



**U.S. Army Corps
of Engineers**
Alaska District

2011 Supplement Background Studies for Expedited Reconnaissance Study of Matanuska River Erosion

Matanuska-Susitna Borough, Alaska

This supplement is a re-evaluation of economic and hydraulic conditions found in "Background Studies for Expedited Reconnaissance Study of Matanuska River Erosion" published in August, 2003.

May 2011

1. STUDY AUTHORITY

A study titled “Background Studies for Expedited Reconnaissance Study of Matanuska River Erosion” was completed in August 2003 in support of a partial response to the “Rivers and Harbors in Alaska” study resolution, adopted by the U.S. House of Representatives, Committee on Public Works, on December 2, 1970. The Congressional direction source is: Public Law 107-66, the Energy and Water Development Appropriations Act, 2002, was enacted on November 12, 2001 and authorized \$100,000 for a reconnaissance level investigation called Matanuska River Erosion Control, Alaska. For the sake of brevity, the Background Studies for Expedited Reconnaissance Study of Matanuska River Erosion will be referred to as the 2003 Study in this supplement.

This supplement is in response to a written request from the Matanuska-Susitna Borough to update the 2003 Reconnaissance Study for a specific part of the study area: the Matanuska River from the Old Glenn Highway Palmer Bridge to its confluence with the Knik River.

2. STUDY PURPOSE

The purpose of this supplement is to revise the benefit-cost (BC) ratios for alternatives identified in the 2003 Study in the study area from the Old Glenn Highway Palmer Bridge south to the Matanuska River’s confluence with the Knik River. This includes updating property, structure, and road values with assessed rates, indexing alternative costs from the 2003 Study to current dollars, and updating the erosion estimate to reflect recent trends in the watershed using new aerial imagery.

The purpose of the 2003 Study was to support an expedited reconnaissance study to document problems, needs, and opportunities related to erosion in the Matanuska River watershed. The 2003 Study found that there was no federal interest in pursuing a feasibility study to further investigate erosion along the Matanuska River.

3. LOCATION OF PROJECT/CONGRESSIONAL DISTRICT

3.1. Congressional District

The study area is in the Alaska Congressional District. The Alaska Congressional delegation is:

- Senator Lisa Murkowski (R)
- Senator Mark Begich (D)
- Representative Don Young (R)

3.2. Location and Erosion Area Description

The Matanuska River flows from the Matanuska Glacier approximately 50 miles upstream of the Old Glenn Highway Bridge in Palmer, Alaska to its confluence with the Knik River approximately 10 miles downstream of the same bridge (Note: The East and South Forks extend an additional 20 miles past the Matanuska Glacier.). Downstream of the confluence the Knik River flows into the Knik Arm of Cook Inlet. From the 2003 Study, the study area extended from the Matanuska River’s confluence with the Knik River at the downstream extent to the Matanuska Glacier at the upstream extent, and included the areas in the vicinity of Palmer and

Sutton which were identified as potential sources of erosion problems. This broad study area is identified in Figure 1. This supplement focuses on a more specific study area: The Matanuska River from the Old Glenn Highway Palmer Bridge to its confluence with the Knik River. This area is shown in Figure 2. The study area was reduced for this supplement update as requested by the Matanuska-Susitna Borough.

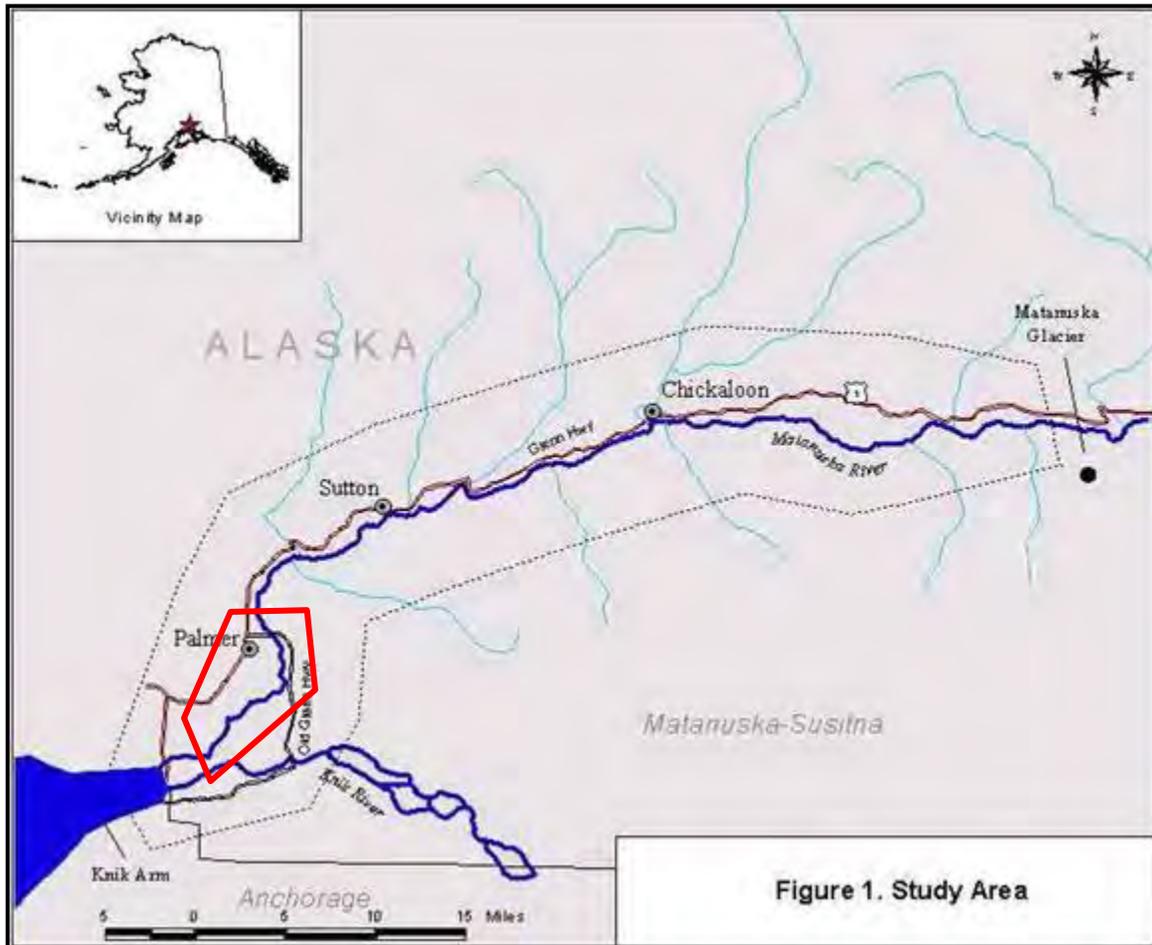


Figure 1. Reconnaissance Study Areas. The 2003 study area is indicated by a dotted black line. The 2011 study area is indicated by a solid red line.



Figure 2. Updated Study Area (May 2011)

4. UPDATED EROSION ANALYSES

4.1. Bank Erosion Rate Analysis

4.1.1. Matanuska River Characteristics

The Matanuska River is a braided system that consists of multiple threads or braids that occupy a wide corridor, referred to as a braid plain. The braid plain is defined as the swath of land that the braided river may occupy in any given year. Note that the braid plain is not defined by vegetation limits as the river may occupy a portion of the braid plain for an extended period of time which can allow significant growth in unoccupied portions of the braid plain. The braid plain is defined by a topographical break where the braid plain occupies a lower elevation and surrounding terraces are at higher elevations. This difference in elevation marks where the river has run historically. The braid plain includes the sloping banks of the braid plain margin and is defined from top of bank to top of bank (Figure 3). The margin denotes the bank slopes between the elevations of the braid plain and adjacent terraces.

Individual channels within the braid plain are subject to rapid changes in alignment and the amount of flow they convey. At the margins of the braid plain, this produces situations where an area of the bank may be attacked by erosion for several years, only to have the braid shift entirely away from the bank in later years. The point at which a channel impinges and attacks the bank may shift hundreds or thousands of feet upstream or downstream of the previous location or to the opposite side of the braid plain. For example, the Matanuska has exhibited this behavior with the main area of bank erosion concern being along the right bank (looking downstream) in the vicinity of the Palmer wastewater lagoons and Mountain View Estates for many years, then shifted 5,000 feet across the channel to the Circle View Estates area along the left bank in the late 1980s.

The unpredictability of the locations of individual channels within the braid plain makes it difficult to predict future erosion trends in the river. Conventional methods for predicting rates of erosion rely on a historical progression of bank lines. Typically, the distance between these bank lines is divided by the number of years between data sets to produce an average rate of erosion. On single channel sinuous rivers, this rate can be reasonably projected into the future to estimate the location of the banks in future years. In braided rivers, the same process occurs within the braid plain; however multiple channels interact in unpredictable ways, either converging or cutting off flow to produce rapid and dramatic changes in location of the individual channels. While erosion in the river is a continuous process, it only has noticeable impact when a channel in the braid plain erodes the bank at the braid plain margin. For purposes of erosion monitoring, the top of bank at the braid plain margin is used to define a bank line for any given year.

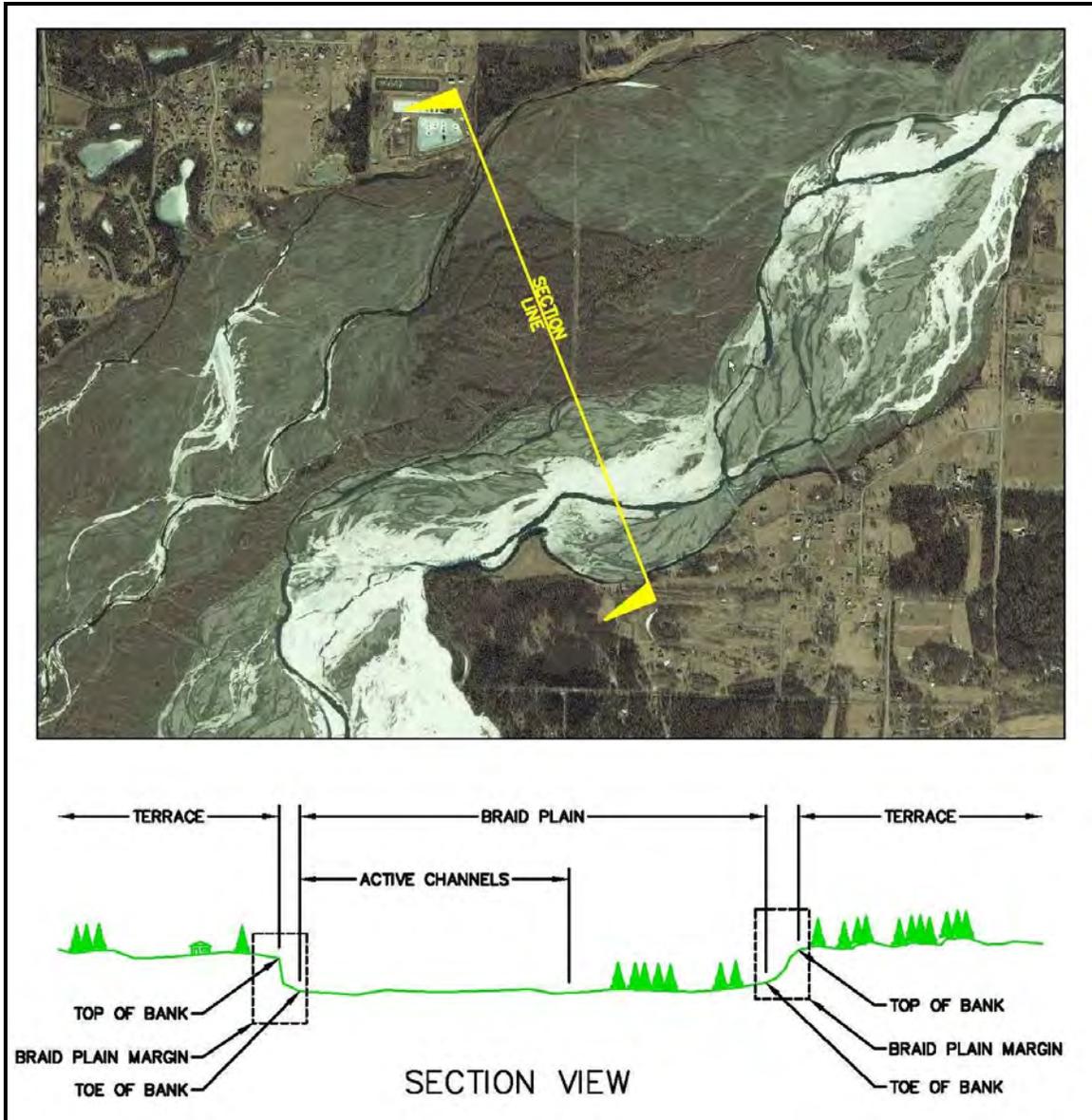


Figure 3: Braid plain definition schematic. Note that the section view does not represent survey data on the Matanuska River.

4.1.2. Previous Method

The 2003 Study analyzed historic bank erosion rates for the left bank of the Matanuska River from the Old Glenn Highway bridge downstream to just below Circle View Estates and for the right bank from about a mile upstream of the Palmer wastewater lagoons downstream to below Sky Ranch Subdivision. The terms “left bank” and “right bank” are defined as banks on the left or right side of the river when looking downstream from the middle of the channel. The lengths of these areas are approximately six miles for the left bank and three miles for the right bank. The previous analysis utilized aerial photographs from 1939 and 1996 provided by the Borough and the Corps, respectively, to obtain historic erosion results. Measurements from fixed points to the banks of the photo sets were compared and analyzed with statistical methods to predict erosion rates in the area of interest. Further descriptions of the methods used are contained in the 2003 Study.

4.1.3. Updated Erosion Rate Analysis

New data was used to update estimates of erosion rates within the study area. The U.S. Geological Survey (USGS) has performed an in-depth analysis of historical erosion of the banks of the Matanuska River (Curran, Unpublished). This data defines the braid plain margin through a series of ortho rectified photo sets of the Matanuska River from 1949 to 2006. An additional ortho rectified photo set of the study area was taken in 2007.

The photo record shows a dramatic shift in the location of the channel within the braid plain between 1962 and 1985. In 1962, the channels in the river were concentrated on the Palmer side of the braid plain below present-day Man-O-War Drive on the left bank. After 1985, the channels shifted predominantly to the Butte side of the braid plain. To account for this shift, erosion rates for the banks below this point were analyzed using the data from 1985 to 2006. Photo sets analyzed for this analysis period include 1985, 1990, 2004 and 2006. This data was supplemented with 2007 imagery to verify the severity of individual erosion events.

Only the left bank of the river was considered in this updated erosion estimate. No erosion was detected on the Palmer (right) banks from 1985 to 2006 so no projections of erosion risk were made. Several channels still exist near the Palmer side of the braid plain, so a sudden northward shift of the Matanuska River in the future may cause severe erosion on the Palmer banks. Also, to the south of the hard point downstream of Circle View Estates, the left margin of the braid plain is not well defined. Active channels run next to cultivated land, but no erosion was detected over the period of record. Heavy vegetation also indicates that water does not flow near this cultivated land frequently.

Areas of the left bank that show significant erosion over the period of record were divided into four reaches (see Figure 4) for further analysis. Reach 1 begins near Clark-Wolverine Road and ends near Ye Olde River Road. Reach 2 begins at Ye Olde River Road and continues to a sharp westward bend in the braid plain margin. This bend is likely caused by hard material at the braid plain margin. Reach 3 begins near Man-O-War Road and ends at the upstream extent of the riprap dikes near Circle View Estates. Reach 4 begins at the downstream extent of the same dikes and extends to a hard point downstream of Circle View Estates. The hard points mentioned showed no discernible erosion over the period of record. All of these reaches are on the left bank of the river.

The erosion in these reaches was categorized by two types of occurrences; sporadic erosion and persistent erosion.

4.1.3.1. Sporadic Erosion Risk Areas

Sporadic erosion was found in Reach 1 and Reach 3. The historic bank lines in these reaches produce inconsistent rates of erosion when analyzed in a traditional method. Some locations will show significant erosion over part of the period of analysis, while other locations show no erosion even though there are no apparent differences in the characteristics of the banks. The photo record shows several events at different locations within these reaches, but these generally do not overlap. To account for the uncertainty of erosion in these reaches, a simple offset of the current braid plain margin was drawn to encompass the maximum incursion into the bank of a single erosion event in these reaches. In Reach 1, an event between 2006 and 2007 eroded 900 feet of bank to a maximum of 165 feet from the 2006 bank line location near Bohman Way. In Reach 3, an event or series of events between 1990 and 2004 eroded 1,000 feet of bank to a maximum of

115 feet from the 1990 bank line near the northwest corner of Bodenburg Loop. A buffer of 165 feet and 115 feet respectively was offset from the 2007 bank line for these reaches to account for the severity of episodic events in these areas. These buffers are not extrapolations to a specific future date since it is possible for multiple events to occur at the same location over any given period.

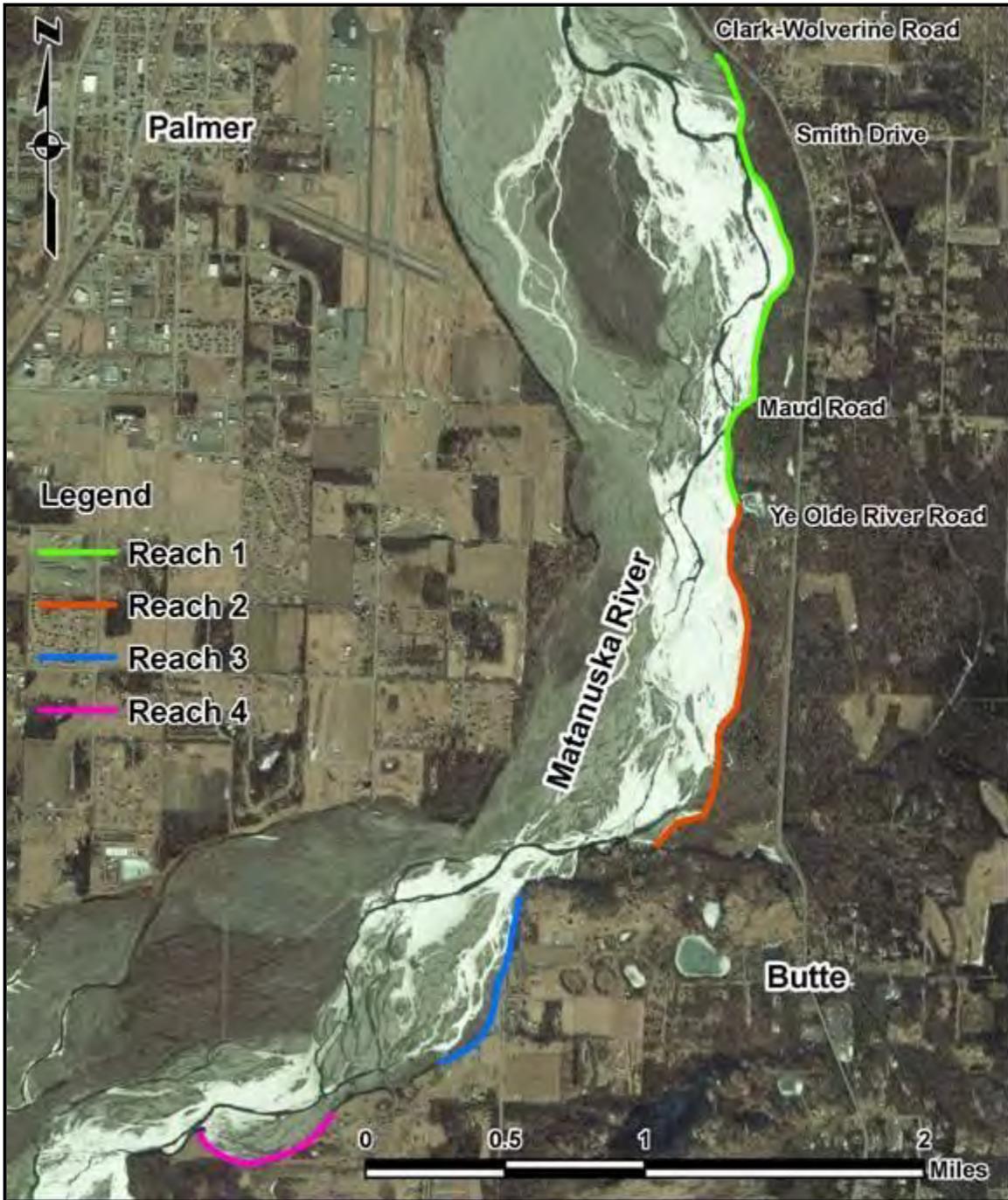


Figure 4. Erosion Reaches in the study area



Figure 5. Erosion Risk Zones

4.1.3.2. Persistent Erosion Risk Areas

Persistent erosion was found in Reach 2 and Reach 4. In these reaches, the frequency of erosion events created a continuous progression of bank loss over the period of record. Erosion on these reaches was calculated in a traditional manner as if the eroding banks were the outside banks in the bend of a sinuous river. Along both reaches, the maximum average rate was estimated to be 17 feet per year. This rate was used to offset the 2007 bank line to project likely erosion in the future, however, since erosion in these reaches is episodic, the yearly rates of erosion may vary greatly from the average making short term predictions of erosion very unreliable. To account for this uncertainty, a 50 year offset at the average rate was created with the ends of the reaches tapering to meet adjacent risk zones or hard points along the bank.

4.2. Expected Erosion Damages

The updated expected value of losses from bank erosion that could occur over the 50-year project period of analysis were determined by examining the significant features in the area estimated to be subject to erosion. The significant features considered were the land, the structures, and the roadways (the Old Glenn Highway and Bodenbug Loop). The values of the land and structures were obtained from the Matanuska-Susitna Borough Assessor's records and Borough GIS files. The roads are the responsibility of the State of Alaska and estimates for the values of roadways were obtained from State of Alaska Department of Transportation and Public Facilities' (DOT&PF) construction estimates. Though not quantified in the original study, or this study update, additional economic costs would be associated with traffic delays and rerouting. Though not significant enough to impact the assessment of alternatives in this analysis, these impacts should be examined during any feasibility-level analysis.

The erosion study area was divided into four subareas or reaches to facilitate determination of potential benefits for alternative projects. All of the areas are located on the left bank (see Figure 5). The four subareas are referred to as Reach 1, Reach 2, Reach 3, and Reach 4, respectively and are more specifically described in previous sections. The subareas described in the 2003 Study were the Upper Left Bank, Lower Left Bank, and Right Bank. For this supplement, the right bank was not included in the erosion risk area because updated information suggested erosion in this area had not occurred in recent history and would therefore not be a problem in the near future. While the reaches on the left bank described in the 2003 Study and this supplement are similar, they are neither identical nor comparable. The reaches were adjusted in this supplement due to updated information on historical erosion patterns available to Corps Engineers and a different method in estimating erosion risk areas. Further information regarding the dynamic nature of the river and associated erosion rates can be found in Section 4.1.1 Matanuska River characteristics.

Reaches 2 and 4 are subject to persistent erosion risk. This type of erosion was modeled using an incremental method which identified the estimated river banks in the years 2021, 2041, and 2061 to present which areas would be subject to erosion. These incremental bank line estimates were compared to the parcel locations provided by the Mat-Su Borough. This comparison was completed to determine which parcels of land, structures, and roadways were expected to be lost in each increment of time. A parcel of land was considered to be a total loss if the majority of the land area was subject to erosion during a given time period. For example, if more than half of a parcel's land mass was identified to be eroded at the 2041 bank line, that parcel was listed as a total loss in the year 2041. Obviously, the random nature and unpredictability of erosion suggest

that the parcel could be lost any time between 2011 and 2041, but erosion rate predictions provide estimates that the parcel will be lost closer to 2041. An analysis of all of the affected parcels was completed, with each parcel being grouped into the time increment in which it was expected to be affected.

The Mat-Su Borough also provided the total value of each affected land parcel, the values of structures located on affected parcels, and whether the structures were likely to be lost to erosion based on the estimated rates of erosion. As is expected, the estimated erosion risk zones (shown in Figure 5) do not correspond with parcel boundaries and only portions of some parcels are estimated to be affected by erosion in some cases. The borough indicated that they would be unable to provide partial parcel values for the parcels which were not fully subjected to erosion over the period of analysis. Similarly, the Corps determined that valuing portions of land parcels was well beyond the scope of this supplement. Therefore, if the majority of a parcel (greater than 50 percent) was expected to be lost to erosion over the 50-year timeframe, the parcel was considered a total loss and the entire value of the parcel was utilized to determine the value of erosion damages. Similarly, the Mat-Su Borough provided estimates as to whether structures would be lost as a result of erosion, based on the defined erosion risk areas. If the Borough identified a structure as at risk for loss based on erosion, that structure was assumed to be lost in the same time period as the parcel on which it resides.

The Mat-Su Borough indicated that there are 2,330 feet of road in Subarea 2 which is subject to erosion. There are no roads in Subarea 4 at risk due to erosion. The 2003 Study provided a replacement value for roads in the study area. The value of roads was estimated based on the cost of pavement, replacing approximately 6 feet of fill, and an allowance for miscellaneous features such as driveways and intersections. In order to update the value of replacing the roadways, Corps Engineers consulted with Jim Amundsen of DOT&PF for an updated estimate. According to Mr. Amundsen, the cost of road replacement for a two-lane highway including environmental work, new alignment, design and construction is approximately \$4 million per mile. Total damages expected to roadways as a result of erosion was estimated by combining the length of road affected (provided by the Borough) with the estimated road value. The timeframe for the loss of road was evaluated using the same method as the parcels of land.

Reaches 1 and 3 are subject to sporadic erosion risk meaning that identification of erosion risk areas over periods of time is more difficult. Therefore, a different damage estimation method was used than for Reaches 2 and 4. This type of erosion is less predictable and the exact location of erosion in 10, 30 and 50 years cannot be determined with any kind of precision. The Mat-Su Borough provided estimates of the amount of acres in the erosion risk zone in Reaches 1 and 3. The Borough also provided the land values and sizes, in acres, of the whole parcels through which the erosion risk areas passed. Using the land value and parcel size, the average dollar per acre value of land in each reach was calculated. This value was then multiplied by the estimated acres in each reach affected by erosion to determine the total value of land lost over the 50-year timeframe. Consultation with Corps engineers determined the method to allocate erosion losses over specific time periods. For the purposes of this analysis, it is assumed that 20 percent of damages will occur in 10 years, 60 percent (or an additional 40 percent) will occur in 30 years, and 100 percent (or an additional 40 percent) will occur in 50 years.

Similar to Reaches 2 and 4, the Mat-Su Borough provided estimates of which structures in Reaches 1 and 3 will be affected by erosion over the 50-year project period of analysis based on the defined erosion risk areas. For the purposes of this analysis, structures subject to erosion damages were assumed to be total losses midway through the 50-year timeframe.

The value of roads in Reaches 1 and 3 were estimated using the same procedure as in Reach 2. Roadways in Reaches 1 and 3 are located near the outer perimeter of the erosion risk area and were assumed to be lost near the end of the 50-year period of analysis.

Expected annual damages for the without project condition are presented in Table 1. These average annual values are calculated using the Federal Fiscal Year 2011 Discount Rate of 4.125 percent and a project period of analysis of 50 years. In developing the damages, the areas that currently have some protection were not excluded from the potential erosion areas. These areas were included because the erosion control structures are isolated and could fail from erosion upstream or downstream. Additionally, the inclusion of these areas may offset some of the smaller damages that were omitted from this level of analysis such as utilities and residential roads. Table 2 presents the net present value (NPV) of expected total losses of existing infrastructure over the fifty-year period of analysis for land, existing structures (nearly all residential), and roadways.

Table 1. Estimated Average Annual Losses from Matanuska River Bank Erosion by Subareas

Subarea	Estimated Annual Erosion Losses			
	Land	Structures	Roadways	Total
Reach 1	\$5,600	\$2,200	\$1,900	\$9,700
Reach 2	\$14,900	\$30,100	\$11,100	\$56,100
Reach 3	\$1,900	\$7,300	\$2,400	\$11,600
Reach 4	\$2,100	\$0	\$0	\$2,100
Total	\$24,500	\$39,600	\$15,400	\$79,500

Note: Average annual losses based on 50-year period of analysis and the Fiscal Year 2011 discount rate of 4 1/8%.

Table 2. Estimated Total Losses (Net Present Value) over 50 Years from Matanuska River Bank Erosion by Subarea

Subarea	Estimated Total Erosion Losses (Net Present Value)			
	Land	Structures	Roadways	Total
Reach 1	\$118,000	\$46,000	\$40,000	\$204,000
Reach 2	\$313,000	\$632,000	\$234,000	\$1,179,000
Reach 3	\$40,000	\$153,000	\$50,000	\$243,000
Reach 4	\$44,000	\$0	\$0	\$44,000
Total	\$515,000	\$831,000	\$324,000	\$1,670,000

Note: Net present value of losses based on 50-year period of analysis and the Fiscal Year 2011 discount rate of 4 1/8%.

4.3. Incorporation of Housing Growth Rate

The data presented in Table 1 and Table 2 was based upon an assumption of no new development in the study area over the period of analysis. The 2003 Study conducted an additional analysis to see the effects of residential development in the study area. This supplement does not attempt to conduct an analysis regarding housing growth in the study area. This supplement assumes that there will be limited housing growth in the areas identified as at risk for erosion over the next 50 years. As the Matanuska Susitna Borough requested this study update, they recognize that erosion is an ever-present issue along the banks of the Matanuska River. As such, this

supplement assumes that the Borough will discourage new development in the areas identified to be at risk for erosion, or potentially create zoning rules which prohibit development in these areas. Furthermore, this analysis assumes that homeowners will choose not to construct new homes along the Matanuska River due to the threat of erosion and structure loss. Any published growth rates which would be used for this supplement (the 2003 Study used U.S. Census data) would be for the Borough as a whole and would not take into account the reduced demand for housing along the Matanuska River as a result of erosion. Therefore, published growth rates are not relevant to this analysis.

4.4. Specific Erosion Damage Reduction Opportunities (Alternative Plans and Preliminary Evaluation of Alternatives)

The 2003 Study combined general erosion control measures into specific alternative plans to reduce erosion at specific locations in the study area (see the 2003 Study for a detailed explanation of the possible erosion control measures). The 2003 Study began with a very broad study area which included almost the entire length of the Matanuska River. Upon further analysis, the 2003 Study determined that the most effective location for erosion control structures was south of the Old Glenn Highway Bridge near Palmer. Though the 2003 Study identified potential erosion damages on both the left and right banks of the river, the final alternatives in the 2003 Study were focused only on the left bank of the river; the right bank was eliminated from consideration during the alternative development stage of planning. Therefore, the alternatives presented in the previous study are in the same general study area which was utilized in this supplement.

Formulating new alternatives is beyond the scope of this supplement and was not included in the Borough's request for updates. So the alternatives which were identified in the 2003 Study are utilized for this effort with the costs updated to current dollar values. The cost estimates from the 2003 Study were indexed to current values using the Civil Works Construction Cost Index System (CWCCIS).¹

For this supplement, the development and evaluation of the alternatives is at a conceptual level. The purpose is not to identify a definitive project, but to determine if there is a possibility that a technically and economically feasible project may exist that warrants further consideration. The specific alternatives were chosen since they appeared to have the highest potential for protection of features of economic value.

The 2003 Study identified three potential alternatives: gravel extraction, bank armoring by riprap, and non-structural measures. This analysis eliminated the gravel extraction alternative as it is no longer viewed as a viable measure to reduce the identified risk of erosion. So the only alternatives addressed in this supplement are bank armoring and non-structural measures.

4.4.1. Alternative 1 – Bank Armoring by Riprap

Description: Alternative 1 consists of a riprap bank armoring extending along the left bank (east side) of the Matanuska River in the identified erosion risk areas. The purpose of the bank armoring would be to control erosion in order to protect homes and the Old Glenn Highway. In this area, the Matanuska River ranges from less than 100 feet to approximately 1,600 feet from the Old Glenn Highway. Approximately 3,800 feet of the river currently has a

¹ <http://140.194.76.129/publications/eng-manuals/em1110-2-1304/entire.pdf>.

combination of riprapped bank and dike installed. The rirpap armoring may also help to protect the area from flooding that can result as the channel erodes into low lying overbank areas and abandoned channels, such as occurred in 1971.

A detailed site-specific design of bank protection for this reach would utilize a combination of riprap armoring applied directly to the banks that have been cut back to an appropriate slope, rip-rap armoring applied to fill or a berm where the current bank alignment is not suitable for applying armor, and possibly some flow deflecting structures such as spur dikes and groins. Armored banks would be used in areas where the existing bank has a suitable alignment for protecting and is sufficiently high to prevent flood flows from flanking the protection. Armored dikes could be used in other areas where the bank is low or an irregular bank line makes the job of protecting the existing bank difficult and expensive.

Engineering Considerations: The 2003 Study identified the use of a riprap bank armoring to control erosion and also reduce possible flooding as a feasible engineering approach in the area proposed. Although feasible, the use of the riprap bank armoring or any other bank protection measure, in a river as dynamic as the Matanuska will require that there be a commitment for significant long-term maintenance. This alternative was formulated with the intent of controlling bank erosion along the entire reach, rather than just applying protection to areas identified as currently eroding, because the dynamic nature of the Matanuska River could quickly shift erosion to new locations. Thus, in the long run, protection would be applied along the entire reach, assuming a strategy to control erosion by structural measures was adopted. By formulating a single project, the risk of smaller individual projects failing is eliminated and an integrated approach is implemented.

Preliminary Cost: Utilizing the Civil Works Construction Cost Index System to inflate 2003 dollars to current values, it is estimated that riprap bank armoring would cost approximately \$543 per foot or roughly \$2.7 million per mile. It was assumed that riprap bank armoring would be applied to the entire length of each of the identified erosion risk areas for a total length of 18,900 feet, and a total cost of approximately \$10.3 million. Table 3 shows the cost of riprap broken down by subarea. Maintenance would be required to ensure long-term performance of the project. The 2003 Study assumed that annual maintenance would average 2 percent of the initial construction cost. Based on this the estimated annual maintenance is \$205,000 per year for all reaches. The present value of construction and O&M costs over the 50-year period of analysis amounts to \$14.6 million, with an average annual value of \$693,000.

Table 3. Amount of Riprap bank armoring needed by reach for Alternative 1

Subarea	Amount of dike needed (feet)	Cost (2011)
Reach 1	5,000	\$ 2,713,000
Reach 2	7,300	\$ 3,961,000
Reach 3	3,600	\$ 1,953,000
Reach 4	3,000	\$ 1,628,000
Total	18,900	\$ 10,255,000

Economic Considerations: This supplement assumes that bank armoring would be implemented in all reaches defined in the study areas. The defined erosion risk areas were combined with

data from the Borough assessor to quantify the potential damages as a result of erosion in the without-project scenario. This analysis is presented in Section 4.2. This supplement assumes that with riprap bank armoring, all of these damages will be eliminated. This means that a total of 382 acres of land, 13 structures, and 3,320 feet of roadways will not be lost to erosion. This corresponds to a total net present value of \$1.7 million with an average annual value of \$80,000. Based on the estimated costs for this alternative in 2011, this results in net benefits of –\$(13) million and a benefit cost ratio of 0.11. Therefore, the bank armoring alternative does not appear to be justified. Even considering the potential benefits of Alternative 1 for each subarea individually, the maximum benefit/cost ratio is 0.21: project benefits do not exceed costs of protection. Table 4 presents the costs, net benefits, and benefit/cost ratios of Alternative 1 by subarea.

Table 4. Alternative 1 Costs, Net Benefits, and Benefit/Cost Ratio by Subarea

Subarea	Total Cost (NPV)	Avg. Annual	Net Benefits	B/C
Reach 1	\$ 3,854,000	\$ 183,000	\$ (3,650,000)	0.05
Reach 2	\$ 5,627,000	\$ 268,000	\$ (4,448,000)	0.21
Reach 3	\$ 2,775,000	\$ 132,000	\$ (2,532,000)	0.09
Reach 4	\$ 2,312,000	\$ 110,000	\$ (2,268,000)	0.02
Total	\$ 14,568,000	\$ 693,000	\$ (12,898,000)	0.11

4.4.2. Alternative 2 – Non Structural Measures Plan

Description: The other alternative identified in the 2003 Study is the non-structural measures plan. A non-structural plan aims to reduce expected future erosion damages by moving homes and infrastructure out of harm’s way and to discourage further development in erosion prone areas. A non-structural measures plan could include a combination of nonstructural features, including land acquisition in erosion hazard areas, control of future development in erosion hazard areas, and public education to foster awareness of erosion risks along the river corridor. These non-structural measures would reduce expected future erosion damages and would have less environmental impacts within the river corridor than the structural solutions identified in this supplement.

Engineering Considerations: The 2003 Study indicated that implementation of non-structural measures involving acquisition of threatened land, relocation of homes where appropriate, and implementation of land use regulations is feasible from an engineering standpoint. This supplement assumes the same.

Preliminary Cost: The 2003 Study identified the costs of the non-structural plan in three major components: 1) costs of land acquisition in erosion hazard areas, 2) removal of existing improvements from erosion hazard areas, and 3) labor costs for a local administrator of an erosion hazard mitigation program that would include erosion education and administration of the land acquisition and land use control functions of the non-structural alternative.

The costs of acquisition and removal of land and improvements would vary depending on the areas planned for acquisition. For the 2003 Study, costs were developed for each erosion risk area. The costs calculated in the 2003 Study do not include costs for relocation assistance payments that may be required under Public Law 91-646 (the Uniform Relocation Assistance

and Real Property Acquisition Policies Act of 1970) for any persons, farms, or businesses that are displaced due to the acquisition of their land and improvements. These costs should be assessed and accounted for in any feasibility level investigations.

The 2003 Study did not provide detailed descriptions of how the costs of land acquisition and removal were calculated. Attempting to collect new data on the cost of land acquisition and disposal is beyond the scope of this supplement. The same escalation factors as applied to the costs in Alternative 1 cannot be applied to land acquisition costs, as the CWCCIS is relevant for Corps construction projects. Any other escalation or index factors which could be used to update the cost estimates would likely add a high degree of uncertainty to the analysis and make estimates of costs and BC ratios less reliable and less able to reflect likely actual events. Therefore, no attempt has been made to estimate the benefits associated with this alternative. Since the most likely structural alternative has proved to be not justifiable from a federal interest perspective, it can be expected that some combination of non-structural measures can be utilized as an effective means to reduce the risk associated with erosion of the Matanuska River.

Non-structural alternatives vary in cost depending on the methods employed. Acquisition of land and removal of structures is on the high end of the cost spectrum. Other methods of non-structural alternatives which may be more cost effective given the range of benefits estimated in previous sections may include land use controls, zoning restrictions, or education to the local population. A combination of these non-structural components will likely be the preferred plan to address erosion issues on the Matanuska River. A more in-depth analysis regarding the costs and associated benefits of these non-structural measures is beyond the scope of this update, but must be conducted in the future in order to determine the most effective plan available.

5. PROJECT AREA MAP

Figure 2 shows the study area for this supplement, while Figure 4 and Figure 5 illustrate the areas identified to be at risk of erosion over the 50-year project period of analysis.

6. RECOMMENDATIONS

Considering current economic conditions, it is recommended that non-structural measures be implemented to reduce erosion damage risk within the study area. Additionally, a monitoring program should be established to evaluate trends in erosion on the Matanuska.

6.1. Non-Structural Measures

It is recommended that development be prohibited within the erosion risk zone defined in this supplement. While this zone does not define the limit of future erosion risk, prohibiting development of these areas will contain the immediate risk to existing structures and properties. A more detailed study of the area would provide better guidance for determining reasonable limits for prohibitions on land development.

6.2. Erosion Monitoring

Due to the unpredictable nature of erosion on the Matanuska River, an erosion monitoring program should be established in the study area. At a minimum, it is recommended that aerial

ortho rectified photos of the study area be at five year intervals. At each collection interval, the braid plain margin should be digitized into a GIS format and compared to existing data. Conducting regular monitoring will refine any future efforts to quantify the extent and severity of erosion in the area. Also, monitoring will detect large scale changes in the river such as the course change that occurred in the 1980's.

7. REFERENCES

1971. Water Resources Reconnaissance of a Part of the Mat-Su Borough.
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