Managing Kenai Peninsula Wetlands

Examples of some of the many kinds of wetlands found on the Kenai Peninsula

Black spruce on Discharge Slope (SM) near Clam Gulch.

Relict Glacial Lakebed (LB1-4) complex near Ninilchik.

Relict Glacial Drainageway (DW21) near Salamatof Lake.

Headwater Fen (H) in the headwaters of the Anchor River.

Homer Soil and Water Conservation District, 12/09/14 version

Managing Kenai Peninsula Wetlands

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Answers to peninsula wetland FAQs

1. **Why would I have any interest in wetlands?**
   See **Issues with locating developments in wetlands versus uplands**.

2. **What's the difference between an "upland" and a "wetland," and why does this matter for what I want to do on the land?**
   See **Issues with locating developments in wetlands versus uplands**.

3. **How do I find out if wetlands are on a piece of property and, if so, where they are?**
   Go to **locating and learning about peninsula wetlands using the online parcel viewer.**

4. **How do I find out what KINDS of wetlands are on a piece of property?**
   Go to **locating and learning about peninsula wetlands using the online parcel viewer.**

5. **How do I find out why a particular wetland matters (its functions and values)?**
   Go to the wetland of interest using the Kenai Peninsula Borough's Mapviewer (see **locating and learning about peninsula wetlands using the online parcel viewer**) and look up its identified functions and values. Then go to **Chapter 2** and look up functions/values of interest.

6. **How do I find out what wetlands might be affected by a project?**
   First, you'll need to find out *where* the project is located. Once you know the project location, go to **locating and learning about peninsula wetlands using the online parcel viewer** for instructions on looking up what wetlands occur in the project area.

7. **Where can I get guidance on managing wetlands?**
   First identify which functions/values are of interest to you (see Question 5 above), then go to **Chapter 3** and look up how to manage those functions/values.

8. **How can I figure out what permits I might need and how to get them?**
   Go to Chapter 5, **Links to wetland permit information**.

Chapter 1: Introduction and background

Introduction

Wetlands contribute to the quality of life on the Kenai Peninsula in many ways. Some of these are widely recognized—the importance of riparian wetlands to salmon populations, for example; some of these are little known—the importance of large volumes of "peat porewater" slowly flowing through a vast, connected system of spongelike peat wetlands. The significance of peninsula wetlands begins to emerge when you realize that roughly 40 percent of the non-federal lands between Cook Inlet and the Kenai National Wildlife Refuge are mapped as some kind of wetland—that's over 370,000 acres of wetlands. You can find an introduction to these wetlands in Chapter 2 of *Kenai Peninsula Wetlands—a Guide for Everyone* and detailed information about every kind of mapped peninsula wetland—and how they were mapped—at *Wetland Mapping and Classification of the Kenai Lowland, Alaska* (see http://www.kenaiwetlands.net/ and http://cookinletwetlands.info/ for different kinds of information).

In 2012, Homer Soil and Water Conservation District received an EPA Wetland Program Development Grant (WPDG CD-00J65301-0) to accomplish the following goal.

> *Help decision makers and land users better understand how to manage peninsula wetlands in order to maintain their long-term functions, conditions, productivity, extent, connectivity, and variety, as well as related resources such as flood storage, clean water, salmon, moose, migratory birds, education, tourism, and other wetland benefits.*

This report constitutes Deliverable #1 identified in the Plan of Work for Homer Soil and Water's 2012 EPA project, namely:

> *an online report describing*
> *(a) the collaborative process used to develop management strategies,*
> *(b) the strategies themselves, and*
> *(c) the steps and rationale for "assigning" particular strategies to specific wetlands.*

The second deliverable resulting from this project is:

> *incorporation of wetlands management information into the Kenai Peninsula Borough (KPB) online "interactive parcel viewer" (IPV). The IPV will make it easy for landowners, managers, government officials, and others to find which management strategies have been recommended for which wetlands, why, and how strategies could be implemented.*

For more information on Deliverable #2, go to Chapter 4,Wetlands information on the borough parcel's viewer.

Organization of this report

As noted above, this report describes (a) the collaborative process used to develop management strategies for Kenai Peninsula wetlands, (b) the process for assigning strategies to specific wetlands, and (c) the strategies themselves. This information is presented in the following chapters.

- **Chapter 1** Describes the impetus and background for this project, as well as the collaborative process by which this project was accomplished.
- **Chapter 2** describes wetland functions/values assessed by Homer Soil and Water as an essential precursor to this project.
- **Chapter 3** outlines wetland management strategies developed to help achieve the overarching goal of maintaining assessed wetland functions/values. Management strategies are outlined at two scales—the *watershed scale* and the *landscape level* or *map-unit scale*. In addition, key issues related to developing in wetlands versus uplands are briefly outlined because of their relevance to wetland management. Finally, Chapter 3 provides an alphabetical list of management *practices*. These are actions, methods, considerations, and approaches that can be incorporated as appropriate into a wide variety of land use activities in order to help avoid or minimize impacts on wetland functions/values.
- **Chapter 4** provides step-by-step instructions for using the Kenai Peninsula Borough's online interactive parcel viewer to locate wetlands of interest and access related information about them, including their functions/values and strategies for maintaining these.
- **Chapter 5** provides information and links to assist in determining whether wetland-related permits are needed in a particular situation and, if so, where to get help with the permit process.

Wetland mapping and assessment as precursors to wetland management

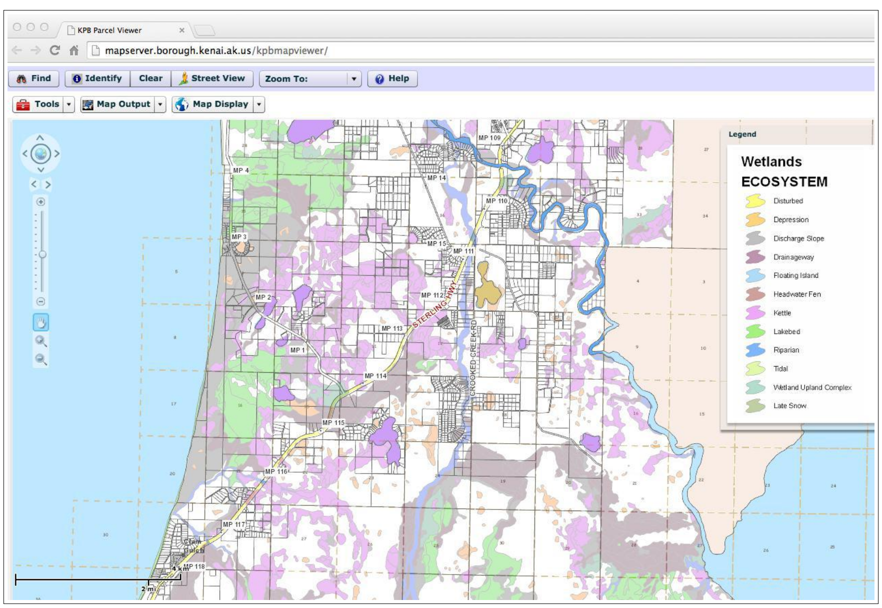
Informed wetland management requires knowing some basic things about any wetland being managed. Principle among these are:

1. What is the wetland's location within its watershed and what physical, hydrological, and biological conditions characterize the wetland? For example:
   a) What landforms (*geomorphic* features) best describe the wetland's shape—e.g., depression, riparian fringe, former glacial lakebed, drainageway, etc.?
   b) What is the wetland's hydrology—how much water flows into, through, and out of the wetland? What water table levels are characteristic? How much water can the wetland potentially hold?
   c) What soil types and plant communities characterize the wetland?
2. What functions and values are associated with the wetland given its location and current conditions?
3. How can beneficial wetland functions and values be maintained for the long-term?

Wetland mapping

Landscape-level answers to the first question were obtained by mapping and classifying Kenai Peninsula wetlands in the early 2000s at a scale of 1:24,000[1]. Mapping and classification, along with related fieldwork, provided information about wetland conditions. The project was funded by an EPA Wetland Program Development Grant and is documented in *Wetland Mapping and Classification of the Kenai Lowland, Alaska* (see http://www.kenai wetlands.net/ and http://cookinletwetlands. info/).

Wetland maps like that below are available on the Kenai Peninsula Borough's interactive parcel viewer (http://mapserver. borough.kenai.ak.us/kpbmapviewer/) by choosing "Wetlands" in the dropdown menu that opens upon clicking the *Map Display* button (make sure you're zoomed in to 1:62,500 scale or more). Once the Wetlands map is displayed on the parcel viewer, information about any wetland can be accessed by clicking the *Identify* button and then double clicking on any wetland of interest; Chapter 4 provides step-by-step instructions for this process.



The system used to classify and name mapped wetlands produced *map unit codes* reflecting wetland geomorphology (landform) and, depending on wetland type, either water table levels or dominant plant communities. Appendix A lists wetland map unit codes, along with links to their online descriptions.

As compared to wetlands in the Lower 48, two unique features are reflected by wetlands mapped on the Kenai Peninsula: (1) the vast majority of them remain in "reference condition" and (2) a large percentage of peninsula wetlands are peatlands—roughly 40 percent on the Kenai lowlands and 20 percent in the Seward area.

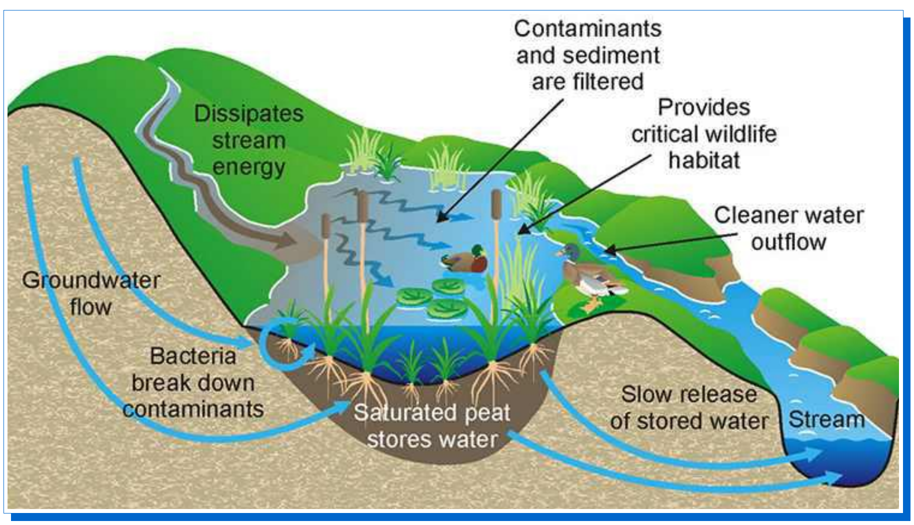
1 Field work for wetland mapping was done in concert with a soil survey of the Western Kenai Peninsula, available at http://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/alaska/AK652/0/WesternKenai_manu.pdf and through Web Soil Survey, http://websoilsurvey.sc.egov.usda.gov/ App/HomePage.htm.

Assessment of wetland functions and values

Once wetlands had been mapped and classified, developing landscape-level answers to the second question—what are the wetland's functions and values—became possible. From 2010 to 2013, Homer Soil and Water Conservation District led a collaborative effort[2] to determine which wetland functions and values could be assessed given available information and the chosen assessment methods. Wetland ***functions*** are the processes that a wetland performs—such as storing stormwater or maintaining natural streamflow regimes; ***values*** are the beneficial services that humans ascribe to functions—such as reduction in flooding of roads and buildings, or maintenance of good water quality. Values also encompass the benefits wetlands provide by affording places where humans can recreate, explore, hunt, fish, gather plants, study nature, connect with the past, etc. Functions and values often overlap, so the term *function/value* is generally appropriate. A number of common wetland functions/values are illustrated below.

Homer Soil and Water's assessment of peninsula wetland functions and values was funded by an EPA Wetland Program Development Grant. The project produced an assessment of 16 functions/values associated with peninsula wetlands. These are described in Chapter 2. Because of data limitations—including the scale at which wetlands had been mapped (1:24,000)—and because it made sense to create a broad-brush assessment into which future site-specific information could be nested, functions/values were assessed at the landscape level. Assessment methodology was based on and modified from two sources: (1) the Ontario Wetland Evaluation System, or OWES (see http://www.ontario.ca/environment-and-energy/wetlands-evaluation), which had previously been used to assess wetlands in Anchorage and then in Homer, and (2) the method used in the Matanuska-Susitna Borough to assess hydrology functions/values (found in http://www.matsugov.us/assembly/legislation/doc_download/3760-msb-wetland-functions-and-values-assessment-march-2012-low-res). For a detailed description of these methods as applied on the Kenai Peninsula, see Chapter 3 in *Kenai Peninsula Wetlands—a Guide for Everyone*. For concise technical descriptions of assessment methods, see *Kenai Peninsula Wetland Assessment – Homer SWCD Technical Report*.

Note, peninsula wetlands provide additional functions/values not assessed by Homer Soil and Water. Examples include sequestering carbon or providing firebreaks. Section 3.1 in *Kenai Peninsula Wetlands—a Guide for Everyone* outlines several other systems used to name and categorize what we call functions and values.



Some of the things that wetlands do (wetland functions) and recognized benefits (wetland values). Functions/values depend on a wetland's location in its watershed and its geomorphology, hydrology, plant communities, and other conditions and processes. Because of connections inherent in watersheds, how wetlands are managed affects downslope lands and waters as well as the wetlands themselves. (Illustration from http://connected-sustainability.org/portfolio_page/ wetlands-2/.)

2 Collaborators in the assessment project are listed in Appendix B.

Collaborative process to develop wetland management strategies

With wetlands classified and mapped and key functions/values assessed, essential elements were in place to develop strategies for managing wetlands so as to maintain assessed functions/values. To that end, Homer Soil and Water applied for and received an EPA Wetland Program Development Grant to complete the project documented here. The overarching goal of this project as stated in the Plan of Work was to:

> *Help decision makers and land users better understand how to manage peninsula wetlands in order to maintain their long-term functions, conditions, productivity, extent, connectivity, and variety, as well as related resources such as flood storage, clean water, salmon, moose, migratory birds, education, tourism, and other wetland benefits.*

To achieve the project goal, Homer Soil and Water developed wetland management *strategies* and compiled a list of wetland management *practices* (see Chapter 3). In many cases, practices represent tools that can be used to implement strategies during particular land use activities. Decision-makers and land users can use strategies and practices to to help maintain functions/values associated with the wetlands in their care.

Management strategies

A common definition of *strategy* is "a plan of action or policy designed to promote achievement of a particular aim or goal." The term means different things in different contexts. The scale and detail of a strategy reflects the scale and detail of the aim or goal it's intended to achieve. Strategy scale and detail also reflect the scale and detail of available information.

As explained earlier, the information that Homer Soil and Water used to develop wetland management strategies was *landscape level*, reflecting the scale and detail—1:24,000—at which peninsula wetlands were mapped, classified, and assessed. As a result, most of the strategies outlined in Chapter 3 are landscape-level strategies. In addition, however, Chapter 3 includes three *watershed-level* management strategies. These reflect the inherent connectivity of watershed processes. Watershed processes and conditions upslope or upgradient of a wetland can profoundly affect what happens in that wetland. Similarly, what happens in a wetland can affect watershed processes and conditions downslope or downgradient of the wetland.

Collaboration

Homer Soil and Water recognized the importance of involving wetland researchers and others with relevant expertise in the process of developing wetland management strategies. Equally important were contributions from "decision makers and land users." Collaboration with these groups had been a major component of Homer Soil and Water's wetlands assessment project, and, as a result, many valuable partnerships were already in place for this project. Collaborative relationships had also grown out of Homer Soil and Water's long-term participation in the Kenai Peninsula Wetland/Watershed Working Group (WWG). The WWG is an ad hoc group of individuals interested in sharing information about Kenai Peninsula wetlands and watersheds. The group has been meeting once or twice a year since 2000 and includes researchers, resource managers, land use planners, conservationists, educators, and other representatives from state and federal agencies, borough and city governments, Native organizations, non-governmental organizations, and, on occasion, local businesses. Individuals who participated in this project, along with their affiliations, are listed in Appendix B.

To share information and solicit input and feedback, Homer Soil and Water held twelve scheduled meetings and work sessions focused on developing management strategies (see Table 1). Meetings were characterized by prepared presentations designed to share information; work sessions were designed to encourage a free-flowing exchange of ideas around a particular topic, such as a function/value, strategy, format, concern, approach, or the like. Meetings and work sessions could be combined and could be as small as one-on-one conversations or involve large inter-agency gatherings. To avoid conflicting with the 2014 field season—when few partners would be available to meet—meetings and work sessions were held throughout the winter of 2013/2014.

Table 1. Meetings and work sessions promoting collaboration during this project.		
Date	**Entities participating***	**Meeting or work session**
10/15/13	CIK, KWF	Work session to review HSWCD initial approaches for developing and presenting management information
10/28/13	COE permit staff	Meeting/work session to update Corps staff on assessment results and introduce management project
12/4/13	ADF&G permitter	Meeting to update ADF&G and solicit feedback
12/12/13	ADF&G, ADNR, Division of Agriculture, CACS, CIK, CIRI, COH, KBC/KPC, KBCS, KBRR, KHLT, KPB (Gilman River Center), MAPP, NNAI, NRCS, Port Graham Village, Senator Paul Seaton, Snomads, Sustainable Homer, USACE, USFWS (Kenai Field Office)	Wetland presentation at Local Working Group meeting coordinated by NRCS and HSWCD
1/28/14	ADF&G (Sport Fish, Homer office), CIK, KBRR, Kenaitze Indian Tribe (via webinar) KWF, USACE,	WWG meeting enabling participants to share information about wetlands; HSWCD introduced wetland management project and solicited collaboration
2/6/14	CIK, COH, KBRR KWF	Work session to discuss wetland management approaches and information so far
2/27/14	KWF	Work session to discuss wetland management approaches and information so far
3/7/14	ADNR (Alaska Hydrologic Survey), COH, KPB, KWF, USFWS (Kenai Field Office)	Meeting/work session at KPB building to share information, review hydrology assessments, and solicit feedback
3/20/14	CIK, COH, KBRR, KWF	Work session to discuss wetland management approaches and information so far
4/9/14	NRCS (Kenai Field Office), USACE	Two separate meetings to update NRCS and USACE staff on wetland management approaches and information so far
4/14/14	CIK, KBRR, KWF USFWS,	Work session to review salmon assessment maps with CIK and KBRR researchers
5/8/14	KPB Land Manager	Work session to update KPB and solicit feedback

* Acronyms: **ADF&G** = Alaska Department of Fish and Game; **ADNR** = Alaska Department of Natural Resources; **CACS** = Center for Alaskan Coastal Studies; **CIK** = Cook Inletkeeper; **CIRI** = Cook Inlet Region, Incorporated; **COH** = City of Homer; **EPA** = Environmental Protection Agency; **HSWCD** = Homer Soil and Water Conservation District; K**BC/KPC** = Kachemak Bay Campus, Kenai Peninsula College; **KBCS** = Kachemak Bay Conservation Society; **KBRR** = Kachemak Bay Research Reserve; **KHLT** = Kachemak Heritage Land Trust; **KPB** = Kenai Peninsula Borough; **KWF** = Kenai Watershed Forum; **MAPP** = Mobilizing for Action through Planning and Partnerships; **NNAI** = Ninilchik Native Association, Inc.; **NRCS** = USDA Natural Resources Conservation Service; **USACE** = US Army Corps of Engineers; **USFWS** = US Fish and Wildlife Service; **WWG** = ad hoc peninsula Wetland/Watershed Working Group

Model provided by Homer wetland management strategies

This project was in part motivated by the desire to develop management recommendations for all peninsula wetlands analogous to those developed for City of Homer wetlands. In Homer, after functions and values of city wetlands were assessed, preliminary management strategies were developed to help guide city staff and others in making decisions affecting those wetlands. Although not formally adopted, Homer wetland management strategies have proven useful, particularly in reviewing applications for projects affecting Homer wetlands, including Corps of Engineers 404 wetland permit applications.

In Homer, management strategies were assigned to wetland *complexes* created by combining individual wetland map units into geographically logical management units, each of which was then named for convenient reference. Table 2 lists the 25 wetland complexes thus created, along with the management strategies assigned to each. Map 1 shows the locations of Homer wetland complexes.

Tailoring management strategies to available information and assigning them to particular wetlands

Homer Soil and Water began this project by reviewing in detail City of Homer wetland complexes and management strategies. The purpose was to see if the same approach could be applied to developing strategies peninsulawide. Initial efforts to delineate wetland complexes on the southern peninsula made it clear that differences in mapping scale and areal extent between the two projects necessitated different approaches. For the City of Homer, strategies had been developed for wetlands covering 3,800 acres and mapped at a scale of 1:12,000; for the Kenai lowlands and Seward area, wetlands covering over 336,000 acres had been mapped at a scale of 1:24,000. Delineating wetland complexes over the larger extent using less-detailed maps proved to be subjective and appeared not to provide useful additional information. As a result, the consensus was that strategies should be developed in terms of functions/values rather than wetland complexes. Also, because of differences in map scale and extent, peninsulawide strategies would need to be more "broad brush" than those in Homer.

One key advantage of developing management strategies in terms of wetland functions/values rather than wetland complexes was the ease and objectivity with which strategies could then be assigned to peninsula wetland maps. Since all map units used during wetland mapping (see Appendix A) had been scored for the 16 assessed functions/values, management strategies for maintaining specific functions/values were automatically correlated with the map units providing those functions/values, and thereby to wetland maps. Chapter 4 explains how to look up both functions/values and management strategies associated with particular mapped wetlands.

Table 2. Homer wetland complexes (management units) and related "management strategies"

Note: "natural vegetation" is the vegetation that would be on the site without human manipulations. Lawns are not natural vegetation. Natural vegetation retains water and filters runoff. It is important for flood control and to remove pollutants from water running off roofs, paved areas, lawns, and cleared ground.

	Wetland complex	Management strategies
1.	**Beluga Lake**	Prohibit fill in Beluga Lake or the two associated wetland polygons (docks are permitted).
2.	**Beluga Slough**	Prohibit fill in Beluga Lake or the two associated wetland polygons (docks are permitted).
3.	**Beluga Slough Discharge**	Development should be encouraged in this core area of Homer. Mitigate for the loss of moose habitat. Further development north of Bunnell Street and east of Main Street should be discouraged. A goal of this plan is to bring private parcels in this area into conservation status. Development in tidally influenced wetlands should be prohibited.
4.	**Bridge Creek**	The wetland management strategy for this watershed is the same as the Bridge Creek Watershed Protection Ordinance, which includes a prohibition on filling wetlands.
5.	**Diamond Creek wetlands**	Maintain large lot sizes. Maintain a 100-ft setback of natural vegetation along either side of Diamond Creek and its tributaries. Crossings should be perpendicular to the channel via bridge or oversized culvert and involve the minimum amount of fill necessary for safety. Where uplands exist on a lot, they must be used prior to filling wetlands. If more than 3% of wetlands on any lot are converted to hardened (impervious) surfaces, they must be compensated for with swales and/or runoff retention ponds. Loss of moose habitat should be mitigated.
6.	**Downtown wetlands**	On City-owned parcels, maintain greenbelts incorporating stormwater retention designs. Where uplands exist on a lot, they must be used prior to filling wetlands. If more than 3% of wetlands on any lot are converted to hardened (impervious) surfaces, they must be compensated for with swales and/or runoff retention ponds. Loss of moose habitat should be mitigated.
7.	**East Beluga Discharge**	Accelerated runoff from hardened (impervious) surfaces should be offset with swales and/or runoff retention ponds [as well as with other Low Impact Development measures]. Site design should include hydrologic connectivity to upstream and downstream parcels. Moose habitat values are high throughout. Moose habitat should be preserved or mitigated. Development along the border with the East Homer Drainageway Complex should maintain an 85-ft buffer of natural vegetation.
8.	**East Homer Drainageway**	This area should be targeted for preservation and restoration. Encourage purchasing of private lots, e.g., by Kachemak Heritage Land Trust, Kachemak Moose Habitat, Inc., and others. If possible, restore hydrology and repair or implement suitable stormwater management measures along Kachemak Drive. Some fill may be allowed along Kachemak Drive.
9.	**Kachemak Kettle**	Maintain a 100-ft buffer along the East Homer Drainageway. Accelerated runoff from hardened (impervious) surfaces will be offset with swales and or/runoff retention ponds [as well as with other Low Impact Development measures]. Loss of moose habitat should be mitigated.
10.	**Lampert Peatland**	Maintain a 100-ft buffer around Lampert Lake. Mitigate for lost hydrologic, general habitat, and moose habitat functions in wetlands west of Lampert Lake. Discourage further development of wetlands east of Lampert Lake. Prohibit wetland filling more than 400 ft from Kachemak Drive.
11.	**Landfill Kettle**	Restrict development to the south side of the wetlands and along the highway. Accelerated runoff from hardened surfaces will be offset with swales and/or runoff retention ponds. Loss of moose habitat should be mitigated. The peatlands should be preserved and buffered with a 50-ft setback of undisturbed natural vegetation, as they are highly functional for water retention and filtering.
12.	**Loop Kettle**	Loss of moose habitat should be mitigated.
13.	**Northeast Slough**	Retain natural vegetation as practicable. Preserve existing wetlands for water quality functions and moose habitat.

14.	**North Paul Banks Discharge**	Encourage development here. Retain natural vegetation as is practicable. Accelerated runoff from hardened (impervious) surfaces will be offset with swales and/ or runoff retention ponds [as well as with other Low Impact Development measures]. Loss of moose habitat should be mitigated.
15.	**Ocean Kettle**	Accelerated runoff from hardened (impervious) surfaces will be offset with swales an/or runoff retention ponds. Loss of moose habitat should be mitigated.
16.	**Ocean Drive Kettle**	Retain natural vegetation as practicable. Accelerated runoff from hardened (impervious) surfaces will be offset with swales an/or runoff retention ponds. Loss of moose habitat should be mitigated.
17.	**Outer Loop Kettle**	Retain natural vegetation as is practicable. Accelerated runoff from hardened (impervious) surfaces will be offset with swales an/or runoff retention ponds. Loss of moose habitat should be mitigated.
18.	**Overlook Park**	**Public lands**: Maintain in conservation status and manage according to site management plan. **Private lands**: Maintain moose habitat by limiting fill to the minimum necessary for a residence and minimum driveway and parking. No ditching or changes to drainageways should be allowed. Locate roads outside of wetlands and drainageways to the extent possible. Maintain a 100-ft setback of natural vegetation on either side of Overlook Park.
19.	**Palmer Drainageway and Fan**	Maintain a 100-ft setback of natural vegetation on either side of Palmer Creek. Crossings should be perpendicular to the channel via bridge or oversized culvert and involve the minimum amount of fill necessary for safety. All of these wetlands should be preserved. A wetlands bank with Kachemak Moose Habitat, Inc., will target private parcels in this area, along with the East Homer Drainageway, for purchase and preservation. Wetlands within the City of Homer that have been targeted for moose mitigation are eligible to receive credits from this bank.
20.	**Quiet Creek Discharge Slope**	Retain natural vegetation as is practicable. Maintain a 50 ft setback of natural vegetation on either side of the stream channel. Crossing should be perpendicular to the channel, via bridge or oversized culvert, and involve the minimum amount of fill necessary for safety. Loss of moose habitat should be mitigated.
21.	**Raven Kettle and Rogers Loop Depression**	Avoid wetland fill. Maintain the hydrologic integrity of drainageways and water retention and filtration capacity of the complex. Where uplands exist on a lot, they must be used prior to filling wetlands. If more than 3% of wetlands on any lot are converted to hardened (impervious) surfaces, they must be compensated for with swales and/or runoff retention ponds. Loss of moose habitat should be mitigated.
22.	**Runway Discharge**	Within the airport boundary, wetland hydrology should be maintained. **Public lands**: Those tracts outside the airport boundary should be maintained and managed for the values of the Homer Airport Critical Habitat Area. **Private lands**: Accelerated runoff from hardened (impervious) surfaces should be offset with swales and/or runoff retention ponds [as well as with other Low Impact Development measures]. Loss of moose habitat should be mitigated.
23.	**Upper Woodard**	On **City-owned parcels**, maintain greenbelts incorporating stormwater retention designs. Retain as much natural vegetation on individual lots as is practicable. Where uplands exist on a lot, they must be used prior to filling wetlands. If more than 3% of wetlands on any lot are converted to hardened (impervious) surfaces, they must be compensated for with swales and/or runoff retention ponds. Loss of moose habitat should be mitigated.
24.	**West Beluga Slope**	**Public lands**: Publicly owned lands should be preserved as undisturbed wetlands. **Private lands**: These should be prioritized and purchased over time for inclusion in a mitigation bank whose purpose is to preserve moose habitat. Development should be discouraged. A master plan should be developed for this area as it is a very important wetland complex, and it is probably the most threatened wetland complex in the City of Homer.
25.	**West Homer Discharge**	Retain natural vegetation as is practicable. Accelerated runoff from hardened (impervious) surfaces will be offset with swales an/or runoff retention ponds. Loss of moose habitat should be mitigated.

Map 1. Wetland complexes delineated and named for City of Homer wetlands

These complexes were used in developing and assigning the wetland management strategies listed in Table 1.

Chapter 2 – Descriptions of wetland functions and values

This chapter provides descriptions of the 16 functions/values assessed for Kenai Peninsula wetlands (see Wetland mapping and assessment as precursors to wetland management). Quick links to each description are provided in Table 3, below. Table 3 can be reached from anywhere in this report by clicking on "Jump to function/value descriptions" in the footer. Methods for assessing and scoring wetlands for their functions/values are described for general audiences in Chapter 3 of *Kenai Peninsula Wetlands – a Guide for Everyone* and for technical audiences in *Kenai Peninsula Wetland Assessment – Homer SWCD Technical Report*.

Describing a function/value (and why it matters) leads to the question: How can this function/value be maintained? Answering that question gives rise to the management strategies outlined in Chapter 3. Chapter 3 also provides an alphabetical list of *practices* that can be incorporated into various land use activities to minimize their impacts on wetland functions/values. Practices can be used to help implement strategies.

Table 3. Functions/values assessed for Kenai Peninsula wetlands

Quick links to function/value descriptions are provided below.

Biology functions/values assessed for Kenai Peninsula wetlands

Click a function/value to go to its description.

• MOOSE WINTER HABITAT	• ANIMAL SPECIES OF CONCERN
• SALMON HABITAT SUPPORT	• SCARCE WETLANDS
• RARE WETLAND PLANTS	• HABITAT DIVERSITY

Hydrology functions/values assessed for Kenai Peninsula wetlands

Click a function/value to go to its description.
(Descriptions of transmitting discharge and contributing discharge have been combined.)

• RECHARGING GROUNDWATER	• MAINTAINING NATURAL STREAMFLOW REGIMES
• STORING WATER	• MAINTAINING WATER QUALITY
• TRANSMITTING or CONTRIBUTING DISCHARGE	• STREAMBANK AND SHORELINE STABILIZATION

Community/culture functions/values assessed for Kenai Peninsula wetlands

Click a function/value to go to its description.

• EDUCATION
• RECREATION
• DENA'INA CULTURE

WETLAND FUNCTION/VALUE: **MOOSE WINTER HABITAT**

Moose are an important big game species on the Kenai Peninsula, where they have been abundant for over 100 years. To humans, they are important and highly valued for hunting—both for meat and for trophies, as well as for non-consumptive uses such as photography and wildlife viewing. More people hunt moose than any other of Alaska's big game species; and statewide, Alaskans and nonresidents harvest approximately 6,000 to 8,000 moose per year, equal to some 3.5 million pounds of meat. Moose are also an important food source to many predators--like wolves and bears—and to scavengers like coyotes, bald eagles, and ravens.

Moose use a wide variety of habitats, from open-water wetlands, to alpine shrublands, to spruce forests. They are most abundant in recently burned areas supporting dense stands of preferred woody food species like willow, aspen, and birch; on timberline plateaus; and along major rivers. Seasonally, they range over large areas to take advantage of shifting food sources, to avoid deep snows, and to find habitats suitable for calving, rutting, and wintering. They may travel as far as 60 miles during these seasonal transitions. On a daily basis, moose seek areas to feed and to bed down for rest, to process food, and to escape temperature extremes and disturbances.

During winter, food is often limited, and moose focus on twigs of woody species like birch and willow. Moose use of woody browse increases with the severity of winter snowfall. Deep snows bury food sources and make traveling more energetically difficult for moose, especially calves. As a result, as snow depths increase at higher elevations, moose tend to move to lower elevations where movement and access to food are easier. Deep snow winters often result in severe over-browsing of preferred shrubs and can cause significant moose die-offs due to malnutrition. Even in relatively mild winters, winter mortality can be significant. Habitats that provide winter forage even after significant snowfall accumulations are particularly crucial to moose survival.

Wetlands below 600 ft in elevation and those that support significant stands of accessible willow received the highest scores for winter moose habitat, as did wetlands located within either the Anchor River – Fritz Creek Critical Habitat Area (CHA) or the Homer Airport CHA. Both of these CHAs were established by the state to protect key areas of moose habitat.

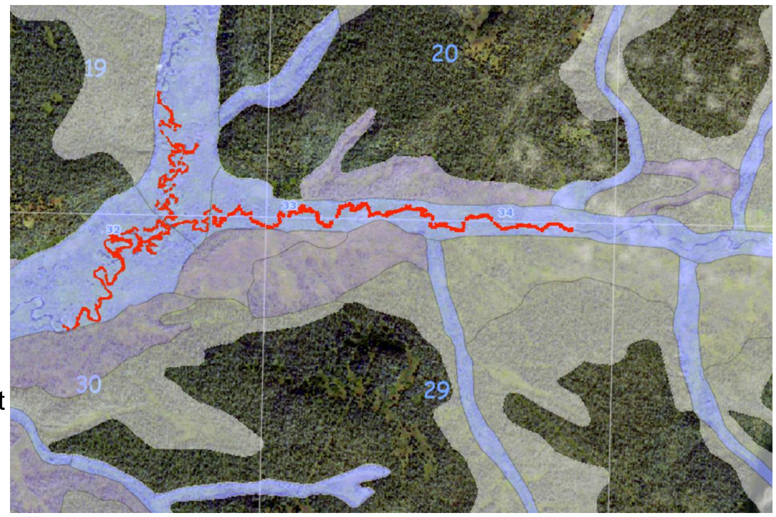
WHY **MOOSE WINTER HABITAT** matters:

Moose survival on the peninsula is closely tied to the availability of food during winter months, when moose are under the greatest stress and most in need of good quality browse. Identifying and maintaining wetland areas that can provide high quality moose winter habitat is a key part of any effort to maintain moose populations on the peninsula.

WETLAND FUNCTION/VALUE: **SALMON HABITAT SUPPORT**

Kenai Peninsula waterbodies support five species of salmon: chinook (king), sockeye (red), coho (silver), pink (humpy), and chum. Salmon go through a variety of life cycle stages* as they grow from eggs incubating in stream gravels to adults returning from the ocean to spawn. Depending on the salmon species and the life cycle stage, salmon use mainstem and side channels of streams and rivers, headwaters and other small tributaries, lakes and ponds, estuaries, and a variety of other wetlands (including peatlands with subsurface streams sometimes called "pipestreams"). Wetlands promote salmon survival in these habitats by maintaining the conditions salmon need, including suitable water flows, water quality (including cool temperatures), food (e.g., plankton, insects, small fish), streambed materials (e.g., spawning gravels), and cover along banks where juvenile salmon can hide and rest.

Although adult salmon are found in peninsula streams only when they return from the ocean to spawn, juvenile salmon occur in peninsula waterbodies and wetlands at all times of year—including winter. Immature salmon often go unnoticed because of their small size, but they are widely distributed.



Riparian/riverine (R) wetlands encompassing anadromous streams scored highest for salmon habitat support. (The Alaska Department of Fish and Game maintains a catalog of anadromous waterbodies.) An example of an R wetland containing an anadromous stream is shown at right. Blue areas are R wetlands; the red line is an anadromous stream (only a portion of which is marked). Other wetlands shown are Drainageways (rose-colored areas) and Discharge slope wetlands (beige areas).

The next highest scores went to wetlands not yet documented as containing salmon but having open water and either adjacent to or hydrologically connected to anadromous streams. Hydrologically connected wetlands without open water received lower scores. (It should be remembered that wetlands were mapped on 1:24,000-scale aerial photos, and as a result, wetlands with hard-to-see streams or other open water were sometimes given map codes indicating no open water.)

WHY **SALMON HABITAT SUPPORT** matters:

Salmon are economically and culturally the most important renewable resource throughout Alaska—annually supporting commercial, recreational, subsistence, and personal use fisheries worth hundreds of millions of dollars. Sport and commercial salmon fisheries are key drivers of the Kenai Peninsula's economy.

Habitat use—in both space and time—varies among salmon species. Wetlands are critical in creating and maintaining the wide variety of habitat conditions needed by salmon during their freshwater life cycle stages*.

* ***salmon life cycle stages***: Salmon use different habitats during different stages of their lives. Salmon freshwater life cycle stages consist of:

1. **egg stage** – salmon eggs are laid in nests called "redds" in streambed gravels; they incubate there until hatching in the spring;
2. **alevin stage** – alevins are salmon hatchlings with yolk sacs still attached; they remain in streambed gravels until they consume their yolks;
3. **fry stage** – fry have emerged from streambed gravels to feed on plankton, they use areas where stream currents are slow enough not to wash them downstream (for example, slow-water habitats along well-vegetated banks);
4. **fingerling stage** – fingerlings move upstream and downstream searching for food, cover from predators, and places to rest out of the current;
5. **smolt stage** – smolts are large and strong enough to hunt in the ocean; they gather in tidal estuaries to undergo physical, behavioral, and metabolic changes to prepare for life in the open sea—a process called "smoltification;" different species smoltify at different ages;
6. **spawning adults** – after feeding in the open ocean for 1 to 5 years (depending on species), salmon reach full size and strength; when ready to spawn, they congregate at stream mouths during low tides and run upriver with the rising tide, eventually reaching gravels where they hatched.

WETLAND FUNCTION/VALUE: **RARE WETLAND PLANTS**

Wetlands support a wide variety of plants, some of which can grow only in the saturated soils found in wetlands. The Alaska Natural Heritage Program (AKNHP, http://aknhp.uaa.alaska.edu/) tracks rare plants found in Alaska. AKNHP ranks species rarity at both state (S) and global (G) levels based on protocols developed by its parent organization, NatureServe. The rarity of different species is ranked using a scale of 1 to 5 for both state and global distributions. A plant with a ranking of S1-G1 (also written S1G1) is most rare both statewide and globally; S1-G5 is most rare statewide but common globally. The AKNHP BIOTICS database (http://aknhp.uaa.alaska.edu/maps/biotics/) lists the following six plant species ranked S3 or rarer growing in freshwater wetland habitats on the Kenai Peninsula. These are illustrated below.

1. *Carex heleonastes* (Hudson Bay sedge) G4, S2S3
2. *Catabrosa aquatica* (water whorlgrass) G5, S1
3. *Ceratophyllum demersum* (coon's tail) G5, S1
4. *Eriophorum viridicarinatum* (thinleaf cottonsedge) G5, S2
5. *Pedicularis groenlandica* (elephanthead lousewort) G4G5, S1S2
6. *Pedicularis macrodonta* (muskeg lousewort) G4 (Questionable taxonomy), S3

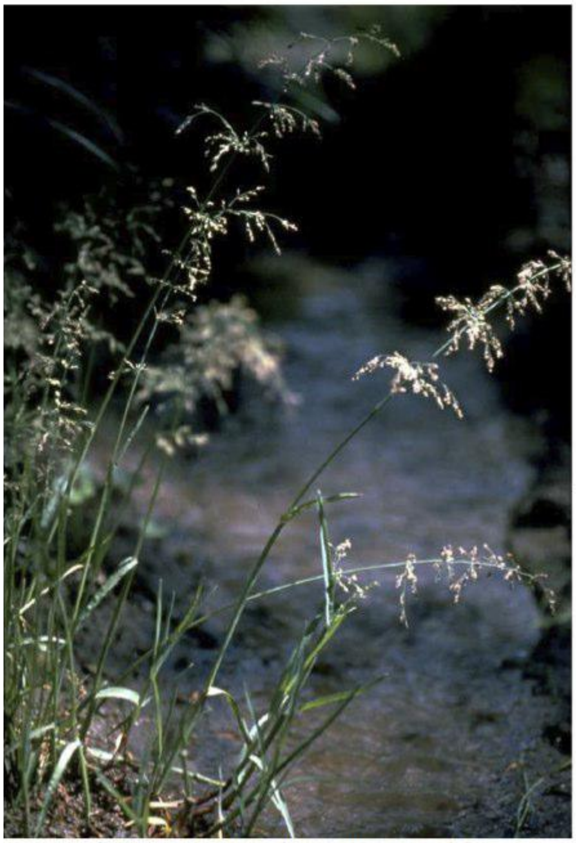
Wetlands within ½ mile of known rare plant location(s) AND that provide appropriate habitats for the rare plant(s) received the highest scores for this function/value. Wetlands with appropriate habitats but further away from the rare plant(s)—up to 1¼ miles away—received the second highest scores. Wetlands within 1¼ miles from rare plant location(s) but without appropriate ecological settings received lower scores.

WHY **RARE WETLAND PLANTS** matter:

Maintaining the biodiversity of peninsula ecosystems is important in maintaining ecosystem function, health, and resilience. Populations of rare wetland plants contribute to overall biodiversity. Rare plants can also serve as indicators of rare habitat types.

Rare plants also provide other societal values, including opportunities for research and education and sources of potentially useful products (including medicinal and manufacturing products).

Rare wetland plants that have been located on the Kenai Peninsula



Catabrosa aquatica **(water whorlgrass) S1**

Carex heleonastes **(Hudson Bay sedge) S2S3**

Ceratophyllum demersum **(coon's tail) S1**

Eriophorum viridicarinatum **(thinleaf cottonsedge) S2**

Pedicularis groenlandica **(elephanthead lousewort) S1S2**

Pedicularis macrodonta **(muskeg lousewort) S3**

All images from http://plants.usda.gov/gallery.html (search by name) except for ***Pedicularis macrodonta*** **(muskeg lousewort)**, which is from http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname= Pedicularis%20macrodonta and ***Carex heleonastes*** (Hudson Bay sedge), which is from http://efloora.ut.ee/Eesti/species/8329.html.

WETLAND FUNCTION/VALUE: **ANIMAL SPECIES OF CONCERN**

Kenai Peninsula wetlands support many species of vertebrates (fish, frog, birds, mammals) and invertebrates (insects, bugs, worms, etc.) The Alaska Natural Heritage Zoology Program (http://aknhp.uaa.alaska.edu/zoology/) tracks selected Alaskan animal species and ranks their rarity at both state (S) and global (G) levels using protocols developed by AKNHP's parent organization, NatureServe (http://www.natureserve.org/). The rarity of different species is ranked using a scale of 1 to 5 for both state and global distributions. An animal with a ranking of S1-G1 (also written S1G1) is most rare both statewide and globally; S1-G5 is most rare statewide but common globally. The primary goal of the Zoology Program is "to assimilate and synthesize information concerning rare and invasive species for use in land management and species conservation applications in Alaska." AKNHP's database was used for assessing animal species of concern on the peninsula.

In addition, because of local interest in caribou and sandhill cranes, wetlands supporting caribou calving/summer habitats and potential sandhill crane nesting habitats were also included in this assessment. The method used to assess peninsula wetlands for these habitats was developed by Kenai Watershed Forum (see http://www.kenaiwetlands.net/Habitat.htm).

On the Kenai Peninsula, five species of birds, two of fish, and one invertebrate received a rank indicating they are vulnerable or imperiled within the state (rank of S1 – S3; qualifier codes are B = breeding, N = nonbreeding), see http://aknhp.uaa.alaska.edu/zoology/species-list/. Three bird species, one fish species, and one invertebrate species were identified as utilizing freshwater wetlands on the Kenai Peninsula. Assessed animal species of concern are listed below, along with their state rankings.

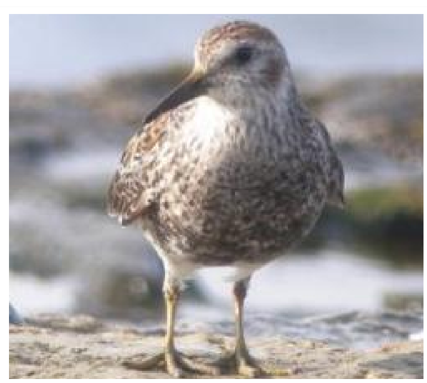
1. Aleutian Tern (*Oncychoprion aleuticas*) S3B
2. Rusty Blackbird (*Euphagus carolinus*) S4B, S3N
3. Pribilof Rock Sandpiper (*Calidris ptilocnemis ptilocnemis*) S2N, S3B
4. Alaskan Brook Lamprey (*Lampetra alaskensis;* also known as *Lethenteron alaskense*) S3
5. Yukon Floater (a freshwater mussel) (*Anodonta beringiana*) S3, S4

Wetlands supporting four or more species of concern (including caribou and sandhill crane habitats) received the highest scores; wetlands supporting incrementally fewer species received incrementally lower scores.

WHY **ANIMAL SPECIES OF CONCERN** matter:

Maintaining the biodiversity of peninsula ecosystems is important in maintaining ecosystem health, resilience, and functionality. Maintaining populations of all species native to the peninsula supports overall biodiversity.

Aleutian terns have nested in Homer wetlands
(see http://aknhp.uaa.alaska.edu/maps-js/integrated-map/species_ranking.php).



The Pribilof rock sandpiper is a subspecies of the rock sandpiper (from http://birds.audubon.org/species/rocsan).

WETLAND FUNCTION/VALUE: **SCARCE WETLANDS**

“Scarce” or (rare) wetlands are those that cover a relatively small total area within a watershed. Within each watershed area, this function/value was measured by looking at what percent of total wetland area was represented by each kind of wetland. Consideration of this function/value was based on the recognition that each watershed has its own unique biodiversity, and this is based in part on which wetland types are present in that watershed and to what extent.

On the Kenai Peninsula, 6th level USGS hydrologic units (HUs) were used to define the watershed areas for this assessment; these hydrologic units are identified with 12-digit Hydrologic Unit Codes (HUCs). Wetland scarcity was assessed by looking at the total wetland acreage within each HU and then determining what percent of that acreage was represented by each wetland ecosystem type, or “geomorphic component” (e.g., Riparian wetland, Drainageway, Lakebed, Kettle, etc.). Wetland ecosystem types representing less than 5% of the hydrologic unit received the highest scores, with wetlands increasingly common in the hydrologic unit receiving incrementally lower scores.

WHY **SCARCE WETLANDS** matter:

Maintaining the biodiversity of peninsula watersheds is important in maintaining watershed functions and health, including the ability of watershed organisms to survive, thrive, and adapt to changing environmental conditions (including, climate change). Maintaining scarce or rare wetlands contributes to overall watershed biodiversity.

WETLAND FUNCTION/VALUE: **HABITAT DIVERSITY**

Habitat diversity reflects the variety of habitat niches that a wetland provides—i.e., the different kinds of food; open water and water sources; places to rest, hide, take cover, display, or breed, etc. found within the wetland. The higher a wetland's habitat diversity, the higher the number of plant and animal species it is likely to support. The higher the number of species a wetland supports, the higher its species *richness*.

To assess habitat diversity, scores were assigned to wetland variables related to habitat physical complexity, spatial interrelationships (including the presence and pattern of open water), plant variety, etc. Then scores for these variables were summed to generate a single score for a wetland's habitat diversity.

Essentially, wetland polygons with open water and many types of plant communities and layers of vegetation (e.g., groundcover, shrubs, trees) received the highest habitat diversity scores. Wetland polygons without open water and having just a few vegetation layers received the lowest scores.

Results of this assessment should be considered a starting point for future discussions of what physical and biological features are most likely to sustain or promote species richness in a wetland or watershed.

The Kettle (K1-3) on Old Sterling Highway (left) has higher habitat diversity than the Lakebed (LB3) on the Sterling Highway (right).

WHY **HABITAT DIVERSITY** matters:

High habitat diversity contributes to biodiversity. This is because of the correlation between habitat diversity and species richness—and the higher the richness of plant and animal species found in a wetland, the higher its biodiversity. This correlation was described in the Anchorage wetlands assessment method as follows:

"*The physical structure of plant vegetation strongly influences species richness and numbers of species that will use a habitat... The spatial distribution of vegetation also strongly influences species richness. There are numerous studies that have shown a positive correlation between species richness and the total number of vertical layers of vegetation... Such correlations would reveal the relative value of a particular wetland for general diversity and habitat potential.*"

WETLAND FUNCTION/VALUE: **RECHARGING GROUNDWATER**

A wetland recharges groundwater when water seeping or flowing out of the wetland reaches the groundwater zone, or aquifer. In the groundwater zone, water fills all pore spaces between particles and all fractures within rocks. The top of this fully saturated zone is called the water table.

The direction that water moves reflects gravity and/or relative water pressure gradients. Water infiltrates into the soil and percolates downward in response to gravity; water can move laterally—or even upwards—in response to water pressure gradients. Unless blocked by an impermeable surface, water moves from areas of higher water pressure (hydraulic head) to areas of lower water pressure.

Peat bogs, Depressions, Headwater Fens, and Late Snow Plateaus are the wetland types most likely to recharge groundwater, at least seasonally. Areas mapped as Wetland-Upland complex are also likely to recharge groundwater, particularly where uplands remain undisturbed.

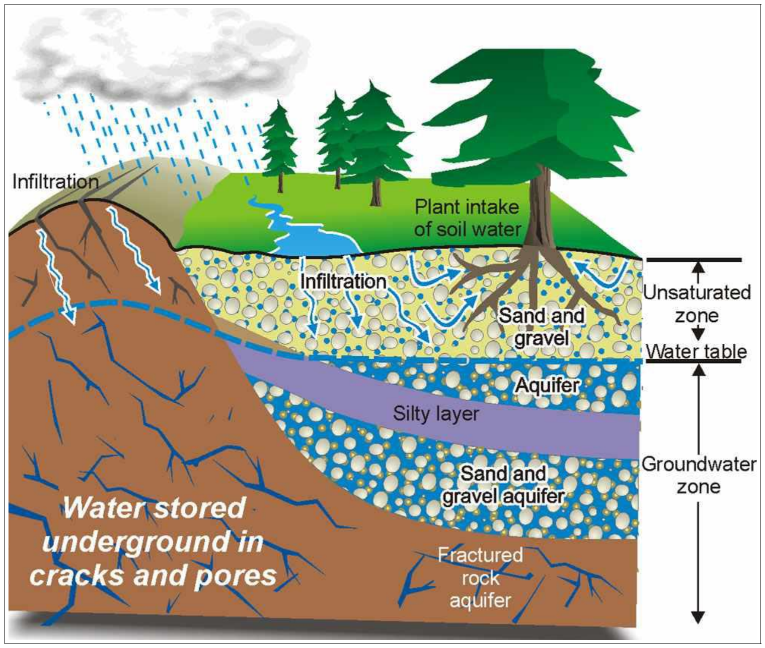


Illustration from http://www.env.gov.nl.ca/env/waterres/cycle/groundwater/.

WHY **RECHARGING GROUNDWATER** matters:

The groundwater system supplies water to wetlands, streams, lakes, and other waterbodies. In addition, the water pressures found in the groundwater zone are high enough to enable water to be pumped out, so recharging groundwater is critical to maintaining the supply of water in wells. Water cannot be pumped from the unsaturated zone.

Recharging groundwater is also important because groundwater (along with peat porewater) maintains streamflows during winter—when surface water sources are frozen—and during low flow periods in late spring and summer (after snowmelt and before rainfall). These groundwater-fed “baseflows” are essential for the survival of aquatic life, including juvenile salmon.

WETLAND FUNCTION/VALUE: **STORING WATER**

Wetlands store water when inflows from precipitation, surface flow, or subsurface flow are absorbed or held within the wetland. Storage is occurring whenever less water leaves the wetland than enters it (inflow is greater than outflow). Storage includes both surface and subsurface storage (in the soil). Wetlands with positive scores for storage can potentially store significant volumes of surface and subsurface water, including stormwater runoff.

The amount of water a wetland can store is called its storage capacity. Storage capacity is generally highest immediately before the rainy season, when wetland water tables are at their seasonal lowest. As rainfall and inflow fill the wetland and water tables rise, the remaining storage capacity declines. When the wetland's storage capacity is full, the amount of water flowing out of the wetland will equal the amount flowing in (inflow = outflow). (See transmitting discharge.) Storage capacity changes in response to antecedent moisture, precipitation, air temperature, evapotranspiration, inflow rates, and other factors.

Wetlands with the largest potential storage capacity tend to be flat or basin shaped, hydrologically isolated (not connected directly to other waterbodies), and characterized by variable water tables. Examples of wetlands scored as storing water include Depressions and wetlands with highly or moderately fluctuating water tables (storage capacity is highest when the water table is lowest). In addition wetland types located at higher elevations—Late Snow Plateaus and Headwater Fens—are likely to store water in the form of snow, and they also received positive scores.

Because of peat's many pore spaces and elastic ability to expand to hold more water, peat soils provide an important type of wetland storage on the Kenai Peninsula, see peatlands and their hydrology. The majority of peninsula wetlands are characterized by peat soils.

WHY **STORING WATER** matters:

Wetlands performing this function help reduce flooding. They do this by retaining inflows and delaying outflows. Stored water can move into subsurface pathways—including peat porewater pathways—and this slows downslope and downgradient water movement. This helps reduce and de-synchronize stormwater runoff to streams and rivers, reducing the height of flood waters and the “flashiness” of flooding.

Wetlands providing storage also help maintain natural streamflow regimes. For example, during dry periods or freeze-up, the gradual release of stored water into streams and rivers can help sustain baseflows, which are critical for juvenile salmon and other aquatic organisms. During summer warm spells, these contributions to streamflow can also help lower stream temperatures.

Actions that reduce a wetland's water storage capacity tend to increase flooding in areas downslope, downstream, or downgradient of affected wetlands. Developments located ***within*** wetland areas having a high storage capacity will be likely to flood whenever water is stored and water tables rise.

WETLAND FUNCTION/VALUE: **TRANSMITTING or CONTRIBUTING DISCHARGE**

Both of these functions/values reflect that a wetland is discharging water. The difference between the two is the length of time that discharge water has been stored in the wetland.

Transmitting discharge: In wetlands that transmit discharge, water entering the wetland spends little or no time in storage before flowing out (inflow = outflow). Inflows come from surface and subsurface flows and onsite precipitation.

The following wetland types received positive scores for transmitting discharge: Riverine wetlands, Non-Depression wetlands characterized by open water, and Non-Depression wetlands with stable water tables at or near the surface. Riverine wetlands generally store water for only short periods of time as inflow from upstream moves through them. Non-Depression wetlands with open water—such as certain Kettles and Drainageways—are receiving a relatively constant inflow of water from surface, subsurface, and groundwater sources, and they have little storage capacity available. As a result, their inflows are transmitted rather than stored. Floating Islands are included in this open water category. Non-Depression wetlands that have high, stable water tables at or near the surface also transmit discharge, but to a lesser degree than open water wetlands, because there is some capacity for storage. Discharge slope wetlands tend to have stable water tables near the surface, and they received positive scores for transmitting discharge.

Contributing discharge: In wetlands that contribute discharge, most of the discharge originates from storage within the wetland itself. These wetlands receive inflow from precipitation and surface or subsurface flows. Wetlands scored for contributing discharge include bogs, Headwater Fens, Late Snow Plateaus, and wetlands with fluctuating water tables. Bogs receive all their water from precipitation, and any discharge comes from storage. Late Snow Plateaus and Headwater Fens are located higher in their watersheds and receive minimal input from groundwater and surface flows. As a result, outflows from these types is primarily from storage. Non-Depression wetlands with highly or moderately fluctuating water tables are not receiving steady groundwater inflow (hence the water table fluctuations), so their outflows are generally from storage.

NOTE: Understanding wetland discharge on the peninsula means thinking less in terms of surface flows in channels and more in terms of water moving as subsurface throughflow, groundwater, and peat porewater. Because most peninsula wetlands are peatlands, and peat is very porous and highly absorbent, huge volumes of water are stored in peatlands and move through them as peat porewater. In peatlands, surface drainage networks and visible channels generally remain very poorly developed. Instead, peatlands tend to “leak out” water wherever hydraulic gradients along their edges are lower than water pressures within the peat. (Shallow or deep pipe-like channels—pipestreams—may develop in peatlands, but these are difficult to locate.) As a result, surface channels and outlets tend to play less significant roles in peninsula wetland discharge than in Lower 48 wetlands. This means that patterns of water movement into, through, and out of peninsula wetlands remain largely invisible and poorly understood. For more information, see peatlands and their hydrology.

WHY **TRANSMITTING or CONTRIBUTING DISCHARGE** matter:

Wetlands performing either of these functions supply water to other wetlands and waterbodies. They keep water moving through their watersheds—along with whatever the water is carrying. At the same time, they slow the water they discharge as compared to how fast that water would move if carried in surface pathways, such as channels or ditches. As a result, these wetlands can help delay the arrival of stormwater to down-slope areas, which helps de-synchronize flood flows and reduce flood heights.

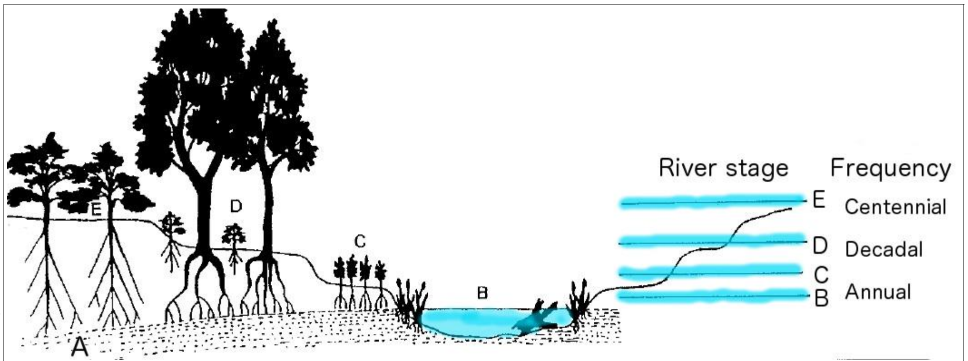
Where hydrologically connected to streams and rivers, these wetlands help maintain natural streamflow regimes, which in turn maintain instream and riparian habitats used by salmon and other aquatic life. Transmitting and contributing wetlands generally filter inflows being discharged, which improves water quality.

Trying to develop within these wetlands means dealing with surface and/or subsurface flows, at least during wetter periods. If wetlands that contribute or transmit discharge are replaced with impervious surfaces like roads, roofs, parking areas, and compacted soils, then downslope and downstream stormwater flooding is likely to occur more quickly and to produce higher flood flows in streams and rivers.

WETLAND FUNCTION/VALUE: **MAINTAINING NATURAL STREAMFLOW REGIMES**

Natural streamflow regimes are those patterns of streamflow variability (high and low flows) that occur naturally over time, that is, without substantial alteration by human activities like dams or large water withdrawals. Natural streamflow regimes reflect variability that ranges from the highest flood flows to the lowest baseflows. **Natural patterns of flow variability** can be understood in terms of five interrelated measures of flow: (1) magnitude (how large is the flow), (2) frequency (how often that flow level occurs), (3) duration (how long that flow level lasts), (4) timing (when that flow level occurs), and (5) rate of change (how fast flow levels increase and decrease).

Certain periodic flows and water levels tend to create certain physical and biological conditions in and along streams and rivers (see drawing at right). For example, conditions within the stream channel itself tend to reflect what are called bankfull discharges—which occur roughly every other year or so—and baseflows—which occur during winter freeze-up and spring and summer dry spells. Riparian plant communities tend to reflect flows that overtop streambanks every few years. Floodplain features beyond the riparian fringe tend to reflect larger, less frequent flows, with floodplain conditions farthest from banks reflecting 50-year, 100-year, and larger storm events.



The drawing above is from "The Natural Flow Regime," Poff et al 1997, see http://www.americanrivers.org/assets/pdfs/water-supply/the-natural-flow-regime.pdf). As explained in Poff et al: "Water tables that sustain riparian vegetation and that delineate in-channel baseflow habitat are maintained by groundwater inflow and flood recharge (A). Floods of varying size and timing are needed to maintain a diversity of riparian plant species and aquatic habitat. Small floods occur frequently and transport fine sediments, maintaining high benthic productivity and creating spawning habitat for fishes (B). Intermediate-size floods inundate low-lying floodplains and deposit entrained sediment, allowing for the establishment of pioneer species (C). These floods also import accumulated organic material into the channel and help to maintain the characteristic form of the active stream channel. Larger floods that recur on the order of decades inundate the aggraded floodplain terraces, where later successional species establish (D). Rare, large floods can uproot mature riparian trees and deposit them in the channel, creating high-quality habitat for many aquatic species (E)."

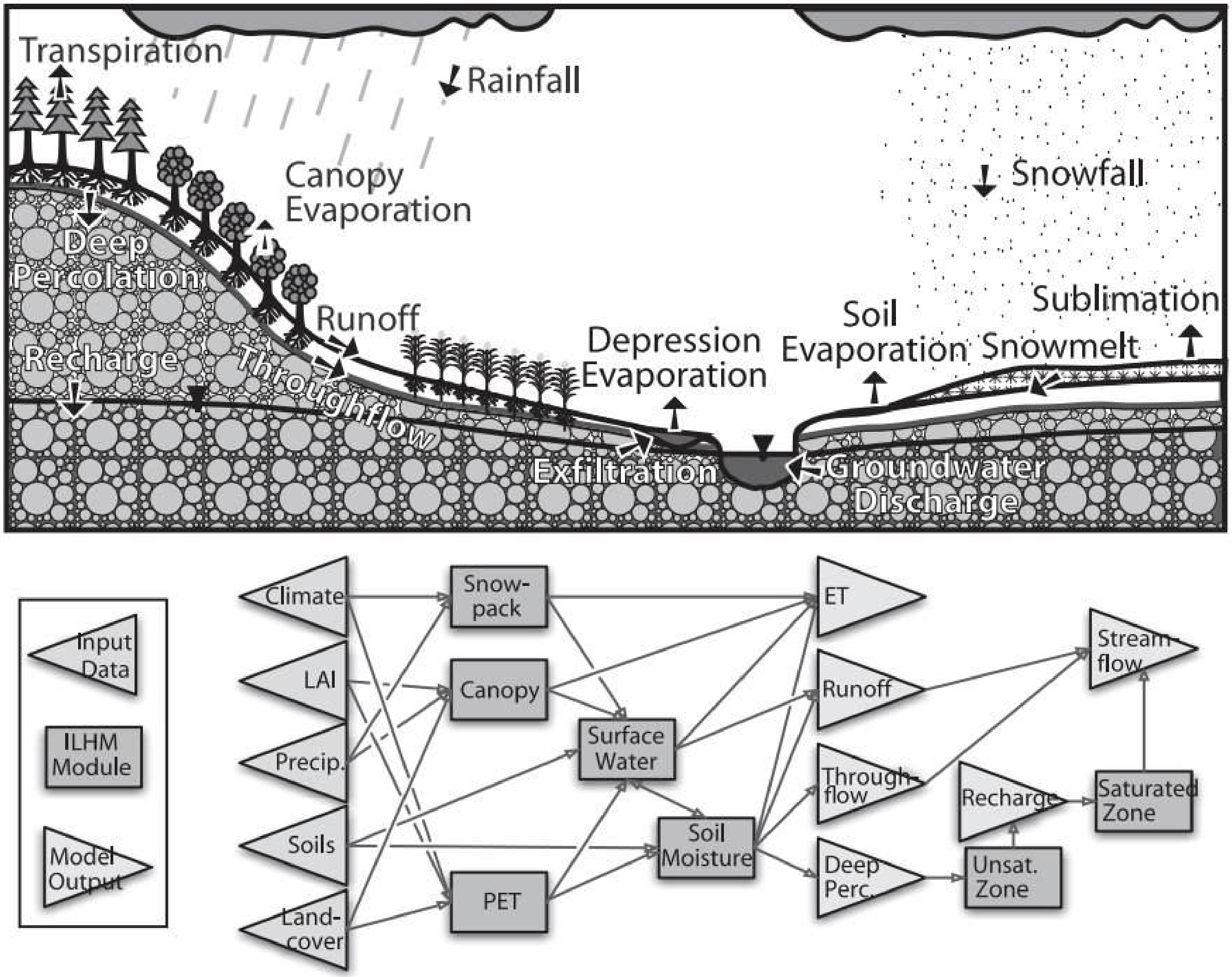
All wetlands play some role in maintaining natural streamflow regimes within their watersheds. However, wetlands with the most direct hydrologic connections to streams and rivers play more active, ongoing roles. These include Riverine wetlands and those adjacent to or near Riverine wetlands. In addition, wetlands within 50 meters of a Riverine wetland were given positive scores to account for wetlands near rivers or streams but separated from them by upland or by a narrow wetland of another type. Because of their location on the landscape, these wetlands can have significant effects on buffering stream flow. Finally, wetlands in the upper reaches of their watersheds—Headwater Fens and Late Snow Plateaus—were given positive scores to reflect the fact that they can have disproportionate effects on streamflow regimes because their effects may travel the entire channel length, from headwater to outlet.

WHY **MAINTAINING NATURAL STREAMFLOW REGIMES** matters:

As suggested above, natural streamflow regimes—in combination with watershed features like plant communities, nutrient and sediment sources, and climate—determine the ecosystem conditions found in and along streams, as well as conditions within hydrologically connected wetlands. Key characteristics of streams include channel shape, streambed material, water quality and temperature, and aquatic and riparian plant communities. These conditions create the habitats on which fish and many species of invertebrates, birds, and mammals depend.

For those managing or living along streams, wetlands, or other waterbodies, maintaining natural streamflow regimes enables likely future conditions to be anticipated to some degree by studying patterns and events that have occurred in the past.

Hydrology models—such as the Integrated Landscape Hydrology Model (ILHM) below—attempt to identify and integrate key elements and relationships that determine flow regimes, whether of watersheds, wetlands, or streams. Many components affect flow regimes, and these change over timeframes varying from hours to seasons to decades. (Illustration from http://hydrogeology.glg.msu.edu/wordpress/wp-content/uploads/2007/12/hyndman_et_al_2007.pdf.)



Conceptual model and simplified box diagram of the Integrated Landscape Hydrology Model (ILHM). The upper portion illustrates the predominant hydrologic fluxes currently simulated by ILHM. The lower portion of the figure shows the relationships between and among input datasets, models, and model outputs... [ET=evapotranspiration, LAI=leaf area index, PET=potential evapotranspiration, Perc=percolation.]

The landscape portion of our model sequentially calculates the water balance along the paths water takes as it is redistributed from precipitation to various subsurface and surface pathways. Incoming rainfall is first subjected to canopy interception, while snow is routed directly to the snow pack model. Next, canopy throughfall and snowmelt are applied to the soil surface. These new inputs are then combined with any water stored in surface depressions and allowed to infiltrate into the soil. Any excess water at this point enters surface depression storage up to the available capacity. Infiltrated moisture is added to the existing surficial soil layer budget, where it can then percolate downward under the influence of hydraulic gradients. Any moisture within the first soil layer is then available for evaporation, along with any transpiration that may occur in any of the biologically active soil layers. Subsurface lateral throughflow is then calculated, which may cause moisture in downgradient cells to exceed saturation. At this point, moisture in the lowest biologically active soil layer may then percolate into the sediments beneath, where it becomes deep percolation. Remaining moisture in excess of saturation is exfiltrated back toward the surface, where it also enters depression storage.

WETLAND FUNCTION/VALUE: **MAINTAINING WATER QUALITY**

This function/value reflects the role that wetlands play in maintaining or improving water quality. Wetlands improve water quality in three main ways:

1. by filtering out of pollutants carried in suspension or moved by the tractive forces of flowing water –

   Plants and micro-topographic relief provide surfaces that physically retain (trap) moving particles. In addition, plant roots can bind sediments that accumulate on the bottom, thus holding them in place. Research has shown that wetlands can remove as much as 90 percent of the sediments carried into them by surface runoff or streamflow.

2. by reducing flow velocity –

   The faster water flows, and the greater its volume, the more and heavier the particles it can carry. By slowing flow velocity, wetlands cause suspended and other moving material to settle out.

3. by providing conditions where chemical transformations occur, often through biological processes –

   Water is an excellent medium for many chemical reactions, particularly still or relatively calm water. Chemical and biochemical transformations reduce nutrient loads and detoxify pollutants.

Wetlands receiving positive scores for water quality include Riparian/Riverine wetlands and wetlands with peat soils. Riverine/riparian wetlands slow, trap, retain, and transform pollutants carried in runoff from upslope and upstream areas, thus maintaining water quality in adjacent streams and rivers. Peatlands—because of their high “roughness,” large volumes of pore space, minimal slope, and high sorptive capacity—can be extremely effective in slowing and filtering flows (see peatlands and their hydrology).

In addition, two categories of wetlands received positive scores for water quality based on their proximity to ongoing disturbances. Wetlands mapped with a “d” modifier (d = disturbance) are moderately disturbed but still possess most of their natural characteristics. These wetlands have increased opportunities to improve water quality because of their proximity to disturbances. Similarly, wetlands located near roads and trails can improve water quality that may otherwise be impaired by runoff from these impervious or disturbed surfaces.

WHY **MAINTAINING WATER QUALITY** matters:

The importance of good water quality is self evident—peninsula plants, animals, and humans need clean water to survive. The degree to which a wetland improves water quality is determined both by the quality of water flowing into it and by wetland conditions and processes. The quality of inflowing water is determined by the wetland's location in its watershed, particularly its location relative to land uses that cause pollution. Sources of pollution include:

- runoff from roads, parking lots, and other impervious surfaces;
- leachate and runoff from improperly designed or managed landfills;
- leachate from failing septic systems or leach fields installed in poorly drained soils or in gravels or other materials that fail to properly filter effluent;
- excess fertilizers or herbicides washing off lawns or agricultural areas;
- biological contaminants (e.g., bacteria) washing off livestock paddocks, dogyards, and other areas where animals are held;
- sediments, hydrocarbons, and other pollutants washing off construction sites and disturbed areas.

WETLAND FUNCTION/VALUE: **STREAMBANK AND SHORELINE STABILIZATION**

Vegetation is Nature's way of stabilizing streambanks and shorelines. Plants reduce erosion and contribute to streambank and shoreline stability in many ways:

- Root systems help bind soil particles together.
- Vegetation increases a bank's hydraulic resistance to flow and buffers against abrasive effects of material transported in water.
- Where plants grow from or hang into the water along banks, vegetation reduces erosive stream velocities. (Such areas of low velocity provide feeding, resting, and hiding areas critical to juvenile salmon and other small aquatic organisms, which can be swept downstream by currents too strong for them to swim against.)
- Dense vegetation on streambanks can induce sediment deposition.
- Vegetation can redirect flow away from the bank.

All Riparian/riverine wetlands received positive scores for this function/value. Wetlands with an open water component bordered by shrubs or other plant communities also received positive scores for stabilizing streambanks and shorelines.

WHY **STREAMBANK AND SHORELINE STABILIZATION** matter:

All streambanks and shorelines are subject to erosion. The two main mechanisms operating on banks and shorelines are scour and mass failure, which often work together. Scour is the direct removal of bank or shoreline materials by the physical action of moving water and waterborne sediments. Mass failure is the sliding, slumping, or toppling downslope of sections of bank. Undercut streambanks and shorelines indicate scour; collapse of an undercut section of bank represents mass failure.

In healthy wetlands, rates of erosion remain at “natural” levels. When rates of streambank and shoreline erosion increase above these levels because of trampling (compaction), clearing, or other forms of disturbance, streamside and shoreline habitat conditions deteriorate, as does the water quality of affected waters. These effects reduce the health and survival of plants and animals dependent on affected habitats. Developments near streambanks and shorelines may be threatened as banks erode.

Of particular note is how increased erosion can affect salmon. Higher than “normal” rates of erosion lead to unnatural increases in the amount of sediments in streams, rivers, lakes, and ponds. Higher sediment loads increase turbidity, which can clog the gills of juvenile salmon and reduce the visibility of plant and animal food (which juvenile salmon find by sight).

Higher sediment loads can also lead to higher rates of sediment deposition in areas where water slows down. Sediments deposited in spawning gravels, for example, can suffocate salmon eggs and alevins, reducing their survival (as well as the survival of other aquatic organisms).

WETLAND FUNCTION/VALUE: **RECREATION**

Recreation includes the full range of enjoyable, enriching, physically challenging, or otherwise healthy outdoor activities that can take place in wetlands. These activities can be consumptive (e.g., hunting, fishing, berry picking, etc.) or non-consumptive (e.g., hiking, skiing, photography, dog mushing, snowmachining, birding, etc.). Recreation also includes uses that can be called "subsistence" in that they contribute to food resources or materials that support subsistence (e.g., collection of plant materials used to manufacture tools or crafts or to prepare medicines).

Education and research—whether for academic or professional reasons or for personal curiosity or enrichment—can also be conducted in wetlands with high recreation scores.

Public access was a key criterion for scoring a wetland's ability to provide recreation. Wetlands received positive scores if they were in land categories that both allowed public access and also tended to maintain natural conditions and processes in the wetland. The most obvious examples of such wetlands are those in state park units. Other examples include state lands classified as "Habitat" or "Recreation," lands legislatively designated as Critical Habitat Areas or Special Use Areas, and lands owned by entities such as Kachemak Moose Habitat, Inc. or Kachemak Heritage Land Trust, which could potentially provide both public access and protection of natural features. Note, land ownership and public access may have changed since this assessment and should be checked for wetlands under consideration for recreation.

WHY **RECREATION** matters:

Different individuals will value different kinds of recreation. In general, however, individuals and communities recognize that recreation is important—whether for health and well-being or for economic benefits enjoyed by communities that offer marketable recreational opportunities. Regardless of how recreation is valued, wetlands provide places where many kinds of recreation can occur.

WETLAND FUNCTION/VALUE: **EDUCATION**

The education function/value encompasses all grades, levels, and kinds of learning—formal and informal—promoted by educational facilities. (Facilities serving only prekindergarten were not considered in this assessment.) Wetlands received a high score for education when they occurred on public land and were located within 0.2 miles of a school or other kind of educational facility, such as a visitor center, museum, library, etc.

Note: wetlands do not follow parcel boundaries, and this assessment gave a positive score to an entire wetland polygon even if only part of the wetland was on public land. As a result, current land ownership and access should be checked for wetlands being considered for educational use.

In general, wetlands with high scores for recreation are also well suited for many kinds of learning and research; what distinguishes wetlands assessed for education from those assessed for recreation is that educational wetlands can be reached by a short walk from a nearby place of learning.

WHY **WETLAND EDUCATIONAL USES** matter:

Experiential education, where students experience hands-on what they are learning about, is recognized as one of the most effective forms of learning. Wetlands close to places of learning allow students to visit and experience the wetland, enabling them to learn by seeing, touching, smelling, hearing, and doing.

Wetlands with high scores for education allow students to visit frequently, enabling them to observe how wetland conditions change seasonally, after storms, and over longer time frames. These wetlands also provide convenient opportunities for students to design and conduct projects that require regular visits to a study site for observations or measurements.

The more peninsula students—of all ages—understand the wetlands with which they interact, the more likely they are to make well-informed decisions about how these wetlands can be used and managed for long-term benefits to society and the environment.

WETLAND FUNCTION/VALUE: **DENA'INA CULTURE**

The goal of this assessment was to recognize those wetlands most likely to play significant roles in the lives of the Dena'ina Athabascans living on the Kenai Peninsula—both past and present. The Dena'ina were the dominant indigenous culture in the project area at the time of Western contact in the late 18th century and remain so to the present. Dena'ina people have been learning about and using peninsula wetland resources—both plant and animal—for hundreds of years. This assessment recognizes the significance and importance of that "Traditional Ecological Knowledge" and related wetland uses.

The heart of this culture/heritage assessment was the identification of wetlands that overlap with Dena'ina "use areas." Use areas reflect lands and waters within a 10-mile radius of traditional and existing Dena'ina villages or other occupation sites. The Dena'ina established permanent villages at the mouths of nearly every large salmon-bearing stream along the western coast of the Kenai Peninsula. Maps and lists of Dena'ina place name sites were used to identify these and other occupation sites.

Dena'ina regularly traveled 10 miles out from a settlement and back in the same day, a round-trip of 20 miles. Longer out-and-back journeys were common. Wetlands within 10 miles of a settlement would have been familiar to community members and considered readily accessible. The nature, extent, and seasonal availability of resources found in such wetlands—both plant and animal—would have been well known, and these resources would have been sought and harvested when seasonally available. Kenai Peninsula Dena'ina still seek and use many of these same wetland-related resources.

These Dena'ina objects are made with wetland plants and/or are used in wetlands; they are part of the "Hands-on loan program" of the Alaska Department of Education and Early Development, Division of Libraries, Archives and Museum (https://education.alaska.gov/product cart/pc/home.asp; see: https://education.alaska.gov/productcart/ pc/viewCategories.asp?idCategory=8). Another useful link is *The Dena'ina Way of Living Educator's Guide,* http://www.anchorage museum.org/images/downloads/DenainaEdGuide2013.pdf.

WHY **DENA'INA WETLAND OPPORTUNITIES** matter:

To the Dena'ina "...the soul, the place, and the history of the people converge in the landscape..."* Despite the profound cultural, subsistence, and spiritual importance of lands to the Dena'ina, many Dena'ina lands on the Kenai Peninsula have been radically altered by development activities, resulting in destruction of many sites of great importance, including sites considered sacred. As developments continue in Dena'ina territory, protecting valued wetland landscapes and resources becomes increasingly important.

The many ways in which the Dena'ina traditionally improved—and still enhance—their well-being through wetland activities reflect longstanding knowledge about and understanding of how to use and appreciate what wetlands offer—materially, experientially, and spiritually. This knowledge and understanding can inform those who interact with wetlands today and can help decision-makers use and manage wetlands in more broadly aware and environmentally sustainable ways.

* Boraas, Alan, 2009, "The Moral Landscape of the South-Central Alaskan Dena'ina," paper presented to the International Conference on the History of Cartography, Copenhagen, Denmark, July 2009, click **here** to read the full article.

Chapter 3 – Wetland management

Introduction

The fundamental reason to manage wetlands is to help peninsula wetlands (and watersheds) meet our long-term needs for essential requirements such as

- clean water;
- healthy populations of salmon, moose, and other fish and wildlife;
- reduction of flooding and related property damage (e.g., washed-out roads, flooded basements, damaged septic systems, etc.);
- places to hunt, fish, recreate, and participate in other satisfying outdoor activities;
- productive areas to harvest animals (e.g., furbearers, waterfowl, wild game) and plant resources (e.g., wild berries, willows for streambank revegetation);
- and other benefits such as those described in Chapter 2.

As the textbox on the next page suggests: “The simple goal of protecting a wetland's existing functions [and values] can prove to be “incredibly complex in the modern landscape.” This chapter provides guidance on how to work towards that “simple goal.” Given how “incredibly complex” achieving this goal can be, the guidance that follows reflects multiple levels of management detail—from relatively general watershed-level guidance, to landscape-level (or “map-unit scale”) guidance, to project- or activity-level guidance (wetland management *practices*).

Regardless of the level of detail—or scale—reflected, the goal of all the guidance provided in this chapter is to maintain wetland functions and values, particularly those described in Chapter 2. Guidance is based on the recognition that maintaining wetland functions and values depends on maintaining the conditions and processes on which they depend. Fundamentally, this means maintaining wetlands in “reference condition”.

The Challenge of Effective Wetland Management

(some thoughts from North Caroline State University—http://www.water.ncsu.edu/watershedss/info/wetlands/manage.html#over)

The simple goal of protecting a wetland's existing functions [and values] can prove to be incredibly complex in the modern landscape. It involves minimizing the human-induced changes affecting the natural forces that shape and sustain a wetland, such as hydrology, climate, biogeochemical fluxes, fire, and species movement.

Pressures created by human activities include (see Wetland Loss and Degradation for a fuller review):

- proposals to fragment wetlands with roads and other linear facility crossings,
- impacts from recreational uses, including off-road vehicles,
- impacts from adjacent property owners, or partial or full wetland owners,
- incursion of trampling, soil compaction, intense herbivory, and waste loading by domesticated animals, and
- in urban settings, pedestrian access, mowing, landscaping, solid waste dumping, and domesticated animal activity.

Other pressures that affect wetland functions/values less directly and are less apparent include:

- hydrologic alterations, such as
  - direct surface drainage by ditch-digging;
  - impoundment;
  - de-watering by redirection of contributing land area inflows;
  - de- watering by consumptive use of surface water inflows;
  - de-watering through drawdown of unconfined aquifer from either groundwater withdrawal or stream channelization;
  - making wetter in wet season and drier in dry season by changing both quantity and timing of inflows (e.g., through placement of impervious surfaces and ditch-digging);
  - over-inundating by increasing contributing land area and/or increasing yield from a given land area through earthmoving, ditching, drain-tiling, and/or pumping;
- increased sediment, nutrient, organic matter, metals, pathogen, and other water pollutant loadings from stormwater runoff and wastewater discharges;
- changes to physical characteristics of inflows—such as temperature, dissolved oxygen, clarity, and pH —resulting from a variety of activities;
- atmospheric deposition of pollutants;
- introduction of nuisance and exotic plant and animal species;
- loss of more sensitive wetland plant and animal species due to changes in adjacent land uses;
- loss of surrounding habitat for wetland-dependent species that also require upland habitats; and
- "edge effect" changes in plant and animal species due to changes in light, temperature, and moisture regimes, and from noise, dust, and pesticide drift.

...[I]n addition to buffering wetlands from human impacts, protective management involves maintaining important natural processes that operate on wetlands from the outside [i.e., watershed processes] and that may be altered by human activities.

Overarching management goal: Maintain assessed wetland functions and values

Chapter 2 describes the 16 functions and values assessed for Kenai Peninsula wetlands. Maintaining these functions/values is the basic goal of wetland management strategies and practices outlined in this chapter. Two overarching strategies come up repeatedly as central in maintaining assessed functions and values. These are:

1. *Keep wetlands in reference condition.*
2. *Maintain peatlands and their hydrology.*

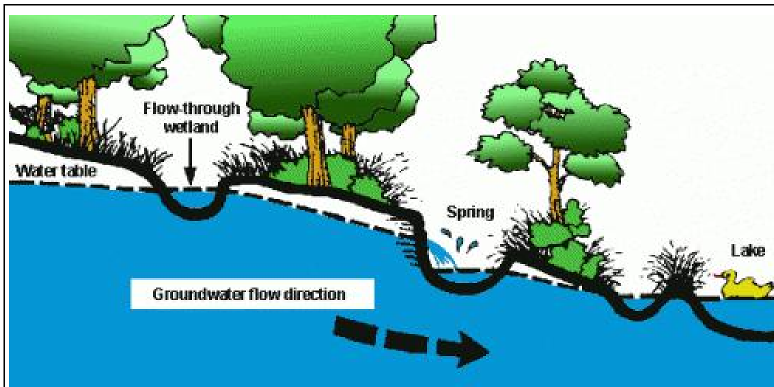
Overarching management strategy 1: Keep wetlands in "reference condition"

Wetlands in reference condition are essentially undisturbed. They function naturally and in self-sustaining ways. A formal definition of reference condition is a "...set of selected measurements or conditions of minimally impaired waterbodies" (including wetlands). Reference conditions are "...representative of the expected ecological conditions of a wetland of a particular type and region."[3] So to be in reference condition, a particular wetland—a peninsula Drainageway or a Kettle, for example—needs to have ecological conditions like other minimally impaired, naturally self-sustaining wetlands of the same type. Since most Kenai Peninsula wetlands are currently in reference condition, the main management goal is to keep them that way. A great advantage is that a wetland maintained in reference condition will continue to provide ALL of the functions and values associated with it, and at relatively low cost.

The following features characterize Kenai Peninsula wetlands in reference condition.

In general, therefore, these are the conditions to maintain in order to maintain wetland functions and values.

- ***Natural surface and subsurface drainage patterns***
  Surface and subsurface drainage systems are connected, as shown at right. Wetlands in reference condition reflect surface and subsurface drainage patterns that developed naturally over long periods of time in response to natural flow variations (see the next feature). Unaltered natural drainage patterns enable wetlands to "keep doing what they've done" in terms of functions/values such as recharging groundwater, storing runoff, transmitting discharge, maintaining streamflow regimes, supporting salmon habitats, and the like.



Surface and subsurface drainage systems are connected. (From "Groundwater Movement," http://wellwater.engr.oregonstate.edu/groundwater-movement.)

- ***Natural variability of flows***
  Wetlands in reference condition exhibit natural patterns of surface and subsurface flow variability. These patterns reflect daily, monthly, seasonal, yearly, decadal, and longer-term variations. The photos below show examples of natural flow variability on Stariski Creek at the Sterling Highway wayside.

  Natural flow variability produces a diversity of conditions and related habitats. Different flow levels erode, transport, deposit, and flush different sized sediments (silts, sands, gravels, etc.), as well as different kinds and volumes of nutrients. As a result, particular flow levels are responsible for various environmental features, such as sandbars, gravel streambeds, undercut streambanks, riparian borders, floodplains, etc. These different environments provide the habitats needed by particular plants and animals, including different salmon life cycle stages.

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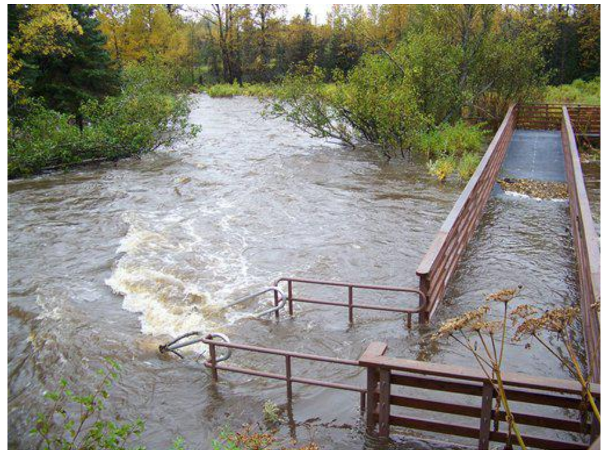
3 Definitions are from the Environmental Protection Agency, see http://water.epa.gov/type/wetlands/ assessment/fact10.cfm and http://water.epa.gov/type/wetlands/assessment/fact6.cfm.

Examples of natural variability of flows, Stariski Creek at the Sterling Highway bridge.	
 Creek at less than bankfull flow (same flow as photo below), October 27, 2014.	 Stariski Creek at a moderate flood flow on September 20, 2012. Riparian wetlands are flooded.
 Creek at less than bankfull flow, October 27, 2014. (Bankfull flow would cover the gravel on the far bank, see photo at right.)	 Creek at bankfull flow, October 29, 2013.

Photos above illustrate natural variability of flows. The photos in the left column illustrate a flow somewhere between bankfull and baseflow discharges. The photos in the right column show a flood flow (top) and bankfull flow (bottom). (Notice how riparian wetlands stabilize streambanks and slow flood flows.) As explained under the function/value of MAINTAINING NATURAL STREAMFLOW REGIMES, "[f]loods of varying size and timing are needed to maintain a diversity of riparian plant species and aquatic habitat. Small floods occur frequently and transport fine sediments, maintaining high benthic productivity and creating spawning habitat for fishes. Intermediate-size floods [like that shown in photo upper right] inundate low-lying floodplains and deposit entrained sediment, allowing for the establishment of pioneer species. These floods also import accumulated organic material into the channel and help to maintain the characteristic form of the active stream channel. Larger floods that recur on the order of decades inundate the aggraded floodplain terraces, where later successional species establish. Rare, large floods can uproot mature riparian trees and deposit them in the channel, creating high-quality habitat for many aquatic species." (Quoted from "The Natural Flow Regime," Poff et al 1997, see http://www.americanrivers.org/assets/pdfs/water-supply/the-natural-flow-regime.pdf.)

- ***Natural conditions along banks and shorelines***
  Wetlands in reference condition have banks and shorelines characterized by well-vegetated plant communities, micro-topography, "large woody debris," and other features reflecting healthy, self-sustaining processes (see photos above and photo at right). Riparian plants reduce erosion during high flows, filter water, maintain habitats, and contribute to reference conditions in other ways.

- ***Natural nutrient flows and food webs***
  Wetlands in reference condition cycle nutrients through complex, dynamic, self-sustaining food webs. Healthy wetlands have all parts of their natural food webs in place, from the microscopic photosynthesizers to the largest apex predators. All trophic levels—from producers, to primary and secondary consumers, to the decomposers that close the circle and restart cycles—are interconnected by multiple, intact and healthy linkages that transfer energy and matter from one trophic level to another.

- ***Natural patterns of sediment input, transport, and deposition***
  Sediments of various sizes (cobbles, gravels, sands, silts, clays, etc.) move through natural stream and wetland systems at certain times and in characteristic amounts. Patterns of sediment movement are responsible for key features of wetland/waterbody systems, including channel substrate, bank conditions, soils, etc.. Wetland systems in reference condition move sediments in patterns that in the long term tend to remain within a natural range of variability. (See also Natural variability of flows, above.)

- ***Natural stream channel slope***
  The slopes of stream channel segments and other surfaces over which water flows affect how fast water moves downstream or downslope—steeper slopes increase flow velocities, flat or moderate slopes slow flows. Streamflow velocity is a key determinant of streambank and stream channel conditions, including conditions in adjacent wetlands. The faster the flow and the larger its volume, the greater the erosive forces of the stream, including the size of material it can dislodge and move. Streams and wetlands in reference condition maintain slopes that represent a dynamic balance between naturally varying flows and natural patterns of sediment deposition and movement.

- ***Unimpaired soil infiltration rates***
  Rainfall or runoff entering wetlands in reference condition can infiltrate into the soil at natural rates. Water that infiltrates enters slower pathways for downslope movement, such as throughflow and groundwater flow systems. Soil infiltration rates affect wetland functions like storing and transmitting water. In addition, water that has infiltrated into the soil becomes available to plant roots. Soil infiltration rates reflect soil pore spaces and their interconnections, described below.

- ***Soil pore spaces and other empty spaces (voids) that can hold and convey water***
  A wetland's capacity to store and/or transmit water is a function of its landform shape and position and
  - the volume of empty spaces (pores and channels) within its soil and subsurface materials and
  - the nature and extent of the interconnections among these voids; interconnections allow water to move from one void to another in response to gravity and hydraulic pressure.

  Wetlands in reference condition have largely undisturbed soils and subsurface materials. This means that pore spaces and other voids have not been reduced by compaction, rutting, vegetation clearing, or other processes. Similarly, interconnections among voids have not been reduced—allowing water to seep into, through, and out of the wetland at natural rates and volumes.

  Peat soils and Peatlands—Soils characterized by a high percentage of undecomposed plant material are called peat soils. Wetlands with peat soils of significant depth are called peatlands. Peatlands have particularly high capacities for absorbing, storing, and conveying water; see peatlands and their hydrology. Because of their importance on the peninsula, peatlands warrant understanding and careful consideration when land use decisions may affect them.

- ***Natural water table levels***
  In reference condition wetlands, water tables fluctuate within a "natural" range. When wetlands are drained by ditching, pumping, or other artificial means, natural water table levels and fluctuations are altered. Water table levels have profound effects on wetland functions. For example, water table levels affect a wetland's capacity to store stormwater runoff, to transmit discharge, and to help maintain natural streamflow regimes, including critical baseflows during winter freeze-up and summer dry spells.

- ***Good water quality***
  The water quality of wetlands in reference condition supports the plants and animals naturally found living there. Good water quality is characterized by
  - low levels of pollutants such as bacteria, hydrocarbons, heavy metals, excess nutrients, etc.;
  - low turbidity—high turbidity has many negative effects. These include hindering the breathing of aquatic organisms (including salmon), suffocating salmon eggs incubating in stream gravels, and blocking sunlight transmission through water—which in turn affects plant growth and the ability of organisms to find food by sight;
  - high oxygen concentrations;
  - low temperatures.

- ***Natural plant cover and percent organic matter***
  Wetlands in reference condition support native plant communities and have a high percent of plant cover (little or no bare ground exposed, see photos below). Plant parts—living and dead—contribute to interception of rainfall, infiltration into soil, slowing of runoff, water storage, nutrient cycling, and habitat quality. During growth, plant roots take up water, while leaves release water vapor to the atmosphere. This *evapotranspiration* draws water from wetland soils, thereby increasing wetland capacity to absorb precipitation and surface or subsurface flows. Large plants and plants with more surface area (e.g., mature spruce trees) transpire more than smaller plants with less surface area. Plants also stabilize soils and streambanks and shorelines; filter sediments and other pollutants from water flowing into wetlands; and shade water surfaces, thereby lowering instream water temperatures during warm periods of the year. On the peninsula, peatlands represent a common and important type of plant cover, see peatlands and their hydrology.

- ***Natural surface roughness and complex micro-relief***
  Wetlands in reference condition are characterized by "rough" (fractal, complex) surface textures (see photos below). Naturally rough surfaces and high micro-relief are created by water flow, plant growth and decay, digging and burrowing animals, soil processes such as freeze-thaw cycles and subsidence, and larger landscape-forming processes such as erosion, mass wasting, earthquakes, etc. These processes create surface irregularities that provide pockets, channels, depressions, and other kinds of texture—from fine, small-scale irregularities (see wetland in photo below right, to large landform shapes. Rough and irregular surfaces capture, slow, and hold water, and slow its release. Water thus held has more time to infiltrate into the soil and enter slower pathways for moving downslope or downgradient.

A Kettle (K3-4) wetland ecosystem in the Seward area (see http://www.kenaiwetlands.net/Seward/Ecosystems/Kettle.htm).

A Relict Glacial Lakebed (LB1-4) wetland complex near Ninilchik (see http://www.kenaiwetlands.net/MapUnitDescriptions/LB1-4.htm).

Overarching management strategy 2: Maintain peatlands and their hydrology

Introduction to peatlands

Understanding Kenai Peninsula wetlands means understanding *peatlands*, particularly their engineering properties (they make very poor road or building sites) and their water holding capacity —which is very high (see Peat porewater below). The majority of peninsula wetlands are peatlands—areas where soils consist of largely undecomposed organic matter that has accumulated under excess moisture, in other words, poorly drained areas where plant material decays so slowly that it builds up faster than it decays. (If accumulation continues long enough, buried and compressed peat layers form coal—hence the coal layers common on the southern peninsula.) Kettle, Depression, Drainageway, and Lakebed peatlands represent over 40 percent of wetland acreage mapped on the Kenai lowlands and over 20 percent of wetland acreage mapped in the Seward area. Riparian wetlands, Discharge slopes, and Wetland/Upland complexes often support peatlands as well.

Histosol peatland soil with organic layer (units are cm) (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046474.pdf).

Peat soils are called *histosols*. Histosols can consist of muck (*sapric* soil material), which is the most decomposed form of peat; mucky peat (*hemic* soil material); or fibrous peat (*fibric* soil material), which is the least decomposed. In fibric soil, plant fibers are readily identifiable as to their plant origins. Examples of histosols mapped on the peninsula include Clunie peat, Doroshin mucky peat, Salamatof peat, Slikok peat, Spenard peat, and Starichkof peat. Most peatland soils are acidic and many are very deficient in major plant nutrients.

Thick, saturated histosols normally occur where the landscape is bowl-shaped or flat, and usually where a restrictive layer, such as glacial till or coal, slows or blocks downward movement of water. Restricted drainage means the water table is shallow and soils are often saturated by accumulated precipitation and/or runoff. In this environment, available oxygen is quickly used up by microbes, creating oxygen-deprived, or *anaerobic* conditions. Decomposers in the soil are inefficient in cold, anaerobic environments like those found in Kenai Peninsula peatlands, which is why decomposition occurs so slowly.

Accumulated plant remains in peatlands may be many feet thick, with layers building up slowly over hundreds or thousands of years. Peatlands dated on the peninsula range in age from over 15,000 years old to less than 2,000 years old (see map of basal peat ages on the following page). Sphagnum mosses represent a major component of many peatlands, but other plants may dominate, including sedges and ericaceous shrubs such as Labrador tea (*Ledum groenlandicum*). Peatlands are generally divided into bogs and fens (see below). Fens are much more common on the Kenai Peninsula than bogs.

Peat porewater

Peat (sometimes called "peat moss") acts like a sponge and has the highest water content when saturated of all organic soil material. After long dry periods, peatlands may appear dry—with the water table some distance below the surface—but as soon as rainfall levels increase, these peatlands will again become saturated. **Peat porewater** is the name given water held within or flowing through peat. Peat porewater generally flows slowly and as diffuse seepage rather than as concentrated flow in channels. Some porewater reaches the water table and becomes part of the groundwater system (saturated zone); some moves as shallow subsurface water above the water table, in the unsaturated zone, and some may pond at the surface.

Huge volumes of peat porewater are held within and move through peninsula peatlands. Water stored and moving through these peatlands is as significant as the water moving through lakes, streams, and rivers. Yet because peat porewater rarely flows in obvious channels, it remains largely invisible (except where it ponds at the surface).

Surface channels fail to develop because peat's infiltration capacities are so high and peatland slopes so low (peatlands tend to be flat) that water moves too slowly and diffusely to create channels. Furthermore, even when peat is saturated to the surface, and drainage channels might be expected to form, peat's high elasticity allows it to expand to hold more water, which discourages channel formation. As a result, visible outlet channels are rare in peatlands, and unlike outlets in lakes and rivers, do not play a significant role in determining peatland water storage and discharge processes. Instead, factors affecting peat's hydraulic conductivity—the size of pore spaces, the extent of pore-space interconnections, the velocity and direction of porewater flow—are more important than outlets in determining peatland water storage and movement.

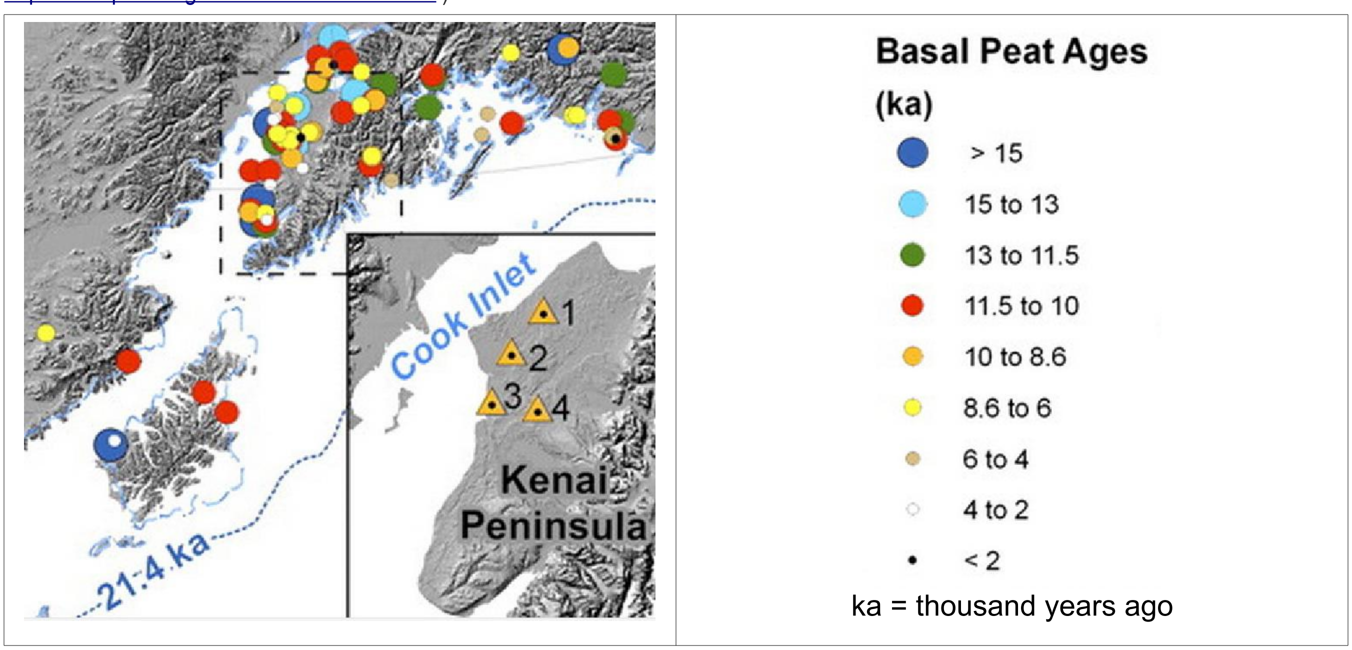
Peat wetlands have very high capacities for absorbing and holding water because of peat's high volume of interconnected pore spaces and its "elastic" ability to stretch to hold more water even when saturated. Water drains more freely into, through, and out of the least decomposed peat (*fibric* peat) because its pore spaces are large and well connected. As these pore spaces fill with water and become saturated, peatland's ability to hold *additional* water declines while its ability to release water increases.

Where peat has built up over many years, the upper layers will tend to be fibric and the lower layers will be hemic and/or sapric. Water moves slowly in hemic and sapric layers. As a result of these differential flow rates, water in peat wetlands will tend to flow on or near the surface—in the fibric layer—including in the root zone. Sapric peat layers, particularly over clay substrates, will store water but will hang onto this water tightly, exchanging it only slowly with groundwater aquifers.

Given the significance of peat porewater and the many variables affecting its volume and flow, altering peatland conditions can have significant and often unanticipated hydrologic effects. These can include increased flooding of lands within, adjacent to, or downslope/downgradient of altered peatlands, as well as reduced quality and/or extent of salmon habitats supported by peatlands.

Basal peat ages, Kenai Peninsula.

Peatlands on the peninsula are of varying ages—some are many thousands of years old. Dots indicate peatland sites with basal dates (the basal—or bottom—layer of the peat has been dated). Colors and sizes indicate paleoclimatically significant age groupings, including the deglacial (>15 ka), the Bølling-Allerød (15–13 ka), the Younger Dryas (13–11.5 ka), the early Holocene (11.5–10 ka and 10–8.6 ka), the mid-Holocene (8–6 ka and 6–4 ka), and the late Holocene (4–2 ka and <2 ka). Paleo-shorelines are depicted with dotted blue lines. The location of the *Inset* is outlined by a dashed-line. *Inset* – Four peatland sites on the Kenai Peninsula used for carbon accumulation rate curves. 1, Swanson; 2, No Name Creek; 3, Kenai Gasfield; 4, Horse Trail. (from Rapid deglacial and early Holocene expansion of peatlands in Alaska. (From "Rapid deglacial and early Holocene expansion of peatlands in Alaska," http://www.pnas.org/content/107/16/7347.full.)

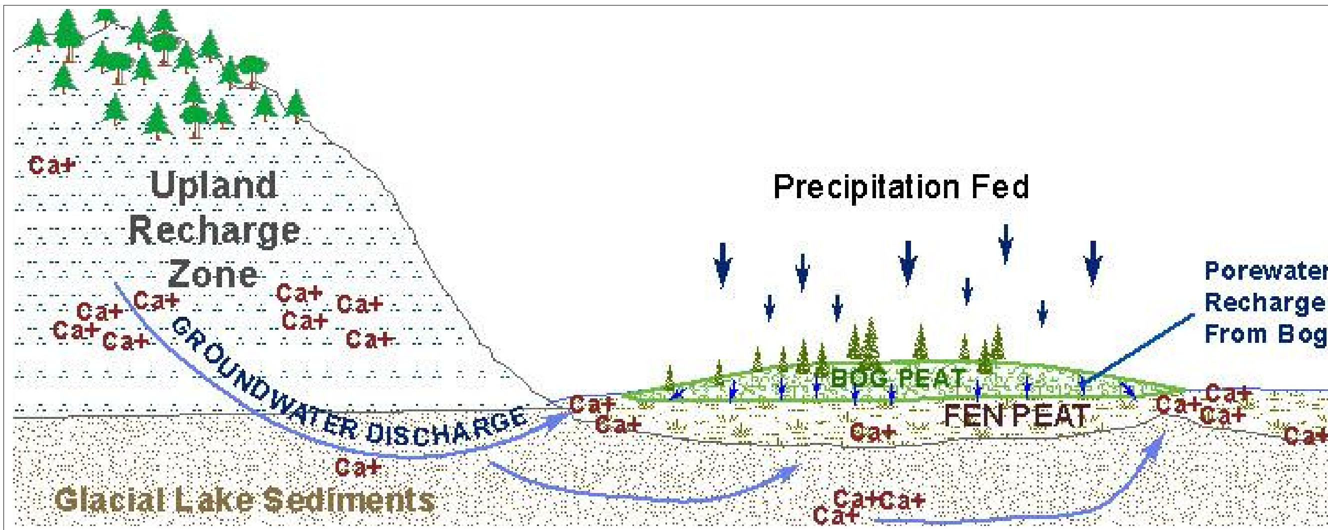


Examples of Kettle (K) and Relict Glacial Lakebed (LB) peatlands

Kettle wetlands are peatlands occupying depressions created when ice-blocks carried within glacial till melted at the end of the last glacial advance. Kettles have deeply fluctuating water tables, and K2 and K3 wetlands can be flooded at the surface. Much late-season water storage becomes available in these wetlands as the water table draws down during summer dry periods. Kettles have a wetland or stream connection to Cook Inlet, unlike Depression wetlands, which also formed in ice-block depressions. Kettles with more than 20 acres of open water are mapped as lakes.

			
A K13 wetland near the Boxcar Hills, 20 mi northeast of Homer (polygon 30730). www.kenaiwetlands.net/MapUnitDescriptions/K1-3.htm	Segregated K2-4 wetland near Kasliof (polygon 9478). Central sedge-dominated area (not visible) is ringed by shrubby peatland (left foreground) and forest (right). www.kenaiwetlands.net/MapUnit Descrip tions/K2-4.htm	A K31 wetland near Mackey Lakes. The shrubby sweetgale component shown above can occupy a K2 or K3 position (polygon 712). www.kenaiwetlands.net/ MapUnitDescriptions/K1-3.htm	A wetland mapped as K4 north of Kasilof (polygon 8783). www.kenaiwetlands.net/ MapUnitDescriptions/K4.htm

How bogs and fens interact with groundwater



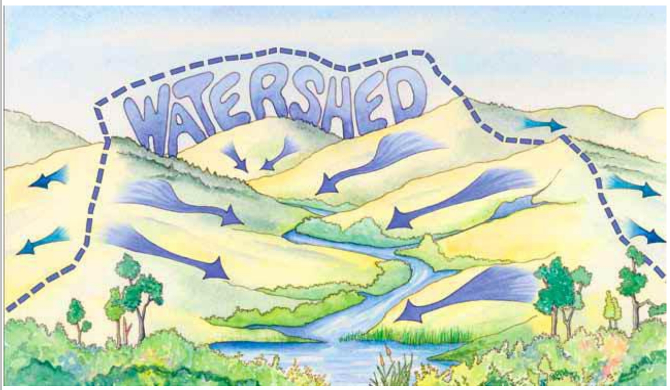
This figure (M. Gracz, Kenai Watershed Forum) illustrates bog and fen peatlands and how they interact with groundwater. Blue arrows show groundwater discharge from upland recharge areas. Fens are in contact with groundwater, receiving minerals such as calcium (Ca+). Bogs occur above the water table and are fed almost exclusively by precipitation. As a result, they are nutrient poor. Bogs develop where precipitation is high, drainage networks poorly developed, and calcium concentrations low. These conditions promote plant communities dominated by *Sphagnum* species. Bogs may form directly over glacial sediments where calcium levels are insufficient for fen peat. Fens are more common on the peninsula than bogs—in part because of nutrients contributed to peninsula soils by volcanic ash that is deposited during eruptions of the volcanoes across Cook Inlet.

Watershed level management strategies for maintaining wetland functions/values

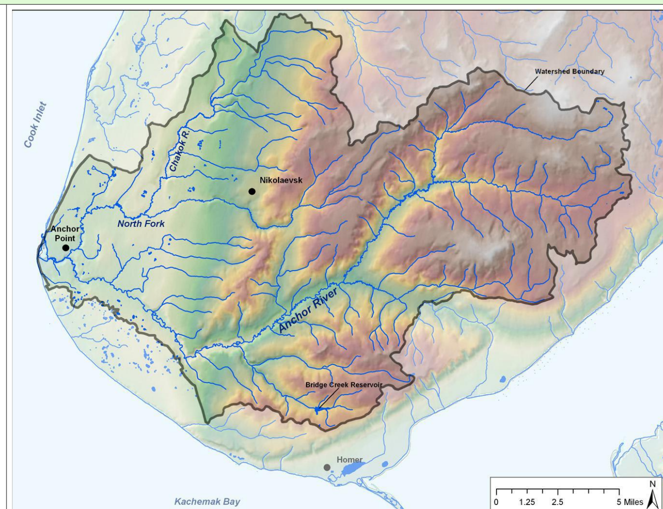
Maintaining a wetland in reference condition requires thinking in terms of several scales, or levels of detail, when making management decisions. The most general management scale is the watershed or subwatershed level, illustrated below.

Watershed-level strategies are important because maintaining a wetland's functions/values depends on maintaining natural processes that operate on the wetland from *outside* its boundaries—from upslope or upgradient in the watershed. Management intended to maintain reference condition needs to maintain these larger, watershed-scale processes and their natural connections to the wetland. Three watershed-level strategies are outlined below.

Illustration of watershed-level scale



A watershed encompasses lands and waters draining to a particular point or waterbody. Water flowing downslope and downgradient connects watershed areas. Watershed connectivity means that wetlands are affected by conditions and processes found upslope of them in the watershed. What's happening upslope—as well as within the wetland itself—should be considered when making management decisions. (Illustration from "Facts About Water in Alberta," pg 9, http://environment.gov.ab.ca/info/library/6364.pdf.)



The Anchor River watershed; larger watersheds contain smaller subwatersheds; examples in the Anchor River watershed include Chakok River, North Fork, and Bridge Creek subwatersheds. (Map from Kachemak Bay Research Reserve.)

1. CONSIDER HOW THE WETLAND FITS INTO ITS WATERSHED CONTEXT

To take into account a wetland's watershed context, use best available information to determine the following; considering this information will promote better-informed wetland management decisions:

a. the acreage and boundaries of watershed areas upslope of the wetland (these areas will contribute runoff, throughflow, and groundwater flow to the wetland);

b. the areas downslope of the wetland that may be affected by changes to wetland hydrology;

c. the amount of precipitation that falls within the watershed boundaries upslope of the wetland;

d. the patterns of surface and subsurface drainage (including peat porewater flow) encompassing the wetland;

e. the percentage of watershed area represented by the wetland to be managed;

f. the percentage of watershed area covered by others kinds of wetlands;

g. the percentage of impervious cover in the watershed upslope and downslope of the wetland;

h. ongoing or likely future changes in upslope watershed land use and plant cover (particularly increases in impervious cover); and

i. the location of animal movement corridors within the watershed and how the wetland to be managed contributes to these corridors.

2. **MAINTAIN THE WETLAND'S CONNECTIVITY –** Maintain connectivity among key pieces of watershed systems that may affect the wetland being managed.

   Watersheds are characterized by many kinds of connectivity. The most important are the multiple different but linked pathways (surface and subsurface) that water takes as it flows from hilltops and ridges downslope to the sea. Healthy connections among these pathways help maintain reference condition. Disrupting key connections can have unforeseen and unintended consequences—such as increases or decreases in surface runoff and streamflow, declines in water quality or habitat quality, reductions in fish and wildlife populations, increases in flooding, etc.

3. **ALLOW FOR THE NATURAL VARIABILITY OF WETLAND WATER LEVELS AND FLOWS**

   Natural variations in water levels and flows within the wetland being managed are critical to maintaining its reference conditions. It's essential, therefore, to allow for short-term, seasonal, and long-term high and low flows and water levels within the wetland. This depends on maintaining natural patterns of surface and subsurface flows INTO the wetland from watershed areas upslope and upgradient of the wetland itself, as wells as flows OUT OF the wetland into downslope/downgradient drainage systems. As a result, it's important to consider how the wetland connects to larger-scale watershed drainage systems that supply it water or receive its discharge. For more information, see hydrology functions/values, particularly MAINTAINING NATURAL STREAMFLOW REGIMES.

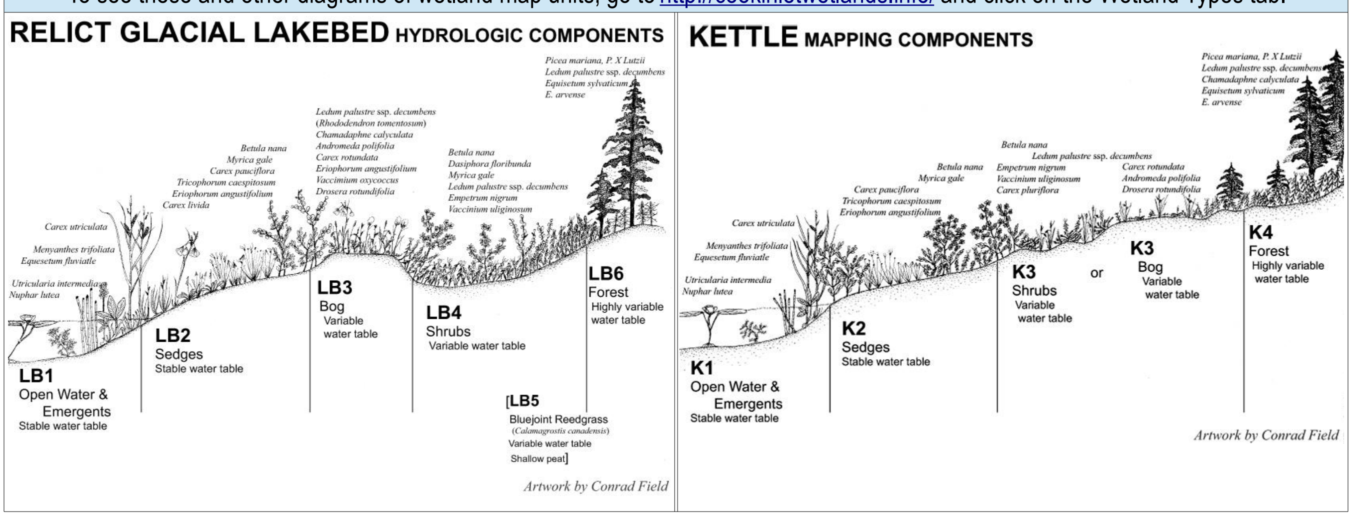
Map-unit level management strategies for maintaining wetland functions/values

A somewhat more detailed management scale is what is here called the map-unit level. This reflects the scale at which peninsula wetlands were mapped[4], classified, and assessed. Each wetland polygon outlined and classified on wetland maps during Wetland Mapping and Classification of the Kenai Lowland is a named wetland map unit.

Wetland functions/values were assessed in terms of conditions characterizing particular kinds of wetland *map units*, such as LB3, K4, etc. illustrated below. For a complete list of map units used during wetland mapping see Appendix A. This means that strategies for maintaining functions/value ares inherently correlated with wetland maps through the map unit polygons found in different locations.

Wetland map unit scale

The codes below (e.g., LB4, K2) illustrate some of the map units that were used for assessing functions/values of peninsula wetlands. To see these and other diagrams of wetland map units, go to http://cookinletwetlands.info/ and click on the Wetland Types tab.



4 As mentioned before, the mapping scale used when outlining map units was 1:24,000.

Map-unit level strategies for maintaining particular functions/values are described below. Click on a function/value to see strategies for maintaining it. The fundamental strategy is to keep wetlands in "reference condition" wherever the goal is to maintain particular functions/values.

Strategies to maintain BIOLOGY functions/values

- MOOSE WINTER HABITAT
- SALMON HABITAT SUPPORT
- RARE WETLAND PLANTS
- ANIMAL SPECIES OF CONCERN
- SCARCE WETLANDS
- HABITAT DIVERSITY

Strategies to maintain HYDROLOGY functions/values

- GROUNDWATER RECHARGE
- WATER STORAGE
- TRANSMITTING or CONTRIBUTING DISCHARGE
- NATURAL STREAMFLOW REGIMES
- MAINTAINING WATER QUALITY
- STREAMBANK and SHORELINE STABILITY

Strategies to maintain COMMUNITY/CULTURE functions/values

- RECREATION
- EDUCATION
- DENA'INA WETLAND OPPORTUNITIES

STRATEGIES FOR MAINTAINING **MOOSE WINTER HABITAT**

The most basic strategy for maintaining this function/value is to keep the wetlands that provide moose winter habitat in *"reference condition"*. Successfully maintaining a wetland in reference condition means applying management strategies at several scales. For example, *Watershed level management strategies for maintaining wetland functions/values* should always be considered when making wetland management decisions.

Along with watershed-scale strategies, the following strategies can help maintain MOOSE WINTER HABITAT:

- Maintain willow coverage and plant production, especially in wetlands below 600 ft in elevation.
- Establish and maintain undisturbed buffers around wetlands that support moose winter habitat. Establishing buffers that include both willows and mature stands of trees will improve moose habitat by providing shelter near food.
- Identify moose travel corridors that encompass wetlands; maintain the integrity and connectivity of adequately sized corridors.
- Schedule activities and developments to protect wetlands from unnecessary human disturbances during periods of heavy moose use or when moose are seasonally stressed.
- To provide moose with shelter from inclement weather and concealment from predators, maintain forests and/or woodlands and/or alder thickets near wetlands that provide moose winter habitat.

Consider employing practices such as those described in Alphabetical list of wetland management practices, particularly:

buffers, connectivity, conservation easements, design layout, floodplains, limits of clearing and disturbance (LOCADS), vegetation and revegetation, timing, trees, vegetation and revegetation, wildlife protection

STRATEGIES FOR MAINTAINING **SALMON HABITAT SUPPORT**

The most basic strategy for maintaining this function/value is to keep the wetlands that provide salmon habitat support in *"reference condition"*. Successfully maintaining a wetland in reference condition means applying management strategies at several scales. For example, *Watershed level management strategies for maintaining wetland functions/values* should always be considered when making wetland management decisions.

Strategies that help maintain SALMON HABITAT SUPPORT include:

- Avoid disturbing conditions within wetlands scored as supporting salmon habitat.
- Maintain natural variability of flows, particularly adequate baseflows, in salmon habitat. For example, minimize water withdrawals (such as well pumping) from wetlands or waterbodies contributing to baseflows.
- Avoid dredging, filling, excavating, draining, impounding, or otherwise altering surface or subsurface drainage patterns in wetlands that support salmon habitat.
- Prevent degradation or contamination of surface or subsurface water quality in salmon habitats; avoid disturbing sediments that could be carried downstream into salmon habitats. (Increased turbidity can make it difficult for salmon to breathe and see—salmon find food by sight; increased sediment loads can also clog spawning gravels and suffocate salmon eggs and alevins.)
- Time activities and developments to protect wetlands from unnecessary human disturbances during periods of salmon use or when salmon are seasonally stressed.
- Maintain plant cover along waterbodies providing salmon habitat support. In particular:
    - maintain plant roots, stems, leaves, and vegetation within the water—salmon shelter among these plant parts.
    - maintain plants that support salmon food sources—insects and other invertebrates falling off leaves and stems provide food for juvenile salmon; algae and plant detritus in the water contribute to instream food webs supporting salmon.
    - maintain natural plant communities along streambanks and shorelines to minimize erosion.
    - maintain vegetation that filters sediments and other pollutants from water flowing into salmon habitats.
    - maintain plants that shade salmon habitats and adjacent areas during warm periods of the growing season—vegetative shading helps cool water temperatures, as does evapotranspiration by streamside plants.
- Maintain natural conditions along streambanks and shorelines that create habitats needed by different salmon life cycle stages.
- Establish and maintain undisturbed buffers around wetlands supporting salmon habitats.

Also consider employing practices such as those described in Alphabetical list of wetland management practices, particularly:

buffers, connectivity, crossings and travel corridors, drainageways and drainage patterns, driveways and parking lots, equipment management, erosion and sediment control, grading, impervious surfaces, invasive species, light penetrating walkways, limits of clearing and disturbance (LOCADS), Low Impact Development, snow removal and storage, stormwater runoff, streambank and shoreline stabilization, timing, trees, vegetation and revegetation, water quality, wildlife protection, wood preservative

STRATEGIES FOR MAINTAINING **RARE WETLAND PLANTS**

The most basic strategy for maintaining this function/value is to keep the wetlands that support rare wetland plants in *"reference condition"*. Successfully maintaining a wetland in reference condition means applying management strategies at several scales. For example, *Watershed level management strategies for maintaining wetland functions/values* should always be considered when making wetland management decisions.

Along with watershed-scale strategies, the following strategies can help maintain RARE WETLAND PLANTS:

- Early in project planning or before land use activities begin, request the most recent data on rare plant locations from the Alaska Natural Heritage Program (AKNHP, http://aknhp.uaa.alaska.edu/).
- Avoid disturbing wetlands scored as supporting rare plants.
- Establish and maintain undisturbed buffers around wetlands that support rare plants.

Also consider employing practices such as those described in Alphabetical list of wetland management practices, particularly *buffers*.

STRATEGIES FOR MAINTAINING **ANIMAL SPECIES OF CONCERN**

The most basic strategy for maintaining this function/value is to keep the wetlands that support animal species of concern in *"reference condition"*. Successfully maintaining a wetland in reference condition means applying management strategies at several scales. For example, *Watershed level management strategies for maintaining wetland functions/values* should always be considered when making wetland management decisions.

Along with watershed-scale strategies, the following strategies can help maintain ANIMAL SPECIES OF CONCERN:

- Early in project planning or before land use activities begin, request the most recent data on species of concern from the Alaska Natural Heritage Program (AKNHP, http://aknhp.uaa.alaska.edu/). Use this information to avoid locations that may support animals species of concern.
- Avoid altering surface or subsurface drainage patterns, including channel slope of stream segments.
- Prevent degradation or contamination of surface or subsurface water quality in wetlands supporting animal species of concern; avoid disturbing sediments that could be carried downstream into these habitats.
- Time activities and developments to protect wetlands from unnecessary human disturbances when animals species of concern are present, particularly when these species may be seasonally stressed.
- Establish and maintain undisturbed buffers around wetlands that support animal species of concern.

Also consider employing practices such as those described in Alphabetical list of wetland management practices, particularly:

buffers, connectivity, crossings and travel corridors, culverts, drainageways and drainage patterns, dredging and filling, driveways and parking lots, easements, equipment management, erosion and sediment control, floodplains, impervious surfaces, limits of clearing and disturbance (LOCADS), Low Impact Development, natural flow regimes, snow removal and storage, stormwater runoff, streambank and shoreline stabilization, timing, trenches, vegetation and revegetation, water quality, wildlife protection, wood preservative

STRATEGIES FOR MAINTAINING **SCARCE WETLANDS**

The most basic strategy for maintaining this function/value is to keep scarce (or rare) wetlands in *"reference condition"*. Successfully maintaining a wetland in reference condition means applying management strategies at several scales. For example, *Watershed level management strategies for maintaining wetland functions/values* should always be considered when making wetland management decisions.

Along with watershed-scale strategies, the following strategies can help maintain SCARCE WETLANDS:

- Avoid disturbing wetlands scored as scarce.
- Establish and maintain undisturbed buffers around scarce wetlands.

Also consider employing practices such as those described in Alphabetical list of wetland management practices, particularly *buffers*

STRATEGIES FOR MAINTAINING **HABITAT DIVERSITY**

The most basic strategy for maintaining this function/value is to keep wetlands with habitat diversity in *"reference condition"*. Successfully maintaining a wetland in reference condition means applying management strategies at several scales. For example, *Watershed level management strategies for maintaining wetland functions/values* should always be considered when making wetland management decisions.

Along with watershed-scale strategies, the following strategies can help maintain HABITAT DIVERSITY:

- Avoid disturbing conditions within wetlands scored as providing high habitat diversity.
- Establish and maintain undisturbed buffers around wetlands that support high habitat diversity.

Also consider employing practices such as those described in Alphabetical list of wetland management practices, particularly:

> *buffers, connectivity, crossings and travel corridors, culverts, drainageways and drainage patterns, dredging and filling, easements, erosion and sediment control, floodplains, impervious surfaces, limits of clearing and disturbance (LOCADS), Low Impact Development, natural flow regimes, stormwater runoff, streambank and shoreline stabilization, trenches, vegetation and revegetation, water quality, wildlife protection*

STRATEGIES FOR MAINTAINING **GROUNDWATER RECHARGE**

The most basic strategy for maintaining this function/value is to keep wetlands that recharge groundwater in *"reference condition"*. Successfully maintaining a wetland in reference condition means applying management strategies at several scales. For example, *Watershed level management strategies for maintaining wetland functions/values* should always be considered when making wetland management decisions.

Along with watershed-scale strategies, the following strategies can help maintain GROUNDWATER RECHARGE:

- Avoid altering surface or subsurface drainage patterns.
- Maintain natural surface roughness and complex micro-relief; avoid compacting wetland soils or smoothing/leveling wetland surface.
- Maintain soil pore spaces and other empty spaces (voids) that can hold water.
- Maximize plant cover that will promote infiltration.
- Establish and maintain undisturbed buffers around wetland.

Also consider employing practices such as those described in Alphabetical list of wetland management practices, particularly*:*

> *buffers, crossings and travel corridors, drainageways and drainage patterns, dredging and filling, grading, floodplains, impervious surfaces, limits of clearing and disturbance (LOCADS), natural flow regimes, stormwater runoff,* ***utility crossings,*** *trenches, vegetation and revegetation*

STRATEGIES FOR MAINTAINING **WATER STORAGE**

The most basic strategy for maintaining this function/value is to keep wetlands that store water in *"reference condition"*. Successfully maintaining a wetland in reference condition means applying management strategies at several scales. For example, *Watershed level management strategies for maintaining wetland functions/values* should always be considered when making wetland management decisions.

Along with watershed-scale strategies, the following strategies can help maintain WATER STORAGE:

- Avoid altering surface or subsurface drainage patterns.
- Maintain natural surface roughness and complex micro-relief; avoid compacting wetland soils or smoothing/leveling wetland surface.
- Maintain soil pore spaces and other empty spaces (voids) that can hold water.
- Maintain natural plant cover and organic matter; avoid clearing vegetation; maximize plants that promote infiltration and have high rates of evapotranspiration.
- Establish and maintain undisturbed buffers around wetland.

Consider employing practices such as those described in Alphabetical list of wetland management practices, particularly*:*

> *buffers, crossings and travel corridors, drainageways and drainage patterns, dredging and filling, grading, floodplains, impervious surfaces, limits of clearing and disturbance (LOCADS), natural flow regimes, stormwater runoff, utility crossings, trenches, vegetation and revegetation*

STRATEGIES FOR MAINTAINING **TRANSMITTING or CONTRIBUTING DISCHARGE**

The most basic strategy for maintaining this function/value is to keep wetlands that transmit or contribute discharge in *"reference condition"*. Successfully maintaining a wetland in reference condition means applying management strategies at several scales. For example, *Watershed level management strategies for maintaining wetland functions/values* should always be considered when making wetland management decisions.

Along with watershed-scale strategies, the following strategies can help maintain TRANSMITTING or CONTRIBUTING DISCHARGE:

- Avoid altering surface or subsurface drainage patterns.
- Avoid compacting wetland soils or smoothing/leveling wetland surface.
- Maintain soil pore spaces and other empty spaces (voids) that can hold water.
- Maintain natural surface roughness and complex micro-relief; avoid clearing vegetation and organic debris; maximize vegetation that promotes infiltration rates.
- Establish and maintain undisturbed buffers around wetland.

Consider employing practices such as those described in Alphabetical list of wetland management practices, particularly*:*

buffers, crossings and travel corridors, drainageways and drainage patterns, dredging and filling, grading, impervious surfaces, limits of clearing and disturbance (LOCADS), natural flow regimes, utility crossings, trenches, vegetation and revegetation

STRATEGIES FOR MAINTAINING **NATURAL STREAMFLOW REGIMES**

The most basic strategy for maintaining this function/value is to keep wetlands that maintain natural streamflow regimes in *"reference condition"*. Successfully maintaining a wetland in reference condition means applying management strategies at several scales. For example, *Watershed level management strategies for maintaining wetland functions/values* should always be considered when making wetland management decisions.

Along with watershed-scale strategies, the following strategies can help maintain NATURAL STREAMFLOW REGIMES:

- Maintain natural variability of flows. (Understand the hydrologic inputs and processes that contribute to this variability; see, for example, the Integrated Landscape Hydrology Model.)
- Avoid altering surface or subsurface drainage patterns, including channel slopes of stream segments.
- Maintain soil pore spaces and other empty spaces (voids) that can hold and convey water.
- Minimize pumping, draining, or otherwise reducing contributions to stream baseflows.
- Minimize obstructing or impounding natural streamflows or peat porewater movement.
- Maintain natural surface roughness and complex micro-relief.
- Maintain natural plant cover; avoid clearing vegetation and organic debris; maximize vegetation that promotes infiltration rates.
- Minimize developments in floodplains that could contribute to increased flood heights.
- Establish and maintain undisturbed buffers around wetland.

Consider employing practices such as those described in Alphabetical list of wetland management practices, particularly*:*

buffers, connectivity, crossings and travel corridors, culverts, drainageways and drainage patterns, dredging and filling, easements, grading, floodplains, impervious surfaces, limits of clearing and disturbance (LOCADS),Low Impact Development, natural flow regimes, stormwater runoff, trenches, vegetation and revegetation

STRATEGIES FOR **MAINTAINING WATER QUALITY**

The most basic strategy for maintaining this function/value is to keep wetlands that maintain water quality in *"reference condition"*. Successfully maintaining a wetland in reference condition means applying management strategies at several scales. For example, *Watershed level management strategies for maintaining wetland functions/values* should always be considered when making wetland management decisions.

Along with watershed-scale strategies, the following strategies can help maintain WATER QUALITY:

- Avoid altering surface or subsurface drainage.
- Avoid altering natural conditions along streambanks and lake shorelines.
- Avoid compacting wetland soils or smoothing/leveling wetland surface.
- Maintain natural surface roughness and complex micro-relief
- Maintain soil pore spaces and other empty spaces (voids) that can hold water.
- Prevent degradation or contamination of surface or subsurface water quality.
- Maintain wetland features—such as plant shade, water tables, and baseflows—that contribute to cooler water temperatures.
- Maintain plant cover and organic debris, particularly plants contributing significantly to infiltration and interception; avoid creating areas of bare ground.
- Establish and maintain undisturbed buffers.

Consider employing practices such as those described in Alphabetical list of wetland management practices, particularly*:*

buffers, connectivity, crossings and travel corridors, culverts, drainageways and drainage patterns, dredging and filling, driveways and parking lots, equipment management, erosion and sediment control, grading, floodplains, impervious surfaces, limits of clearing and disturbance (LOCADS), Low Impact Development, natural flow regimes, snow removal and storage, stormwater runoff, streambank and shoreline stabilization, utility crossings, trenches, vegetation and revegetation, water quality, wood preservative

STRATEGIES FOR MAINTAINING **STREAMBANK and SHORELINE STABILITY**

The most basic strategy for maintaining this function/value is to keep wetlands that maintain streambank and shoreline stability in *"reference condition"*. Successfully maintaining a wetland in reference condition means applying management strategies at several scales. For example, *Watershed level management strategies for maintaining wetland functions/values* should always be considered when making wetland management decisions.

Along with watershed-scale strategies, the following strategies can help maintain STREAMBANK and SHORELINE STABILITY:

- Maintain natural surface and subsurface drainage patterns.
- Maintain plant cover along streambanks and shorelines; avoid clearing, compacting, or otherwise reducing plant cover; maximize plants that promote infiltration and interception.
- Maintain natural surface roughness and complex micro-relief along streambanks and shorelines.
- Maintain natural patterns of sediment input, transport, and deposition.
- Maintain plant cover upslope and upgradient to minimize erosion and sediment runoff into these areas.
- Use soil bioengineering techniques to stabilize disturbed streambanks and shorelines.
- Avoid increasing channel slope.
- Maintain natural flow regimes so as not to increase erosive flows.

Consider employing practices such as those described in Alphabetical list of wetland management practices, particularly:

buffers, culverts, erosion and sediment control, limits of clearing and disturbance (LOCADS), Low Impact Development, natural flow regimes, stormwater runoff, streambank and shoreline stabilization, trees, vegetation and revegetation

STRATEGIES FOR MAINTAINING **RECREATION**

The most basic strategy for maintaining this function/value is to keep wetlands that support recreation in public ownership and *"reference condition"*. Successfully maintaining a wetland in reference condition means applying management strategies at several scales. For example, *Watershed level management strategies for maintaining wetland functions/values* should always be considered when making wetland management decisions.

Along with watershed-scale strategies, the following strategies can help maintain RECREATION:

- Maintain as much of the wetland as possible in public ownership or other ownership categories that accommodate recreational uses; maintain public access to the wetland.
- Identify wetlands warranting acquisition for public recreation—as well as access to these wetlands—and use tools such as easements or purchase to acquire them.
- Establish undisturbed buffers around recreational wetlands in order to maintain existing surface and subsurface drainage patterns into and out of the wetlands.

Consider employing practices such as those described in Alphabetical list of wetland management practices, particularly:

buffers, connectivity, drainageways and drainage patterns, easements, limits of clearing and disturbance (LOCADS), Low Impact Development, natural flow regimes, stormwater runoff, vegetation and revegetation

STRATEGIES FOR MAINTAINING **EDUCATION**

The most basic strategy for maintaining this function/value is to keep wetlands that support education in public ownership and *"reference condition"*. Successfully maintaining a wetland in reference condition means applying management strategies at several scales. For example, *Watershed level management strategies for maintaining wetland functions/values* should always be considered when making wetland management decisions.

Along with watershed-scale strategies, the following strategies can help maintain EDUCATION:

- Maintain as much of the wetland as possible in public ownership or other ownership categories that accommodate educational uses.
- Establish undisturbed buffers around wetlands near places of learning in order to maintain existing surface and subsurface drainage patterns.

Consider employing practices such as those described in Alphabetical list of wetland management practices (some of which could be applied in educational ways), particularly:

buffers, connectivity, drainageways and drainage patterns, easements, vegetation and revegetation

STRATEGIES FOR MAINTAINING **DENA'INA WETLAND OPPORTUNITIES**

The most basic strategy for maintaining this function/value is to keep wetlands that support Den'ina cultural opportunities in appropriate ownership categories and *"reference condition"*. Successfully maintaining a wetland in reference condition means applying management strategies at several scales. For example, *Watershed level management strategies for maintaining wetland functions/values* should always be considered when making wetland management decisions.

Along with watershed-scale strategies, the following strategies can help maintain DENA'INA WETLAND OPPORTUNITES:

- Maintain as much of the wetland as possible in ownership categories that accommodate Dena'ina cultural uses.
- Identify wetlands warranting acquisition for Dena'ina cultural uses, and acquire appropriate easements or title to these wetlands.
- Establish undisturbed buffers around wetlands to maintain existing surface and subsurface drainage patterns.

Consider employing practices such as those described in Alphabetical list of wetland management practices, particularly:

buffers, connectivity, easements

Issues with locating developments in wetlands versus uplands

Wetlands can provide irreplaceable benefits or expensive problems. Chapter 2 described some of the benefits that peninsula wetlands provide—their identified functions and values—and why these matter. This section introduces some of the problems that wetlands can present when used for purposes for which they are poorly suited.

Locating developments in wetlands is significantly different from developing in uplands. *Uplands* are areas where soils drain well, water tables are well below the surface, subsoils tend to have good bearing strength and low subsidence rates, and many other conditions contribute to successful development. As a result, most uplands are well suited for most land uses, including homes and commercial buildings, roads, septic systems, recreational improvements, farms and ranches, and forestry.

Wetlands, on the other hand, are characterized by features such as poor soil drainage and shallow water tables; thick organic soils that hold water like a sponge, low weight-bearing strength, high compaction or subsidence under pressure; and/or other conditions that make them very difficult to develop. As a result, wetlands are poorly suited for many purposes, including building foundations, septic system leach fields, roads and driveways, off-road-vehicle trails, and farming or raising livestock.

Because wetlands are so poorly suited for many kinds of land uses, developing in them requires careful and often expensive engineering and installation to avoid long-term problems such as foundation settling and failure, frost heaving, and/or flooding. Two useful publications discussing these issues are:

- *Understanding Soil Risks and Hazards – Using Soil Survey to Identify Areas With Risks and Hazards to Human Life and Property* (NRCS 2004), online at: http://www.nature.nps.gov/geology/soils/Understanding%20Soil%20Risks%20and%20Hazards.pdf) and
- *Soil Surveys Can Help You* (NRCS 2007), online at: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_023910.pdf

In addition to causing difficulties and extra costs, developing in wetlands usually reduces or eliminates beneficial functions and values, including their ability to store floodwaters; filter pollutants; support habitats used by salmon, moose, and other animals; and provide places for humans to recreate and enjoy nature. Protecting wetland functions and values that benefit society is the reason that wetland-altering projects require a permit from the U.S. Army Corps of Engineers (a "404 wetland permit"), and in some locations, also permits from the Alaska Department of Fish and Game, Kenai Peninsula Borough, and/or the Alaska Department of Environmental Conservation*.

The bottom line is that there are many good reasons to avoid locating developments in wetlands and instead to look for upland areas well suited for intended land uses. Web Soil Survey provides a tool for looking up soils and their suitabilities in areas of interest, see: http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm.

If you're looking for land to buy and you find a parcel whose price seems "too good to be true," be sure to check how much of that parcel is mapped as wetland. For step-by-step instructions on how to do this with the Kenai Peninsula's interactive parcel viewer, see locating and learning about peninsula wetlands using the online parcel viewer.

If you can't avoid developing in a wetland, practices listed in Alphabetical list of wetland management practices can help you reduce the impacts your activities will have on wetland functions and values. Incorporating practices like these into your design may help in obtaining permits, particularly if you explain why no upland alternatives are available for your land use. Some of these practices—using properly engineered pilings as building foundations, for example—may make it possible to develop a desired land use in a wetland without unacceptable risk of failure. But be aware of the risks before deciding that a wetland is your best location.

* For a comprehensive overview of wetland permits that may be required on the Kenai Peninsula, go to Chapter 4 in Kenai Peninsula Wetlands – a Guide for Everyone.

Alphabetical list of wetland management practices

Introduction

Below is an alphabetical list of *practices* that can be incorporated into many kinds of land use activities, as appropriate, to avoid or minimize the negative effects of those activities on wetland functions and values. The term *practices*, as used here, means a particular activity or approach and how it's carried out, including where it's located and how it's designed, timed, and implemented. The term “practices” as used here is similar to the term “conservation practices” used by the USDA Natural Resources Conservation Service (NRCS).

Alaskan sources for the listed practices include the Army Corps of Engineers *General Best Management Practices for Projects in Waters of the US*, Nationwide Permit conditions, and Regional conditions; Alaska Department of Fish and Game permit requirements and recommendations in *Landowners Guide to Fish Habitat Conservation and Restoration Practices* (2001); NRCS conservation practices; US Fish and Wildlife Service permit recommendations for various peninsula projects; Kenai Peninsula Borough anadromous stream and floodplain ordinances; and City of Homer wetland strategies. Other sources used in compiling this list are referenced as appropriate.

Ways to use the list of wetland management practices

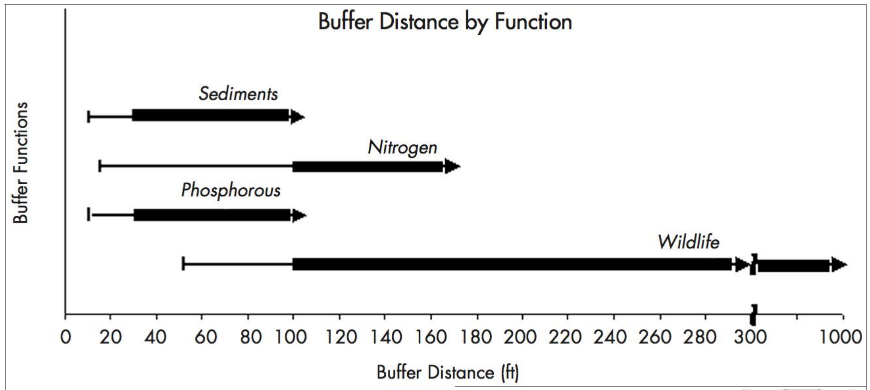
- ***Project designers*** can look through the list to find appropriate features to incorporate into project designs. Designers should begin by reviewing suitabilities of the proposed project area and by locating structures and other developments in areas best suited for them. Looking at soil suitabilities for various land uses by using the NRCS Web Soil Survey is one good way to begin this process.
- ***Landowners*** can use this alphabetical list to review plans developed for them by project designers or engineers. It's a good idea to review project designs with wetlands in mind because some contractors are better than others at recognizing and avoiding potential site problems up front, and the list can help you consider whether your contractor has experience with wetland issues. If you select a contractor to install, for example, a mounded septic system in a wetland or pilings to support your house, check to see if he or she has successfully installed similar systems that have functioned well for several years.
- ***Land buyers*** can use the list to identify practices that may be needed if they buy a parcel that contains large wetland areas. Remember that no laws or regulations are in place on the peninsula to protect you from buying a parcel that is unsuitable for most developments because of high water tables, susceptibility to subsidence, low bearing strength, poor soil drainage, steep or unstable slopes, etc. As a result, buyers should always check whether a parcel they are thinking of buying is likely to be suitable for their intended uses. The Natural Resources Conservation Service can help land buyers look at site conditions as reflected in local soil surveys (see Chapter 5 for contact information).
- ***Reviewers*** of wetland permit applications or of projects planned in wetlands can look through this alphabetical list to find practices to recommend for incorporation into project designs.

Links to practices in the Alphabetical list of wetland management practices

To enable users to compare "practices" as used here with "strategies" as applied to Homer wetland complexes (see Model provided by Homer wetland management strategies), Homer strategies are listed in brackets at the end of practices to which they are similar.

1. buffers	
2. building size	
3. connectivity	
4. conservation easements	
5. crossings	
6. culverts	
7. design layout	
8. drainageways and drainage patterns	
9. dredging and filling	
10. easements (see conservation easements)	
11. equipment management	
12. erosion and sediment control	
13. filling (see dredging and filling)	
14. floodplains	
15. garages	
16. horizontal directional drilling (see utility crossings)	
17. hydrology (see drainageways and drainage patterns)	
18. impervious (impermeable) surfaces	
19. invasive species	
20. light penetrating walkways	
21. limits of clearing and disturbance (LOCADs)	
22. Low Impact Development (LID)	
23. natural flow regimes	
24. performance requirements and impact thresholds	
25. pilings	
26. raised walkways (see light penetrating walkways)	
27. retaining walls	
28. snow removal and storage	
29. soil bioengineering	
30. stormwater runoff	
31. streambank and shoreline stabilization (see soil bioengineering)	
32. subdivisions	
33. timing	
34. trees	
35. trenches	
36. utility crossings	
37. vegetation and revegetation	
38. water quality	
39. wildlife protection (including fisheries)	
40. wood preservative	

buffers



- Buffers around disturbed areas keep impacts within those areas
- Buffers around wetlands and along streams protect them from impacts arising from adjacent or upslope disturbances
- Design buffer width based on intended buffer function(s) and site conditions (e.g., slopes, drainage patterns, plant cover, etc.); example buffers widths for some functions are shown at right
- Buffers can be designed to incorporate nearby wetlands (see #1 and #2 in at right)
- Buffers can be designed as corridors (see #2 at right) (see also *connectivity*)
- Mark buffer zones with flagging, stakes, or other means to protect them during clearing, construction, or other development activities
- Do not construct directional boring vaults/junction boxes or pads within 100 ft (measured from OHW) of anadromous streams

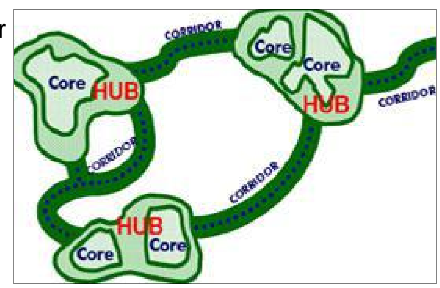
[Similar Homer wetland strategies: maintain a 100-ft setback of natural vegetation; maintain greenbelts incorporating stormwater retention designs;
maintain an 85-ft buffer of natural vegetation; peatlands should be preserved and buffered with a 50-ft setback of undisturbed natural vegetation]

building size

- Minimize building footprint, limit building pad fill to the minimum size necessary for the building
  - Reduce the size of building(s) to be built
  - Build "up" instead of "out"

[Similar Homer wetland strategy: limit fill to the minimum necessary for a residence and minimum driveway and parking]

connectivity



- Maintain connections between wetlands and between wetlands and waterbodies; for example, use the concept of *cores*, *hubs*, and *corridors* illustrated at right (from http://www.planning.org/pas/memo/open/may2009/); core areas provide the nucleus of the connected network; hubs buffer these core areas and are the largest, least fragmented contiguous area of forest, wetlands, stream systems, or other native landscape type; corridors maintain connectivity in the landscape and provide for animal movement, plant dispersal, recreation, and other functions
- In areas with multiple projects, consider the effects of cumulative impacts on connectivity

conservation easements

- A conservation easement is a voluntary agreement that allows a landowner to permanently limit the type and amount of development on his or her property while the property remains in private ownership. Conservation easements can be used to protect wetlands
- For more information on conservation easements, see http://www.landtrustalliance.org/conservation/landowners/conservation-easements and http://www.kachemaklandtrust.org/pages/conservation-easements.php
- Kachemak Heritage Land Trust (http://www.kachemaklandtrust.org/index.php), Natural Resources Conservation Service Easement Program (http://www.nrcs.usda.gov/wps/portal/nrcs/main/ak/programs/easements/), and The Nature Conservancy in Alaska (http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/alaska/) are three sources of additional help to protect wetlands through easements. In addition, Kachemak Moose Habitat, Inc. (http://www.faqs.org/tax-exempt/AK/Kachemak-Moose-Habitat-Inc.html) and the Exxon Valdez Oil Spill (EVOS) Trustee Council (http://www.evostc.state.ak.us/index.cfm?FA=protection.home) buy land to protect habitat.

[Similar Homer wetland strategies: maintain in conservation status and manage according to site management plan]

crossings

- Minimize the number of both road and utility crossings of wetlands
- Locate crossings where wetlands (including streams) are narrowest and use the shortest possible route
- Use existing crossings where possible (upgrade existing crossings rather than creating new ones)
- Locate crossings in areas that are already disturbed

- All permanent and temporary crossings of waterbodies should be suitably culverted, bridged, or otherwise designed and constructed to maintain natural flow regimes, channel width, grade, substrate composition, and sediment transport conditions of the natural streambed being crossed, as well as to sustain movement of aquatic species indigenous to the waterbody
- Lay out stream crossings perpendicular to the stream channel
- Use structures with the greatest span, e.g., use bridges instead of culverts
- Design and install culverts so as to minimize effects to stream or wetland hydrology and instream habitats
- When velocity allows and prior to starting work, erect a silt fence or floating silt curtain downstream or around the crossing; where required, erect a fish barrier of netting, both upstream and downstream of the crossing, to prevent fish from entering the work area
- Design, construct, and maintain equipment bridges to maintain unrestricted flow and to prevent soil from entering the waterbody
- To limit time required for construction at a stream crossing, work areas on both sides of the stream should be prepared prior to construction of the actual crossing
- Avoid crossings that bisect connections between wetlands or between wetlands and waterbodies (*see Connectivity*)
- For stream crossings, maintain adequate flow rates during the project to protect aquatic life and prevent interruption of existing downstream uses
- Establish crossings during low-flow periods
- Design, construct, and maintain equipment bridges to maintain unrestricted flows and to prevent soil from entering wetlands or waterbodies
- Remove equipment bridges as soon as possible after project completion
- Stream channel capacity and location, and streambed material, should be restored when work is completed
- Streambanks should be restored to pre-existing shape, location, and condition, and revegetated with soil bioengineering practices when work is completed
- Directional boring vaults/junction boxes or pads should not be constructed within 100 feet (measured from OHW) of anadromous fish streams

[Similar Homer wetland strategy: crossings should be perpendicular to the channel via bridge or oversized culvert and involve the minimum amount of fill necessary]

culverts

- Authorized structures, pipes, culverts, etc. should be sized and installed so as to maintain natural flow regimes, grade, substrate composition, and sediment transport conditions of wetlands and streams being crossed, including flood flows (at least 100-year flood)
- To maintain natural drainage patterns, install culverts in sufficient numbers and size to prevent ponding, diversion, or concentrated runoff that would adversely impact adjacent wetlands and other fish and wildlife habitats
- Culverts in fish-bearing waters must be installed in accordance with a valid Alaska Department of Fish and Game, Fish Habitat Permit (find application at http://www.adfg.alaska.gov/index.cfm?adfg=uselicense.main); assistance with permits on the Kenai Peninsula is available from the Gilman River Center in Soldotna (http://www.kenairivercenter.org/river-center/permits/permit-applications).

design layout

- Base development layout on an a*ssessment of parcel and site suitability*
- Maintain connections between wetlands and between wetlands and waterbodies
- Protect green infrastructure areas (*see* g*reen infrastructure*)
- Reduce the size of areas to be cleared for building(s), parking, accessory uses, etc. (*see Impervious surfaces*)
- Identify and mark *Limits of clearing and disturbance*
- Methods selected to prevent disturbance to or draining of wetlands should be drawn onto constructions plans and clearly labeled
- Locate any extra work areas at least 50 ft away from waterbodies and wetlands
- Use previously disturbed areas before open ground and open ground before forested areas
- Incorporate Low Impact Development techniques throughout the site (*see Low Impact Development*)
- Stage and store materials and equipment away from wetlands and waterbodies

[Similar Homer wetland strategies: site design should include hydrologic connectivity to upstream and downstream parcels; where uplands exist on a lot, they must be used prior to filling wetlands]

drainageways and drainage patterns

- Design development so as to maintain existing drainage systems and patterns, including hydrologic connectivity; the Corps specifies that work shall not adversely alter existing hydrology of wetlands and waterbodies
- Conduct site preparation, excavation, and fill placement in a manner that prevents adverse hydrologic effects
- Maintain natural drainage patterns using appropriate ditching, culverts, storm drain systems, and other measures to prevent ponding or drying; excessive ponding and/or dewatering of areas adjacent to fill indicate non-compliance with this condition
- To the maximum extent practicable, the pre-construction course, condition, capacity, and location of open waters must be maintained for each activity, including stream channelization and stormwater management activities, except as provided by the

COE (an activity may alter the pre-construction course, condition, capacity, and location of open waters if it benefits the aquatic environment—e.g., stream restoration or relocation activities)

- Activities must be constructed to withstand expected high flows and must not restrict or impede passage of normal or high flows unless the primary purpose of the activity is to impound water or manage high flows
- Minimize alterations to both surface and subsurface drainage conditions; on construction plans, draw and clearly label methods chosen to prevent draining of wetlands
- Minimize grading and other earthwork that alters topography (*see Grading*)
- Maintain vegetation (*see Vegetation and revegetation*)
- Avoid increasing runoff or concentrating flows (see *Buffers, Stormwater runoff, Vegetation and revegetation*)
- Minimize impervious surfaces (*see Impervious surfaces*)
- Incorporate Low Impact Development (LID) techniques to minimize stormwater runoff (*see Low Impact Development and Stormwater runoff)*
- Place detention basins and other structural stormwater controls outside of wetland areas
- Use vegetated swales or texturally rough and non-erosive material where concentrations of stormwater may flow downslope
- Immediately upon project completion, remove spoil, debris, piling, cofferdams, construction materials, and any other obstructions resulting from or used during construction
- Remove dewatering structures as soon as possible after completion of dewatering activities
- Backfill and restore stream beds and banks to their pre-existing course, condition, capacity, and location

[Similar Homer wetland strategies: no ditching or changes to drainageways should be allowed
locate roads outside of wetlands and drainageways to the extent possible
maintain the hydrologic integrity of drainageways]

dredging and filling

- With respect to wetlands, dredging means digging up and removing material from the wetland; digging ditches through a wetland is a kind of dredging. Filling means depositing material in or on a wetland, including material dredged out of the wetland or excavated from elsewhere (e.g., piled up during land grading). Building a road across a wetland involves filling unless the road is built on pilings. Both dredge and fill activities change how water is stored and flows within and through a wetland, as well as disturbing wetland plant communities.
- Fill must be of suitable material
- Fill must be limited to the minimum square footage needed for a principal structure, use, or access
- Topsoil and organic surface material such as root mats should be stockpiled separately from overburden and returned to the surface of the restored site
- Fill for driveways, building pads, septic systems, etc. shall not be placed in wetlands until the wetland permit applicant is prepared to develop the lot, e.g., for a residence, commercial unit, etc.
- To the maximum extent practicable backfill material shall consist of the excavated material and shall be returned to the hole in the same place on the vertical stratum from which it was excavated; as a contingency, use clean gravel or native cobbles for the upper 1-ft of trench backfill in all water bodies that contain fisheries
- Where practicable, fill material should be free from fine material that is subject to erosion and suspension
- Silt and sediment from excavation and fill activities may not enter wetlands outside the project footprint
- Excess dredged or excavated material that is either unsuitable or not used as backfill shall be disposed at an upland disposal site
- Temporary fill in wetlands should be placed on geotextile fabric that is laid on the existing wetland grade
- Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations and revegetated, as appropriate
- Geotextile fabric should be placed beneath all materials stockpiled in wetlands under non-frozen conditions

driveways and parking lots

- Minimize driveway length and width and parking area (locate buildings near roads to shorten driveway length needed for access)
- Use shared driveways to reduce wetland encroachment and impervious surface
- Use pervious materials (e.g., crushed stone, gravel, geoblock, etc.)
- Incorporate *Low Impact Development* (LID) techniques such as permeable paving, bioswales adjacent to parking lots, etc.

easements

See conservation easements

equipment management

- Keep equipment inside identified project limits and within the *Error: Reference source not found*
- Work when site conditions are least vulnerable to impacts—e.g., when the ground is frozen and snow covered, during low flow periods, etc.
- To minimize disturbance use one pass in and out if possible
- To prevent soil disturbance, place heavy equipment working in wetlands on mats or use other measures such as ice roads,

compacted snow, low psi ground bearing weight equipment

- To minimize adding fill into wetlands, excavation equipment should work from an upland site to the extent practicable (e.g., from upslope or the top of a bridge or culverted road crossing)
- If it's not practicable to work from an upland site, equipment must minimize disturbance to the wetland, channel, streambank, or stream bottom (other than removal of accumulated sediments or debris)
- Maintain equipment in good operating order—inspect for leaks on a daily basis; fuel in areas where an accidental spill will not have the chance to reach a wetland; carry spill kits and know how to use them
- Do not store, maintain, or repair equipment in wetlands or where spills could reach wetlands
- Do not store fuel, oil, hydraulic fluids, and dust control substances within 100 ft of wetlands or waterbodies; refueling of over the road vehicles should not occur within 100 ft of wetlands or waterbodies; heavy construction equipment should be refueled only outside wetlands and no closer than 100 ft from watercourses
- To avoid the spread of invasive weeds, equipment should be thoroughly washed (particularly parts in contact with the ground) before being brought onsite if previously used in areas with invasive plants
- If work has been permitted within the wetland, the load of heavy equipment should be dispersed so that the soil bearing strength is not exceeded; suitable methods to accomplish this include working during frozen or dry ground conditions, employing mats when working in wetlands or mudflats, and using tracked rather than wheeled vehicles
- Construction equipment, particularly the width of the excavating bucket head, should be limited to the minimum size necessary to complete the work
- Do not use rock, soil imported from outside the wetland, tree stumps, or brush riprap to support equipment on a wetland work site

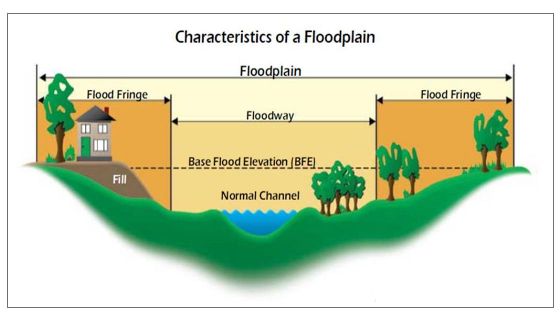
erosion and sediment control

- Conduct site preparation, excavation, fill placement, and construction activities so as to prevent, minimize, and contain any erosion and suspension of fine material that could be carried offsite by surface runoff; avoid excavation, fill, or grading adjacent to wetlands
- Use and maintain appropriate soil erosion and sediment controls in effective operating condition during construction (*see Stormwater control*)
- At the earliest practicable date, establish and maintain a durable, permanent vegetative cover to stabilize and minimize erosion and sedimentation from all exposed soil and other fills as well as any work below the ordinary high water mark
- Stabilize and revegetate in an appropriate and timely manner any disturbed ground and exposed soil not covered with fill, structures, or appurtenances
- To minimize erosion potential, all low growing varieties of vegetation adjacent to wetlands should be preserved to the fullest extent possible; stumps and rocks should not be removed
- Sediment disposal from any activity within the controlled area should be placed at an upland site and suitably contained to prevent erosion and/or transport to a wetland or watercourse
- Silt fences, silt curtains, or other diversion or containment structures should be installed to contain sediment and turbidity at the work site
    - If the fill site is within 50 feet of a wetland or waterbody and has a downslope or surface connection to them, installation should be parallel to and within 10 feet of the toe of any fill or exposed soil
    - All silt fences, curtains, and other structures must be installed properly and maintained in a functioning manner for the life of the construction period where fill material and exposed soils might cause transport of sediment or turbidity beyond the immediate construction site.
- If suspended material is evident in standing or flowing water outside the project footprint, apply appropriate control and containment measures, including, for example, slope stabilization, revegetation, filter fabric fences, straw bales, other effective filters or barriers, fiber matting, settling ponds, drainage control, trenches and water bars, waterproof covers over material piles and exposed soils, avoiding work during heavy precipitation, and other appropriate measures

filling

See dredging and filling

floodplains



- Ensure that activities comply with applicable FEMA-approved state or local floodplain management requirements
- Determine boundaries of 100-year floodplain and appropriate lesser-intensity flood stages, then locate buildings, driveways, parking areas, etc. outside these flood zones
- Avoid filling in the 100-year floodplain
- Contact the Gilman River Center in Soldotna for guidance on locating and developing in floodplains (514 Funny River Road, Soldotna, AK 99669 (907) 260-4882; http://www.kenairivercenter.org/river-

center/resources/flood-information)

garages

- Design the garage to be incorporated as part of a building's first story instead of as a separate structure

grading

- Minimize clearing, grading, and soil compaction
- Identify and mark *Limits of clearing and disturbance* and avoid grading beyond identified limits
- Design with existing contours to avoid the need for cut and fill and other earthwork upslope from wetlands
- Avoid developing on steep slopes (slopes greater than 10-15%) upslope from wetlands
- Use retaining walls in areas of steep or irregular topography to minimize cut and fill near wetlands (*see Retaining walls*)
- Minimize grade changes during regrading
- Maintain existing drainageways

See Buffers, Connectivity, Crossings, Design layout, Drainageways and drainage patterns, Vegetation and revegetation

horizontal directional drilling

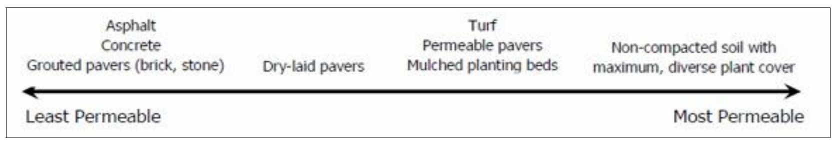
See utility crossings

hydrology

See drainageways and drainage patterns

impervious (impermeable) surfaces

- Impervious (or impermeable) surfaces are covered by materials that block downward movement of water into soil (infiltration). Impervious surfaces prevent rainfall, snowmelt, and stormwater runoff from soaking into the ground, and this increases surface runoff. Examples of impervious surfaces include roads, sidewalks, driveways, parking lots, roofs, bare and compacted soils, and dense, short-mowed lawns. (see http://link.springer.com/article/10.1023%2FA%3A1026211808745)



- Minimize impervious surfaces to the maximum extent possible
- Use buffers along and around impervious surfaces to minimize impacts to adjacent or downslope wetlands
- Wherever possible, use pervious material (crushed rock, gravel, geoblock, etc.) instead of impervious materials for driveways and parking areas.
- Incorporate Low Impact Development (LID) techniques to minimize runoff from impervious surfaces

[Similar Homer wetland strategies: runoff from hardened (impervious) surfaces should be offset with swales and/or runoff retention ponds; if more than 3% of wetlands on any lot are converted to hardened (impervious) surfaces, they must be compensated for with swales and/or runoff retention ponds]

invasive species

- Prevent introduction into wetlands of invasive species via equipment, clothing, animals, seed mixes, straw bales, or other means
- Avoid plant sources that may harbor invasive weeds such as Reed canary grass
- If appropriate (e.g., if gravel or mulch will be imported from sources outside the area or if vehicle trips from outside areas are frequent), develop a "Hazard Analysis–Critical Control Point (HACCP) Plan prior to work occurring to reduce effects of activities and provide guidance for monitoring and evaluation of invasive species through pre-emptive procedures

light penetrating walkways

- Use light penetrating walkways (also called "gratewalks" and elevated walkways) to allow light to penetrate to plants growing beneath the walkways. Plant growth beneath walkways improves habitat, helps maintain wetlands in "reference condition", stabilizes streambanks and shorelines (when walkways affect these areas), and improve adjacent fish habitat. The Alaska Department of Fish and Game lists the following design requirements for light penetrating walkways:
  - Decking must provide at least 60 percent light penetration.
  - Length of gratewalk can be no more than 1/3 the length of the parcel's river frontage.
  - Width of gratewalk must be 8 feet or less.
  - Gratewalks must be elevated at least 4 inches above the ground (everything except pipe supports).
  - No pipe supports can be installed below ordinary high water.
  - No pipe supports can be driven permanently into ground.
  - Gratewalks along streams should be of lightweight construction and seasonally removed.

limits of clearing and disturbance (LOCADs)

- To avoid impacts to wetlands beyond project footprints, prior to clearing and construction, clearly identify in the field all project limits of authorized sites, e.g., with staking, flagging, silt fencing, use of buoys, existing footprint for maintenance activities, etc.
- Define *Limits of clearing and disturbance* that encompass all proposed work, activities, and land uses on the site
- Set realistic Limits of clearing and disturbance; LOCADs vary from project to project; for some it may be 10-15 feet from a structure, for others it may be 30-50 feet; KPB anadromous stream buffers = 50 ft
- Install permanent markers or fencing along LOCADs to serve as long-term reminders to avoid any disturbance past that line without review by appropriate decision makers; permanent markers can alert future buyers that a wetland plan and/or permit applies to the parcel or site
- Consider room for construction vehicles and space for future maintenance (e.g. a backhoe for grading around buildings)
- Increase plantings along LOCADs adjacent to wetlands so as to buffer wetlands and reduce disturbance to wildlife
- Plant thorny species (e.g., native roses, Devil's Club) along LOCADs to discourage foot traffic

Low Impact Development (LID)

- Incorporate LID techniques throughout the project site, such as rain gardens, vegetated swales, permeable paving, etc.
- Go to the EPA Low Impact Development site for more information: http://water.epa.gov/polwaste/green/.

natural flow regimes

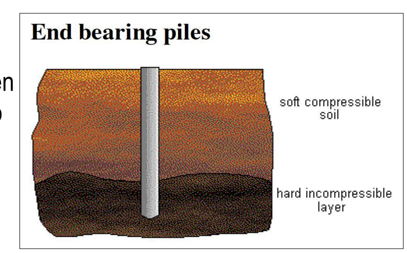
- Prevent alteration of site drainage conditions, either surface or subsurface
- Remove dewatering structures as soon as possible after completion of dewatering activities related to crossings or other activities that affect flow regimes
- Monitor for post-project changes in locations or amounts of ponding and/or dewatering, e.g., near fill or other disturbances; such changes suggest alteration of hydrology patterns and necessitate restoration to pre-project conditions

performance requirements and impact thresholds

- Identify performance standards for (a) specific wetland types (e.g., peatlands); (b) development impacts (e.g., stormwater runoff, vegetation removal); and/or (c) specific land uses/developments (e.g., roads, residential or commercial buildings, subdivisions); specify performance requirements in clearly measurable thresholds not to be exceeded; examples include “no more than 3% impervious surfaces are allowed,” “stormwater runoff volumes shall not exceed pre-project amounts,” “do not disturb native vegetation more than 20 ft from foundation,” etc.
- Use wetland-specific reference conditions as the basis for establishing performance standards designed to maintain water quality and/or quantity; ensure that performance standards protect the variability of natural flow regimes
- Identify how, where, and when measurements will be taken; who will be responsible for taking measurements; and how results will be reported and used
- Require operators to inform appropriate entities as soon as possible if there is evidence that agreed-upon thresholds have been exceeded; operators should provide an explanation for each incident and outline what further action is being taken to avoid or mitigate effects
- Adopt staged mitigation strategies that are automatically implemented if a threshold is exceeded; components of staged mitigation strategies should be able to be implemented quickly when a breach or exceedence is detected
- Judge environmental effects, mitigation measures, and opportunities for improvement within the context of changing environmental conditions brought about by land use and climatic changes within the targeted watershed and over the planning period
- At appropriate pre-determined intervals, use up-to-date methods and technologies to monitor wetland water quality, quantity, and flow patterns so as to ensure that best water management outcomes are being achieved
- Identify enforcement measures that apply if thresholds are exceeded; if no other satisfactory options can be found, consequences may entail cessation of whatever activity (e.g., crossings, water withdrawals, etc.) is giving rise to unacceptable impact(s)

pilings

- Consider pilings to support structures to be constructed in wetlands; piles are relatively long, slender members that transmit foundation loads through soil strata of low bearing capacity to deeper soil or rock strata having a high bearing capacity; they are used when for economic, constructional, or soil condition reasons it is desirable to transmit loads to strata beyond the practical reach of shallow foundations
- Engineer and install pilings in accordance with site conditions and best engineering practices; there are many systems for designing and installing piles (see example of “end bearing pile” at right), a properly engineered pile foundation connects to the structure and transfers the structure's load to piles with solid shafts that transmit load down to a strong stratum at depth
- Review sources of relevant information, such as University of Alaska, Fairbanks, publication “Small House Construction in Muskegs and Bogs (http://www.uaf.edu/files/ces/publications-db/catalog/eeh/HCM-01556.pdf)

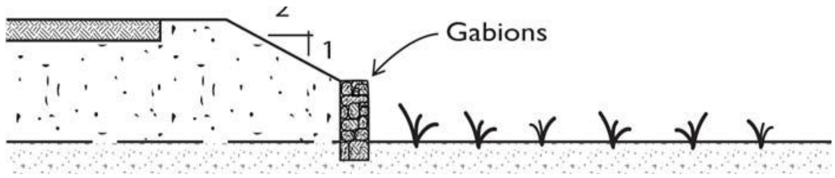


raised walkways

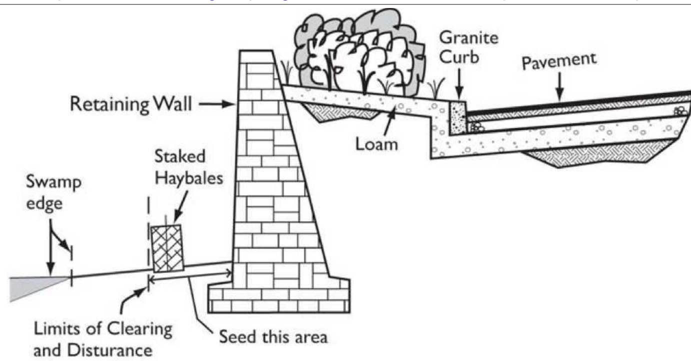
See light penetrating walkways

retaining walls

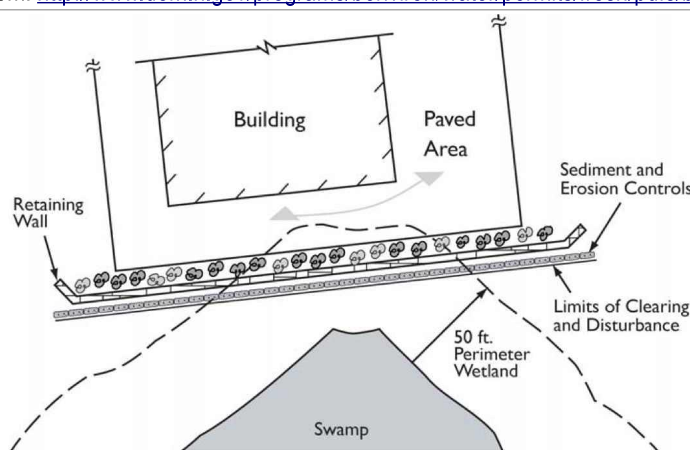
- Use retaining walls, crib walls, gabions, soil bioengineered cribs, or terracing at the *Limits of clearing and disturbance* to reduce cut and fill in wetlands (best practice is crib walls constructed with soil bioengineering techniques); walls can function in place of slopes, eliminating wetland alterations related to creating slopes; however, such walls may not be appropriate where installation will interfere with wildlife travel (examples below are from Rhode Island's *Wetland BMP Manual: Techniques for Avoidance and Minimization*, see: http://www.dem.ri.gov/programs/benviron/water/permits/fresh/wetbmp.htm)



Cross sectional view of gabion retaining wall; wetland is on right of gabions.
Image from: http://www.dem.ri.gov/programs/benviron/ water/permits/fresh/pdfs/bmpch7.pdf



Cross sectional view of retaining wall; wetland is on left of wall and staked hay bales.
Image from: http://www.dem.ri.gov/programs/benviron/water/permits/fresh/pdfs/bmpch4.pdf



Aerial view of retaining wall; wetland is shown below the wall:
http://www.dem.ri.gov/programs/benviron/water/permits/fresh/pdfs/bmpch4.pdf

seasonal restrictions

- As appropriate, impose start date and end date restrictions on activities to protect seasonal uses of wetlands by hunters, recreationists, subsistence users, and others
- As appropriate, impose start date and end date restrictions on activities to protect seasonal uses of wetlands by fish and wildlife species, such as bird use for breeding, nesting, and migratory stopovers; moose use for calving; salmon use of streams and wetlands for spawning, rearing, and overwintering, as well as for travel to different habitat areas; etc.

snow removal and storage

- Designate appropriate location(s) for snow storage where meltwater will not affect wetlands

soil bioengineering

- Review the ADF&G publication *Streambank Revegetation and Protection – A Guide for* Alaska (http://www.uaf.edu/files/ces/publications-db/catalog/eeh/HCM-01556.pdf) which illustrates and describes soil bioengineering techniques that can be used to stabilize streambanks and shorelines
- Determine whether the Partners for Fish and Wildlife program operated by the US Fish and Wildlife Service (http://www.fws.gov/alaska/fisheries/restoration/partners.htm) can provide technical or financial assistance for installing soil bioengineering practices
- Contact the Gilman River Center for guidance in selecting and installing soil bioengineering practices and to determine the availability of cost-share assistance and/or tax incentives to install these practices (e.g., http://www.kenairivercenter.org/river-center/restoration/487-cost-share, http://www.kenairivercenter.org/river-center/restoration/funding-for-restoration, http://www.kenairivercenter.org/river-center/restoration/488-tax-credit-tax-exemption).

stormwater runoff

- Stormwater runoff increases wherever clearing of vegetation and/or creation of impervious (impermeable) surfaces reduces infiltration, interception, and evapotranspiration of precipitation or snowmelt; increased runoff can cause increased flooding in areas that are adjacent to, downslope of, or downstream of areas with decreased infiltration
- Where land uses or activities will increase runoff, incorporate approaches to handle increased runoff volumes via mechanisms that "slow it, spread it, sink it," such as vegetated swales and filter strips, infiltration trenches and basins, retention ponds, raingardens, pervious pavement, green roofs
- Implement Limits of clearing and disturbance (LOCADS) to minimize areas where infiltration will be reduced
- Develop and implement appropriate Stormwater Pollution Prevention Plans (SWPPP) during development activities that will disturb 1 or more acres or are part of the planned disturbance of a larger common plan of development (see
- Implement Low Impact Development (LID) practices
- Maintain greenbelts and other elements of green infrastructure that can slow, spread, or sink (infiltrate) stormwater runoff
- Maximize infiltration and interception of precipitation by maintaining dense stands of vegetation that include trees, shrubs, and groundcover

streambank and shoreline stabilization

- Use soil bioengineering techniques to stabilize banks and shorelines subject to surface erosion, bank scour, or mass failure

subdivisions

- Configure lots to minimize wetland encroachments and filling
- Configure lots to maintain *Connectivity* and minimize alterations to *Drainageways and drainage patterns*
- Cluster developed areas and provide shared open spaces (open spaces can be owned in common by a homeowners association or protected with conservation easements)
- Use shared driveways to reduce impervious surfaces and wetland encroachment
- Avoid subdividing lots in ways that create wetland-related hardships for landowners trying to develop in the future
- Minimize clearing for roads, buildings, and utilities (see *Building size, Driveways and parking areas, Crossings, Utility crossings*)
- Limit and specify the amount of impervious surfaces allowed on each lot (see *Performance requirements and impact thresholds*)
- Do not exceed impact thresholds (see *Performance requirements and impact thresholds*)

[Similar Homer wetland strategy: limit fill to the minimum necessary for a residence and minimum driveway and parking]

timing

- To minimize disturbance to soils, drainage patterns, and streams, work should be conducted during periods of no- or low-flow or during winter when the ground is frozen
- To avoid illegal "taking" of migratory birds, all clearing and other site preparation activities should be performed prior to May 1 or after July 15
- If an active bird nest is encountered at any time, including before or after the local migratory bird timing window, leave the nest in place and protect it until the young hatch and depart

trees

- Protect large trees—especially mature spruce—and tree canopy so as to maximize interception during storms and maintain habitat quality

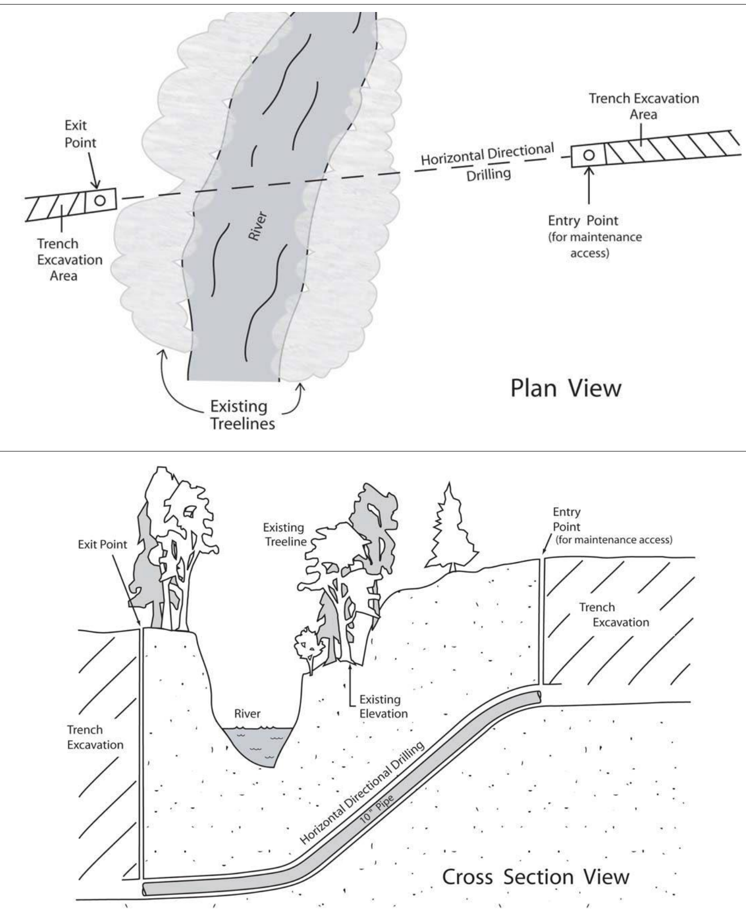
trenches

- Avoid trench excavations across anadromous and/or resident fish streams and in peatlands
- Do not construct or backfill trenches in such a manner as to drain wetlands (e.g., backfilling with extensive gravel layers, creating a French drain effect); use ditch plugs or other methods to prevent this situation
- To the maximum extent practicable backfill material shall consist of the excavated material and shall be returned to the hole in the same place on the vertical stratum from which it was excavated; as a contingency, use clean gravel or native cobbles for the upper 1-ft of trench backfill in all water bodies that contain fisheries

- Except for material placed as minor trench over-fill or surcharge necessary to offset subsidence or compaction, remove all excess materials to a non-wetland location
- The backfilled trench should achieve the original surface condition within a year of disturbance unless climatic conditions warrant additional time, as approved by the Corps
- Excavated material temporarily sidecast into wetlands should be underlain with geotextile, ice pads, or similar material, to allow for removal of the temporary material to the maximum extent practicable
- Revegetate trench as outlined in *Vegetation and revegetation*

utility crossings

- Consider directional drilling/boring under wetlands and fish-bearing streams
- Horizontal directional drilling pilot, entrance, and exit holes must be the minimum necessary, and where a stream crossing is involved, must be set back from the streambank at least 100 ft; excavated materials and drilling muds must be stockpiled on non-wetland areas, where available; under non-frozen conditions, fabric must be placed beneath all materials stockpiled in wetlands
- Use horizontal directional drilling to install utilities under wetlands
    - Horizontal directional drilling pilot, entrance, and exit holes should be the minimum size necessary, and where a stream crossing is involved, must be set back from the streambank by at least 100 feet
    - Excavated materials and drilling muds must be stockpiled on non-wetland areas, where available

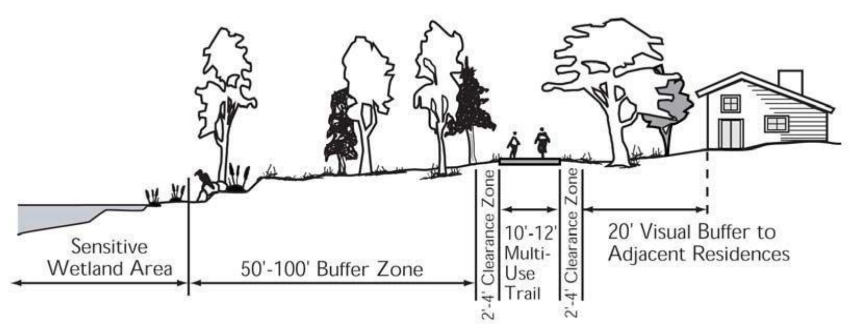


Images from :http://www.dem.ri.gov/programs/benviron/water/permits/fresh/pdfs/bmpch8.pdf.

vegetation and revegetation

- Protect existing vegetation and accumulated plant debris
- Minimize vegetation clearing,
- Remove cut vegetation from the wetland for disposal as needed to prevent soil compaction or other habitat alterations
- For seeding and planting, use plant species in the following order of preference:
    1) species native to the site,
    2) species native to the area,
    3) species native to the peninsula
- Clear vegetation in phases to minimize erosion and wildlife effects

- Stockpile separately all native vegetation and soils removed for the project and use this for site rehabilitation (if soil and/or organic materials are not available from the project site for rehabilitation, use other locally obtained and appropriately adapted native material
- Do not introduce invasive plant species; ensure that hay bales or other material used for temporary erosion control does not contain invasive weeds



From: http://www.dem.ri.gov/programs/benviron/water/permits/fresh/pdfs/bmpch6.pdf

- Stabilize disturbed areas immediately after construction to prevent erosion
- Begin revegetation of cleared and disturbed areas as soon as site conditions allow, preferably during the same growing season as the disturbance
- If plantings will not put on adequate growth before the end of the growing season, use erosion control methods such as geotextiles or straw mulch until cleared areas can be replanted; erosion control should remain remain in place until soil is permanently stabilized
- In peat wetlands, systematically remove the natural vegetative mat (with root masses intact) prior to construction, store it in a manner to retain plant viability (usually frozen or hydrated), then replace it after re-contouring the ground following construction; final contours should be within 1 ft of adjacent undisturbed soil surfaces after one growing season and one freeze/thaw cycle
- Ensure that revegetated areas are developing enough cover to sufficiently control erosion without other methods (such as silt fences, hay bales, or other mechanical means)
- For minor projects in peatlands, where no imported bedding or backfill material is used (such as "plowed in" cables or small utility lines installed with ditch-witches), simple restoration to pre-work contours and appropriate revegetation is generally sufficient
- Maximize interception (e.g., preserve as many large trees and their canopies as possible—especially spruce and other conifers)
- Maintain dense groundcover plantings
- Maximize vegetative layers to maximize interception (multiple layers of groundcover, shrubs, and trees)
- Use 2-3 rows of plantings instead of just one; if additional rows involve increased clearing or soil disturbance in wetland areas, a single row is preferable
- Restoration and revegetation of streambanks and shorelines should be based on most current soil bioengineering techniques and use of biodegradable materials (see, for example, Streambank Revegetation and Protection: A Guide for Alaska 2005); such techniques may include, but are not limited to, brush layering, brush mattressing, live siltation, and use of jute matting and coir logs to stabilize soil and re-establish native vegetation

water quality

- Prevent offsite flow of nonpoint source pollutants
- Avoid using fertilizers, pesticides, herbicides, or pollutants—chemical or organic—within wetlands or upslope of wetlands without an adequate buffer
- Minimize stormwater runoff
- Material used for construction or discharged in wetlands or waterbodies must be free from toxic pollutants in toxic amounts
- Wooden structures in contact with water should be treated with preservatives approved for use in aquatic and marine environments through the US EPA registration process
- Install wood preservative products in accordance with the “Best Management Practices for the Use of Treated Wood in Aquatic and Other Sensitive Environments” August 2006, or the most current version including amendments, published by the Western Wood Preservers Institute (WWPI) (www.wwpinstitute.org) including the standards set forth by the American Wood-Preservers Association (AWPA) (www.awpa.com), the Timber Piling Council (TPC) (www.timberpilingcouncil.org). and/or the American Lumber Standards Committee, as appropriate

wildlife protection (including fisheries)

- Perform work near or in wetlands outside the breeding and migratory seasons of sensitive wetland or waterbody species, including salmon and migratory birds
- Except where a permit has been received to impound water, avoid any activity that may substantially disrupt necessary life cycle movements of species of aquatic life indigenous to a wetland or waterbody, including species that normally migrate through it
- Avoid activities in spawning areas during spawning seasons; activities that result in the physical destruction of an important spawning area (e.g., through excavation, fill, or downstream smothering by substantial turbidity) are unlikely to be permitted
- To the maximum extent practicable, avoid activities in wetlands and waterbodies that serve as breeding areas for migratory birds
- Mitigate losses of moose habitat—for example, prioritize and, over time, purchase wetlands providing moose habitat
- When an activity includes construction and maintenance of intake structures, include adequate fish screening devices to prevent

the entrainment or capture of fish
- Keep potential bear attractants in secure storage containers and where necessary surrounded with 3-wire electric fencing to deter bears

wood preservative

- Preservatives for wooden structures should be applied by pressure treatment (do not use wood structures treated with creosote or pentachlorophenol)

[This area left blank to provide space for additional practices identified during review.]

Chapter 4 – Wetlands information on the borough's parcel viewer

Step-by-step instructions for locating and learning about peninsula wetlands using the online parcel viewer

This chapter provides step-by-step instructions for looking up Kenai Peninsula wetlands online. Anyone with internet access can locate and identify wetlands mapped on the Kenai Peninsula and access information about them. Wetland maps are available on the Kenai Peninsula Borough's (KPB) "interactive parcel viewer." These maps were developed at a scale of 1:24,000, so 1 inch on the map represents 24,000 inches (2000 ft) on the ground.

The borough's parcel viewer comes in two versions: Mapviewer and Flexviewer. Mapviewer is simpler and faster; Flexviewer is more powerful. Both are described below.

The parcel viewer links to three sites that provide additional information about mapped wetlands: (1) Homer Soil and Water's webpage, http://www.homerswcd.org/, (2) the Kenai wetlands site, http://www.kenaiwetlands.net/, and (3) the Cook Inlet wetlands site, http://cookinletwetlands.info/.

For example, the photos below are from the Kenai wetlands site. Click the link under a photo to see typical descriptions found at the Kenai website for each mapped wetland type.

A *segregated* relict glacial **Drainageway** wetland (DW21) near Salamatof Lake (wetland polygon #1941). This wetland is described at http://www.kenaiwetlands.net/MapUnitDescriptions/DW12.htm.

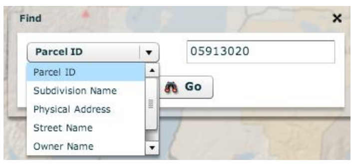
A relict glacial **Lakebed** wetland (LB64) along Beaver Creek (wetland polygon #32592). This wetland type is described at http://www.kenaiwetlands.net/mapunitdescriptions/LB46.htm.

Instructions for using the KPB Mapviewer to locate and identify wetlands

(See the following section for step-by-step instructions on finding additional wetlands information using the "Flexviewer" tool.)

1. Open the borough's interactive Mapviewer at http://mapserver.borough.kenai.ak.us/kpbmapviewer/ and click "Accept." The map will open.

2. There are two ways to go to a particular location from Mapviewer: the "Find" button and the "Zoom To" button, shown in the toolbar at right.



Click the "Find" button to open the dropdown menu shown at left. Use "Find" if you know the parcel ID, subdivision name, physical address, street name, owner name, or lake name for the parcel of interest. Click the "Zoom To" button to go to a more general area. For the map shown on the next page, we clicked the "Zoom To" button and then chose *Homer* from the dropdown menu that opened.

3. Turn on the wetlands layer by clicking the "Map Display" button and choosing *Wetlands* from the dropdown menu. Maps must be at a scale of 1:62,500 or larger for wetlands to be visible. If you need to, move the slider on the left of the screen upwards to enlarge the map scale.

4. Click on the hand below the slider. When the hand is active (highlighted in blue as shown in the screenshot on the next page), you can pan the map by left clicking and holding down the button while moving the cursor. Pan to position the map so wetlands of interest are visible.

5. When the map is positioned where you want it, click the "Identify" button at the top of the map screen to make it active (as shown in the screenshot on the next page).

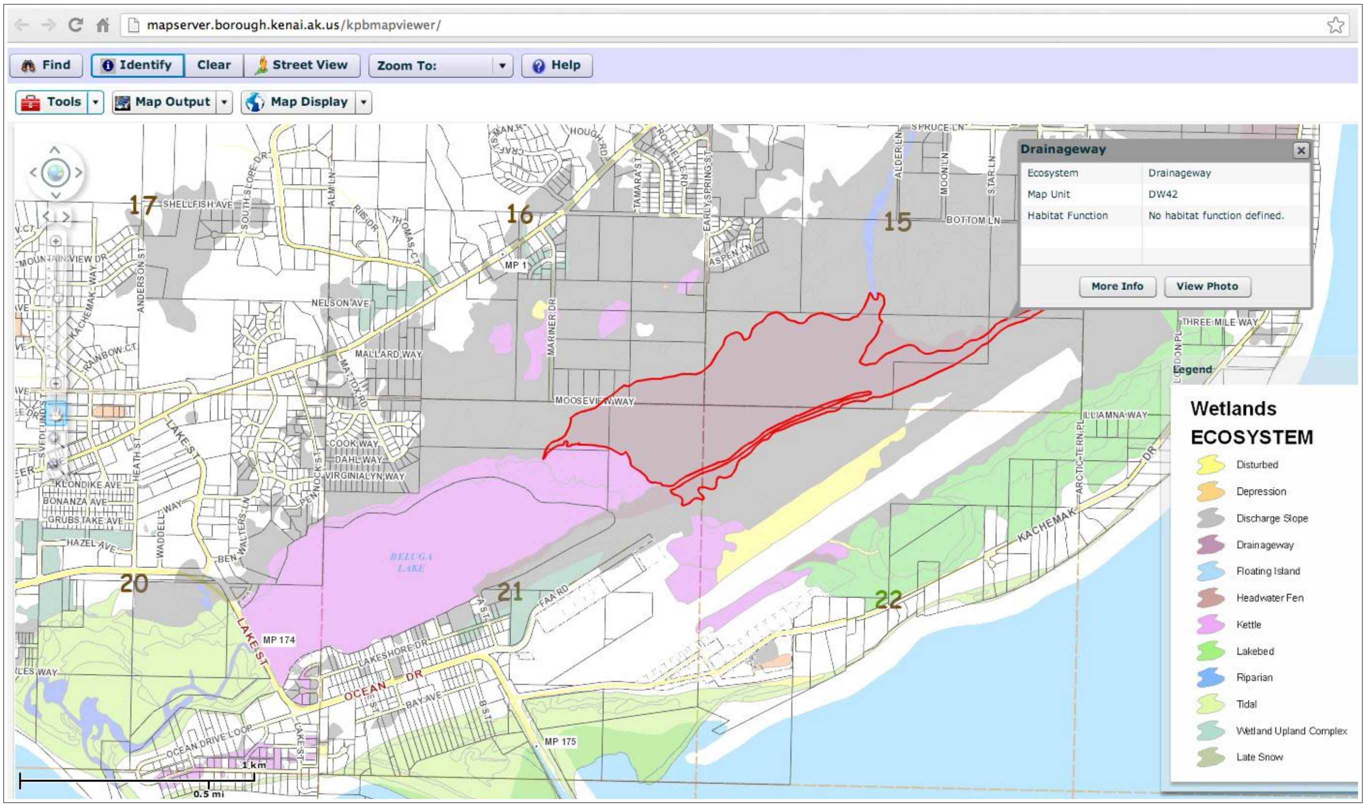
6. With the "Identify" button active, double click any wetland map unit (any colored area), it will be outlined in red—as shown in the screenshot on the next page—and the wetland's information box will appear, as is shown for a "Drainageway" wetland east of Beluga Lake in Homer.

7. If the "View Photo" button is active (not dimmed out) in the wetland's information box, click on it to see a photo of the outlined wetland. The "View Photo" button is shown as active in the screenshot below, clicking on it from the Mapviewer opened the photograph shown in the lower left corner below.

8. Click on the "More Info" button in the wetland information box to access a complete description of the wetland type represented by the map unit (in this case, the wetland map unit is DW42), including additional photos, map unit soils, associated plant communities, and more. (The "More Info" button in the screenshot below takes you to http://www.kenaiwetlands.net/mapunitdescriptions/DW24.htm.)

9. Click on "Function" in the wetland information box to open a list of 16 wetland functions and values. In the list, the functions/values that have active links are those that the wetland was assessed as providing. Click on an active function/value to go to its description and management strategies. The descriptions will be the same found in Chapter 2, the strategies will be those found in Map-unit level management strategies for maintaining wetland functions/values, in Chapter 3.

The screenshot below was accessed using the steps outlined above. It shows a Drainageway wetland map unit east of Beluga Lake in within the City of Homer.



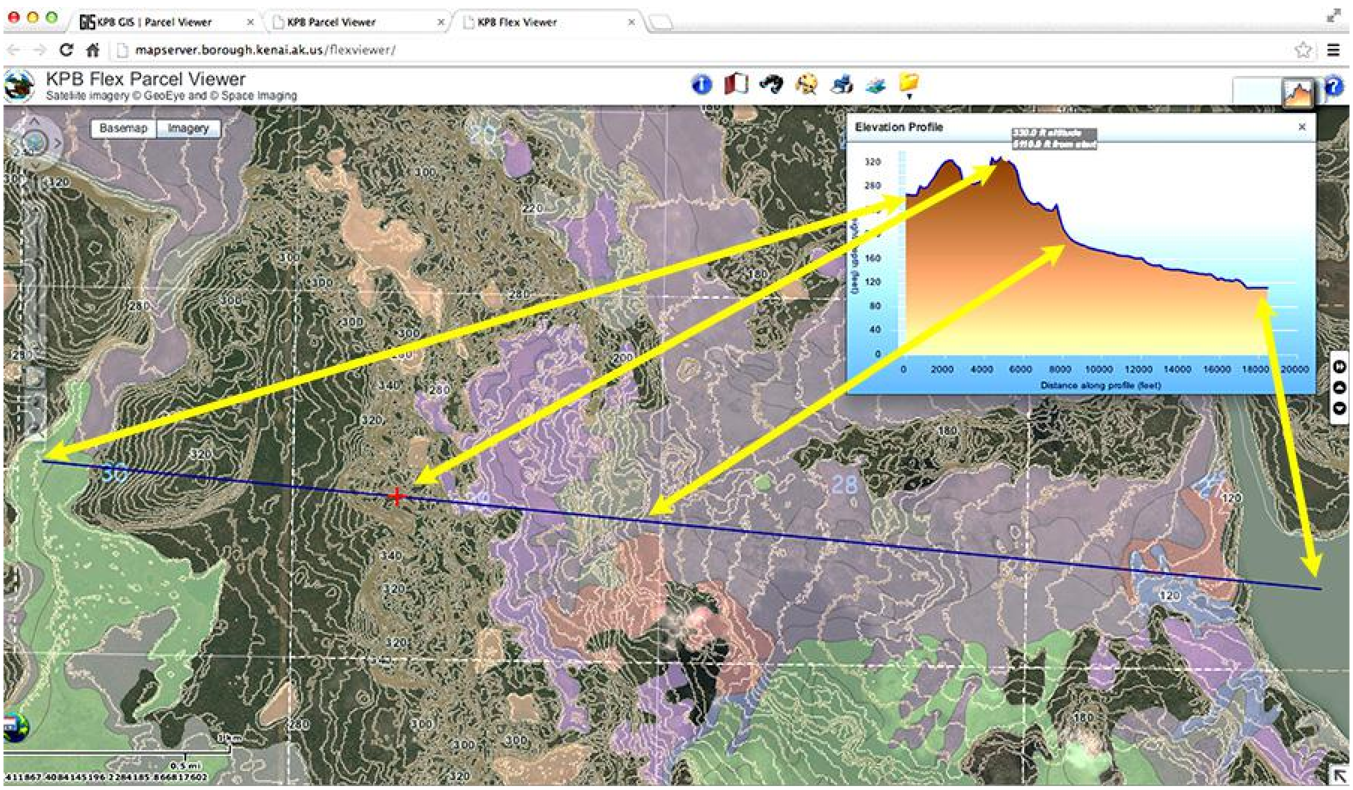
The photo at left was opened by clicking on the "View Photo" button in the information box open on the wetland map above. (The photo link that opened is http://www.kenaiwetlands.net/images/homer/373.jpg.)
This is a photo of the actual "Drainageway" wetland outlined in red on the map above.

An example map developed using tools available through the KPB's Flexviewer

The map below was developed using tools available through the borough's Flexviewer, which is found at http://mapserver.borough.kenai.ak.us/flexviewer/. Maps such as this can easily be developed by anyone with internet access. Step-by-step instructions for using some key Flexviewer tools are provided below. For a manual on Flexviewer tools, go to http://www2.borough.kenai.ak.us/GISDept/images/Help/PrintHelp.pdf.

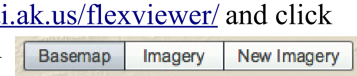
The map below shows wetlands in a topographic context. The beige lines show elevation contours in 4 ft increments. The elevation profile in the upper right corner of the map corresponds to the blue line that runs from Lakebed wetlands on the west (green polygons) to Tustumena Lake on the east. Yellow arrows show corresponding locations on the map and the elevation profile. Heights on the elevation profile are shown in feet, as are distances along the profile. (Note that vertical heights and horizontal distances are shown at different scales.) The surface of Tustumena Lake—the gray area at the right end of the line—is about 110 feet in elevation.

Besides Lakebed wetlands on its west end, the blue line crosses Kettle wetlands (brightest purple) lying in a trough east of the ridge marked with a **+**, Drainageway wetlands (gray purple) sloping east towards Tustumena Lake, and Riparian wetlands (blue) flowing into the lake. (The salmon-colored polygon lying north of the Riparian wetland is a Wetland/Upland complex.) Once you create an elevation profile like the one below, placing your cursor at any point along the top of that profile shows a **+** at the corresponding location on the blue line.



Instructions for using KPB Flexviewer tools (1) to determine which streams are in the borough's habitat protection district and (2) to look at wetlands in a topographic context

(Note: To protect salmon habitat, permits are required for certain activities within the habitat protection district, see Error: Reference source not found.)

1. Open the borough's interactive flexviewer at http://mapserver.borough.kenai.ak.us/flexviewer/ and click on "Agree." Once the map opens, you can choose a background layer from 

2. Click on the address book or binocular tools (shown second and third from left in the toolkit below) to go to a particular location. The binoculars work like the "Find" button discussed in Step 2 under Mapviewer above; the address book works like the "Zoom To" button. In the screenshot below, we clicked the address book and chose *Ninilchik* from the dropdown list that opened. We then zoomed in and panned the map to find the area of interest, as explained under Mapviewer.

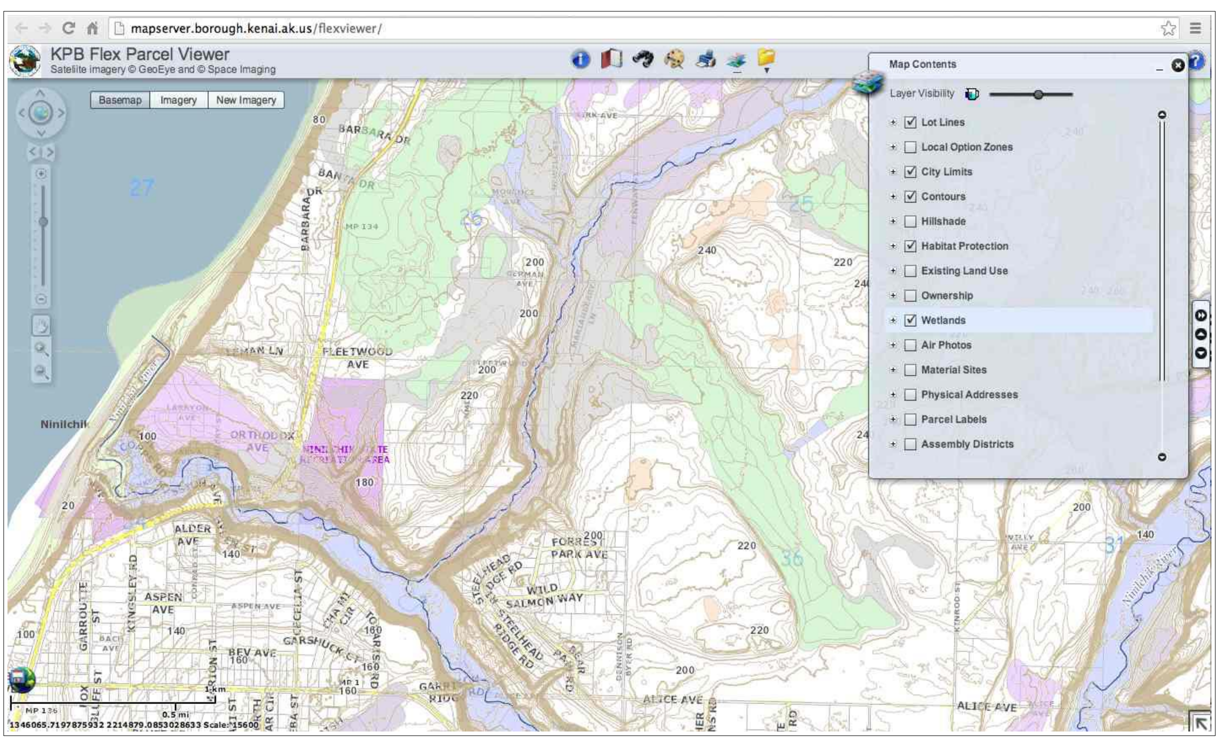
3. Click on the "Map Contents" button (second tool from right). When the Map Contents window opens—as shown in the screenshot below—check the box for each layer you want to see on your map. In the screenshot below, *Lot Lines*, *City Limits*, *Contours*, *Habitat Protection*, and *Wetlands* layers are checked in the Map Contents window. Note: Maps must be at scale of 1:15,600 or larger for contour lines to be visible. If you can't see contour lines, move the slider on the left of the screen upwards to increase map scale.

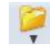
   The *Habitat Protection* layer is the layer that allows you to see which anadromous (salmon-bearing) waterbodies are subject to the borough's Anadromous Waters Habitat Protection Ordinance. (The ordinance in summarized in Table __.) On parcels within 50 ft of anadromous streams, rivers, and lakes, permits are needed for activities that could damage salmon habitats.

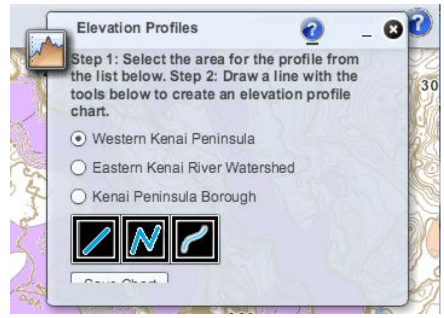
   When the *Habitat Protection* layer is open, a dark blue line marks the location of protected waters. In the screenshot below, you can see this blue line along the Ninilchik River and a tributary flowing in from the north. If you want to check whether a particular parcel is within 50 ft of this line, zoom in until you can see the detail you need.

   In the screenshot below, the Wetlands layer is shown highlighted in the Map Contents window. This opens the "Layer Visibility" slider for the Wetlands layer—as shown at the top of the Map Contents box. The Layer Visibility slider allows you to make the highlighted layer darker or lighter by moving the slider left or right.

4. When all desired layers are checked and visible, close or minimize the Map Contents window by clicking its close or minimize button.



5. Click the “Miscellaneous Tools” button—the yellow folder:  Then click on *Elevation Profiles* in the dropdown menu that appears. The Elevations Profiles window will open, as shown at right. Make sure the “Western Kenai Peninsula” radio button is selected.

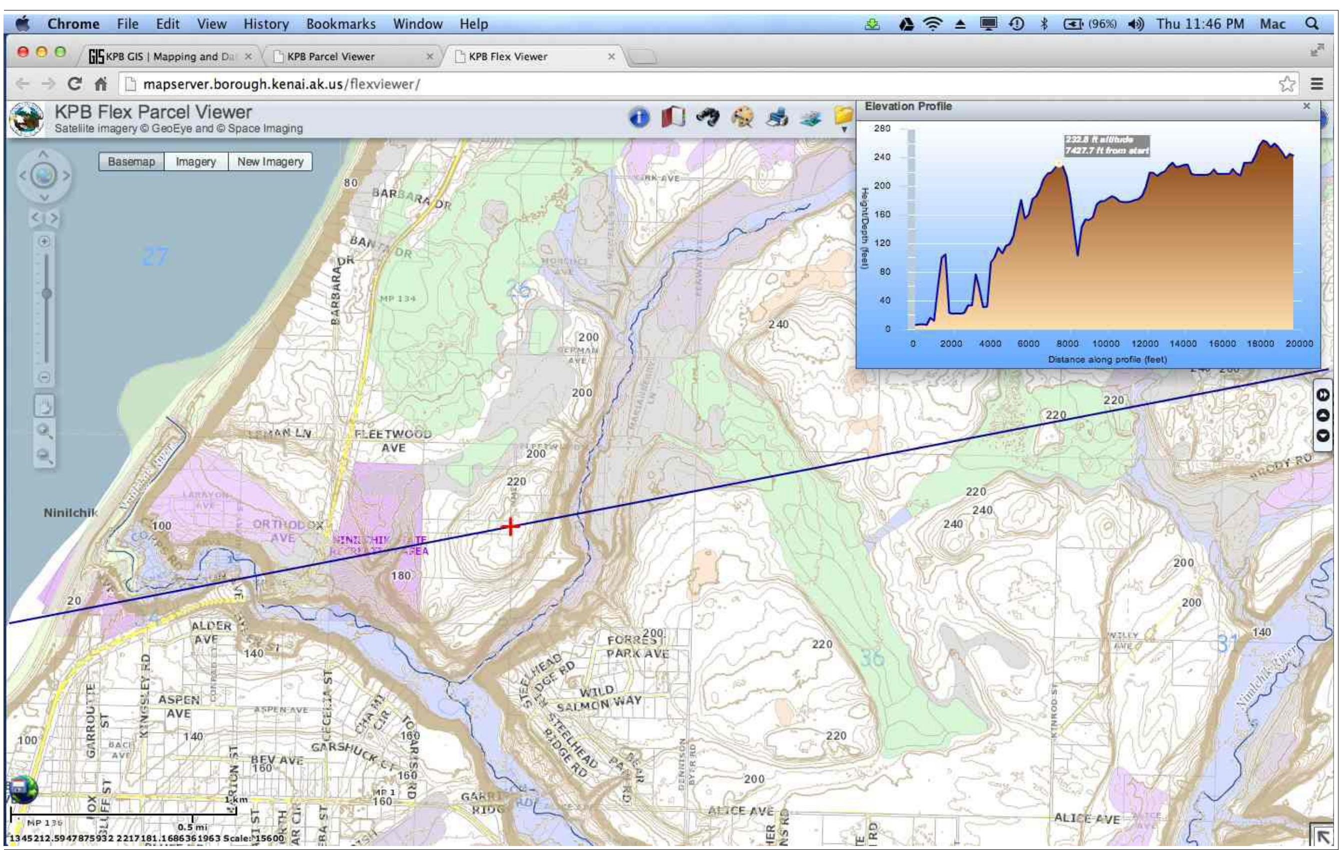


6. Decide whether you want to develop an elevation profile along a straight line, a zig-zag line, or a curvy line. Then click the appropriate button in the Elevation Profiles window. We clicked on the straight line choice, which is the bottom button on the left.

7. On the map, draw a line across the area whose elevation profile you want to see. Right click and hold down your mouse button to start the line and release the button where you want the line (and elevation profile) to end. Once your line is drawn, the elevation profile will be generated for the line you drew.

   You can see in the screenshot below that we drew a straight line roughly west to east from Cook Inlet to a point about 3.7 miles inland (about 19,500 ft from our starting point, as shown on the elevation profile). Note from the elevation profile how steep the bluff is along the coast and along either side of the Ninilchik River—which flows entrenched in a valley. (But remember that the vertical scale on the elevation profile is exaggerated as compared to the horizontal scale.) Steepness is indicated wherever the 4-ft contour lines are so close together that they merge to form a broad brown line. You can see that the highest elevation between the channel of the Ninilchik River and of its tributary is a knoll with an elevation of about 233 ft above sea level. The Ninilchik River channel has an elevation of about 22 ft.

8. By moving your cursor along the elevation profile, you will see a ✚ appear at the corresponding location on the line you drew. Both the elevation at that point and its distance from the start of your line will be shown on the elevation profile. In the screenshot below, you can see that the ✚ shown on the line is located at the top of the knoll mentioned in Step 7. This point is about 7,430 ft east of the line's starting point.



9. If you click the “Identify” button,  a window will open giving you the choice of identifying a feature on the map in terms of a point, polyline, rectangle, or polygon. For example, to identify a wetland, choose one of these options and then click in a wetland of interest. The wetland will be identified and links to the wetland's description and its photo (if available) will appear.

You will probably find that the wetland links in Flexviewer are not as quick and easy to use as the “More Info” and “View Photo” buttons accessed with Mapviewer. Also, unlike Mapviewer, Flexviewer does not provide a legend showing what kind of wetlands are represented by different map colors. However, Flexviewer's capacity to display multiple map layers at once—and especially contour lines—can be very useful. Flexviewer's ability to generate elevation profiles is a powerful tool. Profiles can be generated even if your map is zoomed out too far to see contour lines. In fact, the contour layer does not need to be checked to generate elevation profiles.

Chapter 5 – Links to wetland permit information

- Alaska Department of Fish and Game (ADF&G)
- Kenai Peninsula Borough (KPB)
- U.S. Army Corps of Engineers (COE)
- USDA Natural Resources Conservation Service (NRCS)

Below are brief descriptions of wetland-related permits required on the Kenai Peninsula. Illustrations help identify where different kinds of permit requirements apply. On the Kenai Peninsula, a good first step in determining whether you need a permit for activities that might affect wetlands or salmon streams (anadromous habitat) is to contact staff at the Gilman River Center in Soldotna. Both ADF&G and KPB have offices there to help you figure out which permits you need and how to apply for them. They can also give you direction if you need a wetland permit from the US Army Corps of Engineers.

When you fill out an application for a wetland permit, identify any actions that you plan to incorporate into your project to (1) avoid, (2) minimize, or (3) mitigate[5] any impacts to wetlands. Permitters will want to know what actions you plan to take to **avoid** or **minimize** reducing wetland functions/values, as well as any plans you have to **compensate** for functions/values likely to be lost.

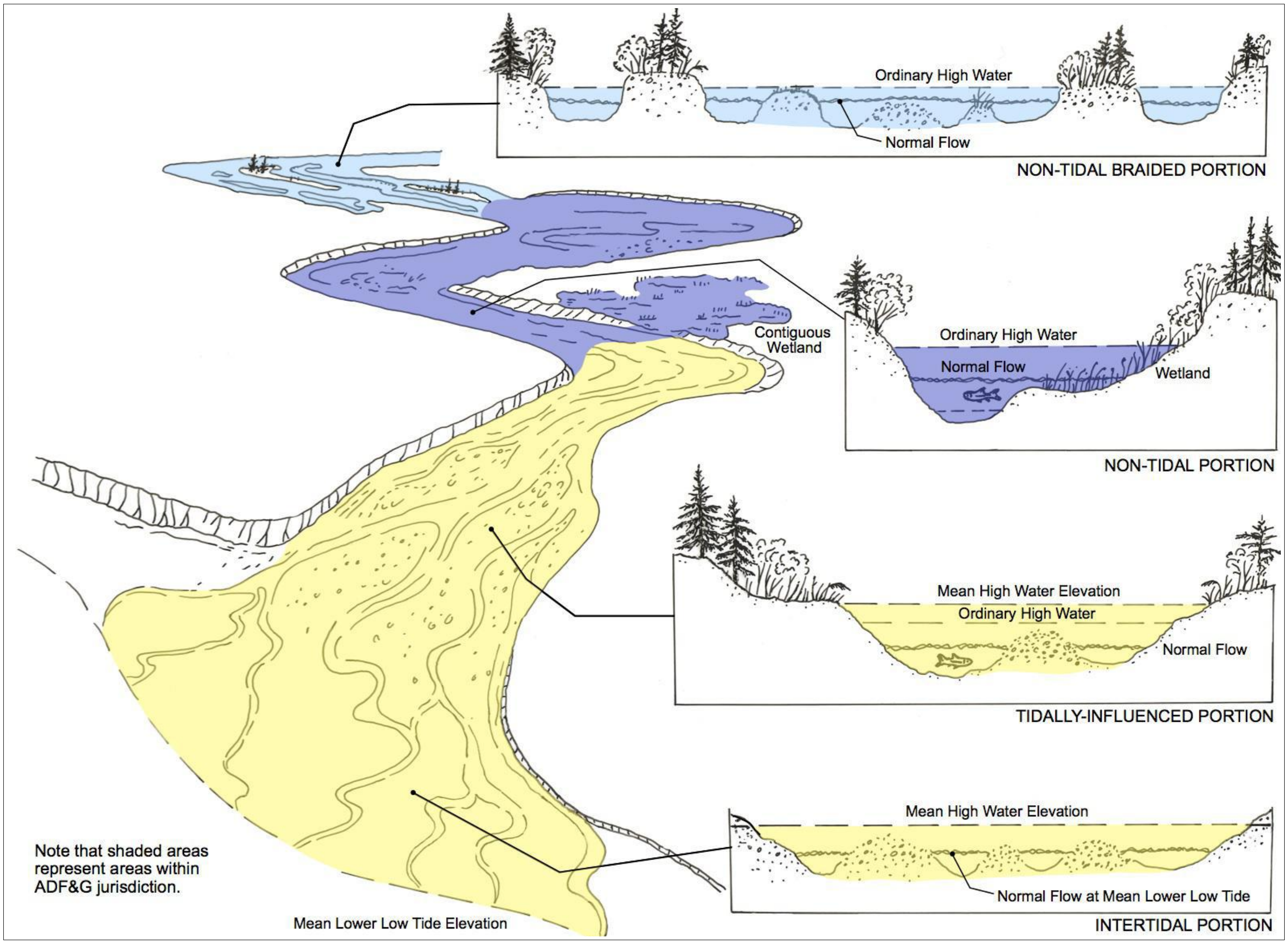
Chapter 4 explains how to identify which wetland functions/values might be affected by your project (see locating and learning about peninsula wetlands using the online parcel viewer). Chapter 2 describes functions and values assessed by Homer Soil and Water and why they matter. Chapter 3 outlines a variety of management strategies and practices you can apply to avoid and/or minimize impacts. You may also want to consider moving your project to a better suited location; Issues with locating developments in wetlands versus uplands explains why.

5 *Mitigation* is a sequential process of *avoidance*, *minimization*, and *compensation*. Compensatory mitigation is not considered until after all appropriate and practicable steps have been taken to first avoid and then minimize adverse impacts to the aquatic ecosystem. (From http://www.poa.usace.army.mil/Portals/34/docs/regulatory/applicantproposed_mitigationstatements.pdf.)

Alaska Department of Fish and Game (ADF&G)

"Title 16" or Habitat Permits are required for activities below ordinary high water of a fish stream (shown below) or in legislatively designated Special Areas, like the Anchor River–Fritz Creek Critical Habitat Area. Some common activities that require a Title 16 Habitat Permit are stream fords, bank stabilization, water withdrawal, floating dock construction, recreational mining, and culvert placement. Contact ADF&G at the Gilman River Center for more information: http://www.kenairivercenter.org/river-center/agencies/alaska-department-of-fish-game; 514 Funny River Road, Soldotna, AK 99669; (907) 260-4882.

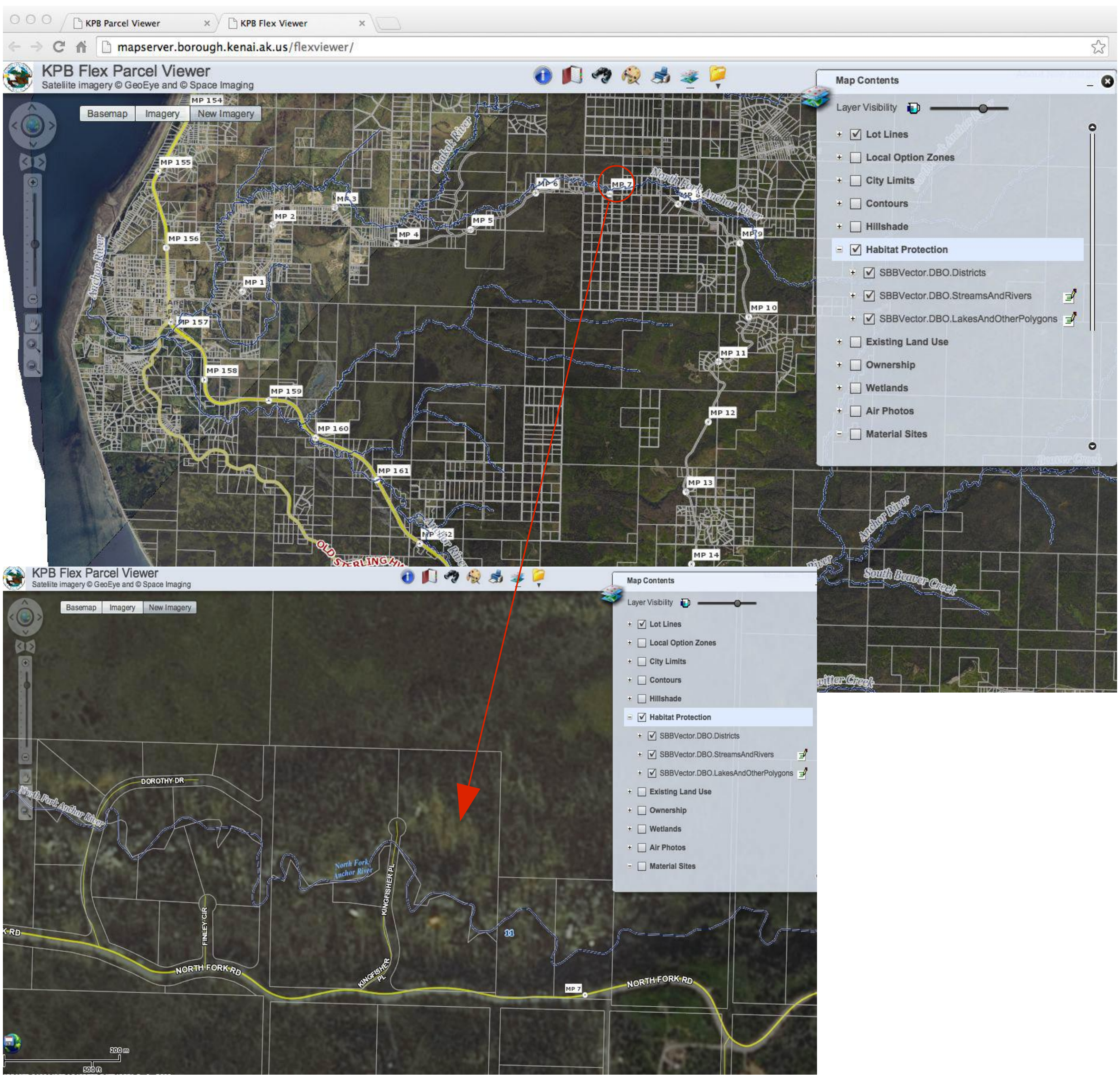
Areas below Ordinary High Water (OHW) in fish streams are subject to ADF&G jurisdiction and permits.
(Illustration from http://www.adfg.alaska.gov/static/license/uselicense/pdfs/ord_hi_wtr.pdf.)



Kenai Peninsula Borough – Habitat Protection Ordinance affecting anadromous streams

If your activity will be located within 50 feet of an anadromous (e.g., salmon-bearing) stream, or within a floodplain, you may need a permit from the Kenai Peninsula Borough. Instructions in Chapter 4 on using the borough's online Flexviewer explain how to identify whether or not your parcel is within the area covered by the borough's habitat protection ordinance. An example Flexviewer map showing stream channels from which to measure the 50-ft permit area is shown below. As shown below, if you check the “Habitat Protection” layer in the window that opens by clicking on the Map Contents icon, anadromous streams appear as blue lines. Zoom in for more detail as to which parcels may be subject to the ordinance. For more information about the ordinance, contact the Kenai Peninsula Borough at the Gilman River Center: http://www.kenairivercenter.org/river-center/agencies/kpb-habitat-protection; 514 Funny River Road, Soldotna, AK 99669; (907) 260-4882.

Flexviewer maps: Blue lines show anadromous streams subject to the Kenai Peninsula Borough's habitat protection ordinance; bottom map shows an enlarged view of an area near Milepost 7, North Fork Road, adjacent to North Fork Anchor River.



U.S. Army Corps of Engineers (ACE or COE)

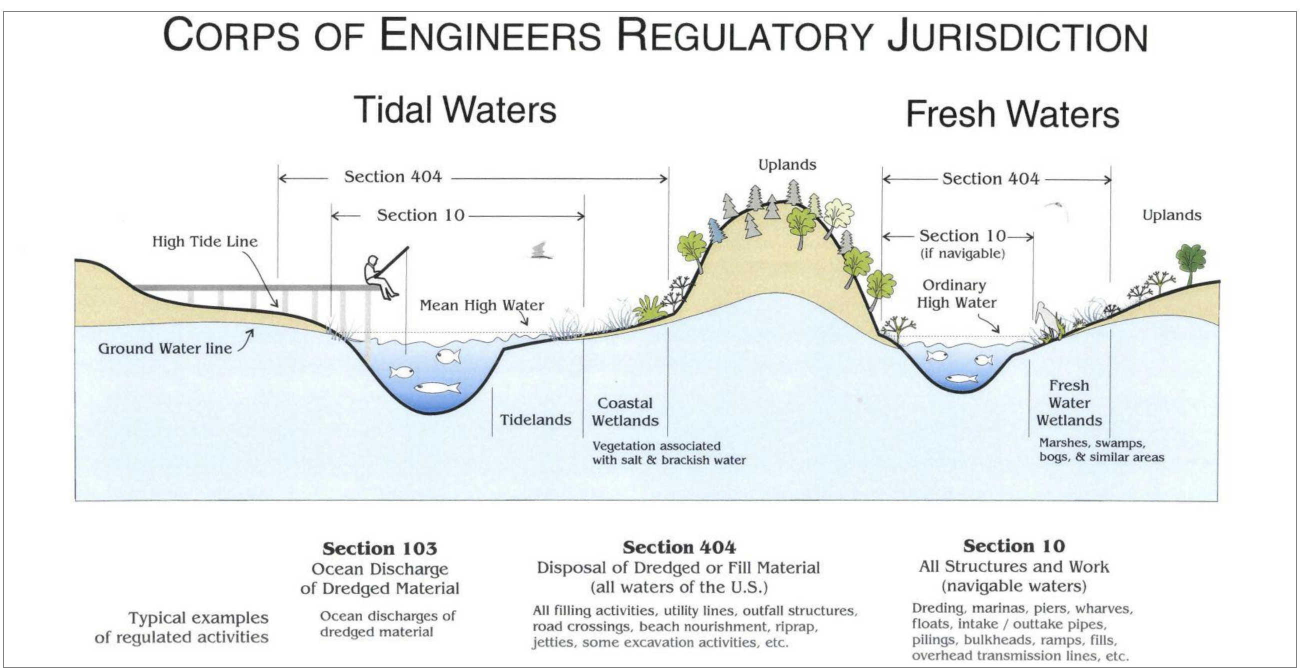
Building in a wetland usually involves discharging dredged or fill material into it (unless you build on pilings). Under Section 404 of the Clean Water Act, the Corps of Engineers regulates discharge of dredged material, fill material, or both into waters of the US, including jurisdictional wetlands. Small projects may fit under a nationwide permit (NWP), for a list of activities covered by NWPs see http://www.usace.army.mil/Missions/Civil Works/RegulatoryProgramandPermits/Nation widePermits.aspx. NWPs are processed faster than permits involving public notice. Your activity may also be covered by a "regional general permit." For more information, contact the US Army Corps of Engineers Kenai Regulatory Field Office, Benco Building, 805 Frontage Road, Suite 200C, KENAI, AK 99611-7755; 907-283-3562. To find out whether a particular wetland comes under Corps jurisdiction, you can request a jurisdictional determination (a request form is available http://www.poa.usace.army.mil/Portals/34/docs/regulatory/JD%20Request%20Form.pdf).

The Corps has prepared a very helpful 7-minute video providing step-by-step instructions for filling out a Corps permit application in Alaska, click on http://www.poa.usace.army.mil/Media/Videos.aspx to view the video.

A complete application for a Corps wetland permit will contain:

1. **a written application** – Download the 3-page application form at http://www.poa.usace.army.mil/Portals/34/docs/regulatory/engform_4345_2013july.pdf)
2. **a mitigation statement** – Download the 3-page "Applicant Proposed Mitigation Statements" at www.poa.usace.army.mil/Portals/34/docs/regulatory/applicantproposedmitigationstatements.pdf. In this statement, you describe how you will *avoid, minimize, or mitigate* (compensate for) the potential wetland impacts of your project; see for ways to avoid and minimize wetland impacts.
3. **a project/property location map –** You can use maps from the borough's parcel viewer for this and for #4, see locating and learning about peninsula wetlands using the online parcel viewer.
4. **project plan view (bird's eye view) –** You can draw your plan on aerial images from the borough's parcel viewer (see #3); or enter your address under Quick Navigation on Web Soil Survey (http://web soilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx), draw an Area of Interest (AOI) and click on Soil Map for a recent air photo showing soils. (Contact NRCS for help—see USDA NRCS below.)
5. **project cross-section view(s)** – Draw your project as seen from the side.

For more information on Corps wetland permits, visit http://www.poa.usace.army.mil/Missions/Regulatory.aspx. The graphic below shows areas subject to Corps permits (from http://www.nwp.usace.army.mil/Portals/24/docs/regulatory/jurisdiction/Regulatory-jurisdiction.pdf).



USDA Natural Resources Conservation Service (NRCS)

The Natural Resources Conservation Service (NRCS) is an agency within the US Department of Agriculture (USDA). The NRCS mission is “helping people help the land.” NRCS works through local landowners, managers, and other partners—such as Soil and Water Conservation Districts in Homer and Kenai—to assist them to conserve soil, water, and other natural resources—including wetlands. For example, NRCS conservation assistance programs help landowners identify and apply appropriate conservation practices and resource management systems to maintain the quality of their lands and waters. NRCS assistance is tailored to each land manager's goals and needs, and to the soil- and water-related resource conditions found on his/her land. Cost sharing and financial incentives are available in some cases.

Participation in NRCS programs is voluntary, and the agency is not regulatory. However, NRCS works to ensure that land managers receiving its assistance avoid any “swampbusting” activities—activities that convert wetlands to non-wetland uses. “Swampbuster” provisions first appeared in the 1985 Food Security Act, also known as the 1985 Farm Bill. The NRCS explains these provisions as follows (from http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/water/wetlands/?cid=stelprdb1043483):

> *The Wetland Conservation (WC) provisions, commonly referred to as “Swampbuster,” prohibit USDA program participants from converting wetlands on their agricultural operations to cropland, pasture, or hayland unless the wetland acres, functions, and values are compensated for through wetland mitigation... [See Section 1221, Public Law 99-198, Title XII – Conservation, Subtitle C – Wetland Conservation, program ineligibility.] The WC provisions are the only law that affords protection to many remaining wetland types. NRCS provides assistance to USDA program participants by identifying wetlands that are subject to the WC provisions and to respond to potential issues of non-compliance. If it is determined that a wetland has been converted, then NRCS works with the farmer or rancher to regain eligibility by developing a wetland restoration plan or compensatory mitigation plan.*

Over the years, Congress has exempted agricultural and silvicultural activities from swampbuster provisions if they meet specific conditions. For example, the NRCS can exempt agricultural actions that “individually and in connection with all other similar actions... will have a minimal effect on the functional hydrological and biological value of the wetlands in the area, including the value to waterfowl and wildlife.” (See Title 16 USC 3821(f) for a list of conditions that NRCS can consider in exempting agricultural producers from swampbuster ineligibility provisions.)

In February 2014, Congress enacted a new Farm Bill. The Agricultural Conservation Easement Program (ACEP) outlined in that bill provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. ACEP has two components, one for agricultural lands and one for wetlands. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect and enhance enrolled wetlands.

A number of peninsula landowners receive USDA technical assistance or cost sharing through peninsula offices of the NRCS. Many participants, for example, receive cost share funds to establish high tunnels and apply other conservation practices through the NRCS Environmental Quality Incentives Program (EQIP). The NRCS determines whether there are swampbuster issues before providing such assistance. The definition of wetlands used by the USDA is identical to that of the Corps and EPA except that, in Alaska, a provision has been added related to permafrost wetlands on lands with high agricultural potential (no such areas are found on the Kenai Peninsula).

The NRCS Alaska State website can be found at: http://www.nrcs.usda.gov/wps/portal/nrcs/site/ak/home/. Alaskan NRCS offices are listed at http://www.nrcs.usda.gov/wps/portal/nrcs/main/ak/contact/. There are two NRCS field offices on the Kenai Peninsula:

NRCS Southern Hub Office 110 Trading Bay, Suite 160 Kenai, AK 99611 (907) 283-8732	NRCS Homer Field Office 4014 Lake St., Suite 201 Homer, AK 99603 (907) 235-8177, ext 3

Appendix A – Map unit codes used during mapping of wetlands on the Kenai lowlands and in the Seward area

The following two tables list wetland map unit codes used in mapping and assessing wetlands on the Kenai lowlands and in the Seward area. Total mapped area was about 809,000 acres in the Kenai lowlands and about 24,600 acres in the Seward area.

Map unit codes used during wetlands mapping on the Kenai lowlands from http://cookinletwetlands.info/ and http://www.kenaiwetlands.net/.				
Wetland ecosystem types and codes	**Acres**	**% of wetland acres**	**no. of polygons**	**Map unit codes used (clicking on codes jumps to online descriptions and photos)**
D – Depression	11,205	3.2	2,081	D1, D12, D13, D1-3, D14, D1-4, D2, D21, D23, D24, D2-4, D3, D32, D34, D4D42, D43
DW – Relict Glacial Drainageway (DWR = Drainageway complex)	43,139	12.3	2,133	DW1, DW12, DW1-3, DW1-4, DW1-5, DW1-5A, DW2, DW21, DW23, DW24, DW2-4, DW25, DW2-5, DW25A, DW2-5A, DW3, DW31, DW32, DW34, DW35, DW3-5, DW35A, DW3-5A, DW4, DW42, DW43, DW45, DW45A, DW4-5A, DW5, DW5A, DW52, DW53, DW54, DW55A, DW5A2, DW5A3, DW5A4, DW5A5, DW3T6, DWR
FI – Floating Island	33	0.01	5	FI
H – Headwater Fen	2,684	0.8	265	H1, H13, H1-3, H2, H21, H23, H2-4, H3, H32, H34, H4, H43
K – Kettle	48,138	13.8	3,519	K1, K12, K13, K1-3, K1-4, K2, K21, K23, K24, K2-4, K3, K31, K32, K34, K42, K4, K43
LB – Relict Glacial Lakebed (LBSF = Lakebed complex, same as patterned fen)	82,910	23.7	2,853	LB1, LB12, LB1-3, LB14, LB1-4, LB1-5, LB2, LB21, LB23, LB24, LB2-4, LB25, LB2-5, LB26, LB2-6, LB3, LB31, LB32, LB34, LB36, LB3-6, LB4, LB41, LB42, LB43, LB45, LB46, LB4-6, LB5, LB54, LB56, LB6, LB62, LB63, LB64, LBSF
LSP – Late Snow	4,887	1.4	25	LSP
R – Riparian (Riverine)	51,376	14.7	1,813	AMT, RA, REI, REs, REb, REa, RB, RC, RDA, Rib, Rt
S – Discharge Slope	78,477	22.4	3,162	SA, SAC, SAG, SAL, SAM, SAS, SC, SCA, SCL, SCS, SG, SGA, SGM, SGS, SL, SLA, SLC, SLM, SLS, SM, SMA, SMG, SML, SMS, SS, SSA, SSC, SSL, SSM
T – Tidal Flat (not assessed)	7,189	2.1	305	
WU – wetland/upland complex	18,716	5.4	209	More than 25% of area is wetland, but individual wetlands are too fine to map individually at 1:24,000. Discharge slopes and Depressions probably account for most wetlands in these map units. If each WU is 50% wetlandt, this reduces total wetland area to about 340,683 acres or 38% of the project area.
DISTURB	1,287	0.4	130	130 wetlands mapped as DISTURB account for the 1,287 acres (0.4%) listed as OTHER, these are too disturbed by humans to be classified.
Totals	350,041	100.21	16,500	Wetland acres classified and mapped on the Kenai lowlands
Totals minus Tidal	342,842			Wetland acres assessed for functions/values on the Kenai lowlands

DW1 wetland in the center of a large relict glacial Drainageway in the Soldotna Creek watershed (polygon 346), http://www.kenaiwetlands.net/MapUnitDescriptions/DW1.htm.

LBSF wetland – peatland pool with emergent vegetation, tree island in the distance, in 1000-ha patterned fen near the Kenai Airport (polygon 8075), http://www.kenaiwetlands.net/MapUnitDescriptions/LBSF.htm.

Map unit codes used during wetlands mapping in the Seward area from http://cookinletwetlands.info/ and http://www.kenaiwetlands.net/SEWARD/Ecosystems/Intro.htm.				
Wetland ecosystem types and codes	**Acres**	**% of wetland acres**	**no. of polygons**	**Map unit codes used**
D – Depression	45	1.0	40	D1, D12, D1-3, D2, D21, D23, D3, D31, D32, D34, D4, D43
DW – Relict Glacial Drainageway	166	3.7	3	DW3, DW5A
H – Headwater Fen	110	2.4	41	H1, H1-3, H2, H23, H3, H42, H31, H32, H34, H4, H43
K – Kettle	751	16.6	130	K1, K2, K12, K13, K1-3, K1-4, K21, K23, K2-4, K3, K31, K32, K34, K4, K43
R – Riparian/Riverine (includes 466 acres of river terraces)	3,180	70.3	211	RB, RC, RD3C, RD4C, RD4SC, RD4T1, RD4T2, RD4F1, RD4F1c, RD4F12, RD4F1-3, RD4F1-4, RD4F2, RD4F2c, RD4F21, RD4F2-4, RD4F23, RD4F3, RD4F32, RD4F34, RD4F4, RD4F43
S – Discharge Slope	18	0.4	3	SPS, SA
T – Tidal Flat (not assessed)	266	5.9	26	T07, T65, T67, T76, T78, T87
WU – Wetland/Upland Complex	7	0.2	1	WU
Totals	4,543	100.5	455	Wetland acres classified and mapped in the Seward area
Totals minus Tidal	4,277			Wetland acres assessed for functions/values in the Seward area


The only **D31** wetland, a small season-variable pond surrounded on a bedrock knob north of Bear Lake, Seward area; http://www.kenaiwetlands.net/SEWARD/MUdescriptions/D1331.htm.


RD4F2 in wetland complex adjacent to Nash Road, Seward; http://www.kenaiwetlands.net/SEWARD/MUdescriptions/RD4F2.htm.


Alders cover this **RD4F3** floodplain wetland along Nash Road, Seward; http://www.kenaiwetlands.net/SEWARD/MUdescriptions/RD4F3.htm.


Mountain hemlock dominates **H4** foreground, with fewflower sedge (**H3**) in openings behind; http://www.kenaiwetlands.net/seward/MUdescriptions/H3443.htm.

Appendix B – Individuals and entities providing project input or participating in project meetings or work sessions

[To be added.]