5 miles long from the valley bottom (at elevations below 450 feet) to an elevation of 1,150 feet at Juneau Creek. These would be similar to the climbs on the Seward Highway to Turnagain Pass and from the Hope Cutoff to Summit Lake, with a similar elevation. It is likely that more snow removal would be necessary at high elevations than on the existing highway, and the grade occasionally would be a transition zone from wet pavement to snow and ice. Such conditions are common on Alaska’s highways, both for drivers and for maintenance crews. But based on topography, both driving and maintenance would be challenges at certain times. These alignments face south, so they should thaw and dry sooner than the north-facing Cooper Creek Alternative.

Effects of Avalanche

The Juneau Creek and Juneau Creek Variant alternatives would pass through avalanche paths at MP 46.3 and 47 at the east end of the project area (see Map 3.12-1). As with the No Build Alternative, avalanches would continue posing potential hazards on the Juneau Creek and Juneau Creek Variant alternatives at these locations. The Juneau Creek and Juneau Creek Variant alternatives would also be subject to a low level of avalanche danger between approximately MP 48 and 51 where the alignments would cross below 26 avalanche chutes, but outside the anticipated hazard areas. Culverts or other drainage features may require specific measures to accommodate the interaction between the highway and avalanche or debris flow deposits. The resulting maintenance liabilities at MP 46.3 and 47 would be similar to those for the No Build Alternative. Winter maintenance between MP 48 and 51 could be slightly greater than that for other stretches of road to remove avalanche debris or mitigate the risk.

Construction Impacts

Construction impacts of the Juneau Creek and Juneau Creek Variant alternatives would be similar to those for other build alternatives and are described above in Section 3.12.2.2.

Mitigation

No specific mitigation for impacts to the project area geology is proposed for the Juneau Creek and Juneau Creek Variant alternatives.

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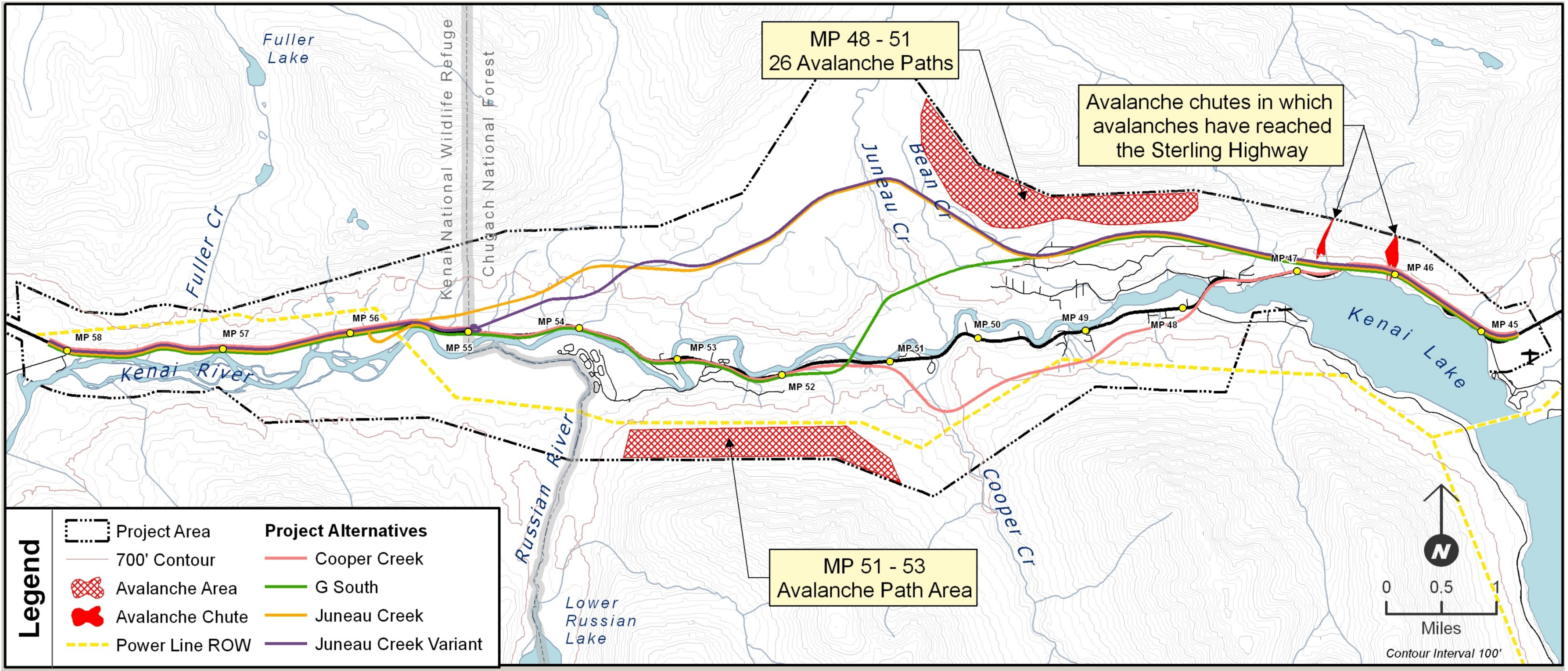

Map 3.12-1. Avalanche paths in the project area

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