US Army Corps of Engineers
Alaska District

FLOOD AND EROSION DATA GATHERING PROCEDURES

A GUIDE TO GATHERING ESSENTIAL DATA AFTER FLOODING AND EROSION EVENTS

SEPTEMBER 2012

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1. PURPOSE

Many Alaskan communities experience damages from flooding and erosion on a recurring basis. Some flooding and erosion is the result of regular seasonal processes and some is the result of episodic basis tied to a specific storm event. Often, after a community experiences damages from flooding or erosion, there is a desire for assistance from State and Federal resource agencies to help repair the damage and mitigate future risk to these damages. In order for these agencies to provide assistance, they are generally required to assess the damage at the community and analyze the risk of similar events recurring again at the community. To make risk assessments for these events, certain types of data are needed. This data consists of physical evidence left by the event or ongoing process. Much of this evidence is transitory and can only be collected within a short span of time after an event, after which the evidence disappears. The intent of this document is to describe the actions members of a community can take to acquire data which can be used to identify flooding and erosion risk and help to develop solutions. These activities are intended to be achievable with a minimum amount of training and require minimal resources.

2. USING HANDHELD GPS EQUIPMENT

GPS equipment has become economical and readily available over the past ten years and it may be possible to record event and measurement locations with handheld units. When using handheld GPS units, there are a few things that the user should bear in mind. First, handheld GPS does not provide survey grade information. The accuracy of a GPS position is determined by the number of satellites the unit can acquire and the strength of the signal. Recent models of handheld GPS units will report an estimate of the accuracy. It is not uncommon for handheld GPS units to report errors of up to 40 feet. Identifiable features should be associated with GPS coordinates, such as building corners, to make it easier for a survey crew to find the location. If a ground point is being measured, measure the distance from two or more identifiable features as well so the point can be retrieved at a later date. Accuracy of handheld GPS is generally poor immediately after the unit is turned on. These units use an almanac of their past position to determine their current location. Depending on the model, it can take anywhere from a few minutes to an hour for the unit to get a decent fix on its position. Also, when using the units, stand in a location for a minute before marking a location. This will allow the unit to refine its position and reduce the error on the measurement. When recording tracks, walk slowly to increase the density of points on the track.

3. PHOTOGRAPHS AND VIDEO

Photographs of events, indicator marks and typical conditions can help others understand the event or hazard in your community. By following a few guidelines, photographs can be used by scientists and engineers to estimate conditions in your community and better understand the processes.

Use a visual scale in photographs as much as possible. Placing an object of known length in a photograph will show others how large, tall, wide or deep and object or feature is. For close up shots, use a 4 to 6 inch ruler to show the size of soil particles and other small objects. For wider shots showing a portion of a building, a yard stick or tape measure is more appropriate. When photographing high water marks, a close up of the water mark with a tape measure showing the distance from a reference point (windowsill, floor elevation, etc.) will validate a high water elevation long after the mark has disappeared. Wide angle shots showing multiple buildings do not benefit from a scale, but identifying the buildings in the photograph will allow someone unfamiliar with the community to better gage distances and find specific locations.

Take many pictures. A good goal for an observer is to take at least 100 pictures of a site affected by flooding or erosion to ensure usable information is captured. Digital cameras allow a person to take many photographs of the same or similar objects with minimal cost. In general, it is better to take too many pictures as opposed to too few since bad photos can always be weeded out at a later date if necessary.

4. FLOOD DATA

Flooding events can cause large amounts of damage in small communities. Flood data that indicates water surface elevation, current speed and flood duration is useful when planning for flood risk mitigation strategies or identifying emergency response actions after an event.

4.1 High Water Elevations

The High Water elevation is the most important piece of information to describe the severity of a flood. The High Water Elevation is best identified by high water marks left by the flood waters. High water marks are generally silt lines or debris lines which are easily disturbed by cleanup efforts and may be washed away by rain. It is essential that high water marks are recorded quickly after a flood event. Also, knowing the time high water occurred is important for verifying flood models and determining the effects of tide and surge on events near the coast. Good marks to record will be on structures or permanent objects that will not be moved prior to data collection by a survey crew. Marks left on the ground or vegetation can also help establish the extent of flooding.

When high water marks are identified, it is be useful to place a durable mark on the high water mark. Good durable markers include nails with flagging for wood or wood backed surfaces and spray paint or permanent marker for rock, steel or other surface that cannot be penetrated. If using spray paint, show the water elevation with a sharp edge by using a sheet of cardboard or similar object to control overspray. Be sure to get permission from the structure’s owner before placing a durable mark. Ground marks can be indicated with lath, if available. Indicate the name of the high water mark on the flagging, paint or surface in permanent marker. Take photographs of the high water marks and keep at record of their locations using well known features and GPS coordinates. The durable marks can be removed once surveyed if desired.

Figure 1: Durable high water mark in Circle placed by USGS on 5/15/09, surveyed by USACE on 5/22/09. Note that the silt line has disappeared at the time of the USACE survey. Without the nail and flagging, this point would not have been surveyed.

Figure 2: Durable high water mark in circle placed by building owner. A record of water levels on this post had been recorded for 20 years and all were measured during the survey.

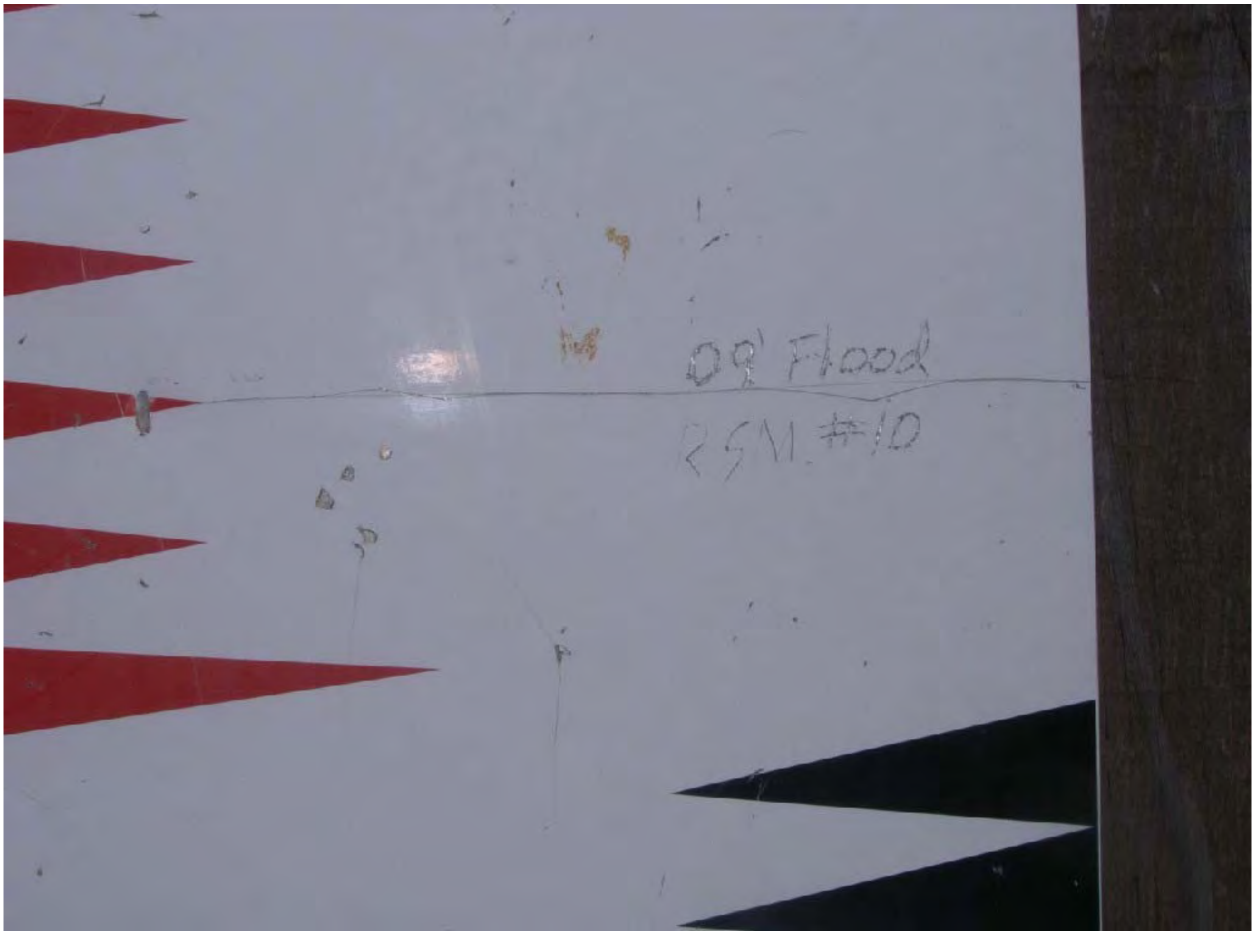

Figure 3: High water elevation engraved on staff gage, Russian Mission, 2009.

When recording high water marks, keep a log with the following information: name, location, type of mark, mark rating, measurement from reference point if applicable and GPS coordinates.

> ***Name:*** A short identifier to keep track of the mark. This can simply be a number.
>
> ***Location:*** Description of the object on which the mark was found, i.e., Post office S.E. foundation pile, IRA office inside of door frame, south fuel tank near valve, etc.)
>
> ***Type of Mark:*** This describes what mark was left by the flood. Typical marks left on vertical surfaces are; silt lines, water stains and debris lines. Typical high water marks left on the ground are debris lines and erosion lines.
>
> ***Mark Rating:*** This is a measure of how precise the mark is.
>
> Table 1 defines the accuracy range of the ratings. Silt lines on steel, glass or well painted surfaces can leave good or excellent marks. Debris lines are typically fair or poor and water stains are usually poor. Erosion lines are usually poor.

Table 1: High Water Mark Ratings

Rating	Accuracy (ft)	Accuracy (in)
Excellent (E)	+/- 0.02	+/- 0.24
Good (G)	+/- 0.05	+/- 0.6
Fair (F)	+/- 0.10	+/- 1.2
Poor (P)	>+/- 0.10	>+/- 1.2

Reference: Lumia, R., Burke, P.M., and Johnston, W. H., 1986, Flooding of December 29, 1984 through January 2, 1985, in northern New York State, with flood profiles of the Black and Salmon Rivers, U.S. Geological Survey Water-Resources Investigations Report WRIR 86-4191, 53p.

Figure 4: Silt line on sheet pile sill, Fair, Chena Flood Control Project, 2008.

Figure 5: Erosion line on Chena River, Poor, North Pole, 2008.

Figure 6: Debris line on grass, Poor, Fairbanks, 2008.

Figure 7: Debris line on road embankment, Poor, Shaktoolik, 2009.

Figure 8: Water stain on wood siding, Emmonak, Poor, 2009

Figure 9: Debris line on access ramp, Fair. Emmonak, 2009.

Figure 10: Erosion line on gravel pile, Poor, Emmonak 2009.

Figure 11: grass line on bulldozer grille, Good, Emmonak, 2009. Equipment may contain usable marks if it doesn't move from the time of the event to the time it is surveyed.

Figure 12: Silt line on aluminum pump house, Good, Russian Mission, 2009

Figure 13: Woody debris on ground, Poor, Shaktoolik, 2009. Some high water indicators, such as large debris fields, can be recorded with a GPS track line as described for tracking erosion.

Measurement from Reference Point: If possible, measure the height of the mark above a fixed reference elevation. This will allow a surveyor visiting the site at a later date to find the elevation of the water surface at this point. Even if a permanent mark is created, it is recommended to record reference elevations whenever possible to protect the data in the event the permanent mark is removed before it can be surveyed. Use objects that won't be moved as reference points for these measurements. Building finished floor elevations make good reference points for marks found near doors, window sills for marks found near windows.

GPS Coordinates: Record the latitude and longitude of the point.

Time of High Water: Record the date and time the high water mark was made. This may require canvassing the area and asking residents when water was highest at the location in question.

4.2 Building Displacement

If a flood is high enough, it can move a building off its foundation and drag it downstream. Knowing the distance a building was moved can help establish the severity of a flood. For emergency actions, it will be necessary to document damages to the community. In this process, it is useful to identify the original foundation locations and measure the displacement of buildings that have moved.

4.3 Event Journal

To ensure accuracy, it is useful to keep a record of conditions as the event occurs. Important events should be noted as well as a record of the water elevation as the event progresses.

High Water Duration: The duration of the event can be recorded by journal entries that record the time and elevation of water levels during a flood. Elevations can be estimated heights from fixed visible points, for example, 1 foot below the windowsill of house X at time Y. High water should be noted at regular intervals, every hour when practical. Water level records should begin when it becomes apparent that the river will flow out of its normal channel.

Debris: In the event journal, the amount and type of debris in the river should be noted at regular intervals. The amount of debris flowing in the river will change over time during the event.

Ice Jams: Ice jams are a common cause of floods in Alaska during the breakup season from April through June. Ice jams temporarily dam a river, or a portion of a river and can impound water to form a pool. The pool may inundate inhabited areas and cause damage. When the ice jam breaks, this pool is released and causes a surge in water levels downstream. This surge can be accompanied by ice debris which poses a danger to life and property. If an ice jam is known to have formed in proximity of the community, records of its location and size will be useful to understanding the flood event. Photographs of the ice jam are particularly helpful when taken from small aircraft. If possible, taking photos of the ice jam from dry ground can be helpful. It is impossible to predict when an ice jam will break with any certainty and under no circumstances should a person attempt to walk on an ice jam at the water's edge downstream of the jam. Approaching an ice jam from a boat can also be dangerous; boat operators must use good judgment in determining safe distances when operating near an ice jam.

Photo Records: A photo record of the event can be more valuable than a written record. Good photos will show the extent of flooding and clearly identify the locations where notable events occurred and measurements were taken. Include wide angle shots to identify the extent of impacts and close ups to document high water marks.

4.4 Coastal Flooding

Coastal flooding can be caused by different mechanisms than floods on a river, however the critical data is similar. Like a riverine flood, the most critical piece of information is the high water elevation. Timing of high water on the coast is especially important due to the influence of tides and surge. This data is collected by identifying high water marks as previously described, however due to wind, spray, and waves which often occur with coastal flooding, the marks left once the flood has receded tend to be of low quality. In addition to water levels, wave information will be of use to resource providers. An estimate of wave heights on the coast and in the flooded area can be useful. Wave height estimates are the height of the highest waves visible to the observer.

5. EROSION DATA

Erosion data can be used to estimate average erosion rates for a reach of river or stretch of coastline. Erosion rates are estimated by comparing the top of bank line in a series of ortho-rectified aerial images (Figure 15), however, the cost of these images is high and they are not usually purchased unless a specific project requires them. In the absence of aerial imagery, erosion can be tracked using handheld GPS measurements or physical benchmark measurements.

5.1 GPS Measurements

The top of bank line can be mapped with handheld GPS. While this data is not as accurate as using aerial imagery, bank line tracks recorded year after year can provide a good record to associate severe erosion with specific storm events and increase the length of data for estimating average rates. The best data set for estimating erosion rates would be to record the top of bank once a year at the same time of the year. It may be most practical to record the bank line in the fall, after the ground has frozen and major storms have passed, but before any major snowfall so that the top of bank is easily identifiable. When recording bank lines with handheld GPS units, be sure to turn the track function on and start a new track for each bank line recorded. In general, the longer stretch of bank recorded the better. On a river, record the entire outside bend in the river if possible. On the coast, try to record the top of beach between rocky outcrops. If rocks are not present on the coastline, use good judgment to determine how much coastline is needed to capture erosion processes likely to affect the community. Photo records will be useful for describing conditions of the bank or beach and identifying the measured feature. Hard points in the bank or coast, such as rock outcrops or structures, should be identified and photographed every year, as these can provide a reference to validate average erosion rates. GPS bank lines should cover the same approximate extents from year to year.

5.2 Benchmark Measurements

A second method to gathering erosion data is to measure the distance to the top of the bank from fixed objects; typically building foundations. These measurements tend to be more accurate than GPS tracks. A good system for defining benchmarks is to plant steel garden stakes into the ground at 25 to 100 foot intervals from a building corner (Figure 14). This ensures that repeated measurements are made in the same direction from the benchmark. The disadvantage to this method is that it only captures point data which will not show changes in bank geometry.

N 60° 41.691' W 161° 57.996' **Napakiak** **RIMG0012**

Figure 14: Stake line at Napakiak, AK used to measure erosion. The foreground stake is labeled 75 feet.

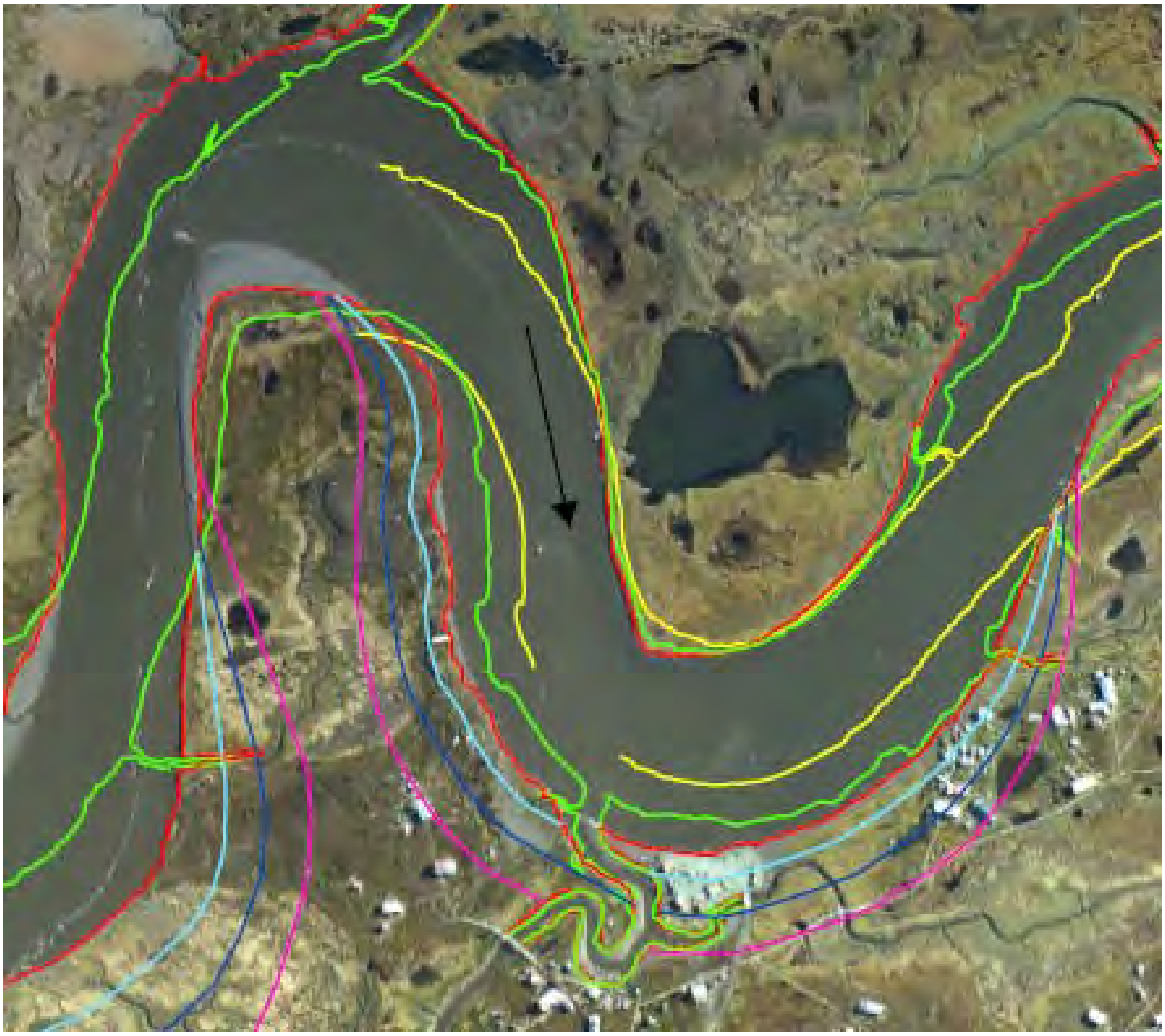

Figure 15: Detail of erosion map at Kwigillingok, AK showing past and estimated future bank lines. GPS tracks of bank lines can be used as past bank lines when making these maps.

N 62° 41.237' W 164° 40.009' **Alakanuk** **RIMG0086**

Figure 16: Top of bank, Alakanuk, 2007. The top of bank is easily identified where erosion creates a vertical cut bank. Beware of overhangs when recording the track line.

Figure 17: Top of bank, Kipnuk, 2007. The top of bank has tundra draped over the edge.

Figure 18: Top of bank at Kongiganak, 2007. In bare soils, the top of bank is easy to find.

N 59° 57.614' W 162° 53.328' Kongiganak RIMG0272

Figure 19: Top of bank at Kongiganak, 2007. Where the bank is heavily vegetated, tension cracks may form where large blocks of soil are in the process of falling into the river. At these locations, record the landward side of the crack.

N 59° 52.719' W 163° 08.892' Kwigillingok RIMG0209

Figure 20: Top of bank at Kwigillingok, 2007. In some locations where the tundra mat drapes over the eroding face of the bank, a tension crack has not fully formed.

6. REFERENCES

Federal Emergency Management Agency. Make Your Mark on the Floodplain. July 1997.

US Geological Survey. Techniques of Water-Resources Investigations of the United States Geological Survey. 1967. http://pubs.usgs.gov/twri/twri3-a1/html/pdf/twri_3-A1_a.pdf