ALASKA HIGH-WATER MARK OBSERVATIONS GUIDE

Keith C. Horen

Techniques and Methods 2

A community member in Teller, Alaska, provides a verbal high-water mark observation in September 2022.

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ALASKA HIGH-WATER MARK OBSERVATIONS GUIDE

Keith C. Horen[1]

INTRODUCTION

Flooding can occur anywhere in Alaska and collecting and retaining records of high-water marks helps communities document flood impacts, supports emergency management and future planning, and improves the accuracy of flood models and predictions. These data are also essential for hazard mitigation and community development across Alaska's coastal and riverine areas, which face recurring challenges from flooding and related hazards. To support these efforts, the Alaska Division of Geological & Geophysical Surveys (DGGS) gathers high-water-mark observations from staff and local observers and is developing online, mobile-friendly tools to standardize data submission across the state. This report provides guidance on collecting, documenting, and preserving high-water-mark data for submission to DGGS, with an emphasis on field methods and documentation practices to build a robust statewide dataset. We encourage users to record and submit observations using the printable form (app. A) or online through DGGS tools at doi.org/10.14509/32078.

METHODS

How to Collect High-Water Marks

Please do not place yourself or others in harm's way while collecting high-water mark observations; your safety is always more important.

What is a high-water mark?

High-water marks are evidence left behind by floods that indicate the maximum height water reached during a flood event (fig. 1). Many high-water marks are only temporary, so identifying and documenting them quickly after an event is very important.

Figure 1. Debris line high-water mark in Hooper Bay, Alaska, taken September 20, 2022. Measuring high-water marks.

Measuring high-water marks

If the high-water mark is above ground level, use a tape measure, ruler, or yardstick to measure vertically from the ground to the high-water mark (fig. 2). It is important that your measurement be as close to vertical as possible. Please do not attempt to take a measurement unless it is safe to do so.

Figure 2. Seed line high-water mark measurement in Hooper Bay, Alaska, taken September 20, 2022

Taking a photograph that includes your measurement can be helpful but try to avoid taking it at a steep angle. If possible, try to align the lens of your camera so that it is at the same height as the high-water mark and the measurement is readable. If you do not have a measurement tool, you can include a person or object in the photograph whose height you know. Adding this information to the high-water mark description allows the mark's height to be estimated by comparison.

Photographing High-Water Marks

At a minimum, each high-water mark should be documented with two photographs. The first photograph should clearly show the type of high-water mark being observed (fig. 3) and, if possible, include any relevant measurements. The second should clearly show the surrounding area (fig. 4) and, if possible, include identifiable landmarks to help with locating the high-water mark. If the high-water mark has been more permanently marked, it is also helpful to include the marker or flagging in the photographs.

Figure 3. Close-up photograph of debris line high-water mark in Stebbins, Alaska, taken September 23, 2022

Figure 4. Area photograph of debris line high-water mark in Stebbins, Alaska, taken September 23, 2022

Preserving High-Water Marks

The most effective way to document high-water marks is to fill out and submit an observation using the Alaska High-Water Mark Observations application or the printable form that accompanies this report (app. A) as soon as possible. Unfortunately, this may not always be possible, especially during or immediately following a flood event, making it necessary to identify, document, and preserve high-water marks for future collection.

Due to their temporary nature, it is sometimes necessary to permanently mark the location of a high-water mark before it fades. Typical markings include flagging with surveyor's tape (fig. 5), permanent marker, or paint. The most important aspect of a good high-water mark is establishing the height of the flooding, so it is important that any marker clearly defines this line. This can be accomplished with a point object, such as a nail, a horizontal line drawn with a permanent marker, or a straight edge at the top of a spray paint stripe (fig. 6).

Figure 5. Flagged fence snag high-water mark (Koenig and others, 2016)

Figure 6. Example spray-painted high-water mark (Koenig and others, 2016)

The date of flooding and the type of high-water mark should be correlated to the marker in some way. This can be done by recording the high-water mark information in relation to a unique identifier that is attached to the marker with flagging or by writing this information directly onto the structure or object the marker is on using a permanent marker or paint (fig. 7). The more information provided, the easier it will be for you or someone else to recover the high-water mark in the future, even if the original evidence has degraded or disappeared. For more in-depth information on identifying and preserving high-water marks, refer to the U.S. Geological Survey (USGS) Techniques and Methods report, TM3-A24 (Koenig and others, 2016).

Figure 7. Dated high-water mark in Shaktoolik, Alaska, taken September 21, 2022

Recording High-Water Mark Locations

Along with the height of the high-water mark, the observation site's physical location is one of the most important pieces of information required. Understanding where the high-water mark is helps provide necessary context for where flood waters reached (fig. 8) and what infrastructure they may have impacted during a flood event.

To upload data through DGGS's high-water mark observation applications, users can use location services on their mobile device, select their location on a map, or provide the latitude and longitude coordinates of the observation. If filling out the printable form that accompanies this report (app. A), observers can write in the latitude and longitude coordinates of the high-water mark. Even an approximate location can be useful.

Figure 8. Modeled flood height with high-water marks collected in Hooper Bay, Alaska, taken September 20, 2022

Recording the Date of Flooding

While it is critical to collect high-water marks as soon as possible after a flood event, evidence of prior events may still be available and can be contributed as observations. The Alaska High-Water Mark Observations application allows users to input the month and year the flooding associated with their observation occurred, while the printable form that accompanies this report

(app. A) allows observers to provide more exact or approximate dates. Noting the dates of flood events helps build the long-term flood history needed for flood modeling and frequency analysis.

Recording High-Water Mark Descriptions

The more detailed the description of the high-water mark and the flooding it represents, the easier it will be for scientists, emergency managers, and community planners to understand local flooding. Proximity to landmarks for orientation, details about the damage caused by the flooding, and information about impacted infrastructure are all useful pieces of information to include in the high-water mark description. The description does not need to be as detailed as the following example, but the more context an observer can provide, the better.

> ***Example:*** *The high-water mark is on the south fork of the Koyukuk River, around 50 feet upstream from the Water Intake Road on the east riverbank, looking downstream. The high-water mark is a debris snag marked with a nail and pink flagging on the river side of power pole number 105, about 1'–6" above ground level. Flooding was caused by an ice jam roughly 3 miles downriver. Water overflowed the riverbank, causing minor erosion along the Water Intake Road. Water reached the footers of 4 nearby homes but did not cause any damage.*

Recording Additional Details

Although not required, the DGGS high-water mark observations application and the printable form (app. A) allow observers to record additional details about the high-water mark, flooding, and affected areas. This information can provide much greater context, not only about a single observation or event, but also about how flooding behaves in the area over time.

High-water Mark Types

Flooding may leave a variety of high-water marks that can represent dynamic or still water heights, depending on the location and type of evidence. The following list provides examples and descriptions of the most common types of high-water marks likely to be encountered in Alaska.

Debris Line

Debris lines are concentrations of sticks, grasses, trash, and other debris left on sloping ground where water deposited these materials (fig. 9). Debris lines may be composed of debris of varying sizes, from small twigs and clumps of grass and seeds, up to large driftwood logs. Debris lines may represent the maximum extent of wind-, wave-, or current-driven water; the full reach of the water as it pushed the debris upward. Alternatively, debris lines may represent the height at which debris settled out of calmer water as it receded.

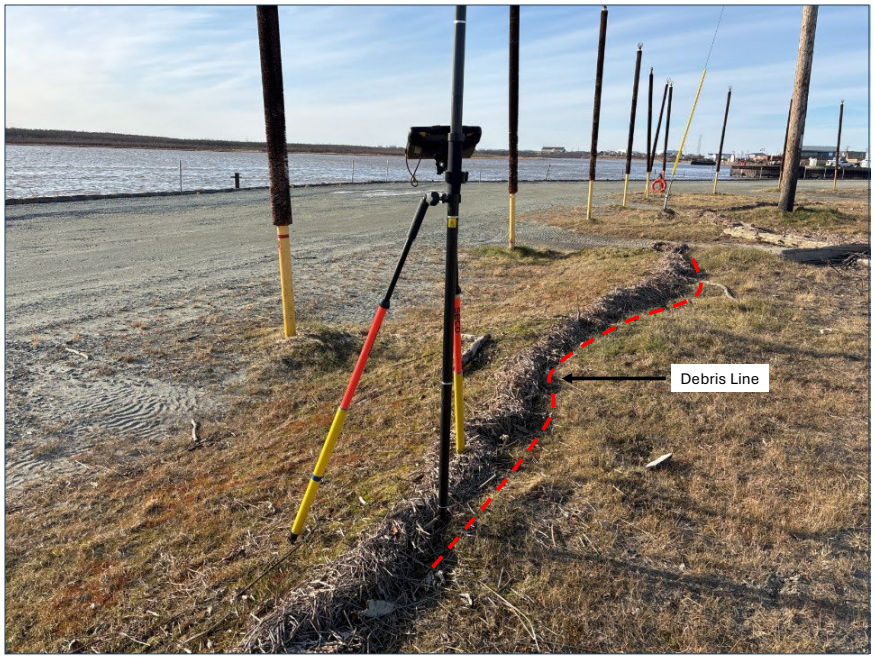

Figure 9. Debris line high-water mark in Bethel, Alaska, taken October 19, 2025

Exterior Seed Line

Seed lines form when fine materials float on top of water and adhere to objects and structures. Seed lines can be left on tree trunks, bridge piers, buildings, and other objects with vertical or near-vertical surfaces (fig. 10). Exterior seed lines are sometimes created by wind-, wave-, or current-driven water, meaning they may represent the height of splashing water or vary in height more than seed lines left behind by calmer waters. These high-water marks are susceptible to sun, wind, and rain exposure, which can quickly cause seeds and small materials to fall off within hours or days.

Figure 10. Exterior seed line high-water mark in Golovin, Alaska, taken September 20, 2022

Interior Seed Line

Like exterior seed lines, interior seed lines are composed of fine materials that float on top of water and adhere to vertical or near-vertical surfaces. Where interior seed lines differ is that they are found in sheltered areas: in buildings, inside electrical or utility boxes, the inside of vehicle windows, etc. (fig. 11). While interior seed lines may be more consistent and well defined compared to exterior seed lines, it is important to check for and compare the heights of both. Interior seed lines may underrepresent the actual height of flood waters if the structure or object they form within lacks a clear connection to the water outside. As these high-water marks dry out, they may degrade and become less well defined.

Figure 11. Interior seed line high-water mark in Hooper Bay, Alaska, taken September 20, 2022

Mud Line

Similar to seed lines, mud lines can form on the vertical or near-vertical surfaces of objects and structures (fig. 12), either interior or exterior, but may also be left behind on sloping ground, especially in non-vegetated areas like roads and parking lots (fig. 13). These marks are made up of silty or muddy residue that is left behind by flood waters, and the same considerations for debris and seed lines apply to these marks. Exterior mud lines, especially those on the ground, are susceptible to degradation from sun, wind, and rain, while interior mud lines may become less defined as they dry out.

Figure 12. Mud line high-water mark on a structure in Nightmute, Alaska, taken October 25, 2025

Figure 13. Mud line high-water mark on a boardwalk in Newtok, Alaska, taken September 20, 2022

Stain Line

Stain lines are also very similar to seed and mud lines, but may be even more impermanent because, while some stain lines can result in lasting discoloration, others may simply be a temporary wetting of material (fig. 14). These marks can be found on the exterior or interior of objects and structures, most often on porous materials such as cloth or wood, but may also appear on concrete. These high-water marks become less well defined or may even disappear entirely as they dry out.

Figure 14. Stain line high-water mark in Tuntutuliak, Alaska, taken October 22, 2025

Cut Line

Sometimes called scour lines, these high-water marks result from the rapid erosion of loose or unconsolidated materials such as sand, dirt, or gravel (fig. 15). High-quality cut lines are characterized by a very distinct, even line of erosion and indicate a still-water height. Cut lines may be found in areas susceptible to wave action or currents, but greater variability in scour height will be observed. Material slumping during or after flooding may also affect the reliability of this type of high-water mark.

Figure 15. Cut line high-water mark in Stebbins, Alaska, taken September 23, 2022

Wash Line

Wash lines appear on grassy, sloping ground where flood water flows over the vegetation, bending and flattening it, leaving a distinctive line of undisturbed grass standing at the extent of flooding (fig. 16). These marks are often indicative of the extent of wind-, wave-, or current-driven flooding because they typically require moving water to form. Wash lines may disappear as the vegetation recovers in the days following a flood event.

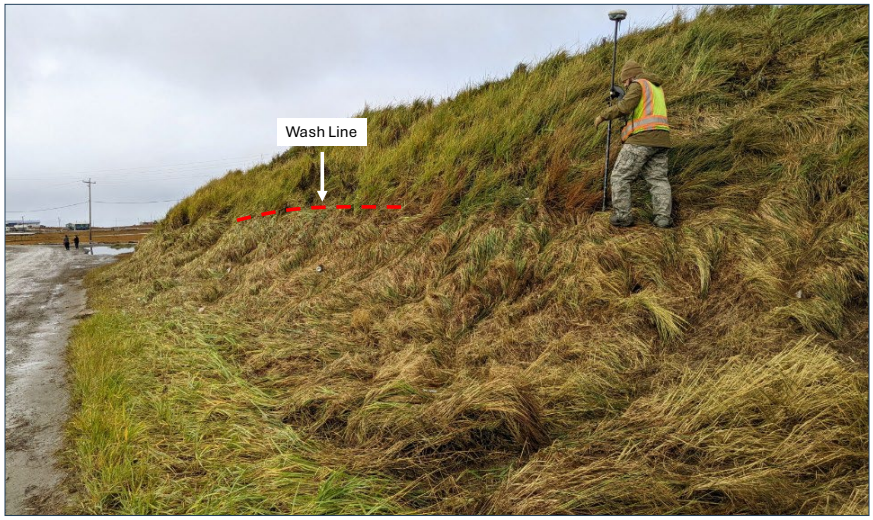

Figure 16. Wash line high-water mark in Hooper Bay, Alaska, taken September 20, 2022.

Debris Snag

As flood water encounters obstructions such as structures, trees, brush, vehicles, etc., smaller debris like twigs, grass, and trash may snag and be left behind (fig. 17). In fast moving water, flexible objects like tree branches or bushes may pick up debris snags while bent, resulting in an inaccurate high-water mark after they have returned to their upright position. Additionally, debris snags on sturdier structures may be affected by wind-, wave-, and current-driven water and therefore may represent the height of splashing water.

Figure 17. Debris snag high-water mark in Tuntutuliak, Alaska, taken October 22, 2025

Fence Snag

Fence snags are a specific type of debris snag that accumulates on chain-link fences (fig. 18). These high-water marks are often very distinctive and well defined, but in areas susceptible to wind-, wave-, or current-driven water, they may represent wave heights rather than still water.

Figure 18. Fence snag high-water mark in Hooper Bay, Alaska, taken September 20, 2022

Ice Ring

Flooding that occurs during cold weather, particularly if high water persists for a prolonged period, may result in ice sheets forming at the water surface. As the flood waters recede, plates of ice may be left behind at the edges of structures or around vertical objects (fig. 19). If temperatures rise above freezing after a flood event, ice rings may melt and disappear.

Figure 19. Ice ring high-water mark (Koenig and others, 2016)

Present at the Peak

Present at the peak high-water marks are eyewitness descriptions or photographs that depict the peak water height during a flood event (fig. 20). The best present at the peak evidence includes infrastructure or objects with an already known height or that can be easily measured against. The timing of an observation or photograph is very important because it is often difficult to determine exactly when floodwaters reached their peak. Making multiple observations or taking multiple photographs during the flood event can help with that determination.

Figure 20. Photographic present at the peak high-water mark in Tuntutuliak, Alaska, taken September 17, 2022

Witness Mark

A witness mark, placed by an observer, is a more permanent marker that signifies the height of flood waters in a specific location at a particular time (fig. 21). Common witness marks include

things like flagging, permanent marker, or paint, and can be an indicator that represents any of the other types of high-water mark.

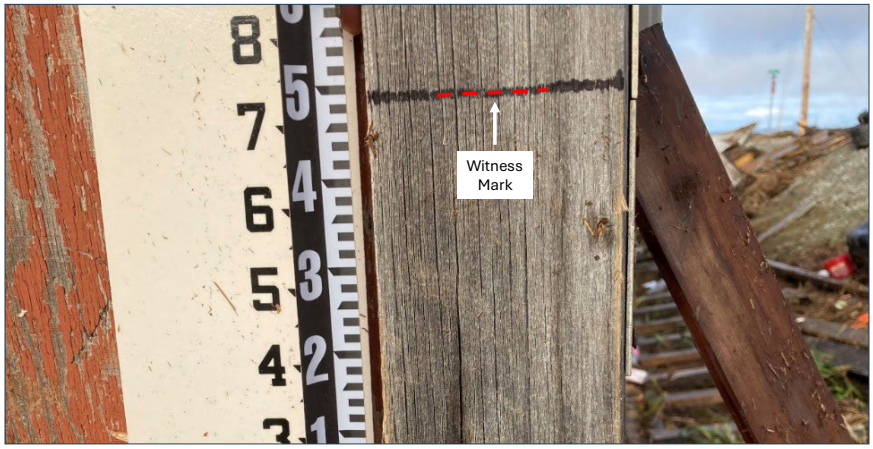

Figure 21. Witness mark representing a present at the peak high-water mark in Golovin, Alaska, taken September 21, 2022

Flood Source

Flooding may result from a single or multiple sources. Understanding the sources of flooding in an area helps identify specific hazards and develop strategies to mitigate them.

Storm Surge

Storm surges occur in coastal and tide-influenced riverine areas and are characterized by a rapid rise in water level generated by a storm. Pressure, fetch (wind), tides, and local geomorphology contribute to storm surge.

High Tide

Even without the added water from storm surge, the tide alone can cause flooding during the peak of the local tide cycle, especially when tides are at or near their highest astronomical tide (HAT), the 40-year maximum predicted high tide at that location. In some coastal areas with low elevation relative to sea level, even normal high tides can cause nuisance or minor flooding on a regular basis.

Ice Jam

Ice jam flooding occurs along rivers, especially during spring breakup, when ice accumulates and blocks river flow, causing water to back up and flood upriver from the ice jam. This type of flooding is often the most severe near the ice jam itself but may extend significant distances upriver.

Rain

Prolonged or intense rainfall can cause flooding, particularly in, but not limited to, riverine locations. In the riverine context, heavy rainfall within the watershed can increase downstream discharge, but prolonged or high-volume rainfall in the local area can also lead to flooding. Rapid accumulation of rainwater in low areas can pose a risk anywhere, especially if the ground is already saturated or frozen. This type of flooding is often exacerbated by drainage problems.

Rain on Snow

Rain on snow can sometimes pose a greater hazard than rain alone. This is because rain can cause rapid snowmelts and runoff, adding to the volume of water on the ground, which already has decreased absorption capacity because it is frozen.

Snowmelt Runoff

As with rain on snow, normal snowmelt runoff can also cause flooding, especially in the spring as the cumulative winter snowpack begins to melt and drain into the watershed. The worst snowmelt runoff flooding is associated with rapid temperature increases over short periods.

Drainage Problems

Plugged, missing, or improperly sited drainage infrastructure can exacerbate all types of flooding. Constructing and maintaining well-engineered ditches, culverts, and storm drains can help alleviate some flooding, but not all of it. Proper drainage helps prevent water accumulation, up to a point—when flood heights exceed the height of drainage infrastructure, above which even the best-maintained drainage system can become a conduit for flooding.

Groundwater Flooding

Although it is also a drainage problem, unlike the issues stemming from drainage infrastructure, groundwater flooding occurs when natural, underground drainage mechanisms are overwhelmed by a rapid increase in water, causing the water table to rise.

Flood Frequency

Understanding how often a location floods can help better identify areas of increased risk, the likely timing of flooding, and potentially why flooding is occurring. This can be especially important for documenting repeated nuisance flooding and drainage problems, allowing community planners to mitigate or, in some cases, alleviate persistent flooding.

Area(s) Affected

Documenting the impacts on homes, vehicles, and subsistence materials, as well as on public and commercial properties, can help categorize flood severity and serve as a resource for recovery. Creating a record of affected infrastructure and specific damage makes it easier for communities and individuals to apply for and receive support and assistance after a flood event. It is especially important to identify damage to utilities and services, as well as roads, airstrips, and other transportation infrastructure.

DISCUSSION

High-water marks are not just data points and numbers; they are vital records that help communities prepare for, respond to, and recover from floods. Collecting high-water marks helps build a reliable flood record, validate and correct flood models, support better forecasting and emergency response, improve hazard assessments and mitigation planning, and document impacts and facilitate recovery. For this reason, local knowledge is critical knowledge.

Community members are the first to observe and experience changes to the coastline, rivers, and infrastructure. Without local input, agencies and researchers can miss important details and context. Online applications for contributing, downloading, and displaying high-water mark observations can help bridge this knowledge gap by enabling communities to share what they know and improve safety for all Alaskans.

ACKNOWLEDGMENTS

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APPENDIX A: ALASKA HIGH-WATER MARK OBSERVATIONS FORM

STATE OF ALASKA
Division of Geological & Geophysical Surveys (DGGS)
Coastal Hazards Program

High-Water Mark Observation Form

Please do not place yourself or others in harm's way while collecting high-water mark observations.

REQUIRED INFORMATION

LOCATION Latitude: _____ N Longitude: _____ W

MEASUREMENT _____ ○ inches ○ feet ○ centimeters ○ meters
If the high-water mark is above ground level, use a tape measure, ruler, or yard stick to measure up, vertically, from the ground to the height of the high-water mark.

DATE OF FLOODING _____ (even an approximate date can be useful)

DESCRIPTION (Please provide as much detail as you are able)

_____
_____
_____
_____
_____

PHOTOGRAPHS Please attach to this form a close-up photograph of the high-water mark and a photograph of the surrounding area

OPTIONAL INFORMATION

HIGH-WATER MARK TYPE
- ☐ Debris Line
- ☐ Seed Line
- ☐ Mud Line
- ☐ Stain Line
- ☐ Debris Snag
- ☐ Fence Snag
- ☐ Cut Line
- ☐ Wash Line
- ☐ Ice Ring
- ☐ Present at the Peak
- ☐ Other (please describe)

_____
_____

FLOOD SOURCE (check all that apply)
- ☐ Storm Surge
- ☐ High Tide
- ☐ Ice Jam
- ☐ Rain
- ☐ Rain on Snow
- ☐ Snowmelt Runoff
- ☐ Drainage Problems
- ☐ Groundwater Flooding
- ☐ Other (please describe)

_____
_____

AREA(S) AFFECTED (check all that apply)
- ☐ Home / Residence
- ☐ Subsistence Camp / Storage
- ☐ Property / Vehicle
- ☐ Tribal Building
- ☐ City / Public Building
- ☐ Commercial Building
- ☐ School
- ☐ Utility (power / fuel / water / sewer)
- ☐ Landfill
- ☐ Transportation Infrastructure
- ☐ Other (please describe)

_____
_____

HAS THIS LOCATION FLOODED BEFORE? ○ Yes ○ No ○ Permanently flooded ○ Not sure

(IF YES) **HOW OFTEN?** ○ 10 – 50 years ○ 5 – 10 years ○ 2 – 5 years ○ 1 – 2 years ○ Every year ○ Multiple times each year

Completed forms and attachments can be sent by email or mail to:

dnr.dggs.coastal.hazards@alaska.gov

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