Eklutna Hydroelectric Project

Lakeside Trail Erosion Study

Study Report

DRAFT

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Terms, Acronyms, and Abbreviations

ADNR	Alaska Department of Natural Resources
ATV	All terrain vehicle
GIS	Geographic Information System
GPS	Geographic Positioning System
IMBA	International Mountain Bicycling Association
LiDAR	Light Detecting and Ranging
NAVD88	North American Vertical Datum of 1988
NGVD29	National Geodetic Vertical Datum of 1929
USGS	United States Geological Survey

1 INTRODUCTION

The Eklutna Lakeside Trail is a popular recreational trail located on the northeast side of Eklutna Lake. The trail is located in Chugach State Park and is part of the state park trail system managed by Alaska Department of Natural Resources (ADNR). The 12.7-mile-long trail includes a former roadbed constructed by the U.S. Army in 1962 that followed the lake shoreline. Erosion along parts of the trail have resulted in narrowing of the original roadbed so that in some places it is too narrow for ATV use; in these areas the main trail has been re-routed up and away from the shoreline and the original shoreline trail is restricted to non-motorized traffic. Portions of the non-motorized trail are classified as Class 4 (very difficult/advanced) in the International Mountain Bicycling Association (IMBA) Trail Difficulty Rating System due to the narrow trail and obstacles.

Operation of the Eklutna Hydroelectric Project results in variations in the water level in Eklutna Lake and may influence erosion of the trail in locations where it is directly adjacent to the lakeshore. Lake elevation fluctuation may also contribute to erosion at other facilities such as public use cabins and can inundate portions of the Bold airstrip along the lake shoreline. Lake elevation based on the USGS gage (USGS 15278000) generally varies between a low of 830 feet[1] in May to a high of 864 feet in September (see Section 5.2.7 for more detail on seasonal variations in lake level). The Eklutna Lake Dam spillway elevation is at 871 feet.

2 STUDY OBJECTIVES

The objectives of the Lakeside Trail Erosion Study were to document locations where erosion affecting trails or facilities is influenced by lake level fluctuations and determine the causes of erosion at these locations. Based on the results of this study, appropriate erosion control or other measures may be developed at areas where the Eklutna Hydroelectric Project influences trail or facility erosion.

3 STUDY AREA

The study area included the Eklutna Lakeside Trail from the trailhead to the head of Eklutna Lake (Figure 3.0-1). The trail includes the main multi-use trail and sections of the trail that are limited to non-motorized vehicles. In locations where the non-motorized trail diverges from the main trail, the study area follows the path closest to the lake shoreline. The study area also included locations where other facilities (e.g., Yuditna and Kokanee Public Use Cabins, Bold Airstrip at the head of the lake) intersect with the lake shoreline.

[1] Note: the datum of the USGS gage is listed as sea level, generally accepted as the National Geodetic Vertical Datum of 1929 (NGVD29). This vertical datum is different that the datum currently used by the Municipality of Anchorage (e.g., datum of the 2015 LiDAR) and different from the currently accepted vertical datum, North American Vertical Datum of 1988 (NAVD88) which was used for the 2020 LiDAR. Conversions among these datums is part of an on-going investigation, so the analysis of lake levels recorded at the USGS gage compared to the spillway crest and elevation of the base of the eroding shorelines presented in Section 5.2.7 is a work in progress.

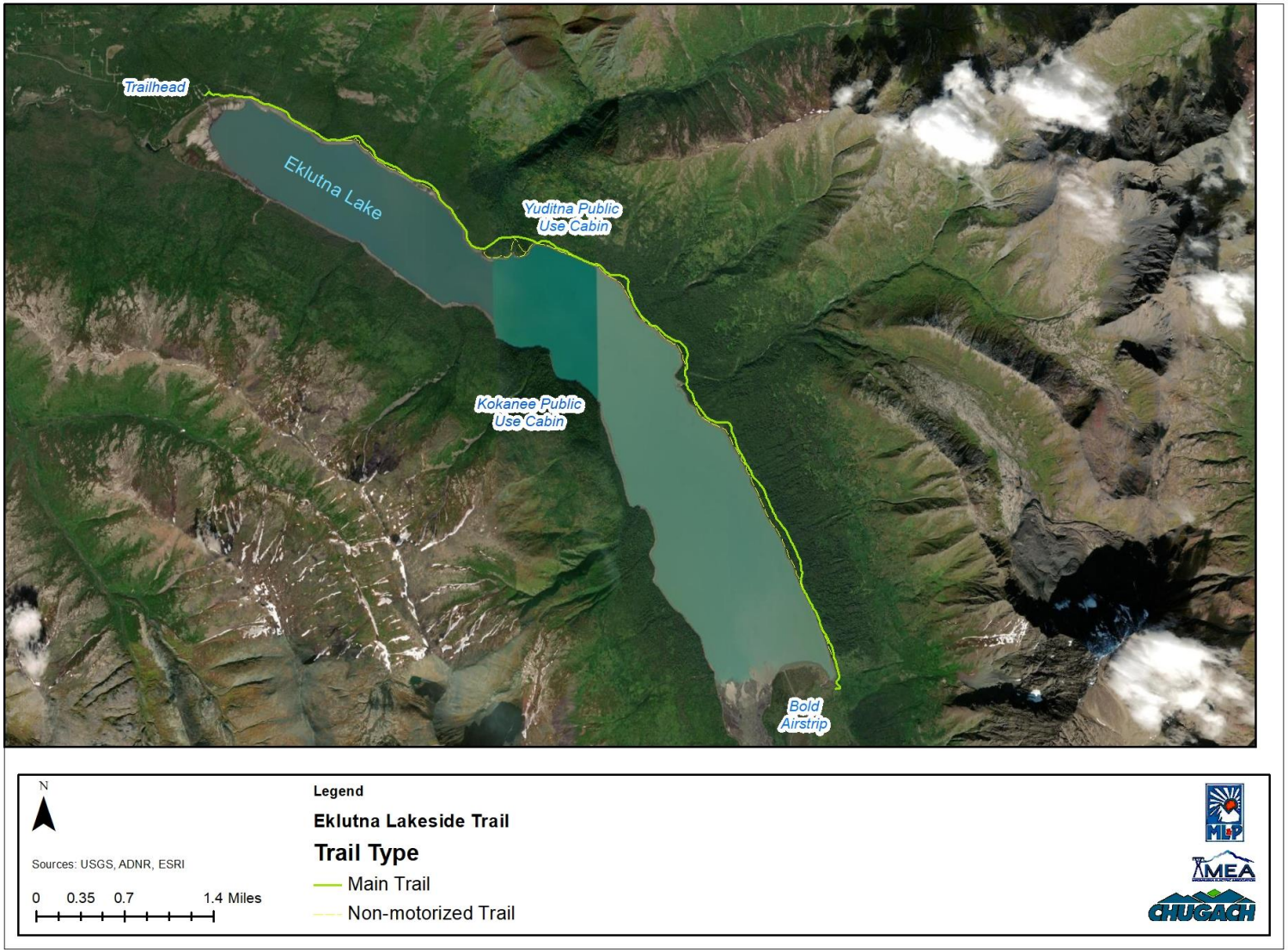


Figure 3.0-1. Eklutna Lakeside Trail Study Area.

4 METHODS

The Lakeside Trail Erosion Study included collecting available information, a field inventory of the trail condition, and post-field analysis.

4.1. Pre-field Work

Existing information was compiled including: current and historical aerial photographs; Light Detecting and Ranging (LiDAR) data sets; Geographic Information System (GIS) datasets (streams, trail/road/facility locations); and geologic soil maps. State Park/ADNR employees Keith Wilson and William Corwin provided detailed information on trail conditions and lake levels that have resulted in past erosion via phone conversations and subsequent e-mails on May 27, 2021.

Landforms were mapped along the lake shoreline using the 2020 LiDAR data. Landforms are visually assessed as distinct surfaces associated with a common geomorphic process; landforms along the shoreline included: valley wall; alluvial fan; river canyon; floodplain; and slumps.

4.2. Field Inventory

A field inventory of the Eklutna Lakeside Trail and lakeside facilities was conducted on June 5, 6, 7, and July 22, 2021 during relatively low lake levels (water surface elevation 828 feet in June and 845 feet in July; full pool is 871 feet) to document existing erosion and trail conditions and to collect information pertaining to erosion at each erosion site. Erosion sites were delineated based on visual observations of erosion that affected the trail such as trail prism narrowing due to bank erosion, drainage issues causing slumps or gullies, or other trampling of vegetation causing surface erosion. Erosion sites were numbered and a Geographic Positioning System (GPS) location was taken at each erosion site with a handheld Garmin GPS unit. Laminated aerial photographs (2020 aerials) were used to help track locations as well. A photograph was taken of each site. Pertinent information was collected including: geology/soil conditions, erosion type, contributing factors, slope gradient, vegetation characteristics (or lack thereof), and length/height of eroding bank using the field forms shown in Attachment A.

A one-day field visit to the lake shoreline was made via boat during higher pool levels (elevation 865 feet; 6 feet below spillway crest) on September 15, 2021 to observe the erosion sites from the lake at higher lake levels.

4.3. Post-field Data Analysis

Erosion locations mapped as part of the field inventory were digitized as line features in GIS using field-collected GPS points and the 2020 LiDAR hillshade layer (Quantum Spatial 2020) to produce a map of erosion sites. Field data/site characteristics were entered into an Excel file and linked to GIS locations.

The 2020 LiDAR data[2] were used to delineate landforms along the lake shore and obtain canopy height information to assist with the assessment of existing conditions that could affect the shoreline erodibility. The historical aerial photographs were assessed to determine if they would be useful to determine shoreline erosion rates, but the resolution was not good enough to measure change along the shoreline.

5 RESULTS

5.1. Geologic and Geomorphic Setting

Eklutna Lake is located in the Chugach Mountains of Alaska. Underlying bedrock geology includes low-grade metamorphic flysch (marine sedimentary) deposits composed of metagreywacke, argillite, and phyllite of the Valdez Group (Updike and Ulery 1983). Bedrock is exposed at higher elevations on the peaks surrounding the lake. Eklutna Lake was carved by the early Eklutna Glacier during numerous glacial advances throughout the Quaternary Period (2 million to 10,000 years BCE). Glacial deposits of the Knick and Naptowne tills line the valley walls up to approximately 2,100 feet in elevation and are present along portions of the current lake shoreline.

As the Eklutna Glacier retreated up the valley, erosion of the glacial deposits and upland bedrock areas resulted in the formation of alluvial fans and colluvium along the valley walls and lake shore. There is evidence on the hillsides above the current Eklutna Lake of a much larger ancestral Eklutna lake that formed sometime after the last glacial maximum. The ancestral lake filled the valley to at least elevation 1,000 feet, suggesting that the lake was formed by a moraine or the thick outwash deposits in the valley downstream from the present Eklutna Dam location. There are multiple shorelines cut into the glacial deposits and alluvial fans along the current valley walls that formed as the ancestral lake level dropped, likely the result of the Eklutna River eroding the material that dammed the lake and cutting the present river valley downstream from the lake. One of the erosion sites along the trail is at the edge of an old delta/fan deposit that was formed at much higher lake levels; the deposits influence the stability of the Lakeside Trail.

Landform mapping provides insights into the current geomorphic conditions of the shoreline where the Lakeside Trail is constructed. Landforms on the northern (trail) side of Eklutna Lake include valley walls covered with till and colluvium, alluvial fan deposits, and river canyons along major tributaries. In addition, one large area with very old slumps was mapped; this unstable area has implications for current trail stability.

[2] Note that vertical datum differences between the 2020 LiDAR data and the USGS gage need to be taken into consideration when comparing LiDAR elevations with lake surface levels. The datum of the 2020 LiDAR is approximately 4 feet above the datum of the USGS gage based on comparison of the spillway invert elevation and the lake surface elevation on the date the LiDAR data were acquired (5/15/2020).

Figure 5.1-1. Shoreline of Eklutna Lake with alluvial fan and valley wall landforms.

5.2. Erosion Types and Factors Affecting Erosion

Five primary types of erosion processes were noted during the field inventory: undercut banks caused by wave erosion, slumping and earthflows caused by saturated soils and/or drainage issues; trampling by recreationalists accessing the lake; raveling of unconsolidated/unvegetated cutslopes and banks; and streambank erosion at major stream crossings.

5.2.1. Undercut Banks/Wave Erosion

Undercut banks occur in areas where soil is relatively consolidated and can stand in steep, near vertical banks when eroded (Figure 5.2-1). On Eklutna Lake, wave action at high lake elevations erodes material along the base of these banks which results in an undercut bank. The undercutting continues until the weight of the overlying material exceeds the strength of the bank and the overlying material topples or slides. The process repeats causing the bank to retreat away from the lake and resulting in a higher and higher bank. In some places vegetation provides additional strength to the top layers of soil and can result in an overhanging mat of vegetation or roots.

Figure 5.2-1. Undercut bank formed by wave action.

5.2.2. Slumping, Earthflows, Saturated Soils, and Drainage Issues

Hillside drainage, blocked culverts, and groundwater seepage along some parts of the trail cause the soil to become saturated and cause earthflows or slumping of bank material. Drainage issues are most pronounced in valley wall landforms on the southeastern (upstream) third of the Lakeside Trail. Several fully or partially blocked culverts and ditches were noted during the field inventory, as well as areas with no drainage structures, that caused runoff and saturation of the trail surface. In areas where underlying soil strength was low or where waves had caused a steep bank, slumping and earthflows occurred on the bank (Figures 5.2-2 and 5.2-3).

Figure 5.2-2. Drainage issue leading to saturated trail surface and earthflow.

Figure 5.2-3. Drainage issue leading to slumping along trail.

5.2.3. Trampling

People recreating along lakes and streams like to access the water using formal access points in designated areas or informal access points in dispersed use areas. Informal access points often result in trampling of riparian vegetation near bridges and lakeside trails, killing vegetation that protects soil from erosion and reducing infiltration capacity due to compaction (Figure 5.2-4). Surface erosion and rills often form in trampled areas from trail runoff.

Figure 5.2-4. Trampling adjacent to Lach Oahu Creek bridge resulting in loss of riparian vegetation and surface erosion.

5.2.4. Raveling

Raveling is a loose, grain-by-grain movement of material down a steep slope that often occurs in unconsolidated material when vegetation or cover is removed. Raveling of colluvium and glacial deposits was observed on unvegetated cutslopes and fillslopes at several locations along the shoreline trail (Figure 5.2-5).

Figure 5.2-5. Raveling cutslopes and bank.

5.2.5. Streambank Erosion

Streambank erosion is the result of moving water at high streamflows acting on unvegetated banks. Streambank erosion was noted near the Bold Creek Bridge footings (Figure 5.2-6).

Figure 5.2-6. Streambank erosion at Bold Creek Bridge.

5.2.6. Wind waves

Wind waves at high lake elevations appear to be the primary cause of erosion at many of the shoreline erosion sites on the Eklutna Lakeside Trail. Wave energy along the shoreline causes erosion by removing material from the base of the banks when the lake level is high and transporting the material downslope into the lake as the lake level drops. Because lake levels fluctuate (see Section 5.2.7), a stable beach profile cannot develop, and bluffs continue to erode.

Waves move through water as a circular motion of water molecules. As a wave approaches the shoreline, the bottom of this circular movement slows due to drag when it touches the lake bottom causing the top of the wave to move faster than the bottom of the wave, increasing the height of the wave and eventually resulting in a breaking wave. The breaking wave energy is transferred to a back-and forth movement along the beach (swash) and results in erosion of

particles from the bottom of the banks and transport out into the lake. The swash zone can cause erosion at a higher elevation than the surface of the lake depending on the size of the waves. The larger the wave, the more energy there is to transfer to the shoreline erosion and transport processes and the farther up the beach the swash zone extends.

Wind-related wave size is driven by wind speed, direction, and fetch distance. Wind waves generally affect the shoreline toward which the wind is blowing at a given time. Wind waves are driven by storm activity as well as the general up- or down-valley wind generated by temperature and pressure differences. Erosion from wind waves is likely most dynamic along shorelines that face up- or down-valley and along shorelines at bends in the reservoir. Wave erosion is also more concentrated on headlands (points) than in bays due to wave refraction (bending), and on steeper beaches where wave energy is not expended on a long swash zone.

5.2.7. Lake levels

Bank erosion around the Eklutna Lake shoreline has resulted in bank profiles with steep bluffs above the high lake levels (elevations higher than approximately the crest of the spillway) and a series of wave-cut benches within the reservoir fluctuation zone. Based on the 2020 LiDAR data[3], the base of most of the steep banks is at approximately elevation 870.5 feet (msl NGVD29), and there are prominent benches at elevation 868, 863, and 859.5. It is likely that there are additional prominent benches at lower elevations, but they are not visible on the 2020 LiDAR because of the lake elevation when the LiDAR data was acquired (elevation 835).

Typical operation of the Eklutna Hydroelectric Project results in seasonal variations in Eklutna lake levels with lowest levels in spring as more water is used than flows into the lake during the winter and highest levels in fall (September) as the lakefills with spring and summer inflow (Figure 6.2-7). Project operational goals include minimizing spill which occurs above elevation 871 feet (USGS gage datum NGVD29). Wave energy on the lake shoreline occurs near the elevation of the lake surface, so the vertical location of erosion is dependent the length of time the water is at a given elevation. Comparing the elevations for the base of the bank and wave-cut benches with the record of Eklutna Lake water levels (Figure 5.2-7 and 5.2-8), the base of the bluffs (870.5 feet) corresponds to an elevation just below the spillway crest. In the past 14 years the highest lake elevation occurred in the fall of 2012 and 2013 (note that the highest lake elevation on records occurred in 1995 when the lake rose to 877.6 feet). ADNR staff report that high winds during the 2012 and 2013 high lake level periods resulted in substantial erosion along the lakeside trail.

[3] Note: as discussed in the footnote to Section 1.0, there are some unexplained discrepancies among the datums of the LiDAR data sets and USGS gage that lead to uncertainty in the correlation of reported lake elevations with elevations of lakeshore erosion. These uncertainties will be further investigated in 2022.

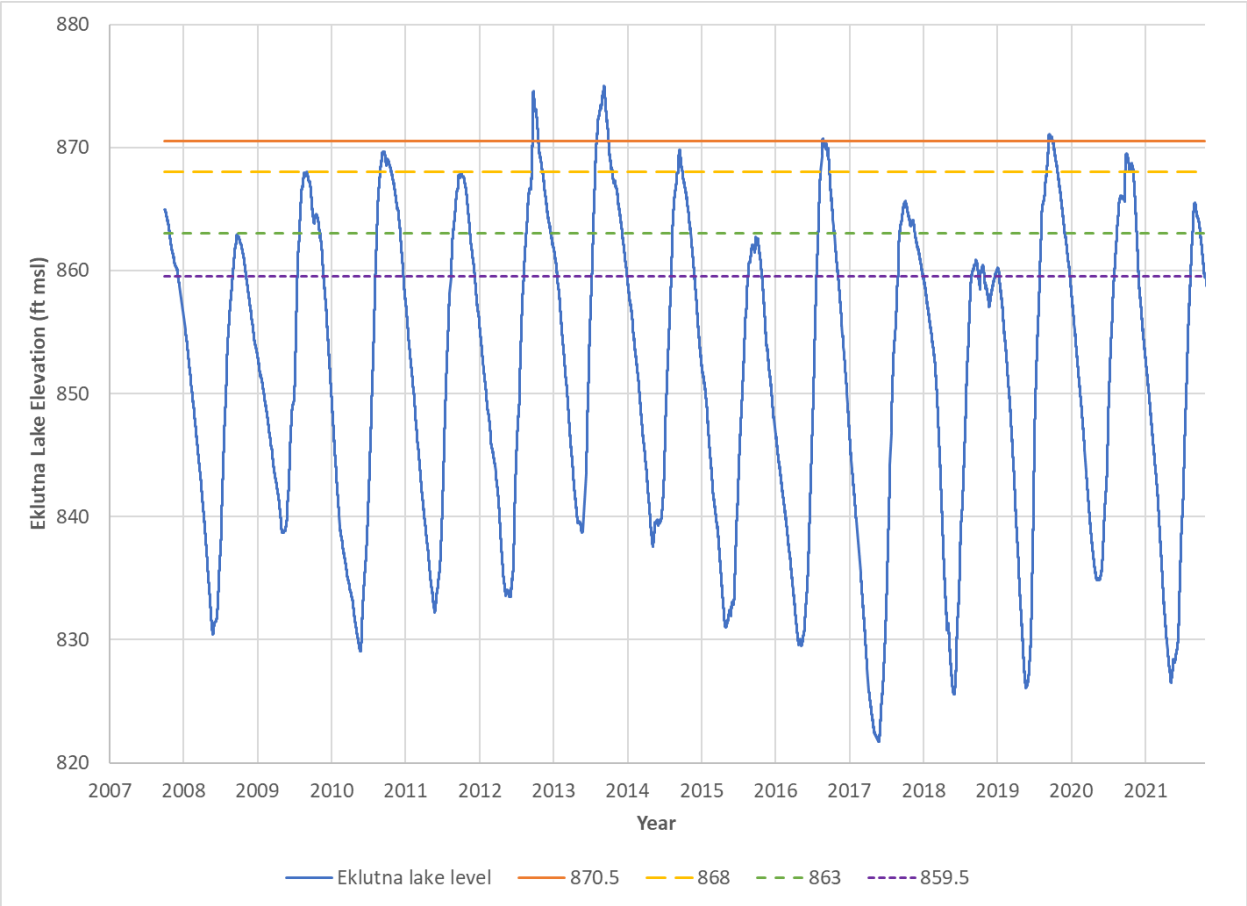


Figure 5.2-7. Eklutna Lake water surface elevation, 2007-2021 and elevations of prominent wave-cut terraces within the lake.

The prominent wave cut bench at elevation 868 corresponds to the highest lake elevation that is frequently reached (Figure 5.2-8). Other prominent benches at approximately elevation 863 and 889.5 likely correspond to other frequent lake elevation levels.

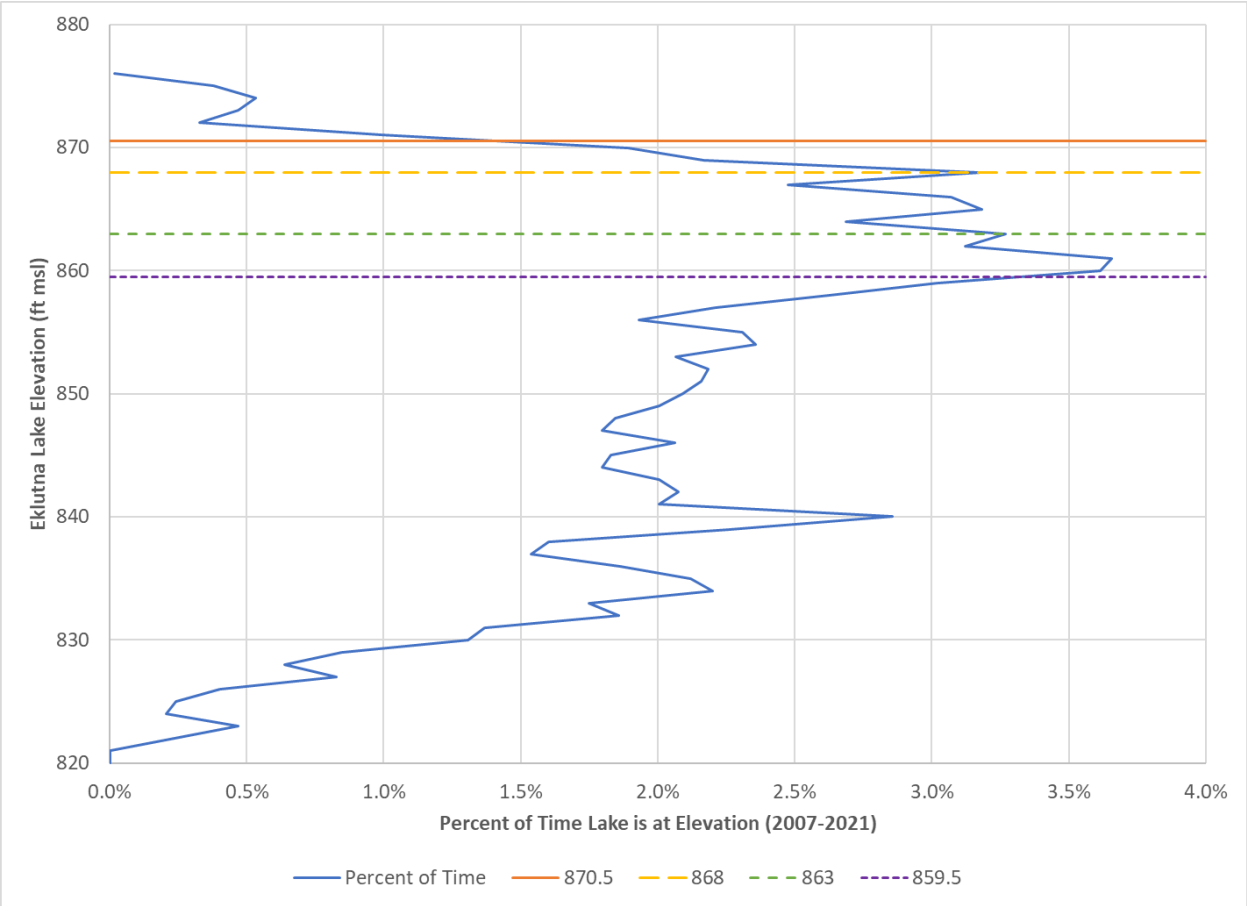


Figure 5.2-8. Percent of time Eklutna Lake water surface was at a given elevation, 2007-2021 and elevations of prominent wave-cut terraces within the lake.

Based on reports from ADNR staff, it appears that most shoreline erosion occurs when the lake is at elevations at and above the spillway elevation (871 feet) depending on the height and swash zone of the waves during the period of high lake levels. Under the current operational regime, the lake exceeds elevation 871 feet less than 2 percent of the time (based on 2007-2021 period). Lake elevations above 871 feet occurred in 9 years since 1965 (MJA 2020, Figure 5.2.9). The effects of any future modifications to Project operations that change lake elevations will be analyzed as part of effects analysis.

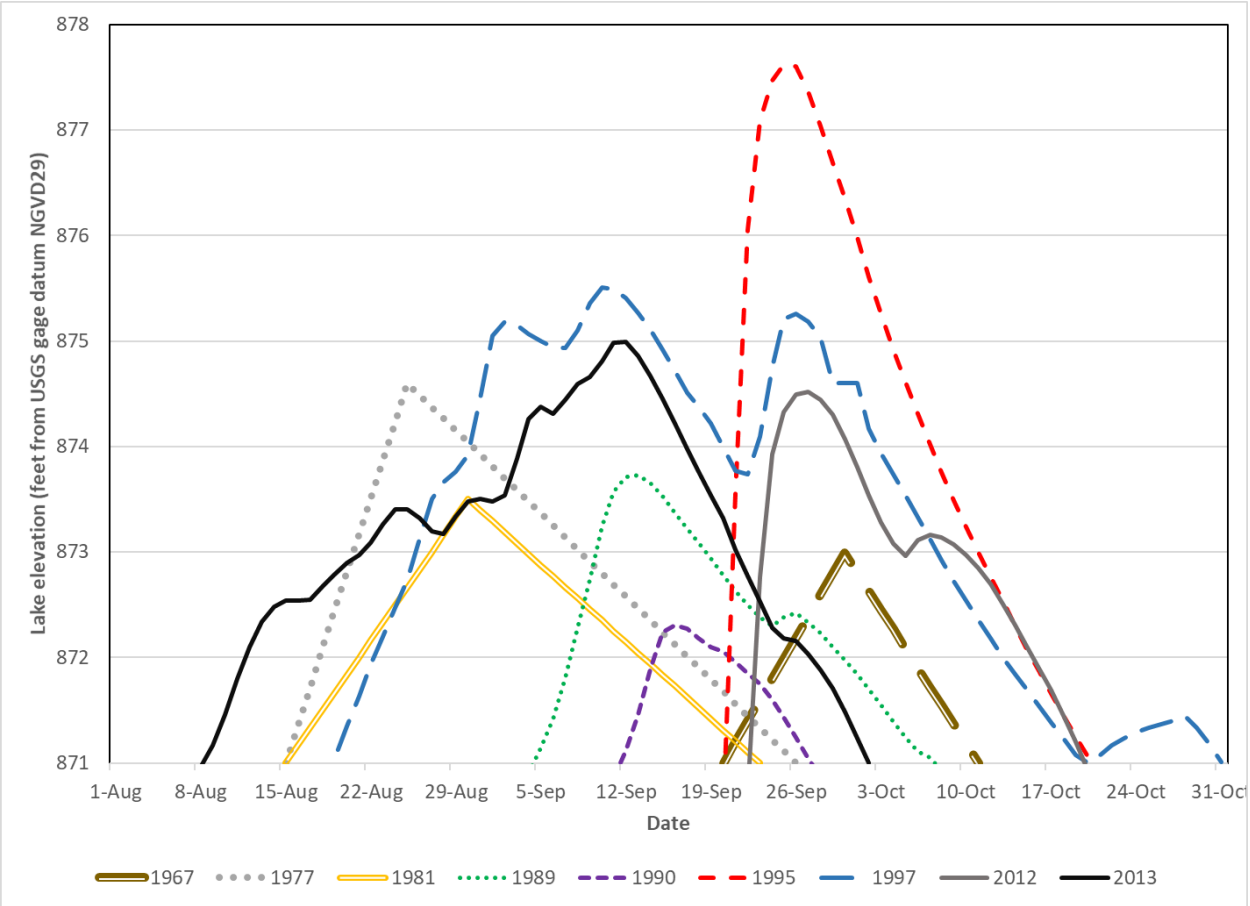


Figure 5.2-9. Lake elevations during spill events at Eklutna Dam from 1965 to 2019 (MJA 2020).

5.3. Field Inventory of Erosion Locations

5.3.1. Trail Erosion Sites

A total of 59 eroding areas were delineated along the lake shoreline portion of the Eklutna Lakeside Trail, including areas showing past and/or more recent erosion (Figure 5.3-1, Appendix 2 and Appendix 3). The inventory followed the pathway closest to the lake and included 2.7 miles of main trail and 4.9 miles of non-motorized trail (side trail). Shoreline erosion was noted along 0.6 miles of the main trail; 2.4 miles of the non-motorized trail had shoreline erosion.

Bank heights were measured from the trail to the base of the bluff along the trail; 16 percent of the eroding areas had bank heights of less than 5 feet, 73 percent had 5- to 10-foot-high banks, and 11 percent had bank heights over 10 feet (maximum measured bank height was 20 feet).

The factors contributing to erosion were recorded at each site; many sites had multiple factors. All lakeshore erosion sites had wave action at high lake levels as one of the factors contributing to erosion. Seepage and runoff were the second most common factor, present at 28 percent of the sites (by length) and blocked culverts were listed at 9 percent of the sites. Reservoir

fluctuations was listed at 28 percent of the sites. Pedestrian use (19 percent of the sites) and raveling of steep cutslopes (8 percent) were the remaining factors affecting erosion.

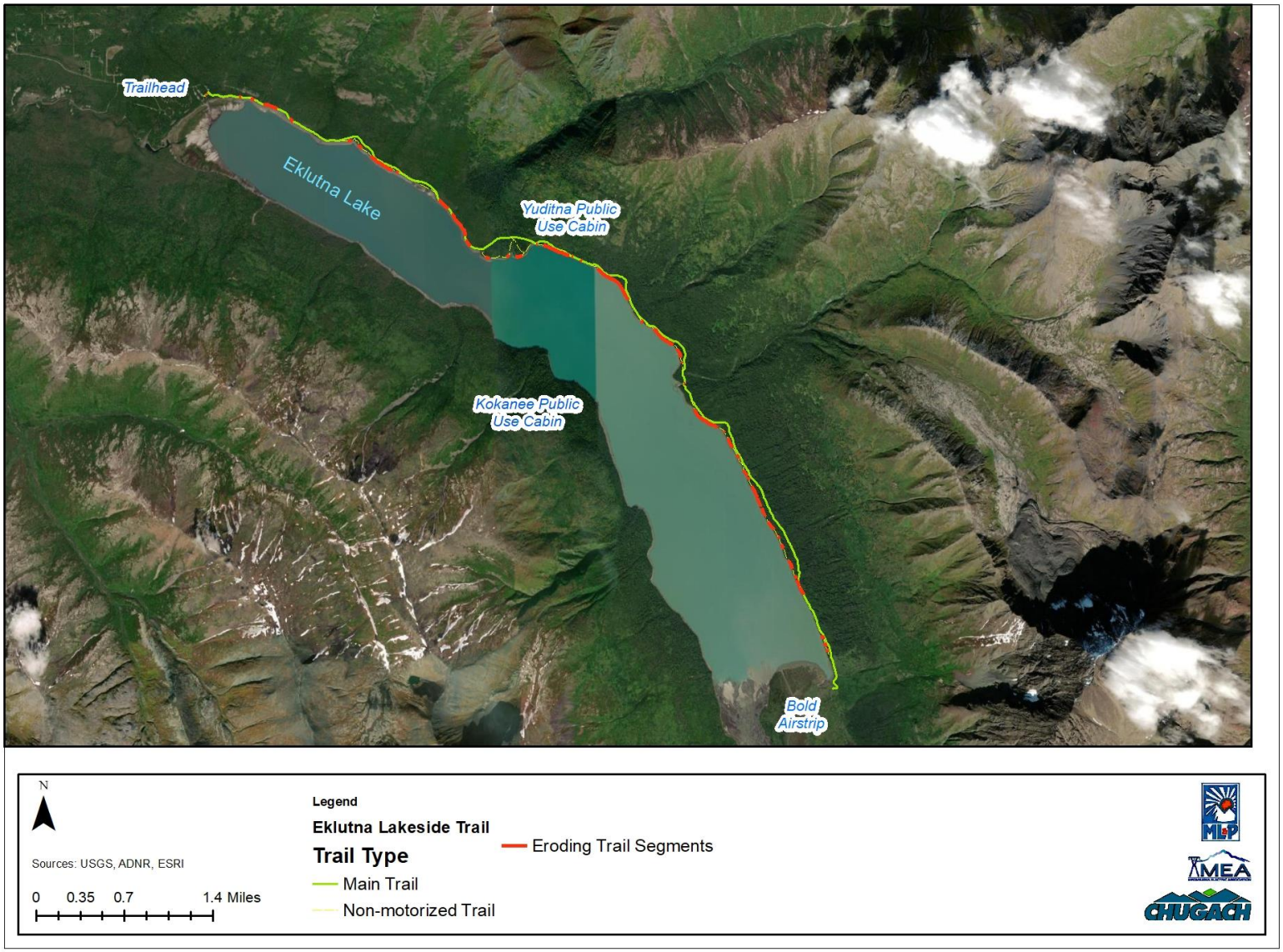


Figure 5.3-1. Shoreline erosion along the Eklutna Lakeside Trail.

The Eklutna Lakeshore Trail is constructed on three main landforms: alluvial fan (64 percent of trail length); valley wall (32 percent of length); and a small area of past slumping (4 percent of length, Figure 5.3-2). Wind waves are the primary factor contributing to erosion at erosion sites on alluvial fans, with erosion on the parts of the fans that face either up- or down-lake where wind have the longest fetch resulting in higher waves.

Erosion areas on valley wall landforms have seepage and drainage issues contributing to erosion and do not appear to be correlated with length of wind fetch although wave action is contributing to erosion at all sites. Drainage issues are most pronounced along the southeastern third of the trail where seepage, plugged culverts, filled ditches, and lack of drainage structures occur frequently. This section of trail follows the valley wall and is underlain by glacial deposits. Overlaying the canopy height (derived from the 2020 LiDAR first hit and bare earth layers) with the drainage and erosion sites shows that areas with taller trees mark places where drainage issues are most prevalent, likely indicating water courses or shallow groundwater that contribute to taller tree growth (Figure 5.3-3).

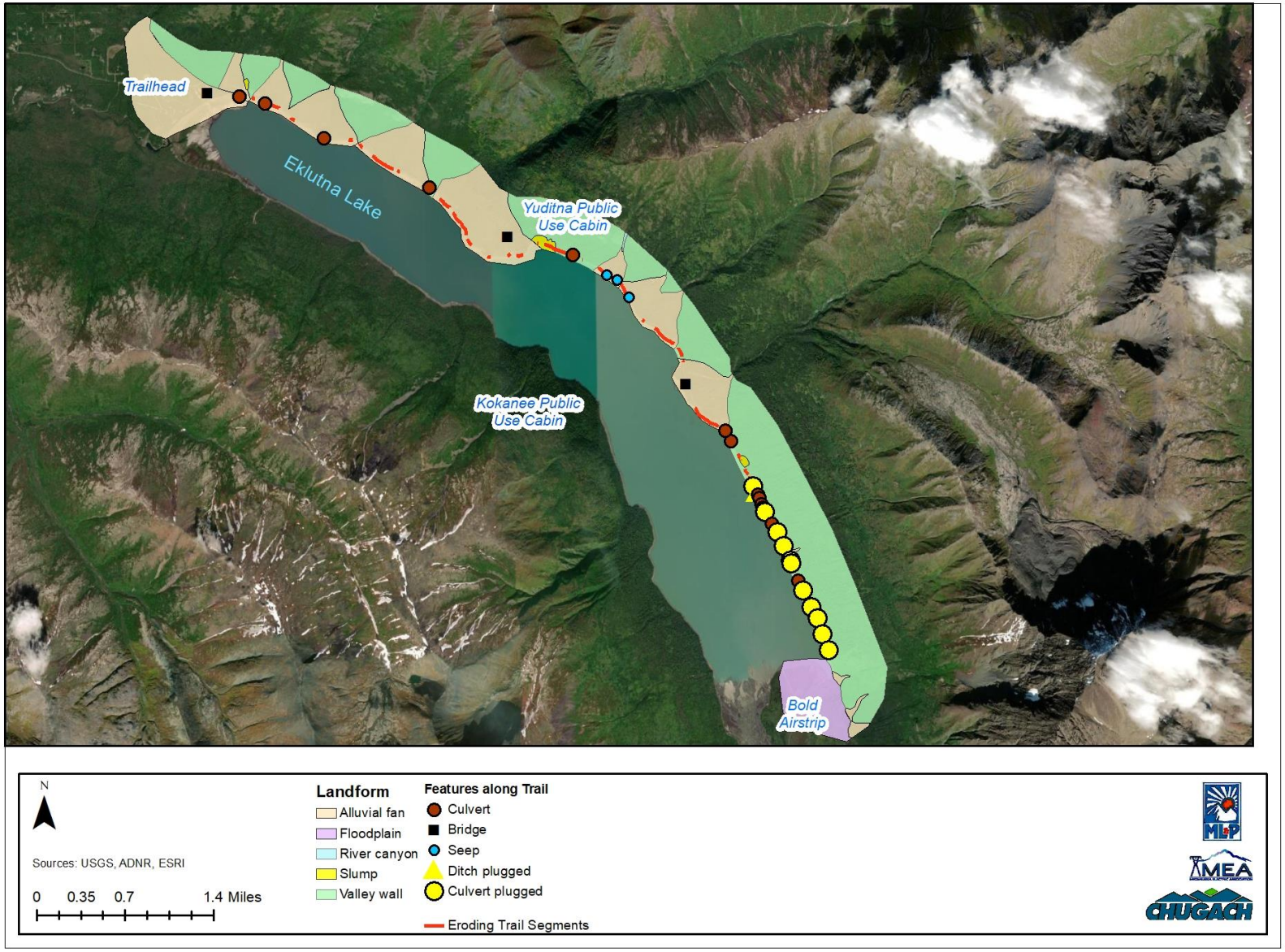


Figure 5.3-2. Eklutna Lakeshore Trail erosion, culverts, drainage issues, and landforms.

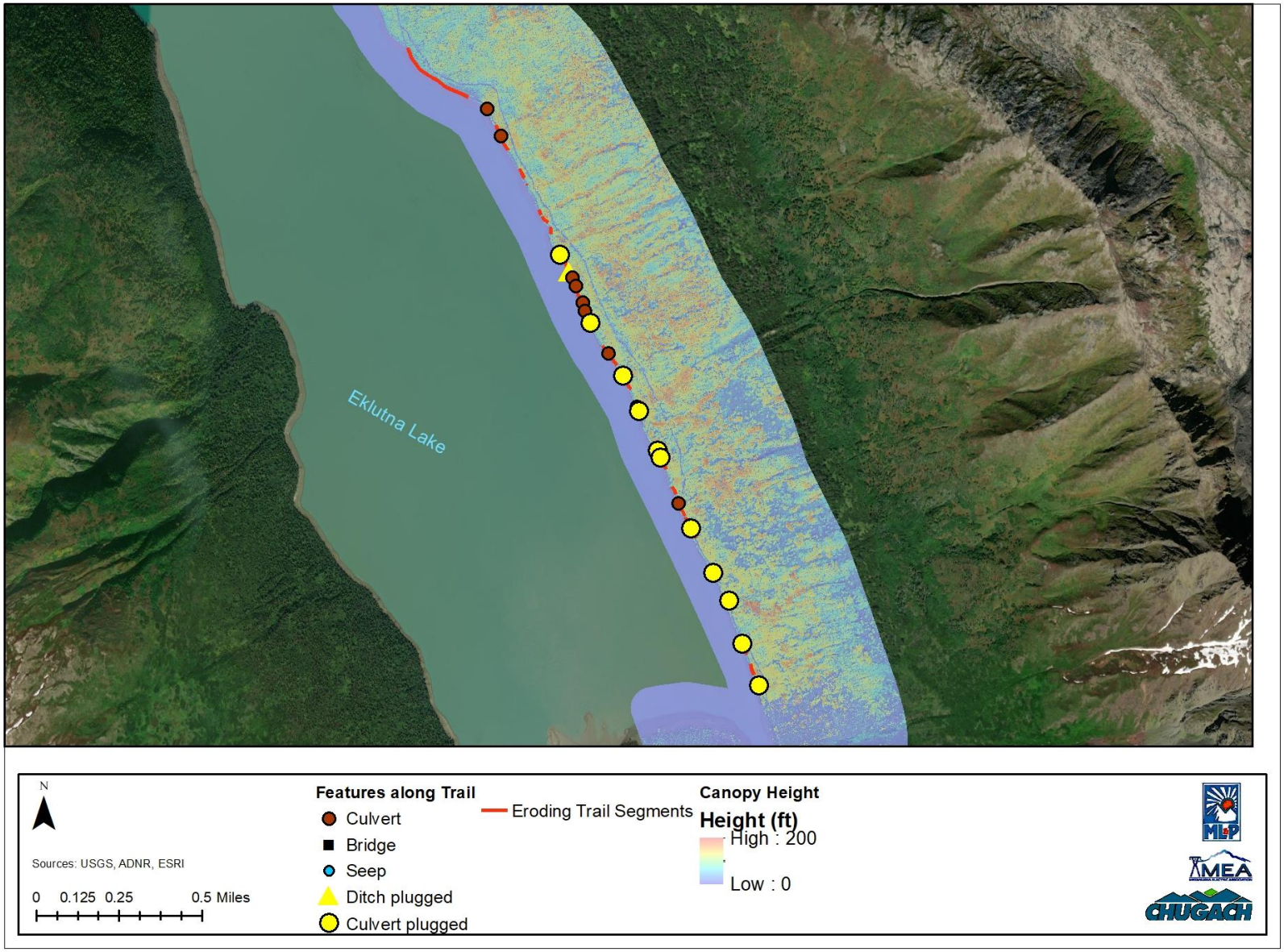


Figure 5.3-3. Southeastern section of Eklutna Lakeside Trail with drainage issues and canopy height.

5.3.2. Yuditna Public Use Cabin

The Yuditna Public Use cabin is located on the northern shore of Eklutna Lake on a side access trail approximately 3 miles from the trailhead. The access trail to the cabin (erosion site E12) has approximately 300 feet of undercut/raveling bank with a bank height of 10-11 feet (Figure 5.3-4). Chugach State Park staff have installed jute mats, coir rolls, and vegetation (grass seeding) as erosion control measures along this bank. The measures are effective in slowing erosion in some spots, but erosion is continuing in other sections.

Figure 5.3-4. Trail to Yuditna Public Use Cabin.

The Yuditna Cabin is located on a point, the outer edge of the Yuditna Creek alluvial fan and set back from the lake bluff (Figure 5.3-5). Cabin visitors have made an informal path down the bluff to the lake. Trampling as well as wave action result in erosion on the shoreline near the cabin.

Figure 5.3-5. Yuditna Public Use Cabin shoreline.

5.3.3. Kokanee Public Use Cabin

The Kokanee Public Use Cabin is located on the south side of Eklutna Lake and is only accessible by boat. The cabin was constructed four years ago and is set back from the shoreline (Figure 5.3-6). The shore near the Kokanee Cabin is approximately 4-5 feet high, partially vegetated and relatively stable, with some evidence of past erosion. The beach near the cabin is lower gradient and has several large logs; both these conditions reduce wave energy on the base of the bank.

Figure 5.3-6. Kokanee Public Use Cabin

5.3.4. Bold Airstrip

The Bold Airstrip is located at the upper end of Eklutna Lake. The airstrip was constructed in summer 1962 based on historical aerial photographs (there may have been an informal airstrip at this location earlier than 1962). No major erosion was noted at the lake shore end of the airstrip. The lake end of the airstrip is reported to be inundated at high lake levels. Based on the 2020 LiDAR map, approximately 200 feet of the runway is below elevation 871 feet (msl, NGVD29) which corresponds to the crest of the Eklutna Lake Dam spillway and approximately 70 percent of the runway length is below elevation 877 feet, the highest lake elevation recorded since 1965.

Figure 5.3-7. Bold Airstrip (top) and lakeshore at end of airstrip (bottom)

5.4. High Priority Erosion Sites

Nine of the inventoried Lakeside Trail erosion sites were identified as having a high priority for either erosion control or, as an alternative, signage indicating a narrow trail/hazardous area ahead to warn bicycle users of hazardous conditions.

5.4.1. Sites E10 and E11

Both Sites E10 and E11 include areas where the non-motorized trail is very narrow with a steep drop adjacent to the trail (7 to 20 feet drop; Figures 5.4-1 and 5.4-2). The approach to both of these areas is relatively steep, and the narrow portion of the trail is at a bend in the trail so the narrow areas are not visible from far away. These areas could be a hazard to bike riders since bikes travel faster than pedestrians. Signs to indicate narrow trail conditions could help remind bike riders to slow down at these locations.

The primary factor contributing to erosion at both of these locations is wave action. Pedestrian traffic to access the beach noted at site E10 is also contributing to bank erosion. At site E11, runoff from trail drainage is contributing to bank erosion by creating rills down the bank.

Figure 5.4-1. Erosion site E10.

Figure 5.4-2. Erosion site E11.

5.4.2. Site E14

Erosion site E14 is an area of undercut bank and slumping of the bank that has resulted in loss of the entire width of the trail at one location (Figure 5.4-3). This site is within a much larger, older slumped area of the hillside (see landform map, Figure 5.3-2 and Figure 5.4-4) and is in an inherently unstable area with seepage and saturated soil conditions. Seepage from the cutslope saturates the trailbed and results in washout and slumping of the trail at this location. In addition, wave action has undercut the toe of the bank on either side of the washout section. The bank is 14 feet high and difficult to cross on foot or bike. This site could benefit from drainage structures that help to dewater the area and erosion control at the base of the slope to minimize wave erosion and allow a wider trail.

Figure 5.4-3. Erosion site E14.

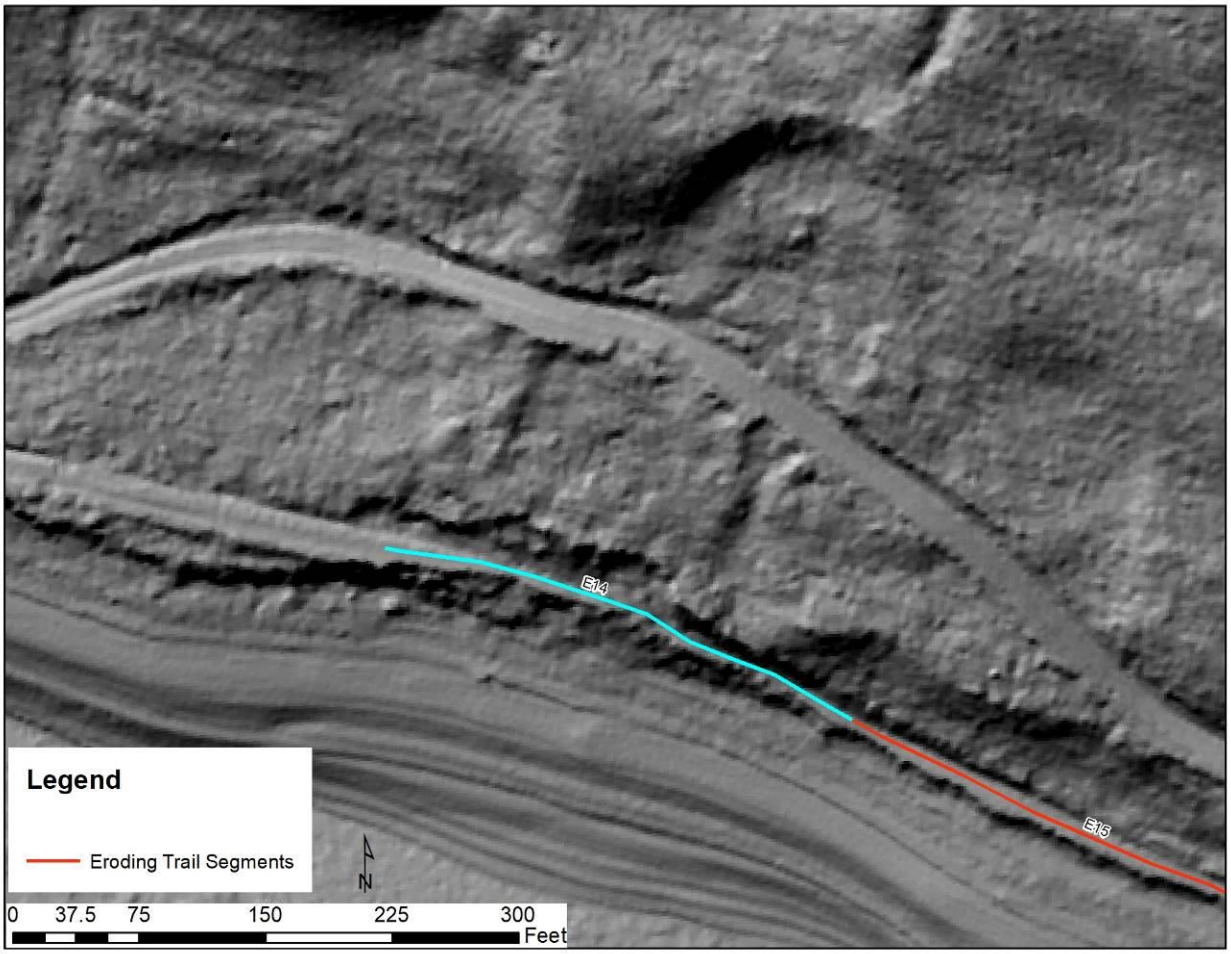


Figure 5.4-4. Erosion site E14 map showing larger, old slump feature upslope from the trail erosion site.[4]

5.4.3. Site E22

Erosion site E22 is located on the eastern edge of the Bold Creek alluvial fan. The Bold Creek fan is a complex fan with many terraces and old lakeshores that likely started developing in the late Pleistocene as the Eklutna Glacier retreated up the valley following the last glacial maximum (Figure 5.4-5). There is evidence of several higher lakeshores on the Bold Creek fan and on the Eklutna valley walls in the LiDAR data suggesting a much larger lake filled the Eklutna valley, possibly dammed by a moraine or outwash deposits farther down the valley than the present Eklutna Hydroelectric Project dam. Erosion site E22 is located at the base of one of the alluvial fan features that is the steep edge of an older terrace composed of loose cobble, gravel, and sand. These loose deposits are ravelling down the steep slope uphill from the trail as well as down the bank to the current lake level (Figure 5.4-6). This area is sparsely vegetated due to the well-drained nature of the deposits. Wave action at the base of the bank contributes to erosion at this site. The trail is very narrow at one location, which combined with the loose rocks makes it

[4] Note the drainage issues and trail erosion on the main trail as well as the non-motorized trail where they cross the old slump feature.

difficult to negotiate. Erosion control or a sign warning users of the narrow conditions would be beneficial at this location.

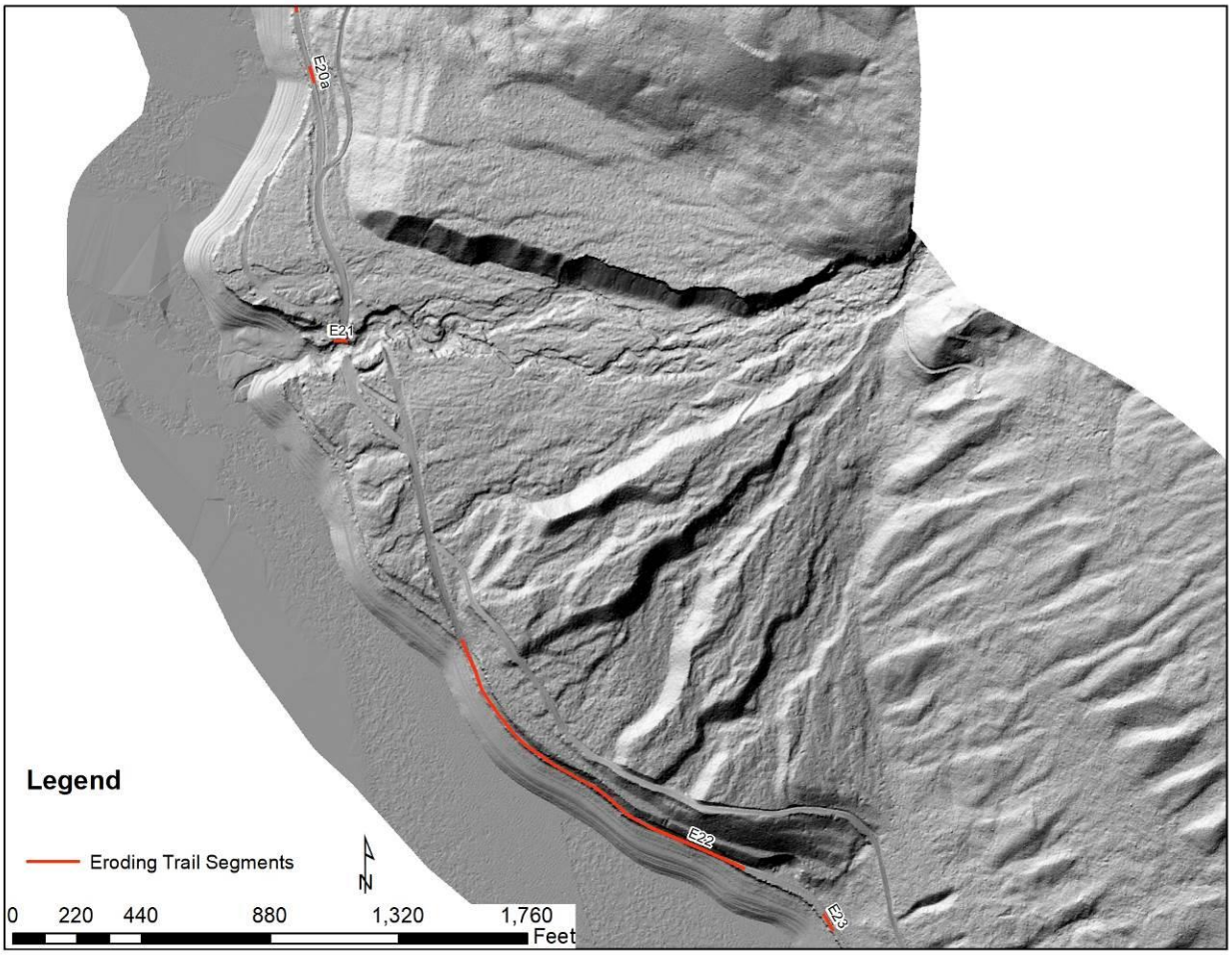


Figure 5.4-5. Bold Creek alluvial fan showing multiple higher lake shorelines and Erosion site E22.

Figure 5.4-6. Erosion site E22.

5.4.4. Site E27

Erosion site E27 includes several blocked culverts, seeps, slumps, and earthflows (Figure 5.4-7). In addition, wave action at the base of the bank has caused erosion of the bank and narrowing of the trail. Maintaining the drainage structures and ditchline would improve the trail conditions and reduced slumps, earthflows, and saturated soil conditions. Erosion control at the base of the bank or signs warning of narrow trail conditions in areas with narrow trail conditions would make the trail safer for users.

Figure 5.4-7. Example drainage issues at Erosion site E27.

5.4.5. Site E36

Erosion site E36 is a short section of trail (140 feet) with seeps and drainage issues that result in saturated soils and slumps, narrowing the trail and making it difficult to cross the top of the slump (Figure 5.4-8). Wave action is a minor contributor to the erosion at this site, but waves at high lake levels do remove slumped material. Drainage improvements such as maintaining a ditch and installing a culvert could help reduce the potential for future slumping at this location.

Figure 5.4-8. Erosion Site E36.

5.4.6. Site E38

Erosion Site E38 includes seeps and runoff from a steep section of trail that result in a saturated trail bed and rills down the bank at several locations (Figure 5.4-9). Two culverts in this segment are plugged, and two additional culverts at small stream crossings south of this segment have high plug potentials and should be maintained to optimize drainage. In addition, wave action along this section has eroded the bank resulting in a 10- to 15-foot-high undercut bank. Keeping the culverts clean and controlling the trail runoff with a drivable dip would improve trail conditions.

Figure 5.4-9. Erosion Site E38.

5.4.7. Sites E40 and E40a

Erosion Sites E40 and E40a are affected by seepage that causes saturated soils along the trail in a few locations and wave action that has eroded the bank and narrowed the trail in several spots (Figure 5.4-10). The bank at these sites are 5 to 7 feet high and the trail is not narrow enough to pose a major safety hazard but maintaining the culvert and controlling the seeps by installing drainage structures would improve trail conditions.

Figure 5.4-10. Erosion site E40.

6 CONCLUSIONS

Erosion of the banks on the Eklutna Lakeside Trail has resulted in narrowing of the trail along approximately 3.1 miles of the trail system. In areas where past erosion has narrowed the original trail bed along the shoreline, the main Lakeside Trail has been re-routed to a higher elevation away from the shoreline. In these locations, the original trail bed is now designated for non-motorized use.

Understanding the factors contributing to erosion at each trail erosion site as well as the type of erosion processes allows for application of appropriate erosion control measures if needed. The primary factor affecting lakeshore erosion is wave action when the lake water surface is above approximately 871 feet which occurs less than 2 percent of the time (note that additional investigations into datum is needed before a definitive lake elevation is determined). The second most common factor affecting lakeshore erosion along the trail system is seepage/drainage issues (e.g., seeps, blocked culverts or ditches), primarily along the southeastern third of the lakeshore. Drainage issues are not related to Project operations. Nine sites were identified as high priority sites for erosion control, maintenance, or warning signs due to concerns for the safety of trail users (Table 6.0-1).

Table 6.0-1. Summary of high priority sites.

Site	Erosion type	Underlying geology	Bank height (ft)/	Factors affecting erosion	Potential measures
E10	Undercut bank/ raveling/ trampling	Alluvial fan deposits	7.5 – 13.5	Wave action, pedestrian use	Signs to indicate narrow trail conditions
E11	Undercut bank/ raveling	Alluvial fan deposits	20	Wave action, trail runoff	Signs to indicate narrow trail conditions
E14	Undercut bank/ slumping	Glacial deposits	14	Wave action, reservoir fluctuations	Drainage structures and erosion control at base of slope
E22	Raveling	Alluvial fan deposits	8.5	Wave action, steep cutslopes (raveling)	Signs to indicate narrow trail conditions
E27	Undercut bank/ slumping/earthflow	Glacial deposits	8 - 10	Wave action, reservoir fluctuations	Signs to indicate narrow trail conditions, maintaining drainage structures, erosion control at base of slope
E36	Undercut bank/ slumping	Glacial deposits	5 - 7	Wave action, seepage	Drainage improvements (ditching, culverts)
E38	Undercut bank/ rills/ gullies/runoff	Glacial deposits	10 - 15	Wave action, seepage	Culvert maintenance, controlling trail runoff
E40	Undercut bank	Glacial deposits	5 - 7	Wave action, seepage	Culvert maintenance, installation of additional drainage structures
E40a	Undercut bank	Glacial deposits	5 - 7	Wave action, seepage	Culvert maintenance, installation of additional drainage structures

The Lakeside Trail Erosion study is complete unless future investigations into datums substantially changes the analysis of erosion elevations/lake levels. If any changes to Project operations that result in an increased occurrence of high lake levels (above approximately 871 feet) are proposed, an analysis of the effects of the operational changes on shoreline erosion will be made as part of the analysis of effects.

7 VARIANCES FROM FINAL STUDY PLAN AND PROPOSED MODIFICATIONS

The study was carried out in accordance with the study plan. The only modification was to add a 1-day field visit to the erosion locations during high lake levels to view erosion areas from the lake.

8 REFERENCES

MJA (McMillen Jacobs Associates). 2020. Quarterly update call meeting minutes. February 13, 2020.

Updike, R.G., and Ulery, C.A., 1983, Preliminary geologic map of the Anchorage B-6 NW (Eklutna Lake) Quadrangle, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 83-8, 2 sheets, scale 1:10,000. https://doi.org/10.14509/2347

Appendix A: Lakeside Trail Shoreline Erosion Field Form

Eklutna River Shoreline Erosion Field Form

Site ID _____

Location _____

Date/Time _____

Surveyors _____

Erosion Type
- ❑ Undercut bank
- ❑ Slumping
- ❑ Raveling
- ❑ Rills/gullies
- ❑ Trampling
- ❑ _____

Seepage?
Y / N

Geology/Soils
- ❑ Bedrock
- ❑ Talus
- ❑ Till
- ❑ Sand/gravel
- ❑ Glaciolacustrine
- ❑ Fill
- ❑ _____

Piping?
Y / N

Gleyed soils?
Y / N

Shore Area Affected
- ❑ Shore above high water
- ❑ Drawdown zone
- ❑ _____

Dimensions of eroding area (ft)
- Shoreline length _____
- Bank height _____
- Dist. from shore _____
- Area (sq ft) _____
- Disturbed slope gradient (%) _____
- Undisturbed slope gradient (%) _____

Evidence of erosion rate/activity
- Exposed roots/stump depth (ft) _____
- Fresh tree fall (#, decay class) _____
- Fresh soil _____
- Stabilized (rationale) _____

Vegetation
- Type _____
- Condition _____ Age _____
- % Bare soil _____
- Percent Cover Trees Shrub Herb Other
- Disturbed area _____
- Undisturbed _____

Potential resource effects noted in field
- Aquatic Habitat _____
- Terrestrial Habitat _____
- Recreation _____
- Trail/Development _____

Comments/Sketch

Factors Affecting Erosion
- ❑ Reservoir fluctuations
- ❑ Wave action
- ❑ Pedestrian Use
- ❑ ATV Use
- ❑ Road Runoff
- ❑ _____

Appendix B: Erosion Site Characteristics

2021 Eklutna Shoreline Trail Erosion Inventory

SiteID	Trail Type	Erosion Type	Geology/Soil	Secondary Geology/ Soil	Seepage	Length (ft)	Bank Height (ft)	Disturbed Slope Gradient (%)	Undisturbed Slope Gradient (%)	Exposed Root Depth (ft)	Fresh Tree Fall	Old Tree Fall	Fresh Soil?	Stabilized/ Rationale	Potential Resource Effects	Vegetation Type	Vegetation Condition	Vegetation Age
E1a	Streambank	Trampling	Stream deposits	Road fill	N	40	2	5-50	10-100 UCB	Y	0	0	Y	N	Stream Banks/ Riparian Veg	Cottonwood/ Understory veg/grass	Good	20-30
E1b	Streambank	Trampling	Stream deposits	Road fill	N	40	2	5-50	10-100 UCB	Y	0	0	Y	N	Stream Banks/ Riparian Veg	Cottonwood/ Understory veg/grass	Good	20-30
E2	Main Trail	Undercut bank	Aluvial Fan	Road fill	N	70	3.5	90	25	3-15 ft bank retreat	0	0	N	N	Riparian Veg/Trail	Cottonwood/ grass	New/good	5
E3	Main Trail	Raveling	Aluvial Fan	Road fill	Y	145	1	40	15	0	0	0	N	Some - cobble/ boulder along shore	Riparian Veg/Trail	Cottonwood	Good	20
E4	Main Trail	Undercut bank/ Rills-gullies	Aluvial Fan	Road fill	N	634	3-4	90	N/A	0	0	0	Y - rills	N	Riparian Veg/Trail	None	N/A	N/A
E5	Main Trail	Undercut bank/ Trampling	Aluvial Fan	Road fill	N	170	13	80-90	70-80	Y	0	0	Y	N	Riparian Veg/Trail	Cottonwood	Young	2
E6	Side Trail	Undercut bank/ Raveling	Aluvial Fan	Road fill	N	180	7.5	90	N/A	0	1	0	Y	N	Riparian Veg/Trail	Cottonwood	Sparse	1-2
E7	Side Trail	Undercut bank/ Raveling	Aluvial Fan	Road fill	N	201	6.5 - 10.5	90	N/A	2-3, 15' at places	2	42	N	N	Riparian Veg/Trail	Cottonwood/ Spruce	Ok	<10
E7a	Side Trail	Undercut bank/ Raveling	Aluvial Fan	Road fill	N	1089	4	90	N/A	2-3, 15' at places	6	30	N	N	Riparian Veg/Trail	Cottonwood/ Spruce	Ok	<10
E7b	Side Trail	Undercut bank/ Raveling	Aluvial Fan	Road fill	N	100	4	90	0	2-3, 15' at places	0	5	N	N	Riparian Veg/Trail	Cottonwood/ Spruce	Ok	<10
E8	Side Trail	Undercut bank/ Raveling/ Trampling	Aluvial Fan	Road fill	N	10	3.5	90	80	0.5	0	0	Y	N	Riparian Veg/Trail	Cottonwood	Good in non-eroded areas	20
E9	Main Trail	Undercut bank/ Raveling/ Trampling (in a few spots)	Aluvial Fan	Road fill	N	555	7-9	90	N/A	4	0	24	Y	N	Riparian Veg/Trail	Cottonwood/ Spruce	N/A	0-5

2021 Eklutna Shoreline Trail Erosion Inventory

SiteID	Trail Type	Erosion Type	Geology/Soil	Secondary Geology/ Soil	Seepage	Length (ft)	Bank Height (ft)	Disturbed Slope Gradient (%)	Undisturbed Slope Gradient (%)	Exposed Root Depth (ft)	Fresh Tree Fall	Old Tree Fall	Fresh Soil?	Stabilized/ Rationale	Potential Resource Effects	Vegetation Type	Vegetation Condition	Vegetation Age
E9a	Main Trail	Undercut bank/ Raveling/ Trampling (in a few spots)	Aluvial Fan	Road fill	N	568	7-9	90	N/A	4	2	12	Y	N	Riparian Veg/Trail	Cottonwood/ Spruce	N/A	0-5
E9b	Main Trail	Undercut bank/ Raveling/ Trampling (in a few spots)	Aluvial Fan	Road fill	N	565	7-9	90	N/A	4	3	8	Y	N	Riparian Veg/Trail	Cottonwood/ Spruce	N/A	0-5
E9c	Main Trail	Undercut bank/ Raveling/ Trampling (in a few spots)	Aluvial Fan	Road fill	N	317	7-9	90	N/A	4	4	12	Y	N	Riparian Veg/Trail	Cottonwood/ Spruce	N/A	0-5
E10	Side Trail	Undercut bank/ Raveling/ Trampling	Aluvial Fan	Road fill	N	155	7.5-13.5	90	N/A	0	0	0	Y	N	Riparian Veg/Trail	Cottonwood	Ok	0-5
E11	Side Trail	Undercut bank/ Raveling	Aluvial Fan	Road fill	N	154	20	90	N/A	0	0	13	Y	N	Riparian Veg/Trail	Cottonwood	Ok	0-10
E12	Side Trail	Undercut bank/ Raveling/ Trampling	Aluvial Fan	Road fill	N	292	10-11	90	N/A	10	1	12	Y	N - but some netting, some trees coming back	Riparian Veg/Trail	Cottonwood	N/A	5
E13	Side Trail	Slumping	Glacial deposits	Road Fill	Y	61	12.5	85	70	3	2	5	N	N	Riparian Veg/ Trail	Cottonwood/ Birch/ Alder/ Rose	Good	50+
E14	Side Trail	Undercut Bank/ Slumping	Glacial deposits	Road Fill	Y	297	14	90	70-80	2	4	11	Y	N	Riparian Veg/ Trail	Cottonwood/ Birch	OK	0-5
E15	Side Trail	Undercut Bank/ Raveling	Glacial deposits	Road Fill	N	870	7	90	70-80	2	3	34	Y	N	Riparian Veg/ Trail	Cottonwood	OK	0-20
E16	Main Trail	Undercut Bank/ Slumping	Glacial deposits	Road Fill	Y	60	7	90	70	2	1	2	Y	N	Riparian Veg/ Trail	Cottonwood	Ok	0-5
E16a	Main Trail	Undercut Bank/ Slumping	Glacial deposits	Road Fill	Y	25	7	90	70	2	0	1	Y	N	Riparian Veg/ Trail	Cottonwood	Ok	0-5
E17a	Side Trail	Undercut Bank	Aluvial Fan	Road fill	N	976	4-7	90	N/A	Y	5	46	Y	N	Riparian Veg/ Trail	Cottonwood	N/A	to 10

2021 Eklutna Shoreline Trail Erosion Inventory

SiteID	Trail Type	Erosion Type	Geology/Soil	Secondary Geology/ Soil	Seepage	Length (ft)	Bank Height (ft)	Disturbed Slope Gradient (%)	Undisturbed Slope Gradient (%)	Exposed Root Depth (ft)	Fresh Tree Fall	Old Tree Fall	Fresh Soil?	Stabilized/ Rationale	Potential Resource Effects	Vegetation Type	Vegetation Condition	Vegetation Age
E17b	Side Trail	Slumping/ Rills	Glacial deposits	Road Fill	Y	120	4-7	90	N/A	Y	11	12	Y	N	Riparian Veg/ Trail	Cottonwood	N/A	to 10
E17c	Side Trail	Undercut Bank/ Slumping/ Rills	Glacial deposits	Road Fill	Y	185	4-7	90	N/A	Y	5	21	Y	N	Riparian Veg/ Trail	Cottonwood	N/A	to 10
E17d	Side Trail	Undercut Bank	Glacial deposits	Road Fill	N	371	4-7	90	N/A	Y	9	21	Y	N	Riparian Veg/ Trail	Cottonwood	N/A	to 10
E17e	Side Trail	Undercut Bank	Glacial deposits	Road Fill	N	212	4-7	90	N/A	Y	4	12	Y	N	Riparian Veg/ Trail	Cottonwood	N/A	to 10
E18	Side Trail	Undercut Bank/ Raveling	Aluvial Fan	Road fill	N	134	10.5	90	N/A	3	3	5	Y	N	Riparian Veg/ Trail	Cottonwood	N/A	2
E19a	Side Trail	Undercut bank/ Raveling	Aluvial Fan	Road fill	N	389	7	90	70-80	2-3	0	16	N	Y - in some places veg older	Riparian Veg/ Trail	Cottonwood	N/A	0-5
E19b	Side Trail	Undercut bank/ Raveling	Aluvial Fan	Road fill	N	354	7	90	70-80	2-3	0	11	Y	N	Riparian Veg/ Trail	Cottonwood	N/A	0-5
E19c	Side Trail	Undercut bank/ Raveling	Aluvial Fan	Road fill	N	335	7	90	70-80	2-3	1	26	N	Y - in some places veg older	Riparian Veg/ Trail	Cottonwood	N/A	0-5
E20	Side Trail	Slumping/ Undercut bank	Glacial deposits	Road Fill	Y	412	1-5	90	70-80	10-15 @ pipe	4	38	Y	N	Riparian Veg/ Trail	Cottonwood/ Birch	OK	0-15
E20a	Side Trail	Slumping/ Undercut bank	Aluvial Fan	Road fill	Y	60	10.5	90	70-80	4-5	4	3	Y	N	Riparian Veg/ Trail	Cottonwood/ Birch	OK	0-15
E21	Streambank	Raveling/ Trampling	Aluvial Fan	Road fill	N	50	N/A	0-90	70	0	0	0	Y	N, but some stabilized areas by veg & sheet pile	Riparian/ Bridge	Cottonwood	Ok	10-15
E22	Side Trail	Undercut bank/ Raveling	Aluvial Fan	Road fill	N	1295	8.5	90	70	0	0	0	Y	N	Riparian Veg/ Trail	Cottonwood	N/A	5
E23	Side Trail	Slumping	Glacial deposits	Road Fill	Y	70	9	90-100	N/A	0	0	0	Y	N	Riparian Veg/ Trail	Cottonwood	N/A	N/A
E24	Side Trail	Slumping	Glacial deposits	Road Fill	Y	153	8-9	90-100	N/A	0	0	0	Y	Slightly more stable	Riparian Veg/ Trail	N/A	N/A	N/A

2021 Eklutna Shoreline Trail Erosion Inventory

SiteID	Trail Type	Erosion Type	Geology/Soil	Secondary Geology/ Soil	Seepage	Length (ft)	Bank Height (ft)	Disturbed Slope Gradient (%)	Undisturbed Slope Gradient (%)	Exposed Root Depth (ft)	Fresh Tree Fall	Old Tree Fall	Fresh Soil?	Stabilized/ Rationale	Potential Resource Effects	Vegetation Type	Vegetation Condition	Vegetation Age
E25a	Side Trail	Slumping	Glacial deposits	Road Fill	Y	295	7-9	90-100	N/A	0	0	0	Y	N	Riparian Veg/ Trail	N/A	N/A	N/A
E25b	Side Trail	Slumping	Glacial deposits	Road Fill	Y	140	10.5	90-100	N/A	0	5	0	Y	N	Riparian Veg/ Trail	N/A	N/A	N/A
E26	Side Trail	Undercut bank/ Slumping	Glacial deposits	Road Fill	Y	182	6	90 UCB	70-80	0	0	0	Y	N	Riparian Veg/ Trail	N/A	N/A	N/A
E26a	Side Trail	Undercut bank/ Slumping	Glacial deposits	Road Fill	Y	20	6	90 UCB	70-80	0	0	0	Y	N	Riparian Veg/ Trail	N/A	N/A	N/A
E26b	Side Trail	Undercut bank/ Slumping	Glacial deposits	Road Fill	Y	102	6	90 UCB	70-80	0	0	0	Y	N	Riparian Veg/ Trail	N/A	N/A	N/A
E26c	Side Trail	Undercut bank/ Slumping	Glacial deposits	Road Fill	Y	120	8.5	UCB	70-80	0	1	0	Y	N	Riparian Veg/ Trail	N/A	N/A	N/A
E27	Side Trail	Undercut bank/ Slumping/ Earthflow (in a few spots)	Glacial deposits	Road Fill	Y	524	8-10	100 UCB	N/A	3-4	5	0	Y	N	Riparian Veg/ Trail	Cottonwood	OK	Young
E28	Side Trail	Undercut bank/ Slumping (in a few spots)	Glacial deposits	Road Fill	Y	390	5-7	100 UCB	N/A	2-3	3	5	Y	N	Riparian Veg/ Trail	Cottonwood/ Alder	N/A	N/A
E29	Side Trail	Undercut bank	Glacial deposits	Road Fill	Y	377	5	100 UCB	N/A	3-4	0	0	Y	N	Riparian Veg/ Trail	Cottonwood/ Alder	OK	5-10
E30	Side Trail	Undercut bank	Glacial deposits	Road Fill	Y - needs more culverts	383	5-10	110 UCB	N/A	2-3	3	Lots	Y - tension cracks	N	Riparian Veg/ Trail	Cottonwood/ Alder/Willow	OK	5-20
E31	Side Trail	Rills/ Gullies- from blocked culvert	Glacial deposits	Road Fill	Y	40	3-5	UCB	N/A	2-3	0	0	N	N	Riparian Veg/ Trail	Cottonwood	OK	10-15
E32	Side Trail	Undercut bank/ Slumping- tension cracks	Glacial deposits	Road Fill	N - not now, past?	114	5-10	90 UCB	N/A	2-3	3	7	Y- tension cracks	N	Riparian Veg/ Trail	Cottonwood	OK	0-20
E33	Side Trail	Undercut bank/ Rills/ gullies (blocked culvert)	Glacial deposits	Road Fill	Y	65	5-7	90 UCB	N/A	3	0	0	N	N	Riparian Veg/ Trail	Alder/ Cottonwood	OK	1-20

2021 Eklutna Shoreline Trail Erosion Inventory

SiteID	Trail Type	Erosion Type	Geology/Soil	Secondary Geology/ Soil	Seepage	Length (ft)	Bank Height (ft)	Disturbed Slope Gradient (%)	Undisturbed Slope Gradient (%)	Exposed Root Depth (ft)	Fresh Tree Fall	Old Tree Fall	Fresh Soil?	Stabilized/ Rationale	Potential Resource Effects	Vegetation Type	Vegetation Condition	Vegetation Age
E34	Side Trail	Undercut bank	Glacial deposits	Road Fill	Y - in past, not active now except @ Culvert 34	105	5-10	90 UCB	N/A	0	0	10	N	N but in some places partially stable, older erosion site	Riparian Veg/ Trail	Cottonwood	Good	5-10
E35	Side Trail	Undercut bank	Glacial deposits	Road Fill	Y	404	5-10	90 UCB	N/A	3 in places	0	5	Y	N	Riparian Veg/ Trail	Cottonwood	Ok/ eroding in places	0-10
E36	Side Trail	Undercut bank/ Slumping	Glacial deposits	Road Fill	Y - slumping	140	5-7	90 UCB	N/A	0	0	0	Y - fresh slump	N	Riparian Veg/ Trail	Cottonwood/ Spruce	OK	10-20
E37	Side Trail	Undercut bank/ Sumping+Rills/ Gullies-from blocked ditch/ culverts	Glacial deposits	Road Fill	Y	300	5-10	90 UCB	N/A	0	0	0	Y - tension cracks/s lumps	N	Riparian Veg/ Trail	Cottonwood	OK	0-10
E38	Main Trail	Undercut bank/ Rills/ gullies (run off @a few spots)	Glacial deposits	Road Fill	Y	366	10-15	110 UCB	N/A	2-3	0	0	N	N	Riparian Veg/ Trail	Cottonwood	OK	1-20+
E39	Side Trail	Undercut bank/ Slumping, Rills/ gullies (from plugged culverts/ seepage)	Glacial deposits	Road Fill	Y	190	5-7	90 UCB	N/A	2 feet root exposure plus tension cracks	0	0	Y - in places	N	Riparian Veg/ Trail	Cottonwood	Good	5-20
E40	Side Trail	Undercut bank	Glacial deposits	Road Fill	Y in spots	185	5-7	90 UCB	N/A	2-3	0	0	Y	N - active in spots	Riparian Veg/ Trail	Cottonwood/ Spruce	Ok	5-20+
E40a	Side Trail	Undercut bank	Glacial deposits	Road Fill	Y in spots	110	5-7	90 UCB	N/A	2-3	0	0	Y	N - active in spots	Riparian Veg/ Trail	Cottonwood/ Spruce	Ok	5-20+

2021 Eklutna Shoreline Trail Erosion Inventory

SiteID	Percent Bare Soil	Disturbed Percent Tree Cover	Disturbed Percent Shrub Cover	Disturbed Percent Herbaceous Cover	Disturbed Percent Other Cover	Undisturbed Percent Tree Cover	Undisturbed Percent Shrub Cover	Undisturbed Percent Herbaceous Cover	Undisturbed Percent Other Cover	Factors Affecting Erosion	Second Factor Affecting Erosion	Third Factor Affecting Erosion	Comments
E1a	80	10	5	0	0	100	50	50	0	Pedestrian Use-to access stream	Streamflow	N	
E1b	80	10	5	0	0	100	50	50	0	Pedestrian Use-to access stream	Streamflow	N	
E2	100	0	0	0	0	100	10	50	0	Wave Action	Pedestrian Use	N	Trail has culverts, drains wet area
E3	70	10	0	0	20 Rock	100	10	10	0	Wave Action	Pedestrian Use	N	
E4	100	0	0	0	0	n/a	n/a	n/a	n/a	Wave Action	Stream-blocked culvert/ recently fixed	N	Stream x-ing looks like recent new culvert, has plugged in past/wave action too.
E5	60	20	0	0	0	100	10	40	0	Wave Action	Pedestrian Use	N	
E6	90	5	5	0	0	n/a	n/a	n/a	n/a	Reservoir fluctuations?	Wave Action	Pedestrain use	
E7	100% on bank/ 50% top	0-50	0	10	0	70	20	0	80 Moss	Reservoir fluctuations?	Wave Action	N	
E7a	100% on bank/ 50% top	0-50	0	10	0	70	20	0	80 Moss	Reservoir fluctuations?	Wave Action	N	
E7b	100% on bank/ 50% top	0-50	0	10	0	70	20	0	80 Moss	Reservoir fluctuations?	Wave Action	N	
E8	90	0	0	0	10 Rock	100 Canopy	50	50	0	Wave Action	Pedestrian Use	N	Lake access spot
E9	80	5	5	10	0	N/A	N/A	N/A	N/A	Reservoir fluctations?	Wave Action	Pedestrain use-1 to 2 spots only	

2021 Eklutna Shoreline Trail Erosion Inventory

SiteID	Percent Bare Soil	Disturbed Percent Tree Cover	Disturbed Percent Shrub Cover	Disturbed Percent Herbaceous Cover	Disturbed Percent Other Cover	Undisturbed Percent Tree Cover	Undisturbed Percent Shrub Cover	Undisturbed Percent Herbaceous Cover	Undisturbed Percent Other Cover	Factors Affecting Erosion	Second Factor Affecting Erosion	Third Factor Affecting Erosion	Comments
E9a	80	5	5	10	0	N/A	N/A	N/A	N/A	Reservoir fluctations?	Wave Action	Pedestrain use-1 to 2 spots only	
E9b	80	5	5	10	0	N/A	N/A	N/A	N/A	Reservoir fluctations?	Wave Action	Pedestrain use-1 to 2 spots only	short more stable section
E9c	80	5	5	10	0	N/A	N/A	N/A	N/A	Reservoir fluctations?	Wave Action	Pedestrain use-1 to 2 spots only	
E10	90	5	0	5	0	N/A	N/A	N/A	N/A	Wave Action	Pedestrian Use	N	
E11	90	10	0	0	0	N/A	N/A	N/A	N/A	Wave Action	Trail runoff	N	Rills down cliff from upper trail runoff
E12	30/100 on bank face	50	0	20	0	N/A	N/A	N/A	N/A	Wave Action	Pedestrian Use-at trampled lake access area	N	Reveg/erosion control measures: jute netting, grass, coir roll. Yuditna Public Use Cabin access
E13	10	50	40	50	0	80	50	50	0	Reservoir fluctuations?	Wave Action-note aspect	Seepage	Tension cracks indicate potential future movement
E14	80	10	5	15	0	N/A	N/A	N/A	N/A	Reservoir fluctuations?	Wave Action	N	
E15	50	20	20	30 grass	0	N/A	N/A	N/A	N/A	Wave Action	N	N	
E16	20	70	50	20	0	N/A	N/A	N/A	N/A	Wave Action	Seepage	N	1 small culvert
E16a	20	70	50	20	0	N/A	N/A	N/A	N/A	Wave Action	Seepage	N	
E17a	50	20	25	25	0	N/A	N/A	N/A	N/A	Wave Action	N	N	

2021 Eklutna Shoreline Trail Erosion Inventory

SiteID	Percent Bare Soil	Disturbed Percent Tree Cover	Disturbed Percent Shrub Cover	Disturbed Percent Herbaceous Cover	Disturbed Percent Other Cover	Undisturbed Percent Tree Cover	Undisturbed Percent Shrub Cover	Undisturbed Percent Herbaceous Cover	Undisturbed Percent Other Cover	Factors Affecting Erosion	Second Factor Affecting Erosion	Third Factor Affecting Erosion	Comments
E17b	50	20	25	25	0	N/A	N/A	N/A	N/A	Wave Action	Seepage-in places, slumps-dr, rills	N	
E17c	50	20	25	25	0	N/A	N/A	N/A	N/A	Wave Action	Seepage-in places, slumps-dr, rills	N	Wet, tensions cracks indicate potential future slumping
E17d	50	20	25	25	0	N/A	N/A	N/A	N/A	Wave Action	N	N	
E17e	50	20	25	25	0	N/A	N/A	N/A	N/A	Wave Action	N	N	Seepage @end of trail coming from main trail
E18	95	5	0	0	0	N/A	N/A	N/A	N/A	Wave Action	N	N	
E19a	20	50	10	70	0	N/A	N/A	N/A	N/A	Wave Action	N	N	
E19b	80	10	10	10	0	N/A	N/A	N/A	N/A	Wave Action	N	N	
E19c	20	50	10	70	0	N/A	N/A	N/A	N/A	Wave Action	N	N	
E20	20	80	40	40	0	N/A	N/A	N/A	N/A	Wave Action	Seepage-saturated soil	N	Several culverts with flow
E20a	20	80	40	40	0	N/A	N/A	N/A	N/A	Wave Action	Seepage-saturated soil	N	
E21	60	10	10	10	10 Rock	100	50	30	0	Reservoir fluctuations - minor	Wave Action-minor	Pedestrain Use/ Streamflow	Bold Creek bridge construction some of issue also (fill, steep, slope, ground disturbances)
E22	95	5	0	0	0	N/A	N/A	N/A	N/A	Wave Action	Steep cutsopes (ravelling)	N	Raveling cuts slope to 20'H
E23	N/A	0	0	0	0	N/A	N/A	N/A	N/A	Wave Action	Seepage	N	Culvert @ end dripping
E24	N/A	0	0	0	0	N/A	N/A	N/A	N/A	Wave Action	Seepage	N/A	

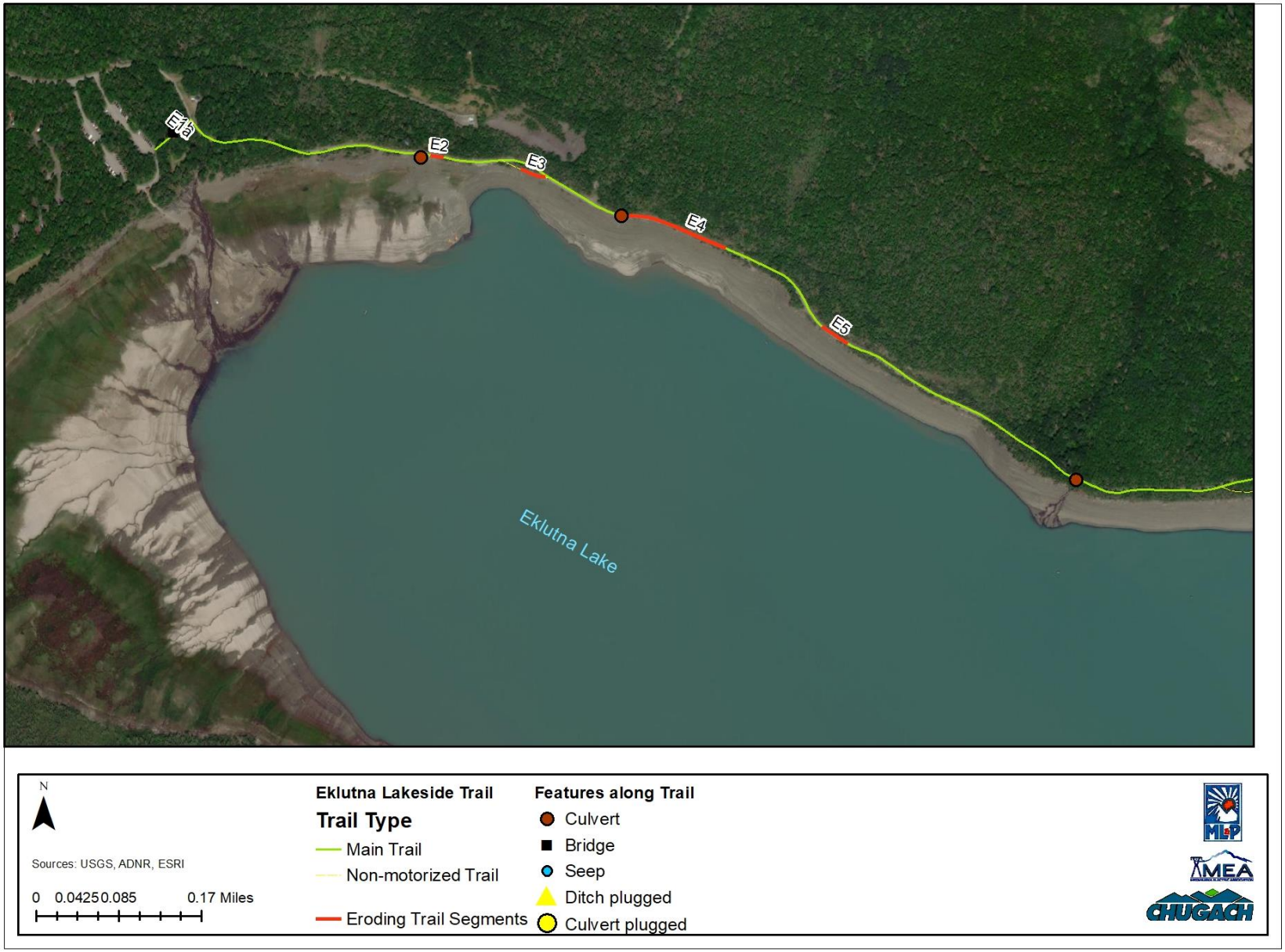
2021 Eklutna Shoreline Trail Erosion Inventory

SiteID	Percent Bare Soil	Disturbed Percent Tree Cover	Disturbed Percent Shrub Cover	Disturbed Percent Herbaceous Cover	Disturbed Percent Other Cover	Undisturbed Percent Tree Cover	Undisturbed Percent Shrub Cover	Undisturbed Percent Herbaceous Cover	Undisturbed Percent Other Cover	Factors Affecting Erosion	Second Factor Affecting Erosion	Third Factor Affecting Erosion	Comments
E25a	N/A	0	0	0	0	N/A	N/A	N/A	N/A	Wave Action	Seepage	N	Active tension cracks + active slumping
E25b	N/A	0	0	0	0	N/A	N/A	N/A	N/A	Wave Action	Seepage	N	Active tension cracks + active slumping
E26	N/A	0	0	0	0	N/A	N/A	N/A	N/A	Wave Action	N	N	
E26a	N/A	0	0	0	0	N/A	N/A	N/A	N/A	Wave Action	N	N	
E26b	N/A	0	0	0	0	N/A	N/A	N/A	N/A	Wave Action	N	N	
E26c	N/A	0	0	0	0	N/A	N/A	N/A	N/A	Wave Action	N	N	
E27	90	5	0	0	5 Rock	N/A	N/A	N/A	N/A	Reservoir Fluctuations	Wave Action	Seepage	Culvert 27 plugged 15' unraveling, exposed, Culvert 27a- wrong spot ditch plugged 20' exposed, seepage/slump result, Culvert 27b- rusted, functioning
E28	50-90 in active areas/ 0 in more stable areas (rocks, trees stabilize)	+/- 40	0	0	10 Rock	N/A	N/A	N/A	N/A	Wave Action	Seepage	N	Tension cracks, ditch plugged. Culvert 28 OK, shotgunned, Culvert 28a-8' exposed, shotgunned. Need more culvets along this section of trail
E29	50	20	20	0	10 Rock	N/A	N/A	N/A	N/A	Wave Action	Seepage	N	Tension cracks. Culvert 29 - 5' exposed, 2' unravel, shotgunned. Culvert 29a - 75% plugged, 4' exposed.
E30	30	50	10	0	10 Rock	N/A	N/A	N/A	N/A	Wave Action	Seepage	N	Culvert 30 - 10% plugged, 8' exposed, shotgunned.
E31	10	80	0	0	10	N/A	N/A	N/A	N/A	Wave Action-minor	Seepage	Plugged culvert	Culvert 31 - 50% plugged/crushed-lots of flow, 5' exposed, shotgun, has plugged in past.
E32	50	40	0	0	10 Rock	N/A	N/A	N/A	N/A	Wave Action	N	N	
E33	10	50	20	20	10 Rock	N/A	N/A	N/A	N/A	Wave Action	Blocked culvert	Runoff	Culvert 33 OK now, has been blocked in past. 10' exposed, blocked, shotgunned.

2021 Eklutna Shoreline Trail Erosion Inventory

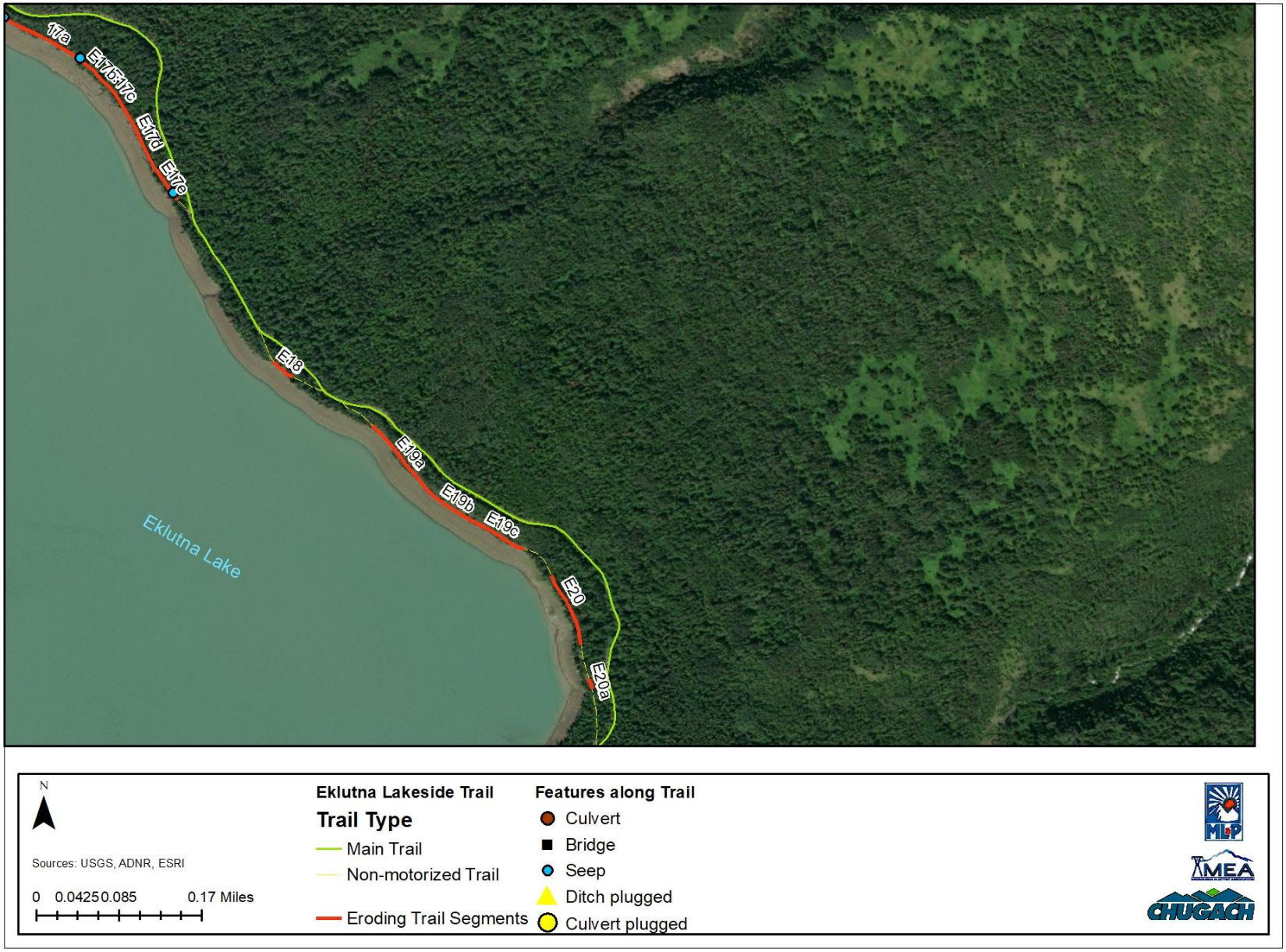
SiteID	Percent Bare Soil	Disturbed Percent Tree Cover	Disturbed Percent Shrub Cover	Disturbed Percent Herbaceous Cover	Disturbed Percent Other Cover	Undisturbed Percent Tree Cover	Undisturbed Percent Shrub Cover	Undisturbed Percent Herbaceous Cover	Undisturbed Percent Other Cover	Factors Affecting Erosion	Second Factor Affecting Erosion	Third Factor Affecting Erosion	Comments
E34	30	20	10	30	10 Rock	N/A	N/A	N/A	N/A	Wave Action	Seepage-older?	N	Culvert 34 totally plugged, needs cleaning
E35	80-90	10	0	0	10 Rock	N/A	N/A	N/A	N/A	Wave Action	Seepage	Blocked culverts	Culvert 35 - outlet mangled, inlet 100% plugged, ditch plugged in places, needs more culverts and/or clearing. Culvert 35a - 100% inlet plugged, 8' exposed.
E36	50	40	0	0	10 Rock	N/A	N/A	N/A	N/A	Wave Action	Seepage	N	
E37	40	30	0	20	10 Rock	N/A	N/A	N/A	N/A	Wave Action	Seepage	Blocked + missing culverts	
E38	70	10	0	10	10 Rock	N/A	N/A	N/A	N/A	Wave Action	Seepage	Runoff in spots	Culvert 38 - 50% plugged, C38a - 100% plugged, Culvert 38x - not in segment, high plug potential, Culvert 38y - not in segment (stream) high plug potential, needs fixing.
E39	40	20	20	10	10 Rock	N/A	N/A	N/A	N/A	Wave Action	Seepage	N	Culvert 39 - 50+% plugged, hillslope slumping, ditch plugged, water over trail.
E40	30	20	20	20	10 Rock	N/A	N/A	N/A	N/A	Wave Action	Seepage	N	Culvert 40 - 50% plugged, needs cleaning.
E40a	30	20	20	20	10 Rock	N/A	N/A	N/A	N/A	Wave Action	Seepage	N	

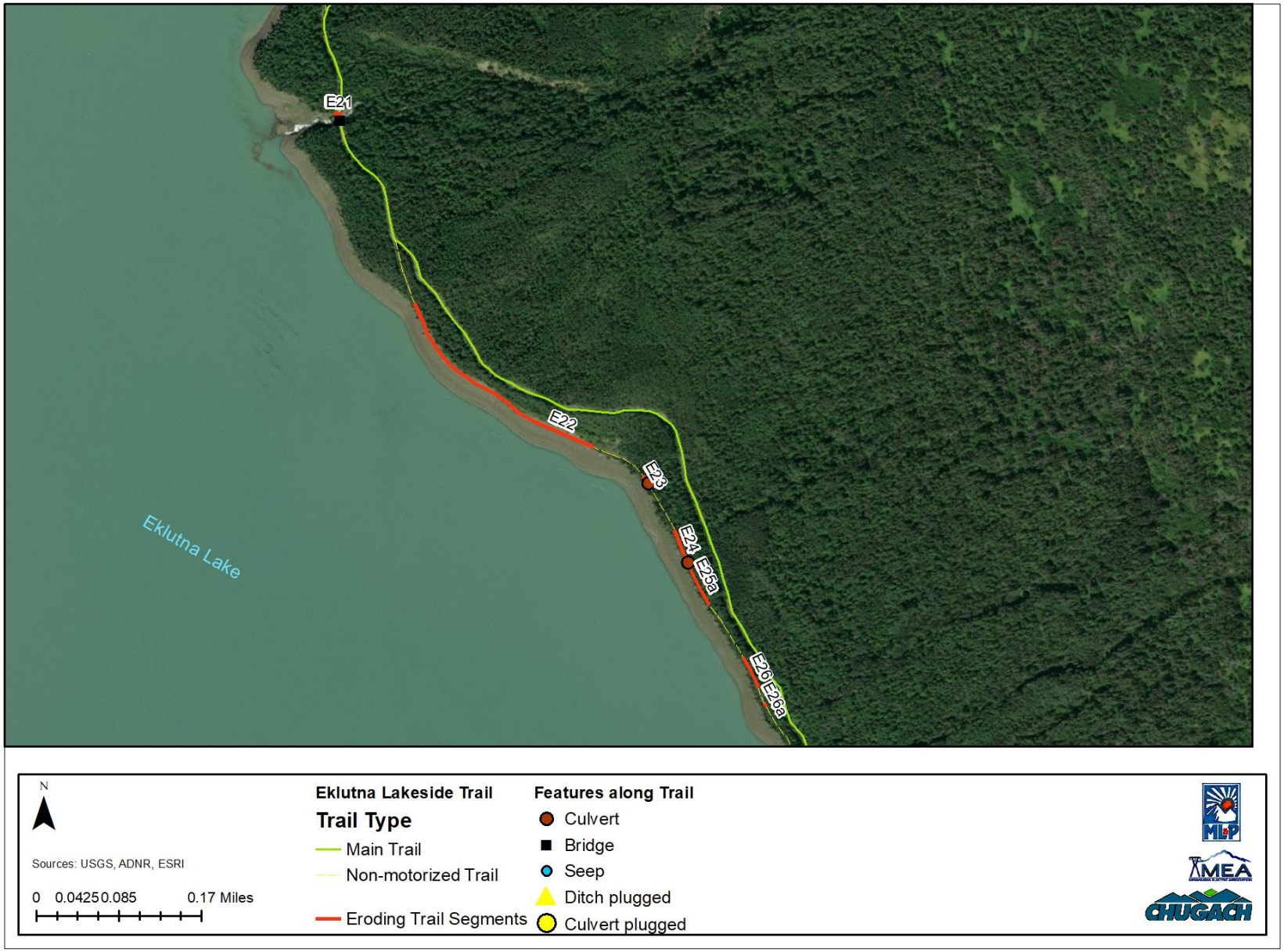
Appendix C: Detail Maps of Lakeshore Trail Erosion Sites


E1a
E2
E3
E4
E5
Eklutna Lake
N
Sources: USGS, ADNR, ESRI
0 0.0425 0.085 0.17 Miles
Eklutna Lakeside Trail
Trail Type
Main Trail
Non-motorized Trail
Eroding Trail Segments
Features along Trail
Culvert
Bridge
Seep
Ditch plugged
Culvert plugged
MEA
CHUGACH

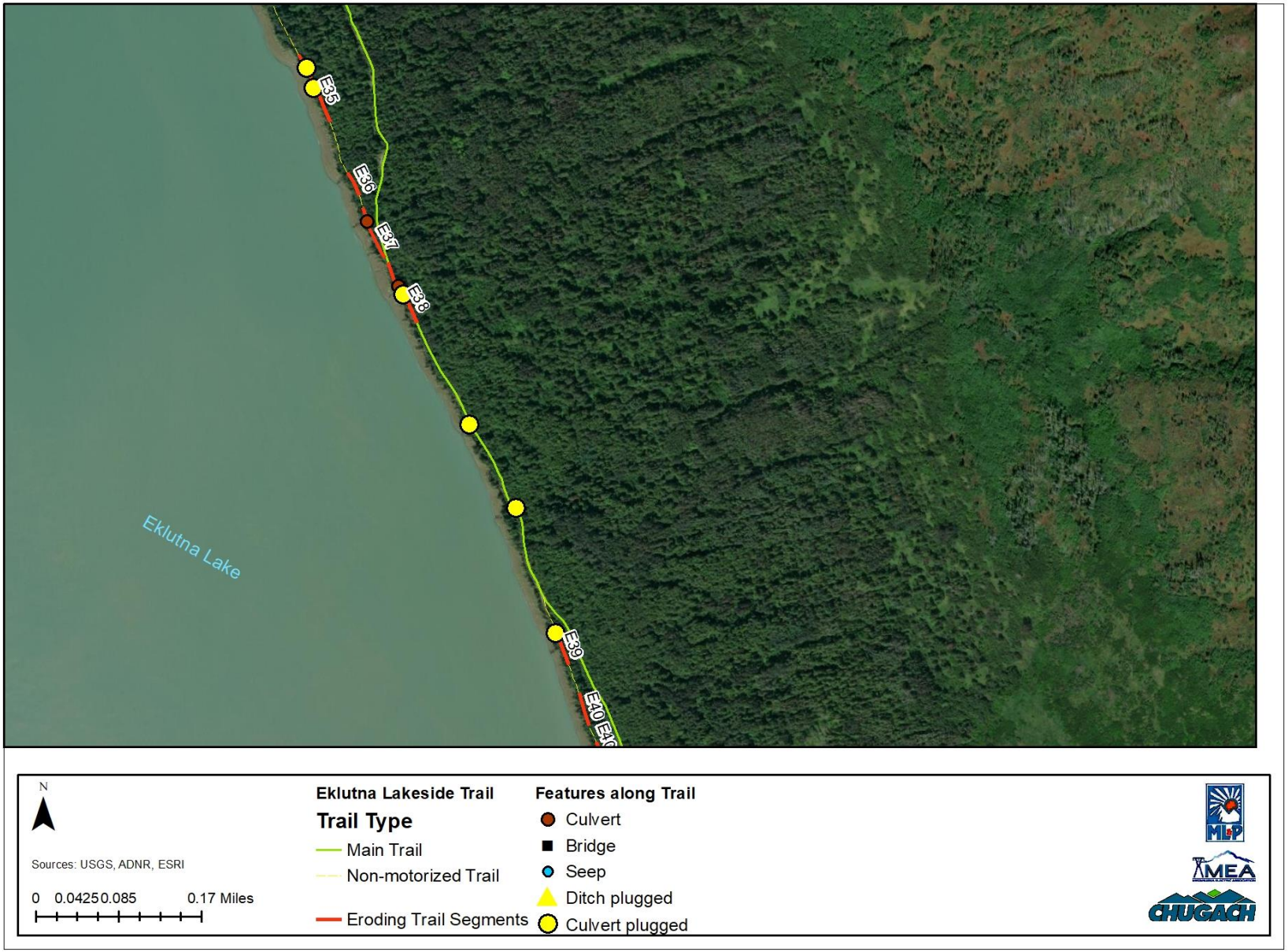

E6
E7
E7a
E7b
E8
E9
E9a
E9b
Eklutna Lake
N
Sources: USGS, ADNR, ESRI
0 0.0425 0.085 0.17 Miles
Eklutna Lakeside Trail
Trail Type
Main Trail
Non-motorized Trail
Eroding Trail Segments
Features along Trail
Culvert
Bridge
Seep
Ditch plugged
Culvert plugged
MEA
CHUGACH

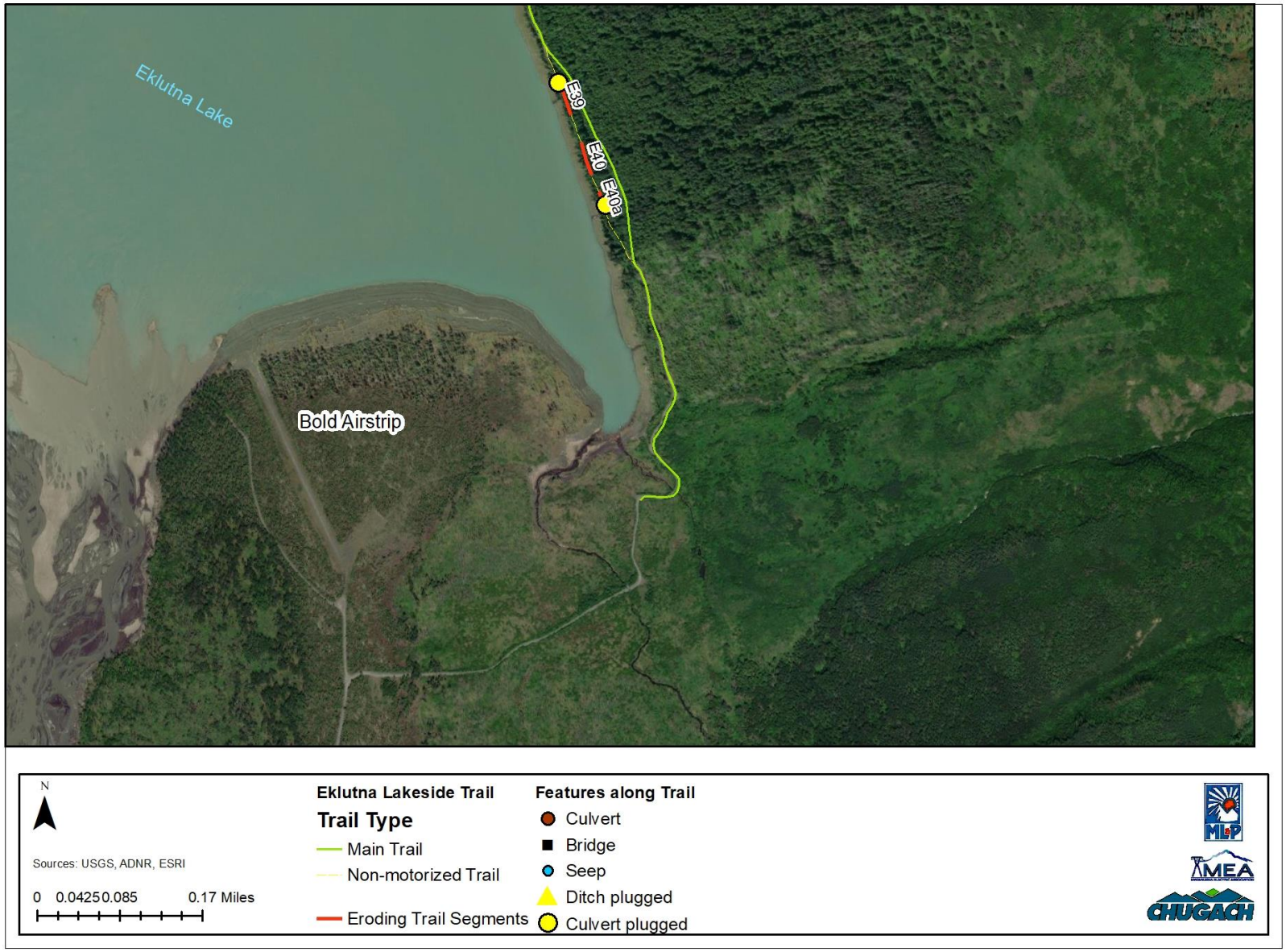

E9b
E9c
E10
E11
E12
E13
E14
E15
E16
E16a
17a
E17
Eklutna Lake
N
Sources: USGS, ADNR, ESRI
0 0.0425 0.085 0.17 Miles
Eklutna Lakeside Trail
Trail Type
Main Trail
Non-motorized Trail
Eroding Trail Segments
Features along Trail
Culvert
Bridge
Seep
Ditch plugged
Culvert plugged
MLP
MEA
CHUGACH


17a
E17b
E17c
E17d
E17e
E18
E19a
E19b
E19c
E20
E20a
Eklutna Lake
N
Sources: USGS, ADNR, ESRI
0 0.0425 0.085 0.17 Miles
Eklutna Lakeside Trail
Trail Type
Main Trail
Non-motorized Trail
Eroding Trail Segments
Features along Trail
Culvert
Bridge
Seep
Ditch plugged
Culvert plugged
MEA
CHUGACH


E21
E22
E23
E24
E25a
E26
E26a
Eklutna Lake
N
Sources: USGS, ADNR, ESRI
0 0.0425 0.085 0.17 Miles
Eklutna Lakeside Trail
Trail Type
Main Trail
Non-motorized Trail
Eroding Trail Segments
Features along Trail
Culvert
Bridge
Seep
Ditch plugged
Culvert plugged
MI-P
MEA
CHUGACH


E26b5b
E26c
E27
E28
E29
E30
E31
E32
E33
E34
Eklutna Lake
N
Sources: USGS, ADNR, ESRI
0 0.0425 0.085 0.17 Miles
Eklutna Lakeside Trail
Trail Type
Main Trail
Non-motorized Trail
Eroding Trail Segments
Features along Trail
Culvert
Bridge
Seep
Ditch plugged
Culvert plugged
MEA
CHUGACH


E35
E36
E37
E38
E39
E40
Eklutna Lake
N
Sources: USGS, ADNR, ESRI
0 0.0425 0.085 0.17 Miles
Eklutna Lakeside Trail
Trail Type
Main Trail
Non-motorized Trail
Eroding Trail Segments
Features along Trail
Culvert
Bridge
Seep
Ditch plugged
Culvert plugged
ML&P
MEA
CHUGACH


Eklutna Lake
Bold Airstrip
E39
E40
E40a
N
Sources: USGS, ADNR, ESRI
0 0.0425 0.085 0.17 Miles
Eklutna Lakeside Trail
Trail Type
Main Trail
Non-motorized Trail
Eroding Trail Segments
Features along Trail
Culvert
Bridge
Seep
Ditch plugged
Culvert plugged
MLP
MEA
CHUGACH